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Lone Star Groundwater Conservation District Effluent Reuse Study

Final Report

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Executive Summary

Reclaimed water is anticipated to be an essential component of the future water supply in Montgomery County. In combination with surface water and water conservation methods, reclaimed water will help to make up the projected 90,000 acre-foot deficit in water supply over the next 40-year planning period. The purpose of this study was to identify the practical extent to which reclaimed water can actually be expected to be implemented in the County and to examine alternative forms of incentives that encourage communities to engage in this solution.

The current technology of reclaimed water limits its use to non-potable use. Over the past decade, nine major projects for reclaimed water use have been evaluated in Montgomery County. Although some successes have been realized in the City of Panorama Village and Montgomery County MUD No. 15, for the most part, the cost of developing a reclaimed water system has not been cost effective when compared to the cost of using groundwater. However, as the cost of water supply increases with the implementation of surface water, reclaimed water is anticipated to be a cost-effective alternative in some cases.

Potential users of reclaimed water and water providers were surveyed to determine the extent to which the concept of using reclaimed water was viewed as an acceptable solution. This was cross referenced to the Lone Star Groundwater Conservation District (LSGCD) groundwater well permitting database. From this analysis, it has been determined that an estimated 4,900 acre-ft of water, or 7 percent of the current total water demand could be used effectively to satisfy irrigation demand in the county. Feasible projects are most prevalent in the area of southwest Montgomery County where the concentration of wastewater treatment-plants is high and the planned development of The Woodlands and adjacent communities have a higher degree of amenity water features. However, other projects in Conroe, the area of Lake Conroe and Porter are also very viable to irrigate golf courses and lawn irrigation. Porter SUD is actually evaluating installing a dual water system for such purpose, if the economics can be proven. New development in Montgomery County, and changing trends in community planning could increase the use of reclaimed water in these communities to much as 15 percent of their total demand.

In spite of its practical application, implementation of reclaimed water systems will still face some obstacles. To begin, reclaimed water systems are localized solutions that will apply in some areas and not in others. The community implementing the system is faced with an up-front capital cost for a system that may not have the demand for the water in place at the outset. Consequently, the unit cost for reclaimed water is initially higher and the community is at a higher risk for recovering its cost. This becomes a deterrent to implementation that requires some form of incentive to overcome.

As the LSGCD imposes a regulation to manage the withdrawal of groundwater an incentive to use alternative supplies will be generated. The previous studies performed for a regional surface water supply system suggests that the cost for that system will range anywhere from $2.65 per 1,000 gallons to $1.40 per 1,000 gallons depending on whether or not the users of that water pay for the water or if a cost neutral solution is adopted wherein all water users pay the same regardless of source. If reclaimed water is to be considered as part of the solution to long term water supply, then the cost of its implementation needs to be figured in to the overall cost of water. It would seem that, if reclaimed water can be implemented for a cost less than or equal to that of surface water, then it is a viable project. If not, then surface water or continued dependency on groundwater is a more viable solution. However, if it is implemented in a manner which does not increase the total cost of water overall, then it must be planned and committed to sufficiently in advance to reduce the size of the surface water system facilities. If the surface water facilities must be sized to convert 30 percent of the demand without considering reuse, than reuse represents an additional cost over and above the cost of a combined groundwater and surface water system. If the cost of reuse is the same or less

than the cost of surface water and if the surface water amount can be reduced in the planning stages, then reuse makes sense from an economics standpoint.

This report presents several alternatives on how the LSGCD might consider both monetary and non-monetary incentives to encourage reclaimed water use. These alternatives vary depending on what role the LSGCD will ultimately participate in the long-term water supply solution.

In addition to developing the alternatives as noted above, there is also a need to present the results of this study in workshop fashion to educate the general public and the water purveyors in the county concerning reuse and its potential utility as a means of reducing groundwater consumption. Responses to the questionnaire on potential use of reclaimed water were likely influenced by past studies showing the inequity of comparing reuse water to low cost groundwater. As further studies are completed to better refine the cost of surface water, then at least one and possibly more workshops with local municipal and district officials are recommended to explore the potential for reuse as a conversion means in direct comparison to the costs of surface water. This workshop will also provide an opportunity for LSGCD to provide information to the general public and to the water purveyors on how costs may be leveled for all purveyors of water in Montgomery County.

Introduction

In 2001, House Bill 2362 was passed by the 77th Legislature establishing the Lone Star Groundwater Conservation District (LSGCD). The purpose of the LSGCD is to ensure the protection and beneficial use of groundwater resources in Montgomery County (the County). Water demands in Montgomery County are currently almost exclusively met from groundwater sources. The Texas Water Development Board - Region H Water Planning Group, empowered by Senate Bill 1, indicates that the annual sustainable recharge rate of the Gulf Coast aquifer in Montgomery County as 64,000 acre-feet. Currently, the LSGCD identified over 500 permittees with requested pumpages totaling more than 68,000 acre-feet per year (ac-ft/yr). Moreover, the 2005 State Water Plan identified that Montgomery County will require surface water supply as an alternative source of water supply to groundwater by 2010 and that the San Jacinto River Authority (SJRA) is the most probable supplier of surface water to that County.

In 2006, the LSGCD completed a study concluding that supplemental water supplies to augment the dependency on groundwater are essential to the continued growth in Montgomery County. These supplemental supplies included demand management through conservation, wholesale surface water, and use of reclaimed or reuse water. The urgency of the situation is such that although sufficient water exists in the aquifer system for many years of supply, conditions of drawdown, land subsidence, higher pumping costs, and potential water quality issues demands that these alternative solutions be implemented as quickly and as cost effectively as practical. Water reuse is a comparatively expensive solution to water supply when compared to the low cost, high quality of the groundwater supply in the Gulf Coast aquifer system. But, when compared to the cost of surface water, reuse is anticipated to be cost effective.

In May of 2006, the LSGCD authorized a study to determine the extent to which effluent reuse can be used to supplant the need for groundwater. Because reuse solutions are localized, they offer the ability to be implemented comparatively quickly compared to a surface water system, although concurrently, efforts are underway to implement surface water by 2015. The authorized study had four major objectives:

- Identify prior water reuse programs in Montgomery County and determine the extent to which they have effectively been implemented.
- Determine the practical opportunity to reuse water in the County.
- Identify probable reuse projects.
- Evaluate incentives for getting suppliers of reuse water and customers to work together.

Reclaimed Water Regulations

The use of reclaimed water for beneficial purposes is regulated by the Texas Commission on Environmental Quality (TCEQ) under *Texas Administrative Code* (TAC) Title 30 Chapter 210 Subchapters A, B, C, and D (hereafter referred to as "Chapter 210"). Chapter 210 establishes the "general requirements, quality criteria, design, and operational requirements for the beneficial use of reclaimed water which may be substituted for potable water and/or raw water" and applies to producers, providers, and users of reclaimed water. Prior to initiating a reclaimed water project, TCEQ Chapter 210 authorization is required.

While Chapter 210 applies to any future reclaimed water projects, it does not apply to entities whose wastewater discharge permits allow them to dispose of treated wastewater by irrigation or to on-site wastewater treatment systems (authorized under 30 TAC §285) that utilize surface irrigation as an approved disposal method. There could also be pre-existing reclaimed water systems that do not have a Chapter 210 authorization but that were required to follow the notification requirements after Chapter 210 went into effect in 1997.

The reclaimed water provider can deliver the water by direct or indirect means. With direct delivery, the reclaimed water is piped from the wastewater treatment plant (WWTP) to the point of use. With indirect delivery, the reclaimed water is discharged into a surface water channel, transported downstream, and diverted at or near the point of use. Reclaimed water projects utilizing indirect delivery require a bed and banks permit from TCEQ under *Texas Water Code* Section 11.042, which authorizes the permit holder to convey and subsequently divert water in a river or stream Texas Water Development Board [*TWDB] 2007 Draft State Water Plan*, p. 240).

Definitions

Pertinent definitions set forth in Chapter 210 are:

Reclaimed water — Domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use, pursuant to the provisions of this chapter (Chapter 210) and other applicable rules and permits.

Beneficial use — An economic use of wastewater in accordance with the purposes, applicable requirements, and quality criteria of this chapter, and which takes the place of potable and/or raw water that would otherwise be needed from another source.

Producer — A person or entity that produces reclaimed water by treating domestic wastewater or municipal wastewater, in accordance with a permit or authorization of the Agency, to meet the quality criteria established in this chapter.

Provider — A person or entity that distributes reclaimed water to a user(s) of reclaimed water. For purposes of this chapter, the reclaimed water provider may also be a reclaimed water producer.

User — Person or entity utilizing reclaimed water for a beneficial use, in accordance with the requirements of this chapter. A reclaimed water user may also be a producer or provider.

Type I reclaimed water use	Use of reclaimed water where contact between humans and the reclaimed water is likely.
Type II reclaimed water use	Use of reclaimed water where contact between humans and the reclaimed water is unlikely.
BOD_5	Five-day biochemical oxygen demand
$CBOD_5$	Five-day carbonaceous biochemical oxygen demand
CFU	Colony forming units
mg/l	Milligram per liter
NTU	Nephelometric turbidity units

Other pertinent definitions are:

Direct reuse	Project where reclaimed water is piped directly from the wastewater treatment plant (WWTP) to the point of beneficial use.
Indirect reuse	Project where reclaimed water is discharged into a surface water channel, transported downstream, and diverted at the point of beneficial use.
WWTP	Wastewater Treatment Plant
mgy	Million Gallons per Year

Type I Reclaimed Water Use

This type of use includes irrigation or other uses in areas where the public may be present during the time when irrigation takes place or other uses where the public may come in contact with the reclaimed water. The following types of uses would be considered Type I uses (30 TAC §210.32):

- Residential irrigation, including landscape irrigation at individual homes.
- Urban uses, including irrigation of public parks, golf courses with unrestricted public access, school yards, or athletic fields.
- Use of reclaimed water for fire protection, either in internal sprinkler systems or external fire hydrants.
- Irrigation of food crops where the applied reclaimed water may have direct contact with the edible part of the crop, unless the food crop undergoes a pasteurization process.
- Irrigation of pastures for milking animals.
- Maintenance of impoundments or natural water bodies where recreational activities, such as wading or fishing, are anticipated even though the water body was not specifically designed for such a use.
- Toilet or urinal flush water.
- Other similar activities where there is the potential for unintentional human exposure

Type II Reclaimed Water Use

This type of use includes irrigation or other uses in areas where the public is not present during the time when irrigation activities occur or other uses where the public would not come in contact with the reclaimed water. The following are examples of uses that would be considered Type II uses (30 TAC §210.32):

- Irrigation of sod farms, silviculture, limited access highway rights of way, and other areas where human access is restricted or unlikely to occur. The restriction of access to areas under irrigation with reclaimed water could include the following:
    - The irrigation site is considered to be remote.
    - The irrigation site is bordered by walls or fences and access to the site is controlled by the owner/operator of the irrigation site.
    - The irrigation site is not used by the public during the times when irrigation operations are in progress. Such sites may include golf courses, cemeteries, and landscaped areas surrounding commercial or industrial complexes. The "syringing" or "wetting" of greens and tees on golf courses shall be allowable under Type II so long as the "syringing" is done with hand-held hoses as opposed to automatic irrigation equipment. The public need not be excluded from areas where irrigation is not taking place. For example, irrigation of golf course fairways at night would not prohibit the use of clubhouse or other facilities located a sufficient distance from the irrigation.
    - The irrigation site is restricted from public access by local ordinance or law with specific standards to achieve such a purpose.
- Irrigation of food crops where the reclaimed water is not likely to have direct contact with the edible part of the crop, or where the food crop undergoes pasteurization prior to distribution for consumption.
- Irrigation of animal feed crops other than pasture for milking animals.
- Maintenance of impoundments or natural water bodies where direct human contact is not likely.
- Soil compaction or dust control in construction areas where application procedures minimize aerosol drift to public areas.
- Cooling tower makeup water. Use for cooling towers which produce significant aerosols adjacent to public access areas may have special requirements.
- Irrigation or other non-potable uses of reclaimed water at a wastewater treatment facility.
- Any Type I reclaimed water may also be utilized for any of the Type II uses identified in this section.

Quality Standards for Reclaimed Water

The following quality standards are from 30 TAC §210.33.

Type I (30-day average) – BOD_5 or $CBOD_5$ – 5 mg/l
Turbidity – 3 NTU
Fecal Coliform – 20 CFU/100 ml*
Fecal Coliform (not to exceed) - 100 CFU/100 ml**

Type II (30-day average) – **System Other than Pond System**
BOD_5 – 20 mg/l
$CBOD_5$ – 15 mg/l
Fecal Coliform – 200 CFU/100 ml*
Fecal Coliform (not to exceed) - 800 CFU/100 ml**

Pond System
BOD_5 – 30 mg/l
Fecal Coliform – 200 CFU/100 ml*
Fecal Coliform (not to exceed) - 800 CFU/100 ml**

* Geometric Mean
** Single Grab Sample

Current Reuse Activity

The first phase of this study was to identify the extent to which effluent reuse is currently being implemented in Montgomery County. Data collected from both the TCEQ and TWDB along with a questionnaire to each water purveyor and WWTP operator were used to evaluate the existing level of reuse.

Current Authorized Reuse

A list of entities with Chapter 210 Authorizations was obtained from the TCEQ and those entities with Authorizations along with the reclaimed water use type are listed below:

- DL Utilities – Del Lago Golf Course

Additional facilities in Montgomery County may be authorized for reuse irrigation authorizations as part of their discharge permits. Databases for these additional authorizations are not readily available; therefore, other authorizations are not used in this study.

