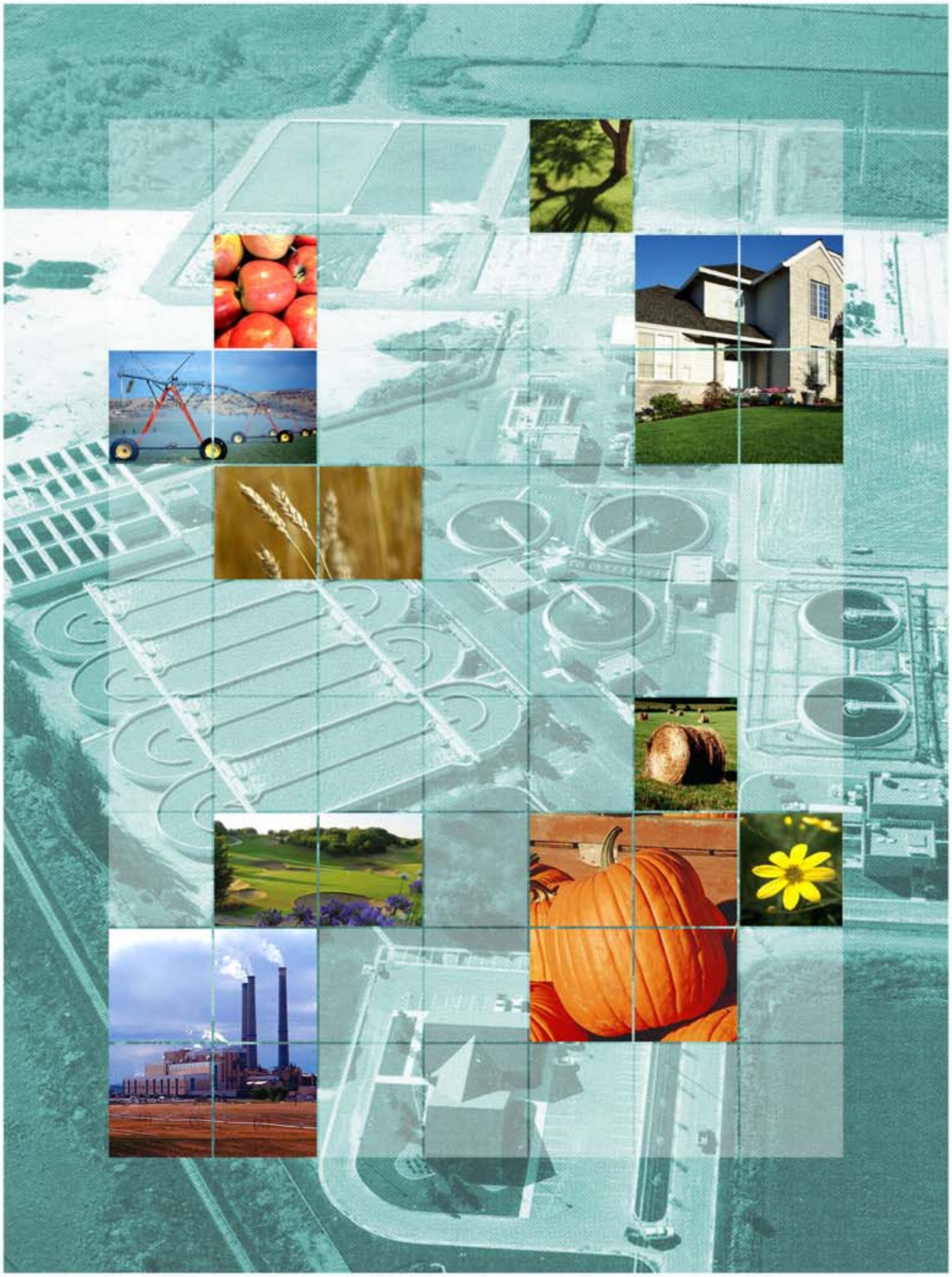
Water Reuse in Utah



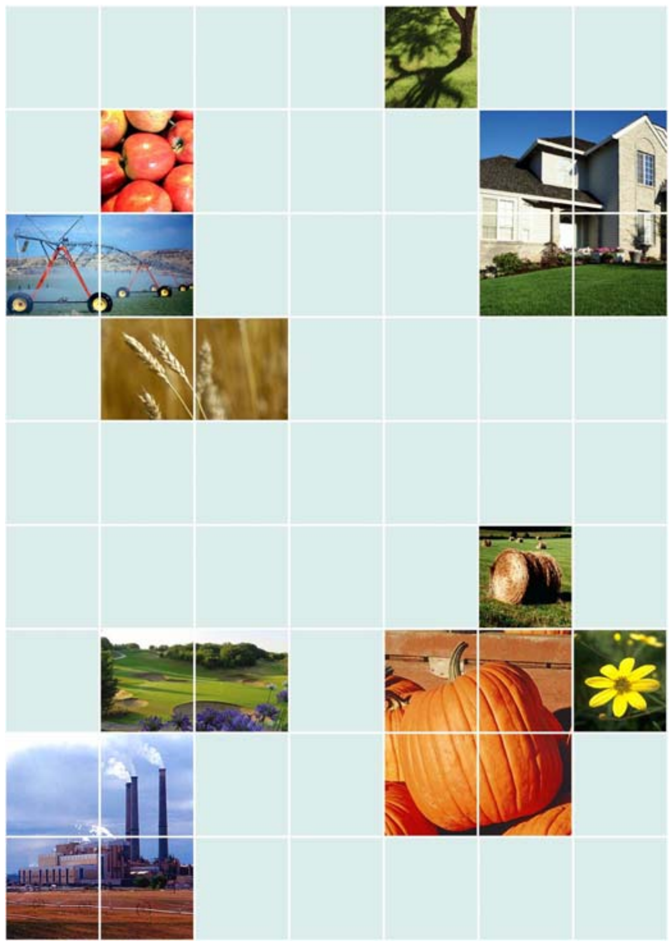
April 2005

STATE OF UTAH
NATURAL RESOURCES
Division of Water Resources

UTAH STATE WATER PLAN

WATER REUSE IN UTAH

April 2005



By:

The Utah Division of Water Resources

U T A H   S T A T E   W A T E R   P L A N

This document is also available online at: www.water.utah.gov

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PREFACE

One of the major responsibilities of the Utah Division of Water Resources is comprehensive water planning. Over the past decade and a half, the division has prepared a series of documents under the title "Utah State Water Plan," including a statewide water plan and an individual water plan for each of the state's eleven major hydrologic river basins prepared through inter-agency and public outreach.

This document is the latest in the "Utah State Water Plan" series and is intended to focus increased attention on the opportunities for water reuse in Utah. In many states throughout the nation, water reuse has proved to be an effective and safe means to help satisfy growing water demands. Many water suppliers in Utah recognize these successes and have taken steps to investigate and implement feasible projects. In addition to summarizing key advancements in the area of water reuse throughout the U.S., this document chronicles the existing and proposed projects in Utah. It also discusses the water quality and water rights requirements for such projects, and addresses other important issues such as human health, environmental impacts, economics and project funding. This document should be a valuable resource for Utah water and wastewater managers as well as other parties interested in water reuse. The Division of Water Resources also hopes this document will assist the Legislative Task Force Studying Water Issues as it addresses important water reuse issues.

In addition to the printed form of this document, the Utah Division of Water Resources has made a "pdf" version available on the Internet. This can be accessed through the division's home page at: www.water.utah.gov.

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EXECUTIVE SUMMARY

Utah's water is one of its most valuable resources. The water delivered to homes, businesses and other enterprises is as essential to the health and productivity of Utah's citizens as the air they breathe. However, once this water has met its initial purposes, it is discarded down the drain, where most users hope to never see or hear of it again. Not a very glamorous fate for such a precious commodity. Yet in recent years, discarded wastewater has taken on renewed value. No longer is it merely seen as a menace to be disposed of, but as a valuable resource that will help satisfy future water demands in Utah's semi-arid climate. With this increased value has come a growing need for information on water reuse technology and its potential applications.

Until recently, most of society has thought little of the fate of its drinking water past the drain or sewer line leaving the residence.

Water Reuse in Utah helps satisfy the need for more detailed information about water reuse and its potential in Utah. It highlights the successful implementation of various reuse applications throughout Utah as well as the United States and focuses on the important role water reuse can play in Utah's future. This document quantifies the volume of treated effluent that is currently produced as well as the volume that will be available in the future, and roughly estimates how much of this effluent could ultimately be reused. It discusses Utah's current water quality and water rights requirements for water reuse projects and other important issues such as human health, environmental impacts, economics and project funding. This document will be a useful guide and reference for local and state decision-makers, water providers, wastewater treatment plant operators, and government agencies interested in water reuse. It will also help those in the general public who wish to make greater contributions to important reuse decisions being made by local, state and federal government officials.

The following paragraphs summarize the main points of each chapter:

CHAPTER 1
INTRODUCTION TO WATER REUSE

Preparing for future water needs is not an easy task. Because Utah's population continues to grow and many of the state's water resources are fully developed, water suppliers and planners are investigating all potential sources of water. Although the beneficial use of treated wastewater, referred to as water reuse, has occurred for many years in various parts of the country, it is relatively new to Utah. This document is a resource to facilitate in the exploration of the potential for water reuse to meet future water demands in Utah.

There is some disagreement among professionals throughout the water supply and wastewater treatment industries as to the correct terms to use in reference to water reuse. For the purposes of this document, the Utah Division of Water Resources defines water reuse and water recycling as follows:

> Water Reuse – the direct or indirect use of effluent for a beneficial purpose.
> Water Recycling – the reuse of wastewater in the same process or for the same purpose that created the wastewater.

The use of effluent with a direct link, such as a piped connection from the wastewater treatment works to the application, is referred to as *direct water reuse*. *Indirect water reuse* involves an additional step such as mixing in a stream between treatment and the eventual reuse that leads to the "loss of identity" of the reclaimed wastewater.

Because of the limited opportunities for future water development in Utah, water reuse has received increased attention throughout the state. Most recently it has been considered more as an option for residential irrigation systems and other nonpotable M&I purposes. However, there are numerous ways that water reuse can be implemented to supplement and increase current water supplies. The categories of reuse include urban reuse, agricultural irrigation, recreational reuse, environmental enhancement, ground water recharge, industrial reuse/recycling and indirect potable reuse.

CHAPTER 2
EVOLUTION OF WATER REUSE AND EXAMPLE PROJECTS IN THE UNITED STATES

The concept of water reuse is not new; for centuries sewage has been recognized as a supply for agricultural irrigation water. However, prior to the mid 1800s the hazards of exposure to sewage were not understood. Following key discoveries that linked the spread of disease to contaminated drinking water, public officials established the first health and sanitation laws. Technological advances in wastewater treatment helped to protect the quality of drinking water supplies and to stimulate the desire and demand to practice water reuse.

As a pioneer of water reuse in the United States, the state of California established the nation's first reuse laws in 1918. Many other states have subsequently patterned their regulations after these laws. Since then, numerous reuse projects have been implemented throughout the United States. These projects have been accompanied by important research investigating the potential of water reuse for nonpotable and potable purposes with emphasis on health risks, reliable treatment processes and technological requirements.

This chapter discusses four successful reuse projects in the United States that illustrate a variety of water reuse methods. The projects discussed include:

- St. Petersburg, Florida – Reclaimed water is used for M&I irrigation purposes in one of the largest urban reuse systems in the world with a capacity of over 68 million gallons per day.
- Southern California – The Sanitation Districts of Los Angeles County utilize over 70 million gallons per day of reclaimed water for landscape irrigation, agricultural irrigation, industrial processes, environmental enhancement and ground water recharge.
- Scottsdale, Arizona – This advanced wastewater treatment facility receives visitors from all over the world because of the state-of-the-art technology it employs in its treatment processes. It provides reclaimed water for the irrigation of golf courses and also for indirect potable reuse through ground water recharge.
- Southern Arizona – The Palo Verde Nuclear Generating Station is the largest nuclear power facility in the U.S. It uses approximately 45,000 gallons of reclaimed water per minute for its cooling system during full operation.

CHAPTER 3
EXISTING REUSE PROJECTS IN UTAH

Many water and wastewater managers in Utah have recently begun exploring the possibilities of water reuse. Because the water needs in the state have not yet necessitated an aggressive pursuit of reuse, it is not surprising that most existing reuse projects in Utah resemble some of the earliest projects implemented in other states. These projects are primarily for agricultural irrigation. Rather than to put treated effluent to beneficial use, the main emphasis or goal has been to protect water quality by eliminating discharge to a receiving water body (zero discharge). These projects use an estimated 5,957 acre-feet per year and are described in the table below.

The most recent reuse projects implemented in Utah have been for higher-value municipal irrigation projects. Two wastewater treatment facilities have implemented advanced treatment processes to put a combined total of 2,576 acre-feet per year of effluent to beneficial use, thus conserving a large amount of potable water for other more suitable purposes. These two projects are described in the table below.

Recent water reuse projects have been implemented in an effort to help conserve valuable potable water resources. (Photo courtesy of Central Valley Water Reclamation Facility.)

Other instances of water reuse exist in the state where individuals or municipalities have obtained a right to use a wastewater treatment facility's treated effluent through the normal water rights appropriation process. Because these rights are treated as normal water rights, the uses are not considered by the Division of Water Rights or the Division of Water Quality (DWQ) as water reuse and, consequently, are not subject to the corresponding regulations. This is the case as long as the effluent has been discharged at the proper location under the corresponding Utah Pollution Discharge Elimination System permit. DWQ then considers the necessary water quality standards to have been met and any subsequent use does not fall under their jurisdiction.

CHAPTER 4
FUTURE REUSE IN UTAH

At least seven municipalities or water suppliers around the state propose to implement a water reuse project over the next few years. Some projects will

Existing Water Reuse Projects in Utah

Entity	Nature of Reuse	Estimated Reuse Volume (acre-feet/year)
Agricultural Irrigation		
Ash Creek Special Service District	The district uses its entire effluent to sprinkle irrigate 126 acres of cattle feed crops.	1,008
Blanding City	One farmer below the containment lagoons uses a portion of the effluent to fill a private fishpond and occasionally irrigate a small patch of alfalfa.	<10†
Cedar City	The city's regional treatment plant flood irrigates 640 acres of pasture in the summer and 2,300 acres in the winter that is grazed by a local rancher's livestock.	2,352
Enterprise	During wetter times, the treatment plant irrigates a 10-acre field that is grazed by cattle.	<40†
Francis	The town irrigates 40-acres of pasture that is leased out for grazing to local farmers.	280
Heber Valley Special Service District	The district uses its entire effluent to irrigate 400 acres of alfalfa and comply with a zero-discharge requirement.	1,568
Roosevelt	The city sprinkle irrigates 160 acres of alfalfa.	571
Santaquin	The city irrigates up to 32 acres of alfalfa when evaporation rates cannot keep up with the amount of wastewater received.	<128†
	SUBTOTAL	**5,957**
M&I IRRIGATION		
Central Valley	The facility irrigates an 80-acre site that includes a golf course, driving range and landscaped area of the Salt Lake County Solid Waste Transfer Station.	672*
Tooele	The city irrigates the nearby Overlake Golf Course and fills its water features with reclaimed water. The city may also use the reclaimed water for irrigation purposes in a residential development in the future.	1,904
	SUBTOTAL	**2,576**
	TOTAL	**8,533**

*This is only the portion of the total flow that is treated for the reuse project.
†Estimated from irrigated acres and water right duty.
(Source: Utah Division of Water Quality and individual treatment plant operators, October – December 2004).

One of the greatest potentials for water reuse is the conversion of irrigation systems for large municipal landscapes such as parks and golf courses.

begin operation as soon as 2005. Similar to the most recent water reuse projects completed in the state, these projects are almost entirely for M&I purposes and have the potential to reuse more than 28,000 acre-feet per year. The projects are described in the table below.

As the population in the state of Utah continues to grow, both the need for additional water and the opportunities for reuse will grow. As the population spreads out, more and more farmland will be converted to residential areas. The need for agricultural irrigation water will diminish while M&I needs will rise. Thus, the greatest potential for water reuse will likely occur from the installation and conversion of residential irrigation systems and other municipal irrigation of large landscapes such as golf courses, parks and schools. One agency, the Central Utah Water Conservancy District, is required by an agreement with the U.S. Department of the Interior to reuse a total of 18,000 acre-feet per year as part of the Central Utah Project's Utah Lake Drainage Basin Water Delivery System.

The Utah Division of Water Resources estimates that over 490,000 acre-feet per year of wastewater will be produced by 2030. This number will increase to 650,000 by 2050. With reductions due to evaporation, lack of storage and other inhibiting factors, the division estimates that only about 200,000

Proposed Reuse Projects in Utah

Entity	Nature of Use	Potential Reuse Amount (ac-ft/yr)
City of Hildale	The city proposes to irrigate city street and highway landscaping and agricultural feed crops.	377
Orem City	The city will initially use about 728 acre-feet per year to irrigate a golf course and a sports park.	9,634
Payson City	The city currently supplies reclaimed water when necessary to the Nebo Generating Facility located adjacent to the treatment facility. It also hopes to supply the city with reclaimed water for residential irrigation purposes.	4,532
St. George City	The city must supply 2,000 acre-feet per year to the Shivwits Band of Paiute Indians and it will use additional reclaimed water produced by the regional treatment plant to irrigate multiple golf courses.	6,496
North Salt Lake/South Davis Sewer District	The district will provide reclaimed water for residential purposes in a development in the western-most part of North Salt Lake City.	463
Saratoga Springs and Lehi City	A satellite plant is proposed to be built to provide reclaimed water for residential irrigation and possibly a golf course.	1,135*
Central Weber Sewer Improvement District	The district proposes to use reclaimed water to help meet growing demands for municipal irrigation water within Pine View Water Systems' service boundaries	5,600*
	TOTAL	**28,237**

*These values are as proposed and have not yet been processed by the State Engineer.

and 265,000 acre-feet per year of these volumes could be available for reuse in the corresponding years. Other factors that will limit possibilities for full development include stringent water quality standards imposed upon reclaimed water, water rights limitations, unknown risks, public acceptance and economics. These issues are discussed in detail in the succeeding chapters.

CHAPTER 5
WATER QUALITY ISSUES AND REGULATIONS

State regulation of wastewater effluent began in 1953 with the passage of the Utah Water Pollution Control Act. The act established the Utah Water Quality Board and required it to classify the state's waters according to water quality and to set effluent treatment requirements and standards for the first time. This was done to protect water quality, the environment and public health. By 1965, all the major communities in Utah with a sewer system were able to reach secondary treatment standards — the level of treatment required under typical discharge permits.

In 1995, the state of Utah implemented water reuse regulations to continue protecting public health and the environment. The *Utah Administrative Code* separates water reuse into two categories: Type I and Type II reuse. The level of treatment necessary to meet Type II water quality standards is equal to the secondary standards with additional disinfection and testing requirements. In addition to Type II standards, Type I requirements specify an additional filtration and disinfection step and higher water quality standards.

Type II effluent is acceptable mainly for agricultural irrigation purposes where it is not likely to come in direct contact with the edible parts of crops or with humans. Type I effluent is required for municipal irrigation purposes and other uses where human contact is likely. Additional regulations may be necessary if future situations present applications of reuse other than those included under Type I and Type II standards, i.e., environmental reuse, ground water recharge and indirect potable reuse.

CHAPTER 6
WATER RIGHTS CONSIDERATIONS

Water and wastewater managers must carefully consider water rights and related issues when planning water reuse projects. The current law and rules that regulate water rights for reuse projects in Utah are (1) the Conservation and Use of Sewage Effluent Act, which was enacted in 1995; and (2) the Administrative Procedures for Notifying the State Engineer of Sewage Effluent Use or Change in the Point of Discharge of Sewage Effluent, which was adopted by the State Engineer in 2003.

The act defines who may legally use sewage effluent in Utah and how the associated water rights for such uses are to be handled. In essence, the act says that a municipality or governmental agency that has water rights that result in sewage effluent may apply the effluent "to a beneficial use consistent with, and without enlargement of, those water rights." The rules outline in detail the requirements for notifying the State Engineer of any reuse contemplated under the new law. Information to be provided includes the following: the water rights to be reused, an evaluation of the diversion and depletion limits of the water rights as originally approved, the quantity and location of proposed reuse and any unused effluent, and a detailed evaluation of the total depletion of water from the local hydrologic system under the original uses of the water and those anticipated under the new reuse scenario.

Since passage of the Conservation and Use of Sewage Effluent Act, nine notifications to reuse sewage effluent have been filed with the Utah Division of Water Rights. As of March 2005, the State Engineer had completely processed seven of these notifications. In addition to these reuse projects — which are all subject to the act — there are several other instances of reuse that have been handled by the State Engineer over the years through the normal water rights appropriation process. Several of these have been approved, some have been rejected, and still others have not yet been fully acted upon (unapproved).

Numerous protests have been filed with the State Engineer regarding some of the applications to appropriate and notifications to use sewage effluent. Lawsuits have been filed against the State Engineer with regards to two of the notifications to use sewage effluent that have been processed. The outcome of these cases could have a significant impact on water reuse in Utah. Federal water rights issues could similarly have a major impact on water reuse in the state. Because the U.S. Bureau of Reclamation holds title to a significant portion of the water rights that serve Utah's population centers, many of which have been imported from other drainages, a coordinated strategy to reuse the effluent produced by these water rights could yield substantial benefits.

CHAPTER 7
OTHER IMPORTANT ISSUES

There are several key components to a reuse project other than how much water can be reused and how it is to be treated. There are many uncertainties in dealing with water reuse, particularly because of the unknown constituents left in the wastewater or the unknown effects of those known to be present. Most of the constituents, including disinfection byproducts, endocrine disruptors and nitrates, are a general problem of water quality and are detrimental to the environment with or without reuse. However, some reuse projects can benefit the environment by preventing the normal discharge of pollutants into the environment by applying effluent in a manner or location that poses less of a threat. In many of these cases, some of the constituents like nitrates can actually become beneficial to a reuse project. Most of the potential negative impacts on the human population would result only from direct or indirect potable reuse where the water is not treated to the appropriate level.

The amount of risk associated with the pollutants that may be present in reclaimed water and the reliability of treatment processes are important factors that must be considered. These risks are particularly important when dealing with the public. In order to increase the reliability of treatment, the types of treatment processes are as important to consider as the final quality of the effluent. Many of the current treatment standards are based upon the capability of certain treatment processes. *Utah Administrative Code* also requires an alternative disposal option or diversion to storage if water quality standards are not met.

Proper communication with the public about the risks, benefits and motivations behind a water reuse project is essential. The average person is not familiar with the wastewater treatment process and has little, if any, knowledge as to the capability of current treatment technology. Because of the preconceived feelings towards sewage, this lack of knowledge often leads to an initial negative response from the public towards reuse. In order to overcome these problems, the public needs to be involved in the process of implementation from the earliest conception and through the completion of any project.

Even if a project makes sense in every other aspect, if it is not economically feasible it will not likely be implemented. The feasibility of a project can be affected by the general economics and the various methods of allocating the costs associated with a reuse project. The economics of a project can be improved through various means of allocating the costs, but the main idea that must be remembered is that any approach used in setting the rate for reclaimed water must take into account the interests of the end user.

Depending upon the specific nature of a water reuse project, several sources of state and federal funding may be available. The main source of funding from the federal government is available through the Bureau of Reclamation's Reclamation Wastewater and Groundwater Studies and Facilities Act, also known as *Title XVI*. State sources of funding include the Utah Board of Water Resources, the Utah Division of Water Quality and the Central Utah Water Conservancy District's Water Conservation Credit Program. The potential for funding from any of these sources depends upon the availability of funds at the time of application, the type of entity applying and the nature of the reuse project.

CHAPTER 8
CONCLUSIONS & RECOMMENDATIONS

Because water is becoming increasingly scarce in Utah, water suppliers and planners are compelled to investigate all potential sources of water. For decades, various individuals have recognized the value of treated effluent and have obtained water rights to use it. Only more recently have numerous municipalities and water-supply agencies turned to water reuse as an important way to develop more water.

Because many of the state's surface and ground water sources are already fully developed, many municipalities are beginning to investigate the potential of water reuse.

Much like the development of water reuse in Utah is in its early stages, so are the current regulations. As the methods of implementation of reuse evolve, the regulations to safeguard the public and environment will likely need to be analyzed and, if necessary, adjusted to meet the changing conditions. Water rights procedures may also need to be adjusted to avoid unintentional discouragement of water reuse.

In order for the full potential of reclaimed water to be developed, professionals in the wastewater treatment and water supply industries need to develop a cooperative framework and strategy for implementation of water reuse projects, pending court cases need to be resolved, and public education and involvement programs need to be implemented. These things, combined with the years of experience of other states with reuse, will allow Utah to venture carefully and responsibly into the important realm of water reuse.

1

INTRODUCTION TO WATER REUSE

Meeting the water needs of Utah's citizens is an important matter. Utah's population is growing rapidly, and existing developed water supplies are insufficient to accommodate all growth in future years. As a result, the state's water suppliers and planners are investigating all potential water sources. In many locations in the United States and throughout the world, water suppliers have utilized treated municipal and industrial wastewater effluent to satisfy some water demands. This practice, called water reuse, is relatively new to Utah, but as the interest in, and need for, water reuse increases in Utah, the Utah Division of Water Resources has prepared this document to help satisfy the need for more detailed information about water reuse and its potential.

PURPOSE AND CONTENT OF THIS DOCUMENT

The purpose of this document is to introduce the concept of water reuse and present a thorough analysis of current laws and regulations that affect water reuse projects in Utah. In addition to depicting the opportunities that water reuse presents, this document also discusses the many challenges and concerns related to water reuse that must be properly addressed in order for reuse to be successfully implemented. A main goal of this document is to provide valuable data and information about water reuse to local and state decision-makers, including the Legislative Task Force that was formed during the 2004 General Session to study various pressing water issues. This document is also intended to be a resource for water providers, wastewater treatment plant operators, state agencies, and individuals in the general public who have an interest in water reuse.

Each chapter of this document discusses a specific and important topic or topics related to water reuse. This chapter introduces the concept of water reuse, including common terminology, the need for reuse, and various ways water reuse can be applied. Subsequent chapters address the following topics: evolution of water reuse and example projects in the United States (Chapter 2); existing water reuse projects in Utah (Chapter 3); proposed and potential water reuse projects in Utah (Chapter 4); wastewater treatment history, treatment processes, and Utah's water quality laws and rules that regulate water reuse (Chapter 5); water rights laws, regulations and case studies that affect water reuse projects in Utah

Rapid growth throughout the state places heavy burdens on water suppliers and planners.

(Chapter 6); other important issues, including potential impacts to the public and the environment, risk assessment, public education, economics, and funding (Chapter 7); and a conclusion about the current and future conditions of water reuse in Utah (Chapter 8).

WHAT IS WATER REUSE?

Professionals throughout the water supply and wastewater treatment industries employ a variety of terms to describe the process of collecting, treating and reusing wastewater effluent. Although not universally applied within these industries, the text in this report, except where otherwise noted, will use the terms and definitions shown in Table 1 to describe the collection and treatment of wastewater and the process of reusing wastewater effluent.

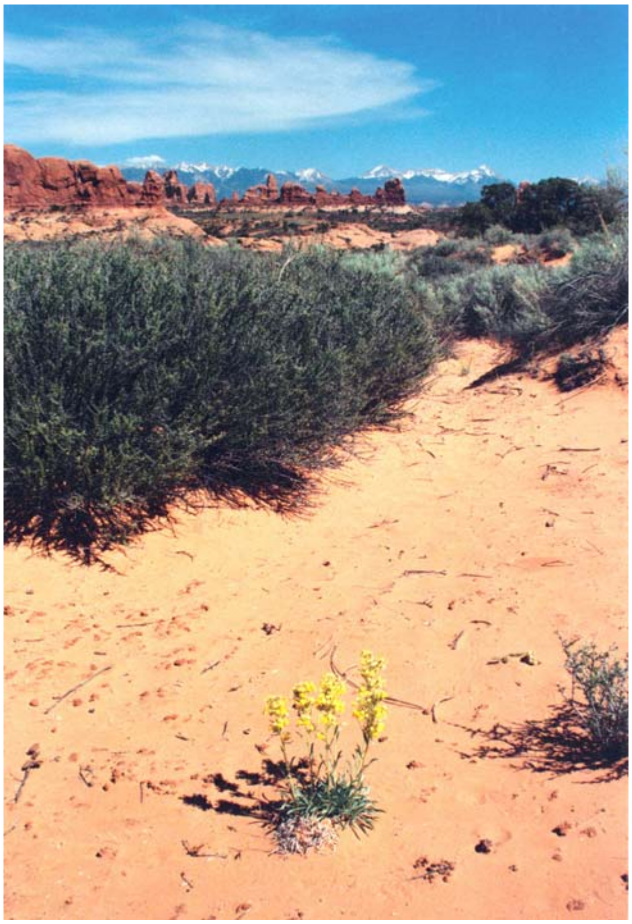
Although water reuse and water recycling are often used interchangeably, there is a distinction between the two terms as used in this report. While the term *water reuse* applies generally to any and all subsequent uses of effluent by any entity, the term *water recycling* is only used to describe uses of effluent by the same entity and for the same purpose that produced the wastewater. Some specific examples of water recycling include industrial applications such as power plant cooling systems and manufacturing processes.[1]

The Utah Division of Water Rights defines water reuse as "water that is discharged by one user and used by other users," and water recycling as "water that is used more than one time before it passes back into the natural hydrologic system."[2] These broad definitions are limited in application as far as regulating purposes are concerned. For instance, for regulatory purposes neither the State Engineer nor the Utah Division of Water Quality (DWQ) considers the use of effluent to irrigate a wastewater treatment plant's own grounds to be water reuse. Thus a treatment facility would not need to file a notification with the State Engineer or obtain a construction permit from DWQ in order to reuse effluent in this manner. Furthermore, the State Engineer does not consider the use of effluent to irrigate agricultural land as water reuse, if such use is considered part of the treatment process. Consequently, a permit would only be required from the Division of Water Quality for such use.

TABLE 1
Commonly Used Terms and Definitions

Term	Definition
Effluent	Liquid discharge from any unit of a wastewater treatment works, including a septic tank. This is frequently referred to as wastewater effluent or in portions of the *Utah Code* as sewage effluent.
Sewage	Waste matter and refuse liquids produced by residential, commercial and industrial sources and discharged into sewers.
Wastewater	Sewage, industrial waste or other liquid substances that if untreated might cause pollution of a natural or man-made water body.
Wastewater reclamation	The act or process of recovering, restoring and making wastewater available for another use. This includes wastewater renovation. The product resulting from this process is often called "reclaimed water."
Wastewater renovation	The physical treatment or processing of wastewater to clean it and make it acceptable for another purpose. The product resulting from this process is often called "renovated water."
Wastewater treatment works or facilities	Any plant, disposal field, lagoon, pumping station or other works used for the purpose of treating, stabilizing or holding wastewater.
Water reuse	The direct or indirect use of effluent for a beneficial purpose.
Water recycling	Reuse of wastewater in the same process or for the same purpose that created the wastewater. Although recycling often requires treatment of the wastewater, recycling can occur without treatment. The product resulting from this process is often called "recycled water."

Some other terms that are commonly used include "direct" and "indirect" water reuse. The use of effluent with a direct link, such as a piped connection from the wastewater treatment works to the application, is referred to as *direct water reuse*. This is mainly the case in agricultural and urban irrigation, industrial applications, and other urban uses. *Indirect water reuse* involves an additional step between wastewater renovation and the eventual use that leads to the "loss of identity" of the reclaimed wastewater. This usually occurs when the effluent is discharged into another water body in which it is mixed, diluted or dispersed such as in a river, wetland, reservoir or ground water aquifer.[3]



Over 50 percent of Utah is a desert and receives less than 10 inches of precipitation throughout the year.

Indirect water reuse has occurred throughout the world for centuries; however, this use has not always been intentional. Anytime an entity discharges treated effluent into a stream or river from which a downstream entity withdraws water for irrigation, municipal or industrial purposes, indirect water reuse is practiced. However, this does not necessarily constitute *planned water reuse*. Such is the case of many communities situated along or at the end of major waterways including New Orleans (Mississippi River); the cities and towns in the Rhine River Valley, Germany; and Osaka, Japan (Yodo River). In the case of London, England (River Thames), the indirect water reuse is planned because the upstream city of Stevenage is required to treat its effluent to a standard appropriate for London's use of the river for drinking water.[4] While unplanned water reuse already contributes to Utah's current water supply, the focus of this report is planned water reuse, or the deliberate use of renovated water to help satisfy future water demands.

WHY IS WATER REUSE NEEDED?

Utah is located in a semi-arid region where the average yearly rainfall is 13 inches. This — coupled with a rapidly increasing population — makes water a precious resource to the inhabitants of the state. With numerous water authorities constantly searching for new sources of water to meet future demands and allow the desired continued growth, the motivations for considering water reuse as an option are varied.

Economics is a large driving force behind the investigations into the use of reclaimed water. In most cases, the closest water sources have already been developed, and only expensive, distant water sources are development options to augment the current water supply. Consequently, the close proximity of reclaimed water to the point of use is economically appealing. Another economically based stimulation for water reuse might be the increasingly stringent water quality standards for wastewater effluent. As discharge regulations require more expensive treatments to prevent pollution of the environment, it may actually become cheaper to reuse the water under less demanding regulations than to discharge it into the environment.

Drinking water sources in Utah are already nearly fully developed. Water reuse may allow water purveyors to supplement and conserve valuable potable water by providing reclaimed water for irrigation and landscaping purposes. At present, 62 percent, or 113 gallons per capita per day (gpcd), of residential water use in Utah is used for outdoor purposes.[5] This may not always be the most efficient use of potable water or of the funds expended to produce that water.

Reclaimed water can also be a more reliable source of water. While many current supplies depend upon unpredictable weather patterns, especially during severe drought conditions, reclaimed water is available in predictable quantities year-round. The uncertainty of the natural water supply caused by sporadic wet and dry seasons might be overcome, at least in part, through water reuse.

While water reuse may not be a strong possibility for direct potable (drinking water) purposes, such use has occurred in the history of the United States where reclaimed water was used temporarily to overcome a failing natural water supply. Following an extended drought from 1952 to 1957, Chanute, Kansas, was forced into an emergency direct reuse situation to meet their drinking water needs. Chanute's only source of water, the Neosho River, had always contained some treated effluent from upstream neighbors in Emporia. But when the river completely dried up, the city of Chanute was without water. A temporary dam was built below the treatment plant outfall to back the discharged treated effluent up to the normal diversion point. For a period of five months, the city recycled their own water multiple times until heavy rains washed out the dam. Chanute then returned to the indirect reuse of Emporia's effluent from the river. Despite the undesirable taste, color and odor of the reused water, the treatment system already in place was able to meet all drinking water standards. Although it is unknown how much treated effluent was actually consumed, no known adverse health effects resulted.[6]

HOW CAN WATER REUSE BE APPLIED?

In principle, reclaimed water can be used for any purpose. The only stipulation is that the water be treated to meet the water quality standards appropri-

TABLE 2
Categories of Water Reuse/Recycling and Example Applications

Category of Wastewater Reuse	Example Applications
Urban Reuse	
Less Restricted	Landscape irrigation of parks, playgrounds and schoolyards. Fire protection, construction, ornamental fountains and impoundments.
Restricted	In-building uses such as toilet flushing and air conditioning. Irrigation of areas where public access is infrequent and controlled: golf courses, cemeteries, residential, greenbelts.
Agricultural Irrigation	
Food Crops	Crops grown for human consumption and consumed uncooked.
Non-food crops and food crops consumed after processing	Fodder, fiber, seed crops, pastures, commercial nurseries, sod farms and commercial aquaculture.
Recreational Reuse	
Less Restricted	No limitations on body contact: lakes and ponds used for swimming and snowmaking.
Restricted	Fishing, boating and other non-contact recreational activities.
Environmental Enhancement	Creation of artificial wetlands, natural wetland enhancement and instream flow maintenance.
Ground Water Recharge	Ground water replenishment, salt water intrusion control and subsidence control.
Industrial Reuse/Recycling	Cooling system make-up water, process waters, boiler feed water, construction activities and washdown waters.
Potable Reuse	Indirect reuse and direct reuse.

