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Dual Water Systems: Characterization and Performance for Distribution of Reclaimed Water

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Dual Water Systems: Characterization and Performance for Distribution of Reclaimed Water

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The Foundation's mission is to advance the science of water to improve the quality of life. To achieve this mission, the Foundation sponsors studies on all aspects of drinking water, including resources, treatment, and distribution. Nearly 1,000 water utilities, consulting firms, and manufacturers in North America and abroad contribute subscription payments to support the Foundation's work. Additional funding comes from collaborative partnerships with other national and international organizations and the U.S. federal government, allowing for resources to be leveraged, expertise to be shared, and broad-based knowledge to be developed and disseminated.

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Dual Water Systems: Characterization and Performance for Distribution of Reclaimed Water

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FOREWORD

The Water Research Foundation (Foundation) is a nonprofit corporation dedicated to the development and implementation of scientifically sound research designed to help drinking water utilities respond to regulatory requirements and address high-priority concerns. The Foundation's research agenda is developed through a process of consultation with Foundation subscribers and other drinking water professionals. The Foundation's Board of Trustees and other professional volunteers help prioritize and select research projects for funding based upon current and future industry needs, applicability, and past work. The Foundation sponsors research projects through the Focus Area, Emerging Opportunities, and Tailored Collaboration programs, as well as various joint research efforts with organizations such as the U.S. Environmental Protection Agency and the U.S. Bureau of Reclamation.

This publication is a result of a research project fully funded or funded in part by Foundation subscribers. The Foundation's subscription program provides a cost-effective and collaborative method for funding research in the public interest. The research investment that underpins this report will intrinsically increase in value as the findings are applied in communities throughout the world. Foundation research projects are managed closely from their inception to the final report by the staff and a large cadre of volunteers who willingly contribute their time and expertise. The Foundation provides planning, management, and technical oversight and awards contracts to other institutions such as water utilities, universities, and engineering firms to conduct the research.

A broad spectrum of water supply issues is addressed by the Foundation's research agenda, including resources, treatment and operations, distribution and storage, water quality and analysis, toxicology, economics, and management. The ultimate purpose of the coordinated effort is to assist water suppliers to provide a reliable supply of safe and affordable drinking water to consumers. The true benefits of the Foundation's research are realized when the results are implemented at the utility level. The Foundation's staff and Board of Trustees are pleased to offer this publication as a contribution toward that end.

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The members of the Project Advisory Committee were very helpful in formulating the project and reviewing interim results. They included Bob Castle, Water Quality Manager for the Marin Municipal Water District and JianYang, an Environmental Engineer who works with Innovation & Environmental Stewardship for American Water. Bob contributed substantially to the project with his valuable insights from long experience and focused responsibility with water reuse in California. Jian paid careful attention to the project progress and interim report, and contributed insights from his experience.

We received very valuable help from the utilities that sponsored our workshops and field visits in Florida, California and Texas. In Florida, Dave Bracciano of Tampa Bay Water and Irvin Kety of the Largo system helped us a great deal in planning and organizing a very useful event. In Oakland, our event was organized in conjunction with a meeting of the Northern California Chapter of the WateReuse Association, and Anita Jain of Whitley Burchett & Associates and Curtis Lam of HydroScience Engineers helped us make the arrangements.

We would like especially to thank Daniel A. Okun, who is now deceased but who inspired us to think more deeply about the possibilities of dual water systems. The AWWA (2009) manual on distribution of reclaimed water includes a dedication and a longer explanation of Dan's contributions.

EXECUTIVE SUMMARY

OBJECTIVES

This report is a retrospective assessment of dual water systems, which are two distribution systems operating jointly, one to supply potable and the other to supply non-potable water. While dual systems can be used to distribute any source of non-potable water, the assessment of their performance for this report focuses on reclaimed water, which is the most common source.

The report responds to USEPA's Sustainable Water Infrastructure Initiative, which identified dual water systems as a potential technology to improve water safety and reduce the cost of drinking water distribution infrastructure. This concept draws on the need to improve drinking water safety while also addressing infrastructure gaps. Distribution system risk must be assessed as the systems age, at the same time that reinvestment levels are lower than needed (NRC 2006; USEPA, 2007). An assessment of dual water systems' performance can set the stage for a strategy to employ dual water systems in the future for appropriate multiple purposes.

The research tasks included an inventory of cases where dual systems have been implemented; formulation of a protocol to identify claimed benefits, costs and risks; collection of data (quantitative and anecdotal) to assess performance; display of data in the form of performance results; and explanations of the results.

BACKGROUND

In addition to the knowledge base for reclaimed water, which focuses on health, safety and economics, assessment of the effectiveness of dual water systems must also address infrastructure management systems and operations and maintenance.

The distribution of non-potable water supplies has occurred for many decades, but the use of dual systems only started to increase significantly after the advent of advanced wastewater treatment during the 1970s. Now, water reuse is expanding in the U.S., mainly to serve the goals of extending water supplies and reducing wastewater discharges. Some water reuse occurs from dedicated lines from wastewater plants to water users and does not involve dual distribution, but more extensive dual systems are also being implemented.

By the 1980s the literature on water reuse was increasing rapidly. Important information was published in the Water Reuse Guidelines by USEPA and the U.S. Agency for International Development (2004). Another important synthesis document is the American Water Works Association's (AWWA) (2009) Manual 24 about distribution of reclaimed water. Authors, such as Okun (2005a) and Asano et. al. (2007), have also published extensively about water reuse.

APPROACH

Because the feasibility of reused water has been studied extensively, this study started with a focused review of the body of knowledge about the infrastructure used to distribute it, which involves issues such as failures, maintenance, costs, and other distribution-related concerns. This was followed by the preparation of an inventory of dual systems to establish basic statistics of the numbers of systems in existence and to compare these with published claims. This was augmented by the knowledge base about the functions and effectiveness of the existing systems from the background literature.

Reviewing the performance of the systems presented a challenge because no standard classification system had been developed and the systems varied widely in scale, type and stage of development. Therefore, a classification framework was developed to enable comparisons among similar dual systems and to avoid comparing dissimilar systems. Another issue in the performance assessment was the need to evaluate parameters relating to different goals, and to facilitate this, a framework with criteria for multi-objective evaluation was developed. This set of criteria was used to evaluate the case studies that were compiled from the literature, interviews, and selected visits. Visits were made to several of the case study utilities in Florida, Texas and California, where most systems are located. A workshop was held in Florida to receive feedback about the preliminary results and a workshop session was also held as part of a meeting of the Northern California Chapter of the WateReuse Association.

RESULTS/CONCLUSIONS

The background literature showed a good understanding about water reuse as an evolving practice and the inventory of systems confirmed anecdotal reports that practically all U.S. dual water systems are being implemented to extend use of scarce supplies and offer new options for wastewater management. This is an important finding because it establishes that the drivers for increased implementation of dual systems are not focused primarily on the improvement of water safety or lowering of infrastructure costs but dual systems for distribution of reclaimed water are being implemented as additions to portfolios for total water management that include augmented supplies and new options for wastewater management.

The case studies showed that the main uses of water reuse systems are for non-potable applications such as landscape and agricultural irrigation, toilet flushing, industrial process water, power plant cooling, wetland nourishment and groundwater recharge. While fire-fighting uses seem appropriate, they are less common than irrigation and commercial and industrial uses because of barriers in acceptance by fire departments and the need for reliability in availability of fire protection water. Also, distribution to residential customers is less common than to commercial and industrial customers, a finding that reflects the significant administrative problems of distributing reclaimed water to large numbers of customers.

The project task where reuse applications were identified showed that the number of systems that qualify to be named dual distribution systems is less than claimed by some published reports, which did not seek to classify the systems and distinguish them from all uses of reclaimed water. The system identification task showed an approximate count of 335 systems in the U.S. This count depends on classification and definitional issues presented in the report. While different criteria could be used to define dual systems, it seems unlikely that this number would increase greatly because it covers the major systems in Florida, California, Arizona and Texas and there is no indication that other states have significant numbers of systems which were not identified. As a result of the identification phase, it is estimated that the national mileage of pipe in dual systems is between 10,000 and 20,000 miles, or upwards of one percent of the total of potable water line mileage on an order-of-magnitude basis.

The literature review and case study analyses showed that, although there have been isolated incidents of cross-connections, there have been no major public health problems from the use of reclaimed water in the U.S. While incidents may occur in other countries or in situations with less regulatory scrutiny than the cases of reclaimed water distribution in the U.S., the evidence from the lack of incidents in the case surveys and the background literature shows that water safety and public health issues of dual systems are being managed effectively.

Six service categories are included in the classification system that was developed to support the assessment. Given that most systems do not serve residential customers, it was not possible to use standard statistics, such as population served, to classify them. The classification variables chosen focus on management characteristics, such as whether the utility owns the infrastructure and water supply for both systems or depends on others; whether it supplies potable and/or recycled water to other utilities; whether it only distributes potable and/or recycled water obtained from others; and if it is a cooperative that supplies recycled and/or potable water. Another set of performance-related variables in the classification system shows the extent of reclaimed water mileage compared to potable pipe mileage and the production of reclaimed water as a percentage of potable water production. These parameters measure the extent to which utilities have extensive mileage of reclaimed water pipeline infrastructure and whether distribution of reclaimed water is a major part of their water service. The reclaimed water distributed by 17 of the case study systems ranges from one to ten percent of their potable water delivery. Another 15 of the utilities distributed from ten to almost sixty percent of their water delivery as reclaimed water (insufficient data were available to classify the other cases). The data must be interpreted with caution because other variables are important. For example, Tallahassee (FL) showed the highest percentage of reclaimed water use (58%), compared to potable water. This utility uses reclaimed water for agricultural irrigation, which might require greater quantities on a relative basis than some other uses.

Financing dual water systems will be an important challenge in the future. While the WateReuse Association offers guidance for rate-setting, more comprehensive guidance for it and other institutional issues and challenges will be needed. The project found that financial feasibility and institutional constraints, such as balancing regulation and management controls, are the primary issues confronting the increasing use of reclaimed water.

The assessment of effectiveness was measured across several categories of goals because of the multiple objectives of the systems. It studied how effectively a dual water system met the following goals; 1-extend scarce water resources, 2-increase wastewater management options, 3-increase the safety of potable water, 4-decrease the total cost of providing potable water, and 5-environmental objectives.

As dual water systems extend water supplies and help with water conservation, they become part of total portfolios of water supply options, particularly for outdoor and industrial uses, including cooling. They can offer new options to improve wastewater management and reduce the need for and cost of wastewater treatment and disposal. In evaluating this reason to implement them, utilities must take a total water management view that considers cost of both water supply and wastewater systems.

Cost accounting and rate-setting systems for dual water systems need further development. When the direct cost for non-potable water is compared to its direct revenue from commodity charges, non-potable water systems generally lose money. However, if the total costs and benefits of distributing non-potable supplies in dual systems are considered, the systems are more feasible from a financial standpoint. These include goals such as extending scarce water supplies, reducing wastewater discharges, and deferring or avoiding capital investments in treatment facilities.

To be reliable, non-potable water systems require seasonal storage. Although the supplies are more interruptible than potable water, utilities do not want reliability to be low because as the case studies show, customers still rely on recycled water. Residential customers increase the risk and complexity of operating dual water systems. Therefore, most new systems are connecting industrial, agricultural and public sector customers, rather than implementing residential services. This focus away from residential customers also reflects the higher burden placed on dual system operators to inspect backflow and cross connection facilities on private properties. This added burden explains one of the institutional issues inhibiting greater implementation of dual systems.

APPLICATIONS/RECOMMENDATIONS

A utility seeking to extend use of water supplies and expand options for wastewater management may use the information in the report to consider a dual water system. The study's findings can also be used to inform state and local policy on regulatory control of the distribution of reclaimed water. A regional or state program, such as the Cooperative Funding Initiative program by Southwest Florida Water Management District, to encourage and help to support dual systems can help to coordinate and stimulate new system development. In addition to financial subsidies, these programs help to coordinate policy and to provide solidarity among the community of utilities that is facing issues of reclaimed water distribution.

At its inception, the project focus was on whether dual systems could improve water safety and offer options to offset infrastructure funding and management problems. The study concluded that dual systems are not being implemented as a strategy to keep drinking water safe, affordable and reliable. It is apparent that the focus is on creation of new options for water management portfolios. Just as in a stock portfolio, the owner spreads risk by diversifying and not depending on one option alone. In the same way, by implementing water reuse in some situations utilities may gain large advantages. It seems appropriate that some utilities view this as an application of total water management.

In addition to distribution of reclaimed wastewater, dual systems can be used to distribute raw water. In the West, new demands are creating a need to consider irrigation water as a secondary supply to offset the need to develop new potable sources. Irrigation water comes at different levels of quality and it can be treated or sometimes used without treatment for non-potable uses. In all regions, demands for raw water for cooling and some industrial processes also creates a need for dual systems. Finally, at the site level the recycling of water through gray water systems creates an analogous application for non-potable supplies at the small scale. These developments point to our finding that although reuse of treated wastewater through dual systems is the major trend, other additions to the total water management portfolio are occurring as well. These new developments do not fit traditional perceptions of infrastructure or operations and they will be a challenge to control. However, they offer new and flexible options to help overcome looming water scarcity and quality concerns.

Dual systems have good possibilities but are not appropriate in all situations. Utilities must decide if their unique situations warrant the additional cost and complexity of implementing dual water systems. Although dual water systems are complex and expensive, there has been enough success with them to see that they can have an important future within overall urban water systems. One can envision possibilities, such as locating water-using industries and energy plants near wastewater treatment plants, so as to pick off low-hanging fruit for application of non-potable supplies. Dual systems might also be part of future non-conventional water and wastewater systems. These are intriguing possibilities, but there are also many situations with adequate source water and few issues with wastewater disposal. In those cases the added complexity and costs of dual water systems make them less attractive.

CHAPTER 1: INTRODUCTION AND PROJECT BACKGROUND

The distribution of reclaimed water through dual piping systems has emerged as an important strategy for augmenting water supplies, disposing of wastewater and reducing demands on environmental water sources. In a dual water system the piping is separated and non-potable water is distributed along with potable water. Reclaimed water from wastewater treatment plants is the major source of non-potable water in the United States, but untreated raw water and sea water can be used as well.

This report describes a retrospective assessment of the performance of dual water systems and is provided as part of work done toward the U.S. Environmental Protection Agency's (2007) research plan entitled "Innovation and Research for Water Infrastructure for the 21st Century." The focus of USEPA's plan is on use of innovative technologies to improve the safety of drinking water and to overcome infrastructure issues, and it identified dual water systems as a potential strategy to improve water safety while addressing the funding gap (USEPA, 2002). The retrospective assessment reported here provides findings for use by utilities and recommendations for the next steps in studies of the feasibility and implementation of dual water systems.

The assessment of dual water systems requires that effectiveness across several categories of goals be evaluated. One category is how they help with the resource issue of extending water supplies and another is the extent to which they improve wastewater management outcomes. Both of these objectives have embedded in them the protection of natural systems, whether source or receiving waters. The safety of dual water systems and whether any violations of drinking water standards have occurred are also important criteria. Finally, the total added cost of dual systems is important to know for performance assessment.

The focus of this study is on the specific performance issues of dual water distribution systems and not on the feasibility of reusing water. Water reuse systems have been studied extensively, and the study builds on the existing body of knowledge to add insight about the performance of their distribution infrastructure.

PROJECT BACKGROUND

While the current levels of drinking water safety in the U.S. are good, the high cost and aging condition of drinking water infrastructure is a cause of concern for the future. In turn, the cost and condition affect the safety of drinking water as it depends on the physical, hydraulic and water quality integrity of distribution systems (National Research Council, 2006). Water distribution systems account for the majority of the capital cost of drinking water systems and their management is difficult due to their buried location. While age is not the only determinant of pipe condition, the likelihood of physical, hydraulic or water quality failure generally increases with pipe age.

While some pipes may last longer than 50 to 75 years, historical growth patterns predict that an era of high replacement needs has arrived (AWWA, 2001). This replacement era is beginning at the same time that multiple demands on distribution systems for drinking water, fire flow and other uses create water quality issues such as increased water age. While the highest quality of treated water should be maintained all the way to the tap, the reality is that substantial changes can occur in distribution systems. Data on waterborne disease outbreaks suggest that distribution systems require more attention than they currently receive. Craun and Calderon (2001) published a survey about outbreaks caused by distribution systems, and when combined with the National Research Council (2006) study on risks from distribution systems, their study indicates the need for more attention to the quality of water in distribution systems.

In 2002 the USEPA performed a gap analysis to identify the major financial issues of maintaining the integrity of distribution systems. This was followed by the National Research Council (NRC, 2006) study entitled "Drinking Water Distribution Systems: Assessing and Reducing Risks," which focused on physical, hydraulic and water quality integrity. The NRC study identified a number of measures to safeguard drinking water quality, but did not devote much study to non-traditional measures, such as decentralized treatment or use of dual distribution systems.

Concerns regarding aging infrastructure and water quality have led to increased interest in distribution system performance with a focus on new and innovative approaches to ensure safety while controlling costs and holding risks to tolerable levels. As a result of these concerns the U.S. Environmental Protection Agency (USEPA) is studying rule revisions that may address water distribution systems. As the nation considers its strategies to manage distribution systems, increased use of dual systems is a visible option.

USEPA's (2007) research plan focused on improving distribution water quality at the same time that infrastructure and financing issues are addressed. It identified the need for two research projects related to dual systems:

1) Retrospective assessments to document the efficiency and performance of in-service dual systems; and
2) Prospective assessments of dual systems for potable and non-potable uses to develop criteria for determining applicability, benefits and costs.

This report responds to the retrospective assessment identified in the first project above. The project proposal was included in a proposal from the Water Environment Research Foundation (WERF) and the Water Research Foundation (WaterRF) to USEPA for the program of "Innovation and Research for Water Infrastructure for the 21st Century." After the grant was awarded, the specific tasks were developed for work at Colorado State University and the University of Texas at Tyler.

To perform a retrospective assessment of the efficiency and performance of dual systems requires study of an evolving set of in-service systems, especially those to distribute reclaimed water. These evolving systems respond to an increasing need to reuse water, for which a large knowledge base is now available. The terms reuse and recycle are used interchangeably, and the term water reclamation means the use of treated wastewater.

The project has the following work tasks:

- Development of an inventory of cases where dual systems have been implemented
- Formulation of a protocol to identify claimed benefits, costs and risks
- Collection of data (quantitative and anecdotal) to assess performance
- Analysis of performance
- Display of data in the form of performance results
- Evaluation of research results in workshops by stakeholder groups
- Explanations of the test and its results.

In addition, a comprehensive literature review was conducted to evaluate lessons and experiences about dual systems, including a study of the reclaimed water rules and regulations for the primary states of water reuse: California, Florida, Texas, and Arizona.

DEFINITIONS AND PERCEPTIONS OF DUAL WATER SYSTEMS

Dual water systems are water systems with source, treatment and distribution components. During the project a number of different types of dual water systems were studied and we provided a classification system for them. We were advised by utilities that the distribution of reclaimed water must be considered in the context of total water use, and Figure 1.1 was prepared to illustrate the general concept.

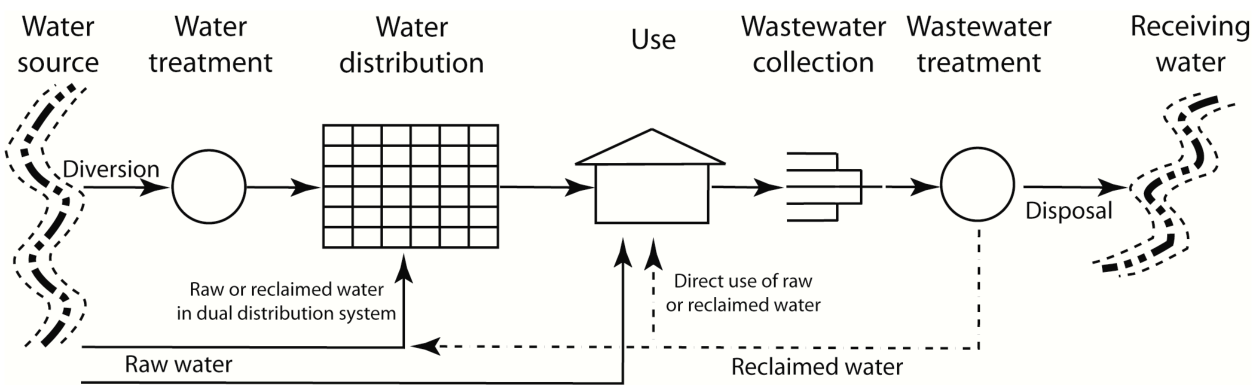


Figure 1.1 Schematic of a Dual Water System

The schematic shows seven water management processes, beginning with raw water diversion and ending with disposal of treated water to receiving waters. If raw or reclaimed water is provided to a distribution system that operates in parallel with the potable water system, the distribution system is considered as “dual.” If raw or reclaimed water is distributed directly to a user, it is shown as “direct use of raw or reclaimed water” and is not a dual system. However, if this direct use is extended to multiple users and a system for distributing non-potable water increases in scope, then it is emerging as a dual system.

For example, a dedicated line to an industrial customer may extend from a wastewater treatment plant and, as the utility and the industry gain experience with the system, other industries and irrigators may seek to use the reclaimed water as well. Then, the system might evolve further to include applications such as commercial buildings and fire fighting. The system would not develop from a single decision to implement a dual water system but would evolve to meet emerging needs.

This incremental development of dual systems explains a perception issue that was encountered in the project where the technical literature suggested that a large number of dual systems existed, but initial findings showed fewer-than-expected systems and wide variation in their types and purposes. As these initial findings were explained to advisory groups, two discerning questions were directed at the research team: where are all of the reported systems and how could a utility afford a second system when the first one needs so much investment? These questions are answered in the report by providing an inventory and classification scheme for the systems and by showing that they are being provided to respond to definite and emerging needs, mainly to extend water supplies and increase options for wastewater disposal. This is a different strategy than a top-down utility decision to develop a dual system to improve water safety or lower infrastructure cost.

The description of dual systems in USEPA's (2007) report suggests a top-down approach: "The dual systems approach involves splitting the distribution system into two systems—one for potable water use only, and the other for firefighting and other non-potable uses." This implies a decision to implement the distribution of non-potable water in a new system that can be planned from the conceptual stage. A top-down decision to retrofit piping as a dual system would seem to align with the explanations by Okun (1997), who advocated that a smaller-diameter potable system could provide safer drinking water alongside a larger-diameter non-potable system used for fire protection and related non-potable uses. His ideas are discussed in more detail in Chapter 2. Okun's advocacy in promoting the concept of dual systems is recognized in the AWWA (2009) manual entitled "Planning for the Distribution of Reclaimed Water."

The bottom-up view is that dual systems are being implemented incrementally to distribute reclaimed water as explained in the "Guidelines for Water Reuse" (USEPA and U.S. Agency for International Development, 2004). The name change of AWWA's manual is another indicator of the shift in focus from the dual systems strategy to a strategy that is focused on the distribution of reclaimed water. The manual explains: "The title (of the original AWWA Manual M24, Dual Water Systems, published in 1983) has been changed to Planning for the Distribution of Reclaimed Water to better represent the content of the manual."

The term "dual water systems" is useful, but the different types of the systems require clarification to avoid misunderstanding. To adopt a definition, the AWWA (2009) manual presents a clear picture of dual systems as: "Two separate water piping systems distributing water to customers, one carrying potable water and the other conveying lesser-quality water (e.g., non-potable reclaimed water) for reuse purposes." This definition seems workable and the only improvement needed might be to include the cases of distributing non-potable water that is not reclaimed wastewater, such as the seawater used for toilet flushing in Hong Kong or raw water used in the West for irrigation. While these applications are comparatively rare compared to those of reclaimed wastewater, the definition could handle them by shortening it to this: "Two separate water piping systems distributing water to customers, one carrying potable water and the other conveying lesser-quality water." The inference is that non-potable water and lesser-quality water are equivalent and it is not known why the AWWA committee did not use the term non-potable.

Although the current status of dual water systems is clear, different types of them are being implemented. As a result of this and our initial findings as outlined above, we added to the work of the project the development of a proposed classification framework for dual water systems (see Chapter 5).

USE OF PROJECT RESULTS BY UTILITIES AND FOR POLICY STUDIES

The goal of the project was to assess the performance of dual water systems to explore policy options for improving the distribution of drinking water on an overall basis. The performance evaluation can be used in conjunction with the studies cited earlier that address policy for drinking water safety, cost and risk management. Presently, national water policy uses regulatory and financial incentives, but strategy for water distribution is implemented mostly at the local level. While no regulatory options for dual water systems were evaluated in the study, the project findings about implementation issues could be useful for utility decisions and by regulators.

The authority to decide on water service approaches is at the local level, so national policy should focus on enabling, support, and governance. Policy questions that arise are:

- Should policy be used to encourage the retrofitting of existing distribution systems to become dual systems with smaller-diameters which provide higher-quality potable water?
- Should policy be used to promote dual systems in newly-developing areas?
- Should policy be used to promote a paradigm shift toward future decentralized systems with combinations of point-of-entry (POE) and point-of use (POU) treatment and dual distribution systems?

Another policy issue is whether national statistics on dual water systems should be developed to accompany USEPA's statistics of public water and wastewater systems. At the national level, USEPA has developed the Community Water Systems Survey and needs surveys for drinking water and wastewater. Information on drinking water systems is maintained in the Safe Drinking Water Information System and information on water quality compliance is maintained in USEPA's Permit Compliance System database in the Envirofacts system for National Pollutant Discharge Elimination System (NPDES) permits. In addition to these, AWWA makes periodic surveys of drinking water utilities and distributes the results through its publications program. Wastewater system surveys do not have as long a history as those for drinking water and no surveys comparable to AWWA's are available for wastewater facilities.

How utilities can use the information developed under this project was addressed by the Innovative Infrastructure Review Committee (IIRC) that advised USEPA on the overall research program. The committee asked: "How do you envision the end-of-project deliverable to be of immediate use to utilities?" The team responded that the project is aimed at assessment of the performance of in-service dual systems and use of the results by utilities depends on their requirements for this information. Utilities that have water reclamation systems and dual systems can use the information to compare their own management and results with those of others. Utilities that do not have dual systems might be able to use the information for future planning purposes. The report's performance assessments include categories for water safety, technical systems, financing and institutional arrangements. These are important issues for utilities, many of whom are considering how to implement or expand non-potable systems and how to sustain them in the current economic climate.

The performance assessments can provide data for benchmarking, where utilities could learn from each other and national policy makers could assess the need for reforms to improve management.

CHAPTER 2: LITERATURE REVIEW: LESSONS FROM RESEARCH AND EXPERIENCE

This chapter sets the stage for assessing the performance of dual systems by reviewing how they have evolved and the issues associated with their performance. The research literature about dual systems spans the issues of water reuse and the implementation of new infrastructure systems. It includes concerns about treatment technologies, emerging chemicals and pathogens, economics, rates and funding, and public involvement, among others.

The review of literature showed that incentives for reclaimed water use include urbanization pressures on water supply sources, diminishing natural water resources, and increasingly stringent wastewater discharge regulations. Reclaimed water is needed especially in dry regions and reclaimed water projects that target large water users are likely to be more feasible.

Topics included in the chapter cover the range of issues required to assess the performance of dual systems including: water quality and public health aspects of dual water distribution; experience with water reuse systems; distribution system asset and operations management; and economics and institutional arrangements of dual distribution systems.

EVOLUTION OF DUAL SYSTEMS

To understand how dual water systems are evolving to respond to emerging needs and have not been widely used until recent decades, it may help to realize that until water treatment was developed after the 1880s, all of the distributed water was non-potable from the standpoint of our current practices. This included water for domestic, industrial and fire fighting uses. In some areas of the world, non-potable water is still distributed in urban networks in cities without safe drinking water.

After the advent of water treatment processes, the drinking water in distribution systems was considered as potable treated water. There were a few instances of deliberate distribution of non-potable water, but the focus was on distributing potable water. Later, it became possible to reclaim wastewater by uses of advanced sewage treatment and reuse.

Okun's (1996, 1997, and 2005a,b) reviews are a good starting point to study the evolution of dual water systems. He cited Haney and Hamann (1965) as the first published paper on dual systems. Also, the Guidelines for Water Reuse were initiated in the 1980s and contain numerous examples (USEPA and U.S. Agency for International Development, 2004). The AWWA (2009) manual on distribution of reclaimed wastewater traced the history of dual systems from use to supply water fountains in ancient Rome through modern applications that included use in Baltimore for a steel plant cooling water, a dual system at the Grand Canyon Village in 1926, use for toilet flushing in Hong Kong dating back to the 1950s, to industrial uses and power plant cooling applications, to cite a few examples.

International use of reclaimed water seems to be increasing and Okun (2005a) cited uses in Japan (Maeda, et. al., 1996), where criteria for reclaimed water quality have been proposed. Area-wide water recycling in the Shinjuku district of Tokyo includes toilet flushing in high-rise buildings. In a project for the Water Environment Research Foundation (WERF), Mantovani et al. (2001) surveyed non-potable water reclamation planning and management practices worldwide and reviewed 65 non-potable water systems, of which 40 were in the U.S..

As a result of these studies it is possible to create a good snapshot of the practice of dual water distribution in the U.S. and, to a certain extent, in other countries. This snapshot shows an evolving practice with roots dating to before water treatment and with a current momentum that is driven mostly by water scarcity and the need to address wastewater treatment.

PURPOSES OF DUAL SYSTEMS

The two perspectives of dual systems (to improve the quality of drinking water systems or to use them to distribute reclaimed water) focus on the main reasons for creating the systems. The reason to point out the nuances between the perspectives is to help establish the evaluation criteria used in this project to assess how well dual systems have performed. There is no conflict between the two perspectives, and both the USEPA (2004) guidelines and the AWWA (2009) manual explain the purposes of dual systems as for distribution of non-potable and potable water in parallel.

The expectation that dual systems could improve drinking water quality is based on the assumption that by distributing potable water in smaller lines, the water safety could be managed better than in larger bulk distribution systems. In promoting this expectation, Okun (1996) explained 19th Century decisions to design water distribution systems to provide fire protection as well as to serve commercial properties and residential areas. He argued that by increasing water age, large diameter distribution systems degrade drinking water quality, which could be improved by distributing potable water in the smaller diameter pipes. By the 1980s, proposals for direct potable reuse of water were emerging, and Okun (1985) was advocating dual systems instead of direct reuse. He expressed this view forcefully in a letter to the editor of the Journal, American Water Works Association (JAWWA) (Okun, 2005a):

"A system designed for drinking water alone would also experience negative pressures, but would not be nearly so affected because the system would have no hydrants and very few joints. Much less drinking water would be wasted on fires, training for fighting fires, flushing sewers, and for cooling children in summer. More important, the small size pipes, possibly stainless steel, would require few joints. Depending on size, they can be laid from spools, or in long lengths with welded connections, thereby maintaining drinking water quality. It seems clear that a system designed for drinking water alone is to be preferred over a system designed for fire protection."

The principal investigator of this project collaborated with Okun in an exchange of letters on this topic and discussed questions that relate to this present report (Grigg, 2005a):

"Will the water supply community continue to install the same type of systems as it has for well over a hundred years, or will it adapt new designs and management practices to respond to the many challenges that Dan described? … Based on current experience, the answer for new systems is that the same practices will be followed. This institutional inertia results from the many standards, practices, codes, and municipal requirements that guide engineering practice. To change any system of large scale infrastructure will require a paradigm shift, which is what Dan is calling for. … In his current letter, he explains that while today's distribution systems remain essential for fire flows, their ability to maintain the quality of drinking water has now been called into question….

The water supply industry … needs a 360-degree technology assessment of the issue, including the institutional problems. This assessment would include a comprehensive analysis of distribution system problems, along with assessment of POU, POE, and dual systems as alternatives to the status quo, which features the current systems and rising consumption of bottled water."

Although Okun's advocacy for dual systems was based on perceived advantages to change the concept for water distribution to smaller-sized and higher-quality potable distribution lines, he recognized that utilities had to work with what they had, which is an inventory of larger-diameter pipes that carry fire protection water along with potable water. This is evident from Okun's contributions to the AWWA (2009) manual and a recent paper by Digiano, Weaver and Okun (2009). In other words, although Okun was an advocate for smaller, higher quality potable water lines, he was realistic in understanding the constraints faced in retrofitting systems.

In fact, Okun (2005a) explained this apparent discrepancy (quoted from the USEPA 2007 research plan): "Today in the U.S., some 2,000 water utilities, large and small, operate dual systems." However, even in these systems the drinking water distribution system is still designed to meet fire flow requirements, so the long-residence-time issue is not resolved. In fact, if the total flow through the drinking water system declines due to elimination of non-potable usage, then residence time will increase. A dual system where the possibility of having drinking water distribution systems being relieved of fire protection has only appeared in a few places in the U.S."

WATER QUALITY AND PUBLIC HEALTH ASPECTS

The need for an assessment of public health risks that is included in this report was identified in the NRC (2006) report, and the research team was asked by a review committee how it was to be addressed in the study. The team replied that the NRC report focuses on traditionally designed distribution systems where potable water is distributed for all uses. The report devoted only a small section to non-traditional systems (such as dual distribution systems), which it considered not in its charge. It stated that alternative methods of distributing water, including dual systems (also POU, POE, and community-based treatment systems) need more research to determine their effectiveness. It also stated: "Such designs, which would be potentially much more complicated than traditional systems, require considerably more study regarding their economic feasibility, their maintenance and monitoring requirements, and how to transition from an existing conventional system to a non-conventional system."

The primary consideration in assessing safety and public health protection is waterborne disease outbreaks. The official database for these is by the U.S. Centers for Disease Control and Prevention (CDC, 2011), which manages a national surveillance system for waterborne disease and outbreaks through a partnership with the Council of State and Territorial Epidemiologists and USEPA. It depends on reports from state public health departments and tracks outbreaks from drinking water and recreational water. Current data are published in the Morbidity and Mortality Weekly Report.

Craun and Calderon (2001) summarized disease outbreaks from distribution systems, but did not address non-potable systems specifically. Over a 27 year period some 619 episodes were reported, of which some 18 percent were associated with distribution or plumbing systems. On an annual basis, few waterborne disease outbreaks are reported from drinking water and none were evident from non-potable water distribution in our limited review of the CDC reports. The most recent report on the CDC website was for 2005-2006 and entitled "Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking --- United States." It reported on cases and outbreaks associated with drinking water and water not intended for drinking (WNID, excluding recreational water). Cases and outbreaks from recreational water are reported separately but we did not consider them.

In 2005-2006, 14 states reported some 28 disease outbreaks, including 20 from drinking water and six from WNID, with two from water of unknown intent. The 20 drinking water outbreaks caused illness in some 612 persons and were linked to four deaths. The causative (etiologic) agents were identified in some 90 percent of the drinking water episodes and included pathogens, bacteria, viruses, parasites, and mixed agents. Of the six episodes associated with WNID, it is possible that they could be linked to non-potable water distribution but data to determine this was not published.

In summary, the major public health concerns are cross-connections and inadvertent use of reclaimed water as potable water. The team was unable to find any case in the literature of a serious public health incident from dual water systems in the U.S. As a confirmation, Dr. Gunther Craun (2011) was contacted to ask if he was aware of any cases. Dr. Craun was formerly with CDC and had studied outbreaks related to distribution systems. He thought there were few if any outbreaks and only a few cases of problems of any kind, mainly because there were so few systems. He thought there might be a few problems with systems in Europe, but data on these is not available. A list of incidents in California also showed no reported illnesses from dual systems. However, California regulations are more stringent than those in most other locales.

WATER RECLAMATION AND REUSE

As most dual water systems are being implemented to distribute reclaimed water, it is useful to review how the rising interest in reclaimed water came about. The timeline shown in Figure 2.1 explains their evolution and frames the issues discussed in the report.

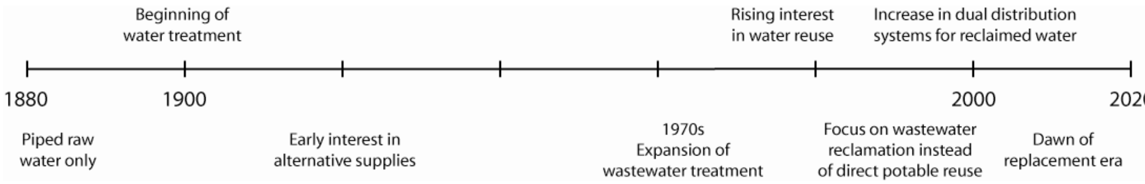


Figure 2.1. Chronology of dual systems

Prior to the advent of water treatment with filtration in the 1880s, all distributed water was untreated. Once water treatment was initiated, then potable water distribution systems began to expand along with urbanization. As early as 1900 there was interest in alternative supplies such as treated wastewater for appropriate uses. Use of alternative supplies increased very slowly until, in the 1970s the increase in wastewater treatment, including advanced treatment systems, initiated discussions of the possibility of direct potable reuse of wastewater on a large scale.

However, by the 1980s, it was clear that the public did not want direct potable reuse but indirect reuse was happening and wastewater could also be reclaimed for non-potable uses. This led to the current slow but continuing increase in the mileage of transmission and distribution systems for reclaimed wastewater.

After the Safe Drinking Water Act was passed in 1974, existing potable water distribution systems came under greater scrutiny and the nation became aware of serious condition issues that affect reliability, water quality and capacity. AWWA (2001) published the "Dawn of the Replacement Era" to highlight the financial dilemma that this poses to utilities and taxpayers. Thus, to manage the large inventory of existing potable water distribution systems is recognized as a daunting task, just at the same time as some utilities are implementing new systems to distribute reclaimed water.

EXPERIENCE WITH WATER REUSE SYSTEMS

The use of reclaimed water, or water that has been treated to remove contaminants and then made available for use again, is increasing in the U.S. and in other water-short countries, such as Australia, which are increasing its use mainly to offset shortages and to supply water are for non-potable applications such as landscape and agricultural irrigation, toilet flushing, industrial process water, power plant cooling, wetlands and groundwater recharge.

Although the use of non-potable supplies is not new, there was an increased interest in water reuse beginning by the 1970s. Asano et. al. (2007) used the year 1960 as a dividing line for discussion of the changed emphasis. Past milestones he mentioned focused on use of wastewater even in ancient times up through treated wastewater used in modern times, such as the 1926 Grand Canyon Village application.

Post-1960 milestones mentioned by Asano et. al. included: 1960 California legislation to encourage reclamation, 1962 groundwater recharge in Los Angeles County, initiation of the

Water Factory 21 in Orange County in 1975, 1977 initiation of the Irvine Ranch system and the system in St. Petersburg, Florida, 1984 to 1993 pilot project in Denver, and the 2003 publication of the recommendations of the California Recycled Water Task Force.

The extensive review by Asano et. al. (2007) included a summary of practices in California, which has been a pioneer in water reclamation. For example, the authors list the 15 largest reclaimed water producing agencies, beginning with the County Sanitation Districts of Los Angeles at 103 million cubic meters (MCM) per year in 2001. The totals for the 15 largest increased from 167 MCM in 1987 to 380 MCM in 2001, with 13 of the 15 showing large increases. They also showed how the California Water Plan anticipates continuing large increases, from the range of 494 to 629 MCM of planned reuse in 2002 to the range of 1875 to 2283 MCM in 2030. On average, this would be about a 4.8 percent annual increase. Additional reviews and guidelines for system design are also published in handbooks such as by Ysusi (1999).

Okun (1996) described how water reuse through dual systems has been on the rise in recent decades: "Accordingly, the production of reclaimed water to replace drinking water that is used for non-potable purposes in urban areas has begun to receive considerable attention." Okun had a long term perspective of water reuse and was able to reach back in time to explain from a public health perspective how it evolved. He was interested in using the highest quality sources for drinking water and using lower-quality sources for other uses. To bolster his arguments, he quoted a United Nations (1958) study that is now over 50 years old: "No higher quality water, unless there is a surplus of it, should be used for a purpose that can tolerate a lower grade." These explanations show the juxtaposition of use of lower-quality water and reclamation of wastewater for reuse.

Since the 1970s the experience base with reused water has grown substantially, and it is reflected in the USEPA (2004) guidelines and in a 2010 workshop at the University of North Carolina, which led to a recommendation that stated: "The growing pressures of population growth, resource consumption, and climate change are making historical approaches to water management obsolete. Dramatic changes to water management are necessary during the first half of this century and must be implemented with great urgency. To address the need, these new approaches must incorporate greater water and resource efficiency along with further improvements in public health and social equity. Fortunately the general outline of this new approach is apparent and includes water reclamation and reuse, rainwater harvesting, and conservation as central components. The undersigned recommend that all parties involved in water management reverse traditional biases and conservation, rainwater harvesting, and water reclamation and reuse be viewed as preferred water supply sources, as appropriate for the intended use."

This workshop was in some ways a capstone event to assess the status of water reuse today. Its recommendation to consider using alternative sources of water is consistent with the findings of this project that dual water systems can be used productively to distribute these non-traditional sources of water.

Many actual cases of dual distribution systems have been explained in the technical literature. As part of this research project, the team reviewed a number of these and new cases (see Chapters 4 and 5, Appendix B). For examples, the Hong Kong System has been in operation from the 1950s, and Tang et. al. (2007) explained problems associated with operating a seawater distribution system. The Engineering Index explained auxiliary water supplies (other than domestic purposes) for Bournemouth, Great Yarmouth, Calcutta and Richmond reaching back over 100 years (Association of Engineering Societies, 1901).

Two systems that have been reviewed extensively are the Irvine Ranch Water District (IRWD) in Southern California and the Rouse Hill development in Sydney Australia. The IRWD is included as one of the case studies in this report. The Rouse Hill Recycled project was reviewed from documents of Sydney Water (2009, 2010). Beginning in 2001, it supplies recycled water to over 60,000 people in homes and businesses in an area of 13,300 hectares and is the largest residential water recycling scheme in Australia. The Rouse Hill Recycled Water Plant supplies up to 1.4 billion liters each year to more than 18,000 homes and businesses for flushing toilets, watering gardens, washing cars and other outdoor uses. An expansion completed in December 2008 increased the capacity to up 4.7 billion liters per year for residential use or the capacity to serve 36,000 homes. The plan is by 2015 to increase water recycling to 70 billion liters per year or up to 12% of water needs in the Greater Sidney area. Customers in the Rouse Hill recycled water area use an average of up to 40% less drinking water than other customers in greater Sydney.

The dual pipe system is known as dual “reticulation”, which is the phrase used in the UK and Australia for what is called distribution in the U.S. Recycled water pipes and fittings are colored purple or lilac to distinguish them from the drinking water system. Safety signs are also required on taps. Tap handles can be removed when not in use. The NSW Health Department has endorsed the Rouse Hill Water Quality Management Plan for residential dual distribution (toilet flushing, washing machines, gardens and ornamental ponds); commercial use (toilet flushing and garden irrigation); parks and recreation irrigation; and fire fighting.

Sydney Water has met AGWR (Australian Guidelines for Water Recycling) requirements for a risk based management framework for the Rouse Hill scheme with this WQMP, which incorporates its certified ISO 9001 and ISO 14001 management systems. Sydney Water considered environmental risks to be low once mitigated due to the high quality of the recycled water and most health risks were also considered low once mitigated due to robust controls. Due to lack of direct control of risks several were rated as ‘medium,’ including possibility of incorrect user installation and modification of plumbing systems (cross connections) and the possibility of incorrect use of recycled water by users.

Sydney water followed the Australian Guidelines for Water Recycling, which were released in 2006 under the National Water Quality Management Strategy. The Guidelines provide direction on best practices and are a reference to support beneficial and sustainable recycling in uses such as agriculture, fire control, municipal, residential and commercial property, and industry. Sydney Water and NSW Health agreed to apply the risk management framework in the AGWR to the Rouse Hill Recycled Water Scheme.

A comprehensive hazard identification and risk assessment (HIDRA) procedure was applied. Water quality is monitored in the distribution system. Sydney Water uses Critical Control Points (CCPs) and Operational Control Points (OCPs) to manage recycled water schemes. The WQMP describes satisfaction of users of recycled. A customer complaint history is maintained. Sydney Water’s (2010) annual report shows robust activity in continuing development of water recycling activities.

In the absence of health outbreaks it appears that quality control procedures such as those applied at Rouse Hill are adequate. Further evaluation is needed for study of finance and maintenance, along with other operational questions. Given the complexity of the utility’s finances and the ongoing development of recycling facilities such as Rouse Hill, together with changes necessary during the financial crisis, it is not possible to assess the financial impacts of dual systems yet.

Today, the incentives for reclaimed water use include urbanization pressures on water, diminishing natural water sources, and increasingly stringent wastewater discharge regulations. Reclaimed water is especially needed in locations with limited potable water sources, such as Israel. In general, reclaimed water projects that target large water users, such as schools and golf courses, seem effective in reducing potable water demands and are more likely to be economical than those that involve residential uses.

Most California systems are located in the Bay area and Southern California. Bischel et. al. (2010) reported on a survey of Northern California water reuse managers. They cited some 140,000 acre-feet per year used in Northern California in 2001, with 69% used for agricultural irrigation, 15% for landscape irrigation, 7% for wildlife enhancement or miscellaneous, 4% for industrial use, and some 2% for groundwater recharge. The most important drivers were wastewater discharge requirements and the need for water supply. Local and state policies and the availability of grant funds were also important. Other drivers included environmental issues, citizen pressures, seawater intrusion, availability of technologies and increased institutional controls.

In this survey, some 76 percent of the respondents reported that they were involved in both production and distribution. The total water production for 2001 was equivalent to 46,000 million gallons per year, or an average of 126 mgd. This Northern California recycled water production is about 0.5 percent of the total national public water use, as reported by the U.S. Geological Survey (2011) for 2005.

On an overall basis, wastewater drivers were more important in the past, but needs driven by supplemental water supplies are overtaking them as the most important drivers. Also, water reuse can be used to enhance environmental areas, and they cited examples such as wetlands restoration and improvements in water quality.

Hindrances to water reuse focused on capital and O&M costs, availability of grants and on cost allocation, perceived risks and social attitudes, complexities and regulatory difficulties. The most important hindrance was cost. Also, the emergence of trace contaminants was of concern.

USEPA GUIDELINES

The most extensive report on reclaimed water is "Guidelines for Water Reuse" (USEPA and US Agency for International Development, 2004). The guidelines were initiated in 1980, updated in 1992 and the 2004 edition was prepared by CDM, an environmental engineering firm. Thus, the evolution of the guidelines tracks the rise in wastewater production and water reuse applications. Their focus is on regulations and methods for use of reclaimed water. Examples of state regulations are given, and guidelines for planning are suggested.

The guidelines explain two types of reclaimed water systems: those with and without fire protection. For example, a non-potable system can be furnished for a purpose such as decorative fountains (even as in ancient Rome) or landscape irrigation, but not have fire protection water. If the fire protection role is assigned to the non-potable water system, the potable system can be smaller. These mixed types lead to multiple configurations, which are illustrated in Figure 2.2 from the USEPA guidelines. The figure shows three categories of customers receiving reclaimed water for urban, agricultural and special need uses. The agricultural customers can include a range of distribution system types and different types of farms and cropping patterns. The special needs customers illustrate the case of a single industrial user with a dedicated line. The urban customers illustrate the dual system and can include residential, commercial, industrial and public groups. The existence of a dual system for the urban customers then depends on the existence of a significant length of non-potable piping.

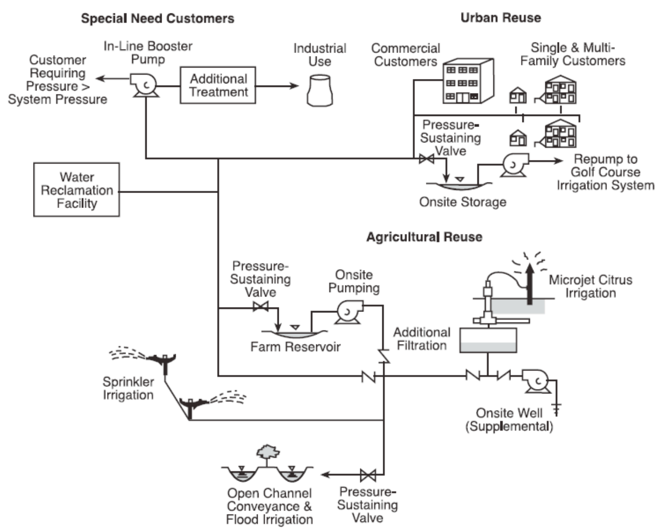


Figure 2.2: Schematic of a Multiple Reuse Distribution System (USEPA, 2004)

The parts of the guidelines that explain design and management issues of reclaimed water systems are of special interest in this study. These address storage, pumping and distribution. Storage to enable diurnal flow variation is required and covered storage is desirable due to biological growth and the need for chlorine residual. Seasonal storage is probably needed as well, but may be infeasible due to economics. Aquifer storage and recovery might be used, as in Hillsborough County, Florida.

The distribution system for reclaimed water is similar to the system for potable water distribution. Reliability is often somewhat less, except in the case of fire protection. Separate identification is essential to prevent cross contamination. Pressure requirements vary with type of user. Some guidelines recommend operating the non-potable system at lower pressures than the potable system to mitigate cross-connections but the experience indicates that this is difficult to sustain. On an urban system, high-pressure users might include some landscape irrigation, industrial processes and cooling water, car washes, fire protection, and toilet flushing in commercial and industrial buildings. Low-pressure users might include golf course and landscape irrigation or other recreational users, as well as industrial or cooling tower sites. Pressures range from minimums of 30 psi for some residential irrigation systems to minimums of 50 psi for larger scale irrigation, car washes, toilet flushing, construction, and some industrial uses. Using reclaimed water for fire protection may impose additional requirements for pipe size, pressure and storage.

Reclaimed water lines of ferrous materials present more opportunities for internal and external corrosion than potable water lines because reclaimed water is more mineralized with higher conductance and chloride content and lower pH and as the last pipe installed have more opportunity for stray currents or coating damage (Ryder, 1996). Because reclaimed water lines are often the last pipe installed, there is an increased opportunity for stray current electrolysis or coating damage.

The USEPA guidelines describe a number of cases. One that is of particular interest to this project is Rouse Hill near Sydney, Australia, which is sizing water lines to handle fire flows and allows potable pipe diameters to be reduced. If utilities replace existing potable water lines due to water quality problems, they could consider converting the network into a non-potable system for fire protection and a new and smaller network for potable uses. The report states that no community has attempted such a conversion so far.

COSTS AND RATE-SETTING

The goals of dual water systems to extend water supplies and provide options for wastewater disposal have important implications for infrastructure construction and maintenance, thus possibly increasing the burden on utility finance and workforces. The major cost drivers of water reclamation are the transmission and distribution systems. Funding can be difficult and the systems may require subsidies. Substantial capital expenditures are required, including wastewater treatment, transmission lines, distribution lines and additional operation, maintenance, and replacement costs. Also an enhanced cross-connection program may add to the O&M costs. Customers serviced for reused water may be different from the potable water customers, such as agricultural and golf courses. Even if customers are encouraged to use an unlimited supply at little to no charge, provisions are required for future conservation. Potential drop in potable revenues can be challenging, especially if water and wastewater are owned by different utilities.

Rate-setting for non-potable water must take into account factors of supply, the water uses, needs to incentivize users, demand management and the multiple benefits to wastewater management. With so many factors involved, it is to be expected that no standard approach would be available and that policy for non-potable water rates would be a work in progress in most utilities.

The literature contains few citations about rate-setting for reclaimed water systems. Neither AWWA's (2000, 2005) manual on rate-setting nor on water utility management addresses non-potable water, but the manual from the WateReuse Assocation (Manual of

Practice: How to Develop a Water Reuse Program) contains a section on setting up the charge schemes and on allocation of cost between reuse water services and wastewater treatment.

As an example of a rate issue, the City of San Diego Water Department (2009) retained Raftelis and Associates, a financial consulting firm, to do a rate study for recycled water. The purposes of the study were to review financial aspects of the recycled water operations and capital programs, calculate the true cost of producing and distributing recycled water, recommend a pricing structure to recovers all such costs, review rate structures to encourage demand for recycled water, determine allocation of revenue and expenses to potable water, wastewater and recycled water and the impacts on customers, and to develop a user-friendly pricing model for staff use.

The City was involved in negotiations with USEPA about coastal wastewater discharges and a 1995 court order required it to construct a recycled water system. The City currently has 66-miles of pipeline from 4- to 18-inches in diameter, a 9 MG reservoir and two pump stations. In addition to the court order, a construction grant required the City to reuse wastewater from the newly-constructed North City Water Reclamation Plant.

To increase use of recycled water, the City is expanding the distribution system and seeking new retail customers, and it assists in retrofitting customers to use recycled water. In addition to some 441retail customers, the City sells wholesale non-potable water to a few small cities and water districts. Since 2008 it has added the U.S. Border Patrol as a customer for construction use and irrigation and Caltrans for freeway landscaping irrigation.

Based on the rate study, the system is operating in a deficit condition. For FY 2008 total revenue requirements for operation and maintenance (excluding tertiary treatment costs), rate-funded capital costs and debt service were about $8.8 million. If past capital investments are amortized over 14 years and recovered from recycled water, the annual revenue requirements would increase to $16.4 million. Rate revenues and credits from other providers are about $5.8 million, making a net deficit of $10.6 million as of 2008.

Although most customers are retail users, the majority of the water use is by wholesale users. The study considered the sensitivity of rates to use and that future sales will be dependent on expansion of the distribution system, seasonal and weather conditions. In the near term, recycled water sales are projected to grow at a stable rate as the distribution systems are expanded by the City and wholesale agencies.

The City needs to make capital investments to expand its distribution system so it can reuse more wastewater. It receives revenues as incentives from the Metropolitan Water District of Southern California (MWD) and the San Diego County Water Authority (SDCWA) ($250 and $200 per acre foot) because those agencies would like to reduce total demand on their resources and to avoid costs of water management such as pumping water through transmission lines.

Some of the observations from the rate study are that current recycled water rate of $0.80 per hundred cubic feet (HCF) is lower than the October 1997 rate of $1.34 per HCF because the City needed to encourage use. Rates are very sensitive to the quantity of water sold and most costs are fixed, including debt service and most O&M costs, therefore spreading them over a larger usage base would lower rates. New capital costs will be funded on a pay-as-you-go basis from rates, debt, system development fees, and grants. Some wastewater cost savings result from producing recycled water at the new plant, primarily from reducing power and chemical costs. The Metropolitan Wastewater Department (MWWD) of San Diego benefits from these savings. By substituting recycled water for potable water, the City creates capacity for new potable users. This has two effects: the City gets an alternate and inexpensive water supply and potable system capacity becomes available to new users. Recycled water customers benefit from lower rates and from a more drought proof system.

The consultants recommended system development fees for recycled water connections at the same rate as potable water, or $3,047 per equivalent dwelling unit (EDU). They proposed that the Metropolitan Wastewater system be treated as a unitary system and wastewater users share in the costs of the recycled water system, which would also be considered a unitary system with all costs shared by retail and wholesale customers. All users would be charged the same commodity rate if they are in the wastewater service area, with outside rates subject to an incremental fee since they do not pay into the wastewater system. They recommended that the commodity rate for recycled water be linked to the potable irrigation rate. Evidence is that most California recycled water agencies charge from 75 to 90 percent of the potable water rate. Currently, the recycled water commodity rate is 26 percent of the January 2009 irrigation rate and they recommend it be set at 75 percent and phased in over three years. This would still be lower than a cost of service rate.

The San Diego rate study shows several aspects that must be considered in rate-setting for non-potable water:

- It takes new infrastructure to provide non-potable water and a system development charge is appropriate if the policy is growth-pays-its-own-way.
- The cost-of-service of non-potable water may be as high or higher as for potable water and its rates may be linked potable rates, but it is difficult to price it at 100 percent of the potable rate.
- Subsidies may be required to stimulate use of non-potable water.
- Considering the benefits of non-potable water to extending supplies and improving wastewater management, it is appropriate to allocate some of its cost to those objective categories.
- Agencies with responsibility for supply (as in this case the MWD, for example) and for wastewater (as in this case the MWWD) might provide funding to the non-potable system to support their objectives.
- As use of non-potable water increases, rate-setting may go through a long transitional phase and it might be well not to hurry too quickly toward full cost recovery.