Those entities (WWTPs) with Chapter 210 Authorizations were compared to the TPDES Permitted Discharge volumes to determine the percent of average daily flow (ADF) to the amount permitted under the Chapter 210 Authorization. *Table 1* shows the results of this analysis.

Table 1. Average Daily Flow versus Chapter 210 Authorized Reuse Volumes

Entity	Irrigated	WWTP ADF (mgd)	Chapter 210 Authorized Reuse (mgd)	% of ADF
DL Utilities	Del Lago Golf Course	0.125	Up to Permitted Limit	-

*Data as of August 9, 2006

The TWDB collects reclaimed water use data using voluntary surveys distributed annually. A review of available data (years 1997-2002) for Montgomery County indicated that there is a limited amount of reuse occurring within the County. Most of the reuse reported is occurring at WWTPs for wash water and for irrigation of golf courses. However, there is no consistency in the reported data from year to year on reclaimed water users and quantities of effluent reuse.

Water Reuse Questionnaire

A planning questionnaire was also used to aid in the determination of the current and future level of reclaimed water use in the County. The planning questionnaire, included in *Appendix C* was sent out to each public water system in Montgomery County requesting information regarding their water and wastewater systems as well as any reuse being performed or evaluated for use within their service area. As of September 27, 2006, approximately 46 responses were received from water purveyors and WWTP operators in Montgomery County. The following entities reported back that either they currently use reuse as a non-potable water supply or would consider using reuse in the future:

- **River Plantation MUD** – Currently uses approximately 171,800 gallons per day of reuse, which represents approximately 42 percent of their reported ADF, for irrigation of the River Plantation Country Club golf course. The annual per golf hole water usage is 7.13 acre-feet. River

Plantation Country Club uses reuse water from River Plantation MUD to irrigate the 27-hole golf course. It is not expected that a reduction in groundwater pumpage, as a result of increased reuse by the Country Club, would result because the irrigation system is not using groundwater as a water supply.

- **Montgomery County MUD No. 19** – Previously evaluated reuse and determined that there were no potential users of the WWTP effluent within their service area. However, if there were serviceable areas within their service area, they would consider reuse.
- **City of Conroe** – Costs associated with reuse were initially too high and they are currently exploring an expanded customer base for reuse. The City currently uses 140,000 gallons per day for in-plant irrigation and in-plant operations.
- **City of Panorama Village** – Currently uses an estimated 215,000 gallons per day, which is approximately 40 percent of the water needed to irrigate the Panorama Country Club golf course.
- **Montgomery County MUD No. 15 –** Currently use 10,000 gallons per day for in-plant irrigation and in-plant operations. They are also exploring the possibility of using reclaimed water for a Conroe Independent School District (ISD) wetlands project, but this usage would not cause a reduction in groundwater pumpage.
- **DL Utilities** – Previously evaluated reuse for golf course irrigation and concluded that initially costs associated with the reuse were too expensive. However, they are currently exploring the possibility of using reclaimed water for the Del Lago Resort golf course irrigation.
- **Porter MUD/SUD** – Currently trying to receive grant funding from TWDB for a study that will determine the feasibility of using effluent reuse. The plan is to use wastewater effluent for irrigation purposes of all future developments, including the concrete companies and the fire department.

Based on the responses to the questionnaire and the data received from the State agencies, limited reuse is currently being performed in the County. Furthermore, the questionnaire responses indicate trends that there is potential for increased reuse within the County.

Reuse Potential

The reuse potential, which is the lesser of the reliable supply of reclaimed water and the non-potable water demand, must be determined to assess the impact reuse could have on reducing groundwater demands. The following steps were performed to quantify the reuse potential in Montgomery County:

1. Identified parameters to be used in supply and demand development planning.

2. WWTPs were identified and located in Montgomery County and the potential supply (i.e., effluent) available for reuse was estimated.

3. Non-potable water demands (i.e., irrigation and recreational use) were identified and estimated for Montgomery County.

4. Available supplies (i.e., effluent) were then matched to potential County demands.

Each of these steps is discussed in greater detail in the following sections.

Existing Studies

To evaluate potential reclaimed water use opportunities for non-potable uses, TCB collected and reviewed previous reuse studies conducted in and around the Montgomery County area

Various feasibility studies have been conducted in and around the Montgomery County area to analyze the potential for meeting non-potable water demands with reclaimed water. Many of these studies have been focused on meeting water demands within regional authorities and master-planned communities throughout the Houston region, including:

- *Region H Water Plan*
  Wastewater Reclamation for Municipal Irrigation
  TCB - KBR
  August, 2005
- *Feasibility Study for the Implementation of a Water Reuse Project in Fairfield Village*
  Final Report
  TCB
  June, 1991
- *Cinco Ranch Reclaimed Water Reuse Study*
  Final Report
  TCB
  December, 1992
- *Cinco Ranch Effluent Reuse Study*
  Cinco MUD No. 1
  TCB
  March, 2005
- *Proposed Irrigation System Options*
  Cinco Ranch Southwest
  TCB
  April, 2004

- *Copperfield Effluent Reuse Study*
  Copperfield Joint Operations Board
  TCB
  October, 2004
- *Copperfield Area Wastewater Treatment Plant Effluent Reuse Study*
  Copperfield Joint Operations Board
  TCB
  August, 2003
- *Water Reuse in Texas*
  Texas Water Development Board
- *Porter SUD/Porter MUD Reuse Feasibility Study*
  Alan Plummer & Associates – Waiting on funding from TWDB
- Walden Water Reuse Program Executive Summary Proposal
  Montgomery County MUD Nos. 8, 9, WCIA
  Jones & Carter
- *San Jacinto River Authority Wastewater Treatment Plant No. 1 Effluent Reuse Study*
  San Jacinto River Authority
  Brown & Gay Engineers, Inc.
  August, 2002

Region H Water Plan – Wastewater Reclamation for Municipal Irrigation

Region H conducted a study on a potential water management strategy to meet shortages with the use of reclaimed water. This study focused on meeting a non-potable portion of water demands in Brazoria, Fort Bend, Harris, and Montgomery Counties. Non-potable demands were limited to municipal uses such as green spaces, amenity lake make-up water, and golf courses. This study focused primarily on future growth in new communities and not retrofitting existing communities. This study identified reuse as a viable alternative to meet a portion of the water demands in each of the counties. The average golf course irrigation demands were calculated using well pumpage data for those groundwater wells known to supply irrigation water to golf courses. This study indicated that the average golf course irrigation demand in Montgomery County was 11.44 ac-ft/yr per golf hole and the overall area golf course demands were identified to be 12.31 ac-ft/yr per golf hole. An irrigation demand of 16.13 inches of additional water was calculated based on rainfall and evaporation data and typical green space acreage per capita is 0.0089 acres. Amenity lake demands were calculated on a per capita basis which was determined to be 0.01 ac-ft/yr per capita. Region H identified potential reuse demands (golf courses, green spaces, and amenity lakes) for Montgomery County of 1,405 ac-ft/yr, 2,437 ac-ft/yr, and 4,622 ac-ft/yr for years 2010, 2020, and 2030, respectively.

TWDB - Water Reuse in Texas

The TWDB article, "Water Reuse in Texas," states that reuse of water is expected to provide 12 percent of the total water demand. This article places emphasis on municipal and industrial reuse with a reported 190 utilities in Texas reporting some level of reuse. According to this article, approximately 160 mgd of reuse was occurring in 1998 with the primary reuse applications being golf course irrigation, industrial manufacturing, and cooling water.

2003 Copperfield Study

The Copperfield development investigated the reuse of effluent for irrigation and other non-potable demands. Currently, the Hearthstone Country Club (HCC) receives treated effluent from the Copperfield WWTP. Other municipal irrigation demands served by potable supplies were investigated for use of treated effluent. The study estimated the quantity of park and esplanade water

use and found that the amount of water applied to esplanades was considerably higher than that for parks. Results of this study are shown in *Table 2*.

Table 2. Irrigation Demands and Application Rates for Copperfield Subdivision [1]

Irrigation Demand	Demand (mgd)	Application Rate (in/yr)
Hearthstone Country Club	0.3	-
Potable Irrigation [2]	4.45	-
Park Area Irrigation [3]	-	19.18
Esplanade Area Irrigation [3]	-	110.02

[1] Data obtained from *Copperfield Area Wastewater Treatment Plant Effluent Reuse Study*, August 2003
[2] Average irrigation demands met from the potable water system for MUD Nos. 162, 163, 179, 186, and 208.
[3] Included in total Potable Irrigation demand

A study conducted in 2004 outlined a 6-phase plan to supply the demands found in the 2003 study.

Cinco Ranch Studies

Cinco Ranch Master Planned Community (MPC) is a 5,000-acre development located in western Harris and eastern Fort Bend Counties. A study conducted in 1992 investigated several alternatives for effluent reuse. The alternatives investigated included:

- Application on the common areas along Mason Road and Westheimer Parkway
- Irrigation of the underdeveloped areas of Cinco Ranch Golf Club
- Application for rice irrigation on a farm approximately 4.2 miles from Cinco Ranch

The three alternatives had total demands of less than 1 mgd. The costs of effluent associated with the three alternatives were estimated to be $1.20, $0.57, and $0.78 per 1,000 gallons, respectively. The maximum allowable rate of application for residential areas in this study was estimated to be 30.2 inches per year. The application rate for agricultural use in the report was 72.8 inches per year.

A study conducted in 2005 investigated supplying reuse water to common areas, golf courses, and amenity lakes within Cinco Ranch MPC. This study evaluated three alternatives with two alternatives providing treated effluent directly to irrigation systems along streets and to reservoirs from which water could be pumped to irrigation systems as needed and an alternative system providing effluent only to amenity lakes, including lakes for irrigation at the golf courses. This last alternative realized a lower cost because it would operate at lower pressure since it would not be connected directly to irrigation systems.

Fairfield Village

Fairfield Village is a MPC of almost 2,600 acres in northwestern Harris County. A study conducted in 1990 investigated reuse to irrigate common, commercial, and residential areas and for fire protection. The study assumed an application rate of approximately 30.0 inches of effluent per year on irrigated areas. The rate of application was based on analysis of soil and climate conditions as specified by TAC Title 30 Chapter 210. The proposed distribution system to supply treated effluent had a capacity of almost 5 million gallons per day (mgd). The cost of the effluent reuse system was $2.35 per 1,000 gallons for a system meeting TCEQ standards for potable water systems. A lower cost of $1.85 per 1,000 gallons was determined for a system meeting lower non-potable water system

standards. The study provides an example of effluent reuse for municipal irrigation that applies to new development.

Cinco Ranch Southwest

The Cinco Ranch Southwest (CRS) study conducted in 2004 investigated alternative systems to provide the potable and non-potable water needs of proposed development. No unit costs were determined for reuse systems in this study. The proposed system is representative of reuse systems for a community that is still under development rather than the retrofit of an existing community.

Walden Water Reuse Program

A joint venture project between Walden Community Improvement Association (WCIA) and Montgomery County MUD Nos. 8 and 9 studied the development of a Walden water reuse program for irrigation of roadside and greenbelt/utility easement areas. This study identified a potential volume of reuse of 80 million gallons per year to irrigate approximately 114 acres of green space. This corresponds to approximately 20 percent of the 2003 to 2005 annual average potable water usage of approximately 402 million gallons. The current Walden WWTP discharge into Lake Conroe is approximately 127,750,000 gallons annually. Although the WCIA would be the only customer during the first phases of the reuse program, the study recognized the potential to increase reuse usage by supplying the Walden Golf and Country Club with an annual volume of 106 million gallons as the cost of surface water increases and overall growth in the Walden area increases flows to the WWTP. However, this reuse program was not implemented due to the costs associated with proposed ground storage facilities.

San Jacinto River Authority Wastewater Treatment Plant No. 1 Effluent Reuse Study

Brown & Gay Engineers, Inc. conducted a study evaluating the potential for using an effluent reuse system to irrigate golf courses associated with the Woodlands Resort and Conference Center (WRCC). The effluent would be from the SJRA WWTP No. 1 and would replace groundwater currently produced from two wells operated by the WRCC. The recommended alternative in this study included replacing two decommissioned effluent reuse pumps at the WWTP with new pumps and adding an additional 12-inch line to connect a third lake. This study assumed that an average annual demand of 600,000 gallons per day was needed for WRCC golf course irrigation, which included the irrigation of two, 18 hole-courses with an alternating irrigation schedule, and that infrastructure is available at the points of discharge for golf course usage. Therefore, a demand of 18.67 acre-feet per golf hole annually was used for planning purposes in this study.

Summary

In reviewing these studies, it was found that the most common identified beneficial uses of reclaimed water were to meet non-potable water demands such as:

- Golf Course Irrigation
- Green Space Irrigation (Parks, Esplanades, etc.)
- Make-up Water for Amenity Lakes (i.e., water level maintenance)

In reviewing these and other reports it became obvious that there is a growing use of reclaimed water for landscape irrigation purposes. There are no issues of perception or water quality which will deter the use of reclaimed water. The TWDB has an extensive database of reuse projects which are more often prevalent in water short areas of the State but which are increasingly located in the Gulf Coast area. As noted elsewhere in this report, the primary deterrent to reuse implementation is comparison of the cost to low cost groundwater.

Summary of Planning Parameters

The previously discussed effluent reuse studies were also utilized to develop a set of planning assumptions and parameters for use in this study.

