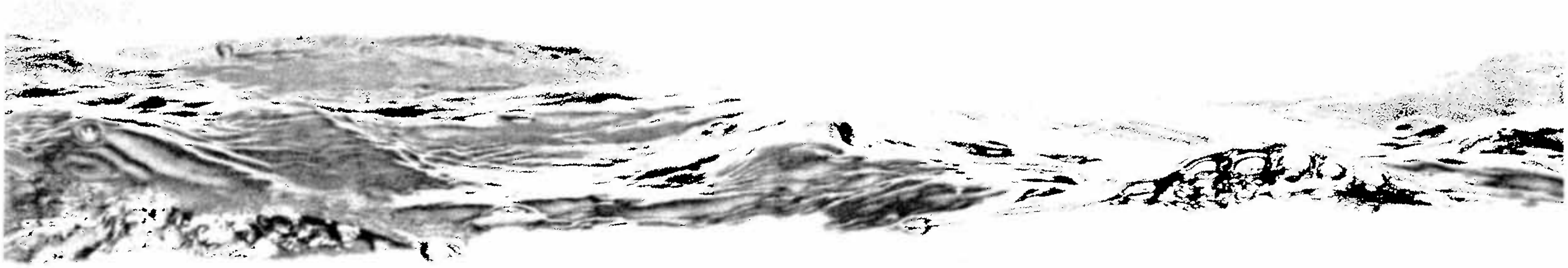
HISTORY OF WATER REUSE IN TEXAS



FEBRUARY 2011

ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

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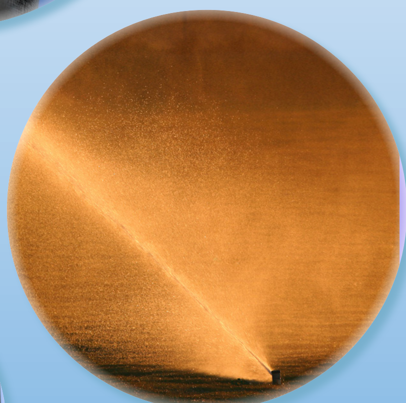

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TEXAS WATER DEVELOPMENT BOARD MISSION STATEMENT

The Texas Water Development Board's (TWDB) mission is to provide leadership, planning, financial assistance, information, and education for the conservation and responsible development of water for Texas. Our mission is a vital part of Texas' overall vision and its mission and goals which relate to maintaining the viability of the state's natural resources, health and economic development.

To accomplish its goals of planning for the state's water resources and for providing affordable water and wastewater services, the TWDB provides water planning, data collection and dissemination, financial assistance and technical assistance services to the citizens of Texas.

The tremendous population growth that the state has and will continue to experience, and the continual threat of severe drought, only intensify the need for the TWDB to accomplish its goals in an effective and efficient manner.

PURPOSE OF THIS DOCUMENT

The TWDB, through the project "Advancing Water Reuse in Texas," has produced a series of documents to address public awareness of water reuse in Texas. This document, History of Water Reuse in Texas, *is developed to provide the chronology and historical achievements of water reuse programs in the state. The document also identifies major challenges for advancing water reuse programs in the state.*

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ACKNOWLEDGMENTS

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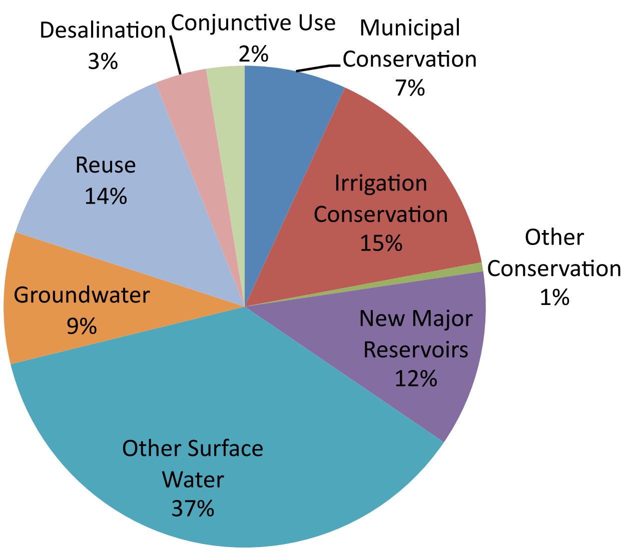
INTRODUCTION

BACKGROUND

The population of Texas is expected to double in the next 50 years, and Texans will be depending on the state's water resources for their health and prosperity more than ever. Water reuse is an important part of the state's overall water portfolio. It is defined as the beneficial use of reclaimed water (domestic or municipal wastewater) that has been purified so that its quality is suitable for the intended use.

Water reuse has been practiced in Texas since the 1800s. While initial uses were primarily for irrigation of agriculture, reclaimed water now provides a valuable source of water for a wide range of beneficial purposes, including power plant cooling water, commercial and municipal irrigation, river and stream flow enhancement, natural gas exploration activities, and augmentation of drinking water supplies.

PROJECTED NEW SUPPLIES BY CATEGORY FOR TEXAS IN 2060[1]

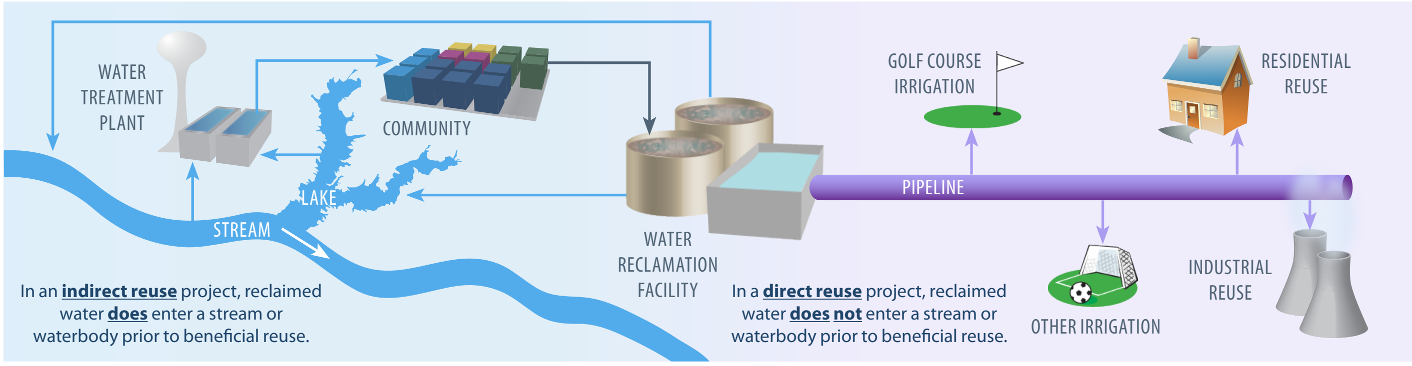


Every five years, the Texas Water Development Board develops a comprehensive state water plan that is the culmination of regional water planning efforts conducted in 16 regions to map out how to conserve water supplies, meet future water supply needs, and respond to future droughts. According to the most recent plan, *Water for Texas 2007*[1], water reuse will provide 800,000 acre-feet[A] per year of supply to Texans in 2010[B]. By the year 2060, the projected supply from water reuse will grow to more than 1.6 million acre-feet per year, which is approximately 14 percent of new water supplies to be met by recommended water management strategies. Of the 16 planning regions within the state, Region C (the Dallas/Fort Worth area) will be the most reliant on water reuse for its future water supply; by 2060, 27 percent of the new water supply in Region C is projected to be provided by water reuse.