For national investment needs, the U.S. EPA (2010c) Clean Watersheds Needs Study has Category X for Recycled Water Distribution. It explains that these are the "capital costs associated with the conveyance of the recycled water (wastewater reused after removal of waste contributed by humans) and any associated rehabilitation or replacement needs; it includes, for example, the costs of the pipes used to convey treated water from a wastewater facility to a ground water recharge location." Total 2008 needs were $4.4 billion of the national total of all wastewater-related needs of $298 billion. Some 20 states reported needs, and the total was down $0.7 billion (14 percent) from the previous survey. California ($1.7 billion) and Florida ($1.2 billion) reported some 66 percent of the total needs and Texas, Washington, North Carolina, Utah, and Hawaii had the largest increases. Florida and California both had decreased needs.

Increases in needs were attributed to increased recognition that recycled wastewater can help meet water quality standards, population growth, and saving money. The decreases were attributed to limitations of resources to enter needs, limited document availability, and difficulty with cross-program coordination with State drinking water programs.

Trends in states included Florida's 2005 law the Water Protection and Sustainability Trust Fund; North Carolina's focus on TMDLs, water shortages, local rate structures, and a state program for awarding priority points for reclaimed water projects in grant programs; and Texas's experience with water shortages, population growth, and the opportunities to use recycled wastewater to irrigate crops or golf courses or to sell to cities to supplement water supplies.

ASSET AND OPERATIONS MANAGEMENT

As the focus of this project is on dual distribution, it was necessary to review the knowledge base about water distribution, as well as water reuse. Advances in distribution systems were summarized in (Grigg, 2010), which explained how as a result of public interest in water quality and the companion issue of aging infrastructure, distribution system research has increased greatly in recent decades. The knowledge base has expanded in the categories of infrastructure management, materials and construction, modeling, data and information, and operations research, but most areas require more projects and synthesis of results to deliver new methods and equipment to utilities.

A few of the main conclusions are of interest in this project on dual systems. Today, the operation of distribution systems requires attention to detail and to real-time conditions. Given the interest in distribution system research, the topics requiring attention have diversified. Asset management is a good example of a technology that has been applied extensively but remains a work in progress with a research roadmap being followed currently by the Water Research Foundation.

Condition assessment of water mains has become an active category for distribution system research. Work is needed to develop and test new devices, as well as to learn how to interpret condition information in decision making. Closely following this research are the advances in risk assessment, which focus on main breaks and water quality upsets that cause health threats. Prioritization of renewal and other programs is required so utilities can use limited funds to achieve maximum results.

Research on distribution system materials has moved from cast iron as the dominant material to use of other metals, plastics, non-leaded brasses, and new linings. These require studies to evaluate their performance and behavior under different conditions. Other distribution system components also need study, such as service lines and joints, brasses in valves and meters, and stainless steel in treatment plants. Research into construction and maintenance methods is leading us to new ways to install and renew pipe and components and toward best practices for maintenance of distribution system assets.

Research into modeling, data, and information helps managers at all levels with decision support. Improved monitoring and modeling of distribution systems is needed to inform optimization studies. New AMR (automated meter reading) and AMI (advanced metering infrastructure) systems will help utilities greatly in understanding their systems. Management issues such as pressure management require intensive real time information through new methods and communication technologies.

Research into negative factors such as internal corrosion in water mains has increased understanding of distribution systems, but much more needs to be done. These insidious issues do not fly high on the radar screens of utilities, unless sudden problems occur. However, they are like plaque building up in arteries. They can lead to premature aging and even to sudden failures unless detected and treated. The research about distribution systems applies to the feasibility of dual systems, which will normally encounter even more severe operating conditions than potable systems.

Indicators are needed to assess the performance of dual water systems because decisions should be based on clear and credible information about system condition and operational effectiveness. Indicators are often adequate to measure technical subsystems such as traffic flows and direct variables such as population size, but they do not function well in providing comprehensive performance information, as in the case of dual water systems. Use of indicators is often not standardized and each management unit may invent its own system.

The information in indicators should be packed to increase its density but this can make them seem more abstract and ambiguous. When confronted with complex information, managers resort to reducing large amounts of information by selectively focusing their attention to interpret and intuit the information they receive (Sutcliffe and Weber, 2003).

While a wide range of ad hoc infrastructure indicators are available, we start with the general categories from a report by the National Research Council (1995) entitled "Measuring and Improving Infrastructure Performance." It adopts indicators for effectiveness, reliability, and cost but we believe that in the case of dual water systems a category for risk should be added.

Performance is the main concern of management, and is the indicator that integrates all others, in this case, it integrates effectiveness, cost, and reliability. Effectiveness is a more specific indicator, which is multi–dimensional and indicates how well a system fulfills its goals. Reliability integrates condition and security of the system and measures the dependability with which it fulfills its mission. Risk is a variable that measures degree of exposure to various threats and consequences. Cost includes both operational and capital cost and can be extended to include indirect costs.

- The indicators must serve decisions about dual water systems in four general categories (Grigg, 2005b):
- Capital decisions (such as to build or renew a component)
- Operating decisions (such as to operate the system)
- Regulatory decisions (such as setting a rule about systems)
- Financial decisions (such as capital programming and budgeting and rates)

INSTITUTIONAL ARRANGEMENTS

A WERF study (Mantovani et al. 2001) reviewed 65 non-potable water reuse projects and confirmed that in addition to operational performance, sound institutional arrangements, conservative cost and sales estimates, and good project communication are keys to success. Institutional obstacles, inadequate valuation of economic benefits, or a lack of public information can hurt projects. The environment in which dual water systems develop is controlled by these institutional arrangements. These explain the societal and political forces that lead to success or failure in implementation.

General lessons about good practices show the needs to: establish public health as the overriding concern, prevent cross-connections, mark all non-potable components of the system, have a proactive public information program, have a monitoring and surveillance program for the non-potable system, train staff members for reuse connections, establish construction and design standards, and ensure physical separation of lines and appurtenances.

Institutional issues identified in the past for potable water distribution systems included complexity, cost, and coordination of solutions. A number of technical issues affected water quality in the systems, including long transit and detention times and some dead ends, infrastructure condition and deterioration/corrosion, intrusions from cross-connections, backflows, and attacks, hydraulic and chemical factors: deposition of sediment, leaching of metals, and water quality outcomes. The gaps in institutional arrangements that inhibit solutions included fragmented authority, inadequate legal controls stemming from poor technical understanding, faulty incentive structures, management cultures and unclear roles and responsibilities made worse by difficulties in enabling the players to undertake their responsibilities.

These issues point to the fact that the overwhelming challenge in managing distribution systems is technical and involves the complexity, scale, cost and uncertainty of the vast underground network.

For dual water systems, institutional issues comprise those related to law, roles and responsibilities, incentives, and other management arrangements. Examples of issues that can be addressed include organizations, finance, staffing, authorities, regulatory structure, coordination, and public involvement.

Institutional analysis for dual water systems should address who has control, or the designated authorities and stakeholders (mainly organizations). Also, it should study the laws, regulations, decision requirements, and enforcement mechanisms. Incentives are very important, to include system ownership and operating incentives. Roles, responsibilities, and relationships between stakeholders are also important, as well as the management culture, including the management practices, customs and ways of doing business (informal institutions) (Grigg, 2005b).

For dual water systems, the following elements are needed and are addressed in the conclusions to the study.

- A conceptual model of how the management and control systems work
- Identification of the key issues and processes that need adjustment, and
- Identification of institutional practices that should lead to improvement

The distinction between the current situation and the ideal of a future dual water system was also explained in a WaterRF project about conventional and unconventional approaches to water service provision (Raucher et. al., 2004). In addition to reviewing current status of reclaimed water distribution, the researchers explained how dual systems might evolve in the future and how a set of institutional and regulatory considerations must be faced. These include: acceptance by the public, utilities and regulators; ownership and distribution rights; public education; and risk management of cross-connections and other code issues. They also explained the need for cost-effectiveness studies and to probe the infrastructure changes needed to implement dual systems. Finally, the team in this study wrote: "…the team struggled to obtain good comparative information with which to determine how much more it cost to develop dual systems … Additional empirical investigation is necessary of the costs and benefits of specific reuse applications and experiences".

A good guide to institutional barriers and obstacles can be derived from the presentations at AWWA's (2010) webcast on "Removing Barriers to Reclaimed Water Use," which was held on May 26, 2010. In a presentation by Karla Fowler of the LOTT Alliance in Washington, barrier one was identified as having reclaimed water policies. In their project, a task force identified over 40 policy issues to address with a series of interlocal agreements. The second barrier was from costs and funding. The third was crossing utility boundaries and the fourth was competing needs. These were followed by user requirements and by public perceptions.

More detailed issues were explained by Don Vandertulip, the water reuse discipline leader for the consulting firm CDM. He began with support from utility and city management, including the city council. The important things were to educate everyone and obtain internal consensus. This might include time for training and internal education, internal briefings, low profile information fairs, and including water reuse as an option in long-range planning and capital improvement programs.

If water and wastewater are not in the same department, then a question is who leads the reuse effort and should reclaimed water be a new department with new equipment? These questions might be answered by state certificated service areas and water rights and permits. The best solution might be merging skills from water and wastewater professional staff and to focus wastewater operator skills to provide the best outcomes.

New utilities will need many new policy and operational procedures and both internal and external policies that require board approval. Rates might even require state approval, but many internal policy decisions about staffing, customer service, user agreements and operations will be required. Given the importance of finance, the budget approval process and rate setting are very important. Capital funding is difficult but can be an opportunity to forge new innovative approaches.

Valuable information about institutional issues of reclaimed water systems was received from Bob Castle, Water Quality Manager at the Marin Municipal Water District and a member of the Project Advisory Committee. He alerted us to the cross connection control requirements required by states with active programs (CA, AZ, TX, and FL) for recycled and reclaimed water systems and reported that in California, local environmental health agencies add requirements to state regulations. Examples include San Diego County, Orange County, and Los Angeles County and he anticipates that there will be a tendency in areas such as these to regulate new dual systems in similar ways.

The added administrative burdens of serving residential customers arise for multiple reasons, including the efforts the water agency must invest in periodic inspections at each customer site. Castle’s definition of dual systems would focus on a system that parallels and supplements an existing potable water distribution system, and he thought that this definition would cover the two potable system version (one smaller and higher quality than the older larger and lower quality or bulk water system) and the raw, recycled, or reclaimed water systems typically built later. The definition should also cover emerging green designs with potable and non-potable distribution systems to optimize resources.

Castle thought that on-site dual distribution systems such as dual plumbed buildings should be excluded from the study because the WaterRF serves mainly public and private potable water agencies that are not responsible for private plumbing and on-site reclaimed water systems. Also, since fire protection systems typically use water infrequently, it is not normally practical to perform regulatory steps for cross connection control for a service that does not generate revenue. An exception is in Livermore, CA where the newer recycled water system has much better pressure than the potable system.

The California Legislature mandated a 2002 Recycled Water Task Force to investigate obstacles and impediments to recycled water. Castle's presentations to the Task Force illustrate problems created when regulators require agencies to oversee customers for their on-site dual systems. His concept is that recycled water should be sold as a utility commodity like potable water, natural gas, electricity, telephone, and cable TV and Internet where transfer of ownership and responsibility is at the property line and that any other practice is unsustainable economically.

Another issue was highlighted by the response of a health agency to a San Diego County recycled water main break. The break in Carlsbad discharged two million gallons of tertiary recycled water into a local creek and the ocean at Carlsbad State Beach. Carlsbad informed health regulators that the water was tertiary recycled water and that bacterial testing levels were better than required for drinking water systems. Despite this information, the health officials treated the event as a sewage spill and closed the beaches. Potable water systems also have spills and breaks, but are treated differently because they do not involve wastewater.

Another regulatory issue is about reports of cross connections. A list of comments from agencies about reports that water agencies believed incorrect or exaggerated was included in a White Paper entitled "Plumbing Code/Cross Connection Control Workgroup of the 2002 Recycled Water Task Force," dated November 15, 2002.

A major cross connection occurred in Australia and affected some 630 homes. Details are under investigation. The incident occurred in December 2009 at Pimpama Coomera, a development site in southeast Queensland. The master plan envisions sustainable water management through multiple water sources and improved management of stormwater and wastewater. New residential developments are required to have a rainwater tank and a dual distribution. The Master Plan anticipates that demand for potable water will be as little as 16 percent of normal.

Soon after recycled water was first supplied to households some residents complained about taste and odor from kitchen and bathroom taps. Investigations found that a cross-connection had allowed recycled water to mix with potable water in over 630 homes. The potable and recycled water services were restored about 11 hours after problem detection.

While the investigation report is not available, the scale makes it seem that the problem was at the mains pipe level. Some customers reported gastroenteritis symptoms but the medical authorities stated that health risks were minimal due to low microorganisms and high residual chlorine. An earlier incident was reported in 2008. The water supply to a building was contaminated with lower quality wastewater and water was used for drinking, laundry and showers. An investigation found 73 illnesses.

A household level cross-connection was reported later and Gold Coast Water inspector found seven residences with cross-connections. Five were at the meter, two within houses and one at a sub-meter. Sydney Water Corporation found 50 cross-connections among 12,000 houses inspected at Rouse Hill.

The writer opined that cross-connections with intrusion of recycled water into the potable supply present a complex problem for detection because of the changing pressure differential between systems and a variable pattern of mixing. He thought that methods to detect cross-connections between recycled and potable water systems is a high priority research area for the water industry (Brown, 2010).

CHAPTER 3: CLASSIFICATION OF DUAL WATER SYSTEMS

INTRODUCTION

Dual water distribution systems serve a variety of purposes and, although a definition of them helps to understand the general concept, a classification system is needed to compare and evaluate them. AWWA's (2009) definition can be used without specifying the source of the lesser-quality water (see Chapter 1): "Two separate water piping systems distributing water to customers, one carrying potable water and the other conveying lesser-quality water." This is only a suggestion and since reused wastewater is the major source of non-potable water, there seems little point in belaboring the definition.

On the basis of mileage, dual water systems comprise only a small percentage of all water distribution systems and no classification system for them has been developed by USEPA or other organizations. Water and wastewater classification systems that were developed for national needs studies conducted by USEPA are embedded in the Safe Drinking Water Information System (SDWIS), the Community Water Systems Survey (CWSS), and the Clean Watersheds Needs Survey (CWNS) (USEPA, 2010 a,b,c). For example, public water systems are either Community or Non-Community systems. Wastewater systems are collection, treatment or combined systems. Other classifiers and modifiers enable costs and risks to be assessed.

The CWSS and the SDWIS contain information about the potable water distribution systems and the CWNS has Category X about distribution of recycled water, which shows that reclaimed water distribution systems are generally classified under the wastewater category rather than the water supply category. The explanation Category X is (USEPA, 2010c): "This category includes the needs and costs associated with conveyance of treated wastewater that is being reused (recycled water), including associated rehabilitation/replacement needs. Examples are pipes to convey treated water from the wastewater facility to the drinking water distribution system or the drinking water treatment facility and equipment for application of effluent on publicly-owned land. The needs and costs associated with additional unit processes to increase the level of treatment to potable or less than potable but greater than that normally associated with surface discharge needs are reported in Category II."

Because the classification of non-potable water in the CWNS is aimed at its use to help with wastewater needs rather than for water supply, all needs are reported, whether they are part of dual systems or not. For example, the USEPA CWNS cites an example of treated wastewater being piped to a groundwater recharge project, which would not be part of a dual distribution system.

This division of water supply and wastewater classification systems means that any classifiers for dual potable and non-potable water distribution systems will have to be hybrids of water and wastewater, and it is not clear whether such a classification system is needed for management or policy purposes. To study this question, it may help to consult how USEPA (2010c) reports uses for the data in the CWNS: "This information is used by EPA to document national needs in a report to Congress. The report provides Congress, as well as state legislatures, with information to assist their budgeting efforts. The data are also used to: help measure environmental progress; contribute to academic research; provide information to the public; and help local and state governments implement water quality programs."

Given these uses for the CWNS data there would appear to be only a limited national need for a classification system for dual systems, and the system presented here primarily serves the present study and enables explanations of the development of dual systems. It is possible that the detail of the proposed classification system could help in future CWNS projects, but there is no apparent national regulatory driver because dual systems are regulated by state governments. The classification system may help local governments explain their systems. In addition, it might be of interest to researchers and policy analysts.

CLASSIFICATION SYSTEM

Reviewing the performance of the systems presented a challenge because no standard classification system had been developed and the systems studied varied widely in scale, type and stage of development. Therefore, a classification framework was developed to enable comparisons among similar dual systems and to avoid comparing dissimilar systems. Another issue in the performance assessment was the need to evaluate parameters relating to different goals, and to facilitate this a framework with criteria for multi-objective evaluation was developed. The classification system is based on data collected from the project's case studies and input from the workshops held in Tampa and Oakland. The issues embedded in the variables of the classification system include the extent of system duality (parallel potable and non-potable pipes or only isolated non-potable pipes serving few customers); differences in customer bases; differences relating to risk tolerance; and different system goals. These are represented by ownership and performance variables.

For example, an issue might involve a utility with a dedicated non-potable line from a wastewater treatment plant to one customer. This arrangement would not be a dual system but would be an isolated case of a single dedicated non-potable supply line. However, as systems develop, they might expand step-wise and eventually evolve into dual systems with potable and non-potable water distribution systems. So, the question of when a system becomes dual becomes important to set management policy for the utility. While no exact answer is available for this question, it is apparent that a system becomes dual when its mileage and management requirements become significant parts of overall utility efforts. The classification system was developed to enable utilities to detect that crossover point by comparing their statistics with other utilities.

The variables included begin with whether the reclaimed water system has residential customers, which is an important variable that determines differences in operations and maintenance requirements. This is shown on the case study data sheets as a yes or no question or by number of taps per mile. Another consideration was whether water providers recycle their own wastewater or get it from other providers. This is similar to the wholesaler arrangement that is common in potable water supply. Another question is who owns the non-potable distribution infrastructure. A utility may have an outsourcing arrangement whereby it relies on another entity to handle this task.

Given these variables, a category was included to measure if the potable and non-potable systems are completely owned and supplied by the utility. Another category is when either the potable or non-potable system relies on an external party for infrastructure and/or source water. Finally, the systems can be mixed in ownership and operations. Also, as wholesalers, a utility can be a supplier or a regional supplier.

Based on these categories, the proposed classification system shown in Table 3.1 was developed. The most straightforward category is A (All), where a utility owns all facilities and supplies, which is distinguished from category P (Partial) either the potable or non-potable system is dependent on another utility for infrastructure, source water, or both. In category L (Limited) systems, both the potable and non-potable systems are dependent to some degree on another utility.

Table 3.1
Service Categories

Category	Description
A (All)	The utility owns the infrastructure and water supply for both systems.
P (Partial)	The utility owns the infrastructure and water supply for one system but not entirely (or not at all) for the other system.
L (Limited)	The utility is partially or entirely dependent on others for its infrastructure or water supply for both systems.
S (Supplier)	The utility supplies potable and/or recycled water to other utilities.
D (Distributor)	The utility distributes potable and/or recycled water obtained from others.
R (Regional)	The entity is a cooperative that supplies recycled and/or potable water.

The S, D, and R (Supplier, Distributor, and Regional) categories capture the wholesaler-distributor relationship that is found in potable water systems. Some utilities obtain treated potable and/or recycled water from other utilities. USEPA calls such systems "consecutive," meaning that they obtain their supplies from others. This scheme also takes into account that some utilities have regional functions to serve other utilities (counties, water districts, MUDs). As examples, Yelm, Washington operates a dual water system with its own supplies of potable and non-potable water. In Pittsburg, CA the recycled system is owned and operated by another utility.

While the classification system is a starting point, it is not able to classify all utilities in single categories. Some would be placed in several categories (P, R, L, or D) because they partner with other utilities for one or both of the systems. For instance, Santa Rosa, CA is a managing partner for the sub-regional wastewater treatment plant which provides treatment, disposal, reclamation, industrial waste inspection and lab services to Santa Rosa, Rohnert Park, and other locations. Santa Rosa contributes about 73% of the sub-regional operating budget.

A weakness of the classification of utilities into service categories is that does not take into account the degree to which a utility is a P or an L. For instance, some utilities (such as Tampa) are a P because they obtain an emergency source of water from another utility on a seasonal basis whereas others such as Largo, Florida receive potable water supply from an external provider continuously.

Using the classification categories and the team's best judgment as to the predominant categories, the 38 case studies are distributed as shown in Table 3.2:

Table 3.2
Distribution of Service Categories

A (7)	Apopka, Cape Coral, Ocala, San Antonio, St. Petersburg, Winter Springs, Yelm
P (13)	Burbank, Cary, Chandler, Denver, Dunedin, Largo, Livermore, Oviedo, Pittsburg, Tampa, Santa Barbara, Eustis, Odessa
L (4)	Redwood City, Santa Rosa, St. Pete Beach
S (6)	Austin, EBMUD, LOTT Alliance, Raleigh, San Diego, Tucson
D (3)	IRWD, Orlando, Pinellas County Utilities
R (5)	El Paso, LVVWD, Gwinnett County GA, Marin MWD, Tallahassee

In addition to the service categories, utilities were assigned performance classes (A, B, C, and D), which are dependent on an infrastructure measure (percent reclaimed water main mileage to total water main mileage) and an operational performance measure (percent reclaimed water production relative to total water production). This normalizes the infrastructure and operational metrics.

The performance classes are listed in Table 3.3:

Table 3.3
Performance Class Descriptions

Class	Description
A (Developing)	Low percent RW mileage, high percent recycled water use.
B (Developed)	High percent RW mileage, high percent RW use.
C (Emerging)	Low percent RW mileage, low percent RW use.
D (infrastructure intensive)	High percent RW mileage, low percent RW use.

Table 3.4 shows the percentage reclaimed water main mileage to total water main mileage and percent reclaimed water production relative to total water production for 33 of the case studies. At the time of this report, the other utilities had not provided mileage and use information. The table also shows the class designation as defined by the class boundaries shown later in Figure 3.1.

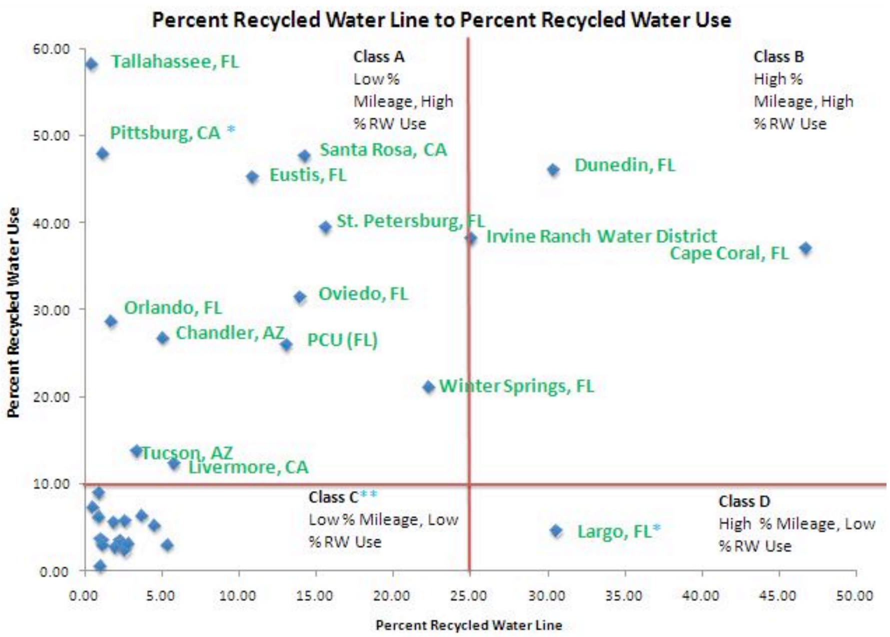
Table 3.4
Summary of the Percent Recycled Water Line and Percent Recycled Water Use of the Case Studies*

Entity	Percent Recycled Water Line	Percent Recycled Water Use	Class
Austin Water, TX	0.95	3.76	C
Burbank Water and Power, CA	0.94	9.02	C
Cape Coral, FL	46.67	37.09	B
Cary, NC	2.23	3.55	C
Chandler, AZ	5.07	26.84	A
Denver Water, CO	1.18	3.57	C
Dunedin, FL	30.36	46.14	B
East Bay MUD, CA	0.93	6.19	C
El Paso, TX	1.89	5.60	C
Eustis, FL	10.85	45.35	A
Gwinnett County Georgia, GA	1.00	0.57	C
Irvine Ranch Water District, CA	25.00	38.19	B
Largo, FL	30.56	4.70	D
Las Vegas Valley WD, NV	1.13	3.05	C
Livermore, CA	5.77	12.37	A
Marin MWD, CA	2.63	2.33	C
Odessa, TX	3.74	6.42	C
Orlando, FL	1.67	28.72	A
Oviedo, FL	13.98	31.42	A
Pinellas County Utilities, FL	13.03	26.00	A
Pittsburg, CA	1.17	48.11	A
Raleigh, NC	0.58	7.31	C
Redwood City, CA	5.38	3.13	C
San Antonio Water System, TX	2.60	5.82	C
San Diego, CA	2.23	3.23	C
Santa Barbara, CA	4.54	5.32	C
Santa Rosa, CA	14.25	47.77	A
St. Pete Beach, FL	1.96	2.79	C
St. Petersburg, FL	15.56	39.49	A
Tallahassee, FL	0.42	58.30	A
Tampa, FL	2.76	3.27	C
Tucson, AZ	3.30	13.86	A
Winter Springs, FL	22.26	21.21	A

* Other utilities did not provide all information needed to summarize performance

Figure 3.1 is a presentation of percent water use versus percent recycled water line. It illustrates capital intensity (Class D-infrastructure intensity, a high percentage of infrastructure but low percentage of water use) and operational efficiency (Class A-developing, the opposite case). The figure shows that the majority of case study systems would be classified as Class C or emerging dual systems.

The dividing points shown on the diagram are at the 10% recycled water use level and the 25% recycled water main boundary. These were selected visually based on the distribution of the 33 case study data points that are plotted, and they enable a division of the systems into the four performance classes. The majority of the systems utilize dual water systems in which less than 10% of the total water demand is met by reclaimed water and where less than 25% of the pipe mileage is for recycled water and with this system are called Class C, emerging.



* One system is dependent on a larger system and statistics are not broken down for the utility specified.
** See Figure 3.2 for this area.

Figure 3.1. Percent Recycled Water Line versus Percent Recycled Water Use

Figure 3.2 provides additional detail for the Class C utilities, which have reclaimed water systems with small mileages and reclaimed water production. It illustrates that even within this single category, most of the utilities have small amounts of recycled water line, compared to their overall distribution mileage, and there is a wide variation in water production.

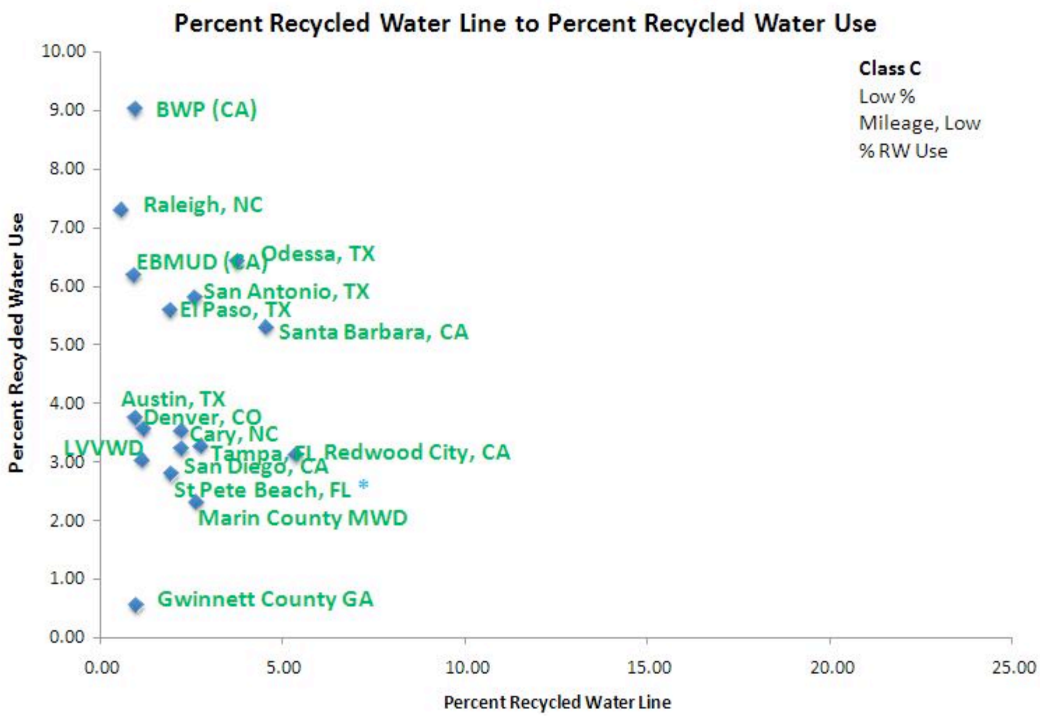


Figure 3.2. Percent Recycled Water Line versus Percent Recycled Water Use (Emerging systems, Class C)

The systems were further analyzed using different approaches to the classifications and the results show interesting details. For example, in St. Petersburg, the utility serves about 10,300 customers, of which about 10,200 are residences and possibly commercial properties. St. Petersburg is a Class A system and the reclaimed water system is comparable in size and scope to the potable water system.

The classification system enables the comparison of similar systems, but by the time the utilities are separated into categories, the sample sizes are only large enough to make anecdotal comparisons but not to present meaningful statistical data.

CHAPTER 4: PERFORMANCE ASSESSMENT AND DATA COLLECTION

INTRODUCTION

This chapter addresses the criteria for the main project goal of performance assessment. USEPA's (2007) research plan identifies performance as the main issue, and it is a function of outcomes in several categories. The categories mentioned in the plan are reliability, energy, water quality, efficiency, water conservation, performance, cost and applicability.

The classification system presented in Chapter 3 offers a starting point to create an evaluation method to assess the efficiency and performance of in-service dual systems. Because of the diversity of system types, the assessment method must be flexible to respond to the goals of each type of system. In general, the systems have purposes to extend water supplies and improve the quality of drinking water and these convert to evaluation criteria. Other evaluation criteria include safety, cost, and institutional arrangements including utility management.

Considering the general needs for performance assessment (see Chapter 2) and drawing from USEPA's (2007) explanation of the need for the project, a performance model with five categories was developed:

1. Water safety and public health protection
2. Effectiveness in meeting system goals including water conservation
3. Total cost (of potable and non-potable systems)
4. Risk and reliability
5. Implementation and operational results

It was apparent in developing these criteria and from the variation in system types and histories that definitive data for all systems across all categories would not be available. The project reviewers asked for quantitative data wherever possible, and the project team attempted to provide it where it was available and credible. The fact that no comprehensive study of the 335 dual systems in the United States exists prevents a valid statistical comparison, especially when the wide variation in their attributes is considered. By use of the case studies, the workshops, and the feedback from experienced managers inferences and conclusions about performance are presented.

In some cases it is possible to develop objective and even quantitative assessment measures, but in other cases qualitative and descriptive data are required. Even when numerical data is available, it cannot always be used directly for assessment. For example, the number of reported violations of standards would make a good indicator, but the reporting of violations is not standardized or quality-assured. Another statistic might relate to financial performance, but numerical data are difficult to obtain and interpret and can be misleading.

Given the challenge to make an assessment of a complex program, a multi-criteria performance model is required to span both objective and subjective measures. The following discussion explains the performance categories and the process of developing an overall assessment.

WATER SAFETY AND PUBLIC HEALTH PROTECTION

The focus of the USEPA (2007) research plan is on the safety of drinking water, so a category of indicators should measure risk of contamination and the compromise of security of water safety. Some measures that might be used are violations of standards, number of cross-connections, and implementation of programs for water safety and public involvement.

With regard to public health and safety, the classification system should incorporate both violations of regulations and empirical evidence from case studies. Although compliance with regulations does not always provide detailed evidence of performance level, it is an indicator of system control. In this category, no national standards for water quality delivered to customers with a comparable monitoring program are available. Instead, the ability to prevent cross connections is like a surrogate water safety measure.

Initially, public health and safety was to be measured based on the number of cross connections and illnesses due to reclaimed water. However, illnesses are rarely reported and difficult to correlate with reclaimed water use. Actually the literature review identified few reported cross connections, and in all cases examined, the water provider resolved the problem immediately. It was determined that utilities that fixed cross connections should not be ranked lower than those that never had cross connections to fix. In some cases, the presence of cross connections caused utilities to implement stricter public health and safety measures than those that never had cross connections.

Since the effects of reclaimed water systems with respect to public health are difficult to quantify, preventative measures such as public education provide at least some measure of safety. Utility engagement with the public can be measured by whether it provides general information to the public, if it has an active educational campaign, whether it offers workshops to participants and whether it requires training to be connected to non-potable water. The public's engagement can be measured by interest in conservation programs and reuse, compliance with ordinances and by participation in training workshops. Once again, a quantitative measure such as whether a utility has a program or does not seems too simplistic to be credible as a statistic.

EFFECTIVENESS IN MEETING SYSTEM GOALS

The goal implied by the idea of retrofitting and dividing the distribution system would be to deliver higher quality water at lower cost and at greater reliability. As the project developed, it became apparent that the main goal of dual water systems is not to divide an existing distribution system into two parts to improve water safety, but goals of extending water supplies and improving the management of wastewater were the main ones embraced by utilities. Therefore, this category was expanded to three parallel goals:

- Deliver higher quality potable water at lower cost and at greater reliability
- Extend water supplies and reduce impacts on source waters
- Improve management of wastewater

TOTAL COST (OF POTABLE AND NON-POTABLE SYSTEMS)

Cost is a challenging criterion to measure because operators use different approaches in accounting for operational and maintenance costs. Whereas a few utilities separate the reclaimed water system costs from the wastewater system costs, the majority account for only the total cost of the potable, reclaimed, and sewer systems. It would, of course, be possible to do cost studies to partition these costs, but this would require great effort and be equivalent to a rate study for each case study.

Although some data on cost of non-potable systems is available, it was apparent from the beginning that the data would not in general enable the partitioning of operating and capital costs into potable and non-potable categories. As utilities were interviewed and at the project workshops, it became clear that the main cost to be evaluated is total water and wastewater cost with and without the reclaimed water system.

Non-potable distribution systems face special cost challenges in maintenance and repair, just as in potable water systems. Some states consider a discharge of recycled water (regardless of quality) to be the same as raw sewage, which may draw enforcement penalties. Uncertainties such as these add to the list obstacles and impediments facing operators of non-potable water systems.

RISK AND RELIABILITY OF SUPPLY?

Risk and reliability issues include operational (short term) reliability and long term availability of supply, especially in the case of drought. Risk of health impacts is covered elsewhere but risk of main breaks, leaks and other issues should be approached separately. The assessment method should consider the risk of not using a dual system based on factors such as water use projections, water resources, and other quantifiable measures.

The most common risk issues encountered during the case study process were water storage for potable and non-potable water systems, diversity of water supply, and diversity of reclaimed water customers. Based on these observations, the selected measures for risk and reliability are availability of reserves and diversity of service. Whereas the diversity of service can be measured by the ratio of number of customers to total reclaimed water production, storage must be based on capacity relative to need.

IMPLEMENTATION AND OPERATIONAL RESULTS

Implementation and operational results form a broad performance category that measures the overall performance of dual systems in categories other than safety, effectiveness in meeting goals, costs and risk management. In interviews and case studies a number of issues that fall into this group were identified, such as these examples:

Strategic advantages in meeting goals such as reducing discharges or water withdrawals, extending the lives of potable water systems or wastewater treatment, reducing peak demands or improving fire protection

- Unexpected loss of revenue after implementing non-potable system
- Management difficulty and complying with more regulations and mandates
- Requiring more and different storage and adding to infrastructure burden
- Added risks, such as projected demands that do not materialize
- Public image effects

These different considerations fall into the general category of institutional issues, and some of them lap over into the other categories. They were handled through descriptive text rather than trying to assign objective criteria to them.

EVALUATION QUESTIONS

Given the multiple criteria, the initial approach was to convert the criteria into questions, which could be used to probe the experiences gained in each case study. Assessment of the performance was based on a combination of yes–and–no answers, on levels of achievement, and on descriptive information.

1. An initial version of the method was used to develop questions for the first round of case study data collection. The following questions were used in searches of documents and discussions with utility personnel:
2. Was protection of water safety and public health protection equal or better than with a single system?
3. Was the dual system effective in meeting system goals?
4. Was the cost of the dual system equal or lower than the separable cost of the non-potable water system in a combined system?
5. Did the dual system lead to beneficial water conservation?
6. Did the dual system lower overall risk and improve reliability of all water services?
7. On an overall basis, did the dual system represent an improvement over a single system on the basis of water safety and public health protection, effectiveness in meeting system goals, overall cost, use of water resources, and risk/reliability?

These evaluation questions were used on an initial set of cases, and by considering issues that emerged, the questions were modified to focus more on the use of reclaimed water systems for expanding supplies and managing wastewater. Based on the initial findings, the questions were made more detailed to focus on experiences with the expanding reclaimed water systems (Table 4.1):

Table 4.1
Evolution of Initial Questions Based on Findings

Initial Question	New Emphasis
Was water safety and public health protection equal or better than with a single system?	Expand on risk factors such as cross connections.
Was the dual system effective in meeting system goals?	Expand on different reasons for implementing reclaimed water systems.
Was the cost of the dual system equal or lower than the separable cost of the non-potable water system in a combined system?	Explain the concept to measure financial results of combined potable and non-potable systems.
Did the dual system lead to beneficial water conservation?	Expand concept to include broader focus on water efficiency to make existing water supplies to further.
Did the dual system lower overall risk and improve reliability of all water services?	Develop concepts to measure risk and reliability of combined potable and non-potable systems.

CHAPTER 5: RETROSPECTIVE ASSESSMENT OF PERFORMANCE OF DUAL WATER SYSTEMS

INTRODUCTION AND DATASET

This chapter explains the results of the retrospective assessment from the studies and using the method, criteria, and questions outlined in the last chapter. The performance assessment includes observations from the literature, from case studies and from the project workshops.

To develop a representative sample of case studies, an inventory of public systems was developed for the U.S., with a few listings from other countries. The WateReuse Foundation database was used as a starting point and each facility in the database was cross checked using online sources to verify that it was a dual water system (see Chapter 1). This revealed that many facilities were essentially stand-alone systems and were not really dual water systems because they had limited pipe lengths.

The WateReuse Foundation (2013) database indicated that water reuse was primarily practiced in Florida and California and additional utilities within those states were identified by the project team to supplement those in the database, which had been developed from voluntary reporting and does not include a number of dual systems.

A search was conducted for utilities in the remaining 48 states to produce a more complete inventory and representative samples of cases. As the project evolved, new systems were added to the inventory. See Appendix A and B for a summary of the project inventory which consists of 335 utilities in the United States and 87 utilities outside of the United States. It is not claimed that this inventory is exhaustive, particularly for international systems. However, as far as we know, it includes all major U.S. systems which distribute reclaimed water.

In selecting case study systems from the database a representative sample was sought from different states with unique features such as using reclaimed water for fire protection or toilet flushing. This yielded a dataset of 37 systems for more detailed case analysis (Figure 5.1). The selected cases are listed in Appendix C and the actual case studies are in Appendix D.

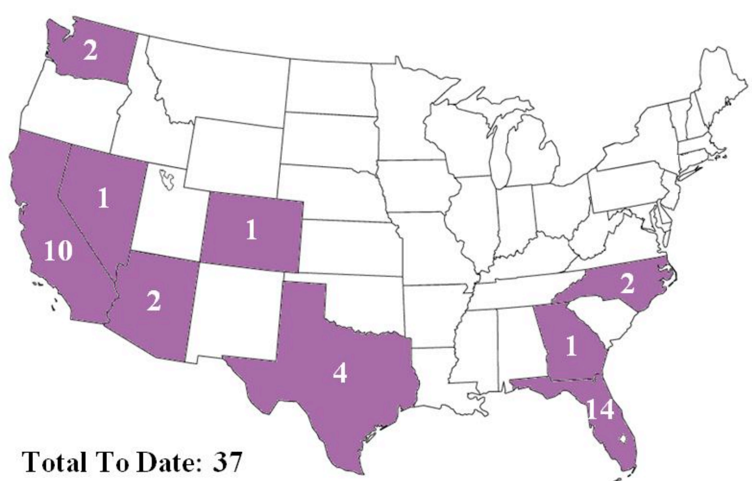


Figure 5.1. Locations of Case Studies in the United States

The 37 case studies were evaluated by assessing the performance categories explained in Chapter 4. The case analysis results were compared to indications from the literature review to verify findings and the suitability of the protocol's performance categories. The case studies were used to prove or disprove trends and conclusions compiled from the literature review and to provide new insights into the performance of dual systems in the assessment categories.

CONCLUSIONS FROM THE RESEARCH LITERATURE

How well dual water systems are performing has been explained to some extent in the research literature. In this section, parts of this literature are summarized to enable a summary of performance information. Most newer applications do not provide residential service or fire-fighting water, so the emphasis is on serving agricultural, industrial and cooling water customers, with applications also sought for uses such as toilet flushing and groundwater recharge. Special cases are also reported, such as the Hong Kong seawater system that has been in operation from the 1950s.

The USEPA (2004) Water Reuse Guidelines provide an extensive record of water reuse experience and lessons. They report few if any distribution systems that were retrofitted to add small potable lines, although some new systems have smaller potable lines. The guidelines explain design and management issues of reclaimed water systems such as storage, pumping and distribution. Problems such as the need for storage to enable diurnal flow and seasonal variation are explained. Separate identification of the non-potable system is essential to prevent cross contamination. Other design and operating rules, such as pressure requirements, vary with type of user.

The NRC (2006) report on distribution system risks provides a comprehensive picture of drinking water distribution risks. However, it includes only a brief section about dual distribution systems, which it considered not in its charge and advised that more research would be needed to learn how to transition from an existing conventional system to a non-conventional system.

The California Water Plan anticipates continuing large increases in use of reclaimed water, although the 2008 USEPA Clean Watershed Needs Survey showed a decrease in investment needs. Florida also had a decrease in needs reported, but all indications are that water reuse will continue to increase. However, it is unlikely that in the near term dual water systems will become a significant percentage of all systems, except in selected areas where they are applied to meet needs such as water scarcity and wastewater disposal problems.

Reported reliability of the non-potable systems is often somewhat less than for the potable system, except where fire protection is included, which is only the case in a minority of the applications.

Reclaimed water lines present more opportunities for internal and external corrosion than potable water lines. Maintenance requirements may be higher than potable water lines.

The major public health concerns with non-potable water are prevention of cross-connections and inadvertent use of it as potable water. No U.S. case was reported in the literature of actual disease outbreaks due to dual systems, although a few incidents of cross connections are known. Outbreaks may occur in other countries, and the case from Australia's Gold Coast is an example (see Chapter 2).

Studies of non-potable projects confirmed that operational performance, sound institutional arrangements, conservative cost and sales estimates, and good project communication are keys to success. Institutional obstacles, inadequate valuation of economic benefits, or a lack of public information can hurt projects.

Good practices include: establish public health as the overriding concern, prevent cross-connections, mark all non-potable components, have a proactive public information program, have a monitoring and surveillance program for the non-potable system, train staff members for reuse connections, establish construction and design standards, and ensure physical separation of lines and appurtenances.

The research literature about dual systems includes treatment technologies, emerging chemicals and pathogens, economics, rates and funding, and public involvement, among others.

The main reason for dual water systems is not to improve drinking water quality but to extend the reach of water supplies and improve options for wastewater management.

Total 2008 needs reported by USEPA for water reuse projects were $4.4 billion of the national total of $298 billion. Where needs increased it indicated recognition that recycled wastewater can help meet water quality standards, population growth, and save money.

Taking this discussion as an integrated whole, a summary of the literature about the assessment categories is shown by Table 5.1:

Table 5.1
Conclusions from the Literature Review

1. Water safety and public health protection	In the U.S., rules and control procedures seem to be working to protect public health. Concern has been expressed about the costs of regulation, but on the whole, few cross connections are occurring and no reports of outbreaks have been cited. In other countries, controls and experiences may indicate more concern.
2. Effectiveness in meeting system goals including water conservation	On a national basis, the numbers of dual systems are relatively few, but in special places such as coastal regions they are effective in extending water supplies and adding to wastewater options. They add to total portfolios of water management options and can be used along with conservation programs to greatly extend local water supplies. Few if any utilities are pursuing the goal of improving potable water quality by having smaller lines with higher levels of protection.
3.Total cost (of potable and non-potable systems)	Accounting for allocation of costs between the goals of dual systems is a work in progress. Dual systems add substantially to total system cost and finding ways to pay for them while encouraging use of reclaimed water will be a continuing challenge.
4.Risk and reliability	Risk of health problems due to dual systems seems relatively low when management controls are

	effective. Reliability of systems can be assured when storage is used, but seasonal demands create management issues. Financial problems due to dual systems may occur. By adding to portfolios of water supply dual systems may add to overall system reliability.
5. Implementation and operational results	A number of institutional issues must be confronted, ranging from public acceptance to cost and regulatory controls and barriers. All of these can be dealt with in cases where dual systems are most feasible, but they may deter system development in other cases.

WATER SAFETY AND PUBLIC HEALTH PROTECTION

Case analysis from this project confirmed observations from the literature that public health risks are low when systems are well managed and regulated. While no disease outbreaks have been reported in the case analysis, the cases do indicate a number of cross connections. Anecdotal and media reports suggest that some illnesses may occur in areas where regulatory controls are not stringent and some significant issues have occurred in Australia and perhaps in other countries.

Reports of cross connections are somewhat uneven, which is to be expected given the different ways they can occur and be measured. At the Tampa workshop the participants advised that reporting the number of cross connections may not be a good indicator of safety because it is sometimes difficult to judge and when one is reported, the utility will handle it and become more diligent. This topic requires more study.

When cross connections were reported, there were no reported illnesses among the cases. For example, in Cary, NC several residences were accidentally connected to the reclaimed water system during construction. In St. Petersburg (Riera, 2010) some 12 years ago a group of residents connected to the reclaimed water system for all water needs. In these and in all other cases reviewed, no illnesses were reported by residents who were unwittingly consuming reclaimed water. The utilities took follow-up action. For example, in St. Petersburg, the utility required the residents to disconnect from the reclaimed water system and substitute potable water for indoor residential use.

Public concern about water safety at the beginning of implementation was not uncommon. Opposition was generally due to concern about health risks from reclaimed water as a non-potable supply. For example, the public in St. Petersburg originally opposed reclaimed water out of a concern about the spread of viruses and damage to plants. Public outreach and education efforts have generally been successful at gaining public support for reclaimed systems. This experience underscores the fact that dual water systems require more attention to public education than potable systems alone.

While it would be desirable to summarize statistics of water safety from the cases in a statistical table, the data do not lend themselves to such a presentation. The summary is that cross connections do occur, they have so far been controlled, no reports of illness have occurred in the U.S., and utilities are implementing public education and involvement programs.

EFFECTIVENESS IN MEETING SYSTEM GOALS

The assessment of effectiveness is based on the three goals pursued by most dual water systems (see Chapter 4):

- Deliver higher quality potable water at lower cost and at greater reliability
- Extend water supplies and reduce impacts on source waters
- Improve management of wastewater

While the goal to deliver higher quality potable water at lower cost and at greater reliability is included, the cases showed that goals for augmenting water supplies and improving management of wastewater outweigh this goal. Also, water quality, cost and reliability are measured by other criteria, so this section focuses on water supply augmentation and wastewater management, with the conclusions about quality of potable water, cost, and reliability derived from results of the other criteria.

Extending Water Supplies

The case analysis showed that the primary reason that municipalities and water districts utilize a dual water system is to conserve potable water and extend their supplies. The case study reviews indicate that dual water systems do help delay expansions or upgrades to the potable water system and that benefits can outweigh the costs of a secondary water supply. The municipalities are concerned about an adequate water supply for future generations and are using reclaimed water to overcome limitations such as poor quality groundwater, the need to import water from other outside sources, and limits on surface or groundwater withdrawals.

On a general basis, reclaimed water is primarily used for irrigation purposes such as golf courses, lawn, and schoolyard watering. Other major uses include providing water for commercial cooling towers and industrial processes. Other uses for recycled water include car washes, concrete making, commercial laundries, and manufacturing. Relatively few systems utilize reclaimed water for fire protection or toilet flushing. These uses of reclaimed water do help free up potable water to meet the needs of residents.

It is not always possible to separate out the effects of reclaimed water and conservation programs. However, the effectiveness of reclaimed water systems is enhanced by conservation and water efficiency measures such as limiting landscape and lawn irrigation by residents and businesses, offering rebates for water efficient fixtures, and reducing the number of leaks in the water system. For example, Tampa's reclaimed system serves only a few thousand users and saves approximately 2 million gallons per day (mgd) while conservation efforts decreased potable water diversions about 15 mgd during droughts.

Oviedo has reduced potable water use by seven percent since conservation measures and the reclaimed water program were implemented. In San Diego, conservation measures accounted for 12 percent of the total water savings compared to the 3 percent due to reclaimed water use. Due to conservation efforts and recycled water use Burbank is on its way to meeting the state-mandated goal of 20 percent potable water consumption reduction by 2020 (a current reduction of 11 percent). Dunedin's recycled water and conservation measures led to a 30 percent decrease in potable water consumption since 1992.

Since El Paso installed their reclaimed water system and implemented an aggressive water conservation program in 1991, potable water pumping decreased from about 225 gallons per capita per day to about 135 gpcd. The Las Vegas Valley Water District reduced potable water demand from 347 gpcd in 1990 to about 250 gpcd in 2010, but was probably due more to conservation. Marin MWD reduced per capita potable water demand from 175 to 120 gallons per capita per day. Most decreases are probably due to conservation, but recycled water use plays some part.

In some cases, reclaimed water meets a significant portion of the total water demand. Reclaimed water meets about 26 percent of the total water demand in the Irvine Ranch Water District and 14 percent in the East Bay Municipal Utility District. Some utilities are not yet meeting their growth targets through recycled water and conservation measures. For example, East Bay MUD is obtaining increased water supplies to augment their water conservation measures and recycled water program.

Dual systems are useful for new developments, such as in Cary, North Carolina which is planning on reclaimed water for new developments. Some city ordinances and state regulations require the use of reclaimed water whenever possible, including for new development, such as Chandler. Oviedo serves several subdivisions via a dual water system to conserve potable water and prevent excessive groundwater pumping. Since Oviedo implemented its water conservation and reclaimed water programs, there has been about a seven percent decline in potable water consumption.

Denver Water supplies reclaimed water to some new developments, such as for the Stapleton and Lowry redevelopment projects. St. Petersburg supplies reclaimed water to several developments. Ocala, FL began a mandatory residential and commercial irrigation program to use reclaimed water for all new construction in 2007. Several utilities serve subdivisions with reclaimed water such as in Eustis, FL and the Marin Municipal Water District.

Water supply crises have proven to be incentives for installing and/or expanding reclaimed water systems. Burbank Water and Power has been affected by a seven year drought in the Colorado River Basin. A Federal Court limited pumping in the Sacramento-San Joaquin Delta and this stimulated utilities to expedite expansion of reclaimed water systems.

As the above discussion indicates, use of dual systems to distribute reclaimed water receives a positive evaluation for its effectiveness in extending water supplies.

Increasing Options for Wastewater Management

The use of dual systems to improve wastewater management was observed in a number of cases. Depending on the entity, wastewater treatment plants are upgraded to produce reclaimed water. Upgrading the wastewater treatment plant may enable the utility to avoid or delay upgrading the potable water treatment plant. The dual system accomplishes this by using the secondary water system to reduce the peak demand on the potable water system, by using it for irrigation purposes among other uses, such as in Cary.

Various forms of treatment technology are used in order to treat wastewater for reclaimed water production. Demineralization is used at a reclamation plant in San Diego to treat a third of the wastewater to higher standards, and the plant uses electro-dialysis reversal to reduce salinity of the reclaimed water. The process is also used in Burbank. Several utilities utilize reverse osmosis plants, such as in Dunedin. In Tampa to produce higher quality the technology must be upgraded because effluent is also discharged into the Tampa and Hillsborough Bays.

Based on the evidence that is available, it is clear that use of reclaimed water systems does increase the options and flexibility for management of wastewater.

RISK AND RELIABILITY

Water safety risk was included in the first category above. In addition, utilities are concerned about risk and reliability issues from operations and long term availability of water, especially in the case of drought.

In their operations, utilities might set lower reliability standards for their reclaimed water systems than for their potable water systems, which might prevent the systems from fire protection use. In fact, San Diego reported that it is an advantage of a reclaimed water system to not have to be as reliable as the potable water system since it is not used for fire protection.

Reclaimed water systems may not have to be looped because it has lower reliability standards. Due to the flexibility offered, the options of shut downs and interruptions were reported as advantages of the reclaimed water system in Santa Rosa, CA. Some reclaimed water systems have backup potable water supplies, such as in Denver which has a branched system without loops.

Reliability of potable systems must be higher than that of reclaimed water systems. Backup potable supplies may come from other utilities such as in Dunedin, where the potable system is hooked up to Pinellas County Utilities for emergency supplies. The East Bay MUD is hooked up to several entities for backup.

Whereas on a short term basis, reclaimed water might be interruptible, on a long term basis the service must be reliable because users depend on it. In some cases, the costs to a large user to retrofit for reclaimed water can be substantial. If the supply is not reliable, the users will not make the investments.

Secondary water systems may benefit utilities by enabling them to ensure more reliable potable supplies. San Diego obtains water from the San Diego County Water Authority, which obtains it from the sources of the Metropolitan Water District of Southern California (MWD) from the Colorado River and Northern California (Wood 2007). The sources of potable water may be less reliable in the future because of drought, increased competition and environmental regulations. Local supplies, including reclaimed water, can improve overall reliability by diversifying water portfolios. For example, Eustis has a small reclaimed water system which upon expansion would reduce potable water consumption and improve reliability. The small sizes of some recycled systems may reduce their reliability benefit. For example, in the Marin MWD the recycled water use contributes only 2 to 3 percent of total water demand.

Based on our interviews with water system managers, it was clear that drought and other water shortage drivers influence public opinion about reclaimed water use. In Tampa, residents opposed using reclaimed water until the media pointed out that it was necessary because of a drought.

The most common risk issues encountered during the case study process were water storage for potable and non-potable systems, diversity of water supply and diversity of reclaimed water customers. For example, a lack of reclaimed water storage is an issue for the LOTT Alliance project in Washington state in that there is reclaimed water available for reuse but the utilities do not have the necessary storage to utilize it. Similarly, the system in Yelm, WA formerly had reclaimed water storage issues before it installed an above ground storage tank.

Diversification of the water supply was an issue for several utilities with several relying on one source for their potable water supply. Gwinnett County Georgia obtains all of its potable water from Lake Lanier, for which water rights are in question as downstream users are contesting the County's water rights and threatening its ability to meet total water demand. Santa Barbara, CA has a similar problem in that its water rights to Lake Cachuma, the primary water source, are also being contested.

Other utilities have potable water supplies that are susceptible to drought, such as San Diego and Santa Barbara. The type of reclaimed water customers also affects the ability to effectively utilize reclaimed water. For instance, Odessa, TX recently had two industries stop using reclaimed water. As a result, the total reclaimed water demand has been cut in half. Reclaimed water still contributes a significant portion of the City's total water demand, but discontinuance of reclaimed water use may have more significant effects on other utilities.

TOTAL COST (OF POTABLE AND NON-POTABLE SYSTEMS)

The capital and operating costs of reclaimed water systems can be substantial and hard to finance from user charges alone. To assess financial impacts of reclaimed water it is necessary to consider water uses and issues comprehensively. A total view of cost will link reclaimed water to conservation in combined portfolios.

Rate-setting is a challenge due to the many issues involved and the lack of clear guidance. Some utilities are launching rate studies to evaluate their situations. The most common rate structure for potable water is an increasing block rate to encourage conservation. For example, potable water and recycled rates are tiered for users in Marin Municipal Water District to encourage potable water conservation. The most common rate system for reclaimed water is a specified percentage of the potable water rate. However, some reclaimed water rates have the increasing block structure and may have fines from over-use of reclaimed water, such as in Dunedin.

Some utilities encourage use of reclaimed water by a decreasing block rate structure, such as Dunedin during the winter when demand is down. Others have low reclaimed water rates to encourage consumption, such as in Ocala where reclaimed water rates are one-quarter those of potable water. Other utilities offer services to customers to encourage use of reclaimed water. Largo offers simplified processes for connecting to the reclaimed system, waiving fees, and free hook-up kits.