Unless otherwise identified in previous studies for an individual community, the below planning parameters were utilized for purposes of this study. The planning parameters identified for use in this study were:

- It was assumed that it may not be possible to capture a plant's ADF for use in a reclaimed water irrigation system due to the need for large amounts of storage to account for daily variation. It was assumed that up to 75 percent of a WWTP's ADF would be available for use in a reclaimed water system. This assumption requires some consideration for on-site storage to minimize peaks and shortages in effluent supply.
- Golf course irrigation demands will be estimated at 11.44 acre-feet per golf hole annually.
- Green Space Irrigation Demands, including make-up water for amenity lakes, for master-planned type communities will be approximately 20 percent of the annual average potable water usage and municipalities will be 2 percent of the annual average potable water usage.
- Future Growth trends will be consistent with past growth trends of master-planned communities and municipalities.

Those communities with identified planning parameter variances are:

- Walden (Montgomery County MUD Nos. 8 and 9) – Walden Golf and Country Club demand of 106 million gallons per year (mg/yr) and WCIA with a demand of 80 million gallons annually.
- Woodlands Area Courses Based on information found in previous studies for the Woodlands area golf courses, a demand of 18.67 acre-feet per golf hole annually will be used for the Woodlands area courses.
- River Plantation MUD – River Plantation Golf Course currently reuses approximately 171,800 gallons per day of treated effluent for irrigation. This usage equates to a 7.13 ac-ft/yr per golf hole irrigation demand.

Reuse Water Balance

Wastewater Treatment Plant Effluent Supply

The quantity and quality of available effluent supply were evaluated as part of this study and discussed in greater detail below.

Quantity of Available Effluent Supply

The potential reuse water supply is defined as treated wastewater effluent from a WWTP that could be transported by either direct or indirect methods to a location which requires water for non-potable uses. The first step in evaluating the reuse potential in Montgomery County is to identify and quantify the volume of reliable WWTP effluent.

A GIS database downloaded from the TCEQ website provided a list of WWTPs with state and federal identifiers, name of permit entity, and location. The reported quantity and quality of permitted effluent from each WWTP was determined by matching the WWTP's federal ID to a national list on EPA Envirofacts database. For purposes of this study, only municipal WWTPs with effluent greater than

0.5 mgy were used in the reuse water balance. The WWTPs are listed in *Table 3 – Identified Wastewater Discharges and Estimated Reliable Flows*. Of the reported ADF for each WWTP, 75 percent was assumed to be reliable on a daily basis. The total estimated volume of WWTP effluent available on a reliable basis for reuse was determined to be in excess of 6.5 Billion Gallons (20,100 acre-feet) annually.

Quality of Available Effluent Supply

As mentioned previously, 30 TAC Chapter 210 sets discharge limits for Type I and II reclaimed water use. The effluent discharge limits for those WWTPs identified in *Table 3* are provided on a CD in *Appendix A*. The discharge limits are typically more stringent than the discharge limits outlined for Type II application. However, there are no WWTPs in Montgomery County with permitted discharge limits as stringent as required for Type I reuse.

Non-Potable Effluent Reuse Demands

The potential reuse water demand is defined as water pumped from wells for non-potable uses, such as irrigation or lake replenishment, that could potentially be replaced with WWTP effluent. This demand is based on the assumption that the user converts to using reclaimed water instead of pumped well water. Therefore, the total groundwater pumpage is reduced by the amount of the potential reuse demand. For those users that have wells permitted for irrigation purposes, this is straightforward. However, there are users that use groundwater for both potable and non-potable supplies, and planning assumptions based on past studies were used to estimate the amount of the non-potable demands based on total reported groundwater pumpage. A detailed discussion of the assumptions and process used to determine the non-potable demands is provided below.

The LSGCD provided TCB with a database of wells in Montgomery County. The database contains permit numbers, yearly pumpage, permitted pumpage, owner names, location, primary use, and occasionally includes extra uses. The database was sorted by user types and if a name appeared to be a particular type of entity, a user type was assigned (e.g., if the owner name was “Country Club” a user type of “Golf” was assigned). If a well record could not be assigned a particular user type based on the name, fields indicating primary use and other use were inspected to determine the potential use of the water. Well records with “Irrigation” listed as “Primary Use” were assigned user type “Primary,” while entities containing key words in other columns were assigned user type “Secondary.” Key words are listed in *Table 4*. If an entity did not fit any user type or was not considered a primary or secondary irrigation user, the well was not included in the analysis.

Table 3 – Identified Wastewater Discharges and Estimated Reliable Flows

NPDES #	TPDES No.[1]	PERMITTEE	TCEQ Permitted Flow[2]	Current Average Design Flow Rate[3]	Reported Average Flow Rate[4]	Estimated Minimum Flow Rate[5]	Estimated Annual Flow
			(MGD)				(mg/yr)
TX0103004	13417-001	ALGONQUIN WATER RESOURCES OF TEXAS LLC*	0.2	0.1	0.040	0.030	10.87
TX0056545	11693-001	APRIL PLAZA MARINA INC., MERY	0.018	0.018	0.000	0.000	0.11
TX0118028	14013-001	AQUA DEVELOPMENT INC., GREENFIELD	0.05	0.05	0.005	0.004	1.42
TX0125113	14357-001	AQUA DEVELOPMENT INC., LAKE CONROE FOREST	0.3	0.15	0.082	0.062	22.50
TX0120073	14141-001	AQUA DEVELOPMENT INC., OLD EGYPT - WWTP	0.45	0.225	0.030	0.023	8.27
TX0117846	14007-001	AQUA DEVELOPMENT INC., TIMBERLOCH - WWTP	0.13	0.045	0.024	0.018	6.52
TX0119504	14114-001	AQUA DEVELOPMENT INC., WHIE OAK RANCH - WWTP	0.6	0.075	0.008	0.006	2.14
TX0117137	14018-001	AQUA UTILITIES INC.	0.45	0.075	0.075	0.056	20.53
TX0095125	12898-001	AQUA UTILITIES INC., BRUSHY CREEK UTILITY - WWTP	0.075	0.075	0.019	0.014	5.09
TX0027391	11419-001	AQUA UTILITIES INC., SHADOW BAY - WWTP	0.12	0.12	0.034	0.026	9.43
TX0127035	14551-001	AUC GROUP L.P.	0.95	0.08	0.080	0.060	21.90
TX0116459	14388-001	BISHOP TRAVIS LYNN	0.115	0.115	0.014	0.011	3.90
TX0124281	14285-001	C & R WATER SUPPLY INC.	0.3	0.3	0.061	0.046	16.70
TX0113255	13766-001	C & R WATER SUPPLY INC.	0.05	0.05	0.012	0.009	3.38
TX0077763	12023-001	CANEY CREEK UTILITIES INC.	0.02	0.02	0.002	0.002	0.56
TX0090000	13697-001	CEDARSTONE ONE INVESTORS LTD.	0.003	0.003	0.000	0.000	0.11
TX0090123	13700-001	CHATEAU WOODS MUD	0.2	0.2	0.073	0.055	19.96
TX0097969	13115-001	CLOVERCREEK MUD	0.12	0.12	0.035	0.026	9.46
TX0022268	10008-002	CONROE CITY OF (SOUTHWEST)	10	6	4.831	3.623	1322.47
TX0027308	12582-001	CONROE BAY CIVIC ASSOCIATION	0.048	0.048	0.028	0.021	7.63
TX0083208	12205-001	CONROE ISD	0.015	0.015	0.007	0.005	1.83
TX0111473	13690-001	CONROE ISD	0.1	0.1	0.047	0.035	12.94
TX0083216	12204-001	CONROE ISD, EM SCHOOL	0.02	0.02	0.006	0.004	1.64
TX0027049	11285-001	CORINTHIAN POINT MUD NO. 2	0.174	0.174	0.044	0.033	11.99
TX0088901	12456-001	CRANE CO.	0.005	0.005	0.003	0.002	0.73
TX0104060	12686-001	DEL LAGO ESTATES UTILITY COMPANY	0.03	0.03	0.011	0.008	2.90
TX0086738	11478-001	DIAMONDHEAD WATER SUPPLY CORPORATION	0.08	0.08	0.022	0.017	6.13
TX0123587	14218-001	DIOCESE OF GALVESTON-HOUSTON	0.015	0.015	0.001	0.001	0.39
TX0089630	12493-001	DL UTILITIES INC.	0.5	0.22	0.125	0.093	34.08
TX0125300	14379-001	E MONTGOMERY COUNTY MUD NO. 3	0.08	0.08	0.028	0.021	7.61
TX0124583	14311-001	EAST MONTGOMERY COUNTY MUD NO.4	0.75	0.15	0.150	0.113	41.06
TX0095621	12788-001	EASTWOOD HILLS MOBILE HOME PARK LIMITED PARTNERSHIP	0.05	0.05	0.050	0.038	13.69

Table 3 contd.

NPDES #	TPDES No.[1]	PERMITTEE	TCEQ Permitted Flow[2]	Current Average Design Flow Rate[3]	Reported Average Flow Rate[4]	Estimated Minimum Flow Rate[5]	Estimated Annual Flow
			(MGD)				(mg/yr)
TX0126713	14523-001	ELAN LAND DEVELOPMENT L.P.	0.6	0.1	0.100	0.075	27.38
TX0073997	11878-001	EVANGELISTIC TEMPLE, THE N.E.T. CHURCH - WWTP	0.008	0.008	0.000	0.000	0.03
TX0126853	14536-001	FLYING J INC.	0.05	0.05	0.006	0.005	1.67
TX0124486	14305-001	GRAND LAKE UTILITY COMPANY INC. THE	0.24	0.12	0.120	0.090	32.85
TX0072222	11829-001	GULF COAST TRADES CENTER	0.0055	0.005	0.003	0.002	0.74
TX0115827	13863-001	H.H.J. INC., DECKER UTILITIES	0.8	0.4	0.071	0.054	19.55
TX0094315	14266-001	HMW SPECIAL UTILITY DISTRICT	0.051	0.025	0.021	0.016	5.85
TX0088501	10495-142	HOUSTON CITY OF (MUD NO. 048)	0.855	0.5	0.271	0.203	74.16
TX0126306	14491-001	IS ZEN CENTER	0.035	0.035	0.035	0.026	9.58
TX0124095	14264-001	JMSC UTILITY CO. INC.	0.06	0.06	0.060	0.045	16.43
TX0123374	14210-001	JOE D. HAVENS INC.	0.02	0.02	0.008	0.006	2.17
TX0126799	14531-001	JTM HOUSING LTD. AND QUADVEST INC.	0.6	0.16	0.012	0.009	3.15
TX0093505	12761-001	KARBALAI LAURA REDOW	0.05	0.05	0.020	0.015	5.46
TX0054364	11569-001	LAKE CONROE HILLS MUD, MONTGOMERY COUNTY___*	0.32	0.15	0.062	0.047	16.98
TX0088447	12439-001	LAKE SOUTH WATER SUPPLY CORPORATION	0.15	0.15	0.042	0.031	11.47
TX0069256	11820-001	LAZY RIVER IMPROVEMENT DISTRICT	0.1	0.1	0.100	0.075	27.38
TX0127400	14586-001	LMV MANAGEMENT CO. LTD.	0.9	0.15	0.150	0.113	41.06
TX0072702	11871-001	MAGNOLIA CITY OF	0.65	0.65	0.221	0.166	60.43
TX0092843	12703-001	MAGNOLIA ISD	0.048	0.048	0.008	0.006	2.13
TX0110663	13653-001	MAGNOLIA ISD	0.015	0.015	0.006	0.005	1.68
TX0119598	14124-001	MAGNOLIA ISD, SMITH ELEMENTARY WWTP	0.02	0.02	0.006	0.005	1.69
TX0118311	14081-001	MARTIN REALTY & LAND INC.	0.45	0.15	0.018	0.014	4.93
TX0091677	12621-001	MARTIN REALTY & LAND INC., COUNTRY WEST	0.15	0.1	0.100	0.075	27.38
TX0118281	13601-001	MEEKER MARK ROGER	0.0085	0.008	0.001	0.001	0.28
TX0090905	12587-001	MONARCH UTILITIES I L.P.**********	0.46	0.211	0.156	0.117	42.64
TX0077275	11968-001	MONARCH UTILITIES I LP, CHAMPIONS GLEN	0.052	0.052	0.002	0.002	0.64
TX0126721	11521-002	MONTGOMERY CITY	0.4	See City of Montgomery Outfall 1			-
TX0056693	11521-001	MONTGOMERY CITY OF	0.25	0.25	0.112	0.084	30.79
TX0022055	11395-001	MONTGOMERY CO MUD NO. 15	0.3	0.3	0.121	0.090	33.00
TX0032514	11271-001	MONTGOMERY CO MUD NO. 2, MONTGOMERY COUNTY UD NO. 2	0.25	0.25	0.201	0.151	54.94
TX0071412	14116-001	MONTGOMERY CO MUD NO. 24	0.4	0.1	0.054	0.041	14.84
TX0076368	11963-001	MONTGOMERY CO MUD NO. 42	0.15	0.15	0.102	0.077	27.95

Table 3. contd.