PURPOSE AND SCOPE

The purpose of this document is to provide basic information about reclaimed water, how it can be beneficially used, the history of water reuse in Texas, and the future importance of water reuse as a major water supply management strategy. The historical review is intended to capture the chronology of water reuse advancements and project development in relation to the overall water supply landscape, beginning with the first known agricultural application in the late 1800s. While many individual reuse projects will be referenced to highlight this chronology, this document does not provide a comprehensive review of all water reuse projects that have been implemented within this time period. It is acknowledged that each one of these projects has contributed to the advancement of water reuse in Texas.

[A] *Acre-feet is a unit of volume commonly used when describing large-scale water supply quantities in the United States. One acre-foot is the volume of water covering one acre of land, if the water were one foot deep. It is equivalent to 43,560 cubic feet or approximately 326,000 gallons.*
[B] Water for Texas 2007 *was the most recently published state water plan available at the time this report was prepared. An updated state water plan will be published in 2012. There is currently no statewide tracking of actual usage of reclaimed water to compare with the plan projections.*



POTABLE WATER: Water that meets all applicable federal, state, and local requirements concerning quality and safety for drinking.

NONPOTABLE WATER: Water that is not suitable for drinking but may be suitable for many other purposes, depending on its quality.

RECLAIMED WATER: Domestic or municipal wastewater that has been treated to a quality suitable for a beneficial use. Also sometimes referred to as recycled water or reuse water.

RETURN FLOWS: Treated wastewater discharged from a wastewater treatment facility then returned to a lake or stream.

DIRECT REUSE: The use of reclaimed water that is piped directly from the wastewater treatment plant to the place where it is used.

DIRECT NONPOTABLE REUSE: The use of reclaimed water, for nonpotable purposes, that is piped directly to a site for beneficial uses not requiring drinking water quality.

DIRECT POTABLE REUSE: The use of reclaimed water, for potable purposes, that is piped directly from the wastewater treatment plant to a drinking water treatment and distribution system.

INDIRECT REUSE: The use of reclaimed water by discharging to a water supply source, such as surface water or groundwater, where it blends with the water supply and may be further purified before being removed for nonpotable or potable uses.

INDIRECT NONPOTABLE REUSE: The use of reclaimed water for nonpotable purposes by discharging to a water supply source, such as surface water or groundwater. The reclaimed water is subsequently diverted from the water body and used for beneficial purposes that do not require drinking water quality.

INDIRECT POTABLE REUSE: The use of reclaimed water for potable purposes by discharging to a water supply source, such as a surface water or groundwater. The water supply source serves to dilute the reclaimed water and provides additional treatment through natural processes. The mixed reclaimed and natural water then receive additional treatment before entering the drinking water distribution system.

WHAT IS WATER REUSE?

WATER REUSE is nothing more than taking water that has already been used and using it again for a beneficial purpose. In fact, all water is being reused (or "recycled") constantly through the earth's water cycle.

The water cycle describes the continuous movement of water on, above, and below the surface of the earth. As water makes its way from precipitation (rain, snow) falling on the land into lakes, rivers, and oceans, it evaporates into the atmosphere, forming clouds that again produce precipitation that falls to earth and continues the cycle. Through its journey, the water sometimes travels underground within the groundwater or is used by plants, animals, and people. However, it never disappears and eventually will make its way through this cycle again.

THE WATER CYCLE

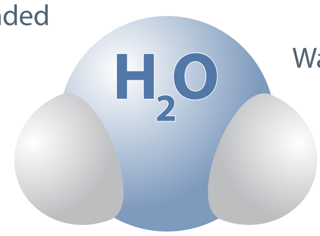
On a local level, water reuse involves collecting water that has already been used by people in their homes or businesses (wastewater), purifying this water to a level suitable for its intended use at a wastewater treatment plant (also called a water reclamation plant) and using it again for beneficial purposes within the community. In Texas, some typical uses of reclaimed water include

1. Irrigation of golf courses, parks, and athletic fields;
2. Cooling water for power generation facilities;
3. Natural gas drilling operations;
4. Decorative fountains or ponds; and
5. Augmentation of potable water supplies through indirect reuse.

One of the primary advantages of reclaimed water is that wastewater treatment plants are usually located in or near the communities where the water is needed. To support projected population growth, water suppliers in Texas will have to look farther from the population centers to find additional water supplies. These new supplies will be expensive to develop and will require more energy to transport the water to where it is needed than local supplies. Water reuse provides an opportunity to take advantage of a reliable supply that is local to the communities it serves.

WHAT IS WATER QUALITY?

WATER QUALITY is a term used to describe the characteristics of water in relation to its intended use. Most people know that pure water is described by the chemical formula H_2O, meaning that each molecule is made up of two hydrogen atoms and one oxygen atom connected by a strong bond. However, no water found in the natural environment is pure. Rather, natural water contains a variety of other constituents found in the environment.



Water quality varies depending on the unique biological and chemical characteristics of the water source and its surrounding environment. The types of rock and soil, surrounding land uses, and local climatic conditions can all influence water quality of a given source.

HOW DO WE ENSURE THAT OUR WATER IS SAFE?

Regardless of the source, federal, state, and local regulations ensure that our water is treated to levels that protect the health and safety of the public and environment.

For example, the Safe Drinking Water Act is the federal law that creates a coordinated set of programs and requirements to help water systems make sure they have a safe supply of drinking water. Individual states establish standards for drinking water. In Texas, the Texas Commission on Environmental Quality is responsible for protection of public drinking water and administration of the Drinking Water Standards for Public Water Systems.

Similarly, the Clean Water Act is the federal law that employs a variety of regulatory tools to reduce pollutant discharges into waterways. The Clean Water Act has a broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support and protect public uses such as aquatic life, recreation, and water supply. Individual states develop water quality standards in accordance with state and federal laws to protect those uses. In Texas, the Texas Commission on Environmental Quality is responsible for protection of water quality in accordance with the Texas Surface Water Quality Standards. In order to discharge water to a stream or lake, the water must meet the treatment and water quality requirements of the Texas Surface Water Quality Standards.

Water quality requirements for direct nonpotable reuse are regulated through Title 30, Chapter 210 of the Texas Administrative Code and are administered by the Texas Commission on Environmental Quality. Chapter 210 defines two classes of water quality standards for water reuse, depending on the specific application of the reclaimed water and the anticipated level of public contact with the water. These requirements ensure that the water is a very high quality and is delivered safely for its intended purpose.

Wastewater is purified using physical, chemical, and biological processes before it is returned to the environment or used as reclaimed water. Prior to reuse, either through discharge to a stream or lake, or delivery to a user such as a golf course or industry, this water satisfies all federal and state water quality requirements for the intended use.

RECLAIMED WATER TREATMENT

A water reclamation plant is just like a natural river but in a concrete box.

- **FIRST**, materials settle to the bottom (primary treatment).
- **SECOND**, microbes use air to breathe while they eat up organic material, and then the microbes settle out (secondary treatment).
- **THIRD**, sand and/or coal filter out leftover particles, much like sand in the bottom of a river (advanced secondary or tertiary treatment).