The case study reviews indicate that any cost savings in producing and distributing a secondary water supply such as reclaimed water could potentially be offset by additional maintenance and personnel costs. Cape Coral reports that the reclaimed system requires more maintenance due to cross connection control, reporting leaks and spills, and field quality testing. In addition, Cape Coral does not have sufficient personnel to enforce watering restrictions. The operation of a dual system instead of just a potable water system in Oviedo has proved more costly, but the city needed another source of water to meet demands without exceeding its cap on groundwater pumping.

Utilizing a secondary supply may offset the cost of producing and distributing potable water. East Bay MUD found that the cost of increasing the amount of imported water was too high and was unable to obtain a permit to construct another potable water reservoir so it increased the amount of recycled water to meet its water needs.

Several case study municipalities subsidize the reclaimed water system from the potable water system but consider conserving potable supply as more necessary than saving money. For example, St. Petersburg subsidizes the reclaimed system and conserves potable water.

Dual water systems can be cost effective for small communities that face difficulty in meeting drinking water standards and ensuring dependable supplies during drought, especially in areas with limited water. For example, Yelm has a population of approximately 6,000 and is located in a critical water area. The dual system saves more than 9 billion gallons of potable water per year by using reclaimed water primarily for irrigation.

Although water providers benefit from reducing potable water demand, in some cases conservation efforts have proven counterproductive. As a result of the Las Vegas Valley Water District's conservation program, water and reclaimed water sales fell and the downturn in the economy magnified the lack of funds. Burbank Water and Power's water sales in 2009 were reduced by 4.9% compared to 2008 because of water conservation efforts coupled with cooler temperatures. St. Pete Beach, FL discovered that the supply of reclaimed water is reduced by potable water conservation efforts.

Fortunately, not all entities lose money due to conservation and dual water systems. Orlando, FL earns a profit from their reclaimed system due to a large year around demand for irrigation water. In addition, the more reclaimed water the City uses, the more potable water the St. Johns Water Management District allows them to withdraw (Johnson, 2010).

Financial incentives are available for utilizing reclaimed water. Several communities have strict quantity and/or quality limits on their effluent discharges into waterways and reusing the water can help. For example, the Tampa Water Department wants to expand its reclaimed water system to offset discharges into Tampa and Hillsborough Bays (City of Tampa, 2009) Largo, FL concluded that although the reclaimed water system is not financially self-sufficient, it is necessary to avoid higher costs from quality and quantity effluent limits.

In the Florida workshop, the topic of subsidies from the Southwest Florida Water Management District drew lively discussion.

Some water providers have limits on potable water diversions from a particular source. For example, the City of Austin attempts to minimize withdrawals from the Colorado River due to potential fines for withdrawing an excess amount, so reclaimed water avoids this risk.

IMPLEMENTATION AND OPERATIONAL RESULTS

The experiences of the case utilities about implementation and operations span a number of important issues. Using a secondary water supply has a number of advantages. For instance, Cary reports extending the life of the potable water system, saving energy and money, delaying expansion of wastewater treatment facilities, and reducing peak demand on the potable system during the dry season. Reducing peak demand on potable water is also reported by Tucson, which also reported a delay in the need to acquiring additional potable supplies and expansions of the potable treatment and distribution systems. Burbank Water and Power indicated advantages in reducing potable water demand and supply costs, added drought protection, and avoiding environmental pressures and court decisions about potable water imports.

In most cases, fire protection is not supplied by the secondary water supply since the secondary water system is sometimes designed primarily for irrigation and does not have the degree of reliability that the potable system has. Tampa determined that supplying needed standby power for fire protection purposes was too costly. However, Tampa Water Department determined that using reclaimed water for toilet flushing was economically feasible.

Operation and maintenance issues occur from too much or too little demand for reclaimed water. For instance, Tampa has a much greater supply of reclaimed water than demand, which results in stagnation and biological growth in the reclaimed water lines. Cary has too much demand on the reclaimed water system, which can lead to shut downs. Yelm, WA dealt with a similar problem by increasing storage capacity to ensure adequate supply during peak demand without having to upgrade the reclaimed water plant. St. Petersburg also had to increase storage to provide reclaimed water to more customers. Cape Coral increased reclaimed water storage to avoid discharging into surface waters.

Demand for reclaimed water in some localities is greater than the supply. In Orlando reclaimed water conservation measures are implemented to keep from shutting down the system due to low system pressures. In some cases, winter storage is a challenge since irrigation demand is seasonal, but wastewater supply is constant.

Irvine Ranch Water District faces increased algae growth because of storage and Tampa reports that it is in the process of finding a solution to reduce the operation and maintenance issues associated with having excess water during periods of non-use. Water quality issues such as salinity must be considered. The Irvine Ranch Water District had salinity issues due to the fact that their water is primarily imported from the Colorado River, which eventually ends up in the reclaimed water supply. Winter Springs is planning on adding an additional plant that would produce a blend of reclaimed water and water from Lake Jesup in order to meet recycled water demand. The potable water quality was negatively impacted due to increased reclaimed water use in Redwood City, CA. But when the supply of potable water was insufficient to meet water needs, such as in Dunedin, the installment of the reclaimed water demand offset potable water demand sufficiently to meet potable water needs. Redwood City had a similar problem since it had exceeded their allotted withdrawals prior to the use of reclaimed water.

Rules and regulations regarding reclaimed water, whether state or local standards, inhibit the development of certain types of reclaimed water use. For instance the rules and regulations study revealed that the State of Arizona has five classifications for reclaimed water with corresponding levels of quality and permitted uses (AAC, 2008). In order to use reclaimed water for fire protection systems and toilet flushing the use of Class A reclaimed water, the most stringent classification, is the minimum requirement (AAC, 2008). For instance, many entities prefer not to provide reclaimed water use for indoor residential uses such as toilet flushing. Commercial uses such as indoor fire protection are unpopular uses due to stringent regulatory requirements. Livermore, CA currently uses reclaimed water for indoor fire sprinklers but rigid inspection and testing requirements from state health department gave the City a reason to quit using recycled water for indoor fire protection. As stated earlier in this proposal, Tampa determined that reuse for toilet flushing to be feasible.

Several utilities began using reclaimed water or expanding their existing reclaimed water system in order to meet state mandates. For instance, Eustis, FL began using reclaimed water in order to meet the "alternative water incentive" mandated by the local water management district. Winter Springs, FL began expanding their reclaimed water system due to the St. Johns River Water Management District's mandating a groundwater withdrawal reduction. Santa Rosa is under a zero discharge requirement which necessitated reuse. Some entities found it to be necessary to use reclaimed water for uncommon applications in order to meet certain requirements. Redwood City uses reclaimed water for urinal flushing, internal cooling, towers, and other applications to meet the Reclaimed Water Use Ordinance.

Several pitfalls identified in the literature review were verified by the case studies. For instance, the viability of a reclaimed water project might be adversely affected by projected demands that did not materialize. Tampa, Florida, is facing the reality that a few thousand of the residents that committed to hooking up to the reclaimed water system, prior to its construction, and did not hook up when it was completed.

CHAPTER 6: CONCLUSIONS

The purpose of the study was to support the goals of USEPA's plan for "Innovation and Research for Water Infrastructure for the 21st Century" by providing a retrospective assessment of the performance of dual water systems. The USEPA plan identified dual water systems as a potential strategy to improve water safety while addressing the gap between needed and current funding levels.

The project results showed that improving water safety and addressing the infrastructure investment gap are not the primary goals being pursued by agencies with dual water systems. Most non-potable systems are being implemented in the U.S. for the distribution of reclaimed water to pursue two other goals. One of these is to extend the reach of scarce water supplies, particularly in drier climates or in coastal areas, and the other is to offer more options for the management and disposal of wastewater. Viewed this way, dual systems increase the options in the portfolios of water resources management but are not being implemented primarily as strategies to improve water safety and manage infrastructure cost. For the future, the goal to extend the reach of scarce water supplies seems to be emerging as the primary reason to implement recycled water systems.

The USEPA plan sought information on the extent to which older distribution systems might be retrofitted by installing newer and small lines for potable water distribution and retaining the older and larger pipelines for distribution of bulk water. While only a few agencies are retrofitting old systems in this way, there is some activity in new developments and some retrofits of some older, developed areas (such as development of the former Stapleton Airport site in Denver). The USEPA (2004) guidelines for water reuse reached the same conclusion, and reported that the study did not identify any distribution systems that had been retrofitted to add small potable lines (although there were some new systems where the potable lines could be smaller (such as in Odessa, Texas and Rouse Hill near Sydney, Australia). While current activity to retrofit older areas is very limited, this could change in the future.

Dual water systems address multiple goals, primarily to extend water supplies and provide options for wastewater management. Given these multiple goals, their performance must be viewed from a comprehensive perspective. In the application of dual systems, the safety of drinking water is affected mainly by the potential for contamination from cross connections, and the cost of infrastructure is more likely to increase than decrease due to the need to have additional distribution pipes.

USEPA's Innovative Infrastructure Review Committee asked whether a fatal flaw was built into this research project because if water utilities do not have money to maintain one distribution system, why they have money to build and maintain two distribution systems? The question is insightful as to the distinction between building new, smaller diameter potable lines and the current actual situation of building new lines for reclaimed water. Its answer is that construction of small lines for potable water is not happening on any significant scale, but a number of utilities are constructing dual systems to distribute reclaimed water in response to other compelling needs.

INVENTORY AND CLASSIFICATION SYSTEM

No inventory exists for the total mileage of non-potable water pipes in the U.S., but it is clearly a very small percentage of the some two million miles of potable piping (USEPA, 2010b). The inventory in Appendix A of the report shows some 335 systems in the U.S. at various stages of development, with mileage of non-potable piping ranging from very few miles up to the mileages in large districts, such as the Irvine Ranch Water District, which has some 300 miles of pipeline and Cape Coral, with about 600 miles of pipeline. The pipeline mileages in the inventory are inexact, but the average value among the case studies is about 80 miles of pipeline. This would be higher than the average among all systems as the project included the largest systems among its case studies.

According to a report completed by the WateReuse Foundation (2007), there are at least 7,335 miles of reclaimed water line in the United States. However, not all of these reclaimed water lines are part of dual water systems as defined here. The statistic provided by the WateReuse Foundation is based on voluntary reporting and does not include all reclaimed water systems. Based on the project's count of systems and the research team's estimate of the average mileage of reclaimed water pipelines, it seems likely that the actual mileage in the U.S. is between 10,000 and 20,000 miles of pipe, or from 0.5 to 1.0 percent of the total U.S. mileage of water supply pipe. Most of the pipe would be in Florida or California, making their mileage percentages higher. The numbers are imprecise but provide an idea of the order of magnitude of this segment of the water utility industry.

A survey of recycled water production in Northern California showed production in 2001 that amounted to about 0.5 percent of national public system water use (Bischel et. al. 2010). Therefore, on the basis of pipeline mileage and water production, recycled water systems remain a very small part of the overall national water supply picture.

The condition of the infrastructure of dual water systems does not seem to be a major concern at this time. Compared to potable water systems, the pipelines are relatively new, but aging of them may occur quicker due to the water quality and other factors. There has been little research about on corrosion and scaling or other threats to them.

The study developed a classification system to enable comparisons among systems. The classification system has categories (see Chapter 3) of system ownership and management and for extent of infrastructure and water production. This enables effectiveness in using resources to be measured with an infrastructure indicator (percent recycled water line mileage to the total system mileage) and water use to be measured with a water production indicator (percent recycled water use compared to the total water use).

The system also enables systems to be classified as to whether they are in development (low infrastructure or produced reclaimed water compared to the potable system) or mature (high infrastructure and water production ratios). The effectiveness of dual water systems is improved by tandem use with water conservation measures such as low flow toilets and landscape irrigation automation. Water reclamation effectiveness is also enhanced by association with other strategies in a water portfolio, such as desalination, aquifer storage and recovery (ASR) and source diversification.

OBJECTIVES OF SYSTEMS

Figure 6.1 shows a comparison of conventional and dual systems. At the top, the single conventional system is linear and draws from a source to provide potable water, which is used for all uses and becomes wastewater, which is disposed to the environment. At the bottom, the dual system offers additional possibilities. It offers the possibility to cut the volume of wastewater that must be discharged to the environment. It also offers the possibility to reduce the volume of water needed from the source. It is possible that the potable water infrastructure could then be downsized, depending on the situation. These new possibilities are gained at the cost of complexity and additional capital and operational expenses.

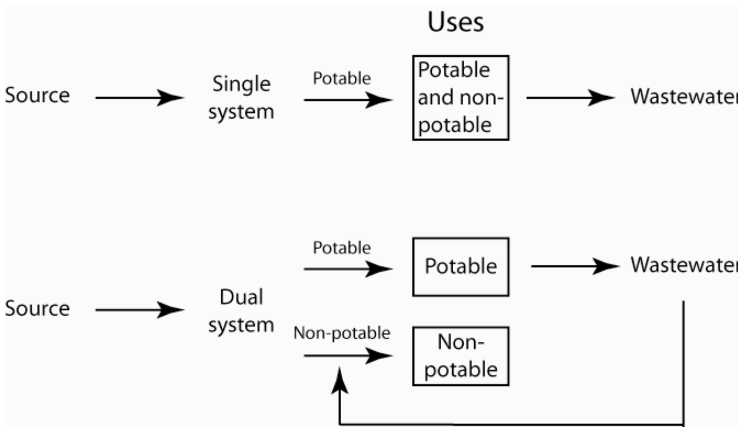


Figure 6.1. Conventional and Dual systems

PERFORMANCE OF DUAL WATER SYSTEMS

As outlined in Chapter 4, the performance of the dual water systems was assessed in five categories: water safety, overall effectiveness, total cost, risk and reliability, and implementation results.

Water safety

In the first of these, the study concluded that the implementation of dual systems to improve drinking water safety is not being pursued as a direct strategy to any significant degree in the U.S. This strategy can be characterized as an idealized way to organize water distribution by reducing the size of the potable line, but it has not been shown to be feasible on a widespread basis due to financial and institutional constraints, including incentives to utilities, regulators and customers.

Water safety due to dual systems is primarily a concern due to cross connections, either those in public systems or in premise plumbing systems, which were not assessed in this study. Neither the study of the literature nor the evaluation of case studies showed major public health problems in the U.S. from the distribution of reclaimed water. This does not mean that reclaimed water systems are free of water safety risks, but it suggests that well-managed systems can avoid public health problems. Issues have been reported in other countries and weaknesses in the system to report waterborne disease outbreaks in the U.S. suggest that continued vigilance about water safety is needed when dual distribution is used.

Overall effectiveness

Three criteria were identified for overall effectiveness: to deliver higher quality potable water at lower cost and at greater reliability; to extend water supplies and reduce impacts on source waters; and to improve management of wastewater. An original project goal to consider water conservation was subsumed under this category as well.

The first of these goals, to deliver higher quality potable water at lower cost and at greater reliability, does not seem as relevant as the goals to extend water supplies and add options for wastewater management. It can be argued that by extending supplies and developing reclaimed water systems you are improving reliability by adding flexibility, but this does not seem like a very strong argument. On the other hand, it is clear that dual water systems extend water supplies and help with water conservation programs by becoming part of total portfolios of water management. Dual water systems also offer new options to improve wastewater management and reduce the need for and cost of wastewater treatment and disposal.

Reliability

In addition to water safety risk, utilities are concerned about reliability issues from the standpoints of operations and long term availability of water, especially in the case of drought. Reliability issues that were discussed in Chapter 5 include: possible lower reliability standards for reclaimed water systems than for potable water, thus preventing use for fire protection; different configurations for pipe systems, such as no requirement for looping; having options available for interruptible supplies; need to provide reliable service for reclaimed water to avoid losing customers; and adding to water reserves, thus increasing the reliability of potable supplies. Water storage for non-potable supplies is a reliability issue because non-potable water systems normally require seasonal storage. Although the supplies are more interruptible than potable water, utilities do not want reliability to be low because customers rely on it.

Finance

A fair assessment of the cost of dual water systems would be the total cost of water service with and without them. Such an assessment could factor in the avoided costs across all sectors, including wastewater management. However, the project did not find that utilities had prepared such rigorous accounts for their dual systems for reclaimed water. It is clear that reclaimed water systems do add capital and operating costs. Rate-setting is difficult and a work in progress. Some utilities must ration reclaimed water while others must work to encourage its use. Cost accounting and rate-setting systems for reclaimed water distribution need additional development.

Implementation results

Assessment of implementation results focuses on institutional outcomes such as strategic advantages in meeting goals, public image and confidence, and unexpected positive or negative outcomes from dual water systems. The institutional outcomes might occur in governance, management and control systems, business processes, or impact on customers, for example. Rules and regulations vary widely with regards to water quality standards and classifications, treatment type requirements, distribution system requirements, mandatory reclaimed water use requirements, governmental responsibilities, and statewide reclaimed water use goals, among other differences. Positive institutional outcomes shown by the study include extending lives of potable water systems, delaying expansion of wastewater treatment facilities, reducing peak demands on potable water systems during dry seasons, and avoiding environmental pressures and court decisions about water imports. Another observation was that state-local cooperation in providing incentives for reclaimed water helps with regional management of water. Negative outcomes focus on rules and regulations that inhibit the development of some types of reclaimed water systems, risks in anticipating demands that do not materialize, and not being able to use non-potable supplies for fire protection water.

FUTURE OF DUAL WATER SYSTEMS

To conclude, the focus of this study was on the distribution system for non-potable water, rather than on the general issues of water reuse. The two subjects have distinct but overlapping sets of issues that involve not only public health and safety but also infrastructure management, operations and maintenance, and economics and finance.

The evolving debate over water reuse is part of the larger debates about the future of water management in general, including the objective to keep drinking water safe, affordable and reliable. Water reuse projects are concerned with water safety and infrastructure management, but they also provide new options for water supply and wastewater management. Given their diffuse objectives, the assessment of dual water systems must consider effectiveness across several categories of total water management goals. The objectives of extending water supplies and increasing wastewater options also enhance the protection of natural waters. The achievement of these objectives must be considered along with whether dual water systems are safe and whether they recover their costs.

Water reuse is increasing and interest in other non-potable sources, such as raw irrigation water, may increase in the future. Evidence for the increase in water reuse comes from the water reuse guidelines (USEPA and USAID, 2004), the 2008 CWNS (USEPA, 2010c), and data from this project and its workshops. Given that the primary applications of non-potable water are to irrigation, industrial and energy uses, the increases are primarily occurring in states with growing population and with significant irrigation, especially in coastal areas where salt water intrusion, surface and groundwater withdrawal limits and discharge restrictions are common.

As the U.S. grows from its present population of some 310 million toward a projected population of over 425 million by the year 2050, existing and new water systems must be managed with water efficiency and sustainability in mind. Dual systems for distribution of non-potable water can be applied anywhere but will not be needed for all situations. They will also face regulatory constraints that provide checks and balances to offset the advocacy of increasing recycled water distribution. Uniform state regulations may help to promote better total water management and lead to improved reclaimed water systems as part of overall portfolios of water supply.

Given their small presence and constraints on their growth, it is unlikely that dual water systems will become a significant percentage of all distribution systems in the near future, although they are common in Florida and California. However, there has been enough success with them to indicate that they can have an important future within overall urban water systems. In addition to increasing use of water reclamation such as locating water-using industries and energy plants near wastewater treatment plants, future dual systems might also be part of emerging unconventional water and wastewater systems that include alternative forms, such as zonal and point-of-entry systems. While these possibilities exist, in the many situations with adequate source water and few issues with wastewater disposal, there would seem to be little reason to take on the added complexity and cost of dual water systems. Comprehensive policies are needed to enable dual water systems to continue to help with wastewater management and add options to utility portfolios for total water management.

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ABBREVIATIONS

AGWR - Australian Guidelines for Water Recycling
ASR - Aquifer storage and recovery
AWWA - American Water Works Association

CCP - Critical Control Point
CDC - U.S. Centers for Disease Control and Prevention
CWNS - Clean Watersheds Needs Survey
CWSS - Community Water Systems Survey

EDU - Equivalent dwelling unit

gpcd - Gallons per capita per day

HCF - hundred cubic feet
HIDRA - Hazard identification and risk assessment

IIRC - Innovative Infrastructure Review Committee
IRWD - Irvine Ranch Water District
ISO - International Standards Organization

JAWWA - Journal American Water Works Association

LVVWD - Las Vegas Valley Water District

MCM - Million cubic meters
MG - Million gallons
MUD - Municipal utility district
MWD - Metropolitan Water District of Southern California
MWWD - Metropolitan Wastewater Department

NPDES - National Pollutant Discharge Elimination System
NRC - National Research Council

O&M - Operations and maintenance
OCP - Operational Control Point

POE - Point-of-entry
POU - Point-of use

QAPP - Quality Assurance Project Plan

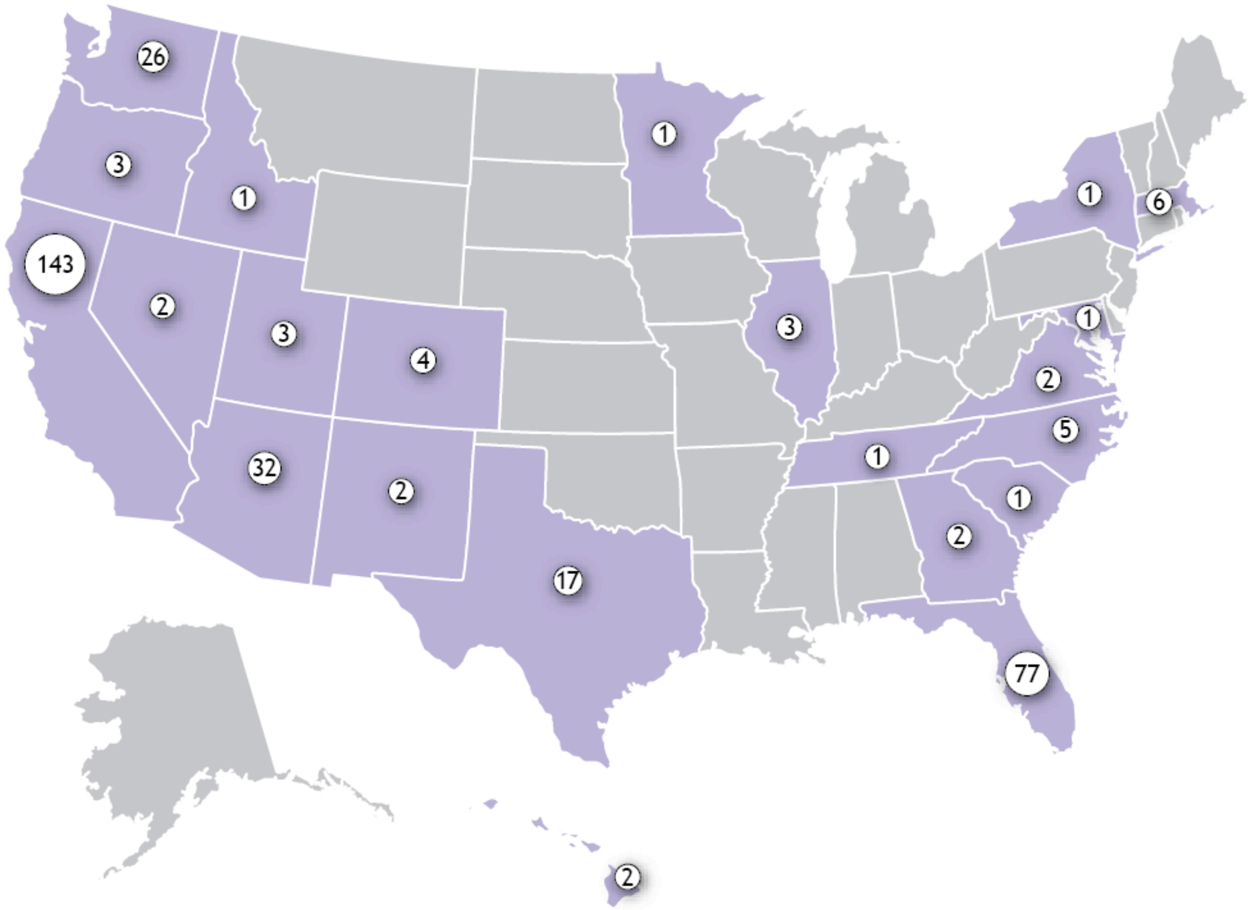
SDCWA - San Diego County Water Authority
SDWA - Safe Drinking Water Act

SDWIS - Safe Drinking Water Information System
TMDL - Total maximum daily load

USEPA - U.S. Environmental Protection Agency

WaterRF - Water Research Foundation
WERF - Water Environment Research Foundation
WNID - Water not intended for drinking
WQMP - Water Quality Management Plan (Australia)

APPENDIX A: CATALOG OF DUAL SYSTEMS WITHIN THE UNITED STATES



Entity	City	State
Anthem	Anthem	Arizona
Buckeye	Buckeye	Arizona
Bullhead City	Bullhead City	Arizona
Casa Grande	Casa Grande	Arizona
Cave Creek	Cave Creek	Arizona
Chandler	Chandler	Arizona
Eloy	Eloy	Arizona
Coconino County	Flagstaff	Arizona
Flagstaff	Flagstaff	Arizona
Fountain Hills Sanitary District	Fountain Hills	Arizona
Gilbert	Gilbert	Arizona
Glendale	Glendale	Arizona
Goodyear	Goodyear	Arizona
Grand Canyon Village	Grand Canyon Village	Arizona
Kingman	Kingman	Arizona

Mesa	Mesa	Arizona
Northern Gila County Sanitary District	Payson	Arizona
Oro Valley	Oro Valley	Arizona
Palm Valley	Palm Valley	Arizona
Payson	Payson	Arizona
Peoria	Peoria	Arizona
Phoenix	Phoenix	Arizona
Prescott	Prescott	Arizona
Queen Creek	Queen Creek	Arizona
Rio Verde Utilities	Rio Verde	Arizona
Scottsdale	Scottsdale	Arizona
Scottsdale	Scottsdale	Arizona
Surprise	Surprise	Arizona
Tempe	Tempe	Arizona
Tolleson	Tolleson	Arizona
Tucson Water	Tucson	Arizona
Verrado	Verrado	Arizona
American Canyon	American Canyon	California
Angel's Camp	Angel's Camp	California
Angwin	Angwin	California
Antioch	Antioch	California
Atascadero	Atascadero	California
Bakersfield	Bakersfield	California
Bodega Bay	Bodega Bay	California
Burbank Water and Power	Burbank	California
Las Virgenes Water District	Calabasas	California
California City	California City	California
Calistoga	Calistoga	California
Camarillo	Camarillo	California
Carmel	Carmel	California
Carlsbad Municipal Water District	Carlsbad	California
West Basin Water District	Carson	California
Castroville	Castroville	California
Inland Empire Utilities Agency	Chino	California
Chowchilla	Chowchilla	California
Coalinga	Coalinga	California
Concord	Concord	California
Corcoran	Corcoran	California
Corona	Corona	California
Marin Municipal Water District	Corte Madera/Rafael	California
Crescent City	Crescent City	California
Crestline	Crestline	California
Daly City	Daly City	California
Delano	Delano	California
Park Water Company	Downey	California
Dublin	Dublin	California
Dublin San Ramon Services District	Dublin	California
El Dorado Hills	El Dorado Hills	California

El Segundo	El Segundo	California
West Basin Water Recycling Program	El Segundo	California
Olivenhaim Municipal Water District	Encinitas	California
Escondido	Escondido	California
Fairfield	Fairfield	California
Ferndale	Ferndale	California
Fort Bragg	Fort Bragg	California
Fresno	Fresno	California
Galt	Galt	California
Gilroy	Gilroy	California
Glendale	Glendale	California
Goleta	Goleta	California
Grass Valley	Grass Valley	California
Guadalupe	Guadalupe	California
Gualala	Gualala	California
Hayward	Hayward	California
Inglewood	Inglewood	California
Irvine Ranch Water District	Irvine	California
Jamestown	Jamestown	California
Laguna Beach	Laguna Beach	California
Lakeport	Lakeport	California
Lancaster	Lancaster	California
Lemoore	Lemoore	California
Livermore	Livermore	California
Lodi	Lodi	California
Lompoc	Lompoc	California
Long Beach	Long Beach	California
Los Angeles	Los Angeles	California
Los Angeles County	Los Angeles	California
Metropolitan Water District	Los Angeles	California
Madera	Madera	California
Manteca	Manteca	California
Marin County Water District	Corte Madera	California
Martinez	Martinez	California
Marysville	Marysville	California
McKinleyville	McKinleyville	California
Mill Valley	Mill Valley	California
Milpitas	Milpitas	California
Montague	Montague	California
Monterey	Monterey	California
Monterey County Water Recycling Project	Monterey	California
Monterey Regional Water Pollution Control Agency	Monterey	California
Morgan Hill	Morgan Hill	California
Newport Beach	Newport Beach	California
North Bay Water Reuse Authority	Novato	California
Napa	Napa	California
Novato	Novato	California
East Bay Municipal Utility District	Oakland	California

Ojai	Ojai	California
Palo Alto	Palo Alto	California
Palmdale	Palmdale	California
Palm Desert	Palm Desert	California
Palm Springs	Palm Springs	California
Pebble Beach Community Services District	Pebble Beach	California
Petaluma	Petaluma	California
Pittsburg	Pittsburg	California
Pleasanton	Pleasanton	California
Pleasant Hill	Pleasant Hill	California
Pomona	Pomona	California
Porterville	Porterville	California
Rancho Murieta	Rancho Murieta	California
Red Bluff	Red Bluff	California
Redding	Redding	California
Redwood City	Redwood City	California
Richmond	Richmond	California
Ridgecrest	Ridgecrest	California
Riverside	Riverside	California
Rohnert Park	Rohnert Park	California
Roseville	Roseville	California
San Bernardino	San Bernardino	California
San Clemente	San Clemente	California
San Diego	San Diego	California
San Francisco Public Utilities Commission	San Francisco	California
San Jose	San Jose	California
Santa Clara County	San Jose	California
San Leandro	San Leandro	California
San Lorenzo	San Lorenzo	California
San Luis Obispo	San Luis Obispo	California
Vallecitos Water District	San Marcos	California
San Mateo	San Mateo	California
San Ramon	San Ramon	California
San Raphael	San Raphael	California
Santa Barbara	Santa Barbara	California
Santa Clara	Santa Clara	California
Santa Cruz	Santa Cruz	California
Castaic Lake Water Agency	Santa Clarita	California
Santa Maria	Santa Maria	California
Santa Rosa	Santa Rosa	California
Padre Dam Municipal Water District	Santee	California
Scotts Valley	Scotts Valley	California
Smith River	Smith River	California
Solvang	Solvang	California
Sonoma	Sonoma	California
South Lake Tahoe	South Lake Tahoe	California
St. Helena	St. Helena	California
Sunnyvale	Sunnyvale	California

Terra Linda	Terra Linda	California
Thousand Oaks	Thousand Oaks	California
Tiburon	Tiburon	California
Twentynine Palms	Twentynine Palms	California
Tulare	Tulare	California
Union City	Union City	California
Upland	Upland	California
Ventura	Ventura	California
Walnut Valley Water District	Walnut	California
Watsonville	Watsonville	California
Weed	Weed	California
Westport	Westport	California
Willits	Willits	California
Windsor	Windsor	California
Yountville	Yountville	California
Yucaipa Valley water district	Yucaipa	California
Colorado Springs	Colorado Springs	Colorado
Denver Water	Denver	Colorado
Centennial Water and Sanitation District	Highlands Ranch	Colorado
Westminster	Westminster	Colorado
Project APRICOT	Altamonte Springs	Florida
Sanlando Water Utility Corporation	Altamonte Springs	Florida
Apopka	Apopka	Florida
Bradenton	Bradenton	Florida
Manatee County Florida	Bradenton	Florida
Southwest Florida Water Management District	Brooksville	Florida
Cape Coral	Cape Coral	Florida
Casselberry	Casselberry	Florida
Clearwater	Clearwater	Florida
Clermont	Clermont	Florida
Cocoa	Cocoa	Florida
Cocoa Beach	Cocoa Beach	Florida
Daytona Beach	Daytona Beach	Florida
Volusia County Utilities	DeLand	Florida
Dunedin	Pinellas	Florida
Edgewater	Edgewater	Florida
Eustis	Eustis	Florida
Fiesta Village	Fiesta Village	Florida
Fort Myers	Fort Myers	Florida
Lee County Utilities	Fort Myers	Florida
St. Lucie County Utilities	Ft. Pierce	Florida
Gainesville	Gainesville	Florida
Green Cove Springs	Green Cove Springs	Florida
Holly Hill	Holly Hill	Florida
Hollywood	Hollywood	Florida
Largo	Largo	Florida
Leesburg	Leesburg	Florida
Longboat Key	Longboat Key	Florida

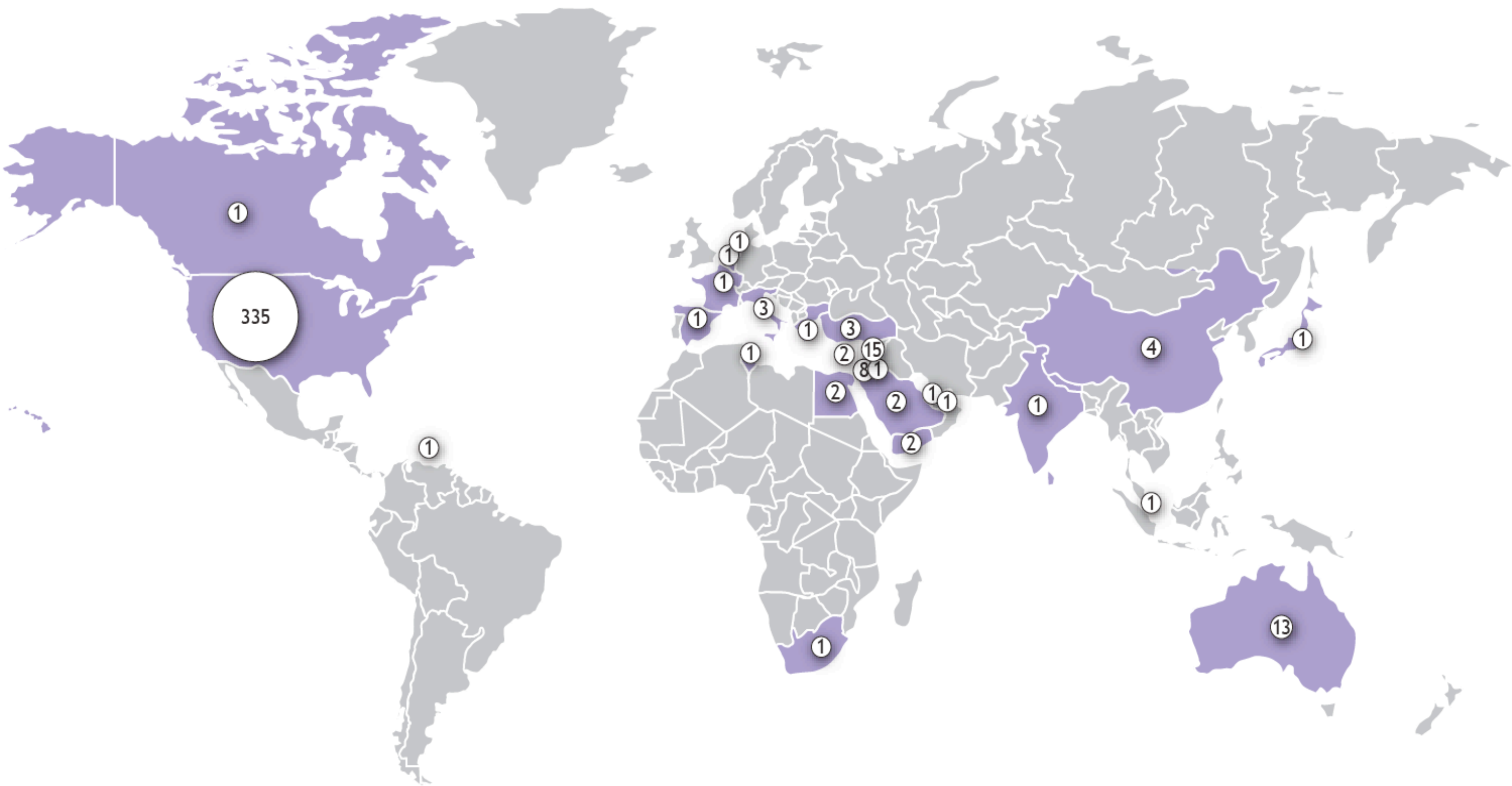
Marco Island Utilities	Marco Island	Florida
Melbourne	Melbourne	Florida
Miami-Dade	Miami	Florida
Clay County Utility Authority	Middleburg	Florida
Miramar	Miramar	Florida
Mount Dora	Mount Dora	Florida
Collier County Utilities	Naples	Florida
Pasco County	New Port Richey	Florida
Ocala Water and Sewer Department	Ocala	Florida
Ocoee	Ocoee	Florida
Oldsmar	Oldsmar	Florida
Orange County	Orlando	Florida
Orlando	Orlando	Florida
Reedy Creek Utilities	Orlando	Florida
Ormond Beach	Ormond Beach	Florida
Oviedo	Oviedo	Florida
St. Johns River Water Management District	Palatka	Florida
Palm Bay	Palm Bay	Florida
Palm Coast	Palm Coast	Florida
Palmetto	Palmetto	Florida
Pinellas County Utilities	Pinellas County	Florida
Pinellas Park	Pinellas Park	Florida
Plant City	Plant City	Florida
Pompano Beach	Pompano Beach	Florida
Port Orange	Port Orange	Florida
Punta Gorda	Punta Gorda	Florida
Rockledge	Rockledge	Florida
Sanford	Sanford	Florida
Seminole County	Sanford	Florida
Sanibel	Sanibel	Florida
Sarasota	Sarasota	Florida
St. Pete Beach	St. Pete Beach	Florida
St. Petersburg	St. Petersburg	Florida
Martin County	Stuart	Florida
Tallahassee	Tallahassee	Florida
Hillsborough County	Tampa	Florida
Tampa	Tampa	Florida
Tarpon Springs	Tarpon Springs	Florida
Tavares	Tavares	Florida
Titusville	Titusville	Florida
Umatilla	Umatilla	Florida
Vero Beach	Vero Beach	Florida
Venice	Venice	Florida
Brevard County	Viera	Florida
Winter Garden	Winter Garden	Florida
Winter Haven	Winter Haven	Florida
Polk County	Winter Haven	Florida
Winter Park	Winter Park	Florida

Winter Springs	Winter Springs	Florida
Atlanta	Atlanta	Georgia
Gwinnett County	Lawrenceville	Georgia
Maui	Maui	Hawaii
Honolulu	Honolulu	Hawaii
Meridian	Meridian	Idaho
Decatur Sanitary District	Decatur	Illinois
Alafaya Utilities (Utilities, Inc)	Northbrook	Illinois
Wheaton	Wheaton	Illinois
Baltimore	Baltimore	Maryland
Foxborough	Foxborough	Massachusetts
Hopkinton	Hopkinton	Massachusetts
Hudson	Hudson	Massachusetts
Kingston	Kingston	Massachusetts
Wrentham	Wrentham	Massachusetts
Yarmouth	Yarmouth	Massachusetts
Turtle Run South	Turtle Run South	Minnesota
Henderson	Henderson	Nevada
Las Vegas Valley Water District	Las Vegas	Nevada
Cloudcroft	Cloudcroft	New Mexico
Albuquerque Bernalillo County Water Utility Authority	Albuquerque	New Mexico
Oneida	Oneida	New York
Orange Water and Sewer Authority	Carrboro	North Carolina
Cary	Cary	North Carolina
Johnston County	Smithfield	North Carolina
Raleigh	Raleigh	North Carolina
Wilson	Wilson	North Carolina
Newberg	Newberg	Oregon
Portland	Portland	Oregon
Woodburn	Woodburn	Oregon
Hilton Head Public Service District 9	Hilton Head Island	South Carolina
Murfreesboro	Murfreesboro	Tennessee
Abilene	Abilene	Texas
Amarillo	Amarillo	Texas
Andrews	Andrews	Texas
Austin	Austin	Texas
Travis County Water Control and Improvement District 17	Austin	Texas
Brownfield	Brownfield	Texas
Cleburne	Cleburne	Texas
El Paso	El Paso	Texas
Georgetown	Georgetown	Texas
Lakeway	Lakeway	Texas
Harlingen	Harlingen	Texas
Irving	Irving	Texas
Odessa	Odessa	Texas
San Angelo	San Angelo	Texas
San Antonio Water Systems	San Antonio	Texas
San Marcos	San Marcos	Texas

Tom Green County Water Control and Improvement District No. 1	Veribest	Texas
Hurricane	Hurricane	Utah
Davis and Weber Counties Canal Company	Sunset	Utah
The Washington County Water Conservancy District	St. George	Utah
Loudoun Water	Ashburn	Virginia
Hampton Roads Sanitation District	Virginia Beach	Virginia
Blaine	Blaine	Washington
Carnation	Carnation	Washington
Chehalis	Chehalis	Washington
Cheney	Cheney	Washington
Ephrata	Ephrata	Washington
Everett	Everett	Washington
Medical Lake	Medical Lake	Washington
North Bay	North Bay	Washington
King County - Renton	Renton	Washington
LOTT Clean Water Alliance (Non-profit corporation)	Olympia	Washington
Washington State Department of Ecology	Olympia	Washington
Olympia	Olympia	Washington
Royal City	Royal City	Washington
King County Wastewater Treatment Division	Seattle	Washington
Brightwater Reclaimed Water System	Seattle	Washington
Sequim	Sequim	Washington
Sunland Water and Sewer District	Sequim	Washington
Mason County - North Base/ Case Inlet	Shelton	Washington
Shelton	Shelton	Washington
Snoqualmie	Snoqualmie	Washington
Tenino	Tenino	Washington
Tukwila City	Tukwila City	Washington
Walla Walla	Walla Walla	Washington
King County – West Point	West Point	Washington
Yelm	Yelm	Washington

APPENDIX B: CATALOG OF DUAL SYSTEMS OUTSIDE THE UNITED STATES

The systems listed do not represent all instances of dual water distribution and/or reclaimed water outside of the U.S. but comprise a sample list of systems identified during the project.



Entity	City	Country
Adelaide	Adelaide	Australia
Bolivar		Australia
Brisbane	Brisbane	Australia
Caboolture	Caboolture	Australia
Goulburn Valley	Goulburn Valley	Australia
Gibson Island and Luggage Point WWTP		Australia
Mawson Lakes		Australia
Melbourne Water	Melbourne	Australia
New Haven		Australia
Shoalhaven Heads	Shoalhaven Heads	Australia
Sydney Water/ Rouse Hill	Sydney	Australia
Virginia	Virginia	Australia
Wagga Wagga	Wagga Wagga	Australia
Bahrain		Bahrain

Flanders	Flanders	Belgium
Toronto	Toronto	Canada
Beijing	Beijing	China
Hong Kong	Hong Kong	China
Jinghua Residential Quarter of Pudong District	Shanghai	China
Tianjin	Tianjin	China
Larnaca		Cyprus
Limassol		Cyprus
Alexandria	Alexandria	Egypt
Cairo	Cairo	Egypt
Paris	Paris	France
Corfu	Corfu	Greece
Amsterdam		Holland
Bangalore Water Supply and Sewerage Board	Bangalore	India
Afula	Afula	Israel
Arad	Arad	Israel
Beer-Sheva	Beer-Sheva	Israel
Eliat	Eliat	Israel
Kibbutz Tzora	Kibbutz Tzora	Israel
Netania	Netania	Israel
Tel-Aviv	Tel-Aviv	Israel
Haifa	Haifa	Israel
Sicily	Sicily	Italy
Sardinia	Sardinia	Italy
Turin	Turin	Italy
Tokyo Metropolitan Government	Tokyo	Japan
Amman Zarqa Basin	Amman Zarqa Basin	Jordan
Jeddah	Jeddah	Saudi Arabia
Riyadh	Riyadh	Saudi Arabia
Singapore	Singapore	Singapore
Durban	Durban	South Africa
Consorci de la Costa Brava, Girona		Spain
Castries	Castries	St. Lucia
Adra	Adra	Syria
Aleppo	Aleppo	Syria
Damascus	Damascus	Syria
Dera'a	Dera'a	Syria
Hama	Hama	Syria
Hassakeh	Hassakeh	Syria
Homs	Homs	Syria
Huran al-Awamid	Huran al-Awamid	Syria
Idleb	Idleb	Syria
Lattakia	Lattakia	Syria
Quneitra	Quneitra	Syria
Raqqa	Raqqa	Syria
Ras al-Ain	Ras al-Ain	Syria
Salamiya	Salamiya	Syria
Sweida	Sweida	Syria

La Soukra	La Soukra	Tunisia
Nigde-Bor	Nigde-Bor	Turkey
Konya-Kadinhani	Konya-Kadinhani	Turkey
Merkez	Merkez	Turkey
Sharjah	Sharjah	U.A. Emirates
Aden	Aden	Yemen
Hodiedah	Hodiedah	Yemen

APPENDIX C: LIST OF CASE STUDIES

Entity	City	County	State
Apopka Public Services Department	Apopka	Orange	FL
Austin Water Utility	Austin	Travis	TX
Burbank Water and Power	Burbank	Los Angeles	CA
Cape Coral Utility Division	Cape Coral	Lee	FL
Cary Public Works and Utilities Department	Cary	Wake	NC
Chandler, Water Distribution Division	Chandler	Maricopa	AZ
Denver Water	Denver	Denver	CO
Dunedin Reclaimed Water Division	Dunedin, FL	Pinellas	FL
East Bay Municipal Utility District	, Oakland	Alameda/ Contra Costa	CA
El Paso Water Utility	El Paso	El Paso	TX
City of Eustis Public Utilities Department	Eustis	Lake	FL
Gwinnett County Georgia Water Resources Department	Gwinnett County,	Gwinnett	GA
Irvine Ranch Water District	Irvine	Orange	CA
Largo Environmental Services Department	Largo	Pinellas	FL
Las Vegas Valley Water District	Las Vegas	Clark	NV
Livermore Water Resource Division	Livermore	Alameda	CA
City of Olympia Public Works Department	Olympia	Thurston	WA
Marin Municipal Water District	Corte Madera	Marin	CA
Ocala Water and Sewer	Ocala	Marion	FL
Odessa Utilities	Odessa	Ector	TX
City of Orlando Wastewater Department	Orlando	Orange	FL
City of Oviedo Public Works Department	Oviedo	Seminole	FL
Pinellas County Utilities	Clearwater	Pinellas	FL
Pittsburg Public Works	Pittsburg	Contra Costa	CA
City of Raleigh Public Utilities	Raleigh	Wake	NC
Redwood City Public Works Services	Redwood City	San Mateo	CA
San Antonio Water System	San Antonio	Bexar	TX
City of San Diego Public Utilities Department – Recycled Water Section	San Diego	San Diego	CA
City of Santa Barbara Public Works Department – Water Resources Division	Santa Barbara	Santa Barbara	CA
City of Santa Rosa Utilities Department	Santa Rosa	Sonoma	CA
City of St. Petersburg	St. Petersburg	Pinellas	FL
St. Pete Beach Public Services Department	St. Pete Beach	Pinellas	FL
Tallahassee Underground Utilities	Tallahassee	Leon	FL
Tampa Water Department	Tampa	Hillsborough	FL

Tucson Water	Tucson	Pima	AZ
Winter Springs Public Works Utility	Winter Springs	Seminole	FL
City of Yelm Public Works Department	Yelm	Thurston	WA

APPENDIX D: THIRTY-SEVEN CASE STUDIES

OVERVIEW – CASE STUDY REPORTS

Case study reports were prepared by the research project staff by interviewing utility personnel and reviewing literature. Only the utility-reviewed and approved case studies are included in this appendix. The information is presented for purpose of case analysis to determine lessons learned and is not presented to evaluate the performance of the individual utilities.

APOPKA PUBLIC SERVICES DEPARTMENT, APOPKA, FL

I. GENERAL INFORMATION

Evaluation Date: 12/13/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Apopka Public Services Department
Contact Person: Kevin Burgess
Title: Water Resources Operations Manager

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1990
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other Nursery
☒ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

Has a Sensus Automated Water Meter Reading System that tracks water consumption through a wireless meter communication that provides real-time readings and improved accuracy (Metro Orlando Economic Development Commission, 2009).

II. SYSTEM OVERVIEW

Apopka, Florida has a population of 56,982 in the utility service area, and is located in Orange County (City Data, 2009).

Potable Water System

The City's source of drinking water is the Floridan Aquifer from which twelve groundwater wells draw water (Water Quality Report, 2009) which is treated at one of five water treatment plants (Water Plants).

The City has a Water Conservation Incentive Program in which residents receive rebates for reduced water consumption through the use of more efficient landscaping and irrigation systems (MOEDC, 2009). Also an Apopka Conservation Award given for the first time in 2009 (MOEDC, 2009).

Reclaimed Water System

The City provides approximately 5,120 residents with 6.2 mgd of reuse water (Water Reclamation).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
There is not enough information to verify.

Provide any other pertinent information
Not available.

Principal Operational Issues

Not available.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
The City supplies approximately 6.2 million gallons of recycled water per day to about 5,120 residential customers as well as commercial customers for irrigation purposes (Water Reclamation).

How has the dual system has impacted any other (system capacity, etc.) goals?
In 2008, 62,653 linear feet of water, sewer and reclaimed pipe were installed (MOEDC, 2009).

Economic Information

What is the yearly O & M budget for the system?
Potable water production cost was $5,702,200 in 2008; however it is difficult to separate expenses for the potable and reclaimed systems (Annual Budget, 2009).

Discuss any additional O & M costs associated with the dual system:

The budget for potable water production for Fiscal Year 2010 was $5,702,200 (FY 2009-2010).

Discuss any rate structures used by the utility to regulate consumption:

Reclaimed water rates for residential use are based on a minimum charge of $6.03 for use up to 6,000 gallons, and the residential rates are according to a three tier increasing block rate structure beginning with $1.04 per 1,000 gallons.

Commercial reclaimed water rates are based on a minimum charge of $7.23 for up to 6,000, above that a two tier increasing block rate structure beginning with a charge of $1.24 per 1,000 gallons. There is a rate for contract and bulk users of $0.51 per 1,000 gallons if there is at least 14 days of usable storage on site, and $0.78 per 1,000 or $500, whichever is more, if there is no site storage.

Potable rates for residential users have a base charge of $6.02 and there is a four tier increasing block rate structure beginning with $1.12 per 1,000 gallons. Commercial rates have a base rate of $6.02 and there is a three tier increasing block rate structure beginning with $1.33 per 1,000 gallons. (Water Rates, 2009)

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, since reclaimed water use is used for irrigation, which is a key water use.

Is the dual system more efficient economically?

It is difficult to tell since reclaimed and potable revenue and expenses are not delineated.

Has the use of a dual system compromised safety?

Due to the lack of information, it is difficult to tell.

Does the dual system position the water authority better for the future?

It is difficult to tell if the reclaimed water system is deemed necessary by Apopka. The use of reclaimed water reduces the impacts and dependence on the Floridan Aquifer for irrigation, thus conserving it for potable use.

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AUSTIN WATER UTILITY, AUSTIN, TX

I. GENERAL INFORMATION

Evaluation Date: 9/15/2010
Prepared By: Pete Rogers

Utility Information:

Utility Name: Austin Water Utility
Contact Person: Dan Pederson
Title: Reclaimed Program Manager

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated:1974
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:

☒ Commercial	☒ Golf courses	☒ Parks	☒ Playgrounds
☒ Road medians	☐ Residential	☐ Schools	☐ Other

☐ Agricultural Irrigation
☒ Toilet and urinal flushing:

☒ Commercial	☐ Residential

☒ Cooling towers
☐ Fire fighting

Unique System Features

1. The utility is in the process of automating the reclaimed water pump operations.
2. One of the reclaimed water tanks is eco-friendly. It harvests rainwater (from the roof) and uses solar energy to power some of its operations.
3. Property owners are required for pay for their backflow preventor and yearly cross-connection testing.

II. SYSTEM OVERVIEW

Austin is the state capital and fourth largest city in Texas with a population of 780,000 (Austin City Connection, 2010). Water, reclaimed, and wastewater services are managed by the Austin Water Utility whereas the City's stormwater system is handled by the Watershed Protection department. The utility supplies the city of Austin as well as the communities of

Rollingwood, Sunset Valley, one water control and improvement district, five supply corporations, seven utility districts, and three private utilities (Austin City Connection, 2010).

Potable Water

Austin draws water from the Colorado River where it is treated at the Davis (118 mgd) and Ullrich (167 mgd) plants. The City's oldest treatment plant, the Green plant, was decommissioned in 2008 following the expansion of the Ullrich plant. The average per capita daily water use is estimated to be 170 gpcd with a total system demand of 140 ~ 170 mgd (Liveablecity, 2010). While the treatment demand does not exceed 60% the plants' capacity, the City is proactively developing plans for a new water treatment plant (Water Treatment Plant 4) which will draw water from Lake Travis. The plant will have a first phase capacity of 50 mgd by 2014 with an expanded capacity of 300 mgd (Austin City Connection, 2010). The distribution system is comprised of 3,651 miles of pipe with 46 pump stations covering 11 major service zones (Austin City Connection, 2010).

Reclaimed Water

Wastewater is collected through a 2648 mile network of sewer lines and 104 lift stations where it is treated at the major centralized plants, Walnut Creek or South Austin Regional, or at three smaller satellite plants (City of Austin, 2003). The Walnut Creek and South Austin regional plants each have a capacity of 75 mgd (Austin City Connection, 2010). Reclaimed water from these plants is distributed through approximately 35 miles of "purple pipe" to several golf courses, parks, businesses, and industries. One of the industrial users uses the reclaimed water for a cooling tower. The City's reclaim program manager, Dan Pedersen, estimates that between 4% and 5% of the total treated wastewater is used as reclaimed water. This amounts to approximately 1.0 billion gallons per year.

The City's Water Reclamation Initiative (WRI), inacted by the Austin City Council in 1992, calls for more than doubling the use of reclaimed water to 5.5 billion gallons per year. Aside from their desire to become environmental stewards, the City also has a financial incentive to minimize draws from the Colroado River. The Lower Colorado River Authority will charge the City of Austin \$7-\$10 million per year if the city pulls more than 201,000 acre-feet from the Highland Lakes for two consectutive years (Statesman, 2010). The WRI's goals involve the expansion of the dual system to 130 miles of pipeline with 7 news storage tanks (Austin City Connection, 2010). This expansion will provide reclaimed water to select residences for toilet flushing and irrigation, parks, the Austin-Bergstrom International Airport, numerous businesses, and the University of Texas for use in their water-intensive cooling systems and irrigation (Statesman, 2010).The pipeline to the UT campus is currently under construction at a cost of \$17.5 million.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
N/A

Provide any other pertinent information:
The City has very strict rules regarding cross connections. Property owners purchase backflow valves and are required to pay for yearly cross connection testing. Reclaimed lines are designated with purple pipe and special shaped valves.

Principal Operational Issues

Because of the limited size of the dual system (approximately 35 miles) the utility has not allocated additional resources to the reclaimed line. This will change as the dual system expands under the City's Water Reclamation Initiative (WRI). At this point in time, Austin Water is not sure how (and who within) the utility will pay the additional costs.

As they expand landscape irrigation to residences, there is a possible discrimination issue since lower-income households may not be able to pay the backflow valve or yearly cross connection testing. Also, the reclaimed cost rate may exceed their subsidized potable rate.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
Since the implementation of the dual distribution system in 1993, on average the City reuses approximately 1 billion gallons of treated wastewater a year. For the year 2009, a particularly dry year, the City reused 2 billion gallons which is equivalent to the amount of water consumed by 9,100 homes (Austin City Connection, 2010). This represents approximately 4% of the 51- 53 billion gallons treated by the wastewater plants per year. As the City WRI program expands to its targeted yearly goal of 5.5 billion gallons, this percentage will increase.

How has the dual system has impacted any other (system capacity, etc.) goals?
The dual system is a critical component of conservation program led by the City's Water Conservation Task Force which identified 21 recommendations which include: irrigation system evaluations, toilet replacement programs, rebates for efficient clothes washers, educational outreach, and rain harvesting incentives (C40 Cities, 2010). The City is also expanding the system's storage capacity.

Economic Information

What is the yearly O & M budget for the system?
The entire utility budget for 2009 was $438.3 million. Due to the detailed financial reporting (engineering services, studies, etc.), it was impossible for us to establish the budget for wastewater services. Because of the limited size of the reclaimed system, there is not a specific line item for this service.

Discuss any additional O & M costs associated with the dual system:
There has not been a significant additional cost in terms of O &M for two reasons: the limited coverage of the dual system and the utility's policy in which the property owner has to

pay for their yearly cross connection testing. The City also indicated that the maintenance cost for the reclaimed mains has been very low since the break rate for these pipes is less than 1 break per year (Pedersen, 2010).