NPDES #	TPDES No.[1]	PERMITTEE	TCEQ Permitted Flow[2]	Current Average Design Flow Rate[3]	Reported Average Flow Rate[4]	Estimated Minimum Flow Rate[5]	Estimated Annual Flow
			(MGD)				(mg/yr)
TX0089672	13760-001	MONTGOMERY CO MUD NO. 56	0.1	0.1	0.082	0.061	22.37
TX0022080	11371-001	MONTGOMERY CO MUD NO. 8	0.9	0.9	0.365	0.273	99.82
TX0128295	14656-001	MONTGOMERY COUNTY MUD 94	-	0.2	-	0.000	0.00
TX0078344	11386-001	MONTGOMERY COUNTY MUD NO. 16	0.177	0.177	0.035	0.026	9.52
TX0100331	13273-001	MONTGOMERY COUNTY MUD NO. 18	0.9	0.5	0.239	0.179	65.47
TX0076538	11970-001	MONTGOMERY COUNTY MUD NO. 19	0.625	0.625	0.406	0.305	111.27
TX0111856	13583-001	MONTGOMERY COUNTY MUD NO. 83	0.6	0.6	0.012	0.009	3.23
TX0126209	14482-001	MONTGOMERY COUNTY MUD NO. 83	0.6	0.2	0.046	0.035	12.65
TX0117706	13985-001	MONTGOMERY COUNTY MUD NO. 89	0.5	0.15	0.150	0.113	41.06
TX0069469	11203-001	MONTGOMERY COUNTY UD 3	0.95	0.95	0.478	0.358	130.80
TX0092517	12670-001	MOUNTAIN MAN INC., CADDO VILLAGES	0.175	0.049	0.008	0.006	2.21
TX0128121	14638-001	MSEC ENTERPRISES INC.	0.02	0.02	0.020	0.015	5.48
TX0084638	12274-001	NEW CANEY MUD, MONTGOMERY COUNTY	4	1.06	0.644	0.483	176.25
TX0127752	14604-001	NORTHWAY LAND COMPANY LTD.	0.58	0.12	0.120	0.090	32.85
TX0020206	11097-001	PANORAMA VILLAGE CITY OF, MONTGOMERY COUNTY	0.4	0.4	0.286	0.215	78.42
TX0022071	11219-001	POINT AQUARIUS MUD	0.39	0.39	0.141	0.106	38.58
TX0084042	12242-001	PORTER MUD	1.6	0.86	0.508	0.381	139.19
TX0117145	14029-001	QUADVEST L.P.	0.6	0.39	0.100	0.075	27.32
TX0078263	12030-001	RAYFORD ROAD MUD, _____*	1.3	0.95	0.531	0.398	145.24
TX0094552	12851-001	RICHARD CLARK ENTERPRISES L.L.C.	0.06	0.06	0.009	0.007	2.54
TX0109622	13636-001	RICHFIELD INVESTMENT CORPORATION	0.405	0.135	0.135	0.101	36.96
TX0108553	13614-001	RICHFIELD INVESTMENT CORPORATION (WOODTRACE WWTP)	0.61	0.61	0.610	0.458	166.99
TX0025674	10978-001	RIVER PLANTATION MUD	0.6	0.6	0.409	0.306	111.85
TX0093220	13638-001	ROMAN FOREST CONSOLIDATED MUD, MONTGOMERY COUNTY	0.322	0.322	0.182	0.136	49.74
TX0063461	11658-001	SAN JACINTO RIVER AUTHORITY	0.9	0.9	0.345	0.259	94.56
TX0091715	12597-001	SAN JACINTO RIVER AUTHORITY	7.8	2.5	1.805	1.354	494.09
TX0093564	12212-002	SHENANDOAH CITY OF	3	0.75	0.477	0.358	130.51
TX0054186	11401-001	SJRA (WOODLANDS SUBDIVISION)	7.8	6	4.259	3.194	1165.79
TX0127663	14592-001	SOUTH CENTRAL WATER COMPANY	0.32	0.038	0.038	0.029	10.40
TX0024759	11001-001	SOUTHERN MONTGOMERY COUNTY MUD	2	2	0.935	0.701	255.97
TX0102512	13389-001	SPLENDORA CITY OF	0.3	0.3	0.075	0.056	20.43
TX0082511	11143-001	SPLENDORA INDEPENDENT SCHOOL DISTRICT	0.07	0.07	0.022	0.016	5.93

Table 3. contd.

NPDES #	TPDES No.[1]	PERMITTEE	TCEQ Permitted Flow[2]	Current Average Design Flow Rate[3]	Reported Average Flow Rate[4]	Estimated Minimum Flow Rate[5]	Estimated Annual Flow
			(MGD)				(mg/yr)
TX0117463	11143-002	SPLENDORA ISD	0.04	0.04	0.008	0.006	2.10
TX0026221	11574-001	SPRING CREEK UTILITY DISTRICT WWTP	0.93	0.475	0.281	0.211	76.84
TX0022063	11367-001	STANLEY LAKE MUD	0.972	0.972	0.259	0.194	70.88
TX0068659	11715-001	TEXAS NATIONAL MUNICIPAL UTILITY DISTRICT	0.075	0.075	0.010	0.007	2.68
TX0127710	14597-001	THE SIGNORELLI COMPANY, VALLEY RANCH WWTP	0.6	0.1	0.100	0.075	27.38
TX0102563	13395-001	THIRTY-TWO REAL ESTATE INVESTMENT LTD.	0.15	0.022	0.001	0.001	0.24
TX0086665	12349-001	THOUSAND TRAILS INC.	0.03	0.03	0.009	0.007	2.39
TX0118851	13960-001	U.S. LAND CORP.	0.0225	0.011	0.002	0.001	0.45
TX0117374	13988-001	UTILITIES INVESTMENT CO. INC.	0.049	0.049	0.001	0.001	0.21
TX0099180	14248-001	VANCECO INC.	0.02	0.012	0.002	0.001	0.44
TX0109339	13575-001	WAGNER RICHARD LYNN, CLEARWATER COVE WWTP	0.08	0.08	0.014	0.010	3.70
TX0088137	12416-001	WALNUT COVE WATER SUPPLY CORPORATION	0.099	0.099	0.062	0.047	17.05
TX0118818	14083-001	WHITE OAK DEVELOPERS INC.	0.75	0.2	0.200	0.150	54.75
TX0119857	14133-001	WHITE OAK UTILITIES INC.	0.2	0.2	0.200	0.150	54.75
TX0127094	14559-001	WHITESTONE HOUSTON LAND LTD.	0.9	0.15	0.150	0.113	41.06
TX0127108	14560-001	WHITESTONE HOUSTON LAND LTD.	0.9	0.15	0.150	0.113	41.06
TX0068845	10315-001	WILLIS CITY OF	0.8	0.8	0.593	0.445	162.36
TX0077241	11993-001	WOODBRANCH VILLAGE CITY OF, MONTGOMERY COUNTY	0.133	0.133	0.057	0.043	15.53
TX0125601	14414-001	WOODLAND LAKE DEVELOPMENT LTD.	0.9	0.1	0.100	0.075	27.38
TX0122327	14166-001	WOODLAND OAKS UTILITY COMPANY	0.498	0.249	0.076	0.057	20.83
TX0075680	11580-001	WOODLOCH TOWN OF	0.15	0.12	0.061	0.046	16.71
Total			71.369	40.188	23.939	17.954	6553.38

Source:

[1]Excludes Industrial TPDES Nos. less than 10,000

[2]TCEQ Shapefile of WWTP Outfalls dated October 2005

[3]As reported in the EPA EnviroFacts website for current reported data

[4]No EnviroFacts data available - reported flow set equal to permitted flow

[5]Assumed to be 75% of average flow

Montgomery County MUD No. 94 Flow information not available

Table 4. Summary of Well User Types

The colors in *Table 5 – Potential Reuse Demands* table represent the following:

Estimated Percent Irrigation	Type of Well User	1. Potential Reuse Water Demand (ignoring questionnaire responses) gallons/year	2. Potential Reuse Water Demand Adjusted gallons/year	3. Potential Reuse Water Demand w. Interested Responses gallons/year
100.0%	Golf Courses	451,475,857	451,475,857	451,475,857
100.0%	Green Space Irrigation (green spaces, amenity lakes) from non-potable	47,997,137	45,274,337	45,274,337
100.0%	Commercial Tree Farms, Nurseries, etc.	174,701,407	174,701,407	174,701,407
90.0%	ISD (Primary Irrigator)	9,198,088	9,198,088	9,198,088
60.0%	Other (Primary Irrigator)	41,741,989	41,741,989	41,741,989
60.0%	House of Worship (Primary Irrigator)	0	0	0
50.0%	Master Planned Community (Primary Irrigator)	117,100,127	117,100,127	117,100,127
25.0%	Other Secondary Irrigator	612,015	612,015	612,015
15.0%	Master Planned Community Potable Water Supply Systems	556,093,023	378,726,934	336,020,673
15.0%	MUD Potable Water Supply Systems	691,034,199	378,204,572	321,444,391
15.0%	Other Potable Water Supply System	6,000,070	6,000,070	6,000,070
5.0%	ISD	0	0	0
1.0%	City Potable Water Supply Systems	132,383,229	180,912,964	109,477,686
0.5%	Commercial or Industrial Supplies	1,665,074	1,665,074	1,665,074

The font of the text in *Table 5 – Potential Reuse Demands* table represents the following:

Font	Irrigator Type	Explanation
Bold	**Primary**	**The word "irrigation" was used in the "Primary Use" Column**
Regular	Secondary	Any of the terms "irr", "landsc", "lawns", "nursery", "fill", "replenish" occurred for that record in any column
Blue	None	Neither of the two above conditions existed

Average 2003 - 2005 Pumped Amount is averaged with zero values removed from the data set.

"Estimated Pumpage for Irrigation" is based on Estimated Percent Irrigation of Average Pumped Amount.

Answers to questionnaires overruled color-coded categories for Estimated Percent Irrigation.

The difference between the Maximum and Minimum Estimated Annual Pumpage for Irrigation is based on Well Users that indicated no interest in reuse.

Based on past studies and experience, each user type was assigned an estimated value for the percentage of total water pumpage that could be considered potential reuse water demand. The estimated percent of total water pumpage for each user type that could be considered potential reuse demand can be viewed in *Table 5.* The three scenarios used to estimate the current potential amount of effluent reuse demand were:

- Potential Reuse Water Demand (ignoring questionnaire responses)
- Potential Reuse Water Demand Adjusted (adjusts the percent irrigation or lake replenishment based on questionnaire for those which responded)
- Potential Reuse Water Demand with Interested Responses (removes from the analysis those entities which expressed no interest in converting to utilizing effluent reuse)

The questionnaire results were incorporated into the planning database, where applicable, based on the scenarios outlined above. The quantities of potential reuse water demand in Scenarios 2 and 3 were adjusted based on questionnaire responses.

Only wells with estimated non-potable water demands greater than 0.5 mgy were included in this study. The total current potential reuse water demand ignoring the questionnaire responses was found to be 2,230 mgy (6,844 ac-ft/yr) or a potential potable water use reduction of 17.4 gallons per capita day (GPCD) based on a year 2005 population of 351,689. By reducing the percent irrigation or lake replenishment using the questionnaire responses, the total current potential reuse water demand decreased to 1,786 mgy (5,481 ac-ft/yr) or a potential reduction of 13.9 gallons per capita per day (GPCD). Removing those entities which expressed no interest in reuse further decreased the total current potential reuse water demand to 1,615 mgy (4,956 ac-ft/yr) or a potential reduction of 12.6 gallons GPCD. The list of wells with user type assignments, pumpage, and estimated reuse potential assigned to each is shown in *Table 5 – Potential Reuse Demands.* A summary of the "user types" can be found in *Table 4 – Summary of Well User Types*.

Exhibit 2 graphically demonstrates potential reuse demand densities throughout Montgomery County. It can be seen that the highest concentrations of reclaimed water demand are in areas with one or more golf courses: e.g. The Woodlands and the west side of Lake Conroe. *Exhibit 2* does not address the relative feasibility of supplying these demands – that topic is addressed in the following section.

Supply versus Demand Balance

The following section describes the process used to match potential opportunities for effluent resource to potential points of applications.

Supply to Demand Match Process

As identified in the previous sections, the supply is greater than the estimated potential demands for all three scenarios. Therefore, the potential amount of effluent reuse is demand limited. There were 106 WWTPs identified as available supplies and 230 wells that used all or some portion of the reported well pumpage for non-potable irrigation or lake replenishment. Therefore, there is a total of 24,380 potential supply/demand matches that are possible. Not all of these combinations are feasible and the following process was used to identify the most beneficial match potential opportunities for effluent resource to potential points of applications. Some of the supplies are used to meet multiple demands or vice versa.

