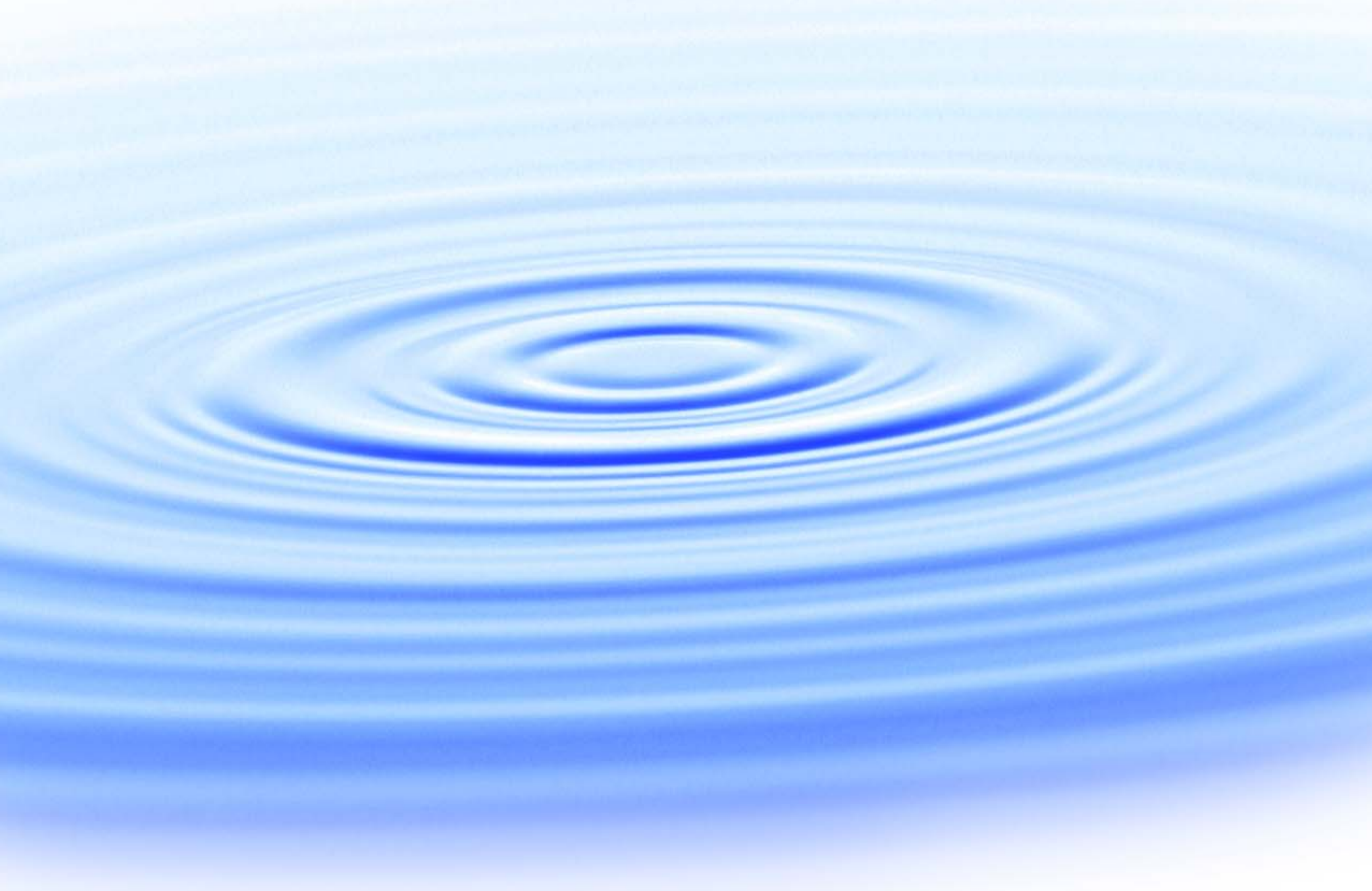
Framework for Informed Planning Decisions Regarding Indirect Potable Reuse and Dual Pipe Systems



WateReuse Research Foundation

Framework for Informed Planning Decisions Regarding Indirect Potable Reuse and Dual Pipe Systems

About the WateReuse Research Foundation

The mission of the WateReuse Research Foundation is to conduct and promote applied research on the reclamation, recycling, reuse, and desalination of water. The Foundation's research advances the science of water reuse and supports communities across the United States and abroad in their efforts to create new sources of high quality water for various uses through reclamation, recycling, reuse, and desalination while protecting public health and the environment.

The Foundation sponsors research on all aspects of water reuse, including emerging chemical contaminants, microbiological agents, treatment technologies, reduction of energy requirements, concentrate management and desalination, public perception and acceptance, economics, and marketing. The Foundation's research informs the public of the safety of reclaimed water and provides water professionals with the tools and knowledge to meet their commitment of providing a reliable, safe product for its intended use.

The Foundation's funding partners include the supporters of the California Direct Potable Reuse Initiative, Water Services Association of Australia, Pentair Foundation, and Bureau of Reclamation. Funding is also provided by the Foundation's Subscribers, water and wastewater agencies, and other interested organizations.

Framework for Informed Planning Decisions Regarding Indirect Potable Reuse and Dual Pipe Systems

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Disclaimer

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Acronyms

CPM	compromise programming method
DPR	direct potable reuse
EPWU	El Paso Water Utilities
GCDWR	Gwinnett County Department of Water Resources
GW	groundwater
IPR	indirect potable reuse
MCDA	multicriteria decision analysis
NPR	nonpotable reuse
NPV	net present value
O&M	operation and maintenance
OCWD	Orange County Water District
PAC	Project Advisory Committee
RAC	Research Advisory Committee
SW	surface water
TBL	triple bottom line
WAM	weighted average method
WRRF	WateReuse Research Foundation

Foreword

The WateReuse Research Foundation, a nonprofit corporation, sponsors research that advances the science of water reclamation, recycling, reuse, and desalination. The Foundation funds projects that meet the water reuse and desalination research needs of water and wastewater agencies and the public. The goal of the Foundation's research is to ensure that water reuse and desalination projects provide sustainable sources of high-quality water, protect public health, and improve the environment.

An Operating Plan guides the Foundation's research program. Under the plan, a research agenda of high-priority topics is maintained. The agenda is developed in cooperation with the water reuse and desalination communities including water professionals, academics, and Foundation subscribers. The Foundation's research focuses on a broad range of water reuse and desalination research topics including:

- Defining and addressing emerging contaminants, including chemicals and pathogens
- Determining effective and efficient treatment technologies to create 'fit for purpose' water
- Understanding public perceptions and increasing acceptance of water reuse
- Enhancing management practices related to direct and indirect potable reuse
- Managing concentrate resulting from desalination and potable reuse operations
- Demonstrating the feasibility and safety of direct potable reuse

The Operating Plan outlines the role of the Foundation's Research Advisory Committee (RAC), Project Advisory Committees (PACs), and Foundation staff. The RAC sets priorities, recommends projects for funding, and provides advice and recommendations on the Foundation's research agenda and other related efforts. PACs are convened for each project to provide technical review and oversight. The Foundation's RAC and PACs consist of experts in their fields and provide the Foundation with an independent review, which ensures the credibility of the Foundation's research results. The Foundation's Project Managers facilitate the efforts of the RAC and PACs and provide overall management of projects.

This project, titled *Framework for Informed Planning Decisions Regarding Potable Reuse and Dual Pipe Systems* (09-02), resulted in the development of a decision tool to facilitate informed, defensible decisions regarding capital investments to meet water demands at both a municipal and regional planning level. The tool is focused specifically on supporting water resource managers with decisions regarding implementation of nonpotable reuse (NPR) or indirect potable reuse (IPR) strategies.

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Global Water – Palo Verde Utilities Company, Arizona, United States
Gwinnett County Department of Water Resources, Georgia, United States
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Executive Summary

This project, titled *Framework for Informed Planning Decisions Regarding Potable Reuse and Dual Pipe Systems* (WRRF-09-02), resulted in the development of a decision tool to facilitate informed, defensible decisions regarding capital investments to meet water demands at both a municipal and regional planning level. The tool is focused specifically on supporting water resource managers with decisions regarding implementation of nonpotable reuse (NPR) or indirect potable reuse (IPR) strategies. Direct potable reuse, the one other form of reuse, had been implemented in only one location worldwide at the time this study was undertaken and was therefore not considered in this work but has seen increasing interest in the intervening months.

One of the primary reasons for developing the decision tool is that once the reclaimed water infrastructure has been constructed, and the reclaimed water is committed, *you cannot take it back*. This knowledge, in combination with the many political, social, environmental, and economic factors influencing a decision may inhibit water reuse managers from making timely decisions on the appropriate use of reuse water (and available funds). The decision tool is intended to minimize these issues by guiding the user through a step-by-step logical decision process, resulting in a ranking of water reuse alternatives.

The project consisted of two main phases. During the first phase, 14 utilities from the United States, Australia, and Spain that have either implemented IPR or considered doing so were surveyed by the project team to identify potential drivers for making decisions between IPR and NPR. The survey identified a number of common drivers for utilities to implement water reuse, including water scarcity, drought, water reliability, increased water demand, and the need for reduced wastewater discharge. However, the factors that led individual utilities to choose between IPR and NPR tended to be driven by project specific constraints and motivations. Utilities that chose not to implement IPR projects cited many different factors, including a lack of political will, regulatory restrictions, a lack of funding, and physical limitations, such as the lack of a suitable aquifer in which to store recycled water. Interestingly, among the utilities surveyed, public opposition to potable reuse did not appear to be an important factor in the decision-making process.

On the basis of the results of the survey, the project team then developed a decision support framework consisting of five steps:

1. Identify project goals and drivers
2. Perform a feasibility analysis
3. Identify and describe project alternatives
4. Identify, score, and weight decision criteria for the triple-bottom-line evaluation
5. Review and analyze results

Steps 1 and 2 asks users to think about what forms of reuse in general terms will meet their project needs and constraints. In Step 3, users are asked to define up to six different reuse project alternatives, choosing from preset lists of recycled water uses, methods, and system components. In Step 4 these alternatives subsequently undergo a multicriteria decision analysis (MCDA) process, also referred to as a triple-bottom-line (TBL) evaluation. The tool’s outputs provided in Step 5 are designed to provide summaries of the alternative evaluation process in both indepth and at-a-glance style formats that can be included in reports, presentations, and as stand-alone handouts for meetings and other decision-making forums.

Chapter 1

Introduction

1.1 Background

The WateReuse Research Foundation (WRRF), in cooperation with the Texas Water Development Board and 14 water utilities from the United States, Australia, and Spain, sponsored the development of a robust decision tool to assist water resource managers in making decisions about the use of available water supplies. This project, titled *Framework for Informed Planning Decisions Regarding Indirect Potable Reuse and Dual Pipe Systems* (09-02), resulted in the development of a decision tool to facilitate informed, defensible decisions regarding capital investments to meet water demands at both a municipal and regional planning level.

1.1.1 Nonpotable Reuse

Nonpotable reuse (NPR) is the planned use of reclaimed water for purposes other than to augment drinking water supplies, such as the following beneficial uses:

- Landscape irrigation
- Agricultural irrigation
- Residential landscaping
- Decorative fountains and other water features
- Industrial processing or cooling
- Toilet flushing
- Recreational impoundments
- Environmental enhancements
- Construction uses (e.g., dust control)

NPR projects utilize separate infrastructure from that of potable water, often referred to as a dual-pipe system. In Texas and Arizona, this system is defined as "direct reuse." In Australia, "dual-pipe system" has a slightly different meaning: it is a system associated with the delivery of drinking water and reclaimed water to residential homes. Yet another variation on the definition of NPR is used in California, where an NPR system utilizes separate piping for drinking water and reclaimed water within a facility that uses reclaimed water for plumbing within a building or for outdoor irrigation at residential homes or other areas served with potable water.

1.1.2 Indirect Potable Reuse

Indirect potable reuse (IPR) is the planned augmentation of a raw water supply with reclaimed water, routed through an environmental buffer. Environmental buffers typically include blending of the reclaimed water with the raw water (surface water or groundwater), natural attenuation that occurs as reclaimed water percolates through soil (for groundwater recharge), and time for attenuation of contaminants in surface waters or as reclaimed water is stored (underground or in surface reservoirs) prior to use. The augmented water supply typically goes through additional treatment in a conventional water treatment plant before being distributed to customers through the potable water distribution system.

Some examples of IPR projects are as follows:

- Groundwater recharge through surface spreading or direct injection
- Seawater intrusion barriers (where a portion of the injected water flows inland to domestic water supply wells)
- Underground storage for subsequent recovery and use
- Surface water augmentation (such as rivers, reservoirs, or lakes)

1.2 Project Objectives

The main objective of this project was to produce a tool that would facilitate informed, defensible decisions regarding capital investments to meet water demands at both a municipal and regional planning levels. This tool is directed specifically at water reuse managers deciding whether to implement nonpotable reuse strategies or indirect potable reuse strategies.

The major goals for this tool include

- Incorporating the findings of the utility survey into the tool, which are built into both the design of the tool itself, as well as into the support information (for example, into the user's manual) to assist users in their decision-making process
- Incorporating nonfinancial goals and criteria into the decision-making process
- Determining the highest and best use of the next increment of reclaimed water that becomes available
- Keeping the decision process transparent and therefore easily defensible
- Maximizing ease of use

1.3 Report Organization

The project scope consisted of two discrete parts: an extensive survey of utilities that currently implement water reuse, or are considering doing so, and an analysis of the survey results. These are summarized in Chapter 2. In addition, a more in-depth description of the survey approach, results, and analysis is presented in its own section of this report.

The second portion of the project consists of constructing the tool itself. The process of using the decision tool is described in Chapter 3. A user's manual, complete with screen shots and step-by-step instructions, has been provided as a separate document. Chapter 4 contains conclusions, and is followed by references.

Chapter 2

Utility Survey and Assessment

The first step in developing the decision tool was to create and disseminate a survey for the 14 participating agencies. These agencies either are actively implementing NPR or IPR or are studying, planning, designing, or constructing new or expanded reuse projects.

The approach, results, and conclusions from the survey were described previously in a stand-alone technical memorandum titled "Background Review/Case Studies." A copy of that memorandum is included in this report as Appendix A. What follows in this chapter is a summary of that report.

A list of the agencies participating in the survey is presented in Table 2.1.

Table 2.1. Participating Agencies

Agency[a]	**Location**
Barwon Region Water Corporation (Barwon Water)	Victoria, Australia
Consorci Costa Brava (Costa Brava), Spain	Spain
El Paso Water Utilities (EPWU)	Texas, United States
Global Water Palo Verde Utilities Company (PVUC)	Arizona, United States
Gwinnett County Department of Water Resources (GCDWR)	Georgia, United States
Marin Municipal Water District (MMWD)	California, United States
Orange County Water District (OCWD)	California, United States
San Francisco Public Utilities Commission (SFPUC)	California, United States
Yarra Valley Water (YVW)	Victoria, Australia
Agency 1 [a]	United States
Agency 2 [a]	United States
Agency 3 [a]	United States
Agency 4 [a]	United States
Agency 5 [a]	United States

[a] Five agencies, all located within the United States, requested anonymity; they are identified as Agencies 1 through 5 throughout this report.

2.1 Survey Design

The intent of the survey was to identify lessons learned and the factors these agencies addressed in their decisions regarding implementing NPR or IPR strategies. Upon review, it became clear that no two agencies are in identical situations; various factors including geography, economy, demographics, and political circumstances heavily influenced the decisions made. However, general trends and patterns in the decision-making process were revealed. This information was used to develop a list of questions and the hierarchy of decisions to be used in developing the decision tool. The following list presents the type of information obtained from the 14 survey participants:

- Current and planned water reuse programs
- Availability and reliability of water resources (including restrictions and limitations) and alternatives considered in lieu of using reclaimed water
- Role of wastewater management
- Institutional arrangements or obstacles between reclaimed water producers and suppliers
- Community leadership or opposition
- Unique circumstances impeding progress or implementation
- Project costs (capital, operating, periodic replacement, etc.)
- Avoided costs of alternative projects or adverse impacts
- Customer base (identification of reclaimed water customers and service needs)
- Financing options
- Environmental impacts or benefits
- Regulatory requirements/flexibility (existence or absence of requirements)
- Public acceptance or opposition
- Political issues
- Benefits of water reuse for users
- Service goals and objectives for water reuse programs
- Internal organization and business integration
- Energy/carbon footprint
- Legal issues (such as water rights, liability, public access, etc.)
- Technical considerations (such as storage, infrastructure, or other requirements)
- Specific assessments of social, economic, and environmental objectives (e.g., triple – bottom-line assessments)

2.2 Survey Results

All but one of the participants are engaged actively in operation of NPR or IPR projects, with many of these agencies currently contemplating project expansions or modifications. One agency is still in the planning, design, and construction stage. A summary of each agency's water reuse status as of September 2011 is shown in Table 2.2.

Table 2.2. Summary of Water Reuse Activities

Agency	Water Reuse Status		Program Modifications Planned
	NPR	IPR	
Barwon Water	Y	R (ASR)	Y – treatment upgrade to improve water quality to expand NPR options; IPR if deemed feasible and implemented
Costa Brava	Y	N	Y – goal to improve water quality to expand NPR options
EPWU	Y	Y (GWR)	Information not provided on modifications; a triple-bottom-line (TBL) study is underway
PVUC	Y	N	ND
GCDWR	Y	Y (SWA)	N
MMWD	Y	N	N
OCWD	Y	Y (GWR)	Y – Construction for GWR expansion to begin in 2011
SFPUC	P, D, C	N	N/A
YVW	Y	N	A 50-year water supply strategy has been developed
Agency 1	Y	P (GWR and SWA)	Y - Expanding NPR and considering IPR
Agency 2	Y	P & Dm (SWA)	Y – IPR if deemed feasible
Agency 3	Y	P (GWR)	Y – NPR expansion and IPR if deemed practicable
Agency 4	Y	P (GWR)	Y – NPR expansion and IPR if deemed practicable
Agency 5	Y	P (ASR and GWR)	Y – NPR and considering IPR if feasible

Notes: Watereuse type abbreviations: Nonpotable reuse (NPR); indirect potable reuse (IPR); aquifer storage and recovery (ASR); groundwater recharge by surface spreading or injection (GWR); surface water augmentation (SWA).

Status abbreviations: Y – yes (ongoing); N – no; R – research stage; P – planning stage, including feasibility studies; D – design stage; C – construction stage, Dm – demonstration stage, ND – not determined, N/A – not available.

2.3 Case Study Assessment

On the basis of review of the 14 case studies, seven common themes emerged:

- Drivers for water reuse
- Planning approaches for implementing water reuse
- Constraints regarding implementation of IPR
- Project costs
- Economic benefits of water reuse
- Environmental benefits of water reuse
- Social, political, and legal issues related to water reuse programs

2.3.1 Drivers for Water Reuse

Survey results indicate that water scarcity, drought, water reliability, increased water demand, and the need for reduced wastewater discharge were key factors for the participating agencies in deciding to develop a water reuse program. Agencies generally needed to have at least one of these factors as a driver to be interested in water reuse. However, although important, these drivers were not sufficient to require a decision for implementing NPR versus IPR.

2.3.2 Planning Approaches

Regardless of whether an agency was developing a short-term or long-term planning strategy (or any defined planning strategy at all), the basic philosophy was the same: consider existing treatment capabilities, the availability and proximity of water reuse customers, and overall cost. Whereas more robust planning strategies can reveal deeper insights into the objectives, costs, and benefits of the water reuse strategies, it is not the only mechanism for determining whether NPR or IPR (or a combination of the two) is the most appropriate for a particular utility.

2.3.3 IPR Constraints

Of the 14 participating agencies, three are actively operating IPR projects using reclaimed water that has received advanced treatment: (1) El Paso Water Utilities (EPWU), (2) Gwinnett County Department of Water Resources (GCDWR), and (3) Orange County Water District (OCWD). Some interesting points about these projects are presented as follows:

- EPWU: IPR is implemented as groundwater recharge. The IPR projects were implemented in the absence of state IPR regulations. Permit requirements were negotiated with state regulators.
- GCDWR: IPR is implemented as surface water augmentation. IPR was implemented on the basis of the need to return reclaimed water to the basin of origin, which includes a drinking water reservoir being augmented with reclaimed water. This decision was compelled by state regulators in establishing wastewater discharge limits that precluded other wastewater management options.
- OCWD: IPR is implemented as groundwater recharge. OCWD implemented IPR using regulations that allow for project approval on a case-by-case basis and draft groundwater recharge regulations that were used as guidance.

Of the remaining 11 agencies, five are considering IPR and six are not considering IPR owing to a variety of factors, including timing, funding, political feasibility and others. For the agencies that have not implemented IPR, there are a number of key factors influencing the decision, including

- Lack of political will
- A corporate/agency philosophy that is opposed to potable water reuse
- Regulatory restrictions, particularly the lack of regulations or the prohibition of IPR under current regulations
- Lack of funding
- The time to implement (IPR projects are typically complex to permit)

- Physical limitations, such as lack of appropriate hydrogeology for a recharge project to be implemented or limitations in reservoir configurations that conflict with regulatory requirements, including retention time, travel distance, and blending water requirements

For the agencies evaluated as part of this effort, public opposition did not appear to be a current determinant. However, public opposition often can be a major obstacle in implementing water reuse projects. The agencies in the study did not include agencies that were not successful in implementing water reuse because of public opposition.

2.3.4 Project Costs

In some instances, project costs rendered a specific project for NPR or IPR infeasible. In cases where project costs were not a limitation to feasibility, nevertheless they were not an insightful factor in the decision making process of implementing NPR or IPR strategies. The specifics of any given agency's financial scenarios, including the impacts of grants, loans, or subsidies, are particular to that entity alone. As a result, no broad categorization can be made regarding the impact of costs on the decision to pursue NPR, IPR, or a combination of the two strategies.

2.3.5 Economic and Environmental Benefits

Both economic and environmental benefits were identified by the 14 participating agencies as important factors in support of water reclamation. However, these factors alone were not indicative of the choice made between NPR and IPR strategies. The primary economic benefits realized by the participants were in the form of avoided costs for use of traditional water supplies and avoided costs for wastewater system upgrades. The primary environmental benefits included ecosystem enhancement, groundwater protection, reduced marine water discharge, and potential energy savings when compared to nonreuse alternatives. Two specific environmental factors may have some bearing on decision-making, however, and as a result are included in the decision tool:

- Water reuse reduces or eliminates the discharge of pollutants (nitrogen, phosphorus, microbial content, etc.) to surface waters.
- Water reuse helps meet wastewater discharge limitations or discharge prohibitions to surface water.
- Water reuse can diminish the extent of habitat destruction in environments that depend on highly saline conditions. Salt marshes in the southern parts of San Francisco Bay are a case in point. In this case, the fresh (low-salt) character of wastewater effluent is the undesirable character of the discharge.

2.3.6 Social, Political, and Legal Issues

The agencies had various experiences concerning public opposition, public outreach, political support, legal issues, and institutional issues. Each of these factors must be addressed on an individual basis, and the decision tool has been developed to facilitate the qualification and quantification of these issues for the user.

2.3.7 Assessment Summary

Several lessons learned were identified from the case study review:

- The use of reclaimed water (both NPR and IPR) provides enhanced flexibility for water resource management.
- Long-term water scarcity, short-term drought impacts, and wastewater management considerations were the primary drivers for implementing water reuse, although they do not distinguish between the use of NPR or IPR.
- Historically, political issues have impeded or prevented IPR projects, but politics were not a hindrance for the 14 agencies participating in this effort.
- IPR and NPR strategies are not mutually exclusive, and many of the agencies surveyed are using elements of both approaches.

Constraints specific to the individual entity are the driving force in selecting between NPR and IPR, and typically include cost, regulatory issues, and water quality impacts. In some cases, water rights were an obstacle in pursuing IPR strategies.

Public opinion was not identified by the participating agencies as an obstacle to IPR, even though historically this issue has been a major challenge. Participating agencies have been successful in part because of a lack of opposition to water reuse, whereas agencies that have been unsuccessful because of public opposition have not had successes to showcase for participation in this project.

It was surprising that cost was not an identifying factor in the selection of NPR or IPR strategies, although it is an important criterion by which any project is judged. In many cases, IPR may be the lower cost alternative, because it allows use of reclaimed water throughout the year (rather than during irrigation season only), the cost advantage of using the groundwater basin as a storage reservoir, or because the potable water infrastructure is built already. However, NPR often is viewed as the most cost-effective option. Therefore, the decision tool was designed to be flexible enough to address the particularities of any given entity yet provide a structured framework to facilitate defensible decisions.

Chapter 3

Decision Tool

One of the primary reasons for developing the decision tool is that once the reclaimed water infrastructure has been constructed and the reuse water is committed, *you cannot take it back*. This knowledge, in combination with the many political, social, environmental, and economic factors influencing a decision, may inhibit water reuse managers from making timely decisions on the appropriate use of reuse water (and available funds). The decision tool is intended to minimize these issues by guiding the user through a step-by-step logical decision process, resulting in a ranking of water reuse alternatives.

This chapter describes the main elements of the decision tool, including the background behind some of the design decisions. However, it is not intended to serve as a user's manual for the tool. A separate user's manual describes the particulars of using the tool, as well as the tool construction, and comes complete with screen shots and step-by-step instructions. This has been provided as Appendix B.

3.1 Basic Tool Layout

There are five main steps included in the decision tool:

Step 1: Identify project goals and drivers

Step 2: Perform a feasibility analysis

Step 3: Identify and describe project alternatives

Step 4: Perform multicriteria decision analysis

Step 5: Review and analyze results

3.1.1 User Preparation Steps

The first two steps (identifying project goals and the feasibility analysis) serve to prepare users for the definition of the desired project alternatives (Step 3) by asking them to think about their situation with a "wide-angle lens."

Although these preliminary steps do not have any functional connection to the remaining steps in the tool (i.e., a user's selections in these steps do not affect their available choices downstream), the steps equip users with a structure through which to better understand their own goals and motivations and what the realm of the possible may be in their situation. Along with many of the preset options and default parameters used in subsequent steps, these first two steps also serve to distinguish this tool from the more generic decision support tools available on the market today.

3.1.2 Alternative Definition

In the third step, users are asked to define up to six different water reuse project alternatives, choosing from preset lists of reclaimed water uses, methods, and system components.

3.1.3 Multicriteria Decision Analysis Process

The alternatives defined by the user in Step 3 subsequently undergo a multicriteria decision analysis (MCDA) process, also referred to as a triple-bottom-line (TBL) approach. First, users define, score, and weight decision criteria, and then one of two available MCDA algorithms chosen by the user ranks the alternatives in order of preference.

3.1.4 Tool Output

The tool's outputs are designed to provide summaries of the alternative evaluation process in both indepth and at-a-glance type formats that can be included in reports, presentations, or stand-alone handouts for meetings and other decision-making forums.

3.2 Home Page and Initial Setup Information

After starting up the tool, users first view the Home page, which shows a basic layout of the main steps in the tool. Although the five steps are not laid out exactly as listed, the Home page provides the same overview (see Figure 3.1):

- Preliminary: Project setup
- Step 1: Project drivers
- Step 2: Feasibility analysis
- Step 3: Alternative elements and development of alternatives
- Step 4: Triple bottom line (TBL)
- Step 5: Tool outputs (reports)

Figure 3.1. Tool flow as shown on the Home Page.

From the Start page, users can navigate to any step in the tool by clicking on the corresponding button.

The subsequent Project Setup page serves to collect basic project information, such as the name of the organization, project name, projected total water demands and cost calculation parameters (such as project life, interest rate, and discount rate). This information is displayed on each of the output reports from the tool.

3.3 Step 1: Identify Project Goals and Drivers

The analysis of the utility survey results discussed in Chapter 2 concluded that the most common drivers for water reuse did not provide reasons to choose IPR over NPR or vice versa. In general, the survey found that the reasons for choosing to implement one form of water reuse over another were case-specific.

Consequently, the first conceptual step of this tool asks users to consider what their project goals and drivers are for implementing water reuse to help them understand their goals and motivations in the context of making a decision between the two general use categories (i.e., IPR and NPR).

Step 1 is completed in on the Project Drivers page, which contains information on drivers that are common to IPR and NPR, as well as drivers that may favor one over the other. Users are asked to read the following information and select which of the goals and drivers apply to them:

Drivers Common to both IPR and NPR

- Potential to offset increased water demands through beneficial use of reclaimed water
- Provision of additional water supplies to serve future customers
- Improvement of water supply reliability
- Provision of a disposal mechanism for wastewater effluent

Potential Drivers for Choosing NPR over IPR

- A specific opportunity to implement nonpotable reuse
- Determination that the water reuse project is time-critical and IPR will take longer to implement than NPR
- General political pressure to implement NPR
- Existing NPR infrastructure provides cost, logistical, or other advantage
- Cost of NPR lower than cost of IPR alternative
- Water rights situation making IPR difficult or too political
- Permitting process for NPR more straightforward than IPR

Potential Drivers for Choosing IPR over NPR

- A specific opportunity to implement IPR
- Determination that the water reuse project is time-critical and NPR will take longer to implement than IPR
- Political pressure to implement IPR
- Existing IPR infrastructure provides cost, logistical or other advantage
- Cost of IPR lower than cost of NPR alternative
- Large-volume seasonal storage needed for IPR to match reclaimed water supply with demand
- Creation of wetlands a priority
- A need for a saltwater intrusion barrier for a coastal drinking water aquifer
- In-stream flow requirements to restrict current drinking water withdrawals
- Permitting process for IPR more straightforward than NPR
- Need to manage/stabilize an aquifer that has been subject to excessive pumping
- Need to manage contaminated plumes in an aquifer
- Concerns with salinity levels of an NPR supply

3.4 Step 2: Feasibility Analysis

Once users have considered the goals and drivers, the second user preparation step involves a feasibility analysis for their particular project. The tool begins with the assumption that both NPR and IPR are feasible, and the "realm of the possible" for users' projects are determined by process of elimination.

The user is led through a series of yes/no questions that evaluate potential legal, physical, political, and water quality hurdles to the implementation of the types of water reuse. Some of the questions relevant to the reclaimed water feasibility analysis are presented as follows:

Legal Issues

- Is IPR legal? If not, are you willing to support changing the law?
- Are groundwater (GW) or surface water (SW) IPR impractical despite being technically legal?
- Will groundwater rights remain with the entity recharging the water?
- Does the reclaimed water need to remain within the watershed?

Physical Constraints

- Will the aquifer accept recharge? Does the aquifer have storage capacity?
- Is a SW body available for discharge?

Political Issues

- Is there political support for IPR?
- Is public perception an impediment to IPR? If so, can public perception be changed?

Water Quality Considerations

- What water quality improvements, if any, are required to provide reclaimed water for GW IPR or SW IPR or NPR?
- Are you willing and able to implement that additional treatment?

The overall logic behind the questions, as well as the precise wording used in the tool, is shown in the Feasibility Analysis Flow Chart presented in Figure 3.2. As shown on the flow chart, users are asked a series of yes/no questions, the answers to which determine the subsequent questions asked by the tool.

As users navigate from one question to the next, they sometimes traverse other boxes, labeled "elimination points" or "actions required."

3.4.1 Elimination Points

Elimination points are reached when the user's answers have led to the conclusion that one method of water reuse is not feasible for legal, physical, political, or water quality related reasons.

For example, if the tool asks, "Can the aquifer accept recharge?" (Question 5) and the user answers "no," the tool will conclude that IPR via GW augmentation is not feasible on the basis of the physical limitations of the available aquifers. The tool will cease asking any questions related to GW IPR and begin evaluating the feasibility of IPR via SW augmentation at Question 10.

3.4.2 Actions Required

In addition to elimination points, the user can pass through "actions required" boxes. This occurs when an action is necessary to maintain the feasibility of the particular method of water reuse in question.

For example, if a user has determined that SW IPR is not currently politically acceptable but thinks he or she possesses the political sway to change people's minds, the user may answer "yes" to Question 14 ("Will you try to change political acceptability?"). For SW IPR to remain a feasible option, the user will need to change public perception regarding that water reuse method; changing public perception is therefore the "action required."

3.4.3 Feasibility Summary

The Feasibility Analysis page provides dynamic updates to a Feasibility Summary located next to the list of questions. Once users have navigated a path through the flow chart by answering the yes/no questions posed by the tool, the Feasibility Summary provides them with the conclusions from the feasibility analysis, including any constraints on the feasibility of reclaimed water methods and any actions that may be required to allow water reuse by a certain method.

3.5 Step 3: Identify and Describe Project Alternatives

To support the user developing project alternatives, the process is broken down into two sub-steps, selecting reclaimed water applications and constructing alternatives based on those applications.

3.5.1 Define Reclaimed Water Uses

Before choosing reclaimed water uses, users are asked to consider the business case for each use, in general terms, based on a series of pertinent questions. Users may then choose reclaimed water uses that they might want to include in one or more alternatives from a list of predefined options. This approach provides them with a library of sorts that may include elements that they had not considered before but would be interested in including in one or more of their project alternatives. The available options for reclaimed water uses are as listed:

- Agricultural − Irrigation
- Agricultural − Feed lots/Animal husbandry
- Commercial − Irrigation
- Commercial − Toilet flushing
- Commercial − Other
- Industrial − Cooling towers
- Industrial − Power generation
- Industrial − Manufacturing
- Industrial − Car washing
- Industrial − Cleaning
- Industrial − Fracking/Mining
- Municipal − Irrigation
- Municipal − Public water features
- Municipal − Direct potable reuse

- Municipal − Indirect potable reuse
- Municipal − Saltwater intrusion barrier
- Residential/Irrigation
- Residential/Toilet Flushing
- Other − Fire fighting
- Other − Stream augmentation
- Other − Dust control
- Other – Snow making
- Other

3.5.2 Define Alternatives

After choosing any number of the desired water uses, the user is directed to the first of up to six alternative definition pages. On these pages, the user is asked to enter a brief description of the alternative and some other pertinent basic data.

From drop-down menus, users may choose up to six different reclaimed water uses, six reclaimed water methods, and six system components. The available options for uses are constrained to those selected by the user during the previous step, the available options for methods and system components are shown as follows:

Water Reuse Methods

- Spreading basins
- Vadose zone wells
- Aquifer storage and recovery (ASR)
- Stream channel recharge
- Injection wells to prevent seawater intrusion
- Potable water credits
- Surface water augmentation
- Trench recharge
- Dual pipe system
- Other

Water Reuse System Components

- Direct recharge wells
- Recovery wells
- Pipelines
- Pump stations
- Reservoir (tank)
- Reservoir (surface water body)
- Treatment plant improvements
- Satellite plant
- Other—user defined

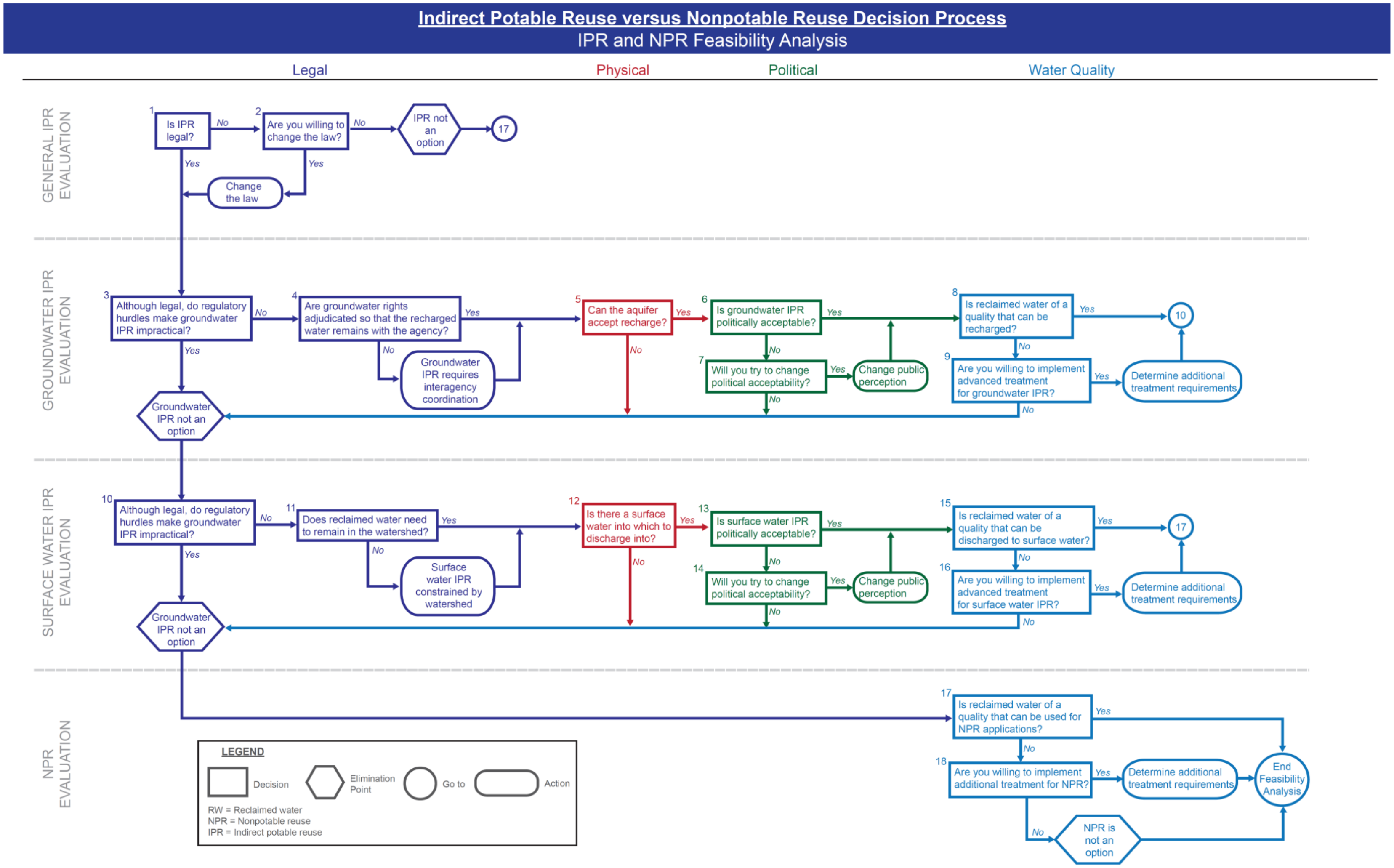


Figure 3.2. IPR and NPR Feasibility Analysis flow chart.

Users' ability to choose elements (i.e., uses or methods) in their alternatives is not constrained, even if some of those elements may have been eliminated previously in the feasibility analysis. However, the Alternative Summary Page for each alternative (see Section 3.9, Tool Outputs) shows a summary of what was included in the feasibility analysis. There is a red "x" next to any type of reuse was determined to be infeasible. This provides some warning about potential conflicts in the final summary of the results.

Also, users are asked to provide basic additional information regarding the alternative, including estimates of capital and O&M costs for each of their system components. They are encouraged to consider and include costs that might not come to mind initially under the general categories of "capital" and "O&M", such as

- Renewal/ replacement costs
- Land cost
- Cost offsets
- Avoided costs of baseline projects

Note that cost information is not required, but – assuming that cost is a significant factor in a user's decision-making processes – the value of the alternatives evaluation is significantly greater if accurate comparative cost information is available.

After completing one alternative definition page, users are given the option of adding additional alternatives, up to a total of six. Each subsequent alternative is defined as described previously.

3.6 Step 4: Identify, Score, and Weight Criteria

The first step in a multicriterion decision analysis (MCDA) approach is to identify the criteria by which the alternatives will be evaluated. Together, the list of alternatives and the list of criteria define the framework of the alternatives evaluation matrix, with the alternatives defining the columns and the criteria defining the rows. A completed (scored and weighted) example of this matrix framework is shown in Figure 3.3.

SCORING MATRIX		Alternatives				Criteria Importance Ranking	Criteria Weight
		No. 1	No. 2	No. 3	No. 4		
CRITERIA		Land Application	Wetland Project for IPR	Direct Injection for IPR	Purple Pipes		
FINANCIAL							
✓	Capital Cost	$ 35,000,000	$ 16,500,000	$ 159,000,000	$ 55,500,000	1	100.0
✓	NPV Cost of O&M Over Project Life	$ 7,978,155	$ 3,875,104	$ 36,471,565	$ 12,992,995	4	66.7
✓	Financial Risk	None	Low	Low	High	3	77.8
SOCIAL							
✓	Increased Water Supply Reliability	0.0%	50.0%	50.0%	25.0%	2	88.9
✗		H/M/L/N	H/M/L/N	H/M/L/N	H/M/L/N		
✓	Perceived Negative Public Health Impact	Low	Medium	Medium	Medium	5	55.6
✗		H/M/L/N	H/M/L/N	H/M/L/N	H/M/L/N		
✓	Agricultural Benefits	High	Low	Low	None	8	22.2
ENVIRONMENTAL							
✓	Ease in Meeting Discharge Requirements	High	High	High	High	9	11.1
✓	Energy Use / Greenhouse Gas Emissions	Low	Medium	High	Medium	7	33.3
✓	Development of Environmental Amenities	None	High	None	Medium	6	44.4
✗		H/M/L/N	H/M/L/N	H/M/L/N	H/M/L/N		
✗		H/M/L/N	H/M/L/N	H/M/L/N	H/M/L/N		

Figure 3.3. Example of a decision evaluation matrix framework.

In the subsequent steps, the user provides input on the criterion scores (i.e., cost, level of impact) and weights (i.e., the measure of each criterion's relative importance). These inputs then are used to calculate final overall scores for each alternative, using one of two MCDA algorithms (see Section 3.8). The user can see the results of the selected MCDA analysis, then select the other algorithm to prepare a second set of results for comparison.

Although the algorithms for scoring the alternatives are hidden from the user, they are explained in the user's manual to enable users to make informed choices about the differences in output they may observe when using one or the other.

3.6.1 Identify Criteria

To define the criteria for the alternatives evaluation, users select the criteria relevant to their particular situation from a series of possibilities. They also will have the ability to enter manually any additional criteria that may not be included in the tool. A sample of the types of evaluation criteria are shown as follows:

Financial

- Capital costs
- Net-Present Value (NPV) cost of O&M over the project life
- Financial risk

Social

- Increased water supply reliability
- Community impact (noise, odor, etc.)
- Public health impact;
- Business integration issues
- Agricultural benefits

Environmental

- Ease in meeting discharge requirements
- Energy use/greenhouse gas emissions
- Development of environmental amenities
- Downstream water quality impacts
- Groundwater impacts

Users are asked to select any number of criteria from the ones listed, by which they would like to evaluate their alternatives. They are encouraged, though not required, to balance the number of criteria selected for evaluation among the three categories such that each category is given equal consideration in the subsequent evaluation.

3.6.2 Score Criteria

Many decision criteria can be expressed directly as numbers, the simplest of these being costs (or cost savings). These *quantitative* criteria are scored more easily than the *qualitative* criteria, for which the user is not asked to provide a numerical score.

3.6.2.1 Quantitative Criteria

The user is asked to enter dollar values (net present value basis) for the various cost criteria. The capital and O&M costs entered by the user in the alternative definition pages will carry over onto this page.

The user is also asked to provide a quantitative input for the “increased water supply reliability” criterion. The raw score for this criterion is expressed as a percentage that represents the ratio of the total amount of reclaimed water the project will supply divided over the total amount of water in the user’s portfolio that is considered “unreliable.”

Unreliable water is subject to drought restrictions or other uncertainties and may include water from many of the conventional water supplies, including surface water, water transfers, and groundwater, depending on a user’s particular situation. Reclaimed water is considered drought-proof and therefore a “reliable” water supply.

Note that financial risk, as implemented for this tool, is considered a qualitative criterion and will be scored as described as follows.

3.6.2.2 Qualitative Criteria

The qualitative criteria are scored using a 4-point scale (high, medium, low, and minimal) based on the expected impact each alternative is expected to have with respect to that criterion. For these qualitative criteria, the user is asked to select a qualitative score from the drop-down menus for each alternative.

Choosing values for qualitative criteria is inherently a subjective process. To reduce variability among users, some guidelines for what high, medium, low, or minimal impact mean in the context of this tool are provided in Table 3.1.

3.6.3 Weight Evaluation Criteria

Now that the evaluation criteria have been scored (i.e., quantitative and qualitative values have been assigned, as objectively as possible, to each alternative for each criterion), the next step involves judging the importance of the criteria. This involves deciding whether greenhouse gas emissions, for example, caused by the project are more important—and by how much— in relation to other factors, such as effects on the local neighborhood.

In this step, the users are asked to mark the criterion they feel are most important in determining their preferred alternative with a 1 in the Criteria Importance Ranking column. The next-most important criterion should receive a 2, and so forth, until all criteria have been ranked.

On the basis of this ranking, the adjacent Criteria Weighting column will assign default weights automatically, with numbers evenly spaced between 0 and 100. Users may override these default values but must “unlock” the Excel sheet to do so (with instructions provided in the user’s manual). For example, if someone thinks that two criteria are very close in importance, that person may choose to keep the difference in ranking weight very small (or even weight them the same).

Once the criteria have received raw user scores and raw ranking weights, the user input phase of the tool is complete. Users are asked to choose a method for calculating final scores from two options—which are described following—and are then redirected to the output screens of the tool, where users can view the results of the alternatives evaluation in tabular, text, and graphic formats (see Section 3.9).