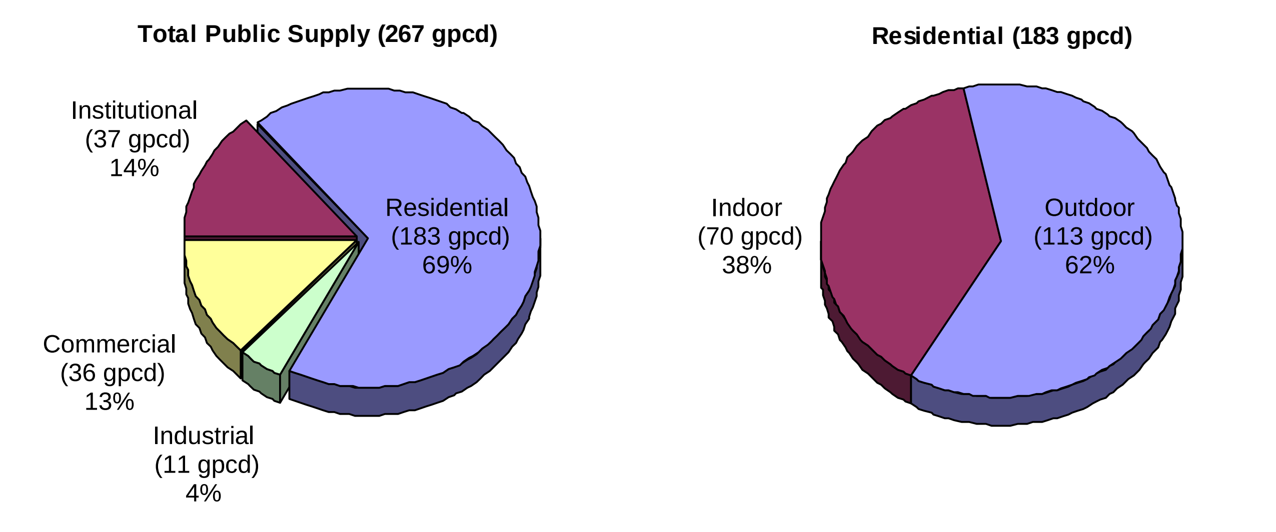
Source: Adapted from Takashi, Asano, *Wastewater Reclamation and Reuse*, (New York: CRC Press LLC, 1998), 24-25.

ate for the intended use. The different methods for application of reclaimed water vary from irrigation of residential landscapes to industrial cooling purposes to fulfilling instream flow requirements. The major categories of reuse and several example applications are listed in Table 2. Each of these major categories of reuse is discussed in further detail below.

Urban Reuse

Urban reuse involves using reclaimed water for such purposes as irrigation of parks, playgrounds, schoolyards, golf courses, cemeteries and residential landscapes. It also includes uses such as fire protection, construction, ornamental fountains, toilet flushing and air conditioning. As previously mentioned, 62 percent (113 gpcd) of residential water use throughout the state is used for outdoor purposes (see Figure 1). In addition to this use, the Utah Division of Water Resources estimates that 80 percent of institutional water use (30 gpcd) and 20 percent of industrial and commercial use (2 and 7 gpcd, respectively) occurs outdoors. This amounts to a total of about 152 gpcd that is used for outdoor purposes.[7] Because some communities are supplied by secondary systems, not all of this is potable water. However, the division estimates that about 100 gpcd (65 percent) of the 152 gpcd is drinking water, a portion of which could potentially be replaced with reclaimed water. In Utah, water quality standards governing the reuse of water are divided into two categories depending on whether human exposure is likely (Type I) or unlikely (Type II). These requirements are discussed at length in Chapter 5.

FIGURE 1
Breakdown of Public Community System Water Use Including Secondary Water in Utah (2003)



Source: Utah Division of Water Resources, “Municipal and Industrial Supply Studies,” 2003.

Agricultural Irrigation

Water reuse for agricultural purposes includes, among others, irrigation of food crops, fodder crops and sod farms. Irrigation of agricultural crops is one of the leading direct uses of renovated water throughout the United States. This is not by accident. The original method of sewage treatment was the application of such on farmland. The reason is that soil can provide excellent degradation of biological solids, and some of the pollutants found in wastewater are actually nutrients for plants. However, certain minerals and pollutants must be monitored and treated because they will not be removed by the soil or will be harmful to the soil itself, i.e. salts, heavy metals, toxic substances and other trace elements, etc.[8]

Agricultural irrigation is an excellent use of reclaimed water as land application of wastewater has often been used as part of the treatment process.

Recreational Reuse

Several possibilities exist for recreational reuse, and the water quality standards depend on the anticipated level of human contact. Indirect and unplanned reuse for recreation already occurs in many water bodies in Utah. These include boating, fishing and swimming in many of Utah's streams and some reservoirs. Some states in the United States also use reclaimed water for snowmaking, but it is not among the list of approved uses in *Utah Code R317-1-4*. Planned recreational reuse is not foreseen to be a major constituent of water reuse, as the levels of treatment required for swimming and other contact or non-contact activities are rather expensive and provide little direct revenue.

Environmental Enhancement

For as long as wastewater has been treated and discharged into streams and other waterways, reclaimed water has technically been reused by the environment. More recently, wastewater has been treated to comply with evolving water quality standards to minimize harm to fish, waterfowl and other wildlife. In addition, the effluent has helped maintain adequate stream flows to support wildlife habitat. Where needed, reclaimed water could be put to specific environmental uses and create new wetlands as well as maintain existing areas. The construction of wetlands can serve multiple purposes; it can create habitat for waterfowl and other wildlife, provide non-contact recreation, and serve as a non-standard wastewater treatment method by providing additional treatment of treated wastewater.

Ground Water Recharge

Ground water recharge is another more common application of water reuse that can be accomplished by well injection or land surface spreading of treated wastewater effluent. If the recharge method is through surface spreading, the treated water may be further filtered and biologically oxidized by the soil likely resulting in treatment "equivalent to, or better than, conventional treatment followed by filtration and disinfection."[9] As the aquifer is recharged, the renovated water mixes with and is diluted by the in situ water. This leads to an indirect reuse, as the reclaimed water will typically "lose its identity." Depending upon the characteristics of the aquifer, a long period of time may elapse before the water is extracted. This allows time for the renovated water to further improve its quality naturally.

Ground water recharge is used in several places in the U.S. to prevent saltwater intrusion into freshwater aquifers as water levels decrease due to pumping. In a few other instances, reclaimed water is used to supplement drinking water supplies by recharging ground water sources. Utah does not currently allow indirect potable recharge to high quality drinking water aquifers.

Industrial Reuse/Recycling

In many cases, industrial processes are strong candidates to reuse or recycle water. Industries can reuse water by receiving treated effluent from a water reclamation facility, or they can recycle their own process wastewater by capturing it, treating it onsite and then applying it back to the same processes. Three

Wetlands are an important part of many ecosystems and can be created or enhanced through planned water reuse.

categories of industrial water use are of particular interest because they require high volumes of water: cooling tower makeup water, once-through cooling water and process water.[10] Industrial water quality issues tend to be site specific depending upon the process in which the reclaimed water is used. These requirements differ from those governing other uses because industrial reuse requirements are not usually established to protect the public but are more for protection of infrastructure from degredation.

Potable Reuse

Potable reuse is the use of reclaimed water to augment drinking water supplies. Currently, there are no cases of direct potable reuse in the United States. Some possible reasons for this are discussed in Chapter 7. However, indirect potable reuse occurs frequently through situations in which the reclaimed water is mixed with surface water that is later diverted and treated for municipal and industrial use and ground water recharge, planned and unplanned. With indirect potable reuse, longer periods between release and reuse can provide an environmental buffer that allows mixing, dilution, and natural physical, chemical, and biological processes to occur. All these processes help to purify the water.[11]

CONCLUSION

Any one of the uses listed above can often lead directly or indirectly to another application. Direct reuse for irrigation can lead to indirect recharge of ground water aquifers, which can lead to indirect reuse in the drinking supply. The multiple uses of water in this case are not often considered reuse because the effluent loses its identity through a "natural" process. Some soils inhibit the spread of impurities by filtration as the reclaimed water passes through it. Depending upon its makeup, the aquifer then acts as a buffer between the newly arrived water and the intake to the drinking water system by providing in essence a "holding tank" that can allow natural degradation of some impurities over time. Much of this process does not stray far from the hydrologic cycle, and is already a natural, ongoing process.

NOTES

[1] Asano, Takashi, ed. *Wastewater Reclamation and Reuse*, (New York: CRC Press LLC, 1998), 2.

[2] Utah Division of Water Rights, "Glossary of Terms." Retrieved from the Utah Division of Water Rights' Internet web page: http://waterrights.utah.gov/wrinfo/glossary.htm, July 2004.

[3] Asano, Takashi, 2.

[4] Ibid, 3.

[5] Utah Division of Water Resources, "Municipal and Industrial Supply Studies," 2003.

[6] Middlebrooks, E. Joe, *Water Reuse*, (Ann Arbor: Ann Arbor Science Publishers, Inc., 1982), 200-202.

[7] Utah Division of Water Resources, "Municipal and Industrial Supply Studies," 2003.

[8] Dean, Robert B. and Ebba Lund, *Water Reuse: Problems and Solutions*, (New York: Academic Press Inc., 1981), 11-13.

[9] Ibid, 11.

[10] Asano, Takashi, 35.

[11] National Research Council, *Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies with Reclaimed Water*, (Washington, D.C.: National Academy Press, 1998), 21.

2

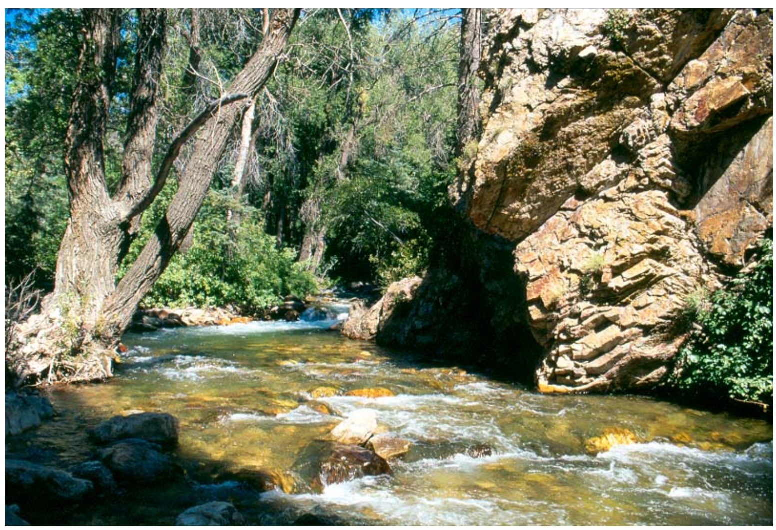
EVOLUTION OF WATER REUSE AND EXAMPLE PROJECTS IN THE UNITED STATES

In order to better comprehend the driving forces causing water reuse to be investigated in Utah, it is important to understand the history and evolution of wastewater treatment technology. Recognizing when and why some regulations were implemented helps explain why many entities have turned to water reuse in place of discharging their effluent. The following section explains some of the discoveries that have been made linking public health to the lack of proper wastewater treatment as well as some of the regulations that followed the acquired knowledge. Subsequent sections provide summaries of a few projects in the United States that demonstrate a variety of some of the successful applications of reclaimed water discussed in Chapter 1 and to highlight the substantial benefits that such uses can provide.

EVOLUTION OF WATER REUSE

The concept of water reuse is not new; it is believed that civilizations as early as 3000 B.C. utilized sewage to irrigate cropland.[1] However, prior to the public movement to improve sanitary conditions in the mid-nineteenth century (known as the "Great Sanitary Awakening"), the biological hazard of contact with sewage was not understood. Following the famous cholera epidemic of 1832, Edwin Chadwick, a lawyer in England, was inspired to attempt to improve the public health conditions in large cities. Through Chadwick's investigations, the founding principles of public health were born around 1840.[2]

Observations by John Snow and William Budd from 1848 to 1854, which linked polluted drinking water to the spread of cholera and typhoid fever in London and northern England, stimulated the public's concern and demand for clean drinking water. The breakthroughs of the "germ theory of disease" proposed by Louis Pasteur in 1873 and the anthrax connection to bacterial etiology discovered by Rober Koch in 1877 led to the now common knowledge of disease transmissions through improper sanitation. As a result of these discoveries, officials began instigating projects and creating laws to control environmental pollution and clean up drinking water sources and sanitation facilities.[3] For the first time, responsibility for public health was placed upon the state to enforce sanitation laws. People were no



In the late 1800s, public health officials began to realize the importance of clean drinking water and of protecting the quality of the nation's surface waters.

longer allowed to carelessly throw waste out the window or into surface waters.

Along with improvements in protecting the quality of drinking water, technological advances in wastewater treatment helped stimulate the desire and motivation to practice water reuse. Promotional efforts for reuse in the United States were pioneered largely by the state of California in the early 1900s. The city of Bakersfield was one of the earliest practitioners of reuse — irrigating fields of corn, barley, alfalfa, cotton and pasture with reclaimed water in 1912. California later established the nation's first water reuse regulations in 1918. In the late 1920s, many more irrigation projects using reclaimed water were developed in Arizona and California. And in the 1940s, chlorination of wastewater effluent was implemented to allow its use in steel processing. Later, in the 1960s, water suppliers in Colorado, Florida and elsewhere expanded the use of treated effluent to urban irrigation systems.[4] These developments were stimulated in part by the Federal Water Pollution Control Act of 1948, the first federal regulation on abatement of surface water pollution. Amendments to the act in 1956 and 1966 further strengthened these regulations.

Since the 1960s, regulatory pressures and water shortages have led to intensive research efforts that have provided fundamental insight into health risks and reliable treatment processes for water reuse projects. During the 1970s and '80s, research was conducted through demonstration projects that were implemented to determine the potential of water reuse for nonpotable and potable purposes with emphasis on health risks, reliable treatment processes and technological requirements. These efforts have significantly increased the number of permanent reuse projects in various regions and the evolution of new options for reuse throughout the world.[5] Congress also aided these efforts in the U.S. by passing the Federal Water Pollution Control Act of 1972. This helped to promote the elimination of pollutant discharge into navigable waters by providing grants for the development and implementation of advanced treatment technologies and management practices.

URBAN REUSE IN ST. PETERSBURG, FLORIDA[6]

Florida's climate is extremely wet compared to Utah's semi-arid environment. Despite this fact, the city of St. Petersburg, Florida, boasts one of the first and largest urban reuse systems in the world. The city is located at the tip of the Pinellas County peninsula and has limited access to sources of potable water. Thus, an ever-increasing population and strict discharging regulations have made the expansion of the drinking water supply and disposal of wastewater an integral part in the growth and development of the city since it was founded in 1880.

St. Petersburg built its first sewer conveyance system and primary treatment plant in 1894. After removal of only settleable solids at the plant, primary effluent was discharged directly into Tampa Bay. With increasing wastewater production from the growing population, the treatment plant was expanded in 1925 and again in 1954. By 1956, three additional plants were under construction to meet the rapidly growing demands. Relying greatly on subsequent dilution and natural decomposition of wastes, all four treatment facilities discharged partially treated effluent directly into Tampa Bay or the adjacent Boca Ciega Bay. This method of disposal was initially accepted, but the rising number of discharging facilities in this area and throughout the state created a threat to the quality of Florida's water bodies.

The Federal Water Pollution Control Act of 1956 and a report produced by the U.S. Environmental Protection Agency in 1969, which declared Tampa Bay one of the most polluted bodies of water in the United States, prompted Florida's Legislature to protect the area's water bodies. In 1972, the Legislature adopted the Wilson-Grizzle Act banning the disposal of any wastes into any of the area's bays, bayous, sounds or sound tributaries without providing advanced wastewater treatment approved by the Department of Pollution Control. Later the State Pollution Control Board clarified the meaning of "advanced treatment" by setting limits of 5 mg/L of BOD (Biological Oxygen Demand), 5 mg/L of TSS (Total Suspended Solids), 1 mg/L of phosphorous and 3 mg/L of nitrogen with a minimum treatment efficiency of 90 percent.

These new discharge limitations forced the city of St. Petersburg to evaluate its alternatives to meet the new requirements. Based on the cost of upgrades necessary for the wastewater treatment facilities and potential potable water supply shortages, the city turned its attention to water reuse. A pilot study authorized in 1971 yielded results that also played a key role in the decision. This study determined that spray irrigation using reclaimed wastewater was more feasible and cost effective than advanced treatment of the city's wastewater prior to its discharge into Tampa Bay. Another huge benefit was the conservation of valuable potable water. As a result of the study, the St. Petersburg City Council decided to implement a reuse project by treating the wastewater to a degree suitable for irrigation of parks, schools and golf courses. The plan also included an aquifer storage and recovery project with a deep injection well system to help eliminate discharge (zero-discharge) into the bay, particularly during the months when irrigation demand was low.

With the aid of several federal grants, the city was able to upgrade the existing treatment plants, build an intricate dual distribution system, and add numerous injection well sites. Soon after the City Council adopted policies and regulations for reclaimed water service in 1981, the water reuse distribution system was expanded into residential areas. The city's goal of zero-discharge was eventually realized with the completion of upgrades to the fourth and final plant in late 1987.

Both injection and monitoring wells were constructed at each of the four treatment plants to provide independent injection well systems for each facility. The city injects reclaimed water into confined saltwater aquifers when the quality of the effluent does not meet standards or when there is excess water that cannot be stored in the distribution system. This allows the city to achieve zero-discharge year-round. It was originally planned that the city would recover the injected water in time of need. Unfortunately, this proved infeasible as the reclaimed water formed a thin layer on top of the denser salt water and was difficult to recover.

Initially, some citizens expressed concerns about the spread of viruses and others claimed that leaf damage or plant death was directly caused by irrigating with reclaimed water. However, further studies showed that treatment processes sufficiently removed potential risks and that the majority of residential plants were not affected by the reclaimed water. A few exceptions included cases where slight restrictions on use were suggested due to higher chloride levels from saltwater infiltration into parts of the sewer system.

Perhaps the most impressive part of the St. Petersburg experience comes from a "Needs and Sources" report prepared in 1987. The report projected that by the year 2020, if a 20-year drought occurred, the city of St. Petersburg could expect a deficit in the water supply of 23 million gallons per day (mgd). However, with the full implementation of water reuse, instead of a deficit of 23 mgd, the city would still have a surplus of 1 mgd.

As of September 1995, the total design capacity of St. Petersburg's water reuse system was 68.4 mgd with an average total influent flow to the four plants of 49.2 mgd. The system has a total storage tank capacity of 25 million gallons and 10 deep wells with a total capacity of 133 mgd. As of 1998, all four treatment facilities provide activated sludge secondary treatment, followed by alum coagulation, filtration and chlorine disinfection.

MULTIPURPOSE REUSE IN CALIFORNIA[7]

Next to Florida, the state of California is the largest user of reclaimed water. It was also a pioneer of water reuse regulations, which serve as the model for many other states' regulations. One California regulation that is now widely enforced is the use of the color purple as an indicator of the presence of reclaimed water. Any pipes transporting reclaimed water are to be purple or marked by purple tape, and any signs or other structures associated with the distribution of reclaimed water are to be painted purple as well. The color purple was first selected by the California-Nevada Section of the American Water Works Association and later adopted by the California State Department of Health Services (DHS) and the WateReuse Association of California.

Early on, California took a proactive role in water reuse. In addition to establishing the nation's first reuse regulations in 1918, the state Legislature established the California Porter-Cologne Water Quality Act in 1969. This act strongly encourages water reuse proclaiming "the people of the state have a primary interest in the development of facilities to recycle water containing waste to supplement existing surface and underground water supplies and to assist in meeting the future water requirements of the

California law helps to preserve precious drinking water by prohibiting the use of potable water for non-potable purposes if reclaimed water is available as an alternative.

state." The act further encourages reuse projects by stating that the use of potable domestic water for nonpotable purposes is a waste or an unreasonable use of the water if reclaimed water that meets certain requirements is available as an alternative.[8]

One of the earliest and largest reuse projects in the state of California was implemented by the Sanitation Districts of Los Angeles County, which were formed by an act of the California State Legislature in 1923. The districts' facilities include a Joint Water Pollution Control Plant (JWPCP) and six water reclamation plants (WRP). The JWPCP is a wastewater treatment plant with a 385 million gallon per day (mgd) capacity, and the six WRPs have a collective capacity of 190.7 mgd. Five of the six WRPs provide tertiary treatment that produces high quality effluent to meet the standards for numerous reuse applications. (For more information of treatment processes see Chapter 5). The economy of these operations is improved by the JWPCP acting as the central solids handling facility for all the water reclamation plants, eliminating the need and expense of building such a facility at each individual plant. Several areas outside of the Los Angeles Basin are served by four additional WRPs.

Even without specific projects that reuse all the effluent, the districts' WRPs must treat wastewater to levels appropriate for non-restricted recreational use, as effluent is discharged into local waterways where full-body recreational contact occasionally occurs. Thus, by the standards of the California State Department of Health Services, the plants' discharge is already fit for direct, nonpotable reuse applications including landscape irrigation of all public areas, irrigation of food and fodder crops and pasture, water supply for livestock, non-restricted recreational impoundments, ground water recharge and industrial purposes. In the early 1960s, the districts began practicing reuse, and by 1997 were reusing approximately 38 percent (70.93 mgd) of the total effluent produced for various purposes as shown in Table 3.

For over nine decades now, California has practiced water reuse throughout the state with the project in

TABLE 3
Categories of Reuse by the Sanitation Districts of Los Angeles County (1997)

Reuse Application	Specific Areas of Reuse	Amount of Water Reused (mgd)	% of Total Water Reused
Landscape Irrigation	90 parks, 85 schools, 66 roadway greenbelts, 17 golf courses, 19 nurseries, 5 cemeteries, 55 miscellaneous landscaped areas.	11.23	15.8%
Agricultural Irrigation	10 sites.	4.54	6.4%
Industrial Processes	12 sites including paper manufacturing, carpet dyeing, concrete mixing, cooling, oil field repressurization, and construction applications.	6.12	8.6%
Environmental Enhancement	1 wildlife refuge on Edwards Air Force Base.	6.59	9.3%
Ground Water Recharge	Central Groundwater Basin.	42.45	59.9%
	TOTAL	**70.93**	**100%**

Source: Takashi, Asano, ed. *Wastewater Reclamation and Reuse*, (New York: CRC Press LLC, 1998), 926-927.

Los Angeles County being just one of many. The Sanitation Districts of Los Angeles County have initiated several health effects studies with particular focus on the ground water recharge efforts. These studies have all shown that there have been no apparent adverse effects on the health of the general public, on the quality or performance of the irrigated soils, or on the quality of ground water aquifers.

URBAN IRRIGATION AND INDIRECT POTABLE REUSE — SCOTTSDALE WATER CAMPUS[9]

The Scottsdale Water Campus is a unique facility that serves the population of Scottsdale, Arizona, just north of Phoenix. The city of Scottsdale originally had a single main sewer line running south through the city and on to the regional facility in Phoenix. As Scottsdale began to expand northward, the city investigated options to expand the sewer line or create its own treatment facility. With both options about equal in cost, the city decided to build the Scottsdale Water Campus in order to keep and reuse the city's water within its own boundaries.

The facility is unique not only because of its advanced technology but also because it provides drinking water for the city as well as treating the wastewater produced by its residents. The water campus treats the city's allotment of Central Arizona Project (CAP) water to provide drinking water for residents; it produces reclaimed water for irrigation of parks, medians and golf courses; and it recharges the aquifer, above which the roughly 50-acre facility lies, with advanced treated reclaimed and CAP water.

Scottsdale Water Campus receives visitors from all over the world to see the state-of-the-art treatment technology utilized as part of the water reuse project. (Photo courtesy of the city of Scottsdale.)

The reclamation section of the water campus has a capacity of 12 million gallons per day (mgd), and the advanced water treatment portion has a current capacity of 10 mgd. The reclamation plant provides tertiary treatment for about 9,500 acre-feet per year of effluent that services 22 golf courses. The advanced water treatment plant further treats surplus effluent through microfiltration and reverse osmosis and excess CAP water with microfiltration. Following the advanced treatments, the aquifer below the facilities is recharged with approximately 3,300 acre-feet per year of treated effluent and 3,200 acre-feet per year of treated CAP water that are injected through 180-feet deep, vadose-zone wells. The water then percolates down 300 to 400 feet to the confined aquifer. It takes about five years for the recharged water to migrate to the production wells where it is pumped out of the aquifer and added to the drinking water supply.

As of September 2004, the water campus was just beginning to detect the presence of recharged water in monitoring wells near the production wells by detecting trace constituents known to be present in the injected water. Thus far, officials have been satisfied with the quality of water achieved by the advanced treatments and claim that all harmful constituents including pesticides, pharmaceuticals and others are removed by the advanced treatment processes (particularly reverse osmosis). The Scottsdale Water Campus now receives visitors from all over the world because of the state-of-the-art technology it employs in its treatment facilities.

INDUSTRIAL REUSE — COOLING TOWERS AT THE PALO VERDE NUCLEAR GENERATING STATION[10]

The Palo Verde Nuclear Generating Station (PVNGS) in Arizona is unique in its size, location and operation procedures. As the largest facility for the peaceful use of nuclear power in the U.S., PVNGS is a cornerstone of energy in the Southwest. Consisting of three pressurized water reactors and turbine-generators, the standardized triple-unit commercial nuclear power facility produces 1,270 megawatts per unit, totaling 3,810 megawatts.

PVNGS is located in the Sonoran Desert 55 miles west of Phoenix, Arizona. This location is unique because most other nuclear power plants are situated near a natural body of water; PVNGS is miles from any river, lake or ocean creating a dilemma when it comes to securing an essential dependable water supply. The area's meager 7 inches of rainfall per year does little to alleviate this problem.

The Palo Verde Nuclear Generating Station had to look elsewhere for water since the Central Arizona Project's canals (such as the one shown above) could not deliver enough water even without any other appropriations.

Like other steam-electric plants, PVNGS requires a dependable water supply to produce steam and cool equipment. Each unit requires 0.56 million gallons per minute (gpm) for cooling purposes. With all three units fully operational, the facility requires approximately 1.7 million gpm. The only body of water in all of western Arizona that could possibly satisfy the plant's water demands, ignoring the fact that Arizona's share is already fully appropriated, is the Colorado River. The Central Arizona Project, also already totally appropriated, could not even deliver enough water. Ground water was also out of the question because of the already declining aquifer levels due to pumping for irrigation and municipal purposes.

The plant's designers overcame the lack of a dependable water supply in the vicinity by implementing an innovative strategy — the plant is the only nuclear energy facility in the world to use reclaimed water as a source of water for cooling tower operation. The city of Phoenix 91st Avenue Wastewater Treatment Plant (WWTP) is located 38 miles east of PVNGS. The treatment plant typically discharged roughly 130 million gallons per day (mgd) into the normally dry Salt River bed, which has few downstream appropriations of its flow. PVNGS began obtaining the treated sewage effluent from the treatment plant in the mid-1970s and treating it further at an onsite water reclamation plant (WRP) to meet the stringent industrial water quality requirements. However, since even this quantity was insufficient to meet the requirements of a once-through cooling system, a recycling process was also established. Thus, a continuous water supply is only necessary for the water lost to evaporation, which in the summer months is approximately 45,000 gpm for all three units at full capacity.

Before the onsite WRP could be built, a study was conducted with the construction of a demonstration plant at the WWTP. Testing was performed in order to determine the WRP process and specify major equipment. In order to meet the cooling demands of PVNGS, it was determined that water must be recycled through the system 15 times; because of this, harmful constituents in the wastewater (such as calcium, magnesium, silica and phosphates) needed to be removed by the WRP to avoid scaling.

The final design for the WRP included the following components: trickling filters containing plastic media with 100 percent recycle capability, first and second stage solids contact clarifiers with lime injected into the first stage and soda ash and carbon dioxide in the second stage, and gravity filters to remove additional suspended solids. The contractual cost of the effluent from the WWTP is approximately \$50 per acre-foot. The total operation and maintenance cost to treat the effluent is roughly \$170 per acre-foot — the majority of which is the cost of chemicals utilized in the process. The use of reclaimed water by PVNGS is an environmentally friendly solution and an economic benefit to the local communities and the entire region served by the power plant.

NOTES

[1] Asano, Takashi, ed. *Wastewater Reclamation and Reuse*, (New York: CRC Press LLC, 1998), 6.

[2] Chitnis, Dr. Shantanav P., "Biohazard waste management: A TQM perspective." Retrieved from the Express Healthcare Management's Internet web page: http://www.expresshealthcaremgmt.com/20010915/tqm.htm, August 2004.

[3] Ibid.

[4] Asano, Takashi, 6.

[5] Ibid, 7-8.

[6] This section was summarized from: Asano, Takashi, 1037-1086.

[7] The majority of the information for this section is summarized from: Asano, Takashi, 917-922, 926-933, except where explicitly noted.

[8] California Resources Agency, Porter-Cologne Water Quality Act, Chapter 7, Article 2, Section 13510 and Article 7, Section 13550. Retrieved from the state of California's Internet web page: http://ceres.ca.gov/wetlands/permitting/tbl_cntnts_porter.html, August 2004.

[9] The information for this section came from a personal communication with William Vernon, Scottsdale Water Campus, September 2004.

[10] This section was summarized from: Asano, Takashi, 1143-1148, 1160-1161.

3

EXISTING REUSE PROJECTS IN UTAH

Many water and wastewater managers in Utah have recently begun exploring the possibilities of water reuse. Because water needs in the state have not yet necessitated an aggressive pursuit of water reuse, it is not surprising that the majority of reuse projects currently in operation, mainly agricultural irrigation, resemble some of the earliest projects implemented in other states. Thus far, the primary emphasis or goal of these projects has been to ensure zero-discharge of the effluent, rather than to put treated effluent to beneficial use.

The state's wastewater treatment facilities that have initiated agricultural reuse have done so because of the inability to treat the effluent to the standards required to obtain permits from the Utah Division of Water Quality to discharge effluent into a receiving stream or aquifer. Under the state's current water quality standards, many wastewater treatment facilities, particularly in rural areas, are required to maintain total containment of effluent and rely heavily upon evaporation to dispose of it. A few wastewater treatment facilities have found it beneficial to enhance the evaporation process with evapotranspiration resulting from irrigation of animal feed crops and pastureland. These facilities have turned to agricultural reuse primarily as a means to increase the rate of disposal of effluent. This is evidenced by the fact that many of these treatment facilities reduced or completely eliminated agricultural reuse by being able to dispose of the entire flow within existing containment lagoons during recent drought years.

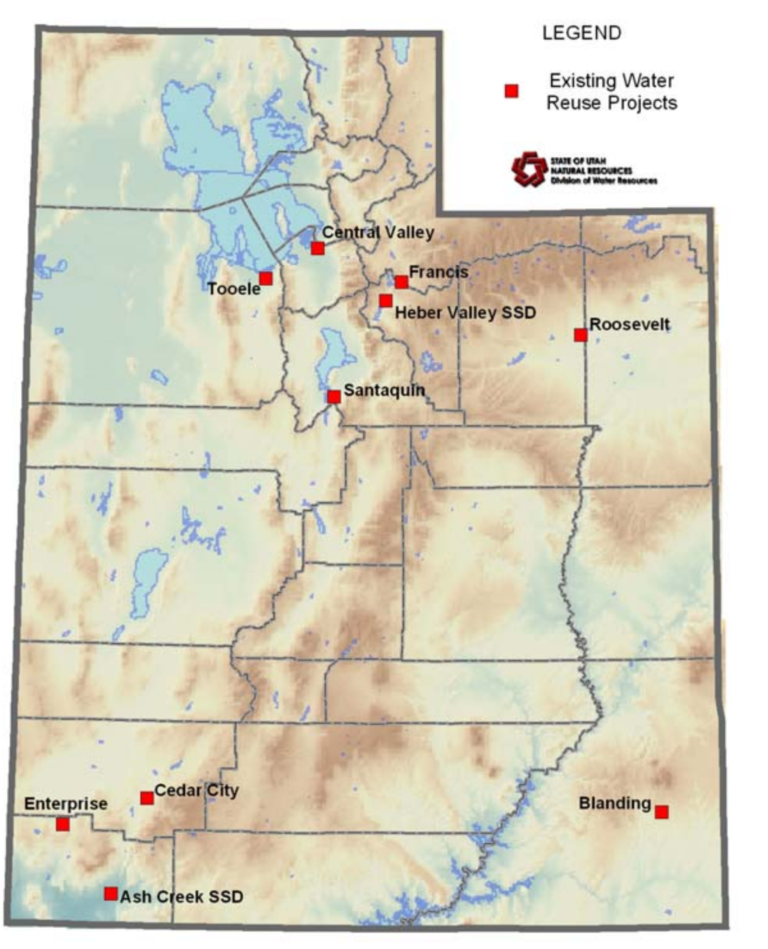
Agricultural irrigation is not the only water reuse application that has occurred in Utah. Two wastewater treatment facilities, Central Valley and Tooele, currently use reclaimed water to irrigate golf courses. These facilities have implemented advanced treatment processes to make this possible, thereby conserving a large amount of potable water for other more suitable purposes. This chapter discusses the agricultural and municipal irrigation projects in the state that have received a construction permit from the Utah Division of Water Quality for water reuse (as of 2004). The locations of these projects are shown in Figure 2. Other instances of reuse that are not subject to the state's reuse regulations are also discussed.

AGRICULTURAL IRRIGATION PROJECTS

Heber Valley Special Service District[1]

The Heber Valley Special Service District's (HVSSD) water reuse project is probably the best example in the state of agricultural reuse of wastewater effluent. Because the treatment facility is located on the Provo River just above Deer Creek Reservoir, a source of drinking water for many Wasatch Front residents, the facility is not allowed to discharge its effluent to the river without advanced treatment. Therefore, the primary function of the agricultural reuse project is the complete disposal of effluent resulting in zero-discharge. HVSSD treats wastewater from the entire Heber Valley and uses the effluent to grow alfalfa. The district treats approximately 1.4 million gallons per day (mgd) — approximately 1,500 acre-feet per year. The aerated lagoon facility is located in the central portion of the valley between Heber City and Midway. The efflu-

FIGURE 2
Location of Existing Water Reuse Projects in Utah



ent is pumped approximately three miles southeast to irrigate 400 acres located southwest of Heber and directly across U.S. Highway 89 from the Heber airport. The water is applied by the use of five center pivot sprinklers. The district has an additional 50 acres of land for future expansion of treatment facilities as the valley grows in population.

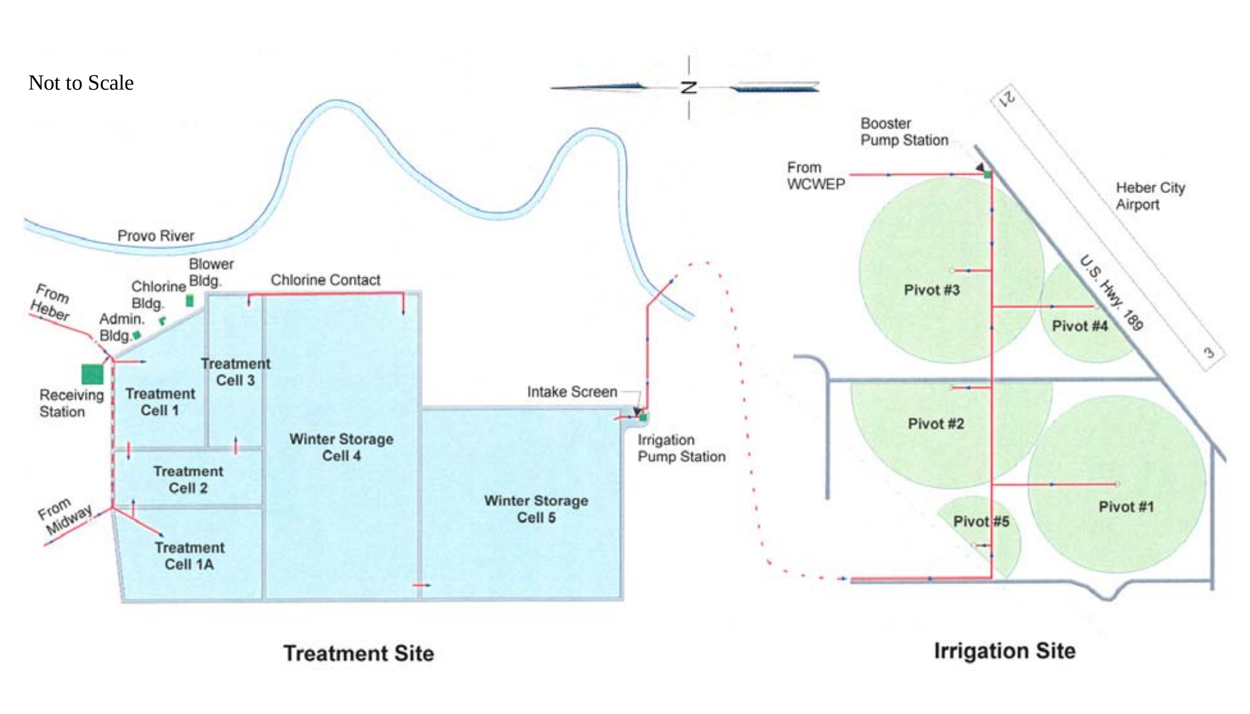
To regulate the supply proportionate to the irrigation demand and to provide containment during the winter months, the district has a 1,100 acre-feet containment lagoon located on 75 acres adjacent to the treatment lagoons. A schematic of the Heber Valley wastewater treatment facility and irrigated ground is shown in Figure 3. The lagoons are lined to prevent seepage. The treatment plant went on line in 1981 and the reuse of the treated effluent for irrigation began the following year. Initially some expressed concerns regarding seepage of the effluent into the ground water. But reportedly, the only recent complaints concern odor problems, which develop periodically when the water level in the storage lagoons is low or when the lagoons become covered with ice.