Discuss any rate structures used by the utility to regulate consumption:

There is an increasing block rate structure for potable water consumption with four tiers. Pricing for reclaimed water is a based on consumption (all users are metered) at a fixed rate of \$1.03 per 1,000 (Austin City Connection, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, but in its current form the benefit is limited to saving less than 5%. As the dual system (reclaimed water) program expands, the City is hoping that the water savings will reach 10%. These reductions are vital in reducing withdrawals from the Colorado River and contractual water payments.

Is the dual system more efficient economically?

Because of the limited scope of the dual system (35 miles of reclaimed pipeline compared to 3,651 miles of potable pipeline) the utility's O & M cost for the dual system has been very limited. Their cost has also been limited by their policy in which the property owner pays for the backflow device and yearly cross connection testing. The most difficult challenge for Austin Water Utility has been financing the required CIP.

Has the use of a dual system compromised safety?

No, there have been no reported cases of cross connection related illnesses.

Does the dual system position the water authority better for the future?

Yes. From a community relations perspective, because Austin is a progressive city, it shows the citizens that the utility is serious about conservation. Secondly, by reducing their withdraws from the Colorado River, they are enabling the community to become less dependent on "foreign" water sources while limiting their risk of excessive river withdrawals.

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BURBANK WATER AND POWER, BURBANK, CA

I. GENERAL INFORMATION

Evaluation Date: 10/13/2010
Prepared By: Stephanie Edmiston

Utility Information:

Utility Name: Burbank Water and Power
Contact Person: Shadi Bader
Title: Civil Engineering Assistant-Water Division

Services Provided

☒ Water ☐ Wastewater ☒ Recycled water ☐ Stormwater ☒ Other Power

Dual System Information

Year initiated: 1967
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☒ Road medians ☐ Residential ☒ Schools ☒ Other Cooling systems, landfill, power plant
☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☒ Cooling towers
☒ Fire fighting

Unique System Features

1. Implemented several water conservation measures in light of the current water crisis including: the build out of the recycled water system, citizen education, and working with regional agencies to influence the state legislature to develop long term comprehensive sustainable water supply solutions for the State and southern California (BWP, 2009). Other measures included limiting lawn watering to three days of the week, issuing fines for water waste, and requiring businesses to meet plumbing code standards by October 31, 2010 or face a water use surcharges, requiring resold properties to meet specific plumbing code efficiency standards, and having water saving programs to help residents and businesses reduce water usage (California Water Supply: In Crisis).

2. Infrastructure replacement program which resulted in record low water losses far below the national average. Losses are below 4% for five straight years (BWP, 2009).
3. Burbank was the first in the nation (1967) to use recycled water in place of potable water for cooling tower use (Water Treatment, 2002).
4. Where there are recycled water tanks, Burbank uses recycled water for fire-fighting. Recycled water from tanks provides more reliable fire protection than using pumps.

II. SYSTEM OVERVIEW

The City of Burbank, CA is located in Los Angeles County in southern California with a population of about 103,000 people (City Data, 2010). The City is currently facing a water crisis due to a seven year drought in the Colorado River Basin and the Federal Court limiting pumping in the Sacramento-San Joaquin Delta (BWP, 2009). The State issued a Drought Declaration on June 4, 2008 and State Emergency Proclamation on Water Supply on February 27, 2009 in order to promote a 20 % water use reduction by 2020 (BWP, 2009).

Potable Water System:

Burbank's potable water supply comes from northern California and the Colorado River through the Metropolitan Water District (MWD) as well as local groundwater sources (BWP, 2009). Burbank is heavily dependent on the MWD. Approximately 57.8%, or 3,920 MG, of the City's water came from the MWD in 2009 compared to 42.2% (2,873 MG) from local production in 2009 (BWP, 2009). Due to water shortages from the MWD, the City is implementing a number of water conservation measures and expanding the use of recycled water in order to reduce its dependence on the MWD (BWP, 2009). Rates are high since the State Water Supply Allotment from the State Water Project to MWD was decreased from 65% to 40% in 2009 compared to normal precipitation years (BWP, 2009). In 2009, the total number of potable water customers was 26,453 (BWP, 2009). The peak day demand was 29 million gallons in 2009 down from 35.1 million gallons in 2005 (BWP, 2009).

Recycled Water System:

Burbank Water and Power (BWP) is in the process of completing an expedited build out of its recycled water system in order to reduce potable water demand, potable supply costs, and enable the community to have added drought protection (BWP, 2009). Over the next four years the City plans on doubling the use of recycled water within Burbank (BWP, 2009). BWP is facing drought, environmental and judicial decisions which are endangering its water supply and causing potable water costs to rise (BWP, 2009). In 2009, 794 ccf of recycled water was sold (BWP, 2009). Of the 330 million gallons of recycled water distribution over the last year, 50 % was used for cooling tower at the Burbank Water and Power steam power plant, 30 % was for Debell Golf Course, 10 % was used at the City of Burbank landfill, and 10 % went to other uses (BWP, 2009). Burbank does not use recycled water for residential purposes (Baber, 2010). The City of Burbank Public Works owns and operates sanitary sewer system and water reclamation facility (BWP, 2009). The Water Reclamation Facility is a tertiary treatment facility, utilizing microfiltration and demineralization processes (Water Treatment, 2002), with a capacity of 9 mgd and was upgraded in 2002 to remove ammonia (BWP, 2009).Recycled water is also pure enough to power turbines and saves $160,000 per year compared to the old system (Water Treatment, 2002).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
None reported

Provide any other pertinent information:
In order to prevent cross connections, multiple pressure tests are completed on both the recycled and potable water systems when a site is converted to recycled water use (Bader, 2010). Burbank, like other entities, uses identification tape and/or use a different color for recycled water line to prevent cross connections. In addition, a minimum pipeline separation between potable water lines and recycled water lines is maintained and recycled water meters are a minimum of ten feet away from the nearest potable water meter (Bader, 2010).

Principal Operational Issues

1. A possible potable water quality issue is the presence of Chromium VI, less than 5 ppb, in Burbank's local groundwater supply. Currently, federal and state maximum contaminant limits are 100 ppb and 50 ppb respectively. However, the California Department of Health Services is reviewing Chromium IV contamination in groundwater for possible health issues, which may lead to the MCL being lowered (BWP, 2009). The City realizes that it may need to improve the potable water system or obtain more water from the MWD if the MCL was lowered to less than 5 ppb.
2. The principal operations issue is keeping both the recycled and potable identification tags. Also, when converting a site to recycled water use, the Reduced Pressure devices are required for all potable water services, which are very costly but help protect the potable system (Bader, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
The infrastructure replacement program resulted in significant potable water conservation due to reducing losses which led to a lower cost of service to the community (BWP, 2009). Water sales were reduced by 463,097 CCF or 4.9% in the 2009 Fiscal Year compared to the 2008 FY mainly due to water conservation and cooler temperatures (BWP, 2009). Recent conservation measures implemented as a result of the water supply crisis reduced potable water use by 11%, 173 average use in gallons per person in 2009, since 2007 (California Water Supply:

In Crisis). The State law requires a 20% drop by 2020 against a specific baseline, which is 194 gallons for Burbank (California Water Supply: In Crisis). In 2002, Burbank saved between 60,000 to 100,000 gallons of potable water per day by using recycled water (Water Treatment, 2002).

How has the dual system has impacted any other (system capacity, etc.) goals?

Burbank is currently completing a build out of the recycled water system to be finished in 2013 to increase use of recycled water to more than 1 billion gallons per year (BWP, 2009).

Economic Information

What is the yearly O & M budget for the system?

An overall figure was not given but Burbank Water and Power only pays for the pumping and maintenance of the system while Burbank Public works treats the water (Bader, 2010).

Discuss any additional O & M costs associated with the dual system:

Water supply expenses include purchased water, electricity to pump water, and chemicals used in water treatment (BWP, 2009). Miscellaneous expenses include all costs associated with water and electric utility administration, customer service, telecom services, PB programs, and transfers to City for cost allocation (BWP, 2009).

Discuss any rate structures used by the utility to regulate consumption:

The charge for recycled water is 15% less than that of potable water (Bader, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes. BWP has switched several large water users, such as irrigation and industrial users, from potable water use to recycled water use (Bader, 2010). The users include the Magnolia Power Plant, golf courses, and City parks. The recycled water system is essential to meeting water needs and conservation of potable water. The state of California mandated that the state conserve 20% of the potable by 2020 and as of June 2010, Burbank has achieved that goal (Bader, 2010).

Is the dual system more efficient economically?

Having the recycled water system is a reasonable thing to do since BWP does not have to buy the recycled water, as opposed to potable water. Instead of discharging water into the Pacific Ocean, BWP receives sales revenue from recycled water. However, the new recycled water infrastructure requires loans (Bader, 2010).

Has the use of a dual system compromised safety?

No, there are no reported cases of cross connections or associated illnesses.

Does the dual system position the water authority better for the future?

Yes, the recycled water system played a vital role in reducing the potable water demand and meeting the state mandated goal of 20% potable water reduction.

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CAPE CORAL UTILITY DIVISION, CAPE CORAL, FL

I. GENERAL INFORMATION

Evaluation Date: 6/15/2010

Utility Information

Utility Name: Cape Coral Utility Division
Contact Person: Brian Fenske
Title: Superintendent

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1992
Non potable water source: Reclaimed water
Uses of the non-potable line

☒ Irrigation:

☒ Commercial	☐ Golf courses	☒ Parks	☒ Playgrounds
☒ Road medians	☒ Residential	☒ Schools	☐ Other

☐ Toilet and urinal flushing:

☒ Commercial	☐ Residential

☒ Cooling towers
☒ Fire fighting

Unique System Features

1. The City has a freshwater canal system which provides additional irrigation water.
2. The utility uses reverse osmosis (RO) plants to address high salinity found in the deep aquifer.
3. The City has sufficient storage to avoid surface water discharges. This makes use of all the reclaimed water and saves on treatment cost.

Principal Operational Issues

1. High salinity associated with the deep aquifer.
2. Concern that excess aquifer withdrawals would increase salinity (saltwater intrusion) resulting in higher RO treatment costs.

II. SYSTEM OVERVIEW

Cape Coral is the largest city in southwest Florida with an estimated population of over 167,000 (Cape Coral Facts, 2010). Water, reclaimed, and wastewater services are managed by the City's utilities division which is divided into three sections: collection/distribution, water production, and water reclamation. Cape Coral's stormwater and canal infrastructure is managed by a separate division.

Potable Water

The City's drinking water comes from a series of 33 wells that extract brackish groundwater from the Lower Hawthorn Aquifer. Drinking water is treated using a recently expanded 18 MGD Reverse Osmosis (RO) plant located in southwestern part of the City and a newly constructed RO facility (12 mgd) located in the north. The average daily potable water use is 12 mgd (Stroud and Graff, 2009), approximately 40% of the total plant capacity. There are 681 miles of potable water miles of potable water lines.

Reclaimed Water and Wastewater

Wastewater is collected through a 535 mile network of sewer lines and lift stations where it is treated at either the Everest Parkway or Southwest Water Reclamation Facility. The Everest plant, which utilizes a 5-stage Bardenpho treatment process, was recently expanded to 13.4 mgd. The Southwest plant uses a 3-stage Bardenpho process and was also recently expanded to 15 mgd. Reclaimed water from these plants (referred to as rescued water) is distributed using 596 miles of a dual pipeline throughout the City as irrigation water for over 38,000 domestic households, 17 parks and playgrounds, 11 schools, and numerous commercial buildings (Cape Coral, 2010). Reclaimed water is also used on a limited number of fire hydrants throughout the City (Fenske, 2010). The average daily use of reclaimed water is 21 mgd. Although water from the Everest plant can be discharged into the Caloosahatchee River, recent improvements in the system's storage capacity enable the utility to avoid surface water discharges and make use of all the reclaimed water. Both plants also have deep injection wells. In lieu of Florida's stringent regulations for discharges into surface water, the storage of the reclaimed water allows the utility to save on treatment costs (Fenske, 2010).The Cape Coral system is unique in that the City's freshwater canal system, which includes five canal pumping stations, provides additional irrigation water.

Water use is also controlled through City-imposed restrictions on lawn irrigation and an increasing block rate structure for potable water consumption. Pricing for reclaimed water is a fixed rate of \$9.50 per month for residences and \$0.50 per 1,000 gallons for commercial customers. Residential use of reclaimed water is not metered.

City officials indicated that the reclaimed system requires more maintenance than the potable system for cross connection control, reporting of leaks and/or spills, and field water quality testing. They also indicated that they do not have sufficient personnel to enforce City-wide watering restrictions (Fenske, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.
The City reported 4 cases of potable and non potable pipeline cross connections in 2008 (Fenske, 2010).

Provide any other pertinent information

1. There were no reported illnesses associated with the cross connections.
2. Water and reclaimed water are continuously monitored and tested by the City's own laboratory, as required by the Florida Department of Environmental Protection.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
A reduction in potable water consumption was achieved through the implementation of the dual distribution system in 1992. Prior to its installation, potable water use in 1990 for a population of 74,000 peaked at 13 mgd. With a 2010 population of over 160,000 (a 238% growth in population from in 1990) the current potable water use is still 13 mgd (Stroud and Graff, 2009). This reduction in per capita potable water consumption is very important to the city since they are concerned with the increased treatment costs associated with increased salinity resulting from seawater intrusion (Fenske, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?
The City upgraded the reclaimed water storage capacity to ensure that all of the reclaimed water could be stored. No effluent has been discharged into surface waters since 2008.

Economic Information

What is the yearly O & M budget for the system?
The Utility's proposed operating budget for 2010 was $75,372,582 with $28,127,230 (36%) for the potable water system and $47,245,352 (64%) for the reclaimed system

Discuss any additional O & M costs associated with the dual system:
City officials indicated that the reclaimed system requires more maintenance than the potable system for cross connection control, reporting of leaks and/or spills, and field water quality testing (Fenske, 2010).

Discuss any rate structures used by the utility to regulate consumption:
There is an increasing block rate structure for potable water consumption. Pricing for reclaimed water is a fixed rate of $9.50 per month for residences and $0.50 per 1,000 gallons for commercial customers.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, the dual system does an excellent job in minimizing withdrawals from the aquifer and avoiding saltwater intrusion.

Is the dual system more efficient economically?

Not enough data to evaluate this. Cannot compare O & M costs before and after the dual system installation because the demands (population and industry) have changed so much in the past 20 years. In 2011, the Southwest WRF will not require an NPDES permit because they are designed to be 100% reuse which result in a savings due to a reduction of required regulatory sampling.

Has the use of a dual system compromised safety?

No since there have not been any illnesses associated with the cross connections reported.

Does the dual system position the water authority better for the future?

Yes, because it is protecting the integrity of the aquifer. Without this protection, the aquifer could experience sea water intrusion which would make the RO plants more costly to operate.

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CARY PUBLIC WORKS & UTILITIES DEPARTMENT, CARY, NC

I. GENERAL INFORMATION

Evaluation Date: 8/23/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Cary Public Works & Utilities Department
Contact Person: Rick Jordan
Title: Reclaimed Water Coordinator

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☒ Other Garbage and recycling, and street maintenance

Dual System Information

Year initiated: 2001 (reclaimed system)
Non potable water source: Reclaimed water
Uses of the non-potable line:
☒ Landscape Irrigation:
☒ Commercial ☐ Golf courses ☒ Parks ☐ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other: Industrial plants, multi-family
☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
☒ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. Bulk Reclaimed water is available at no charge under certain conditions to customers that transport at least 250 gallons of reclaimed water from either of the North Cary and South Cary Water Reclamation Facilities (Reclaimed Water System).
2. Every February, Cary shuts down the reclaimed water system for 10 days to perform annual maintenance (Reclaimed Water System). This is referred to as the Reclaimed Water Holiday.
3. In 2005, Cary began operating a bio solids dryer facility to provide a cost effective and flexible bio solids reuse program. Liquid byproduct from the North and South Cary WRFs is converted into dry BB-sized pellets for use as

fertilizer for agriculture, and is a cost effective means of waste disposal (Bio solids Dryer).

4. Cary was the first Town in North Carolina to provide reclaimed water to residential neighborhoods (Jordan, 2010).
5. The reclaimed systems has automatic monitoring equipment for water quality which will automatically shut down the reclaimed system when the water quality does not meet standards and notify system operators.

II. SYSTEM OVERVIEW

The Town of Cary consists of approximately 136,000 people and is located in Wake County (City Data, 2009).

Potable Water System

Potable water comes from Jordan Lake and is treated at a 40 mgd capacity plant that is jointly owned with the Town of Apex (Water Treatment). Super-Pulsator Flocculator Clarifiers remove particles from the water and the technology requires less space than conventional sedimentation basins (Water Treatment). Cary has the ability to receive potable water via interconnections from other agencies during emergencies. (Jordan, 2011).

Reclaimed System

The Town of Cary is permitted to divert a total of 5 million gallons of effluent from the two water reclamation facilities for reuse. Currently Cary uses approximately 1 million gallons on peak days and as much as 20 million gallons monthly in the summer (Water Reclamation System). The reclaimed water system is active April through October and about 219 million gallons of reclaimed water was used during this time in 2010 (Jordan, 2011). The reclaimed system also extends the life of the potable water system, saves energy and money since the discharge into the Neuse River is reduced, and delays the expansion of the water reclamation facilities due to decreased discharges into the Neuse River Basin (the plants have a cap on the total amount of nutrients discharged), and reduces the peak demand on the potable system in the dry season (Frequently Asked Questions).

North Cary Water Reclamation Plant: The NCWRF has a capacity of 12 mgd and receives wastewater from the north side of Cary. Effluent is discharged into Crabtree Creek (NCWRF).

South Cary Water Reclamation Facility: The SCWRF has a capacity of 12.8 mgd and receives wastewater from the south side of Cary. Effluent not used for the reclaimed water system is discharged into Middle Creek. In June 2001, the SCWRF started an 864,000 gallons per day reuse system (SCWRF) which allows sites to use reclaimed water for irrigation and cooling purposes (Reclaimed Water System).

Jordan Lake Water Reclamation and Reuse Project: The Durham County Triangle Wastewater Treatment Plant was designed to provide reclaimed water to existing customers in the Wake County portion of Research Triangle Park and to the Town of Cary's Thomas Brooks Park. Cary also planned on providing reclaimed water to currently undeveloped portions of northwestern Cary.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

There have been at least four cross connections discovered at residences in 2007, but no associated illnesses have been reported (Capital Broadcasting Company, 2007). Afterward, the town revised their standard specifications and details in order to clearly differentiate potable water and reclaimed water standards. (Jordan, 2010). Additionally, in reclaimed water service areas, water is sampled at the outside hose bib to the house at the time of the plumbing final inspection as well as when reclaimed water service is requested. This insures proper connection to the potable and reclaimed water services. (Jordan, 2010).

Provide any other pertinent information

Cary relies on regulations to ensure that reclaimed water is safe to use. The N.C. Department of the Environment and Natural Resources has developed criteria and standards for reclaimed water. Cary is required to continuously monitor and design control strategies that ensure reclaimed water consistently meets criteria. The reclaimed system is fitted with automatic monitoring equipment that will shut down the system and warn plant operators of the problem if water quality does not meet the criteria. Operators are highly trained and routinely test and monitor critical water quality parameters within the reclaimed water system to provide additional quality assurance (Frequently Asked Questions).

All single-family residential irrigation customers are required to have an approved backflow prevention assembly installed and tested annually. Residents have the choice of allowing Cary to manage the annual process (Residential Backflow Prevention Assembly Testing Program).

Cary routinely inspects 50-75 miles of the water distribution system per month with electronic listening devices to minimize losses in the potable water system. (Water).

Cary daily monitors water quality by sampling and testing water from over 30 locations throughout Cary and Morrisville (Annual Water Disinfecting Change).

Principal Operational Issues

1. During water sampling at residences, cross connections were discovered in at least four relatively new residences in 2007 and the reclaimed system was temporarily shut down as result. One of the homes reportedly had been using reclaimed water for potable water since 2006 (Capital Broadcasting Company 2007). The only cross connection issues occurred in 2007, since measures were taken afterward to prevent it from occurring again (Johnson, 2010).

2. Citizens were initially opposed to reclaimed water use in Cary, since North Carolina receives 48 to 50 inches of rainfall every year (Jordan, 2010). Citizens did not understand the need for water conservation and the use of reclaimed water as opposed to simply using rainwater (Jordan, 2010). However, droughts have occurred in Cary and the irrigation demand was enough to necessitate reclaimed water use (Jordan, 2010). Now, there is sufficient demand for reclaimed water. In fact, instead of people calling to be taken off the reclaimed water system in light of 2007's cross connections, people are requesting to be connected to the reclaimed system (Jordan, 2010). Although most of the citizens now want reclaimed water, most of the time they are located in areas where it is economically infeasible to connect them to the system (Jordan, 2010).
3. A significant issue is nutrient loading from wastewater treatment plant effluent which results in effluent needing to be diverted to the reclaimed water system (Jordan, 2010).
4. Maintaining the chlorine residual in the reclaimed water system is another significant issue for the reclaimed water system. Routine flushing of the reclaim water distribution system is done to ensure that bacteria growth does not occur (Jordan, 2010). In addition, ordinances concerning irrigation use (rain sensor and water waste ordinances) are enforced, but no significant violations (Jordan, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

One of the goals for the reclaimed water system is to conserve potable water and extend the life of the potable treatment facility (Jordan, 2010). The goal was also part of Cary's goal to reduce potable water use by 20% by 2015. (Jordan, 2010). The primary use of reclaimed water is irrigation (Jordan, 2010), which saves a significant amount of potable water. When the reclaimed system's first bulk reclaimed water program began in 1999, the Town of Cary was permitted to distribute 100,000 gallons of reclaimed water per day from each of their two facilities. This was made available to contractors, landscape professionals and even homeowners that went through the required training to obtain bulk reclaimed water (Town of Cary, 2001). As of 2001, the south plant was permitted to supply as much as 864,000 gallons per day for reclaimed water use (Town of Cary, 2001).

How has the dual system has impacted any other (system capacity, etc.) goals?

The main goals for the reclaimed system are reducing the amount of potable water used for irrigation, cooling and manufacturing; reducing water consumption 20% by 2015; increasing regulatory compliance; reducing the likelihood of greater outdoor watering restrictions; fulfilling a commitment to the Neuse River Foundation; and providing a safe, cost-effective alternative to drinking water (Reclaimed Water System).

Economic Information

What is the yearly O & M budget for the system?

The operation and maintenance costs for water and sewer pumping was $1,102,197 in 2009; $2,014,713 for field operations; $23,921 for pretreatment; $174,912 for water conservation; $3,200,000 for the North Cary Water Reclamation Facility; $1,986,050 for the South Cary WRF; and $4,173,871 for the Cary/Apex Water Treatment Plant (CAFR, 2009). The total operation and maintenance costs was $14,024,027.

Discuss any additional O & M costs associated with the dual system:

The Town of Apex pays a portion of the operating costs of the Cary/Apex Water Treatment Plant (23% of capital costs and actual usage of other costs) as 23% owner of the facility (CAFR, 2009). Thus, the operation and maintenance costs of Cary do not reflect all the costs involved in operating the water treatment plant.

Discuss any rate structures used by the utility to regulate consumption:

Cary uses tiered water rates, where the water rate increases with each tier, to encourage potable water conservation (Water Rates). Retail customers outside the City limits are charged three times as much for water and sewer (CAFR, 2009). The reclaimed water rate has been set to be equal to the Town's tier 1 water use rates, which are currently $3.60 per 1000 gallons, and there is a policy in place that the reclaimed rate would remain the same as the tier 1 water usage rate (Frequently Asked Questions). The City of Morrisville is charged $3.87 per 1,000 gallons for reclaimed water (CAFR, 2009).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

It is difficult to tell since the demand for reclaimed water can be as much as 20 million gallons for summer use and a peak day can be 1 million gallons of reclaimed water use (Reclaimed Water System).

Is the dual system more efficient economically?

Somewhat since revenue from water and sewer rates make up for the costs of the reclaimed water system especially during times that reclaimed water demand is lowest (Jordan, 2010). During times of low demand, the reclaimed system still needs to be maintained and line flushing needs to occur (Jordan 2010).

Has the use of a dual system compromised safety?

Since there have been no illnesses associated with cross connections and the standards and specifications for reclaimed water have been revamped, the dual system has not compromised safety (Jordan, 2010).

Does the dual system position the water authority better for the future?

Since the reclaimed water system is essential for ensuring the longevity of the potable system and potable water conservation, the dual system ensures that Cary has sufficient water supply since it would extend the life of the potable treatment plant, aid in not exceeding nutrient discharge limits in the Neuse River, and other reasons listed elsewhere in this report.

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CITY OF CHANDLER, WATER DISTRIBUTION, CHANDLER, AZ

I. GENERAL INFORMATION

Evaluation Date: 6/26/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Chandler, Water Distribution Division
Contact Person: Ray Dubois
Title: Water Distribution Superintendent

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1989
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☒ Road medians ☐ Residential ☐ Schools ☒ Other: Recharge, industry
☒ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. Backflow prevention and flushing programs (Municipal Utilities-Administration, 2010).
2. Supervisory and Data Acquisition Program (Municipal Utilities-Administration, 2010).
3. Ordinance No. 2961 requires all new public recreation facilities and other new development to use reclaimed water, or recharge water on landscaped areas of 5 or more acres.
4. Requires new residential and non-residential buildings to have water efficient plumbing fixtures installed.
5. Leak detection program.
6. Water conservation rebate program conserved 18 million gallons of water according to the "Department Budgets 2009-2010" report (COC, 2009).

II. SYSTEM OVERVIEW

The City of Chandler has a population of approximately 255,000 people and is located in the Phoenix metropolitan area (City Data, 2009).

Potable Water

Chandler receives potable water from three different sources. Chandler Surface Water Treatment Plant which treats Salt River, Verde River, and Colorado River water as well as Salt River Project water. The plant supplied about 56% of Chandler's drinking water in 2009. 26 groundwater wells supplied about 36% of the City of Chandler's drinking water in 2009. Chandler partnered with the Town of Gilbert for the construction of the Santan Water Treatment Plant which supplied Chandler with 8 percent of its drinking water supply in 2009. Chandler distributed about 20 billion gallons of potable water in the 2009/2010 fiscal year. (COC, 2009). The potable distribution system consists of more than 1,180 miles of water main (COC, 2009).

Reclaimed Water

Chandler obtains reclaimed water from wastewater that has been filtered and disinfected either by ultraviolet or chlorination. Reclaimed water is used for irrigating turf, parks, golf courses, residential common areas, roadside landscaping, and non-edible crops (Water Conservation Office, 2010). In all, the reclaimed water system consists of 63 miles of reclaimed water main (COC, 2009).

Chandler also operates various facilities, including three water reclamation plants and a reverse osmosis facility which also uses nanofiltration and microfiltration for groundwater recharge. The reverse osmosis facility injected over 3 billion gallons of water into the aquifer (COC, 2009). Collectively the three water reclamation facilities treated 8.8 billion gallons of wastewater, of which 7.8 billion, was used for irrigation (COC, 2009).

Chandler has passed Ordinance No.2961 in 1999 concerning reclaimed water which amended Section 1903 of the City Zoning Code "to require that when reclaimed water is available, all new public recreation facilities and other developments with a water intensive landscaped area of five (5) or more acres shall be watered with reclaimed water supplied by the City either directly or from recovery wells. When reclaimed water is not available, the amount of water intensive landscaped area utilized will be restricted according to the provisions stated in Ordinance No. 2961" (City of Chandler Drought Management Plan, 2004). Recovery wells consist of reclaimed water.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
Not enough information to verify.

Provide any other pertinent information

Chandler conducts regular monitoring on drinking water entering the water distribution system to determine if land uses, which would affect groundwater sources, have impacted the source water (City of Chandler, 2010).

The Water Quality Division of the Water Utilities Department manages a backflow prevention and flushing program (COC, 2009).

Principal Operational Issues

The main operational issue with a reclaimed water system relates to the need for storage and recovery as a means to meet seasonal and daily supply and demand cycles. Chandler stores reclaimed water in lakes and through recharge wells during low demand cycles and recovers reclaimed water during high demand cycles.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Yes. The dual system conserved 1.49 billion gallons of potable water by delivering reclaimed water for landscape irrigation. Chandler diverted 103 million gallons of reclaimed water to Chandler Heights Recharge Facility..

How has the dual system has impacted any other (system capacity, etc.) goals?

Yes. The dual system conserved 1.49 billion gallons of potable water by delivering reclaimed water for landscape irrigation. Chandler diverted 103 million gallons of reclaimed water to Chandler Heights Recharge Facility..

Economic Information

What is the yearly O & M budget for the system?

Chandler breaks down the budget depending on what component of the potable system is involved. Water distribution expenses were about $7,441,960 in the 2008/2009 fiscal year. The Water Treatment Plant expenses were $12,291,505. Water production facilities: $5,777,740, Santan Water Treatment Plant: $605,520 (COC, 2009).

The reclaimed system was a little more difficult to determine since not all reclaimed water goes to customers directly, since some is used for recharge into the aquifer. Airport and Ocotillo Water Reclamation Plants collectively cost about $10,000,746 in the 2008/2009 fiscal year. Wastewater treatment for use at the Lone Butte Facility cost about $1,448,049 in 2008/2009 (COC, 2009).

Discuss any additional O & M costs associated with the dual system:

The cost for operating and maintaining the Reverse Osmosis Facility, which treats Intel's computer chip campus wastewater via reverse osmosis, nanofiltration, and microfiltration was $2,558,645 in the 2008/2009 fiscal year. Water quality testing, which includes the backflow prevention and flushing program, was about $1,814,483 (COC, 2009).

Discuss any rate structures used by the utility to regulate consumption:

Potable water rates increase based on the amount of water use, the size of the meter, and the water user type. The volume charges are seasonal consisting of five summer and seven winter months (Municipal Utilities Department 2010). Volume charges are also higher for users living outside the city limits than for those living in the city limits (Craig Y, 2009). Using potable water for landscape irrigation in the summer inside the city limits is $2.66 per 1,000 gallons compared with $3.73 per 1,000 gallons (Craig Y, 2009). The rate is a flat rate.

The reclaimed water rates depend on the water usage and the type of water user. (Municipal Utilities Department, 2010). The volume charge for landscape reclaimed water usage is higher for users outside the city limits. The volume charge for landscape use, like potable usage, consists of rates for the 5 summer and 7 winter months. Inside the city limits, the summer the rate is $0.398 per 1,000 gallons compared with the $0.513 per 1,000 gallons outside the city limits (Craig Y, 2009).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes. The dual system conserved 1.49 billion gallons of potable water by delivering reclaimed water for landscape irrigation. Chandler diverted 103 million gallons of reclaimed water to Chandler Heights Recharge Facility. Chandler relies on direct use of reclaimed water as a water conservation measure. Chandler also recharges and recovers reclaimed water as a means to meet seasonal supply and demand and to provide wildlife habitat.

Is the dual system more efficient economically?

It is difficult to tell due to the limited information at this time. However, the very low volume rate for reclaimed water use for landscaping may not make up for the cost to produce and convey the reclaimed water. Chandler may be more concerned about conservation than having a self-sustaining reclaimed distribution system, and the potable system may make up for the losses due to producing reclaimed water.

Has the use of a dual system compromised safety?

It is difficult to tell given the limited information.

Does the dual system position the water authority better for the future? Possibly. Chandler is in the process of increasing its water supply, which was the goal in partnering with the Town of Gilbert for the construction and ownership of the Santan Water Treatment Plant, through purchasing more water whether through buying surface water from willing sellers or excess CAP water. Chandler also plans on storing more water underground to have a stable supply of water during droughts (City of Chandler 2010-2019 CIP, 2009). If the plan is carried out, Chandler would be better prepared for the future.

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DENVER WATER, DENVER, CO

I. GENERAL INFORMATION

Evaluation Date: 7/16/2010
Prepared By: Pete Rogers

Utility Information:

Utility Name: Denver Water
Contact Person: Abigail Holmquist
Title: Recycled Water Program Manager

Services Provided

☒ Water ☐ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 2004
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:

☒ Commercial	☒ Golf courses	☒ Parks	☒ Playgrounds
☒ Road medians	☐ Residential	☒ Schools	☒ Other: Zoo

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:

☐ Commercial	☐ Residential

☒ Cooling towers
☐ Fire fighting

Unique System Features

Because the recycled water plant is located at the low point in the system, its operation requires substantial pumping.

Whereas most areas serviced with recycled water were retrofitted with secondary mains, new areas such as Stapleton and Lowry were planned and originally constructed for recycled water use.

The focus of the recycled water program is on large irrigation and commercial consumers.

Denver Water's water conservation program provides opportunities for small water users to conserve water through their "use only what you need" campaign. In 2007, of the total $11.3 million spent on conservation efforts in Colorado, Denver Water spent $8 million (Denver Water, 2010).

Water reuse in the west is impacted by unique water law issues. Denver Water only has rights to reuse water that has been transferred out of its original river basin. Reusing this transferred water helps fulfill a 1950s water rights decree.

II. SYSTEM OVERVIEW

Potable Water

Water service for the 1.3 million residents living in Denver and the surrounding areas is provided by Denver Water. Denver Water's supply comes from three primary systems: South Platte, Western Slope, and Moffat. The South Platte system collects snowmelt from the upper South Platte River basin and stores water in six reservoirs with a combined storage of approximately 252,000 AF (Denver Water, 2010). Water from these reservoirs travels via the South Platte River to the Foothills (280 MGD) and Marston (180 MGD) treatment plants. The Western Slope system collects water from the Blue River located on the west slope of the Continental Divide where it is stored the Dillon (259,000 AF) and Williams Fork (96,000 AF) reservoirs. Water from Dillon reservoir is pumped through the Roberts Tunnel and fed into the South Platter River, where it is also treated at the Foothills and Marston treatment plants (Groves et al., 2008). The Williams Fork reservoir is primarily used as an exchange facility: water taken to service the Denver Metropolitan area through Dillon reservoir is returned to the western slope through Williams Fork. This reservoir serves as the primary water and hydroelectric energy supply for the western slope. The Moffat system is located north of the South Platte and Western Slope systems. It is the smallest of the three systems providing approximately 10% of the entire water supply (Jeffco Business Forum, 2010) and operates separately from the others. This system's water originates from the west slope of the Continental Divide in the upper Fraser River basin. Water collected from the multiple tributaries of the Fraser River is pumped through the Moffat tunnel and stored in the Gross and Ralston reservoirs (combined capacity of 52,587 AF) where it is eventually treated at the Moffat treatment plant (180 MGD) (Denver Water, 2010).

Following the 2002 drought, Denver Water's Board of Water Commissioners approved an update to the 1997 Integrated Resource Plan (IRP) which called for the utility to reduce water use by 22% by 2016, develop new supplies, and recycle. In response, Denver Water has developed an internationally recognized conservation program, proposed the Moffat Collection System project which calls for enlarging Gross Reservoir's storage capacity from 42,000 AF to 114,000 AF, and developed a recycled water plant in 2004 (Denver Water, 2010).

Wastewater and Recycled Water

Denver's wastewater services area is provided by two entities: the sanitary sewer pipelines are operated through the City's Wastewater Management Division (WMD) and the Metro Wastewater Reclamation District (Metro District) operates the wastewater treatment plant. The City's WMD is also responsible for operating and maintaining the stormwater system. Whereas the WMD's jurisdiction is confined to Denver, the Metro District is stand-along special district servicing 1.6 million customers in Denver, Arvada, Aurora, Lakewood, Thornton, Westminster, and more than 45 sanitation districts (MWRD, 2010).

Approximately 140 MGD of wastewater is treated by the Metro District at the Robert W. Hite treatment plant (capacity 220 MGD) located in northeast Denver (Metro Wastewater

Reclamation District, 2010). Treated effluent is either discharged to the South Platte River, where it comprises roughly 85% of the total river flow, or to the Recycle Plant located next to the wastewater treatment plant (Metro Wastewater Reclamation District, 2010). The current capacity of the recycled water plant is 30 MGD, but it is expandable to 45 MGD (Denver Water, 2010). The recycled water distribution currently includes more than 50 miles of pipe, two major pump stations, and storage facilities (Denver Water, 2010). The focus of the program is on major water consumers (Holmquist, 2010). Current landscape irrigation applications include more than 20 parks, 6 schools, and 4 golf courses. Commercial users include the Xcel power plant which uses recycled water for fire suppression and water tower cooling as well as the Denver Zoo which uses it for landscaping and animal wash down (Holmquist, 2010). At this point in time, recycled water is not available for residential use. The utility's website indicates that once the planned build-out is complete, the project will supply more than 5 billion gallons every year.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

A cross connection occurred in 2006 during construction of the dual system at the Denver Zoo. The contaminated portion was flushed and the pipe was disinfected (Sanchez, 2006). The cross connection was isolated to a non-potable water use area and did not result in any illnesses.

Provide any other pertinent information.

Denver Water's Backflow Prevention and Cross-Connection Control program supports annual inspections of recycled water for customers.

Denver Water must meet all requirements outlined in the Colorado Department of Public Health & Environment's Regulation 84.

Denver Water treats its recycled water to the highest water quality standards outlined in the Colorado Department of Public Health & Environment's Regulation 84.

Principal Operational Issues

Because the recycled water system is branched, rather than looped, there is less redundancy (higher vulnerability).

Because so many of the users are large users whom were previously connected to raw water sources, their transition to recycled water has had very little effect on the operation of the existing potable system.

Unlike the potable system which is almost entirely gravity-fed, because the recycled water plant is located at the low point in the system, its operation requires substantial pumping.

Since many recycled water customers are irrigators with short, high peak flow use patterns, many infrastructure components are oversized and not used on a continuous basis. Therefore, adding commercial and industrial customers with more continuous demands has become a priority for the system to improve operational and infrastructure use efficiency.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Once build-out is complete, Denver Water is expecting the project to supply more than 5.7 billion gallons (17,500 AF) of recycled water per year. If the utility produces approximately 265,000 AF per year, this represents a savings of 6.6%. Additionally, Denver Water's conservation program has a goal of increasing water conservation by 22% by 2016.

How has the dual system has impacted any other (system capacity, etc.) goals?

Despite having a recycled system that was designed as a complete standalone system, Denver Water has added a potable water backup in the event of a recycling plant shut down event.

Economic Information

What is the yearly O & M budget for the system?

Denver Water's 2009 O & M budget for recycled water was $3.7 million (Denver Water, 2009). Information regarding water sales from recycled water was not available.

Discuss any additional O & M costs associated with the dual system:

Unlike the potable system which is mostly gravity-fed, because the recycled water plant is located at the low spot in the system, its operation requires expensive pumping.

There are some minimal additional costs associated with annual customer inspection and testing relating to the Backflow Prevention and Cross-Connection Control program and the mandatory yearly recycled water training for all customers.

Discuss any rate structures used by the utility to regulate consumption:

Denver water uses an increasing block rate structure for potable water. Recycled water is charged at a flat rate ($0.89 per 1,000 gallons). Recycled water rates are on average 70% lower than potable water rates. System development charges (i.e. tap fees) are 20% lower for recycled water taps than for potable water taps.

They offer a variety of rebates for both residential and commercial users through Denver Water's conservation program.

The Colorado Department of Public Health & Environment and Denver Water utility imposes various water rules (e.g. implementation of best management practices, signage, and prevention of public exposure) for recycled water customers. Denver Water also reserves the ability to set use schedules for recycled water customers.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, but at a limited scale. Conservation, new supply, and water recycling are the three key supply initiatives in Denver Water's portfolio. The utility feels that it does provide a better use of water for a small number of large-use customers. Recycling water also helps Denver Water fulfill water rights decrees.

Is the dual system more efficient economically?

Yes, despite the large pumping and infrastructure build-out costs, Denver Water asserts that the recycled water system is less expensive than developing new water sources.

Has the use of a dual system compromised safety?

No. The cross connection at the Denver Zoo was an isolated case that did not result in any illnesses.

Does the dual system position the water authority better for the future?

Yes, especially when combined with conservation. Denver Water's conservation goal of 22% and its growing recycled water program will help the utility meet the community's future needs.

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CITY OF DUNEDIN, DUNEDIN, FL

I. GENERAL INFORMATION

Evaluation Date: 10/18/2010
Prepared By: Pete Rogers

Utility Information

Utility Name: City of Dunedin, Reclaimed Water Division
Contact Person: Steve Haynes
Title: Reclaimed Water Dist. Tech III

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1992
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
- ☒ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
- ☒ Road medians ☒ Residential ☒ Schools ☒ Other: cemetery

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
- ☐ Commercial ☐ Residential

☒ Cooling towers
☐ Fire fighting

Unique System Features

1. During the dry season (Feb 1- June 30) reclaimed water is allocated to each customer based on 0.8 inches of water per week multiplied by the effective acreage (total acreage minus the house, pool, and driveway). There is a fine of $2.00 per 1,000 gallons of over-used reclaimed water (City of Dunedin: Public Works, 2010).
2. Customers are strongly encouraged not irrigate during the hours of 9 am to 6 pm and 10 pm to 5 am daily and all day Wednesday. These periods are designated to fill storage tanks and perform system maintenance. There is also a zone-specific (8 zones) watering schedule.
3. Reclaimed water is billed at an inverted rate structure (established in 1992 to encourage the usage of reclaimed water). This practice is offset by the dry season allocation system.

4. The utility uses automatic meter reading (AMR) for both potable and reclaimed water.
5. On an annual basis, every customer is provided with a report (hung on their door) comparing their actual reclaimed water use versus their allotted use.

II. SYSTEM OVERVIEW

The City of Dunedin, located 20 miles north of St. Petersburg, has an estimated population of 36,000 (City Data, 2010). The City's water, wastewater, reclaimed water, and stormwater services are managed by the water, wastewater, reclaimed water, and divisions within the Department of Public Works and Utilities.

Potable Water

The City's potable water comes from a well field containing 26 wells which a combination of fresh water and brackish water (City of Dunedin: RO Facility, 2010). Having their own water source makes the system quite unique in that most communities in the area rely on Pinellas County Utilities (PCU) for their potable water supply. Drinking water is treated at the City's Reverse Osmosis (RO) water treatment that was constructed in 1992. The plant has 9.5 MGD design capacity but is permitted for 6.2 MGD (Van Amburg, 2010). According to the City of Dunedin's 2009 Consumer Confidence Report, the average daily potable water use is 3.2 MGD or 67.3 gpcd. This demand is approximately 34% of the total plant capacity, implying that the plant has ample capacity for population growth. The community's water system is also connected to PCU's potable system which allows Dunedin to purchase water from PCU for emergencies.

Wastewater and Recycled Water

The Wastewater Division manages the collection and treatment of the community's wastewater. The collection system consists of 42 lift stations and 140 miles of sanitary sewer mains which convey the sewage to the City's Wastewater Facility. The plant has a rated capacity of 6 MGD and was designed using the A20 Biological Nutrient Removal (BNR) process (City of Dunedin: Public Works, 2010). In addition to treating sewage, the plant also treats concentrate flow from the City's reverse osmosis water treatment plant. All effluent (for use as reclaimed water or returned to surface water sources) is treated primary and secondary standards (Haynes, 2010). The average production of the Wastewater Facility is 3.8 MGD (Haynes, 2010).

The distribution and management of the City's reclaimed water system is performed through the Reclaimed Water Division. The system is comprised of 76 miles of pipeline and 4 storage tanks offering a combined storage of 5.5 MG. The system currently provides reclaimed water for over 3,400 residential customers and 160 commercial customers (Haynes, 2010). Of the average wastewater production of 3.8 MGD, the City reports that 2.8 MGD is used as reclaimed water and the remaining 1 MGD is returned to St. Joseph's Sound (Haynes, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.
The only known incident occurred due to a plumbing mistake on a residential renovation project. This occurred at the onset of the reclaimed water project and there no resulting illnesses (Haynes, 2010).

Provide any other pertinent information

1. The City has a cross connection control program which includes annual testing and inspection of backflow prevention devices. They also inspect drinking and reclaimed water plumbing for each customer on an annual basis.
2. The utility has a very extensive educational program which includes television videos and brochures that are delivered door-to-door.
3. The City also programs (free of charge) customer irrigation timers.

Principal Operational Issues

1. During the winter months, a large portion of the treated wastewater is discharged into St. Joseph's Sound since it is not needed as reclaimed water for irrigation. This has spurred talks with neighboring communities about methods to make better use of this reclaimed water. The City encourages reclaimed water usage during the winter months by using an inverted cost structure (i.e. reduced price with increased usage).
2. The City must utilize a strict irrigation schedule (9 am ~ 6 pm and 10 pm ~ 5 am daily and all day Wednesday) during the dry season in order to ensure an adequate supply of recycled water.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
Prior to the reclaimed water system, the City was unable to keep up with the potable water use demand (for example, their storage tanks were often empty). The City estimates that, since the start of the dual system in 1992, the demand for potable water has decreased from 4.85 MGD to 3.19 MGD (Haynes, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?
The reduction in potable water demand has reduced the operation time of the water treatment plant considerably (Haynes, 2010).

Economic Information

What is the yearly O & M budget for the system?
The yearly budget for 2010 is $360,785 (Haynes, 2010).

Discuss any additional O & M costs associated with the dual system:

There are a total of 3 three full time employees assigned to the reclaimed water system.

Discuss any rate structures used by the utility to regulate consumption:

There is an increasing block rate structure for potable water and an innovative dry season allotment program (based on a depth of 0.8 inches multiplied by the effective acreage) for reclaimed water. There is a fine of $2.00 per 1,000 gallons of over-used reclaimed water.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

In conjunction with conservation programs, the use of the dual system has reduced water consumption by 30% since 1992 (Haynes, 2010).

Is the dual system more efficient economically?

Yes. The City indicated that there are significant costs savings associated with reductions in well pumping and water treatment plant operation times. Likewise, the use of reclaimed water also reduces the need (and costs) associated with developing additional supplies.

Has the use of a dual system compromised safety?

No. The one reported cross connection case occurred at the onset of the project (1992) and did not result in any illnesses.

Does the dual system position the water authority better for the future?

Yes. The dual system enables the community to keep up with the community's demand without having to provide additional supplies (delaying system expansion). It also allows them to consume less energy at the well pumps and water treatment plant. Lastly, reductions in well withdrawals help maintain the integrity of the aquifer (sea water intrusion is possible in all coastal communities).

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EAST BAY MUNICIPAL UTILITY DISTRICT, OAKLAND, CA

I. GENERAL INFORMATION

Evaluation Date: 11/1/2010
Prepared By: Stephanie Edmiston

Utility Information:

Utility Name: East Bay Municipal Utility District
Contact Person: Lori Steere
Title: Community Affairs Representative II-Recycled Water Program
Phone: (510) 287-1631
Email: Community Affairs Representative II-Recycled Water Program

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1971 at EBMUD's WWTP; 1984 1st external customer
Non-potable water source: Reclaimed water
Uses of the non-potable projects

☒ Landscape Irrigation:
- ☒ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
- ☒ Road medians ☒ Residential ☒ Schools ☒ Other Industrial processing, sports fields, street cleaning

☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
- ☒ Commercial ☐ Residential

☒ Cooling towers
☐ Fire fighting

Unique System Features

The majority of recycled water customer sites are for irrigation. The Chevron refinery in Richmond, CA is EBMUD's largest recycled water customer and uses recycled water for industrial applications. Reclaimed water is produced at EBMUD's North Richmond Water Reclamation Plant for use in three large cooling towers at the Chevron refinery (averaging almost 4 million gallons per day [mgd]). In 2010, EBMUD completed construction of the Richmond Advanced Recycled Expansion (RARE) Water Project onsite at the Chevron refinery; RARE produces MF/RO recycled water for boiler makeup water (3.5 mgd) for Chevron's manufacturing production uses. Chevron's total use of recycled water (about 7.5 mgd) offsets potable water in a quantity sufficient to meet the indoor and outdoor water needs of 46,000 to 50,000 EBMUD customers.

II. SYSTEM OVERVIEW

The East Bay Municipal Utility District is located in the San Francisco Bay area in California and serves residents and businesses in portions of Contra Costa and Alameda counties. The water system serves approximately 1.34 million people and the wastewater system serves about 650,000 people (Service Area Map). Twenty cities and fifteen unincorporated communities, of which the six largest cities are Oakland, Alameda, Berkeley, and San Leandro within Alameda County, and Richmond and Walnut Creek within Contra Costa County (Summary Financial Information Statement Fiscal Year 2009). The six largest cities had a combined population of 859,774 in 2009 (Summary Financial Information Statement Fiscal Year 2009).

Potable Water System

Ninety percent of EBMUD's potable water originates from the 577-square-mile watershed of the Mokelumne River 90 miles away in the Sierra Nevada (Water Supply). When water demand is high, EBMUD supplements the Sierra supply with water from protected local watersheds (2010 Annual Water Quality Report). For emergency preparedness, EBMUD has emergency interties with other local agencies to provide back-up water supplies. In 2009, EBMUD received 870 million gallons of treated water from the San Francisco Public Utilities Commission system (2009 Annual Water Quality Report).

EBMUD's annual water consumption was 82,833 ccf in 2009 with a total of 381,728 water accounts and a service area average daily consumption of 181 mgd. The total treatment capacity for the potable water system was 500 mgd in 2009 (Summary Financial Information Statement Fiscal Year 2009). The potable water system consists of over 4,000 miles of pipe and 170 reservoirs (Summary Financial Information Statement Fiscal Year 2009).

Recycled Water System

EBMUD's wastewater service area incorporates only 88 square miles of its 331-square-mile water service area. So, in order for EBMUD to have a successful recycled water program, it must partner with other sanitation entities, with only one exception: EBMUD's main wastewater treatment plant (WWTP) in Oakland supplies the secondary effluent for the District's multi-phased, multiple-uses East Bayshore Recycled Water Project. The EBRWP produces and supplies tertiary-treated recycled water that currently serves portions of Oakland and Emeryville and eventually will serve areas of Albany, Berkeley, and Alameda (2.5 mgd at build out). Current partner agencies in EBMUD's recycled water program include: the West County Wastewater District for Richmond area customer sites; the City of San Leandro's Water Pollution Control Plant for EBMUD irrigation customer sites near the Oakland Airport and on Bay Farm Island in Alameda; and the Dublin San Ramon Services District for the multi-phased, irrigation-only San Ramon Valley Recycled Water Program (2.4 mgd to EBMUD at build out, with 3.3 mgd to DSRSD). EBMUD and DSRSD signed a Joint Powers Agreement in 1995 that created the DSRSD-EBMUD Recycled Water Authority (DERWA), which constructed a number of SRVRWP recycled water facilities that are owned in partnership and that are operated and maintained per contract by DSRSD. Additionally, EBMUD and DSRSD are responsible for constructing, operating and maintaining certain of their own separate infrastructure required to serve SRVRWP customers within their respective service areas (Steere, 2011).

In calendar year 2010 recycled water use was 5.3 mgd, served 56 customer sites (some customers have multiple sites), which saved enough drinking water to serve about 34,000 people (Steere, 2011). EBMUD used another 6.3 mgd at its main WWTP (Steere, 2011).

EBMUD's use of recycled water is necessary to help meet the District's total water needs, and helps diversify EBMUD's water supply portfolio with a source that is virtually drought proof.

EBMUD's recycled water applications are not unique. The cost of retrofitting existing customer sites tends to be expensive, and EBMUD, not the customer, pays to retrofit customer sites that the District deems cost effective to retrofit. (Steere, 2010). Much of EBMUD's service area has been developed so opportunities to retrofit large-water use sites are limited. New development that can be cost-effectively supplied with recycled water by EBMUD must pay the cost to install recycled water irrigation systems.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

This was not a cross connection as defined by regulations, but a single cross connection between two irrigation-only systems was discovered and fixed in June 2011. The potable irrigation meter is located four blocks away from the recycled water irrigation site. This situation likely resulted in the potable irrigation site not being included in the original cross-connection testing. Because the potable irrigation system has a backflow prevention device on it, technically this is not considered a cross connection according to California regulations. No illnesses resulted and the drinking water system was not affected.

Provide any other pertinent information

Principal Operational Issues

1. March and April of 2008 together were the second driest on record. In May 2008 the EBMUD Board of Directors declared a water shortage emergency and mandated water rationing to protect against a third dry year (East Bay Water 08). In response to EBMUD's recall of hydrant meters and potable water rationing and prohibition for construction purposes, EBMUD quickly developed a recycled water truck program. Additionally, the increasing use of recycled water helped stretch the drought-impacted potable supply (Steere, 2011). Droughts are a fact of life in California, with its limited water supply and growing population (Steere, 2010).
2. DSRSD is responsible for operating and maintaining the SRVRWP's DERWA facilities. A few months after the reclaimed water system started up in 2006, EBMUD customers reported having low water pressure and little water coming

out of their irrigation systems. An EBMUD investigation of its customers' sites discovered that the problem was due to clogging of the wye strainers installed downstream of the customers' recycled water meters as part of the EBMUD retrofit. EBMUD found that small plastic produce stickers were the main clogging culprit. The produce labels passed through the continuous-backwash sand filtration system used at the SRVRWP recycled water plant during times of high recycled water demand, when the microfiltration system is not capable of producing a sufficient supply. DSRSD used to manually clean off temporary screens installed upstream of the sand filtration system after the problem was discovered. DSRSD now has installed a screening system that automates the cleaning process (Steere, 2010).

3. EBMUD once discovered a problem with mosquitoes getting into one of its recycled water storage tanks. Out of concern about these last two temporary operational issues (#2 and 3) and observing a need to deal with nitrification issues that tend to develop in recycled water storage tanks over the winter months, DSRSD now cleans the tanks and DERWA pipeline system annually all the way back to the recycled water treatment plant and refills with fresh recycled water. After a few initial problems with the system shut down procedure and cleaning process, DSRSD now contacts large water-use customers (e.g., golf courses) to identify dates to avoid before embarking on the annual cleaning process (Steere, 2011).
4. The treatment plant for the East Bayshore RWP underwent almost a year of start-up testing before a variety of problems and processes were resolved and the plant was able to reliably produce a tertiary-treated supply that was delivered the EBRWP’s 1st external customer in April 2008. Prior to this, the recycled water was provided to the WWTP where the occasional loss of recycled supply was not as critical.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Fourteen percent of EBMUD’s system-wide demand was met by water rationing, conservation, and recycling in fiscal year 2008 (East Bay Water 08). Conservation programs led to a savings of 859,000 gallons per day in 2008 (East Bay Water 08).

How has the dual system impacted any other goals (system capacity, etc.)?

Use of recycled water in place of potable water for appropriate uses permits EBMUD to stretch its limited drinking water supply (Steere, 2011). Recycled water expansion and other conservations measures are due to EBMUD's need to save its limited potable supply. Since the 1990s, EBMUD's goal has been to incrementally reduce the daily consumption to 229 mgd by 2020 from the use in 1993 (Summary Financial Information Statement Fiscal Year 2009).

Economic Information

What is the yearly O & M budget for the system?

Water revenue was about $287.3 million in 2009. Total operations and maintenance for water, power, etc. in 2009 was $176.6 million. (Summary Financial Information Statement 2009). Operating expenses for raw water for 2010 was $28,959,000 and was $85,970,000 for water treatment and distribution (Biennial Budget Fiscal Year 2010-2011 Volume 1 Overview and Operating Budget). The EBMUD Board of Directors adopted a two-year budget on June 14, 2011 that includes an operating budget for the water system of $372 million in FY12 (FY11's was $369 million) and $395 million in FY13 (EBMUD Sets New Budgets, 2011).

Discuss any additional O & M costs associated with the dual system:
Recycled water costs are included in the operating budget for EBMUD's water system.

Discuss any rate structures used by the utility to regulate consumption:

EBMUD has a financial incentive rate (20% less than the potable water rate for "All Other Water Use" plus a seismic improvement charge for this category of use, as adopted by the EBMUD Board of Directors for any given fiscal year) to encourage customers to use recycled water (Steere, 2010). The rate is "fair" since recycled water customers have responsibilities (and their associated costs) not required of potable water customers: site monitoring and reporting among the key recycled water customer requirements. EBMUD also provides customers with free training and other services in order to make it easy for them to use recycled water (Steere, 2010).