Table 3.1. Examples for Scoring Qualitative Criteria

Category	Qualitative Criterion[a]	Large Impact "H"	Medium Impact "M"	Slight Impact "L"	Minimal Impact "N"
Financial	Financial Risk (Negative impacts)	Significant likelihood of financing problems (e.g., ratepayers will refuse to pay for higher cost of water, project is reliant on revenue from uncertain demands, legal uncertainties make project outcome doubtful)	Remote possibility of financing problems (e.g., overly reliant on one specific group of customers, like golf courses, who may change their minds about using reclaimed water)	Demand projection data is only cursory, so demands (and therefore revenue) may end up being smaller than projected	Does not change risk
Social	Local/Neighborhood Impacts (Negative impacts)	Significant increase in truck traffic, odor problems, or aesthetic issue (i.e., a clear strategy needed to deal with complaints)	Volume of complaints expected to increase significantly during construction but will decline afterward	Small increase in truck traffic, or the frequency of odor complaints, but nothing the current complaints personnel cannot handle	Does not affect neighborhood
	Change in Perceived Public Health Impacts (Negative impacts)	Significant public outcry likely (i.e., clear strategy / investment in public outreach is needed for alternative to proceed)	Some fringe groups may be upset, but effects should not hinder project progress	Some negative press may need to be countered by active stakeholder engagement	No changes anticipated
	Organizational and Business Integration Issues (Negative impacts)	A whole new business line must be created, with new administrative staff, offices, and facilities	A small increase in administrative effort required (e.g., small number of additional positions within existing organizational structure)	Temporary increase in workload for current staff would be expected	No organizational changes needed
	Agricultural Benefits (Positive impacts)	Availability of significantly more water results in increased crop value and regional economic productivity	Availability of more water results in limited increased crop value, involving local effects only	Farmers like reclaimed water as it contains more nutrients than the groundwater they were using previously	No effects on agriculture

Table 3.1. Examples for Scoring Qualitative Criteria

Category	Qualitative Criterion[a]	Large Effect "H"	Medium Effect "M"	Slight Effect "L"	Minimal Effect "N"
Environmental	Increased Number/Stringency of Discharge Requirements (Negative impacts)	New permits needed, resulting in significant administrative and additional monitoring/compliance efforts	Change in discharge requirements results in significant additional monitoring/compliance effort	Additional discharge requirements do not affect current operation of facilities	No effect on discharge requirements
	Energy Use/Greenhouse Gas Emissions (Negative impacts)	Significant increase in greenhouse gas emissions (i.e., facility's energy footprint goes up by more than factor of 2)	Small increase in greenhouse gas emissions (i.e., facility's energy consumption increases but not by more than a factor of 2)	Increased energy consumption is offset by use of renewable power	Greenhouse gas emissions the same or decrease
	Environmental Amenities Associated with the Project (Positive impacts)	Large new wetlands/salt marsh/habitat for endangered species created	Isolated pockets of habitat created or improved by increased water quality or quantity	Water quality improvements will result in more abundant/ diverse wildlife in existing habitat	No enhancements
	Water Quality Impacts (Negative impacts)	Regulatory problems anticipated because of water quality impacts (salinity buildup, increased nutrient loads to local surface waters from reclaimed water runoff/leachate)	Water quality changes (more saline, increased nutrient concentrations) may alter habitat and reduce its ability to support native species	Some recreational users protest change to aesthetics of water	No changes anticipated
	Groundwater Improvements (Positive impacts)	Solves a significant saltwater intrusion (or land subsidence) problem	Injection or offsetting existing groundwater pumping is expected to halt or reverse falling groundwater levels	Alternative will allow utility to discontinue practice of occasionally over-pumping aquifer in times of need	No affect on groundwater by alternative

[a] Rows shaded in gray indicate criteria representing positive impacts; unshaded rows indicate criteria representing negative impacts.

3.7 Preliminary Calculations

Whereas the tool provides a choice of two MCDA algorithms by which the user inputs can be calculated into final ranks and/or scores for each alternative, both methods have several preliminary steps in common, which are discussed first.

3.7.1 Normalizing Scores on a Scale from 0 to 1

To compare all the criteria on the same basis, both quantitative and qualitative raw scores entered by the users are normalized to fall on a scale of 0.00 to 1.00, with 1.00 being the most favorable.

3.7.1.1 Quantitative Score Normalization: Costs

Quantitative raw scores are normalized based on the sum of the costs for that criterion (i.e., if alternatives 1 through 6 have capital costs of $500,000 each, the first step is to divide the individual costs by $3 million, which is arrived at by 6 × $500,000). The normalized costs are then mirrored (i.e., subtracted from 1) such that the highest cost alternative receives the lowest score.

Mathematically, the normalized score for each quantitative criterion i under alternative j (x_{ij}) can be defined as

$$x_{ij} = 1 - C_{ij} / \sum_i C_{ij} \qquad (3.1)$$

where C_{ij} = "raw" cost of alternative i under cost category j.

3.7.1.2 Quantitative Score Normalization – No-Cost (or Cost Savings) Criteria

For quantitative scores for which higher scores mean a more positive input (i.e., cost savings, and increased water supply reliability), mirroring is not necessary. These are calculated according to Equation 3.2, which is the same as Equation 3.1 but without the mirroring.

$$x_{ij} = C_{ij} / \sum_i C_{ij} \qquad (3.2)$$

3.7.1.3 Qualitative Score Quantification

Qualitative raw scores i.e. high, medium, low, and none) are scored with scores 0.00, 0.33, 0.66, and 1.00, with 1.00 being the most favorable score. The mapping from qualitative to quantitative scores depends on the way the criterion is phrased, for example, a "high" impact may be scored as 0.00 or 1.00, respectively.

For criteria that describe beneficial impacts, such as agricultural benefits, a high impact is scored as a 1.00 (and no impact is scored as 0.00), whereas for criteria that describe negative impacts, such as energy use/greenhouse gas emissions, a high impact is scored as a 0.00 (and no impact is scored as 1.00). Which criteria describe beneficial impacts and which describe negative impacts is shown in Table 3.1.

3.7.2 Calculating Swing Weights

Once all the scores have been normalized or quantified such that they can be compared on an apples-to-apples basis, the user-assigned ranking weights for each criterion also must be normalized. This is important to ensure consistency among different scenarios a user may wish to run with the tool.

Therefore, the final swing weight for each criterion (w_i) is calculated as a normalized form of the ranking weights (r_i), by dividing the individual ranking weights by the sum of the ranking weights:

$$w_i = r_i / \sum_i r_i \tag{3.3}$$

This results in final swing weight values between 0 and 1.

3.8 Multicriterion Decision Analysis Algorithms

This tool provides a choice of two MCDA algorithms by which user inputs can be calculated into final ranks or scores for each alternative, the weighted average method (WAM) and the compromise programming method (CPM).

3.8.1 Weighted Average Method

WAM is a simple method to determine alternative rankings (O'Neil and Yates, 2011). Rankings are calculated based on multiplying the normalized score by the normalized weight for each criterion/alternative pair. The overall score for each alternative (A_j) is calculated as

$$A_j = \sum_i w_i x_{ij} \tag{3.4}$$

where w_i is the criterion weight, as determined by the swing weight process (as described) and x_{ij} is the normalized score (i.e., value) of the ith criterion with respect to the jth alternative (as described).

The individual scores then are ranked so that the highest score receives Rank 1, and so forth.

WAM is the simpler of the two methods and is more easily understood (and explained) than other methods, making it the preferred approach for a decision-making process where transparency and simplicity of the results may be valued more highly than more detailed information content.

3.8.2 Compromise Programming Method

The discrete compromise programming method (CPM) is effectively an augmentation of the simpler WAM. Like WAM, this method provides a ranking of alternatives, but unlike WAM, it also provides information on the "relative distance" of those alternatives to a hypothetical ideal alternative that is defined by the best possible score achieved by any alternative for each criterion (i.e., this ideal alternative would have a score of 1.00, to which the scores of "real" alternatives can be compared).

This requires one additional step beyond simply multiplying the normalized score by the normalized weight, as was done for WAM. Instead, the normalized scores are incorporated into a CP-score, R_{ij}, which assesses the "distance" of the normalized score from the best and worst scores for that criterion i

$$R_{ij} = \left[\frac{x_{ij} - x_i^-}{x_i^+ - x_i^-} \right]^p \tag{3.5}$$

where x_i^- is the worst normalized score for criterion *i*, x_i^+ is the best normalized score for criterion *i*, and *p* is a "relative distance measure" (O'Neil and Yates, 2011). Note that O'Neil and Yates (2011) indicated that Rij should be calculated using the raw scores (not the previously normalized scores). However, because of the need to "mirror" the scores for the cost criteria, it was simpler to work with the pre-normalized (and pre-mirrored) scores that had been calculated already for WAM. The results provided by this approach are functionally equivalent to the approach described by O'Neil and Yates (2011).

The normalized scores are normalized a second time, this time with respect to the total spread in scores for that criterion. Note that if the best and worst normalized scores for criterion *i* span the full possible distance, in other words if they are 1.00 and 0.00, respectively (and *p* is set = 1, generally a safe default), $R_{ij} = x_{ij}$, thus the CPM reduces to WAM.

The total score for each alternative *j* is calculated as follows, and is in direct analogy to the calculation under WAM (Equation 3.6):

$$A_j = \sum_i w_i R_{ij} \tag{3.6}$$

The use of the exponent *p* provides a mechanism to magnify differences among alternatives, if so desired, by setting $p>1$. This would be advisable if, for example, providing significant distinction between two alternatives that appear equivalent with $p=1$ were important.

Though CPM provides more information on the relative distances between alternatives and the flexibility to tease out differences between closely-spaced alternatives, it is a more complex method. Due to the complexity, and the flexibility to not only "choose" swing weights, but also the exponent *p*, the use of this method may be more difficult to defend if a decision-making process is under critical scrutiny.

3.9 Step 5: Tool Outputs

A number of outputs were built into the tool to provide the results of the alternatives evaluation in three formats:

1. The final Scoring Matrix for the MCDA analysis, which provides the raw and weighted scores for each alternative/criterion pairing and the total scores achieved by each alternative.
2. An Alternatives Comparison bar graph showing the score for each criterion, color-coded by the relative contributions of financial, social, and environmental scores to each total score.
3. An Alternative Summary Sheet for each alternative is included in the evaluation.

The intent is that, together, these outputs provide users with the materials necessary to present the results of their analysis to others without significant additional work on their part.

3.9.1 Alternatives Evaluation Matrix

Once the MCDA algorithm of choice has finished calculating, users are redirected to a page showing a completed Scoring Matrix. The Scoring Matrix is a one-page table that presents the mathematical results of the alternatives evaluation, with columns representing alternatives and rows representing decision criteria. Shown within the matrix are the individual scores for each alternative/criterion pair. The bottom row provides the final rank and score for each alternative under the selected MCDA algorithm. For WAM, the scores serve only to provide a general ranking of alternatives; however, for CPM, the scores' relative proximity to 1.00 provides an additional indication of the separation among the alternatives that were evaluated.

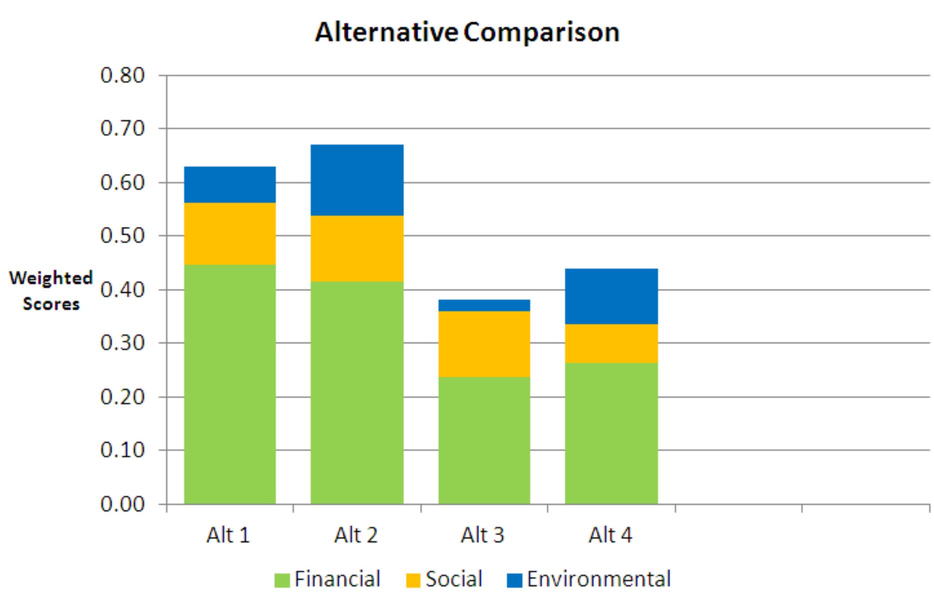
This matrix is intended for inclusion in decision documentation or as a stand-alone summary. An example of an alternatives evaluation matrix is shown in Figure 3.4(a).

3.9.2 Graphic Alternatives Comparison

The second output from the tool is a bar graph that provides a summary of the information provided in the alternatives evaluation matrix in graphic form using either of the MCDA alternatives. Each bar represents one alternative, and the total bar height represents the alternative's score. The colored blocks within each bar indicate the relative contribution of financial (green), social (red), and environmental (blue) criteria to the alternative's total score.

SCORING MATRIX	Criteria	Alternatives							
		No. 1		No. 2		No. 3		No. 4	
CRITERIA	Weight	Land Application		Wetland Project for IPR		Direct Injection for IPR		Purple Pipes	
		Raw	Weight	Raw	Weight	Raw	Weight	Raw	Weight
FINANCIAL									
Capital Cost	100.0	$ 35,000,000	0.17	$ 16,500,000	0.19	$159,000,000	0.08	$ 55,500,000	0.16
NPV Cost of O&M Over Project Life	66.7	$ 7,978,155	0.12	$ 3,875,104	0.12	$ 36,471,565	0.05	$ 12,992,995	0.11
Financial Risk	77.8	None	0.16	Low	0.10	Low	0.10	High	0.00
SOCIAL									
Increased Water Supply Reliability	88.9	0	0.00	0.5	0.07	0.5	0.07	0.25	0.04
Perceived Negative Public Health Impact	55.6	Low	0.07	Medium	0.04	Medium	0.04	Medium	0.04
Agricultural Benefits	22.2	High	0.04	Low	0.01	Low	0.01	None	0.00
ENVIRONMENTAL									
Ease in Meeting Discharge Requirements	11.1	High	0.02	High	0.02	High	0.02	High	0.02
Energy Use / Greenhouse Gas Emissions	33.3	Low	0.04	Medium	0.02	High	0.00	Medium	0.02
Development of Environmental Amenities	44.4	None	0.00	High	0.09	None	0.00	Medium	0.06
TOTAL SCORE		0.63		0.67		0.38		0.44	
RANK		2		1		4		3	

(a) Completed scoring matrix



(b) Alternative comparison bar graph

Figure 3.4. Examples of tool outputs: (a) scoring matrix, and (b) bar graph.

The total area of each color across all bars also provides an immediate impression of the relative importance each of those categories held in the evaluation process overall.

An example of a bar graph summarizing the results of the alternatives evaluation is shown in Figure 3.4(b).

3.9.3 Alternative Summary Sheet

The tool provides one alternative summary sheet for each alternative defined by the user. These are intended for printing or incorporation into other planning documents. The goal in the design of these one-page summaries it to provide all the significant data for each alternative in a compact, one-page format. The contents of this summary sheet include basic project information (which will be the same on all summary sheets), basic information about the alternative, and the results of the alternatives analysis for that alternative (i.e., its column from the alternative evaluation matrix). An example of an alternative summary sheet is shown in Figure 3.5.

WATEREUSE RESEARCH

Decision Support Tool for Non-Potable and Indirect Potable Reuse Projects
2/8/2013

Alternative **2**

Name:	Wetland Project for IPR
Description:	Construct a riparian preserve that (eventually) feeds into a drinking water supply, with a grant from US Parks and Wildlife
Project Start Year:	2012
Project End Year:	2015
Estimated Number of Customers:	4,000
Estimated Volume Delivered:	20.0 (mgd) 22,400 (AF/yr)
Reclaimed Water Quality Class:	Texas Type I
Estimated Project Life:	25 (years)
Interest Rate:	5.0%
Discount Rate:	3.0%
Estimated Capital Costs:	$ 16,500,000
Estimated O&M Costs:	$ 3,875,104 (present value over project life)
Estimated Total Present Value:	**$ 20,375,104** (dollars)

Feasibility Analysis Results

Type of Reuse	Feasible?	Constraints: Change Law	Constraints: Interagency Coordination / Watershed Constraints	Constraints: Change Public Perception	Constraints: Additional Treatment Requirements
Groundwater IPR	✓		!		!
Surfacewater IPR	✓				!
NPR	✓				

Background

Organization Name:	My Utility
Key Stakeholders:	Stakeholder 1, Stakeholder 2, Stakeholder 3
Project Goals:	Develop a wetland project with the ability to recharge excess reclaimed water
Special Circumstances:	None
Current Reclaimed Water Demand:	2.0 (mgd) 2,240 (AF/yr)
Future Reclaimed Water Demand:	6.0 (mgd) 6,720 (AF/yr)

Results - Triple Bottom Line Analysis

Criteria	Weight	Alternative Scoring: Raw	Alternative Scoring: Weighted
FINANCIAL			
Capital Cost	1	$ 16,500,000	0.20
NPV Cost of O&M Over Project Life	4	$ 3,875,104	0.13
Financial Risk	3	Low	0.10
SOCIAL			
Increased Water Supply Reliability	2	0.5	0.18
Perceived Negative Public Health Impact	5	Medium	0.00
Agricultural Benefits	8	Low	0.01
ENVIRONMENTAL			
Ease in Meeting Discharge Requirements	9	High	
Energy Use / Greenhouse Gas Emissions	7	Medium	0.03
Development of Environmental Amenities	6	High	0.09
Total Score			**0.75**
Rank			**1**

TBL Calculation Method: Compromise Programming

P Factor (Compromise Programming Only): 1

Figure 3.5. Example of an Alternative Summary Sheet.

Chapter 4
Conclusions

The decision to implement a water reuse strategy, like all other water resource projects, requires significant advanced planning. For a water resources manager considering both NPR and IPR, however, there is an additional opportunity cost associated with choosing one strategy over the other, because both strategies depend on the same source of water. Once the reclaimed water infrastructure has been constructed under one strategy, the water is committed, and the other strategy is no longer an option. This opportunity cost, in combination with the many other factors influencing a decision, may inhibit water reuse managers from making timely decisions on the appropriate use of their water and financial resources.

The case studies confirm that long-term water scarcity, drought impacts in the shorter term, and wastewater management considerations are the drivers for reuse. They are necessary conditions for interest in reuse, but they generally do not provide distinguishing factors in selecting IPR versus NPR. The case studies revealed that specific constraints are the major driving factors for the choice between IPR and NPR. The major constraints are cost, regulatory issues, and water quality impacts/concerns. For a few of the case studies, the issue of water rights was cited as an obstacle for moving forward with IPR. Typically, this issue is a critical determinant for the diversion of wastewater for any type of water reuse. Also of note is that public opinion was not raised by the case study participants as a major current IPR obstacle, even though this issue has resulted in past failure to implement numerous proposed IPR projects. Cost is not always a constraint that forces choice of one type of option over another. In those cases, cost is an important criterion by which the choice between project options is judged. In many cases IPR may be perceived as the most cost-effective option, because it allows use of recycled water year round instead of only in the irrigation season, because of the advantage of using the groundwater basin as a storage reservoir, or because the potable water distribution system already exists (as illustrated by OCWD and A2). However, the case studies showed that there are circumstances where NPR was viewed as the more cost-effective option (for example Global Water PVUC).

The decision support tool constructed for this project was designed to address the difficulty of making water reuse strategy decisions. It is based on a MCDA alternatives evaluation that allows users to define project alternatives and weigh them quantitatively against one another based on financial, environmental, and social criteria. The differentiating features of the decision support tool are at the “front end,” which aims to provide water resources managers with broad background information on reuse drivers and support them in an evaluation of what types of water reuse are feasible in their situation. These first steps of the tool are based on the survey results from the 14 utilities that have considered IPR as part of their water resources portfolio, making it a unique tool specifically tailored to the decision between IPR and NPR.

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Framework for Informed Planning Decisions Regarding Potable Reuse and Dual Pipe Systems

Appendix A

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Acronyms

A1	Agency 1
A2	Agency 2
A3	Agency 3
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AF	acre-foot
ASR	aquifer storage and recovery
AWT	advanced water treatment
CDPH	California Department of Public Health
CEC	constituents of emerging concern
EPWU	El Paso Water Utility
GAP	Green Acres Project
GCDWR	Gwinnett County Department of Water Resources
GWR	groundwater recharge
GWRS	groundwater replenishment system
IPR	indirect potable reuse
LGVSD	Las Gallinas Valley Sanitary District
mgd	million gallons per day
MMWD	Marin Municipal Water District
NPR	nonpotable reuse
OCWD	Orange County Water District
OCSD	Orange County Sanitation District
PVUC	Palo Verde Utilities Company
RA	reservoir augmentation
RO	reverse osmosis
SFPUC	San Francisco Public Utilities Commission
SWA	surface water augmentation
TBL	triple bottom line
WRRF	WateReuse Research Foundation
WRP	water reclamation plant
YVW	Yarra Valley Water

Executive Summary

This technical memorandum presents the results of the first two tasks of WRRF-09-02, *Framework for Informed Planning Decisions Regarding Potable Reuse and Dual Pipe Systems*. The goal of the project is to develop a decision tool (or framework) that supports water resource managers and those responsible for the deployment of available water supplies in making informed decisions regarding the use of recycled (or reclaimed water) via implementation of nonpotable reuse (NPR) and/or indirect potable reuse (IPR) within a water supply portfolio. Task 1 of the project collected information from 14 agencies in the United States, Australia, and Europe that represent a microcosm of water resource agencies actively involved in (1) implementing NPR and/or IPR, or (2) planning, designing, constructing, or studying new or expanded reuse projects. Task 2 consisted of compiling the information from each agency and to identify determinants that shaped each agency's decisions in implementing their water reuse programs.

Thirteen of the 14 agencies are actively implementing NPR. With regard to IPR, two agencies are implementing groundwater recharge projects, one agency is implementing a surface water augmentation project, six agencies are in the research/planning stage for IPR (either groundwater recharge and/or surface water augmentation), and five agencies do not intend to implement IPR. Information was collected from each agency using a standardized template that addressed specific topics and issues, including triple bottom line (TBL) criteria. Templates for the participants are presented in Appendix 1.

The case studies confirmed that long-term water scarcity, drought impacts in the shorter term, and wastewater management considerations were the drivers for reuse. They are necessary conditions for interest in reuse, but they generally do not provide distinguishing factors in selecting IPR versus NPR. The case studies revealed that specific constraints are the major driving factors for the choice between IPR and NPR and they included:

- cost
- regulatory issues
- water quality impacts/concerns

For a few of the case studies, the issue of water rights was cited as an obstacle for moving forward with IPR. Typically, this issue is a critical determinant for the diversion of wastewater for any type of water reuse. Also of note is that public opinion was not raised by the case study participants as a major current IPR obstacle, even though this issue has resulted in past failure to implement numerous proposed IPR projects. Cost is not always a constraint that forces choice of one type of option over another; however, it is an important criterion by which the choice between project options is judged. There were cases where IPR was viewed as the most cost effective option because it allows use of recycled water year-round instead of just in the irrigation season, because of the advantage of using the groundwater basin as a storage reservoir, or because the potable water distribution system was already in place. However, the case studies showed that there were circumstances where NPR was viewed as the more cost-effective.

The next step is to organize the case study information for use as a reference in support of the decision framework (WRRF 09-02 Tasks 3 and 4). The framework will utilize a weighted multi-criteria decision approach that can be applied by water resource managers to assist with presenting a "business case" for why a utility, agency, or water company would justify moving forward with plans to develop and deploy alternative water resources through NPR or

IPR programs, or combinations of the two. The framework is intended to be flexible to accommodate the diverse set of site- and utility-specific circumstances relevant to the wide range of potential users taking into consideration both quantitative and qualitative factors.

Introduction

The objective of WateReuse Research Foundation WRRF-09-02, *Framework for Informed Planning Decisions Regarding Potable Reuse and Dual Pipe Systems*, is to develop a decision tool (or framework) that supports water resource managers and those responsible for the deployment of available water supplies in making informed decisions regarding appropriate investments in sustainable water resources development and capital projects necessary to meet water demands at the project, municipal, or regional level of planning. It specifically focuses on decision making related to the use of recycled (or reclaimed water) via implementation of non-potable reuse (NPR) and/or indirect potable reuse (IPR) within a water supply portfolio.

IPR is defined as the planned augmentation of a raw water supply with reclaimed water followed by an environmental buffer. The blend of raw and reclaimed water typically receives additional treatment before being distributed as a drinking water supply. Environmental buffers include assimilation/blending of the reclaimed water with the surface water or groundwater that is being augmented, natural attenuation that can occur as reclaimed water percolates through soil (for groundwater recharge), and time for attenuation to occur as reclaimed water is stored (underground or in surface reservoirs) prior to use. IPR projects use reclaimed water to recharge groundwater by surface spreading or direct injection; create seawater intrusion barriers; store water underground for later recovery and use; or to augment surface water supplies (reservoirs or lakes).

NPR is the planned use of reclaimed water for purposes other than to augment drinking water supplies, such as landscape irrigation, agricultural irrigation, residential landscaping, industrial processing or cooling, toilet flushing, recreational impoundments, environmental enhancement, and construction. NPR projects rely on the use of reclaimed water delivered through a dual pipe system (e.g., a distribution system that is separate from that of delivery of potable water). Texas and Arizona define this as "direct reuse." In Australia, dual pipe specifically refers to systems where drinking water and recycled water are delivered to homes in separate pipelines. Another variant of NPR is a "dual plumbed system." In California, this is defined as a system that utilizes separate piping for recycled water and potable water within a facility where the recycled water is used to serve plumbing within a building or for outdoor irrigation at individual homes.

This technical memo presents the results of the first two project tasks for WRRF-09-02:

- Task 1: Background Review and Data Collection
- Task 2: Case Studies

Information generated from these tasks has been organized and will be used to develop the decision framework (Tasks 3 and 4). The framework will utilize a decision making approach that can be applied by water resource managers to assist with presenting a "business case" for why a utility, agency, or water company would justify moving forward with plans to develop and deploy alternative water resources through NPR or IPR programs, or combinations of the two. The framework is intended to be flexible to accommodate the diverse set of site- and utility-specific circumstances relevant to the wide range of potential users taking into consideration both quantitative and qualitative factors.

A1.1 Background Review

The first task was to develop utility profiles for agencies in the United States Australia, and Europe that represent a microcosm of water resource agencies actively involved in implementing NPR or IPR, or planning, designing, constructing, or studying new or expanded reuse projects. As shown in Table 1, information was compiled for 14 agencies. Five of the agencies, located in the United States, asked to remain anonymous and are designated as Agency 1 through Agency 5.

Table 1. Participating Utilities

Agency	Location
Barwon Region Water Corporation (Barwon Water)	Victoria, Australia
Consorci Costa Brava (Costa Brava), Spain	Spain
El Paso Water Utilities (EPWU)	Texas, United States
Global Water Palo Verde Utilities Company (PVUC)	Arizona, United States
Gwinnett County Department of Water Resources (GCDWR)	Georgia, United States
Marin Municipal Water District (MMWD)	California, United States
Orange County Water District (OCWD)	California, United States
San Francisco Public Utilities Commission (SFPUC)	California, United States
Yarra Valley Water (YVW), Australia	Victoria, Australia
Agency 1	United States
Agency 2	United States
Agency 3	United States
Agency 4	United States
Agency 5	United States

On the basis of the experience of these agencies, the goal was to identify the lessons learned and the types of factors used in making past and impending decisions regarding NPR and IPR. In developing this information, it was understood that no two entities have identical circumstances with regard to economic, demographic, historical, and political circumstances. Thus, the experience and circumstances of an entity that has already implemented an NPR or IPR project may or may not be relevant (by itself) to another entity in the process of determining if NPR or IPR is the right way to proceed; however, a comparison of the backgrounds and circumstances of the selected agencies reveals patterns and generalizations that lead to a list of suggestions to develop and use as part of the decision framework, particularly the key determinants in decision making and the hierarchy of decisions leading to final choices in program selection.

A1.2 Data Collection

Information was collected and documented for the 14 participants based on the following factors and the role they played in project implementation and decision making:

- Current and planned reuse programs
- Availability and reliability of water resources (including restrictions and limitations), and alternatives considered in lieu of using recycled water
- Role of wastewater management
- Institutional arrangements or obstacles between reclaimed water producers and suppliers
- Community leadership or opposition
- Unique circumstances impeding progress or implementation
- Project costs (capital, operating, periodic replacement, etc.)
- Avoided costs of alternative projects or adverse impacts
- Customer base (identification of reuse customers and service needs)
- Financing options
- Environmental impacts or benefits
- Regulatory requirements/flexibility (existence or absence of requirements)
- Public acceptance or opposition
- Political issues
- Benefits of recycling for users
- Service goals and objectives for water reuse programs
- Internal organization and business integration
- Energy/carbon footprint
- Legal issues (such as water rights, liability, public access, etc.)
- Technical considerations (such as storage, infrastructure, or other requirements)
- Specific assessments of social, economic, and environmental objectives (e.g., triple-bottom-line assessments)

To collect standardized information for all of the participants (to the best extent possible), a template was developed, and each participating agency was asked to fill out the template and provide supporting documentation if available. In some cases, the project team assisted with filling out the templates or providing supplemental information included in the templates on the basis of knowledge of the participating utility. Completion of the templates was an iterative and somewhat resource intensive process between the project team and agency participants, highlighting the challenge of obtaining this kind of information.

The draft templates provided by the agencies were first reviewed by the project team. In each case, further communication with the responsible agency was undertaken to obtain additional information, clarify responses, fill in missing information, or resolve questions. Some of the agencies asked to review the templates before they were finalized. Each template was modified by the project team to incorporate the additional information. This iterative process was deemed to be important to ensure that the information collected was correct, meaningful, and useful for developing the framework. Nevertheless, not all of the information sought was obtained.

With the exception of one agency, all of the participants are engaged actively in operation of NPR or IPR projects, with many of these agencies currently looking at project expansions or modifications. One agency is still in the planning, design, and construction stage. A summary of each agency's reuse status as of September 2011 is shown in Table 2.

Table 2. Summary of Water Reuse Activities

Agency	WaterReuse A3 Implemented/Status [1]		Program Modifications Planned
	NPR	IPR	
Barwon Water	Y	R (ASR)	Y – treatment upgrade to improve water quality to expand NPR options; IPR if deemed feasible and implemented
Costa Brava	Y	N	Y – goal to improve water quality to expand NPR options
EPWU	Y	Y (GWR)	Information not provided on modifications; a TBL study is underway
Global Water PVUC	Y	N	ND
GCDWR	Y	Y (SWA)	N
MMWD	Y	N	N
OCWD	Y	Y (GWR)	Y – construction for GWR expansion to begin in 2011
SFPUC	P, D, C	N	N/A
YVW	Y	N	Nothing specifically noted; a 50-year water supply strategy has been developed
Agency 1	Y	P (GWR and SWA)	Y - expanding NPR and considering IPR
Agency 2	Y	P and Dm (SWA)	Y – IPR if deemed feasible and implemented
Agency 3	Y	P (GWR)	Y – NPR expansion and IPR if deemed practicable and implemented
Agency 4	Y	P (GWR)	Y – NPR expansion and IPR if deemed practicable and implemented
Agency 5	Y	P (ASR and GWR)	Y – NPR and considering IPR if feasible

Notes:
[1] Nonpotable reuse (NPR); indirect potable reuse (IPR); aquifer storage and recovery (ASR); groundwater recharge by surface spreading or injection (GWR); surface water augmentation (SWA).
Y = yes (ongoing); N = no; R = research stage; P = planning stage, including feasibility studies; D = design stage; C = construction stage, Dm = demonstration stage, ND = not determined, N/A = not available.

Overviews for each participant are presented following. The individual templates for the participants are presented in Case Studies.

Barwon Water

In Australia, Barwon Water is Victoria's largest regional urban water corporation, providing water, sewerage, and recycled water services to more than 275,000 people across 3100 sq mi. The agency's nine water reclamation plants produce "Class C" recycled water, which is reused onsite, provided to external customers, or discharged to the environment. Class C recycled water has received secondary treatment and pathogen reduction and can be used for restricted nonpotable uses with controlled public access (i.e., golf courses, sporting facilities), agricultural uses (such as human food crops cooked/processed, vineyards, grazing or fodder for livestock), and industrial systems with no potential worker exposure.

In 2009−2010, approximately 800 mg/year were reused for irrigation of flowers, landscapes, and crops, or for dust suppression and construction. The primary drivers for reuse are lack of water because of drought and the need for a reliable water supply.

The original type of treatment at the plants was not chosen with reuse in mind. All of the plants are relatively old and the treatment train was selected based on cost, operation, and its ability to produce consistent effluent that could be disposed of appropriately. The infrastructure servicing the Class C customers was privately installed and operated. "Class A" recycled water had not yet been implemented, but was slated to be by 2012. Class A recycled water has tertiary treatment and pathogen reduction to achieve a lower (critical) limit of a 6-log removal of viruses and a 5-log removal of protozoan parasites. Class A water can be used for urban nonpotable uses with uncontrolled public access; agricultural uses (human food crops consumed raw); and industrial open systems with worker exposure potential.

The decision to produce Class A water, which is of higher quality and therefore allows allow for a broader range of reuse applications, was primarily driven by the drought and the need for a reliable water supply. The yield for Class A water has not been quantified. This effort is being funded by public/private partnerships (Barwon Water, private company, federal government, and state government).

The use of recycled water for IPR is not allowed by state and federal policy. There are efforts underway to advance the discussion about IPR at the national level. In the short-term, Barwon Water is conducting research related to IPR via aquifer storage and recovery (ASR), where ASR is defined as the use of injection wells to recharge and store water in the ground coupled with recovery wells to extract the water for use. The eventual source of water used for ASR may be recycled water, storm water, or even excess surface water. Currently, no project is committed beyond the research phase, which is expected to be completed by 2012. However, the outcome of ASR is uncertain.

Consorci Costa Brava

Consorci Costa Brava is a consortium of 27 municipalities in a coastal, tourist area in northeast Spain. It is a wholesale supplier of drinking water and provides for wastewater collection and treatment, water reclamation and reuse for NPR. The population varies from 240,000 to greater than 1 million in the summer. In 2010, Costa Brava's seven water reclamation plants provided approximately 1.7 mg/year for NPR including aquifer recharge (where the extracted water is used for agricultural irrigation), environmental uses, golf course and landscape irrigation, agricultural irrigation, and internal and nonpotable urban uses. The primary drivers for reuse are lack of water and increased demand.

Costa Brava does not have a planned reuse program in the sense that everything was designed from the start. Instead, projects have been developed gradually over time, and water recycling has been promoted where there was an interest by the user. For those municipalities in Costa

Brava where reuse is not occurring or is not planned, the reason is usually because of the high salinity of wastewater, mostly because of seawater intrusion in the sewer lines. Until now, interested users have been those that have had the need to find water resources for the irrigation of their facilities (mostly golf courses but also some small agricultural fields).The golf courses are located on the outskirts of urban areas and are connected directly to the reclamation plants. Reuse project costs for direct users (golf courses) are paid by the users; municipal reuse costs are subsidized at present but likely to be converted to a user charge.

The other alternative water source (desalination) is subsidized. Spanish regulations for water reuse were adopted in late 2007, and they do not address IPR (and thus it is not allowed). Therefore, the focus for Costa Brava has been on NPR. The initial goal was to comply with the reclaimed quality that enabled the public service uses previously mentioned and with a future goal to "approach" quality levels that will allow for the irrigation of private gardens, which may require additional treatment processes.

El Paso Water Utilities (EPWU)

EPWU manages and operates the water and wastewater system for the City of El Paso, Texas, including two surface water treatment plants, four groundwater arsenic treatment plants, multiple wells, booster stations and reservoirs, four wastewater treatment plants that produce reclaimed water for a variety of uses, and (in a joint project with the U.S. Army), a brackish inland groundwater desalination plant. EPWU supplies more than 7 mgd of reclaimed water for NPR and IPR. Type I reclaimed water is provided for various NPR applications, such as irrigation, industrial (cooling tower makeup water, and cooling processes), construction (dust abatement and compaction), and commercial businesses (car washing, street cleaning, and others). Type I uses include irrigation or other uses in areas where the public may be present during the time when irrigation takes place or other uses where the public may come in contact with the reclaimed water. It must meet a 30-day turbidity standard of 3 NTU, 30-day geometric mean standard for fecal coliform or *E. coli* of 20 CFU/100 mL, and a 30-day geometric mean standard for *Enterococci* of 4 CFU/100 mL. Advanced treated reclaimed water is used for aquifer recharge (IPR), in-plant uses, and irrigation of pasture land (grazing). The quality of the advanced treated water meets potable water standards prior to application.

The primary drivers for reuse are water scarcity and the need for a reliable water supply. For NPR, the program focused on large water users. For IPR, the program was designed to preserve the groundwater system. IPR implementation was done in the absence of specific state regulations for potable reuse. Advanced treated reclaimed water used for IPR is supplied by one of the four EPWU treatment plants and was built specifically to produce water for recharge. This plant also does not have access to a natural conveyance system for wastewater disposal. Decisions to create or expand plants were driven by historical circumstance of demand combined with geography (proximity of a wastewater treatment plant to water users). Wastewater from two of the plants is discharged to downstream farmers for irrigation, and in exchange EPWU receives credits for surface water.

Global Water Palo Verde Utilities Company (PVUC)

Global Water PVUC is an investor-owned utility (owned and operated by Global Water Resources). PVUC provides wastewater collection and treatment, as well as recycled water distribution. Global Water – Santa Cruz Water Company is the sister investor-owned utility providing potable water service. The drivers for reuse are water supply reliability and water demand. In the City of Maricopa, Arizona, PVUC generates approximately 2.2 mgd of reclaimed water (filtered and disinfected using UV) and distributes this to water retention structures (lakes) throughout the service area, where the water is used for home owner associations-owned NPR irrigation systems (direct reuse). PVUC is permitted for discharge of reclaimed water to surface water in the event there is insufficient demand for the water (during winter/rainy periods). Direct NPR was chosen to maximize the use of "the right water for the right use."

The City of Maricopa is a "new" city with significant population growth. Its population increased more than 4000% from the year 2000 to 2010. This situation was beneficial from an infrastructure perspective, because it allowed for the installation of potable and sewer infrastructure at the same time, with no retrofitting required to implement water reuse. With regard to IPR, PVUC's corporate philosophy is that NPR is the best option, because it is more cost effective versus ASR (power cost and avoided cost of treating potable water), and IPR via groundwater recharge is a concern because of perceived water quality impacts (salts and CECs).

Gwinnett County Department of Water Resources (GWDWR)

GCDWR is responsible for water supply, water production and distribution, wastewater collection, wastewater treatment, water reuse, and storm water for approximately 750,000 Gwinnett County, Georgia, residents. The water reuse program includes NPR and IPR but predominantly IPR. GCDWR operated an advanced wastewater treatment facility, the F. Wayne Hill Water Resources Center, which includes nitrogen and phosphorus removal, biological granular activated carbon treatment, ultrafiltration, pre-ozone/ granular activated carbon treatment, and ozonation for disinfection.

For NPR, approximately 180 mg/year is provided for golf course and part irrigation. Customers consist of users that are located within a reasonable distance from the discharge line that connects the F. Wayne Hill Water Resources Center to the Chattahoochee River. For IPR, approximately 30 mgd of reclaimed water is "sent back" into the Corps of Engineers Lake Lanier reservoir from which GWDWR withdraws water. The outfall diffuser is a few thousand feet from the newest, largest drinking water intake. The remainder of the reclaimed water not reused is discharged to the Chattahoochee River downstream of Lake Lanier.

The main driver for IPR was the need to return reclaimed water to the basin of origin, which includes Lake Lanier. When GCDWR looked at wastewater management options, the Georgia Environmental Protection Division (EPD) determined that an option involving the expanded discharge to the Chattahoochee River could impact dissolved oxygen levels adversely and recommended that GCWDR apply for a discharge to Lake Lanier. The Chattahoochee Basin has been at the center of the interstate water wars between Alabama, Florida, Georgia, and the rest of the United States since 1990. The Lake discharge requirements issued by EPD are stringent, and the depth of the submerged outfall diffuser was designed to mitigate any possible detrimental change in water temperature. There was opposition from an organization of lake users/property owners who wanted GCDWR to implement direct reuse. There was also opposition from environmental groups that opposed a lake discharge or advocated for direct potable reuse. The opposition was based on concerns that the proposed discharge would pollute the lake and create algae blooms in the vicinity of its popular beaches. The IPR permit process was complex and involved a four and an half year legal dispute over discharge arrangements, which reached as far as the Georgia Supreme Court. Since 1996, GCWDR ratepayers have spent approximately $1.4 billion in new infrastructure to draw from and return reclaimed water to the basin of origin.

Marin Municipal Water District (MMWD)

MMWD supplies water to a population of 190,000 in central and southern Marin County, California. The water supply incorporates a 2 mgd water reclamation plant that provides tertiary recycled water for NPR, (filtered and disinfected), which is suitable for unrestricted nonpotable reuse. The water meets total coliform requirements of 2.2 MPN/100 mL as a 7-day median and no more than 23 MPN/100 mL in any 30-day period; an average turbidity of 2 NTU within a 24-hour period, 5 NTU no more than 5% of the time within a 24-hour period; and is less than 10 NTU at any time.

MMWD receives secondary effluent from the Las Gallinas Valley Sanitary District (LGVSD) and produces tertiary recycled water that is supplied to 350 customers for landscape irrigation, toilet flushing, commercial laundries, air conditioning cooling towers, and car washes. MMWD subsidizes the recycled water system and loses about $1.5 million annually compared to revenue.

IPR is not currently an option for MMWD. Local geology consists of nonporous rock that makes a poor aquifer. Although MMWD has seven surface water reservoirs for drinking water supply, currently none of these appear to be feasible for surface water augmentation using recycled water based on expected California Department of Public Health (CDPH) regulatory requirements that may require a recycled water hydraulic retention time in a reservoir for at least 6 months. In addition, long distances and high lifts make this option extremely expensive. The same constraints apply for using other reservoirs in the general area.

The approach used to develop the water reuse program was to start with the least expensive reuse options and proceed to more costly options. However, the point has been reached where the next options entail unit costs in excess of other available marginal sources of water. For example, other NPR options are too expensive because the source wastewater has high salinity from saltwater intrusion into sewers making it unsuitable for landscape irrigation. Sewer repair or the addition of reverse osmosis (RO) treatment to remove the salt makes the cost for the water prohibitive.

Discharge of wastewater effluent into shallow areas of San Francisco Bay is prohibited in the dry season. Thus, water recycling reduces the discharge to and extends the dry season’s no discharge period for LGVSD from 3 months to 5 to 6 months.

Orange County Water District (OCWD)

OCWD is a special district responsible for managing the Orange County Groundwater Basin that provides groundwater to 20 cities and water agencies and their 2.3 million customers in northern and central Orange County. OCWD’s program includes both IPR and NPR projects to increase water reliability and protect the groundwater basin. The Groundwater Replenishment System (GWRS) can produce up to 70 mgd of advanced treated recycled water (microfiltration/reverse osmosis/advanced oxidation) for groundwater recharge by surface spreading and seawater barrier injection. Secondary effluent for treatment is provided by the neighboring Orange County Sanitation District (OCSD) free of charge; OCSD also accepts brine from the advanced treatment facility free of charge. GWRS has helped OCSD with peak flow relief and avoid the need for a new ocean outfall. An expansion of GWRS to 100 mgd will begin construction in the fall of 2011. OCWD’s Green Acres Project (GAP) can produce up to 7.5 mgd of Title 22 tertiary treated recycled water for nonpotable irrigation reuse, filtered and disinfected.

OCWD considered a number of factors when faced with the decision to construct GWRS versus expanding GAP. These included the need for additional high-quality water for the seawater barrier and for groundwater replenishment; the difficulty in recovering the capital investment for GAP based on GAP revenues; the high capital cost for NPR storage and pipelines; and the advantage of using the groundwater basin as a storage reservoir, allowing a larger project to be built and lowering unit costs. In addition, the GWRS advanced treatment enhances groundwater basin salt management.

The water reuse program has benefited from a number of unique circumstances. OCWD and OCSD essentially serve the same customer/rate payer base allowing for easier negotiation of cost sharing. OCWD's prior experience with IPR (Water Factory 21) operations and water quality, as well as OCWD's history of research and monitoring helped establish a successful working relationship and confidence with the regulatory agencies that permit and oversee GWRS. OCWD's comprehensive outreach program for the GWRS garnered public and political acceptance of the project.

San Francisco Public Utility Commission (SFPUC)

SFPUC is a retail and wholesale water purveyor, serving approximately 2.5 million customers in the San Francisco Bay Area. SFPUC currently is implementing a program to diversify local water supplies using a combination of conservation, groundwater, recycled water, and other supplies, such as desalination. Meanwhile, the SFPUC also has the objective of minimizing wastewater flows in its sewer system. No reuse projects are currently in operation; however, NPR projects are currently in the construction phase (0.31 mgd), design phase (1.6 mgd), or planning phase (2.91 mgd) to deliver tertiary treated recycled water (filtered and disinfected) primarily for landscape irritation in SFPUC's service area. The primary drivers for the reuse program are to diversify the local water supply and to offset potable water use. SFPUC has not considered IPR because the potable supply is expected to be adequate as long as some of the nonpotable uses can be shifted to alternative sources of local water (recycled water, groundwater, and conservation).

Yarra Valley Water (YVW)

YVW is the largest of Melbourne, Australia's three retail water businesses providing water supply and sewerage services to more than 1.6 million people and more than 50,000 businesses in the northern and eastern suburbs of Melbourne. The primary drivers for reuse are lack of water owing to drought and the need for a reliable water supply. During the drought, there was considerable media attention regarding scarcity of water.

YVW has two treatment plants that produce Class A recycled water, and one scheme supplying Class B recycled water. Class A recycled water has received tertiary treatment and pathogen reduction to achieve a lower (critical) limit of a 6-log removal of viruses and a 5-log removal of protozoan parasites and can be used for urban nonpotable uses with uncontrolled public access; agricultural uses (human food crops consumed raw); and industrial open systems with worker exposure potential. Class B water can be used for agricultural uses, such as dairy cattle grazing and industrial uses, such as wash down water.