Due to the relatively high growth rate in Heber Valley, the population is projected to exceed the capacity of the existing facilities between 2009 and 2013. In order to meet these future demands, the district is considering three expansion options:

1) Construct new storage cells and additional land application sites. Under this option, the district would continue to operate as it does today. The projected cost estimate for this alternative is $13,968,000.
2) Construct a discharging mechanical treatment facility and discontinue reuse of the wastewater effluent. Under this option, the district would treat wastewater to a higher standard, including the removal of phosphorus, and discharge the effluent into the Provo River above Deer Creek Reservoir. The cost estimate for this alternative is $29,500,000.
3) Construct a non-discharging mechanical treatment facility. This alternative is a hybrid of the other two in that the treated effluent would not be discharged into the Provo River but would be used for irrigation (or other uses) by other entities. The estimated cost for this option is $10,800,000.

It is interesting to note that the most economical option of the three being investigated involves expanding the reuse project to include higher-valued irrigation purposes. Not only is it the most economical, but the reuse option is barely one-third the cost of treating the effluent to a higher standard only to discharge it into the Provo River and receive no further beneficial use locally.

FIGURE 3
Heber Valley Special Service District Wastewater Treatment Facilities and Water Reuse Project



Source: Horrocks Engineers, *Heber Valley Special Service District 2003 Facility Plan — Executive Summary,* June 16, 2004.

Ash Creek Special Service District[2]

Ash Creek Special Service District was created in 1979 to treat wastewater from the communities of Hurricane, La Verkin and Toquerville in southwest Utah. At the time, Hurricane's treatment facility was overloaded, and La Verkin and Toquerville residents utilized septic tanks, which had problems with a high ground water table. The municipalities were of the opinion that consolidating and building a new facility would solve the individual problems. The district's aerated lagoon treatment facility went on line in 1986. It is designed to treat 1.4 mgd and could be upgraded to a 2 mgd plant. At the present time, it is treating about 1 mgd.

The treatment process routes the wastewater through a series of seven ponds on about 60 acres. The ponds have a total capacity of 438 acre-feet. The wastewater is treated and held in the lagoons over the winter months and then released throughout the spring and summer to irrigate 126 acres of cattle feed crops, primarily alfalfa and oats. The water is sprinkler-applied by a combination of several center pivots and hand lines. Irrigation of the crops is done pri-

Aerial view of Ash Creek Special Service District's lagoons and irrigated cropland. (Photo courtesy of Ash Creek Special Service District.)

marily to dispose of the treated effluent. Despite the fact that local ranchers eagerly purchase the hay, little or no profit is realized from the sale of harvested crops.

Depending upon growth in the surrounding area, the district plans to upgrade the treatment process to a mechanical treatment facility in the next five years. Future plans may include conversion of the hay fields to a sod farm or providing reclaimed water for a golf course in a proposed development nearby.

Blanding

Blanding has a 2.6 mgd wastewater treatment facility and is currently treating about 0.8 mgd. The facility has self-contained lagoons and evaporates nearly all the treated effluent. Blanding has considered reusing the effluent to water city parks, but at this time the city considers it a major capital investment. The city would need to upgrade the treatment facility and install a pump station and distribution system for the reclaimed water; thus, there are no immediate plans to do so. At the present time, there is one farmer below the treatment plant who uses a small amount of the water to fill a private fishpond and every couple of years uses two or three acre-feet to flood irrigate an alfalfa field.

Cedar City[3]

Cedar City's regional wastewater treatment plant began operation in 1996 and currently treats about 2.1 mgd. The city's plant is a trickling filter treatment facility with a capacity of 4.4 mgd to meet anticipated future growth. When the land was purchased from a local rancher, an agreement was made that the rancher would receive a portion of the reclaimed water for a minimal fee to irrigate some land.

During the spring and summer, the plant's effluent is used to irrigate 640 acres of pasture owned by the city. During the non-irrigation season the water is diverted onto 2,300 acres of pasture — the local rancher owns approximately 1,000 acres and the other 1,300 is owned by the city. All the land is grazed by the rancher's cows and sheep.

Because the land is flood irrigated, the Utah Division of Water Quality (DWQ) requires the city to maintain monitoring wells in which excessive nitrates have been detected. In order to alleviate this problem the city is exploring two options: (1) convert the irrigation system to center pivots, and (2) convert about 1,300 acres into a wetland system that would eventually flow into nearby Rush Lake. Converting the flood irrigation system to center pivots would eliminate the monitoring requirements from DWQ, but is not a practical option as the city would not be able to maintain an adequate flow during off-peak hours in the winter to keep the sprinkler system from freezing. The facility is currently conducting a small wetland pilot test to determine the effectiveness of the plants' removal of nitrates during the cold winter months. If results are as expected, the city anticipates conducting a feasibility study for a wetland system.

Cedar City's regional wastewater treatment plant uses all of its wastewater effluent to irrigate pastureland (shown above).

Enterprise

Enterprise's wastewater treatment facility receives and treats roughly 0.11 mgd through the use of two 10-acre aerated lagoons. At the present time, 100 percent of the effluent is evaporated. During wetter times, when evaporation rates cannot keep up with effluent flows, part of the water is drained to an adjacent 10-acre field, the site of a future third lagoon. Enterprise has not raised any crops there, but cattle have grazed the land. For several years, community leaders have discussed the possibility of using the effluent for irrigation, but haven't yet done so.

Francis

Francis Town's wastewater treatment facility treats about 0.25 mgd of wastewater through a series of four evaporation ponds that cover approximately eight acres. Built in the early 1980s, the town's evaporative ponds have adequate capacity to store all winter flows. Although, the town's primary treatment is total containment and evaporation, effluent from the fourth pond is diverted onto a 40-acre pasture in the spring. The field is leased out for grazing to local farmers.

Roosevelt

Roosevelt City may have been the first community in the state to initiate reuse of wastewater effluent for agricultural purposes. In 1976, the city first started using reclaimed water to irrigate about 400 acres of alfalfa with five center pivots. Much of the flow at that time came from the industrial sector. However, with many of the oil companies closing operations in the Roosevelt area over the past decade, flow volumes to the treatment plant have been reduced. Today, agricultural production has been reduced to 160 acres with only two pivots. Wintertime flows are stored in a 55-acre pond.

Santaquin

Santaquin City has a facultative lagoon treatment facility (a facultative lagoon is one in which the digestive bacteria are able to grow both with or without oxygen). It treats about 0.4 mgd in three treatment ponds with a total capacity of 12.8 million gallons. The city also has two winter storage reservoirs with a total capacity of about 550 acre-feet. Santaquin diverts some of the treated effluent from the storage reservoirs onto 32 acres of land owned by the city. Harvesting of the crops is then contracted out to local farmers who keep a portion of the harvested crop as payment. Due to the recent ongoing drought, which has reduced the amount of water available for use, the city has not irrigated the fields for several years.

MUNICIPAL IRRIGATION PROJECTS

Central Valley[4]

The Central Valley Water Reclamation Facility completed a project in the year 2000, which provides treated effluent for irrigation of a public golf course. Because of the likelihood of human contact, the project needed to meet stricter state water quality standards for irrigation water applied on the course. Less stringent standards must be met for reclaimed water conveyed to the flow-thru decorative ponds on the golf course, which have limited access.

The construction cost of the additional treatment processes necessary for municipal irrigation, which have the capacity of approximately 1.5 million gallons per day (mgd), was about $1.5 million. Construction included a continuous backwash sand filter, transmission lines, and pumps to deliver the irrigation water. The system currently produces 0.6 mgd

The Central Valley Golf Course receives approximately 0.6 million gallons per day of reclaimed water from the Central Valley Water Reclamation Facility to irrigate its greens and fill the various decorative ponds. (Photo courtesy of Central Valley Water Reclamation Facility.)

for irrigation on the 80-acre site, adjacent to Central Valley, that now includes the golf course, driving range and landscaped area of the Salt Lake County Solid Waste Transfer Station.

The water is applied at night by means of a pressurized spray irrigation system. Shrubs, trees and grass appear to have responded well to the managed watering system. The need to fertilize the grounds has also been reduced due to the nutrients available in the reclaimed water. The estimated total operation and maintenance costs to deliver water to the golf course, not including capital depreciation, are approximately $60 per acre-foot.

Tooele[5]

In 1995, the city of Tooele began exploring options to increase its wastewater treatment capacity. At the same time, a developer was looking for water for a residential development and an 18-hole golf course. An agreement was reached that Tooele City would supply water for the development for a fee, and the developer would donate land for the expansion of the treatment plant.

In May 2000, Tooele City began using reclaimed water meeting strict reuse standards from the new Tooele City Wastewater Treatment Facility on the nearby Overlake Golf Course. The reclaimed water for the Water Reuse Storage Lakes Project, constructed and owned by Tooele City, meets strict municipal irrigation standards. It is stored briefly onsite before being pumped through a 12-inch diameter force main from the distribution pump station to the storage lake system located on and around the golf course. The storage lake system is comprised of 17 clay-lined lakes with an approximate total surface area of 66 acres and a capacity of roughly 768 acre-feet. Two pump stations then deliver water from the lakes to the irrigated sites on the course.

Aerial view of Tooele's Wastewater Treatment Plant and the golf course's lakes that store the reclaimed water for irrigation. (Photo courtesy of Tooele Wastewater Treatment Plant.)

As the surrounding population grows, resulting in increased sewage flows to the treatment plant, a third pump station will deliver reclaimed water to the Overlake development's residential irrigation system.

OTHER INSTANCES OF WATER REUSE IN UTAH

There are numerous instances throughout the state in which water rights to treated effluent from wastewater treatment facilities have been obtained through the normal water rights appropriation process. Some municipalities have filed for and received water rights to the effluent from their own treatment facilities. Some of the beneficial uses listed in these water rights applications include agricultural irrigation, stock watering, wildlife propagation, and municipal and industrial uses.

For regulatory purposes, the Utah Division of Water Quality does not consider the use of effluent as water reuse if the effluent has been discharged as specified under a facility's Utah Pollutant Discharge Elimination System (UPDES) permit. Once the effluent has been discharged at the proper location under the corresponding UPDES permit, DWQ considers the necessary water quality standards to have been met and any subsequent use (indirect reuse) does not fall under their jurisdiction. Also, because the entities have obtained rights to use the effluent through the normal appropriation process, the Utah Division of Water Rights does not consider it reuse as far as regulatory purposes are concerned. For more information on water rights to use treated effluent that were filed through the normal appropriation process, see Chapter 6 – Approved, Rejected and Un-

TABLE 4
Existing Water Reuse Projects in Utah

Entity	Nature of Reuse	Average Daily Flow (mgd)	Estimated Reuse Volume (acre-feet/year)
Agricultural Irrigation			
Ash Creek SSD	Alfalfa production	0.90	1,008
Blanding City	Alfalfa production	0.20	<10[†]
Cedar City	Irrigation of pastureland and native vegetation	2.10	2,352
Enterprise	Irrigation of pastureland	0.24	<40[†]
Francis	Irrigation of pastureland	0.25	280
Heber Valley SSD	Alfalfa production	1.40	1,568
Roosevelt	Alfalfa production	0.51	571
Santaquin	Irrigation of pastureland	0.37	<128[†]
	SUBTOTAL	**5.97**	**5,957**
M&I Irrigation			
Central Valley	Irrigation of a golf course	0.60*	672*
Tooele	Irrigation of a golf course and residential development	1.70	1,904
	SUBTOTAL	**2.30**	**2,576**
	TOTAL	**8.27**	**8,533**

*This is only the portion of the total flow that is treated for the reuse project.
[†]Estimated from irrigated acres and water right duty.
(Source: Utah Division of Water Quality and individual treatment plant operators, October - December 2004).

Unapproved Appropriations of Sewage Effluent in Utah.

SUMMARY

The existing water reuse projects in Utah are summarized in Table 4. Combined, these projects use over 8 million gallons per day (8,533 acre-feet per year). The majority of this total is utilized for agricultural irrigation at almost 6 mgd (5,957 acre-feet per year). With the exception of Central Valley, the amount shown in the table represents the total amount of wastewater treated by the facilities. While Central Valley and Tooele reuse the entire amount shown, over half of the facilities reusing effluent for agricultural irrigation only use a portion as discussed earlier in this chapter. Although only two of the 10 projects are for municipal and industrial (M&I) irrigation purposes, the two projects make up over 25 percent of the total reuse at 2.3 mgd (2,576 acre-feet per year). While the primary motivation for most of the current projects has been to comply with a zero-discharge requirement, the most recent projects have been for higher-value M&I purposes.

NOTES

[1] Horrocks Engineers, Heber Valley Special Service District 2003 Facility Plan — Executive Summary, June 16, 2004.

[2] Personal communication with Darwin Hall, Ash Creek Special Service District Superintendent, December 1, 2004.

[3] Personal communication with Daniel Morrison, Cedar City Corporation — Industrial Pretreatment, December 1, 2004.

[4] Personal communication with Ron Roberts, Engineer at Central Valley Water Reclamation Plant, July 2004.

[5] Personal communication with Dan Olson, Tooele Reclamation Plant Superintendent, October 2004.

4

FUTURE REUSE IN UTAH

Since water reuse is relatively new in Utah, many possibilities exist for future water reuse projects. As described in Chapter 3, most projects already in place are for agricultural irrigation with just two projects using reclaimed water for municipal irrigation purposes. This chapter provides a description of other projects that have been proposed, including several already evaluated by the State Engineer. Figure 4 shows the location of these projects as well as the existing projects from Chapter 3. This chapter also provides a list of all the current wastewater treatment facilities throughout the state with their estimated daily discharge and total annual volume treated, as well as a rough estimate of the potential for further reuse.

PROPOSED PROJECTS IN UTAH

The current proposals listed in this section demonstrate only a part of the wide range of reuse possibilities and the increased attention authorities are giving to this technology. The known water reuse proposals are listed in Table 5. Although an attempt has been made to list all proposals, this table may not include all projects currently under consideration.

Hildale

In conjunction with Twin City Water Works, the city of Hildale proposes to change the point of discharge of its treatment plant and divert approximately 460 acre-feet per year of treated effluent. However, the State Engineer decided that the proposed effluent reuse and change in point of discharge would only be consis-

FIGURE 4
Location of Proposed Water Reuse Projects in Utah

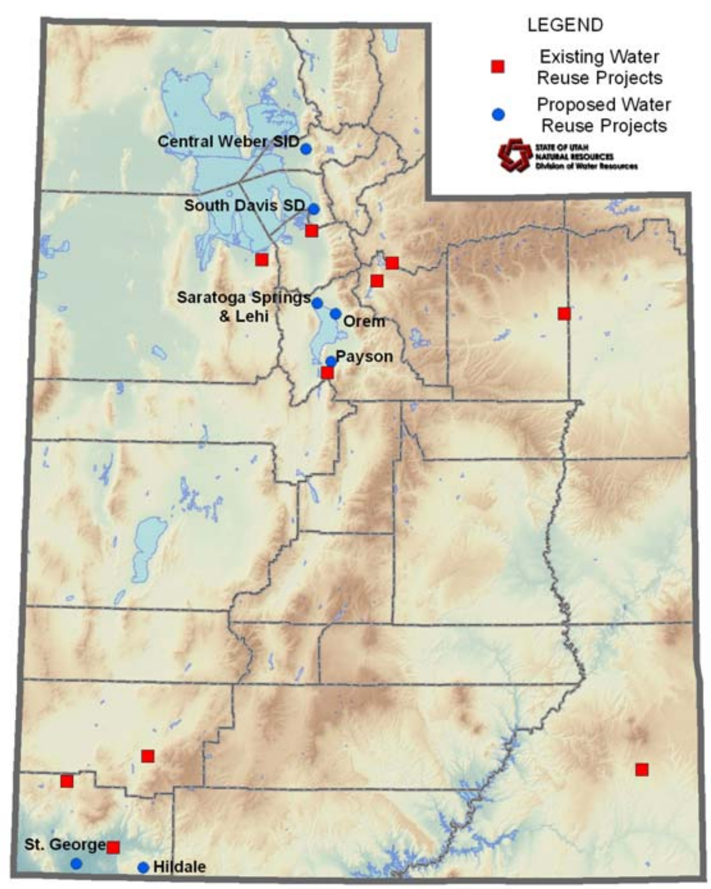


TABLE 5
Proposed Reuse Projects in Utah

Entity	Nature of Use	Potential Reuse Amount (ac-ft/yr)
City of Hildale	City street and highway landscaping and agricultural feed crops.	377
Orem City	Municipal irrigation of golf course and city sports park.	9,634
Payson City	Residential irrigation and industrial non-contact cooling water.	4,532
St. George City	Irrigation of parks and golf courses and to fulfill Shivwits Band of Paiute Indians Water Rights Settlement Agreement.	6,496
North Salt Lake/South Davis Sewer District	Residential Irrigation.	463
Saratoga Springs and Lehi City	Residential irrigation and irrigation of a golf course.	1,135*
Central Weber Sewer Improvement District	Residential Irrigation.	5,600*
	TOTAL	**28,237**

*These values are as proposed and have not yet been processed by the State Engineer.

tent with the underlying water rights if only 377 acre-feet per year were depleted from the hydrologic system. (See Chapter 6 – Evaluating Diversion and Depletion Limits of Underlying Water Rights, for more information on the State Engineer's evaluations.) The city proposes to use the reclaimed water to irrigate city street and highway landscaping, agricultural feed crops, and possibly a tree farm. Discussions are still being held as to the best possible uses, but the city must implement some type of reuse project in time for the 2005 irrigation season in order to divert some of the effluent out of the lagoons and increase the capacity of the treatment facility.

Orem[1]

Although the city of Orem has been approved by the State Engineer to reuse over 9,500 acre-feet per year of reclaimed water from the Orem City Water Reclamation Plant, it currently only has plans to use about 1.3 million gallons per day (728 acre-feet per year based on a 180-day irrigation season), less than eight percent of the approved amount.

A golf course under construction adjacent to the treatment plant will be completed mid-summer 2005. The golf course will have a dual irrigation system that will allow it to be irrigated with potable water for the first two to three years. The city will then irrigate the golf course with reclaimed water. At that time, the city will also provide reclaimed water for irrigation of the 40-acre City of Orem Lakeside Sports Park located a few city blocks from the reclamation plant. A supply line will be hooked into the existing irrigation system for the sports park, and purple sprinkler heads will be installed to signify the presence of reclaimed water.

Payson[2]

Payson City Corporation proposes to use 4,532 acre-feet per year of treated effluent from the Payson City Wastewater Treatment Plant. The effluent is currently discharged from the Payson City Wastewater Treatment Plant into a ditch that flows to Beer Creek, a tributary to Utah Lake, within the service area of Payson City. The project will include non-contact cooling water and water for a retrofitted secondary irrigation system for Payson City. Due to water quality rule changes that were made during the original construction of the treatment plant, the facility has already been meeting the necessary standards for municipal irrigation. Thus, reuse has proven to be a particularly economical option for Payson because the only upgrade necessary for the reuse project has been the addition of a pump station to provide the reclaimed water to where it is needed.

The project has already been partially completed. The Nebo Generating Facility (NGF), located adjacent to the city's treatment facility, began reusing some of the reclaimed water in October 2004. The natural gas-fired generating facility was completed in June 2004 by the Utah Association of Municipal Power Systems and was specifically constructed next to the wastewater treatment facility with the intent to receive some of the reclaimed water for its cooling towers. NGF operates only during peak demand hours and uses about 1,000 to 2,000 gallons per minute depending upon the demand. It purchases the reclaimed water from the treatment facility for approximately $0.40 per 1,000 gallons ($130 per acre-foot) and draws the necessary water from storage tanks with a capacity of about 150,000 gallons.

The Nebo Generating Facility is located adjacent to Payson City's Wastewater Treatment Facility to take advantage of the available reclaimed water for cooling tower purposes. (Photo courtesy of Utah Association of Municipal Power Systems.)

The rest of the reuse project is scheduled to be online for the irrigation season in 2005. The city already maintains a secondary irrigation system for its residents, but the city is waiting on a decision from the Utah Division of Water Quality as to what adjustments must be made to the current system before reclaimed water can be used. Once online, reclaimed water will be mixed with water from the city's current surface supplies.

Payson City's proposal was processed by the State Engineer in December 2003, despite protests that the right to use the effluent had been foregone by the city due to more than five years of nonuse. The Provo River Water Users Association has appealed the State Engineer's decision (for more information regarding this appeal, see Chapter 6).

St. George[3]

As part of the Shivwits Band of Paiute Indians Water Rights Settlement Agreement, St. George City must deliver 2,000 acre-feet of water per year for various uses on the Shivwits Indian Reservation. The agreement allows the city to fulfill its obligation by providing reclaimed water through an eight-mile pipeline to Ivins Reservoir. Since the city must already provide the necessary level of treatment to meet reuse standards, it will also be able to provide reclaimed water to irrigate several golf courses along the route of the pipeline. Because of the strict reuse

St. George has already built sections of its eight-mile pipeline to deliver reclaimed water to the Shivwits Indian Reservation. The city installed various sections of the pipe as areas along the route of the pipeline were developed. (Photo courtesy of City of St. George Water Services.)

standards that must be met for municipal irrigation, the management personnel for the golf courses that will receive the reclaimed water are excited that the water quality will actually exceed that of the irrigation water currently being used. The city of St. George also hopes to irrigate a city park and cemetery with reclaimed water.

Necessary construction for the project will include the pipeline to Ivins Reservoir, improvements to the water reclamation facility to meet reuse standards, and pumping and storage facilities for the reclaimed water. The city anticipates that the project will be online for the irrigation season in 2006. Because a large portion of the city's water is purchased from the Washington County Water Conservancy District, the State Engineer has currently limited the city's reuse amount to 6,496 acre-feet per year out of the originally proposed 11,732 acre-feet per year. Through agreements with the district, the city of St. George hopes to be able to increase its reuse capacity and meet all the demands for reclaimed water within its service area.

South Davis Sewer District[4]

In conjunction with Weber Basin Water Conservancy District and the South Davis Water Reclamation Plant, North Salt Lake filed a notification with the State Engineer to reuse approximately 463 acre-feet per year of effluent from the plant. This water will be placed in holding ponds and pumped into a new municipal irrigation system for the residential and commercial customers in the western-most part of the city. Since North Salt Lake has an ordinance requiring secondary water systems for all new developments, and the South Davis plant already treats water to a level that is acceptable for such uses, water reuse appears to be one of the city's most economical alternatives. The reclaimed water, however, is high in dissolved salts. Proper education and changes in watering habits by the end user will likely be necessary to avoid undesirable effects such as ground sterilization. The city has already begun construction of the necessary facilities.

Saratoga Springs and Lehi City[5]

Saratoga Springs and Lehi City are currently serviced by Timpanogos Special Service District. The two cities are investigating a proposed "satellite" water reclamation plant. A satellite plant is a small treatment facility located near the desired area of reuse that removes and treats a portion of the wastewater from a main sewage collection line. Solids removed during treatment are discharged back into the collection system for further treatment at the main treatment plant. The proposed satellite plant will have a capacity of 1.0 million gallons per day (mgd) that could be expanded into 2.0 mgd as needed.

The new plant would provide reclaimed water for residential irrigation systems (and possibly a golf course) in Saratoga Springs and Lehi City. The satellite plant would be the first of three possible plants to provide reclaimed water for the cities served by the district. Other cities served include American Fork, Pleasant Grove, Alpine, Highland, Cedar Hills and Eagle Mountain. Two additional plants will be investigated only if the initial project is economically viable.

The Timpanogos Special Service District currently services several cities in north Utah County. A proposed satellite plant near Saratoga Springs will reclaim a portion of the city's wastewater for reuse while sending the removed solids on to the district's main wastewater treatment facility shown above. (Photo courtesy of Timpanogos Special Service District.)

Central Weber Sewer Improvement District[6]

Central Weber Sewer Improvement District is proposing a water reuse project in Weber County, northwest of Ogden. In conjunction with the District, Pine View Water Systems proposes to use approximately 10 mgd (5,580 acre-feet per year based on a 180-day irrigation season) of treated effluent to help meet the growing demand for nonpotable irrigation water within its service boundaries. This is approximately 30 percent of the effluent that is currently treated and discharged into the Weber River and the Warren Canal.

In order to meet water quality standards required for use in municipal irrigation systems, the treatment plant will install bio-enhanced membrane filters. Design engineers recommended this technology because it will provide a level of treatment that is more reliable than other filtering technology, and although more expensive, will likely be more acceptable to water users. After treatment, the water will be pumped approximately four miles into an existing secondary water storage reservoir where it will mix with untreated Ogden River water before it enters the existing irrigation system pipelines. The total estimated cost of the project is approximately $22.5 million.

FUTURE POTENTIAL FOR REUSE IN UTAH

As the population of Utah grows, water demand will increase. As mentioned in previous chapters, water reuse is an important option to help meet some of these growing demands. Because the water supply situation in each area of the state is different, the implementation of reuse will also be diverse. To facilitate a discussion of how these needs may be met in general terms, the state has been divided into three areas: Northern, Southwestern and Eastern Utah. Figure 5 shows how the regional divisions have been made, the location of the existing and proposed reuse projects and all of the wastewater treatment facilities in each region. All the wastewater treatment facilities in each region are listed in Tables 6 – 8 accompanied with brief discussions of each area and a summary of the potential for reuse in each area as shown in Tables 9 and 10.

Northern Utah

Since the northern part of the state is the fastest growing area, excluding the St. George area, it will face the greatest challenges in meeting future water needs. As the population spreads out, more and more farmland will be converted to residential areas. While municipal and industrial needs will rise, the need for agricultural irrigation water will diminish. Thus, the greatest potential for water reuse will likely be for municipal irrigation systems that serve residential landscapes or large landscapes such as golf courses, parks and schools. One factor that may limit the potential of future projects in Northern Utah is the dependence of some downstream users on the effluent from discharging treatment facilities. Water rights protests about some reuse projects from downstream users have already occurred because of this issue, and because the majority of the facilities in Northern Utah are discharging facilities, more protests will likely result as additional projects are proposed.

As can be seen in Table 6, several facilities discharge more than 10 million gallons per day (mgd) and could implement large-scale water reuse projects in Northern Utah. The most suitable projects will likely be similar to the Central Valley and Tooele reuse projects, because they are located in growing urban areas and provide water for high-value M&I uses. Ten out of the 17 reuse projects already in place or currently proposed are located in this region. Particular areas that might experience a strong interest in reuse as a future supplement to water supplies are Weber, Davis, Salt Lake and Utah counties. Jordan Valley Water Conservancy District already plans to implement water reuse in two phases (Figure 6) in order to meet anticipated demands over the next 50 years.

The Central Utah Water Conservancy District (CUWCD) is required by an agreement with the U.S. Department of the Interior to reuse a total of 18,000 acre-feet per year as part of the Utah Lake Drainage Basin Water Delivery System, a part of the Central Utah Project. The agreement requires entities served by CUWCD to begin reusing 1,000 acre-feet per year by 2016, and an additional 1,000 acre-feet per year every year until 2033. From the year 2033 until 2050, CUWCD must continue reusing 18,000 acre-feet per year. For every year that CUWCD fails to

FIGURE 5
Wastewater Treatment Facilities and Existing and Proposed Water Reuse Projects

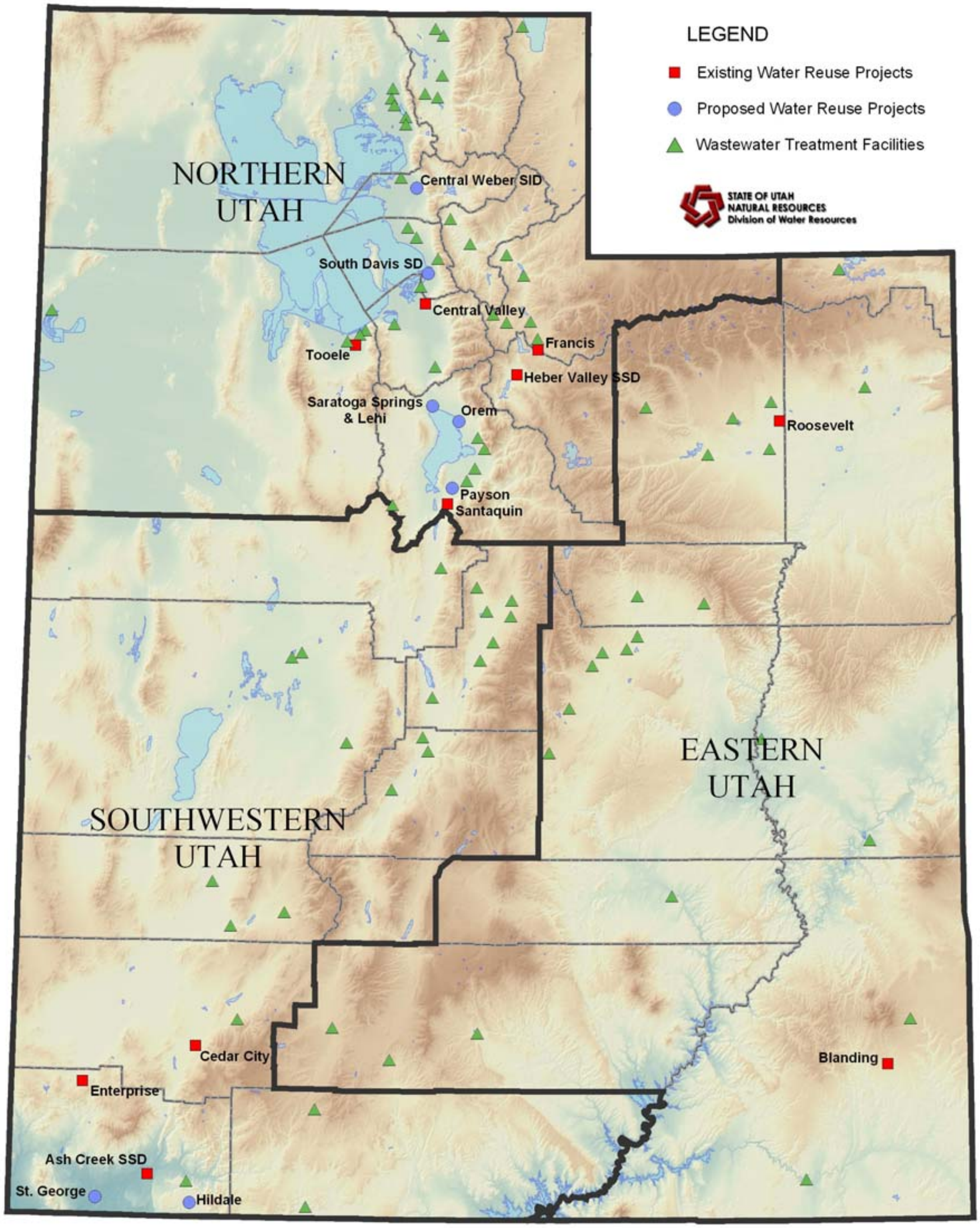


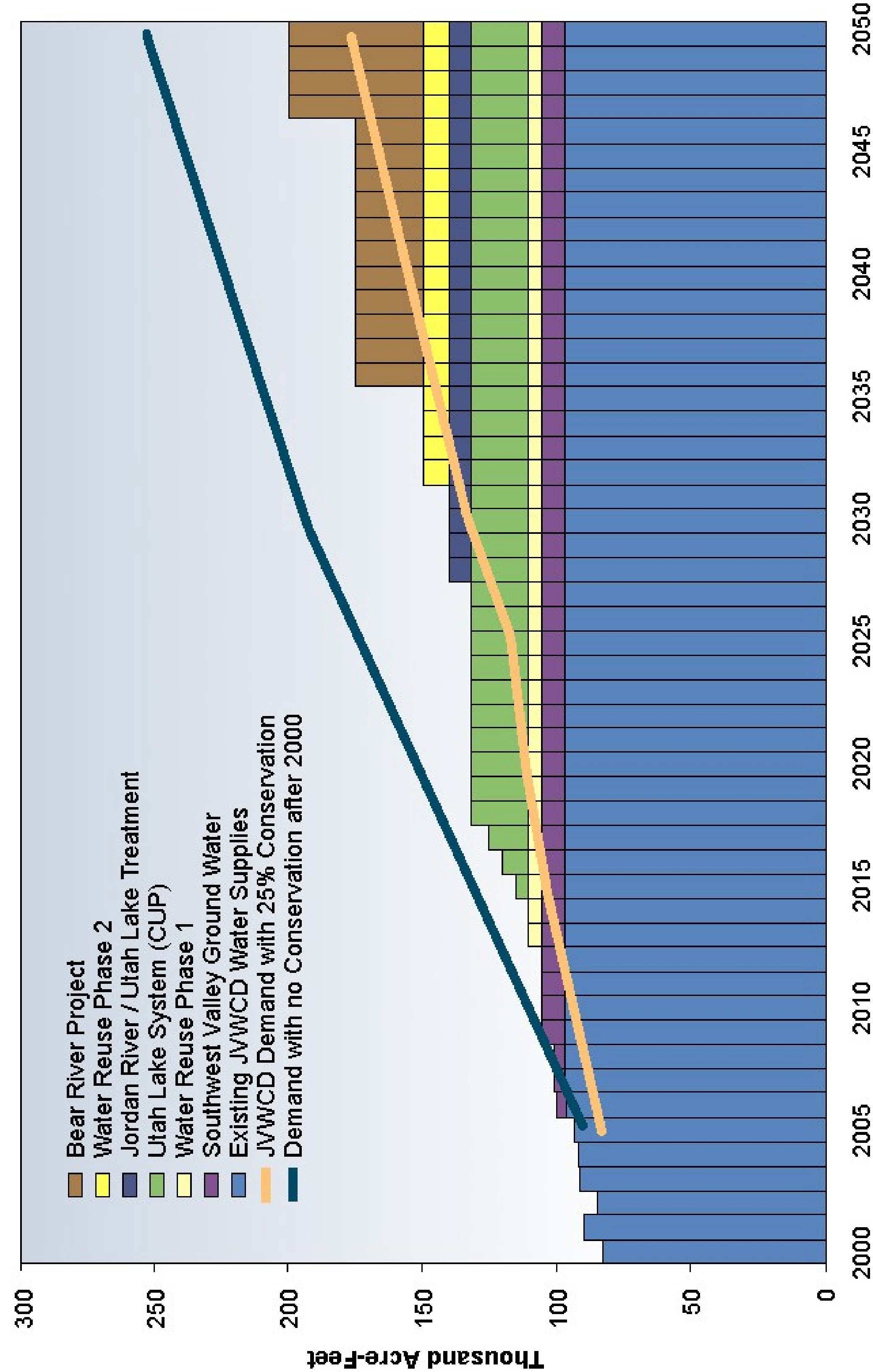
TABLE 6
Wastewater Treatment Facilities in Northern Utah

County	Facility	Treatment Type—Disposal Method	Average Flow (mgd)	Average Annual Flow (acre-feet/year)
Box Elder	Bear River	Lagoon--Discharging	0.18	202
	Brigham City	Mechanical--Discharging	2.02	2,262
	Corinne	Lagoon--Discharging	0.05	56
	Perry	Lagoon--Discharging	0.48	538
	Tremonton	Mechanical--Discharging	1.02	1,142
Cache	Hyrum	Mechanical--Discharging	0.78	874
	Lewiston	Lagoon--Total Containment	0.08	90
	Logan	Lagoon--Discharging	11.66	13,059
	Richmond	Lagoon--Discharging	0.19	213
	Wellsville	Lagoon--Discharging	0.23	258
Rich	Bear Lake	Lagoon--Total Containment	0.17	190
Weber	Central Weber†	Mechanical--Discharging	34.12	38,214
	Plain City	Lagoon--Discharging	0.36	403
Davis	Central Davis	Mechanical--Discharging	4.57	5,118
	North Davis	Mechanical--Discharging	17.98	20,138
	South Davis North	Mechanical--Discharging	6.06	6,787
	South Davis South†	Mechanical--Discharging	2.46	2,755
Morgan	Henefer	Lagoon--Discharging	0.33	370
	Morgan	Lagoon--Discharging	0.18	202
	Mountain Green	Lagoon--Discharging	0.09	101
Summit	Coalville	Mechanical--Discharging	0.27	302
	East Canyon Creek	Mechanical--Discharging	2.48	2,778
	Francis†	Lagoon--Land Application	0.25	280
	Kamas	Lagoon--Discharging	0.45	504
	Oakley	Lagoon--Discharging	0.10	112
	Silver Creek	Mechanical--Discharging	1.11	1,243
Tooele	Grantsville	Lagoon--Discharging	0.53	594
	Lake Point	Lagoon--Discharging	0.10	112
	Stansbury Park	Lagoon--Discharging	0.85	952
	Tooele†	Mechanical--Discharging	1.70	1,904
	Wendover	Lagoon--Discharging	NA	NA
Salt Lake	Central Valley†	Mechanical--Discharging	54.82	61,398
	Magna	Mechanical--Discharging	2.21	2,475
	Salt Lake City	Mechanical--Discharging	34.18	38,282
	South Valley	Mechanical--Discharging	23.51	26,331
Utah	Orem†	Mechanical--Discharging	8.95	10,024
	Payson†	Mechanical--Discharging	1.03	1,154
	Provo	Mechanical--Discharging	15.23	17,058
	Salem	Lagoon--Discharging	0.66	739
	Santaquin†	Lagoon--Total Containment	0.37	414
	Spanish Fork	Mechanical--Discharging	3.06	3,427
	Springville	Mechanical--Discharging	3.50	3,920
	Timpanogos†	Mechanical--Discharging	6.47	7,246
Wasatch	Heber Valley†	Lagoon--Land Application	1.40	1,568
		Total	**246.24***	**275,789***

*Some values were not available, thus the actual total is a little higher.
†These facilities are part of an existing or proposed water reuse project.
(Source: Utah Division of Water Quality, November 2004).