Potable water system rates and charges are designed to encourage conservation and include: a water service charge (based on the size of the customer's meter), water flow charge (amount consumed by customer), an elevation charge (if applicable), and a seismic improvement program (SIP) surcharge. The SIP surcharge, for system-wide seismic improvements, is paid by residential customers. Single-family residential volume (consumption) charges are in a three-tier increasing block rate structure which in FY10 started with a Tier 1 (0-7 units) rate of $2.15 per unit (ccf or 748 gallons/unit). Effective July 1, 2011, this basic Tier 1 single-family residential rate increases by 6% to $2.28 per unit (100 cubic feet or ccf) in FY12 and by another 6% to $2.42 per ccf in FY13. The "All Other Water Use" charge for potable water in FY12 will be $2.99 per ccf, plus an SIP surcharge of 11 cents, for a total of $3.11 per ccf. The non-potable rate in FY11 is $2.34 per ccf for all water used plus elevation charges (if applicable), but no SIP surcharge for non-potable water customers. The non-potable rate increases 6% in FY12 to $2.49 per ccf (20% less than the $3.11 per unit cited above) and another 6% in FY13 to $2.64 per ccf. There are private fire service rates on the potable water system that depend on the meter size. (Water Rates, 2010 and FY12-13 Biennial Report and Recommendation of the General Manager for Revisions to the Rates and Charges).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes. However the use of recycled water and conservation are not enough to meet projected water demands and at times current demands (Summary Financial Information Statement Fiscal Year 2009). EBMUD has worked to obtain supplemental water supplies. After long legal battles ended in 2002 an agreement was reached with the City and County of Sacramento for a joint project, the Freeport Regional Water Project. The agreement is such that EBMUD can rely on up to 100 mgd of water from the Sacramento River during dry years. The project was completed in 2010. The District also plans on injecting surplus water when available into a deep, pristine local aquifer for use in the future (East Bay Water 08). EBMUD is very aggressive in seeking state grants, low interest-rate loans, and federal and other external funds to assist with design and construction costs of its recycled water projects (Steere, 2010).

Is the dual system more efficient economically?

A strong local economy and a healthy environment both depend on adequate and reliable water supplies. So, the cost of not having a recycled water supply available should be taken into account. Although a very small part of every customer's water bill provides funding for the recycled water program, this supply is necessary since it is almost impossible to get permits from state and federal agencies to construct new reservoirs in California for drinking water supplies (Steere, 2010). Since EBMUD takes into account various factors and has differing assumptions that go into cost-benefit analyses when determining the economic viability of potable vs. recycled water supplies and projects, it is difficult to compare the two water systems (Steere, 2010). Obtaining certain potable supplemental supplies can be "hugely expensive" if measured on a per unit (or ccf) basis when compared to historic potable sources (Steere, 2010). For potential recycled water projects, if the unit costs are in a particular range, EBMUD determines them to be cost effective (Steere, 2010).

Has the use of a dual system compromised safety?

No.

Does the dual system position the water authority better for the future?

Yes. As with conservation and proposed supplemental supply sources, the recycled water program is necessary to help meet EBMUD's total water demand, both in droughts and for long-term needs (Steere, 2010).

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EL PASO WATER UTILITY, EL PASO, TX

I. GENERAL INFORMATION

Evaluation Date: 6/30/2010

Utility Information

Utility Name: El Paso Water Utility
Contact Person: John E. Balliew, P.E.
Title: Vice President

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated:1963 (reclaimed water)
Non-potable water source: Reclaimed water
Uses of the non-potable line
☒ Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other: Apartments and townhome complexes, zoo, industrial processes, construction, roadway maintenance, car washing, aquifer storage recharge
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. Very low rate of main breaks per mile compared to other utilities.
2. Utilizes dispensing stations for reclaimed water users for uses such as construction.
3. Kay Bailey Hutchinson Desalination Plant is the largest inland desalination plant in the world.
4. El Paso operates three arsenic removal plants in order to produce potable water with adequate quality (EPWU Financials 2009).

Principal Operational Issues

Reclaimed water has a higher salt content than potable water and can accumulate in the soil with time if not managed properly (EPWU Irrigating With Reclaimed Water 2007).

EPWU is vigilant about maintaining the potable water system, ranking among the most reliable in the world. AWWA reported an average break rate of one main break per 4.2 miles of water line, but the EPWU has one per 16.08 miles of water line (EPWU 2010).

II. SYSTEM OVERVIEW

The City of El Paso has a population of approximately 620,500 people and is located in El Paso County (City Data 2009).

Potable Water

The total available potable supply in El Paso is about 150,000 AF/yr, which includes about 5,000 AF/yr of reclaimed water (approximately 6,500 AF in 2010-2011), about 60,000 AF/yr of surface water, 50,000 AF/yr of Hueco Bolson groundwater, and about 35,000 SF/yr of Mesilla Bolson groundwater. Surface water supply varys and El Paso largely uses increased groundwater pumping to make up the difference. However, El Paso is encountering problems related to declining groundwater levels and brackish groundwater intrusion. The potable water system consists of over 2,400 miles of pipeline. The reclaimed system consists of 46 miles of pipeline (EPWU Financials 2009).

Reclaimed water system

1. Northwest Reclaimed Water Project – was put into service in 1999, consists of 25 miles of pipeline and provides approximately 525 million gallons of reclaimed water annually to a golf course, seven schools, nine parks, several street parkways, condominium associations, townhomes, apartments, and residential customers for irrigation of landscapes. The system also uses an automated dispensing station that provides wholesale on-demand service to water haulers for construction and other non-potable uses (EPWU Northwest Reclaimed Water Project 2007).
2. Central Reclaimed Water Project – The project consists of several phases, the second phase was completed in 2005 and the two phases collectively consist of more than ten miles of pipeline, a 1 million gallon elevated storage tank, treatment filters, a pumping station, and two permanent Dispensing Stations. The project was designed to save over 400 million gallons of drinking-quality water annually upon the completion of upcoming phases. The system is being expanded to serve customers that include several schools and parks, and provide wholesale service to Ft. Bliss. The first phase of the expansion (North Central Project) will be completed in Summer 2011. The second part of this first phase will include construction of a reservoir and pump station in 2012. Various water users include parks, golf courses, schools, cemeteries, city medians, and parkways (EPWU Central Reclaimed Water Project 2007).
3. Mission Valley Reclaimed Water Project - The Roberto Bustamante Wastewater Plant supplies reclaimed water through 8,000 linear feet of pipe to the Riverside International Industrial Center. The project was expanded to include

irrigation customers such as commercial sites, parks, schools, and a cemetery (EPWU Mission Valley Reclaimed Water Project 2007).

4. Northeast Water Reclamation Project – The reclaimed water originates from the Fred Hervey Water Reclamation plant and is treated to tertiary standards meeting drinking water quality. The project consists of 10 miles of pipeline, 2 pump stations, several recharge wells and infiltration basins, and has a ten million gallon per day capacity. Water available for recharge is declining as demand for water for irrigation and industrial purposes increases. Water users include a regional park, golf course, ranch, cooling tower for power generation, and construction uses.(EPWU Northeast Water Reclamation Project 2007).

Potable Water System

1. Upper Valley Water Treatment Plant –Designed in order to meet the stringent 10 ppb maximum allowable amount of arsenic. The water comes from the Mesilla Bolson, from which El Paso obtains 19% of its water. The treated water is blended with untreated groundwater to reduce arsenic concentration. Potable water is eventually supplied to the west side of El Paso and smaller municipalities. The plant capacity is 30 MGD (EPWU Upper Valley Water Treatment 2007).
2. Jonathan Rogers – Treats Rio Grande water for use by El Paso Water utilities, and 32,000 feet of pipeline to supply water to El Paso residents and colonias. Capacity is over 60 MGD (EPWU Jonathan Rogers 2004).
3. Robertson/Umbenhauer – These two plants supply more than 40 MGD. (EPWU Robertson/Umbenhauer 2004)
4. Kay Bailey Hutchinson Desalination Plant – World's largest inland desalination plant which is designed to produce 27.5 million gallons of fresh water daily (MGD) and purifies previously unusable brackish groundwater supply. The plant increases the El Paso Water Utilities' fresh water production by approximately 25 percent. The plant was completed jointly with Ft. Bliss.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
More information is needed to verify this.

Provide any other pertinent information

The City of El Paso has a wellhead protection program in order to prevent the contamination of groundwater supplies and prevents costly solutions to purifying contaminated groundwater (EPWU Wellhead Protection 2004). El Paso also posts signs near the water wells to notify the public of the well protection area, which is a one quarter mile radius surrounding all public wells, including well fields (EPWU Wellhead Protection 2004). Information concerning potential source of contaminants within the protection areas is inventories one every three to five years (EPWU Wellhead Protection 2004). There are approximately 200 wellhead protection areas located throughout El Paso (EPWU Wellhead Protection 2004).

All sites using reclaimed water have reclaimed water warning signs posted within the premise (EPWU Wellhead Protection 2004). The number of signs is based on the property size, the number of access points, and how many people access the site (EPWU Wellhead Protection 2004).

El Paso uses two types of cross-connection controls in order to protect potable water supply:

1. Isolation cross-connection control – installing approved backflow prevention assemblies at the customer's drinking water system.
2. Containment cross connection control - use of an air gap and/or an approved backflow prevention assembly at each water service connection to a customer's water system.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

In 1989, The El Paso Water Utilities adopted various ways to conserve groundwater such as an increasing block rate structure, incentive programs, increased use of the Rio Grande water, and expanding the use of reclaimed water. Groundwater pumping peaked in 1989 with the pumping of about 80,000 acre-feet compared with pumping below 40,000 AF in 2002. However, pumping increased in 2003 through 2004 due to a drought. But conservation proved to be effective in 2005 when pumping was below 40,000 AF. Surface water is another significant source of water supply and accounts for the fact that the total water demand is about 110,000 SF/yr. Due to conservation measures, the per capita water demand has reduced from about 225 gpcd in the 1970s (EPWU Present and Past Water Supplies 2007) to about 135 gpcd in 2010 as shown in Figure 1 (EPWU Service Area Profile 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

The dual system has been expanded many times and is currently in the process of being expanded. It has enabled EPWU to reduce the potable water peak demands over time.

Economic Information

What is the yearly O & M budget for the system?

The total operating expenses for the potable and non-potable systems for fiscal year 2009, or as of August 2009, was $146,374,180 and total revenue was $176,909,889 (Financials 2009). The 2009 Annual Report 2, gives a better indication for how extensive the potable system is compared to the non-potable system by delineating the revenue and expense of the water compared to the reclaimed system. The revenue from the water, potable, system was $79,844,029 compared to the $2,300,400 for the reclaimed system. The total expense for the water and reclaimed water systems was $41,675,693 (Byram 2010).

Discuss any additional O & M costs associated with the dual system:

Investing in reclaimed water system infrastructure has a good cost benefit because “of millions of dollars in grants from the federal government for these projects and is comparative in costs to other viable new water supply sources” (EPWU 2010). Not to mention El Paso surpasses 1.9 billion gallons of billed reclaimed water per year (EPWU 2010).

Discuss any rate structures used by the utility to regulate consumption:

The reclaimed water rate is $1.24/1,000 gallons, unless otherwise specified in a contractual agreement (EPWU Reclaimed Water Rates 2007). The base potable water rate depends on the meter size of the customer (El Paso Financial Statistics 2009). The volumetric rates are based on the customer's average winter consumption (AWC),that includes the previous December, January, and February water use, and are organized by a three tier increasing block rate structure beginning with $1.45 per CCF (Water, 2008).

IV. CONCLUSIONS

Does the dual system provide a better use of water?
Yes

Is the dual system more efficient economically?
Yes

Has the use of a dual system compromised safety?
As far as I can tell, no it has not. More information is needed.

Does the dual system position the water authority better for the future
Yes, due to water conservation achievements.

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CITY OF EUSTIS PUBLIC UTILITIES DEPARTMENT, EUSTIS, FL

I. GENERAL INFORMATION

Evaluation Date: 10/28/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: El Paso Water Utility
Contact Person: John E. Balliew, P.E.
Title: Vice President

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated:2003 (reclaimed)
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:

☐ Commercial	☐ Golf courses	☒ Parks	☒ Playgrounds
☒ Road medians	☒ Residential	☐ Schools	☒ Other: Cemetery, sold to other entities for golf course irrigation

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
  ☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. Some reclaimed water is sold to Sorrento Springs and Heathrow for golf course irrigation (Wastewater Treatment Facility, 2010).
2. Several residential developments use reclaimed water (Johnson, 2010). Whether or not the distribution lines were larger for the reclaimed water supply to these developments could not be verified (Johnson, 2010).
3. The use of reclaimed water meets the City's "alternative water incentive" mandated by the local water management district (Johnson, 2010).

II. SYSTEM OVERVIEW

The City of Eustis has a population of approximately 19,100 people and is located in Lake County (City Data, 2009). The Public Utilities Department is generally responsible for the water transmission, sewer force main, reclaimed water transmission and stormwater retrofits projects (Public Utilities, 2010).

Potable Water System

Potable water use is governed by the St. John's River Water Management District, which has limited irrigation to twice per week, prohibited watering between 10 and 4 pm, and has limited the amount of watering that can be done (Utility Customer Service, 2010).

Reclaimed Water System

The use of reclaimed water began in 2000 primarily to support hay crops, but beneficial use began in 2003 when the first golf course was hooked up to the reclaimed water system (Johnson, 2010). Eustis began the cross connection program in 2007 when residential irrigation with reclaimed water began (Johnson, 2010).

About half of the reclaimed water used is for landscape and turf grass irrigation (Reclaimed Water, 2007). Anyone who wishes to use it for other than the sprinkling of plants, landscapes and turf grass must submit a request for evaluation and approval (Reclaimed Water, 2007).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

So far there have not been any cross-connections or associated illnesses noted (Johnson, 2010).

Provide any other pertinent information

Eustis has a cross connection control program which requires all sites where reclaimed water is provided; the public potable water supply must be protected by an approved double or dual check valve assembly. A minimum of one annual inspection by the City is required for all customers that have reclaimed water (Reclaimed Water, 2007). Eustis also distributes pamphlets detailing the local ordinance concerning system tampering and cross connections and other water use information, such as water dosing and times for watering (Johnson, 2010).

Principal Operational Issues

1. Producing and distributing reclaimed water costs more and is a "fairly new concept" to Eustis.
2. The distribution infrastructure does not exist in most the older portions of town, and the cost to retrofit and upgrade those areas would not be cost effective (Johnson, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

The reclaimed water system has a minor potable water conservation impact, since the system is still in the early stages of development, only effecting a reduction of potable water use by about 0.5 mgd (Johnson, 2010). As the reclaimed water system expands, "hopefully these numbers will improve" (Johnson, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

The reclaimed water system is expanding (CAFR, 2010).

Economic Information

What is the yearly O & M budget for the system?

The total expense for water and sewer operations for Fiscal Year 2009 was \$6,698,303 and the total revenue was \$7,080,886 (CAFR, 2009).

Discuss any additional O & M costs associated with the dual system:

The additional costs are difficult to pull out from the total cost.

Discuss any rate structures used by the utility to regulate consumption:

Volumetric reclaimed water rates depend on the user type, whether the user is in or outside the City limits. Residential users, outside and inside the City limits, are charged according to a three tier increasing block rate structure. Customers outside the City limits pay higher rates (Reclaimed Water Rates, 2010).

Commercial users pay a flat rate for volumetric usage. However, the rate depends on whether or not the user is inside or outside the City limits, and if the user is a "larger user". Larger users are those that use more than 100,000 per day and pay the lowest flat fee, \$0.28 per 1,000 gallons (Reclaimed Water Rates, 2010).

Potable water rates also depend on whether or not the user is inside or outside the City limits and each set is according to a four tier increasing block rate structure. Potable irrigation rates depend on the user type, commercial or residential, and whether or not they are inside or outside the City limits. All irrigation rates are according to a three tier increasing block rate structure (Water Rates, 2010).

For potable water use, RV parks pay availability charges and depending on the location, inside or outside the City limits, and pays a flat volumetric rate. Commercial user charges depend on the location and are according to a two tier increasing block rate structure. Industrial potable water users are charged depending on the location and according to a two tier increasing block rate structure (Water Rates, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Since the system is fairly new, the potable water conserved has only been about 0.5 mgd, but will probably increase as the reclaimed water system expands.

Is the dual system more efficient economically?

No it is not. Producing and distributing reclaimed water is more expensive than providing potable water. The system does not pay for itself and will take many years to recoup the monies being utilized on storage tanks, distribution lines, pumps and hydro tanks and design costs (Johnson, 2010).

Has the use of a dual system compromised safety?

No, since there have not been any cross connections reported nor associated illnesses.

Does the dual system position the water authority better for the future?

Yes, since the reclaimed water system is necessary in meeting projected water demands. The use of reclaimed water was necessitated by the fact that the local water management district has "tasked all municipalities in the region to seek out and develop alternative water sources to meet future demands" (Johnson, 2010). Eustis conducted a study recently on alternative water supply which indicated that the "most viable option is in the further development of reclaimed water" (Johnson, 2010).

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GWINNETT COUNTY WATER RESOURCES, LAWRENCEVILLE, GA

I. GENERAL INFORMATION

Evaluation Date: 2/8/2011
Prepared By: Stephanie Edmiston

Utility Information:

Utility Name: Gwinnett County Water Resources
Contact Person: Neal Spivey
Title: Water Production Division Contact

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other

Dual System Information

Year initiated:2003 (RW)
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☐ Road medians ☐ Residential ☐ Schools ☒ Other: Trucked for uses such as dust control, sewer cleaning, professional chemical/pesticide applications and concrete mixing.
☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
☒ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. Wastewater is treated at the F. Wayne Hill Water Resource Center and treated effluent is discharged into the Chattahoochee River via a 20 mile pipeline from which reclaimed water customers siphon reclaimed water (Reuse in Gwinnett).
2. There are currently no residential reclaimed water customers since they would need to install dual plumbing systems (Reuse in Gwinnet).
3. A portion of the reclaimed water treated is returned to Lake Sidney Lanier, the raw water source (Jalla, 2011).
4. The Gwinnett Environmental & Heritage Center and the Coolray Stadium use reclaimed water for toilets in addition to irrigation (Jalla, 2011).

II. SYSTEM OVERVIEW

Potable Water System

As of 2008, Gwinnett County Georgia had 233,675 potable water customers/meters, 3,399 miles of water main, 40,614 fire hydrants, and a water use of about 71.9 mgd (Department of Water Resources, 2008). The potable system also has a raw water storage capacity of 45 million gallons. Gwinnett County obtains water from Lake Sidney Lanier.Two plants, Shoal Creek and Lanier Filter Plants, produce potable water and produced a total of 32 billion gallons of water in 2008 (DWR, 2008). At the end of 2008, there was 91.7 million gallons of storage capacity in the potable water system (DWR, 2008). The County used 23,367.75 million gallons of potable water in 2009 (Jalla, 2011).

The County is in the middle of interstate water conflicts for various reasons including: the question of whether or not Congress authorized the Army Corp of Engineers to operate Buford Dam, which created Lake Lanier, to accommodate water supply; the various uses of storage in the Flint River Basins (ACF) (DWR, 2008).

Reclaimed Water System

Gwinnett County Georgia is the home of a unique reclaimed water system. Wastewater is treated at the F. Wayne Hill Water Resource Center in Buford, GA, via a stringent 11 step treatment process which involves double ozone disinfection and carbon filtration (FAQs) which returns it to "an almost pristine state" (Water Reuse FAQs) before conveying it via a 20 mile pipeline to the Chattahoochee River (Reuse in Gwinnet). In all, the reclaimed water system is composed of 37 miles of main (Jalla, 2011). The pipeline is non-pressurized and spans an uneven terrain, "which makes pressure also an issue for service". Reclaimed water is siphoned off of this pipeline for service, thus, the availability for customers to have a direct connection is limited. However, some customers utilize holding ponds for the reclaimed water and pump out of the holding pond when needed, and the ponds are located such that no storm water runoff can enter the pond and cause overflow (Jalla, 2011). There is a Reuse Trucking Program for those who cannot hook up to the system directly, and they must complete an online training program, meet vehicle requirements for transporting and operating within Gwinnett County to haul water for irrigation (Reuse in Gwinnett). Reclaimed water customers include the Bear's Best Golf Course, the Mall of Georgia, the Bunten Park in Duluth, and Pinckneyville Park in Peachtree Corners (Water Reuse FAQs). Currently, there is a 72 inch reuse pipeline to convey reclaimed water from the Hill WRC to Lake Lanier, in construction which is expected to be complete in 2010 (Waterwords, 2010). One of the listed benefits of reclaimed water is postponing treatment plant expansions. Currently, reclaimed water customers are using over 185 million gallons of reuse water each year (Waterwords, 2010). In 2009, about 133 million gallons of reclaimed water was used (Jalla, 2011). Customers include public parks, private golf courses, retail malls, the Gwinnett Environmental & Heritage Center, and the Coolray Stadium (Jalla, 2011). The Gwinnett Environmental & Heritage Center and the Coolray Stadium use reclaimed water for toilets in addition to irrigation (Jalla, 2011). A portion of the reclaimed water is returned to Lake Sydney Lanier (Jalla, 2011). The Hill WRC is one of four wastewater reclamation facilities owned and operated by Gwinnett County (Crooked Creek, Yellow River, Jackson, Jacks WRF) and an additional wastewater treatment plant is partially owned by Gwinnett County and is operated by another utility, Pole Bridge (DWR, 2008).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

Gwinnett County continuously samples and analyzes reclaimed water to ensure quality before leaving the Hill WRC and at the discharge point. In about five years of testing, "no bacteria or virus has been detected" (FAQs).

Provide any other pertinent information

Visible components of the reuse water system are painted a light purple to distinguish the system from the drinking water supply (FAQs).

Gwinnett County requires double detector check backflow preventers to be installed on the potable system along with a three foot air gap between the reuse system and the potable system (Jalla, 2011).

Principal Operational Issues

1. The principal operational issue is the fact that the reclaimed water system pipeline is not pressurized for its entire length and flows by gravity in sections which limits customer access to areas that are geographically located in troughs where the terrain induces hydraulic head (Jalla, 2011).
2. The principal operational issue with the potable system is that the two water treatment plants serve four pressure zones since the elevation ranges from 1400' MSL to 750' MSL (Jalla, 2011). However, the County implemented an Energy Management Software package that "projects system demand, schedules pump operations, tank filling and turnover (for water quality), and makes production plant rate changes based on system conditions and power costs" (Jalla, 2011). The package monitors pressures and adjusts automatically to changing conditions, "while saving more than $100K per year in power costs" (Jalla, 2011).
3. Gwinnett receives all its source water from Lake Lanier, which is at the center of a water dispute between Georgia, Alabama, and Florida. The final resolution of this dispute will influence future priorities of the County and reclaimed water use (Jalla, 2011).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

On a limited basis since reclaimed water use accounts for less than 1 percent of the total water demand in Gwinnet County.

How has the dual system has impacted any other (system capacity, etc.) goals?

On a limited basis since reclaimed water use accounts for less than 1 percent of the total water demand in Gwinnet County.

Economic Information

What is the yearly O & M budget for the system?
Water production costs are approximately $540/MG; water reclamation costs average (for four facilities) approximately $1500/MG (Jalla, 2011).

Discuss any additional O & M costs associated with the dual system:
This information is not available.

Discuss any rate structures used by the utility to regulate consumption:
The base potable water rates depend on the size of the meter with the exception of multi-family housing. Wholesale and retail customers are charged a flat rate for volumetric potable water use which increases periodically. Accounts other than irrigation and builders account pay a surcharge for potable water use depending on how much is used. Single family volumetric rates are according to the three tiered increasing block rate structure. Volumetric rates are set according to average usages in January, February, and March. The volumetric reclaimed water rate is a flat rate that will increase every year until 2015, and is currently $0.93 per 1,000 gallons (Rates Resolution, 2009).

IV. CONCLUSIONS

Does the dual system provide a better use of water?
On a very limited basis since reclaimed water use accounts for less than 1 percent of the total water demand.

Is the dual system more efficient economically?
No, since the cost per million gallons to produce reclaimed water is about 3 times the cost of producing potable water per million gallons.

Has the use of a dual system compromised safety?
No, since the cost per million gallons to produce reclaimed water is about 3 times the cost of producing potable water per million gallons.

Does the dual system position the water authority better for the future?
No, since the cost per million gallons to produce reclaimed water is about 3 times the cost of producing potable water per million gallons.

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IRVINE RANCH WATER DISTRICT, IRVINE, CA

I. GENERAL INFORMATION

Evaluation Date: 9/10/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Irvine Ranch Water District
Contact Person: Carl Spangenberg
Title: Senior Engineer, Capital Projects

Services Provided

☒ Water ☒ Wastewater☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1967
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other Industrial processes
☒ Agricultural Irrigation
☒ Toilet and urinal flushing:
☒ Commercial ☒ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. The treated and recycled water that is supplied by the IRWD comprises over 25 percent of the water used in the service area.
2. Most of the recycled water is used for landscape and agricultural irrigation, but it is also used for toilet and urinal flushing in 40 dual plumbed office buildings and as make-up water in several cooling towers.
3. There are various water conservation measures such as having a Commercial and Industrial Water Use Efficiency Incentive Program, which consists of awarding business and industry by paying them a certain amount of money for saving water (IRWD Make It Your Business. To Be Water Smart); offering water use efficiency surveys and free residential and professional landscape workshops (IRWD Saving Water. From The Ground Up); co-funding rebates for water conservation for residential, commercial and landscape, and

industrial customers (IRWD Rebates. For One And All); offering landscape workshops geared toward conservation (IRWD Hands On. Expert Guidance); limiting spray head irrigation (IRWD How Often? How Long?); and educational outreach (IRWD Resources. At Your Fingertips).

II. SYSTEM OVERVIEW

Irvine Ranch Water District (IRWD, 2009) was established in 1961 and provides potable water, wastewater, and recycled water services to a population of approximately 330,000. In FY 2007-2008, water deliveries were: 57,795 AF treated; 26,185 AF recycled; and 8,036 AF non-potable untreated.

Potable System

IRWD's potable water comes from two primary sources, local groundwater and imported water (IRWD Water Now. Secured Future). About 50 percent of the overall water supply comes from local groundwater sources in the Orange County Groundwater Basin, and the Irvine and Lake Forest sub-basins. In the past, almost all the water supply was imported, but now it supplies about 20 percent of the overall water supply (IRWD Water Now. Secured Future). The water is purchased through the Municipal Water District of Orange County from the Metropolitan Water District of Southern California (MWD), which obtains water from Northern California and the Colorado River (IRWD Water Now. Secured Future). About 26 percent of the total supply comes from reclaimed water and 4 percent comes from non-potable native water sources (IRWD Water Now. Secured Future).One of the reasons for the diversified water portfolio is that the supply that ultimately comes from the San Francisco Bay Delta Estuary and the Colorado River has come under additional environmental and other restrictions that have impaired their reliability (IRWD Plan Ahead. Bank It Now). Potable water is disinfected with chloramines, rather than chlorine, in order to maintain the required disinfection residual (IRWD Water Quality. Questions? Answers).

Water Supply Measures

IRWD plans to be able to augment imported water reliability and safeguard against imported water shortages through the Strand Ranch Integrated Water Banking Project. The goal is to provide enough water meeting approximately 15 percent of IRWD water needs during critically dry years (IRWD Plan Ahead. Bank It Now). IRWD also partnered with the Rosedale-Rio Bravo Water Storage District in Kern County to construct 502 acres of groundwater recharge ponds (IRWD Plan Ahead. Bank It Now). Groundwater wells are being constructed to be able to pump water out of the bank (IRWD Plan Ahead. Bank It Now). Also, IRWD is in the process of obtaining more water to add to the water bank (IRWD Plan Ahead. Bank It Now).

Reclaimed System

In Southern California, water efficiency is important and the District operates a treated recycled water system that serves some 4,000 sites with over 300 miles of pipelines. The numbers of recycled water connections are: 4,022 landscape irrigation; 40 commercial; 18 agricultural (including some untreated); and 2 industrial.

The IRWD is a leader in the distribution of recycled water and has been studied a number of times including in Asano, et. al., 2007. It dates the recycled water service to 1967, when the agricultural water services started. The purpose of the recycled water system is to maximize drinking water sources by reducing the use of potable water for non-potable uses and to minimize the treated wastewater that is sent to a regional wastewater agency for ocean disposal (Crook, 2004).The water complies with Title 22 of the California Department of Health Services.IRWD has a water quality laboratory to monitor the reclaimed water.

Distribution of water to commercial users dates to 1991, when IRWD assisted with construction of six office buildings with dual plumbing systems.IRWD considered nonresidential buildings appropriate due to the high level of attention to prevention of cross-connections and it had in 2005 two employees dedicated to monitoring the system for cross-connections.It also has a group for monitoring construction and inspecting facilities for cross-connections.

Recycled water comes from the Michelson Water Recycling Plant, producing about 18 mgd (IRWD Reservoirs. Pipes. Treatment Plants), and is treated to tertiary standards (IRWD The Vision). The IRWD, a member of agency of the South Orange County Wastewater Authority, a joint powers authority, operates the Los Alisos Water Recycling Plant; which converts about 7 mgd of wastewater into recycled water (IRWD Reservoirs. Pipes. Treatment Plants), located in Lake Forest under the permit issued to the SOCWA (IRWD Regulations. Rules. Policies).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
More information is needed to verify this.

Provide any other pertinent information

From Crook, 2004: Quote from Steve Bourke, Landscape Superintendent for Irvine—no adverse effects from using recycled water for more than 30 years.

According to Title 17 of the California Code of Federal Regulations backflow prevention devices are required at sites that use reclaimed water as well as outlines requirements for cross connection programs (IRWD Recycled Water. Questions? Answers).

The California Department of Public Health is in charge of regulating both potable and recycled water programs through enforcement of applicable regulations (IRWD Regulations. Rules. Policies). The Orange County Health Care Agency oversees portions of IRWD's recycled water program on behalf of the Department of Public Health (IRWD Regulations. Rules. Policies). IRWD has its own regulations for reclaimed water including requirements on the use of recycled water, requirements to use recycled water, the design and construction of on-site recycled water facilities, and the operation of on-site recycled water facilities (Regulations. Rules. Policies).

Principal Operational Issues

The principal operational problems are salinity and need for winter storage. Salinity is caused by source water, the closed-loop water reclamation system, and use of self-regenerating water softeners that add salt to sewage. IRWD passed rules to prohibit self-generating water softeners but it was overturned in court.

The storage issue arises from synchronization of production of reclaimed water with demand, especially for irrigation. Wastewater production peaks in winter and summer irrigation demand is high. Finding storage sites is difficult and nutrients in reclaimed water cause algae growth.

In general, reclaimed water systems require more maintenance than potable water including: reservoir cleaning; corrosion of control valves due to corrosion; cross-connection control; and reporting of leaks or spills to the health agency. Also, a water reuse program requires vigilance and effective community outreach.

IRWD implemented the nitrification/denitrification activated sludge process at MWRP in 1997 which has significantly reduced the total inorganic nitrogen levels in recycled water that minimizes impacts on water quality within IRWD's storage reservoirs.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

According to the IRWD, producing recycled water is an essential component of the water supply portfolio. In fact, approximately 25 percent of the water demand is met with reclaimed water (IRWD Innovative Approach).

How has the dual system has impacted any other (system capacity, etc.) goals?

Capital expansion is planned to meet increased demands for recycled water. This includes the Michelson Recycling Plant Phase II Expansion, with includes adding about 10 mgd of capacity in order to meet projected water needs (IRWD Michelson Recycling Plant Phase II Expansion).

Economic Information

What is the yearly O & M budget for the system?

O&M including treatment and distribution was $6.6 million in FY 2002-2003.

Discuss any additional O & M costs associated with the dual system:

Capital costs are financed through internal funding mechanisms and recovery from property taxes and connection fees.

Discuss any rate structures used by the utility to regulate consumption:

For its rate structure, IRWD uses five-tiers of charges on ascending blocks with the aim to promote water efficiency and it has an active program to assist customers in saving water. Base recycled rate is 90% of base domestic rate or $0.68/100CF. However, savings depend on what the reclaimed water is used for. For instance, recycled water sold for industrial purposes such as toilet flushing, cooling towers, composting, and concrete production, is sold for 40 percent less than potable water (IRWD Recycled Water Rates, effective July 1, 2010). There are added costs for recycled residential water users who reside at higher elevations, with surcharges ranging from \$0.16 to \$0.42 per ccf (IRWD Recycled Water Rates. Effective July 1, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Based on water use, the dual system has extended water supplies for IRWD significantly. This enables the District to offer more irrigation water and to fit commercial buildings with dual systems. Recycled water reduces the need for expensive imported water. Recycled water improves drought preparedness. Recycled water has high public acceptance, bolstered by public outreach program.

The rate allocation has improved water conservation since the per acre consumption dropped significantly:

"Between 1992 and 2005, the average landscape water use within the district decreased from 4.2 acre-feet per acre per year to 1.9 acre-feet per acre per year, a 61 percent reduction. From 2001 to 2006, irrigated area in the district increased 280 percent, but total landscape water usage only increased 70 percent" (IRWD Reward Efficiency. Discourage Waste).

Is the dual system more efficient economically?

It is difficult to tell, more information is needed in order to determine this.

Has the use of a dual system compromised safety?

No, IRWD has a 35-year record of successfully and safely providing recycled water.

Does the dual system position the water authority better for the future?

Yes it does, since it is essential for water conservation purposes and a large portion of the water demand is met with reclaimed water. Incentives for reclaimed water use include: extending drinking water supplies, reducing the need for additional potable water facilities, reducing the amount of treated wastewater discharged into the ocean, reducing reliance on costly imported water supplies, and increasing water supply reliability (IRWD Innovative Approach).

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CITY OF LARGO, LARGO, FL

I. GENERAL INFORMATION

Evaluation Date: 10/18/2010
Prepared By: Pete Rogers

Utility Information

Utility Name: City of Largo, Environ. Services Department
Contact Person: Irvin Kety
Title: Environ. Services Director

Services Provided

☐ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1984
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other: cemeteries
☒ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. The pressure of the reclaimed water leaving the treatment plant is 95 psi (even though the area is very flat).
2. There are two primary motivations behind the dual system: decrease demand for potable water provided by an external supplier and reduce effluent discharge to Tampa Bay. The issue of minimizing discharge to Tampa Bay (using as much reclaimed water possible) is the primary reason why the City has three tanks with a combined storage capacity of 18 MG.
3. The utility requires a certain percentage of "commitments to connections" prior to installing the reclaimed water pipeline to an area. Once the purple pipeline is installed, everybody is charged an availability fee (even if they are not connected). Once they are connected, there is a regular flat service fee.

II. SYSTEM OVERVIEW

The City of Largo is located 25 miles west of Tampa along the Gulf Coast of West Central Florida. Largo is the 4th largest city in the Tampa Bay Area with an estimated population of 75,000 (City of Largo, 2010). The City's Environmental Services Department operates all phases (collection, transmission, and treatment) of the community's wastewater and reclaimed water systems and the Street and Drainage division of the Public Works Department operates the stormwater system which services approximately 140,000 people. Potable water service is provided by Pinellas County Utilities.

Potable Water

Pinellas County Utilities receives its water from Tamp Bay Water (TBW) which serves as a regional water wholesaler to three nearby cities (New Port Richey, St. Petersburg, and Tampa) and three counties (Hillsborough, Pasco, and Pinellas). TBW's system is unique in that its supply is a blend of surface water, groundwater, and desalinated seawater (Tampa Bay Water, 2010). Whereas surface water comes from the Tampa Bypass Canal, the Alafia River, and the Hillsborough River the ground water is pumped from 13 well fields scattered throughout the three participating counties. Seawater is extracted from Tampa Bay. The TBW system consists of a 15.5 billion gallon (47,568 AF) reservoir, a 72 MGD surface water treatment plant, a 25 mgd seawater desalination plant, and 200 miles of interconnected water mains (Tampa Bay Water, 2010).

Wastewater and Recycled Water

Largo's Environmental Services Department is responsible for the collection and treatment of the City's wastewater. The collection system consists of 52 lift stations and 380 miles of sanitary sewer mains which convey the sewage to the Wastewater Reclamation Facility (WWRF). Although the WWRF has a rated capacity of 18 mgd, the City reports an average production of 10.91 mgd (2009) and 11.72 mgd (through June 2010) (Kety, 2010). Effluent from the plant is either used in the reclaimed water system or discharged into Tampa Bay via the Feather Sound Lake system. The reclaimed system contains 93 miles of purple pipeline and 3 storage tanks (3 mg, 5 mg, and 10 mg). The City reports that for 2009 the reclaimed system used an annual average of 6.49 mgd, with occasional peak flows of over 10 mgd (Kety, 2010). Of the 6.49 mgd used by the reclaimed system, approximately 40% is consumed by commercial customers and the remaining 60% by residential customers (Environmental Services, 2010). As of August of 2010, reclaimed water is provided to 2,554 residential customers and 147 commercial customers (Kety, 2010).

An article appearing in the St. Petersburg Times on May 8, 2001 reported that City's reclaimed water project was losing approximately $1.2 million annually. The article proposed two solutions: increasing the monthly service fee and attracting more customers by eliminating the initial hookup fee. Since the publication of this article, the Utility has focused on attracting more users to the reclaimed system by simplifying all the processes (administration, installations), waiving all the fees (permit, connection), and offering the hook up kit for free.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
N/A

Provide any other pertinent information
The county (Pinellas Municipal Utilities) performs yearly backflow and cross connection tests for all users.

Principal Operational Issues

1. Limited carrying capacity in the pipeline between the Wastewater Reclamation Facility (WWRF) and Tampa Bay creates an overflow risk.
2. Wastewater leaving the WWRF often has high levels of disinfection by-products which lead to occasional compliance fines.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
The total usage of reclaimed water for 2009 was 2.368 billion gallons. Because Pinellas County Utilities does not have data regarding the total annual potable water consumption, and the percent savings cannot be accurately established.

How has the dual system has impacted any other (system capacity, etc.) goals?
The City has increased the storage capacity of the reclaimed system to 18 MG in order to minimize discharges into Tampa Bay.

Economic Information

What is the yearly O & M budget for the system?
The annual operation and maintenance budget for the reclaimed system was $2.4 million. This represented approximately 11% of the total $22 million budget for the Environmental Services Department.

Discuss any additional O & M costs associated with the dual system:
Costs associated with the City's reclaimed water maintenance crew (5-6 people) and supervisor.

Discuss any rate structures used by the utility to regulate consumption:
Reclaimed water is billed at a flat rate: $10 per month for customers within the City limits, $12.50 per month for customers outside the City limits.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes. Water in this region of the country is too valuable to be used just once.

Is the dual system more efficient economically?

Like most reclaimed systems, the system is not self-sufficient in that it requires fiscal support from the water and wastewater systems (Kety, 2010). However, the City feels that the costs associated with meeting quantity and quality requirements without the reclaimed system (i.e. developing other water supplies and treat effluent to the higher levels of treatment required for discharging to surface waters) would be larger.

Has the use of a dual system compromised safety?

No. There have been no reported cases of cross connections or illnesses related to the consumption of reclaimed water.

Does the dual system position the water authority better for the future?

Yes. The dual system allows the community to be less dependent on outside services (Pinellas County Utilities) for their water supply. The system also saves the City on treatment costs by lowering the amount of highly treated water discharging into Tampa Bay.

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LAS VEGAS VALLEY WATER DISTRICT, LAS VEGAS, NV

I. GENERAL INFORMATION

Evaluation Date: 6/17/2010

Utility Information

Utility Name: Las Vegas Valley Water District
Contact Person: Bronson L. Mack
Title: LVVWD/SNWA Public Information

Services Provided

☒ Water ☐ Wastewater ☒ Recycled water ☐ Stormwater ☒ Other: Wastewater services within Las Vegas and Unincorporated Clark County are provided by the City of Las Vegas and Clark County Water Reclamation District, respectively. The Las Vegas Valley Water District has partnered with the City of Las Vegas and Clark County Water Reclamation District for reclaimed water services. The LVVWD serves in the distribution role of the reclaimed water system, providing the reclaimed water to the end-users.

Dual System Information

Year initiated: The City of Las Vegas' Durango Hills Water Resource Center was the first facility to begin operation in 2001. In 2003, the Clark County Water Reclamation District's Desert Breeze Water Resource Center began operation.

Non potable water source: Reclaimed water

Uses of the non-potable line

☒ Irrigation:

☒ Commercial	☒ Golf courses	☒ Parks	☐ Playgrounds
☐ Road medians	☐ Residential	☐ Schools	☐ Other

☐ Toilet and urinal flushing:

☐ Commercial ☐ Residential

☒ Cooling towers

☐ Fire fighting

Unique System Features

Note: These apply to the entire LVVWD system.

1. Utilizes 6 solar power generating facilities for onsite operations including pumping and water treatment processes.
2. Utilizes 76 recharge and recovery wells.
3. Partnered with the Southern Nevada Water Authority to store more than 330,000 AF of water in the primary aquifer for future use.

4. Utilizes Computer-aided Rehabilitation of Water networks system (CARE-W), a program that aids engineers in creating a cost-efficient strategy for preventative maintenance and repair of the LVVWD's transmission system.
5. Permalog leak detection system consists of more than 8,556 leak detection units for the 4,100 plus miles of potable water line.
6. Annual water quality testing program consists of collecting more than 30,000 water samples, conducting more than 500,000 analyses of those samples, monitoring the water quality in real time 365 days a year, and testing for nearly 120 regulated and unregulated contaminants (LVVWD Testing, 2010). There are 100 sampling stations used for required bacteriological and chemical testing (LVVWD Testing, 2010).

Principal Operational Issues

1. Water sales are down due to the downturn of the economy and water conservation program. However, the utility wants to ensure future water availablity.
2. A Supervisory Control and Data Aquisitition System (SCADA) is used for monitoring and operating the potable system. Unfortunately, the existing SCADA system is no longer supported by the original provider, so the LVVWD is in the process of researching in order to select a new SCADA system. (LVVWD Department Budgets, 2010).

II. SYSTEM OVERVIEW

In 1947, the Nevada Legislature created the Las Vegas Valley Water District in order to serve the City of Las Vegas and unincorporated areas of Clark County (LVVWD Timeline, 2010), and became operational in 1954 with the drilling of its first well. LVVWD became the operating agent of the Southern Nevada Water Authority (SNWA), which was formed in 1991 to address Southern Nevada's water needs on a regional basis (LVVWD Timeline, 2010). Overall, the main service area is the City of Las Vegas and surrounding unincorporated areas in Clark County Nevada including six smaller municipalities that are also served (LVVWD Facilities, 2010).

Potable System

The LVVWD obtains approximately 90 percent of its drinking water from the Colorado River via Lake Mead while the other 10 percent comes from groundwater sources. The potable system consists of 4,100 miles of transmission and delivery pipeline, 68 storage reservoirs and tanks, and 65 pumping stations (LVVWD Facilities, 2010).

Reclaimed System

The LVVWD supplies reclaimed water from two plants: Durango Hills and Desert Breeze Water Resources Centers. The Durango Hills WRC has a capacity of 10 mgd, consists of one main pump station, a storage reservoir, about 17 miles of pipelines, two remote booster pumping stations, and four recharge wells. Water is stored in a 2 million gallon reservoir before conveyance to parks and golf courses. The Durango Hills Water Resources Center was constructed by a partnership with the City of Las Vegas (Durango Hill Water Resource Center, 2005). Along with the Desert Breeze Water Resource Center, a 10 mgd satellite water reclamation facility completed in 2003 ultimately capable of providing over 11,200 acre-feet per year (City of Las Vegas WE 2005), the two plants supply reclaimed water via 30 miles of pipeline. The LVVWD partnered with the Clark County Water Reclamation District to construct the Desert Breeze Water Resources Center (City of Las Vegas WE, 2005). The City of Las Vegas and the Clark County Water Reclamation District operate their respective plants; however, the LVVWD distributes the reclaimed water to the end-users.

The City of Las Vegas has a population of about 567,600 people (City Data 2009) and owns its own reclamation facilities. In 2006, total reuse was about 5,144 acre-feet (SNWA Reclaimed Current). However, total reuse was higher in 2003, at 6,400 acre-feet (City of Las Vegas WE 2005).

• The Water Pollution Control Facility – capacity is 91 mgd (City of Las Vegas WE, 2005) and serves a power plant and four golf courses.

• Bonanza Mojave Water Resource Center – a 1 MGD satellite reuse facility (City of Las Vegas WE, 2005) provides about 1,120 acre-feet to adjacent park and golf course. The Clark County Water Reclamation District provides wastewater services for the unincorporated areas of Clark County and provides reclaimed water for parks, golf courses, and power plants. In 2006, the total water reuse was 12,232 AF (SNWA, 2010).

Rural system

The LVVWD distinguishes between larger systems and the rural systems. Facilities for the rural system include 10 production wells, 10 reservoirs and tanks, 2 pump stations, and 7 disinfection facilities (LVVWD Department Budgets, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

Since the 1990s, when the Nevada Administrative Code 445A required backflow prevention programs, cross connections have occurred. Cross connections included fertilizer injections systems connected to on-site irrigation piping or anti-freeze systems connected to on-site fire protection plumbing. Backflow occurrences have not occurred to the knowledge of the LVVWD. Many of the cross-connections did have some form of backflow prevention; however, it was usually minimal protection -- like an atmospheric vacuum breaker rather than a double-check valve or reduced pressure assembly. The number of cases could not be verified (Bronson, 2010).

Cases of illnesses have not been reported to LVVWD due to cross connections (Bronson, 2010).

Provide any other pertinent information

1. For backflow prevention the LVVWD owns, operates, maintains and tests all of its own assemblies. This means that each assembly installed behind the water meter is LVVWD property. The customer pays a small fee for this service which ultimately it ensures that all devices are tested, maintained and operating properly (Mack, 2010).
2. Although groundwater composes ten percent of the water supply, the LVVWD utilizes a wellhead protection program to protect the public groundwater supplies from contamination and prevent the need for costly water treatment (LVVWD WP, 2010).
3. The LVVWD utilizes a vigorous water-testing program in order to ensure that drinking water meets or surpasses drinking water standards (LVVWD Testing, 2010). Each year more than 30,000 water samples, more than 500,000 analyses of those samples are conducted, the water quality in real time 365 days a year is monitored, and tests for nearly 120 regulated and unregulated contaminants are completed (LVVWD Testing, 2010). There are 100 permanent sampling stations used for required bacteriological and chemical testing (LVVWD Testing, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Decreasing water losses is a primary goal of the LVVWD. The LVVWD implemented a Permalog leak detection program in early 2004 at a cost of $2.1 million. The LVVWD employs 8,556 leak detection units for the 4,100 plus miles of potable water line (LVVWD Department Budgets, 2010), which are attached to underground water valves, within the service area. LVVWD crews patrol the valley collecting data the help identify leaks which are pinpointed by using additional listening equipment (LVVWD Leak Detection, 2010). Leak detection, via Permalog leak detection technology, has been effective. More than 1,300 underground leaks have been detected since 2004, and an estimated 3,336 acre-feet of water has been saved (LVVWD Leak Detection, 2010). The current percentage of unaccounted for water is about 7%, which is a 1.5% increase from 2008/2009; however, this is still well below the national average of 10% (LVVWD Department Budgets, 2010). The increase could be due to the fact that LVVWD has become more accurate in accounting for system losses via its leak detection program. As of December 2008, LVVWD detected 1,322 leaks in the system, which was calculated to save about 381 acre-feet of water (LVVWD Department Budgets, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

The reclaimed water system has helped the LVVWD to meet the organization's sustainability goals. Although direct reuse has improved sustainability and provided a lower-cost water resource, it does not extend Southern Nevada's Colorado River allocation. Rather, through indirect reuse, Southern Nevada already recycles 100 percent of its indoor water use through return flow credits. Because Southern Nevada discharges treated effluent to the Lake Mead via the Las Vegas Wash, Southern Nevada receives a return flow credit: For every gallon of treated effluent returned to Lake Mead, SNWA can take another gallon of raw water out (SNWA, 2010).

Economic Information

What is the yearly O & M budget for the system?

The total expenditure for the LVVWD was $52,978,451 for the 2009/2010 budget for the entire dual system.

Discuss any additional O & M costs associated with the dual system:

Total expenditure includes salaries and wages, water, energy, materials and supplies, maintenance and repairs, rentals and leases, other employee expenses, other operating expenses, capital outlay, major construction.

Discuss any rate structures used by the utility to regulate consumption:

Las Vegas Valley Water District uses a multi-tier increasing block rate structure in order to conserve potable water supply. Potable water rates depend on the size of meter used, which of the four specified tiers of water usage the customer is in, and type of water users. Four tiers correspond to each meter size.

The reclaimed water rate is $2.33 per 1,000 gallons. Golf courses are also on a water budget of 6.3 acre-feet per irrigated acre per year (Section 12.6 (B) -- pages 82-83). If they exceed the budget, they pay a hefty penalty. (Bronson, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Difficult to tell. The LVVWD is located in the Mojave Desert, which on average receives 4.2 inches of rainfall annually, while the evaporation rate reaches 100 inches (City of Las Vegas WE, 2005). LVVWD along with the Southern Nevada Water Authority has come up with a water use goal of 250 gpcd by 2010 and 199 gpcd by 2035 (LVVWD Department Budgets, 2010). Since 1990, the water use has reduced from 347 gpcd to about 250 in 2010 (LVVWD Department Budgets, 2010). This is a significant reduction but may be more due to conservation measures.

However, the better use of water could be due to conservation efforts more than the use of reclaimed water. For an example of a reclaimed conservation measure, golf courses are on a water budget and pay a penalty if they use more than the 6.3 per irrigated acre-feet per year water limit. The water budget caused many golf courses to remove grass from areas that are not associated with the playing area and have removed about 856 acres of land. The removal saves 2 billion gallons of reclaimed water per year. (Bronson, 2010).

Is the dual system more efficient economically?

Yes, the replacement cost of service line replacements has an average cost less for the LVVWD than for thirteen other utilities contacted by the LVVWD (LVVWD Department Budgets, 2010).

The LVVWD is the first United States agency to fully implement Computer-aided Rehabilitation of Water networks system (CARE-W), a program that aids engineers to create a cost-efficient strategy for preventative maintenance and repair of the LVVWD's transmission system (LVVWD Transmission and Delivery, 2010). The system is intended to ensure a steady and reliable water supply by repairing the correct pipelines at the right time at a minimum costs before failure occurs (LVVWD Transmission and Delivery, 2010). The LVVWD is innovative also in its use of alternative fuel sources to power some of its facilities and vehicles (LVVWD Hydrogen Fueling Station, 2010). Alternative fuel vehicles, including gas/electric hybrids and those using biodiesel, comprise about 85% of the LVVWD's fleet (LVVWD Hydrogen Fueling Station, 2010). LVVWD has built solar powered generating systems at six facilities (LVVWD Solar Projects, 2010). A total of 5.3 million kilowatt-hours of electricity is generated every year which supports onsite operations, including pumping operations and water-treatment processes (LVVWD Solar Projects, 2010). Benefits include not having to raise water rates on account of the project and the reduction of demand on the communities power supply during peak usage times, when electricity costs are the highest (LVVWD Solar Projects, 2010).

The LVVWD pumps groundwater in order to meet peak summer demand. During the hot summer months from May through September, groundwater can account for up to 39 percent of the valley's daily water supplies (LVVWD GW, 2010). In addition, to meet future demands in case of drought, the LVVWD, along with the City of Las Vegas, have stored more than 320,000 acre-feet of water (LVVWD GWB, 2010). In addition, the LVVWD has approximately 70 recharge and recovery wells with a total injection capacity of 100 million gallons per day, and is the largest recharge program of its kind in the world (LVVWD GWB, 2010).

Has the use of a dual system compromised safety?

No, since there are no reported cases of illnesses due to cross connections. The use of the leak detection system, backflow prevention system, and the frequent testing have proven to be effective.

Although groundwater composes ten percent of the water supply, the LVVWD utilizes wellhead protection programs to protect the public groundwater supplies from contamination and prevents the need for costly water treatment (LVVWD WP, 2010).

The LVVWD utilizes a vigorous water-testing program in order to ensure that drinking water meets or surpasses drinking water standards (LVVWD T, 2010). Each year, more than 30,000 water samples, more than 500,000 analyses of those samples are conducted, the water quality in real time 365 days a year is completed, and tests for nearly 120 regulated and unregulated contaminants are performed (LVVWD T, 2010). There are 100 permanent sampling stations used for required bacteriological and chemical testing (LVVWD T, 2010).

Does the dual system position the water authority better for the future?

Not economically since the utility is facing decreasing revenue in spite of its innovative technology used for leak detection and pipe replacements. However the system is beneficial for ensuring adequate potable water supply in the future.

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LIVERMORE WATER RESOURCE DIVISION, LIVERMORE, CA

I. GENERAL INFORMATION

Evaluation Date: 6/30/2010
Prepared By: Pete Rogers

Utility Information

Utility Name: Livermore Water Resource Division
Contact Person: Randy Werner
Title: Water Supervisor

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: early 1970s
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☐ Other
☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
☒ Commercial ☐ Residential
☐ Cooling towers
☒ Fire fighting

Unique System Features

1. The use of recycled water for fire hydrants and indoor fire suppression (sprinkler systems).
2. Recycled water samples are tested weekly at multiple sample stations located throughout the recycled system network. This testing exceeds state requirements.
3. Although the utility promotes (with limited enforcement) a state-wide initiative to reduce individual potable water consumption by 20%, there are no restrictions on recycled water use.
4. In a viticulture class at a local community college, students are examining the impact of recycled water on wine production. This study will impact future recycled water use.
5. The number of organizations involved (WRD, Cal Water, Zone 7, LAVWMA, EBDA).

II. SYSTEM OVERVIEW

The city of Livermore is located in the San Francisco Bay Area, approximate 43 miles southeast of San Francisco. The 2010 estimated population of Livermore is 83,600 (City of Livermore, 2010). Water service is provided to the city via two providers: the city's Water Resource Division (WRD) and California Water Service -Livermore District. Whereas WRS functions within the city's public works department, the California Water Service (Cal Water) is a subsidiary of the California Water Service Group (CWSG) which provides water and wastewater services in California, Hawaii, Nevada, and Washington (California Water Service Group, 2010). Whereas Cal Water is limited to providing only water service, WRD's services include water, wastewater, recycled water, and stormwater.

Potable Water

Water delivery is determined by service boundaries. Whereas Cal Water services the older areas of the community, the WRD's service boundaries area located in the newer areas (Werner, 2010). Cal Water currently services two thirds of the community, although in time WRD's share will grow since their service boundary is geographically less confined (Werner, 2010).

Livermore's water comes from a combination of groundwater and surface water supplies purchased from the Zone 7 Water Agency. Zone 7 is a water wholesaler, providing drinking water to retailers like Cal Water for several communities in the area including Pleasanton, Livermore, Dublin, and Dougherty Valley (Zone 7, 2009). Most of the surface water originates as snowpack in the Sierra Nevada, making it way to Zone 7 through the natural conveyance of the Delta and the region's South Bay Aqueduct (Livermore District, 2010). Whereas WRD's portion of the water system is supplied primary from surface water purchase from Zone 7, Cal Water's portion is supplied from both surface and subsurface (12 wells) sources. WRD's system includes approximately 130 miles of mains and 5 large storage tanks. Cal Water's system entails 205 miles of water mains and 25 small storage tanks.

Wastewater and Recycled Water

The city's WRD is responsible for the collection and treatment of wastewater. The utility's collection system consists of 267 miles of sanitary sewer lines which convey the sewage to the Livermore Water Reclamation Plant. Although the design capacity of the plant is 8.5 mgd, the UV treatment of the plant limits the capacity to 6 mgd (Water Resource Division, 2010). A portion of the treated wastewater is pumped a recycled water to the Doolan Tanks (recently expanded to a combined storage of 4 million gallons) where it is distributed through 15 miles of pipe to a variety of landscape irrigation, toilet/urinal flushing, and firefighting applications. In the case of the firefighting application, the non-potable line is used for 64 hydrants throughout the city as well as in sprinkler systems for 16 commercial/industrial buildings (Werner, 2010). The portion of treated wastewater not used as recycled water is sent through the Livermore Amador Valley Water Management Agency (LAVWMA) pipe for disposal by the East Bay Dischargers Authority (EBDA) in San Francisco Bay (WRD, 2010).In 2009, of the 2,100 million gallons of treated wastewater leaving the plant, 450 million gallons (21%) where used as recycled water (Werner, 2010).