Table 5. Potential Reuse Demands

User Type	Well Owner	Estimated Percent Irrigation	OID	Permit #	Permitted Amount (gallons per year)	Average 2003 - 2005 Pumped Amount (gallons per year)	Well for Irrigation	1. Potential Reuse Water Demand (ignoring questionnaire responses) (gallons per year)	2. Potential Reuse Water Demand Adjusted (gallons per year)	3. Potential Reuse Water Demand w. Interested Responses (gallons per year)
Golf	April Sound Country Club	100%	932	HUP002	91,000,000	45,505,433	Primary	45,505,433	45,505,433	45,505,433
Golf	Bentwater Yacht & Country Club #3 GMC	100%	945	HUP030	25,000,000	37,787,667	Primary	37,787,667	37,787,667	37,787,667
Golf	City of Panorama Village (Country Club) fka Panorama Village Country Club	100%	2960	HUP161	37,000,000	16,429,367	Primary	16,429,367	16,429,367	16,429,367
Golf	The Links at West Fork	100%	675	OP-04012302	53,405,000	2,263,440	Primary	2,263,440	2,263,440	2,263,440
Golf	The Woodlands Commercial Properties Co, L.P. (Palmer)	100%	1469	HUP246	170,000,000	85,299,000	Primary	85,299,000	85,299,000	85,299,000
Golf	The Woodlands Commercial Properties Co. L.P. (Panther Trails) (fka Pines)	100%	1622	HUP255	60,000,000	20,426,500	Primary	20,426,500	20,426,500	20,426,500
Golf	The Woodlands Commercial Properties Co. L.P. (Player)	100%	1620	HUP254	130,600,000	23,086,950	Primary	23,086,950	23,086,950	23,086,950
Golf	The Woodlands Commercial Properties Co. L.P. (TPC)	100%	1619	HUP253	150,000,000	95,667,500	Primary	95,667,500	95,667,500	95,667,500
Golf	Wedgewood Golf Course	100%	641	OP03-0041	10,000,000	25,744,200	Primary	25,744,200	25,744,200	25,744,200
Golf	Wedgewood Golf Course	100%	641	OP03-0042	75,000,000	26,896,800	Primary	26,896,800	26,896,800	26,896,800
Golf	Woodforest Golf Club LLC	100%	927	OP-04071501	190,000,000	72,369,000	Secondary	72,369,000	72,369,000	72,369,000
Green	Benders Landing POA (Lexington) fka Lipar Group	100%	2958	OP03-0033	45,000,000	32,102,200	Primary	32,102,200	32,102,200	32,102,200
Green	Benders Landing POA (Rayford Rd) fka Houston Lipar LLC	100%	2959	OP-04071401	9,300,000	9,300,000	Primary	9,300,000	9,300,000	9,300,000
Green	Bentwater Property Owners Association Inc.	100%	944	HUP029	5,000,000	2,995,837	Primary	2,995,837	2,995,837	2,995,837
Green	Crighten Ridge HOA (fka Lake Pro, Inc.)	100%	1512	HUP117	2,700,000	876,300	Primary	876,300	876,300	876,300
Green	Lunde's Point POA	100%	2870	OP-05101101	3,000,000	2,722,800		2,722,800	0	0
Tree	Container Grown Nursery Inc.	100%	297	HUPAG1500011	76,283,674	65,075,878	Primary	65,075,878	65,075,878	65,075,878
Tree	Cutting Edge Growers	100%	286	HUPAG1500005	16,553,230	5,374,500	Primary	5,374,500	5,374,500	5,374,500
Tree	David C. Kleimann / Trees of Texas	100%	298	HUPAG1500001	30,304,143	18,752,910	Primary	18,752,910	18,752,910	18,752,910
Tree	Dempsey Carter (C-3 Tree Farm)	100%	299	HUPAG1500023	13,913,837	5,030,933	Primary	5,030,933	5,030,933	5,030,933
Tree	Dempsey Carter (Carter's Florist Nursery)	100%	300	HUPAG1500024	6,745,116	3,158,867	Primary	3,158,867	3,158,867	3,158,867
Tree	El Kay Farms & Nursery, Inc.	100%	301	HUPAG1500003	19,551,060	5,046,523	Primary	5,046,523	5,046,523	5,046,523
Tree	Green Valley Growers	100%	613	HUPAG1500020	183,454,113	13,572,300	Primary	13,572,300	13,572,300	13,572,300
Tree	Green Valley Growers	100%	613	OP03-0002	31,280,000	13,913,433	Primary	13,913,433	13,913,433	13,913,433
Tree	Houston Garden Center #17	100%	1535	OP-04081201	7,500,000	3,293,815	Secondary	3,293,815	3,293,815	3,293,815
Tree	Major Tree Texas Inc. (fka Sampres Tree Farm)	100%	1617	HUPAG1500009	16,201,312	3,712,974	Primary	3,712,974	3,712,974	3,712,974
Tree	Moorhead's Blueberry Farm	100%	852	HUPAG1500004	15,640,848	3,164,150	Primary	3,164,150	3,164,150	3,164,150
Tree	NF Nursery	100%	1476	HUPAG1500006	2,401,522	954,500	Primary	954,500	954,500	954,500
Tree	Number 1 Nursery	100%	1477	HUPAG1500010	19,551,060	1,551,955	Primary	1,551,955	1,551,955	1,551,955
Tree	Oak Ridge Farms, Inc	100%	1478	HUPAG1500025	5,278,786	2,028,290	Primary	2,028,290	2,028,290	2,028,290
Tree	Palm Tree Plantation	100%	1479	HUPAG1500016	6,047,795	1,286,380	Primary	1,286,380	1,286,380	1,286,380
Tree	Ray's Nursery	100%	1481	HUPAG1500017	10,303,408	28,784,000	Primary	28,784,000	28,784,000	28,784,000
ISDP	Conroe ISD (New Woodlands High School)	90%	592	OP-04031901	21,600,000	2,222,870	Primary	2,000,583	2,000,583	2,000,583
ISDP	Montgomery I S D (Montgomery High School, Irrg)	90%	96	OP02-0005	20,000,000	7,997,228	Primary	7,197,505	7,197,505	7,197,505
Prim	Bhold Investments	60%	295	HUPAG1500014	9,000,005	11,507,650	Primary	6,904,590	6,904,590	6,904,590
Prim	David Kosmitis	60%	618	OP02-0002	30,000,000	11,488,967	Primary	6,893,380	6,893,380	6,893,380
Prim	Gary Calfee	60%	303	HUPAG1500022	13,141,570	859,684	Primary	515,810	515,810	515,810
Prim	Greens Parkway Partners, L.P.	60%	1142	OP-04112301	3,500,000	2,283,600	Primary	1,370,160	1,370,160	1,370,160
Prim	Klein Funeral Home	60%	244	OP03-0064	4,000,000	2,920,400	Primary	1,752,240	1,752,240	1,752,240
Prim	Klein Memorial Park Inc.	60%	667	OP-04011603	3,300,000	3,221,900	Primary	1,933,140	1,933,140	1,933,140
Prim	Larry Jacobs	60%	1473	HUPAG1500008	65,170,200	23,305,812	Primary	13,983,487	13,983,487	13,983,487
Prim	McCants Forest Land Limited Partnership	60%	1474	OP-05113001	3,095,584	1,269,408	Primary	761,645	761,645	761,645
Prim	Natural Waste Solutions, Inc. (dba Nature's Way Resources	60%	677	OP-04012601	4,000,000	1,547,350	Primary	928,410	928,410	928,410
Prim	Peter Wakefield	60%	1480	HUPAG1500019	14,663,295	1,154,655	Primary	692,793	692,793	692,793
Prim	Portofino Shopping Center	60%	1670	OP-05012601	15,000,000	10,010,556	Primary	6,006,334	6,006,334	6,006,334
MsPr	Canyon Lake At Legends Ranch	50%	1352	OP03-0049	30,000,000	5,458,550	Primary	2,729,275	2,729,275	2,729,275
MsPr	Canyon Lake At Legends Ranch (Riverstone Springs)	50%	2837	OP-05092003	30,000,000	7,106,400	Primary	3,553,200	3,553,200	3,553,200
MsPr	Mansion Custom Homes (FM 1488 Well 2)	50%	2090	OP-05042201	3,000,000	3,011,000	Primary	1,505,500	1,505,500	1,505,500
MsPr	Montgomery County Pct. 3 (Pruitt Rd.)	50%	2838	OP-05042601	1,500,000	1,249,300	Primary	624,650	624,650	624,650
MsPr	The Woodlands Land Development Company, LP	50%	1470	HUP248	190,000,000	214,264,000	Primary	107,132,000	107,132,000	107,132,000
MsPr	Windsor Lakes / Lennar Homes	50%	904	OP-04061401	10,000,000	3,111,005	Primary	1,555,502	1,555,502	1,555,502
Seco	Rayford Crossing R. V. Resort	25%	833	OP-04050701	8,000,000	2,448,059	Secondary	612,015	612,015	612,015
Mast	Aqua Texas, Inc. (Crystal Forest)	15%	1395	HUP009	15,713,000	13,535,900		2,030,385	2,030,385	2,030,385
Mast	Aqua Texas, Inc. (Crystal Forest)	15%	1395	OP03-0011	16,000,000	12,888,000		1,933,200	1,933,200	1,933,200
Mast	Aqua Texas, Inc. (Brushy Creek)	15%	1390	HUP004	18,132,000	12,791,000		1,918,650	1,918,650	1,918,650
Mast	Aqua Texas, Inc. (Carriage Hills)	15%	1391	HUP005	84,574,000	73,701,000		11,055,150	11,055,150	11,055,150
Mast	Aqua Texas, Inc. (Cimarron Country)	15%	1392	HUP006	32,403,000	31,371,333		4,705,700	4,705,700	4,705,700
Mast	Aqua Texas, Inc. (Clear Creek Forest)	15%	1393	HUP007	21,863,000	32,152,667		4,822,900	4,822,900	4,822,900
Mast	Aqua Texas, Inc. (Crighton Ridge)	15%	1394	HUP008	26,169,000	70,497,000		10,574,550	10,574,550	10,574,550
Mast	Aqua Texas, Inc. (Decker Woods)	15%	1396	HUP010	27,820,000	25,262,000		3,789,300	3,789,300	3,789,300
Mast	Aqua Texas, Inc. (Deerwood Sub.)	15%	1397	HUP011	26,608,000	30,418,000		4,562,700	4,562,700	4,562,700
Mast	Aqua Texas, Inc. (Dogwood Hills)	15%	1398	HUP012	39,522,000	27,696,667		4,154,500	4,154,500	4,154,500
Mast	Aqua Texas, Inc. (Huntington Est.)	15%	1399	HUP013	16,216,000	12,192,667		1,828,900	1,828,900	1,828,900
Mast	Aqua Texas, Inc. (Indigo Ranch)	15%	1400	HUP014	5,992,000	7,837,000		1,175,550	1,175,550	1,175,550
Mast	Aqua Texas, Inc. (Lake Conroe Forest & Tejas Creek)	15%	1401	HUP015	28,200,000	30,412,967		4,561,945	4,561,945	4,561,945
Mast	Aqua Texas, Inc. (Lake Conroe Village)	15%	1402	HUP016	15,000,000	11,520,333		1,728,050	1,728,050	1,728,050
Mast	Aqua Texas, Inc. (Lake Creek Forest)	15%	1403	HUP017	23,497,000	22,908,000		3,436,200	3,436,200	3,436,200
Mast	Aqua Texas, Inc. (Legends Ranch Estates)	15%	1047	OP03-0038	27,000,000	15,438,000		2,315,700	2,315,700	2,315,700
Mast	Aqua Texas, Inc. (Oakwood Acres)	15%	1404	HUP018	9,251,000	6,575,000		986,250	986,250	986,250
Mast	Aqua Texas, Inc. (Shadow Bay)	15%	1405	HUP019	26,353,000	21,039,333		3,155,900	3,155,900	3,155,900
Mast	Aqua Texas, Inc. (Timberloch Estates)	15%	1406	HUP020	14,230,000	15,851,000		2,377,650	2,377,650	2,377,650
Mast	Aqua Texas, Inc. (Turtle Creek)	15%	1407	HUP021	21,451,000	17,107,667		2,566,150	2,566,150	2,566,150
Mast	Aqua Texas, Inc. (Walnut Springs)	15%	1408	HUP022	24,900,000	17,905,000		2,685,750	2,685,750	2,685,750
Mast	Aqua Texas, Inc. (Westwood 1&2/Old Egypt)	15%	1409	HUP023	38,645,000	44,629,000		6,694,350	6,694,350	6,694,350
Mast	Aqua Texas, Inc. (Wilshire Sub.)	15%	1412	HUP025	4,804,000	4,390,333		658,550	658,550	658,550
Mast	Aqua Texas, Inc. (Woodland Ranch)	15%	1413	HUP026	4,727,000	3,596,333		539,450	539,450	539,450
Mast	Big Oak Ranchette	15%	934	HUP031	4,622,000	3,792,500		568,875	568,875	568,875
Mast	Cape Malibu Water Supply Inc.	15%	939	HUP035	12,962,300	10,982,233		1,647,335	1,647,335	1,647,335
Mast	Consumers Water Company (Pioneer Trails)	15%	1033	HUP173	19,753,000	15,838,500		2,375,775	2,375,775	2,375,775
Mast	Consumers Water Company (Peach Creek Oaks)	15%	1032	HUP168	10,134,000	5,826,667		874,000	874,000	874,000
Mast	Consumers Water Company (Porter Terrace)	15%	1384	HUP176	14,772,000	10,032,333		1,504,850	1,504,850	1,504,850
Mast	Consumers Water Company (Spring Forest)	15%	1321	HUP211	41,224,000	31,571,500		4,735,725	4,735,725	4,735,725
Mast	Crystal Springs Water (Afton Park Civic Imp. Assoc.)	15%	181	HUP055	1,462,010	162,275,119		24,341,268	0	0
Mast	Crystal Springs Water (Afton Park Civic Imp. Assoc.)	15%	181	OP03-0032	4,015,000	12,339,072		1,850,861	0	0
Mast	Cypresswood Estates Water System	15%	3222	HUP057	23,395,000	19,595,440		2,939,316	2,939,316	2,939,316
Mast	Cypresswood Estates Water System	15%	3222	OP03-0015	7,300,000	3,683,000		552,450	552,450	552,450
Mast	Del Lago Estates	15%	105	HUP060	29,420,000	20,108,004		3,016,201	3,016,201	3,016,201
Mast	Diamondhead Water & Sewer	15%	961	HUP061	22,772,000	19,790,474		2,968,571	178,114	0
Mast	DL Utilities	15%	962	HUP062	85,794,000	80,386,108		12,057,916	12,057,916	12,057,916
Mast	Dobbin-Plantersville WSC	15%	734	HUP063	56,038,100	66,419,767		9,962,965	9,962,965	9,962,965
Mast	Domestic Water Company	15%	963	HUP064	28,919,400	23,769,967		3,565,495	0	0
Mast	East Montgomery County Mud 3	15%	636	OP03-0020	25,000,000	18,176,702		2,726,505	2,726,505	2,726,505
Mast	Enviro Management	15%	969	HUP073	8,174,000	7,780,333		1,167,050	1,167,050	1,167,050
Mast	Everett Square Inc. (Windcrest Est., Honea Egypt, Part of 1488 System)	15%	1490	OP03-0069	20,000,000	12,545,930		1,881,890	1,881,890	1,881,890
Mast	Everett Square, Inc. (Shady Oaks)	15%	1508	OP03-0068	25,000,000	15,838,690		2,375,804	2,375,804	2,375,804
Mast	H.H.J., Inc / Decker Utilities	15%	981	HUP083	14,741,000	18,137,333		2,720,600	163,236	0
Mast	Johnston's Utilities,Inc.	15%	1001	HUP104	30,201,000	69,164,667		10,374,700	622,482	0
Mast	Joy Village Subdivision	15%	1002	HUP105	8,588,000	8,596,000		1,289,400	1,289,400	1,289,400
Mast	Keenan Water Supply Corp.	15%	614	HUP106	25,000,000	21,945,667		3,291,850	0	0
Mast	Lake Bonanza Water Supply Corp.	15%	367	HUP111	37,606,900	39,020,500		5,853,075	5,853,075	5,853,075
Mast	Lake Forest Falls	15%	1008	HUP114	22,603,000	14,448,560		2,167,284	2,167,284	2,167,284
Mast	Lake Lorraine	15%	18	HUP115	10,035,000	8,113,795		1,217,069	1,217,069	1,217,069
Mast	Lake South Water Supply	15%	1009	HUP118	18,016,000	24,193,183		3,628,977	3,628,977	3,628,977
Mast	Lakewood Colony	15%	1010	HUP120	9,447,000	4,904,333		735,650	735,650	735,650
Mast	Lazy River Improvement District	15%	564	HUP123	49,559,000	37,934,667		5,690,200	7,773	0