FIGURE 6

Jordan Valley Water Conservancy District Water Supply Plan (Drought Year Scenario)



Source: Jordan Valley Water Conservancy District, February 2005.

fulfill this requirement, it must assess itself a surcharge as specified in the amendment. Under Section 207 of Central Utah Project Completion Act, any surcharges collected are to be used by CUWCD to help fund water reuse projects that are created within its service area. More information on possible funding for reuse through this program can be found in Chapter 7 – Potential State Funding Sources.

Even some water users in Cache Valley, one of the more water-rich areas of the state, are practicing reuse and recycling and investigating future possibilities. West Point Dairy in Hyrum is recycling water by using filtered water captured from evaporation during the manufacturing process to rinse equipment. The Logan Cow Pasture Water Company has a water right to use about 12 mgd of Logan's effluent (see Chapter 6 for more information on appropriations of treated effluent) for irrigation during the summer and an additional three mgd of Logan's effluent is used for wetland and wildlife habitat. The city of Hyrum is investigating using reclaimed water to supplement a secondary irrigation system.[7]

Southwestern Utah

The majority of this region consists of dry rural areas that could benefit from water reuse projects to increase the amount of water available for agricultural irrigation. The majority of the treatment facilities in southwestern Utah (Table 7) currently use

TABLE 7
Wastewater Treatment Facilities in Southwestern Utah

County	Facility	Treatment Type—Disposal Method	Average Flow (mgd)	Average Annual Flow (acre-feet/year)
Juab	Eureka	Lagoon--Discharging	0.13	146
	Nephi	Lagoon--Total Containment	0.42	470
Sanpete	Ephraim	Lagoon--Total Containment	0.57	638
	Fountain Green	Lagoon--Total Containment	0.06	67
	Gunnison	Lagoon--Total Containment	0.19	213
	Manti	Lagoon--Total Containment	0.38	426
	Moroni	Mechanical--Discharging	0.49	549
	Mt. Pleasant	Lagoon--Total Containment	0.23	258
	Spring City	Lagoon--Total Containment	0.05	56
Millard	Delta	Lagoon--Total Containment	0.85	952
	Fillmore	Lagoon--Total Containment	0.23	258
	Hinckley	Lagoon--Total Containment	0.04	45
Sevier	Redmond	Lagoon--Total Containment	0.05	56
	Richfield	Lagoon--Total Containment	0.73	818
	Salina	Lagoon--Discharging	0.57	638
Beaver	Beaver	Lagoon--Total Containment	1.13	1,266
	Milford	Lagoon--Total Containment	0.17	190
	Minersville	Lagoon--Total Containment	0.07	78
Iron	Cedar City†	Mechanical--Discharging	2.10	2,352
	Parowan	Lagoon--Total Containment	0.43	482
Washington	Ash Creek†	Lagoon--Land Application	0.90	1,008
	Enterprise†	Lagoon--Discharging	0.24	269
	Hildale†	Lagoon--Land Application	0.72	806
	Springdale	Lagoon--Discharging	0.39	437
	St. George†	Mechanical--Discharging	6.44	7,213
Kane	Kanab	Lagoon--Total Containment	0.24	269
	Long Valley	Lagoon--Land Application	0.09	101
		Total	**17.91**	**20,061**

†These facilities are part of an existing or proposed water reuse project.
(Source: Utah Division of Water Quality, November 2004).

total containment lagoons, which do not have a permit to discharge effluent into surface water bodies. This alleviates many of the problems that communities in northern Utah will face in terms of potential water right conflicts with downstream users. Since these facilities do not provide an effluent that downstream users have come to rely upon, the reclaimed water could easily be diverted to supplement irrigation water or, in the case of the few high growth cities in Washington County, to supplement supplies in similar fashion to that of St. George's proposed project. In Iron County, possible water reuse in the Cedar City area represents one of the few feasible alternatives available to supplement limited water supplies.

Eastern Utah

Water reuse could prove useful in this part of the state in much the same way as the southwestern part — for irrigation purposes. Although small in terms of total volume, reclaimed water would be an excellent addition to the water supplies in this part of the state, as it would be one of the most reliable sources of water available in this arid region. Several cities in this area have been forced to impose heavy restrictions on landscape irrigation in times of drought in order to conserve drinking water supplies. In addition, many farmers do not receive enough water for crops to survive the dry summers because supplies run out. Two treatment facilities already apply effluent to land, but do so largely as part of the

TABLE 8
Wastewater Treatment Facilities in Eastern Utah

County	Facility	Treatment Type—Disposal Method	Average Flow (mgd)	Average Annual Flow (acre-feet/year)
Duchesne	Altamont	Lagoon--Total Containment	0.06	67
	Duchesne	Lagoon--Discharging	0.21	235
	Myton	Lagoon--Total Containment	0.59	661
	Neola	Lagoon--Discharging	0.07	78
	Roosevelt†	Lagoon--Land Application	0.51	571
	Tabiona	Lagoon--Total Containment	0.01	11
Daggett	Manila	Lagoon--Total Containment	0.17	190
Uintah	Ashley Valley	Lagoon--Discharging	2.04	2,285
Carbon	East Carbon	Lagoon--Total Containment	0.06	67
	Price River	Mechanical--Discharging	1.77	1,982
Emery	Castle Dale/ Orangeville	Lagoon--Discharging	NA	NA
	Cleveland	Lagoon-Total Containment	0.04	45
	Elmo	Lagoon--Total Containment	0.02	22
	Emery	Lagoon--Total Containment	0.06	67
	Ferron	Lagoon--Discharging	0.21	235
	Green River	Lagoon--Total Containment	0.18	202
	Huntington	Lagoon--Discharging	0.17	190
Grand	Moab	Mechanical--Discharging	0.76	851
Wayne	Hanksville	Lagoon--Total Containment	0.03	34
San Juan	Monticello	Lagoon--Land Application	0.22	246
	Blanding†	Lagoon--Total Containment	0.20	224
	Mexican Hat	Lagoon--Total Containment	0.20	224
Garfield	Escalante	Lagoon--Total Containment	0.07	78
	Panguitch	Lagoon--Total Containment	0.18	202
	Tropic	Lagoon--Total Containment	0.10	112
		Total	**7.93***	**8,879***

*Some values were not available, thus the total flow is actually higher.
†These facilities are part of an existing or proposed water reuse project.
(Source: Utah Division of Water Quality, November 2004).

treatment process. With much of the area's effluent terminating in total containment lagoons, as in the southwestern region, watering restrictions in cities like Blanding and Monticello could be alleviated by water reuse. Agricultural irrigation supplies might also be supplemented to reduce the harsh effects of drought.

SUMMARY

Since the northern part of Utah is the most densely populated, it is not surprising that five of the seven proposed projects lie within this area. The combined flows of the five projects represent over 21,000 acre-feet per year, while the seven projects as a whole could ultimately provide over 28,000 acre-feet per year. This is a significant contribution to meeting future water needs.

Additional water reuse projects could help satisfy future water demands in critical areas of the state. In order to provide a reliable[8] supply in the year 2050, the Utah Division of Water Resources estimates that an additional 486,000 acre-feet will be needed above and beyond conservation and agricultural transfers.[9] As shown in Table 9, wastewater treatment facilities in Utah currently discharge over 270 mgd. This equates to over 300,000 acre-feet per year and is estimated to eventually increase to over 650,000 acre-feet per year by 2050.[10]

TABLE 9
Current and Projected Discharges from Statewide Wastewater Treatment Facilities

	Current Discharge* (2004)		Projected Discharge† (acre-feet/year)	
Region	mgd	acre-feet/year	2030	2050
Northern Utah	246.24	275,789	440,550	565,234
Southwestern Utah	17.91	20,061	47,287	73,060
Eastern Utah	7.93	8,879	11,031	12,488
TOTAL	**272.08**	**304,729**	**498,868**	**650,782**

*Current discharge values were obtained from the Utah Division of Water Quality.
†Projected discharges are based on population projections from the Governor's Office of Planning and Budget.

TABLE 10
Estimated* Current and Projected Volumes Available for Reuse

	Current Discharge (2004)		Projected Discharge (acre-feet/year)	
Region	mgd	acre-feet/year	2030	2050
Northern Utah	98.81	110,665	176,778	226,810
Southwestern Utah	8.04	9,004	21,225	32,793
Eastern Utah	3.44	3,854	4,788	5,420
TOTAL	**110.29**	**123,523†**	**202,791‡**	**265,023‡**

*Estimates are based on a 60 percent reduction for discharging facilities and a 50 percent loss for total containment facilities (see text for further details).
†Approximately 8,533 acre-feet per year of this total is currently being reused (4,552 in the northern region, 3,400 in the southwestern region, and 581 in the eastern region).
‡In addition to the current reuse amount, 28,237 acre-feet per year of this total is currently proposed for reuse (21,364 in the northern region and 6,873 in the southwestern region).

This is a significant portion of the estimated additional supply that needs to be developed. However, due to various factors, the amount of effluent that could be developed to help meet future needs is limited. Table 10 shows the estimated volume of effluent that could potentially be currently developed, as well as the estimated volumes in 2030 and 2050. Because irrigation is the most probable use for reclaimed water, the division reduced the estimated volumes available for reuse by considering seasonal demands. Because irrigation requirements vary throughout the season, reaching a peak in midsummer, without storage facilities, the division estimated that only 40 percent of the annual volume from discharging facilities could reasonably be utilized. Treatment facilities with total containment lagoons would be able to provide a slightly larger portion of the effluent for irrigation purposes with an estimated 50 percent reduction due to seepage and evaporation.[11]

Storage capability and various year-round uses such as industrial reuse could potentially increase the amount estimated; however, there are other factors that could further limit the amount of effluent available for reuse. These include potential downstream impacts to the environment and downstream users. Many water rights do not allow 100 percent depletion and would thus limit the amount that could be reused. Stringent water quality standards imposed upon reclaimed water, unknown risks, public acceptance and economics will also limit possibilities for full development. Each of these issues is discussed in detail in later chapters.

Despite the issues that may arise, it is evident that water reuse has the potential to play an important role in satisfying future water demands. The success of existing projects combined with this potential will likely propel future developments to help meet needs in the state of Utah.

NOTES

[1] Personal communication with Lawrence Burton, Water Reclamation Section Manager for the City of Orem Department of Public Works, December 9, 2004.

[2] Personal communication with Bruce R. Ward, Project Engineer for Payson City, December 9, 2004.

[3] Personal communication with Scott Taylor, Water Quality & Resource Engineering Manager with the City of St. George Water Services, December 1, 2004.

[4] Personal communication with Scott Paxman, Assistant General Manager for the Weber Basin Water Conservancy District, December 3, 2003.

[5] Personal communication with Garland J. Mayne, District Manager for the Timpanogos Special Service District, December 9, 2004.

[6] Pine View Water Systems, *Wastewater Recycling Project Appraisal Report*, (April 2004), 2, 6 and 8.

[7] Scott, Earl, "Reclaiming water adds up," (*Logan Herald Journal*, July 12, 2004).

[8] A reliable supply includes an additional 20 percent added to the estimated demand to provide in essence a safety buffer for uncertainties in population growth as well as in demand.

[9] Utah Division of Water Resources, "Meeting Utah's Future M&I Needs," February 2005. This is an un-published document used internally by the Utah Division of Water Resources.

[10] Projected discharges are based on population projections from the Governor's Office of Planning and Budget.

[11] Personal communication with Ed Macauley, Manager of the Construction Assistance Section for the Utah Division of Water Quality, January 27, 2005.

5

WATER QUALITY REGULATIONS AND ISSUES

Regulation of water quality is an important topic. Nearly all the efforts made and rules created with respect to water quality are for the benefit of public health. Due to greater understanding of the spread of diseases through drinking water and an increased knowledge about wastewater treatment methods, epidemics and plagues as seen in past centuries have essentially been eliminated.

This chapter discusses some of the history of federal and state water quality regulations relative to water reuse. It discusses the requirements for water reuse projects as specified by the Utah Division of Water Quality (DWQ) and the steps that must be taken to acquire the proper permits. It also provides a description of some of the treatment processes, including operation and accomplishment, in order to provide a general understanding of what is possible with today's technology. Lastly, this chapter discusses the categories of reuse for which Utah has not yet defined regulations and lists the U.S. Environmental Protection Agency's suggested guidelines for these categories.

GENERAL DISCUSSION OF STATE AND FEDERAL WATER QUALITY REGULATIONS

In order to understand the water quality requirements for reuse projects in Utah, it is important to review the federal and state regulations that have been developed over time to protect water quality. During the past 50 years, Utah's water quality regulations have focused on protecting and restoring water quality in the state's surface waters. State regulation of wastewater effluent began in 1953 with the passage of the Utah Water Pollution Control Act. Known as Utah's "Water Quality Act," *Title 19, Chapter 5* of the *Utah Code* established the Utah Water Quality Board and granted it regulatory authority. The act required the newly formed board to classify the state's waters according to water quality, and also to set effluent treatment requirements and standards for the first time. As a result, all major communities in Utah were required to construct municipal sewer systems. By 1965, all major Utah cities had a wastewater treatment facility, which achieved secondary treatment.[1]

Federal Regulation and the Total Maximum Daily Load Program

Passed in 1972, the Federal Clean Water Act established regulations and enforcement designed to stop pollution from industrial and municipal sources. The Clean Water Act, which focused primarily on reducing water pollution from point sources, was revised in 1987 to include regulation of nonpoint source pollution and provide a funding mechanism for cleanup.[2]

The U.S. Environmental Protection Agency is charged with administering the Federal Clean Water Act, including the Total Maximum Daily Load (TMDL) program. The TMDL program requires each state, territory or Tribe to conduct a review of all water bodies within its jurisdiction. Impaired waters are identified according to criteria in *Section 303(d)* of the act. In Utah, the Division of Water Quality (DWQ) is responsible for performing this task. In developing this list (called the 303(d) list), DWQ reviews the beneficial uses identified by all available information and determines if the water body's quality does or does not support the identified uses. Should an impaired water body be identified, DWQ and local stakeholders propose ways to reduce impairments to an acceptable level in order to return the water to a supporting condition. Municipalities discharging effluent to state waters are also required to obtain a Utah Pollutant Discharge Elimination System (UPDES) permit from DWQ. The limits for pollutants are generally determined by TMDLs, with individual waste load allocations designated in the UPDES permit. To date, 197 water bodies in Utah have been identified as impaired and 169 TMDLs have been approved.[3]

State Regulation

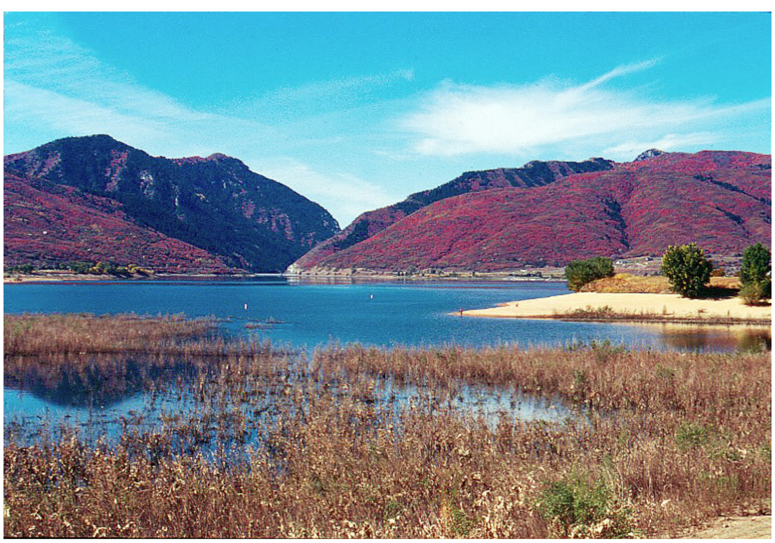
As already mentioned, the Utah Water Quality Board has classified the water bodies of the state according to beneficial use and water quality. State water quality designations can be found in *Utah Administrative Code*, *Rule R317-2-6*, and a list of water body classifications in *Rule R317-2-13*.

Waters that are designated as High Quality Water Category 1 cannot receive new discharges of wastewater. High Quality Water Category 2 waters cannot be degraded below Category 2 water quality. In addition, "Waters whose existing quality is better than the established standards for the designated uses will be maintained at high quality unless it is determined by the Board, after appropriate intergovernmental coordination and public participation in concert with the Utah continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located."[4] All other waters of the state (Category 3 and below) allow point source discharges and degradation depending upon completion of an Antidegradation Review (ADR). An ADR is conducted to determine compliance with state and federal regulating activities such as Clean Water Act *Sections 401* (FERC and other federal actions), *402* (UPDES permits), and *404* (Army Corps of Engineers permits). Alternatively, municipalities are not required to reduce pollutants in discharged effluent below existing levels in the water diverted for use. Utah's antidegradation policy is meant to maintain current water quality and uses. In cases where pollutants exceed the allowable limits for historical uses, the TMDL program goes a step further towards restoration of water quality.

Impact of Regulations on Reuse

The Total Maximum Daily Load program and the Utah Water Pollution Control Act may impact communities wishing to reuse wastewater effluent. In some instances, removing large volumes of effluent from a river or lake for reuse may cause the concentrations of some downstream contaminants, such as fertilizers and pesticides, to increase above acceptable thresholds. Such a scenario would require adjustments to TMDL goals and individual entities' waste load allocations. In other cases, the opposite may be true because preventing the effluent from discharging to a stream or lake may be the best option to meet water quality standards downstream.

State and federal regulations that protect water quality were put in place to protect public health as well as the environment. The standards are partially met through primary and secondary treatment of wastewater that remove much of the contaminants that would otherwise degrade the state's waters and jeopardize the public's health. *Utah Administrative Code, Rule R317, Water Quality* designates how surface water quality is to be pro-



Some water bodies in Utah, such as Pineview Reservoir shown above, are a source of drinking water for downstream communities and are therefore subject to strict pollution discharge limitations.

tected, and also outlines the water quality requirements for water reuse.

Municipalities currently discharging into waters of the state already have to meet *Utah Administrative Code, Rule R317-1-3, Requirements for Waste Discharges*. In order to reuse treated wastewater effluent, the requirements of *Rule R317-1-4, Utilization and Isolation of Domestic Wastewater Treatment Works Effluent*, must also be met. A full copy of these requirements can be found in Appendix B. This section of the code separates water reuse into two categories: Type I reuse, where human exposure is likely, and Type II reuse, where human exposure is unlikely. (For information on acceptable uses for Type I and II reuse, see Table 12 on page 67). Both types of water reuse share common treatment process requirements that were developed for treating drinking water and wastewater effluent. These treatment techniques include mechanical, chemical and biological processes that remove contaminants from the water. Type II reuse requires achieving secondary treatment standards or better; Type I reuse requires tertiary treatment including additional filtration and sterilization to reduce pathogen and virus levels even further. Secondary and tertiary treatments are described in the following section.

WASTEWATER TREATMENT PROCESSES

In the past, some municipalities with sewage collection systems discharged untreated sewage directly into Utah's streams and rivers. With few communities downstream, wastes could be diluted, broken down, and reduced by natural processes to reasonably safe levels. With increases in population came increases in waste volumes. Newly developing chemical wastes also gradually increased in number and concentration, adding to the complexity of wastewater treatment.

In order to reduce human and chemical wastes, treatment methods were developed to optimize and concentrate natural processes that break down constituents in wastewater. Untreated wastewater discharged to surface waters would often result in unnatural increases in bacterial growth. These bacteria would consume the organic waste in the effluent and, at the same time, all the dissolved oxygen, leaving the water unable to support aquatic life. Called biochemical oxygen demand (BOD), the consumption of oxygen by bacteria is used as a measure of organic content in effluent and is one of the main indicators specified for measuring the effectiveness of wastewater treatment. Artificially concentrating bacteria and other microbes in the wastewater treatment plant facilitates the removal of organic and chemical constituents under controlled conditions. Oxygen can be added for the aerobic bacteria, and at the end of the process the bacteria are either filtered out, killed or both before the effluent is returned to the environment. The products left after treatment are generally less harmful to the environment and some, such as nitrogen and phosphorus, can even be beneficial if the effluent is used for irrigation purposes.

Several difficulties arise in the treatment of municipal sewage. The number of pollutants and the concentration in effluents from human activities can vary from community to community depending upon the mix of industrial, commercial and residential contributions. Treatment processes themselves can also vary depending upon climate, effluent constituents and volume, desired degree of treatment, and final intended use of the effluent. Conventional treatment of wastewater is typically divided into four steps: preliminary, primary, secondary and tertiary or advanced treatment. A brief description is given below to provide an understanding of the purpose of each step in the treatment process. This is done to describe existing secondary treatment requirements for effluent discharged to waters of the state and put into perspective the additional treatment needed to meet Type I and Type II water reuse requirements.

Preliminary Treatment

Preliminary treatment is typically the first step in the treatment "train." It usually includes coarse screening of the sewage to remove plastics, rags and other large solids. Sand, food particles (from kitchen disposals), eggshells and other particles are also removed in subsequent grit chambers. The screened and settled solids are collected and hauled to a landfill for disposal. Some processes may also mechanically reduce the particulate matter in size after screening using grinders to further aid downstream operations. Other preliminary treatments can include aeration and chemical treatment. For example, aerated sewage is often found to be more conducive to subsequent primary treatment (see below). Also, introduction of strong chemical oxidants such as chlorine or permanganate immediately after preliminary treatment may aid succeeding treatment processes.

Primary Treatment

Primary treatment is the physical process by which solids are removed from wastewater through sedimentation and flotation. In this process, heavier solids drop out of solution in stilled effluent and are collected from the bottom of the tank as sludge; lighter constituents such as oils and grease float to the surface and are skimmed off. Primary treatment can be enhanced by the addition of flocculation and coagulation agents upstream of the settlement tank, which aid the removal of heavy metals and organic phosphorus through precipitation and filtration. Additionally, filtration downstream of the settlement tank can remove smaller particulates that are difficult to settle out. Primary treatment removes large portions of heavy metals, grease and oil but removes little of the dissolved organics or biological species and pathogens present in wastewater.

Secondary Treatment

After primary treatment, wastewater moves on to secondary treatment processes. *Utah Administrative Code, Rule R317* specifies that secondary treatment may include: "activated sludge, trickling filters, rotating biological contactors, oxidation ditches, and stabilization ponds."[5] Secondary treatments utilize concentrated microbial populations that are suspended in the effluent or attached to solid media to metabolize and break down wastes. High-rate metabolizing processes include: activated sludge, rotating biological contactors (RBCs) and trickling filters. Stabilization ponds and aerated lagoons are considered low-rate processes that require large storage areas and long retention times.

Activated sludge processes suspend microbial populations in constantly agitated and aerated effluent, maximizing the contact among nutrients, oxygen and microbes. Microbial digestion breaks down constituents in the effluent as the sludge moves slowly through tanks or basins. RBCs consist of closely-spaced, slowly-rotating discs that are partially submerged. The discs are covered with microbes, which are alternately immersed in the wastewater and then exposed to air when rotated. Trickling filters utilize stationary growth media such as formed plastic shapes, rocks or wooden slats to which the microbes attach. Wastewater is distributed (trickled) over the bacteria-covered media by slowly rotating arms, providing oxygen and nutrients. After treatment, the effluent from the above processes then typically moves to a secondary clarifier where the remaining solids settle out.

Stabilization ponds and aerated lagoons are used mostly by smaller communities in Utah. The impoundments typically treat wastewater in a series of aerobic, facultative and anaerobic ponds, making use of bacteria that thrive under differing oxygen conditions. The amount of biological activity decreases with temperature, resulting in considerable changes in efficiency that requires an increase in retention time for cooler temperatures.

The last step in secondary treatment is disinfection to inactivate or kill the remaining microorganisms. Disinfection can be performed by several methods including chlorine gas, ozone, sodium hypochlorite or ultraviolet light. Chlorine gas and ozone are both infused into the effluent stream. Sodium hypochlorite is a liquid, made either on site or purchased, that is mixed in with the effluent stream. Disinfection dosage is typically determined by the desired end

Tooele's wastewater treatment facility uses an oxidation ditch as part of its treatment process. (Photo courtesy of Tooele Wastewater Treatment Plant.)

Renovated water after tertiary treatment at Tooele's Wastewater Treatment Plant. (Photo courtesy of Tooele Wastewater Treatment Plant.)

product and is adjusted to meet the necessary requirements.

Tertiary/Advanced Treatment

In order to achieve Type I (human contact likely) effluent quality, tertiary treatment with additional filtration is required to remove remaining particulates and pathogens from secondary effluent. Filtration is then followed by a final disinfection step to reduce levels even further. For Type I effluent quality standards, *Utah Administrative Code, Rule R317-1-4* requires the turbidity of the effluent to be reduced to a daily average of 2 NTU[6] or less before final disinfection with no single sample to exceed 5 NTU. This ensures that particulate matter has been reduced enough for the final disinfection step to effectively achieve the required level of "none detected" for fecal coliforms. *Rule R317-1-4* requires disinfection with chlorine with a minimum residual dosage concentration of 1 mg/L of chlorine after 30 minutes of contact. Alternative methods of disinfection are allowed if disinfection levels comparable to the chlorine standard can be demonstrated.

Tertiary treatment alternatives to filtration and disinfection include other advanced treatment processes such as reverse osmosis, microfiltration and chemical treatments. These processes can produce effluent that is near to drinking water quality. However, some chemical contaminants may remain even in highly treated effluent. At present no state in the U.S. allows direct reuse of treated effluent as a drinking water source.

REUSE WATER QUALITY LIMITS AND PERMITS

The Utah Division of Water Quality (DWQ) is responsible for monitoring water quality and issuing permits for wastewater discharges and reuse in Utah. Presently, DWQ is in the process of developing a specific reuse permit program. Current discharge permits are handled either through the UPDES permit program or construction permits for wastewater treatment plants. Facilities discharging any portion of the effluent to the waters of the state require a UPDES permit. Facilities that apply all of the effluent to land require a construction permit.

Any treatment facility that desires to reuse reclaimed water for anything other than landscaping on its own site, even for irrigation of land owned by the facility, must submit a reuse project plan to DWQ. The plan must include the following four components:[7]

1) "A description of the source, quantity, quality, and use of the treated wastewater to be delivered, the location of the reuse site, and how the requirements of this rule would be met.
2) Evidence that the State Engineer has agreed that the proposed reuse project planned water use is consistent with the water rights for the sources of water comprising the flows to the treatment plant which will be used in the reuse project. (See Chapter 6 of this report for more details.)
3) An operation and management plan that includes:
    a. A copy of the contract with the user, if other than the treatment entity.
    b. A labeling and separation plan for the prevention of cross-connections between reclaimed water distribution lines and potable water lines. Guidance for distribution systems is available from the Division of Water Quality.

c. Schedules for routine maintenance.
d. A contingency plan for system failure or upsets.

4) If the water will be delivered to another entity for distribution and use, a copy of the contract covering how the requirements of this rule will be met."

Each water reuse plan is evaluated considering the individual characteristics of the reuse site. The permits specifically detail testing requirements and conditions and place of use. Some applications, such as flood irrigation with treated effluent over permeable soils, may require an additional permit to discharge to the ground water aquifer. In this case, additional treatment may be required before land application of the effluent. Modifications to testing requirements may be made to accommodate treatment processes that produce acceptable effluent quality. For example, *Utah Administrative Code, Rule R317-1-3* designates alternative test limits for stabilization ponds that produce secondary effluent. Modifications, however, are ultimately determined by the Water Quality Board on a case-by-case basis with the goal of meeting water quality requirements for designated end uses. Proposals submitted to the Division of Water Quality for permitting must also be sent to local health authorities for review and recommendations. Local health departments may place additional restrictions on the use or disposal of effluents.

In order to monitor the quality of wastewater treatment, the state of Utah has set limits for Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Total Coliform Bacteria and Fecal Coliform Bacteria in secondary effluent, Type II effluent and Type I effluent. *Utah Administrative Code, Rule R317-1* indicates required testing and limits for tested constituents. Table 11 displays the limits of state-required effluent parameters.

TYPES OF EFFLUENT, TESTING REQUIREMENTS AND ACCEPTABLE USES

The levels of testing required for secondary, Type II and Type I effluents are discussed below along with the respective acceptable uses. The acceptable uses for each level of treated effluent as shown in Table 12 are specified in *Utah Administrative Code, Rule R317-1-4*. Additional restrictions for use may be imposed and depend on site conditions for each intended use.

Secondary Effluent and Type II Effluent

Wastewater that is treated to secondary standards receives the least rigorous treatment and testing and has the most restricted use — limited to uses around wastewater treatment facilities that exclude the public. For secondary effluent and Type II effluent, treatment and testing requirements are nearly identical. The main differences being that Type II effluent requires disinfection and more frequent testing including daily and weekly sampling of TSS and BOD, respectively. The extent of additional steps necessary depends upon the final application desired.

Type II effluent is acceptable for many more applications than secondary effluent such as cooling water, irrigation of food crops where the effluent will not contact edible parts, animal feed crops (excluding pasture for milking animals), dust control and other uses, but it is still restricted from human contact. Operations that spray-apply Type II water are limited to areas with a buffer zone of 300 feet or more from public access areas and any irrigation must also be 300 feet from a potable well.

Type I Effluent

Type I effluent quality standards require continuous testing for turbidity and chlorine residual in addition

Sprinkler irrigation is only allowed with Type II effluent if there is a buffer of 300 feet or more from public access and potable wells.

TABLE 11

Utah Water Quality Limits

	Utah constituent limit after secondary treatment			Utah constituent limit for Type II effluent			Utah constituent limit for Type I effluent		
	30 day Period	7 day period	Other req.	30 day	7 day	Other req.	30 day	7 day	Other req.
Total suspended solids (TSS), mg/L	25[a]	<35[a]	15% of municipal influent SS maximum.	25[c]	<35[e]	Daily Sampling	--*	<5*	Continuous Sampling, 2 NTU[a]; Daily No Sample >5 NTU*
Biochemical oxygen demand, (BOD), mg/L	25[a]	<35[a]	15% of municipal influent BOD maximum.	25[d]	--	Weekly Sampling	10[c]	--	Daily Sampling
Total coliform bacteria (# / 100mL)	2000[b]	<2500[b]	--	--	--	--	--	--	--
Fecal coliform bacteria (# / 100mL)	200[b]	<250[b]	--	--	200[f]	Daily Grab, No Sample >800	--	None Detected[f]	Daily Grab, No Sample >14
pH	6.5 to 9.0	6.5 to 9.0	Continuous or Daily Grab	6.0 to 9.0	6.0 to 9.0	Continuous or Daily Grab	6.0 to 9.0	6.0 to 9.0	Continuous or Daily Grab
Disinfection	Not Required			Required			1mg/L chlorine residual after 30 minutes or equivalent		
Alternatively CBOD may be monitored in place of BOD for secondary treatment									
Carbonaceous Biochemical Oxygen Demand, (CBOD), mg/L	25[a]	<35[a]	15% of influent CBOD maximum.						

[a] Arithmetic mean, daily sampling
[b] Geometric mean, daily sampling
[c] Arithmetic mean, daily composite sampling
[d] Arithmetic mean, weekly composite sampling
[e] Weekly mean
[f] Weekly median

* Because Type I standards do not require testing for TSS, the values shown are for turbidity requirements.

Composite sampling = six flow proportionate samples, taken over a 24 hour period.

Source: *Utah Code R317-1-3.2*, *R317-1-4.3*, and *R317-1-4.4*

TABLE 12
Acceptable Uses for Treated Effluents

Secondary Effluent
At the plant site:
1. Chlorinator injector water for wastewater chlorination facilities.
2. Water for hosing down wastewater clarifiers, filters and related units.
3. Irrigation of landscaped areas around the treatment plant from which the public is excluded.
4. Other uses approved by the Water Quality Board on a case-by-case basis.

Type II Effluent
1. Irrigation of sod farms, silviculture (tree farming), limited access highway rights-of-way, and other areas where human access is restricted or unlikely to occur.
2. Irrigation of food crops where the reclaimed water is not likely to have direct contact with the edible part, whether the food will be processed or not (spray irrigation not allowed).
3. Irrigation of animal feed crops other than pasture used for milking animals.
4. Impoundments of wastewater where direct human contact is not allowed or is unlikely to occur.
5. Cooling water. Use for cooling towers that produce aerosols in populated areas may have special restrictions imposed.
6. Soil compaction or dust control in construction areas.

Type I Effluent
1. All Type II uses listed above.
2. Residential irrigation, including landscape irrigation at individual homes.
3. Urban uses, which includes nonresidential landscape irrigation, golf course irrigation and other uses with similar potential for human exposure.
4. Irrigation of food crops where the applied reclaimed water is likely to have direct contact with the edible part. Type I water is required for all spray irrigation of food crops.
5. Irrigation of pasture for milking cows.
6. Impoundments of treated effluent where direct human contact is likely to occur.

Source: *Utah Administrative Code*, *Rule R317-1-4*.

to daily testing for fecal coliforms, BOD and pH. Turbidity must be tested to verify that particulate matter has been properly filtered from the effluent before disinfection. Chlorine is tested to ensure that minimum dosage requirements are met.

Because water treated to Type I standards has received further filtration and disinfection relative to Type II standards, its use is allowed for many more applications. These include human contact, sprinkle irrigation of food crops, pasture for milking animals and residential irrigation. While Type I effluent is cleaner than Type II effluent, its use still entails special requirements. Residential irrigation requires the use of a separate delivery system. Delivery pipes are required to be marked either with the color purple or, in the case of retrofitted secondary systems, with special buried tape that indicates nonpotable water. Hose bibs (exterior faucet connections in a water line for lawn and garden hoses) are prohibited on reuse delivery systems and individual underground irrigation systems are to be directly connected. Checks for cross-connections must also be performed as specified in *Utah Administrative Code,* *Rule R309-105-12* in order to prevent improper connections to potable water supplies. Direct connection with secondary irrigation systems is prohibited due to differing water quality requirements. In addition, Type I effluent cannot be sprayed on or near drinking fountains, picnic tables or food establishments. A complete list of all requirements for reuse can be found in *Utah Administrative Code, Rule R317-1-4* (see Appendix A).

For Type I treatment systems, an alternative disposal option or diversion to storage must be available in case water quality requirements are not met. This typically means either temporary storage ponds that are isolated from the public or a discharge permit to discharge, under less stringent standards, effluent not meeting high reuse quality requirements.

ADDITIONAL REGULATIONS OF OTHER STATES

Since most states have historically based their rules on progress other states have made, it may prove useful in future Utah decision-making to know the regulations that other states have implemented. Although Utah is by no means the largest user of reclaimed water, very few states have regulations that address more categories for how reclaimed water may be put to use. Three categories of reuse that other states have defined in their regulations, for which Utah has not, are environmental reuse, ground water recharge and indirect potable reuse. Florida and Washington have regulations in place for all three of these, and California, Hawaii and Massachusetts have regulations for ground water recharge and indirect potable reuse. Table 13 shows the U.S. Environmental Protection Agency's (EPA) suggested guidelines for two of these three categories. The EPA recommends ground water regulations be site-specific and use-dependent. Most of the suggested guidelines are more lenient than any of the regulations individual states have already implemented.