The use of recycled water for indoor fire suppression is unusual for because of the required dual plumbing, greater risk of human exposure, and the limited savings of potable water (Asano, 2007). In the case of Livermore, the city's initial decision to use recycled water was based on the distribution system not having sufficient pressure and flow capacity to meet the fire flow requirements for sprinkler systems. However, with the construction of a new 3 million gallon potable water storage tank, this is no longer the case (Werner, 2010). Randy Werner mentioned that the City has stopped using recycled water for building sprinkler systems because the water savings do not justify the added inspection and reporting effort and costs. The City is, however, continuing to expand the number of recycled water fire hydrants (Asano, 2007).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
N/A

Provide any other pertinent information

1. The WRD samples and tests recycled water on a weekly basis from sample stations throughout the recycled water distribution system.
2. Shut down testing is performed on a yearly basis.
3. The rigid inspection and testing requirements imposed by the state health department have motivated the City to stop using recycled water for building sprinkler systems.
4. Fire fighters were initially concerned about using recycled water for fire suppression. This concern has been put to rest through utility outreach.

Principal Operational Issues

1. The use of recycled water for any non-irrigation related application requires labor intensive testing and reporting. The City has decided that the conservation benefits outweigh this additional burden.
2. Storage concerns promoted the City to expand their recycled water storage capacity from 2 to 4 million gallons.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

In 2009, 450 million gallons (21%) of the total wastewater effluent was recycled. In 2010, 489 million gallons (19%) of the total wastewater effluent was recycled.x

How has the dual system has impacted any other (system capacity, etc.) goals?

1. The WRD recently expanded its recycled water storage capacity from 2 to 4 M.G. The City plans on increasing the storage capacity more in the future.
2. The City is making improvements to Livermore's Water Reclamation Plant in order to increase our treatment capacity to 10 MGD.

Economic Information

What is the yearly O & M budget for the system?

The City reports their 2009 O&M costs for the water and sewer system as $11,140,495 and $19,770,491 respectively. However, within the sewer system budget, the costs associated for the reclaimed portion are not specified.

Discuss any additional O & M costs associated with the dual system:

1. Weekly sampling and testing from sample stations throughout the recycled system.
2. Quarterly cross connection inspections and reporting.

Discuss any rate structures used by the utility to regulate consumption:

There is an increasing block rate structure for the potable water. The existing potable structure has 3 rate tiers. The pricing for the recycled water is set at 80% of the #2 tier of potable water. For potable water there is a wholesaler connection fee and a City connection fee. For the recycled water, there is only a City connection fee. Currently, there are no restrictions on recycled water use.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes. The dual system currently reduces potable water demand by 20%. This percentage is certainly going to increase.

Is the dual system more efficient economically?

Having a dual system provides a better use of the resources, but it may not pay its own way right now. There are some proposed improvements in the near future that may improve the economics of the recycled system.

Has the use of a dual system compromised safety?

No. There have been no reported cases of cross connections or illnesses relating to the consumption of recycled water.

Does the dual system position the water authority better for the future?

Yes. The use of the dual system enables the community to be less dependent on outside sources for water. Recycled water use also provides added protection from drought

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CITY OF OLYMPIA PUBLIC WORKS DEPARTMENT (LOTT ALLIANCE), OLYMPIA, WA

I. GENERAL INFORMATION

Evaluation Date: 12/17/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Olympia Public Works Department (LOTT Alliance)
Contact Person: Donna Buxton
Title: Groundwater Protection and Reclaimed Water Program

Services Provided

☒ Water ☒ Wastewater☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 2005 (Olympia Reuse)
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☐ Parks ☐ Playgrounds
☐ Road medians ☐ Residential ☐ Schools ☒ Other: Industrial facility wash water, dust control, decorative fountains.
☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

Tumwater's reclaimed water system pumping system is not connected to the plant's emergency power system, so the reclaimed system is shut down during power outages (Tumwater Budget, 2010).

II. SYSTEM OVERVIEW

The LOTT Alliance is located in Thurston County Washington and was incorporated on April 17, 2000 (LOTT CAFR, 2009). The LOTT Alliance's Wastewater Alliance is composed of four government partners that jointly manage wastewater facilities that serve more than 80,000 people (Resource Management Plan, 2003). The alliance is comprised of the Cities of Lacey, Tumwater, and Olympia, and Thurston County. The LOTT Alliance treats wastewater and distributes reclaimed water, with each individual entity managing its own potable water system (Dennis-Perez, 2010).

The City of Lacey, operates its own water system that serves 22,100 accounts and a population of approximately 57,000 (Lacey CAFR, 2009).

Potable Water

The City of Olympia, with a population of 45,250 in 2009, operates a water system that consists of 404.7 miles of water main and a reclaimed water system of more than 2.2 miles of water line. The City of Tumwater has a population of 16,710 people (Tumwater Budget, 2010).

Reclaimed Water System

The first reclaimed water treatment facility was constructed in 2004 at the Budd Inlet Treatment Plant and produces Class A reclaimed water, which is the highest quality. Currently, about 10 million gallons per year of reclaimed water is provided to several customers in downtown Olympia (Buxton, 2010). A second treatment plant was constructed as well as 3 miles of reclaimed line, reclaimed water ponds, and infiltration basins completed in 2006 which serves customers in the Hawk's Prairie area (Tumwater Budget, 2010).

A 1.5 mgd of reclaimed water is produced at the BUDD Inlet reclaimed water plant, a sand filter, site and the Martin Way reclaimed water plant, a membrane bioreactor, has a capacity of up to 2 mgd (Dennis-Perez, 2010). The Alliance produces reclaimed water where excess reclaimed water produced is put into recharge basins (Dennis-Perez, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

There have not been any cross connections associated with reclaimed water use in Olympia (Buxton, 2010).

Provide any other pertinent information

Olympia has End User Agreements to contractually hold reclaimed water customers to complying with state regulations and reclaimed water plant permit requirements (Buxton, 2010). Olympia also requires signage for reclaimed water sites, distributes educational materials, and color-codes all reclaimed water system appurtenances purple (Buxton, 2010).

Principal Operational Issues

1. One of the principal operational issues is the fact that there is no storage capacity for customers who want to use reclaimed water (Dennis-Perez, 2010). Reclaimed water lines were routed to a golf course in Tumwater and they do not have the necessary storage capacity for it. Currently, the Alliance is seeking a joint fund in order to get them the necessary storage.

2. Olympia is currently looking into the possibility of storage, additional pumping, and possible re-chlorination facilities as they seek to expand their reclaimed water use area and uses (Buxton, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

The City of Olympia alone uses about 10 million gallons of reclaimed water per year, which conserves potable water use.

How has the dual system has impacted any other (system capacity, etc.) goals?

The LOTT Alliance Master Plan calls for incremental expansions and in 2009 LOTT began construction of a reclaimed water distribution main from the Budd Inlet Treatment Facility to portions of Tumwater and West Olympia (Tumwater Budget, 2010). Phase one of this project, which has an expected completion date of 2010, consists of providing reclaimed water to several large irrigation users in Tumwater, including the Tumwater Valley Municipal Golf Course (Tumwater Budget, 2010). A future satellite treatment facility is planned for Tumwater, but the location is uncertain at this time.

LOTT's 20 year plan calls for the construction of three satellite facilities, each producing reclaimed water, located in the Lacey-Olympia-Tumwater area. The facilities are each to produce at least 1 mgd and be expandable to up to 5 mgd of reclaimed water. Based on demand projections, each increment of the overall project would be built "just in time" (Tumwater Budget, 2010). Some of the project has been completed but more is yet to be built. The Lott Alliance has completed several projects in 2009 including "LEEDs CoGen", "reclaimed water plaza", a reclaimed water line to Martin Way Pump Station, and a reclaimed water storage (LOTT CAFR, 2009).

One of LOTT's goals is to develop more recharge basins to allow more reclaimed water to be produced (Dennis-Perez, 2010).

Economic Information

What is the yearly O & M budget for the system?

Lacey budgeted $1,889,255 for the reclaimed water fund in 2009 and used $19,075, 235 for the water system (Lacey CAFR, 2009). Olympia expended $25,508,295 on the water and sewer distribution systems (Olympia CAFR, 2009). Tumwater's enterprise fund for the water utility fund was $10,066,966 (Tumwater 2010 Budget). The LOTT Alliance's operating expense was $17,465,394 in 2009 (LOTT CAFR, 2009).

Discuss any additional O & M costs associated with the dual system:

Discuss any rate structures used by the utility to regulate consumption:

Where reclaimed water is used for irrigation, Olympia charges 70 percent of the potable water irrigation rates. More generally, Olympia's potable water rates are organized in a four tier increasing block rate structure with separate charges for irrigation (Buxton, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

On a limited scale there is a more efficient use of potable water due to the use of about 10 million gallons per year of reclaimed water by the City of Olympia alone.

Is the dual system more efficient economically?

One of the main incentives for having the reclaimed water system is the strict limits imposed on the LOTT alliance to discharge effluent from the BUDD Inlet treatment plant into Puget Sound (Dennis-Perez, 2010). Thus, as the cities grow, there cannot be an increased amount of discharge, so water reuse was a way to meet that strict requirement (Perez, 2010). However, the requirements for dual systems make indoor use of reclaimed water not economical (Buxton, 2010).

Has the use of a dual system compromised safety?

No, since Olympia, the primary user of reclaimed water, did not report any cross connections or associated illnesses.

Does the dual system position the water authority better for the future?

Yes, since the reclaimed water system was built to keep the LOTT Alliance from discharging excess effluent into Puget Sound.

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MARIN MUNICIPAL WATER DISTRICT, CORTE MADERA, CA

I. GENERAL INFORMATION

Evaluation Date: 11/15/2010
Prepared By: Stephanie Edmiston

Utility Information:

Utility Name: Marin Municipal Water District
Contact Person: Bob Castle
Title: Water Quality Manager

Services Provided

☒ Water ☐ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1975
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other: Commercial laundries, car washes, inside buildings.
☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
☒ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

There are several unique uses of reclaimed water including one commercial laundry, three car washes, 2 HVAC cooling towers, toilet flushing for a new condominium complex, and toilet flushing for 20 commercial buildings.

II. SYSTEM OVERVIEW

Marin Municipal Water District is located in the area of south and central Marin County and provides 195,000 people with potable water (Marin Municipal Water District, 2010). The MMWD is the oldest water district in California having been in operation since 1912 (Fact Sheet, 2010).

Potable Water System

Approximately 75 percent of the potable water supply for Marin Municipal Water District is composed of surface water collected by reservoirs with the remaining 25 percent of the supply coming from the Russian River by a contract with the Sonoma County Water Agency (SCWA). The potable water system consists of 889 miles of pipeline and three treatment plants produce on average 25 mgd (Fact Sheet, 2010). In all, about 25,000 AF of potable water was used in 2009 (MMWD's Budget and Rates, 2010).

Reclaimed Water System

The reclaimed water system consists of 24 miles of water line and the water is produced by one treatment plant (Fact Sheet, 2010). The recycled water plant is operated in conjunction with the Las Gallinas Valley Sanitary District (MMWD's Budget and Rates, 2010). San Rafael is served by the reclaimed water system by receiving up to more than two million gallons a day to more than 250 customers (Recycled Water, 2010). Overall, about 700 acre-feet of reclaimed water is being produced per year for 340 reclaimed water customers (Castle, 2010). In 25 years of operation, the public has generally believed that reclaimed water use is a "good idea" and there were only a few that did not like the idea of using reclaimed water (Castle, 2010).

The primary obstacle to system expansion is the cost associated with installing recycled mains over large distances in a highly urbanized area. The utility is always on the lookout for opportunities such as building renovations, new construction, etc. in which more users can be connected to the existing system (Castle, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

There was one cross connection during construction of a subdivision consisting of several single family homes. It occurred during the rainy season, which is from November to April, in which the reclaimed system had shut down and was supplemented with potable water. The cross connection was subsequently discovered. One homeowner was upset about it but no illnesses resulted from the cross connection.

Provide any other pertinent information

California regulations are the "most stringent in the world" and have several built-in safety mechanisms (Castle, 2010).

Principal Operational Issues

The principal operational issue is the fact that the initial quality of the reclaimed water is low (Castle, 2010). Namely, the trickling filters used to treat wastewater tend to slough off solids and promote algae growth.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

MMWD has successfully reduced the per capita potable water consumption from 175 gallons per day to 120 gallons per day (MMWD's Budget, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

New construction located near the reclaimed water system is required to be connected to it. Expansion, however, is impeded due to the large expense. It costs about $200 to $300 per foot to retrofit into streets (Castle,2010). In addition, the area "pushed" water conservation and customers are frugal with water use in general (Castle, 2010), so the water savings would not justify the costly expansion.

Economic Information

What is the yearly O & M budget for the system?

The operation and maintenance cost for the reclaimed water system varies and is around $250,000 per year (Castle, 2010). On the other hand, the potable system cost could not be verified, but is presumably many times more than the reclaimed water system.

Discuss any additional O & M costs associated with the dual system:

Need to perform regulatory compliance inspections of customers for overspray, runoff, cross connections.

Discuss any rate structures used by the utility to regulate consumption:

The potable water rates are organized in a steeply tiered rate structure in order to promote potable water conservation (Castle, 2010). In addition, there are incentives for conserving potable water (Castle, 2010). The reclaimed water rates are 55 percent of the potable rate and are organized in an increasing block rate structure (Castle, 2010). The charge depends on user type with the least costly rate being $3.39 per CCF (Water Rates, 2010). The reclaimed use is a three tier increasing block rate structure beginning with a charge of $2.33 per CCF. The MMWD also charges for raw water use which is according to a three tier increasing block rate structure, and is more expensive than reclaimed water (Water Rates, 2010). There is also a bimonthly charge for water use which is according to the meter size (Water Rates, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, to a small degree. The reclaimed water system meets 2 to 3 percent of the total water demand and new customers located near the reclaimed water system must connect to the reclaimed system (Castle, 2010).

Is the dual system more efficient economically?

It is difficult to tell since the operation and maintenance costs for the potable system could not be verified. However, it is important to note that the $250,000 per year for the reclaimed water system is relatively inexpensive compared to other reclaimed water systems studied.

Has the use of a dual system compromised safety?
No, since the single cross connection did not cause any illnesses.

Does the dual system position the water authority better for the future?
Yes, since the reclaimed water system is necessary to ensure water demands are met currently and in the future (Castle, 2010). The primary motivation behind the use of recycled water is to reduce the community's vulnerability to drought.

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OCALA WATER AND SEWER DEPARTMENT, OCALA, FL

I. GENERAL INFORMATION

Evaluation Date: 12/14/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Ocala Water and Sewer Department
Contact Person: Jeff G. Halcomb
Title: Director

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1986 (Reuse)
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☐ Road medians ☒ Residential ☐ Schools ☒ Other: Pest control and fertilizer company, nursery, sports facilities
☒ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

Ocala's reclaimed water system has a variety of uses including agricultural and recreational uses (Reclaimed Water, 2006).

II. SYSTEM OVERVIEW

Ocala, Florida has a population of 55,568 residents and is located in Marion County Florida (City Data, 2009).

Potable Water System

Ocala has a water treatment plant with a capacity of 24.4 mgd and 386 miles of water lines (Water and Sewer, 2006.

Reclaimed Water System

Ocala has three water reclamation plants (Water and Sewer, 2006). Since it would be costly to install reclaimed water lines to existing residences, the Water and Sewer Department initially planned on allocating all of its reclaimed water to recreational and agricultural uses (Reclaimed Water, 2006). However, in 2007 the City began a mandatory residential and commercial irrigation program to use recycled water for all new construction in areas adjacent to large reclaimed water mains (Reclaimed Water, 2006). Summerset Estates was the first subdivision in Ocala to use reclaimed water for lawn and garden irrigation (Reclaimed Water, 2006). Users of the reclaimed water system include landscape irrigation at the airport, a pest control and fertilizer company, the Perry Sprayfield, nurseries, a 200 acre site growing hay for sale to local farmers, at least three golf courses, and a recreational site that includes a baseball, softball, and football fields as well as open areas, walking trails, and other recreational areas (Reclaimed Water, 2006). According to a news story written in 2008, Ocala produced about 5 million gallons of reclaimed water each day and had about 18 million gallons of storage as of 2008 (Greene, 2008).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
There is not enough information to tell.

Provide any other pertinent information
In the light of the recent mandate that all new residential and commercial construction near reclaimed water mains be hooked up to the system, the City has adopted the Reuse Ordinance, section 70-350, to meet state requirements for the use of reclaimed water (Reclaimed Water, 2006).

Principal Operational Issues

In 2008, the St. Johns River Management District considered imposing a reclaimed water use limit on Ocala's reclaimed water system. The City opposed it since it would potentially limit development of reclaimed water usage which was intended to conserve the use of potable water (Greene, 2008). Also, the City would have to increase reclaimed water storage capacity.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
Yes, since the City uses reclaimed water for irrigation uses and produces about 5 mgd.

How has the dual system has impacted any other (system capacity, etc.) goals?

The City is reportedly trying to expand reclaimed water usage and the distribution system (Greene, 2008). In addition, Ocala is trying to get more neighborhoods and businesses to hook up to the system (Greene, 2008).

Economic Information

What is the yearly O & M budget for the system?
Water and sewer expenses were $25,677,661 in 2009 (CAFR, 2009).

Discuss any additional O & M costs associated with the dual system:

Discuss any rate structures used by the utility to regulate consumption:
Although Ocala originally did not charge any customers for reclaimed water (Reuse Systems, 2006), in 2007 the City began to charge customers for it (Reclaimed Water, 2006). The cost of reclaimed water is about one quarter the cost of potable water (Reclaimed Water, 2006).

IV. CONCLUSIONS

Does the dual system provide a better use of water?
It is inconclusive since it is difficult to tell how much reclaimed water is being used relative to the potable water system. Since the potable water system is relatively small, the reclaimed water usage is potentially significant compared to potable usage.

Is the dual system more efficient economically?
It is difficult to tell since the water and sewer expenses were not separated.

Has the use of a dual system compromised safety?
There is not enough information to tell.

Does the dual system position the water authority better for the future?
There is not enough information to tell.

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ODESSA UTILITIES DEPARTMENT, ODESSA, TX

I. GENERAL INFORMATION

Evaluation Date: 2/15/2011
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Odessa Utilities Department
Contact Person: Matt Irvin
Title: Director

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1949 (reuse)
Non potable water source: Reclaimed water
Uses of the non-potable line
☐ Landscape Irrigation:

☐ Commercial	☒ Golf courses	☒ Parks	☐ Playgrounds
☒ Road medians	☒ Residential	☒ Schools	☐ Other _____

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:

☐ Commercial ☐ Residential

☒ Cooling towers
☐ Fire fighting

Unique System Features

1. The residential development area with a dual water system has 6 inch potable water piping and 8 inch reclaimed water piping.
2. Odessa's reuse system is the oldest in the state of Texas (McReynolds, 2006). The reuse program was initiated due to Odessa's lack of water resources and was expanded since due to conflicts with discharging effluent in Monahan's Draw, and the state discharge permit which included recommendations for Odessa to expand its effluent reuse (McReynolds, 2006).

II. SYSTEM OVERVIEW

The City of Odessa has a population of 100,807 people and is located in Ector County Texas (City Data, 2009).

Potable Water System

Odessa's drinking water is purchased untreated from the Colorado River Municipal Water District (CRMWD), which has water stored in Lake Ivie, Lake Spence, Lake Thomas (WTP), and from the Ward County Well Field and Odessa Wells during summer months (Freese and Nichols, 2005). The average daily consumption in the fiscal year ending September 2009 was 19.81 million gallons, or 7.23 billion gallons per year, via 618 miles of water line (CAFR, 2009).

Reclaimed Water System

The reclaimed water system consists of about 24 miles of reclaimed water main (Irvin, 2011) with deliveries of approximately 496 million gallons in 2010. The 2010 reclaimed water delivery was reduced from 997 million gallons in 2008 and 578 million gallons in 2009 due to a lack of industrial deliveries due to a plant shut-down (Irvin, 2011). Odessa has contracted or has agreements with 8 irrigation users and two industrial users (Irvin, 2011). The irrigation users include 3 golf courses, the UT-Permian Basin campus, 2 city parks, a TxDOT right-o-way, and a residential development. The residential development is a "fairly high-end" development with large lots (Irvin, 2011). The two industry users are under contract but are currently not receiving any reclaimed water, but will when the demand should arise (Irvin, 2011). The City is currently assessing the feasibility of providing reclaimed water to a new industrial user (Irvin, 2011).

The reclaimed irrigation delivery system is "pretty well automated" based on the demands of the individual customers (Irvin, 2011). The delivery times are scheduled so that the demand over the course of the day will be evened out (Irvin, 2011). In addition, there are on-site individual batching stations that allow monitoring of individual deliveries to the plant through the SCADA system (Irvin, 2011).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
There have not been any cross connections identified (Irvin, 2011).

Provide any other pertinent information
In order to reduce health risks to the public, the City of Odessa requires the development of Operation and Maintenance plans by users, conducts annual meetings with users, and requires cross-connection devices (Irvin, 2011).

Principal Operational Issues

1. Customers with on-site reclaimed water storage have issues with algae and other growths which lead to irrigation system issues (Irvin, 2011).
2. Typical delivery operation and maintenance problems with equipment such as SCADA malfunction (Irvin, 2011).

3. Reclaimed water customers with their own control valve systems, which may fail. In the case of failures, "close coordination is necessary to ascertain City (provider) delivery issues as opposed to customer equipment issues" (Irvin, 2011).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Reclaimed water use meets approximately 6 percent of the total demand. The reclaimed water system is an asset to the City since the potable water supplies are "very susceptible to drought conditions given that they are primarily reservoirs dependent on run-off in the Colorado river basin in West Texas" (Irvin, 2011). The reclaimed water supply is "somewhat more drought resistant because of the more consistent supply from the raw wastewater flow" (Irvin, 2011).

How has the dual system has impacted any other (system capacity, etc.) goals?

The City is in the process of assessing the feasibility of providing reclaimed water to an industrial user (Irvin, 2011).

Economic Information

What is the yearly O & M budget for the system?

According to Irvin (2011), the City does not "do any close financial monitoring" of the dual system. Due to the early low contractual pricing, "it is very doubtful the reclaimed delivery pays for itself in even an O&M view" and "certainly there is no payback for the initial capital investment". In addition, the system was never designed to have a payback according to Irvin. Ballpark cost figures could not be estimated for either system.

According to the Comprehensive Annual Report for fiscal year ended in 2009, the expenses and revenues for the water and sewer systems are combined (CAFR, 2009). The total revenue for the water and sewer systems was $37,178,348 in 2009 and the expense was about $38,818,000 (CAFR, 2009). However, the water and sewer system receives a grant which is an additional amount added to the revenue.

Discuss any additional O & M costs associated with the dual system:

It is difficult to tell since there are no close records kept on either the potable or the reclaimed water systems.

Discuss any rate structures used by the utility to regulate consumption: Potable base rates depend on meter size, user type, whether or not the customer is within City limits or outside the City limits (Billing and Collection, 2009). The base charge takes into account volumetric use up to 2,000 gallons and any amount above 2,000 gallons is charged a flat rate depending on the user type. Residential customers pay a rate of $3.48 per 1,000 gallons for consumption over 2,000 gallons and senior residential customers pay $3.09 (Billing and Collection, 2009). Also, customers are also charged an "energy surcharge" which is $0.1133 cents per 1,000 gallons of water used (Billing and Collection, 2009).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, since the reclaimed water use is approximately 6 percent of the total water demand. Although ballpark cost figures could not be given, the reclaimed water system is seen as an asset as far as off-setting raw water/potable water uses and important for future water planning (Irvin, 2011).

Is the dual system more efficient economically?

Due to the lack of cost data it is difficult to know for sure. However, Irvin is confident that the reclaimed water system does not pay for itself.

Has the use of a dual system compromised safety?

No, since there have not been any cross connections identified or associated illnesses.

Does the dual system position the water authority better for the future?

Yes, since the reclaimed water use meets a significant portion of the total water demand even though the two industrial users are currently not receiving reclaimed water. When the demand for reclaimed water arises with the two industrial users and potentially a third industrial user, the portion of the total water demand met by reclaimed water will likely increase, making the reclaimed water system more necessary. In addition, the reclaimed water system is seen as an asset in terms of meeting future water demand.

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CITY OF ORLANDO WASTEWATER DEPARTMENT, ORLANDO, FL

I. GENERAL INFORMATION

Evaluation Date: 7/29/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Orlando Wastewater Department
Contact Person: Daron Johnson
Title: Reclaimed Water

Services Provided

☐ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1964 (WC I Plant)
Non potable water source: Reclaimed water
Uses of the non-potable line

☒ Landscape Irrigation:

☒ Commercial	☒ Golf courses	☒ Parks	☐ Playgrounds
☒ Road medians	☒ Residential	☒ Schools	☐ Other _____

☒ Agricultural Irrigation
☐ Toilet and urinal flushing:
  ☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. About 8,000 acres of citrus crop irrigation is completed using Orlando's reclaimed water (Wastewater Division), which was a solution for not discharging effluent into the Little Econlockhatchee River and for avoiding costly land acquisition (Wastewater Division). Citrus irrigation with reclaimed water also reduced the demand on the Floridan Aquifer.
2. Use of rapid infiltration basins (RIBs) in four different sites covering about 1,600 acres of freeze-damaged citrus groves and open land in an area of groundwater recharge (Wastewater Division). The RIBs provide reuse capacity when the irrigation demand is low (Wastewater Division).
3. Beneficial to agricultural users because reclaimed water is a dependable supply, provides freeze protection, potentially reduces fertilization, reduces energy costs since the supply is pressurized. According to Daron Johnson, freeze protection of orange groves is an important use of reclaimed water such that

residences sometimes have to get shut off from the reclaimed system when the demand is high enough (Johnson, 2010). Johnson expects that the 20 year agreement to use reclaimed water will be renewed when the agreement expires in the near future (Johnson, 2010).

4. FFMS completed the installation of an environmentally friendly car wash system that uses reclaimed water (Budget, 2009).
5. Uses reclaimed water to supply a fire suppression system near the airport in order to keep the system pressurized (Johnson, 2010).
6. Several developments in St. Petersburg use reclaimed water for irrigation uses and use potable water for drinking water (Johnson, 2010).
7. The use of reclaimed water for cooling at a power plant was a unique use of reclaimed water and saves about 3.5 mgd of drinking water (Johnson, 2010).

II. SYSTEM OVERVIEW

The City of Orlando has a population of approximately 33,000 people and is located in Orange County Florida (City Data 2009).

Potable Water System

The Orlando Utilities Commission (OUC) was created by a special act of the State Legislature in 1923 to manage and operate the City of Orlando's electric light and water works plants (City of Orlando 2009/2010 Annual Budget, 2009). The potable water system consists of 1,768 miles of water line and 15.76 miles of chilled water line. The total demand on the water system is approximately 187 gpcd, and the residential demand is 83 gpcd (OUC, 2009). The OUC provides electric and water services to over 251,000 customers in Orlando, St. Cloud and parts of unincorporated Orange and Osceola Counties (OUC, 2009). The potable water originates from 32 deep wells that tap into the Floridan Aquifer, and seven water treatment plants treat the water via ozone. The OUC also obtains water from the St. Johns River Water Management District. The OUC pumped about 28.9 billion gallons of water in 2009 (OUC, 2009). The projected water supply from the OUC for 2010 is 93.8 mgd from groundwater and 11.2 mgd from reclaimed water (Ksionek, 2009).

Reclaimed Water System

Orlando has three wastewater treatment plants that produce reclaimed water consisting of over 30 miles of pipeline. Reclaimed water is used for irrigating green spaces including golf courses, apartment complexes, medians, schools, and parks. Orlando has successfully reduced the amount of phosphorus, nitrogen, and other constituents in wastewater effluent as well as reducing operation and maintenance costs of the reclaimed water system.

Iron Bridge Water Reclamation Facility:

Since the mid-1970s, Orlando strove for advanced levels of wastewater treatment, including nutrient removal in order to prevent adverse impact to the Little Econlockhatchee River. The formerly 24 MGD facility used rotating biological contactors (RBCs) for BOD removal and nitrification, and denitrification. Since then, changes were made to the system and processes, including a man-made wetland, were added to increase nitrogen and phosphorus removal.In 1988, the Iron Bridge facility capacity was increased to 40 MGD through the use of a five-stage Bardenpho™ biological nutrient removal (BNR) process. As a result, it also decreased operating costs by over $300,000 per year and improved treatment efficiency and nutrient removal capabilities. Several improvements were made since, including replacing failed RBCs and the addition of a 12 mgd BNR plant. Water quality of the Little Econlockhatchee River has greatly improved since 1980. Reclaimed water from the Iron Bridge plant will soon be conveyed to Baldwin Park and to the southeast area of the City (OUC, 2009). Project RENEW involves conveying reclaimed water to the City of Apopka (OUC, 2009).

Water Conservation I WRF:

Water Conservation I Water Reclamation Facility was constructed as a result of the Consent Decree to eliminate discharges to Boggy Creek. The delivery point of this high quality product is the Floridian Aquifer. The facility utilizes a two-stage biochemical process to achieve the nitrogen level required for groundwater discharge.Nitrogen and phosphorus concentrations have been reduced since 1980.

Water Conservation II WRF:

Orlando faced a March 1988 zero-discharge mandate for its McLeod Road plant and an Orange County plant faced a similar order. Thus, the Water Conservation II WRF was constructed. Some effluent is disposed of via citrus irrigation. The reclaimed water is conveyed to a distribution center located in west Orange County and then used for irrigating landscaping, golf courses, six residential neighborhoods, and 3,200 acres of citrus groves (City of Orlando, 2007). Another portion of the effluent goes to rapid infiltration basins for recharge of the aquifer. The Water Conservation II WRF also receives effluent from Orange County's South Regional Water Reclamation Facilities (Water Conservation II). The facility is capable of producing 68 million gallons of reclaimed water per day and consists of a 55 miles of pipeline (City of Orlando, 2007). Though the agreement was updated in 2006, the original agreement between citrus growers and the City and Orange county required growers to receive a weekly amount of reclaimed water for free under a 20 year agreement (Water Conservation II).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

According to Daron Johnson, there have been no cross connections or associated illnesses (Johnson 2010).

Provide any other pertinent information

No other information is given concerning cross connections, illnesses, or other issues with the reclaimed water system.

Principal Operational Issues

1. In recent years the demand for reclaimed water has gone up, which led to low pressures in the system during peak demands. The citrus growers have priority use, so residential areas get shut off from the reclaimed system during low pressure events (Johnson, 2010).
2. Sediment in the reclaimed water system (Johnson, 2010).
3. Demand for reclaimed water has grown greater than the available supply, so communities and businesses have only two days out of the week when they can use reclaimed water (Green Works Orlando, 2008).
4. RBCs have proven to be costly due to the requirement for breakpoint chlorination to remove residual ammonia (City of Orlando Reclaimed Water).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
The use of reclaimed water saved more than 50 mgd to the demand on the Florida aquifer (Green Works Orlando Pillars).
The OUC has over 20 residential and commercial conservation programs in place and offers incentives for water conservation (Ksionek, 2009).
Conservation programs along with the use of reclaimed water both reduce demand on the aquifer but the savings was not quantified (Johnson, 2010).
The main goal of the reclaimed water system is water conservation by using more reclaimed water for irrigation purposes such as citrus irrigation, landscaping, watering gardens, and other such uses (Johnson, 2010). The demand for reclaimed water has increased which means more potable water conservation (Johnson, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?
Several expansions and modifications to the reclaimed water system have taken place since Orlando began using reclaimed water. Three significant projects are being started by the Environmental Services Wastewater Division in order to meet the wastewater and reclaimed water capacity through 2025: "the re-rating and expansion of treatment capacity at the Iron Bridge facility, the development of collection system improvements to allow for the conveyance of future flow to Iron Bridge, and the implementation of a regional reclaimed water system in east Orlando to return reclaimed water from Iron Bridge to the southeast expansion areas as well as other communities". (City of Orlando-Environmental Services Management Division Budget, 2009).

The Environmental Services Management Division is working with the Orlando Utilities Commission (OUC) to implement Project RENEW, which involves the reuse of 9.2 mgd of reclaimed water to satisfy the requirements of OUC's Consumptive Use Permit, for which, the project is undergoing improvements (City of Orlando ESMD Budget, 2009).

The Wastewater Division is working in conjunction with the OUC to implement a residential reclaimed water program for new developments. Because of concerns with limited availability of groundwater supplies, OUC will be required to maximize the use of alternative water sources to decrease the demand on the aquifer as part of their Consumptive Use Permit.

Orlando is currently implementing the Eastern Regional Reclaimed Water Distribution project, which will provide interconnections between the Iron Bridge reclaimed system and other systems in need of additional reclaimed water supplies (Public Works Department Budget, 2009).

Orlando wants to take the Greater Orlando Aviation Authority hangar fire pumps off of the Water Conservation I reclaimed water system and connect them to the OUC's potable water system in order to provide them with continuous fire protection. Orlando reports that this move would improve their reclaimed water system.

Economic Information

What is the yearly O & M budget for the system?

The water system operating expense in 2009 was $34,655,000, of which $14,997,000 was for production and $5,560,000 for distribution.

Orlando obtained $74.4 million in the 2009/2010 fiscal year from the OUC from franchise fees and OUC dividend. The franchise fee consists of 6% of the OUC's gross revenue from electric and water services to customers within Orlando City limits. The dividend consists of 60%, which has been recently raised to 70%, of the OUC's net income in payment annually to the City of Orlando's General Fund (City of Orlando 2009/2010 Annual Budget, 2009). The City of Orlando Public Works Department total wastewater revenue fund for the 2009/2010 fiscal year is $46,354,779 of which, $2,833,556 is for the Water Conservation I Plant, $7,916,993 for Water Conservation II Plant, $9,688,996 for the Iron Bridge Facility, and $9,120,488 for the Easterly Wetlands (City of Orlando 2009/2010 Annual Budget, 2009). However, the budget documents were unclear as to whether or not these numbers represent operations for all portions of the reclaimed water system.

Discuss any additional O & M costs associated with the dual system:

Other allocations for the wastewater budget are administration, water business management, lift station operations, industrial automation group, environmental lab services, and non-departmental wastewater projects (City of Orlando 2009/2010 Annual Budget, 2009).

Discuss any rate structures used by the utility to regulate consumption:

Potable water obtained from the OUC is charged based on meter size, whether or not the user is within City limits, and the amount of water used. The OUC uses a five tier increasing block rate structure for residential users. Commercial potable water users with meters 1" and greater have a flat volumetric rate of $1.541 per 1,000 gallons for any consumption within City limits and $1.772 outside City limits. Irrigation water is also provided to commercial users by the OUC and is based on meter size, whether or not the user is within City limits, and volume charges are based on a three tier increasing block rate structure and acreage irrigated (OUC, 2009).

Water Conservation II reclaimed water is currently provided to commercial citrus growers at a rate of $0.15 per 1,000 gallons which will increase 3% annually. The base rate depends on the size of the meter used. For commercial uses, the reclaimed water rates depend on the type of commercial user, the size of the meter used, whether or not there is onsite storage for water, and there is a limit on how much water the user may use (Water Conservation II) .

IV. CONCLUSIONS

Does the dual system provide a better use of water?

It is difficult to tell since the reclaimed water system was put into place to dispose of effluent and information regarding conservation is limited. One source states that using reclaimed water saves 50 million gallons of water from being pumped from the Floridan Aquifer (Green Works Orlando Pillars).

Is the dual system more efficient economically?

According to Daron Johnson, the reclaimed water system is a money maker for the City. The profits are used to increase the reclaimed water quality. In addition, profits were recently used to expand the reclaimed system with the addition of a booster pump and pipeline conveying water from the north to the south side of town (Johnson, 2010).

Has the use of a dual system compromised safety?

According to Daron Johnson, there have been no cross-connections or associated illnesses (Johnson, 2010).

Does the dual system position the water authority better for the future?

1. Yes, the reclaimed system proved to be a valuable asset when the City agreed to share reclaimed water use with other entities in order to obtain more drinking water. In addition, the City agreed to help develop alternative drinking water supplies for the region. (Dyer, 2005)

2. According to Johnson (2010), the more reclaimed water Orlando uses, St. Johns Water Management District allows Orlando to pump more water from the aquifer for drinking purposes.

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CITY OF OVIEDO PUBLIC WORKS DEPARTMENT, OVIEDO, FL

I. GENERAL INFORMATION

Evaluation Date: 8/16/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Oviedo Public Works Department
Contact Person: Josef Grusauskas
Title: Utilities Manager

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 2007 (reclaimed)
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:

☒ Commercial	☒ Golf courses	☒ Parks	☐ Playgrounds
☒ Road medians	☒ Residential	☐ Schools	☐ Other

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. Several subdivisions have true (parallel lines installed at the same time) dual water systems: The Sanctuary, Live Oak, Ekana Green, Waverlee Woods, Oviedo Forest, subdivisions (Reclaimed & Potable Water Irrigation Procedures Node, 1074). The "real benefit is to the homeowner…Typically reclaimed water costs less to irrigate with than potable water, so they save money. Also, reclaimed water has phosphorous and nitrogen which means they use much less fertilizer" (Grusauskas, 2010).
2. Reclaimed water comes from two reclaimed systems in Oviedo: City of Oviedo and Alafaya Utilities (Reclaimed & Potable Water Irrigation Procedures Node, 1074).
3. Conservation and incentives were put into place in 2007 due to the fact that Oviedo was exceeding its permitted groundwater pumping (City of Oviedo, 2007). LEED certified facilities were constructed to encourage citizens to

implement water conservation methods at their homes. Oviedo offers free irrigation audits in order to show customers where they could save the most water (A Sustainable Commitment: Oviedo's Green Stewardship).

4. The H2 Oviedo Water Conservation Incentive Program was established in 2009 and is an incentive approach to water conservation. Residents with or without irrigation systems can benefit and the program works with the permitting procedures of homeowners associations (A Sustainable Commitment: Oviedo's Green Stewardship).

II. SYSTEM OVERVIEW

The City of Oviedo has a population of 33,529 people and is located in Seminole County Florida (Oviedo CAFR, 2009).

Reclaimed Water System

Two reclaimed water systems serve customers in Oviedo. The Oviedo reclaimed system consists of about 17 miles of water main serving approximately 720 reclaimed water customers (Oviedo CAFR, 2009). Several subdivisions are served by the reclaimed system from Alafaya Utilities including The Sanctuary, Live Oak Reserve, Waverlee Woods, Ekana Green, and commercial property on County Road 419 (Reclaimed & Potable Water Irrigation Procedures Node 1577). Oviedo's reclaimed water system serves Lake Rogers, Kingsbridge East, Kingsbridge West, Chapman Groves, Chapman Oaks, Capman Cove and Easton Park subdivisions. Subdivisions were built with dual systems to conserve potable water and prevent the City from using too much groundwater (City of Oviedo, 2007).

The reclaimed water provided by Oviedo originates from Seminole County via the City of Orlando's Iron Bridge Wastewater Treatment Facility facilitated through bulk service agreements between Seminole County and the City of Oviedo (Wastewater & Lift Station Systems). Oviedo is planning on buying out Alafaya Utilities as of April 2010, which currently serves about 8,500 City residents with reclaimed and sewer service (Roberts, 2010). However, residents have the final say as to whether or not the utility will be bought out (Roberts, Gary, 2010). "Alafaya Utilities is a subsidiary of Utilities, Inc., which operates more than 500 utility systems in 15 states" according to Gary Robert of Knight Newspaper Production (Roberts, Gary, 2010). The buyout is expected to lead to more development in the area (Azam, 2010). According to Grusauskas, "The City is currently trying to acquire Alafaya so it can add its contracted reclaimed water to the private utilities distribution system to save money and make the Oviedo system sustainable" (Grusauskas, 2010). "Alafaya is a private utility within the City limits. They have limited reclaimed availability and trouble providing irrigation water to homes when it is dry. Limited reclaimed and intermittent service availability is a customer service nightmare" (Grusauskas, 2010). In addition, due to the "limited reclaimed supply from Alafaya, many residents use potable water for irrigation and refuse to hook up to reclaimed" (Grusauskas, 2010).

Potable Water System

Oviedo supplies drinking water to about 12,000 customers and the potable system consists of about 160 miles of water main (Oviedo CAFR, 2009). The City operates two water treatment plants including the West Mitchell Hammock Water Treatment Facility (WMHWTF), which is the City's main production facility providing the entire City with high quality drinking water. The other is the A.M. Jones Water Treatment Facility, which operates to boost water production during high demand periods (Water Production). The distribution system consists of over 160 miles of water main ranging from 2 to 36 inches in diameter and over 12,000 water meters and service lines (Water Production).

Oviedo consumes about 4.67 million gallons of potable water per day, or about 150 gallons per person. The potable water comes from groundwater wells, 400 ft. deep in the aquifer, and is controlled by the St. Johns River Water Management (City of Oviedo, 2007). As of 2007, Oviedo was exceeding its allotted water use (City of Oviedo, 2007). Currently, the City is not exceeding its groundwater allotment (Grusauskas 2010), probably due to the fact that the reclaimed water program began in 2007 (Oviedo CAFR, 2009). According to Grusauskas, the fact that the "City Fathers" invested heavily in the reclaimed system is the reason why groundwater allotments are not exceeded (Grusauskas, 2010).

Reclaimed water is a benefit to homeowner's associations. Since Oviedo is a top 100 City to live in, homeowners association want homes to be kept up with Florida-Friendly but “green” yards (Grusauskas, 2010).According to Grusauskas, "reclaimed water keeps things green and it is cheaper to use and less regulated then potable water" (Grusauskas, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

Every other year or so, the City encounters a do-it-yourself resident who may contaminate their own system. Such residents are found out when they call the City about water quality issues. Typically, cross connections are found with new constructions and are subsequently corrected due to the "very pro-active" inspection program (Grusauskas, 2010).

Provide any other pertinent information

Every potable meter in the City has a backflow device to prevent system contamination. The City is has also undertaken putting radio read meters in which automatically flag any back-flow. (Grusauskas, 2010).

Principal Operational Issues

1. Frequent (i.e. every other year) cross connections are caused by residents who decide to perform their own potable/reclaimed water connections. These cases are identified when they call the City about water quality issues.

2. City exceeded its allotted groundwater use in 2007 and had to put conservation measures and incentives in place in order to reduce demand on the aquifer (City of Oviedo, 2007). Incentives included: the removal of St. Augustine grass with grass that required less water, use of more efficient toilets, aerators, etc. A homeowner's associate reportedly sent out letters to residents stating that it would not implement conservation measures.
3. City planning on buying Alafaya Utilities in order to ensure a more efficient operation of the reclaimed water system and curb the "rising tide" of increasing rates for customers (Roberts, 2010). The rates are due to increasing electricity costs according to Alafaya Utilities (Azam, 2010). Alafaya Utilities does not provide good customer service and could not keep customers costs under control. Azam reports that Alafaya Utilities has had some issues with their customer service including cases in which customers were left without reclaimed water for their lawns and landscaping. The City plans to link the two reclaimed systems within three months of purchasing Alafaya Utilities, which could be finalized in September 2010 (Azam, 2010) and add as many as 900 reclaimed water customers (Roberts, 2010).
4. Running two systems is more expensive than one system and the provider needs to be diligent for cross contamination. The cheapest way would have been using one potable system for drinking water that also provided irrigation. However, since groundwater resources have become stressed (in Florida) that is no longer possible, which created a need for two systems. Changing an existing single system to dual system has left water suppliers with two operational cost issues (Grusauskas, 2010).

• Retrofitting neighborhoods with a dual system is expensive. With revenue from reclaimed water less than revenue from potable water, the City had to increase water rates. This rate increase can be significant; as it not only compensates for lost water sales, but also may help pay off new debt for reclaimed piping construction.

• The reduced use of water in the old drinking water piping system may allow water to age and chemically change to no longer meet new EPA drinking water standards (e.g. THM's). This can result in the requirement of high water treatment standards or flushing (wasting) large amounts of water to keep water fresh and compliant. Flushing also may cause a utility to go over their consumptive use permit (CUP)" (Grusauskas, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

A total of 36 homes participated in the H20viedo Water Conservation Incentive Program implemented in 2009. This saved 1.8 million gallons of potable water (40% savings per household). Since implementation of water conservation measures and the startup of the reclaimed water program, potable water consumption has declined by approximately 7 percent (Oviedo CAFR, 2009).

How has the dual system has impacted any other (system capacity, etc.) goals?

A total of 36 homes participated in the H20viedo Water Conservation Incentive Program implemented in 2009. This saved 1.8 million gallons of potable water (40% savings per household). Since implementation of water conservation measures and the startup of the reclaimed water program, potable water consumption has declined by approximately 7 percent (Oviedo CAFR, 2009).

Economic Information

What is the yearly O & M budget for the system?

Water production cost was $1,669,881, water distribution and maintenance was $464,168, cross-connection control was $166,051, and reclaimed water and conservation cost was $223,212 in Fiscal Year 2009-10 (City of Oviedo Annual Budget, 2009).

Discuss any additional O & M costs associated with the dual system:

Due to odor and THM issues, the City built a new state-of-the-art water plant (2006) with forced draft aerators (Grusauskas, 2010). This new treatment plant meets and exceeds new drinking water standards, but is more costly to operate than what neighboring cities experience (Grusauskas, 2010). Oviedo budgeted $1,383,660 for reuse system expansion in the 2009-2010 Budget (City of Oviedo Annual Budget, 2009).

Discuss any rate structures used by the utility to regulate consumption:

The City switched from using a decreasing block rate structure to an increasing block rate structure in 2007 to cut back on groundwater use (City of Oviedo, 2007). The potable water rates are according to a five tier increasing block rate structure for residential use beginning with $0.83 per 1,000 gallons for a bracket of 0 to 3,000 gallons of potable water use, whereas irrigation residential use is a 3 tier increasing block rate structure beginning with a rate of $3.48 per 1,000 gallons of potable water use (Oviedo CAFR, 2009). Commercial use is a flat rate of $2.50 per 1,000 gallons and commercial irrigation use is a flat rate of $3.89 per 1,000 gallons (Oviedo CAFR, 2009). Reclaimed water rates are cheaper and are according to a three tier increasing block rate structure for residential use beginning with $1.09 per 1,000 gallons for a bracket of 0 to 15,000 gallons of reclaimed water use (Oviedo CAFR, 2009). Commercial reclaimed water use is a flat rate of $1.09 per 1,000 gallons (Oviedo CAFR, 2009). Base rates for both the reclaimed water and potable water depend on the user type, meter size, and whether or not the customer is inside or outside the City limits. (Finance Department)

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, since using reclaimed water is vital to not exceeding the pumping allowance from the aquifer. According to Josef, "for every reclaimed gallon sold, ¾ of a gallon of potable is saved. This is based on people seeing potable as a cost beneficial resource. They typically use about 20 to 25% more reclaimed. They also feel good about using reclaimed water and believe they are recharging their water aquifer". Since implementation of water conservation measures and the startup of the reclaimed water program, potable water consumption was reduced about 7 percent (Oviedo CAFR, 2009).

Is the dual system more efficient economically?

Somewhat, according to Josef, "Reclaimed water infrastructure (Construction of piping systems) is being subsidized by potable water system in Oviedo. This is because if the resident had to pay for the reclaimed improvements directly, no one would hook up or want it. The whole community wins by having reclaimed water use".

Has the use of a dual system compromised safety?

Although there have been reported cross connections, there have not been any associated illnesses reported from the alternative chlorinated reclaimed water source.

Does the dual system position the water authority better for the future?

Yes, the reclaimed system is a significant contributor to ensuring a reliable water supply for the next 20 years at least. Due to the consumptive use permit the City cannot obtain more than 4.78 mgd, which is the 2013 projected quantity, the current demand being 4.6 mgd. Thus, implementing reclaimed water irrigation is essential, Grusauskas stated, "water for new growth will have to come from reductions in use by implementing reclaimed water irrigation". The City's wastewater goes to the Iron Bridge Regional Wastewater Reclamation Facility and in addition has a long term contract to purchase up to 3 MGD of reclaimed water for its new reclaimed system (Grusauskas, 2010). The projected water need for 2030 is 6.6 mgd of which 4.78 mgd would come from groundwater and 1.82 mgd from reclaimed water, and 1.18 mgd is excess reclaimed water capacity (Grusauskas, 2010).

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PINELLAS COUNTY UTILITIES, CLEARWATER, FL

I. GENERAL INFORMATION

Evaluation Date: 9/30/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Pinellas County Utilities
Contact Person: Wayne Nichols
Title: Water Reclamation Facility Supt

Services Provided

☐ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: N/A
Non potable water source: Reclaimed water
Uses of the non -potable line
☒ Landscape Irrigation:

☐ Commercial	☒ Golf courses	☒ Parks	☐ Playgrounds
☐ Road medians	☒ Residential	☒ Schools	☐ Other _____

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. Several water conservation measures are utilized by Pinellas County Utilities, two of which have recently been completed, the Ultra Low Flow Toilet Rebate Program and the Alternate Water Sources Rebate Program. The ULFT Program has surpassed the goal of saving 2 million gallons of potable water per day (ULFT, 2010). The AWS Rebate Program provided financial assistance for customers installing non-potable irrigation systems (AWS Rebate Program, 2010).
2. Pinellas County Utilities uses chloramine for drinking water disinfection, due to environmental regulations for chlorine byproducts, but uses chlorine for a temporary time during the year in order to maintain system water quality (Press Release Aug 17, 2010).
3. Pinellas County Utilities does not utilize increasing block rate structures for water use (Water and Sewer Rates, 2010).

4. Several subdivisions on the mainland and on the beach are hooked up to the reclaimed water system as well as several schools, parks, and golf courses (Reclaimed Water FAQs).

II. SYSTEM OVERVIEW

Pinellas County Utilities is located in Clearwater, Florida.

Potable Water System

Pinellas County Utilities obtains potable water through Tampa Bay Water. The water is a blend of groundwater, treated surface water, and desalinated seawater. Approximately 2,000 miles of pipe constitute the Pinellas County Utilities potable water distribution system (Pinellas County Drinking Water, 2010).

Reclaimed Water System

Reclaimed water produced by Pinellas County meets the requirements for use in public areas, residential lawn and landscape irrigation (Reclaimed Water FAQs). The reclaimed water program is voluntary. The total reuse was 7.72 mgd, of which 3.59 mgd is for residential irrigation, 1.77 mgd for golf course irrigation, 1.56 mgd for other public access areas, and 0.8 mgd at the treatment plant (DEP Form, 2006). Reclaimed water is produced from three plants: William E. Dunn WRF with 6.4 mgd of raw water, City of Clearwater Northeast AWWTF with 1.25 mgd of reclaimed water, and the City of Oldsmar WRF with 0.07 of reclaimed water (DEP Form, 2006).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

According to a report completed in 2006, there have been two illegal cross connections identified during the reporting period, but both cross connections were eliminated (DEP Form, 2006). New connections to the recycled water system are inspected at the time of initial connection. Existing residential reclaimed water customers are inspected as needed for follow up and HB re-inspections started (DEP Form, 2006).

Provide any other pertinent information

1. Has a wellhead protection program in order to comply with state regulations.
2. When a site is hooked up to the reclaimed water system a cross connection test is conducted (Reclaimed Water FAQs). In addition, wells and irrigation systems hooked up to the potable water system must be disconnected in order for a site to be hooked up to the reclaimed water system (Reclaimed Water FAQs). Those hooked up to the reclaimed water system in North Pinellas County are required to have wye strainers

for irrigation systems (Reclaimed Water FAQs).

Principal Operational Issues

1. At least one company not associated with Pinellas County Utilities has attempted to scare drinking water customers into buying expensive potable water treatment systems for their water (Utilities, 2010).
2. The reclaimed water system is experiencing low pressure issues and water shortages during the non-rainy season and an appeal was made to customers to limit their reclaimed water use (Conservation Measures-Seasonal Restrictions, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Coupled with conservation measures per capita water use was reduced from 153 gpcd in 1989-1990 to 72 gpcd in 2008-2009.

How has the dual system has impacted any other (system capacity, etc.) goals?

There is not enough information to determine this.

Economic Information

What is the yearly O & M budget for the system?

There is not enough information to determine this.

Discuss any additional O & M costs associated with the dual system:

There is not enough information to determine this.

Discuss any rate structures used by the utility to regulate consumption:

Pinellas County Utilities does not use increasing block rate structures to encourage water conservation. Retail water rates are composed of a base rate charge, $3.35, and a flat volumetric rate of $4.78 per 1,000 gallons. Reclaimed water rates for retail customers on a “funded” reclaimed water system are composed of a user fee of $14 and a volumetric rate of $0.64 per 1,000 gallons (if metered). If the customer is on an "unfunded" reclaimed water system, the user fee is $7.00, the availability charge is $8.00, and the volumetric rate is $0.64 per 1,000 gallons. The difference between a funded and an unfunded system is that the availability charge is used to pay for infrastructure costs on the unfunded system (Water and Sewer Rates, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes since conservation measures and the reclaimed water system have substantially reduced potable water demand. However, setting up an increasing block rate structure may lead to more potable water conservation.

Is the dual system more efficient economically?

There is not enough information to determine this.

Has the use of a dual system compromised safety?

There have been a very limited number of cross connections, which were resolved expeditiously.

Does the dual system position the water authority better for the future?

Yes, since conservation measures and the reclaimed water system have substantially reduced potable water demand.

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PITTSBURG PUBLIC WORKS, PITTSBURG, CA

I. GENERAL INFORMATION

Evaluation Date: 7/26/2010
Prepared By: Pete Rogers

Utility Information

Utility Name: Pittsburg Public Works
Contact Person: Walter Pease
Title: Director of Water Utilities

Services Provided

☒ Water ☒ Wastewater ☐ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 2001
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:

☐ Commercial	☒ Golf courses	☒ Parks	☒ Playgrounds
☐ Road medians	☐ Residential	☐ Schools	☒ Other City Hall

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. The dual system was originally designed to supply recycled water to two power plants located in Pittsburg. With adequate capacity at the recycled water plant, the City later installed the necessary pipelines and storage tank to incorporate the parks and golf course into the system for irrigation.
2. The 1.2 MG recycled water distribution tank (used exclusively for irrigation) is situated at an elevation so that the pressure in the recycled water lines is approximately 20 psi below that of the potable water lines.
3. The City is not planning on expanding the recycled system coverage since the cost of the dist. system expansion is not cost effective at this time. (Pease, 2010).

II. SYSTEM OVERVIEW

The City of Pittsburg is located at the junction of the Sacramento and San Joaquin Rivers approximately 30 miles northeast of Oakland. The 2010 estimated population is 65,000 (California Department of Finance, 2009). The City's Water Utilities Department is responsible for providing the community with water, wastewater, and storm water services.

Potable Water

Raw water is provided to the City through the Contra Costa Water District (CCWD) which sells treated and untreated water to various municipal, industrial, and irrigation customers throughout the area. The CCWD draws its water from the Rock Slough and Old River intakes on the Sacramento-San Joaquin Delta under a contract with the United State Bureau of Reclamation's Central Valley Project (Contra Costa Water District, 2010). This water is conveyed through the 48 mile Contra Costa Canal, which extends from the Rock Slough intake to the Martinez Reservoir. Raw water provided by the CCWD is treated at the Pittsburg Water Treatment Plant which has a plant capacity of 32 mgd. The Water Utilities department operates the eight reservoirs, seven pumping stations, and 211miles of pipe that makeup the distribution system.

Wastewater and Recycled Water

The City of Pittsburg owns and operates the 170 miles of wastewater collection system. The treatment, effluent disposal, and recycled water services are provided by the Delta Diablo Sanitation District (DDSD). DDSD services unincorporated areas of Contra Costa County and the communities of Bay Point, Antioch, and Pittsburg. The DDSD wastewater treatment plant, located on the Pittsburg-Antioch border, has capacity of 16.5 mgd with an average dry weather flow of 14.2 mgd (Contra Costa LAFCO, 2007).

The City's recycled water program began in 2001 with the completion of the Recycled Water Facility (RWF) located adjacent to the wastewater treatment plant. The RWF is operated by DDSD and sized to deliver a peak flow of 12.8 mgd (14,000 acre feet per year). Approximately 8,600 AF per year of recycled water is used for the cooling towers of the Los Medanos and Delta Energy Centers (Cohen et al., 2009). An additional 600 AF per year of recycled water also used within Pittsburg to irrigate 5 parks (Central, Columbia Linear, 8th Street Linear, City Park, and Stoneman North), City Hall, and the Delta View Golf Course. The golf course is the largest user or recycled irrigation water, using approximately 1 mgd during the spring and summer months (Pease, 2010). The use of recycled water for irrigation within the City required the construction of a 1.2 mg distribution tank to make up for the water distribution system pipeline capacity deficiencies (an 8 inch water supply line was reused for this project). Any treated wastewater that is not used as recycled water is discharged in New York Slough (canal) through a deep water outfall.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
N/A

Provide any other pertinent information
The City has a backflow prevention program with yearly testing.

Principal Operational Issues

Due to the large fluctuation in elevation throughout the City, a large portion of the utility's operation budget is spent on pumping recycled water.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

1. The City estimates that the recycled water system reduces the potable water demand by approximately 5% (600 AF per year).
2. The golf course alone consumes roughly 1 mgd of recycled water during the spring and summer months.