For some reuse applications, additional processes are used for further purification.

PRIMARY TREATMENT

Just as in nature, when storm runoff first enters a river, heavier solid particles settle to the bottom while lighter materials float to the top and are carried away. At a water reclamation plant, long concrete tanks replace the river. The heavier solids (which settle to the bottom) and the lighter materials, like plastic and grease (which float to the top), are called primary sludge and are removed and treated. The remaining wastewater, containing dissolved and suspended materials (mostly organic), then moves to the second phase of treatment (secondary treatment).

SECONDARY TREATMENT

As dirty water in a river flows downstream, naturally occurring microorganisms feed on the dissolved organic materials. As the river flows downstream, oxygen naturally enters the water so the organisms can breathe. At a water reclamation plant, this same process takes place in aeration tanks, where air is bubbled through the water to supply the oxygen. The same microorganisms in the wastewater grow as they feed on the organic materials in these tanks. In the secondary treatment settling tanks, the microorganisms clump together and settle to the bottom, where they are removed and recycled back into the treatment process. Some of the solids are removed for further treatment.

TERTIARY TREATMENT

Finally, in a natural river, some of the clean water soaks into the ground beneath the river and joins the underground water supply. The ground is replaced at the treatment plant by filters, which remove any remaining suspended materials from the water. The filters contain layers of anthracite coal, sand, and/or gravel. In a river, natural ultraviolet light disinfects the water to reduce bacteria and viruses. At a water reclamation plant, the water is disinfected after filtration using chemicals or applied ultraviolet light. It is now free of harmful bacteria and viruses and safe for human contact and beneficial uses.

ADVANCED TREATMENT

Some types of reuse projects apply additional purification processes, such as those used to produce distilled water. One example is reverse osmosis, which is a high-pressure membrane filtration process that forces water through the molecular structure of several sheets of thin plastic membranes to filter out minerals and contaminants, including salts, viruses, pesticides, and other materials. The reverse osmosis membranes are like microscopic strainers. Bacteria and viruses, as well as inorganic and most organic molecules, cannot pass through the membranes. Some projects also apply a combination of ultraviolet light and hydrogen peroxide. For ultraviolet disinfection, water is exposed to ultraviolet light in high doses, just like the instruments in medical and dental offices, to provide disinfection. Additionally, ultraviolet light combined with hydrogen peroxide creates an advanced oxidation reaction that eliminates any remaining compounds in water by breaking them down into harmless compounds like carbon dioxide and water. This multiple purification process creates an ultra-pure quality water.

The evolution of water reuse in Texas has been influenced by five key factors.

1. WATER AVAILABILITY: In the drier areas of the state, particularly West Texas, water reuse was originally driven by the need for water to irrigate crops. For the state as a whole, it has also been driven by droughts that can impact all of the state's water supplies. The droughts that occurred in the 1950s and the 1990s significantly contributed to the recognition of the importance of water reuse for meeting the state's water needs. Increased scarcity of surface water and groundwater supplies continues to be a key factor in motivating the further development of water reuse in the state. In West Texas, where the water supply has been scarce for many decades, reuse has played a key role in cities such as Amarillo, Lubbock, Odessa, and El Paso. San Antonio also recognized early on that water reuse could help supplement the City's limited water supplies. More recently, the City of Austin and communities within the Dallas-Fort Worth Metroplex have initiated major efforts to promote water reuse in order to meet the water supply needs of their growing communities. In the Houston area, overuse of the groundwater supplies has led to land subsidence and the need to utilize other sources of water, including reclaimed water. Limited water availability will continue to challenge communities to use all available water resources as efficiently as possible, and water reuse will be a key component of this effort.

2. POPULATION GROWTH: During the 50 years between 1950 and 2000, the population in Texas grew from 7.7 million to 20.8 million. Even before the first Texas Water Development Board *Water for Texas* publication in 1968, it was recognized that the existing identified water supplies were not adequate to meet the state's projected population growth. Since this time, a plan to harness the state's 196 major reservoirs (defined as having a storage capacity of 5,000 acre-feet or more) has been developed and many projects that will provide additional supply to the state have been implemented. However, new surface water supplies have become increasingly difficult to develop, both due to diminishing availability of potential reservoir sites and the rigorous regulatory permitting requirements. Groundwater supplies are also limited. Many have either already reached or been used beyond their sustainable supply capacity. According to *Water for Texas 2007*, the population in Texas is expected to grow to about 46 million by 2060, or more than double what it was in 2000. With this population, the supply of reclaimed water will grow and will become a more available supply.

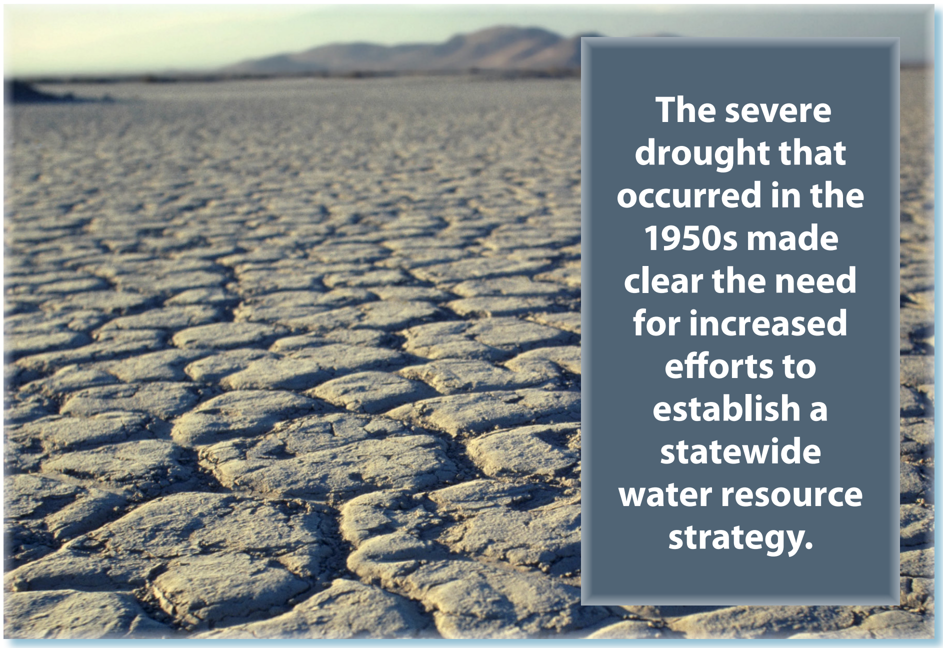
3. REGULATIONS: Water quality regulations associated with the Clean Water Act have become more protective over time, resulting in higher levels of wastewater treatment and the availability of higher quality reclaimed water from many wastewater treatment facilities. These regulatory advances have allowed many entities to implement reuse projects with minimal additional treatment enhancements to the existing facilities.

4. ADVANCING TECHNOLOGY: Over time, treatment technologies have advanced to meet more stringent water quality requirements and provide more efficient, cost-effective treatment options. These advances have led to the ability to produce extremely high-quality water which is safe for a variety of beneficial uses.

5. PUBLIC ACCEPTANCE: Protection of our water resources and maintaining public health and safety have always been high priorities for the citizens of Texas. Historically, Texas water reuse projects have consistently demonstrated that reclaimed water can be used beneficially without compromising the health of the public or the environment. Recognition by the public that water resources are limited and should be used as efficiently as possible has led to a increased acceptance of safe and responsible implementation of water reuse projects statewide. Continued public education is essential to the success of future water reuse projects in Texas.