Table 5. ***contd.***

User Type	Well Owner	Estimated Percent Irrigation	OID	Permit #	Permitted Amount (gallons per year)	Average 2003 - 2005 Pumped Amount (gallons per year)	Well for Irrigation	1. Potential Reuse Water Demand (ignoring questionnaire responses) (gallons per year)	2. Potential Reuse Water Demand Adjusted (gallons per year)	3. Potential Reuse Water Demand w. Interested Responses (gallons per year)
Mast	Monarch Utilities, Inc (Hulon Lake/Woodcreek Valley)	15%	2026	HUP223	26,731,000	15,055,000		2,258,250	2,258,250	2,258,250
Mast	Monarch Utilities, Inc (Serenity Woods, Pine)	15%	2028	HUP225	15,317,000	12,556,667		1,883,500	1,883,500	1,883,500
Mast	Monarch Utilities, Inc. (Decker Hills/Park Place)	15%	1050	HUP222	78,448,000	67,298,667		10,094,800	0	0
Mast	Monarch Utilities, Inc. (Decker Hills/Park Place)	15%	1050	OP03-0018	11,552,000	11,173,000		1,675,950	0	0
Mast	Monarch Utilities, Inc. (Champions Glen)	15%	2024	HUP220	5,048,000	3,910,667		586,600	586,600	586,600
Mast	Monarch Utilities, Inc. (Crystal Springs)	15%	2025	HUP221	9,797,000	7,498,667		1,124,800	1,124,800	1,124,800
Mast	Monarch Utilities, Inc. (Oak Woods)	15%	2027	HUP224	5,201,000	4,304,000		645,600	645,600	645,600
Mast	Montgomery Co. WC & ID #1	15%	2098	HUP149	145,886,000	114,110,000		17,116,500	1,026,990	0
Mast	Montgomery County Fresh Water Supply (Dist #6)	15%	1364	HUP135	11,098,000	10,791,300		1,618,695	0	0
Mast	Montgomery County M.U.D. #83	15%	1373	HUP146	10,504,000	24,180,467		3,627,070	3,627,070	3,627,070
Mast	Montgomery County Mud 56	15%	615	OP02-0008	40,000,000	30,291,500		4,543,725	4,543,725	4,543,725
Mast	Montgomery County Mud 94	15%	617	OP03-0027	70,000,000	64,399,000		9,659,850	9,659,850	0
Mast	Montgomery County UD # 3	15%	1375	HUP148	154,856,000	137,876,473		20,681,471	20,681,471	20,681,471
Mast	Montgomery County UD #2	15%	1374	HUP141	120,037,000	124,578,000		18,686,700	18,686,700	18,686,700
Mast	Montgomery County UD #4	15%	1376	HUP143	209,805,000	202,660,541		30,399,081	30,399,081	30,399,081
Mast	Montgomery Place Water System	15%	1504	OP03-0067	12,000,000	6,951,020		1,042,653	1,042,653	1,042,653
Mast	MSEC Enterprises (Montgomery Trace WS)	15%	616	HUP151	28,393,000	101,481,400		15,222,210	15,222,210	15,222,210
Mast	Mt. Pleasant Village Water System	15%	1377	HUP152	7,803,100	4,047,467		607,120	607,120	607,120
Mast	North Woods Water Supply Corp.	15%	1570	OP-04082401	14,000,000	11,681,000		1,752,150	0	0
Mast	Northwest Water System (Shady Brook Acres)	15%	2979	HUP158	3,979,400	3,939,700		590,955	590,955	590,955
Mast	Northwest Water System (White Oak Valley)	15%	527	HUP159	17,257,400	13,654,833		2,048,225	2,048,225	2,048,225
Mast	Northwest Water Water Systems (Hazy Hallow East Estates)	15%	2464	HUP157	52,649,700	50,219,433		7,532,915	7,532,915	7,532,915
Mast	Paradise Cove Water System	15%	289	HUP162	4,784,800	5,572,860		835,929	835,929	835,929
Mast	Patton Village Water Co., Inc (West)	15%	1383	HUP165	13,835,000	17,955,333		2,693,300	2,693,300	2,693,300
Mast	Patton Village Water Co., Inc. (East)	15%	1562	HUP164	16,800,000	16,636,667		2,495,500	2,495,500	2,495,500
Mast	Patton Village Water Co., Inc. (Peach Creek Colony)	15%	1561	HUP166	3,953,000	3,730,000		559,500	559,500	559,500
Mast	Pine Lake W.S Corp	15%	1387	HUP169	6,378,000	4,391,345		658,702	658,702	658,702
Mast	Pinehurst Decker Prairie	15%	245	HUP171	29,889,464	30,608,138		4,591,221	4,591,221	4,591,221
Mast	Piney Shores Utility	15%	1388	HUP172	20,834,000	16,675,667		2,501,350	0	0
Mast	Quadvest Inc (Benders Landing)	15%	726	HUP180	8,136,000	53,272,500		7,990,875	0	0
Mast	Quadvest Inc (Indigo Lakes)	15%	625	HUP181	77,864,000	96,002,000		14,400,300	0	0
Mast	Quadvest, Inc. (Creekside Village)	15%	37	OP-04122901	20,000,000	13,727,000		2,059,050	0	0
Mast	Quadvest, Inc. 1 (Lake Windcrest WS)	15%	1414	HUP178	75,414,000	213,027,500		31,954,125	0	0
Mast	Quadvest, Inc. 2 (Lonestar Ranch)	15%	1415	HUP179	17,114,000	111,236,000		16,685,400	0	0
Mast	Ranch Utilities (Caddo Village)	15%	2318	OP-05060601	25,000,000	7,959,000		1,193,850	1,193,850	1,193,850
Mast	San Jo Utilities	15%	1430	HUP194	14,762,000	10,703,333		1,605,500	1,605,500	1,605,500
Mast	Settlers Crossing Water System	15%	218	HUP196	7,680,000	5,923,000		888,450	888,450	888,450
Mast	Southwest Utilites, Inc. (Hidden Forest)	15%	1437	HUP204	6,000,000	6,965,000		1,044,750	1,044,750	1,044,750
Mast	Southwest Utilities, Inc. (Forest Woods)	15%	1435	HUP202	5,500,000	4,773,333		716,000	716,000	716,000
Mast	Southwest Utilities, Inc. (Frontier, Arrowhead)	15%	1436	HUP203	20,000,000	21,375,000		3,206,250	3,206,250	3,206,250
Mast	Southwest Utilities, Inc. (Lake Conroe West)	15%	1439	HUP206	5,500,000	5,157,000		773,550	773,550	773,550
Mast	Southwest Utilities, Inc. (Pine Vista)	15%	1440	HUP207	5,250,000	5,101,333		765,200	765,200	765,200
Mast	Stone Hedge Utility Co.	15%	1444	HUP215	4,131,000	4,377,767		656,665	656,665	656,665
Mast	T & I Taylor, Inc. (Hillgreen)	15%	2853	OP-05100404	7,200,000	4,355,700		653,355	653,355	653,355
Mast	T & I Taylor, Inc. (Loch Ness)	15%	2852	OP-05100403	6,500,000	3,386,500		507,975	507,975	507,975
Mast	T & I Taylor, Inc. (River Club/River Ridge)	15%	2851	OP-05100402	18,000,000	9,311,100		1,396,665	1,396,665	1,396,665
Mast	T & I Taylor, Inc. (Woodhaven)	15%	2850	OP-05100401	6,500,000	3,761,500		564,225	564,225	564,225
Mast	T & W Water Services (Riverwalk)	15%	1048	HUP218	10,118,000	168,310,667		25,246,600	16,999,377	0
Mast	T & W Water Services (Riverwalk)	15%	1048	OP03-0012	186,000,000	129,073,000		19,360,950	13,036,373	0
Mast	Texaba Water System	15%	1457	HUP227	24,809,000	13,365,667		2,004,850	2,004,850	2,004,850
Mast	Thousand Trails Lake Conroe	15%	163	HUP230	6,786,800	5,197,090		779,564	779,564	779,564
Mast	Wagner Services (Bridgepoint Water System)	15%	1563	HUP236	6,000,000	8,269,767		1,240,465	1,240,465	1,240,465
Mast	Wagner Services (Emerson Estates)	15%	656	HUP235	2,999,300	77,456,867		11,618,530	11,618,530	11,618,530
Mast	Wagner Services (Emerson Estates)	15%	656	OP03-0030	51,169,400	71,472,200		10,720,830	10,720,830	10,720,830
Mast	Walnut Cove Water Supply Corp.	15%	118	HUP237	33,184,500	31,581,633		4,737,245	4,737,245	4,737,245
Mast	Weisinger Water Well, Inc.	15%	417	HUP239	5,000,000	5,030,228		754,534	754,534	754,534
Mast	Westwood North Water Supply	15%	1466	HUP242	42,780,262	65,469,867		9,820,480	9,820,480	9,820,480
Mast	White Oak Utilities, Inc.	15%	1467	HUP243	2,215,000	13,834,333		2,075,150	2,075,150	2,075,150
Mast	White Oak Water Supply Corporation	15%	642	HUP244	13,755,000	21,014,733		3,152,210	1,012,066	0
Mast	Woodland Lakes WSC	15%	1468	HUP247	40,752,000	9,559,100		1,433,865	1,433,865	1,433,865
Mast	Woodland Oaks Utility Co. Inc.	15%	633	HUP249	26,488,000	35,654,743		5,348,211	5,348,211	5,348,211
Mast	Woodland Oaks Utility Co. Inc.	15%	633	OP02-0004	25,000,000	4,426,303		663,945	663,945	663,945
MUD	Chateau Woods MUD	15%	941	HUP037	55,478,000	53,011,000		7,951,650	7,951,650	7,951,650
MUD	Clover Creek MUD	15%	951	HUP047	25,522,000	20,337,167		3,050,575	3,050,575	3,050,575
MUD	Corinthian Point MUD No.2	15%	952	HUP051	53,009,300	44,284,333		6,642,650	0	0
MUD	East Plantation Utility District	15%	965	HUP069	87,215,258	77,103,750		11,565,563	0	0
MUD	East Plantation Utility District	15%	965	OP-05052001	-	88,928,700		13,339,305	0	0
MUD	Far Hills Utility District	15%	156	HUP076	64,679,000	47,437,000		7,115,550	7,115,550	7,115,550
MUD	HMW Special Utility District (Allenwood)	15%	982	HUP084	23,116,000	15,190,000		2,278,500	2,278,500	2,278,500
MUD	HMW Special Utility District (Armadillo Woods)	15%	983	HUP085	16,860,000	14,764,333		2,214,650	2,214,650	2,214,650
MUD	HMW Special Utility District (Coe Country)	15%	984	HUP086	64,411,000	61,690,000		9,253,500	9,253,500	9,253,500
MUD	HMW Special Utility District (Deer Ridge)	15%	985	HUP087	5,594,000	4,593,333		689,000	689,000	689,000
MUD	HMW Special Utility District (Hunters Retreat)	15%	986	HUP088	34,464,000	34,433,000		5,164,950	5,164,950	5,164,950
MUD	HMW Special Utility District (Kipling Oaks #1)	15%	987	HUP089	47,691,000	32,852,667		4,927,900	4,927,900	4,927,900
MUD	HMW Special Utility District (Kipling Oaks #2)	15%	988	HUP090	75,911,000	52,753,667		7,913,050	7,913,050	7,913,050
MUD	HMW Special Utility District (Pleasant Forest)	15%	990	HUP092	6,266,000	4,548,000		682,200	682,200	682,200
MUD	HMW Special Utility District (Rimwick Forest)	15%	991	HUP093	8,995,000	5,623,667		843,550	843,550	843,550
MUD	HMW Special Utility District (Sendera)	15%	993	HUP095	32,765,000	24,503,667		3,675,550	3,675,550	3,675,550
MUD	HMW Special Utility District (Towering Oaks)	15%	994	HUP096	39,406,000	29,853,333		4,478,000	4,478,000	4,478,000
MUD	Kings Manor MUD	15%	1348	HUP107	63,897,000	100,736,000		15,110,400	15,110,400	15,110,400
MUD	Kings Manor MUD	15%	1348	OP03-0058	146,103,000	81,633,000		12,244,950	12,244,950	12,244,950
MUD	Lake Conroe Hills MUD	15%	132	HUP112	56,062,000	43,055,401		6,458,310	6,458,310	6,458,310
MUD	Montgomery County MUD # 15 (c/o Young & Brooks)	15%	1367	HUP136	66,571,000	60,622,667		9,093,400	545,604	0
MUD	Montgomery County MUD # 16	15%	1368	HUP137	18,428,000	17,242,333		2,586,350	2,586,350	2,586,350
MUD	Montgomery County MUD # 18 (Yacht Club)	15%	1370	HUP139	5,603,000	3,495,252		524,288	524,288	0
MUD	Montgomery County MUD #18	15%	1369	HUP138	234,159,000	297,382,109		44,607,316	44,607,316	0
MUD	Montgomery County MUD #19	15%	637	HUP140	165,719,000	134,697,333		20,204,600	0	0
MUD	Montgomery County MUD #19	15%	637	OP03-0021	29,281,000	68,957,000		10,343,550	0	0
MUD	Montgomery County MUD #24	15%	1371	HUP142	22,001,000	21,348,000		3,202,200	3,202,200	3,202,200
MUD	Montgomery County MUD #8	15%	1365	HUP145	212,277,000	248,922,371		37,338,356	37,338,356	37,338,356
MUD	Montgomery County MUD #9	15%	1366	HUP147	187,914,000	153,105,898		22,965,885	22,965,885	22,965,885
MUD	Montgomery County MUD 89 (Also MUD 88)	15%	638	OP03-0043	294,000,000	59,480,500		8,922,075	7,317,612	0
MUD	New Caney MUD	15%	1303	HUP154	320,818,900	308,062,733		46,209,410	46,209,410	46,209,410
MUD	Point Aquarius MUD	15%	135	HUP175	109,129,000	120,684,933		18,102,740	18,102,740	18,102,740
MUD	Porter Special Utility District	15%	1339	HUP177	471,564,000	502,320,765		75,348,115	0	0
MUD	Porter Special Utility District	15%	1339	OP03-0006	44,494,451	296,739,450		44,510,917	0	0
MUD	Rayford Road MUD	15%	1248	HUP184	325,000,000	371,651,333		55,747,700	55,747,700	55,747,700
MUD	River Plantation MUD	15%	439	HUP187	225,868,339	161,802,700		24,270,405	0	0
MUD	Roman Forest Consolidated MUD	15%	1295	HUP189	100,837,000	93,502,667		14,025,400	14,025,400	14,025,400
MUD	Southern Montgomery County MUD	15%	610	HUP199	379,896,000	367,609,333		55,141,400	0	0
MUD	Spring Creek Utility District	15%	1325	HUP210	131,528,000	146,306,500		21,945,975	3,379,857	0
MUD	Spring Creek Utility District	15%	1325	OP03-0075	63,472,000	155,372,500		23,305,875	23,305,875	23,305,875
MUD	Stanley Lake MUD	15%	740	HUP213	119,581,000	138,215,667		20,732,350	345,539	0
MUD	Stanley Lake MUD	15%	740	OP-04031003	110,000,000	15,986,000		2,397,900	39,965	0
MUD	Texas National MUD	15%	1516	OP-04080602	30,000,000	26,054,600		3,908,190	3,908,190	3,908,190
OthP	Conroe Bay Civic Association	15%	807	HUP048	14,065,000	10,425,000		1,563,750	1,563,750	1,563,750
OthP	Kingwood Athletic Club	15%	1003	HUP108	2,500,000	4,295,067		644,260	644,260	644,260
OthP	Lakeland Section 4 Civic Club	15%	581	HUP119	16,000,000	12,685,000		1,902,750	1,902,750	1,902,750
OthP	Peach Creek Dam & Lake Club	15%	291	HUP167	12,908,000	12,595,400		1,889,310	1,889,310	1,889,310
City	City of Conroe	1%	942	HUP038	2,709,400,000	2,659,666,667		26,596,667	13,506,120	13,506,120
City	City of Conroe	1%	205	OP02-0001	262,800,000	2,583,600,000		25,836,000	25,836,000	25,836,000
City	City of Houston	1%	1333	HUP1300001	975,710,000	964,479,667		9,644,797	8,272,208	8,272,208
City	City of Magnolia	1%	502	HUP039	131,000,000	118,802,500		1,188,025	1,188,025	1,188,025
City	City of Magnolia	1%	502	OP-04041601	85,000,000	100,838,000		1,008,380	1,008,380	1,008,380
City	City of Oak Ridge North	1%	943	HUP041	175,000,000	163,844,667		1,638,447	4,644,808	4,644,808
City	City of Panorama Village	1%	946	HUP042	199,286,000	156,093,667		1,560,937	1,404,843	0
City	City of Shenandoah	1%	589	HUP043	168,851,000	217,326,000		2,173,260	30,425,640	0