How has the dual system has impacted any other (system capacity, etc.) goals?
Due to the limited scope (coverage) of the dual system, the use of recycled water has had a very minor impact on the remainder of the system.

Economic Information

What is the yearly O & M budget for the system?
Since the Delta Diablo Sanitation District operates the recycled water plant for multiple communities, it is difficult to extract this data for just the City of Pittsburg. Walter Pease indicated that DDSD charges the power companies $398 per AF and the City $317 per AF. Based on an average irrigation consumption of 600 AF per year, the recycled water production costs would be $190,200.

Discuss any additional O & M costs associated with the dual system:
Yearly back flow device testing and quarterly inspections.

Discuss any rate structures used by the utility to regulate consumption:
The City uses an increasing block rate structure for potable water based on a per Ccf (hundred cubic feet) interval rather than a per 1,000 gallon interval. The primary users (power plants) purchase recycled water from DDSD at $398 per AF.

IV. CONCLUSIONS

Does the dual system provide a better use of water?
Yes. The primary use of the recycled water is for the power plants with other uses based on the limitation of the distribution system. There is potential for an expansion of connections

based on their proximity to the existing system.

Is the dual system more efficient economically?

Yes, due to the high cost of potable water. Walter Pease indicated that the utility pays approximately $750 per AF (raw water, treatment, and distribution) versus $310 per AF for recycled water. Based on an average consumption of 600 AF, this results in $264,000 annual savings.

Has the use of a dual system compromised safety?

No. There have been no reported cases of cross connections or illnesses related to the consumption of recycled water.

Does the dual system position the water authority better for the future?

Yes. The use of recycled water for the golf course alone has freed up approximately 1 mgd of water treatment plant and reservoir storage capacities during the spring and summer months. This helps reduce the vulnerability of the potable system against droughts while also protecting valuable water assets.

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CITY OF RALEIGH PUBLIC UTILITIES DEPARTMENT, RALEIGH, NC

I. GENERAL INFORMATION

Evaluation Date: 1/6/2011
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Raleigh Public Utilities Department
Contact Person: Marla Dalton
Title: Environmental Reuse Coordinator

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 2007
Non potable water source: Reclaimed water
Uses of the non potable line
☒ Landscape Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☐ Road medians ☒ Residential ☒ Schools ☒ Other: Odor control, fertilizer make up water, facility washdown, pesticide make up water, concrete production
☒ Agricultural Irrigation
☒ Toilet and urinal flushing:
☒ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. There are two reclaimed water systems served by Raleigh.
2. There are four bulk distribution systems serving reclaimed water.
3. Reclaimed water is used for toilet flushing.

II. SYSTEM OVERVIEW

The City of Raleigh has a population of 405,791 people and is located in Wake County North Carolina. The City of Raleigh Public Utilities Department water and sanitary sewer service to about 450,000 people in Raleigh, Garner, Wake Forest, Rolesville, Knightdale, Wendell, and Zebulon areas (Public Utilities Department, 2009). Raleigh has four wastewater treatment plants, two water treatment plants, and two reuse systems (MPU, 2007).

Potable Water System

Most of Raleigh's potable water originates from the Falls Lake Reservoir in northern Wake County. The water is treated at the E.M. Johnson Water Treatment Plant. According to Dalton (2011), potable water use averages at about 50 mgd.An additional plant located in southwest Wake County, the Dempsey E. Benton Water Treatment Plant, treats an additional potable water (Articles).The potable water system consists of approximately 2,300 miles (Dalton, 2011) of water line to serve an average of 44.8 mgd of water to 165,298 consumers (CAFR, 2009).

Reclaimed Water System

Raleigh's reclaimed water system, the Neuse River WWTP reuse system, was put into service in 2000 (MPU, 2007). As of 2007, the system consisted of 10 miles of reclaimed water line (MPU, 2007). Raleigh's Zebulon Service Area (ZSA) reclaimed water system has recently been expanded including a system that was approximately 4,500 feet long in 2007. This reclaimed water system began constructing their reclaimed water system in 2003 to use reclaimed water for cooling tower make-up and irrigation (MPU, 2007). In addition, the ZSA is also served with water and sewer service from Raleigh (Utility Billing). Reclaimed water users include US Foods, Five County Stadium, four WWTP non-potable users, golf courses, commercial irrigation, schools, residences, and nurseries (MPU, 2007). In 2007, there were 233 bulk reuse customers for which the annual average flow of 3.86 mgd (MPU, 2007). According to Marla Dalton (2010), Raleigh has 4 bulk systems in which customers can pick up water in tanks, and two reclaimed water systems, consisting of a total of 20 miles of pipeline. In 2010, 69,635, 825 gallons of reclaimed water was used (Dalton, 2010).

The reclaimed water system is currently being expanded, and as of December 2010, the Southeast Raleigh Distribution System was expanded and currently serves 4 users for irrigation, odor control, area wash down uses (Reuse Water, 2010). By 2011, Raleigh plans on the system being expanded to serve more parks, recreational facilities, a softball complex, and other locations (Reuse Water, 2010).

Concerning the distribution expansion for the City of Zebulon; 30,963,900 gallons of reclaimed water was sold through October 2010 and now serves Glaxo Smith Kline for irrigation, cooling tower, toilet flushing) and Alliance Concrete Company (Reuse Water, 2010). The system will eventually serve a Wal-Mart (Reuse Water, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
There have been no cross connections or associated illnesses (Dalton, 2011).

Provide any other pertinent information

The measures taken to protect public health and safety are: cross connection testing, system identification, and different reclaimed water meter set ups from that of potable water (Dalton, 2011).

Principal Operational Issues

According to Dalton (2011), the principal operational issues are water quality and quantity.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

On a limited scale since about 70 million gallons of reclaimed water was used in 2010.

How has the dual system has impacted any other (system capacity, etc.) goals?

The Town of Zebulon's water and reclaimed water is now provided by the City of Raleigh.

Potable water system expansions have been deferred.

Economic Information

What is the yearly O & M budget for the system?

A single staff member (coordinator) and support from other existing devisions.

Discuss any additional O & M costs associated with the dual system:

NA

Discuss any rate structures used by the utility to regulate consumption:

The potable water rates are organized by an increasing block rate structure and reclaimed water rates are 50 percent of the potable rates (Dalton, 2011).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

On a limited basis since reclaimed water use is limited compared to potable water use.

Is the dual system more efficient economically?

Efficiency occurs with dual pipeline installation.

Has the use of a dual system compromised safety?

No, since there have not been any cross connections or associated illnesses.

Does the dual system position the water authority better for the future?

Only on a limited basis.

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REDWOOD CITY PUBLIC WORKS SERVICES, REDWOOD CITY, CA

I. GENERAL INFORMATION

Evaluation Date: 11/15/2010
Prepared By: Pete Rogers

Utility Information

Utility Name: Redwood City Public Works Services
Contact Person: Justin Ezell
Title: Public Works Superintendent

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 2000 (pilot)
Non potable water source: Reclaimed water
Uses of the non-potable line

☒ Landscape Irrigation:

☒ Commercial	☐ Golf courses	☐ Parks	☐ Playgrounds
☒ Road medians	☒ Residential	☐ Schools	☐ Other

☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
    ☐ Commercial   ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. The utility has a very extensive public outreach/education program consisting of:
    a. Free training sessions twice a year on the safe and proper use of recycled water.
    b. Training for site supervisors. Recycled water customers are required to have a
2. designated site supervisor, trained by the City, to manage recycled water at their site.
    a. Free one-on-one residential conservation consultations and site water use analysis.
3. The utility has a "delta 10 control strategy" within the system that ensures that the pressure in the recycled water lines is always 10 psi below that of the potable lines.

4. Under the 2008 recycled water ordinance, new parks, playgrounds and schools (urinals and irrigation) will use recycled water.
5. A portion of the recycled meters are connected to automated meter information (AMI). These customers can view their usage online and also receive weekly emails.

II. SYSTEM OVERVIEW

Redwood City is located in the Bay Area, approximately 25 miles south of San Francisco and 27 miles north of San Jose. The 2010 estimated population is 80,000 (Redwood City Profile, 2008). The City's Public Works Services Department provides the community with water, wastewater, recycled, and storm water services. The City's water supply is provided by the Hetch Hetchy water system, operated by the San Francisco Public Utilities Commission (SFPUC). The SFPUC provides water to over 2.4 million customers in the Bay Area and within the City of San Francisco through contractual agreements with 29 wholesale customers in Santa Clara, Alameda, San Francisco, and San Mateo counties (SFPUC, 2010). One such agreement is with Redwood City for approximately 12,243 AFY (3.98 billion gallons per year).

Potable Water

Most of the City's potable water supply comes from the Hetch Hetchy reservoir located on the Tuolumne River in Yosemite National Park. The SFPUC operates the gravity fed 160 mile long transmission from the Hetch Hetchy Reservoir to Redwood City. Because of the watershed's remote and pristine condition, the State has granted the Hetch Hetchy water source a filtration exemption, although water is chloraminated (Ezell, 2008). A small portion of the City's water comes from two local watersheds which drain to the San Antonio and Calaveras reservoirs. Prior to distribution, water from these reservoirs is treated at the Sunol Valley Water Treatment, which was recently expanded to a capacity of 160 mgd. The plant uses coagulation, flocculation, sedimentation, filtration, and disinfection processes.

Wastewater and Recycled Water

Redwood City's Public Works Services department is responsible for the collection and treatment of wastewater. The collection system consists of 280 miles of sewer mains with 31 lift stations (Public Works Services, 2008). The sewage is treated at the South Bayside System Authority (SBSA) Wastewater Treatment Plant with a capacity of 29 mgd. Redwood City has agreements with the County of San Mateo and the town of Woodside that permit these jurisdictions to convey wastewater through the City system to the SBSA treatment plant (Draft General Plan, 2009). SBSA is managed by a Joint Powers Authority (JPA) made up of Redwood City, San Carlos, Belmont, and the West Bay Sanitary District. Effluent from the SBSA is discharged to the San Francisco Bay, as permitted by the San Francisco Regional Water Quality Control Board (RWQCB).

The City's water recycling project was initiated in 2000 through a joint pilot study between Redwood City and SBSA which demonstrated the feasibility of producing recycled water that meets the distribution goals and health requirements specified by the California

Department of Health Services. Despite the success of the pilot study, the City faced strong opposition from citizen groups who objected the use of recycled water, particularly in areas where children play. The City responded in 2003 by forming a professionally-affiliated and consultant-staffed Recycle Water Task Force which explored different ways of achieving water conservation goals while avoiding schools and playgrounds (Public Works Services, 2008). Recently the recycled water project has expanded to include the completion of a recycled water treatment facility with a capacity of 3200 AFY (2.85 mgd) at the SBSA plant in 2006 and recent pipeline expansion projects in the Redwood Shores, Bayfront, and Seaport areas (Ezell, 2010). The project is still a joint effort: SBSA is responsible for treating the wastewater for recycling, while the City's Public Works Services department is responsible for distribution and quality testing. The City reports that the water recycling system also has sufficient capacity available to supply recycled water to adjacent communities (Draft General Plan, 2009). Under the City's 2008 Recycled Water Use Ordinance, the use of recycled water was expanded to include internal separate plumbing for urinals, internal cooling, towers and external landscaping on new apartments, townhouses and condominiums, and on industrial, commercial, and governmental projects (including schools, parks, and playgrounds). For existing customers, it requires recycled water for external landscaping on existing and remodeled commercial and industrial buildings (Draft General Plan, 2009). The recycled water project currently services a total of 38 residential, commercial, industrial, and municipal sites with an additional 40 applications in process (Connections, 2009). Justin Ezell reports that the recycled project is gaining momentum; the original protesters are now loyal supporters.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
N/A

Provide any other pertinent information

1. The utility has a cross connection control program that consists of routine inspections to determine the degree of risk (used in determining backflow device) and annual inspections of all existing devices.
2. The utilities "delta 10 control strategy" ensures that the pressure in the recycled water mains is always (regardless of pressure changes) 10 psi less than that in the potable mains. This minimizes any impact of potential cross connections.
3. The City conducts free training sessions twice a year on the safe and proper use of recycled water.
4. Recycled water customers are required to have a designated site supervisor trained by the City to manage recycled water at their site.

Principal Operational Issues

1. Increases in recycled water (and subsequent reductions in potable use) have led to several potable water quality issues. Justin Ezell indicated that the potable mains are now even more oversized.
2. Because the City's conservation and recycled water programs started at the same time, there were some initial issues with brown lawns. While the public initially blamed the high salinity (750 ppm) of the recycled water, a study concluded that the public simply was not watering enough.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

From 2003 through 2008 the City exceeded its annual water allocation by SFPUC of 12,243 AF by an average of 800 acre feet with a peak of 1,400 AF in 2003. With the 2008 City water reuse ordinance, massive infrastructure additions, and conservation measures, in 2009 the City used only 11,589 AF (654 AF less than its allocation). Recycled water accounted for 360 AF (Ezell, 2010). Although the original goal of the recycled water program was 900 AFY by 2010, the City feels that this goal is met when including conservation (Ezell, 2010). Recycled water use will increase once the 2008 ordinance is applied to new customers. Meanwhile, the City is clearly moving in the right direction.

How has the dual system has impacted any other (system capacity, etc.) goals?

The increased use of recycled water has reduced potable water demand to the point that the utility is experiencing some water quality issues (oversized mains).

Economic Information

What is the yearly O & M budget for the system?

The total 2009 recycled water budget was approximately $5 million. Most of this ($4.5 million) was allocated to debt service and the remaining $500,000 for the operation and maintenance of the recycled water project (Ezell, 2010). Justin Ezell indicated that revenues from the recycled water project are slightly less than the $500,000 operational costs.

Discuss any additional O & M costs associated with the dual system:

1. Doubled the number of valve exercising and main flushing operations.
2. Weekly sampling and testing from sample stations throughout the recycled system.
3. Quarterly cross connection inspections and reporting.

Discuss any rate structures used by the utility to regulate consumption:

1. The utility uses an increasing block rate structure for both potable water consumption. Pricing for recycled water is priced at the lowest tier at a fixed rate which is 75% that of potable water.
2. Existing customers do not have to pay a recycled water connection fee, however, future customers will have to pay the fee.
3. The City uses a variety of other measures to conserve water including rebates (washer, toilets), free conservation devices, and one-on-one conservation consults.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes. Combined with conservation, it has reduced the City's allocations from SFPUC to the point that their use no longer exceeds the allotted withdrawals. They now use less than their allotment.

Is the dual system more efficient economically?

At this point probably not since the system is in its infancy. However, the project is clearly gaining momentum and will improve economically

Has the use of a dual system compromised safety?

No. There have been no reported cases of cross connections or illnesses relating to the consumption of recycled water.

Does the dual system position the water authority better for the future?

Yes. It reduces the community's dependence on the SFPUC's system and provides some measure of security against droughts.

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SAN ANTONIO WATER SYSTEM, SAN ANTIONIO, TX

I. GENERAL INFORMATION

Evaluation Date: 1/3/2011
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: San Antonio Water System (SAWS)
Contact Person: Pablo Martinez
Title: Water Recycling

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 2001
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☐ Parks ☐ Playgrounds
☐ Road medians ☐ Residential ☒ Schools ☒ Other: Data center cooling and other industrial processes, stream augmentation
☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. The SAWS also has an Aquifer Storage and Recovery facility that was opened in 2004, which produces about 15% percent of the total water supply (SAWS Annual, 2009). As of January 2011 more than 90,000 AF of water has been stored underground.
2. There is an effective leak detection program which resulted reduced the percentage of unaccounted for water down to seven or eight percent annually (2002 Annual Report, 2002).
3. The system uses an aggressive water conservation program with a goal to reduce the per capita water demand to 116 gpcd during normal weather conditions. Despite, a 50 percent increase in customers since 1987, the volume of water distributed has been unchanged (2009 Water Management Plan Update, 2009).

The potable water usage in 2008 was 139 gpcd, and 115 gpcd in 2007, whereas in 1982 it was 225 gpcd (2009 WMPU, 2009).

4. By the end of 2009, SAWS exceeded 98 percent beneficial biosolids use (Annual Report, 2009). In 2009 conservation efforts resulted in 2,918 acre-feet of water savings (Annual Report 2009).

II. SYSTEM OVERVIEW

The San Antonio Water System is located in the City of San Antonio, a population of 1,373,668, located in Bexar County Texas.

Potable Water System

In 2009, the potable water system consisted of 4,886 miles of water main and the total potable water supply available was 343,717 acre-feet in 2010. The available water supply comes from 3,500 AF from the Trinity Aquifer, 6,400 AF from the Carrizo Aquifer, 8,210 AF from Canyon Lake, 67,000 AF from the Aquifer Recovery and Storage system, and 258,607 AF from the Edwards Aquifer which is 80 percent of the total water supply. The total number of wells in 2009 was 140 (Annual Report 2009). The system also has a total storage capacity of 166.2 million gallons (Annual Report 2009). Currently, the actual potable water demand is about 55.3 billion gallons per year (Annual Report, 2009).

Reclaimed Water System

The reclaimed water system consists of approximately 130 miles of recycled water line (Martinez, 2010) and 85,000 AF is the total available reclaimed water supply in 2010. Approximately 50,000 AF is available for CPS Energy Power Plants and 35,000 AF to other customers, which is 20 percent of the total water supply available. Since the program began in 2001 the total reclaimed water usage surpassed 10 billion gallons in 2008 (Freckmann, 2008). According to Pablo Martinez (2010), the reclaimed water usage is approximately 7,600 acre feet during a wet year and 13,400 acre feet during a dry year. Thus, the average usage is about 3.42 billion gallons per year. The SAWS has three water recycling centers: Medio Creek WRC, Leon Creek WRC, and the Dos Rios WRC (Water Recycling Center Locations, 2010) (Service Areas, 2010).

The reclaimed water is used for lawn irrigation, which includes the Alamo, USAA, Brackenridge Park, Trinity University, Lackland Air Force Base and the University of Texas at San Antonio (Freckmann, 2008). Reclaimed water is proving to be an economic benefit to San Antonio in that the City is competitive in the economic development arena. For instance, a data center plans to use recycled water for cooling servers (Freckmann, 2008).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

Reportedly, a cross connection occurred in March 2002, when the Brackenridge Golf Course switched to using reclaimed water, and it affected the River Road neighborhood since some non-potable water got into the water system. A lawsuit was filed since people in the neighborhood claimed that they got sick as a result of the cross connection and that SAWS operators took about two to three weeks to resolve the problem. In April 2002, one of the residents affected reported that the water was brown in color, cloudy, had particulate matter, and had a bad odor (Lavelle, 2002).

Provide any other pertinent information

The 2002 cross connection was the only cross connection that the system had since. Public health and safety measures are: back flow devise annual testing, customer training, and annual site inspections (Martinez, 2010).

Principal Operational Issues

1. The SAWS is facing challenges related to aging infrastructure, and has the goal of replacing water and wastewater infrastructure as well as accommodating new growth (2002 Annual Report, 2002).
2. San Antonio Water System filed a lawsuit against the LCRA alleging that there was a breach of contract for water.

The reclaimed water supply has been stable for the last ten years indicating that the reclaimed water system is efficient and effective (Martinez, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Ever since SAWS has initiated a strong conservation program along with an assertive recycling program San Antonio started noticing a reduction in gpcd consumption beginning in the 1990s. Potable water has been saved according to the following provided by Pablo Martinez (2010): In 1982 the GPCD was 225, in 2004 it was 117 and in 2006 it was 136.

How has the dual system has impacted any other (system capacity, etc.) goals?

The City is in the process of re-rating the Dos Rios WRC from its capacity of 125 mgd to 217 mgd in order to accommodate future growth in the San Antonio metropolitan area (Annual Report 2009).

The City also plans on having a brackish groundwater desalination plant (Annual Report, 2009).

According to Martinez (2010) the SAWS is not planning on expanding the reclaimed water system or increasing reclaimed water supply.

Economic Information

What is the yearly O & M budget for the system?

The operating expense for the San Antonio Water System (which includes the wastewater system) was $306,058,000 in 2009. The net income was -$14,116,000 before calculating in capital contributions (Annual Report 2009). Martinez says that the reclaimed water system costs about 2 million per year in operation and maintenance costs. In addition, Martinez reported that the reclaimed water system does not pay for itself.

Discuss any additional O & M costs associated with the dual system:

The expenses included water delivery, supply, chilled water and steam distribution, and wastewater (Annual Report 2009).

Discuss any rate structures used by the utility to regulate consumption:

Potable water rates depend on the user type, meter size, and whether the user is inside or outside the City limits. User types that have volume rates depending on whether or not they are standard or seasonal charges are: residential, general class (includes apartments, commercial, industrial, and municipal customers), and landscape irrigation. There are also volumetric rates for wholesale customers which are not organized into standard or seasonal rates. All potable rates are organized into their respective four tier increasing block rates structures and are per 100 gallons.

Recycled water service depends on whether or not the customer is an Edwards Exchange Customer or Non-Edwards Exchange Customer. The respective rates are organized into a two tier increasing rate structure and the rates are per 100 gallons. The rates are also standard and seasonal. (Water and Sewer Rates, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, since the reclaimed water system conserves potable water. When combined with the strong conservation program and the recycling program, SAWS has noticed the potable water usage has gone down from 225 gpcd in 1982 to 136 gpcd in 2006.

Is the dual system more efficient economically?

SAWS has some of the lowest water rates in the state, butthe reclaimed water system does not pay for itself.

Has the use of a dual system compromised safety?

In 2002 a cross connection caused a group of residents to become ill and incur medical expenses as a result. However, there have not been any cross connections or associated illnesses reported since.

SAWS has implemented a detailed process for retrofit connections plus new connections including plan review, on-site construction observation, annual monitoring, and inspection.

Does the dual system position the water authority better for the future?

It does, since the potable water usage has reduced since substantially since the reclaimed water system has been used in conjunction with a strong conservation program plus citizen awareness regarding protection of natural resources.

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CITY OF SAN DIEGO PUBLIC UTILITIES DEPARTMENT, SAN DIEGO, CA

I. GENERAL INFORMATION

Evaluation Date: 7/6/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of San Diego Public Utilities Department, Recycled Water Section
Contact Person: Fabiola Amarillas
Title: Associate Engineer- Civil (OCA Senior Engineer)

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1850 with potable and 1997 with reclaimed water
Non potable water source: Reclaimed water
Uses of the non-potable line

☒ Landscape Irrigation:
- ☐ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
- ☒ Road medians ☒ Residential ☒ Schools ☒ Other: Other industrial use, irrigation of landfill, and irrigation of temple

☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
- ☒ Commercial ☐ Residential

☒ Cooling towers
☐ Fire fighting

Unique System Features

1. North Central Water Reclamation Plant (NCWRP) is entirely powered by an on-site cogeneration facility operated by Minnesota Methane, using methane from Miramar landfill and MBC digester. The remainder of the power generated after NCWRP usage is sold to the electrical grid. (San Diego RWMPU, 2005)
2. Reportedly, the reliability of the reclaimed water system does not have to be as stringent as the potable water system since it does not provide essential services, such as fire protection and sanitary services (San Diego RWMPU, 2005).
3. Aggressive water conservation program which requires retrofitting toilets with ultra-low flush toilets and utilizes public information and education (San Diego 2002-2030 LRP 2010). The retrofits accounted for over half the water savings (San Diego 2002-2030 LRP).

II. SYSTEM OVERVIEW

The San Diego Water Department serves more than 1.3 million people and San Diego is located in San Diego County California. San Diego relies almost entirely on surface water to meet its water demand. Currently, San Diego obtains anywhere from 75% to 90% (San Diego, 2005) of its water by importing it from the San Diego County Water Authority (CWA), which gets their water from the Metropolitan Water District of Southern California (MWD). The water ultimately comes from the Colorado River and northern California (Wood 2007). Anywhere from 10 to 25% of San Diego's water comes from runoff collected in the City's reservoirs (San Diego UWMP, 2005).

Potable System

The potable system serves San Diego, customers in unincorporated areas, several cities, and irrigation districts. The system has approximately 3,460 miles of pipeline (San Diego UWMP, 2005) and has a system capacity of 294 mgd collectively from three water treatment plants. In addition, there are 90 pressure zones in the potable distribution system (Public Utilities, 2010).

Reclaimed System

The reclaimed system consists of about 83 miles of pipeline (Recycled Water Overview, 2010). Reclaimed water comes from either the South Bay Water Reclamation Plant (SBWRP) or the North Central Water Reclamation Plant (NCWRP) which both treat a portion of its wastewater to standards suitable for being used as reclaimed water by reclaimed water customers (San Diego RWMPU, 2005). The remainder of the effluent is discharged into the ocean (San Diego RWMPU, 2005).

The NCWRP began operation in 1997 and has a capacity of 30 mgd, of which 22.5 mgd of wastewater was treated in 2005. The NCWRP utilizes a Demineralization Facility to further treat a third of the treated wastewater, which uses electro dialysis reversal (EDR) to reduce salinity of the reclaimed water. The portion treated by EDR is eventually blended with filtered effluent and chlorinated for 90 minutes prior to conveyance (San Diego RWMPU, 2005).

Some new developments in the North Service Area have installed reclaimed water pipelines and installed irrigation system for future connections to the North City Recycled Water Distribution System (San Diego RWMPU, 2005). There are rules and regulations which specify who is required to hook up to the reclaimed water system depending on user type, distance from reclaimed water system, and the amount of water the user uses or plans to use; the height, occupancy, and square footage of new buildings; the type of cooling tower used; among other rules (PBS&J, 2005).

The SBWRP began operation in 2002 and has a capacity to treat 15 mgd of wastewater. San Diego entered into an agreement in 2005 with the Otay Water District to sell 6 mgd of reclaimed water (San Diego RWMPU 2005). About 0.7 mgd of reclaimed water is conveyed to the International Boundary and Water Commission (IBWC) (San Diego RWMPU, 2005). The SBWRP uses ultraviolet for tertiary treatment of the reclaimed portion of the wastewater treated. The capacity of the plant to produce reclaimed water is 13.5 mgd (San Diego RWMPU, 2005).

San Diego is considering increasing the amount of reclaimed water it produces to decrease reliance on imported water (San Diego RWMPU, 2005).

In all, the "City of San Diego has 2 reclamation plants with a capacity to treat 45 MGD of wastewater and a recycled water production capacity of approx. 38 MGD" (Amarillas, 2010). In 2009, the actual amount of reclaimed water produced was approximately 7 MGD (Water, 2009).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

One cross connection in 2001 was found by a City inspector, valves were closed, and there was no water flowing from one system to the other. In addition, there were no associated illnesses. (Amarillas, 2010)

Provide any other pertinent information

1. San Diego has a 7 month supply of emergency water in case of catastrophe (San Diego 2002-2030 Long Range Plan, 2010).
2. The potable water system serves as a backup supply for the reclaimed water system (San Diego RWMPU, 2005).
3. Plan check and inspections of the reclaimed water system is a collaborative effort of San Diego, California Department of Health Services (CDHS) and County Department of Environmental Health (DEH).
4. Cross-connection control shutdown testing is required at each reclaimed water customer site to identify any cross connections with the potable water system, and is repeated every 4 years thereafter. In addition, site walks and record checks are performed annually. (San Diego RWMPU, 2005).
5. Backflow Prevention Program which tests backflow devices annually (San Diego County Apartment Association, 2010).

Principal Operational Issues

1. Unreliable supply of surface water from the CWA/MWD due to drought, increased competition amongst water users, new and more restrictive environmental regulations (Wood, 2007).
2. Surface water obtained from CWA/MWD has high salinity which prevents the reclaimed water system from being used to its fullest potential (San Diego 2002-2030 LRP 2010).
3. San Diego is in the process of finding new sources of local water to decrease dependence on imported water (Wood, 2007).
4. Public acceptance issues (San Diego 2002-2030 LRP, 2010).
5. Disagreements over water rates and conveyance options between the CWA and MWD (San Diego 2002-2030 LRP, 2010), which contributes to uncertainty in utilizing imported water to meet water demand.

6. People posing as water utility service employees are "trying to collect water bills or sell water treatment devices using false or misleading statements about the quality or contents of your water" (Utility Service Imposters, 2010).
7. The City has committed to a TDS of 1000 mg/mL or less to its customers. This level is less than the 1200 mg/ml level allowed by title 22. This is an added cost at one of the treatment plants (Amarillas, 2010). At the other treatment plant, conservation measures have led to the generation of less wastewater leading to decreased supplies of raw water.
8. The reclaimed system was designed as a wastewater distribution system, not like a water system, therefore there is no real reliability in the system, it is not looped (Amarillas, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Concerning whether or not the reclaimed water system is a significant contributor to conservation efforts in San Diego, Fabiola Amarillas stated that conservation accounted for a 12% reduction in potable water demands and recycled water 3% (Amarillas, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

In 2007, the San Diego City Council authorized the Water Reuse Demonstration Project. The project consists of a one-million gallon per day advanced recycled water treatment plant at the North City Water Reclamation Plant (Water History, 2010). In 2009, the Water Department and the Metropolitan Wastewater Department merged to become the Public Utilities Department (Water History, 2010).

Due to the presence of the reclaimed water system, San Diego has a policy that "recycled water be used for any purpose approved for recycled water use when it is economically, financially, and technically feasible, as mandated by Ordinance 0-17327" (San Diego Rules and Regulations, 2008). Customers that meet the requirements for reclaimed water service are required to apply for reclaimed service (San Diego Rules and Regulations, 2008).

Economic Information

What is the yearly O & M budget for the system?

The Water Department budget for the 2010 Fiscal Year is $536,311,930 which includes the personnel, operations, and maintenance expenses. The reclaimed water program is also included in this amount. Personnel expenses: $65,945,842; Non-personnel expenses: $470,366,088. Non-personnel expenses are broken down into four categories, Supplies & Services: $446,885,877; Information Technology: $11,571,975; Energy & Utilities: $9,741,215; Equipment Outlay: $2,167,021.

Discuss any additional O & M costs associated with the dual system:

Water purchases are included in the expenses for Fiscal Year 2010. Capital improvement planning and management, stormwater and watershed management, and capital improvement projects are a few unique expenses of the Water Department.

Discuss any rate structures used by the utility to regulate consumption:

The potable water rate for single family domestic customers is a three tier increasing block rate structure to encourage conservation. For example, the first tier volumetric bimonthly charge is $4.40 per 1,000 gallons. Other domestic customers pay a lower bimonthly rate, $3.571 per 1,000 gallons. Temporary construction and irrigation customers pay 4.89 per 1,000 gallons. Generally, the volumetric charge for potable water use depends on the type of water user and the base fee depends on the type of user and meter size (Water Rates, 2010).

The volumetric charge for reclaimed water currently is $0.80 HCF, or $1.07 per 1,000 gallons (Public Utilities RWR, 2010)

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Only on a small scale currently. The reclaimed system does not contribute as much to reducing potable water use as does conservation measures. However, San Diego sees the need to expand the use of reclaimed water to ensure that future water demand will be met. The City is also exploring the use of desalination plants to treat salt water and brackish groundwater. Other sources of water are also being explored to meet future demand.

Is the dual system more efficient economically?

It is difficult to tell since the reclaimed and potable water revenue and expenses are somewhat combined in the San Diego Budget for the water budget (Water, 2009). The revenue from reclaimed water was $7,399,000 for Fiscal Year 2010, which could have been a target revenue, and the revenue from potable water was $342,798,830.

Has the use of a dual system compromised safety?

No, since there has only been one cross connection, in 2001, and no associated illnesses have been reported.

Does the dual system position the water authority better for the future?

Currently, the City is in need of more water sources due to the heavy reliance on imported water which is drought susceptible and comes with legal, environmental, and other issues (San Diego 2002-2030 LRP, 2010).

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SANTA BARBARA PUBLIC WORKS DEPT.-WATER RESOUCES DIV., SANTA BARBARA, CA

I. GENERAL INFORMATION

Evaluation Date: 2/1/2011
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Santa Barbara Public Works Department-Water Resources Division
Contact Person: Rebecca Bjork
Title: Water Resources Manager

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1989 (reclaimed water)
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other: Public areas irrigation, zoo
☐ Agricultural Irrigation
☒ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

Reclaimed water is used for toilet flushing at public restrooms in sites where irrigation water is also supplied using with recycled water.

II. SYSTEM OVERVIEW

Santa Barbara has a population of 86,353 people and is located in Santa Barbara county California (City Data, 2009).

Potable Water System

The potable water system treats and distributes approximately 4.7 billion gallons of water per year (FY 2011 Budget) and currently consists of 300 miles of water line (Bjork, 2011). In

Fiscal Year 2010, 4.1 billion gallons of potable water was treated (CAFR 2010). There are two water treatment plants (Cater WTP and Ortega GWTP), 9 wells, 1 water supply reservoir, 13 distribution reservoirs, and 12 pump stations (FY 2011 Budget).

The water demand is typically met by a combination of local surface water and recycled water. In the case of an emergency, Santa Barbara's water demand is augmented by local groundwater and state water. Also, the City owns a desalination facility, which is currently offline (2009 Water Supply Management Report). The surface water supply comes from the Gibraltar Reservoir and Lake Cachuma, the primary source of surface water. Average rainfall is sufficient to fill the Gibraltar Reservoir (2009 Water Supply Management Report). However, above average rainfall is necessary to produce significant inflow into Lake Cachuma, thus, the City participates in a cloud seeding program administered by Santa Barbara County in order to enhance rainfall (2009 Water Supply Management Report). In 2009, the cloud seeding program was limited due to the Zaca Fire (2009 Water Supply Management Report). Groundwater is infiltrated into the Mission Tunnel and from five of nine production wells (Bjork, 2011), some of which are treated at Ortega Groundwater Treatment Plant (2009 Water Supply Management Report). In 2009, the City received 427 AF of water from the State (2009 Water Supply Management Report). The City is permitted to store carryover State water in San Luis Reservoir (2009 Water Supply Management Report).

Reclaimed Water System

Santa Barbara treats and distributes approximately 260 million gallons of reclaimed water per year (FY 2011 Budget) and contributes to about 5 percent of the total water demand in a typical year (2009 Water Supply Management Report).There is one water reclamation plant, El Estero Wastewater Treatment Plant, producing reclaimed water (FY 2011 Budget). There are nine fill stations located throughout the reclaimed water system (Bazzell, 2008). Reclaimed water is used at over forty sites throughout the community and the City is looking for additional users adjacent to the existing system (Bjork, 2011). Reclaimed water is used at parks, schools, a zoo, home associations and retirement homes, as well as for toilet flushing at public sites that are irrigated with reclaimed water (Recycled Water). After several dry years in the 1970s, Santa Barbara conducted a water supply analysis and concluded that additional water resources were necessary and that reclaimed water was a potential additional water sources (Recycled Water). After a feasibility study was conducted reclaimed water was found to be economically, technically, and environmentally feasible (Recycled Water).

Currently, Santa Barbara requires the use of recycled water for irrigation for multiple family developments, developments with common area irrigated lots, and commercial developments that are adjacent to the recycled water main line (City Municipal Code 14.23.010-14.23.030). Single family residences are encouraged but not required to use recycled water on their sites (Recycled Water).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
There have not been any reported cross connections or associated illnesses (Bjork, 2011).

Provide any other pertinent information
The City performs inspections in order to ensure public health and safety (Bjork, 2011).

Principal Operational Issues

1. There are water rights issues concerning Lake Cachuma as well as issues regarding an endangered species, the steelhead trout (2009 Water Supply Management Report).
2. The Gibraltar Reservoir is currently "silting in" due to the Zaca Fire and historical siltation and the City is attempting to "'pass through" a portion of its Gibraltar water to Lake Cachuma for delivery through Cachuma Project facilities (2009 Water Supply Management Report).
3. Since the recycled system wasn't designed for 100% availability, when the system is down for maintenance the City must provide portable toilets for those that use recycled water for toilet flushing (Bjork, 2011).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
On a limited basis currently since reclaimed water use accounts for 800 AF of water use of a total water demand of 14000 AF per year, which is 5.71 percent of the total demand.

How has the dual system has impacted any other (system capacity, etc.) goals?
1. Several water wells are in the process of being reconstructed in order to ensure that there is a reliable source of back-up water supplies during drought and emergency water supply in case of catastrophic water supply interruptions (2009 Water Supply Management Report).
2. Ozone treatment is being added to the Cater Water Treatment Plant.
3. Reservoir 1 is being improved in order to "facilitate distribution of water from low elevations to higher zones as would be necessary during catastrophic water supply interruptions (2009 Water Supply Management Report).
4. The City is currently evaluating the possibility of demineralizing the recycled water at the El Estero Wastewater Treatment Plant (2009 Water Supply Management Report).
5. The reclaimed water system infrastructure/use is not currently being expanded (Bjork, 2011).

Economic Information

What is the yearly O & M budget for the system?
For year ended June 30, 2010 the revenue for the water program (approx. $33 million) exceeded the expenses (29,757,267) (CAFR 2010).

Discuss any additional O & M costs associated with the dual system:
This information is not available.

Discuss any rate structures used by the utility to regulate consumption:

Base potable water rates depend on the meter size and volumetric water rates depend on the user type, whether the customer is inside or outside the City limits, and base allotments which depend on user type. The allotments are either base allotment s which equal the average monthly consumption during most recent January - June period, or annualized allotments which run July to June. Single family residence charges are in a three tier increasing block rate structure beginning with a charge of $2.93 per 100 cubic feet for up to 4 hcf of water use. Residential volumetric charges are not based on allotments, but only commercial, irrigation, and industrial use charges. Reclaimed water use is $1.75 per 100 cubic feet of use for all types of water users. (Water and Sewer Rates, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

On a limited basis since reclaimed water use accounts for 5.71 percent of the total water demand.

Is the dual system more efficient economically?

No, since the reclaimed water system does not pay for itself. However, the cost has to be factored against the cost of developing new sources (Bjork, 2011).

Has the use of a dual system compromised safety?

No, since there have not been any cross connections or associated illnesses.

Does the dual system position the water authority better for the future?

It is difficult to tell since the necessity of the system is measured against the cost of having other water sources and is not currently being expanded.

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CITY OF SANTA ROSA UTILITIES DEPARTMENT, SANTA ROSA, CA

I. GENERAL INFORMATION

Evaluation Date: 9/15/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Santa Rosa Utilities Department
Contact Person: Randy Piazza
Title: Reclamation Superintendent

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1970s (reclaimed water)
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☒ Parks ☒ Playgrounds
☒ Road medians ☐ Residential ☐ Schools ☒ Other: Sports complex, power generation
☒ Agricultural Irrigation
☒ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☒ Cooling towers
☐ Fire fighting

Unique System Features

1. The City's conservation measures, affecting residents and businesses, saved over 1.4 billion gallons of water annually since 2004 (Water Conservation, 2009). Measures include cash for clothes washer program and even providing conservation awards to residents and businesses (City of Santa Rosa, 2009).
2. The potable water system has 25 steel reservoirs (Connections, 2010).
3. "During the 1980's when our original recycled water system was built, it was the largest agricultural reuse system in the world. It still irrigates over 6,000 acres with a variety of crops including pasture, oat hay, rye, sod farms, vegetables, orchards, and vineyards. In the 1990's urban reuse became part of the system and has been expending since. And in 2004 we began delivering recycled water to the Geysers steam fields for generation of renewable green power. So the

current split of uses is about 60% to Geysers, 35% to agriculture, and 5% to urban" (Carlson, 2010).

4. Recycled water is pumped from the treatment plant 41 miles and up 3,300 feet for the Geysers Recharge Project (Carlson, 2010). "This does take energy but only about 10% of the power that is made with this water". Calpine owns most of the geothermal plants at the Geysers and is a partner in the project (Piazza, 2010). Calpine provides the power to pump the water at the three upper lift stations and reimburses Santa Rosa for the cost of the power used at the Laguna plant pump station. Calpine reportedly says that there is an 85 MW net power gain, but it may be even greater than that (Piazza, 2010). There are some other benefits to Calpine in addition to the steam field recharge, and such as using the reclaimed water in cooling towers (Piazza, 2010).
5. The City has approximately 4500 AF of recycled water storage ponds. The system was weather dependent originally, and the Geysers project was a way to have a use for the water during the winter rainy season (Piazza, 2010).

II. SYSTEM OVERVIEW

The City of Santa Rosa has a population of approximately 157,500 people and is located in Sonoma County (City Data, 2009).

Potable System

Santa Rosa purchases potable water from Sonoma County Water Agency and Santa Rosa only produces a small amount of its own water from wells located within the City limits (Russell, 2009). In all, more than seven billion gallons of water was distributed to customers via 620 miles of distribution lines serving about 50,000 individual residences, basin, and irrigation users (Russell, 2009). Wells only produced about 489 million gallons of water in 2008 (Russell, 2009).

Reclaimed System

The reclaimed water system started in the mid 1970's as a way to meet the plant's NPDES requirement of zero discharge from May 15 through October (Piazza, 2010). The original system consisted of an agricultural reuse system using secondary treated water. In 1989 the plant was upgraded to tertiary treatment and the City began doing urban reuse and expanded to irrigation of fruits (specifically vineyards) and vegetables (Piazza, 2010).

Sub regional operations comprised of eight sections that operate and maintain the Laguna Plant, Oakmont Treatment Plant, Sub regional Compost Facility, and the Reclamation System (Water Reuse System, 2009). Santa Rosa is a managing partner for the sub regional wastewater treatment plant that provides treatment, disposal, reclamation, industrial waste inspection and lab services to Santa Rosa, Rohnert Park, Sebastopol, Cotati and the South Park County Sanitation District (City of Santa Rosa, 2009). The sub regional water reuse system has been using reclaimed water for irrigation for over 35 years (Connections, 2009). The sub regional water reuse system is funded by five regional partners (Russell, 2009). Each of the five partners pays operating costs based on the flow into the plant from the year before, the debt service costs based on the flows into the plant and growth calculations (Russell, 2009). Santa Rosa contributes about

73% of the sub regional operating budget (Russell, 2009), which includes operating the Laguna Sub regional Water Reclamation Facility. About half of the sub regional system's reclaimed water is sent to the Geysers where it is pumped into an underground steam field in order to generate enough electricity for about 100,000 households (City of Santa Rosa Recycled Water, 2009). In 2008, 6.6 billion gallons of wastewater was converted to recycled water, of which, 2.3 billion gallons was used for irrigation (Russell, 2009). In addition, 2,003 dry tons of biosolids was produced in 2008 (Russell, 2009). Water reuse is beneficial since the use of potable water from the Russian River and its tributaries is reduced (Connections, 2009). Other incentives for using reclaimed water include having a drought proof water supply and having an environmentally friendly way to dispose of reclaimed water (Connections, 2009).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

There have not been any cross connections or associated illnesses (Carlson, 2010). This could be attributed to the fact that there are not many sites that are dual plumbed (Piazza, 2010). For instance, there are two municipal parks and several buildings at Sonoma State University that use reclaimed water for toilet flushing, six private sites use reclaimed water for landscape irrigation and are classified as dual plumbed. All other parks, schools and other urban users use reclaimed water for landscape irrigation and are not classified as dual plumbed (Piazza, 2010).

Provide any other pertinent information

The City uses air gap separation and on-going cross-connection checks along with site supervisor training in order to protect public health and safety (Carlson, 2010). Also, all users are either commercial or industrial and there are no individual homeowners (Carlson, 2010). All urban sites that use reclaimed water are required to have dual check valve back flow preventers, which are also tested annually (Piazza, 2010). Dual plumbed sites are required to have a cross connection test every four years (Piazza, 2010).

Principal Operational Issues

1. Rate revenue is the largest component of the Water Fund, contributing about 80 percent of the total water utility's main revenue sources (Hartz, 2009). Conservation efforts have resulted in decreased rate revenue. Demand fee revenue contributes about 10 percent of the total water utility's revenue, but was a historical low in the 2008/09 Fiscal Year (Hartz, 2009). The City is feeling the effects of the downturn in the economy with decreases in utility tax revenue (Hartz, 2009).
2. The City operates both potable and recycled systems pretty much the same way although the recycled is a bit more forgiving with regard to shutdowns and interruptions (Carlson, 2010). Depending on the type and age of irrigation systems, the recycled water system may need to be cleaned more often. Also,

since chlorine is not used for disinfection, since they are 100% ultra violet light, the City periodically doses the recycled system whereas the potable system always has a slight chlorine residual (Carlson, 2010).

3. For the reclaimed system the two biggest operational challenges are one, dealing with algae and aquatic organisms that grow in the ponds which are difficult to filter out (Piazza, 2010). The other problem is a result of the City beginning to use UV disinfection in 1998, due to having no residual in the water, the City began to have regrowth of algae and snails in some pipelines (Piazza, 2010). To address the second issue, the City installed sodium hypochlorite disinfection systems on all pump stations supplying urban areas (Piazza, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Yes, with the utilization of other conservation measures. Residents and businesses were able to save over 1.4 billions of gallons of water annually as a result of conservation measures (City of Santa Rosa, 2009).

The use of reclaimed water helped limit some of the results of pumping water. Rohnert Park, one City served by the reclaimed plant, had issues with dropping ground water levels. But in 1996, all the parks, schools and a large portion of the commercial landscape irrigation was converted to reclaimed water, which helped decrease the groundwater over drafting problem (Piazza, 2010). All reclaimed water use is metered so the City can tract how much is being used (Piazza, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

A recycled water pilot project is currently under construction which seeks to expand recycled water service by the design of recycled water mainline, customer retrofits, and outreach in order to add customers to the system (Russell, 2009). The primary use of the reclaimed water will be irrigation (Connections, 2010).

Economic Information

What is the yearly O & M budget for the system?

The 2009/10 Fiscal Year Sub regional Wastewater facility operations expenditure request was $27,808,163 (Russell, 2009).

Discuss any additional O & M costs associated with the dual system:

There is not enough information to verify this.

Discuss any rate structures used by the utility to regulate consumption:

The rate for recycled water use, by ordinance, is marketed at 95% of the cost of potable water (Carlson, 2010).

The urban water users are charged 75% of the potable water rate which will be changed to 95% of the potable water rate in the future. The urban reuse systems do pay for the operation and maintenance costs to run them (Piazza, 2010). Potable water is quite expensive in Santa

Rosa; the current rate for tier 1 water is $4.09 per 1000 gallons.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes, the City is irrigating about 500 million gallons per year of urban landscape that would otherwise use potable water (Carlson, 2010).

Is the dual system more efficient economically?

To some extent, but it is still slightly subsidized. "None of the original recycled system was intended to pay for itself-it was necessary to avoid discharge of water to streams and other more costly alternatives such as an ocean outfall, advanced treatments, etc. The urban reuse systems that are now being expended do pay for themselves and as water supply (rather than discharge avoidance) has become the primary driver which it will be for the continued future, this will continue to grow. The Geysers steam fields reuse are also coming close to cost neutral. The agricultural system will improve but likely always be slightly subsidized" (Carlson, 2010).

The system is not economical. However, the plant has to "treat the water to tertiary level in order to discharge so the treatment costs cannot really be included in the cost calculation". Also, the majority of the agricultural users get reclaimed water for free, but the City has just begun to negotiate agreements that charge agricultural users for the water. The reason is that the agricultural use is one way to "discharge" the reclaimed water but still comply with the zero discharge requirement. The City originally got farmers to agree to take a minimum amount of water, but the need was reduced when the Geysers project went on line in 2004. The City possibly could begin charging them for the reclaimed water, but there has been a "great deal of conversion of dairies to vineyards in the last 15 years" (Piazza, 2010). According to Piazza, "Originally almost all of our users were dairies; in the last 20 years over half the dairies that we originally served either converted to vineyards or sold their herds and got out of the dairy business. The ones that left have irrigation agreements that run to 2017 or 2018, at that time agreements will be made where the farmers pay at least a low cost for the water". Once agricultural users begin paying for the reclaimed water, then the system may be more economical but still benefit the users.

Has the use of a dual system compromised safety?

No the system has not compromised safety since there have not been any cross connections or associated illnesses.

Does the dual system position the water authority better for the future?

The projected reclaimed water use will meet the needs of Santa Rosa, "it is projected to be 10% of the total estimated water needs for year 2030" (Carlson, 2010).

The investment in the reclaimed system will prove to be essential as the City grows. Currently, the system is essential to Rohnert Park (Piazza, 2010). The prospect of Santa Rosa getting any more water from Sonoma County is "not good in the next 10 years" (Piazza, 2010). Thus, any increase in water supply would have to come from reclaimed water and groundwater (Piazza, 2010).

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ST. PETE BEACH PUBLIC SERVICES DEPARTMENT, ST. PETE BEACH, FL

I. GENERAL INFORMATION

Evaluation Date: 10/13/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: St. Pete Beach Public Services Department
Contact Person: Phil Christman
Title: Operations Manager

Services Provided

☐ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated:1995
Non potable water source: Reclaimed water
Uses of the non-potable line
☐ Landscape Irrigation:
☐ Commercial ☐ Golf courses ☐ Parks ☐ Playgrounds
☐ Road medians ☒ Residential ☐ Schools ☒ Other: Street sweeping
☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☒ Fire fighting

Unique System Features

1. Reclaimed water is used for firefighting, though on a limited basis, since there are a limited amount of reclaimed water fire hydrants (Christman, 2010).
2. All residents of St. Pete Beach have access to reclaimed water and he is not "aware of any buildings that irrigate with potable" (Christman, 2010). He did not know if the reclaimed water lines are larger than the potable water lines.

II. SYSTEM OVERVIEW

St. Pete Beach, FL has a population of approximately 9,800 people and is located on a barrier island in Pinellas County (City Data, 2009).

Potable Water System

St. Pete Beach obtains potable water by Pinellas County Utilities.

Reclaimed Water System

St. Pete Beach owns and operates its own reclaimed water system but purchases reclaimed water produced by Pinellas County Utilities (Estrada, 2010). St. Pete Beach also establishes its own voluntary watering restrictions for the reclaimed water system. The reclaimed water system was built as a result of 1992 referendum when voters approved the borrowing of $24 million from the State of Florida in order to construct distribution lines to "every property in the city" (Estrada, 2010). Currently, the reclaimed water system consists of 40 miles of water line and the average daily consumption is about 1.8 mgd (CAFR, 2010). The reclaimed water system has been losing money and the deficit is made up for by a loan from the City's general fund (CAFR, 2010).

Residents do not generally oppose the use of reclaimed water but those who do can choose to discontinue service (Christman, 2010). When residents discontinue reclaimed service, they are advised that they will need to pay the activation fee if they change their mind (Christman, 2010). Also if they sell their house the new owner will be required to pay the activation fee if they want reclaimed water service (Christman, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

There is not enough information to tell if there were cross connections or associated illnesses.

Provide any other pertinent information

Principal Operational Issues

1. The reclaimed water system is not economical and the City has considered charging an availability fee for those who are able to connect to the system but will not. The City is struggling to offset the cost of the system by considering raising rates for users (Estrada, 2010). The plan is to raise the reclaimed water rates over a two year period by about 21 percent for users and charge an availability fee to non-users of $7.70 (Estrada, 2010). Currently, about 80 percent of property owners are on the reclaimed water system and 800 are not (Estrada, 2010). The rate increase and availability fee will be used to pay off the nearly $400,000 loan from the general fund (Estrada, 2010 and CAFR, 2009).
2. The principal operational issues are reclaimed water line breaks, filter clogging, and unauthorized use/irrigation hookups (Christman, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

The reclaimed water system has been "very effective" (Christman, 2010) when it comes to water conservation but no objective data was given. Christman agreed that the reclaimed water system is essential to meeting current and projected water needs (Christman, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

The economically inefficient reclaimed water system has led to the City considering hiring a consultant to perform a rate study for the reclaimed water system (CAFR, 2009).

Economic Information

What is the yearly O & M budget for the system?

Pinellas County Utilities owns and operates the potable water system but St. Pete Beach owns and operates the reclaimed water system. St. Pete Beach purchases the reclaimed water produced from Pinellas County Utilities. The cost for the reclaimed water system operation was $776,244 in Fiscal Year 2009 (CAFR, 2010).

Discuss any additional O & M costs associated with the dual system:

Pinellas County Utilities provides the reclaimed water and potable water and system.

Discuss any rate structures used by the utility to regulate consumption:

Unlike most reclaimed water providers, reclaimed water in St. Pete Beach is available for a residential flat fee of $11.50 per month or $23.00 on a bi-monthly basis. Two-family, multi-family, and commercial property fees are calculated according to permeable square footage of the lot size (St. Pete Beach). Christman reported that there was a recent increase in water rates, "We recently had a slight rate increase, though rates were the same for over a decade" (Christman, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes. But Christman reported that as people conserve potable water the supply of reclaimed water goes down. Thus, St. Pete Beach also encourages conservation of reclaimed water (Christman, 2010).

Is the dual system more efficient economically?

The reclaimed water system is not economically efficient since the program has been losing money.

Has the use of a dual system compromised safety?

There is not enough information to tell if the reclaimed water system has a negative impact on public health.

Does the dual system position the water authority better for the future?

Yes, since the reclaimed water system is considered necessary to meet future and current water needs.

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CITY OF ST. PETERSBURG, ST. PETERSBURG, FL

I. GENERAL INFORMATION

Evaluation Date: 7/25/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of St. Petersburg
Contact Person: John Riera
Title: Manager- Water and Reclaimed Water Division

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1977, (Reuse)
Non potable water source: Reclaimed water
Uses of the non-potable line

☒ Landscape Irrigation:

☒ Commercial	☒ Golf courses	☒ Parks	☐ Playgrounds
☐ Road medians	☒ Residential	☒ Schools	☐ Other

☒ Agricultural Irrigation

☐ Toilet and urinal flushing:

☐ Commercial ☐ Residential

☒ Cooling towers

☒ Fire fighting

Unique System Features

1. Uses reclaimed water for backup fire protection (Nelson, Niles 2010). However, the fire department does not prefer to use reclaimed water because the chloride content is higher than for potable water (Riera, 2010). Firefighters prefer potable water for use in engines and storage tanks (Riera, 2010). Reclaimed water is generally used for fire line flushing when it is used (Riera, 2010).
2. Initially, there was public opposition to reclaimed water use due to a concern about the spread of viruses and others claimed that leaf damage and plant death was directly related to irrigating with reclaimed water. However, studies have shown that the reclaimed water was sufficiently treated except in a few cases (State of Utah, 2005).
3. St. Petersburg achieved zero discharge into Tampa Bay in 1987 (State of Utah, 2005).

4. Offers free sprinkler system checkups in order to encourage conservation of potable, reclaimed, and well water. The City offers a free water efficient pre-rinse spray valve for dishwashers and indoor conservation kits (low flow shower heads, a toilet leak detection dye tab, and faucet aerators for the kitchen and bathroom). St. Petersburg also employs a low flow toilet rebate to potable water customers (Riera, 2010).
5. Green buildings in St. Petersburg are reportedly using reclaimed water for urinal flushing (Niles, 2010), of which, three buildings use cisterns of rainwater, and reclaimed water as a back-up supply, for use inside the buildings for toilet flushing.

II. SYSTEM OVERVIEW

The City of St. Petersburg has a population of approximately 244,000 people and is located in Pinellas County (City Data, 2009).

Potable Water System

The St. Petersburg potable water system consists of approximately 1,600 miles of pipeline. Water from deep wells is conveyed from northwest Hillsborough County via a 26 mile pipeline to St. Petersburg (Water Treatment and Distribution, 2010). The conveyed water is treated at the Cosme Water Treatment Plant via chloramination due to increasingly stringent water quality standards for disinfecting with chlorine (Water Resources, 2010). St. Petersburg also obtains water from surface and desalinated water (Water Treatment and Distribution, 2010).

Reclaimed Water System

St. Petersburg began using reclaimed water in 1977 and was the first large urban reuse system in the United States (SFWMD, 2009). St. Petersburg faced limited access to potable water sources, strict effluent discharge regulations set by the Department of Pollution Control, and an increasing population (State of Utah, 2005). The Wilson-Grizzle Act required any discharges into Tampa Bay area's bays, bayous, sounds or sound tributaries to undergo advanced treatment approved by the Department of Pollution Control. The stringent requirements included 5 mg/L BOD, 5 mg/L of TSS, 1 mg/L of phosphorous, and 3 mg/L of nitrogen with a minimum treatment efficiency of 90%. The requirements spurned the reuse system use since a 1971 pilot study showed that spray irrigation with reclaimed water was more feasible and cost effective than discharging into Tampa Bay. St. Petersburg later used reclaimed water for an aquifer storage recovery project (State of Utah, 2005).