HISTORY OF REUSE IN WATER SUPPLY PLANNING

Water supply planning has been important in identifying and selecting water management strategies required to meet Texas's water demands.



Planning and public development of Texas water resources began in the early 1900s with the adoption of a constitutional amendment for development of public water resources and the creation of the Texas Board of Water Engineers. The severe drought that occurred in the 1950s made clear the need for increased efforts to establish a statewide water resource strategy. The first statewide planning document was issued in 1961 by the Texas Board of Water Engineers. Water resource planning functions were transferred to the Texas Water Development Board in 1965.

Basic reuse principles and the benefits of reuse were presented in the 1968 *Texas Water Plan*. The plan recognized that wastewater return flows are "... an essential and valuable water resource that should be managed and administered conjunctively with other water resources."[(2)]

The 1984 *Texas Water Plan* identified conservation measures based on technology and changing practices as necessary advancements for reducing municipal and agricultural water use. The substitution of reclaimed water for potable supplies was supported for industrial water needs.[(3)]

In 1990, the *Texas Water Plan* recognized that increased water use efficiency through conservation and reuse would be essential for extending existing supplies. Recommendations included legislative action creating official policy to guide the use of reclaimed water.[(4)] The 1992 update, titled *Water for Texas,* highlighted two critical needs for furthering reuse: the lack of legislative action on adopting policy to guide water reuse and the lack of funding to study stream return flow needs.[(5)]

In 1997, the overwhelming magnitude of Texas water planning was recognized with passage of Senate Bill 1. The 1997 Plan compiled by the Texas Water Development Board from regional submittals cited the provisions of Senate Bill 1 as important clarifications of reuse policy that were incorporated into Chapters 210, 295, and 297 of the Texas Administrative Code.[(6)]

The 2002 *Water for Texas Plan* stressed regional cooperation and planning as one of the keys to satisfying the water needs of Texas and advanced the policy of a priority system based on level of conservation achievement for state funding assistance programs. In this plan, water reuse was projected to provide over 600,000 acre-feet per year of supply statewide by 2050.[(7)]

WHO HAS DEVELOPED WATER REUSE PLANS?

The 2007 Plan devoted a four-page chapter to Texas water reuse. Reclaimed water was recognized as a water source that has emerged as a valuable and competitive supply option. With management of existing supplies, this plan states that the quantity of water supplied from reuse is projected to double from 800,000 acre-feet per year in 2010 to 1.6 million acre-feet per year in 2060, a significant increase over projections from the 2002 plan.

Planning for water reuse has significantly increased during the last decade. Numerous local water reuse plans have been developed during this period. The following is a partial list of entities that have developed water reuse plans:

ENTITIES WITH REUSE PLANS[C]

- Arlington
- Austin
- Big Spring
- Cleburne
- College Station
- Dallas Fort Worth International Airport
- El Paso
- Flower Mound
- Fort Worth
- Frisco
- Georgetown
- Irving
- Lewisville
- McAllen
- New Braunfels
- North Texas Municipal Water District
- Odessa
- San Angelo
- San Antonio
- San Marcos
- Sugarland
- Tarrant Regional Water District
- Upper Trinity Regional Water District
- Sweetwater
- White River Municipal Water District

[C]*This is a partial list of entities in Texas with Reuse Plans.*

WATER QUALITY

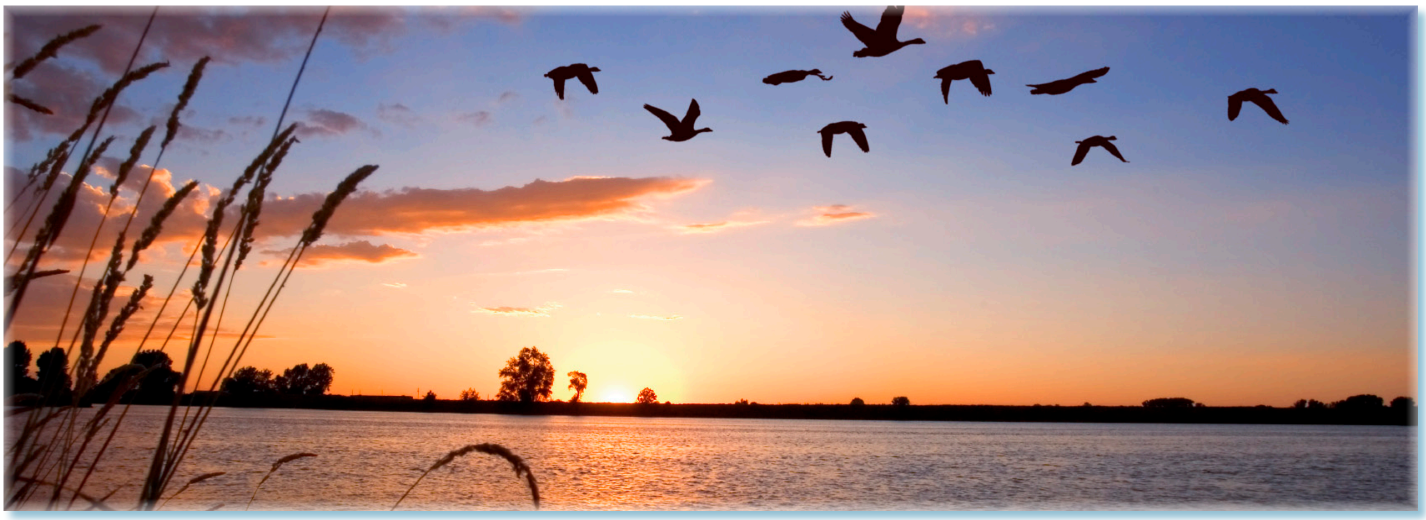
The Safe Drinking Water Act was adopted in 1974 and protects drinking water quality. The Texas Commission on Environmental Quality adopts and enforces drinking water rules for Texas that are at least as stringent as the requirements in the Safe Drinking Water Act.

In 1962, the Texas Water Pollution Control Board—now the Texas Commission on Environmental Quality—adopted rules related to surface water quality and wastewater treatment. This action represented a key initial step towards improving treated wastewater quality in Texas with the benefits of protecting water quality and providing a water source suitable for certain beneficial uses. Passage of the Federal Clean Water Act in 1972 and subsequent amendments resulted in further requirements for treatment, monitoring, and compliance with surface water quality criteria. The Clean Water Act generally resulted in more stringent requirements being imposed on wastewater treatment plant discharges.

Water quality regulations have become more and more stringent over time, resulting in higher quality water discharged from wastewater treatment facilities.

Beginning in 1986, the Texas Commission on Environmental Quality adopted watershed protection rules (Texas Administrative Code Chapter 311) that prohibited the discharge of treated wastewater in specific watersheds or required more stringent treatment requirements for discharges. The primary purpose of the prohibition was to prevent nutrients such as nitrogen and phosphorus from entering specific lakes. If the levels of nutrients increase, the lakes may grow more algae and become more turbid. Since 1986, watershed protection rules have been established for the following Texas water sources.