Approximately 40 mg/year of Class A recycled water is used for residential applications and open space irrigation; approximately 2 mg/year of Class B water is used for golf course and other landscape irrigation. Any irrigators that require a higher quality supply along the Class B scheme must treat the water themselves to the higher standard. The use of recycled water for IPR is not allowed by state and federal policy. There are efforts underway to advance the discussion about IPR at the national level.

YVW's position is that it considers all options when investigating the feasibility of a project, including rainwater, storm water, and recycling sewage (both graywater, urine separation, and Class A/B schemes). YVW has utilized triple-bottom-line (TBL) assessments using multiple project-specific criteria to identify the preferred alternatives.

Agency 1

Agency 1 (A1) is a public agency that acts as a water wholesaler for the county in which it is located, as well as flood protection agency and steward for streams and creeks, underground aquifers, and A1-built reservoirs. In the county, recycled water is developed by four wastewater treatment plants owned and operated by local cities within the county. A1 works with these wastewater entities in partnerships to promote NPR for irrigation and industrial uses through agreements, collaborative projects, financial incentives, and technical assistance. In fiscal year 2009–2010, approximately 13 mgd of recycled water was used in the county. Recycled water currently comprises 5% of the A1's water supply portfolio.

A1's original role was passive involvement by paying $115/acre-foot (AF) to one of the local wastewater reuse agencies (M1), stimulating it to develop nearly 12.5 mgd of recycled water for NPR. A1 recently has taken a more active role by executing a long-term agreement with M1 to expand NPR in part by building an advanced water treatment (AWT) facility that will be completed in 2012. The water from the AWT facility will be blended with recycled water to improve water quality for NPR use applications and protect groundwater quality. The goal is for the blended AWT water and recycled water to have a total dissolved solids concentration of 500 mg/L. The largest NPR project that A1 supports (in partnership with M1) is 10,000 AFY of which about 2/3 is used for landscape irrigation and the remainder is supplied for industrial cooling and indoor use. Project1 provides about 8.9 mgd of recycled water for NPR. About two-thirds of this water is used for landscape irrigation and the remainder is supplied for industrial cooling and indoor use. The initial decision to supply recycled water to Project1 for NPR was decided on the basis of a number of feasibility studies that compared the cost of the NPR distribution system with various alternatives, including a deep water outfall and IPR. With the development of the AWT facility and the increased cost for expansion of NPR, A1 is reconsidering IPR and is currently exploring the feasibility of IPR via groundwater recharge and surface water augmentation.

The drivers for expanded water recycling include the desire for an increased water supply and increased reliability of the water supply, as long as the quality of recycled water is improved. A1 is concerned about salinity and constituents of emerging concern (CECs), including pharmaceuticals, ingredients in personal care products, and endocrine disruptors.

Agency 2

Agency 2 (A2) provides water, wastewater, and recycled water services to a municipality and neighboring agencies serving more than 1.3 million people in service area of more than 200 sq mi. A1 imports nearly 90% of its water from other areas. The primary drivers for water reuse are water scarcity and water supply reliability. The combination of conservation and water reclamation are expected to offset 20 to 25% of the 200 mgd total water demand.

Currently A2 provides 12 mgd of tertiary recycled water (filtered and disinfected using UV or chlorine) for NPR produced by two reclamation plants. The recycled water is suitable for unrestricted nonpotable reuse. The water meets total coliform requirements of 2.2 MPN/100 mL as a 7-day median and no more than 23 MPN/100 mL in any 30-day period; an average turbidity of 2 NTU within a 24-hour period, 5 NTU no more than 5% of the time within a 24-hour period, and is less than 10 NTU at any time.

Recycled water is used for industrial processing, cooling towers, construction site dust suppression and soil compaction, decorative fountains, and toilet and urinal flushing. Only NPR has been implemented to date, because there is a regulatory framework to follow and NPR projects generally have public support.

A2 actively addressed the feasibility of IPR via surface water augmentation; groundwater recharge is not a viable option based on the limited size of the area's groundwater basins. Initial efforts related to surface water augmentation were unsuccessful because of public opposition. A 2006 study determined that IPR through reservoir augmentation (IPR/RA) was more cost effective than expanding the NPR reuse customer base and distribution system. IPR also provides for a year-round supply. Currently, A2 is undertaking a demonstration IPR project using highly treated recycled water. The objective of the project is to define the regulatory requirements for a full-scale IPR/RA project. Public outreach is a major project component of the demonstration project.

Agency 3

Agency 3 (A3) is a joint powers agency comprised of seven cities, three unincorporated areas, and the county. A3 collects and treats wastewater from a portion of the county. Wastewater for recycling receives tertiary treatment (filtration and disinfection). The recycled water is suitable for unrestricted nonpotable reuse. See A2 for more details about the water quality. Approximately 13.6 mgd is used to irrigate food crops, including strawberries, lettuce, celery, cauliflower, broccoli, spinach, fennel, and artichokes. Water not needed for irrigation receives secondary treatment and is discharged to the ocean. The primary driver for reuse is the diminishing groundwater supply that is impacted by seawater intrusion and increased water demand.

A3 elected to start with NPR as the best solution to address demands on the groundwater basin from agriculture and prevent a seawater intrusion problem. Federal and state financing for the system was linked to water recycling. The location for the water reclamation plant location partially was determined because of its proximity to agricultural fields. NPR also was chosen based on capital cost per volume of water provided. Initially, there was opposition to the project from the county environmental health officer, who led to a comprehensive research project on the use of recycled water for irrigation of food crops. After the study was completed, the health officer helped convince the growers that the water was safe.

Up to 12.5 mgd of recycled water is available for other reuse applications. As the first of several options (in order of preference), A3 is considering NPR with water used for urban landscape irrigation. The project will require a distribution pipeline, pump stations, and storage reservoirs. The project has been designed and has completed environmental review but needs funding to proceed. It was chosen as the favored project to pursue, because it was the least expensive option and because it was a necessary component of the second option. It is also necessary to meet approved growth in an area of development in accordance with the development project's environmental review.

The second option, which is in the planning stage, is an IPR project using recycled water for groundwater recharge (GWR). The project was chosen to respond to groundwater overpumping and adjudication, the availability of wastewater during the winter, and an almost unused pipeline (the urban irrigation project if constructed) during the winter. Initially it is planned to use approximately 2 mgd of advanced treated recycled water (similar to the treatment scheme for GWRS) for injection into a regional groundwater basin. The IPR project has been delayed by political pressure to focus on a desalination project, as well as limitations for funding.

A3 is in the early planning stages for a project that would store recycled water during the winter for NPR during the summer. Options include reservoirs and ASR.

Agency 4

Agency 4 (A4) is a special district created to manage wastewater and solid waste on a regional scale. One section of service area is located in a very arid environment and services two cities (City1 and City2) and unincorporated property where A4 operates two water reclamation plants (WRP1 and WRP2). These plants have historically provided recycled water for NPR applications. Expanded use of recycled water from WRP1 for NPR and use for IPR is being considered by multiple stakeholders and a regional water management group.

The historical use of recycled water was based on proximity to WRP1 and requests by local users for water. The primary driver was a limited available water supply. WRP1 currently provides secondary treatment using aerated oxidation ponds. This type of low-technology treatment was selected when the WRP was first built based on cost, land availability, and the low populations served. On average, currently 3 mgd of secondary treated recycled water is reused at a local farm for irrigation of alfalfa and 3 mgd is used to maintain 400 acres of wetlands as a wildlife refuge. Two ancillary treatment facilities also provide recycled water. A tertiary treatment plant provides 0.2 mgd of recycled water for recreational lakes and landscape irrigation at a local park. The recycled water is suitable for unrestricted nonpotable reuse. See A2 for more details about the water quality. A membrane bioreactor/UV plant produces 0.9 mgd of recycled water used for effluent management/recycling at A4's agricultural site and by City1 for sewer cleaning and street sweeping.

Modifications to the reuse program for WRP1 have considered both IPR and expanded NPR. Feasibility studies have been conducted for IPR using recycled water for groundwater recharge. There are, however, a number of obstacles to implementation. The groundwater basin is not yet adjudicated and there is significant debate about water rights post recharge. There are limited locations in the area to recharge water by surface spreading based on hydrogeology (primarily soil conditions). In addition, the time required to obtain regulatory approval for a GWR project presents challenges in light of balancing effluent management needs.

Because of increased flow because of expanded population growth in the area and seasonal use of recycled water, the discharge of secondary effluent from WRP1 was overflowing onto a neighboring Air Force base dry lake, potentially interfering with the use of the lake bed as an emergency aircraft landing area. A4 received an enforcement order and administrative penalty that established a schedule to eliminate effluent induced overflows. As a result of the time period to satisfy these orders and the current obstacles to IPR (e.g., impeding soils, groundwater rights, time to implement), A4 elected to pursue new effluent management options, including expanded NPR as the preferred reuse approach. This effort includes converting the oxidation ponds to conventional activated sludge treatment and providing tertiary treatment for the full effluent flow. The upgrade will be completed in 2011. Thus, recycled water from WRP1 will be managed via discharge to the wetlands, impoundments and storage reservoirs, reuse at the local park (lake and landscape irrigation), and agricultural reuse operations. A sufficient quantity and quality of tertiary treated effluent will be provided to City1, and any other entities, to meet the municipal recycled water reuse demand. City1's initial goal is to implement a project to distribute up to 1.5 mgd of recycled water to municipal NPR users, with plans for future expansion.

Agency 5

Agency 5 (A5) provides drinking water, wastewater treatment and disposal, solid waste collection and disposal, and recycling. A5 operates numerous facilities, including four major water treatment plants and seven wastewater treatment plants. A5 provides reclaimed water to two sections of its service area for NPR. One system provides 9.7 mgd of water for a resource recovery facility, power plant, for golf course and residential irrigation, and commercial uses. This system has 48.5 mgd of pumping capacity and 51 mg of storage. The second system provides 10.9 mgd of reclaimed water for irrigation of golf courses, residential subdivisions, schools, and common areas in residential subdivisions and along road rights-of-way, and represents 59% of the available effluent treated. This system has 38 mgd of pumping capacity and 54 mg of storage. Treatment consists of biological treatment (all with nutrient removal except for one plant), sand filtration, and disinfection. A5 indicated that the primary goal of the reclaimed water program is to maximize the available reclaimed water for beneficial use with the result of reducing potable water consumption and ground and surface water withdrawals, and reducing the discharge of nitrogen to surface waters to meet load allocations established by Total Maximum Daily Loads. The reuse program also helps meet potable water requirements established by the local water management agency in the region.

A5 built two ASR projects using recycled water, one of which operated for six years and was shut down, and the other that was never operated. The first ASR facility yielded water with total dissolved solids and salinity concentrations that were not amenable to irrigation of turf. Arsenic mobilization in groundwater also was observed at concentrations above the drinking water standards.

With regard to IPR, a groundwater recharge project currently is being considered for creating a saltwater intrusion barrier. A pilot study project is underway.

A1.3 Case Study Assessment

A comparison of the backgrounds and circumstances of the selected agencies evaluated results in the emergence of patterns and generalizations that can be used as part of the decision framework, particularly the key determinants in decision making and the hierarchy of decisions that lead to final choices in program selection.

A1.3.1 Common Themes

Information from the templates was organized according to seven themes:

- Drivers for water reuse
- Planning approaches for implementing water reuse
- Constraints regarding implementation of IPR
- Project costs
- Economic benefits of water reuse
- Environmental benefits of water reuse
- Social, political, and legal issues related to water reuse programs

A1.3.1.1 Drivers for Reuse

As shown in Table 3, the participants generally indicated that water scarcity, drought, water reliability, increased water demand, and the need for reduced wastewater discharge were key factors for developing water reuse programs. Agencies generally needed to have at least one of these factors as a driver to be interested in water reuse. Although important, these basic drivers generally are not illuminating for understanding the choice between NPR and IPR.

Table 3. Drivers for Water Reuse

	Water Scarcity	Drought	Water Reliability	Increased Water Demand	Infrastructure in Place	Comments
Barwon Water	✓	✓ CC	✓	✓	✓	Severe drought impacted quality of life
Costa Brava	✓	✓	✓	✓	✓	Reuse is not feasible in areas where wastewater is impacted by saltwater I&I
EPWU	✓	✓	✓	✓		Reuse is somewhat limited by the need to continue discharges for downstream users in exchange for surface water credits and "time of use" rates for electricity
Global Water PVUC	✓		✓	✓		Rapidly expanding population
GCDWR	✓	✓	✓			The need to return reclaimed water to the basin of origin
MMWD	✓	✓	✓			
OCWD	✓	✓	✓	✓		
SFPUC		✓	✓			The primary driver is to diversify the local water supply; another key driver is to reduce wastewater flows in the sewer system
YVW	✓	✓ CC	✓	✓		Severe drought impacted quality of life
A1		✓	✓[1]	✓[1]		Water reuse will be supported by A1 pending improvement of recycled water quality
A2	✓	✓	✓			90% of the water supply is imported water

Table 3. Drivers for Water Reuse

	Water Scarcity	Drought	Water Reliability	Increased Water Demand	Infrastructure in Place	Comments
A3	✓		✓	✓		Reuse is needed to relieve demands on a stressed groundwater basin; it is condition for financing; it is required for approved growth in an area of development
A4	✓	✓	✓	✓		Limited effluent management options; rapidly expanding population; regulatory enforcement
A5	✓		✓	✓	✓	Reuse also is driven by the need to reduce surface water and groundwater withdrawals, reduce discharges and pollutant loadings to surface water

Notes:
CC = climate change
[1] Concerns regarding salts and CECs

A1.3.1.2 Planning Approaches

By looking at the planning approaches used by the participating agencies, other decision making factors were apparent. As shown in Table 4, some participants have been involved in long-term planning, more recent planning efforts (including TBL in one case), or not specific planning activities at all. Even in cases where agencies were engaged in long- or short-term planning, the philosophy for implementing reuse is based on existing treatment and availability/proximity of customers. This approach inherently includes starting with the least expensive options and proceeding to more expensive options.

Some agencies, such as Barwon Water, started with this approach, but have shifted to adding additional treatment to provide higher quality water for more NPR applications. For some of the participants, such as EPWU, some of the water reclamation treatment facilities were built specifically to provide water for reuse.

Table 4. Planning Approaches for Water Reuse

	Planned from Beginning of Program	Planning Now Part of Program	TBL	Comments
Barwon Water		✓		Started by using existing treatment and available customers
Costa Brava				Evolved over time; no specific planning
EPWU		✓	Retrospective study	Started by basing decisions on historic demand combined and in proximity to users; some facilities have been specifically built for reuse
Global Water PVUC				Information was not provided on specific planning activities
GCDWR	✓			Planning primarily directed at wastewater management options that lead to IPR
MMWD	✓			Started with the least expensive options and proceeded to more costly options; all new options are cost prohibitive
OCWD	✓			Assessed expansion of NPR versus implementing IPR
SFPUC	✓			Decision making for selection of specific projects is unclear
YVW	✓		✓	TBL studies are available
A1		✓		Passive role by working with wastewater agencies in partnerships
A2	✓			2006 and an ongoing study evaluating NPR versus IPR
A3				No planning process for decision making regarding implementation; recycling is considered “the right thing to do” for the region
A4		✓		Historic reuse was on the basis of proximity to the treatment plant and requests by local users for water
A5				The selection of customers is a function of economic feasibility and proximity to the reclamation plant; a master plan has been prepared

YVW has utilized TBL assessments using multiple project-specific criteria to identify the preferred alternatives. Each time a TBL assessment is conducted, YVW selects the key parameters specific to the project and key stakeholders. YVW also uses a pair-by-pair comparison of variables because of the highly subjective nature of multicriteria analysis. Another model is being evaluated that uses a software voting package, allowing all participants to vote with a hand set, which then shows the collective votes on a screen. It shows the distribution of votes, after which a discussion can follow to understand the votes better, and gives everyone the opportunity to recast their vote if they would like. This includes an added sensibility test to make sure all voting is consistent.

Other agencies, such as A1, have taken a passive role in water reuse implementation by working with wastewater agencies in partnerships. A1 also has provided subsidies and now participate in cost-sharing agreement for an AWT facility to improve recycled water quality for NPR.

A1.3.1.3 IPR Constraints

Of the 14 selected agencies, three are actively operating IPR projects using recycled water that has received advanced treatment:

- EPWU – groundwater recharge
- GCDWR – surface water augmentation
- OCWD – groundwater recharge

As shown in Table 5, for the remaining agencies, some are considering IPR (A1, A2, A3, A4, and A5), and some are not (Global Water PVUC, MMWD, SFPUC, and YVW).

Table 5. IPR Constraints[2]

	Under Consideration	Regulatory	Hydrogeology	Reservoir Design	Public Opposition	Other
Barwon Water	P[1]	Y[2]	N/A	N/A	N/A[3]	
Costa Brava	N	Y[2]	N/A	N/A	N/A[3]	
Global Water PVUC	N	N/A	N/A	N/A	N/A[3]	Corporate decision not to pursue IPR; concern over impacts on water quality (salts and CECs)
MMWD	N	Y[4]	Y	Y	N/A[3]	
SFPUC	N	N/A	N/A	N/A	N/A[3]	IPR not considered
YVW	N	Y[2]	N/A	N/A	N/A[3]	
A1	N	N	N	N	N[5]	When first considered, considered too costly; lack of political will to implement

Table 5. IPR Constraints[2]

	Under Consideration	Regulatory	Hydrogeology	Reservoir Design	Public Opposition	Other
A2	Y	Y[6]	Y[7]	N	P[8]	
A3	Y	P[9]	N	N/A	Y[10]	Lack of funding
A4	Y	N	Y	N/A	P[11]	Time to implement in light of effluent management needs
A5	Y[12]	---	---	---	---	ASR projects for NPR were discontinued because of arsenic mobilization and cost

Notes: Y = yes; N = no; N/A = not applicable; P = possibly

1 Agency is conducting ASR research, but the feasibility of using recycled water is not clear (regulatory obstacles).

2 Existing regulations do not allow it.

3 No projects have been proposed to test public acceptance.

4 The regulatory restrictions do not apply to groundwater recharge. They only apply to anticipated surface augmentation requirements for retention time in reservoirs.

5 The proposals were not specifically addressed but were of concern to the agency.

6 IPR/RA projects are allowed, but there are no current or draft regulations for IPR/RA; A1 is working with regulators on requirements.

7 Groundwater recharge is not feasible because of the small size of the groundwater basin.

8 The originally conceived IPR/RA project met with public opposition; current outreach efforts have shown there is more interest and openness to the concept.

9 Some of the proposed regulatory requirements may be challenging to meet.

10 Opposition is from local potable water purveyors; a public outreach program is being conducted.

11 Opposition may originate from a battle over groundwater rights.

12 A pilot study project is currently underway.

For the three agencies that implemented IPR, there are some interesting factors that should be considered:

- EPWU implemented IPR in the absence of state IPR regulations (not even draft regulations were available). The permit requirements were negotiated with state regulators.
- OCWD implemented IPR using regulations that allowed for project approval on a case-by-case basis and draft groundwater recharge regulations as guidance.
- GCDWR implemented IPR on the basis of a need to return reclaimed water to the basin of origin, which includes the lake being augmented with water (Lake Lanier). This decision was compelled by state regulators in establishing wastewater discharge limits that precluded other wastewater management options.

For agencies that have not implemented IPR, there are a number of key determinants:

- Lack of political will
- Corporate/agency philosophy that is opposed to potable reuse

- Regulatory restrictions, particularly the lack of regulations or IPR is not allowed under current regulations
- Lack of funding
- Time to implement—typical IPR projects are complex to permit
- Physical limitations, such as lack of appropriate hydrogeology for a recharge project to be implemented or limitations in reservoir configurations that conflict with regulatory requirements, such as retention time

Public opposition did not appear to be a current determinant for the agencies evaluated.

A1.3.1.4 Project Costs

The cost information provided by the participants was in many cases incomplete or not helpful in understanding how decisions were made. In some cases, projects received extensive grants, loans, or subsidies that impacted costs. In other cases, the costs were considered null, because they were part of the wastewater management program. For one participant, MMWD, the water reuse program loses about $1.5 million annually compared to revenue.

A1.3.1.5 Economic and Environmental Benefits

As shown in Tables 6 and 7, the participants generally indicated that avoided use of traditional water supplies, improved supply reliability, ecosystem enhancement, and groundwater protection were key factors for developing water reuse programs.

Although important, they are not illuminating for decision making, because they are common factors for support of water reclamation.

Table 6. Economic Benefits of Water Reuse

	Avoided Use Traditional Water Supplies	Avoided Wastewater System Upgrades
Barwon Water	✓	✓
Costa Brava[1]	✓	
EPWU	✓	
Global Water PVUC	✓	
GCDWR[2]		
MMWD[3]		
OCWD	✓	
SFPUC		
YVW		
A1	✓	✓[4]
A2	✓	✓[5]
A3	✓	
A4		
A5	✓	

Notes:
1 The reuse system is subsidized.
2 GCWDR ratepayers have spent approximately $1.4 billion in new infrastructure to draw from and return reclaimed water to the basin of origin.
3 MMWD loses about $1.5 million annually compared to revenue.
4 The addition of advanced treatment for NPR will facilitate maintenance of the filter system at source wastewater treatment plant and extend the useful life of the plant.
5 IPR implementation will avoid costs to upgrade a wastewater treatment plant that discharges to the ocean to meet anticipated regulatory requirements.

Table 7. Environmental Benefits of Water Reuse

	Ecosystem Enhancement	Groundwater Protection	Reduced Marine Water Discharge	Energy Savings Versus Other Alternatives
Barwon Water			✓	
Costa Brava	✓	✓[1]		✓[2]
EPWU	✓[3]	✓		
Global Water PVUC		✓[4]		
GCDWR[5]				
MMWD	✓[6]		✓[7]	
OCWD		✓	✓[8]	✓
SFPUC			✓	
YVW	✓[9]		✓[10]	
A1	✓	✓[11]		
A2	✓[12]		✓	
A3		✓	✓	
A4	✓[2]			
A5[13]		✓[3]	✓	

Notes:

1 For some areas where reuse has occurred, there are increased groundwater elevations and decreased salinity.
2 Compared to desalination
3 Water is used for wetlands
4 The benefit to groundwater, other than reduced production, was not provided
5 IPR was implemented to return reclaimed water to the basin of origin, which is the subject of water wars between Alabama, Florida, Georgia, and the rest of the United States.
6 Reduced take from natural streams
7 Helps meet discharge prohibition to San Francisco Bay
8 Helps OCSD with peak flow relief and avoids the need for a new ocean outfall
9 Reduced demand on water supplies and streams
10 Reduced nitrogen discharge to Port Phillip Bay
11 Achieved by adding advanced treatment for NPR
12 Will improve salinity levels in a reservoir used for IPR/RA
13 Reduced discharge of wastewater and pollutants to surface water (the specific TMDL requirements were not provided); in 2009 the reuse system eliminated approximately 19 tons of nitrogen from entering area surface waters.

With regard to environmental benefits, some specific factors may be important for the framework:

- Reuse reduces the discharge of pollutants to surface waters (such as reduced nitrogen).
- Reuse helps meet wastewater discharge limitations or prohibitions to surface water.

A1.3.1.6 Social, Political, and Legal Issues

As shown in Table 8, the participants had varied experiences with regard to public opposition, political issues, legal issues, and institutional issues. Effective public outreach programs were linked with changes in positions from opposition to support in the community.

Table 8. Social, Political, and Legal Issues

	Public Opposition	Outreach Program	Political Issues	Legal Issues	Institutional	Improved Supply Reliability
Barwon Water	N- NS	Y[1]	N	N	---	✓
Costa Brava	N	Y	N	---	---	✓
EPWU	N	Y	M	N	---	✓
Global Water PVUC	N	Y	---	P	Y	✓
GCDWR	Y	Y	Y	Y	--	
MMWD	N	Y	---	---	Y[2]	✓
OCWD	L[3]	Y	L[4]	N	N	✓
SFPUC	Y	Y	Y[5]	N	---	✓
YVW	N	Y[6]	Y[7]	---	---	✓
A1	N	ID[8]	N	Y	Y	
A2	P[9]	Y	Y[10]	N	N	✓
A3	Y[11]	Y	Y[12]	Y	Y[2]	✓
A4	Y	---	Y	Y	---	
A5	M	P	Y[13]	N	---	✓

Notes:

N = none; NS = not significant and resolved; Y = yes; M = minimal; L = limited;
--- = information not provided; ID = in development; P = possibly.

1 Not specifically related to water recycling, but to the water program

2 Opportunities for use of recycled water dependent on removal of institutional barriers, cooperation, or formation of collaborative partnerships

3 Limited to IPR. The concerns were based on public health but were addressed by inviting the individuals and groups with concerns to oversee or participate in the project's planning, feasibility, and risk studies.

4 Limited to IPR. These issues were resolved as part of the outreach program and by providing one superior level of water quality.

5 For siting of NPR facilities

6 For some projects

7 Varied by project from lack of water to the environmental condition of a local creek

8 For IPR

9 The originally conceived IPR/RA project met with public opposition; current outreach efforts associated with the demonstration project have shown there is more interest and openness to the concept.

10 Support of IPR/RA from the governing body has shifted from opposition to support.

11 For NPR: originally from the local health officer, but was resolved by a long-term research study on the safety of using recycled water for irrigation of food crops; for IPR, from local potable water suppliers.

12 For planned NPR and IPR projects

13 Resistance to conversion of older flat rate customers to metered customers, which has reduced the program's ability to better manage the resource

For example, the OCWD experienced some limited initial opposition to its IPR project on the basis of public health concerns, but these were addressed by inviting the individuals and groups with concerns to oversee or participate in the project's planning, feasibility, and risk studies, which ultimately demonstrated the effectiveness of the multibarrier advanced treatment technologies and comprehensive monitoring plan. Focus groups, telephone surveys, and surveys of likely voters were conducted by OCWD. Much of the extensive project outreach was performed by OCWD staff (as opposed to hired public relations consultants), which helped confirm a personal commitment to an open and transparent project planning and development process. Outreach efforts successfully communicated with elected officials, the business community, taxpayer groups, environmental organizations, and the medical/public health community to obtain project support.

For GCDWR, the opposition was quite different. The IPR project was opposed by an organization of lake users/property owners who wanted GCDWR to implement direct potable reuse. The Lake Lanier Association, Sierra Club, and Upper Chattahoochee Riverkeeper appealed the state-issued Lake Lanier discharge permit on the basis of concerns about growth and that the discharge would pollute the lake and create algae blooms in the vicinity of its popular beaches. GCDWR went through a complex regulatory and legal process that involved a 4½-year legal dispute over discharge arrangements, which reached as far as the Georgia Supreme Court.

Institutional issues are another challenge for some agencies that want to develop reuse programs. For example, A1 is responsible for water supply and environmental stewardship but not wastewater treatment. The administering agency for the wastewater treatment plant (M1) has multiple interests but especially wastewater treatment. These interests have not always overlapped. Spending resources of M1's wastewater enterprise on a strictly water supply project initially was deemed illegal, even though M1 is also a retailer of potable water to a portion of the city within A1. Resolution of the shared costs for a reuse project took three years of weekly meetings in a facilitated "coordination" process. For A3, which has a planned urban irrigation project, the local water district is focusing on a desalination project, whereas A3 and the cities are trying to expedite the urban irrigation project, which has brought the project to a standstill.

With regard to legal issues, these tend to focus on water and are case-specific. For example, in the case of A4, the lack of an adjudicated groundwater basin was a significant constraint for moving forward with IPR. In that case the specific issue was what rights the agency or private entity had to the recycled water once it comingled with groundwater. In the absence of adjudication, this would depend on where a recharge project was located and where the groundwater would be withdrawn. Although not specifically noted by many of the case studies, water rights often play a critical role in decisions regarding water reuse. Water rights law determines the extent to which an individual can use the water that runs across, underlies, or moves through the atmosphere above a person's property. Such laws are complex and can be a significant obstacle to NPR and IPR. Diversion of wastewater for reuse can reduce water flowing to a natural watercourse and impact downstream water rights holders or can impact aquatic ecosystems adversely.

A1.3.2 Summary of Findings

The case studies confirm that long-term water scarcity, drought impacts in the shorter term, and wastewater management considerations are the drivers for reuse. They are necessary conditions for interest in reuse, but they generally do not provide distinguishing factors in selecting IPR versus NPR. The case studies revealed that specific constraints are the major driving factors for the choice between IPR and NPR. The major constraints are cost, regulatory issues, and water quality impacts and concerns. For a few of the case studies, the issue of water rights was cited as an obstacle for moving forward with IPR. Typically, this issue is a critical determinant for the diversion of wastewater for any type of water reuse. Also of note is that public opinion was not raised by the case study participants as a major current IPR obstacle, even though this issue has resulted in past failure to implement numerous proposed IPR projects (according to Resource Trends Inc. *Best Practices for Developing Indirect Potable Reuse Projects: Phase I Report*. WRRF-01-04, WateReuse Foundation, 2004). Cost is not always a constraint that forces choice of one type of option over another. In those cases, cost is an important criterion by which the choice between project options is judged. In many cases IPR may be perceived as the most cost-effective option, because it allows use of recycled water year round instead of only in the irrigation season, the advantage of using the groundwater basin as a storage reservoir, or the potable water distribution system already exists (as illustrated by OCWD and A2). However, the case studies showed that there are circumstances where NPR was viewed as the more cost-effective option (for example, Global Water PVUC).

A1.3.3 Next Steps for Decision-Making Framework

The case studies discussed in this report help show what considerations have been important in the decision between NPR and IPR projects. The decision framework for this project is designed to guide utilities systematically through the decision process to help ensure that important considerations are not overlooked and provide a tool for weighing multiple criteria in project selection. The tool will present criteria that may impact decision making in a triple-bottom-line (TBL) context and provide supporting information that is navigated easily to understand and weigh these criteria.

The next step is to organize the case study information for use as a reference in support of the decision framework. The case study information can be used as supporting information for each of the TBL criteria in the decision support framework. For instance, information on the impact of public opinion regarding NPR and IPR projects from the case studies will be incorporated into a discussion of public opinion in the framework that will introduce the concept, give examples from the case studies, and provide concluding thoughts on how the concept fits into the planning decision framework.

A1.4 Case Studies

Case Study WRRF-09-02	**Barwon Water**
BACKGROUND	
Name of Agency	Barwon Water
Do they want to be anonymous? (Y or N)	N
Agency contact(s) [name, email address, phone number]	Rhys Bennett Rhys.Bennett@barwonwater.vic.gov.au T (03) 5226 2545 | M 0409 017 719 | W www.barwonwater.vic.gov.au
Location	Geelong, Victoria, Australia
Brief description of the agency (what they do with regard to water or wastewater management or other)	Barwon Water (Barwon Region Water Corporation) is Victoria, Australia's largest regional urban water corporation, providing world-class water, sewerage and recycled water services to more than 275,000 people across 8100 sq km. (See http://www.barwonwater.vic.gov.au/about/about.) We manage more than $1 billion in assets, including • 10 major reservoirs • 10 water treatment plants • 9 water reclamation plants • 13 groundwater bores • 206 pumping stations • 39 local water storages • More than 5700 kilometers of pipes

<table>
<tr>
<td>Are you currently reusing water?

If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?</td>
<td>
Yes. Barwon Water’s nine water reclamation plants treat up to 20,000 ML/year of raw sewage using several different technical processes. See reuse table following.
All plants produce “Class C” recycled water, which is reused onsite, provided to external customers or discharged to the environment. Class C recycled water has received secondary treatment and pathogen reduction based on a risk assessment outlined in the Australian Guidelines for water recycling 2006. Class C recycled water can be used for restricted nonpotable uses with controlled public access (i.e., golf courses, sporting facilities); agricultural uses (such as human food crops cooked/processed, vineyards, grazing/fodder for livestock); and industrial systems with no potential worker exposure. See Recycled Water fact sheet: http://www.barwonwater.vic.gov.au/image_get. cfm?id=A2439580
<table>
<tr><th rowspan="3">Treatment plant</th><th colspan="3">2009-2010</th></tr>
<tr><th colspan="3">Actual</th></tr>
<tr><th>Volume produced (Ml)</th><th>Volume reused (Ml)</th><th>% Reused</th></tr>
<tr><td>Aireys Inlet WRP – Lagoon</td><td>98.73</td><td>98.73</td><td>100%</td></tr>
<tr><td>Anglesea WRP - Mechanical</td><td>277</td><td>95</td><td>34%</td></tr>
<tr><td>Apollo Bay WRP − Mechanical</td><td>469</td><td>15</td><td>3%</td></tr>
<tr><td>Bannockburn WRP – Lagoon</td><td>48</td><td>48</td><td>100%</td></tr>
<tr><td>Colac WRP − Mechanical</td><td>1515</td><td>22</td><td>1%</td></tr>
<tr><td>Lorne WRP − Mechanical</td><td>289</td><td>15</td><td>5%</td></tr>
<tr><td>Portarlington WRP – Lagoon</td><td>138</td><td>138</td><td>100%</td></tr>
<tr><td>Winchelsea WRP– Lagoon</td><td>21</td><td>21</td><td>100%</td></tr>
<tr><td>Black Rock WRP − Mechanical</td><td>15,965</td><td>2565</td><td>16%</td></tr>
<tr><td>Summary Totals</td><td>18,820</td><td>3017</td><td>16.0%</td></tr>
</table>
The largest use is the irrigation of flowers for the cut flower market; however, the Class C water also is used to irrigate golf courses, turf growing, racetracks, sports ovals, potatoes, hydroponic tomatoes, wine grapes, lucerne, and tree lots. Smaller volumes are used for dust suppression and construction.
The type of treatment at the plants was not chosen with reuse in mind. All plants are relatively old, and the treatment train was chosen based on cost, operation, and its ability to produce consistent effluent that could be disposed of appropriately.
Class A recycled water has received tertiary treatment and pathogen reduction to achieve a lower (critical) limit of a 6-log removal of viruses and a 5-log removal of protozoan parasites (https://epanote2.epa.vic.gov.au/EPA/publications. nsf/2f1c26257317 46aa4a256ce90001cbb5/d20acdacef3d03bfca257067001 c13d0/$FILE/1015.pdf).
Class A water can be used for urban nonpotable uses with uncontrolled public access; agricultural uses (human food crops consumed raw); and industrial open systems with worker exposure potential. The use of recycled water is governed by the Environmental Protection Authority (EPA) and the Department of Health (DOH), which is responsible for providing Class A accreditation of schemes.
Class A has not been implemented yet, but will be by 2012. This is described further as follows.
</td>
</tr>
</table>

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Despite drought breaking rains in the region in 2010, climate change is expected to reduce the yields of surface water catchments over the medium to longer term. In response to this long-term threat to water security, Barwon Water has augmented its existing water supplies through new groundwater (Anglesea Borefield) and surface water (Melbourne Geelong Pipeline); however, the long-term outlook suggests further declines in surface water and increased demand because of strong regional population growth. Recycled water (for nondrinking purposes) from water reclamation plants is considered to be a critical component of a more diverse water supply portfolio because it • Is a climate independent source of water that is available all year round • Can replace up to 40% of potable water use especially in new, greenfield residential developments • Adds to the livability and marketability of these new urban landscapes. • Is strongly supported by the community • Strongly supports the urban water cycle management and reduces discharge of treated effluent to the environment By 2007, at the peak of the drought, severe water restrictions had been implemented in Geelong. This water security threat drove renewed interested in the potential for a higher level of recycled water, which could be used to offset demand for potable supplies, especially in the rapidly expanding residential areas of Geelong. In response to this challenge, Barwon Water worked in partnership with local, state and federal governments, and private companies, such as the Shell Refinery to secure substantial investment commitments to cofund the significant recycled water production infrastructure required to deliver Class A recycled water where it was most needed, including • The Black Rock Recycled Water Plant – Stage 1 (2012) $35 million. The new Black Rock Recycled Water Plant will receive secondary effluent from the existing Black Rock Water Reclamation Plant and further treat it to produce high-quality, Class A recycled water. The treatment process will include ultra-filtration (UF) and reverse osmosis (RO), as well as disinfection via ultraviolet (UV) light and chlorine dosing. The Class A water will be supplied through a dual pipe reticulated network to more than 22,000 residential and business properties in the Armstrong Creek Urban Growth Area and more than 3000 properties in the Torquay North growth corridor. • The Northern Water Plant (2012) $90 million, supplying 2000 ML of Class A water to the Shell Oil Refinery and adjacent sports fields. The plant will use biological treatment, UF, and RO. Barwon Water's increased use of recycled water is underpinned by three strategic commitments: • To providing sustainable, high-quality, and affordable water services to existing customers • To provide recycled water from water reclamation plants (increase to 25% reuse by 2015) to new customers where it is economically, environmentally, and socially efficient to do so • To support dual reticulation schemes in greenfield urban developments where supported by developers and local government and provided there is a satisfactory business case accompanying the scheme Barwon Water also is conducting research related to aquifer storage and recovery (ASR). During the research phase, only groundwater (previously extracted) will be injected into the bores. The eventual source of water may be recycled water, stormwater, or even excess surface water. Currently no project is committed beyond the research phase. The research phase is expected to be completed by 2012.

If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, etc.	Not applicable
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	Reuse always was considered as an option to diversifying Geelongs water supply system for the future. As part of Barwon Water's water supply demand strategy, a wide range of other water supply options worth more than $766 million over 5 years are being constructed, including new water storage and reservoir improvements (see http://www.barwonwater.vic .gov.au/projects /more-projects).
For each reuse option: What alternatives were considered, and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	Black Rock RWP Alternatives considered: (1) maintaining the existing Class C output and developing additional markets for the Class C water; or (2) adding treatment to provide Class A recycled water. The second alternative was chosen as a Class A plant is crucial to meeting the increased recycled water needs of the community, industry and agricultural sector and is a direct response to the community's expectations on sustainable water management. The key drivers for the project are to • Save valuable drinking water and secure the region's supply through a diversified supply system • Supply Class A recycled water to new water-sensitive communities • Make better use of water by reducing the quantity of treated water discharged to the ocean

	Northern Water Plant There were no alternatives. The Shell Refinery continues to use 2000 ML/year of potable water. In addition to this, the downstream sewerage network would require significant and costly augmentation if the new plant was not constructed so there were multiple benefits, such as • An immediate 2000 ML reduction in Geelong's drinking water use (5% of current demand, equivalent to the water used in 10,000 homes) • High-quality Class A recycled water for industry and community ventures, such as sporting grounds, in Geelong’s northern suburbs • A 10% reduction in excess recycled water discharged to ocean at the Black Rock Recycled Water Plant • Around 150 new jobs and associated flow-on economic benefits
Was the project developed with other agencies; if so, what were the roles of other agencies?	Yes. All projects required support and assistance from a wide range of stakeholders. Class A recycling required partnerships with local, state, and federal governments, private developers, industry, and the community to ensure recycled water use was supported. These stakeholders also were required to provide substantial investment commitments to cofund the significant recycled water production infrastructure required to deliver Class A recycled water where it was most needed.
Was there major leadership input from the community? Was there opposition from the community?	Yes, there has been leadership input from the community in developing Barwon Water’s Class A recycled water projects. *A Perceptions and Attitudes Study* conducted by BW (Sweeny Research, 2008) asked business and community customers whether they support recycling water so that it can be used for nondrinking purposes. The results show that 96% of people surveyed “strongly” or “somewhat” supported recycling water for nondrinking purposes. Total support for water recycling was higher than the alternatives of subsidizing rainwater tanks and sourcing water from underground aquifers. The research concluded that, “There is clearly strong support for recycling water for non-drinking purposes. BW [Barwon Water] could lead projects that support the development and implementation of recycled water, with considerable community support.”
Were there any unique circumstances favoring or impeding progress?	Yes. As mentioned, at the time of planning and implementing many of Barwon Waters recycled water schemes, Barwon Water was experiencing a period of prolonged drought leading to severe water restrictions. This certainly was a unique factor favoring progress in this area.
ECONOMIC and FINANCIAL	
Project costs (for the reuse component only, not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	Class C reuse costs not involving the wastewater treatment plants are minimal, as the infrastructure servicing these customers was privately installed and operated. Class A: Black Rock RWP – Stage 1 (2012) $35 million Northern Water Plant – (2012) $94 million Acre-foot yield: unknown.
Avoided costs as a result of utilizing the reuse option, did the	Avoided costs: Yes. • Northern Water Plant – experienced tens of millions of dollars of avoided costs through upgrades to the downstream sewerage network.

utility Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion/upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	• Black Rock RWP – experienced avoided costs through minimal downgrades to the water reticulation network
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	Yes, the customer survey as described earlier identified strong support for recycled water.
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	Both the Black Rock RWP and the Northern Water Plant projects required investment from a wide range of stakeholders. Northern Water Plant: $94 million total Australian government: $20 million Victorian government: $9 million Barwon Water: $17.5 million Shell Refinery: $47.5 million Black Rock RWP: $35 million total Australian government: $10 million Barwon Water: $25 million Loans – Unknown The price of connections to customers for Class A recycled water is done in accordance the Essential Services Commission (ESC), a government regulated body in Victoria. In accord with the ESC, Barwon Water is required to fund shared water assets (>150 mm diameter), whereas the developer is required to fund reticulation assets (<=150 mm). There are contracts with existing Class C customers.
	The pricing principle for Class A recycled water is a percentage of the variable charge for potable water. This approach negates the problem of discrete pricing for separate dual pipe schemes. The principle sends a consistent message regarding the value recycled water and customers willingness to pay regardless of the area the customer lives, similar to postage-stamp pricing currently adopted in Barwon Water for potable water. Developers and customers have certainty regarding the price they will have to pay for recycled water upfront, reducing the likelihood of any conflict occurring. The pricing principle for Class C recycled water is as per the ESC pricing principles,

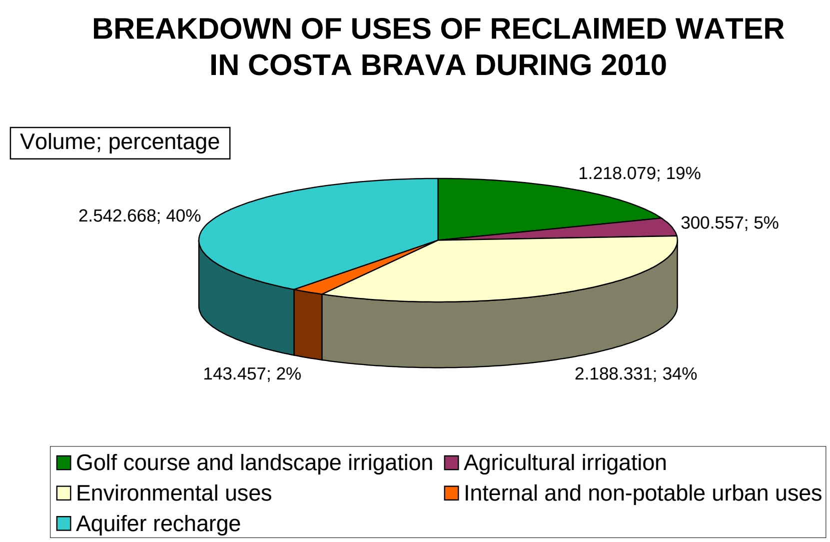
	whereby the full cost of providing the service is recovered. As Class C recycled water generally does not form part of drinking water supply-and-demand balance, it cannot be justified to be cross subsidized from the rest of the customer base. The price includes a variable component based on consumption.
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, etc.)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	The use of recycled water avoids the use of potable supplies. The increased use of recycled water at Barwon Water's water reclamation plants leads to a reduction in the volumes of treated Class C water discharged to the environment, which in most cases is the ocean. The implementation of the Northern Water Plant upstream of the Black Rock RWP increases the salt content of the incoming sewage, thus necessitating RO treatment at Black Rock.

Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	The use of recycled water for drinking is currently against government policy in Australia. There are efforts underway to advance the discussion about this option at the national level. The most prominent example is the Beenyup Groundwater Replenishment Trial in Perth, Western Australia. (See http://www.environment.gov.au/water/policy-programs/water-smart/projects/wa02.html.) This project is providing UF, RO, and UV disinfection to produce very high-quality water. The water will then be injected into the Leederville aquifer at a location remote from existing drinking water bores where it will be further cleansed by natural groundwater processes. The aim of the project is to provide the basis for raising community confidence, gaining regulatory approval, and demonstrating technical feasibility to deliver groundwater replenishment using recycled water as a new, sustainable water source option for Australia. At this stage Barwon Water's position is that aquifer storage and recovery (ASR) is currently against government policy and as such is not being considered. In the future, that position could change if government policy changes.
SOCIAL and POLITICAL	
Public acceptance/ opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	Black Rock RWP To date there has been no opposition to this project. Northern Water Plant There was some opposition to this project from a small number of adjacent land owners. The objection was related largely to plant location in the vicinity to housing, not related to the use of recycled water. Significant amounts of public consultation were implemented but they were unrelated largely to recycled water use, which was always supported.

Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	No.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	As described previously, during the planning phases of these projects there was significant water stress in the community because of drought and water restrictions. Obviously with restrictions, the region's water supplies were not sufficient to meet demand. However more recently, there has been a higher rainfall, and Barwon Water currently is investing in a number of projects that aim to secure Geelong's water supply for the future. These projects include the Northern Water Plant and the Black Rock Recycled Water Plant. Through the implementation of such projects, it is unlikely that the greater Geelong area will experience water restrictions in the future.
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	In terms of what was important, it varies dependent on the user. Factors include reliability, cost, diversification of supply, substitution of potable water, and others.
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	Class A water – yes, the same level of service as potable water. Class C water – quantity and quality are not guaranteed: however, agreements are in place to ensure recycled water is available for a set period of agreement. The customer acknowledges that there may be issues beyond Barwon Water's control that may impact quantity and quality, but the agency will endeavor to provide supply in accordance with the agreement.
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	Yes. A new Recycled Water Planning and Business Unit was created to manage the increased requirements associated with Class A recycled water.