Table 5. ***contd.***

User Type	Well Owner	Estimated Percent Irrigation	OID	Permit #	Permitted Amount (gallons per year)	Average 2003 - 2005 Pumped Amount (gallons per year)	Well for Irrigation	1. Potential Reuse Water Demand (ignoring questionnaire responses) (gallons per year)	2. Potential Reuse Water Demand Adjusted (gallons per year)	3. Potential Reuse Water Demand w. Interested Responses (gallons per year)
City	City of Shenandoah	1%	589	OP-04113002	59,000,000	227,100,000		2,271,000	31,794,000	0
City	City of Splendora	1%	1288	HUP044	258,127,500	230,687,500		2,306,875	3,460,313	0
City	City of Splendora	1%	1288	OP-04062801	-	242,757,000		2,427,570	3,641,355	0
City	City of Willis	1%	183	HUP045	248,032,200	147,952,200		1,479,522	1,479,522	1,479,522
City	San Jacinto River Authority	1%	542	HUP193	4,913,370,000	5,354,262,333		53,542,623	53,542,623	53,542,623
City	Town of Cut & Shoot	1%	1460	HUP231	54,744,000	70,912,667		709,127	709,127	0
Comm	Entergy Gulf States / Lewis Creek Plant	1%	970	HUP072	263,998,660	138,003,969		690,020	690,020	690,020
Comm	Huntsman Petrochemical Corp.	1%	996	HUP099	316,571,000	195,010,775		975,054	975,054	975,054
Summary								2230 MGY	1786 MGY	1615 MGY

The location of the 106 WWTPs (supply) and the 230 wells (demand) are shown on *Exhibit 1 – Estimated Water Reuse Demand and Reclaimed Water Reuse Supply*. A table was created to spatially analyze the distances between the WWTPs and the wells. For purposes of this study, longer distances between wells and WWTP were considered less effective than shorter distances. The match process ranked each well/WWTP combination to minimize the distance between each pair. The potential reuse demands of each well user and the quantity of available supply from each WWTP were then ranked to maximize the amount of reuse. The table including the distances was adjusted to account for size of supply and demand. Each distance value was divided by the amount of supply and then divided by the amount of demand at each supply/demand transaction. The 24,380 WWTP/well pairs were ranked according to this number. The analysis then determined the amount of supply and demand remaining after the match. The maximum distance between a potential effluent reuse user and a supply source was found to be 8.4 miles. Only 12 out of 238 ranked supply/demand pairs was found to have distance greater than 5 miles. The distances identified between supplies and demands are linear. The geographic areas of the County that offer the best opportunity for effluent reuse as a primary strategy for meeting groundwater use goals were identified to be Southern Montgomery County and around Lake Conroe (see *Exhibit 2*).

These matches do not take into account the potential to share costs in infrastructure by utilizing WWTP effluent to meet more than one potential demand. There is also the potential to use both direct and indirect methods for transporting the supply to the demand. The optimization of infrastructure costs will need to be performed during the facility planning process.

A list of the supply/demand match results is in *Table 6 – Supply/Demand Match*. This list identifies potential transactions between providers (WWTPs) and users (well permit owners who could potentially use reclaimed water), and ranks them based on the volume of the transaction and the distance between the provider and the user's well(s). *Table 6* merely prioritizes the potential projects – it does not take into account the economics of constructing reclaimed water projects. A discussion of specific projects is included in later sections.

Table 6. Supply/Demand Match

Rank	WWTP NPDES#	Well Permit Number	Distance	WWTP reliable capacity for this transaction	Well demand remaining for this transaction	Total Transaction
0.109302442	TX0125113	HUP143	0.400	22.50	30.40	22.50
0.13111725	TX0078263	HUP184	0.471	145.24	55.75	55.75
0.142207629	TX0026221	OP03-0075	0.174	76.84	23.31	23.31
0.144055326	TX0100331	HUP138	0.561	65.47	44.61	44.61
0.16167239	TX0095621	HUPAG1500017	0.388	13.69	28.78	13.69
0.176036175	TX0118028	HUP248	1.950	1.42	107.13	1.42
0.183459539	TX0120073	HUP248	2.209	8.27	105.71	8.27
0.186744996	TX0117145	HUP179	0.328	27.32	16.69	16.69
0.192112852	TX0076538	HUP199	0.650	111.27	55.14	55.14
0.217979878	TX0091715	HUP254	0.389	494.09	23.09	23.09
0.223407421	TX0088901	HUPAG1500011	1.067	0.73	65.08	0.73
0.223462958	TX0089672	HUP177	1.656	22.37	75.35	22.37
0.231223115	TX0115827	HUP083	0.063	19.55	2.72	2.72
0.236356451	TX0104060	HUP213	0.394	2.90	20.73	2.90
0.2375876	TX0054186	HUP253	1.077	1165.79	95.67	95.67
0.250860435	TX0084638	HUP154	0.804	176.25	46.21	46.21
0.25792493	TX0026221	HUP210	0.296	53.53	21.95	21.95
0.281197895	TX0092843	HUP248	2.451	2.13	97.44	2.13
0.283705525	TX0091715	HUP246	1.872	471.00	85.30	85.30
0.288418106	TX0117137	HUP002	1.370	20.53	45.51	20.53
0.302228517	TX0122327	HUP248	3.671	20.83	95.31	20.83
0.302876779	TX0083208	HUP177	1.515	1.83	52.98	1.83
0.316276945	TX0119598	HUP248	3.740	1.69	74.48	1.69
0.333868954	TX0126306	HUP248	4.484	9.58	72.80	9.58
0.350893227	TX0110663	HUP012	0.139	1.68	4.15	1.68
0.355059768	TX0069469	HUP002	0.636	130.80	24.97	24.97
0.359131776	TX0094552	HUP086	0.280	2.54	9.25	2.54
0.372418759	TX0100331	HUP030	1.230	20.87	37.79	20.87
0.376761906	TX0071412	HUP1300001	0.397	14.84	9.64	9.64
0.379608707	TX0091715	HUP248	3.147	385.71	63.21	63.21
0.383611019	TX0118311	HUP177	3.075	4.93	51.15	4.93
0.401629715	TX0125300	HUP177	3.673	7.61	46.21	7.61
0.403918958	TX0127400	HUP177	4.029	41.06	38.60	38.60
0.438464255	TX0126209	OP03-0006	2.427	12.65	44.51	12.65
0.457081378	TX0089630	HUP213	0.705	34.08	17.83	17.83
0.471238072	TX0054186	HUP255	0.456	1070.12	20.43	20.43
0.475088185	TX0069469	HUP143	0.569	105.83	7.90	7.90
0.484660071	TX0089630	HUP145	1.346	16.25	37.34	16.25
0.488905492	TX0125601	HUP193	3.230	27.38	53.54	27.38
0.490216455	TX0118818	OP03-0006	2.343	54.75	31.86	31.86
0.491222049	TX0090123	HUP037	0.380	19.96	7.95	7.95
0.492637716	TX0090123	HUP193	2.568	12.00	26.17	12.00
0.506368371	TX0124095	HUPAG1500001	1.096	16.43	18.75	16.43
0.508301973	TX0088447	HUPAG1500011	2.394	11.47	64.35	11.47
0.513926489	TX0022080	HUP145	0.852	99.82	21.08	21.08
0.52403784	TX0126799	OP-04122901	0.137	3.15	2.06	2.06
0.573294602	TX0109339	HUP030	1.958	3.70	16.92	3.70
0.575993902	TX0119504	OP03-0042	1.679	2.14	26.90	2.14
0.578262768	TX0124486	OP-04071501	4.954	32.85	72.37	32.85
0.582948943	TX0032514	HUP141	0.451	54.94	18.69	18.69
0.598436295	TX0115827	HUP086	0.556	16.83	6.71	6.71
0.607096879	TX0093505	HUPAG1500011	3.254	5.46	52.87	5.46
0.623118187	TX0127400	OP-04071401	0.767	2.46	9.30	2.46
0.645346531	TX0076538	HUP193	2.121	56.13	14.16	14.16
0.650160112	TX0022063	OP-04031003	0.068	70.88	2.40	2.40
0.702182393	TX0123374	HUPAG1500011	5.226	2.17	47.42	2.17
0.715523251	TX0113255	HUPAG1500011	4.627	3.38	45.25	3.38
0.717830712	TX0069469	HUPAG1500011	1.839	97.93	41.88	41.88
0.785569204	TX0102512	HUP044	0.160	20.43	2.31	2.31
0.807672464	TX0127108	HUP189	1.488	41.06	14.03	14.03
0.847690661	TX0116459	HUP175	1.878	3.90	18.10	3.90
0.89045191	TX0076538	HUP140	1.104	41.97	20.20	20.20
0.939448508	TX0054364	HUP112	0.312	16.98	6.46	6.46
0.95553019	TX0077763	HUP030	2.288	0.56	13.23	0.56

Table 6 contd.