- Lake Austin and Lake Travis (Colorado River Basin)
- Lake Inks and Lake Buchanan (Colorado River Basin)
- Clear Lake (San Jacinto River Basin)
- Lake Houston (San Jacinto River Basin)
- Colorado River Basin
- Lake Lyndon B. Johnson and Lake Marble Falls (Colorado River Basin)
- Lake Worth, Eagle Mountain Lake, Lake Bridgeport, Cedar Creek Lake, Benbrook Lake, and Richland Chambers Lake (Trinity River Basin)



DIRECT REUSE

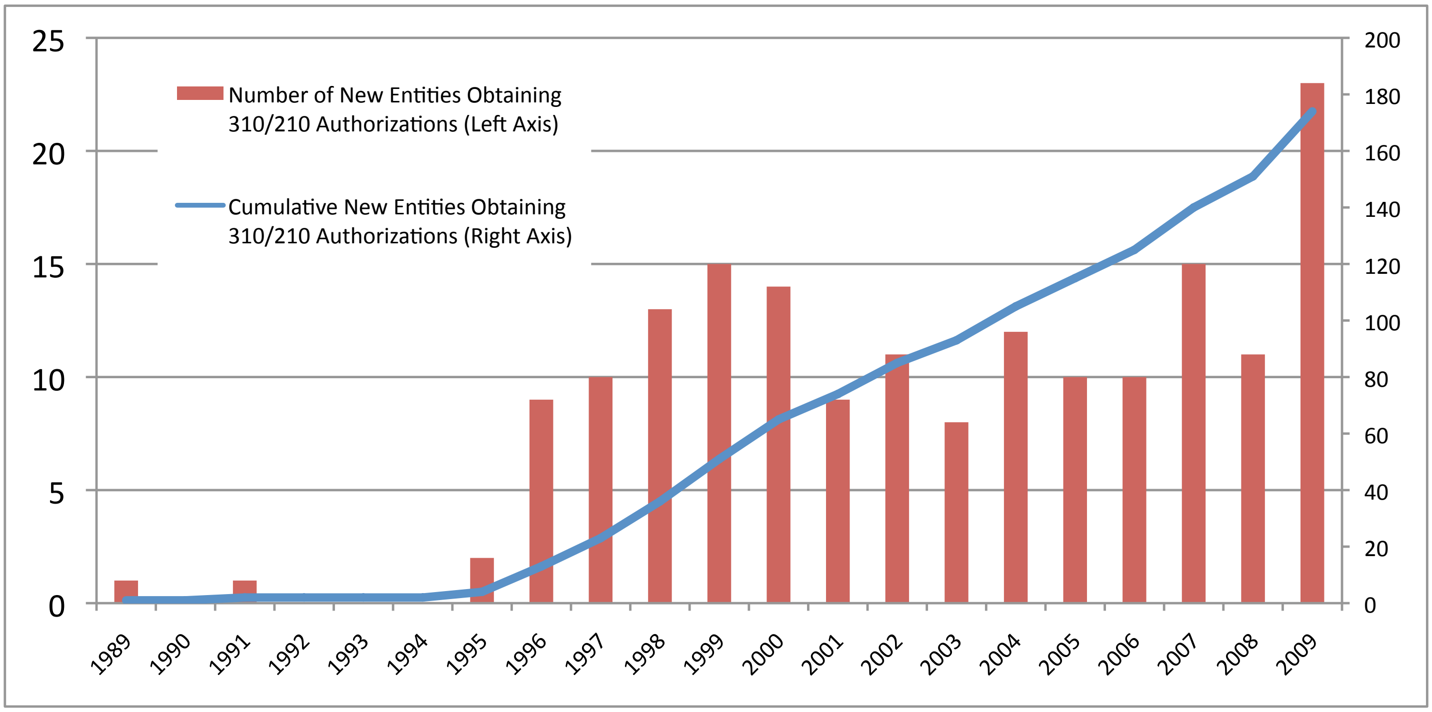
Regulations specifically relating to direct nonpotable reuse were first established in 1990. At right is a summary of the key regulatory milestones.

REGULATORY MILESTONES	
1990	Adoption of Texas Administrative Code Chapter 310—The first state regulations specifically addressing the use of reclaimed water.
1997	Adoption of Texas Administrative Code Chapter 210—Establishes rules and the authorization process for direct nonpotable water reuse projects. Replaces Chapter 310.
1999	Adoption of Texas Administrative Code Chapter 297.49—Grants the right to reuse treated wastewater as long as the water is not discharged to a waters belonging to the state of Texas.
2002	Adoption of amendments to Texas Administrative Code Chapter 210 to include rules for use of industrial reclaimed water.
2008	Adoption of Texas Administrative Code Chapter 321, Subchapter P – Reclaimed Water Production Facilities—Establishes streamlined permitting requirements for reclaimed water treatment (production) facilities at remote sites.

Since the 1990s, the number of entities applying for and receiving Chapter 310 / Chapter 210 reclaimed water authorizations from the Texas Commission on Environmental Quality for direct, non-potable reuse projects has been steadily increasing.

As of June 2010, 187 entities had obtained reclaimed water authorizations from the Texas Commission on Environmental Quality. Currently, no entities in Texas are implementing direct, potable reuse.

NEW ENTITIES OBTAINING AUTHORIZATIONS



INDIRECT REUSE

Currently, Texas does not have any regulations specifically addressing indirect reuse. However, regulations that impact indirect reuse are summarized below.

SURFACE WATER

Water quality for indirect reuse applications in surface water bodies is regulated through Texas procedures implementing requirements of the federal Clean Water Act. These include

1. Texas Commission on Environmental Quality - Texas Pollutant Discharge Elimination System permitting procedures
2. Texas Commission on Environmental Quality - Texas Surface Water Quality Standards

In Texas, surface water rights are issued through a "prior appropriations" system, which means that anyone wishing to use the state's surface waters, including reclaimed water, must get permission (a permit) from the state. Texas Administrative Code Chapters 295 and 297 establish the rules and process for application and issuance of surface water rights.