Energy/Carbon Footprint: Quantify energy use in kilowatt hours. What are the pounds or kilograms of emission for each applicable green-house gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?	Northern Water Plant – Average of 3500 MWh/year Black Rock RWP – Average of 3500 MWh/year
Were there legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	Barwon Water has sought legal advice on a number of issues relating to water reuse. It is not felt that any issue has hindered the progress of a scheme.
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration, and if so, please describe the role (for example was storage needed to make the option feasible and why– this is intended to be a cost question)?	Yes, storage was required for most schemes. ASR currently is being investigated as a potential storage mechanism for recycled water. ASR has the potential to store significant volumes of recycled water at a reduced cost to aboveground storage.
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	Class A water needs to be stored in a lined and covered storage facility.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	Yes. Barwon is still in the process of evaluating ASR as a potential storage option. This evaluation will consider the full range of storage options to determine the preferred.
Other?	---

Attachment A — Barwon Water Reuse Project Cost Estimate Form		
Part 1. Cost Estimate Available from Agency? (Record in whatever form it is available in the box directly following and then ask whether specific cost elements are included.)		
Northern Water Plant Utility/Agency's Cost Estimate: Capital: $94 million – Multiple investors (Barwon Water, Shell Refinery, federal government, state government) Annual O&M: Approximately $4 million/year. http://www.barwonwater.vic.gov.au/projects/nwp		
Year in which cost estimate was made: 2011		
Part 2. Cost Estimate Clarification		
Category	**Included in Part 1?**	**Additional Estimate (if available)**
Preconstruction	Y	
Research	Y	
Planning	Y	
Design	Y	
Capital	Y	
Treatment	Y	
Distribution system	Y	
Pumping	Y	
Storage	Y	
Flow equalization	Y	
Brine disposal	Y	
Land acquisition	Y	
Buildings and structure	Y	
Other	Y	
Annual Cost Elements	Y	
O&M labor	Y	
Chemicals	Y	
Electric power	Y	
Membrane replacement	Y	
Repairs	Y	
Spare parts	Y	
Insurance	Y	
Contingency	Y	

<table>
<tr><th>Case Study
WRRF-09-02</th><th>Consorci Costa Brava</th></tr>
<tr><td colspan="2">BACKGROUND</td></tr>
<tr><td>Do they want to be anonymous?
(Y or N)</td><td>N</td></tr>
<tr><td>Agency contact(s)
[name, email address, phone number]</td><td>Luís Sala
lsala@ccbgi.org
+34 972201467 / +34 972222726</td></tr>
<tr><td>Location</td><td>Girona, Spain</td></tr>
<tr><td>Brief description of the agency (what they do with regard to water or wastewater management or other)</td><td>Consortium of 27 municipalities in coastal, touristic area in Northeast Spain. Wholesale supplier of drinking water, wastewater collection and treatment, and water reclamation and reuse for nonpotable uses. The population varies from 240,000 to more than 1 million in the summer.</td></tr>
<tr><td>Are you currently reusing water?
If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?</td><td>


Volume is 10^3 m^3 (2,542,668 m3).
The following is a description and number of the water reclamation facilities in operation in the Costa Brava area as of first half of 2011.
<table>
<tr><th>List number</th><th>Description and number of facilities</th></tr>
<tr><td>1</td><td>Constructed wetland system (cw) (1)</td></tr>
<tr><td>2</td><td>Disinfection (chlorine) (ch) (1)</td></tr>
<tr><td>3</td><td>Combined disinfection, UV (uv) + chlorine (ch) (1)</td></tr>
<tr><td>4</td><td>Sand filtration and combined disinfection (1)</td></tr>
<tr><td>5</td><td>Coagulation, flocculation, double-step filtration, combined disinfection (6)</td></tr>
<tr><td>6</td><td>Title-22 with combined disinfection (2)</td></tr>
<tr><td>7</td><td>Microfiltration and reverse osmosis – pilot plant (1)</td></tr>
</table>
</td></tr>
</table>

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	The main drivers are scarcity of water for main single water users (golf courses and other irrigated areas, as well as in the case of nature enhancement and aquifer recharge by surface percolation). More specific factors include • Overextraction, depletion, and pollution of the small coastal aquifers (mid 1960s). • Increase in nonpotable urban demand (golf courses, private, and municipal gardens) (late 1980s mid 1990s). • Significant investment for an adequate supply of drinking water (water transfers and desalination) (late 1980s to early 2000s). • Significant investment in wastewater collection and treatment to biological, secondary level (mid 1970s to present day). Effluent discharged into the sea through submarine outfalls was the common practice; a valuable resource was lost. • An additional treatment (reclamation) produces safe water to cope with nonpotable demands equals more logical resources management in the area, especially in dry periods (see http://ccbgi.org/docs/jornada_riyadh/l_sala_riyadh_2009-2-final.pdf). Costa Brava did not have a reuse program, in the sense that everything was planned from the start. Instead, projects have been developed gradually over time. Water and recycling has been promoted where there was an interest by the user. Until now, interested users have been those who have had the need to find water resources for the irrigation of their facilities (mostly golf courses but also some small agricultural fields); that is why most of the supply is for irrigation. Spanish regulations for water reuse were passed in late 2007, much later than some of the initiatives. With regard to IPR, current Spanish reuse regulations do not address IPR, and thus the focus for Costa Brava has been on nonpotable uses. In Costa Brava, golf courses are located on the outskirts of urban areas and not in the middle of them, and thus golf courses are not considered within the urban supply category. They are connected directly to the reclamation plants and are treated as a different kind of user. Reclaimed water supply through municipal networks are a logical evolution of the water reuse activities in Costa Brava, after confidence of using reclaimed water has been gained because of its use as a successful supply for golf courses and for the other uses in the area. Among the three municipalities that have built a reclaimed water distribution network (Tossa de Mar, Lloret de Mar and Port de la Selva), two (Tossa de Mar and Lloret de Mar) based the decision on limited resources and also the high cost of drinking water (desalination plant); Port de la Selva based its decision on the severe limitations for drinking water. The main idea in all these cases is to supply reclaimed water to cover a portion of the nonpotable municipal water demand. In Port de la Selva, an additional project delivers reclaimed water upstream of the local creek from October to May in dry years to produce recharge by percolation.

If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	In some municipalities in Costa Brava, reclaimed water schemes have been developed that involve direct use for irrigation and other nonpotable uses in summer and aquifer recharge by percolation in winter. This occurs mostly in northern Costa Brava, where rain is scarcer and sometimes municipalities rely solely on small, local aquifers. For those municipalities in Costa Brava where reuse is not occurring or is not planned, it is usually because of the high salinity of wastewater, mostly because of seawater intrusion into the sewer lines. Note: Unless otherwise indicated, the information provided in the remainder of the template is for the three reclaimed water systems: Tossa de Mar (2007), Lloret de Mar (2007), and Port de la Selva Tossa (2010).
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	The consideration of other options is case-specific. Sometimes, like in the small village of El Port de la Selva, the reclaimed water distribution system has been implemented, because its cost was much smaller than the drinking water augmentation investments that had been evaluated (delivering water through a branch of the northern Costa Brava main pipeline system). In other cases (i.e., Portbou and Colera, and two other small villages in northern Costa Brava), the Catalan Water Agency (ACA) has taken action without considering the reuse alternative seriously. In Portbou and Colera, two small desalination plants have been built but are idle, because they will be necessary only under extreme drought. The cost of the desalination plants was subsidized entirely by ACA. Thus, on the basis of the small volumes supplied and the subsidization, it is difficult to compare the actual cost of the desalination plants to water reuse costs.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	Decisions on the construction of reclaimed water distribution systems in Tossa de Mar and Lloret de Mar have been independent from other options, because the goal was to develop a local resource, safe and usable for nonpotable uses. In Port de la Selva, the goal was to increase the guaranteed supply through the replacement of drinking water used for nonpotable purposes.

Was the project developed with other agencies; if so, what were the roles of other agencies?	Tossa de Mar, Lloret de Mar, and Port de la Selva have been implemented at the municipal level with different degrees of financial aid by ACA. CCB, the middle administration level between ACA and municipalities, has provided technical support.
Was there major leadership input from the community? Was there opposition from the community?	The communities, until now, have remained rather neutral and have trusted the decisions by these municipalities. There would have been complaints if there had been failures (poor quality, smell, etc.), but that it is not the case. In Tossa de Mar, the first reuse project was the creation of a local park (Parc de Sa Riera), which was a former uncontrolled landfill area. Because it was such a positive transformation, reclaimed water has had an especially good reputation in that village. In Lloret de Mar, reclaimed water is used mostly to irrigate the Santa Clotilde Gardens (http://www.flickr.com/photos/lluissala/sets/72157615992219351/), which is one of the main local attractions.
Were there any unique circumstances favoring or impeding progress?	In Tossa de Mar, many of the streets of the village had to be opened for the installation of natural gas, and it was then when the municipality installed the reclaimed water pipelines. In Lloret de Mar, the goal was to find a reliable and cheaper option than drinking water for the maintenance and enhancement of Santa Clotilde Gardens. In Port de la Selva, it was because 3 consecutive years with rain of less than 350 mm/year and the high cost of bringing other drinking water to the municipality that made water reuse for nonpotable uses a viable, short-term option to increase guarantee of supply.
ECONOMIC and FINANCIAL	
Project costs (for the reuse component only, not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	Information was provided for the Tossa de Mar project: • Infrastructure: – Constructed, 837.000 € • Water reclamation plant: 35 m3/h (max 840 m3/day), 472,000 € (2002) • Distribution network: 5500 m, 365,000 € (2006) – Pending, 226,000 € (budget) • Gravity storage tank
Avoided costs, as a result of utilizing the reuse option, did the utility. Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion/ upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	

Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	No market surveys were conducted. Quality requirements were evaluated according to Spanish regulations (Royal Decree [RD] 1620/2007).
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	In Tossa de Mar: Water reclamation plant: 100% ACA Distribution network: Municipality and Diputació de Girona (provincial government) Until now, ACA has been paying the operation and maintenance costs of the reclamation plant (100,000 m^3/year produced) as a sort of demonstration project for the use of reclaimed water in municipalities. Average direct cost (chemicals, energy, maintenance, analysis) equals 0.11 €/m^3 for a reclamation treatment that has coagulation, flocculation, sedimentation, filtration, and disinfection. The future trend will be aimed at recovering a portion of the investment for municipal reuse through reclaimed water tariffs. Tariffs have not yet been defined or applied for the supply to municipal networks because of the low volume of reuse (part of the demonstrations). It is likely that the tariffs will be established in the next year or so. For private users (golf courses, agriculture, a winery), there are contracts and a demand dependent charge with an average price of 0.12 €/m^3.
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)?	All three projects are avoiding the use of some traditional water supplies, but it is true that some new water uses have appeared because of the availability of reclaimed water. A few gardens have been created, and the irrigation of others has been improved, and street cleaning can occur with no water restriction in mind. The overall result is that these three municipalities are cleaner and greener than they would be if they did not have a reclaimed water distribution system. Apart from this, it is obvious that discharges into the sea have been reduced by that amount that it is reused. In the case of Tossa de Mar and Lloret de Mar, where a portion of water comes from a desalination plant, the development of the local resource (reclaimed water) and the replacement of some drinking water for nonpotable uses also is producing energy savings (not defined). In Tossa de Mar, in Parc de Sa Riera, there is an indirect recharge of a local stream through soil percolation that prevents its total desiccation in summer, which has been proven essential for macroinvetebrates and other aquatic flora and fauna in very dry years.

<table>
<tr>
<td>Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others?

Were wetlands created or enhanced as part of the project?

Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?</td>
<td>For the Blanes Water Reclamation Plant (Lloret de Mar and Tossa de Mar), which supplies reclaimed water for aquifer recharge and agricultural irrigation, the project has resulted in increased groundwater levels and decreased groundwater salinity (caused by seawater intrusion).</td>
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<tr>
<td>Regulatory requirements:

Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?</td>
<td>The Spanish reuse regulations only apply to specific uses—urban, agricultural, industrial, recreational (limited), and environmental—and is not allowed for human intake, except in cases of catastrophe, fountains, and other ornamental ponds in public places or buildings, hospitals and similar facilities, aquaculture of filter feeder mollusks culture, and recreational bathing activities. It is only allowed on a limited basis for the food industry and cooling towers and steam condensers.

The initial goal was to comply with the reclaimed quality for uses under category 1.2 of RD 1620/2007 for public services and gradually approach compliance with category 1.1, which will open the door for the irrigation of private gardens. The reclaimed water is achieving the more stringent E.coli limit (<1/100 mL consistently, 100% absence in 2 consecutive years in Tossa de Mar) but has not yet met the turbidity limit of 2 NTU limit 90% of the time based on current treatment systems. (No membrane treatment systems have been installed yet.)
<table>
<tr><th colspan="2" rowspan="2">USES</th><th colspan="4">GLOBAL PARAMETERS</th><th colspan="2"></th></tr>
<tr><th>Intest Nema</th><th>E. COLI</th><th>SS</th><th>TURB</th><th>LEGIO NELLA</th><th>Ha Sub</th></tr>
<tr><th></th><th></th><th>egg/10L</th><th>CFU/100ML</th><th>mg/L</th><th>UNT</th><th>CFU/L</th><th>µg/</th></tr>
<tr><td>1</td><td>URBAN</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.1</td><td>Residential</td><td rowspan="2">1</td><td>0</td><td>10</td><td>2</td><td rowspan="2">100</td><td rowspan="2">EQ</td></tr>
<tr><td>1.2</td><td>Services</td><td>200</td><td>20</td><td>10</td></tr>
</table>
HACCP has been applied and the key parameters and processes (i.e., turbidity, residual chlorine, and disinfection) are governed by online probes. If certain values related to disinfection are not met, the supply is automatically shut down, so any water that may not comply with the regulations will never leave the facility.</td>
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<tr>
<td colspan="2">SOCIAL and POLITICAL</td>
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<tr>
<td>Public acceptance/ opinion:

Was there opposition to the project because of public health concerns?

Were public opinion polls taken, or public meetings or focus groups conducted?</td>
<td>No public opposition.

Wastewater treatment and water reclamation and reuse is explained in the visits to the facilities by schools, so that children can learn from these experiences.</td>
</tr>
</table>

Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	Leadership was clearly from the municipalities for the three cases.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	Because of its geographical position and lack of connection to other water sources, Port de la Selva's drinking water supply is impacted easily by droughts. Reclaimed water may play an essential role in increasing the guarantee of water supply, either as a direct supply for nonpotable uses (summer) or as by aquifer recharge via percolation (autumn, winter, and spring). Lloret de Mar and Tossa de Mar have a greater reliability of the supply of drinking water because they both rely on two sources: the Tordera river aquifer and the Blanes desalination plant, both located in Blanes, which is further south. There is a big energy cost in production and transportation, and thus reclaimed water provides a more sustainable resource (less energy is consumed per m^3) for nonpotable uses.
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	The main value is reliability. Cost may also be a factor, but maybe second, because when the demonstration period funded by ACA ends, municipalities will have to take care of these costs.
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	Reclamation treatment plants are operated following specific protocols and several internal controls to ensure compliance with RD 1620/2007.

<table>
<tr><td>Organization and business integration issues:

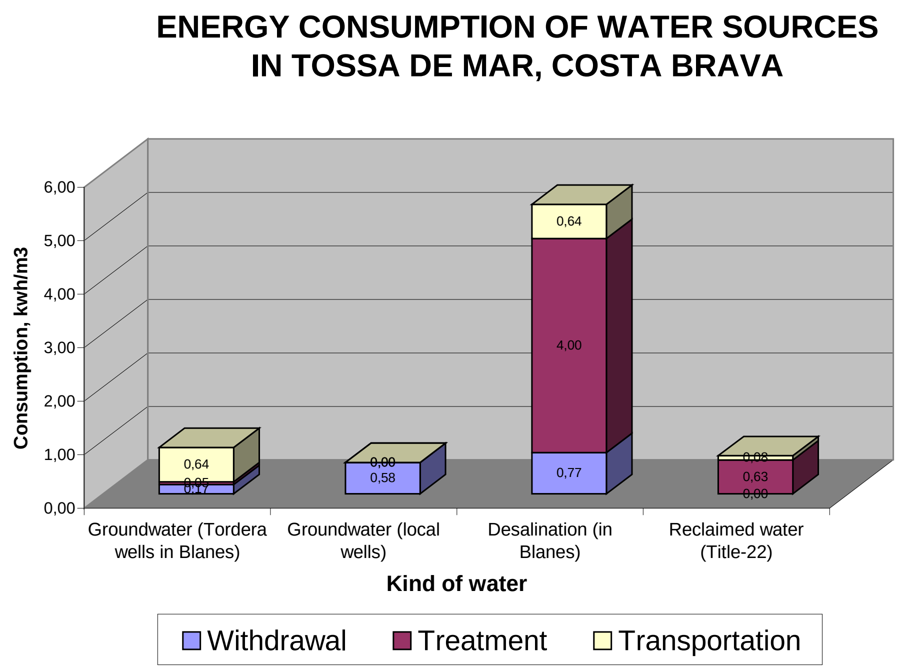
Was it necessary to make institutional re-arrangement or changes?

Were there any institutional barriers and if so what were they? Could they be overcome?</td><td>ACA is changing the way concessions for the use of reclaimed water are given: when the only users were large, single consumers (i.e., golf courses), concessions were given directly to them. Golf courses had to reach an agreement with CCB to determine the conditions of the supply.

Now, with the introduction of the supply through municipal specific networks, ACA is planning to give CCB a general concession of all treated wastewater, so CCB reclaims and supplies water to the municipality for the uses approved in the RD 1620/2007. CCB will have to obtain a permit for each reclamation treatment and a description of them, plus the operational protocols and safety measures needed so that these general concessions can be evaluated thoroughly.</td></tr>
<tr><td>Energy/Carbon Footprint:

Quantify energy use in kilowatt hours.

What are the pounds or kilograms of emission for each applicable green-house gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?</td><td>



</td></tr>
<tr><td>Were there legal issues that helped or hindered implementation?

Water rights? Liability? Public access issues? Other?</td><td>---</td></tr>
<tr><td colspan="2">TECHNICAL FEASIBILITY and ENGINEERING</td></tr>
<tr><td>Was storage a technical consideration, and if so, please describe the role (for example was storage needed to make the option feasible and why — this is intended to be a cost question)?</td><td>Port de la Selva has a small storage tank in the reclaimed water plant and a large gravity one (relative scale to production) from which water enters the network.

Lloret de Mar lacks a storage tank in the reclaimed water plant (it was taken out of the project for financial reasons), and now this is making the operation of the system more difficult. There is a small gravity tank that supplies the network.

Tossa de Mar has a large storage tank at the reclamation plant, which makes operation much easier but lacks the gravity storage tank. The network is supplied from pressure pumps at the reclaimed water plant.</td></tr>
</table>

Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	---
Were there other technology evaluations/needs considered in deciding which option to choose over another?	---
Other?	---

Attachment A — Consorci Costa Brava, Spain Reuse Project Cost Estimate Form (not completed by participant)

There is further information about Tossa de Mar and Lloret de Mar ones (in Catalan) in the following links:

- http://ccbgi.org/docs/informe_xarxes_aigua_regenerada_tossa_i_lloret_2007_-_versio_20090820.pdf
- http://ccbgi.org/docs/jornada_r_d_costa_brava/11_Marin_xarxes.pdf
- http://ccbgi.org/docs/jornada_xarxes_aigua_regenerada_2010/03_emacbsa_xarxes_tossa_i_lloret.pdf

For further information see:

http://ccbgi.org/activitats.php

http://ccbgi.org/publicacions.php

Case Study WRRF-09-02	**El Paso Water Utilities (EPWU) Public Service Board**
BACKGROUND	
Do they want to be anonymous? (Y or N)	N
Agency contact(s) [name, email address, phone number]	Edmund G. Archuleta, PE, President/CEO earchuleta@epwu.org
Location	El Paso, Texas
Brief description of the agency (what they do with regard to water or wastewater management or other)	The Public Service Board was established May 22, 1952, by City Ordinance No. 752 to completely manage and operate the water and wastewater system for the City of El Paso. The seven-member board of trustees, which make up the Public Service Board, consists of the Mayor of the City of El Paso and six residents of El Paso County, Texas, who are appointed by the El Paso City Council for four-year staggered terms (www.epwu.org). Also see "Strategic Plan" at www.epwu.org/Public_Information EPWU operates two surface water treatment plants, four groundwater arsenic treatment plants; multiple wells, booster stations, and reservoirs; four wastewater treatment plants that produce reclaimed water for a variety of uses; and (in a joint project with Fort Bliss), the Kay Bailey Hutchison Desalination Plant, which is a 27.5 mgd brackish inland groundwater desalination plant. (See http://www.twdb.state.tx.us/innovativewater/reuse/projects/reuseadvance/doc/PhaseB_final.pdf, page112.)
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes – NPR and IPR. EPWU supplies more than 7 mgd of reclaimed water for reuse. Type I reclaimed water is provided for various NPR applications, such as irrigation, industrial (cooling tower make up water, cooling processes), construction (dust abatement and compaction), and commercial businesses (car washing, street cleaning, etc.). Advanced treated reclaimed water is used for aquifer recharge, in-plant uses, and irrigation of pasture (grazing). The quality of the advanced treated water meets potable water standards prior to application. Note: Type I uses include irrigation or other uses in areas where the public may be present during the time when irrigation takes place or other uses where the public may come in contact with the reclaimed water. It must meet a 30-day turbidity standard of 3 NTU, 30-day geometric mean standard for fecal coliform or *E. coli* of 20 CFU/100 mL, and a 30-day geometric mean standard for *Enterococci* of 4 CFU/100 mL.

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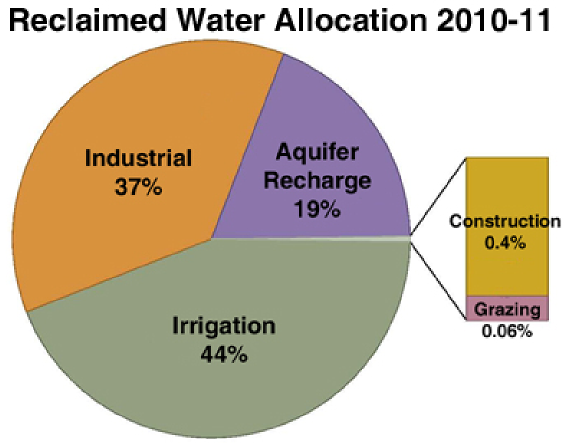

Three of the four facilities treat wastewater to advanced secondary standards. One facility (the Fred Hervey Water Reclamation Plant or FHWRP) provides advanced treatment to meet potable water quality standards. Treatment at FHWRP includes sand filtration, and disinfection accomplished through chlorination, UV plus chlorination, or ozonation. Treatment processes were selected on the basis of economies of scale and available technology during the respective construction or upgrade periods.
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For those reusing water, they need to tease out what helped them decide to start or decide between different reuse practices (NPR versus IPR), or decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process.
Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.
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Water is scarce, with an average rainfall of 8 inches per year and an average evaporation rate of 80 inches per year. El Paso shares groundwater from the Hueco Bolson and the Mesilla Bolson aquifers and surface water from the Rio Grande River with communities in New Mexico and Ciudád Juarez, Mexico. Water from the Rio Grande is available only during the spring, summer, and early fall months and is further limited in years of drought. As a result of long-term pumping that began in the early 20th century to sustain increasing growth, groundwater pumping exceeded the recharge rate, and groundwater levels declined in the Hueco Bolson aquifer.
“Implementation of multiple uses” —this was the result of addressing the needs of “large water users” that included large irrigation sites (golf courses, parks, schools, and others) and industrial uses (cooling tower makeup water, wash-down and other cooling processes). IPR was selected as a means of extending the life of the aquifer and because the FHWRP was not nearby a natural conveyance system, such a river, stream, or others. An additional consideration in the selection of a water reuse scheme was that the municipal wastewater in the northeast area of El Paso served by the FHWRP is mostly of domestic origin and contains less than 0.1% industrial wastes. (See http://www.twdb.state.tx.us/innovativewater/reuse/projects/reuseadvance/doc/PhaseB_final.pdf, page112.)
Decisions to create or expand plants were driven by historic circumstance of demand combined with geography (proximity of a wastewater treatment plant to water users). Wastewater from two of the plants is discharged to downstream farmers for irrigation, and in exchange, EPWU receives credits for surface water.
Current decisions about changing the program or expanding the program toward one type of use versus another and what is driving the decision-making process.
Continuous drought and water supply shortages have required the creation of a sustainable supply that includes a comprehensive portfolio of water resources alternatives (surface and ground water, reclamation, desalination of brackish water, and future importation of groundwater).
Note: EPWU develops a 5-year strategic plan that addresses reclaimed water. See http://www.epwu.org/public_info/2011_Strategic_Plan.pdf.
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If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]. Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Not applicable
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	A solid conservation program has been the basis of EPWU's water resources planning. It has been instrumental in managing water resources. The success in decreasing the per capita water consumption is largely attributed to EPWU's effective conservation program. Groundwater desalination was incorporated in 2007 to offset the increasing demands because of growing population.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	El Paso has four wastewater treatment plants that assist with distribution of reclaimed water. Reclaimed water was demand-driven, as well as driven from a long-term water resources plan. • The FHWRP was built in the 1980s originally for sustainability purposes to preserve the aquifer. This plant would have been developed to support aquifer storage and recovery (ASR) even if there had not been large NPR users available to reuse the water. • The Northwest Wastewater Treatment Plant (NWWTP) reuse system was started because the plant already had filters and the effluent already met Type I reuse regulatory requirements. Large demand was anticipated (golf course irrigation). • The R. Bustamante WWTP was developed to serve an adjacent industrial park, which would also promote reclaimed water. • The reuse system at Haskell R. Street WWTP was demand-driven and for further development of sustainable resources.
Was the project developed with other agencies; if so, what were the roles of	The Texas Water Development Board and U.S. Bureau of Reclamation provided assistance with funding. The Texas Commission on Environmental Quality (TCEQ) provided regulatory overview.

other agencies?	
Was there major leadership input from the community? Was there opposition from the community?	Leadership: Yes. Reclaimed water has been generally well accepted. Opposition: Not really.
Were there any unique circumstances favoring or impeding progress?	Favoring: financial participation from other agencies in the form of grants and loans; reuse reduced demand on the aquifer to extend its life.
ECONOMIC and FINANCIAL	
Project costs (for the reuse component only, not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	Reclaimed water – the original cost asset value as of 2/28/10: Includes reclaimed water pipe, reservoir tank, and pump station as appropriate, according to *EPWU Reclaimed Water Rate Study*, Draft Report 2010 NWWTP: $22,907,074 Haskell WWTP: $12,968,558 Bustamante WWTP: $6,841,247 FHWRP: $60,650,407 O&M 2010-11 NWWTP: $767,000 Haskell WWTP: $1,368,000 Bustamante WWTP: $1,296,000 FHWRP: $3,591,700
Avoided costs as a result of utilizing the reuse option, did the utility Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion /upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	There were avoided costs related to an alternative water supply. Plant expansions or upgrades: No expansions but some upgrades were needed for reuse, such as construction of additional filters at some of the facilities. A TBL (triple bottom line) study is underway. Past estimates indicate as much as approximately $500 million in avoided costs were accrued because of conservation programs, which include reclaimed water.

Market surveys and analysis: what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	Yes. Surveys were conducted as part of the respective preliminary studies for each project and included customer class, peaking, number and location of customers, reuse water quality requirements, and soil analyses to determine unsuitable soils for reclaimed water applications.
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	Payment: Funding varied by project. The U.S. Bureau of Reclamation (25/75 cost share); the Texas Water Development Board (loans); the U.S.EPA (50/50 cost share). • Sharing between agencies: Yes, as stated. • Grants: Yes, varied by project. • Loans: Yes, varied by project. Connections: • Connections to the customer were included as part of the project for those with dedicated meters for the specific use (i.e., irrigation, industrial processing). Customers without dedicated meters were required to pay for the new service installation. • All customers paid for onsite adjustments to separate systems or install new systems. • Some customers were offered a deferred rate implementation plan because of the significantly extensive amount of onsite adjustments. • Initially, the rate was structured according to the quality of the reclaimed water (higher rate for advanced quality, lower rate for secondary quality). Later, the rate was homogenized so that all customers pay the same rate. Contracts (user agreements) included the terms and conditions of service. In cases where a special rate was established, this was stipulated in the user agreement and its maturity term.
ENVIRONMENTAL and PERMITTING	

Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, etc.)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project?	• Avoids increase in dependence on traditional supplies and extends the life of groundwater aquifer. • Reuse works against meeting discharge releases/obligations to third parties. Wastewater inflows have remained relatively unchanged; however, increases in reuse reduce the amount of available effluent to meet contractual requirements with third parties (irrigation district). • Wetlands. At the FHWRP site, there is a wetland that has supported migratory fauna for a long time. Improvements at this plant have improved the quality of the ecosystem. The Rio Bosque wetland was created from discharge of wastewater from the Bustamante WWTP (which was not counted in the reuse allocation presented earlier). • Environmental costs. Traffic disruptions have been observed and accounted for during the planning phases of the project. However, these are temporary impacts related to the construction of the infrastructure and its maintenance (main breaks, etc.).
Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	
Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of	Yes. TCEQ. Note: there are no state IPR regulations.

groundwater, Hazard Analysis and Critical Control Points [HAACP])?	
SOCIAL and POLITICAL	
Public acceptance/ opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	Issues related to public acceptance: • Degradation of the soil owing to the higher salinity content in reuse water at some of the plants and the peculiarity of native soils (clay and caliche). Public meetings: • Public meetings were held as part of National Environmental Policy Act/Finding of No Significant Impact requirements. Public education: • EPWU's ongoing public outreach efforts include presentations at events, and targeted meetings where new projects are discussed.
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	Political issues: • Minimal.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	• Surface water is subject to drought, which periodically limits availability. • Groundwater will be depleted if overused. EPWU is trying to protect the aquifer. • Reclaimed water is limited to certain areas. • Desalination is reliable but expensive to operate. • Importation is extremely expensive. It is a more than 35 years option.
For all classes of	Increasing the cost of potable water; the economic cost of reclaimed water; and

users, what are the benefits that were most important for the users: reliability cost of water, others?	reclaimed water's reliability during times of drought.
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	Yes. The number of customers and amount of water sold.
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes?	Institutional arrangements: A reclaimed water program team was created under Environmental Compliance as part of the Operations Division to market the service and coordinate connection of customers with other departments (engineering, new installations, etc.). This team also implements and enforces State and local regulations, and reports compliance to the state authorities. Institutional barriers: Yes, with city government (building services and its plumbing and irrigation groups). Sometimes the city groups are not aware that a particular development intends to use reclaimed water. Implementation of codes is for potable water systems and not reclaimed water, which creates a conflict with EPWU staff when trying to enforce reuse code. The same conflict occurs during inspection of new installations: who should inspect for reuse code compliance?
Were there any institutional barriers and if so what were they? Could they be overcome?	These inconsistencies can be overcome with better communication or with tools that allow both entities to track these applications.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	Different sand filters were considered before selection.
Other?	---
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why — this is intended to be a cost question)?	Storage was a hydraulic need to operate the system in a multipressure zone scheme. Any unused reclaimed water can be discharged into the river or canal, or used for ASR, depending on the facility.
Were there infrastructure standards and	Yes, in accordance to TCEQ (30TAC210)

requirements that had to be considered (these are structural requirements)?	
Were there legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	• Water rights: in the long run, potential water rights issues might arise. • Liability: maybe. • Public access: no.
TECHNICAL FEASIBILITY and ENGINEERING	
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?	Reclaimed water energy usage, 2010 (kWh): • Northwest – 543,750 • Haskell – 704,450 • Bustamante – 503,400 • Fred Hervey – 2,153,300 Information provided by Mr. Zuazua of El Paso Electric: the carbon footprint is approx. 1.38lbs of CO_2 /kWh in year 2008 figures. (based on a personal communication with Carlos R. Zuazua, El Paso Electric Environmental Manager, P.O. Box 982, El Paso, Texas 79960).

Attachment A – EPWU Reuse Project Cost Estimate Form Attachment A (not completed by participant)

Case Study WRRF-09-02	**Global Water Palo Verde Utilities Company (PVUC)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	N
Agency contact(s) [name, email address, phone number]	Graham Symmonds Graham.symmonds@gwresources.com 623-580-9600 x 106 (office) 602-615-4532 (mobile)
Location	City of Maricopa, AZ
Brief description of the agency (what they do with regard to water or wastewater management or other)	PVUC is an investor-owned utility (owned and operated by Global Water Resources). PVUC provides wastewater collection and treatment, as well as recycled water distribution. Global Water – Santa Cruz Water Company is the sister investor owned utility providing potable water service.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes. PVUC generates approximately 2.2 mgd and distributes this to recycled water retention structures (lakes) throughout the service area. Home owner associations (HOAs) use these RWRS storage facilities as irrigation water for HOA-owned irrigation systems. PVUC operates a 3.4 mgd (design capacity) AquaAerobics Sequential Batch Reactor (SBR) treatment facility with cloth media filtration and UV disinfection. [Note: the PVUC Annual Report provided shows that the plant capacity is 9 mgd, so there is a conflict with the information provided in the template. The project team was unable to resolve this issue with PVUC.] PVUC has an Arizona Pollutant Discharge Elimination System (AzPDES) permit for discharge to the Santa Cruz Wash in the event that there is insufficient demand for recycled water (winter/rainy periods).
For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the	Direct NPR was chosen to maximize the use of "the right water for the right use." In PVUC's opinion, using the water while it is available and on the surface saves power (when compared to aquifer recharge and recovery) and saves on potable water treatment costs (as reclaimed water is provided as part of the City of Maricopa development in lieu of potable water. Using recycled water also increases the available resources significantly in the water-short Pinal Active Management Area (AMA). The Pinal AMA has a "renewable groundwater" capacity of 82,500 AFY (source: Pinal AMA Groundwater Users' Advisory Council). The Arizona Department of Water Resources (ADWR) allows for available recycled water to be used as a source in Designations of Assured Water Supply, reducing drawdown of groundwater. References: http://www.gwresources.com/pdf/twm.pdf http://www.gwresources.com/land-use-section.php).

program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	
If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Not applicable.
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	No.

<table>
<tr>
<td>For each reuse option:
What alternatives were considered and what were the most important elements distinguishing them?
What criteria were used in selecting between project options and in selecting specific alternatives?
What were the most important of these criteria?</td>
<td>See “Power and Water Efficiency of Recycled Water” (DB09-152)
Note: This is a general paper that is not specific to the project described in the template. The project team was unable to obtain more specific information about the project. In addition, in this paper, PVUC fundamentally advocates against IPR via groundwater recharge because of perceived water quality impacts (salts and CECs).
PVUC has used a quantitative model calibrated from field experience and data accumulated from the Santa Cruz Water Company and Palo Verde Utilities Company. The model looked at three sources of water and three reuse alternatives, and came up with the following analysis of front-end capital expenditures (infrastructure) and cost to the consumer (monthly billing).
<table>
<tr><th>Water Resource Scenario</th><th>Level of Reclamation</th><th>Infrastructure Total (per EDU)</th><th>Monthly Billing (per EDU/Mo)</th></tr>
<tr><td>Groundwater/No Treatment</td><td>None</td><td>$6,494</td><td>$83.19</td></tr>
<tr><td>Groundwater/No Treatment</td><td>Basic</td><td>$6,694</td><td>$80.99</td></tr>
<tr><td>Groundwater/No Treatment</td><td>Advanced</td><td>$8,214</td><td>$85.94</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Surface Water</td><td>None</td><td>$12,428</td><td>$164.26</td></tr>
<tr><td>Surface Water</td><td>Basic</td><td>$10,533</td><td>$133.45</td></tr>
<tr><td>Surface Water</td><td>Advanced</td><td>$11,610</td><td>$132.33</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Arsenic Treatment</td><td>None</td><td>$6,945</td><td>$104.03</td></tr>
<tr><td>Arsenic Treatment</td><td>Basic</td><td>$6,985</td><td>$94.48</td></tr>
<tr><td>Arsenic Treatment</td><td>Advanced</td><td>$8,472</td><td>$97.87</td></tr>
<tr><td colspan="4">EDU - Equivalent Dwelling Unit ● EDU/Mo - Equivalent Dwelling Unit Monthly</td></tr>
</table>
The analysis also looked at water savings and water savings in terms of cost to customer.</td>
</tr>
<tr>
<td>Was the project developed with other agencies; if so, what were the roles of other agencies?</td>
<td>---</td>
</tr>
<tr>
<td>Was there major leadership input from the community?
Was there opposition from the community?</td>
<td>PVUC predated the incorporation of the City of Maricopa.
The community is very supportive of recycled water and has used its leadership in water resources management to characterize the city as “THE Green Hub.”</td>
</tr>
<tr>
<td>Were there any unique circumstances favoring or impeding progress?</td>
<td>This is a new city. The City of Maricopa grew 4081% from the year 2000 to 2010 (U.S. Census Data). This means there was a “clean sheet” from an infrastructure perspective allowing for installation of potable and sewer infrastructure at the same time with no retrofitting required.</td>
</tr>
</table>

ECONOMIC and FINANCIAL	
Project costs (for the reuse component only, not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	The original capital cost was $108,338,370, including land, structures, equipment, reservoirs, and distribution systems. Current operating expenses are $6,464,213/year.
Avoided costs, as a result of utilizing the reuse option, did the utility Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion /upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	The avoided costs provided are not specific to the example project but relate to reuse in general.
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	Not applicable.
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan?	Equity from parent company and Industrial Development Authority (IDA) bonds

Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	The major environmental impact is reduction in groundwater use.

Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	Needed A+ for use. Class A reclaimed water is required for reuse applications where there is a relatively high risk of human exposure to potential pathogens in the reclaimed water and must meet a total nitrogen concentration of less than 10 mg/L.
SOCIAL and POLITICAL	
Public acceptance/opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	No opposition. PVUC built an education center (Global Water Center) and provides outreach via tours and materials: http://www.gwresources.com/community-outreach.php
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation?	Winning over the financial regulator, the Arizona Corporation Commission (ACC), was – and still is – hard. Its definition of the public interest is "lowest cost water." This is inconsistent with the philosophy of sustainable water management.

Leadership from the community or the utility?	
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	Reclaimed water is part of the AMA water portfolio. http://www.azwater.gov/AzDWR/WaterManagement/Assessments/documents/PinalAssessmentFinal5-18-2011.pdf
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	Reliability of supply. Ability to have amenities [like water for] turf and water features.
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	Not specifically but are in the process of developing
Organization and business integration issues: Was it necessary to make institutional rearrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	Global was founded on the certainty of water scarcity so the business is built around recycled water.
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh	Provided a report, "Power and Water Efficiency of Recycled Water," that is not applicable for the example project but is for water reuse in general

Were there legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	Use of recycled water as a source in DAWS was important. Note: the project team was unable to obtain additional information on DAWS and the specific legal issues involved. The Arizona Corporation Commission (ACC) financing restrictions are a hindrance. Note: the project team was unable to obtain information on the specific restrictions imposed by ACC.
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why—this is intended to be a cost question)?	The project uses reservoirs as an integrated part of the scheme.
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	See Global Design Standards (http://www.gwresources.com/standards-for-pdc.php) and Acceptance of Underground Facilities (http://www.gwresources.com/ Construction_and_acceptance_of_underground_utilities.php)
Were there other technology evaluations/needs considered in deciding which option to choose over another?	Not really. Membranes were deemed unnecessary for the uses; however, if a project was to take recycled water directly to homes or if the recycled was ever used for IPR or direct potable use, membranes would be used as a treatment barrier.
Other?	---

Attachment A – Global Water PVUC Reuse Project Cost Estimate Form

Part 1. Cost Estimate Available from Agency? (record in whatever form it is available in the box directly below and then ask whether specific cost elements are included.)

Utility/Agency's Cost Estimate:

Capital: $108,338,370

Annual O&M: $6,464,213 (monthly flows are available in the report provided by Global PVUC).

Year in which cost estimate made: 2010

Part 2. Cost Estimate Clarification		
Category	**Included in Part 1?**	**Additional Estimate (if available)**
Preconstruction	N	
Research	N	
Planning	N	
Design	N	
Capital		
Treatment	Y	
Distribution system	Y	
Pumping	Y	
Storage	Y	
Flow equalization	N	
Brine disposal	N	
Land acquisition	Y	
Buildings and structure	Y	
Other	Power equipment, flow measurement devices, pumps, lab equipment, office furniture and equipment	
Annual Cost Elements		
O&M labor	Y	
Chemicals	Y	
Electric power	Y	
Membrane replacement	N	
Repairs	N	
Spare parts	N	
Insurance	Y	
Other	Contracts, taxes, depreciation	
Contingency	N	

Case Study WRRF-09-02	Gwinnett County Department of Water Resources (GCDWR)
BACKGROUND	
Do they want to be anonymous? (Y or N)	N
Agency contact(s) [name, email address, phone number]	Frank Stephens frank.stephens@gwinnettcounty.com 678-376-7133
Location	Gwinnett County, GA
Brief description of the agency (what they do with regard to water or wastewater management or other)	GCDWR is responsible for water supply, water production and distribution, wastewater collection, wastewater treatment, and storm water for approximately 750,000 Gwinnett County residents.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes – both NPR and IPR Advanced treated reclaimed water is produced at the F. Wayne Hill Water Resources Center, which was developed in two phases. Phase I provided biological treatment for complete nitrification, partial denitrification, and phosphorus reduction. Tertiary treatment processes include ferric chloride chemical coagulation/clarification followed by granular media filters, pre-ozone and granular activated carbon (biologically enhanced activated carbon), and ozone disinfection. As part of a Phase 2 expansion, the tertiary treatment process included metal salt coagulant addition/clarification for reduction of phosphorus, organics and solids; ultrafiltration for turbidity and particle (pathogen) removal; blending with the existing granular media filter effluent followed by pre-ozone/ granular activated carbon for organics removal; and final ozonation for disinfection. NPR. The existing reuse line is located along the northeastern portion of the county from the F. Wayne Hill Water Resources Center to the Chattahoochee River. The location of the line limits service to potential customers who are feasibly within a reasonable distance of the line. Approximately 180 mg/year of NPR occurs for golf course and park irrigation. IPR. Approximately 30 mgd of reclaimed water is sent back into the Corps of Engineers Lake Lanier reservoir from which GWDWR withdraws water. The outfall diffuser is a few thousand feet from the newest, largest drinking water intake. The remainder of the reclaimed water not reused is discharged to the Chattahoochee River downstream of Lake Lanier.

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	The main driver for IPR was the need to return reclaimed water to the basin of origin. Gwinnett County straddles the eastern subcontinental divide. Approximately 115 sq mi of Gwinnett County is in the Chattahoochee basin (which includes Lake Lanier, from which GCDWR withdraws water) drains to the Gulf of Mexico, and approximately 325 sq mi of Gwinnett County drains to the Atlantic. Drawing from Lake Lanier and discharging to the east slope is an interbasin transfer (IBT), and IBT policies have driven much of GCDWR's capital program and operational decisions in the past 20 years.
If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Not applicable.

Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	Consideration of conservation is independent of all other options.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	GCDWR looked at two options (also taking into consideration the primary goal of returning water to the basin of origin): (a) a nonreuse option that involved an expanded discharge to the Chattahoochee River, and (b) the IPR option of sending reclaimed water to Lake Lanier. The Georgia Environmental Protection Division (EPD) determined that the expanded discharge to the Chattahoochee River could impact dissolved oxygen levels adversely and recommended that GCWDR apply for a discharge to Lake Lanier. This water body is both a drinking water source and an important leisure amenity for the area. The proposed new discharge was planned to enter Lake Lanier in the vicinity of GCWDR's newest drinking water intake. This led inevitably to concerns regarding possible impacts on water quality and a variety of potential impacts were addressed. Environmental modeling was used to ensure that the permitted phosphorus level would be consistent with the lake's eutrophication status. The depth of the submerged outfall diffuser was determined in conjunction with the Division of Wildlife and the EPD to mitigate any possible detrimental change in water temperature. Georgia, being one of the few states to set specific water quality requirements for all of its lakes, imposed a set of limits that were stricter than any other permitted wastewater discharge in the state. It is important to note that there are other discharges and intakes in Lake Lanier, and intakes and outfalls are interspersed along the Chattahoochee River. For many days of the year, reclaimed water that was in a sewage treatment plant 24 hours earlier constitutes 10% of the raw water withdrawn at the two largest intakes on the Chattahoochee River, including that of the City of Atlanta.
Was the project developed with other agencies; if so, what were the roles of other agencies?	No.
Was there major leadership input from the community? Was there opposition from the community?	There was opposition from an organization of lake users/property owners who wanted GCDWR to keep the reclaimed water out of the lake; instead, they wanted GCDWR to mix the reclaimed water (50/50 or so) with raw water from the lake in a blending pond with perhaps a 10-day hydraulic capacity en route to the drinking water plant. The Lake Lanier Association, Sierra Club, and Upper Chattahoochee Riverkeeper appealed the lake discharge permit. Some opposed a lake discharge; others advocated direct potable reuse. The opposition was based on concerns that the proposed discharge would pollute the lake and create algae blooms in the vicinity of its popular beaches.
Were there any unique circumstances favoring or impeding progress?	The IPR permit process was complex and involved a 4½ year legal dispute over discharge arrangements, which reached as far as the Georgia Supreme Court.

ECONOMIC and FINANCIAL	
Project costs (for the reuse component only, not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	Not relevant, because our reuse programs are incidental to what GCDWR would otherwise be doing as part of its wastewater management program
Avoided costs as a result of utilizing the reuse option, did the utility Avoided costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion /upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	No.
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	None.
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan?	Financing was entirely for the cost incurred by the wastewater program, independent of reuse concepts or programs. In general, since 1996, GCWDR ratepayers have spent approximately $1.4 billion in new infrastructure to draw from and return reclaimed water to the basin of origin.

Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, etc. Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	Augmenting the resources in the Chattahoochee Basin, which is at the center of the interstate water wars with Alabama, Florida, Georgia and the rest of the United States since 1990, was part of EPD’s premise when they directed GCDWR to apply for a permit to discharge to Lake Lanier.

Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	The limits in the 40 mgd permit to discharge to Lake Lanier are as follows (all monthly averages): Chemical oxygen demand 18 mg/L Total suspended solids 3 mg/L Ammonia (as nitrogen) 4 mg/L Total phosphorus 0.08 mg/L Turbidity 0.5 NTU
SOCIAL and POLITICAL	
Public acceptance/opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	There was opposition from an organization of lake users/property owners who wanted GCDWR to implement direct reuse. The Lake Lanier Association, Sierra Club, and Upper Chattahoochee Riverkeeper appealed the lake discharge permit. Some opposed a lake discharge; others advocated direct potable reuse. The opposition was based on concerns that the proposed discharge would pollute the lake and create algae blooms in the vicinity of its popular beaches.
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	At the time of the litigation over the Lake discharge permit, water availability was less germane as an issue. Some ascribed no-growth motivations to the lake discharge opponents on the premise that if expansion of the infrastructure could be stopped, then future development would be limited to single family residences on large lots with septic tanks. As previously noted, the Chattahoochee Basin has been at the center of the interstate water wars between Alabama, Florida, Georgia and the rest of the United States since 1990, and was the reason EPD directed GCDWR to apply for a permit to discharge to Lake Lanier.

Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	---
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	---
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	No. The NPR customers have no assurance of continuous delivery.
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	No.
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?	---

Were there legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	No legal issues regarding NPR. The regulatory/legal issues related to IPR are presented as follows.

1993	The original 50-year Water and Sewer Master Plan was approved by the Board of Commissioners (BOC). The master plan included additional future discharges to the Yellow River.
Apr 1994	The Georgia Environmental Protection Division (EPD) determined that there would be no new wasteload allocation (WLA) assigned to the Yellow River, in part because of interbasin transfer, i.e., exporting water from basin of origin.
May 1994	GCDWR requested WLAs to Lake Lanier and the Chattahoochee River, both in the basin of origin of GCDWR's water withdrawals; both outfall locations are upstream of water supply intakes.
Jul 1994	EPD denied a new WLA to the Chattahoochee River. Returning water to Lake Lanier was preferred, but EPD lacked resources to create a water quality model for the lake.
Nov 1995	EPD agreed with a plan for a 20 mgd Chattahoochee River discharge with a net decrease in the WLA through effluent trading.
Feb 1996	GCDWR approved intergovernmental funding to develop the Lake Lanier predictive water quality model.
Nov 1996	EPD issued a 20 mgd NPDES permit for discharge to the Chattahoochee River from the first phase of F. Wayne Hill (FWH) Water Resources Center, with broad public support.
Feb 1998	The Lake Lanier water quality model was completed and submitted to EPD at a cost of $1,700,000, of which GCDWR paid $1,400,000. The Lake Lanier Association (LLA) was on the steering committee.
Jun 1998	The Water and Sewer Master Plan update was completed. Consistent with no new interbasin transfers, the preferred alternatives were discharge to (a) Chattahoochee River or (b) Lake Lanier.
Jul 1998	GCDWR requested an additional WLA to the Chattahoochee River. The request was denied by EPD, who instructed GCDWR to apply for lake discharge.
Sep 1998	The updated Water and Sewer Master Plan was accepted by BOC.
Dec 1998	GCDWR requested a WLA to Lake Lanier from EPD.
Sep 1999	GCDWR completed the lake study and applied for a lake discharge permit in deep water.
Jan 2000	Lake Lanier water quality standards were adopted by the state.
Jul 2000	The existing WLA for Lake Lanier was redistributed by EPD through state-determined effluent trading, with partial allocation to GCDWR. There was no net increase in lake WLA.
Nov 2000	The NPDES permit for a 40 mgd lake discharge was issued by EPD; the diffuser depth was made shallower than originally designed based on comments received; the permit contained the same effluent standards as those for a discharge to the Chattahoochee River downstream of Buford Dam.
Dec 2000	The lake discharge permit was appealed by LLA, Sierra Club, and Upper Chattahoochee Riverkeeper. Some opposed a lake discharge; others advocated direct potable reuse.
Feb 2001	The 20 mgd FWH Water Resources Center began sending flow to Chattahoochee River. The total cost for the first phase of the plant and 20-mile pipeline equaled $270 million.
Oct 2002	An administrative law judge (ALJ) of the Office of State Administrative Hearings (OSAH) affirmed EPD's NPDES permit for Gwinnett County to return up to 40 mgd to Lake Lanier.
Jan 2003	GCDWR applied for an easement from the Corps of Engineers for the reclaimed water pipeline to cross the shoreline and enter the lake.
Mar 2003	Hall County Superior Court remanded the ALJ decision to OSAH.
Sep 2003	The regional water supply and wastewater plans both built around the expectation that GCDWR would return 40 mgd to Lake Lanier, thus improving basin yield.
Jan 2004	The Georgia Court of Appeals affirmed the EPD's permit for Gwinnett County to return up to 40 mgd to Lake Lanier, reversing the Hall County Superior Court decision.

Nov 2004	The Georgia Supreme Court ruled that the FWH Water Resources Center could outperform its limits; therefore, the limits should be more strict. There was no change made in the plant design or receiving body requirements; the lake discharge was affirmed.
Apr 2005	Negotiations with the LLA facilitated by State Representative Heard regarding limits were concluded. A deep diffuser was requested by LLA and GCDWR.
Jan 2006	The River NPDES permit was issued to increase the river discharge temporarily from 20 to 29 mgd, until the reclaimed water pipeline to lake was built.
Feb 2006	The second phase 40 mgd FWH Water Resources Center expansion began operation. The second phase cost equaled $400 million.
Nov 2006	The Lake NPDES permit was revised with lower limits and a return to original deep diffuser design.
Sep 2007	An easement was granted for the pipeline on the Corps of Engineers' property. Construction of the pipeline and diffuser begins at cost equaling $72 million.
Dec 2007	Lake Lanier reached a record low elevation.
Sep 2008	The FWH Water Resources Center won a U.S. EPA first-place award for wastewater treatment excellence.
May 2010	The pipeline and diffuser construction was completed. Reclaimed water was returned to Lake Lanier.
May 2011	GCDWR pumped more than 10 billion gallons of reclaimed water into Lake Lanier.

NOTES

1 More than $800 million for 60-mgd reclamation facility and pipelines supporting IPR.

2 Whereas the NPDES limit for phosphorus decreased from 0.13 mg/L to 0.08 mg/L from 2000 to 2006, the FWH Water Resources Center design did not change. Litigation made no difference in water quality outcomes because the plant was designed and built to perform better than its limits. The final permit reduced the margin of safety for consistently meeting NPDES limits.

TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration, and if so, please describe the role (for example was storage needed to make the option feasible and why — this is intended to be a cost question)?	No.
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	No.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	GCWDR elected not to pursue direct modes or closed-loop modes of potable reuse.
Other?	---

Attachment A – GCDWR Reuse Project Cost Estimate Form (not completed by participant)

Case Study WRRF-09-02	**Marin Municipal Water District (MMWD)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	N
Agency contact(s) [name, email address, phone number]	Bob Castle bcastle@marinwater.org 415- 945-1556
Location	Corte Madera, CA
Brief description of the agency (what they do with regard to water or wastewater management or other)	MMWD provides water supply to a population of 190,000 in central and southern Marin County. To supplement a limited water supply, MMWD started to recycle wastewater in 1981, one of the first programs in Northern California.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes. MMWD operates a 2 mgd tertiary treatment plant that receives secondary effluent from a trickling filter wastewater plant operated by the Las Gallinas Valley Sanitary District (LGVSD), and polishes it to meet California Department of Public Health (CDPH) disinfected tertiary recycled water standards in Title 22 regulations. (Note: Meets total coliform requirements of 2.2 MPN/100 mL as a 7-day median and no more than 23 MPN/100 mL in any 30-day period; an average turbidity of 2 NTU within a 24-hour period, 5 NTU no more than 5% of the time within a 24-hour period; and is less than 10 NTU at any time.) The tertiary recycled water is distributed in a 25-mile distribution system with more than 350 different users. Up to 2 mgd is reused for landscape irrigation, toilet flushing, commercial laundries, air conditioning cooling towers, and car washes. Local geology in Marin is the Franciscan Formation, a nonporous rock that makes a poor aquifer. Because of this geology and usually abundant rainfall on the Mt. Tam watershed (55 inches versus 25 inches for the San Francisco Bay Area), MMWD has seven surface water reservoirs for drinking water supply. None of the reservoirs can be isolated to meet an expected CDPH regulatory requirement for 6 months hydraulic retention of recycled water used to augment surface water reservoirs. In addition, long distances and high lifts make this option extremely expensive. Note: In 1994, for the San Diego Water Repurification Project, CDPH provided a number of recommended requirements, including a 12-month theoretical retention time in the reservoir. CDPH is working on draft regulations internally for the use of recycled water for surface water augmentation, and specific requirements have not yet been released; however it is expected that these draft regulations will include at least a 6-month retention time in a reservoir before the water is withdrawn. MMWD started water recycling in 1981. At that time, the Title 22 regulations only included provisions for NPR, case-by-case provisions for groundwater recharge by surface spreading, and no provisions for surface water augmentation (as is currently the case). The only recycled water opportunities in the MMWD service area available at that time were for landscape irrigation.

	Because trickling filter wastewater plants slough off organic matter, treating this secondary effluent required full conventional treatment (coagulation, flocculation, filtration) instead of direct filtration. If MMWD were to have initiated water recycling at the present time, it is likely that microfiltration would be employed instead of conventional treatment, because it is easy to automate and is more reliable and cost effective.
For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	The 2.2 mgd dry weather flow from the LGVSD already is committed to landscape irrigation for the existing and proposed MMWD system plus a new proposed 0.7 mgd system to serve landscape irrigation at the North Marin Water District area of Hamilton Field (a converted Air Force base). The largest wastewater treatment plant in Marin County is the 8 mgd dry weather flow plant operated by the Central Marin Sanitation Agency (CMSA). MMWD has evaluated building a purple pipe system from CMSA. However, the cost is high and the secondary effluent suffers from high saltwater intrusion (via local sewers) making it unsuitable for landscape irrigation. The cost to fix the leaking sewers has been explored and also adding reverse osmosis (RO) to remove the salt. Either fix is prohibitively expensive (conservative estimates are $2100 per acre-foot (AF) for RO and $3740/AF for sewer rehabilitation (according to *Review of Water Recycling and Gray Water*, Bahman, Sheikh, and Parsons, 2001, pg. 11). The problems for IPR cited for Las Gallinas are also true for CMSA: extremely long distances and high lifts to the existing surface water reservoirs and none of the reservoirs have 6-month hydraulic detention. The best potential for this site would be direct potable reuse (i.e., pipe-to-pipe). However, that is not currently allowed by regulation. As many people in the area had doubts that desalination of water from San Francisco Bay could remove all contaminants of concern, a direct potable reuse project would require a huge public relations program to convince the public to drink highly purified wastewater.
If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, etc.	Prior information illustrates plans for reuse.

<table>
<tr>
<td>Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?</td>
<td>Yes. Reservoir enlargement is prohibited because of endangered species act protections. Desalination of San Francisco Bay has been extensively studied and pilot tested. MMWD has the most aggressive conservation program in the United States.</td>
</tr>
<tr>
<td>For each reuse option:

What alternatives were considered and what were the most important elements distinguishing them?

What criteria were used in selecting between project options and in selecting specific alternatives?

What were the most important of these criteria?</td>
<td>MMWD has explored all forms of reuse. The cost of constructing expanded purple pipe systems is too expensive: $4000 to $8000/AF and more. (Note: Estimate provided by MMWD).

The approach used was to start with the least expensive reuse sites and proceed to more costly options. However, the point has been reached where the next options for conversion entail unit costs in excess of other available marginal sources of water. This is demonstrated in an analysis of the recently completed 21-phase study of expansion of the MMWD's water recycling program (according to Expansion of Recycled Water Distribution System, MMWD, January 2000). It would take a policy decision by the MMWD Board of Directors to proceed with a project that delivers another 1000 acre-ft per year of recycled water at a unit cost of $2600/AF (or higher, according to Review of Water Recycling and Gray Water, Bahman, Sheikh, and Parsons, 2001).

MMWD also considered decentralized satellite plants with an estimated cost range of $1442/AF to $4097/AF, according to Review of Water Recycling and Gray Water, Bahman, Sheikh, and Parsons, 2001 (but determined that more study was needed); residential back-lot irrigation (but determined that more study was needed, including public acceptance); and trading recycled water for the right to limited pockets of groundwater supply (in-lieu recharge). The cost of providing recycled water service to save this much potable water is approximately $2864/acre ft, according to Review of Water Recycling and Gray Water (Bahman, Sheikh, and Parsons, 2001). Whereas this use of recycled water does not directly free up potable water, it has the potential of adding a new source—albeit very small—of water supply to the mix of water resources.

For MMWD, the cost of the next source of developable water supply represents the criterion against which the costs of other alternative sources of water may be judged—in terms of cost-effectiveness alone. Of the phased imported supply, the next logical source of water for MMWD customers to be eliminated is the so-called "Phase-5" supplemental supply from Sonoma County Water Agency which in 2001 was estimated to be $1,414/AF (according to Review of Water Recycling and Gray Water, Bahman, Sheikh, and Parsons, 2001).

Table 7.1. Summary of costs of Alternative Water Resources in MMWD Service Area (Review of Water Recycling and Gray Water, Bahman, Sheikh, and Parsons, 2001, pg.46)
<table>
<tr><th>Water Recycling and Other Alternative New Water Resource</th><th>Potential Volume of New Water, Acre-ft</th><th>Range of Costs, $</th><th>Ave. Cost, $</th><th>Departure from Marginal Cost, $</th><th>Major Potential Obstacles</th></tr>
<tr><td>Planned 21-Phase</td><td>1308 to 2864</td><td>2398 to 3223</td><td>2787</td><td>1372</td><td>Capital Funding</td></tr>
<tr><td>Indirect Potable Reuse</td><td>5000</td><td>2407 to 2554</td><td>2,480</td><td>1067</td><td>Public Acceptance Issues, inadequate reservoir capacity</td></tr>
<tr><td>Direct Potable Reuse</td><td>5000</td><td>2591 to 2932</td><td>2762</td><td>1348</td><td>Major Regulatory Hurdle, Public Acceptance</td></tr>
<tr><td>Satellite Water Recycling Plants</td><td>35 to 1327</td><td>1442 to 4097</td><td>2159</td><td>749</td><td>NIMBY Syndrome</td></tr>
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</tr>
</table>

Satellite Plants with Residential Irrigation	95 to 4327	1635 to 2923	2119	705	Public Acceptance, NIMBY Syndrome
Satellite w/ Irrigation, Toilet Flush	105 to 4827	1625 to 2838	2058	644	Public Acceptance, NIMBY Syndrome
Salt Separation at CMSA, Sewer Rehab	5000	—	3740	2326	High Cost
In-Lieu Recharge	50	—	2864	1450	Very Low Yield, No Potable Offset
Graywater	50 to 1000	2250 to 3211	2730	1317	Public Cooperation, Regulatory Complexities

Was the project developed with other agencies, if so, what were the roles of other agencies?	There is a cost sharing arrangement with LGVSD; potentially there will be an arrangement with NMWS if that project goes forward. It should be noted that wastewater agencies in Marin are reluctant to use financial resources to advance the use of recycle water at this time.
Was there major leadership input from the community? Was there opposition from the community?	The community likes purple pipe recycled water and wants more, but the costs are prohibitively high. MMWD loses about $1.5 million annually from the existing purple pipe system.
Were there any unique circumstances favoring or impeding progress?	It is hard to recycle water economically in a bedroom community with a 45-inch annual rainfall, no aquifer, and where landscape irrigation has been reduced with a variety of demand management programs and policies.
ECONOMIC and FINANCIAL	
Project costs (for the reuse component only, not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	---
Avoided costs, as a result of utilizing the reuse option, did the utility Avoided costs related to an alternative water supply project?	There are not any avoided costs.

Water or wastewater treatment plant capacity expansion /upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	The MMWD service area is pretty much built out. Looking at water use at each site by examining records is easy. The cost of a project is a function of the low collective water use at each site and the distance from one site to another. Recycled and potable water rates may be found via this link: http://marinwater.org/documents/proposed_2011_rate_changes.pdf
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	Funding of recycled water projects has been borne almost entirely by the MMWD. Refer to January 2000 Recycled Water Expansion Study for cost sharing between LGVSD and MMWD, low-interest SRF loan plus district financing, and others. MMWD pays the cost for connection to customers. The recycled water system loses about $1.5 million annually compared to revenue (MMWD currently discounts the recycled water price to customers, at 68% of the potable water price).
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements?	MMWD's recycled water program was designed to reduce the demand on limited local water supplies. At peak demand, up to 2 mgd (estimate only) of water is retained in the in the upstream reaches of the watershed for fish and wildlife ecosystem maintenance, fisheries, and recreational uses. The upstream reaches in this case may extend to Eel River, Russian River, Lagunitas Creek, and other streams flows used, in part, for supplying water to the customers of MMWD.

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<td>Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)?

Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others?

Were wetlands created or enhanced as part of the project?

Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?</td>
<td>Discharge of wastewater effluent into shallow areas of San Francisco Bay is prohibited in the dry season. Thus, as a secondary benefit, water recycling reduces the discharge to and extends the dry season no discharge period for LGVSD from 3 months to 5 to 6 months.

Water recycling also reduces the discharge of pollutant loadings into San Francisco Bay.

No wetlands are involved, although there is potential to build them. There is no one to support the cost of building wetlands, and local Marin environmental groups (such as the Audubon Society) prefers natural salt marsh wetlands as opposed to constructed fresh water wetlands.

Following is a list of benefits attributable to utilization of recycled water in the MMWD service area:

Water supply value (accounted for in terms of the marginal cost of the next logical resource available to the district)
Increased reliability of the potable water system for the whole community
Decreased energy requirement, especially in case of satellite plants
Environmental benefits upstream (reduced take from natural streams)
Downstream environmental benefits, such as reduced discharge to the shallow waters of the San Francisco Bay
Environmental use of water for wetlands, bird refuges, lakes, and others
Local origin of the resource, local control, local economic stimulation
Drought-proofing the community, potable demand peak shaving (according to Review of Water Recycling and Gray Water, Bahman Sheikh and Parsons, 2001, pg.49)

As valuable as these benefits are, most of them cannot be quantified readily and accurately in dollars and cents.</td>
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<td>Regulatory requirements:

Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?</td>
<td>The recycled water project was driven by lack of water supply reliability. Information from the MMWD 2010 Draft Urban Water Management Plan on the role of recycled water in current and projected water supplies is presented in the following table.

<table>
<tr><th colspan="7">Table 4-1
Water Supplies – Current and Projected (ac-ft/yr)</th></tr>
<tr><th>Water Supply Sources</th><th>2010</th><th>2015</th><th>2020</th><th>2025</th><th>2030</th><th>2035</th></tr>
<tr><td>Sonoma County Water Agency[1]</td><td>6,521</td><td>8,500</td><td>8,500</td><td>8,500</td><td>8,500</td><td>8,500</td></tr>
<tr><td>Supplier-Produced Groundwater</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Supplier-Produced Surface Water</td><td>19,077</td><td>20,000</td><td>20,000</td><td>20,000</td><td>20,000</td><td>20,000</td></tr>
<tr><td>Transfers In</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Exchanges In</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Recycled Water</td><td>514</td><td>534</td><td>763</td><td>765</td><td>766</td><td>768</td></tr>
<tr><td>Desalinated Water</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total</td><td>26,112</td><td>29,034</td><td>29,263</td><td>29,265</td><td>29,266</td><td>29,268</td></tr>
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SOCIAL and POLITICAL	
Public acceptance/ opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	MMWD's purple pipe recycled water program, which is mainly landscape irrigation but also includes 20 buildings that flush toilets with recycled water, 3 car washes, 2 cooling towers, and 1 commercial laundry, has received widespread customer acceptance. Salinity used to be an issue, but saltwater intrusion has been decreased and landscape training plus a Recycled Water Demonstration Garden have shown that landscape plants grew better with recycled water than potable. The key to success is proper water management and good drainage. Most problems were the result of over-watering (Sheikh, B. (2010) *Terra Linda Demonstration Garden for Recycled Water Irrigated Landscapes in Marin County*. Prepared for MMWD and U.C. Davis, June 2010).
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	The political issues come down to how much water recycling an agency can afford. The MMWD purple pipe system operates at a big loss. To date, all water recycling has been confined to the areas within the service area of MMWD. Opportunities for use of recycled water across political boundaries are dependent on removal of institutional barriers and formation of collaborative partnerships with neighboring jurisdictions.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	The use of reclaimed water (even at the low level in current practice) provides increased reliance on local (versus imported) sources of water supply and avoids—to some extent—the potential for competitive or controversial demand on the same water by another agency. Specifically, the imported water from the Russian River is adequate during normal years and MMWD has an additional water right of 10,000 AFY that has not been exercised in part because of the need for another transfer pipeline, and in part because of the MMWD Board's own sensitivity to the ecological needs in the Russian River. Beyond all that, there is also competition to the water source from another agency.
For all classes of users – what are the benefits that were most important for the users: reliability cost of water, others?	---

Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	---
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	---
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?	3.1 kWh/1000 gallons for recycled water, slightly more than required for potable water but lower than other alternative sources of water considered, such as IPR, direct potable reuse, satellite water recycling plants, salt separation at CMSA, sewer rehabilitation, in-lieu recharge, and gray water
Were there legal issues that helped or hindered implementation? Water rights Liability Public access issues? Other?	---
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why—this is intended to be a cost question)?	---

Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	---
Were there other technology evaluations/needs considered in deciding which option to choose over another?	---
Other?	---

Attachment A – MMWD Reuse Project Cost Estimate Form (not completed by participant)

Case Study WRRF-09-02	**Orange County Water District (OCWD)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	N
Agency contact(s) [name, email address, phone number]	Mike Wehner, mwehner@ocwd.com, 714-378-3200 Jason Dadakis, jdadakis@ocwd.com, 714-378-3200
Location	Fountain Valley, CA
Brief description of the agency (what they do with regard to water or wastewater management or other)	OCWD is a special district responsible for managing the Orange County Groundwater Basin that provides groundwater to 20 cities and water agencies and their 2.3 million customers in northern and central Orange County.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes – both indirect potable reuse (IPR) and nonpotable reuse (NPR). IPR: OCWD's Groundwater Replenishment System (GWRS) project can produce up to 70 mgd of advanced treated microfiltration/reverse osmosis/advanced oxidation (MF/RO/UV-AOP) purified recycled water for groundwater recharge by surface spreading and seawater barrier injection (*2010 Draft GWRS Annual Report*, Orange County Water District). Secondary effluent for treatment is provided by the neighboring Orange County Sanitation District (OCSD) free of charge; OCSD also accepts brine from the advanced treatment facility free of charge. An expansion of the facility to 100 mgd will begin construction in the fall of 2011. In calendar year 2010, the facility produced 67,330 AF of purified recycled water. NPR: OCWD's Green Acres Project (GAP) can produce up to 7.5 mgd of Title 22 tertiary treated recycled water for nonpotable irrigation reuse (*2010 Draft GAP Annual Report*, Orange County Water District). Note: Meets total coliform requirements of 2.2 MPN/100 mL as a seven day median and no more than 23 MPN/100 mL in any 30-day period; an average turbidity of 2 NTU within a 24-hour period, 5 NTU no more than 5 percent of the time within a 24-hour period; and is less than 10 NTU at any time. GAP treats secondary effluent provided by the OCSD by rapid mix/flocculation, dual media gravity filtration, and chlorination. In calendar

	year 2010, GAP treatment facilities produced approximately 4500 AF of recycled water during six months of operation, not including the groundwater (deep well production) that is used periodically for makeup water. OCWD generally operates GAP from April to October. For November to March, the plant is typically shut down and GAP customers receive Title 22 water produced by the Irvine Ranch Water District (IRWD) Michelson Water Reclamation Plant via an intertie between the two systems. This is done because IRWD has excess recycled water in the winter, and it is more cost-effective for OCWD to purchase this water for its GAP customers versus running the GAP facility.

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	The first deliveries of GAP water occurred in 1991. GWRS came on online in 2008 (replacing Water Factory 21, OCWD's original seawater intrusion barrier project that used alternative advanced treatment and which began operation in 1976). The GWRS Initial Expansion currently is expected to be completed in 2014. The following factors were considered in the decision to construct GWRS versus expanding GAP. (This information comes from many sources: OCWD District-wide Water Reclamation-Reuse Master Plan, 1991; OCWD and OCSD Orange County Regional (OCR) Water Reclamation Project Feasibility Report, 1995 (former name for GWRS project); and OCWD Water Supply Alternatives to Meet Future Needs of OCWD, 1997): • The need for additional water to expand the seawater barrier via direct injection required advanced treatment to comply with California regulations for IPR • The difficulty in recovering the original capital investment with GAP revenues/pricing; the GAP sales/pricing/policy provides sufficient revenue to cover OCWD's GAP operational costs but does cover its required debt service. In contrast, the original capital recovery for GWRS is supported by potable water sales • The high capital cost of new pipelines to convey additional GAP water to new customers • Groundwater recharge with GWRS allowed for use of the natural groundwater basin as a storage reservoir, allowing a larger project to be built and lowering unit costs; building additional GAP capacity would have required construction of additional storage or seasonally reducing production and not fully utilized capital • Greater flexibility to end users with IPR quality for recharge • Improved GWRS advanced treatment with groundwater basin salt management: the GWRS project improves salinity concentrations in the groundwater basin; this improvement does not occur with GAP
If not reusing water, are you considering reusing water and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]?	---

Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	According to *OCWD Water Supply Alternatives to Meet Future Needs of OCWD*, 1997, the alternatives included • Purchasing additional imported water for recharge • Enhancing stormwater capture • Promoting conservation • Ocean desalination OCWD is still pursuing enhanced stormwater capture and still purchases discounted imported replenishment water (surface water from the Metropolitan Water District of Southern California) when it is available. Currently, promoting conservation and pursuing ocean desalination are not primary OCWD activities, but the agency supports and monitors the efforts of other local agencies, such as the Municipal Water District of Orange County (MWDOC), which is more directly involved.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	• OCWD considered only building GWRS to supply expanded seawater barrier without additional capacity for surface recharge. However the unit cost benefits of a larger facility, the greater reliability of additional surface recharge supply compared to imported water purchases and stormwater capture, and the overall water quality benefits of recharging advanced treated water distinguished the full-scale project. • Some consideration also was given to providing a lesser level of treatment (tertiary equivalent) to a portion of the water going to surface recharge. However, the costs savings for building and operating a small slip-stream process for some of the surface recharge supply were negligible. Furthermore, public confidence in the project was enhanced by providing a single superior product water quality for both direct injection and surface spreading, thereby eliminating any potential environmental justice issues because of the geographic differences in recharge water quality. With regard to environmental justice, at

	the time (mid- to-late 1990s), there was a general awareness that the initial San Diego potable reuse project (reservoir augmentation project) had failed in part because of a misconstrued public perception that certain disadvantaged communities were going to receive a disproportionate amount of the reuse water. As such, this was a factor in the decision to have GWRS produce a single water quality for both recharge locations.
Was the project developed with other agencies; if so, what were the roles of other agencies?	The GWRS project was developed by OCWD in close collaboration with OCSD, as it helped OCSD with peak flow relief and helped avoid the need for a new ocean outfall. OCSD initially contributed half the project capital costs remaining after grant funding and then a small portion of the operation and maintenance cost (O&M). During the first two years of operation, OCSD's contribution to GWRS O&M averaged approximately $450,000/year. This cost-sharing subsequently was discontinued under a more recent agreement between the two agencies, whereby OCWD is responsible for all the GWRS O&M costs. The Metropolitan Water District of Southern California (MWD) provides a $121/AF operating subsidy for all water produced by GWRS in excess of 5000 AFY (i.e., production beyond that of the original Water Factory 21).

Was there major leadership input from the community? Was there opposition from the community?	Yes. Support for GWRS from all the elected representatives/boards of all the major groundwater producing cities and water districts was solicited and obtained early in the project development process. Similar support was obtained early in the process from the business community, taxpayer groups, environmental organizations, and the medical/public health community. The effort was conducted almost entirely by OCWD staff outreach and direct communication efforts. Some limited assistance was obtained from outside consultants, but it was believed that staff-based outreach would be more effective and successful. There was some initial concern about water quality and associated health risks from the medical community, but this was addressed by inviting individuals to oversee the supporting planning, feasibility, and risk studies. These studies demonstrated the effectiveness of the multibarrier advanced treatment technologies and comprehensive monitoring plan. As a result of these efforts, the project came online without any organized public opposition.
Were there any unique circumstances favoring or impeding progress?	OCWD's good working relationship with OCSD because of operating Water Factory 21 since the 1970s provided a strong foundation for working together on GWRS. The fact that OCWD and OCSD essentially serve the same customer/rate payer base allowed for easier negotiation of cost sharing and supports OCSD providing the influent supply water to GWRS without charge. OCWD's prior experience with Water Factory 21 operations and water quality, as well as the OCWD's history of rigorous monitoring and investigations into source control, water quality, and groundwater recharge helped establish a good working relationship with the regulatory agencies that issued permit requirements to GWRS, namely the California Department of Public Health (CDPH) and the Santa Ana Regional Water Quality Control Board (RWQCB). The rising cost and reduced reliability of imported water played a role as well.
ECONOMIC and FINANCIAL	
Project costs (for the reuse component only, not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	See Attachment A

Avoided costs, as a result of utilizing the reuse option, did the utility Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion /upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	By building and operating GWRS, OCWD has avoided the cost of purchasing untreated MWD water for groundwater recharge. Additional groundwater recharge supports a higher level of pumping in the groundwater basin, allowing local water retailers (e.g., cities and water districts) to purchase less higher-cost imported water. OCSD avoided the cost of having to construct an additional ocean outfall to handle peak flow events. 2011–2012 MWD rates ($/AF): Treated Full Service Tier II = $869/$920 Treated Full Service Tier I = $744/$794 Untreated Full Service Tier I = $527/$560 Untreated Discounted Replenishment Water (taken via recharge) = $409/$442 Treated Discounted Replenishment Water (taken via in-lieu) = $601/$651 OCSD additional ocean outfall cost was estimated to be $200 million in the mid-1990s.
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	See previous responses regarding building public support for GWRS project during the early planning and design phases.
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	State Grants = $69 million Federal Grants = $20 million OCWD = $196 million OCSD = $196 million Total capital cost = $481 million This total cost includes advanced water treatment plant, 16 additional seawater intrusion barrier injection wells, and a 13-mile pipeline to spreading basins. OCWD Loans: Initially issued short-term variable rate debt at 3% interest rate, then converted to fixed-rate debt over five years at an effective interest rate of 1.7% through the State of California Local Match Program.

ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	• The GWRS project reduces OCWD's reliance on traditional sources of recharge, including the Santa Ana River and imported water supplied by MWD. • The GWRS project helps OCSD meet discharge requirements, especially during peak flow events by providing additional treatment and discharge capacity. • The GWRS MF/RO/UV-AOP advanced treatment train produces the highest quality recharge water available to OCWD compared with other available sources. It also helps reduce the salt burden on the groundwater basin and aids in compliance with RWQCB Basin Plan Objectives for protection of surface and groundwater. • The project consumes less energy per acre-ft compared to imported water brought to Southern California and ocean desalination. For typical operation, the project does not discharge to surface water (Santa Ana River); spreading occurs in dedicated off-stream spreading basins. Thus, there are no downstream water quality objectives that apply. If the project provides peak flow relief for OCSD and discharges to the river (this primarily would occur during wet weather periods), the quality of water meets water quality objectives for the Santa Ana River (see next section).
Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g. reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	• The GWRS advanced treatment train (MF/RO/UV-AOP) was selected to produce water superior to CDPH recycled water recharge requirements for total organic carbon (TOC) and total dissolved solids (TDS) ultimately without the need for blending. • When operating in peak flow relief mode on behalf of OCSD, GWRS will use MF and UV components of the treatment train followed by discharge of wastewater to the Santa Ana River (in lieu of going to OCSD's ocean outfall) to enable compliance with OCSD's National Pollutant Discharge Elimination System (NDPES) permit discharge requirements. • The Operations, Maintenance, and Monitoring Plan (OMMP) required by CDPH and the RWQCB for GWRS incorporates some elements of Hazard Analysis Critical Control Point (HACCP), as recommended by the GWRS permit-

	required Independent Advisory Panel for the Project (from *GWRS Operating, Maintenance, and Monitoring Plan*, prepared by DDBE Engineering, Inc., 2010).
SOCIAL and POLITICAL	
Public acceptance/opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	• There was some limited initial opposition to the project based on public health concerns, but these were addressed by inviting the individuals and groups with concerns to oversee and participate in the project's planning, feasibility, and risk studies, which ultimately demonstrated the effectiveness of the multibarrier advanced treatment technologies and comprehensive monitoring plan (from *GWRS Water Quality Evaluation*, prepared by Eisenberg, Olivieri & Associates (EOA) Inc., 2000). Focus group, telephone surveys, and surveys of likely voters were conducted by OCWD. Various studies also were conducted by the Lawrence Group on behalf of OCWD between 1997 and 2000. • Much of the extensive project outreach was performed by OCWD staff as opposed to hired public relations consultants, which helped confirm a personal commitment to an open and transparent project planning and development process. Outreach efforts successfully communicated with elected officials, the business community, taxpayer groups, environmental organizations, and the medical/public health community to obtain project support.
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	These included • Water supply reliability • Local control of water supply and rates • Providing one superior water quality to all recharge and injection locations avoided potential environmental justice issues The political process leading to implementation occurred over more than a decade by OCWD's 10-member locally elected board.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	The GWRS project replaces or augments less reliable imported water recharge supplies that are impacted by drought, climate, and environmental restrictions (i.e., the Sacramento Delta), as well as less reliable regional recharge water supplies, such as the Santa Ana River, which is impacted by drought, as well as greater upstream conservation, recycling, and recharge.

For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	The benefits include • Reliability and sustainability of water supply from the groundwater basin • Predictability of future rates and groundwater availability • Groundwater quality
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	The GWRS project has annual production goals, as well as internal goals for the performance of individual treatment components (e.g., MF Pressure Decay Test (PDT), RO rejection of TOC and TDS, and others) and achieving an overall product water beyond permit requirements (from *GWRS Operating, Maintenance, and Monitoring Plan*, prepared by DDBE Engineering, Inc., 2010).
Organization and business integration issues: Was it necessary to make institutional rearrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	The preexisting relationship between OCWD and OCSD due to cooperation on the Water Factory 21 and GAP projects was leveraged and enhanced in order to form a partnership for the GWRS project. A Steering Committee with appointed members from both agencies was established to approve shared project costs and an operational management group comprised of staff from both agencies meets monthly.
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable green-house gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh	For calendar year 2010, GWRS energy consumption was approximately 94,134,145 kWh. The estimated GHG emissions associated with operating the planned 30 mgd GWRS Initial Expansion are 12,995 metric tons CO_2 equivalent per year ($MTCO_2e$/year) (from Addendum No. 5 to Orange County Water District final program environmental impact report/environmental impact statement groundwater replenishment system modified Phase II expansion project, prepared by OCWD, March 2011). Applying the same production rate to the existing 70 mgd GWRS facility results in an estimate of 30,322 MTCO2e/year for the existing facility. Note that neither estimate accounts for the corresponding reduction in GHG emissions associated with reduced imported water delivery to the area; for the 30 mgd initial expansion, this was very conservatively estimated to be a reduction of 5,164 $MTCO_2e$/year.
Were there legal issues that helped or hindered implementation?	The fact that the Orange County Groundwater basin is *not* adjudicated in terms of water rights

Water rights? Liability? Public access issues? Other?	but managed by OCWD under state law greatly helped with GWRS project implementation. OCWD regulates the allowable pumping of groundwater on annual basis through essentially a tiered rate-setting process. This creates an incentive to allow greater amounts of groundwater pumping, which is a less expensive water supply compared to alternatives (e.g., imported water supplied by MWD). Groundwater pumping can be sustained only by balancing it with equal recharge over the long term, so projects like GWRS that create new recharge supplies at competitive prices are economically feasible.
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why –this is intended to be a cost question)?	• The "free" natural storage provided by the groundwater basin allowed the GWRS project originally to be built without the need for storage for treated purified recycled water. • During beginning GWRS operations, it was realized that additional flow equalization of influent supply could result in greater production and lower unit costs by mitigating the diurnal variation. Specifically, the diurnal fluctuations of influent raw wastewater to OCSD's Plant No.1 resulted in insufficient influent supply to GWRS at night and during the early morning. As such, instead of running at the designed production rate of 70 mgd all the time, GWRS had to ramp treatment up and down with the available influent supply. Subsequent completion of OCSD projects and changes to the wastewater plant and collection operations have increased the availability of the night-time influent supply to GWRS, but a diurnal deficit still exists. As such, the GWRS Initial Expansion includes 15 mgd of storage/flow equalization to be built such that secondary effluent produced during the day in excess of the GWRS treatment capacity can be stored and used as influent during the diurnal low period.
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	---
Were there other technology evaluations/needs considered in deciding which option to choose over another?	---
Other?	---

Attachment A – OCWD Reuse Project Cost Estimate Form

Part 1. Cost Estimate Available from Agency? (record in whatever form it is available in the box directly below and then ask whether specific cost elements are included.)

Utility/Agency's Cost Estimate:

Capital: $481 million (actual costs, includes ELA, see below)

Annual O&M: $31.5 million, including debt service and operating subsidies

Year in which cost estimate made: Capital = Actual cost of project construction (2004–2007), O&M from actual FY09-10 actual costs.

Part 2. Cost Estimate Clarification

Category	Included in Part 1?	Additional Estimate (if available)
Preconstruction		
Research	No	
Planning	No	
Design	Total project ELA = $75.9 million	
Capital		
Treatment	$325.6	
Distribution system	$89.4 (includes a 13-mile pipeline to recharge basins and additional seawater barrier injection wells)	
Pumping	Included in treatment	
Storage	N/A	
Flow equalization	N/A	
Brine disposal	N/A	
Land acquisition	Included in distribution system	
Buildings and structure	Included in treatment	
Other		
Annual Cost Elements		
O&M labor	$7.7 million, Yes	
Chemicals	$4.2 million, Yes	
Electric power	$7.7 million, Yes	
Membrane replacement*	$4.8 million, Yes *(annual R&R contribution for entire facility, not just membranes)	
Repairs	$4.1 million, Yes	
Spare parts	Included in Repairs	
Insurance		
Debt Service (added this in)	$11.5 million, Yes	
Operating Subsidies	($8.4 million), Yes	
Contingency		

FY2009–2010 unit costs were $478/AF including operating subsidies. Without operating subsides, the unit cost was $606/AF. Projected unit cost removing all grants and subsidies is ~$800–850/AF.

Case Study WRRF-09-02	**San Francisco Public Utilities Commission (SFPUC)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	N
Agency contact(s) [name, email address, phone number]	Ms. Paula Kehoe pkehoe@sfwater.org 415-554-3271
Location	San Francisco, California
Brief description of the agency (what they do with regard to water or wastewater management or other)	The SFPUC is a retail and wholesale water purveyor, serving approximately 2.5 million customers in the San Francisco Bay area. The SFPUC currently is implementing a program to diversify local water supplies using a combination of conservation, groundwater, recycled water, and other supplies, such as desalination. Meanwhile, the SFPUC also has the objective of minimizing wastewater flows in its sewer system.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Although none are currently in operation, several projects are being planned or constructed to deliver tertiary treated recycled water for appropriate uses in the SFPUC's service area. The SFPUC also is evaluating the contribution that graywater systems could make to the water supply and wastewater flow goals in San Francisco.
For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus	In 2006, the SFPUC updated the Recycled Water Master Plan to develop a terrestrial discharge option for treated wastewater for landscaping purposes. The Recycled Water Master Plan identified where and how San Francisco could most feasibly develop recycled water in the city and provides a strategy for implementing the recycled water projects. The implementation of recycled water projects are a component of the SFPUC's Water System Improvement Program (WSIP), which includes facility improvement projects designed to (1) maintain high-quality water; (2) reduce vulnerability to earthquakes, (3) increase delivery reliability and improve the ability to maintain the system, (4) meet customer purchase requests in nondrought and drought periods, (5) enhance sustainability in all system activities, and (6) achieve a cost-effective, fully operational system. (See http://www.sf-planning.org/index.aspx?page=1829.)

another and what's driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	The SFPUC's objectives that impact reuse decisions and long-term supply sustainability are to • Diversify local water supply • Offset potable water use • Match the best supply with the best use • Reduce wastewater flows in the sewer system SFPUC has not considered IPR since the potable supply is expected to be adequate as long as some of the nonpotable uses can be shifted to alternative sources of local water (recycled water, groundwater, and conservation).
If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	The following projects are currently being developed or evaluated to deliver tertiary treated recycled water in the SFPUC service area (and meets total coliform requirements of 2.2 MPN/100 mL as a 7-day median and no more than 23 MPN/100 mL in any 30-day period; an average turbidity of 2 NTU within a 24-hour period, 5 NTU no more than 5% of the time within a 24-hour period; and is less than 10 NTU at any time). These are primarily for landscape irrigation with a few toilet flushing uses. No industrial uses are planned at this time. All amounts are shown in average annual terms on the basis of demands for customers served by the SFPUC. The primary drivers for moving to water reuse are water sustainability and diversification, as previously mentioned. Under Construction: 1. Harding Park Recycled Water Project (0.23 mgd). The tertiary recycled water will be supplied by the North San Mateo County Sanitation District (NSMSD), a subsidiary of Daly City to users previously utilizing potable water. The NSMCSD constructed facilities at its wastewater treatment plant to produce recycled water and had excess recycled water available for use by SFPUC. 2. Pacifica Recycled Water Project (serving Sharp Park Golf Course) (0.08 mgd). Recycled water will be supplied by North Coast County Water District (NCCWD) to users previously using potable water. The project includes installation of a pumping station at the Calera Creek Water Recycling Plant (CCWRP), construction of a new aboveground recycled water tank, and installation of approximately 17,000 lineal feet of pipelines. The new system also will replace several thousand feet of the golf course's irrigation pipelines and a small underground tank. In Design: 1. Westside Recycled Water Project (1.6 mgd) In Planning (conceptual / feasibility study stage): 1. Eastside Recycled Water Project (2 mgd) 2. Menlo Country Club Recycled Water Project (0.18 mgd) 3. South San Francisco Recycled Water Project (0.3 mgd) 4. Daly City Recycled Water Expansion Project (0.4 mgd) 5. Presidio-Marina Corridor Pipeline Project (0.03 mgd)
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	Yes, the SFPUC has an active and aggressive conservation program, and the SFPUC is participating in the Bay Area Regional Desalination Project along with the East Bay Municipal Utility District, Contra Costa Water District, Santa Clara Valley Water District, and Zone 7 Water Agency. A wide array of alternatives was evaluated as part of the WSIP Environmental Impact Report. See http://www.sf-planning.org/index.aspx?page=1829 and http://www.sf-planning.org/Modules/ShowDocument.aspx?documentid=7948

<table>
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<td>Under the WSIP, the SFPUC proposes to meet the increased 35 mgd in purchase requests by continuing to maximize use of local watershed supplies, increasing diversions from the Tuolumne River under its existing water rights, and developing new local resources consisting of a combination of additional conservation, water recycling, and groundwater supply programs in San Francisco, as shown in Figure S.4. The water recycling and groundwater supply programs would be developed as part of the proposed facility improvement projects. This combination of water supply sources is expected to meet customer purchase requests fully during nondrought years through 2030. During drought periods, the WSIP level of service goals include a policy to limit customer rationing to a maximum of 20% systemwide in any one year of a drought, and water transfers from the Tuolumne River, groundwater banking of potable water, and restoration of operating capacities at two of the system reservoirs, Calaveras and Lower Crystal Springs Reservoirs.