Despite the fact that regulations have been established in these states, in most instances, requirements are still determined on a case-by-case basis for these three categories. Requirements for wetland enhancement vary for different types of wetlands and the degree of public access. Ground water recharge requirements vary depending upon soil characteristics, hydrogeology and distance to withdrawal. For potable aquifer recharge, most of the states require a pretreatment program, a public hearing prior to project approval, and a ground water monitoring program.[8]

TABLE 13
EPA's Suggested Guidelines for Reuse Categories not Regulated in Utah

	Environmental Reuse	Ground Water Recharge	Indirect Potable Reuse$^{\Phi}$
Treatment	Secondary and disinfection (minimum)	Site Specific	Secondary, filtration, disinfection and advanced treatment
BOD_5	≤ 30 mg/l	Site Specific	--
TSS	≤ 30 mg/l	Site Specific	≤ 5 mg/l
Turbidity	--	Site Specific	≤ 2 NTU
Coliform	≤ 200/100 ml*	Site Specific	All samples less than detection[†]
Total Nitrogen	--	Site Specific	--
TOC	--	--	≤ 3 mg/l
Primary and Secondary Standards	--	--	Meet drinking water standards

Source: U.S. Environmental Protection Agency, Guidelines for Water Reuse, EPA/625/R-04/108, (Washington, D.C.: U.S. Environmental Protection Agency, 2004), 168-169.
$^{\Phi}$Suggested guidelines vary depending on method of indirect potable reuse whether by augmentation of surface waters, spreading into potable aquifers, etc. The method for which standards are shown is injection into potable aquifers.
*Fecal Coliform limits
[†]Total Coliform

NOTES

[1] "Clean Water Act Turns 30," Utah Watershed Review. Vol. 10, No. 4, Oct-Dec 2002, 1-2.

[2] Ibid.

[3] U.S. Environmental Protection Agency, "Total Maximum Daily Loads." Retrieved from the U.S. EPA's Internet web page: http://oaspub.epa.gov/waters/state_rept.control?p_state=ut, September 2004.

[4] *Utah Administrative Code*, *Rule R317-2-3, 3.1 Maintenance of Water Quality*.

[5] *Utah Administrative Code*, *Rule R317-1-4.3B* and *4.4B Use of Treated Domestic Wastewater Effluent Where Human Exposure is Likely (Type I) – Required Treatment Processes*.

[6] NTU — nephelometric tubidity units — A measure of the clarity of water. An instrument called a nephelometer can be used to measure the amount of light scattered by suspended matter in the water. Turbidity is visually detectable at 5 NTU and above. Drinking water requires 0.5 NTU or below.

[7] *Utah Administrative Code*, *Rule R317-1-4.2 Submittal of Reuse Project Plan*.

[8] U.S. Environmental Protection Agency, *Guidelines for Water Reuse*, EPA/625/R-04/108, (Washington, D.C.: U.S. Environmental Protection Agency, 2004), 159-162.

6

WATER RIGHTS CONSIDERATIONS

In the state of Utah, a water right is a right to use water. It is not a right of ownership. The state retains ownership of "natural" or public water within its boundaries, and state statutes, regulations, and case law govern the allocation and administration of the rights of private parties and governmental entities to use water. A water right allows water to be diverted at a particular location and a portion of the water to be used for one or more beneficial purposes. A basic doctrine in water rights law is that harm cannot be rendered upon others who have a valid claim to the water.[1]

Water rights and related issues are often the most important considerations that must be made when planning a water reuse project. Frequently, water rights issues are also the most complex and challenging to resolve satisfactorily for all interested parties. The intent of this chapter is to present the current laws that regulate water rights for reuse projects in Utah, illustrate the process the State Engineer uses to evaluate such projects, summarize existing projects that are subject to these laws, and discuss pertinent case law in Utah and other states that relate to water reuse.

LAWS AND REGULATIONS IN UTAH

Utah laws and rules that regulate water reuse are relatively new. Responding to an increased public interest in this topic, the Utah State Legislature passed the Conservation and Use of Sewage Effluent Act in 1995. This act set forth some basic guidelines regarding the administration of water rights for water reuse projects and authorized the State Engineer to make rules regarding the notification process required for anyone desiring to pursue such a project. These rules were officially adopted by the State Engineer in 2003. Full copies of the act and rules are provided in Appendix B.

Conservation and Use of Sewage Effluent Act (1995)

Important Definitions

The Conservation and Use of Sewage Effluent Act *(Utah Code, Title 73, Chapter 3c, 1995)* defines several terms that are important to understand relative to water reuse in Utah. A few of these definitions are given below:[2]

- Publicly-Owned Treatment Works (POTW) – "any facility for the treatment of pollutants owned by the state, its political subdivisions, or other public entity."[3]
- Regional POTW – a publicly-owned treatment works that serves more than one governmental entity.
- Sewage Effluent – the product resulting from the treatment of sewage and other pollutants by a POTW.
- Water Right – (1) a right to use water as [evidenced by a decree, a certificate of appropriation, a diligence claim, or a water user's claim filed in general determination proceedings],[4] (2) a right to use water under an approved application: to appropriate, for a change of use, or for the exchange of water, or (3) a contract authorizing the use of

water from a water wholesaler or other water supplier having a valid water right.

These definitions help clarify important items within the act. The definition of a water right, especially item (3) referring to a "contract," is unique to the act and only applies in the context of sewage effluent use.

Who Can Use Sewage Effluent?

The act identifies who may legally use sewage effluent as a "municipality or other governmental entity owning and operating a POTW."[5] It also states that a municipality or other governmental entity that does not own and operate a POTW "may contract with the person responsible for administration of [a] regional POTW to act as its agent for the purpose of using sewage effluent discharged from the regional POTW."[6] In both cases, the municipality or other governmental entity must have valid water rights for the water that produced the effluent. The following paragraphs define "municipality" and "government entity" and provide some examples of entities in Utah that can legally use sewage effluent.

A municipality is a geographically defined unit having corporate status and powers of self-government such as a city or incorporated town. Examples of municipalities in Utah that own and operate their own POTW are Brigham City, Tooele, Grantsville, Provo, Blanding, Monticello and Cedar City. Each of these municipalities owns water rights for the water that produces the effluent from its POTW and can legally use it.

A governmental entity is a state or federal agency, a state institution of higher education, a county, a municipality, a local school district or a special district. Examples of governmental entities served by a regional POTW are Taylorsville-Bennion Improvement District, Granger-Hunter Improvement District, Cottonwood Improvement District, Kearns Improvement District and Salt Lake Suburban Sanitary District No. 1. The regional POTW serving these entities is Central Valley Water Reclamation Facility (CVWRF). CVWRF also serves two municipalities, South Salt Lake and Murray. In this example, all of the municipalities and governmental entities served by CVWRF, except for Salt Lake Suburban Sanitary District No. 1 and Cottonwood Improvement District (which do not hold any water rights), can legally contract with CVWRF to act as their agent for the purpose of using the sewage effluent.

How are Water Rights Handled?

Perhaps the most significant part of the Conservation and Use of Sewage Effluent Act is how the water rights of a reuse project are handled. In essence, the act says a municipality or governmental agency, which has water rights that result in sewage effluent, may use the effluent for "a beneficial use consistent with, and without enlargement of, those water rights" after filing a notification with the State Engineer. In other words, the proposed sewage effluent use must not change the consumptive nature of the water rights as originally approved. This part of the law is very important, because it establishes a role of oversight for the State Engineer, who has the statutory authority to administer water rights. This does not mean a change in the nature of use is not al-

Cedar City is one of several municipalities that owns and operates its own POTW. Such municipalities typically own water rights that produce the treated effluent, and thus can legally reuse that effluent.

lowed, rather, that due process must be followed when such a change has the potential to adversely impact other water users.

The act establishes important criteria that help determine when a water right change application must be filed with the State Engineer and what the priority of use will be for the proposed use of sewage effluent. In essence, a change application must be filed when the proposed use: (1) "lies outside the place of use as defined by the underlying water rights," (2) "is for purposes other than those authorized under the underlying water rights, or" (3) "is in a manner otherwise inconsistent with the underlying water rights."[7] A change application is also required if the proposed use of effluent will change the point of discharge of the effluent.

Sewage Inflow May be Appropriated

The act also contains a provision that allows any water that infiltrates into the wastewater collection system to be appropriated for use. This is an interesting provision because it is difficult to estimate the amount of infiltration that occurs in any given collection system. The infiltration that does occur can vary significantly from year to year due to fluctuations in the water table. In most areas of the state with significant wastewater collection systems (large cities along the Wasatch Front, St. George and elsewhere), the fact that infiltration may be appropriated is irrelevant because these areas are closed to new appropriations.

Administrative Procedures for Notifying the State Engineer of Sewage Effluent Use or Change in the Point of Discharge for Sewage Effluent (2003)

The Conservation and Use of Sewage Effluent Act of 1995 directed the State Engineer to draft administrative rules to outline the notification requirements for use of sewage effluent or change in point of discharge. The State Engineer began this process in 1998 and adopted rules in February 2003. These rules *(Utah Administrative Code, Rule R655-7, 2003)* provide further insight into the handling of the water rights critical to any water reuse proposal. One year after the State Engineer adopted the rules, a single change was made to the act; a 2004 amendment stated that a $750 fee must be paid to the State Engineer to cover the cost of processing a notification. The following sections summarize key notification requirements outlined in the rules.

Important Definitions

The administrative rules define several terms that pertain to the notification requirements. These definitions are given below:[8]

- Change Application – an application filed to obtain authorization from the state engineer to allow a water right to be changed with respect to point of diversion, period of use, place of use, or nature of use.
- Depletion – water consumed and no longer available as a source of supply; that part of a withdrawal that has been evaporated, transpired, incorporated into crops or products, consumed by man or livestock, or otherwise removed.
- Diversion – the maximum total volume of water in acre-feet or the flow in second-feet which may be diverted as allowed by a water right to meet the needs of the beneficial uses authorized under the right."
- Hydrologic System – the complete area or basin where waters, both surface and underground, are interconnected by a common drainage basin.
- Notification – an application filed with the state engineer requesting authorization to use or to change the point of discharge for sewage effluent.

Contents of Notification

The Division of Water Rights has developed forms that applicants are required to use to help facilitate the notification process. The State Engineer verifies the information provided on the forms and uses it to determine if the use of sewage effluent is "consistent with and without enlargement of the underlying water rights or if a change in point of discharge is required."[9] Key information required is listed below:[10]

- The water right numbers of the water proposed for reuse.
- An evaluation of the diversion and depletion limits allowed for each water right as origi-

nally approved and certified by the State Engineer.
- The original and current uses approved under the water rights.
- The quantity of water to be reused.
- The point of discharge of unused effluent.
- An evaluation of total depletion of water from the hydrologic system from the initial use of water and the proposed use of the sewage effluent.

Processing the Notification

Once the required information is submitted, the State Engineer publishes the information for public inspection. Notifications are published according to *Utah Code Section 73-3-6* once a week for two successive weeks in a paper of general circulation in the county in which the source of supply is located and where the water is to be used. Any interested person may comment on the published notification within 20 days of publication. If deemed necessary, the State Engineer will hold a public hearing.

After the 20-day period, the State Engineer evaluates the proposed reuse and either determines that it is valid under existing water rights or that an application to appropriate or a change application is required to use the sewage effluent. Some of the important details of this process are rather complicated and are described later in this chapter in the section entitled, "Evaluating Diversion and Depletion Limits of Underlying Water Rights." If a change application or an application to appropriate is required, the applicant is responsible to file the associated paper work and submit it to the State Engineer. Such an application is processed according to the normal appropriation rules as outlined in the *Utah Code.*

While the information required is necessary for the State Engineer to make a careful evaluation of how much water can be reused consistent with and without enlargement of the underlying water rights, some within the local water community have complained that the level of detail required in the rules and used in the evaluation is unnecessary and goes beyond the intent of the law. To resolve these conflicts, the Legislature may need to revise the law and provide the State Engineer with more specific direction.

EVALUATING DIVERSION AND DEPLETION LIMITS OF UNDERLYING WATER RIGHTS

As noted in the administrative rules for the notification of sewage effluent use, an evaluation of the diversion and depletion limits allowed for each water right as originally approved and certified by the State Engineer is required. While the applicant is supposed to make this analysis, the State Engineer verifies it to make sure it was done correctly. Because it is essential to know the volume of effluent that can be diverted and depleted in order to determine the feasibility of a reuse project, this section describes the process the State Engineer uses to evaluate these limits and provides an example detailing key steps.

Key Assumptions and Reasoning

Each approved water right has a diversion and depletion limit. The diversion limit is explicitly stated in the water right as a flow rate (cubic feet per second or gallons per minute) and/or total volume (acre-feet per year). While not explicitly stated, each water right also has a depletion limit (acre-feet per year) that can be estimated. The depletion limit depends on the type of use designated in the original approved water right. The difference between the diversion and depletion limits is generally referred to as return flows.

Municipal and Industrial Water Rights

The State Engineer considers municipal and industrial (M&I) water rights that were originally approved for M&I uses to be potentially 100 percent consumptive. This is because all the water diverted for M&I uses has the potential to be entirely consumed. For instance, a water-bottling company with an approved water right can bottle the entire volume allowed under the diversion limit of the water right and distribute it to distant locations, entirely removing the water from the local hydrologic system. Another example of M&I water rights that are considered 100 percent consumptive is the case where a community employs a total containment lagoon as part of its wastewater treatment system. In such a case, none of the sewage effluent is considered by the State Engineer to return to the hydrologic cycle.

Although the State Engineer's position on the consumptive nature of M&I water rights is fairly straightforward, no community in Utah has historically utilized all their water rights in a way that results in 100 percent depletion. As a result, many water users have argued that the consumptive nature of M&I water rights proposed for reuse should be evaluated on a case-by-case basis to prevent adverse impacts to downstream water users.

Water rights originally approved for agricultural uses that are converted to M&I use must be evaluated to determine the amount of depletion allowed to the hydrologic system based on the rights originally approved.

The State Engineer requires that all water rights originally approved for uses other than M&I use, that have since been converted to M&I use, be evaluated individually to determine the amount of depletion allowed to the hydrologic system based on the rights originally approved. The amount of the diversion limit that can be depleted by an agricultural water right that has been converted to a M&I water right depends on the consumptive use of alfalfa and the water right duty for the area of approved use. Water right duties vary according to location from 3 to 6 acre-feet per acre. For example, in the Salt Lake Valley the duty is 5 acre-feet per acre and the consumptive use of alfalfa is 2.12 acre-feet per acre, which equates to a depletion limit of 42.4 percent (2.12 divided by 5) of the diverted amount. Thus, only 42.4 percent of an agricultural water right that has been converted to M&I use can be depleted in the Salt Lake Valley.

Imported Water Rights

The State Engineer considers water imported into a drainage basin from another hydrologic system for any beneficial use is considered potentially 100 percent consumptive. In simple terms, any water taken from one basin can be entirely consumed without impacting other water rights within the system because it is not native to the hydrologic system to which it was exported. This has important implications in Utah because several local and federal water development projects import water from other hydrologic basins.

Example Evaluation (Orem City)

In May 2002, Orem City filed a notification to use 10,000 acre-feet of sewage effluent from the city's wastewater treatment plant. A copy of this notification (as published by the State Engineer) is included in Appendix C. The city identified 12 water rights by number as well as water rights from the Central Utah Project as the underlying water rights that produced the effluent. Nine of these water rights are owned by Orem City; one is co-owned by Orem City and the Provo Bench Canal and Irrigation Company; and two are owned by the Provo River Water Users Company. The United States and the Central Utah Water Conservancy District own the water rights for the Central Utah Project. An evaluation by the State Engineer found that the Provo Bench Canal water right had not been amended to be used within Orem City and that there were no contracts to use effluent from the Central Utah Project water or the Provo River Water Users Company water. Therefore the State Engineer did not evaluate nor allow Orem City to use the effluent produced by these water rights. The State Engineer did evaluate and approve the use of the effluent produced by Orem City's nine water rights. A summary of this analysis is presented in Table 14 and the following discussion.

As shown in Table 14, the State Engineer determined the diversion and depletion limits of Orem City's nine water rights to be approximately 21,607 and 18,960 acre-feet per year, respectively. Orem can deplete 100 percent of the diversion limits associated with the municipal water rights. The city can deplete 57.25 percent of the water rights that were originally approved for agricultural irrigation. This

TABLE 14
Summary of Orem City's Underlying Water Rights

Water Right Number	Original Beneficial Use	Diversion Limit (acre-feet/yr.)	Depletion Rate (%)	Depletion Limit (acre-feet/yr.)
55-290	Cooling in a theater and irrigation of lawns	724.00	10	72.40
55-321	Municipal – 1.19 cfs	861.56	100	861.56
55-654	Municipal – 2.38 cfs	1,723.12	100	1,723.12
55-690	Municipal – 13.82 cfs	10,005.68	100	10,005.68
55-572	Agricultural irrigation	1,339.20	57.25	766.70
55-954	Recreation: cooling of theater, swimming pool, bowling alley, incidental irrigation (limited by WUC)	88.17	40	35.00
55-2105	Municipal – 4.12 cfs	2,982.88	100	2,982.88
55-4160	Agricultural irrigation	3,205.56	57.25	1,835.20
55-4695	Agricultural irrigation (limited by cert.)	677.11	100	677.11
	TOTAL	**21,607.28**	**--**	**18,959.65**

Source: Utah Division of Water Rights, "Memorandum Decision Notification of Sewage Effluent Use Number 2." See Appendix C for the full copy of this decision.

percentage is based on a consumptive use for alfalfa of 2.29 acre-feet per acre and a water right duty of 4 acre-feet per acre (2.29 divided by 4 = 57.25%). Orem is also allowed to deplete 10 percent of a water right originally approved as cooling water and irrigation for a local theater and 40 percent of a water right originally approved for various recreational purposes, including a swimming pool, bowling alley and incidental irrigation. The 10 and 40 percent values are the State Engineer's best estimates of the potential depletions of these water rights under the original application.

The depletion limit of 18,960 acre-feet per year includes all indoor and outdoor uses of the water in Orem City, if the city were to divert its entire limit of 21,607 acre-feet per year. In order to determine the amount of effluent that can be used, the State Engineer had to estimate how much of the diverted amount ends up as effluent discharged by the wastewater treatment plant. To do this, the State Engineer looked at historic diversion records and treatment plant discharges for the five-year period from 1998 to 2002. These records showed that Orem City has diverted an average of 8,172 acre-feet per year of its 21,607 acre-feet limit and the wastewater treatment plant has discharged an average of 10,643 acre-feet per year.

Since the total discharge volume from the wastewater treatment plant includes water produced by water rights not owned by Orem City, the State Engineer had to estimate what portion of the effluent belonged to Orem City. To do this, the State Engineer divided the amount of water diverted under Orem City's water rights (8,172 acre-feet) by the total diversion of water used in Orem City under all water rights serving the city (23,867 acre-feet); this yielded a value of 34.24 percent. Next, the State Engineer assumed that all sources of water are commingled in Orem City's distribution system and that 3,644 acre-feet of the average annual wastewater treatment plant discharge belonged to Orem City (10,643 multiplied by 34.24% = 3,644). This represents 44.59 percent of the amount Orem City diverts under its water rights (3,644 divided by 8,172 = 44.59%). Because the volume of water Orem City diverts under its water rights can vary from year to year (up to a maximum of 21,607 acre-feet), the State Engineer ruled that Orem City water reuse is limited to 44.59 percent (or 9,634 acre-feet per year, whichever is less) of the water diverted under its water rights.

SUMMARY OF EXISTING NOTIFICATIONS OF SEWAGE EFFLUENT USE

Since the Conservation and Use of Sewage Effluent Act was passed in 1995, the State Engineer has re-

TABLE 15
Notifications of Sewage Effluent Use Submitted to the Division of Water Rights

Municipality or Governmental Entity	Notification Number	Notification Date	Status	Volume Requested (ac-ft/yr)	Volume Approved (ac-ft/yr)
Central Valley Water Reclamation	NS005	7/12/99	Processed 12/7/99*	829[†]	829[†]
Tooele City	NS006	9/22/99	Processed*	2,632[‡]	2,632[‡]
City of Hildale	NS001	7/6/01	Processed 8/29/01*	460	377
Orem City	NS002	5/24/02	Processed 7/23/03	10,000	9,634
Payson City	NS003	11/4/02	Processed 12/19/03	5,049	4,759
St. George City	NS004	1/17/03	Processed 5/6/03	11,732	6,496
South Davis Sewer District	NS007	5/21/03	Processed 9/14/04	463	463
Saratoga Springs	NS008	2/12/04	Pending	1,135	-
Central Weber Sewer Improvement District	NS009	9/15/04	Pending	5,600[†]	-

* These were approved by the Division of Water Rights before the administrative rules regarding notification of sewage effluent (*R655-7*) were adopted in Feb. 2003.
[†] This volume was estimated based on the maximum proposed flow in cfs applied over the typical irrigation period of April 15 to October 15.
[‡] This volume was estimated based on the proposed year-round use of the facility's design capacity, 2.35 mgd.

ceived nine notifications of sewage effluent use. Table 15 lists each notification and a summary of the action taken by the State Engineer. As of March 2005, the State Engineer has evaluated and completed processing seven of these proposals and continues to evaluate the remaining two. The first three notifications that the State Engineer received (Tooele, Central Valley Water Reclamation and Hildale) were processed prior to February 2003, when the administrative rules related to reuse were adopted. The processing of the other six notifications began after the administrative rule requirements were in place. A copy of each notification can be obtained from the Division of Water Rights web page: **www.waterrights.utah.gov** (notification numbers NS001 through NS009).

The only protests that were made to any of these notifications came from the U.S. Bureau of Reclamation (BOR) and the Provo River Water Users Association. BOR protested the notifications of Payson City, South Davis Sewer District and Saratoga Springs. The Provo River Water Users Association protested Payson City's notification. In the case of Payson City's notification, the State Engineer held a hearing. After listening to all the arguments, the State Engineer determined the evaluation of Payson City's notification adequately addressed the concerns of the protestors and established the limits within which the effluent could be used consistent with and without enlargement of the underlying water rights. The Provo River Water Users Association has appealed the State Engineer's decision to approve Payson City's water reuse proposal. The details of this appeal are discussed in a later section.

Approved, Rejected and Unapproved Appropriations of Sewage Effluent in Utah

As discussed briefly in Chapter 3, several instances of water reuse in Utah are not subject to the Conservation and Use of Sewage Effluent Act of 1995 and are not considered reuse by the Utah Division of Water Quality or the Utah Division of Water Rights for regulatory purposes. This is because the owners of the water rights associated with these uses legally filed under the normal water rights appropriation process for the right to use sewage effluent after it is discharged to a receiving water body. While most of the filings that were approved occurred prior to the passage of the act in 1995, several occurred after. In addition to the applications that the State Engineer approved, many more similar applications were rejected, were allowed to lapse or have not yet been acted upon (unapproved). Because of the potential significance these applications represent to water reuse in Utah, the following sections present a representative sample of these water rights, including one that has been approved, one that has been rejected, and one that has not yet been acted upon. Appendix D contains a list of the known applications to appropriate sewage effluent and the status as of February 2005.

Price River Water Improvement District (1963)[11]

The Price River Water Improvement District was formed in the early 1960s to provide water services to the communities of Helper, Price and Wellington as well as the unincorporated areas within the Price River Valley. In the late 1960s, the district began planning to provide sewage collection and treatment. In March of 1963, several years before a wastewater treatment plant was built, the district filed an application with the State Engineer to appropriate 10 cfs of sewage effluent that would be "developed" by the plant. The proposed uses of the effluent included industrial coal washing and agricultural irrigation.

U.S. Steel Corporation and a local irrigator protested the district's application. The corporation, which had previously filed an application to appropriate flows in the Price River downstream of the proposed wastewater treatment plant, argued that the district's application should not be approved because it would interfere with the corporation's water rights filings and appeared to be for speculation purposes. The local irrigator argued that effluent from the local communities had previously been discharged to the Price River and was already fully appropriated. The State Engineer held a hearing with all interested parties in 1964 and chose not to act on the application until after the plant was constructed. When the plant was finally built in 1972, it was placed in a different location than originally anticipated, so the district petitioned the State Engineer to modify the proposed point of diversion on the application. Again, U.S. Steel Corporation and another local irrigator protested the application. Soon after, Price River Water Improvement District began negotiations with the steel corporation to use the plant's reclaimed wastewater for its operation and convinced them and the other protestant to withdraw the protests. In 1980, the State Engineer approved the application.

Since receiving approval of its application, Price River Water Improvement District has actively sought to put the effluent to beneficial use. Over the years, the nature of the use has changed several times. U.S. Steel Corporation has used a portion of the effluent in its coal washing operations and another company has used a portion of the effluent for dust suppression and other industrial uses. In the early 1990s, the district was within weeks of closing a deal with Utah Power & Light to use the effluent for cooling water purposes; however, this deal fell through when Scottish Power purchased the power company. As of 2004, the district was using a portion of the water right (135 to 180 acre-feet per year) to cultivate animal feed crops on 45 acres of its own land (part of its biosolid disposal operation) and delivering a very small amount (about 1 acre-foot per year) to a local stone cutting company.

Ogden City and Warren Irrigation Company Exchange Applications (1961)[12]

In 1961, Ogden City and Warren Irrigation Company filed exchange applications with the State Engineer proposing to exchange sewage effluent for irrigation water stored in Pineview Dam. According to the applications, Ogden City would discharge 31 cubic feet per second (cfs) of its sewage effluent into the Warren Canal in exchange for 19 cfs of the Warren Irrigation Company's water rights at Pineview Dam. Both parties would benefit from the proposed exchange. The city would obtain 19 cfs of additional water, which it could then divert above the dam into its municipal water system to meet growing urban demands; and the irrigation company would utilize the city's nutrient-rich effluent to satisfy the irrigation demands within its system.

The Utah State Department of Fish and Game, Utah Power and Light Company, U.S. Bureau of Reclamation (BOR), and Weber Basin Water Conservancy District (WBWCD) protested these exchanges. The Utah State Department of Fish and Game contended that the proposed exchanges could not be made without interfering with their Ogden Bay Bird Refuge water rights. Utah Power and Light Company contended that any water delivered to Ogden City's water system at the dam would bypass the company's power plant, resulting in loss of revenue. The BOR and WBWCD contended that the water rights of Ogden City were fully satisfied by the present uses and that the exchanges were an attempt to enlarge the city's rights and should, therefore, not be allowed.

The State Engineer agreed with several of the protestors' main objections and rejected the exchange applications. The State Engineer's memorandum decision ruled that "the contemplated exchange could not be made without adequate safeguards for those already owning rights to the use of water in the system" and that such an exchange amounted to "nothing more than the appropriation of water on an exchange application form."[13]

U.S. Bureau of Reclamation (1998)[14]

In March of 1998, the U.S. Bureau of Reclamation filed an application to appropriate 35,500 acre-feet per year of the sewage effluent in the Salt Lake Valley and other return flows to the Jordan River. The stated purpose of the application was "to appropriate the return flow from Central Utah Project water imported to the Salt Lake Valley." The points listed for the diversion of the sewage effluent were the discharge locations of Magna Water Company Improvement District's wastewater treatment plant and Salt Lake City, Central Valley, and South Valley water reclamation facilities. The Bureau plans to use this water directly, or by exchange, for Central Utah Project purposes.

All the major water suppliers in the Salt Lake Valley as well as PacifiCorp, Jordan Fur & Reclamation Co. and the Utah Division of Wildlife Resources protested this application. All protestants claimed that the application, if approved, would interfere with their water rights. PacifiCorp argued that further depletions from the Jordan River could alter stream quality and quantity to a point that it would impair the operation of the Gadsby Steam Electric generating station, which holds a senior water right. Jordan Fur & Reclamation Co. argued that the Jordan River is fully appropriated and the said application, if approved, would interfere with its senior water right. The Utah Division of Wildlife Resources feared that the application would adversely affect flows into the Farmington Bay Waterfowl Management Area. Several protestants argued that the Bureau did not supply sufficient information regarding the underlying water rights and the intended uses and that such should be fully studied before the State Engineer takes any action. Others argued that the application appeared to be filed for purposes of speculation and monopoly. The State Engineer has not yet acted on this application and its current status is unapproved.

Two pending court cases that deal with water reuse and water rights issues could have a significant impact on future water reuse projects in Utah. (Photo of Scott Matheson Courthouse taken by Kevin Delaney.)

PERTINENT UTAH COURT CASES AND SELECTED CASES FROM OTHER STATES

In Utah, there are only two known court cases available for study related to water reuse. These cases were filed after the Conservation and Use of Sewage Effluent Act of 1995 and have not yet been decided. The case law available in other states is much more substantial. Although the rulings, policies, and guidelines enunciated by courts in other states apply only to the parties and circumstances of each case,[15] several example cases are presented in this section to provide valuable insight into the water reuse issues that Utah may also face.

Salt Lake City Suburban Sanitary District No. 1 v. State Engineer (decision pending)

In January 1995, Salt Lake City Suburban Sanitary District No. 1 filed an application with the Division of Water Rights to appropriate approximately 22 cubic feet per second (14.2 million gallons per day) of water collected by the district's wastewater collection system. The State Engineer received numerous protests to this application and held an informal adjudicative proceeding in August 1995. On September 7, 2001, the State Engineer issued a memorandum decision denying the sanitary district's application. After a Request for Reconsideration was denied, the sanitary district appealed the State Engineer's decision in Utah's Third Judicial District Court in Salt Lake County.

The State Engineer filed a motion with the court to dismiss or remand the case for further proceeding due to a lack of information provided by the applicant regarding the sources of water it wished to exchange. The court granted the motion with instructions for the sanitary district to clarify and amend its application. On May 20, 2003, the sanitary district submitted its amended application, which no longer sought the appropriation of infiltration into its sewer collection system, estimated to be 2.0 cubic feet per second. After advertising the amended application, the Division of Water Rights received 31 formal comments, a few in support of the sanitary district's application and the majority opposed. The State Engineer then held a second informal adjudicative proceeding. After reviewing all arguments, the State Engineer again rejected the application. After a Request for Reconsideration was again denied, the sanitary district appealed the State Engineer's decision in the Third Judicial District Court in January 2004. There are numerous co-defendants named in this case. Many of these are entities owning downstream water rights that believe they will be directly impacted. Others believe they will be indirectly affected by the ruling, which could set an undesirable precedent.

The State Engineer rejected the sanitary district's application on the following grounds:

- A sewage collection entity does not require a water right.
- Accepting transport of the customer's effluent does not transfer ownership of any water rights to the district.
- The waters in the applicable watershed are fully appropriated.
- The sanitary district did not specify a beneficial purpose for which the water would be used.
- The proposed appropriation was speculative in nature.

In its suit, the sanitary district makes the following assertions:

- "The District is the sole owner of the sewage discharged into its system by its customers, and no other person or entity has any claim on that sewage."
- "The District has the right to use the sewage in its ownership, possession, and control, in any lawful manner consistent with its ownership right."
- "The District is also entitled to declaratory judgment that there are no return flow obligations associated with the water that the District generates from the sewage in its system."
- Because the sanitary district filed its application prior to the enactment of the Conservation and Use of Sewage Effluent Act, this act has no force and effect on its application. To the extent, however, that it is found that the act does apply, the sanitary district alleges that it has a valid water right as defined in the act to include "a contract authorizing the use of water from a water wholesaler or other water supplier having a valid water right under Utah law."[16]

In February 2005, the judge appointed to this case encouraged all involved parties to negotiate an agreement outside of court. If such an agreement cannot be met, the court will be forced to make a difficult and likely controversial ruling.

Provo River Water Users Association v. State Engineer (decision pending)

In January 2004, the Provo River Water Users Association (PRWUA) appealed in Utah's Fourth Judicial District Court in Utah County the State Engineer's decision to approve Payson City's notification to use sewage effluent. Co-defendants named in this case include the U.S. Bureau of Reclamation (BOR) and Payson City.

PRWUA is the local sponsor of the Provo River Project, a BOR project developed to supplement the water supplies of north-central Utah County. PRWUA's water rights are in part dependent upon the water levels in Utah Lake and PRWUA is sensitive to any activities that would adversely affect lake levels. Because Payson City's sewage effluent has historically flowed into Utah Lake, and reusing it would alter this flow pattern, PRWUA feels that its water rights would be impaired if such reuse were allowed.

In its appeal, PRWUA seeks declaratory judgment and modifications to the State Engineer's memorandum decision regarding Payson City's notification of sewage effluent use. The judgments and modifications sought are summarized below:

- "Payson City's municipal water rights are not to be considered 100 percent consumptive and instead shall be limited to historical depletion levels."
- "The [State Engineer's] estimate that 80 percent of diverted water in question arrives at the treatment plant and only 20 percent is depleted is unsupported" and Payson City should be required to report annually the total water diverted as well as a computation showing the "accurate depletion percentages."
- Payson City should be required to determine the amount of ground water that infiltrates into the collection system so that this volume can be deducted from the amount of effluent that can be reused.
- Payson City should be required to discharge an amount of water equal to the infiltration amount and maintain its sewer collection system to prevent infiltration of ground water.

PRWUA also seeks injunctive relief preventing Payson City from acting upon the State Engineer's decision. The court's determination in this case is pending.

Thayer v. City of Rawlins, Wyoming (1979)

(The entire text of this section was borrowed from, U.S. Environmental Protection Agency, Manual: Guidelines for Water Reuse, 1992, 149.)

Faced with more stringent state and federal standards for the treatment of its municipal wastewater, the city of Rawlins, Wyoming, proposed to construct a new treatment facility and to change the location of its existing effluent discharge point in Sugar Creek. Downstream of the existing discharge point, several parties since 1914 had been diverting the waters of Sugar Creek (comprised entirely of the city's effluent) for irrigation, stock water, and other purposes. Such diversions were made pursuant to certificates of appropriation issued by the state of Wyoming, and the holders of such certificates sought compensation from the city for the loss of water caused by the proposed change of location in the city's effluent discharge to a point farther downstream and beyond the points of diversion authorized by the certificates.

The court, by majority opinion, held that since the waters of Sugar Creek were not "natural waters" and since a priority relates only to the natural supply of the stream at the time of appropriation, the downstream users had no priority of use and no right to compensation for the loss of such waters. The determination that such waters were not "natural waters" was based on the fact that the city, via its water supply system, imported these waters from basins outside the natural drainage basin of Sugar Creek. The majority opinion cited a 1925 Wyoming case (Wyoming Hereford Ranch v. Hammond Packing Company, 33 Wyo. 14m 236 P. 764) in support of a policy to the effect that a municipality should be able to utilize a means of sewage disposal that would completely consume water and to change the location of its effluent disposal point without any consideration of the demands of water users who might benefit from its disposal by other means. The court also held that the State Engineer and Board of Control had no jurisdiction over this dispute.

A strong dissenting opinion indicated that this dispute should be decided by the State Engineer and Board of Control on the basis of beneficial use, and should be subject to court review only after such expertise is applied. The dissent would not utilize a distinction between "natural waters" and "imported waters" as a basis for a decision, but would have the State Engineer and Board of Control apply the concept required to compensate or otherwise respect the appropriation rights of downstream uses of its wastewater effluent.

Arizona Public Service v. Long (1989)

(The entire text of this section was borrowed from, U.S. Environmental Protection Agency, Manual: Guidelines for Water Reuse, 1992, 150.)

Several cities in the Phoenix metropolitan area, including the city of Phoenix, contracted in 1973 to sell reclaimed water to a group of electric utilities, including the Arizona Public Service Company, for use as cooling water for the Palo Verde Nuclear Power Project. Pursuant to the contract, the utilities spent some $290 million to construct a 50-mile pipeline and a facility to further treat the effluent, and were utilizing approximately 60 mgd of effluent. Several parties brought suit seeking a court determination that the contract was invalid on various grounds. The Arizona Department of Water Resources filed an amicus brief that sided with the parties seeking to have the contract ruled invalid.

The parties opposing the contract included a major real estate developer in the Phoenix area and owners of ranches located downstream of the effluent discharge point. The real estate developer argued that the contract was in violation of statutory restrictions on the transportation of groundwater contained in the *Arizona Groundwater Code*, and the ranch owners argued that the cities had no right to sell unconsumed effluent because surface waters belong to the public and unused surface waters must be returned to the river bed. The cities and utilities, on the other hand, argued that reclaimed water has essentially lost its character as either ground or surface water and becomes the property of the entity, which has expended funds to create it.

In deciding this case in 1989, the Supreme Court of Arizona, for the most part, rejected the basic arguments of all the parties. The court's majority opinion validated the contract, holding that the cities can put the reclaimed water to any reasonable use. The court determined that effluent is subject to appropriation by downstream users, but that the cities were not obligated to continue to discharge effluent to satisfy the needs of such appropriators. It was pointed out that if scientific and technical advances enabled the utilization of water to eliminate such waste, then the appropriators would have no reason to complain.

In reaching this decision, reclaimed water was determined not to be subject to regulation under Arizona's *Surface Water Code* or *Groundwater Code*, and the available body of case law dealing with rights to and the use of effluent was found lacking. The court indicated that a case-by-case approach to the questions of water use in a desert state was unsatisfactory and urged the state Legislature to enact statutes in the area.

A dissenting opinion concluded that the sale of the ground water portion of the reclaimed water is not regulated by the *Arizona Groundwater Code* and that the concept of beneficial use under the *Arizona Surface Water Code* should be applied only to the surface water component. In this regard, the sale of reclaimed water may be embodied within the concept of full beneficial use. However, the cities may be precluded from entering into the contract for the sale of reclaimed water on the grounds that the discharge constituted an abandonment of the right to increase consumptive use under applicable provisions of the *Surface Water Code*.