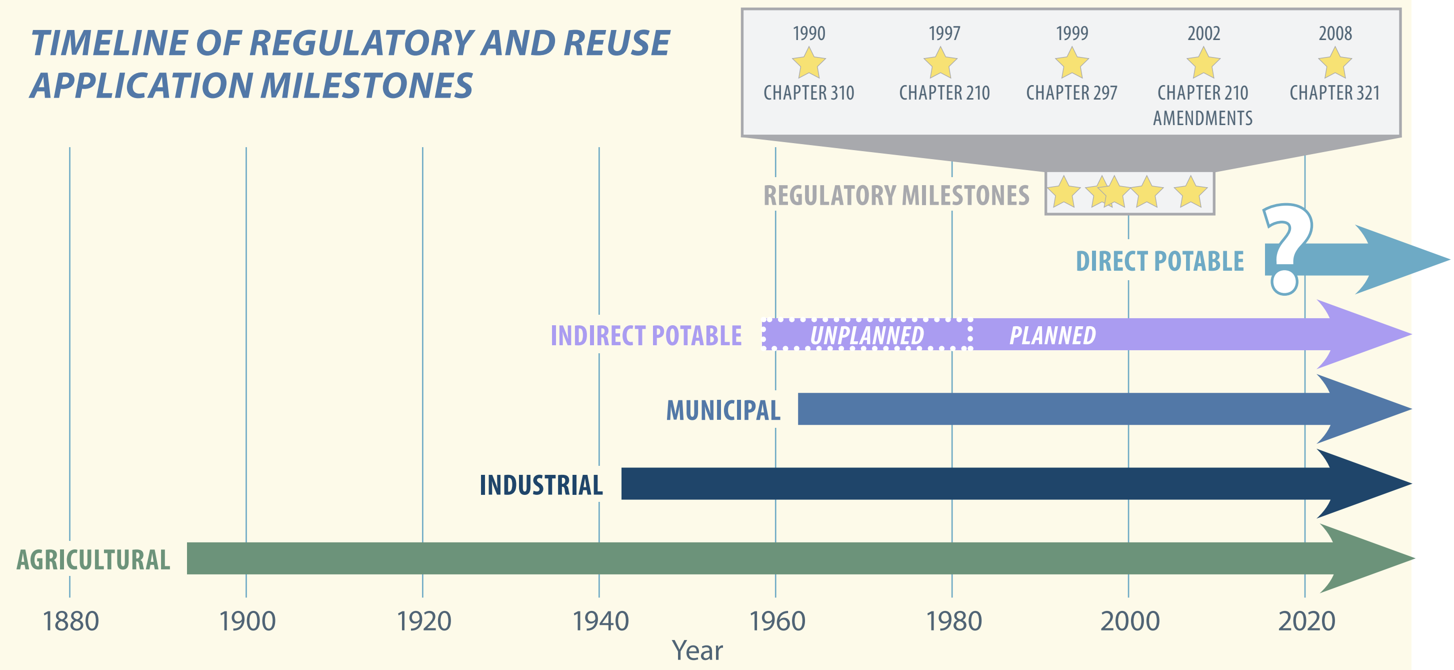
GROUNDWATER

For direct injection of reclaimed water into a drinking water aquifer, Texas Administrative Code Chapter 331 requires that the reclaimed water quality meet or exceed the requirements of the Safe Drinking Water Act and Texas drinking water standards, per Texas Administrative Code Chapter 290. There are no specific Texas regulations addressing the use of spreading (percolation) basins for aquifer recharge.

WATER CONSERVATION

Water reuse has been identified as a Best Management Practice for water conservation by the Water Conservation Implementation Task Force established by the 78th Texas Legislature under Senate Bill 1094.(8) It has also been identified as a conservation measure in the State Water Code. (9) Therefore, in addition to other conservation efforts, development of a water reuse program can be used to demonstrate the efficient use of water supplies.

TIMELINE OF REGULATORY AND REUSE APPLICATION MILESTONES



NONPOTABLE REUSE

Known applications of water reuse in Texas date back to the 19th century. The primary uses of reclaimed water have evolved over time. Initial uses focused on agricultural irrigation. Subsequently, industrial uses and municipal nonpotable uses (such as golf course irrigation) became more widely practiced. Most recently, planned indirect potable reuse has been implemented by several entities. In addition, unplanned indirect potable reuse[D] has been practiced in many areas of the state for a number of years.

This section provides a summary of some of the key milestones impacting the evolution of reuse in Texas.

AGRICULTURAL USES (BEGINNING IN LATE 1800s)

Initial applications of water reuse in Texas were for agricultural irrigation, which occurred in arid areas in Texas. Perhaps, the earliest recorded use of "sewage" for irrigation occurred on agricultural land located south of San Antonio during the late 1890s and early 1900s. "In a 1901 contract, the San Antonio Irrigation Company was granted exclusive use for irrigation of all sewage present and future, except for those quantities already contracted for by the City of San Antonio."[10]

During the 1920s, the City of Amarillo provided treated effluent to ranchers within the area.

During the 1930s, all of the City of Lubbock's "sewage effluent" was used to irrigate the 200-acre Gray farm, and later expanded to an area of over 6,000 acres. The irrigation application was further expanded to provide water to the Hancock farm in 1981, which now includes approximately 4,000 additional acres. The crops grown at these farms originally included cotton, wheat, and grain sorghum.[11]

During the 1940s, the City of Odessa began its reuse program using effluent from its first wastewater treatment plant, the South Dixie Water Reclamation Plant. At that time, 3 million gallons per day (3,363 acre-feet per year) of the primary treated wastewater was committed to a landowner for irrigation of alfalfa.[12]

The City of Abilene began providing treated wastewater for agricultural irrigation at locations near their treatment plant in the 1960s.

Agriculture continues to be a significant user of reclaimed water today.

[D] *Indirect potable reuse occurs when treated wastewater is discharged to a water body and is subsequently diverted downstream for water supply.*

INDUSTRIAL USES (BEGINNING IN THE 1940s)

During 1944, the City of Big Spring began providing reclaimed water to the Cosden Oil and Chemical refinery. The chemical company had previously been using well water with poor water quality. Addition of the reclaimed water as a source not only provided adequate supply, but also resulted in an overall improvement in quality of the source water.[13]

In the 1950s, the City of Odessa began providing primary treated wastewater to a petrochemical plant at a rate of up to 4,480 acre-feet per year. An agreement with the petrochemical plant resulted in the primary treatment plant being upgraded to a secondary treatment plant in order to provide higher quality water.

Starting in the 1950s, Amarillo began providing treated wastewater to the Texaco refinery for use as process water. Subsequently, in 1960, Amarillo began providing treated wastewater to Southwestern Public Service Company for cooling water needs. By 1984, about half of the wastewater generated annually by Amarillo was sold to Southwestern Public Service Company.

In 1971, Lubbock also began providing treated wastewater to Southwestern Public Service Company for cooling water needs. In both Amarillo and Lubbock, Southwestern Public Service Company disposed of its blowdown water by selling it to farmers for irrigation.[14]

In the 1960s, the City Public Service of San Antonio built Braunig and Calaveras Lakes to provide cooling water for power generation. Prior to construction of the lakes, the water supply was obtained from the Edwards Aquifer. The decision to construct the lakes followed a severe seven-year drought, which led to significant depletion of groundwater levels throughout the region. Supply to these lakes is provided by the San Antonio River, which is dominated by treated wastewater during much of the year. The City Public Service was one of the first utilities in the nation to use treated effluent for power plant cooling water.[15]

During the 1970s, the City of Denton began providing reclaimed water to the Spencer Road Power Plant cooling towers.[16]

In 1991, the Harlingen Water Works System partnered with Fruit of the Loom to produce highly treated wastewater for a new textile bleaching and dyeing production facility. Harlingen Water Works System originally constructed a 2-million-gallon-per-day reverse osmosis treatment system to provide the high-quality water required by the facility. The facility was eventually expanded to a capacity of 4 million gallons per day (4,484 acre-feet per year) before the textile plant closed in 2003.[17]

MUNICIPAL USES (BEGINNING IN THE 1960s)

Municipal use of reclaimed water includes irrigation of golf courses, parks, athletic fields, and other landscaped areas. In addition, reclaimed water can be used as a supply for ornamental lakes and fountains. Numerous municipal applications of water reuse are currently in place across Texas. A sampling of these projects is presented below.

El Paso Water Utilities has been providing reclaimed water for municipal use since the 1960s. Currently, reclaimed water is used for irrigation of golf courses, parks, school grounds, cemeteries, zoo grounds, street parkways and medians, a city tree farm, and other landscaped areas. In addition, the water is also used for other municipal uses such as car washes, construction, and street sweeping.