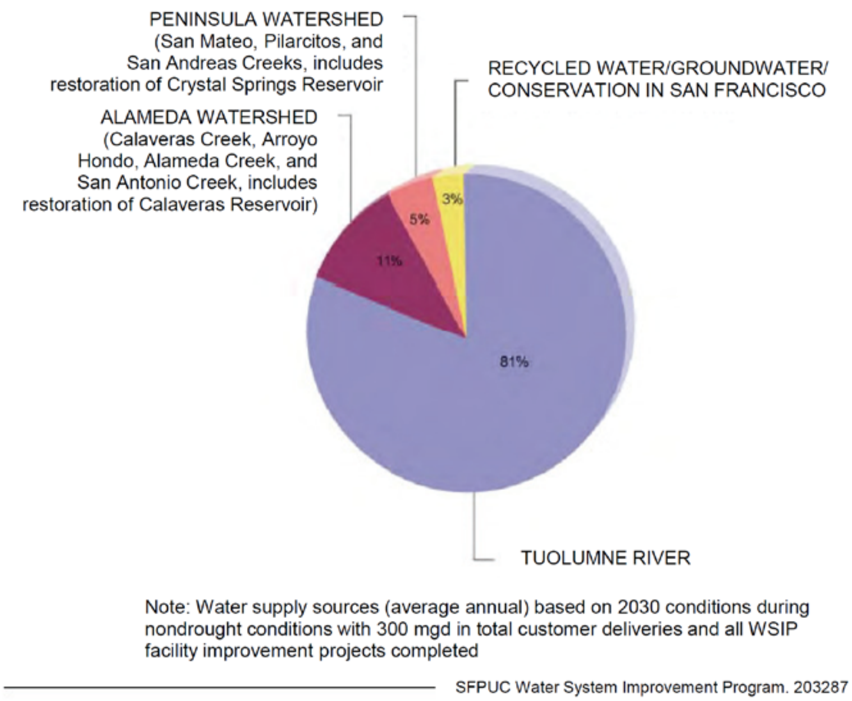

Figure S.4
WSIP Water Supply Sources, Nondrought Years</td>
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<td>For each reuse option:
What alternatives were considered and what were the most important elements distinguishing them?
What criteria were used in selecting between project options and in selecting specific alternatives?</td>
<td>The programmatic Environmental Impact Report (EIR) for the WSIP included a list of regional reuse projects that were likely to be implemented in the early planning stages or potentially eligible for future consideration that were evaluated in terms of the overall objectives of the WSIP. See http://www.sf-planning.org/ Modules/Show Document.aspx?documentid=8055
For specific projects, such as the Westside Recycled Water Project, which includes construction of a tertiary treatment facility, the location/feasibility of projects was based on meeting the broad objectives cited previously, as well as other factors, such as proximity to recycled water customers, availability of existing conveyance facilities to and from a site, availability of land, compatibility of project land use requirements, and public input. See http://www.sf-planning.org/ftp/files/MEA/ 2008.0091E_ Westside_Water_NOP.pdf</td>
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What were the most important of these criteria?	Implementation of the project is related to the SFPUC's San Francisco Groundwater Supply Project, which involves developing local groundwater supply and blending that supply with surface water supply. The Groundwater Supply Project would convert two existing irrigation wells at Golden Gate Park to potable use; however, those wells would not be used to supply municipal water under the Groundwater Supply Project unless the San Francisco Westside Recycled Water Project is implemented and recycled water is available for Golden Gate Park landscaping requirements, or unless another landscaping water source is identified.
Was the project developed with other agencies; if so, what were the roles of other agencies?	Where feasible and where there are synergies, the SFPUC partners with other agencies to serve customers, with SFPUC providing financial assistance and other collaborative facilitations for the projects. Harding Park Recycled Water Project, for example, is being developed with NSMCSD, which has excess recycled water capacity that can serve the Harding Park Golf Course. The Pacifica Recycled Water Project is a partnership with NCCWD, which serves northern Pacifica. For the Menlo Country Club Recycled Water Project, SFPUC is in discussions with the City of Redwood City to partner for the development of the project. The regional desalination project is a partnership with four other local water purveyors.
Was there major leadership input from the community? Was there opposition from the community?	Both proponents and opponents of the projects have been vocal. For the most part, the notion of implementing recycled water projects and diversifying local water supplies is embraced by SFPUC customers and stakeholders. For the Westside Project, there was opposition to constructing a water reclamation facility (perceived to be an "industrial" facility) in iconic Golden Gate Park at the site of an old primary treatment facility had produced water for use at the park. Mitigation has included placing some of the facilities at other locations and providing reverse osmosis to meet "perceived" water quality goals for irrigating in the park.
Were there any unique circumstances favoring or impeding progress?	None.

ECONOMIC and FINANCIAL

Project costs (for the reuse component only, not existing wastewater treatment):

For this cost estimate, what is the acre-foot yield for the project?

Specific costs per project were not provided because they are in the construction and/or design stage. Project cost estimates range from $3 - $155 million, depending on breadth of the project (i.e., pipeline only to full treatment facility needed for reuse). The estimated cost per acre-foot yield similarly ranges from approximately $2000 - $7000 / AF. (It is not clear if this is capital or capital and O&M).

The following table was provided in the 2005 draft Recycled Water Master Plan. See http://www.lmtf.org/FoLM/recycling/RWMPExecSummarySept.05PublicDraft.pdf

TABLE ES-2: PROPOSED PHASE 1 PROJECT ALTERNATIVES COST ESTIMATE [a]

Project Component	Preferred Phase 1 Project Alternatives			Phase 1 Project Alternatives to be Evaluated Further		
	Westside Baseline	Harding Park/ Lake Merced	TOTAL	Expanded Westside	Marina Corridor	TOTAL
Treatment [b]	$27.8 M	$15.8 M	$43.6 M	$2.5 M	$1.1 M	$3.6 M
Storage	$8.0 M	$5.3 M	$13.3 M	$1.7 M	$0.4 M	$2.1 M
Pumping	$6.8 M	$1.0 M	$7.8 M	$1.2 M	$0.6 M	$1.8 M
Distribution [c]	$16.0 M	$2.4 M	$18.4 M	$11.9 M	$2.6 M	$14.5 M
Accuracy of Estimate (15%)	$8.8 M	$3.7 M	$12.4 M	$2.6 M	$0.7 M	$3.3 M
Construction Cost Estimate	$62.4 M	$28.2 M	$90.6 M	$19.9 M	$5.5 M	$25.4 M
Construction Phase Contingency (10%)	$6.7 M	$2.8 M	$9.4 M	$2.0 M	$0.5 M	$2.5 M
Environmental Mitigation (1.3%)	$0.9 M	$0.4 M	$1.3 M	$0.3 M	$0.1 M	$0.4 M
Art Commission (2%) [d]	$0.1 M	$0 M	$0.1 M	$0.1 M	$0 M	$0.1 M
Total Construction Cost	$75.1 M	$31.4 M	$106.5 M	$22.1 M	$6.1 M	$28.2 M
Program Delivery Cost (22%)	$16.5 M	$6.9 M	$23.2 M	$4.9 M	$1.3 M	$6.2 M
Total Project Cost	$91.6 M	$38.4 M	$130.0 M	$27.0 M	$7.4 M	$34.4 M
Annualized Capital Cost [e]	$6.8 M	$2.9 M	$9.7 M	$2.0 M	$0.6 M	$2.6 M
Operations and Maintenance Cost	$1.7 M	$0.9 M	$2.6 M	$0.3 M	$0.2 M	$0.5 M
Total Annualized Cost	$8.5 M	$3.8 M	$12.3 M	$2.3 M	$0.8 M	$3.1 M
Annual Demand (afy, rounded)	3,100	1,410	4,510	290	100	390
Annual Demand (mgd, rounded)	2.8	1.3	4.1	0.3	0.1	0.4
Unit Cost (per acre-foot)	$2,750	$2,660	$2,730	$8,090	$7,250	$7,950

Footnotes:

a Estimates represent project alternatives described previously in this chapter. Costs based on estimation method detailed in the WSIP, at an Alternative Analysis Report level of accuracy. Costs do not include escalation or onsite customer retrofit costs.
b Use of alternative treatment sites for Westside projects (e.g., Richmond/Sunset) could incur greater costs.
c Pipeline unit costs were revised per recent Department of Public works project cost data provided in August, 2004 (see Appendix D)
d Art Commission fees were applied to above ground building structures. This includes the Fleishhacker treatment plant building and Lincoln Park pump station building. The following components were excluded: underground distribution and storage facilities, and Marina Corridor project facilities located within the Presidio.
e Assuming an interest rate of 5.5 percent and a recovery period of 25 years.

Avoided costs as a result of utilizing the reuse option, did the utility

Avoid costs related to an alternative water supply project?

Avoided costs include imported water supply offset, groundwater supply demand offset, and treated wastewater discharge reduction to the bay or ocean. Lack of diversification or reliability is also an avoided cost.

Water or wastewater treatment plant capacity expansion /upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	The SFPUC has conducted public outreach for the local water supply diversification program, recycled water program, as well as individual projects. SFPUC typically reaches out to all our customers, with special noticing to neighbors or customers who will be impacted directly by the construction or operation of a project. SFPUC has conducted telephone surveys, focus groups, prepared educational materials (fact sheets, brochures, website updates) and have held open houses (both during and before the California Environmental Quality Act [CEQA] process).
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was itdirectly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	The SFPUC typically funds all costs associated with delivering water to our customer meter. When costs are shared with other agencies, typically they have been split proportionately on the basis of relative customer demands on an average annual basis. Some of the projects are funded through a bond program (Water Supply Improvement Program or WSIP projects), whereas others are funded through the operating budget. SFPUC (or its partners) have applied for and received grants, such as the Pacifica Recycled Water Project and Bay Area Regional Desalination Project. The costs are capitalized over a 30-year period, and interest rates typically are very low (may vary). The customer is responsible for costs associated with any retrofits necessary downstream of the meter connection. However, the SFPUC does have a Large Landscape Grant program to help offset the costs of retrofits that could result in significant potable water savings either through conservation or enabling the use of alternate appropriate water supplies (areas more than 2.5 acres). Customers typically pay the same rate for recycled water as they do for potable water, although the SFPUC bears the cost of delivering the recycled water.

ENVIRONMENTAL and PERMITTING	
Environmental impacts : Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on.)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	Reuse projects help diversify SFPUC's water supplies, avoid incremental environmental impacts of greater reliance on the regional water system and help reduce sewer discharges; each of these is an important objective of the overall program. Protecting environmental resources is an important part of each project and varies from project to project. All the reuse projects have temporary construction-related impacts but most are mitigated to a level that is less than significant under CEQA.
Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g. reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	No.

SOCIAL and POLITICAL	
Public acceptance/ opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so, what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	As noted, the SFPUC has conducted substantial public outreach on both a programmatic and project-specific level as part of the Recycled Water Master Plan and WSIP. Use of recycled water as an alternative to potable water for uses, such as irrigation, is largely accepted and well-received by customers. Concerns have been project-specific with respect to facility siting or impacts to native species, and so on. Consistent communication and making design changes, as necessary, has been the best way we have found in being responsive to public concerns.
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	Facility siting has been the primary issue that was important for control, environmental justice, or other such issues (for example, siting of treatment facilities in poorer neighborhoods, iconic areas such as Golden Gate Park). In projects where these concerns are greater, the SFPUC has taken the time to hold more workshops, focus groups, and generally do outreach. Bond funds also have requirements that may guide how and where monies can be spent. For example, to use bond funds, the SFPUC must own the assets that are built with those funds. Such issues may drive how a project is structured or funded.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	SFPUC's primary water supply—the Regional Water System —delivers water from a great distance. Diversification and development of local water supplies is a critical feature of water supply reliability, particularly in the event of a disaster, as evaluated under the WSIP.
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	Cost and water quality are usually the most important factors for SFPUC customers.

Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	The WSIP has reliability objectives in terms of meeting demands for the SPUC overall water supply during nondrought and drought conditions, and the water reuse program is intended to help meet those goals by freeing up potable water. To that end, we have an objective to develop recycled water projects (in conjunction with conservation and groundwater programs) that will collectively help offset 10 mgd of potable demand by 2018.
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so, what were they? Could they be overcome?	No institutional changes within the SFPUC were necessary to plan, develop, or implement the reuse programs.
Energy/Carbon Footprint: Quantify energy use in kilowatt hours Pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh	As part of the WSIP programmatic EIR, under air quality impacts, the recycled water projects were found to be less than significant with respect to any conflict with implementation of applicable regional air quality plans addressing criteria air pollutants and state goals for reducing greenhouse gas emissions.
Legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	No, there were no legal issues with regard to water recycling projects.
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why — this is intended to be a cost question)?	Storage has been incorporated for some projects. For example, a large storage tank (700,000-gal) was necessary for the feasibility of the Harding Park Recycled Water Project. While the demand is only 0.23 mgd, the large storage tank was necessary to meet delivery requirements because of the schedules of the other golf clubs currently taking water for irrigation from the same facility. As they are priority customers, Harding Park needed a larger storage tank to make the available capacity sufficient to serve its demand. For the Westside Project, a proposed recycled water storage may be sited at the recycled water treatment facility and the project proposes to use the Golden Gate Park central reservoir and a proposed 400,000-gal water tank at the Presidio Golf Course.

Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	Standard structural requirements, although the storage tank did have to be placed underground to maximize the use of the limited parking space.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	No.
Other?	Facilities in San Francisco require review and approval from our Arts Commission to ensure that they are aesthetically consistent with and enriching to the surrounding environment.

Attachment A – SFPUC Reuse Project Cost Estimate Form

Part 1. Cost Estimate Available from Agency? (record in whatever form it is available in the box directly below and then ask whether specific cost elements are included.)

Utility/Agency's Cost Estimate:

Capital: $9 ,831,763 (for the Harding Golf Course: 1 mile of pipeline, pump station, storage tank)

Annual O&M: not available—water is purchased at 1.62 per CCF and regularly adjusted for inflation.

Year in which cost estimate made: 2010

Part 2. Cost Estimate Clarification

Category	**Included in Part 1?**	**Additional Estimate (if available)**
Preconstruction		
Research		
Planning		
Design		
Capital		
Treatment		
Distribution system		
Pumping		
Storage		
Flow equalization		
Brine disposal		
Land acquisition		
Buildings and structure		
Other		
Annual Cost Elements		
O&M labor		
Chemicals		
Electric power		
Membrane replacement		
Repairs		
Spare parts		
Insurance		
Contingency		

Case Study WRRF-09-02	**Yarra Valley Water (YVW)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	No
Agency contact(s) [name, email address, phone number]	Mr. Francis Pamminger Francis.Pamminger@yvw.com.au T: +14 (03) 9872 1443
Location	Yarra Valley Water Lucknow Street, Mitcham Victoria 3132 Australia
Brief description of the agency (what they do with regard to water or wastewater management or other)	YVW is the largest of Melbourne's three retail water businesses providing water supply and sewerage services to more than 1.6 million people and more than 50,000 businesses in the northern and eastern suburbs of Melbourne. As a retailer, YVW buys bulk water from Melbourne Water. This water is harvested mostly from protected mountain catchments. YVW also is responsible for taking away sewage for treatment. Most of the sewage is transferred to Melbourne Water's eastern or western treatment plants. The balance is treated at YVW's nine regional plants, several of which produce recycled water for use in new homes or for the irrigation of sports fields or open space.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	YVW has two treatment plants producing Class A recycled water, and one scheme supplying Class B recycled water. Class A recycled water has received tertiary treatment and pathogen reduction to achieve a lower (critical) limit of a 6-log removal of viruses and a 5-log removal of protozoan parasites (https://epanote2.epa.vic.gov.au/EPA/publications.nsf/2f1c2625731746aa4a256ce90001cbb5/d20acdacef3d03bfca257067001c13d0/$FILE/1015.pdf). Class A water can be used for urban nonpotable uses with uncontrolled public access; agricultural uses (human food crops consumed raw); and industrial open systems with worker exposure potential. The use of recycled water is governed by the Environmental Protection Authority (EPA) and the Department of Health (DOH), which are responsible for providing Class A accreditation of schemes. Class B recycled water has received secondary treatment and pathogen reduction (including helminth reduction for cattle grazing) to achieve: <100 *E.coli* org/100 mL; pH 6 – 95; < 20 / 30 mg/L BOD / SS. Class B water can be used for agricultural uses, such as dairy cattle grazing and industrial uses such as wash down water. For more information see: http://epanote2.epa.vic.gov.au/EPA/publications.nsf/2f1c2625731746aa4a256ce90001cbb5/64c2a15969d75e184a2569a00025de63/$FILE/464.2.pdf

Scheme Name	Brushy Creek	Aurora	Yering
Treatment Plant[a]	Brushy Creek	Aurora	Lilydale
Source	Sewerage	Sewerage	Sewerage
Location	35km east of Melbourne	25 km north of Melbourne	40km east of Melbourne
Class of RW	A	A	B

<table>
<tr>
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<table>
<tr><td>Commencement of Supply</td><td>September 2007 (Supply to residential soon to commence.)</td><td>March 2009</td><td>December 2010</td></tr>
<tr><td>Reuse type</td><td>Residential, Open space irrigation and Class A standpipe</td><td>Residential, open space irrigation and Class A standpipe</td><td>Irrigation of golf courses and other fit for purpose irrigators</td></tr>
<tr><td>Volume (09/10)</td><td>42 ML</td><td>112 ML</td><td>9 ML</td></tr>
<tr><td colspan="4">a. Additional information on the plants is available at: http://www.yvw.com.au/Home/Waterandsewerage/Sewerageservices/Sewagetreatmentplants/index.htm</td></tr>
</table>
YVW recycled water schemes must meet all environmental and health and safety regulations prior to use. The specific type of reuse is based on fit for purpose requirements.
The Class B Yering scheme presented a viable business case. Class B was deemed suitable for users along the Yering scheme; any irrigators that require a higher quality supply along this scheme must treat the water themselves to the higher standard. The projects viability was based on sufficient demand for Class B water. This is not a residential third pipe scheme.
</td>
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For those reusing water, they need to tease out what helped them decide to start or decide between different reuse practices (NPR versus IPR), or decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process.
Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.
</td>
<td>
<u>Brushy Creek Class A Scheme.</u>
This is a nonpotable reuse scheme. Extended drought conditions across Victoria created significant media attention (November 2006 – January 2007) when several municipal sporting ovals, gardens, and fountains were closed down as a result of stringent water restrictions being introduced. Because there were no other projects planned to supply Class A recycled water in the eastern suburbs, a fast-tracked 1 ML/d upgrade of the Brushy Creek Sewage Treatment Plant (STP) by December 1, 2007, was proposed to provide Class A water.
<u>Aurora Class A Scheme</u>
The Aurora Recycled Water Treatment Plant (RWTP) is located in the suburb of Wollert approximately 20 kms north of Melbourne and commenced operation for reticulated supply of Class A recycled water in March 2009. The Class A water is supplied throughout the Epping and Craigieburn area for use in dual pipe residential households for toilet flushing and outdoor use. It is also available to other nonresidential users, such as councils and industry, for uses such as irrigation of municipal areas and within processes where the water quality provided is deemed fit for the intended purpose (dust suppression, process water etc). The Aurora RWTP treats Class B recycled water produced by the Aurora STP, located on the same site. The key treatment steps within the Aurora RWTP's process are ultrafiltration, ultraviolet disinfection (UV) and chlorination using sodium hypochlorite.(See http://www.wioa.org.au/conference_papers/09_vic/ documents/ChrisBrace.pdf)
<u>Yering Class B Scheme</u>
This is a nonpotable reuse scheme, specifically to provide fit-for purpose water to a number of golf courses. This project was driven by the expiry or lack of extraction license from the local Olinda Creek and the inability for the golf courses to secure any alternative water rights.
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</table>

	<u>YVW's Program</u> YVW is proposing to extend its reuse program to include other schemes. These include the following: • Coburg – treating stormwater to a third pipe system (separate from potable water and sewerage systems) – in-fill area. • Doncaster Hill – treating sewage to Class A third pipe – in-fill area • Melbourne's new northern growth area – providing Class A recycled water from sewage to approximately 90,000 new properties to the north of Melbourne. • Kalkallo – Capturing stormwater from an industrial estate and treating initially for supply to a third pipe system. This is a demonstration project with the ultimate goal of supplying this treated stormwater into the potable network. • Kinglake – trial collection of urine from peri-urban residential area (approximately 25 homes) for reuse as an agricultural fertilizer. Melbourne's reuse practices are governed by the following: • Government policy, regulatory requirements and legislation, including environmental and health requirements • Melbourne's Water Supply Demand Strategy (WSDS). The WSDS is a 50-year strategy to balance the supply of water to meet Melbourne's consumptive, environmental, industrial, and agricultural water needs. It includes water conservation targets, reuse targets, and potable augmentation options. There are currently no regulatory frameworks to manage public health risks associated with rainwater, stormwater, and industrial water. The Department of Health (DOH) is in the process of reviewing the regulatory framework to manage public health risks from the use of alternative water supplies for nondrinking water purposes. The Government and DOH's current position on treated sewage and stormwater for drinking purposes is they do not support adding alternative water supplies to drinking water but rather to supply this water as a substitute for nondrinking water purposes. This is because of what is believed to be significant health-related regulatory gaps. YVW's position is that it considers all options when investigating the feasibility of a project, including rainwater, stormwater, recycling sewage (both greywater, urine separation, Class A/B schemes). YVW has utilized Triple Bottom Line (TBL) assessments using project specific multicriteria to conduct the analyses and identify the preferred alternatives. Each time a TBL assessment is conducted, YVW selects the key parameters specific to the project and key stakeholders. YVW also uses a pair-by-pair comparison of variables because of the highly subjective nature of multicriteria analysis. Another model is being evaluated that uses a software voting package that allows all participants to vote with a hand set, which then shows the collective votes on a screen. It shows the distribution of votes, after which a discussion can follow to better understand the votes, and gives everyone the opportunity to recast their vote if they would like. This includes an added sensibility test to make sure all voting is consistent. The decision to use TBL is not mandated but based on an interpretation of YVW's License, which states that YVW needs to provide services in a sustainable way. YVW has interpreted this to mean that a TBL is analysis is necessary.

If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse?	Not applicable.
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	Melbourne has developed a Water Supply Demand Strategy. (See http://www.melbournewater.com.au/content/library/water_storages/water_supply-demand_strategy.pdf). The WSDS is a 50-year strategy to balance the supply of water to meet Melbourne's consumptive, environmental, industrial, and agricultural water needs. The Metro Melbourne water businesses are required to prepare a WSDS every five years under their statement of obligations (SoO). This forms a key input into the development of water plans for each of the Melbourne Metropolitan Water Authorities. The water plans are submitted to the Essential Services Commission to secure funding for a five-year period. The WSDS identifies the best mix of demand measures and supply options for Melbourne's urban supply systems. It includes water conservation targets, reuse targets, and potable augmentation options. YVW's recycled water schemes are normally of a local scale and contribute to the targets contained in the WSDS. A new WSDS is currently in preparation, with an emphasis on assessing alternative water sources at the city scale (>10 GL/year), local scale and individual lot scale.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	Information is presented for the Brushy Creek and Yering projects. <u>Brushy Creek Class A Scheme</u> Extended drought conditions across Victoria created significant media attention (November 2006 – January 2007) when several municipal sporting ovals, gardens and fountains were closed down as a result of stringent water restrictions being introduced. Councils, Members for Parliament, and commercial enterprises throughout Melbourne's eastern suburbs made numerous enquiries to YVW for Class A recycled water supply via tanker trucks for unrestricted irrigation and road construction uses. Because of this level of interest and as there were no other projects planned to supply Class A recycled water in the eastern suburbs, a fast-tracked 1 ML/d upgrade of the Brushy Creek STP by December 1, 2007, was proposed to meet forecast Class A demands. Following the construction of the plant, the scheme was extended to supply Class A water to the neighboring developments and for open space irrigation. No alternative options were considered.

<table>
<tr><td></td><td><u>Yering Class B Scheme</u>

YVW was approached by Croydon Golf Club to investigate the potential for supplying Class B recycled water to their site on Macintyre Lane in Yering. This request was driven by the expiration of their extraction license from Olinda Creek and their inability to secure any alternative water rights at an acceptable cost.

An alternative option to use Olinda Creek as a conduit to supply the Class B water to the golf course was investigated. This option was not deemed viable because of the extraction licenses being fully committed and the need to revisit the Olinda Creek Management Plan, which could potentially take three years.

Following surveys of other customers along the proposed alignment, two other golf courses and a crematorium registered interest in the scheme. Following the completion of a business case, the design and construction of a 7.9km Class B recycled water pipeline from YVW’s Lilydale STP to the Croydon Golf Club site were completed.</td></tr>
<tr><td>Was the project developed with other agencies; if so, what were the roles of other agencies?</td><td><table><tr><td>Brushy Creek</td><td>Yering</td></tr><tr><td>DHS – Approval of Management Framework, validation
EPA – Works/regulatory approval
Maroondah Council – Planning permits, commitment to take water</td><td>DHS – Approval of Management Framework</td></tr></table></td></tr>
<tr><td>Was there major leadership input from the community?
Was there opposition from the community?</td><td><table><tr><td>Brushy Creek</td><td>Yering</td></tr><tr><td>Councils, Members for Parliament, and commercial enterprises throughout Melbourne’s eastern suburbs made numerous enquiries to YVW for Class A recycled water available in the eastern suburbs. No community opposition was encountered.</td><td>Croydon Golf Club was the main driver for this project. No community opposition encountered.</td></tr></table></td></tr>
<tr><td>Were there any unique circumstances favoring or impeding progress?</td><td>The past 13 years have been a time of significant water shortage for Melbourne. There have been record low inflows into Melbourne’s supply catchments that have placed considerable pressure on available resources. These circumstances have favored alterative supply options, such as the third pipe schemes. Community engagement also has been easier to obtain.</td></tr>
</table>

ECONOMIC and FINANCIAL		
Project costs (for the reuse component only not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?		
Avoided costs as a result of utilizing the reuse option, did the utility Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion/ upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	**Brushy Creek** No avoided costs relating to alternative water supply options. The existing water supply system has capacity. No wastewater treatment plant works were required.	**Yering** No avoided costs. The key users, the proposed golf courses, would either source their water from on-site dams or have extraction licenses from Olinda Creek. As it is unlikely additional extraction licenses will be granted, the proposed golf courses may not proceed without the Class B water to irrigate. Very minor wastewater treatment plant works were required.
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers’ reuse water quality requirements? Other?	**Brushy Creek** Customers were not surveyed. YVW sent emails to all municipal councils in an attempt to quantify demand for Class A recycled water from Brushy Creek STP, should it be made available. Eight municipal councils replied indicating that they would be interested in carting water for irrigation.	**Yering** YVW letter-dropped and phone surveyed the businesses that front the proposed main. Information was obtained on the quantity, usage, existing onsite storage, current source of supply, and willingness to pay for the Class B water. Approximately 30 customers front the main.

Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?			

Scheme Name	Brushy Creek	Yering
Who paid?	State Government committed to fund $1M of the project costs. The remainder was funded by YVW within the five-year Water Plan	Fully funded by YVW within the 5-year Water Plan
Grants?	None	None
Loans?	None	None
Customer Connections.	Fully funded by YVW within the 5-year Water Plan	Fully funded by YVW within the 5-year Water Plan
Contracts	Customer Charter	Customers to sign 25-year take or pay agreements, where they agree to take a volume over the year. The unit price /kl increases by CPI each year. The rate is calculated from a net present cost, which includes capital costs and operating expenses for the recycled water components.

ENVIRONMENTAL and PERMITTING

Environmental impacts; Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	

Scheme Name	Brushy Creek	Yering
Avoid traditional supplies?	Yes, reduces the demand on the potable network	Yes, less reliance on stream flows
Helps meet discharge requirements?	Yes, Brushy Creek has a discharge license.	Yes, Lilydale has a discharge license.
Environmental Benefit?	Reduces nitrogen discharged to Port Phillip Bay	Reduces Nitrogen discharged to Port Phillip Bay
Downstream water quality?	---	---
Wetlands?	None created	None created
Environmental costs?	---	---

<table>
<tr><td>Regulatory requirements:
Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g. reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?</td><td>All schemes must comply with DOH and EPA regulations. These guidelines define what is permissible.
See http://www.epa.vic.gov.au/water/reuse/default.asp#framework</td></tr>
<tr><td colspan="2">SOCIAL and POLITICAL</td></tr>
<tr><td>Public acceptance/opinion
Was there opposition to the project because of public health concerns?
Were public opinion polls taken, or public meetings or focus groups conducted?
Was a public outreach and/or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?</td><td><table>
<tr><td>Scheme Name</td><td>Brushy Creek</td><td>Yering</td></tr>
<tr><td>Opposition?</td><td>No</td><td>No</td></tr>
<tr><td>Polls or meetings?</td><td>No</td><td>No</td></tr>
<tr><td>Public education program?</td><td>Yes. A communication and education program has been developed by YVW for all Class A customers (not specific for this project). The program includes information on the YVW website, and a customer package for new customers.</td><td>No, not required</td></tr>
</table></td></tr>
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<tr>
<td>Political issues:

Specific political issues that were important (e.g., environmental justice issues, local control over water resources)?

Political process leading up to implementation?

Leadership from the community or the utility?</td>
<td>
<table>
<tr><th>Scheme Name</th><th>Brushy Creek</th><th>Yering</th></tr>
<tr><td>Important political issues?</td><td>The major political issue was the ability to provide recycled water to communities during a time of drought. Melbourne was in restrictions; sporting ovals and parks could not be watered This enabled stakeholder approvals to be fast-tracked.</td><td>The major political issue was the environmental condition of Brushy Creek, and whether further extraction licenses would be allowed. In the end this necessitated the building of the pipeline.</td></tr>
<tr><td>Political process before implement-tation</td><td>The Managing Director was directly in contact with the Water Minister, Councilors and regulators to facilitate approvals for the project.</td><td>Negotiations were conducted with key stakeholders, mainly Melbourne Water, on the feasible options and potential funding.</td></tr>
<tr><td>Leadership</td><td>---</td><td>---</td></tr>
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<tr>
<td>Water supply reliability:

Water supply situation in terms of degree of water stress?

Reliability of other supplies in utility’s portfolio?</td>
<td>Between 1997 and 2010 Melbourne experienced its longest drought on record. It has reduced the amount of water flowing in rivers and creeks severely and the level of water stored in water supply reservoirs. Storage levels in Melbourne’s dams were reduced to 27% in July 2009. Current levels are 55.2%. Melbourne has legislation in place to implement water restrictions, and the decision to lift or introduce water saving rules is made by the Victorian Government based on information it receives from Melbourne Water and Melbourne’s three retail water companies. Stage 2 water restrictions are now in place across metropolitan Melbourne and will remain in place until at least the end of Spring 2011.

Melbourne is soon to commission a 150GL desalination plant. The plant can be augmented with another 50GL should the need arise.

Melbourne’s has a 50-year WSDS to balance the supply of water to meet Melbourne’s consumptive, environmental, industrial and agricultural water needs. It includes water conservation targets, reuse targets and potable augmentation options.</td>
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<td>For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?</td>
<td>
<table>
<tr><th>Brushy Creek</th><th>Yering</th></tr>
<tr><td>The main benefits are unrestricted use of the water outdoors when the rest of the city is in restrictions.</td><td>The main benefits are reliability of supply and ensuring the water is affordable.</td></tr>
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<tr>
<td>Do you have any “Level of Service” objectives for your reuse program (e.g., internal goals set by the utility for their performance)?</td>
<td>YVW has guaranteed service levels established for residential Class A customers. (See http://www.yvw.com.au/yvw/groups/public/ documents/document/ yvw001394.pdf) These are contained in the residential Class A customer Charter.

YVW is in the process of establishing a charter for Class A business customers that will define the agreed level of service. Until this is established, YVW has establish a Recycled Water Agreement with these customers individually, which have differing service levels.</td>
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</table>

	YVW has also established individual Recycled Water Agreements for Class B customers, with no guarantee on supply. YVW requires these customers to have sufficiently sized on site storage.
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	---
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What were the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh	---
Legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	---
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why - this is intended to be a cost question)?	Storage must always be assessed. Whether storage is required is dependent on the size of the sewerage catchments and the STP, and the demands from the system. If the capacity of the STP exceeds the demands from the Class A or B scheme, then the only scheme where storage is required is a balancing function for the pump station that supplies the zone. In these cases, normally the STP is already operating and the excess sewage can be discharged (with appropriate treatment) to a local waterway or to an outlet sewer. If the sewerage inflows cannot match the peak recycled water outflows, then storage always will be required (winter storage). As much of the sewerage inflow occurs during the wetter winter period, the treated water is stored until summer when it is used to meet the zone demands.

<table>
<tr><td></td><td>Acquiring land can be very difficult and has real cost implications. This is particularly relevant for schemes in areas already developed.
<table>
<tr><td>Scheme Name</td><td>Brushy Creek</td><td>Aurora</td><td>Yering</td></tr>
<tr><td>Winter Storage</td><td>None. Sufficient Sewerage inflows. Excess Class B sewage discharged to creek.</td><td>280ML</td><td>None. Sufficient Sewerage inflows. Excess Class B sewage discharged to creek</td></tr>
<tr><td>Balancing Storage</td><td>1ML</td><td>1ML</td><td>Existing lagoons</td></tr>
</table></td></tr>
<tr><td>Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?</td><td>Yes. Class A water was a new product.</td></tr>
<tr><td>Were there other technology evaluations/needs considered in deciding which option to choose over another?</td><td>---</td></tr>
<tr><td>Other?</td><td>---</td></tr>
</table>

Attachment A – YVW Reuse Project Cost Estimate Form (not Completed by Participant)

Case Study WRRF-09-02	**Agency 1 (A1)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	Y
Agency contact(s) [name, email address, phone number]	---
Location	---
Brief description of the agency (what they do with regard to water or wastewater management or other)	A1 is a public agency that acts as a water wholesaler for the county in which it is located, flood protection agency, and steward for streams and creeks, underground aquifers and A1-built reservoirs. A1's stream stewardship responsibilities include creek restoration and wildlife habitat projects, pollution prevention efforts and a commitment to natural flood protection. Since 1989, A1's various sources of water have remained relatively constant as a percentage of total supply. Groundwater represents the biggest share of total use, ranging from approximately 40 to 50%. Treated surface water (local rainfall in reservoirs or imported water represents the second largest share, from 30 to 38%. A regional surface water source water represents the third largest share, ranging from 16 to 19%. Other sources include recycled water (approximately 5%) and other non-A1 local surface water (approximately 4 to 5%). A1 supplies water to local water agencies, which in turn provides it to their retail customers in the county. A1 also manages the groundwater basin to the benefit of agricultural users and individual well owners who pump groundwater.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Recycled water is developed by four wastewater treatment plants owned and operated by cities within the county. A1 works with these wastewater entities to promote water recycling for irrigation and industrial uses through agreements, collaborative projects, financial incentives, and technical assistance. In fiscal year 2009–2010, approximately 14,500 AF of recycled water was used in the county. A1 has institutional arrangements with different recycled water producers. For Project1 (a partnership with a municipality that operates the wastewater treatment plant (M1), A1 has changed from a passive to an active partner. Previously, A1's support for promotion and development of recycled water use in the county was limited to paying $115/AF for recycled water, stimulating the development of nearly 14,000 AFY of recycled water for NPR. However, recently A1 adopted a more active role by executing a 40-year agreement with M1 to expand recycled water use. As part of Project 1, A1 and M1 plan to expand the production of recycled water, in part through the development of an advanced water treatment facility (AWT) to enhance the mineral quality of recycled water available for NPR. The AWT facility will use microfiltration, reverse osmosis, and ultraviolet disinfection to produce up to 8 mgd of highly purified water that will be blended into the existing recycled water flow. In the future, if all issues are resolved, A1 may invest in IPR and currently is looking at the feasibility of various IPR alternatives and direct potable reuse using AWT recycled water. A1 also serves as a recycled water wholesaler to another municipality (M2) within the county; M2 in turn retails recycled water to its customers.

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision-making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Project1 provides about 10,000 AFY of recycled water for NPR. About two-thirds of this water is used for landscape irrigation and the remainder is supplied for industrial cooling and indoor use. The initial decision made for Project1 to supply recycled water for NPR was based on a number of feasibility studies that compared the cost of the NPR distribution system with various alternatives, including a deep water outfall and IPR reuse. The capital cost of NPR originally was estimated to be about $120 million to distribute 9000 AFY of recycled water for landscape irrigation, whereas the cost of IPR was estimated in excess of $200 million, largely because of the inclusion of evaporation and landfill disposal of residual solids from the reverse osmosis (RO) process (ocean discharge of brine was not considered as an option at that time). It should be noted that blending RO reject with treated wastewater for marine discharge is now considered a feasible option for potable reuse.
If not reusing water, are you considering reusing water - and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]. Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Originally A1 wanted to enhance its water supply with NPR. With respect to IPR, A1 is primarily interested in conducting a feasibility study to see if it would be appropriate as a future water supply. A1's board is interested in expanding recycled water use because it is a drought-proof supply, and more reliable than some other supplies. The major drivers for considering additional recycled water use include increased water supply and increased reliability of water supply, as long as the quality of recycled water is improved. A1 is concerned about salinity and constituents of emerging concern (CECs), including pharmaceuticals, ingredients in personal care products, and endocrine disruptors. With respect to IPR, a 2008 planning report indicated that while the amount of NPR could double to 20,000 AFY over the next 10 years, further expansion beyond that amount could cost in excess of $500 million. By comparison, an IPR program capable of reusing up to 30,000 AFY could be developed for half that amount ($200 million to $300 million). This prompted interest in taking steps to explore the local feasibility of IPR. As a result, A1 currently is working in both areas—expanding NPR and considering IPR. A1 is conducting an IPR feasibility study to evaluate groundwater recharge, reservoir augmentation, direct injection, and perhaps augmentation of AWT water upstream of the drinking water treatment plant. A1 is building an AWT plant to enhance recycled water quality for NPR in order to expand uses and protect groundwater. A1 is also using the AWT to pilot technology as part of the feasibility evaluation for IPR.

Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	A1 is actively investigating regional desalination to maintain a diverse portfolio.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	A1 believes that NPR is easier to implement, and more readily accepted by the public (especially in A1's service area). However the pipelines are expensive. Where NPR is less expensive than IPR, this is the preferred option. A1 believes that IPR is more difficult to implement than NPR because there are different perceptions of recycled water—for example, the negative image of potable reuse portrayed by the "toilet to tap" moniker by its opponents persists in the mind of many people among the general public. Water professionals know that the technology is there to make the cleanest water, but A1 believes that it will be necessary to perform more outreach to help the public reach the same understanding. A1 has already begun strategic planning to prepare the public to participate in the decision-making process. Desalination is more acceptable to the public than potable reuse, but it has a higher cost and a greater environmental impact through greenhouse gas emissions. The question at this point is how desalination can be made "more green" from an energy standpoint. A1 is also concerned about brine disposal. The most important criteria for expansion of NPR and consideration of future IPR are water supply reliability (in 2009 there was a 15% water shortage because of drought), maintaining a diverse portfolio with less environmental impact, and controlling costs.
Was the project developed with other agencies; if so, what were the roles of other agencies?	NPR: A1 began by supporting the work of other jurisdictions through a reimbursement policy ($115/AF). Now A1's role includes a partnership with M1 for Project1 to enhance water quality with an AWT facility that will be owned and operated by A1 and located at M1's wastewater treatment plant. In addition, A1 is partnering with M1 to make joint decisions about future expansions of Project1's regional recycling distribution system. IPR: A1 is the lead in developing IPR, in partnership with local municipalities and privately owned water retailers. A1 is also looking into partnerships for IPR with other agencies. Desalination: A1 is currently working with other agencies in the region to develop a regional desalination pilot facility.
Was there major leadership input from the community? Was there opposition from the community?	Yes. A regional business group coalition has encouraged A1 to look more closely into the feasibility of IPR. There has not yet been opposition from the community.
Were there any unique circumstances favoring or impeding progress?	A drought from 2006 to 2009 stimulated interest in water recycling. Concerns about potable water supply restrictions/reliability also stimulated interest. These concerns relate to supply interruptions because of the potential for earthquake-induced catastrophic failures of levees and restrictions in pumping to protect endangered species.

ECONOMIC and FINANCIAL	
Project costs (for the reuse component only – not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	M1 has invested approximately $250 million to date in water recycling facilities that currently provide about 10,000 AFY of recycled water. Of this total investment, M1 has received about $50 million in grants from the U.S. Bureau of Reclamation, A1, and the state. The AWT, now under construction, is estimated to cost about $50 million. With respect to yield, investment in advanced treatment will not only ensure the continued feasibility of current reuse (i.e., 10,000 AFY), it will facilitate expansion of the program to 20,000 AFY, as well as provide a benchmark technology for future development of IPR. Construction of the AWT facility began in October 2010 and is planned to be completed by the summer of 2012. The AWT project was awarded $8.25 million from the Federal Stimulus grant funds and approximately $3 million from a state grant; it will receive $11 million from M1 because the AWT facility will contribute to system reliability, provide a filtration benefit, and enhance water quality. The remainder of the cost will be borne by A1. M1 has leased the land for the AWT facility to A1 at a nominal price.
Avoided costs as a result of utilizing the reuse option, did the utility Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion /upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	1. *Avoided costs related to an alternative water supply project?* A water supply infrastructure master plan compared different options, including IPR. Avoided costs for IPR could include not needing to invest in reservoir expansion, more imported water, additional conservation, or gray-water development. 2. *Avoided costs related to water or wastewater treatment plant capacity expansion /upgrade?* The AWT will facilitate maintenance of the filter system at the M1 treatment plant, extend the useful life of the plant, and enhance recycled water quality (thereby avoiding costs associated with these actions in the future). M1 has provided $11 million to the project for these benefits.
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	Focus groups from 2003 to 2006 suggested that enhanced water quality (principally lowering of the salinity to below 500 mg/L and secondarily reducing the concentration of CECs) would lead to expanded irrigation and industrial use of recycled water.

Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	The AWT project was awarded $8.25 million from the federal stimulus grant funds and approximately $3 million from a state grant, and will receive $11 million from M1 because it will contribute to system reliability and provide a filtration benefit and enhance water quality. M1 has leased the land for the AWT facility to A1 at a nominal price. A1 will bear the remainder of the cost.
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	Use of traditional supplies: yes, the expanded use of recycled water will make other traditional supplies available for other uses. Meet discharge requirements: discharge requirements are the responsibility of another agency. However, as more wastewater effluent is recycled, water quality in the receiving water body is improved because of reduced pollutant loads (this benefit has not been quantified). Environmental benefits: yes, the more recycled water used in the A1 service area, the more water remains for the environment. Improving the quality of recycled water used for irrigation also helps protect the groundwater. There are also avoided GHG emissions compared to alternative supplies (this benefit has not been quantified; however, information is available on the AWT). Water quality objectives: no, except that the discharge of brine from the AWT had to be coordinated with wastewater effluent discharge. Environmental costs: no. There are minimal environmental impacts related to construction, including minor increases in truck traffic, air pollution requiring dust control, and relocation or mitigation for burrowing owl habitat.

Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g. reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	1. A1 has general concerns about the use of recycled water and protecting groundwater quality (salts, CECs, and disinfection byproducts). Protection of groundwater quality is governed under the state's anti-degradation policy for groundwater. The state has adopted requirements for the use of recycled water for landscape irrigation and groundwater recharge under this policy. At this stage, it does not appear that these requirements have an impact on the allowable types of reuse applications to be pursued by A1. 2. Future decisions about development of potable reuse also might be influenced by the desire to reduce wastewater discharges to surface water to avoid long-term conversion of salt marshes to freshwater marshes and protect endangered species that depend on salt marsh habitats.
SOCIAL and POLITICAL	
Public acceptance/opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so, what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	There has been no opposition to date. A public poll was conducted in 2010 regarding IPR. The outcome was that education will be a very important element, and the public must understand the technology behind IPR. Public outreach programs have not yet been conducted by A1. However, A1 is working with a public relations firm to develop a countywide recycled water strategic communications plan. The objective of the plan is to build community support and awareness for existing recycled water programs and to foster community support for any potential future uses of AWT water including IPR.
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	For AWT, local control was a factor in that the enhanced water quality would expand NPR. A1 and M1 worked for four years with extensive staff and consultant support to develop the partnership agreements necessary to collaborate on the AWT and further expansion of recycled water use. Leadership from the A1 board and their persistent interest in using recycled water kept this initiative moving forward. With respect to the AWT, community support was also helpful (lack of opposition, the lowering of salts, and demonstration of the value of AWT).

Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	A1 maintains a robust water supply portfolio, having invested in diverse supplies. However, a number of issues related to potable supply reliability, ranging from climate change to reductions in imported water to protect endangered species have stimulated interest in AWT and further development of IPR.
For all classes of users, what are the benefits that were most important for the users: reliability, cost of water, others?	The planned introduction of AWT water will provide a number of benefits, including water supply reliability, improved water quality for current uses, protection of groundwater, and potentially expanding the number of uses for recycled water (including IPR).
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	To ensure an "uninterruptable supply" of recycled water, M1 is constructing a potable backup system.
Organization and business integration issues: Was it necessary to make institutional rearrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	Institutional arrangements. Yes; a policy advisory committee was developed supported by A1 and M1 staff. Institutional barriers. Yes; A1 is responsible for water supply and environmental stewardship but not wastewater treatment. M1, as administering agency for the treatment plant, had multiple interests, but especially wastewater treatment. These interests did not always overlap. Spending resources of M1's wastewater enterprise on a strictly water supply project initially was deemed illegal, even though M1 is also a retailer of potable water to a portion of the city within A1. Resolution of exactly which entity pays how much for what part of the project took 3 years of weekly meetings in a facilitated "coordination" process.
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable green-house gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?	Operation of the AWT would result in direct GHG emissions from area sources, employee commutes, and chemical deliveries. The consumption of electricity related to the operation of the proposed action would result in indirect GHG emissions. It is anticipated that electricity would be supplied by a large energy utility and that the operation of the proposed facility would result in an estimated annual energy consumption of approximately 6.3 million kWh. Based on this estimate, it is predicted that operation of the AWT would result in the annual emission of approximately 1500 metric tons of GHG per year. This is slightly above the local air quality management district threshold of 1100 metric tons GHG per year. However, when the GHG produced by the AWT is added to the 1600 metric tons of GHG per year produced by pumping an average of 10,000 AFY (9 mgd) of recycled water to regional customers, the total of 3100 metric tons of GHG per year amounts to a savings of 500 metric tons of GHG per year when compared with the average greenhouse gas produced by use of an equivalent amount of domestic (nonrecycled) water supplied by A1.

Were there legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	Spending resources of M1's wastewater enterprise on a strictly water supply project initially was deemed illegal, even though M1 is also a retailer of potable water to a portion of the city within A1. Resolution of exactly which entity pays how much for what part of the project took 3 years of weekly meetings in a facilitated "coordination" process.
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why — this is intended to be a cost question)?	Storage of AWT treated water was needed to ensure adequate quantities for a consistent blended water quality. Potable backup will provide potable water in place of tertiary recycled water (and later the blend of tertiary/AWT water) if there is a process failure in recycled water treatment.
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	The AWT facility is being built according to best practices for structural and seismic stability.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	In developing the AWT, a great deal of time and professional effort was spent on selection of the most appropriate membranes for microfiltration (MF) and RO to remove salts, so that the blend water would meet an goal established by A1 and M1 to maintain dissolved solids in the blended recycled water under 500 mg/L.
Other?	It was also important to ensure that the blend of AWT and tertiary recycled water was consistent and that seasonal uses were accommodated in determining peak flow rates.

Attachment A – A1 Reuse Project Cost Estimate Form

Part 1. Cost Estimate Available from Agency? (record in whatever form it is available in the box directly below and then ask whether specific cost elements are included.)