LAWS AND REGULATIONS OF OTHER STATES

As exemplified in the court cases above, each state has its own water rights laws and court rulings that have a profound effect on the ability to use reclaimed water. The manner in which a state chooses to handle water rights is an especially important issue because the rights allocated by a state can either promote or hinder water reuse efforts. Although water reuse is a very attractive water supply option for many states in the West, some states have certain laws that tend to encourage water reuse and other laws that tend to discourage reuse. Such mixed messages can ultimately discourage the implementation of water reuse projects in those states.[17]

This section summarizes some of the pertinent laws regulating water rights and water reuse in other western states. Table 16 provides a general overview of these laws. This is a summary of the information that was readily available and should not be construed as an authoritative review of the water rights laws associated with water reuse in those states.

Impacts on Downstream Users

While most states require the impacts of water reuse projects on downstream users to be addressed, other states have minimal or no requirements to consider downstream effects. In Arizona, with the exception of large graywater reuse systems, water reuse projects are permitted without any review of impacts to

TABLE 16

Overview* of Water Rights Laws Regulating Water Reuse in Utah and Other States

State	Laws/Statutes	General Description
Arizona	*Arizona Code:* Title 18, Chapter 9, Article 7 Title 18, Chapter 11, Article 3	General Note – Arizona does not have any regulations that specifically address the water rights issues related to water reuse. The state encourages water reuse by allowing the end user to use the reclaimed water so long as the water quality requirements associated with each type of use are followed. All notification and permitting requirements are handled through the Department of Environmental Quality reclaimed water use permitting process. Use of reclaimed water is facilitated by allowing the end user to use the effluent directly on their property without an agreement with the treatment plant operators or, if delivery is required, to contract with the operators or water supplier for delivery. The state also allows effluent to be blended with other water sources for certain uses. The only type of reuse that requires the impacts on downstream users to be considered is graywater reuse in systems that use more than 400 gallons per day.
California	*California Code of Regulations:* Title 17 Title 22 Article 7, Sec. 13550	Title 17 & 22 – Contains regulations and guidance for use of recycled water. Local sanitation districts have the authority to sell reclaimed water, but this authority is limited in areas served by other water suppliers. In these areas, sanitation districts may work with water suppliers to produce reclaimed water for the water suppliers' customers. Article 7, Section 13550 – Prohibits the use of potable water for nonpotable purposes when reclaimed water is available. Exceptions are allowed where quality of reclaimed water is inadequate, when the cost is too high, where public health is at risk, or if the use of reclaimed water would adversely affect downstream water users or harm the environment.
Colorado	*Colorado Revised Statutes:* Title 37, Article 60, 82, & 96	Title 37-60-126 – Water reuse shall be considered as an option when conducting water conservation and drought mitigation planning in the Colorado River drainage. Title 37-82-106 – Water imported from one hydrologic drainage basin into another can be reused until it is entirely depleted from the drainage to which it was imported. Title 37-96-103 – If available, reclaimed water shall be considered for use in place of potable water when developing water efficient landscaping plans for public buildings.
Nevada	*Nevada Revised Statutes:* Title 48, Chapter 533 & 534	General Note – Nevada does not have any regulation that specifically addresses the water rights issues related to water reuse; instead, the state relies on existing water rights laws and statutes to evaluate the merits of individual water reuse proposals. Beneficial use of sewage effluent is generally encouraged and is allowed under the normal water appropriation process. Such use shall meet the following criteria: it is in the public interest, it will not adversely impact other users, and there is unappropriated water available. Title 48, Chapter 533 & 534 – Reuse projects typically require the wastewater treatment facility operators to obtain a primary water right (or storage right). The actual distributor or user of the water then must enter an agreement with the facility operators to use the effluent produced by the plant and obtain a secondary water right (or beneficial use permit) from the State Engineer.
Utah	*Utah Code:* Title 73, Chapter 3c *Utah Administrative Code:* Rule R655-7	Title 73 Chapter 3c – Authorizes a municipality or other governmental entity owning and operating a wastewater treatment works to reuse sewage effluent collected from water supplied under the governmental entity's water rights. Also authorizes a governmental entity to contract with a regional wastewater treatment facility to act as its agent for the purpose of using sewage effluent. Such use shall be consistent with and without enlargement of those water rights. A change application and new priority date is required for any use inconsistent with the underlying water rights. Title R655-7 – Anyone desiring to use sewage effluent must notify the State Engineer. The State Engineer shall evaluate such proposals to determine if the use of sewage effluent remains within the diversion and depletion limits of the underlying water rights and does not impair other water users with established rights.
Washington	*Revised Code of Washington:* Title 90, Chapter 46	Title 90.46.005 – Declares the use of reclaimed water to be a primary interest of the state's citizens. Reclaimed water shall be used to replace potable water in nonpotable applications, to supplement existing surface and ground water supplies, and to assist in meeting the future water requirements of the state. Directs state agencies to develop an efficient and streamlined process for encouraging, creating and implementing water reuse projects in order to help meet the state's growing water needs. Allows state funding programs to be used for reuse projects. Title 90.46.110 – Authorizes funding for five demonstration projects to study the feasibility of various reuse applications. Title 90.46.120 – The owner of a wastewater treatment facility has the exclusive right to any reclaimed water generated by the facility. Such use and distribution of reclaimed water is exempt from the state's water appropriation permit requirements. Title 90.46.130 – Facilities that reclaim water shall not impair any existing downstream water right unless compensation or mitigation for such impairment is given and agreed to by the affected water right holder.

* The overview in this table is a summary of the information that was readily available and should not be construed as an authoritative review of the water rights laws associated with water reuse in the respective states.

the water rights of downstream users. In Washington, wastewater treatment plant owners are granted the "exclusive right" to any reclaimed water generated by the facility and the use and distribution of such water is exempt from the state's normal water appropriation permit requirements. However, such use shall not impair any existing downstream water right without compensation or mitigation. In Nevada, all water reuse applications are subject to the normal water rights appropriation process, which allows new appropriations only if there are no adverse impacts to other water users. In Colorado and California, the impacts on downstream water users must be considered, but this review is not as intensive as the appropriation process utilized by Nevada.

Incentives for Water Reuse

In 1977, the California State Legislature enacted one of the most progressive water reuse laws anywhere in the United States — a statutory mandate requiring the use of reclaimed water in place of potable water when reclaimed water is available. This law and subsequent legislation has led directly to the implementation of literally hundreds of water reuse projects throughout the state of California. Selected text from California's mandate "Legislative Findings and Declarations; Use of Potable Water for Nonpotable Uses Prohibited" is provided below:[18]

> (a) The Legislature hereby finds and declares that the use of potable domestic water for nonpotable uses, including, but not limited to, cemeteries, golf courses, parks, highway landscaped areas, and industrial and irrigation uses, is a waste or an unreasonable use of the water ... if reclaimed water is available which meets all of the following conditions:
>
> (1) The source of reclaimed water is of adequate quality for these uses and is available for these uses. ...
>
> (2) The reclaimed water may be furnished for these uses at a reasonable cost to the user. ...
>
> (3) After concurrence with the State Department of Health Services, the use of reclaimed water from the proposed source will not be detrimental to public health.
>
> (4) The use of reclaimed water for these uses will not adversely affect downstream water rights, will not degrade water quality, and is determined not to be injurious to plant life, fish, and wildlife.
>
> (b) In making the determination pursuant to subdivision (a), the [state] shall consider the impact of the cost and quality of the nonpotable water on each individual user.

Several states have since followed the example of California and passed laws actively promoting and funding water reuse projects. In Colorado, water reuse must be considered as a water supply option when conducting certain water conservation or drought mitigation planning. Colorado also requires that reclaimed water be considered for use in place of potable water when developing water efficient landscaping plans for public buildings. In Washington, the law requires reclaimed water to be used in the following three applications: (1) in place of potable water in nonpotable applications, (2) to supplement existing surface and ground water supplies, and (3) to assist in meeting the future water requirement of the state. Washington law also directs state agencies to develop an efficient and streamlined process for implementing water reuse projects, authorizes the use of state funds for reuse projects, and provides specific funding for several demonstration projects.

NOTES

[1] U.S. Environmental Protection Agency, *Guidelines for Water Reuse*, EPA/625/R-04/108, (Washington, D.C.: U.S. Environmental Protection Agency, 2004), 175.

[2] *Utah Code, Title 73, Chapter 3c-1. Conservation and Use of Sewage Effluent, Definitions*, (1995).

[3] *Utah Code, Section 19-5-102. Water Quality Act, Definitions*, (2001).

[4] *Utah Code, Section 73-1-10 (1)(a). Conveyance of water rights – Deed – Exceptions – Filing and recording of deed – Report of water right conveyance*, (2003).

[5] *Title 73, Chapter 3c-2 (1). Municipality may use sewage effluent in a manner consistent with its water rights – Change application to be filed for uses inconsistent with water rights.*

[6] *Title 73, Chapter 3c-3 (1)(a). Agent for use of sewage effluent – Change application for inconsistent uses.*

[7] *Title 73, Chapter 3c-3 (2)(a)&(b). Agent for use of sewage effluent* -- *Change application for inconsistent uses.*

[8] *Utah Administrative Code, Rule R655-7-2. Administrative Procedures for Notifying the State Engineer of Sewage Effluent Use or Change in the Point of Discharge for Sewage Effluent, Definitions*, (2003).

[9] *Utah Administrative Code, Rule R655-7-3. Administrative Procedures for Notifying the State Engineer of Sewage Effluent Use or Change in the Point of Discharge for Sewage Effluent, Contents of the Notification.*

[10] Ibid.

[11] Information regarding this application was obtained from the water right file (No. 91-737) on file with the Utah Division of Water Rights in Salt Lake City. This information can also be viewed online at the division's web site: www.waterrights.utah.gov.

[12] Ibid, Water Right No. 35-1573.

[13] Utah State Engineer, *Memorandum Decision*, *In the Matter of Applications for Exchange Nos. 93 and 94*, dated February 19, 1962.

[14] Information regarding this application was obtained from the water right file (No. 59-5578) on file with the Utah Division of Water Rights in Salt Lake City. This information can also be viewed online at the division's web site: www.waterrights.utah.gov.

[15] U.S. Environmental Protection Agency, *Manual: Guidelines for Water Reuse*, EPA/625/R-92/004, (Washington, D.C.: U.S. Environmental Protection Agency, 1992), 149.

[16] *Title 73, Chapter 3c-1 (5)(c). Definitions.*

[17] U.S. Environmental Protection Agency, 2004, 175.

[18] For more information, see *California Code of Regulations,* Article 7, “Water Reuse” *Section 13550*, “Legislative Findings and Declarations; Use of Potable Water for Nonpotable Uses Prohibited.”

7

OTHER IMPORTANT ISSUES

The concepts presented in this chapter are crucial to consider in the implementation of any water reuse project. The topics discussed include: the potential negative impacts of reuse to the human population and the environment, the importance of risk assessment and reliability of treatment processes to ensure public safety, common social concerns and how to deal with concerns effectively through public education, and basic economics and funding of reuse projects. Improperly addressing any one of these topics could lead to the ultimate failure of a proposed project.

POTENTIAL NEGATIVE IMPACTS OF WATER REUSE

Numerous pollutants enter the environment through the discharge of municipal and industrial wastewater. Many of these pollutants result from the production, use and disposal of chemicals that improve industrial and agricultural operations. Other pollutants result from the use of pharmaceutical products and common household activities. While traditional wastewater treatment processes successfully treat and remove biological and pathological contaminants, they are not designed to effectively remove many of the chemical, pharmaceutical and other domestic pollutants.[1] Some of the chemical constituents that have been found in wastewater are categorized in Table 17.

While it is intuitive that such chemicals are potentially harmful to humans and aquatic life, the determination of what contaminant level constitutes toxic or dangerous exposure is complex. This issue is further complicated by the concept of bioaccumulation that can result throughout the food chain as multiple plants and animals that are contaminated are consumed, possibly resulting in a higher concentration of toxins in the consumer. Additional difficulties arise because of the limited ability of studies to separate health effects due to contaminant exposure from effects due to smoking, consumption of alcohol or even general health conditions.[2] Any of the chemicals in Table 17 might pose some short- and long-term risks. The risks may also change from one location and situation to the next. The categories of constituents in this table are listed according to the general ability of wastewater managers to evaluate and manage these risks. This ability is greatest for minerals and trace inorganic chemicals, less for chemical compounds of human origin (of, relating to, or derived from living organisms) and disinfection byproducts, and minimal for the unidentified chemicals that unfortunately comprise the majority of the organics in the water.[3]

It is important to note that although the contaminants found in wastewater are potentially harmful, the related concerns are not unique to water reuse projects. With or without reuse, the contaminants will be introduced into the environment through traditional discharge practices. Concerns and impacts on the human population specific to water reuse would likely result only from direct or indirect potable reuse where the water is not treated to the appropriate level.

While this report could expand at length on the thousands of contaminants found in wastewater, the dis-

TABLE 17
Categorization of Chemical Constituents in Wastewater

Recognized Chemical Constituents	**Examples**
Naturally occurring minerals and inorganic chemicals	Chloride, sodium, sulfate, magnesium, calcium, phosphorus, nitrogen.
Chemicals of human origin	Regulated contaminants and pollutants (trace inorganic and organic chemicals); pesticides, herbicides, fungicides; volatile organic concentrates; fertilizers, nitrates and nitrites; other industrial chemicals.
Chemicals generated as a result of water and wastewater treatment	Known disinfection byproducts, humic substances (material resulting from decomposition of plant or animal matter).
Unknown or of Potential Concern	**Examples**
Possibly present as a component of organic mixtures	Proprietary chemicals and mixtures from industrial applications and their metabolites (chemical changes in living cells); unidentified halogenated compounds (DBPs); pharmaceuticals; endocrine disruptors.

Sources: National Research Council, *Issues in Potable Reuse, The Viability of Augmenting Drinking Water Supplies With Reclaimed Water,* (Washington, D.C.: National Academy Press, 1998), 46. Dorworth, L. E., "Understanding Why Some Organic Contaminants Pose a Health Risk," retrieved from the Illinois-Indiana Sea Grant College Program's Internet web page: http://www.iisgcp.org/aquaecol/wic/contamin.htm, September 2004.

cussion of a few significant constituents and corresponding impacts on the human population and the environment contained in the following sections suffices to illustrate the concerns. Since the contaminants are all human-caused, and typically have similar transport mechanisms, the presence of one is often an indicator of the possible presence of others. Figure 7 illustrates the mechanisms of chemical contaminant transport in the hydrologic system, including pharmaceuticals and personal care products found in a typical wastewater discharge.

Impacts on the Human Population

Water reuse poses many potential negative impacts on the human population if the correct measures for water treatment are not employed and if the impacts are not properly considered. The impacts most commonly considered include health effects resulting from unwanted constituents such as disinfection byproducts, endocrine disruptors and nitrates. Many of the risks associated with these constituents are relatively small under the limitations of Type I and Type II reuse, which prohibit direct human consumption of reuse water. The greatest concerns would be if reuse water were to accidentally enter the potable water system for a sustained period. Although detrimental effects of individual contaminants will be briefly discussed in the following text, it is important to keep in mind that the most severe consequences to humans may not occur as a result of individual contaminants but from the unknown synergistic effects of the combination of multiple contaminants.

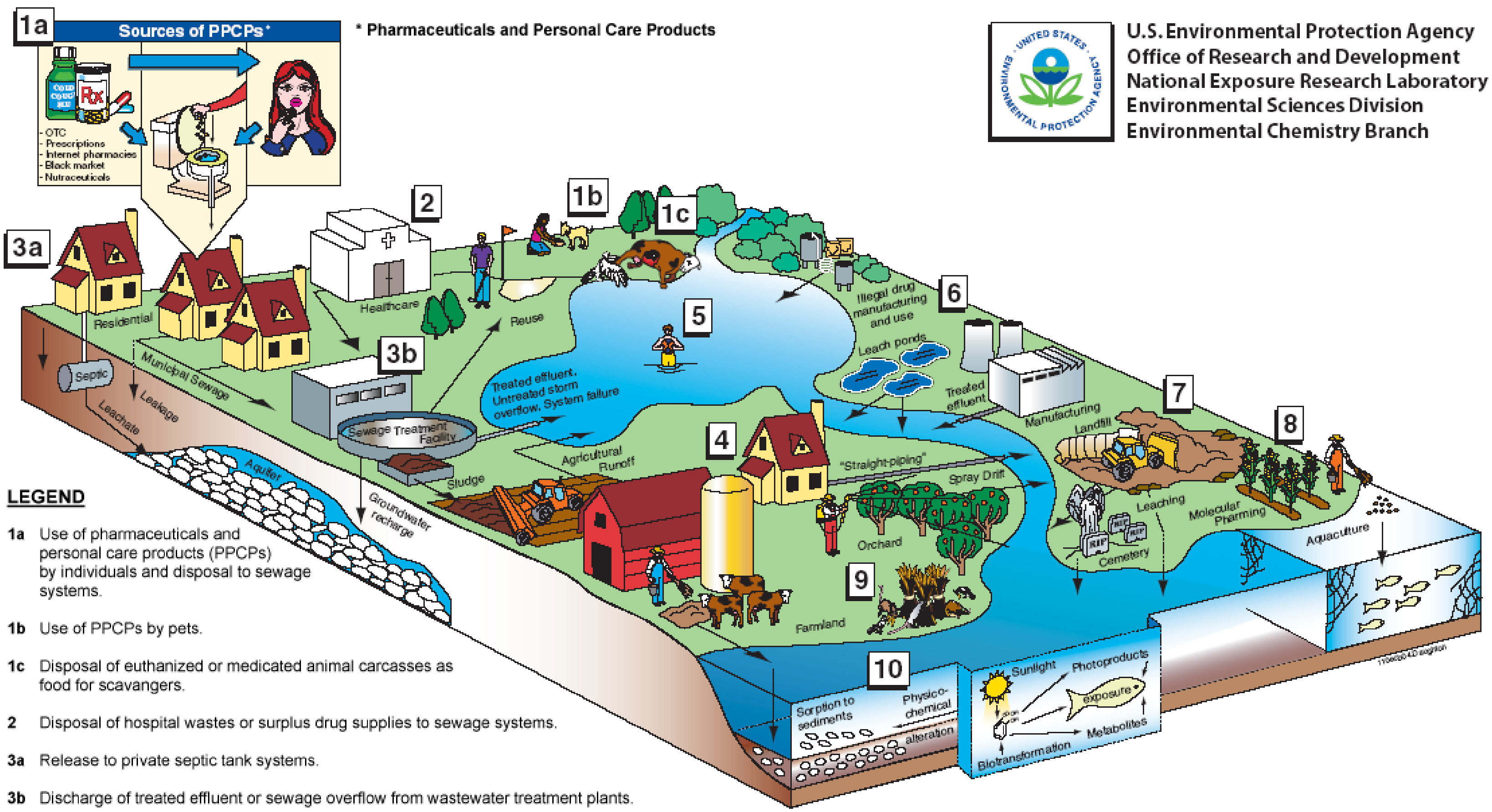
Disinfection Byproducts

Although chlorine disinfection is effective in protecting drinking water and renovated water from bacterial and viral contamination, some detrimental side effects can occur. Disinfectants are chemically very active compounds that not only kill bacteria and inactivate viruses, but can also react with other chemicals present in the water creating new compounds known as disinfection byproducts (DBPs). DBPs associated with chlorine disinfection include trihalomethanes (THMs), such as chloroform and haloacetic acids. THMs are linked to a number of serious health risks. Chloroform is believed to retard fetus growth, while some other THMs are believed to cause cancer.[4]

Because chlorination has been used for almost 100 years to disinfect drinking water supplies, approximately 40 percent of the DBPs from chlorination have been identified and researched. However, much less is known about DBPs produced by other disinfectants because of their relatively recent emer-

FIGURE 7

The Origin and Fate of Various Pollutants in the Environment



LEGEND

- **1a** Use of pharmaceuticals and personal care products (PPCPs) by individuals and disposal to sewage systems.
- **1b** Use of PPCPs by pets.
- **1c** Disposal of euthanized or medicated animal carcasses as food for scavengers.
- **2** Disposal of hospital wastes or surplus drug supplies to sewage systems.
- **3a** Release to private septic tank systems.
- **3b** Discharge of treated effluent or sewage overflow from wastewater treatment plants.
- **4** Land-application of biosolids; straight piping of sewage from homes; and spray drift from crops.
- **5** Direct release to open waters via washing/bathing/swimming.
- **6** Disposal from clandestine drug labs and discharge of industrial waste.
- **7** Leaching from defective landfills and cemeteries.
- **8** Aquaculture waste releases and molecular pharming (production of therapeutics in crops).
- **9** Release of drugs that serve double duty as pest control agents.
- **10** Ultimate environmental transport/fate of pharmaceuticals and personal care products.

Source: Christian G. Daughton, U.S. Environmental Protection Agency-Las Vegas, retrieved from EPA's internet web page: http://epa.gov/nerlesd1/chemistry/pharma/images/drawing.pdf, September 2004.

gence. The use of chloramines (chlorine gas plus ammonia) or chlorine dioxide gas in disinfection produces fewer DBPs than free chlorine. However, there are also risks associated with these options.[5] Research on the relationship between DBPs and respective health risks is ongoing.

Endocrine Disruptors

Endocrine disruptors are chemicals or compounds that can "block, mimic, stimulate, or inhibit the production of natural hormones, thereby disrupting the endocrine system's ability to function properly."[6] Thus, endocrine disruptors are harmful depending on the timing and functional changes stimulated. Low doses of endocrine disruptors that would otherwise have little impact can cause serious adverse effects if introduced during biological development, when hormones are vital to proper maturation.

While there are some natural endocrine disruptors, most are human-made chemicals. These include pharmaceuticals, plasticizers (chemicals added to impart flexibility), industrial detergents, personal care products, and food packaging materials that are released into the environment. Unfortunately, some of the chemicals that show up most often do so because they have been specifically designed by humans not to degrade in order to be effective. Examples include antibiotics and birth control drugs. Between 50 and 90 percent of a typical drug dosage can be excreted and introduced to the environment unchanged.[7]

The EPA Endocrine Disruptor Research Initiative provides the following overview of the negative effects of endocrine disruptors:

> There is evidence that domestic animals and wildlife have suffered adverse consequences from exposure to environmental chemicals that interact with the endocrine system. These problems have been identified primarily in species exposed to relatively high concentrations of organochlorine pesticides, PCBs, dioxins, as well as synthetic and plant-derived estrogens. Whether similar effects are occurring in the general human or wildlife populations from exposures to ambient environmental concentrations is unknown. Reported increases in incidences of certain cancers (breast, testes, prostate) may also be related to endocrine disruption. Because the endocrine system plays a critical role in normal growth, development, and reproduction, even small disturbances in endocrine function may have profound and lasting effects. This is especially true during highly sensitive prenatal periods, such that small changes in endocrine status may have delayed consequences that are evident much later in adult life or in a subsequent generation. Furthermore, the potential for synergistic effects from multiple contaminants exists. The seriousness of the endocrine disruptor hypothesis and the many scientific uncertainties associated with the issue are sufficient to warrant a coordinated federal research effort.[8]

Regulatory action in the United States will probably be delayed until more research is completed that quantifies the dose-response of such chemicals. Fortunately, depending on the disruptor, trickling filters and activated sludge have proved to be effective removal methods. Thus, these problems are less of a concern for water reuse projects. Additionally, the long residence times and high biological activity involved in constructed wetlands and soil aquifer treatment systems should be effective as they provide opportunities for biotransformation.[9] However, it is still advisable to consider potential effects of endocrine disruptors in any direct or indirect potable water reuse project.

Nitrates

Nitrates in wastewater are not a concern for most water reuse projects; in fact, nitrates are actually beneficial for irrigation purposes. However, they can cause problems if allowed to contaminate drinking water supplies. Nitrate has the chemical formula NO_3 and is a negatively charged ion, or anion. It is very soluble in water and is therefore easily transported in water. Although nitrate is not a primary constituent of raw sewage, nitrate is a byproduct of the biological treatment of human waste. While nitrates can be removed from wastewater through biological denitrification or ion exchange, traditional wastewater treatment processes do not remove nitrate. Because nitrates are commonly found in wastewater effluent and can cause problems at elevated levels, they are periodically monitored.[10]

Nitrates in drinking water can enter the human body and decrease the oxygen-carrying capacity of the blood. As a result, nitrates pose a potential health threat especially to infants and can cause the condition known as "blue baby syndrome." Even though fatalities are rare, less severe asymptomatic developmental impairment is a potential concern. Chronic consumption of high levels of nitrate is believed to also cause other health problems, such as cancer and teratogenic effects (developmental malformations). Although data are inconclusive as to all the effects of nitrates, the greatest concerns would arise only from potable reuse.[11]

Impacts on the Environment

Endocrine Disruptors

Many of the same impacts resulting from the contaminants discussed above can occur in the environment. Studies have confirmed that wastewater contains sufficient levels of endocrine disruptors to potentially cause hormonal changes in aquatic life, but as with other contaminants, not enough data exist to conclusively link exposure to such compounds with adverse effects in wildlife. However, considerably more data are available on the effects of endocrine disruptors on wildlife, particularly fish, than on humans.[12] The possibility that endocrine disruptors are harmful to the environment can actually be an incentive to implement water reuse projects that would remove the contaminants from aquatic ecosystems.

Total Dissolved Salts

One constituent that is a considerably larger problem to the environment than to humans directly is dissolved salts in the effluent. As explained in Chapter 5, reclaimed water used for irrigation purposes is only required to meet Type II standards. Thus, more constituents would remain in the effluent than with Type I treatment standards that allow direct contact with humans. As long as the concentration of total dissolved salts is below 500 mg/L, no harmful effects are usually apparent. Sensitive plants can be affected by concentrations between 500 and 1000 mg/L. At levels from 1,000 to 2,000 mg/L, many crops can be affected and careful management processes need to be followed.[13]

If not properly managed, salt can accumulate in a plant's root zone affecting the ability of crops to take up water and of soil to support crop growth. The accumulation of salts in the soil can ultimately lead to sterilization of the soil, which dramatically reduces crop yield or turf performance. One way to mitigate this problem is to ensure a proper net downward flux of water and salt through the root zone with adequate drainage conditions to allow flushing of the salts away from the critical soil zone for plant roots.[14]

Effects on Polluted Water Bodies

If water reuse were practiced on a large enough scale, the quality of some waters previously receiving highly treated effluent might diminish. As is the case with the Jordan River in the Salt Lake Valley, some rivers are actually more contaminated than the effluent discharged to them. Thus, if the effluent is diverted to another use, the amount of water necessary to dilute contaminants to acceptable levels may no longer be available. A detrimental effect may also be felt by the Great Salt Lake if a significant amount of return flows from wastewater treatment plants are reused. However, any effects from reuse would likely not be any different than those resulting from other methods of water development necessary to meet future demands.

It may be important to note here that the above example is not the case with all water bodies. Nitrogen

Endocrine disruptors can have an effect on fish and wildlife that come in contact with effluent, but the full effects including bioaccumulation are not totally understood.

and phosphorus present in wastewater stimulate algae growth and can cause undesirable eutrophication of lakes and reservoirs. Water reuse may benefit many streams, lakes and reservoirs, as the diversion of reclaimed water containing nitrogen and phosphorus would help prevent some water bodies from becoming eutrophic. This water could then be used for irrigation purposes where the nitrogen and other constituents such as phosphorus could actually be beneficial to plants and crops under controlled conditions. The extra nutrients may result not only in increased performance of the irrigated plants or crops, but also in increased savings due to the reduced requirements for commercial fertilizers. The presence of nitrogen and phosphorus may be a detriment if reclaimed water is being considered for river restoration, recreational purposes or other uses where the water may be stored in reservoirs or lakes where algae growth is undesirable.

Instream Flows

As more and more sources of water are developed to supply water for municipalities, discharged wastewater constitutes a continually larger portion of the surface water supplied to downstream users. One such example is the Santa Anna River in California, which is composed of nearly 80 percent tertiary treated effluent by the time it is used by San Diego. As more reclaimed water is diverted for reuse in Utah, there is the potential for a reduction of stream flows.

Varying amounts of instream flows can be required depending on the designation and use of a particular water body. Uses include swimming, rafting, sustaining fisheries, maintaining wetlands, providing downstream water supplies, assimilating wastes and generating hydroelectric power. Although some of these uses may be simultaneously maintained and each one produces economic benefits, they often compete with each other for limited resources.[15]

A recent study reviewed and summarized over 125 studies performed over the past two decades on instream flows. The studies focused on the actual economic benefits produced by the protection of instream flows, on the public's willingness to pay to protect instream flows, and on the adverse economic impacts resulting from a failure to protect such flows. Categories of instream flow were identified as recreational, water quality and hydropower. The following pertinent conclusions were drawn from the study.[16]

- Results strongly suggest that protection of instream flows has the potential to produce significant economic benefits. This conclusion appears to be valid irrespective of whether the instream flows provide benefits from recreational, water supply, water quality or hydropower activities.
- The pollution control requirements of the National Pollutant Discharge Elimination System (NPDES) permit are usually based on the 7Q10 flow (the lowest flow occurring for seven consecutive days in a 10-year period) of the stream receiving the pollutant to be discharged. If streamflows fall below this level, then the 7Q10 flow would have to be recalculated. If the 7Q10 flow has to be recalculated, then the requirements of the NPDES permit must be recalculated. In essence, if the assimilative capacity of the stream is reduced, then the stringency of treatment requirements must be increased. Any recalculation of the treatment requirements contained in the NPDES permit could increase treatment costs significantly.

For many, knowing the potential impacts on the human population and the environment resulting from endocrine disruptors, total dissolved solids, nitrates, and other pollutants is only additional motivation to reuse reclaimed water. The reasoning is that treated effluent containing these contaminants would no longer be discharged to further degrade the state's water bodies, but could be put to a beneficial use that is not affected by such constituents. This would aid in preserving vital water resources for potable purposes.

When one investigates the potential negative impacts of reusing water, the totality of the system must be considered. This includes the chain of events from the first acquisition of water for drinking, treatment of that water, treatment levels at the wastewater treatment plant, return of wastewater to the environment (which acts as a buffer), and subsequent reuse of the water. Because of the standard measures of safety taken to protect public health in wastewater treatment systems and water treatment systems, the risks associated with consumers' exposure to regulated contaminants are small.[17] However, the risks associated with unregulated contaminants are unknown.

While everyone accepts risk in driving an automobile or riding in an airplane, when it comes to water supplies and public health, people sometimes expect zero risk. Although it is not humanly possible to fully eliminate risk, it can be managed and minimized. Assessing this risk and the reliability of the treatment process as it relates to reuse is discussed in the following section.

RISK ASSESSMENT AND RELIABILITY OF TREATMENT PROCESSES

With all the possible contaminants in wastewater, it is obvious that there is some risk involved in reusing or recycling treated wastewater. Just how big of a risk is an important question that authorities must answer in establishing regulations to protect public health and safety. Thus, it is understandable why the standards are dependent upon the category of reuse — the greater the risk of human contact or exposure, the stricter the standards. Historically, water quality standards have been based largely upon the qualitative performance of treatment methods to minimize the risk of public exposure to pathogens and other harmful constituents. These qualitative standards appear to have functioned well for many of the water reuse projects in operation for years around the country. However, as water shortages increase and indirect potable reuse through ground water recharge or direct human contact through recreational uses become more prevalent, the lack of a better quantitative method to evaluate the risk of exposure associated with these uses creates a problem.[18]

An example of this occurred in California when the state assembled an advisory panel to evaluate the use of reclaimed wastewater for recharge of aquifers used for potable purposes. The panel's report, issued in 1987, stated that because current treatment processes were capable of removing known pathogens below detectable levels, further ground water recharge with reclaimed water was allowable. The report also stated the risks did not seem to exceed the analogous risks from surface water supplies of drinking water. Problems later arose as regulators attempted to convert the panel's conclusions (based upon qualitative findings) into public policy without a formal quantitative analysis. This left policymakers without the necessary scientific information to establish clear guidelines in California for future ground water recharge projects using reclaimed water.[19]

Risk Assessment

Part of the solution to the challenge of establishing water reuse guidelines is performing a risk assessment. Although numerous harmful constituents are known to be present in wastewater, the actual harmful effects of all these constituents are not known. However, just because a substance is known to be harmful does not necessarily make its use unsafe. "People are continuously exposed to infectious disease hazards such as drinking polluted water, consuming contaminated foods and swimming in unsanitary water, but the concentration of infectious agents, the amount ingested, the duration of exposure and the characteristics of the exposed population are factors of importance for actual risk."[20] The safety of a substance relates to the likelihood of adverse effects resulting from exposure to the substance.[21] A risk assessment attempts to evaluate the probability of these adverse effects.

The four elements of a risk assessment as defined by the National Research Council (NRC) are: [22]

- Identify the hazard.
- Assess the extent and route of exposure.
- Determine the response of humans to exposure.
- Describe the risk.

A risk assessment done properly, and with state-of-the-art methods, allows authorities to ensure that water quality standards reflect the latest understanding of disease occurrence and transmission and the latest technology applications. A risk assessment is never without uncertainty due to the difficulty of monitoring every chemical, pathogen or other harmful constituent. Risk managers have an obligation to communicate this uncertainty to the public in a manner that preserves the public's confidence and trust in wastewater reuse projects without creating a false sense of security. The message that should be conveyed is that all practices that will be undertaken are sensible and essentially risk-free within reason.[23]

Reliability of Treatment

Another important factor in determining and reducing the risk present in the use of reclaimed wastewater is the reliability of the treatment processes. From the mid-1940s until 1980, about 40 percent of drinking water disease outbreaks in public water supplies were attributed to failures in the treatment process.[24] Although these inadequacies or failures occurred during the treatment of drinking water, the same complications could arise during wastewater reclamation. As previously mentioned, many of the current treatment standards are based upon the understanding of the capability of certain treatment processes. Any deviation from standard treatment practices in a proposed treatment system must demonstrate treatment capabilities equivalent or superior to time-proven methods.

The following two sections discuss a study in San Diego to investigate the reliability of an advanced water treatment plant (AWT) and safety precautions taken to help ensure effective treatment including natural barriers, treatment barriers and other precautions.

San Diego Total Resource Recovery Project — Health Effects Study

In 1977, the California State Water Resource Control Board formed a Technical Advisory Committee to study the impacts of a proposed Total Resource Recovery Project. A Health Advisory Committee (HAC) was also set up to address public health issues. The proposed treatment system would provide advanced water treatment through tertiary treatment including ultraviolet disinfection, reverse osmosis and other treatment methods. The objective of the project was to study "the technical and public health issues associated with, and to develop a strategy for, wastewater reclamation that includes evaluating the feasibility of recycling a portion of the city's wastewater" mainly as a means to supplement the drinking water supply.[25]

Results from the study include the following: [26]

- The average concentration of most constituents of public health concern was so low as to be close to detection limits as were microbial indicator organisms in the final effluent from the plant.
- Over a two-and-a-half year period at the first site and over a one year period at the second site, critical equipment was operational nearly 100 percent of the time, and observed equipment failures did not result in any significant down time of the facilities or significantly affect the quality of the effluent.
- Based on hazard index results, "a significant public health risk would not be anticipated."

The HAC concluded that the health risk associated with the use of reclaimed water as a supplement to its drinking water supply was less than or equal to that of the city's existing raw water entering the water treatment plant.[27]

Barriers and Safety Precautions in the Treatment Process

Any part of a wastewater treatment process that reduces the risk of exposure to contaminants is referred to as a "barrier." Different types of barriers remove different types of contaminants. The independence of each barrier in a treatment process as well as the cumulative effect of multiple barriers must be evaluated in order to determine the overall capability and reliability of treatment. Indirect reuse provides additional barriers by definition as it provides an environmental buffer that can provide: [28]

- further reduction of contaminants through natural processes,
- substantial lag time and separation between the discharge of the treatment plant and entrance into the reuse system allowing time for further degradation of contaminants, and
- mixing of the reclaimed water with natural waters in the environment reducing the concentration of any remaining effluent constituents.

The more barriers present in a treatment process, the better the reliability of the process, as long as the barriers are independent of one another. The independence of the barriers is key to a treatment process with regards to reliability and safety. If a system lacks sufficient independent barriers, the failure of an initial component of treatment can cause havoc during the rest of the process. Such was the case with the *Cryptosporidium* outbreak in Milwaukee in 1993, where proper coagulation did not occur prior to the sedimentation and filtration steps in a drinking water system. However, multiple independent barriers to remove certain wastewater constituents are not always necessary. The ability of the treatment system to consistently remove harmful pathogens (i.e. *Cryptosporidium*) is much more important than to consistently remove lead or nitrate since pathogens pose a much higher risk over a short period whereas other constituents such as lead or nitrate would likely only have detrimental effects if allowed to persist over a long period of time.[29]

Reservoirs provide an environmental barrier that can reduce some of the risks involved with indirect water reuse through natural degradation of contaminants, lag time between discharge and reuse, and reduction of contaminant concentration by mixing with natural waters.