Texas municipalities began using reclaimed water in the 1960s to irrigate parks and other areas.

In the late 1960s, the City of Lubbock developed plans for the Canyon Lakes project. Due to the extensive land application of reclaimed water, a shallow groundwater mound formed under the irrigation sites. Wells have been installed to extract water from the sites and beneficially use the excess groundwater. This water is used to supplement five small on-channel reservoirs (Jim Bertram Lake System or Lubbock Canyon Lakes). Without supplemental inflow, the level in these recreational lakes would fluctuate significantly.

During the 1980s, the City of Odessa expanded its reuse program to provide reclaimed water for irrigation of a number of landscaped areas, including university grounds, highway right-of-way areas, golf courses, and a small residential subdivision.

In the 1980s, the Trinity River Authority partnered with the Dallas County Utility Reclamation District to implement a water reuse project for maintenance of lakes and canals and irrigation of golf courses and other landscaped areas in the Las Colinas development within the City of Irving. At the time of its implementation, this project was the largest urban area reclaimed water project in Texas.[18]

In the late 1990s, the City of Abilene began using Lake Kirby for storage of reclaimed water and started providing water to municipal irrigation users, including golf courses, university and school grounds, and the Dyess Air Force Base.

In 2000, the San Antonio Water System completed construction of over 80 miles of pipelines to provide reclaimed water to users in the City of San Antonio. In addition to stream augmentation, the reclaimed water is used to maintain flows within the riverwalk area; for maintenance of ornamental lakes and fountains; for irrigation of golf courses, parks, and other landscaped areas; for cooling tower makeup water; and for other industrial and commercial uses. At the time of its implementation, this water reclamation project was the largest of its kind in the nation.

The City of Fort Worth is implementing a regional reclaimed water system that, in addition to users within the City of Fort Worth, will serve the cities of Arlington and Euless and the Dallas Fort Worth International Airport. The water will initially be used for irrigation of golf courses, athletic fields, parks and other open areas; for cooling water at the main airport utilities plant; and for natural gas exploration operations. The project is scheduled to be completed in March 2011.

USE OF RECLAIMED WATER FOR IRRIGATION OF GOLF COURSES

In 2007, 487 Texas United States Golf Course Association member golf course superintendents were surveyed. Of the 487 surveys, 150 surveys (31 percent) were returned with 40 of the respondents (27 percent) indicating that reclaimed water was used at their courses. The primary benefits reported included a reliable water source, conservation of fresh water, and cost.[19] However, the biggest impediments to using reclaimed water were reported to be initial cost and availability of a nearby source. Texas currently has over 1,000 golf courses.[20] Increasing the number of courses using reclaimed water could conserve significant quantities of fresh water, making it available for other uses.

POTABLE REUSE

"Unplanned" indirect potable reuse has been occurring for many years throughout the state. Any time treated wastewater is discharged to a stream or lake and is subsequently diverted at a point downstream for municipal water supply, indirect potable reuse is occurring. For example, unplanned indirect potable reuse has been occurring in the Trinity River Basin for as long as wastewater treatment plants in the Dallas/Fort Worth area have been discharging to the Trinity River. The Trinity River flows to the Huntsville and Houston areas, where it is used as a water supply for these and surrounding communities.

In recent years, as treated wastewater quality has improved and the value of reclaimed water as a supplemental water supply source has become more widely recognized, a number of "planned" indirect potable reuse projects to augment surface water have been planned or implemented. Water providers in the Dallas/Fort Worth area have taken the lead in this area and, starting as early as the 1980s, began acquiring water rights from the Texas Commission on Environmental Quality to divert and use treated wastewater discharges. Permitted water rights to treated wastewater discharges from the Dallas/Fort Worth area wastewater treatment facilities currently exceed 900,000 acre-feet per year.

Several of these projects, and others throughout the state are described in the following table. In 1985, the North Texas Municipal Water District (serving communities primarily north and east of Dallas) implemented an indirect potable reuse project in Lavon Lake. Treated wastewater from the District's Wilson Creek Regional Wastewater Treatment Plant was discharged to Lavon Lake and subsequently diverted and treated for municipal use as drinking water. Initially, the Wilson Creek plant was permitted for discharge of 8 million gallons per day (8,968 acre-feet per year), but has grown over time and facilities are currently in place to discharge up to 48 million gallons per day (53,808 acre-feet per year) to Lavon Lake. Treatment at the Wilson Creek plant currently includes advanced secondary (or tertiary) treatment, as well as additional processes to remove phosphorus from the water.

PERMITTED INDIRECT REUSE WATER RIGHTS IN THE TRINITY RIVER BASIN		
ENTITY	DESCRIPTION	DIVERSION RIGHT (ACRE-FEET/YEAR)
City of Dallas	Return flows from Dallas Central and Southside Wastewater Treatment Plants (WWTPs), pumped to Lake Ray Hubbard	150,000
City of Dallas	Return flows from Dallas Central and Southside WWTPs, Flower Mound WWTP, Lewisville WWTP, pumped to Lewisville Lake	97,200
City of Irving	Return flows from Trinity River Authority's Central Regional Wastewater System, originating from City of Irving Chapman Lake supply	31,600
North Texas Municipal Water District	Return flows from Wilson Creek WWTP into Lavon Lake	71,882
North Texas Municipal Water District	Return flows from multiple WWTPs, diverted from East Fork Trinity River, polishing treatment through constructed wetland and pumped to Lavon Lake	157,393
Tarrant Regional Water District	Return flows from multiple WWTPs, diverted from Trinity River, polishing treatment through constructed wetlands and pumped to Richland Chambers Reservoir and Cedar Creek Reservoir	195,818
Trinity River Authority	Return flows from City of Ennis WWTP, pumped to Lake Bardwell	3,696
Trinity River Authority	Return flows from Waxahachie WWTP to Lake Bardwell	5,129
Trinity River Authority	Return flows from Mountain Creek Regional Wastewater System to Joe Pool Lake	4,368
Trinity River Authority	Return flows from Central, Red Oak, and Ten Mile Creek Regional Wastewater Systems to the Trinity River and on to Lake Livingston	246,219
Upper Trinity Regional Water District	Return flows from multiple WWTPs discharging to Lewisville Lake, originating from Upper Trinity Regional Water District Chapman Lake supply	9,664
TOTAL		**972,969**

In 2009, the North Texas Municipal Water District completed construction of a second indirect reuse project that involves diverting water from the East Fork of the Trinity River (which is predominantly treated wastewater during dry periods), providing polishing treatment through a constructed wetland, and pumping the wetland-treated water to Lavon Lake. This project, which includes approximately 1,800 acres of wetlands that provide further polishing of the reclaimed water, will ultimately augment the District's supply by about 102,000 acre-feet per year.

The City of El Paso's water sources include groundwater aquifers and surface water from the Rio Grande. Water from the Rio Grande is only available seasonally, and pumping from the groundwater aquifers has exceeded the recharge rate. In order to increase groundwater levels, the El Paso Water Utilities injects advanced treated reclaimed water into the aquifer. The advanced treatment facilities use ozone and granular activated carbon for purifying the water. The Hueco Bolson Recharge Project, which initially began in 1985, currently recharges 1,700 acre-feet per year of reclaimed water at 10 injection wells and 800 acre-feet per year at an infiltration basin for groundwater recharge.