Utility/Agency's Cost Estimate:

Capital: $54 million

Annual O&M: $3-$4 million

Year in which cost estimate made: (2010)

Part 2. Cost Estimate Clarification		
Category	**Included in Part 1? Yes or No**	**Additional Estimate (if available)**
Preconstruction	Yes	
Research	Yes	
Planning	Yes	
Design	Yes	$3,600,000
Capital		$50,200,000
Treatment	Yes	$29,700,000
Distribution system	Yes	$1,400,000
Pumping	Yes	$400,000
Storage	Yes	$3,700,000
Flow equalization	Yes	$-
Brine disposal	Yes	$300,000
Land acquisition	Yes	$5,200,000
Buildings and structure	Yes	$3,800,000
Other	Yes (Environmental Mitigation)	$1,200,000
Annual Cost Elements		$3 to 4 million per year
O&M labor	Yes	
Chemicals	Yes	
Electric power	Yes	
Membrane replacement	Yes	
Repairs	Yes	
Spare parts	Yes	
Insurance	No (self-insured)	
Contingency	Yes	$5,300,000

Case Study WRRF-09-02	Agency 2 (A2)
BACKGROUND	
Name of Agency	Agency 2 (A2)
Do they want to be anonymous? (Y or N)	Y
Agency contact(s) [name, email address, phone number]	---
Location	---
Brief description of the agency (what they do with regard to water or wastewater management or other)	A2 provides water, wastewater, and recycled water services to a municipality and neighboring agencies serving more than 1.3 million people in service area of over 200 sq mi. The current average annual water demand is 200 mgd; current wastewater flows are 154 mgd; the current NPR recycled water demand is 12 mgd. A2 imports nearly 90% of its water from other areas. Potential water supply offsets, such as conservation and water reclamation, are part of the water supply portfolio but are only expected to offset 20 to 25% of total demand. A2 operates solely on funds from rates and service charges.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes: NPR ongoing and IPR in the planning/demonstration phase. NPR Tertiary recycled water (filtered and disinfected using UV or chlorine) is produced by A2's two reclamation. Recycled water meets about 4% of the region's water supply demand. Recycled water is used for industrial processing, cooling towers, construction site dust suppression and soil compaction, decorative fountains, and toilet and urinal flushing. A2 currently has water-use restrictions in place for potable water; however, recycled water customers are not subject to restrictions. Only NPR has been implemented to date, because there is a regulatory framework to follow, and NPR projects generally have public support. IPR A2 currently is undertaking a demonstration IPR project for surface water augmentation using highly treated recycled water. The objective of the project is to define the regulatory requirements for a full-scale project. Public outreach is a major project component that has been in progress since spring 2010 and will continue for the duration of the project.

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	A 2006 study determined that IPR through reservoir augmentation (IPR/RA) is more cost effective than expanding the NPR reuse customer base and distribution system. IPR/RA provides the additional benefit of being a year-round supply, while NPR demands peak during the summer and drop off significantly in the cooler winter months. Customer plumbing retrofits to take NPR recycled water are costly, and the conversion does not pencil out for all potential customers. Prior to 2010, NPR demands have been typically much greater than actual demands (not quantified); however, demands have dropped concomitantly with the imposition of mandatory potable water restrictions, which may have had a carryover effect on recycled water customers (no restrictions were placed on recycled water use (Note: Restrictions were lifted in 2011.) A2 is in the final stages of a second study that reinforces the 2006 findings; potential NPR customers are disbursed widely throughout A2's service area, and a significant amount of parallel infrastructure would be required to serve them. The majority of recycled water project concepts developed in the study are IPR projects. IPR represents a much greater local supply than NPR; it also represents a greater reduction in wastewater discharged to the ocean. The outcome of the demonstration project is considered to be critical; the technical and economic feasibility of IPR/RA must be demonstrated for A2 to implement not only the IPR/RA concept but all potential IPR projects.
If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	---

Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	Yes. Six other sources exist to address A2's water demands: imported river water, surface water, groundwater, desalinated seawater, and conservation. A2 is not leading any effort to develop desalination, but is a member agency of another entity that has taken the lead in evaluating desalination options for the region. A2 has had an aggressive conservation program since the 1980s. While the population has increased by ~ 40% in the last 20 years, demands have remained relatively flat.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	The two reuse options that have been recently evaluated are NPR and IPR. IPR/RA in comparison to IPR via groundwater recharge currently is seen as the most viable IPR option for A2. A2's groundwater basins are either too small or too little physical data (size, water quality) are available. A2 continues to investigate its groundwater resources, and as more data become available, IPR through groundwater recharge may be pursued. In comparing NPR to IPR/RA, the following were considered their most distinguishing elements: • Ability to maximize use of existing reclamation capacity; only IPR/RA would fully utilize A2's reclamation capacity, while NPR would not • Significant capital investment would be required to expand the NPR distribution system; additional operating and maintenance costs (O&M) also would be incurred for maintaining a separate system • Seasonality of NPR demand versus a more year-round demand for IPR because its uses are not as limited as NPR uses • More advanced treatment requirements associated with IPR Criteria applied during the 2006 reuse study that recommended IPR/RA: health and safety value, social value, environmental value, local water reliability, water quality, technical feasibility, operational reliability, cost, ability to implement. IPR/RA was seen as the option having the lowest ultimate unit cost. Other NPR options that were considered had lower initial capital requirements but higher ultimate unit costs.
Was the project developed with other agencies; if so, what were the roles of other agencies?	With respect to the IPR/RA demonstration project, no other agencies were involved in its development (not excluding state regulators). With respect to the recycled water study, the other 15 agencies that participate in the region's wastewater system are project stakeholders. A2 operates the region's system, which in turn handles wastewater from A2 and 15 other agencies in the region. Project stakeholders participate in the development and review of all the study concepts and findings. The IPR/RA demonstration project also is being reviewed by an independent expert panel.
Was there major leadership input from the community? Was there opposition from the community?	With respect to the 2006 reuse study that recommended further development of the IPR/RA concept, community leaders were engaged in an American Assembly format (a nonpartisan public policy forum). Public participation was extensive.
Were there any unique circumstances favoring or impeding progress?	Community outreach is a major task of the IPR/RA demonstration project. Until recently water use was put under strict drought-related guidelines. There has seemed to be broader awareness about the scarcity of water and lack of supply reliability in the region.

<table>
<tr><th colspan="2">ECONOMIC and FINANCIAL</th></tr>
<tr><td>Project costs (for the reuse component only – not existing wastewater treatment):
Please use the Reuse Project Cost Estimate Form in Attachment A.
For this cost estimate, what is the acre-foot yield for the project?</td><td>Project costs for recycling are not yet finalized. The ongoing recycled water study will contain estimates and will be finalized in Fall 2011. The demonstration project final report will contain costs specific to the IPR/RA concept and will be finalized in late 2012.

Estimates (2010) for the marginal cost of recycled water compared to other water supplies are available. Marginal cost includes both operating costs and amortized fixed capital costs. Subsidies are not included. Operating costs encompass various expenses involved in the extraction, treatment, transportation, and distribution of water. The allocation of fixed capital costs represents both the investment in infrastructure and financing costs over time. Although there is a large supply of wastewater available for recycling, the capital costs required to install new distribution systems make the marginal cost of NPR relatively high. Although the cost of treatment for IPR adds about 10% to 15% to the cost of NPR, the expense of conveying recycled potable water for reservoir augmentation is less than that required to construct an entirely separate system for distribution to customers as required for NPR. Conveyance costs are still a factor for IPR, as well as pumping costs. If the IPR project was closer to the source of recycled water, the conveyance costs would be significantly less.
<table>
<tr><th>Type</th><th>Low $/AF</th><th>High $/AF</th></tr>
<tr><td>Imported river water</td><td>875</td><td>975</td></tr>
<tr><td>Surface water</td><td>400</td><td>800</td></tr>
<tr><td>Desalinated water</td><td>1800</td><td>2800</td></tr>
<tr><td>Recycled water NPR</td><td>1600</td><td>2600</td></tr>
<tr><td>Recycled IPR</td><td>1200</td><td>1800</td></tr>
<tr><td>Conservation</td><td>150</td><td>1000</td></tr>
</table></td></tr>
<tr><td>Avoided costs as a result of utilizing the reuse option, did the utility
Avoid costs related to an alternative water supply project?
Water or wastewater treatment plant capacity expansion /upgrade?
If so, is there a rough estimate of the avoided cost (capital and O&M and year)?</td><td>Actual costs figures will be included in fall 2011 report. Avoided costs include costs to upgrade a wastewater treatment plant that discharges to the ocean at less than its current capacity; costs to purchase imported water (currently projected to double within the next 10 years).</td></tr>
<tr><td>Market surveys and analysis – what types were performed:
Customer class?
Peaking or base?
Number and location of customers?</td><td>As part of the recycled water study due in fall 2011, A2's potable customer database was analyzed to identify potential customers. Potential customers were those with significant demands and uses that do not require potable water. Other water purveyors within the region were surveyed for what their potential NPR demand may be. Based on these research efforts, ~ 30 mgd in potential NPR demands were identified. When they were mapped, they were shown to be widely disbursed. Further, experience has shown that not everyone converts to recycled water; if the 30 mgd was to be pursued, significantly less may actually</td></tr>
</table>

Customers' reuse water quality requirements? Other?	be realized.
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	The cost framework currently is under development for recycled water projects going forward. Water and wastewater funds are separate, yet both systems will benefit from reuse. It has yet to be determined how to allocate the costs for recycled water projects between the two funds. The portion of costs allocated to wastewater will be shared among the 16 agencies who participate in the region's wastewater system. Grants and low-interest loans are expected to be available. NPR connections: new customers pay; existing customers switching to NPR only pay for any incremental increase in capacity. There are agreements with wholesale customers (other agencies) that typically dictate the amount of recycled water that A2 must provide or that the agency must take. A2 is in the process of finalizing a Recycled Water Cost of Service Study, which will likely lead to a change in recycled water rates.
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)?	Yes, reuse will reduce A2's need for imported water. The greater the reuse, the lower the flows to the ocean discharge plant and the less costly it will be to upgrade treatment at the plant based on anticipated regulatory requirements. The impacts/benefits of putting advanced-treated water in a local reservoir are currently under study; however, advanced-treated water is expected to have a positive impact relative to salinity in the reservoir. A2 has access to an ocean outfall for disposal of brine from the advanced treatment facility; it will be a small input compared to overall disposal of wastewater to the ocean. A 23-mile pipeline from the proposed advanced water treatment plant to the local reservoir would have to be built. Environmental and community impacts are expected, but can be mitigated.
Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project?	

Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	
Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g. reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	A key driver of the recycled water study is to reduce flow to the ocean discharge plant to the greatest extent possible. Future regulatory requirements for the plant are likely to result in the need to upgrade treatment and lower flows would result in reduced costs.
SOCIAL and POLITICAL	
Public acceptance/opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	IPR/RA was proposed in the mid-1990s, and it was met with great public opposition. Current outreach efforts associated with the demonstration project have shown there is more interest and openness to the concept; findings from the public outreach effort will be documented in the final project report that is due out in late 2012.

Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	A2's political body receives monthly updates on the progress of the IPR/RA demonstration project. Further, it approves all consultant contracts associated with the project, and also helps identify specific groups and associations for public outreach. The final report for the demonstration project will be presented to this political body for approval of its findings and recommendations. Several business and environmental groups repeatedly spoken at political body meetings in support of the IPR/RA demonstration project and its related contracts. They organized themselves into the group known as the Water Reliability Coalition and are implementing their own independent outreach efforts.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	Imported water costs continue to increase while their reliability goes down. A2 relies on imported water for 80 to 90% of its total need. Conservation is estimated to reduce demands by 10 to 15%; conservation is still pursued actively but is not expected to yield reductions significantly different from current levels. NPR represents 3 to 5% of A2's water supplies; the supply is reliable, but the demand is highly seasonal. Long-term sustainability requires the development of more local supplies.
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	For current NPR customers, reliability and cost are key benefits. Over the long term, IPR is expected to be reliable and competitive relative to imported water costs.
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	No
Organization and business integration issues: Was it necessary to make institutional rearrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	No organization or institutional barriers to date. Relative to IPR/RA implementation, none foreseen at this time.

<table>
<tr><td>Energy/Carbon Footprint:
Quantify energy use in kilowatt hours
What are the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?</td><td>For 2010, estimates of energy usage for NPR and IPR are available in comparison to other water sources. For NPR, energy use is relative low at 600 to 1000 kWh/AF. Locating primary or satellite recycling plants relatively close to end users can help keep energy costs at the lower end of this range. IPR requires considerably more energy than NPR because of the transportation costs necessary to convey the treated water to a storage reservoir, if this is the chosen treatment strategy. Energy costs for this source are estimated at 1500 to 2000 kWh/AF. Where significant pumping is required, energy expenditures could be substantial. The extent of treatment costs necessary to achieve desired quality standards for potability also adds to energy requirements.
<table>
<tr><th>Type</th><th>Low kWh/AF</th><th>High kWh/AF</th></tr>
<tr><td>Imported river water</td><td>2000</td><td>3000</td></tr>
<tr><td>Surface water</td><td>500</td><td>1000</td></tr>
<tr><td>Desalinated water</td><td>4100</td><td>5100</td></tr>
<tr><td>Recycled water NPR</td><td>600</td><td>1000</td></tr>
<tr><td>Recycled IPR</td><td>1500</td><td>2000</td></tr>
<tr><td>Conservation</td><td>Negligible</td><td>Negligible</td></tr>
</table></td></tr>
<tr><td>Legal issues that helped or hindered implementation?
Water rights? Liability?
Public access issues?
Other?</td><td>None to date. Regarding IPR/RA, none foreseen at this time.</td></tr>
<tr><td colspan="2">TECHNICAL FEASIBILITY and ENGINEERING</td></tr>
<tr><td>Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why — this is intended to be a cost question)?</td><td>The local reservoir has a primary role in the feasibility of IPR/RA. Discussion is taking place with regulators regarding residence time of recycled water in the reservoir, pathogen reduction, and nutrient inputs.</td></tr>
<tr><td>Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?</td><td>Yes (not specified).</td></tr>
<tr><td>Were there other technology evaluations/needs considered in deciding which option to choose over another?</td><td>Relative to NPR versus IPR, the advanced treatment technology is viewed as being proven in other communities such the system operated by the Orange County Water District. In June 2011, A2 began pilot testing the same treatment technology in use by the Orange County Water District.</td></tr>
<tr><td>Other?</td><td>---</td></tr>
</table>

Attachment A – A2 Reuse Project Cost Estimate Form (not Completed by Participant)

Case Study WRRF-09-02	**Agency 3 (A3)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	Y
Agency contact(s) [name, email address, phone number]	---
Location	---
Brief description of the agency (what they do with regard to water or wastewater management or other)	A3 is a joint powers agency comprised of seven cities, three unincorporated areas, and the county. A3 collects and treats wastewater from a portion of the county. Wastewater receives tertiary treatment and is used to irrigate food crops. Water not needed for irrigation receives secondary treatment and is discharged to the ocean. The primary source for drinking water is groundwater; however, the reserve is diminishing as the number of farms, businesses, and residences have increased. So much water has been removed, in fact, that intruding seawater has come within 2 mi of groundwater production wells. In addition to threatening the drinking water supply, seawater intrusion threatens the region's multibillion-dollar agricultural economy.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes. A tertiary water recycling facility and a distribution system including 45 miles of pipeline and 22 supplemental wells. (The recycling facility meets total coliform requirements of 2.2 MPN/100 mL as a 7-day median and no more than 23 MPN/100 mL in any 30-day period; an average turbidity of 2 NTU within a 24-hour period, 5 NTU no more than 5% of the time within a 24-hour period; and is less than 10 NTU at any time.) Treatment consists of trickling filter/solids contact secondary treatment followed by coagulation/flocculation, dual media deep bed filtration, and gaseous chlorine disinfection. The objective of the water reuse program is to retard the advance of seawater intrusion by supplying irrigation water to nearly 12,000 acres of farmland (agricultural projects). A3 recycles up to 15,200 AFY of tertiary water. The water is used to irrigate food crops including strawberries, lettuce, celery, cauliflower, broccoli, spinach, fennel, and artichokes. Before the design of the tertiary treatment system, A3 elected to delete intermediate sedimentation on the basis of in-house research that showed equivalent results with direct filtration. During design, A3 considered membranes rather than media filtration, but at that time, membranes were much more expensive and did not have a track record. Deep bed dual media was chosen for its reliability. A3 also considered UV disinfection, but the customers (growers) wanted a chorine residual so chlorine was selected rather than building dual facilities (UV and chlorine); the design allowed for the addition of UV in the future. A3 has considered IPR via groundwater recharge. Treatment would start with either secondary effluent or tertiary effluent followed by micro- or ultra-filtration and reverse osmosis followed by hydrogen peroxide and UV for disinfection and organic reduction (similar to the treatment scheme for the Orange County Water District).

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	A3 elected to start with NPR, because one groundwater system has a severe seawater intrusion problem; no access to state or federal imported potable water; another groundwater basin has been adjudicated due to over-pumping, and thus water availability was limited severely; mandates from the state grant for the interceptor and secondary treatment systems to recycle water; and a goal eventually to have zero discharge to the ocean. The water reclamation plant location was determined partially because it is adjacent to agricultural fields. NPR was chosen as it uses a majority of the water available at the least cost (total project capital cost and per AF cost). During the year, A3 treats around 22,000 to 25,000 AF of wastewater. Because food crop irrigation uses 11,000 to 15,000 AF, approximately 7000 to 14,000 AF recycled water is available for other applications. A3 is considering two new projects based on regional needs. Note: There is no planning process for decision making regarding implementation. Recycling is considered “the right thing to do” and A3 responds to regional needs. The first option (in order of preference for implementation) is NPR to use the water for irrigating for urban landscapes using the existing treatment plant facilities. The project will require a distribution pipeline, pump stations, and storage reservoirs. This project consists of two phases: (1) initially 1727 AFY and (2) eventually 3000 AFY. The water will be used for golf courses, playing fields, schools, common areas, and front yards. For the first phase of this project, the state and federal environmental review processes and project design have been completed. This project needs funding to proceed. It was chosen as the favored project to pursue, because it was the least expensive option and because it was a necessary component of the second option. The second option, which is in the planning stage, is an IPR project using recycled water for groundwater recharge (GWR). It is initially planned to start with 2400 AFY and potentially expand. It is intended to use the urban NPR pipeline during the winter for the IPR project that would inject water into the second of the abovementioned groundwater basins. This project has been delayed by political pressure to focus on another project (desalination) so that the desalination project could be built first. In addition, funding is limited severely for pursuing pilot testing and design for the GWR project. The choice for IPR is based on the severely over-pumped and adjudicated groundwater basin. No other project considered could refill this specific groundwater basin or help to prevent seawater intrusion. Note: This groundwater basin has water elevations below sea level, but salt water intrusion has not yet been observed. It has been adjudicated and is managed by a water master. Planning for subsequent projects includes expanding the agricultural irrigation system (expand by 3000 acres or more), the second phase of the urban landscape irrigation project (Phase 2 to 3000 AFY and potentially, with storage, a Phase 3 using even more water), and GWR (additional water to the same basin or additional basins). The expansions of the agricultural and urban landscape projects will require storing water during the winter and using it during the summer. The volume of recycled water that can be stored during the winter in reservoirs or using aquifer storage and recovery and the willingness of the customers to pay for the resulting water will determine if NPR, IPR, or both will be pursued.

If not reusing water, are you considering reusing water and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Not applicable
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	The water purveyors in the area continue to pursue conservation (it has one of the lowest per capita water uses in the U.S.) and desalination. The desalination projects consist of (1) a small private system in use, (2) a small public system (300 AFY) in use, and (3) a large public/private project (10,000 AFY) under design. The effective capacity of one local reservoir was increased by installing an inflatable dam on top of the existing concrete dam. One new seasonal (inflatable) dam has been installed in the local river, which increases groundwater replenishment, supplements recycled water for agricultural irrigation, and may provide potable water in the future. Attempts have been made to dredge out or replace existing reservoirs without success (because of environmental and political hurdles).
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	Agricultural irrigation project. The existing tertiary water recycling facility and the distribution system used for agricultural irrigation was selected as discussed above. The distribution system was chosen to approximately coincide with the seawater intrusion boundaries of the 400-foot aquifer and represent the amount of irrigation water demand eventually expected from the fully utilized project. The overall project was broken into two elements (treatment and distribution) for funding purposes. There were not many alternatives. Urban irrigation project. A3 expects to use recycled water for an urban project that would be mostly landscaping (golf courses, parks, schools, and playing fields). The project is designed.

The project is not yet being built because of many factors:

- The partner (public water and wastewater district) wants to redesign it to give them better control.
- The project will result in water that is more expensive than current drinking water.
- It has been difficult to get funding.
- The second phase of the project might involve collaboration with the private water company in the area who is not currently receptive.

Historically the project was delayed because

- A3 had to give away rights to the recycled water to obtain funding for the agriculture irrigation projects. It took years and hundreds of thousand dollars in legal fees to reestablish rights to enough of the water to make this a viable project.
- The urban irrigation project connects to a project built with a federal loan (the agricultural reuse project); A3 was required to perform full state and federal environmental review. The addition of the federal review lengthened the process by about 2 years.

GWR Project

The GWR project was chosen to respond to groundwater over-pumping and adjudication, the availability of wastewater during the winter, and an almost unused pipeline (the urban irrigation project) during the winter. Other factors included the type of treatment for the recharge water (tertiary versus advanced treatment), the method to get the water into the ground (percolation, vadose well, or injection), and the location. Advanced treated water was chosen (based on the Orange County Water District treatment scheme) to minimize concerns with the water. A combination of vadose and injection wells was chosen for cost and aesthetic (minor visual impact) reasons. The inland location was chosen because it was the least expensive and in a location with a much larger capacity for new water than a coastal location that would have provided a direct seawater intrusion barrier. The decision to use the urban irrigation project pipeline to transport the water to the injection field was made to minimize cost and to provide leaching water to the landscapers during the winter when the pipeline would transport advanced treated water.

A second injection location was proposed in another aquifer system, but the farming community was opposed to interfering directly with the highly intruded aquifer.

Winter Storage

A3 is in the early planning stages for a project that would store recycled water during the winter for use during the summer. Options include reservoirs and aquifer storage and recovery (ASR). A reservoir, if chosen, would be located where land is relatively inexpensive and reasonably close to the urban irrigation pipeline. ASR options must consider the location of the facilities and the method for introducing the water. The location would be chosen close to the urban irrigation pipeline. A new pump station would need to be built if it were located away from the wastewater treatment facilities. The three methods of introducing the water include percolation, vadose wells, and injection wells. The regulators may require advanced treated water and dilution for vadose or injection wells, even into a nonpotable aquifer even though the resulting water would be for NPR purposes. If so, the costs would dictate that percolation be used even though the price of land is high. Alternately, a reservoir could be built.

Was the project developed with other agencies; if so, what were the roles of other agencies?	**Agricultural Irrigation Project** The agricultural irrigation project was developed with the county water resource agency. The county was responsible for the design and construction of the distribution system project element and owns that project. The resource agency pays A3 to operate the distribution system. A3 designed and constructed the recycled water treatment facility and owns it. The resource agency pays A3 to operate that treatment facility. The distribution system and treatment system were developed as the direct result of cooperation between A3, the resource agency, county environmental health, state regulators, and other stakeholders, which participated in an agricultural irrigation research project that proved that the concept was safe. Continued review and input into the overall project are provided by a committee comprised of the general managers of A3 and the resource agency, the local health officer, and six growers (users of recycled water). **Urban Irrigation Project** The urban irrigation project is a joint project with a local water district. A3 has designed a pump station and the pipe within its treatment plant, which it will own after construction. A3 or a private water purveyor will be responsible for the design, construction, and operation of a small extension of the pipeline system. The water district will pay A3 through water delivery charges for the capital and operation and maintenance (O&M) costs. The water district has designed and will build the remainder of the system. The county water resource agency is involved with all projects using recycled water and they specifically have granted A3 and the water district rights to certain amounts of recycled water to allow this project to proceed. **GWR Project** The GWR project is being studied in conjunction with the local water management district and groundwater watermaster. The water management district and watermaster are the two public entities that have the most responsibility for the groundwater basin that will receive the water. The watermaster provided funding to help with the program level environmental review of the project. The watermaster also has modeled the impacts of GWR on the groundwater basin. The watermaster may provide some funding for pilot testing, design, construction, or O&M. The water management district has provided technical support of the project and may provide funding for pilot testing, design, construction, or O&M. The municipality served may provide land for well sites and may provide dilution water during the initial years (if needed). This project currently requires connection with and water being pumped through the urban irrigation project pump stations and pipeline system. Interaction and cooperation with the local water district, therefore, is required for that part of the project. The county water resource agency is involved in review of this and all projects using recycled water. **Winter Storage** The winter storage project is being pursued separately. The local water district and county water resource agency will be included in the project after some additional preliminary studies. Other entities, such as a private water purveyor, could become involved later.

Was there major leadership input from the community? Was there opposition from the community?	**Agricultural Irrigation Project** Though there was wide support for the overall project, the county environmental health officer originally was opposed to it; however, he helped to secure grant funding for the 11-year research project. After all of his safety concerns had been answered, he became one of the strongest proponents of the project. After design and construction, the growers (users) had second thoughts. Although they were not opposed to the project, they did not want to connect to the project before they were assured about emerging pathogens. A3 delayed project startup to conduct a recycled water food safety study that looked at pathogens in recycled water, including *E. coli* O157:H7, *Legionella*, *Salmonella*, *Giardia*, *Cryptosporidium*, *Cyclospora*, culturable virus, and fecal coliform and compared the result to other recycled, groundwater, surface, and drinking waters. The study concluded that the A3 recycled water is safe for irrigation of vegetables. There has been some opposition to the project from outside the community, but it has not impacted local support. **Urban Irrigation Project** The project sponsor wanted this to be entirely a seawater desalination project. A3 proposed to make the project one-half recycled (NPR) water and one-half desalination. That revised project became the preferred environmental project and underwent full state and federal environmental review. The environmental community supports increasing the amount of recycled water and decreasing the desalination portions of the project. The cities need the recycled water and are requesting that the project be constructed. The project sponsor continues to want the project to be committed to desalination. A local land use authority is responsible for most of the recycled water use and for funding of the project. However, developers are opposed to paying for the project (through land purchase fees), so the land use authority deleted those fees. Some of the future NPR customers are in favor of receiving recycled water, and some are opposed. Opposition is mostly because of the higher cost of NPR water than current potable water. The water purveyors may have to provide the recycled water below the potable water cost. **GWR Project** After initial support, both local potable water purveyors (one public and one private) appear to be opposed to the project. After initial support, the watermaster publicly supports the project, but is unwilling to help pay for the project. The watermaster is chaired by the private potable water purveyor. The water management district is very supportive of the project and wishes to help pay for the project. **Winter Storage** There is no apparent opposition to the project yet. There are, however, strong political reasons for the project in a location that might not work well hydrogeologically. There is a limited aquitard between the upper aquifer (to be used for recycled water storage) and the underlying aquifers used for drinking. The upper aquifer is thin with little and poor water quality.

Were there any unique circumstances favoring or impeding progress?	Agricultural irrigation project. Circumstances favoring progress: • There was wide range support from environmental, agricultural, scientific, “growth,” and “no growth” communities. • The U.S. Bureau of Reclamation allowed the project to be split into two project elements to allow for two low-interest loans. • The federal government authorized the U.S. Bureau of Reclamation loans. • The state authorized a low-interest state revolving loan for the agricultural project. • Landowners provided the seawater intrusion pipeline right-of-ways without cost (one public waste management district got a turnout and rights to some recycled water). • A3 gave up their water rights to allow the loans to go through. Some of these water rights were returned later, though most were not. Although favoring progress for these projects, they impeded progress on the urban irrigation project. • At the behest of state regulators to implement NPR, the water reclamation plant site deliberately was located near the agricultural fields. **Urban Irrigation Project** Circumstances favoring progress: • The state regulators encouraged and favored the project. • The distribution system built for the agricultural project reduced costs for the urban users. • To assist with implementation, the local water district with the help of the local land use authority applied for a grant to study the project. Circumstances impeding progress: • The lack of water rights was a huge impediment. It took more than 3 years and $500,000 in legal assistance to obtain the water rights needed for the project. • As part of obtaining the water rights, the county water resource agency required A3 to obtain the ability to increase the filter loading rate of the tertiary filters or help pay for new filters. • The regional desalination project became a competitor for money, which resulted in the sponsor (the local water district) no longer actively pursuing the reuse project. **GWR Project** Circumstances favoring progress: • The local water district is the local agency responsible for the local groundwater. The basin is helped considerably by the GWR project. The local water district has entered into MOUs and other forms of support for the project and may supply funds for studies and pilot facilities. • The watermaster is responsible for the adjudicated groundwater basin and is looking for new water supplies for the basin. The watermaster has provided funding for part of the GWR environmental review. • The watermaster has provided assistance via use of the agency’s groundwater model, which indicates that the GWR is the only option that improves the groundwater elevations in the basin. • Several environmental groups are in favor of GWR because it is recycling and/or because it reduces wastewater flow into sensitive receiving waters.

	Circumstances impeding progress: • The private and potable water purveyors in the area are currently opposed to the project because they favor seawater desalination over IPR. • The environmental process resulted in desalination as the preferred project over GWR. Desalination will therefore provide the needed water to meet current overdrafts. If desalination is implemented, GWR would be considered growth inducing, and thus likely would be opposed by various stakeholders. . • GWR, as currently envisioned, depends upon the urban irrigation system pipeline to transport advanced treated water during the winter. **Winter Storage** Circumstances favoring progress: • Winter storage would allow for expansion of the urban irrigation project up to 3,000 AFY, which is supported by the county water resource agency, many of the cities, and most of the environmental groups. The higher use of recycled water would make the project more economical. Circumstances impeding progress: • There is a dispute between the participating agencies over the location of the storage facility. One option favored by the local water district would make the urban irrigation pipeline unavailable for winter use with advanced treated water, and thus would thwart the GWR project.
ECONOMIC and FINANCIAL	
Project costs (for the reuse component only – not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A For this cost estimate, what is the acre-foot yield for the project?	**Agricultural Project** • The treatment system cost was \$347/AF including loan repayments for 2009–2010 year (\$179/AF without loan repayment) with 10,340 AF recycled water treated. The distribution system cost was an additional \$228/AF, including loan repayments for 2009–2010 year (\$120/AF without loan repayment) with 17,477 AF (10,340 AF recycled, 5874 AF well, and 1263 AF river water) passing through the system. • Urban irrigation system estimated cost (2008) was \$1800/AF. However, using the Attachment 1 form results in \$2290/AF with loan repayment. However, it would also use the “agricultural” treatment system resulting in a total cost of \$2638/AF including repayment of all the loans (\$179/AF for the recycled water and \$168/AF for the RUWAP portion of the loan repayment). Note: The project must provide for reimbursement of a portion of the capital cost and for the increase in loan interest related to its use. **GWR Project** The estimated cost (2008) was \$1850/AF. However, using the Attachment 1 form and the aforementioned data a more accurate value may be \$3055/AF including \$71.14/AF for the urban irrigation system. O&M and \$887/AF for the urban irrigation system loan repayment.

<table>
<tr>
<td>Avoided costs as a result of utilizing the reuse option, did the utility
Avoided costs related to an alternative water supply project?
Water or wastewater treatment plant capacity expansion/upgrade?
If so, is there a rough estimate of the avoided cost (capital and O&M and year)?</td>
<td>Agricultural Irrigation Project
There were no viable alternate projects, so no avoided costs were calculated. Potable water was not available as an alternative. A farming operation could not afford $8000 to $12,000/AF for irrigation water.
Urban Irrigation Project
The recycled water portion of this project does avoid the cost of building and operating a seawater desalination facility of the same capacity. The capital cost for the proposed desalination plant is $1348/AFY. Therefore, for 1727 AFY, the savings would be about $2.3 million. There would be an O&M savings (power for recycled water is much less), but the projects are not well defined enough to discern the difference.
GWR Project
The capital cost of this project is about $44 million more than same-sized desalination facilities.
Winter Storage
This project could result in reducing the size of the seawater desalination facility expansion in the future. There are too many unknowns at this time to quantify.</td>
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<tr>
<td>Market surveys and analysis – what types were performed:
Customer class?
Peaking or base?
Number and location of customers?
Customers’ reuse water quality requirements?
Other?</td>
<td>Agricultural Irrigation Project
• Marketing studies were performed as part of the research study.
• Initially the growers and landowners were provided with a set of documents explaining the project and recycled water.
• There are 112 turnouts to 222 parcels of land. About 30 grower groups farm nearly all of the project area.
• Continued review and input into overall project are provided by a committee comprised of the general managers of A3 and the resource agency, the local health officer, and six growers (users of recycled water). The committee meets monthly to review costs, maintenance, repairs, water quality, pathogens, emerging concerns, impacts of recycled water on soil, sampling plans, and so on.</td>
</tr>
<tr>
<td></td>
<td>The monitoring program for the project also encompasses outreach to address user and regulatory stakeholder needs and thus has been modified over time. Initially, testing was only going to have been to prove compliance with state water recycling requirements for unrestricted use. However, following a food safety study that demonstrated that the recycled water was safe to use for food crops eaten raw, additional parameters were added to the project monitoring program (fecal coliform, Clostridium perfringens, E. coli O157:H7, Legionella, Salmonella, Giardia, Cryptosporidium, Cyclospora, Helminth, and Shigella). The growers wanted to know the impacts of the recycled water irrigation on their soil, so more testing was added. The growers wanted to pursue improving the recycled water quality by reducing sodium and Sodium Adsorption Ratio. In trying to meet these requests, A3 worked with the largest salt dischargers (food processor, hospitals, commercial laundries, and hotels to convert to potassium chloride from sodium chloride for water softening or to haul their brine from automatic water softeners to A3’s wastewater treatment plant for disposal without entering the recycled water treatment scheme. In response to a state farmer’s coalition marketing agreement to sell products grown in compliance with the food safety practices, A3 added regular testing of generic E. coli. Most recently, the soil salinity study discovered that chlorides are accumulating and that new restrictions on chloride or treatment may be required in the future.</td>
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<table>
<tr><td></td><td>Urban Irrigation Project
A3 has held periodic public forums to describe the project, the expected costs, and to determine user interest. A pilot irrigation study was conducted on a golf course to prove the value of the water. Some potential users want recycled water, some do not.</td></tr>
<tr><td>Financing:
Who paid and how much?
Sharing between agencies?
Grants? How much?
Loans? What interest rate, duration of loan?
Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure?
Are there contracts with customers? Are they for reuse rates only or other costs?</td><td>GWR Project
A3 has an active public outreach program. As part of the program, community leaders have visited the Orange County Water District’s Groundwater Replenishment Project and the West Basin Municipal Water District’s facilities to observe viable GWR projects. Also, key public figures have been interviewed about their feelings and thoughts. The results of those surveys have been used to improve the public handouts created for the project.
Winter Storage
A3 has not yet pursued future customers of the stored water.
Agricultural Irrigation Project
• The treatment system financing included a U.S. Bureau of Reclamation loan for $20,444,141.34. The loan is interest free for the small farms and 7.625% interest on the portion (24.07%--changes each year) of the distribution system owned by “excess” (large) farms over a 35-year repayment period. Annual payment is $780,264.09 plus interest per year. Secondary financing was from an $8,850,000 state revolving fund loan with 3.1% interest over a 20-year repayment period. Annual payment is $632,090.19. Local bonds were sold to cover expenses while the loans were received (multiyear process). Those bonds have been retired. A3 obtained the loans and repays them with funds provided by the county water resource agency.
• The distribution system was financed with a U.S. Bureau of Reclamation loan for about $32,550,000 (same conditions at the treatment system loan). The current loan repayment is about $1,887,642 per year. Local bonds, now retired, paid expenses before the loan was all received. The county water resource agency obtained the loan and repays it with their money. No grants were obtained.
• The construction contract included the pipeline laterals and the turnouts on the private land with no charge to the grower (remember, all the growers provided free right of way for the construction, there were some payments for lost crops). The growers were responsible for attaching a flow regulating backflow preventing valve on each turnout and for connecting that valve into their own system. The growers paid directly. There were no advances to the growers from the project.
• There are no contracts with customers. All issues are handled with county ordinances including the rates (assessments and water delivery charges).
Urban Irrigation Project
• The current plan is to terminate the pipeline laterals at the property line with a meter box and have the property owner pay to bring it onto their property and install the proper backflow preventers.
• There are no customer contracts. Water rates will be a percentage of the potable water rate. The local water district will subsidize the project. Project funding is unknown.</td></tr>
</table>

	GWR project. Water will be injected into the ground. Water will be extracted through existing wells. No customer contracts exist yet. It is unclear if the customer would pay directly for the project, pay when the water is injected, or pay as the water is extracted. Winter storage. Customer contracts would be necessary prior to designing the project.
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project?	**Agricultural Irrigation Project** • The overall project increased chemical usage and did not play a role in meeting wastewater discharge requirements. • There was short-term mitigated noise and dust during construction. • There was short-term reduction in crop production during construction (1994–1997). • The project helped to reduce seawater intrusion by as much as 50%. • A small wetland was created as a research project. **Urban Irrigation Project** • This project will increase chemical usage and power usage compared with pumping more groundwater, which is the current water source. • It does not play a role in meeting discharge requirements. • It will cause short-term mitigated noise, dust, and traffic during construction (1½ to 2 years). • It will reduce groundwater removal, which will reduce groundwater basin overdraft. **GWR Project** • It will decrease chemical usage and power usage compared with desalinated ocean water, which is the alternative. • It does not play a role in meeting discharge requirements. • It will cause short-term mitigated noise, dust, and traffic during construction (1 to 1½ years). • It should reduce groundwater over-pumping.
Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	**Winter Storage** • This project will increase chemical usage and power usage compared with directly recycling water. • This project will increase chemical usage and power usage compared with pumping more groundwater, which is the current source. • It does not play a role in meeting discharge requirements. • It will cause mitigated short-term noise, dust, and traffic during construction (1 to 1½ years). • If the water is used for agricultural project expansion, it will reduce groundwater removal, which will help the seawater intruded aquifer system • If the water is used for the urban landscaping project expansion, it will reduce groundwater over-pumping in an adjudicated groundwater basin.

Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g. reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	**Agricultural Irrigation Project** Not driven by regulatory requirements. **Urban Irrigation Project** Not impacted by regulatory requirements and does not involve changes to treatment. **GWR Project** The anticipated regulatory requirements for injection combined with economics resulted in choosing reverse osmosis (RO)/UV peroxide (H2O2) rather than tertiary recycled water and spreading basins. The current draft regulatory requirement for dilution water to be used for injection of recycled water (start at 50% dilution water with lower dilution requirements over time) makes this project more than twice as expensive as if no dilution water were required. If the dilution requirements change, the project cost would decrease. The source of the dilution water may pose challenges for compliance with draft regulatory requirements. **Winter Storage** The regulatory requirements may result in an above ground storage basin. In establishing designated beneficial uses of groundwater for the purpose of establishing water quality criteria and permit limits, regulators do not seem logically to differentiate between an aquifer never used *and* unusable as a drinking water aquifer from an aquifer that has or could be used for drinking water. If RO/UV H2O2 treatment is required for underground storage of recycled water, then reservoirs will be built or the project will not be implemented.
SOCIAL and POLITICAL	
Public acceptance/ opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted?	**Agricultural Irrigation Project** • The county environmental health officer was opposed to the project in the 1970s. It was necessary to conduct an 11-year research project that studied the use of recycled water for irrigation of food crops to prove safety in order to get his buy-in to the project. He helped acquire the grant funding for the study. After the study was completed, he helped convince the growers that the water was safe. A few growers have said they believe the water is safe, but their company policy is to not use recycled water for food crop irrigation. • Opinion polls were taken of produce handlers, shippers, and buyers.

Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	**Urban Irrigation Project** There is no project opposition because of public health concerns. The opposition is mostly from the local water purveyor who would have to subsidize recycled water use compared with continuing groundwater extractions. **GWR Project** • There is opposition to the project because of the “yuck” factor, particularly among the potable water purveyors. There are minor concerns about chemicals of emerging concern. • A3 did not conduct public opinion polls but participated in many public meetings in all the major cities impacted and in public meetings of the groups looking for water solutions. • A public outreach and education program has been and is being conducted. The most important aspect of the program was the tours of Orange County Water District’s GWR project and West Basin’s operations. These tours were offered to various elected officials and staff from various cities and public agencies. Valuable, though less effective, were lengthy interviews of all the main political leaders in the region and preparation of handouts.
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	**Agricultural Irrigation Projec**t Local control over water is very important especially because no federal or state water is available. The biggest issues were the existing seawater intrusion and the desire for a sustainable/renewable water source. **Urban Irrigation Project** The political issue in the 1990s was the transfer of the project from A3 to the local water district to expedite it. The local water district currently is focusing on a desalination project while A3 and the cities are trying to expedite the urban irrigation project. **GWR Project** The local water utility has brought up, in informal discussions, the environmental justice issue (the project would be in one of the poorer cities). However, the water would be used throughout the water system, which includes the wealthiest communities. **Winter Storage** The political issues are agriculture versus cities and between which public organization will be the lead (A3, the county water resource agency, or the local water district).
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility’s portfolio?	The water supply system was **Agricultural Irrigation Project** entirely private and extremely stressed because of seawater intrusion. There was no utility providing the water originally. There were no other viable options for water. **Urban Irrigation Project** This project is primarily required for approved growth in an area of development in accordance with the development project’s environmental review. The water purveyor’s supply is stressed by seawater intrusion and by chemical plumes from legacy military waste. The water utility has sufficient water capacity for at least 20 years.

	GWR Project The water supply situation is extremely stressed, which is why the groundwater basin was adjudicated and is under the control of a watermaster. The utility that would benefit from this project has another groundwater basin that is extremely stressed by over-pumping, which is why the other groundwater basin has a cease and desist order. That utility is working on the new regional seawater desalination project for its inclusion into their portfolio. **Winter Storage** This water would be used for expansions of the agricultural projects or the urban irrigation project. It would increase the quantity of water available during the summer.
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	**Agricultural Irrigation Project** The most important benefit is safety (farm worker and consumer). The other benefits, in order, are improved water quality (allows other crops to be grown), sustainability, and fertilizer benefit. The water is more expensive (down side) than pumping groundwater. **Urban Irrigation Project** The most important benefit is water reliability (sustainability). The recycled water supply will not be cut off by a legal or regulatory action (versus the current supply). The recycled water may be less expensive than potable water. **GWR Project** The major benefit is that it is the only project under consideration that refills the depleted groundwater basin. It is may be less expensive than desalinated seawater. It is also much more reliable than river water aquifer storage and recovery (which is only possible in wet years). **Winter Storage** The biggest benefit is the new water that could be available in the summer, which could be reliable and sustainable.
Do you have any “Level of Service” objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	**Agricultural Irrigation Project** A3 attempts to offer superb customer service. Internal performance goals: • Secondary total suspended solids: <10 mg/L • Secondary turbidity: <4 NTU • Secondary pH: between 7.0 and 7.5 units • Recycled water volume: >20 mgd • Secondary effluent captured and recycled: 100% • ACH/polymer dosage: <17 mg/L • Chlorine dosage: <25 mg/L • Average tertiary turbidity: between 1.5 and 1.7 NTU • Frequency average tertiary turbidity exceeds 2.0 NTU: <10% • Average chlorine residual after disinfection: 10.0 mg/L • Total coliform, fecal coliform, generic *E. coli* of recycled water after disinfection, after storage in open pond, and within the distribution system: nondetect • Tertiary effluent chlorine residual in the distribution system: between 4 and 8 mg/L • Elevation of recycled water in storage pond: >124 feet

	Urban Irrigation System The internal performance goals would be the same as for the agricultural irrigation projects with three exceptions: • Total coliform: nondetect • Tertiary effluent chlorine residual in the distribution system: between 4 and 8 mg/L • Elevation of recycled water in storage pond: unimpacted by the storage pond elevation **GWR Project** Goals would be established after regulatory requirements are determined. **Winter Storage** At this time, the goals would be the same as for the urban irrigation system.
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	**Agricultural Irrigation Project** A3 created two new departments to track costs for the projects properly. There were no internal barriers. **Urban Irrigation Project, GWR Project, and Winter Storage Project** A3 would create a new department to track costs for the projects properly. There were no internal barriers.
Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?	**Agricultural Irrigation Project** • For the treatment system: 2,084,704 kWh were used in fiscal year 2009–2010. The power source is a natural gas power plant. However, we have installed solar panels, which may provide about half of the power in future years (they provided about 287,844 kWh during the first 3 months of operation). • For the distribution system: 2,825,896 kWh were used in fiscal year 2009–2010. Future power use mostly depends on grower demand (weather). The power source is a natural gas power plant. • A3 does not have estimates of GHG emissions. **Urban Irrigation System** • The power estimate is about 1,443,500 kWh per year. The power source will be a natural gas power plant. • A3 does not have estimates of GHG emissions. **GWR Project** Estimated power use is about 1,500,000 kWh per year. The power source will be a natural gas power plant. **Winter Storage** • Estimated power use is about 600,000 kWh per year. The power source will be a natural gas power plant. • A3 does not have estimates of GHG emissions.
Legal issues that helped or hindered implementation? Water rights?	**Agricultural Irrigation Project** Water rights were an issue. As described above, the water rights were given by A3 to the county water resource agency without compensation to allow for loans.