An additional precaution or barrier required by *Utah Code* is the requirement of an alternative disposal option or diversion to storage if water quality standards are not met. In the event that wastewater has not been sufficiently treated to meet reuse standards, the effluent must be rerouted to the beginning of the treatment plant to be re-treated or is discharged to an alternate storage area. In the case of Tooele's wastewater treatment facility (described in Chapter 3), continuous monitoring of chlorine residual and turbidity is done by online analyzers. If at any point in time the water fails to meet quality standards, the plant automatically diverts the water to a holding pond. This water is then returned back to the headworks for re-treatment. The interruption of finished irrigation water production for a short time is not a concern because of the large storage of treated effluent on the plant site (3.5 mgd) and at the Overlake Golf Course.

SOCIAL CONCERNS AND PUBLIC EDUCATION

One of the most important aspects in the exploration of and implementation of a water reuse project is proper communication with the public. The average person has never witnessed the treatment of sewage at a treatment plant and does not have much, if any, knowledge or understanding of the treatment process. Unfortunately, because of the ingrained, psychological preconception about sewage, this often leads to the public's initial negative response to a reuse project with claims that the reclaimed water is "unclean," "smelly," "filthy" or "disease-ridden." Consumers are also often unaware that the existing raw water supply may already contain treated wastewater effluent. In a study completed in 1971, it was found that one-third of the U.S. population consumes treated water from streams of which approximately 3.3 percent is wastewater effluent produced upstream and returned to the stream.[30] Another study by the University of California performed in 1978 found that public knowledge of water resources was extremely poor, with 67 percent of those surveyed not knowing the source of their drinking water.[31]

This lack of knowledge and education can present a problem in attempting to implement a water reuse project or even just in determining public opinion. Numerous studies conducted over the years show that acceptance of reclaimed water varies significantly with different social factors such as education, gender and age. Acceptance of reclaimed water varied from 26 to 36 percent (depending on the study) among those with eight or fewer years of formal education, while 63 to 90 percent of those with some college background were willing to drink reclaimed water.[32] Other factors that can influence public opinion include: [33]

- Economics – Those financially well-off are sometimes willing to pay more for water to avoid the use of reclaimed water.
- Experience – Often those with previous water-shortage experience are more accepting of reclaimed water.
- Knowledge – Not only does higher education in general increase acceptance, but also actual knowledge about reclaimed water and or treatment processes.
- Likeliness of implementation – One hypothesis suggests that the closer the reality of reuse the more negative the response.

One statistic shown not to be influenced by these or other factors is that public acceptance is inversely connected to the level of proposed human contact or exposure to the reclaimed water. In other words, as the level of human contact decreases, the level of acceptance by society increases.[34] This suggests, as one might logically expect, that society is willing to allow the reuse of renovated water for lower contact purposes even if it is reluctant to support direct potable reuse.

The difficulty of understanding public opinion is demonstrated by the often erroneous predictions of public officials who are supposed to represent this opinion. Studies show that public officials underestimate significantly the acceptance of the public. A 1969 survey of residents in Chanute, Kansas, (following the emergency reuse situation described in Chapter 1) showed a public acceptance rate of 61 percent for drinking the reclaimed wastewater while surveyed officials predicted only 1.4 percent. Other surveys conducted show similar results with industries. Industry officials expressed far greater acceptance of water reuse than surveyed public officials had assumed.[35]

As difficult as it may be to determine if the public will accept water reuse, one thing is certain — if the public is opposed to a project, it will not be implemented. Such was the case with a project in Los Angeles, that would have diverted a portion of the 65 million gallons per day of treated effluent for irrigation and industrial purposes. Due to a public outcry, caused largely by a misleading newspaper headline "'Toilet to tap': Let's not get hasty" that appeared in the *Sacramento Bee*, the project was doomed from the outset. Even after the facts came out as authorities tried to educate the public, officials were pressured into condemning the project.[36]

Nearly every reuse project will experience some concerns about the safety of the proposed reuse. In order to avoid the same magnitude of opposition that occurred in Los Angeles, careful planning and communication must occur to ensure public understanding.

Acceptance of water reuse likely will not come immediately and results of efforts may not be apparent for some time. But through joint efforts and effective communication among officials, authorities and the public, common ground can be found to implement beneficial reuse projects. The message that must be conveyed to society is that the earth's finite supply of water has been reused innumerable times over the history of time whether by dinosaurs and woolly mammoths, zebras and giraffes, or by our upstream neighbor and us. The only difference now is that instead of occurring naturally, components of nature's water cycle are being technologically accelerated.

WATER REUSE ECONOMICS AND POTENTIAL FUNDING SOURCES

Economics is an additional obstacle that might present itself at any time during the consideration of a water reuse or recycling project. If a project makes sense in every other aspect, but is not economically feasible, it will not likely be implemented. In determining the feasibility of a reuse project, the following things must be considered: the general economics of the best alternative, implementation of various cost allocations, and possible sources of funding. These concepts are discussed in the following text.

Best Alternative

As is the case when developing any water supply, the economics of all possibilities for new water sources must be considered. Investigating the potential for water reuse projects is no different. In comparing water reuse to the "best" alternative source, one must consider any un-appropriated sources as well as waters that are currently in agricultural or other uses that may be valued at less than the reclaimed water for the intended purpose. A project to

As additional water developments require long, expensive pipelines, the economics of meeting future water needs may favor a water reuse project.

reclaim water from a treatment facility is economically feasible if the reclaimed water provides equal or better service at an equal or lower cost to the sponsor's customers than could be expected of water from the next best alternative source. In some instances, such as the Central Utah Project, the best alternative is influenced by a requirement from the federal government to implement water reuse in order to obtain funding.

For example, if water reuse is being evaluated as a source of water for a lawn and garden irrigation system, planners must ask what other sources are now, or may soon become available to meet this same need. If the setting for the proposed reuse project is a heavily urbanized area where water sources are fully committed to a single-purpose drinking water system, all future additions to the water supply will most likely be from established potable water vendors. In such cases, the best alternative to a reuse project may be the expansion of the drinking water conveyance and delivery system and the purchase of water treated to meet all needs. Experience in Utah suggests that in such cases the benefits of the reuse project (often figured as equivalent to the cost of the next best alternative) may be approximately equal to the costs.

If the setting for the proposed reuse project is more rural, where untreated water used for irrigation is plentiful and available, the best alternative source may be to purchase shares in the local irrigation company. In such cases, the cost of water from this alternative will likely be less than the cost of the reuse project water, making the reuse project infeasible.

If all local sources are fully committed or utilized, the best alternative may be importing the water from another basin or sub-basin. If this alternative water source is only available after the construction of dams, reservoirs, and pipelines, it is likely that the cost of the best alternative will exceed the cost of the reclaimed water, leading to a favorable outcome of benefits (cost of the next best alternative) exceeding the costs.

Another important aspect that must be factored into the cost of reuse is the cost of future upgrades of the wastewater treatment facility to meet discharge requirements. If an upgrade were altered to provide for a reuse project, additional funding might be available that otherwise would not be accessible. This would not only reduce the cost of the reuse project but also of the necessary expansion itself.

Cost and Cost Allocation of Water Reuse Projects

Due to the relative newness of water reuse in Utah, not a lot is known about some of the specifics of implementing a project. However, based on the economic analyses of a few project proposals in Utah, the additional cost of treating wastewater to Type I standards is in the range of $220 to $300 per acre-foot.[37] Since wastewater treatment plants are usually located at or near the lowest point in elevation of the entire water system and current water rights regulations require reuse water to be used in the same manner and location as the original water right (without a change application), extensive pipeline and pumping costs will often be required. This may add $100 to $200 per acre-foot, or more, to the cost of reclaimed water. Another cost component may include distribution system piping. Additional studies are underway by various agencies that will provide additional unit cost data for water reuse projects in Utah.

In comparison with other states in the southwest, this range of costs is not unreasonable. In states such as California, Arizona, and Texas, reuse water sells for $300 to $350 per acre-foot. One large difference in the economics of reuse for these states is that potable water sells for around twice that amount or $600 to $700 per acre-foot. In contrast, the state average for potable water in Utah is about $380 per acre-foot. This could create a problem in trying to recover costs for a reuse project if the amount charged to reclaimed water customers exceeds the charge the same customers would have faced for available potable water. There are some parts of the state, such as Park City, where the current price for potable water (approximately $700 per acre-foot) would favor the implementation of water reuse.[38]

Cost allocation can become complicated and the manner in which it is done can have a great effect on the success of a water reuse project. In most cases where a reuse project would be put into service, a treatment plant already exists. The capital costs and cost of treatment (usually secondary treatment) are already largely recovered through user charges to all those served by the treatment facility. In the instance where facility upgrades for increased capacity or additional treatment are necessary in order to implement a reuse project, there are various methods to allocate these costs.

One cost allocation method is to separate the cost of normal sewage treatment from the cost of full water reclamation. This is the model used by the Irvine Ranch Water District IRWD) in southern California. In order to maintain a fair approach in charging its customers, IRWD separates the costs involved with normal treatment and disposal of sewage, regardless of whether a reuse project is in place, from the additional costs resulting from the production and distribution of reclaimed water. Thus, those who produce the waste are charged fees based only on the cost to treat that waste, and those who are using reclaimed water are charged only for the increased costs incurred as a result of the production of an additional water supply.[39]

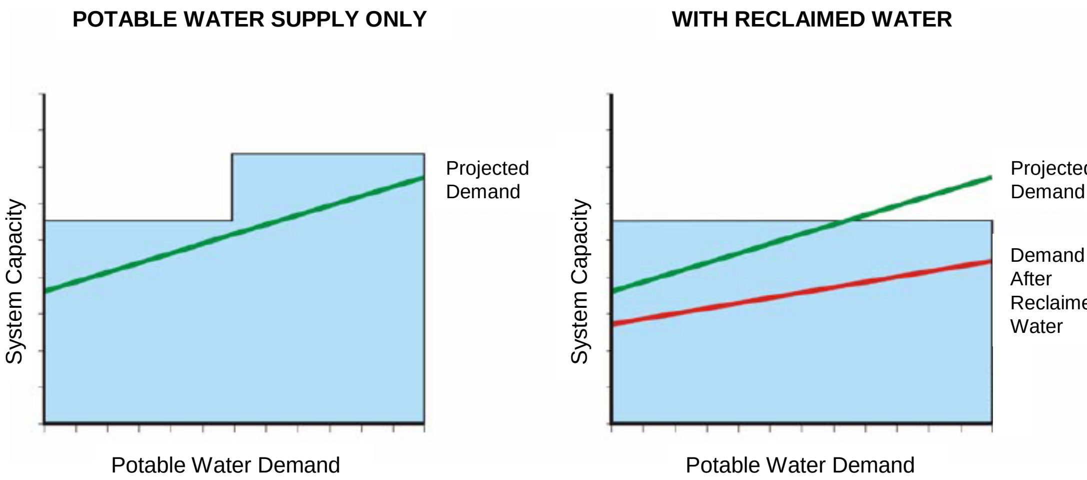
Another creative method to allocate the cost of a reuse project involves requiring growth to pay for the project. In order to compensate for the costs associated with providing additional capacity to serve growth, municipalities have the authority to impose capital facilities fees on new developments for the right to connect to existing water systems. Water reclamation facilities could create an additional water supply, thus expanding capacity. As reclaimed water is substituted for potable water in various applications and delivered through a separate distribution system, more potable water becomes available to serve further development and expansion. This might delay or reduce the normal expansion of the potable water system (as shown in Figure 8) and the associated costs. Thus, the capital costs to implement water reuse facilities could be incorporated in the costs charged to new development normally attributed to expansions through capital facilities charges.[40]

There are, no doubt, numerous ways that an agency could allocate the costs depending upon its respective policies. The main idea that is that any approach used in setting the rate for reclaimed water must take into account the interests of the end user. Some users may be perfectly willing to pay a price equal to or even slightly higher than potable water in order to have access to a reliable supply of reclaimed water. In contrast, others may only be willing to pay a dramatically discounted price because of some of the unknowns involved with the quality of reclaimed water.

Potential Federal Funding Sources

Depending on the specific nature of a water reuse project, multiple governmental agencies may be available to provide partial funding. The most likely federal agency that would provide funding for a reuse project in Utah is the U.S. Bureau of Reclamation (BOR). However, if the nature of reuse fits into the U.S. Army Corps of Engineers' (COE) mission of "planning, designing, building and operating water resources and other civil works projects (Navigation, Flood Control, Environmental Protection, Disaster Response, etc.)," COE would also be available to fund up to 65 percent of the cost of a project. Ex-

FIGURE 8
Expansion of Capacity through Reclaimed Water



Source: Grantham, Robert S., "Alternative Funding Sources for Recycled Water Programs" (WateReuse Symposium, September, 2004), 4.

amples of this are several projects in Arizona that use reclaimed water for river restoration purposes. A third possible federal source of funding is through Community Development Block Grant (CDBG) programs.

<u>*U.S. Bureau of Reclamation*</u>

BOR is responsible for implementing the act of Congress entitled Reclamation Wastewater and Groundwater Studies and Facilities Act. This act, often referred to as *Title XVI*, is the only federal program that provides assistance to localities specifically for developing water reuse projects, particularly in small communities. Funds made available by this act can be used to plan, design and construct water reuse and recycling projects. Although COE as well as the Environmental Protection Agency may be able to provide some assistance in limited circumstances, *Title XVI* is the only regularly funded program specifically for such purposes. It was designed by Congress to provide an incentive to local agencies to initiate water reuse projects as alternative water supply projects by providing money to help defray the expensive costs of implementation.[41]

Title XVI, *Section 1602*, defines a water reuse project as a project that reclaims and reuses municipal, industrial, domestic, or agricultural wastewater, or naturally impaired ground water and/or surface waters for a variety of purposes including environmental, ground water recharge, municipal, domestic, agricultural, recreational and others. The BOR is authorized to fund any congressionally authorized reuse project up to 25 percent of the total project cost, but under *Section 1631* it is limited to a total contribution of $20 million (1996 dollars) per project. BOR is authorized to fund up to 50 percent of a feasibility study, but the amount contributed is figured into the total 25 percent cap if the project is subsequently constructed. All operation and maintenance costs must be covered by the nonfederal or local agency.[42]

Before Congress will authorize a project that meets the definition in *Title XVI*, the following prerequisites must be met:[43]

- "[BOR] or the nonfederal project sponsor completes a feasibility study that complies with the provisions of the Act (the feasibility study report under this act differs from the traditional reports required by the [BOR]),
- The Secretary of the Interior determines that the nonfederal sponsor is financially capable of funding the nonfederal share of the project costs, and
- The Secretary of the Interior approves a cost-sharing agreement with the project sponsor."

BOR must also ensure appropriate environmental compliance under the National Environmental Policy Act during the feasibility stage before construction funding can be authorized.

Because Congress appropriates requested funds, several things are important to remember. There are a number of projects that were authorized directly in the *Title XVI* legislation that have not been funded or completed. Since the program's budget has been flat and is now declining, any new projects would probably have to get specific congressional authorization written into future budgets to receive funding. Depending on the number of funding requests, a delay of several years may be expected due to the schedule of Congress. Continuation of funding from one fiscal year to the next may also be an issue as it is at the discretion of Congress.[44] Also, due to limited budgets, not all projects may receive a full 25 percent contribution from BOR. In accordance with *Title XVI* and other federal laws, priority will be given by BOR to projects that: [45]

- "reduce, postpone, or eliminate development of new or expanded water supplies;
- reduce or eliminate the use of existing diversions from natural watercourses;
- reduce the demand on existing federal water supply facilities;
- improve surface or groundwater quality, or the quality of effluent discharges, except where the purpose is to meet surface discharge requirements;
- help fulfill BOR's legal and contractual water supply obligations, such as Indian trust responsibilities;
- serve the federal environmental interests in restoring and enhancing habitats and providing water for federally threatened and endangered species;
- promote and apply a regional or watershed perspective;
- serve a Native American community;
- serve a small, rural, or economically disadvantaged community;
- provide significant economic benefits."

Several agencies throughout the state have already been able to take advantage of BOR's funding including St. George, Tooele, Central Valley Water Reclamation in Salt Lake County, and Pine View Water Systems in Weber County. Agencies interested in seeking federal aid or simply in finding out more about the possibilities and guidelines, should contact the proper regional BOR coordinator.

Community Development Block Grant (CDBG)

The CDBG is available through the federal Housing and Urban Development program. It is available to communities in Utah outside of Salt Lake County with less than 50,000 residents. Because the program is directed towards helping low income areas, a community must also consist of 51 percent or more of low- to moderate-income families to be eligible. Certain regions throughout the state have additional restrictions on the amount of funds available. More information on this funding program can be found through the Department of Community and Economic Development or through the CDBG web page (http://dced.utah.gov/cdbg).

Potential State Funding Sources

Local sources of funding may include the Utah Board of Water Resources and the Utah Division of Water Quality. Both entities analyze each proposal separately and award funding on a case-by-case basis. Agencies within the service boundaries of the Central Utah Water Conservancy District may be eligible to obtain funding under the Water Conservation Credit Program, and agencies outside of the Wasatch Front may be eligible for funding through the Permanent Community Impact Fund (CIB).

Utah Board of Water Resources

The Utah Board of Water Resources could provide funding for reuse projects that fall under the board's mission to "promote the orderly and timely planning, conservation, development, utilization and protection of Utah's water resources."[46] As of 2005, only one request for funding for a water reuse project had been requested from the board. An application form for financial assistance can be obtained from the Utah Division of Water Resources webpage (http://www.water.utah.gov/construction/makeappl.asp) or by contacting the Utah Division of Water Resources. A document containing guidelines for applicants can be obtained in the same manner.

Utah Division of Water Quality

Any publicly owned treatment works can apply for funding from the Utah Division of Water Quality (DWQ). As of November 2004, DWQ has provided funding for several reuse projects and has ample funding available for future projects. Any interested agency is encouraged to contact the Construction Assistance Section, Utah Division of Water Quality at (801) 538-6940, or at 288 North 1460 West, Box 144870, Salt Lake City, Utah 84114-4870.

Central Utah Project Completion Act — Water Conservation Credit Program[47]

In order to fulfill obligations made in 1992 by Congress as part of the Central Utah Project Completion Act (CUPCA), the Central Utah Water Conservancy District (CUWCD) initiated the Water Conservation Credit Program to identify, evaluate and implement water conservation programs. The credit program helps to partially fund projects that help to conserve water resources within the Central Utah Project area.

In 2002, CUPCA was amended to allow certain unexpended funds authorized for the Central Utah Project for use in conservation measures. The amendment also expanded the definition of conservation to include water reuse. Any entities interested in obtaining funding through the Water Conservation Credit Program must develop a proposal to be submitted to the Credit Program Manager for CUWCD for evaluation. The telephone number is (801) 226-7144.

Any surcharges collected from the CUWCD for not meeting its annual water reuse requirements between 2016 and 2050, as discussed in Chapter 4, will also be available to aid in the implementation of water reuse projects. All funds must be used by CUWCD to help fund water reuse projects by the end of 2055 or its responsibility for administration of the funds will be forfeited.

Permanent Community Impact Fund (CIB)

The CIB provides funding for governmental entities outside of Utah, Salt Lake, Davis and Weber counties. The program's main focus is to provide assistance to energy resource producing areas in the southern and eastern parts of the state through grants and low interest loans. Funding is available for feasibility studies with a 50/50 cash match and for the implementation of a project up to $2.5 million. More information is available through the CIB web page (http://dced.utah.gov/pcifb) or through the Department of Community and Economic Development.

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8

CONCLUSION: THE NEXT STEP FOR WATER REUSE IN UTAH

Utah is a semi-arid state, so water is scarce. There is no doubt that water will always be a valuable resource in the state and obtaining it will only become increasingly difficult as time passes. Most of the easily obtainable sources of water have already been developed, and in some areas, other than potential water reuse projects, only large trans-basin diversions remain to meet future increases in demand. The population of the state is increasing, and as a result, water demand continues to rise. The potential for water reuse to meet some of this demand is promising and implementation of reuse is already occurring. Eventually, water reuse will become an essential element of many communities' water supplies. Consequently, the question with respect to water reuse is not if it will become commonplace, but when and how much.

THE CURRENT CONDITION OF REUSE IN UTAH

Past engineers, city planners and water managers have done an excellent job in providing water for the needs of Utah's residents. Largely due to this success, Utah has not yet needed to seriously consider water reuse to augment water supplies. However, for years various individuals have realized the potential of reclaimed water as a valuable source of water and have subsequently filed for water rights to utilize local effluent flows. Only more recently have numerous municipalities and water-supply agencies turned to water reuse as a means to develop more water. This is evidenced by the fact that the currently proposed projects discussed in Chapter 4 will nearly double the number of reuse projects in the state.

The primary purpose of a reuse project is to expand water supplies by putting what has been seen as a waste product to beneficial use while still protecting public health and the environment. In response to the increased attention given to water reuse as a way to augment water supplies for the public, the legislature has enacted laws and directed agencies responsible for protecting the health and interests of the public to adopt associated rules with respect to water reuse projects.

Largely due to the successful planning of water managers and other authorities, Utah's water resources have been effectively developed to help the desert state bloom.

Much like the development of water reuse in Utah is in its early stages, so are the current regulations. Although not all encompassing, existing water quality regulations for reuse do protect public health and the environment. As entities further explore the possibilities and applications of reuse, additional water quality regulations may be needed. Just as the methods of implementation of reuse will evolve, the regulations to safeguard the public and environment will likely adjust to meet changing conditions.

With respect to current water rights regulations, opinions as to the necessity of additional regulations vary. It is the opinion of some, particularly those in the wastewater treatment industry, that Utah's water rights regulations are not very conducive to reuse. If a municipality owns a wastewater treatment facility, the current laws make it simpler to implement a reuse project. Otherwise, it is often impractical and uneconomical to transport the reclaimed water to the original designated places of use consistent with the underlying water rights whereas the areas of growth that could benefit from the additional water supply may be in the vicinity of the treatment plant.

It is the opinion of others, particularly in the public water supply industry, that Utah's water rights regulations are appropriate and need to be strict. The current regulations keep the public water supply distribution agencies involved in the center of any water reuse proposal. This ensures beneficial use and efficiency within existing and established service areas. The current regulations encourage and require cooperation between water and wastewater public agencies in most cases, thus resulting in better-planned projects.

As discussed in Chapter 6, many other states regulate quite differently who can reuse water and where it can be applied. For example, the state of Washington gives full right to reuse the effluent to the entity providing wastewater treatment. The state of California goes so far as to make it unlawful to not use reclaimed water unless it is deemed unfeasible under certain conditions. While the effects that reuse can have on current water rights — particularly the impacts to downstream users — are extremely important and must not be ignored, the current system in determining the permissibility of reuse should be analyzed and, if necessary, reformed to facilitate reuse rather than unintentionally discourage it.

THE FUTURE CONDITION OF REUSE IN UTAH

The recurrence of drought in Utah is inevitable. The drought years of 2000 to 2005 have heightened the awareness of dwindling water supplies. This, combined with enormous growth, has brought renewed emphasis to find creative water supply solutions to meet demands. Fortunately, the growing population that will continue to put pressure on water supplies may also provide part of the solution.


Irrigating large municipal landscapes with reclaimed water could help to conserve precious potable water supplies.

An estimated 65 percent (100 gallons per capita per day) of the municipal and industrial water used for outdoor purposes is potable water. At the present population this amounts to over 300 million gallons per day (342,700 acre-feet per year) of drinking water that is used for purposes that do not require high quality water. In comparison, about 118 gallons per capita per day is used indoors with approximately 80 percent of that making its way to the wastewater treatment plant. The Utah Division of Water Resources estimates that over 650,000 acre-feet per year of wastewater will be produced in 2050. With reductions due to evaporation, lack of storage and other inhibiting factors, the Utah Division of Water Resources estimates that around 265,000 acre-feet per year of this total could potentially be available for reuse. This represents a considerable amount of water that could be used for outdoor purposes to replace valuable potable water that could then meet a portion of the 486,000 acre-feet the division estimates will be needed to be developed for M&I purposes by 2050.

The current volume of reclaimed water being reused is approximately 8,533 acre-feet per year. The proposed projects could potentially quadruple this volume by adding a combined volume of 28,237 acre-feet per year. Over the next three decades, even more reclaimed water will be developed. Entities within the boundaries of the Central Utah Water Conservancy District (CUWCD), for instance, must reuse a combined 18,000 acre-feet per year by 2033 as part of the Central Utah Project's Utah Lake Drainage Basin Water Delivery System.

In order for the full potential of water reuse projects to be developed throughout the state, it is likely that a few key things will need to occur. Coordinated efforts will need to be developed between various agencies. Pending court cases will need to be resolved or negotiated out of court. And, public education and involvement programs will need to be initiated to ensure cooperation and understanding between the public and the respective authorities.

One key coordination need is for professionals in the wastewater treatment and water supply industries to develop a cooperative framework and strategy for implementation of water reuse projects. Coordinated efforts among local, state and federal entities may also be necessary in order to develop the return flows resulting from federal water projects.

The rulings made by the court in the pending decisions discussed in Chapter 6 could have a significant impact on how future water reuse projects are implemented. Depending on the decision, rulings made could have unintended consequences and set an undesirable precedence. Thus, it may be more desirable to resolve these disputes outside of litigation.

Public education and involvement programs are also important to the future of water reuse in Utah. These types of programs are crucial in implementing a reuse project and must be included in all aspects of a project from start to finish. This must be done in order to avoid any misunderstandings between officials and the general public as to any health risks and to the motivations behind any reuse project. Additional research into the potential risks from some of the constituents found in treated wastewater may also need to be performed in order to be able to properly convey the risks to the public.

The experience of other states with reuse presents a valuable learning tool, which Utah can use to its advantage. Intense research and numerous pilot studies have been conducted in other states that show how reuse can be practiced efficiently and safely. Agreements between different water agencies have been reached and public education programs implemented. Using this information will enable Utah to venture carefully and responsibly into the important realm of water reuse.

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APPENDIX A

UTAH'S WATER QUALITY REGULATIONS FOR WATER REUSE

Utah Administrative Code:

Rule R317-1-4. Utilization and Isolation of Domestic Wastewater Treatment Works Effluent

Rule R317-1-5. Use of Industrial Wastewaters

R317-1-4. Utilization and Isolation of Domestic Wastewater Treatment Works Effluent.

4.1 Untreated Domestic Wastewater. Untreated domestic wastewater or effluent not meeting secondary treatment standards as defined by these regulations shall be isolated from all public contact until suitably treated. Land disposal or land treatment of such wastewater or effluent may be accomplished by use of an approved total containment lagoon as defined in R317-3 or by such other treatment approved by the Board as being feasible and equally protective of human health and the environment.

4.2 Submittal of Reuse Project Plan. If a person intends to reuse or provide for the reuse of treated domestic wastewater directly for any purpose, except on the treatment plant site as described in R317-1-4.6, a Reuse Project Plan must be submitted to the Division of Water Quality. A copy of the plan must also be submitted to the local health department. Any needed construction of wastewater treatment and delivery systems would also be covered by a construction permit as required in section R317-1-2.2 of this rule. The plan must contain the following information. At least items A and B should be provided before construction begins. All items must be provided before any water deliveries are made.

A. A description of the source, quantity, quality, and use of the treated wastewater to be delivered, the location of the reuse site, and how the requirements of this rule would be met.

B. Evidence that the State Engineer has agreed that the proposed reuse project planned water use is consistent with the water rights for the sources of water comprising the flows to the treatment plant which will be used in the reuse project.

C. An operation and management plan to include:

1. A copy of the contract with the user, if other than the treatment entity.
2. A labeling and separation plan for the prevention of cross connections between reclaimed water distribution lines and potable water lines. Guidance for distribution systems is available from the Division of Water Quality.
3. Schedules for routine maintenance.
4. A contingency plan for system failure or upsets.

D. If the water will be delivered to another entity for distribution and use, a copy of the contract covering how the requirements of this rule will be met.

4.3 Use of Treated Domestic Wastewater Effluent Where Human Exposure is Likely (Type I)

A. Uses Allowed

1. Residential irrigation, including landscape irrigation at individual houses.
2. Urban uses, which includes non-residential landscape irrigation, golf course irrigation, toilet flushing, fire protection, and other uses with similar potential for human exposure.
3. Irrigation of food crops where the applied reclaimed water is likely to have direct contact with the edible part. Type I water is required for all spray irrigation of food crops.
4. Irrigation of pasture for milking animals.
5. Impoundments of wastewater where direct human contact is likely to occur.
6. All Type II uses listed in 4.4.A below.

B. Required Treatment Processes

1. Secondary treatment process, which may include activated sludge, trickling filters, rotating biological contactors, oxidation ditches, and stabilization ponds. The secondary treatment process should produce effluent in which both the BOD and total suspended solids concentrations do not exceed 25 mg/l as a monthly mean.

2. Filtration, which includes passing the wastewater through filter media such as sand and/or anthracite or approved membrane processes.

3. Disinfection to destroy, inactivate, or remove pathogenic microorganisms by chemical, physical, or biological means. Disinfection may be accomplished by chlorination, ozonation, or other chemical disinfectants, UV radiation, membrane processes, or other approved processes.

C. Water Quality Limits. The quality of effluent before use must meet the following standards. Testing methods and procedures shall be performed according to Standards Methods for Examination of Water and Wastewater, eighteenth edition, 1992, or as otherwise approved by the Executive Secretary.

1. The monthly arithmetic mean of BOD shall not exceed 10 mg/l as determined by daily composite sampling. Composite samples shall be comprised of at least six flow proportionate samples taken over a 24-hour period.

2. The daily arithmetic mean turbidity shall not exceed 2 NTU, and turbidity shall not exceed 5 NTU at any time. Turbidity shall be measured continuously. The turbidity standard shall be met prior to disinfection. If the turbidity standard cannot be met, but it can be demonstrated to the satisfaction of the Executive Secretary that there exists a consistent correlation between turbidity and the total suspended solids, then an alternate turbidity standard may be established. This will allow continuous turbidity monitoring for quality control while maintaining the intent of the turbidity standard, which is to have 5 mg/l total suspended solids or less to assure adequate disinfection.

3. The weekly median fecal coliform concentration shall be none detected, as determined from daily grab samples, and no sample shall exceed 14 organisms/100 ml.

4. The total residual chlorine shall be measured continuously and shall at no time be less than 1.0 mg/l after 30 minutes contact time at peak flow. If an alternative disinfection process is used, it must be demonstrated to the satisfaction of the Executive Secretary that the alternative process is comparable to that achieved by chlorination with a 1 mg/l residual after 30 minutes contact time. If the effectiveness cannot be related to chlorination, then the effectiveness of the alternative disinfection process must be demonstrated by testing for pathogen destruction as determined by the Executive Secretary. A 1 mg/l total chlorine residual is required after disinfection and before the reclaimed water goes into the distribution system.

5. The pH as determined by daily grab samples or continuous monitoring shall be between 6 and 9.

D. Other Requirements

1. An alternative disposal option or diversion to storage must be automatically activated if turbidity exceeds or chlorine residual drops below the instantaneous required value for more than 5 minutes.

2. Any irrigation must be at least 50 feet from any potable water well. Impoundments of reclaimed water, if not sealed, must be at least 500 feet from any potable water well.
3. Requirements for ground water discharge permits, if required, shall be determined in accordance with R317-6.
4. For residential landscape irrigation at individual homes, additional quality control restrictions may be required by the Executive Secretary. Proposals for such uses should also be submitted to the local health authority to determine any conditions they may require.

4.4 Use of Treated Domestic Wastewater Effluent Where Human Exposure is Unlikely (Type II)

A. Uses Allowed

1. Irrigation of sod farms, silviculture, limited access highway rights of way, and other areas where human access is restricted or unlikely to occur.
2. Irrigation of food crops where the applied reclaimed water is not likely to have direct contact with the edible part, whether the food will be processed or not (spray irrigation not allowed).
3. Irrigation of animal feed crops other than pasture used for milking animals.
4. Impoundments of wastewater where direct human contact is not allowed or is unlikely to occur.
5. Cooling water. Use for cooling towers, which produce aerosols in populated areas, may have special restrictions imposed.
6. Soil compaction or dust control in construction areas.

B. Required Treatment Processes

1. Secondary treatment process, which may include activated sludge, trickling filters, rotating biological contactors, oxidation ditches, and stabilization ponds. Secondary treatment should produce effluent in which both the BOD and total suspended solids do not exceed 25 mg/l as a monthly mean.
2. Disinfection to destroy, inactivate, or remove pathogenic microorganisms by chemical, physical, or biological means. Disinfection may be accomplished by chlorination, ozonation, or other chemical disinfectants, UV radiation, membrane processes, or other approved processes.

C. Water Quality Limits. The quality of effluent before use must meet the following standards. Testing methods and procedures shall be performed according to Standards Methods for Examination of Water and Wastewater, eighteenth edition, 1992, or as otherwise approved by the Executive Secretary.

1. The monthly arithmetic mean of BOD shall not exceed 25 mg/l as determined by weekly composite sampling. Composite samples shall be comprised of at least six flow proportionate samples taken over a 24-hour period.
2. The monthly arithmetic mean total suspended solids concentration shall not exceed 25 mg/l as determined by daily composite sampling. The weekly mean total suspended solids concentration shall not exceed 35 mg/l.
3. The weekly median fecal coliform concentration shall not exceed 200 organisms/100 ml, as determined from daily grab samples, and no sample shall exceed 800 organisms/100 ml.

4. The pH as determined by daily grab samples or continuous monitoring shall be between 6 and 9.

5. At the discretion of the Executive Secretary, the sampling frequency to determine compliance with water quality limits for effluent from lagoon systems used to irrigate agricultural crops, may be reduced to monthly grab sampling for BOD, and weekly grab sampling for fecal coliform, TSS and pH.

D. Other Requirements

1. An alternative disposal option or diversion to storage must be available in case quality requirements are not met.

2. Any irrigation must be at least 300 feet from any potable water well. Spray irrigation must be at least 300 feet from areas intended for public access. This distance may be reduced or increased by the Executive Secretary, based on the type of spray irrigation equipment used and other factors. Impoundments of reclaimed water, if not sealed, must be at least 500 feet from any potable water well.

3. Requirements for ground water discharge permits, if required, shall be determined in accordance with R317-6.

4. Public access to effluent storage and irrigation or disposal sites shall be restricted by a stock- tight fence or other comparable means which shall be posted and controlled to exclude the public.

4.5 Records. Records of volume and quality of treated wastewater delivered for reuse shall be maintained and submitted monthly in accordance with R317-1-2.7. If monthly operating reports are already being submitted to the Division of Water Quality, the data on water delivered for reuse may be submitted on the same form.

4.6 Use of Secondary Effluent at Plant Site. Secondary effluent may be used at the treatment plant site in the following manner provided there is no cross-connection with a potable water system:

A. Chlorinator injector water for wastewater chlorination facilities, provided all pipes and outlets carrying the effluent are suitably labeled.

B. Water for hosing down wastewater clarifiers, filters and related units, provided all pipes and outlets carrying the effluent are suitably labeled.

C. Irrigation of landscaped areas around the treatment plant from which the public is excluded.

4.7 Other Uses of Effluents. Proposed uses of effluents not identified above, including industrial uses, shall be considered for approval by the Board based on a case-specific analysis of human health and environmental concerns.

4.8 Reclaimed Water Distribution Systems. Where reclaimed water is to be provided by pressure pipeline, unless contained in surface pipes wholly on private property and for agricultural purposes, the following requirements will apply. The requirements will apply to all new systems constructed after May 4, 1998, and it is recommended that the accessible portions of existing reclaimed water distribution systems be retrofitted to comply with these rules. Requirements for secondary irrigation systems proposed for conversion from use of non-reclaimed water to use with reclaimed water will be considered on an individual basis considering protection of public health and the environment. Any person or agency that is constructing all or part of the distribution system must obtain a construction permit from the Division of Water Quality prior to beginning construction.

A. Distribution Lines

1. Minimum Separation.

a. Horizontal Separation. Reclaimed water main distribution lines parallel to potable (culinary) water lines shall be installed at least ten feet horizontally from the potable water lines. Reclaimed water main distribution lines parallel to sanitary sewer lines shall be installed at least ten feet horizontally from the sanitary sewer line if the sanitary sewer line is located above the reclaimed water main and three feet horizontally from the sanitary sewer line if the sanitary sewer line is located below the reclaimed water main.

b. Vertical Separation. At crossings of reclaimed water main distribution lines with potable water lines and sanitary sewer lines the order of the lines from lowest in elevation to highest should be; sanitary sewer line, reclaimed water line, and potable water line. A minimum 18 inches vertical separation between these utilities shall be provided as measured from outside of pipe to outside of pipe. The crossings shall be arranged so that the reclaimed water line joints will be equidistant and as far as possible from the water line joints and the sewer line joints. If the reclaimed water line must cross above the potable water line, the vertical separation shall be a minimum 18 inches and the reclaimed water line shall be encased in a continuous pipe sleeve to a distance on each side of the crossing equal to the depth of the potable water line from the ground surface. If the reclaimed water line must cross below the sanitary sewer line, the vertical separation shall be a minimum 18 inches and the reclaimed water line shall be encased in a continuous pipe sleeve to a distance on each side of the crossing equal to the depth of the reclaimed water line from the ground surface.

c. Special Provisions. Where the horizontal and/or vertical separation as required above cannot be maintained, special construction requirements shall be provided in accordance with requirements in R317-3 for protection of potable water lines. Existing pressure lines carrying reclaimed water shall not be required to meet these requirements.