Four water reclamation plants provide about 37 mgd of reclaimed water to 10,284 active customers via 291 miles of pipeline, including to 316 fire hydrants as a secondary water supply.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

Operators at the Northeast and Northwest Water Reclamation Facilities respectively stated that they are not aware of any cross connections or associated illnesses.

About 12 years ago some people decided to use reclaimed water in their homes as well as for non-potable uses, and there were no illnesses as a result. However, the City required them to disconnect from the reclaimed system for potable water uses (Riera, 2010). Otherwise, there have not been any unintentional cross connections (Riera, 2010).

Provide any other pertinent information

Personnel on staff inspect for cross connections on a yearly basis. St. Petersburg would not allow customers to connect to the reclaimed water system for irrigation unless they have an underground sprinkler system (Niles, 2010). Cross connection inspectors go onto residential property in order to inspect for cross connections (Niles, 2010).

Principal Operational Issues

1. In 2000, the reclaimed water system has "virtually shut down under peak demand" every day for a week according to the St. Petersburg Times (St. Petersburg Times, 2000). Ron Nelson says that during droughts it is difficult to provide enough pressure in the reclaimed water system since the demand for reclaimed water goes up (Nelson, 2010). From January through July is the time of the year when it is difficult to maintain pressure in the system (Nelson, 2010). St. Petersburg has non-watering days in order to keep the demand from peaking too high (Nelson, 2010). Golf courses have responded to the seasonal shortages by constructing reclaimed water ponds for storage (Nelson, 2010).
   1. The reclaimed water system has been shut down at times due to line breaks, and the typical response to it was to valve off the line, and repair the line. There was a time where the reclaimed system leaked so much that Niles had to call the other three plants telling them to shut down (Niles, 2010).
   2. During droughts sometimes the reclaimed system is shut down in order to fill up storage tanks (Niles, 2010).
   3. Very high tides, though rarely, increase the salinity of the reclaimed water supply since the ocean water backs up the stormwater system and intrudes into manholes. The City would not distribute any reclaimed water that is greater than 600 "parts of chlorides" (Niles, 2010). High tides lead to more salt water in the reclaimed system since the City treats wastewater from beach communities that have salt water intrusion into the wastewater system (Riera, 2010).
   4. There have been public acceptance issues in the past, but more people are on board with using reclaimed water. Originally, there were many misconceptions, but the fact that reclaimed water supply is drought tolerant to a greater degree than potable water, more have decided to use it (Nelson, 2010).

5. In 1976, when the system was new, the City had to ask people to hook up to the system and it took a lot of government funding to get potential users (such as schools) to use reclaimed water. Now, there is a great demand for reclaimed water but they cannot get it, since the City is built out and the reclaimed water system has been "maxed out" (Riera, 2010). At one time, there was a ten year moratorium on reclaimed water system expansions due to the fact that the system was maxed out, and expansions would have led to unacceptable low pressures (Riera, 2010). St. Petersburg has put into place conservation measures and added more reclaimed water storage capacity that allowed them to expand the system to more customers (Riera, 2010).

3. There are occasional turbidity issues at the Albert Whitted Wastewater Treatment Plant and it must be put offline until water quality meets standards before distribution (Riera, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

According to a "Needs and Sources" report in 1987, St. Petersburg was to expect a deficit in water supply of 23 mgd if a 20 year drought, but a surplus of 1 mgd was to be expected if St. Petersburg fully implemented water reuse (State of Utah, 2005).

How has the dual system has impacted any other (system capacity, etc.) goals?
St. Petersburg had to employ more conservation measures and add more reclaimed water storage capacity to distribute reclaimed water to more customers that demanded it (Riera, 2010).
St. Petersburg is trying to get reclaimed water to salt water intrusion areas (Riera, 2010).

Economic Information

What is the yearly O & M budget for the system?
The expense for the Water Resources Division, which handles water and wastewater services, was $95,656,000 in 2009.

Discuss any additional O & M costs associated with the dual system:
The potable water revenue partially subsidizes the reclaimed water system (Riera, 2010). Since the reclaimed water system is fairly new, the City does not expect to have significant maintenance monetary issues related to pipe (or other materials), plant deterioration, for another 15 to 20 years.

Discuss any rate structures used by the utility to regulate consumption:
The charges for reclaimed water service are dependent on whether or not the user is inside or outside the City limits, the acreage of the land irrigated, and whether or not the service is metered or not. Any property that is less than 1 acre pays a flat rate, and any acre or fraction above one acre is charged an additional amount. Metered connections are $0.45 per 1,000 gallons ($15.62 minimum). A 10% tax is added to customers inside the City limits.All rates are 125% greater than those inside the City limits for customers outside the City limits. Unmetered

services are charged a flat fee of $15.62 for one acre or less and an additional $8.95 per acre above one acre. (City of St. Petersburg, 2010)

IV. CONCLUSIONS

Does the dual system provide a better use of water?

The potable water demand has gone down due to conservation measures, which include mandatory water restrictions during droughts. Demands used to be about 35 to 36 mgd and now the typical demand is around 27-28 mgd (Riera, 2010).

The reclaimed water system is good for irrigation since the City is situated at the coast and people are unable to drill wells and would otherwise get all their water from potable supply (Niles, 2010).

Is the dual system more efficient economically?

The reclaimed system does not pay for itself since it is partially subsidized by potable water revenue, but the conservation of potable water makes the reclaimed water system beneficial (Riera, 2010).

Conservation of potable water by using reclaimed water for large water users such as schools and golf courses make the system worth the added cost (Riera, 2010). The system is also economical due to the fact that the system is new and the PVC water line used for the reclaimed system has not led to water quality issues (Riera, 2010).

The flat rates give a predictable amount of income and metered customers are smarter about water use. Niles says that in either case, to the best of his knowledge, the reclaimed water system is economical (Niles, 2010).

Has the use of a dual system compromised safety?

Since there have not been any deliberate cross connections or associated illnesses, the reclaimed water system has not compromised safety. The users that had reclaimed water for use in their homes 12 years ago did not get sick from consuming it (Riera, 2010).

Does the dual system position the water authority better for the future?

Yes, the potable water system demand has gone down due to conservation measures. Water consumption has gone down from 35 to 36 mgd to a 27 to 28 mgd. The reclaimed system has also been a contributor to potable water savings.

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TALLAHASSEE UNDERGROUND UTILITIES, TALLAHASSEE, FL

I. GENERAL INFORMATION

Evaluation Date: 10/26/2010
Prepared By: Stephanie Edmiston

Utility Information:

Utility Name: Tallahassee Underground Utilities
Contact Person: Craig Dough.
Title: Plant Supervisor

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☐ Other _____

Dual System Information

Year initiated:1966
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☐ Parks ☐ Playgrounds
☐ Road medians ☐ Residential ☒ Schools ☐ Other _____
☒ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

1. The City produces Class AA biosolids that are sold as fertilizer and soil conditioner, since 2005 the City ceased all land application of biosolids.
2. Water conservation measures include implementing advanced stormwater controls and water considerations and a water reduction plan for the largest customers.
3. In order to reduce nitrogen content in water sources, ecosystems, and storm water, the City has a fertilizer ordinance that regulates any and all applicators of fertilizer and areas of application. This includes application rates, a prohibition against applying fertilizer to impervious surfaces to limit nitrogen content entering the stormwater system and water bodies, a prohibition against using fertilizer within a "fertilizer free zone", encouraging limited fertilizer use in "low maintenance zones", and specifying modes of application requirements,

among other rules (Ordinance No. 08-O-72AA, 2009).

II. SYSTEM OVERVIEW

Tallahassee, Florida has a population of 172,574 and is located in Leon County (City Data, 2009).

Potable Water System

The Water Division owns, operates, and maintains a water production and distribution system that serves Tallahassee and portions of Leon and Wakulla counties. As of March 2009, the potable water system consisted of approximately 1,199 miles of water main and approximately 4.5 billion gallons of water have been sold to 75,100 customers. Capital improvement plan consists of maintaining, replacing, and upgrading water system infrastructure, which includes water supply wells, storage tanks, and distribution facilities (Fund Pro Forma, 2009). All the potable water comes from the Floridan Aquifer (Will, 2010).

Reclaimed Water System

The City is in the process of expanding the Advanced Wastewater Treatment (AWT) Program, which is expected to be completed in January 2014. The wastewater treatment system consists of the Thomas P. Smith Water Reclamation Facility (TPSWRF), the Lake Bradford Road Wastewater Treatment Facility (LBRWWTF), the Southeast Farm, and the Tram Road Reuse Facility (TRRF). Effluent is conveyed to the Southeast Farm for agricultural reuse via an eight and a half mile 36 inch water line. Various crops are grown each year on each of the sixteen spray fields. The LBR has a capacity of 4.5 mgd and the TPS a capacity of 26.5 mgd and the majority of treated effluent is used for spray irrigation for crops and pasture. In addition, about 2 mgd of reuse water is used for plant operations at the TPS facility. The other major use of reclaimed water is landscape irrigation (Will, 2010). Additionally, the reclaimed water system is an interruptible water supply (Will, 2010).

The Southwest Sprayfield, Southeast Farm, and Tram Road Wastewater Reuse Facilities use effluent for spray irrigation. About 2,200 acres of crop fields, where corn, soybeans, coastal Bermuda grass, and other feed and fodder crops, is irrigated with reclaimed water. The capacity of the spray irrigation system is 27.4 mgd, of which, 17 mgd was reused in 2003.

The TRRF currently uses highly treated wastewater to irrigated the South Wood Country Club golf course and for a high school. Eventually, the TRRF will be used to serve additional customers, including government facilities, commercial office buildings, apartment complexes, athletic fields, golf courses, roadway medians and other properties in the Southwood area (Green Initiative, 2009). The TRRF has a production capacity of 1.2 million gallons per day. Currently Southwood Golf Course, government facilities, schools and open spaces within the Southwood development are receiving the treated wastewater (Green Initiative, 2009). The TRRF project has taken about ten years and came as a result of a partnership between the City's Water Utility, the Florida Department of Environmental Protection (FDEP), the Northwest Florida Water Management District (NWFWMD) and the St. Joe Company. The project began operation in 2007. Benefits of the TRRF project include lessening the demand on the Floridan Aquifer, reducing the volume of water being disposed of at the City’s Southeast Sprayfield, reducing the costs for high volume water customers, and preserving potable water for more critical needs (Green Initiative, 2009).

The main incentives for using reclaimed water are conservation of the Floridan Aquifer water and preserving area ecosystems, such as Wakulla Springs.

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
There have not been any cross connections according to Will (2010).

Provide any other pertinent information
Tallahassee requires backflow prevention on all potable water services where reuse is also present (Will, 2010). The City also has a cross connection control program that regulates and inspects backflow prevention devices (Will, 2010).

Principal Operational Issues

1. The Southeast Farm project was suspected of contributing to the environmental degradation of Wakulla Springs State Park, since increased nitrogen levels have been detected (A Clear Commitment to Protecting Our Environment, 2010). The City responded by: beginning a scientific study with the USGS and added 10 new water quality monitoring wells near the Southeast Farm; stopped applying biosolids on land in Wakulla and Leon counties; installing a dryer that converts biosolids to fertilizer material suitable for residential use; reducing fertilizer application at the farm by more than 80 percent since 1994; upgrading wastewater treatment facilities in order to remove more nitrogen; created a Nutrient Management Plan for the Southeast Farm for optimal nutrient removal by plants and other methods; constructing the TRRF; extending wastewater service to residents on septic tanks that had overflow issues; implementing a Water Utility Environmental Management System; providing free sewer connections for qualified homeowners with septic tanks; eliminating fertilizer and cows at the Southeast Farm; completing a 20-year Wastewater Treatment Master Plan (Clear Commitment to Protecting Our Environment, 2010).
2. The potable water system has multiple sources throughout the system: 28 deep water wells into the Floridan Aquifer supply water to the potable system, of which, five require carbon filtration to remove hydrocarbon contamination, one requires green sand filtration due to high levels of iron, and the remainder receive chlorination and fluoridation (Will, 2010).The major operational issue with the potable system is preventing excessive water age (Will, 2010).

3. The reuse water coming from the Water Reclamation Facilities requires constant monitoring and operational control to maintain the water quality (Will, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Although the reclaimed water system is relatively new and serves a very limited area, within the service area there has been a significant drop in water use for irrigation (Will, 2010). In addition, "while Tallahassee sits on an abundant water supply, reclaimed water is considered to be an important tool in maintaining aquifer withdrawals near current levels" (Will, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

The City is in the process of upgrading from secondary wastewater treatment to advanced wastewater treatment standards, which involves the modifying or replacing existing equipment in both the liquids processes and in the biosolids processes. The upgrade is geared toward all wastewater facilities (Green Initiative, 2009).

The build out of the TRRF reuse system will include using the water for irrigation purposes at the Southwood Golf Club, the Capital Circle Office Complex, athletic fields at the Florida State University Developmental Research School (Florida High) and Pope John Paul II High School as well as medians and landscaping along Capital Circle Southeast.

The TPS facility is being upgraded in order to bring down the nitrogen in the effluent to 3 mg/L or less by January 2014 (Green Initiative, 2009). The first milestone consisted of bringing down the concentration to 12 mg/L or less by January 2009, due to a permit requirement. Fortunately, the plant average was 8.81 mg/L as of 2009. The next milestone consists of bringing down the concentration to 9.0 mg/L by January 2011 (Green Initiative, 2009).

Economic Information

What is the yearly O & M budget for the system?

The actual comprehensive total expenditure of the Utilities Services was $119,158,323 for Fiscal Year 2008, which includes water and reclaimed water operational costs. The City has a detailed summary specifying the actual various expenses for Fiscal Year 2008 (Fiscal Year 2010 Approved Budget).

Discuss any additional O & M costs associated with the dual system:

As mentioned above the expenditure includes everything from administration costs to sewer system collection systems to water quality testing.

Discuss any rate structures used by the utility to regulate consumption:

The potable water rates are structured to encourage conservation, with the reclaimed water rate being lower to encourage the use of reclaimed water instead of potable water (Will, 2010). The reclaimed water rate is $1.00 per thousand gallons (Will, 2010). The base potable water rate depends on the meter size (Water and Sewer Rates, 2010). The volumetric rates for potable water use depend on user type, whether the customer is located inside or outside the City limits (Water and Sewer Rates, 2010). For residential customers, the potable rates are organized in a three tier increasing block rate structure beginning with a charge of $1.29 per 1,000 gallons

(Water and Sewer Rates, 2010). Commercial rates are $1.29 per 1,000 gallons up to a monthly allowance and the charge is $1.51 per 1,000 gallons beyond the allowance. Irrigations rates are also $1.29 up to a monthly allowance and are $2.20 beyond the allowance (Water and Sewer Rates, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

On a limited scale since the reclaimed water system is relatively new and is rather small (Will, 2010).

Is the dual system more efficient economically?

No, since the reclaimed water system does not pay for itself (Will, 2010).

Has the use of a dual system compromised safety?

No, since there have not been any cross connections or associated illnesses.

Does the dual system position the water authority better for the future?

Yes, since the reclaimed water system is useful to reduce pumping from the Floridan Aquifer (Will, 2010).

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TAMPA WATER DEPARTMENT, TAMPA, FL

I. GENERAL INFORMATION

Evaluation Date: 9/7/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: Tampa Water Department
Contact Person: Jeff Vilagos
Title: Production Manager

Services Provided

☒ Water ☐ Wastewater ☒ Recycled water ☐ Stormwater ☒ Other Wastewater department produces the reclaimed water

Dual System Information

Year initiated: 2000 (Pre-design enrollment campaign)
Non potable water source: Reclaimed water
Uses of the non-potable line

☒ Landscape Irrigation:

☒ Commercial	☒ Golf courses	☐ Parks	☐ Playgrounds
☒ Road medians	☒ Residential	☐ Schools	☐ Other

☐ Agricultural Irrigation

☐ Toilet and urinal flushing:

☐ Commercial ☐ Residential

☒ Cooling towers

☐ Fire fighting

Unique System Features

1. Tampa does not have unique uses for reclaimed water other than using it for cooling towers. At one time the City encouraged aquariums to use it, but they did not want to even though aquariums heavily treat their water already.
2. Utilizes various water conservation measures in order to conserve Potable Water toilet rebates, plumbing codes that require low water use toilets, aerators, and special shower heads. Conservation measures have been successful. (Vilagos, 2010).
3. An additional conservation measure is requiring customers to quit using their in-ground sprinkler systems during times of extreme drought (Vilagos, 2010) and only allowing them to hand water once a week.

II. SYSTEM OVERVIEW

The City of Tampa, FL has a population of approximately 344,000 people and is located in Hillsborough County (City Data, 2009).

Potable System

Tampa obtains most of its water from Hillsborough River which is treated at the David L. Tippin Water Treatment Facility. The City is limited in how much water can be withdrawn from the river (annual average of 82 MGD) and any additional potable water is purchased from Tampa Bay Water. Currently, Tampa is right at its maximum permitted use from the River and plans on maximizing reclaimed water use to replace an estimated 23.4 mgd of that with reclaimed water. (Reclaimed Water Master Plan, 2009). Tampa Bay water obtains water from various sources: surface water, ground water, and desalinated water (Bracciano, 2010). Tampa, Florida typically obtain water from TBW when the reliability of their reservoir is lowest, which is usually during the dry season and after an extended drought (Bracciano, 2010).

Reclaimed System

The reclaimed water system consists of 120 miles of distribution main and 8 miles of transmission mains (Weiss 2010). Tampa uses approximately 2 mgd of the effluent discharged from the Howard F. Curren AWTP, which has a capacity of 57.5 mgd. The Wastewater Department produces the reclaimed water and the Water Department is responsible for reclaimed water distribution. Tampa primarily uses reclaimed water for irrigation and cooling purposes since the two uses demand the most reclaimed water and have the greatest potential to conserve potable water supply. Water users include a Refuse to Energy Facility for cooling purposes and CF Industries for a chemical heating process. The STAR Project has about 3,000 of the possible 5,000 residential users voluntarily hooked up to the reclaimed water system. Tampa plans on expanding and maximizing the use of reclaimed water in order to reduce dependence on Tampa Bay Water to provide additional water when the City maximizes its permit to divert water from Hillsborough River. Additional water (above the permitted limit) is purchased at a cost of $2.25 per 1,000 gallons (Reclaimed Water Master Plan, 2009).

Florida, along with the USEPA, is considering reducing discharges into Hillsborough Bay (Reclaimed Water Master Plan, 2009). Tampa may need to reduce nitrogen discharges into Hillsborough Bay and Tampa Bay as well. Tampa desires to use more reclaimed water in order to offset the amount of discharge into the two bays.

Tampa considers using reclaimed water for fire flow to be infeasible due to the fact that the reclaimed water system was designed primarily for irrigation and does not have the degree of reliability that the potable system has. Tampa determined that supplying the needed standby power for fire protection purposes was too costly. However, Tampa considers grey water applications, such as toilet flushing, with reclaimed water to be feasible. (Reclaimed Water Master Plan, 2009).

Tampa has given away reclaimed water for free to keep from discharging more water into Tampa Bay (Times, 2009). Vilagos heard about the idea of trucking reclaimed water to customers but did not know if anyone actually had water trucked to them for residential irrigation use (Vilagos, 2010). The City attempted to get more people interested in getting reclaimed water trucked to them by eliminating all charges for delivery in 2009 (Times, 2009).

The City also trucks water in order to water right of ways and for the Parks Department use during droughts (Vilagos, 2010).

The cost of installing reclaimed water lines into existing developed areas is too high, so the City at one time investigated using indirect potable reuse (pumping effluent directly to the potable system reservoir) in order to use reclaimed water.The indirect potable reuse would have been cheaper than retrofitting the potable system (Vilagos, 2010). However, there were serious public acceptance issues with indirect potable reuse concerning endocrine disruptors and other health issues (Vilagos, 2010). The issue of endocrine disruptors, viruses, and other health issues could be taken out by using ozone, lime softening, and membrane technology (Vilagos, 2010). Public opposition was due to perceptions rather than actual characteristics of reclaimed water.

Tampa is late in the game with having a reclaimed water system since the City originally investigated indirect potable reuse and upgraded the wastewater facility to tertiary treatment (Vilagos, 2010). In addition, Tampa Bay Water did not like the idea either, instead desiring to use other water sources such as groundwater (Vilagos, 2010). According to Dave Bracciano, the idea to use indirect potable reuse was a politically charged issue and that Tampa, FL is no longer considering it was far as he knows.

The plant cannot be upgraded in order to reduce nitrogen in discharged effluent, but would have to use different technology (like membranes) to reduce it more (Vilagos, 2010). The City is under pressure to use the nitrogen instead of discharging it (Vilagos, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.

Tampa requires backflow preventers on the domestic water line if the residence (and the same is true for commercial users) has reclaimed water as well (Vilagos, 2010). The City pays for the backflow preventer, which is intended to protect the potable water system, and uses the more reliable double check valve assemblies instead of dual check valves (Vilagos, 2010).

There have been no cross connections but Vilagos reported that St. Petersburg at one time had issues with cross connections, in that entire subdivisions were connected to the reclaimed system by accident (Vilagos, 2010).

Provide any other pertinent information

The public generally accepts the use of reclaimed water for irrigation (Reclaimed Water Master Plan, 2009). There were significant issues with indirect potable reuse so the Tampa instead used the reclaimed water system for irrigation uses as well as cooling (Vilagos, 2010).

Principal Operational Issues

1. The reclaimed water system is shut down sometimes due to water quality issues (Reclaimed Water Master Plan, 2009). Generally, shut downs do not occur since there is a lot more available water than demand (Vilagos, 2010).

2. Tampa is limited on how much the Howard F. Curren ATWP is able to discharge into the Hillsborough Bay, 96 mgd on an average annual basis. In addition, Tampa is limited to discharging 3.0 mg/L of total nitrogen on an average annual basis into Hillsborough Bay. There is no limit on phosphorous discharge, unlike other cities (Vilagos, 2010). Currently, Tampa discharges 60 mgd of effluent and 2.5 mg/L of total nitrogen on an average annual basis. Since Tampa is approaching the limit of total nitrogen, it is seeking to maximize reclaimed water use to prevent costly upgrades to the plant. The limit of total nitrogen may be lowered in the near future due to the Tampa Bay Estuary Program and Nitrogen Management Consortium. (Reclaimed Water Master Plan, 2009). Nitrogen removal is successful, the sea grass level in Tampa Bay is at the level it was in 1950 (Vilagos, 2010).
3. In the reclaimed water system service area, hooking up to it is voluntary, but the City wants to maximize reclaimed water use (Answering Your Questions About Tampa's Reclaimed Water). There are no restrictions on how much customers can use (Vilagos, 2010), so the voluntary hook up does not hinder the accomplishment of Tampa's goal.
4. During the peak demand season, March through June, Tampa still only suggests that water users spread out the demand by watering certain days (Answering Your Questions About Tampa's Reclaimed Water).
5. In 2009, the City adopted new watering restrictions, effective during the dry season, to limit potable water irrigation to once a week by hand. Reclaimed water demand went up, but the City's reclaimed water system could only convey water by pipe to 8,700 residents, of which, only 3,000 were hooked up at the time. The City decided to deliver reclaimed water for free, by trucking it to customers who otherwise would not be able to get it (The Tampa Tribune, 2009).
6. There are a few flush points in the reclaimed water system which leads to more issues with nutrients, black water, etc. Installation of the PVC reclaimed water lines is a problem due to not flushing out the lines, including the shavings, prior to putting the lines to use. Leaving the shavings has led to clogging in sprinklers and other appurtenances (Vilagos, 2010).
7. Only half of the people that made a commitment to sign up for reclaimed water use actually signed up for reclaimed water (Vilagos, 2010).
8. Tampa has had bad press regarding the fact that the chloride level in the reclaimed water is a lot more than the potable water, and plants like azaleas are not very chloride tolerant (Vilagos, 2010). Since the City is a coastal city, chloride problems are hard to avoid with reclaimed water production (Vilagos, 2010). However, during a drought, the news media helped people realize that people need to reduce their potable water use and possibly use reclaimed water (Vilagos, 2010).
9. The reclaimed water system is a maintenance headache due to biological growth, shavings in meters, stagnation in reclaimed water lines since only relatively few people use it, currently figuring out what to do about having so much reclaimed water during non-use times (Vilagos, 2010).

10. The principal operation and maintenance issues for the reclaimed system stem from the design. Tampa did not have a robust capital budget to build the reclaimed system. Several cost-saving measures were implemented in the design that impacted operation and maintenance. The principal "cost-saving" measure was the installation of the distribution system via horizontal directional drilling (HDD). At the time, Tampa did not have extensive experience with HDD to understand the shortcomings. The shortcomings were as follows:

* The pipe wall thickness was too thin. This resulted numerous service saddle failures.
* The pipes were installed too deep during construction to avoid hitting sanitary sewer laterals/water services. This resulted in significant O&M effort to perform repairs or add future reclaimed services.
* A sufficient number of blow-offs were not installed. This resulted in no efficient method to flush the system.
* The design specified that service saddles be installed using electrofusion. Electrofusion requires the main to be completely free of dirt and water. Our water table in Tampa is extremely shallow and hard to dewater. This resulted numerous service saddle failures subsequent to startup." (Weiss, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

The primary goal of the reclaimed water system is to conserve potable water, maximize the use of reclaimed water, maximize potable water offsets, reduce nutrient discharge into Hillsborough Bay, and have more control over reclaimed water as a resource (Reclaimed Water Master Plan, 2009). The reclaimed water system has a minor impact on potable water conservation, but coupled with water conservation measures, the dual system has improved conservation (Vilagos, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

Tampa is considering having reclaimed water projects in South and North Tampa and partnering with Tampa Bay Water, and tasks include capital improvement projects, project phasing, funding strategies, changes to City policies and procedures (Reclaimed Water Master Plan, 2009).

Economic Information

What is the yearly O & M budget for the system?

The operation expenditure fund was $67,543,766 for the 2010 budget and the operation from which the water sales were $77,514,149 and reclaimed water sales were $2,170,000.Since the reclaimed water meter fund, consisting of installing reclaimed water lines and meters into existing residential areas, was $1,000,000, the reclaimed water sales probably do not make up for the operation and maintenance costs of the reclaimed system . Prior to construction, customers pay $375 for the water meter installation plus an application fee of $15 if they want to reclaimed water service.

Discuss any additional O & M costs associated with the dual system:
Costs associated with the installation & testing of backflow devices.

Discuss any rate structures used by the utility to regulate consumption:
The reclaimed water rate is a flat rate of $1.20 per hundred cubic feet (CCF), or $1.60 per 1,000 gallons, for both residential and non-residential reclaimed customers (Reclaimed Water, 2010 and Weiss, 2010). For potable water usage Tampa employs a 6 tier increasing block rate structure for single family residences to encourage conservation, with tiers 5 and 6 being effective May 2010. Customers are billed per 100 cubic feet (748 gallons) of water. Overall, the number and size of the usage blocks are based on the customer classification. Customers outside the City limits are charged higher rates. There are charges according to bi-monthly thresholds based on the square footage for certain types of customers, and the number of beds for others, and number of rental rooms for others (Schedule of Rates, 2009).

IV. CONCLUSIONS

Does the dual system provide a better use of water?
The use of the reclaimed water system has contributed to lowering potable water demand, but implementing conservation measures have the greatest impact. About 2 mgd of reclaimed water is used while conservation measures dropped the potable water demand from about 80 mgd to 65 mgd almost immediately after the extreme drought measures were implemented (Vilagos, 2010).

Is the dual system more efficient economically?
The reclaimed portion of the dual system is not economical, but was the "next best option to an indirect potable use project that was rejected in 1998 in favor of a desalination plant and a regional 15 billion gallon reservoir" (Weiss, 2010). The federal government agreed and the City was able to build the reclaimed water system (Weiss, 2010). The reclaimed system is getting close to paying for itself. Weiss stated, "Our billings now exceed $2 million per year for just over 4,000 customers. Our system cost $34 million to build, but we received over $13 million in grants. Our annual debt service associated with reclaimed water is $1.3 million for a $12.1 million principal. We obviously used some money of Wastewater and Water reserves to make up the difference" (Weiss, 2010).

Has the use of a dual system compromised safety?
No, since there have been no cross connections or associated illnesses.

Does the dual system position the water authority better for the future?
Currently, the reclaimed water system only saved 2 mgd of water, but coupled with conservation measures, the system positions Tampa better for the future. Reducing potable water use and effluent discharges keeps the City below diversion and discharge limits.

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TUCSON WATER, TUCSON, AZ

I. GENERAL INFORMATION

Evaluation Date: 6/17/2010

Utility Information

Utility Name: Tucson Water
Contact Person: Karen Dotson
Title: Reclaimed Water/Backflow Prevention Coordinator

Services Provided

☒ Water ☐ Wastewater ☒ Recycled water ☐ Stormwater ☐ Other _____

Dual System Information

Year initiated: 1983
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Irrigation:
☒ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other: Agriculture, City of Oro Valley, construction, cemetery, multifamily residences
☒ Toilet and urinal flushing:
☒ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

Potable: Groundwater and Colorado River (CAP) water. CAP water treated through recharge and recovery. There are 17 pressure zones

Reclaimed: Treated through mechanical filtration plant or recharge and recovery. Serves 900 sites.

Principal Operational Issues

Wide range of pressures for the potable and reclaimed water pressures.

II. SYSTEM OVERVIEW

Potable System

In 2003, Tucson Water delivered 109,700 acre-feet of potable water to the Tucson area (Clark and Dotson 2007). The potable water comes from a combination of the Central (93 MGD), Avra Valley (31 MGD), Santa Cruz (9 MGD), and Southside (9 MGD)groundwater fields (Tucson Water 2007), which collectively consist of 200 wells and combined capacity of 196 MGD (City of Tucson 2008) including CAVSARP, the blend of Colorado River water and native groundwater, is 54 MGD.

The potable system consisted of 4,200 miles of pipe, served more than 200,000 businesses and residences, had 124 booster stations, utilized more than 50 reservoirs, and had an overall storage capacity of 273 million gallons (City of Tucson 2008). The CAVSARP, otherwise known as the Central Avra Valley Storage and Recovery Project, is a recharge and recovery facility in Avra Valley providing a blend of native groundwater and Colorado River water (City of Tucson 2008). The City of Tucson has water rights to 135,966 acre-feet of Colorado River water, but the water has a high mineral content, which detracts from aesthetic quality (City of Tucson 2008). Thus, the water must be blended with higher quality groundwater before being distributed for potable use. Using the Colorado River water helps to offset the amount of water pumped from wells and some wells were discontinued (Tucson Water LRWRP 2004).

Reclaimed Water System

The Tucson Water reclaimed water system began operation in 1984 providing water to La Paloma destination resort golf course (Thomure and Kmiec 2008) and the U of A Farms as the first customers (Tucson Water 2003).In 2007, there were 220,571 potable water connections, over 4,500 miles of pipeline, 51 potable reservoirs, and 296 million gallons of storage capacity (Tucson Water 2007-2).As of 2007, Tucson Water delivered 4.5 billion gallons of reclaimed water for turf irrigation (Tucson Water 2007-2). Water deliveries in 2009, was 17,249 AF (Dotson 2010). 18 golf courses consumed 58% of the supply, 39 parks 16%, other providers 11%, 52 schools 8%, and other users 7% of (Dotson 2010). In 2010, the reclaimed water system had 160 miles of pipeline, 29 MGD peak day demand, and the pressure range from 10 psi to 200 psi (Dotson 2010).

As of 2008, the Tucson Water Regional Reclaimed Water System covered the majority of the City of Tucson-Pima County metropolitan area (Thomure and Kmiec 2008). In addition the City of Tucson provides a regional service by treating and wheeling effluent supplies owned by other regional entities (Thomure and Kmiec 2008). For instance, some reclaimed water is provided to the Town of Oro Valley for distribution and use (Thomure and Kmiec 2008).

The reclaimed water originates from the Pima County Roger Road Wastewater Treatment Facility then is conveyed to Tucson Water's reclaimed water treatment plant, or "filtration plant", for tertiary treatment of secondary effluent (Thomure and Kmiec 2008) via pressure filters containing anthracite coal and sand and disinfected by chlorine (Tucson Water 2003). The filtration plant is permitted to produce up to 10 MGD (Clark and Dotson 2007). After treatment at the filtration plant, the water is stored in a reservoir before being piped through its own system of pipes and reservoirs to customers throughout the Tucson region (Tucson Water 2003). The backwash water from the filtration plant is piped to the Sweetwater Recharge and the Recovery Facility where it is naturally treated and released to recharge basins (Tucson Water 2003). The Sweetwater Recharge facility is permitted, as of 2007, to allow 6,500 acre-feet of treated wastewater to be recharged and recovered annually (Clark and Dotson 2007). Some of the effluent from the Roger Road Wastewater Treatment Facility is piped directly to Tucson Water's recharge basins. Tucson Water also blends water from the recharge facilities with water produced at the filtration plant in order to meet Tucson's Reuse Permit requirements (Clark and Dotson 2007). Some of the effluent is discharged into the Santa Cruz River (City of Tucson 2008). The primary purpose of the City of Tucson, Arizona's reclaimed water system is irrigation. Arizona Department of Environmental Quality (ADEQ) allows Class A reclaimed water, which Tucson Water provides, to be used for irrigation of food crops and spray irrigation of orchards and vineyards (Tucson Water 2005).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
More information is needed to verify this.

Provide any other pertinent information

The Arizona Department of Environmental Quality (ADEQ) requires all sites using reclaimed water to have a backflow prevention assembly on the drinking water service (Tucson Water 2009). The backflow prevention is intended to protect the potable water system in case there is a cross connection between the reclaimed and potable systems (Tucson Water 2007). The backflow prevention system is tested annually (Dotson 2007). The reclaimed water system produces Class A water which is safe for areas where there is unrestricted public access (Tucson Water LRWRP 2004).

In order to ensure the safety of water customers, Tucson Water assures that the water "always meets or is better than the State regulatory standards by monitoring water quality more often and at more locations than is required by the Reuse Permit" (Dotson Customers 2006). Tucson Water also tests every site for potential cross connections before initiating reclaimed water service (Dotson Customers 2006.)

Parks, schools, residences, and other smaller customers generally rely on the distribution system pressure to power their irrigation systems, and Tucson Water has analyzed various alternatives for curbing the wide range of pressures that are experienced in the distribution system (Dettmer et al 2006). Pressures can be as low as 40 psi to as high as 190 psi depending on the proximity of the use site to the booster facilities (Dettmer et al 2006). The system has 17 pressure zones in order to even out the water pressures (Tucson Water LRWRP 2004). Reservoirs are placed at strategic locations to provide backup storage for peak use periods and water can be conveyed across pressure zones when needed (Tucson Water LRWRP 2004).

The potable system has a series of emergency system interconnect located where the Tucson Water system abuts other water providers (Tucson Water LRWRP 2004). These interconnect supply water to other providers in case of an emergency.

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

The City of Tucson, Arizona is located in a desert environment and receives less than 11 inches of rainfall per year (Clark and Dotson 2007). The City of Tucson owns and operates Tucson Water, which serves more than 690,000 people (about 80 percent of the metropolitan population) (Clark and Dotson 2007), and historically relied heavily on groundwater to meet water needs (Dettmer et al 2006). As of 2007, Tucson Water serves over 710,000 people, which was about 75 percent of the metropolitan population (Dotson 2007). Population increases in Tucson after World War II, caused accelerated depletion of groundwater (Thomure and Kmiec 2008). The water level declines resulted in the gradual loss of native riparian habitat, increased pumping costs, the production of lower quality water, and measured land subsidence (Thomure and Kmiec 2008). In 1984, Tucson Water constructed a reclaimed water system originally intended to irrigate golf courses and has since expanded to include parks, schools, residences, and other types of customers (Dettmer et al 2006). By 2001, the system delivered approximately 12,000 acre-feet of reclaimed water annually to about 560 customers (Dettmer et al 2006). In 2008, the reclaimed water system had more than 800 accounts, of which less than 20 were golf courses, and delivered a total of 14,000 acre feet per year (Thomure and Kmiec 2008). Tucson Water has a conservation target of 164 gpcd of water use in its service area (Dotson 2007). In 2006, reclaimed water use accounted for 15 gpcd that otherwise would have been potable water use (Dotson 2007).

The destination resort golf industry, which historically relied on mined groundwater, represented the "largest economic index" associated directly with the success of the regional reclaimed water program as of 2008 (Thomure and Kmiec 2008). The switch to reclaimed water occurred as a result of the passage of local laws and regulations, such as the 1980 Groundwater Management Act, the Assured Water Supply Rules, and the Recharge and Recovery Program, to curb groundwater use (Thomure and Kmiec 2008). Golf courses were previously identified by Tucson Water to be major water users and thus, candidates for the reclaimed water system. According to Tucson Water, most publicly owned golf courses can consume up to 400 acre-feet per year and destination resort golf courses, as much as 800 acre-feet per year in the Tucson area (Thomure and Kmiec 2008). During the past few decades, the resort golf industry continued to develop in southern Arizona, "providing economic opportunities for the local communities that might otherwise have been prohibited" (Thomure and Kmiec 2008).

Tucson Water sought to lay the water line to not only supply water to golf courses but also to secondary water users such as schools, parks, and residences (Thomure and Kmiec 2008).

The combined water use per capita per day for both the potable and reclaimed water system is 177 (City of Tucson 2008). Of this 14 gpcd is for reclaimed water and 163 for the potable system (City of Tucson 2008). The water use of 177 gpcd has remained relatively stable for the last 20 years (City of Tucson 2008). The priority in using reclaimed water is water conservation, matching water quality with water use in that the high quality groundwater is used for drinking and bathing, and saving money (Tucson Water 2005). According to Tucson Water the main considerations in determining where to locate reclaimed water lines are as follows (Clark and Dotson 2007):

1. What is the goal of reuse, conservation or disposal of effluent?
2. Volume of water that could be saved by to reclaimed water
3. Probable customer satisfaction with reclaimed water

4. Utility infrastructure costs to deliver reclaimed water
5. Utility staff time required to assure that reclaimed water is used safely and in compliance with all of the State and local regulations
6. Whether other ways to conserve drinking water, i.e. xeriscaping or water harvesting, might be more cost-effective and acceptable to the customer

The main goal was water conservation with regards to groundwater use and the water demand has remained around 177 gpcd, which is due to a combination of factors. Dotson estimates the reclaimed water saves enough potable water annually to serve 60,000 people.

A benefit of having a dual system is the ability of the reclaimed water system to reduce the summer peak demand on the potable system and as a result delays the need for acquisition of addition potable supplies and expansion of the potable treatment and distribution systems (Dotson 2007).

How has the dual system has impacted any other (system capacity, etc.) goals?

The reclaimed water system has allowed Tucson Water to move towards its goal of full "wet water" use of its effluent entitlement.

Economic Information

What is the yearly O & M budget for the system?

The City of Tucson's total budget for the potable water system for 2010 is $65,552,230. The total budget for the reclaimed water system is $3,858,440. The total budget for the entire Tucson Water utility is $180,753,940 of which $128,631,940 is for maintenance and $52,122,000 is for capital. Dotson indicated that 3% of the current reclaimed water costs of service is subsidized by the potable water system.

Discuss any additional O & M costs associated with the dual system:

Included in the total cost, Tucson Water decided to subsidize reclaimed water use for various reasons of which the major reasons are (Dotson 2007):

1. Community acceptance of use of reclaimed water
2. Reclaimed water as water supply
3. Role in meeting regulatory requirements
4. Ability to delay potable system capital expenditures
5. Customer off-site expenses
6. Customer on-site expenses

Discuss any rate structures used by the utility to regulate consumption:

Potable water rates depend on the size of meter used and the amount of water used. The following is the monthly service charge for potable water service effective July 2010 (Tucson Water Rate Schedule 2010).

Meter Size	Rate
5/8 inch	$5.87
1 inch	$10.70
1-1/2 inch	$18.75
2 inch	$28.41

2-1/2 inch	$41.29
3 inch	$54.17
4 inch	$91.20
6 inch	$183.93
8 inch	$276.34
10 inch	$421.23
12 inch	$694.92

The potable usage charges depend on the meter size and type of water user. For instance, the single family residential usage charges are as follows effective July 2010:

Usage Residential Block Rates		
1 – 15 Ccf	$1.39	$1.54
16 – 30 Ccf	$5.13	$5.75
31 – 45 Ccf	$7.25	$8.14
Over 45 Ccf	$9.90	$11.13

The reclaimed service charge is identical to the potable service charge but the usage charge is $1.83 per Ccf no matter the amount of water used (Tucson Water Rate Schedule 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?
Yes.

Is the dual system more efficient economically?
Yes, the reclaimed water system allows capital expenditures on the potable system to be delayed or deferred, saves groundwater credits for future use, and delays the need to use additional costly Colorado River water.

Has the use of a dual system compromised safety?
In the 27 years that the reclaimed water has been operating, there have been no documented reports of injury or illness caused by reclaimed water. There have been no cross-connections with the potable water system that have resulted in contamination of the potable system.

Does the dual system position the water authority better for the future?
Yes. The reclaimed water system allows Tucson Water to continue reusing a portion of its effluent entitlement for non-potable uses and allows for the wheeling of the effluent entitlements of other entities. It also allows for the wheeling of Tucson Water's effluent not used for non-potable purposes to facilities for long-term storage and/or indirect potable reuse.

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CITY OF WINTER SPRINGS PUBLIC WORKS/UTILITY, WINTER SPRINGS, FL

I. GENERAL INFORMATION

Evaluation Date: 12/8/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Winter Springs, Public Works/Utility
Contact Person: Kipton Lockcuff, P.E.
Title: Director

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☒ Other: Public Works - Roads, sidewalks, landscaping, facilities maintenance, fleet services.

Dual System Information

Year initiated:1989
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☒ Golf courses ☒ Parks ☐ Playgrounds
☒ Road medians ☒ Residential ☐ Schools ☐ Other
☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☐ Fire fighting

Unique System Features

Winter Springs is currently in the process of augmenting the reclaimed water system with surface water from Lake Jesup, which is "geographically fortuitous". The surface water will be pumped into the reclaimed system after treatment on an as needed basis (Lockcuff, 2010).

II. SYSTEM OVERVIEW

The City of Winter Springs, Florida has a population of 33,282 and is located in Seminole County (City Data, 2009).

Potable Water system

The City's potable water system consists of 167.6 miles of water main, 1,000 fire hydrants, and water is drawn via 8 deep wells from the Floridan Aquifer (FY 2009 CAFR). The groundwater is pumped to aerator trays that remove about 20 percent of the sulfur content, and then the treated water is stored, chlorinated, and then pumped to customers (Lockcuff, 2010). In spite of the treatment process being "behind the times" the water quality still meets regulatory requirements and is cheaper than surrounding cities (Lockcuff, 2010). There are 12,802 potable water customers and water use is 110 gallons per capita (FY 2009 CAFR). Compared to the 13 water main breaks in 2008, there were 21 in FY 2009 (FY CAFR 2009). In November, a typical month, the potable water use was 3.79 mgd (Lockcuff, 2010). In 2008, 1,448,385 gallons of potable water was sold (Tables Final, 2010) and a total of 1,527,947 gallons was produced (Tables Final, 2010).

Reclaimed Water System

The City currently produces 2.2 mgd of reclaimed water to supply 1,644 homes, the Tuscawilla Golf Courses, city parks, such as the Sunshine, Sam Smith, Trotwood and Central Winds Parks, and right of ways, such as the medians on Highway 434, Tuscawilla Blvd and Winter Springs Blvd (Reclaimed Water System, 2009). The system consists of 48 miles of reclaimed water main (Lockcuff, 2010). Residences on the system are required to only have in-ground sprinkler systems (Reclaimed Water System, 2009)

The City plans on constructing the Lake Jesup Reclamation Plant which will allow the City to expand reclaimed water service by adding 2,500 homes to the system. The driver for the expansion is reducing groundwater withdrawals as mandated by St. Johns River Water Management District (Lake Jesup Plant). In 2009, approximately 390 million gallons of reclaimed water was used for irrigation (Lockcuff, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☒ Yes ☐ No

If yes, provide detail regarding the number of cases and any reported illnesses.

There have been several cross connections over the years between the reclaimed water system and homeowners' private wells. Fortunately, there have never been any cross connections between the potable and reclaimed systems (Lockcuff, 2010). The City has initiated an annual inspection of customers for cross connections and tested backflow devices during those inspections where possible.

Provide any other pertinent information

Yearly testing for cross connections of residences is not feasible and a "waste of resources". However, Winter Springs does have double check valves on all meters for both the reclaimed and potable water systems.

Principal Operational Issues

The demand for reclaimed water sometimes exceeds the supply and Winter Springs must put limits on the use. In addition, the City is in the process of planning for an additional treatment plant to augment the supply of reclaimed water (Reclaimed Water System, 2009). Peak demand can exceed the supply of reclaimed water leading to running out of reclaimed water or low pressure at a minimum, which is the principal operating issue, and that the large variations in demand are weather dependent. (Lockcuff, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:

Approximately 390 million gallons of reclaimed water is used per year for irrigation which replaces potable water, but Lockcuff recognizes that it may not be a 1:1 correction in potable water savings, since "reclaimed water is cheaper" (Lockcuff, 2010). Also, conservation savings are difficult to measure (Lockcuff, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

The reclaimed water demand sometimes exceeds the supply so the City is seeking to augment the reclaimed water system with water drawn from Lake Jesup during peak periods (Utility/Public Works).

Economic Information

What is the yearly O & M budget for the system?

The expenses for the water and reclaimed water systems are all under one category "Operating Expenses-Water System" with the projected amount being $1,661,278 for 2009 based on historical data up to 2008. The category includes everything from expenses related to postage and telephone use to repair and maintenance of the reclaimed water system. Expenses were broken down and were projected to be $0 for reclaimed water, $73,500 for water plants repair and maintenance, $8,800 for fire hydrants R&M, $24,500 for water line R&M, $11,760 for water meter R&M, $25,480 for water plant chemicals, $3,920 for backflow devices, $57,452 for chlorine for 2009 (Tables Final, 2010).

Discuss any additional O & M costs associated with the dual system:

The total potable water system revenue was $2,853,069 in 2008. The total reclaimed water revenue was $157,718 in 2008.

Discuss any rate structures used by the utility to regulate consumption:

The commercial potable water rates depend on the meter size, for the base charge, and a flat rate of $1.80 per 1,000 gallons and a 10% utility tax. Commercial irrigation customers are charged according to a five tier increasing block rate structure beginning with a charge of $1.72 per 1,000 gallons for up to 5,000 gallons of use. Commercial reclaimed water customers are charge a base rate of $4.10 and volumetric charges are according to a five tier increasing block rate structure beginning with a charge of $0.75 per 1,000 for up to 5,000 gallons of use. Reclaimed water customers are also charged a 10% utility tax. (Commercial Water and Sewer Rates, 2010).

Residential potable water customers are charged a base rate according to the meter size and volumetric rates are according to a six tier increasing block rate structure beginning with a charge of $1.19 per 1,000 gallons for up to 10,000 gallons of use. Residential reclaimed water customers are charged a base rate of $4.10 and volumetric charges are according to a five tier increasing block rate structure beginning with a charge of $0.75 per 1,000 gallons for up to 5,000 gallons of use. Residential irrigation water customers are according to a five tier increasing block rate structure beginning with a charge of $1.72 for up to 5,000 gallons of use. All residential customers also are charged a 10 percent utility tax. (Residential Water and Sewer Rates, 2010).

IV. CONCLUSIONS

Does the dual system provide a better use of water?

Yes it does since approximately 390 million gallons of reclaimed water is used for irrigation saving potable water.

Is the dual system more efficient economically?

No, since the reclaimed water system does not pay for itself. In 2009, Winter Springs tripled its reclaimed water rates raising rates from $0.25 per 1,000 gallons to $0.75 per 1,000 gallons. However, there was a significant backlash from existing customers who were used to low (discounted) rates. Winter Springs has the goal of making the reclaimed water rates "roughly equivalent" to potable rates, but the "political will to make it happen may not be present in these economic conditions" (Lockcuff, 2010).

Has the use of a dual system compromised safety?

Although there have been several cross connections over the years, the absence of illnesses did not allow the dual system to compromise public health and safety.

Does the dual system position the water authority better for the future?

Yes. Although the reclaimed water system is reportedly not necessary in the present it is necessary in that a groundwater withdrawal limit cap in 2013 was implemented by the local water management district. Thus, the goal of Winter Springs is to have zero potable water irrigation within the next 20 years. This is to avoid the expensive use of surface water in order to meet future potable water needs (Lockcuff, 2010).

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CITY OF YELM PUBLIC WORKS DEPARTMENT, YELM, WA

I. GENERAL INFORMATION

Evaluation Date: 8/26/2010
Prepared By: Stephanie Edmiston

Utility Information

Utility Name: City of Yelm Public Works Department
Contact Person: Jim Doty
Title: Plant Manager

Services Provided

☒ Water ☒ Wastewater ☒ Recycled water ☒ Stormwater ☒ Other: Parks and animal control.

Dual System Information

Year initiated: 1999
Non potable water source: Reclaimed water
Uses of the non-potable line
☒ Landscape Irrigation:
☐ Commercial ☐ Golf courses ☒ Parks ☒ Playgrounds
☒ Road medians ☒ Residential ☒ Schools ☒ Other: Plant equipment wash-down and process water, street cleaning, dust control, vehicle washing, concrete plant
☐ Agricultural Irrigation
☐ Toilet and urinal flushing:
☐ Commercial ☐ Residential
☐ Cooling towers
☒ Fire fighting

Unique System Features

1. Supplies water to fire hydrants, but the water is not used for firefighting, but for hose testing (Doty 2010).
2. There are a number of conservation measures taken in order to conserve limited potable water resources including providing free conservation kits to customers with low flow shower heads, toilet leakage tabs, toilet balloons, faucet aerators, lawn and garden nozzles, and irrigation timers (City of Yelm-Appendix 4, 2010).
3. Yelm has successfully reduced potable water loses to a three year average of 6.9% from 2005 to 2007 by implementing an annual leak detection survey and working with the fire department to track water usage (City of Yelm-Appendix

4, 2010). Leakage was on average 13 percent from 1996 to 2000 (City of Yelm-Appendix 4, 2010).

4. According to the City of Yelm Water Conservation Strategy, once the annual allocation of potable water is reached, irrigation meters will be locked (City of Yelm Water System Plan, 2009).

II. SYSTEM OVERVIEW

The City of Yelm is a small community of about 6,000 (City Data, 2009) residents located in Thurston County. The first wastewater/reclaimed water plant went online in 1999 and had a capacity of 1 mgd. Yelm is located in a "critical water supply area", meaning that the City has limited water resources (Water System Plan-Chapter 1, 2010). According to the Washington Administrative Code (WAC) Chapter 246-290, a critical water service supply area is “a geographical area which is characterized by a proliferation of small, inadequate water systems, or by water supply problems which threaten the present or future water quality or reliability of service in such a manner that efficient and orderly development may best be achieved through coordinated planning by the water utilities in the area” (Water System Plan, 2010). In 2008, the City used 11,565,531 gallons of reclaimed water (Water System Plan-Chapter 1, 2010). The need for a treatment plant was due to concerns about public health if the City continued to rely on septic systems. In addition, the need for water reuse was driven by the fact that the Nisqually River supported 5 species of Pacific Salmon and wastewater effluent would have a negative effect on the Nisqually River Salmon (USEPA, 2004).

Potable Water System

Yelm is supplied with potable water primarily from two wells, with a third being used as a monitoring well located in the same well field as the other two wells (Water System Plan-Chapter 1, 2010). Under normal operating conditions water is drawn from the two wells, treated, and stored into Baker Hill reservoir (Water System Plan-Chapter 1, 2010). Each well can supply up to 1,200 gpm, but only one well can operate at any given time (Water System Plan-Chapter 1, 2010). As of 2008, the total potable water produced and purchased was 238 million gallons (City of Yelm-Appendix 4, 2010).

Reclaimed Water System

The primary use of the reclaimed water system is irrigation for parks, church, school, ball fields, and the public works facility (Doty, 2010 and Yelm, 2005). During the winter rainy season where there is little irrigation demand, excess water is sent to generate power in the Centralia Power Canal. Currently, there are about 30 users connected to the reclaimed water system (Doty, 2010). Since the City has concentrated on providing reclaimed water to large water users, no residential users have been connected to the system since the cumbersome regulatory requirements (backflow testing, etc.) (Doty, 2010). Yelm has a goal of 100 percent upland reuse via a program to add reclaimed water users and customers (USEPA, 2004), and is successful since the demand for reclaimed water is approximately equal to production (Doty, 2010).

Yelm also uses reclaimed water for groundwater recharge, which is produced at the Cochrane Memorial Park Facility, which amounts to approximately 56 acre-feet of water per year (City of Yelm-Appendix 4, 2010).

III. EVALUATION INFORMATION

Water Safety and Public Health Protection

Have there been any reported cases of cross connections? ☐ Yes ☒ No

If yes, provide detail regarding the number of cases and any reported illnesses.
There have been no cross connections or associated illnesses reported due to reclaimed water exposure.

Provide any other pertinent information
When the reclaimed water is not produced to standards, particularly for turbidity, the pumps automatically shut down in order to quit producing reclaimed water (Doty, 2010). There is also an automatic dialer monitoring the chlorination and dechlorination systems of the plant, so that the manager would find out about it immediately during off hours (Doty, 2010).

Principal Operational Issues

1. The main operational issue is keeping the total nitrogen (nitrate, nitrite, etc.) concentration below 10 mg/L in the reclaimed water, which is difficult to do during the winter (Doty, 2010).
2. Keeping the nutrient level low as well as maintaining adequate chlorine residual throughout the reclaimed water system (Doty, 2010).
3. The Nisqually River Coalition, whose primary objective is to protect the pristine condition of the Nisqually River, was formed out of concern for the discharge of secondary effluent and reclaimed water into the river. The City has shown that the reclaimed water supplements the flow of the Nisqually River and desires to use as much reclaimed water as possible in order to offset impacts to Yelm Creek (City of Yelm-Appendix 4, 2010).

Effectiveness in Meeting System Goals

Explain how the dual system has improved conservation:
The reclaimed water system has been a significant contributor to water conservation in Yelm. Approximately 350,000 gallons of reclaimed water is produced in Yelm every day, mainly during the summer months, which amounts to a significant water savings for a small town like Yelm (Doty, 2010). To encourage conservation, the City's water trucks no longer use potable water, but reclaimed water for irrigation purposes (Doty, 2010).

The City has limited water resources, so a number of water conservation measures are being implemented in order to meet conservation goals. One conservation goal is to reduce single family residential use to 200 gallons per day within 5 years; currently usage is about 215 gallons per day (City of Yelm, 2009). Measures include installing locks on 380 fire hydrants in order to prevent water theft (City of Yelm-Appendix 4, 2010).

How has the dual system has impacted any other (system capacity, etc.) goals?

The demand for reclaimed water has been on the rise to the point where storage tanks were built in order to ensure a more reliable supply of reclaimed water during peak demand times (Doty, 2010). Yelm was producing 350,000 gallons in a 24 hour time frame, but the demand for all 350,000 gallons was during an eight hour time period every day (Doty, 2010).

Economic Information

What is the yearly O & M budget for the system?

The 2007 budget (most recent detailed report) shows that the City had a total of $2,074,200 for "municipal water" use and a total of $2,982,000 for "sewer/reuse operation and maintenance" (City of Yelm, 2007).

Discuss any additional O & M costs associated with the dual system:

Other costs relating to the dual system are capital improvements, capital reserves, debt repayment, among other costs (City of Yelm, 2007).

Discuss any rate structures used by the utility to regulate consumption:

Water base rates depend on the meter size, and user type. Volumetric rates are according to an increasing block rate structure. There are seasonal rate increases for dry season months for certain tiers (City of Yelm-Appendix 4, 2010). Overall water demand reduced from 254 gpd in 2003 to 206 gpd in 2007 which is primarily attributed to increasing block rate structure for water use (City of Yelm-Appendix 4, 2010). There needs to be farther investigation to see if the City charges for reclaimed water use since reclaimed water rates are not found on the rate table.

IV. CONCLUSIONS

Does the dual system provide a better use of water?

According to the City of Yelm, about 9 million gallons of potable water is saved per year due to using reclaimed water primarily for irrigation (Yelm, 2005).

Is the dual system more efficient economically?

Given the limited amount of revenue information, it is difficult to ascertain if the reclaimed water system costs exceed any its revenue.

Has the use of a dual system compromised safety?

Since there have been no reported cross connections or associated illnesses from reclaimed water and the City is not providing reclaimed water to any residential customers, the dual system has not compromised safety.

Does the dual system position the water authority better for the future?

The water savings is significant for a city of its size, and given the limited water resources, the dual system does ensure a more reliable water supply for future water needs.

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