Liability? Public access issues? Other?	**Urban Irrigation Project** Because the water rights were given away to allow for construction of the agricultural irrigation system, substantial legal costs were expended to get enough water rights returned to allow for this project. **GWR Project** Water rights are one of the two main reasons that this is planned as a five month per year (winter months) project. (The other reason is the monetary savings of using the urban irrigation project pipeline while not heavily used.) **Winter Storage** There are no current legal issues.
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why –this is intended to be a cost question)?	**Agricultural Irrigation Project** Nominal one-day storage was provided. Flow equalization was considered during design but was dropped as being too expensive. **Urban Irrigation Project** Nominal storage (4 AF) initially was designed but determined not to be needed. Flow equalization is desirable but impractical financially. **GWR Project** Storage has not been considered and is not relevant to this project. **Winter Storage** This is essentially a storage project with either a pond or aquifer storage.
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	**Agricultural Irrigation Project** • The treatment facilities had to blend with the regional treatment plant architecture, including matching of construction materials. • The distribution system facilities were built as inexpensively as possible. Changes to meet infrastructure standards are being made through repairs. **Urban Irrigation Project** Electrical panels were designed to be inside to improve the safety of electricians working on the facilities in the rain.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	**Agricultural Irrigation Project** As previously mentioned, UV was considered for disinfection but not used because of the customer demand also to have chlorine. **Urban Irrigation Project** No other technologies were considered. **GWR Project** No other technologies were considered (based on the Orange County Water District's treatment system). **Winter Storage** Currently under consideration are deep ponds and aquifer storage and recovery (ASR). We are considering percolation ponds and vadose wells for the ASR option.
Other?	---

Attachment A – A3 Reuse Project Cost Estimate Form

Part 1. Cost Estimate Available from Agency? (record in whatever form it is available in the box directly below and then ask whether specific cost elements are included.)
Agricultural Irrigation Project – Treatment System: Capital:$29,294,141 construction cost (completed 2007) Annual O&M:$179/AF without capital costs
Year in which cost estimate made: Fiscal Year 2009–2010

Part 2. Cost Estimate Clarification

Category	Included in Part 1?	Additional Estimate (if available)
Preconstruction		
Research	No	
Planning	No	
Design	Partial	
Capital		
Treatment	Yes, loan repayment	1740671
Distribution system		
Pumping		
Storage		
Flow equalization		
Brine disposal		
Land acquisition		
Buildings and structure		
Other		
Annual Cost Elements		
O&M labor	Yes	451677
Chemicals	Yes	425933
Electric power	Yes	380071
Membrane replacement	No	0
Repairs	Yes	233209
Spare parts	Yes, Included in repair	
Insurance	No, Not separate	
Contingency	Yes, including office expense, outside professional services, operational supplies, contract services, equipment replacement funds, indirect costs, capital outlay	361285

Agricultural Irrigation Project – Distribution System:

Capital: Construction cost about $32,500,000 (completed 2007)

Annual O&M: $120/AF for combined recycled water, groundwater, and river water delivered without capital costs

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Year in which cost estimate made: Fiscal Year 2009–2010

Part 2. Cost Estimate Clarification		
Category	**Included in Part 1?**	**Additional Estimate (if available)**
Preconstruction		
Research		
Planning		
Design		
Capital		
Treatment		
Distribution system	Yes	1887642
Pumping		
Storage		
Flow equalization		
Brine disposal		
Land acquisition		
Buildings and structure		
Other		
Annual Cost Elements		
O&M labor	Yes	856146
Chemicals	Yes	0
Electric power	Yes	569983
Membrane replacement	No	0
Repairs	Yes	55155
Spare parts	Yes, included in repairs	0
Insurance	Yes, liability and earthquake	231646
Contingency	Yes, supplies, radios, legal, publications, office expense, outside professional services, operational supplies, contract services, equipment replacement fund, vehicles, indirect costs	389978

Urban Irrigation Project (UIP):

Capital: $45,776,000 (2008 estimate)

Annual O&M:$517/AF without capital for the UIP facilities but capital towards the agricultural irrigation treatment facilities

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Year in which cost estimate made: Estimated 2008

Part 2. Cost Estimate Clarification		
Category	**Included in Part 1?**	**Additional Estimate (if available)**
Preconstruction		
Research		
Planning		
Design		
Capital		
Treatment		
Distribution system	Yes	3662080
Pumping	Yes, included in distribution system	
Storage	Yes, included in distribution system	
Flow equalization		
Brine disposal		
Land acquisition		
Buildings and structure		
Other		
Annual Cost Elements		
O&M labor	Yes	71958
Chemicals	Yes, included in cost of water in contingency	0
Electric power	Yes	143917
Membrane replacement	No	0
Repairs	Yes	28783
Spare parts	Yes, included in repairs	0
Insurance	No, not separate	
Contingency	Yes, Agricultural irrigation treatment system cost of treating recycled water and paying share of capital are NOT included here (another $179/AF and $168/AF respectively)	48932

Groundwater Replenishment Project (GWR):

Capital: $47,222,850 (2008 estimate)

Annual O&M:$3,055/AF including use of UIP and capital payment

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Year in which cost estimate made: 2008 estimate

Part 2. Cost Estimate Clarification		
Category	**Included in Part 1?**	**Additional Estimate (if available)**
Preconstruction		
Research		
Planning		
Design		
Capital		
Treatment	Yes	
Distribution system	Yes, included in treatment	3,777,828
Pumping	Yes, included in UIP	
Storage		
Flow equalization		
Brine disposal	Yes, included in treatment	
Land acquisition	No	
Buildings and structure		
Other		
Annual Cost Elements		
O&M labor	Yes	225,000
Chemicals	Yes	104,000
Electric power	Yes	281,000
Membrane replacement	Yes	395,000
Repairs	Yes	39,000
Spare parts	Yes, included in repair	0
Insurance	No, not separated	
Contingency	Yes, includes	208,800

Winter Storage:

Capital: $2,500,000 (2011 WAG)

Annual O&M: $700/AF including agricultural irrigation treatment and capital replacement costs but without winter storage capital costs

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Year in which cost estimate made: 2011 estimate

Part 2. Cost Estimate Clarification		
Category	**Included in Part 1?**	**Additional Estimate (if available)**
Preconstruction		
Research		
Planning		
Design		
Capital		
Treatment		
Distribution system		
Pumping	Yes, included in storage	
Storage	Yes	200,000
Flow equalization		
Brine disposal		
Land acquisition	Yes, included in storage	
Buildings and structure		
Other		
Annual Cost Elements		
O&M labor	Yes	100,000
Chemicals	Yes	6600
Electric power	Yes	120,000
Membrane replacement	No	0
Repairs	No	0
Spare parts	Yes, in repairs	0
Insurance	No, not separate	0
Contingency	Yes	45,320

Case Study WRRF-09-02	**Agency 4 (A4)**
BACKGROUND	
Do they want to be anonymous? (Y or N)	Y
Agency contact(s) [name, email address, phone number]	---
Location	---
Brief description of the agency (what they do with regard to water or wastewater management or other)	A4 is a special district created under state law to manage wastewater and solid waste on a regional scale. The agency consists of 23 independent special districts serving about 5.7 million people. The service area covers approximately 820 sq mi and encompasses 78 cities and unincorporated territory within the county, including a service area that includes two cities located in the northern portion of the county (NC). A4 operates two water reclamation plants (WRPs) in the NC that historically have provided recycled water for NPR applications (WRP1 and WRP2). Expanded use of recycled water for NPR and use for IPR is being considered by multiple stakeholders in the NC, including City1 and a regional water management group (regional group). The information presented here is based on the reuse program for recycled water from the WRP1.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes. WRP1 currently provides primary and secondary treatment (aerated oxidation ponds) for 16 mgd. This type of low-technology treatment was selected when the WRP was first built in 1959 based on cost, land availability, and the low populations served. On average, 3 mgd of WRP1 secondary treated recycled water currently is reused at a local farm for irrigation of alfalfa; 3 mgd is used to maintain 400 acres of wetlands as a wildlife refuge. Secondary treated recycled water is also being used for various construction activities as part of the WRP1 Stage V expansion. WRP1 also supports two small tertiary treatment facilities: • A tertiary treatment plant (TTP) with a design capacity 0.6 mgd that uses chemical coagulation, settling, and dual-media filtration to remove additional amounts of phosphorus. Recycled water from the TTP is used at a local park during most of the year to maintain the water level in recreational lakes and for landscape irrigation (on average 0.2 mgd is reused). • A 1 mgd membrane bioreactor (MBR) plant that uses membrane technology and ultraviolet disinfection (with chlorination as a backup disinfection system) to produce tertiary treated recycled water for municipal and irrigation use. The MBR-produced recycled water is used for effluent management/recycling at A4’s eastern agricultural site and by City1 for sewer cleaning and street sweeping (on average 0.87 mgd in 2010).

A summary of recycled water use for 2010 is presented for WRP1.

User	Recycled Water Delivered (mg)	Type of Use
Wetland ponds	2,655	Environmental enhancement
Private agricultural property	1,147	Agricultural irrigation
Regional park	57	Landscape irrigation and impoundment
WRP1 in-plant uses	0.12	Landscape irrigation, wash-down for septage handling station, other in-plant uses
WRP1 Stage V Expansion	22	Various construction activities
A5 eastern irrigation site	315	Crop irrigation, field preparation, dust control
City1	0.87	Landscape irrigation, street sweeping, dust control, sewer flushing
Total	4,197	

A 26-mgd conventional activated sludge (CAS) secondary and tertiary treatment facility will be constructed in stages (Stage V and Stage VI expansions) to replace the existing WRP1 16 mgd-capacity oxidation pond secondary treatment facilities. The CAS process will be operated in "nitrification-denitrification" mode to increase nitrogen removal from the wastewater. Tertiary treated effluent for NPR municipal reuse projects, such as those planned by City1 (landscape irrigation, street sweeping, dust control, sewer flushing, industrial uses), will be provided from the new tertiary facility. The MBR plant also will be decommissioned.

WRP1 is being converted to CAS/tertiary treatment to (1) accommodate projected wastewater flows because of expanded population in the service area, (2) manage effluent without unauthorized overflows to a neighboring property (3) provide recycled water for agricultural and municipal reuse projects, and (4) maintain the marsh-type habitat and wildlife resources at the wetland pond.

The first phase of the Stage V expansion is expected to be completed in late 2011 and will have the capacity to produce 18 mgd of tertiary recycled water. The major effluent management facilities that will be constructed as part of Stage V include storage reservoirs, a recycled water pipeline, a pump station, and agricultural effluent management/reuse operations (winter grain and alfalfa). A second phase, Stage V Phase II, will increase capacity to 21 mgd.

A backbone recycled water distribution system is being constructed in phases to serve City1 and City2 and the surrounding unincorporated communities. For City1, the two initial phases (1A and 1B) consist of a delivery system that connects to WRP1. The system is in proximity to the majority of the potential recycled water users. Phase 1A has been constructed.

<table>
<tr>
<td>For those reusing water, they need to tease out what helped them decide to start or decide between different reuse practices (NPR versus IPR), or decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process.

Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.</td>
<td>The historical use of recycled water was based on proximity to WRP1 and requests by local users for water.

Several recent planning efforts have been undertaken to look at expanded reuse, including a facilities plan, groundwater recharge feasibility study, groundwater recharge fatal flaw analysis, City1 recycled water master plan, a regional recycled water facilities plan, and integrated urban water management plan.

Drivers for expanded water reuse are
An over-drafted groundwater basin, which limits the amount of water that can be pumped economically and sustainably in the long term.
Uncertain future reliability of imported potable water supplies because of factors such as climate change, levee breach, earthquake, power outage, or environmental and wildlife protection needs.
Limited local water treatment and conveyance capacity and increasingly stringent potable water quality standards, which will require significant capital improvements in the next 20 years.
Limited effluent management options and increasingly stringent wastewater discharge requirements (in particular to protect groundwater quality in an enclosed groundwater basin), which will require significant capital improvements in the next 20 years to accommodate increased wastewater flow because of population growth Population growth proceeded at a slow pace until 1985 because agriculture was the primary focus. However, between 1985 and 1990, the growth rate increased approximately 1,000% from the average growth rate between the years 1956 to 1985 as land uses shifted from agricultural to residential and industrial. It is expected that by 2030, approximately 1,013,000 will reside in the area of the county (increase of 187% from 2000).
Drivers for IPR via groundwater recharge include
Availability of recycled water that could be used as a new potable water supply.
Recycled water is produced locally and a reliable source of supply (not subject to drought or other reliability issues associated with imported water).
Urban recycled water use alone cannot maximize the use of recycled water in the area. New agriculture use is not the most beneficial use of recycled water in the area (agricultural development in the area is declining while urban housing is increasing).</td>
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The following benefits of using recycled water for IPR were identified as part of a feasibility study:
<table>
<tr><th>Benefits</th><th>Description</th></tr>
<tr><td>Water supply reliability</td><td>Provides new source of water supply that is reliable, drought proof, and locally controlled
Diversifies the regional water portfolio</td></tr>
<tr><td>Effluent management</td><td>Provides beneficial use project for winter recycled water flows and reduces recycled water storage needs
Provides alternative effluent management mechanism
Promotes the highest beneficial use of recycled water</td></tr>
<tr><td>Integration and synergies with other solutions</td><td>Supports other solutions being developed to address the limited availability of water supplies, including groundwater recharge and management projects</td></tr>
<tr><td>Consistency with state and federal goals and objectives</td><td>Upholds state guidelines and policies relative to recycled water that promote diversification of regional water portfolios and encourage the use of recycled water</td></tr>
</table>
Key obstacles to expanding reuse:
For IPR:

Groundwater rights. The groundwater basin is not yet adjudicated, and who has rights to the recycled water is complicated depending on where a recharge project would be located and where the groundwater would be withdrawn.
Limited locations in the area to recharge water by surface spreading based on hydrogeology (primarily soil conditions).
The time required to obtain regulatory approval for a groundwater recharge (GWR) project.

For NPR and IPR:

Salts and nutrients and concerns regarding groundwater degradation. It is believed that the salt/nutrient management plan to be developed for the region will help address this issue.
Cost for facilities to distribute water, treatment and recharge facilities for IPR

</td>
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<td>
If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]?
Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse?
</td>
<td>
IPR is still in the conceptual stage. City1 took the lead in two feasibility studies that were conducted with other stakeholders. The groundwater recharge feasibility study looked at various configurations for a project that would meet regulatory requirements and optimize recycled water use. The groundwater recharge fatal flaw analysis assessed a GWR pilot project that would utilize 1 mgd of recycled water from the MBR plant in addition to stormwater or treated imported water at a proposed stormwater basin. The analysis looked at benefits, estimated costs, and potential obstacles (technical, regulatory, environmental, and institutional). The estimated capital cost for the pilot was $37 million for 48,000 AFY (recycled water and blend water).
City1 is looking at another project, which is also in the conceptual stage. Tertiary treated water would be discharged to a dry unlined creek. During transport in the stream, some of the water would recharge the groundwater basin enroute (this is categorized as incidental unplanned GWR), with the remainder collected at a retention basin (approximately 4.7 mi downstream) where it would be available for irrigation and dust control. It would use
</td>
</tr>
</table>

Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	between 100 AF and 1000 AF of recycled water at a capital cost of $100K to $1 M. In addition to recharge, other benefits are believed to include enhanced flood control and storm water management due to utilization of storm and municipal nuisance water as blend and recharge water. The project also will result in improved riparian habitat, which will provide flood control and storm surge dissipation, and enhanced water quality through incidental recharge to the over-drafted groundwater aquifer. This project may face considerable regulatory challenges regarding water quality requirements for discharge to the creek and water rights.
Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	The regional group is looking at a wide range of new water supply options. At this time no specific projects have been selected, but future water supply plans will focus on • Expanded conservation efforts • Acquisition or development of new imported supplies by introducing a developer fee • Creation of a combination of local surface spreading facilities to percolate untreated imported river water and aquifer storage and recovery (ASR) wells to inject potable water • Additional groundwater extraction capacity in order to recover stored water Desalination is not an option based on the location of region.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	See prior discussion regarding drivers for reuse projects.
Was the project developed with other agencies; if so, what were the roles of other agencies?	The historic reuse projects were developed with end users under contractual arrangements. Recent efforts for project development are being conducted with stakeholders in the region as part of the regional water management group. In some cases like the IPR effort, City1 has taken the lead for its service area in conducting feasibility studies and construction of NPR infrastructure. The stakeholders include water supply contractors, retail water purveyors, local cities, land use planning agencies, regulatory agencies, environmental groups, the local building association, agriculture, A4, and municipal water companies. In terms of operating responsibilities, A4 owns and operates WRP1, and has constructed a pipeline that serves as the point of connection for the backbone recycled water distribution system. A4 also holds the regulatory permit for production of recycled water for NPR reuse applications.

<table>
<tr><td></td><td>For recycled water distribution:

Phase IA – It is a 24-in recycled water distribution system, which stretches approximately 4.5 mi to serve up to 1.5 mgd of recycled water. It also involves a 0.5-mg storage tank and will include a 3,150-gpm pump station (not yet designed or constructed). Phase IA was a joint effort between City1 and the county waterworks district (WWD), who owns and operates most of the potable water system within City1. WWD agreed to provide up to 60% of the cost.

Phase IB – construction has started on the 3.2 mile pipeline to connect the Phase 1A pipeline to a city park and extend the pipeline. Financing has been provided by the Army Corp of Engineers (ACOE) via federal funds from the American Recovery and Reinvestment Act (ARRA), and A4 via funds from a settlement of a civil administrative fine.</td></tr>
<tr><td>Was there major leadership input from the community?

Was there opposition from the community?</td><td>For projects in the area, there is considerable leadership on the part of City1 for conducting feasibility studies and moving forward with construction of NPR distribution systems; A4 and WWD for support of recycled water optimization and financing. There is significant political support from City1, the county, and A4’s Board of Directors.

For WRP1, there were some comments from the public related to the 2020 facilities plan and environmental review regarding impacts on wildlife, human health, property value, and groundwater quality. In general, there isn’t vocal opposition to the NPR projects.

There was also public outreach as part of a regional facilities plan/environmental review with similar comments but no vocal opposition.</td></tr>
<tr><td>Were there any unique circumstances favoring or impeding progress?</td><td>Yes. Because of increased flow and seasonal use of recycled water, treated wastewater discharged to the ponds overflowed onto a neighboring Air Force base dry lake, potentially interfering with the use of the lake bed as an emergency aircraft landing area. This is a potential violation of A4’s permit. A4 was issued an enforcement order and administrative penalty from the state regulatory agency. The enforcement orders are the drivers for providing the new effluent management facilities, or effluent management arrangements that can eliminate unauthorized effluent induced overflows. As a result of the time period to satisfy these orders and the current obstacles to IPR as discussed (e.g., impeding soils, groundwater rights, time to implement), NPR is the favored reuse approach.

Thus, effluent from WRP1 initially will be managed via discharge to (1) the pond, (2) impoundment areas (existing), (3) reuse at the local park (lake and landscape irrigation), (4) storage reservoirs, and (5) agricultural reuse operations. A sufficient quantity and quality of tertiary-treated effluent will be provided to City1, and any other entities, to meet the municipal recycled water reuse demand. For the first phase, City1’s goal is to implement a project to distribute up to 1.5 mgd of recycled water to municipal users.

In the near-term, City1 has indicated its projected use:
<table>
<tr><td></td><td colspan="5">RW Quantity (AFY)</td></tr>
<tr><td></td><td>FY11–12</td><td>FY12–13</td><td>FY13–14</td><td>FY14–15</td><td>FY15–16</td></tr>
<tr><td>City1</td><td>390</td><td>613</td><td>1680</td><td>1680</td><td>1680</td></tr>
</table>
City1’s long term goal is to use/distribute 3.1 to 3.6 mgd (3480 to 4070 AFY).</td></tr>
</table>

ECONOMIC and FINANCIAL	
Project costs (for the reuse component only – not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	The capital costs for WRP1 are not included here, as the project is required to be completed for effluent management. As stated in the purchase agreement with recycled water users, the recycled water price is based on A4's unit cost of WRP1's operations and maintenance (O&M), which is derived by dividing the total O&M cost of the plant, excluding costs for solids treatment and effluent disposal, by the volume of recycled water produced by the plant. The total projected cost of O&M for WRP1 is $10.1 million per year. The total biosolids treatment and disposal cost is $1.6 million per year. Therefore, the O&M cost excluding biosolids costs is $8.5 million. A4 assumes that 15 mgd of recycled water will be produced in the first year of operation, so the unit cost of recycled water is $1,560/mg or $510/AF. The recycled water pricing also is adjusted to include a discount (shared savings) that will drop the price to 30% of this amount. Thus, based on the first year of operation, the estimated cost of recycled water will be approximately $153/AF. The facilities and costs for the recycled water distribution system have been revised since the completion of the 2006 facilities plan. The current capital cost of Phase IA is $5 million; WWD agreed to provide 60% of construction up to $3.4 million. The size and costs of Phase 1B have changed since the facilities plan was completed. The Phase 1B capital cost is estimated to be $8.3 million (it originally was almost $28 million), with $7 million requested from ARRA; $1 million provided by A4. No operation and maintenance costs are available. The estimated costs for IPR based on the feasibility study are presented as follows:

Baseline Project Components	GWR-RW Project Cost ($ Million; 2006 dollars)[1]	No Project Alternative Cost ($ Million; 2006 dollars)[1]
Recharge Basins	$30 M	$30 M
Recycled Water Treatment Facilities	-	-
Recycled Water Conveyance Facilities	$30 M	-
Imported Water Conveyance Facilities	$70 M	$80 M
Extraction and Delivery Facilities	$70 M	$70 M
Capital Cost Subtotal	$200 M	$180 M
Annualized Capital Cost[2]	$15.0 M/yr	$13.2 M/yr
Operational & Maintenance Cost[3]	$22.0 M/yr	$23.6 M/yr
Total Annual Cost	$37.0 M/yr	$36.8 M/yr

1. The no-project alternative (50,000 AFY regional GWR project using imported water only). The costs in this table are based on costs for other groundwater recharge projects in the state, generic costs for pipelines and pump stations, a planning level contingency of 25% and a 20% contingency for planning, design, environmental review, and administrative costs.
2. Annualized at 6% over 30 years (A/P Factor = 0.073).
3. It includes the price of imported river water. The purchase price of recycled water was not included; at the time this table was developed, it was being negotiated between A4 and potential customers.

Avoided costs – as a result of utilizing the reuse option, did the utility

Avoid costs related to an alternative water supply project?

Water or wastewater treatment plant capacity expansion /upgrade?

If so, is there a rough estimate of the avoided cost (capital and O&M and year)?

Information is available on wastewater capital costs as part of the facilities plan; however, they are not included here, as the project is required to be completed for effluent management.

Avoided costs were reviewed as part of the groundwater recharge feasibility study as shown as follows:

Incremental Costs versus Avoided Costs[1]

Project Component	Benefit/Impact	Incremental Cost ($M/year)	Avoided Cost ($M/year)
Capital Costs[2]			
Recycled water conveyance	New pipeline and pump stations	$2.6	
Imported water conveyance	Reduced size of pipeline and pump station		$0.8
Recharge basins[3]	Avoided acreage (100 ac) required for recharge		$0.2
A4 agricultural reuse project[4]	Avoided storage ponds, equipment, roads, etc.		$2.5
O&M/year Costs			
Recycled water conveyance[5]	New pumping costs and recycled water purchase	$1.2 to $2.2	
Imported water conveyance[6]	Avoided pumping costs and imported water purchase		$2.9 to $7.3
A4 agricultural reuse project[4]	Avoided agricultural operations and lost revenue	$2.5	$1.7
Well Mitigation[7]	New water supply and/or well replacement or relocation	$0.05	
Access to new water supply	New water supply available for use in proximity of pipelines	Not quantified[8]	Not quantified[8]
Total		**$6.8 to $7.8**	**$8 to $12.5**

1. The costs are derived in comparison to a no-project alternative (50,000 AFY regional GWR project using imported water only).
2. Capital costs were annualized based on an interest rate of 6% over 30 years (A/P Factor = 0.073).
3. The GWR project using recycled water would require100 less acres that a regional GWR project because of a lower blend water peak flow. The lower peak flow results from delivery of the recycled water over the full year instead of imported water over 5 months during the wet season.
4. The incremental cost of the agricultural reuse project is based on the loss of $250/AF of projected annual revenue once the project is fully operational. Avoided costs for the project are $33.8 million for the avoided construction of storage ponds, equipment, roads, fences, culverts). Avoided costs also include $1.7 million/year of avoided O&M costs for agricultural operations.
5. Recycled water O&M includes the purchase price of recycled water, which was not included in the baseline project because negotiations are underway with A4 and potential customers for urban users (at the time this study was done). To be conservative, the price could be up to $100/AF, which is equivalent to $1 million/year in incremental costs. The potential range of recycled water purchase price results in a range of incremental costs.
6. Imported water O&M includes the purchase price of imported water, which was assumed to be $200/AF based on a current price, but could cost up to $650/AF. The potential range of imported water purchase price results in the range of avoided costs.
7. Well mitigation assumes one well per recharge basin would have to be relocated or a new water supply would be provided to a well owner (relocation would be necessary to meet regulatory requirements for residence time of recycled water).
8. Agricultural users in the vicinity of the imported water and recycled water pipelines alignments would have access to nonpotable water for agricultural uses. This benefit is not quantified but could be significant in dry years if access to groundwater is limited because of future adjudication.

	The assessment concluded that there was a favorable comparison of avoided and incremental costs. The GWR project using recycled water was considered to be feasible economically in addition to being feasible technically. Avoided costs were not considered in the facilities plan for the Phase 1A and Phase 1B recycled water distribution system.
Market surveys and analysis – what types were performed: Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	A recycled water market assessment was performed for City1 to identify all existing and future NPR uses for disinfected tertiary recycled water. The assessment identified 5030 AFY of annual demand (8.99 mgd peak day demand) for existing users; 1620 AFY of annual demand (2.89 mgd peak day demand) for future users. The assessment assumed a peak day factor of 2.0 and a peak hour factor of 3.0 for most users.
Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer - directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	A4 is responsible for the wastewater treatment facilities, which are financed through annual service charges and sewer connection fees. A4 charges a recycled water fee based on annual O&M adjusted by a share benefit discount rate. Phase IA is a 24-inch recycled water distribution system, which stretches approximately 4.5 mi, to serve up to 1.5 mgd of recycled water. Phase IA was a joint effort between City1 and WWD, who owns and operates most of the potable water system within the City. WWD provided for 60% of the cost. Phase IB comprises construction of the 3.2 mi pipeline that is underway; financing has been provided by the ACOE via federal funds from ARRA, and A4 via funds from the enforcement settlement. City1 will assume ownership and maintenance of the recycled water line upon completion of construction. WWD charges a connection fee to support the water system.

ENVIRONMENTAL and PERMITTING	
Environmental impacts – does the project: Avoiding use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project? Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	A4 is obligated to maintain the ponds under: • A three-party letter of agreement (LOA) with state fish and game and the air force base. Specifically, this 1981 LOA requires A4 to discharge effluent from WRP1 to the ponds at a rate sufficient to maintain a minimum of 200 wetted acres of habitat. Neither the ponds nor their extensive marsh-type habitat would exist if it were not for the discharge of effluent from the WRP. • A 1991 MOU with A4 and the air force base to maintain 200 wetted acres • The 2004 facilities plan and environmental review for WRP1 stipulated that A4 would maintain up to 400 wetted acres. Permit compliance (and the WRP1 treatment upgrade) has enabled the production of more tertiary recycled water that is available for reuse. Salt and nutrient management is becoming important as the region plans to aggressively expand recycled water and, in the future, continue to import an increasing amount of water from outside the region. A salt/nutrient management plan is being developed by stakeholders led by A4 and WWD. None of the projects assume that the use of recycled water will offset the use of imported water, with the exception of the IPR projects, which compared GWR of recycled water to that of imported water.
Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	At this time, no, but this may change in the future depending on salt and nutrient management issues related to protecting groundwater quality. If the stakeholders elect to move forward from the conceptual stage to implement an IPR project, there may be additional requirements that come into play.

SOCIAL and POLITICAL	
Public acceptance/ opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach and/or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	Public outreach was conducted as part of the WRP1 Stage V expansion. Only minor opposition from the public regarding public health concerns and other issues (property value, wildlife protection, and so on). The backbone distribution system programmatic environmental review included public outreach. There were minor concerns over medications and chloramines in the recycled water. Public outreach is also conducted as part of the activities conducted by the regional management group.
Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water resources)? Political process leading up to implementation? Leadership from the community or the utility?	The biggest concerns are related to groundwater adjudication and who will have the rights to any recycled water that becomes part of the groundwater supply by NPR (incidental) or IPR. A4 is also sensitive to issues about oversubscribing recycled water based on the status of the WRP1 expansions and construction of the recycled water distribution system.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	The region is a dessert environment that receives just over 7 in. of rain during the year. The area is rapidly expanding in terms of population and has very stressed water supplies. The main source is imported river water and groundwater. Recycled water will diversify the water supply portfolio and offer a drought-resistant source of supply.

For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	Recycled water • Provides for a new reliable water source that is drought resistant • Frees up imported water and local groundwater, currently used for landscape irrigation and other purposes, for strictly potable uses • Improves availability of potable water supplies for future development • Sustains landscape value during droughts when potable water use may be restricted
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	A4 and City1 have adopted requirements for recycled water users; A4 has prepared a user handbook.
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	At this point, no.
Energy/Carbon Footprint: Quantify energy use in kilowatt hours Pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh	There is information available in the 2004 WRP1 environmental review document on estimated greenhouse gas emissions for construction and operation of the WRP1 Stage V expansion. However, they are not included here, as the project is required to be completed for effluent management. Information is not available on the recycled water distribution system.
Legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	Groundwater adjudication is hindering IPR.

TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why — this is intended to be a cost question)?	Yes. To balance the supply and demand for recycled water throughout the year, WRP1 relies on four storage reservoirs. For the WRP1 Stage V expansion, the project is adding new storage reservoirs, a pump station, and pipelines for the storage and distribution of recycled water to reuse sites. These facilities will allow recycled water to be stored during wet winter months when the demand for water is low and utilized in dry summer months when the demand for water is high. City1 included storage as part of the Phase IA distribution system for storage and pressure in the distribution line
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	The WRP1 reservoirs had to been lined to protect groundwater quality (primarily salts and nutrients). Construction of all infrastructure must meet state structural design standards.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	Nothing for the current projects. Based on the outcome of the salt/nutrient management plan, there may be mitigation measures that need to be undertaken. For IPR, the existing treatment technology may need to be revised to meet regulatory requirements for the desired level of recycled water used for GWR.
Other?	The current soil types in much of the City1 area restrict where groundwater recharge by surface spreading can occur. Recharge by injection has not been considered at this time.

Attachment A – A4 Reuse Project Cost Estimate Form

Part 1. Cost Estimate Available from Agency? (record in whatever form it is available in the box directly below and then ask whether specific cost elements are included.)
Utility/Agency's Cost Estimate: Capital: Phase IA recycled water distribution system is $5 million (completed). Year of cost is not known – assume 2009. The Phase 1B recycled water distribution system is estimated to cost $8.3 million. Year of cost is 2010. The specifics of the cost components are not known. Annual O&M: $153/AF (this is estimated price of recycled water for the first year of operation in 2011–2012); no information is available on the distribution system O&M.

Part 2. Cost Estimate Clarification

Category	Included in Part 1?	Additional Estimate (if available)
Preconstruction		
Research		
Planning		
Design		
Capital		
Treatment		
Distribution system		
Pumping		
Storage		
Flow equalization		
Brine disposal		
Land acquisition		
Buildings and structure		
Other		
Annual Cost Elements		
O&M labor	Y	
Chemicals	Y	
Electric power	Y	
Membrane replacement		
Repairs		
Spare parts		
Insurance		
Contingency		

Case Study WRRF-09-02	Agency 5 (A5)
BACKGROUND	
Name of Agency	Agency 5 (A5)
Do they want to be anonymous? (Y or N)	Y
Agency contact(s) [name, email address, phone number]	---
Location	---
Brief description of the agency (what they do with regard to water or wastewater management or other)	A5 provides drinking water, wastewater treatment and disposal, solid waste collection and disposal, and recycling. A5 operates numerous facilities, including four major water treatment plants and seven wastewater treatment plants. A5 has recognized the importance of reclaimed water since 1978 when it began using reclaimed water as a valuable resource and means of water conservation, as well as reducing discharges to the surface receiving water. A5 is effectively managing this resource by maximizing its reuse systems for regulatory compliance, resource conservation and environmental benefit. This commitment is reflected through the development of a progressive reclaimed water program with the resource management goals of producing high-quality reclaimed water to meet regulatory requirements and to be used for the most environmentally and economically feasible water conservation benefit.
Are you currently reusing water? If yes, a brief description of the type(s) and amount(s) of water reuse currently practiced (including description of treatment), and types of use(s) that have been considered but not implemented. Why was the specific type of reuse and type of treatment selected?	Yes, a system that serves the south-central (SC) and northwest (NW) portions of the service area. The SC reclaimed water system consists of 48.5 mgd of pumping capacity and 51 mg of storage. Reclaimed water is used for a resource recovery facility, power plant, for golf course and residential irrigation, and commercial uses. Reclaimed water usage for FY2010 on annual average basis was 9.61 mgd, representing 51% of available treated effluent. The NW reclaimed water system consists of 38 mgd of firm high service pumping capacity (e.g., this is the quantity delivered with the largest pump out of service), and 54 mg of aboveground storage. This system currently provides service to golf courses, residential subdivisions, schools, and common areas in residential subdivisions and along road rights-of-way. Reclaimed water usage for 2010 on an annual average basis was 10.8 mgd, representing approximately 59% of available treated effluent. The treatment system is directed at Grizzle-Figg Standards of: BOD (5-day) = 5 mg/L, total suspended solids = 5 mg/L, total nitrogen (N) = 3 mg/L, and total phosphorus = 1 mg/L P. There is one bardenpho, 1 Kruger biodenipho, 3 modified bardenpho, 1 BC A2O2, and 1 extended air secondary treatment only. All except the one secondary plant provide biological nutrient removal with deep bed sand filters and high-level disinfection.

For those reusing water, they need to tease out what helped them decide to start *or* decide between different reuse practices (NPR versus IPR), *or* decide to implement multiple uses. For those with long-term programs, we primarily want information on current decisions about changing the program or expanding the program toward one type of use versus another and what is driving that decision making process. Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	A5 started reusing water in 1978 prior to any regulations requiring water reclamation. The primary focus at that time was to protect the stressed local groundwater supply. Since that time, restrictions have been imposed by the local water management agency in the region on how much potable water can be used from surface and groundwater. The water management agency also provides resources to develop the use of reclaimed water to reduce the demand. Over the past 10 years, reclaimed water expansion also is needed to keep pace with pollutant loadings imposed for nitrogen via adoption of total maximum daily loads (TMDLs). TMDL loads have been based on average plant performance. For the SC RW system, the TMDL limits are 28.4 tons of nitrogen per year based on a 5-year average and 37.8 tons per year based on a rolling annual average. In the NW RW system the TMDL limits are 25.2 tons of nitrogen tons per year based on a 5-year average and 31.5 tons per year based on a rolling annual average. The interconnection of the four wastewater treatment plants in the Northwest area and the separate interconnection of the three plants in the SC area allow for optimal operational flexibility, service reliability, and expansion of the customer base. Continual reclaimed water system expansion also provides the benefit of environmental conservation and potable water offset. Environmental conservation in this context means that by using reclaimed water, potable water is not used, thereby reducing the amount of potable water/ groundwater pumped, which has an impact on the groundwater levels, lake levels, and saltwater intrusion into the drinking water source. When looking into the future, A5 goals are to increase the number of NPR customers and overall water reclamation and to decrease wastewater discharge. A groundwater recharge project currently is being considered.
If not reusing water, are you considering reusing water, and what type(s) of reuse, type(s) of treatment, amount [and why for all of them]? Where are you in the implementation process (feasibility study, research, pilot testing, planning, design, construction, etc.)? What is driving you to consider water reuse? Examples include water supply shortage, sustainable supply, regulatory requirements (discharge or reuse), cost, and so on.	Not applicable.

Did you consider options that did not involve reuse (e.g., reservoir enlargement, conservation, or desalination)?	Yes, a reservoir for the water reuse system and reclaimed water system expansion. All wastewater disposal options consider water reuse.
For each reuse option: What alternatives were considered and what were the most important elements distinguishing them? What criteria were used in selecting between project options and in selecting specific alternatives? What were the most important of these criteria?	Aquifer storage and recovery (ASR): A5 built two ASR projects, which together cost $3 million. From 1998 to 2004, one project used water from one of the NW wastewater treatment plants. The second was built to support one of the SW wastewater treatment plants, but was shut down before testing could begin. Rising costs and the new U.S. Environmental Protection Agency (EPA)/[State] Department of Environmental Protection arsenic drinking water standards contributed to the shutdown. The first ASR yielded water with total dissolved solids and salinity concentrations that were not amenable to irrigation of turf. Arsenic mobilization also was observed at concentrations above the drinking water standards. A5 operates a spray irrigation/disposal system at one of its plants. Developing the NPR reclaimed water program to serve residential commercial, golf course, and agricultural applications. The main factors considered were cost, maintenance, and legal issues (not specified). A5 recently has considered the benefits of a wet weather reservoir where wet weather excess reclaimed water could be stored and used during the dry season. Further development of a reservoir is on hold (reasons not specified). Also under consideration is an IPR aquifer recharge project. A 5-year pilot study project is currently underway that is evaluating the use of a recharge well in the greater than 10,000 TDS zone in the SC service area to be used as a salinity barrier to reduce saltwater intrusion. Finally, water use permits have been approved through the regional water management district to augment the reclaimed water system with groundwater on days of peak demand, after the existing reclaimed water resource has been consumed. This will allow for new customers to use groundwater for a month or two during the peak dry season and reclaimed water the rest of the year. Because most surface water discharges of wastewater originate from groundwater consumption, these new customers further reduce surface water discharges, provide environmental benefit to stressed groundwater levels and also reduce nitrogen loadings to surface water.
Was the project developed with other agencies; if so, what were the roles of other agencies?	Yes, the NPR project was developed with the assistance of state regulators and the regional water management district. The regional water management district helped obtain cofunding for the recharge project.
Was there major leadership input from the community? Was there opposition from the community?	The initial reclaimed system met with some opposition (the “yuck” factor) in the early 1980s, but over time the community and developers have embraced reclaimed water as an asset by increasing property values.
Were there any unique circumstances favoring or impeding progress?	Factors favoring progress: limited potable water resources; potable water restrictions imposed by the water management district; limitation of reclaimed water use to NPR; and minimized discharges to surface waters, thereby meeting TMDL permit requirements.

ECONOMIC and FINANCIAL	
Project costs (for the reuse component only – not existing wastewater treatment): Please use the Reuse Project Cost Estimate Form in Attachment A. For this cost estimate, what is the acre-foot yield for the project?	---
Avoided costs as a result of utilizing the reuse option, did the utility Avoid costs related to an alternative water supply project? Water or wastewater treatment plant capacity expansion/ upgrade? If so, is there a rough estimate of the avoided cost (capital and O&M and year)?	By utilizing reclaimed water, A5 avoided the cost of expanding and installing new water treatment infrastructure in order to meet customer demands.
Market surveys and analysis – what types were performed? Customer class? Peaking or base? Number and location of customers? Customers' reuse water quality requirements? Other?	Number and location of customers: The selection of reclaimed water customers is a function of economic feasibility and opportunity. Opportunity is dependent on development schedule and the proximity of potential users to the reclaimed water infrastructure. As a result, because of opportunity, lower priority users such as golf courses can be reclaimed water projects before those that replace potable water usage. Developing the reclaimed water program involves many components, including intensive research of each service area to determine its existing and future development; the capacity and potential for reuse; the balance of available water versus reuse demand; ordinances, technical manuals, policies, feasibility studies, and cost analyses; obtaining funding; projects' initiation, design, and construction. Staff interacts with the developers, residents and their homeowners' associations, and the commercial sector.

Financing: Who paid and how much? Sharing between agencies? Grants? How much? Loans? What interest rate, duration of loan? Who paid for the connections to the customer? If it was the customer, was it directly or with a payback agreement with the utility or in the rate structure? Are there contracts with customers? Are they for reuse rates only or other costs?	Currently, A5 is responsible for the costs of the primary reclaimed water facilities such as the interconnections among treatment plants, effluent discharge lines, storage tanks, pump stations, and main transmission lines. The regional water management district has provided financial support for several reclaimed water projects through a cooperative capital improvement funding program and has expressed interest in supporting reclaimed water expansion (specifics not provided). New development, residential, commercial, and industrial has the opportunity to utilize reclaimed water service if sufficient reclaimed water supply is determined to be available and the proposed subdivision or commercial/industrial site is within the urban service area and the reclaimed service area. If a project is determined to be feasible, a developer may assume the cost to extend the reclaimed water transmission system from existing A5 facilities and install reclaimed infrastructure to accommodate the new development. In cases where the benefit is shared between A5 and the potential customer, an agreement will be pursued between the two regarding the financial and construction responsibility for the transmission main to serve that customer. For existing residential subdivisions, a dedicated legal mechanism was adopted that allows for residents to petition the county board to establish a special assessment district to finance the design and construction of a reclaimed water distribution system within a subdivision. The residents are then assessed their share of the cost of the installed infrastructure on their annual property tax bill. Revenue also is obtained by A5 through monthly fees for the use of reclaimed water and a flat charge to water and wastewater utility customers.
ENVIRONMENTAL and PERMITTING	
Environmental impacts: Does the project Avoid use of traditional supplies? Help meet discharge requirements? Have an environmental benefit (such as augmentation of stream flow supporting ecosystems, protecting endangered or threatened species, providing recreational benefits, and so on)? Are there water quality objectives downstream that influenced the project selection? Salts, chlorine, or others? Were wetlands created or enhanced as part of the project?	The reclaimed water program maximizes the available reclaimed water for beneficial use with the end result of reducing potable water consumption and ground and surface water withdrawals, and reducing the discharge of nitrogen to surface waters. Should the IPR aquifer recharge pilot project lead to a full-scale project, it could provide another method to minimize surface water discharges and without the need to increase the customer base. It can provide a “sink” for excess reclaimed water and also has other environment benefits, such as creating a salinity barrier for groundwater and assisting in the mitigation of areas where groundwater resources have been over committed. No wetlands have been augmented. In 2009 the reuse system eliminated approximately 19 tons of nitrogen from entering area surface waters.

Are there environmental costs associated with the project (e.g., traffic disruption) and if so what are they (year)?	
Regulatory requirements: Are there any specific reclaimed water quality regulatory requirements that drove you to one option versus another (e.g., reuse requirements for treatment or underground retention, NPDES, total maximum daily load, degradation of groundwater, Hazard Analysis and Critical Control Points [HAACP])?	Continual reclaimed water system expansion is needed to keep pace with regulatory compliance of TMDLs. A5 is currently conducting a pilot study with in cooperation with the regional water management district. This study will address the technical and regulatory issues with recharging reclaimed water into a high TDS aquifer to create a salinity barrier. Should this alternative become a viable project, it is estimated that it could begin in 3 to 6 years. No new reclaimed water customers would be created by this project, and no potable water offset would result. However, there is a potential of a groundwater credit from the regional water management district that could be sold to a local water agency to offset AR costs (A5 did not elaborate on what these costs were). A5 has obtained water use permits through the regional water management district to augment the reclaimed water system with groundwater on days of peak demand, after the existing reclaimed water resource has been consumed. This will allow for new customers to use groundwater for a month or two during the peak dry season and reclaimed water the rest of the year. Because most surface water discharges of wastewater originate from groundwater consumption, these new customers further reduce surface water discharges, provide environmental benefit to stressed groundwater levels, and also reduce nitrogen loadings to surface water.
SOCIAL and POLITICAL	
Public acceptance/ opinion: Was there opposition to the project because of public health concerns? Were public opinion polls taken, or public meetings or focus groups conducted? Was a public outreach or education program conducted specifically for the project(s)? If so what type(s) and what aspect of the program helped most with moving from opposition to acceptance?	At first the there was some opposition from the community, but as the public is informed and educated about the reuse water, opposition has moved to acceptance.

Political issues: Specific political issues that were important (e.g., environmental justice issues, local control over water Political process leading up to implementation? Leadership from the community or the utility?	The reclaimed water program has run into political resistance with regard to conversion of older flat-rate customers to metered customers, which has reduced the program's ability to manage the resource better.
Water supply reliability: Water supply situation in terms of degree of water stress? Reliability of other supplies in utility's portfolio?	The reclaimed water supply is very predictable, and the only impediment is proper management for dry season availability so as not to overcommit the resource and not have available water.
For all classes of users, what are the benefits that were most important for the users: reliability cost of water, others?	User benefits include • Cost – reclaimed water is a fraction of the cost of potable water (specifics not provided) • Reliability – the reclaimed water program provides reclaimed water at the same level of reliability as potable water • Availability – lack of restrictions (specifics not provided)
Do you have any "Level of Service" objectives for your reuse program (e.g., internal goals set by the utility for their performance)?	1. To maximize the percent utilization of reclaimed water available through system expansion 2. To provide reliable service to all reclaimed water customers at the same level as potable water service 3. To work toward more efficient use of reclaimed water so the resource can be utilized by more customers
Organization and business integration issues: Was it necessary to make institutional re-arrangement or changes? Were there any institutional barriers and if so what were they? Could they be overcome?	No.

Energy/Carbon Footprint: Quantify energy use in kilowatt hours What are the pounds or kilograms of emission for each applicable greenhouse gas, or collect emission factor in pounds or kilograms of GHG gas per kWh or MWh?	---
Legal issues that helped or hindered implementation? Water rights? Liability? Public access issues? Other?	No legal issues. All classes of customers enter into service agreements that vary depending on their class and the cost.
TECHNICAL FEASIBILITY and ENGINEERING	
Was storage a technical consideration and if so please describe the role (for example was storage needed to make the option feasible and why - this is intended to be a cost question)?	The storage requirement is important. Having no seasonal storage restricts commitments and limits the customer base, and at the same time limits the utilization of the resource to approximately 60 to 70% of the total reclaimed water supply. The system does have sufficient diurnal storage.
Were there infrastructure standards and requirements that had to be considered (these are structural requirements)?	Yes, there are reclaimed water system design standards.
Were there other technology evaluations/needs considered in deciding which option to choose over another?	---
Other?	---

A5 Reuse Project Cost Estimate Form (not completed by participant)




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