2. Depth of Installation. To provide protection of the installed pipeline, reclaimed water lines should be installed with a minimum depth of bury of three feet.

3. Reclaimed Water Pipe Identification.

a. General. All new buried pipe, including service lines, valves, and other appurtenances, shall be colored purple, Pantone 522 or equivalent. If fading or discoloration of the purple pipe is experienced during construction, identification tape is recommended. Locating wire along the pipe is also recommended.

b. Identification Tape. If identification tape is installed along with the purple pipe, it shall be prepared with white or black printing on a purple field, color Pantone 512 or equivalent, having the words, "Caution: Reclaimed Water-- Do Not Drink". The overall width of the tape shall be at least three inches. Identification tape shall be installed 12 inches above the transmission pipe longitudinally and shall be centered.

4. Conversion of existing water lines. Existing water lines that are being converted to use with reclaimed water shall first be accurately located and comply with leak test standards in accordance with AWWA Standard C-600 and in coordination with regulatory agencies. The pipeline must be physically disconnected from any potable water lines and brought into compliance with current State cross connection rules and requirements (R309-102-5), and must meet minimum separation requirements in section 4.8.A.1 of this rule above. If the existing lines meet approval of the water supplier and the Division, the lines shall be approved for reclaimed water distribution. If regulatory compliance of the system (accurate location and verification of no cross connections) cannot be verified with record drawings, televising, or otherwise, the lines shall be uncovered, inspected, and identified prior to use. All accessible portions of the system must be retrofitted to meet the requirements of this rule.

5. Valve Boxes and Other Surface Identification. All valve covers shall be of non-interchangeable shape with potable water covers, and shall have an inscription cast on the top surface stating "Reclaimed Water". Valve boxes shall meet AWWA standards. All above ground facilities shall be consistently color coded (purple, Pantone 512) and marked to differentiate reclaimed water facilities from potable water facilities.

6. Blow-off Assemblies. If either an in-line type or end-of-line type blow-off or drain assembly is installed in the system, the Division of Water Quality shall be consulted on acceptable discharge or runoff locations.

B. Storage. If storage or impoundment of reclaimed water is provided, the following requirements apply:

1. Fencing. For Type I effluent, no fencing is required by this rule, but may be required by local laws or ordinances. For Type II effluent, see R317-1-4.4.D.4 above.

2. Identification. All storage facilities shall be identified by signs prepared according to the requirements of Section 4.8.D.6 below. Signs shall be posted on the surrounding fence at minimum 500 foot intervals and at the entrance of each facility. If there is no fence, signs shall be located as a minimum on each side of the facility or at minimum 250 foot intervals or at all accessible points.

C. Pumping Facilities.

1. Marking. All exposed and above ground piping, fittings, pumps, valves, etc., shall be painted purple, Pantone 512. In addition, all piping shall be identified using an accepted means of labeling reading "Caution: Reclaimed Water - Do Not Drink." In a fenced pump station area, signs shall be posted on the fence on all sides.

2. Sealing Water. Any potable water used as seal water for reclaimed water pumps seals shall be protected from backflow with a reduced pressure principle device.

D. Other Requirements.

1. Backflow Protection. In no case shall a connection be made between the potable and reclaimed water system. If it is necessary to put potable water into the reclaimed distribution system, an approved air gap must be provided to protect the potable water system. A reduced pressure principle device may be used only

when approved by the Division of Water Quality, the local health department, and the potable water supplier.

2. Drinking Fountains. Drinking fountains and other public facilities shall be placed out of any spray irrigation area in which reclaimed water is used, or shall be otherwise protected from contact with the reclaimed water. Exterior drinking fountains and other public facilities shall be shown and called out on the construction plans. If no exterior drinking fountains, picnic tables, food establishments, or other public facilities are present in the design area, then it shall be specifically stated on the plans that none are to exist.

3. Hose Bibs. Hose bibs on reclaimed water systems in public areas and at individual residences shall be prohibited. In public, non-residential areas, replacement of hose bibs with quick couplers is recommended.

4. Equipment and Facilities. To ensure the protection of public health, any equipment or facilities such as tanks, temporary piping or valves, and portable pumps which have been used for conveying reclaimed water may not be reused for conveying potable water.

5. Warning Labels. Warning labels shall be installed on designated facilities such as, but not limited to, controller panels and washdown or blow-off hydrants on water trucks, and temporary construction services. The labels shall indicate the system contains reclaimed water that is unsafe to drink.

6. Warning signs. Where reclaimed water is stored or impounded, or used for irrigation in public areas, warning signs shall be installed and contain, as a minimum, 1/2 inch purple letters (Pantone 512) on a white or other high contrast background notifying the public that the water is unsafe to drink. Signs may also have a purple background with white or other high contrast lettering. Warning signs and labels shall read, "Warning: Reclaimed Water - Do Not Drink". The signs shall include the international symbol for Do Not Drink.

R317-1-5. Use of Industrial Wastewaters.

5.1 Use of industrial wastewaters (not containing human pathogens) shall be considered for approval by the Board based on a case-specific analysis of human health and environmental concerns.

APPENDIX B

WATER REUSE STATUTE AND WATER RIGHTS REGULATIONS

Utah Code:

Title 73, Chapter 3c. Conservation and Use of Sewage Effluent

Utah Administrative Code:

Rule R655-7. Administrative Procedures for Notifying the State Engineer of Sewage Effluent Use or Change in the Point of Discharge for Sewage Effluent

Utah Code:
Title 73 – Water and Irrigation
Chapter 3c – Conservation and Use of Sewage Effluent

73-3c-1. Definitions.

As used in this chapter:

(1) "DEQ" means the Department of Environmental Quality.

(2) "POTW" means a publicly-owned treatment works as defined by Section 19-5-102.

(3) "Regional POTW" means a publicly-owned treatment works that serves more than one governmental entity.

(4) "Sewage effluent" means the product resulting from the treatment of sewage and other pollutants by a POTW pursuant to discharge limitations set under the Clean Water Act of 1977, 33 U.S.C. Sec. 1251 et seq. and Title 19, Chapter 5, Water Quality Act.

(5) "Water right" means:

(a) a right to use water evidenced by any means identified in Section 73-1-10;

(b) a right to use water under an approved application:

(i) to appropriate;

(ii) for a change of use; or

(iii) for the exchange of water; or

(c) a contract authorizing the use of water from a water wholesaler or other water supplier having a valid water right under Utah law.

73-3c-2. Municipality may use sewage effluent in a manner consistent with its water rights -- Change application to be filed for uses inconsistent with water rights.

(1) Any municipality or other governmental entity owning and operating a POTW that treats sewage and other pollutants contained in water collected from water supplied under the governmental entity's water rights may apply the resulting sewage effluent to a beneficial use consistent with, and without enlargement of, those water rights.

(2) The governmental entity must file a change application with the state engineer if it proposes to use sewage effluent:

(a) outside the defined place of use or for purposes other than those authorized in the underlying water rights; or

(b) in a manner otherwise inconsistent with the underlying water rights.

73-3c-3. Agent for use of sewage effluent -- Change application for inconsistent uses.

(1) (a) Any municipality or other governmental entity served by a regional POTW that treats sewage and other pollutants contained in water collected from water supplied under the governmental entity's water rights may contract with the person responsible for administration of the regional POTW to act as its agent for the purpose of using sewage effluent discharged from the regional POTW.

(b) The sewage effluent may be applied to a beneficial use consistent with, and without enlargement of, the governmental entity's water rights referred to in Subsection (a).

(2) The person administering the regional POTW, as agent for an individual municipality or other governmental entity served by it, must file a change application with the state engineer if the person administering the POTW proposes to use sewage effluent:

(a) outside the defined place of use or for purposes other than those authorized in the underlying water rights; or

(b) in a manner otherwise inconsistent with the underlying water rights.

73-3c-4. Consideration and approval of change applications to effect the use of sewage effluent.

Any change application filed to effect the use of sewage effluent shall be considered and approved in accordance with Section 73-3-3.

73-3c-5. Priority of a use of sewage effluent.

(1) The priority of any use of sewage effluent shall be consistent with the priorities of the underlying water rights, except as provided in Subsection (2).

(2) If the state engineer approves a change application filed in accordance with Subsection 73-3c-2(2) or 73-3c-3(2), the priority of the sewage effluent use shall be the date the change application was filed.

73-3c-6. Sewage inflow that consists of unappropriated water -- Application to appropriate may be made.

If a portion of the sewage inflow to any POTW consists of any unappropriated water of the state, the person owning or administering the POTW or any other person may apply to the state engineer to appropriate the water to a beneficial use.

73-3c-7. Change of point of discharge of sewage effluent.

(1) The point of discharge of sewage effluent from a POTW may be changed, if:

(a) the change in point of discharge is required for treatment purposes as a matter of public health, safety, or welfare under DEQ rules and the POTW's discharge permit; and

(b) (i) the sewage effluent is discharged into waters of the state and not applied to a beneficial use; or

(ii) the sewage effluent is applied to a beneficial use consistent with, and without enlargement of, the underlying water rights as provided in Subsection 73-3c-2(1) or 73-3c-3(1).

(2) If a change in the point of discharge is to be made in conjunction with a proposed use of sewage effluent that is specified in Subsection 73-3c-2(2) or 73-3c-3(2), a change application must be filed as provided in those subsections.

73-3c-8. Notification of a sewage effluent use or change in point of discharge -- State engineer to make rules.

(1) Any person intending to apply sewage effluent to a beneficial use pursuant to Subsection 73-3c-2(1) or 73-3c-3(1) or change the point of discharge of sewage effluent pursuant to Subsection 73-3c-7(1) shall notify the state engineer of the use or change in point of discharge as provided by rules of the state engineer.

(2) (a) The state engineer shall publish the notification in a newspaper of general circulation in the county where downstream water users may be affected by the use or change in point of discharge.

(b) The notification:

(i) shall be published once a week for two successive weeks; and

(ii) may be published in more than one newspaper.

Utah Administrative Code:
Rule R655. Natural Resources, Water Rights.
Rule R655-7. Administrative Procedures for Notifying the State Engineer of Sewage Effluent Use or Change in the Point of Discharge for Sewage Effluent.

Rule R655-7-1. Authority and Effective Date.
1.1. These rules establish and govern procedures for notifying the state engineer of sewage effluent use or change in the point of discharge for sewage effluent as required under Section 73-3c-8(1).

1.2. These rules govern all notifications for use of sewage effluent or change in point of discharge of sewage effluent commenced on or after May 5, 1998.

R655-7-2. Definitions.

"Application to Appropriate" means an official request for authorization to develop a source and quantity of water for beneficial uses as covered in Section 73-3-2.

"Beneficial Use" means the basis, the measure and the limit of a water right and includes the amount of water use allowed by the water right expressed in terms of the purposes to which the water may be applied. For example, in the case of irrigation, the beneficial use is expressed as the number of acres which may be irrigated by the water right (e.g. 40 acres).

"Change Application" means an application filed to obtain authorization from the state engineer to allow water right to be changed with respect to point of diversion, period of use, place of use, or nature of use. As allowed by Section 73-3-3, any person entitled to the use of water may make permanent or temporary changes listed by making application upon forms furnished by the state engineer.

"Depletion" means water consumed and no longer available as a source of supply; that part of a withdrawal that has been evaporated, transpired, incorporated into crops or products, consumed by man or livestock, or otherwise removed.

"Diversion" means the maximum total volume of water in acre-feet or the flow in second-feet which may be diverted as allowed by a water right to meet the needs of the beneficial uses authorized under the right.

"Effluent" means discharged wastewater or similar products, such as a stream flowing out of a body of water and includes products that result from the treatment of sewage and other pollutants pursuant to discharge limitations set under the Clean Water Act.

"Hydrologic System" means the complete area or basin where waters, both surface and underground, are interconnected by a common drainage basin.

"Notification" means an application filed with the state engineer requesting authorization to use or to change the point of discharge for sewage effluent.

R655-7-3. Contents of the Notification.
3.1. The notification shall include adequate information for the state engineer to determine if the use of sewage effluent is consistent with and without enlargement of the underlying water rights or if a change in point of discharge is required. This information shall be supplied on forms provided by the state engineer or an acceptable reproduction and shall include the information described below as well as any other information deemed necessary by the state engineer to evaluate the notification.
3.2. Information Required on a Notification for Use of Sewage Effluent.

A. The name and post office address of the applicant.
B. The Water Right Numbers of the water proposed for reuse.
C. An evaluation of the diversion and depletion limits of the underlying water rights. This would include evaluating the diversion and depletion limits allowed for the underlying right at the time it was originally approved and certificated by the state engineer.
D. The nature of use of the underlying water rights. This would include the present approved use of the water and the original approved use if different from the present.
E. The quantity of water in acre-feet or the flow in second-feet to be reused.
F. The point of diversion, the nature of use, and the place of use for the proposed sewage effluent use.
G. The point of discharge of the sewage effluent where the sewage would be released if it were not put to beneficial use.
H. An evaluation of the amount of water depleted from the hydrologic system from the use of the sewage effluent.
I. An evaluation of the cumulative total depletion of water from the hydrologic system from the initial use of water and the proposed use of the sewage effluent.
J. An indication whether or not a change application needs to be filed to cover the proposed uses. A change application is required if the proposed nature or place of use for the water reused was not authorized by the underlying water right upon which the reuse is based.
K. An indication whether or not an application to appropriate water needs to be filed to cover the proposed uses of any of the water. An application to appropriate is required if the reuse project proposes to use any unappropriated water of the state.

3.3. Information Required on a Notification for a Change in Point of Discharge
A. The name and post office address of the applicant.
B. The Water Right Numbers of the water proposed to change the point of discharge.
C. The quantity of water in acre-feet or second-feet to have the point of discharged changed.
D. The current point of discharge for the sewage effluent.
E. The proposed point of discharge for the sewage effluent.
F. In addition to the above information required, if the sewage effluent is to be put to a beneficial use in conjunction with the change in point of discharge, the information required in Subsection 3.2 ?Notification for Use of Sewage Effluent? must be provided.

R655-7-4. Processing the Notification.
4.1. Upon receipt of the notification, the state engineer shall determine if the information submitted is acceptable and complete.
A. If the information is acceptable and complete, the state engineer shall deem the notification filed.
B. If the information is not acceptable and complete, the state engineer shall return the notification to the applicant and indicate the deficiencies.
C. Once the notification is filed, the state engineer shall publish information from the notification to inform the public of its contents in accordance with Section 73-3c-8(2).
D. Any interested person may file comments with the state engineer within 20 days after the notice is published.

E. A meeting regarding the notification and public comment may be held at the discretion of the state engineer.

4.2. The state engineer shall determine if water use is consistent with, and without enlargement of, the underlying water right or whether an application is required to use the sewage effluent water.

A. If the proposed sewage effluent use is consistent with the and without enlargement of the applicant’s water rights, the state engineer shall issue a letter indicating that there is a water right for the proposed use.

B. If the proposed sewage effluent use is not consistent with the existing beneficial uses or enlarges the right, the state engineer shall issue a letter indicating that there is not a water right for the proposed use.

B.1. If a change application or an application to appropriate is required in conjunction with the proposed use of sewage effluent, it shall be the responsibility of the applicant to file the required application with the state engineer. The state engineer shall process the change application or the application to appropriate according to Section 73-3 of the Utah Code.

B.2. The state engineer shall review the change application and the application to appropriate according to Sections 73-3-3 and 73-3-8, respectively, of the Utah Code.

KEY: sewage effluent use
February 1, 2003 **73-3C**

APPENDIX C

NOTIFICATION OF SEWAGE EFFLUENT USE NUMBER 2 – CITY OF OREM

BEFORE THE STATE ENGINEER OF THE STATE OF UTAH

IN THE MATTER OF NOTIFICATION OF	)	
	)	MEMORANDUM DECISION
SEWAGE EFFLUENT NUMBER 2	)	

Notification of Sewage Effluent Use Number 2 in the name of City of Orem was filed May 3, 2002, to use 10,000 acre-feet per year of treated effluent water from the Orem City Water Treatment Plant. This notification stated that the following water rights will be included in the proposed reuse: Water Right Numbers 55-290, 55-321, 55-654, 55-690, 55-752, 55-954, 55-2105, 55-3767, 55-4160, 55-4695, 55-7899, 55-11007. This list includes water rights owned by Provo River Water Users Association and Provo Bench Canal and Irrigation Company. Also, included in the notification were water rights owned by Central Utah Water Conservancy District. The effluent is currently discharged to Utah Lake through Powell's Slough from the Orem City Treatment Plant. Under this notification, it is proposed that up to 10,000 acre-feet of water per year will be diverted from the outfall of the treatment plant and used for municipal, industrial, irrigation, and non-contact cooling water within the service area of Orem City. The notification was advertised in the Orem-Geneva Times on May 30 and June 6, 2002, and was not protested.

The State Engineer has now undertaken a review of the notification to determine the extent to which the proposal will allow the application of the treated effluent water to a beneficial use consistent with, and without the enlargement of, the underlying water rights. In reviewing this notification, the State Engineer observes the following:

1. The notification indicated that Central Utah Project water would be utilized. Since Orem is not the owner of the underlying water right and no evidence was submitted of a contract for reuse of the water with the water right owner, no credit can be allowed for this water.

2. Provo River Water Users water (Right Numbers 55-3767 and 55-7899) was included in the notification. Orem City is not the owner of these water rights and no evidence was submitted of a contract for reuse of the water from the water right owner , and no credit can be allowed for these water rights.

3. Water Right Number 55-11007 is owned by Provo Bench Canal and Irrigation Company. No change application has been filed to amend the right for use in Orem City. Orem City is not the owner of the water right and no evidence was submitted of a contract for reuse of the water with the water right owner, no credit can be allowed for this water.

4 All irrigation is calculated at a diversion rate of 4.0 acre-feet per acre and a depletion rate of 2.29 acre-feet per acre ("Consumptive Use of Irrigated Crops in Utah", Research Report 145, Utah State University, utilizing the Pleasant Grove station). This would yield 57.25 percent that is depleted.

The State Engineer has evaluated the water rights that can be included as follows:

Water Right Number	Original Beneficial Use	Diversion (af/yr)	Depletion Rate (%)	Depletion (af/yr)
55-290	Cooling in a theater and Irrigation of lawns	724.0	10	72.4
55-321	Municipal - 1.19 cfs	861.56	100	861.56
55-654	Municipal - 2.38 cfs	1,723.12	100	1,723.12
55-690	Municipal - 13.82 cfs	10,005.68	100	10,005.68
55-752	Irrigation	1,339.2	57.25	766.7
55-954	Recreation: cooling of theater, swimming pool, bowling alley, incidental irrigation (limited by WUC)	88.17	40	35.0
55-2105	Municipal - 4.12 cfs	2,982.88	100	2,982.88
55-4160	Irrigation	3,205.56	57.25	1,835.2
55-4695	Irrigation (limited by certificate)	677.11	100	677.11
Total for all uses		21,607.28		18,959.65

It is assumed that the treated effluent applied to irrigation will be efficiently used and that the water application efficiency should be about 70%. In evaluating this notification, the State Engineer has recognized two elements which need to be addressed; the amount of water physically available for reuse under the appurtenant water rights and the amount of water which the applicant may legally reuse under the depletion limit of 18,959.65 acre-feet per year of the water right covered by this notification.

Physical Availability: Over the last five years (1998 through 2002), Orem City has diverted and used an average of 23,867 acre-feet per year, of which 15,695 acre-feet of water was supplied from sources under water rights owned by others as described in paragraphs 1, 2, and 3 above. This yields a total of 8,172 acre-feet of water that has been diverted under the subject water rights owned by Orem City ,or 34.24% of the total diversion (8,172 / 23,867). During the same period the waste water treatment plant discharges an average of 29.16 acre-feet per day, which would yield 10,643 acre-feet per year. Assuming that all of the sources of water are commingled, 34.24% of the water currently discharging from the sewage treatment plant or 3,644 acre-feet of water, could be utilized by the applicant under its rights listed. The applicant will not be able to claim the water diverted under the water rights of others, only under its water rights up to the limitations listed above. Based on current data available only 44.59% (3,644 ÷ 8,172) of the water diverted under these rights is available for reuse at the treatment plant. Based on current uses and under full utilization of the water rights involved in this notification, the city would only have physically available 9,634 acre-feet for reuse from the treatment plant water (44.59% of 21,607.28 acre-feet). Maximum diversion of effluent water will have to be restricted to that amount or an amount equal to 44.59% of the total water diverted under the rights involved in this notification, whichever is less.

Physical Availability Summary

Current water diverted for municipal use by applicant	23,867 acre-feet
Current water diverted under the water rights in this notification	8,172 acre-feet
Current water discharged from treatment plant annually	10,643 acre-feet
Water available if total amount is diverted under subject rights	9,634 acre-feet
Amount of diverted water available for reuse from treatment plant	44.59%

Depletion Limitation: Under current practices, it is reported that Orem City diverts about 8,172 acre-feet of water per year from the sources listed above. Of this diverted amount, it is estimated that the wastewater from the sewage treatment plant is 3,644 acre-feet; approximately 44.59% of the amount diverted into the system. With 8,172 acre-feet diverted and 3,644 acre-feet ending up in the treatment plant, 4,528 acre-feet are used for other municipal purposes or depleted by the inside domestic use. An estimated 20% of the water diverted for inside use is depleted from the hydrologic system and therefore, 4,555 acre-feet would have been diverted for inside use (4,555 - 20% = 3,644 return flow to treatment plant). This leaves 3,617 acre-feet that would have been used for outside use and other municipal uses (8,172 - 4,555 = 3,617). It is estimated that 70% (2,532 acre-feet) of that use is depleted from the hydrologic system and that 30% (1,085 acre-feet) is return flow. This gives a total return flow credit of about 4,729 acre-feet per year. Hence, under current practices, the total depletion of the diverted water is about 3,443 acre-feet (8,172-4,729) or 42.1%. If the city utilized the subject water rights in the same proportions, and to their full extent, the total depletion would be about 9,097 acre-feet (42.1% of 21,607.28 acre-feet). Subtracting this amount from the total depletion allowance under the subject water rights (18,959.65-9,097), the city would have about 9,863 acre-feet per year of depletion allowance remaining for use under the subject water rights. In no instance could the city through the combination of its uses exceed a system depletion greater than 87.75% (18,959.65 / 21,607.28) of the water diverted under these rights.

Depletion Limitation Summary

Current diversion under the water rights involved in this notification	8,172 acre-feet
Current depletion under the water rights involved in this notification	3,443 acre-feet
Total depletion allowed under the water rights involved in this notification	18,960 acre-feet
Depletion limit	87.75%

If the city alters the amount of water that is consumed or the amount of water delivered to the sewer treatment under the water rights involved in this notification, the city can request that the State Engineer review this notification and modify the figures accordingly.

In evaluating the various elements of the underlying rights, it is not the intention of the State Engineer to adjudicate the extent of these rights, rather to provide sufficient definition of the rights to assure that other vested rights are not impaired by the change and no enlargement occurs. If, in a subsequent action, the court adjudicates that this right is entitled to either more or less water, the State Engineer will adjust the figures accordingly.

It is, therefore, the **CONCLUSION** of the State Engineer that the proposed use of treated effluent by Orem City is **CONSISTENT** with the underlying water rights on the condition that Orem City restrict its use of treated effluent under this notification to 44.59% of the amount of water diverted under the water rights covered by this notification; or a maximum of 9,634 acre-feet, which ever is less. Under the combination of all uses of water under the water rights involved in this notification, not more than 87.75% of the water diverted can be depleted from the hydrologic system.

This Decision is subject to the provisions of Rule R655-6-17 of the Division of Water Rights and to Sections 63-46b-13 and 73-3-14 of the Utah Code Annotated, 1953, which provide for filing either a Request for Reconsideration with the State Engineer or an appeal with the appropriate District Court. A Request for Reconsideration must be filed with the State Engineer within 20 days of the date of this Decision. However, a Request for Reconsideration is not a prerequisite to filing a court appeal. A court appeal must be filed within 30 days after the date of this Decision, or if a Request for Reconsideration has been filed, within 30 days after the date the Request for Reconsideration is denied. A Request for Reconsideration is considered denied when no action is taken 20 days after the Request is filed.

Dated this 23 day of July, 2003.

Jerry D. Olds

Jerry D. Olds, P.E., State Engineer

JDO:JER:kkh

Mailed a copy of the foregoing Memorandum Decision this 23rd day of July, 2003, to:

City of Orem
c/o Bruce W. Chesnut
955 North 900 West
Orem, UT 84057

Division of Water Quality
Don Ostler
PO Box 144870
Salt Lake City, UT 84116

BY: Kelly K. Horne
Kelly K. Horne, Secretary

APPENDIX D

Water Rights Applications to Appropriate Sewage Effluent

Water Rights Applications to Appropriate Sewage Effluent

Entity	Water Right No.	Status	Priority Date	Source of Effluent	Flow (cfs) or Volume (ac-ft)	Beneficial Use(s)	Protested (Y/N)
Monticello City	09-1420	Water User Claim	9/16/1949	Monticello City	27.2 ac-ft	Irrigation	N
Logan Cow Pasture Water Co.	25-2970	Water User Claim	3/29/1962	Logan City	19 cfs	Irrigation	N
Logan Cow Pasture Water Co.	25-3449	Water User Claim	3/29/1962	Logan City	5.8 cfs	Irrigation	N
Private Individual	45-2117	Water User Claim	2/13/1957	Vernal City	1.5 cfs	Irrigation, Stockwatering	Y
Private Individual	15-3146	Certified	6/23/1986	Granstville City	0.39 cfs	Irrigation	N
Division of Wildlife Resources	31-2680	Certified	11/2/1959	North Davis Sewer District	25 cfs	Wildlife	N
Division of Wildlife Resources	31-3864	Certified	4/6/1967	South Davis Sewer District	10 cfs	Wildlife	N
Warren Irrigation Co.	35-8065	Certified	12/30/1905	Central Weber Sewer Improvement District	15 cfs	Irrigation	N
Division of Wildlife Resources	05-629	Approved	2/15/1996	Moab City	5 cfs	Wildlife	N
Monticello City	09-969	Approved	12/28/1977	Monticello City	358 ac-ft	Irrigation	Y
Private Individual	13-3632	Approved	5/10/1995	Thiokal Corporation	1 cfs	Irrigation, Stockwatering	Y
Private Individual	15-4020	Approved	9/2/1998	Granstville City	1 cfs	Irrigation, Stockwatering, Salt Leaching	N
Private Individual	29-4176	Approved	3/17/2004	Corrine City	220 ac-ft	Irrigation	Y
Price River Water Imp. District	91-737	Approved	4/17/1963	Price River Water Improvement District	10 cfs	Irrigation, Industrial	Y
Grand County Water Cons. Dist.	05-1386	Unapproved	11/23/1977	Moab City	2000 ac-ft	Irrigation	N
Grantsville Soil Conservation Dist.	15-2634	Unapproved	2/22/1978	Tooele City	3.75 cfs	Stockwatering	N
Lake Point Improvement District	15-4283	Unapproved	1/18/2002	Lake Point Improvement District	0.324 cfs	Municipal	Y
Logan City	25-9675*	Unapproved	11/30/1995	Logan City	27 cfs	Municipal	Y
Logan City	25-9676*	Unapproved	11/30/1995	Logan City	24.8 cfs	Municipal	Y
Davis County	31-5084	Unapproved	1/6/1993	Davis County Wastewater Treatment Plants	50,000 ac-ft	Dom., Mun., Rec., Wild., Fish Culture	Y
Private Individual	35-10419	Unapproved	6/3/1997	Central Weber Sewer Improvement District	35 cfs or 12,600 ac-ft	Irrigation, Stockwatering	Y
Warren Irrigation Co.	35-11204	Unapproved	2/8/2002	Central Weber Sewer Improvement District	4 cfs or 2,896 ac-ft	Irrigation, Stockwatering	Y
Central Weber Sewer Imp. District	35-11603	Unapproved	5/26/2004	Central Weber Sewer Imp. District (infiltration)	12.13 cfs	Municipal	Y
Duck Creek Irrigation Co.	51-1677	Unapproved	5/4/1964	Salem City	3 cfs	Irrigation	Y
SLC Suburban Sanitary Dist. No. 1	57-10283	Unapproved	7/19/2001	Central Valley Reclamation (effluent & infiltration)	3.052 cfs	Mun., sewage transport & treatment	Y
Private Individual	59-3400	Unapproved	8/10/1966	Salt Lake City	6 cfs	Irrigation	Y
U.S. Bureau of Reclamation	59-5578	Unapproved	3/13/1998	Salt Lake County Wastewater Treatment Plants	35,500 ac-ft	Mun., Ind., Irr., Stock., Wild., Rec., other	Y
Wind River Resources Corp.	81-2782	Unapproved	8/12/1986	St. George	16 cfs	Irrigation	Y
South Davis Sewer Imp. District	31-2395	Rejected	9/9/1964	South Davis Sewer Improvement District	-	-	N
Ogden City	35-1573*	Rejected	5/1/1961	Central Weber Sewer Improvement District	19 cfs	Municipal	Y
Leavitte Interprise	35-5444	Rejected	10/24/1985	Francis Town	3 cfs	Irrigation	N
SLC Suburban Sanitary Dist. No. 1	57-10097	Rejected	1/6/1995	Central Valley Reclamation	20.213 cfs	Municipal	Y
Central Davis Sewer District	31-4313	Lapsed	4/17/1976	Central Davis Sewer District	300 ac-ft	Irrigation, Stockwatering	N
Nephi City	53-683	Lapsed	3/1/1979	Nephi City	1.2 cfs	Irrigation	N
Salt Lake City	57-149	Lapsed	4/18/1935	Salt Lake City	50 cfs	Irr., Mun., flushing sewer system, Ind.	N

* These filings are exchange applications where sewage effluent would be exchanged for the right to use other water sources.

GLOSSARY

Acre-Foot (ac-ft) - The volume of water it takes to cover one acre of land (a football field is about 1.3 acres) with one foot of water; 43,560 cubic feet or 325,850 gallons. One acre-foot is approximately the amount of water needed to supply a family of four with enough water for one year.

Aquifer - A geologic formation that stores or transmits water. A confined aquifer is bounded above and below by formations of impermeable or relatively impermeable material. An unconfined aquifer is made up of loose material, such as sand or gravel, that has not undergone settling, and is not confined on top by an impermeable layer.

Beneficial Use - Use of water for one or more of the following purposes including but not limited to, domestic, municipal, irrigation, hydropower generation, industrial, commercial, recreation, fish propagation, and stock watering.

Biochemical Oxygen Demand (BOD) – A measure of the oxygen that aerobic bacteria need to breakdown the organic compounds in wastewater. Treatment plants seek to meet this demand before effluent is discharged to natural waterways with insufficient oxygen levels to accomplish such treatment.

Commercial Use - Water use normally associated with small business operations, which may include drinking water, food preparation, personal sanitation, facility cleaning and maintenance, and irrigation of landscapes.

Conservation - According to Webster's Dictionary, conservation is the act or process of conserving, where conserve is defined as follows: (1) To protect from loss or depletion, or (2) to use carefully, avoiding waste. In this document, the second definition is used exclusively. However, in the water resources field the first definition is also used. Using the first definition, constructing a reservoir to capture excess runoff in order to more fully utilize the water is also considered conservation.

Consumptive Use - Consumption of water for residential, commercial, institutional, industrial, agricultural, power generation and recreational purposes. Naturally occurring vegetation and wildlife also consumptively use water.

Culinary Water - See "Potable Water."

Depletion - The net loss of water through consumption, export and other uses from a given area, river system or basin. The terms consumptive use and depletion, often used interchangeably, are not the same.

Developable - That portion of the available water supply that has not yet been developed but has the potential to be developed. In this document, developable water refers to the amount of water that the Division of Water Resources estimates can be developed based on *current* legal, political, economic and environmental constraints.

Diversion - Water diverted from supply sources such as streams, lakes, reservoirs, springs or wells for a variety of uses including cropland irrigation and residential, commercial, institutional, and industrial purposes. This is often referred to as withdrawal.

Drinking Water - See "Potable Water."

Effluent - Liquid discharge from any unit of a wastewater treatment works, including a septic tank. This is frequently referred to as wastewater effluent or in portions of the Utah Code as sewage effluent.

Eutrophication – The undesirable process of loading water bodies with mineral and organic nutrients. This reduces the dissolved oxygen available within a water body when bacteria and other fauna such as plants and weeds bloom in the nutrient rich waters.

Export - Water diverted from a river system or basin other than by the natural outflow of streams, rivers and ground water, into another hydrologic basin. The means by which it is exported is sometimes called a trans-basin diversion.

Gallons per Capita per Day (gpcd) - The average number of gallons used per person each day of the year for a given purpose within a given population.

Ground Water - Water that is contained in the saturated portions of soil or rock beneath the land surface. It excludes soil moisture that refers to water held by capillary action in the upper unsaturated zones of soil or rock.

Hydrology - The study of the properties, distribution, and effects of water in the atmosphere, on the earth's surface and in soil and rocks.

Industrial Use - Use associated with the manufacturing or assembly of products, which may include the same basic uses as a commercial business. The volume of water used by industrial businesses, however, can be considerably greater than water use by commercial businesses.

Institutional Use - Uses normally associated with operation of various public agencies and institutions including drinking water; personal sanitation; facility cleaning and maintenance; and irrigation of parks, cemeteries, playgrounds, recreational areas and other facilities.

Instream Flow - Water maintained in a stream for the preservation and propagation of wildlife or aquatic habitat and for aesthetic values.

Municipal Use - This term is commonly used to include residential, commercial and institutional water use. It is sometimes used interchangeably with the term "public water use," and excludes uses by large industrial operations.

Municipal and Industrial (M&I) Use - This term is used to include residential, commercial, institutional and industrial uses.

Nephelometric Turbidity Units (NTU) - A measure of the clarity of water. An instrument called a nephelometer can be used to measure the amount of light scattered by suspended matter in the water. Turbidity is visually detectable at 5 NTU and above. Drinking water requires 0.5 NTU or below.

Potable Water - Water meeting all applicable safe drinking water requirements for residential, commercial and institutional uses. This is also known as culinary or drinking water.

Public Water Supply - Water supplied to a group through a public or private water system. This includes residential, commercial, institutional, and industrial purposes, including irrigation of publicly and privately owned open areas. As defined by the State of Utah, this supply includes potable water supplied by either privately or publicly owned community systems which serve at least 15 connections or 25 individuals at least 60 days per year.

Recharge - Water added to an aquifer or the process of adding water to an aquifer. Ground water recharge occurs either naturally as the net gain from precipitation, or artificially as the result of human influence. Artificial recharge can occur by diverting water into percolation basins or by direct injection into the aquifer with the use of a pump.

Reclaimed Water – The product resulting from wastewater reclamation is often called "reclaimed water."

Recycled Water – The product resulting from wastewater recycling is often called "recycled water."

Renovated Water – The product resulting from wastewater renovation is often called "renovated water."

Residential Use - Water used for residential cooking; drinking; washing clothes; miscellaneous cleaning; personal grooming and sanitation; irrigation of residential lawns, gardens, and landscapes; and washing automobiles, driveways, etc.

Secondary Water System - Pressurized or open ditch water delivery system of water that does not meet drinking water standards, used for irrigation of privately or publicly owned lawns, gardens, parks, golf courses and other open areas. Communities with separate drinking water and nondrinking water systems are called "dual" water systems.

Sewage - Waste matter and refuse liquids produced by residential, commercial and industrial sources and discharged into sewers.

Total Maximum Daily Load (TMDL) - As defined by the EPA, a TMDL "is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. [Its] calculation must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality." The TMDL must also provide some "reasonable assurance" that the water quality problem will be resolved. The states are responsible to implement TMDLs on impaired water bodies. Failure to do so will require the EPA to intervene.

Wastewater - Sewage, industrial waste or other liquid substances that if untreated might cause pollution of a natural or man-made water body.

Wastewater Reclamation - The act or process of recovering, restoring and making wastewater available for another use. This includes wastewater renovation.

Wastewater Renovation - The physical treatment or processing of wastewater to clean it and make it acceptable for another purpose.

Wastewater Treatment Works or Facilities - Any plant, disposal field, lagoon, pumping station, or other works used for the purpose of treating, stabilizing or holding wastewater.

Water Recycling – Reuse of wastewater in the same process or for the same purpose that created the wastewater. Although recycling often requires treatment of the wastewater, recycling can occur without treatment. See also "Water Reuse."

Water Reuse - The direct or indirect use of effluent for a beneficial purpose. See also "Water Recycling."

Water Right Duty - The quantity of water required to satisfy the irrigation water requirements of land.

Wetlands - Areas where vegetation is associated with open water and wet conditions including high water table.

Withdrawal - See "Diversion."

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