During the 1990s, the Tarrant Regional Water District (serving Fort Worth, Arlington and surrounding communities) initiated planning and research that resulted in the implementation of an indirect potable reuse project that will ultimately augment the District's supply from Richland Chambers reservoir by up to 63,000 acre-feet per year. The project involves diverting water from the Trinity River (which is predominantly treated wastewater during dry periods) and introducing it into a constructed wetland for polishing treatment. The wetland-treated water is then pumped into the reservoir. The first phase of this project became operational in 2009 and currently provides 10,000 acre-feet of additional supply. Construction of additional phases as well as a sister project, which will augment the District's supply from Cedar Creek Reservoir by 52,500 acre-feet per year, will be completed by 2020.

During the 1990s, the Trinity River Authority began acquiring water rights for return flows to augment supplies in its system. The first project resulting from this effort involved capturing return flows from the City of Waxahachie wastewater treatment plant, which discharges into a tributary of Lake Bardwell. A follow-on project, to be constructed by 2040, will also augment supply in Lake Bardwell and involves pumping return flows from the City of Ennis wastewater treatment plant to the lake.

In addition to the Lake Bardwell project, the Trinity River Authority augments its supplies in both Joe Pool Lake and Lake Livingston with return flows from wastewater treatment plants that flow directly to these reservoirs.

In 2006, the Upper Trinity Regional Water District implemented a project which uses return flows originating with the District's raw water supply in Chapman Lake. The District pumps water from Chapman Lake to Lewisville Lake, where it is used by customers and subsequently returned to Lewisville Lake via District and customer wastewater treatment plants. The project is permitted for 9,664 acre-feet per year, but current return flows provide approximately 3,600 acre-feet per year of additional supply.

The Colorado River Municipal Water District is implementing a project to capture treated municipal effluent from the City of Big Spring, and provide additional advanced treatment prior to blending into their raw surface water delivery system. Advanced treatment of the municipal effluent will consist of membrane filtration, reverse osmosis, and ultraviolet oxidation, producing very high quality water, which will be blended with surface water from Lake E.V. Spence for distribution to their member and customer cities. The anticipated yield of about 1.75 million gallons per day (1,962 acre-feet per year) of reclaimed water will be 5 to 15 percent of the total blend in the Lake E.V. Spence pipeline and is expected to begin flowing in early 2012. The blended water will subsequently be treated at the City's water treatment plant and then distributed to customers.

ROLE OF WATER REUSE

Water reuse is an important water management strategy for Texas, the value of which has become more recognized over time. The State Water Plans, prepared by the Texas Water Development Board, have included increases to the planned water supply from water reuse with each five-year update.

Total Supply from Water Reuse in State Water Plans			
Plan Year	Number of Regions[(E)]	Supply from Water Reuse (ac-ft/yr)	Percent of Total[(F)]
2002[(G)]	10	702,726	3.5
2007[(H)]	14	1,630,000	7.5

[(E)] Number of regions with water reuse as an existing supply or planned water management strategy
[(F)] Percent of total demand
[(G)] For 2002 plan, supply and demand numbers shown are for the year 2050
[(H)] For 2007 plan, supply and demand numbers shown are for the year 2060

CHALLENGES FOR ADVANCING WATER REUSE

There are a number of challenges to advancing water reuse in Texas. Addressing these challenges requires a deliberate, effective approach and will take time. Several of these challenges are discussed below.

WATER RIGHTS

As reflected in earlier sections of this document, significant quantities of indirect reuse water have been permitted in recent years. The success of obtaining these permits has been largely due to coordination and collaboration between various stakeholders potentially impacted by the issuance of the permits. It is critical that similar coordination and collaboration be emphasized in the future in order to continue the advancement of indirect water reuse projects. Direct reuse projects currently do not require a water right in Texas.

BALANCE BETWEEN ECOLOGICAL AND HUMAN NEEDS

A need exists to balance the water required for municipal, industrial, and agricultural use with the water needed to support the environment. A balance should be established that is based on a sound scientific and technical analysis which may include data on water sources such as rainfall runoff, wastewater treatment plant return flows (reclaimed water), and natural groundwater and spring flows. The role reclaimed water will play in achieving the balance between water demands and environmental needs will be determined as part of the regulatory process.

FUNDING

A major challenge for implementing direct, nonpotable reclaimed water projects is funding for constructing the initial infrastructure. During the initial stages of nonpotable systems, the projects often do not generate adequate revenue to pay for the cost of constructing and operating the systems. Similarly, obtaining funding for advanced treatment facilities that may be required for some indirect potable reuse projects is also a challenge. The Texas Water

Development Board has some funding programs in place that can be used for water reuse projects. These include the State Revolving Funds, Water Infrastructure Fund, and State Participation Fund. However, there is a need to establish funding mechanisms that specifically address the challenges of starting up a reclaimed water system.

The 2007 State Water Plan estimates that implementation of the water reuse projects identified to meet 2060 demands will cost nearly $4 billion dollars.

WATER QUALITY

There has been significant research demonstrating that reclaimed water is safe for many nonpotable uses, including those that involve potential public contact.[21] In addition, research has been and continues to be performed related to the use of reclaimed water for augmenting potable water supplies.[22][23][24] However, as Texas continues to develop additional potable reuse projects, it is critical that additional, Texas-specific research be performed to improve our understanding of water quality, particularly as it relates to potable water reuse. These research efforts should be closely coordinated with other national and international research programs.

PUBLIC OUTREACH AND AWARENESS

Advancement of water reuse in Texas will depend on support from the public, who ultimately will pay for and benefit from the projects. Therefore, it is extremely important that proactive public outreach and awareness programs be implemented on a local, regional, and statewide basis. The programs need to inform the public and policy-makers about the need for and value of reclaimed water and provide information about the safety of using reclaimed water for water supply.

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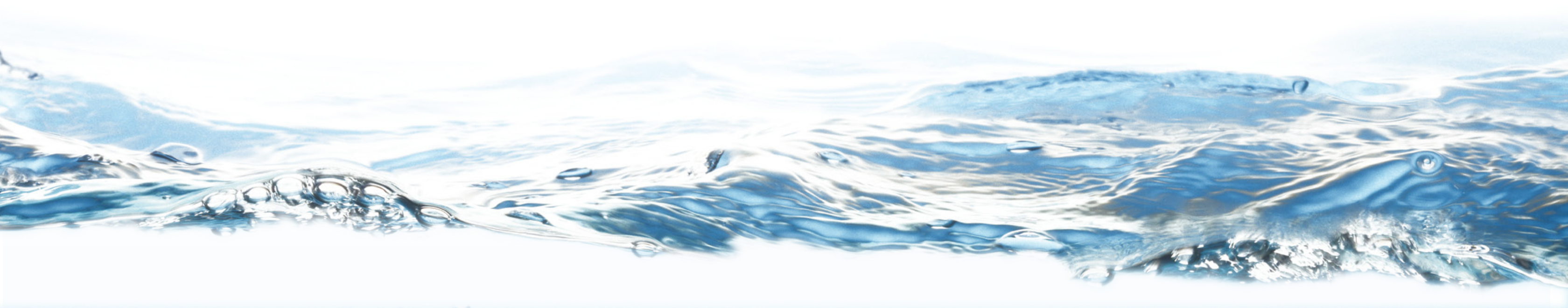

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