Rank	WWTP NPDES#	Well Permit Number	Distance	WWTP reliable capacity for this transaction	Well demand remaining for this transaction	Total Transaction
0.985517196	TX0076368	OP03-0042	1.574	27.95	24.76	24.76
1.003529609	TX0054364	HUP175	0.933	10.53	14.20	10.53
1.030196013	TX0111856	HUP107	1.422	3.23	15.11	3.23
1.047843453	TX0127035	HUP157	1.021	21.90	7.53	7.53
1.054551422	TX0126799	HUPAG1500017	3.866	1.09	15.10	1.09
1.072449729	TX0076368	OP03-0041	1.639	3.19	25.74	3.19
1.081164928	TX0076538	HUPAG1500017	1.910	21.77	14.01	14.01
1.09137519	TX0127035	OP-04071501	10.218	14.37	39.52	14.37
1.126227149	TX0103004	OP03-0041	2.591	10.87	22.56	10.87
1.16733403	TX0022080	HUP147	1.190	78.74	22.97	22.97
1.181523613	TX0084042	HUP107	1.221	139.19	11.88	11.88
1.185308233	TX0126713	HUP180	1.197	27.38	7.99	7.99
1.191570278	TX0090905	HUP178	2.908	42.64	31.95	31.95
1.200353217	TX0102512	OP-04062801	0.258	18.12	2.43	2.43
1.211424241	TX0092517	OP03-0030	1.031	2.21	10.72	2.21
1.22845039	TX0086665	HUPAG1500001	1.621	2.39	2.33	2.33
1.254301654	TX0091715	OP-04071501	7.024	322.49	25.15	25.15
1.322743518	TX0124281	HUP011	0.708	16.70	4.56	4.56
1.324828188	TX0022071	HUP175	0.968	38.58	3.67	3.67
1.334164085	TX0076538	OP03-0021	0.847	7.76	10.34	7.76
1.343160136	TX0054186	HUP149	1.089	1049.69	17.12	17.12
1.365631253	TX0078263	HUP211	0.416	89.50	4.74	4.74
1.383141234	TX0068659	HUPAG1500014	0.529	2.68	6.90	2.68
1.410749258	TX0069469	HUP148	1.149	56.05	20.68	20.68
1.425514251	TX0117706	OP03-0027	1.396	41.06	9.66	9.66
1.43792805	TX0117706	OP03-0049	0.398	31.40	2.73	2.73
1.464309522	TX0083216	HUPAG1500005	0.514	1.64	5.37	1.64
1.47758926	TX0119857	HUP181	2.370	54.75	14.40	14.40
1.512758607	TX0090905	HUP222	1.166	10.69	10.09	10.09
1.526515857	TX0093564	OP-05012601	0.618	130.51	6.01	6.01
1.532492222	TX0084042	OP03-0058	1.283	127.30	12.24	12.24
1.547413729	TX0069256	HUP187	2.117	27.38	24.27	24.27
1.556975315	TX0127094	HUP218	5.125	41.06	25.25	25.25
1.672670087	TX0097969	HUP047	0.441	9.46	3.05	3.05
1.698955536	TX0115827	HUP171	0.783	10.11	4.59	4.59
1.754131486	TX0022063	HUP030	2.875	68.48	12.67	12.67
1.796639644	TX0020206	HUP161	1.074	78.42	16.43	16.43
1.800723523	TX0086665	OP03-0041	3.262	0.07	11.68	0.07
1.86073708	TX0027308	HUP048	0.219	7.63	1.56	1.56
1.895852102	TX0117145	HUP173	0.475	10.63	2.38	2.38
1.898222743	TX0126713	OP-04071401	2.231	19.38	6.84	6.84
1.904965876	TX0071412	HUP142	0.667	5.19	3.20	3.20
1.955094699	TX0127094	OP03-0012	4.935	15.82	19.36	15.82
1.958400762	TX0090905	HUP010	0.567	0.59	3.79	0.59
2.073337009	TX0097969	HUP104	1.858	6.41	10.37	6.41
2.09569323	TX0022063	HUP062	1.096	55.81	12.06	12.06
2.104471316	TX0020206	OP03-0041	1.971	61.99	11.62	11.62
2.158140472	TX0093564	HUP136	1.322	124.50	9.09	9.09
2.198994429	TX0027308	HUP051	1.101	6.07	6.64	6.07
2.320856776	TX0118818	OP03-0012	4.825	22.89	3.55	3.55
2.354208728	TX0086738	HUP061	0.345	6.13	2.97	2.97
2.426174481	TX0127663	HUP089	0.351	10.40	4.93	4.93
2.429029897	TX0084042	HUP146	0.602	115.06	3.63	3.63
2.433400532	TX0117706	OP-05092003	0.877	28.67	3.55	3.55
2.446018398	TX0109622	HUP090	1.807	36.96	7.91	7.91
2.44882792	TX0022063	OP02-0005	0.765	43.75	7.20	7.20
2.512904506	TX0119857	HUP243	0.581	40.35	2.08	2.08
2.57833229	TX0108553	HUP010	0.903	166.99	3.20	3.20
2.631554121	TX0069469	HUP015	0.473	35.37	4.56	4.56
2.64862562	TX0126713	OP03-0043	2.986	12.55	8.92	8.92
2.73446065	TX0115827	OP-04011603	0.531	5.52	1.93	1.93
2.741154397	TX0078263	OP03-0038	0.409	84.76	2.32	2.32
2.746567396	TX0069256	HUP123	0.881	3.10	5.69	3.10
2.765665719	TX0025674	HUP069	1.100	111.85	11.57	11.57

Table 6 contd.

Rank	WWTP NPDES#	Well Permit Number	Distance	WWTP reliable capacity for this transaction	Well demand remaining for this transaction	Total Transaction
2.776747653	TX0117846	HUP096	1.273	6.52	4.48	4.48
2.805201162	TX0025674	HUP008	1.020	100.28	10.57	10.57
2.844828671	TX0124281	HUP038	8.881	12.14	26.60	12.14
2.845137121	TX0072702	HUP088	0.858	60.43	5.16	5.16
3.025837937	TX0117846	HUP020	0.737	2.04	2.38	2.04
3.183571306	TX0056693	OP03-0033	5.148	30.79	32.10	30.79
3.215391147	TX0119857	OP03-0033	11.496	38.27	1.31	1.31
3.255288703	TX0027049	HUP051	0.916	11.99	0.58	0.58
3.295802906	TX0063461	HUP123	1.020	94.56	2.59	2.59
3.299431517	TX0054186	OP03-0021	1.617	1032.58	2.59	2.59
3.414558823	TX0095125	HUP004	0.559	5.09	1.92	1.92
3.422218953	TX0027049	HUP019	0.458	11.42	3.16	3.16
3.524509088	TX0117145	HUP038	9.878	8.26	14.46	8.26
3.67530057	TX0078344	HUP164	0.416	9.52	2.50	2.50
3.719231592	TX0025674	OP-05052001	1.705	89.71	13.34	13.34
3.768495657	TX0111473	HUP038	9.660	12.94	6.20	6.20
3.826258674	TX0109622	HUP104	3.707	29.04	3.97	3.97
3.917490793	TX0022268	HUP005	1.359	1322.47	11.06	11.06
3.976123223	TX0088137	HUP237	1.344	17.05	4.74	4.74
3.987042201	TX0119857	HUP247	0.637	36.97	1.43	1.43
4.117878049	TX0078344	HUP165	0.503	7.02	2.69	2.69
4.452263738	TX0072222	HUP055	6.218	0.74	24.34	0.74
4.541886364	TX0032514	HUP076	1.337	36.25	7.12	7.12
4.641308678	TX0088137	OP02-0001	8.559	12.31	25.84	12.31
4.792360117	TX0093564	OP-04113002	0.733	115.41	2.27	2.27
5.066597628	TX0124583	HUP137	1.564	41.06	2.59	2.59
5.077773075	TX0124583	HUP167	1.145	38.48	1.89	1.89
5.217837031	TX0022063	HUP060	0.683	36.55	3.02	3.02
5.355972923	TX0094315	HUP084	1.420	5.85	2.28	2.28
5.357266631	TX0111473	OP02-0001	13.339	6.73	13.52	6.73
5.629599115	TX0088501	OP-05100402	0.262	74.16	1.40	1.40
5.655702266	TX0093564	HUP043	0.828	113.14	2.17	2.17
5.868740976	TX0086738	HUP235	3.367	3.16	11.62	3.16
6.033750177	TX0126853	OP02-0001	20.012	1.67	6.79	1.67
6.176632721	TX0108553	HUP151	8.685	163.79	15.22	15.22
6.299753707	TX0063461	OP-04081201	1.128	91.97	3.29	3.29
6.45026344	TX0126713	HUPAG1500004	2.579	3.62	3.16	3.16
6.477625943	TX0068845	OP02-0001	5.418	162.36	5.12	5.12
6.516043137	TX0091715	HUP242	4.951	297.34	9.82	9.82
6.711851568	TX0119857	HUP007	3.605	35.53	4.82	4.82
6.735270015	TX0115827	HUP093	0.570	3.59	0.84	0.84
7.046693056	TX0022080	OP-05101101	0.851	55.77	2.72	2.72
7.159891681	TX0102512	HUP105	0.816	15.69	1.29	1.29
7.476174046	TX0127108	HUP168	0.858	27.04	0.87	0.87
7.605052841	TX0069469	HUP118	1.087	30.81	3.63	3.63
7.777900512	TX0128121	HUP111	1.292	5.48	5.85	5.48
8.116011784	TX0020206	HUP235	3.430	50.37	8.45	8.45
8.179808304	TX0124583	HUP055	23.768	36.59	23.60	23.60
8.347193171	TX0126713	HUP244	3.325	0.46	3.15	0.46
8.780047672	TX0091715	OP-04031901	1.359	287.52	2.00	2.00
8.796010627	TX0069469	HUP111	2.027	27.18	0.38	0.38
9.090631421	TX0077275	HUP023	3.674	0.64	6.69	0.64
9.273603543	TX0068845	OP03-0030	3.219	157.24	8.52	8.52
9.382066227	TX0119857	OP02-0002	7.203	30.71	6.89	6.89
9.420829152	TX0119857	HUP012	4.359	23.82	2.47	2.47
9.501635315	TX0091715	HUP023	4.922	285.52	6.05	6.05
9.584968837	TX0119857	HUPAG1500008	14.928	21.34	13.98	13.98
9.785631882	TX0027391	HUP194	0.760	9.43	1.61	1.61
9.962942443	TX0094315	HUP022	3.114	3.58	2.69	2.69
10.04620905	TX0093564	HUP119	1.288	110.96	1.90	1.90
10.19275686	TX0117706	HUP244	3.257	25.12	2.69	2.69
10.52727641	TX0063461	OP-04061401	0.890	88.68	1.56	1.56
11.13215379	TX0091715	HUP249	4.607	279.47	5.35	5.35
11.294273	TX0091677	HUP159	1.813	27.38	2.05	2.05

Table 6 contd.

Rank	WWTP NPDES#	Well Permit Number	Distance	WWTP reliable capacity for this transaction	Well demand remaining for this transaction	Total Transaction
11.42500112	TX0032514	HUP135	0.765	29.14	1.62	1.62
11.81647384	TX0091715	HUP018	0.902	274.12	0.99	0.99
11.81943436	TX0124583	HUP166	0.789	12.98	0.56	0.56
11.86847003	TX0022063	HUPAG1500003	2.598	33.54	5.05	5.05
11.93534558	TX0119857	HUP063	13.244	7.36	9.96	7.36
12.26247335	TX0118818	HUP073	1.537	19.34	1.17	1.17
12.47226659	TX0095125	HUP021	2.732	3.17	2.57	2.57
12.72741205	TX0094315	HUP020	3.522	0.89	0.34	0.34
13.0694517	TX0124583	OP02-0008	7.089	12.42	4.54	4.54
13.56449955	TX0108553	HUP006	5.896	148.57	4.71	4.71
13.63340576	TX0027391	HUPAG1500020	8.951	7.82	13.57	7.82
13.92438051	TX0075680	HUP013	1.359	16.71	1.83	1.83
14.02383447	TX0124583	OP03-0002	23.292	7.88	13.91	7.88
14.10533222	TX0072702	HUP039	0.978	55.27	1.19	1.19
14.3875362	TX0127108	OP03-0002	26.299	26.16	6.03	6.03
14.70192691	TX0068845	HUPAG1500020	6.460	148.72	5.75	5.75
15.30060936	TX0084042	OP-04112301	1.433	111.43	1.37	1.37
15.31677461	TX0068845	HUPAG1500014	3.424	142.97	4.22	4.22
16.74924622	TX0069469	HUP016	1.140	26.80	1.73	1.73
16.75396196	TX0068845	OP-04080602	2.120	138.75	3.91	3.91
16.8206184	TX0094315	HUP063	19.502	0.55	2.60	0.55
16.89676473	TX0108553	HUP095	5.737	143.86	3.68	3.68
17.62083776	TX0091677	OP03-0020	3.765	25.33	2.73	2.73
17.63532324	TX0069469	HUPAG1500025	1.408	25.07	2.03	2.03
17.66590866	TX0026221	OP-04050701	0.566	31.58	0.61	0.61
17.84587803	TX0091715	HUP017	4.745	273.13	3.44	3.44
18.17852402	TX0084042	HUP176	1.870	110.06	1.50	1.50
18.30584636	TX0115827	HUP063	18.306	2.75	2.05	2.05
19.60107339	TX0091677	HUPAG1500005	8.256	22.60	3.74	3.74
19.89317541	TX0063461	OP-05042201	1.628	87.12	1.51	1.51
19.98854183	TX0072702	HUP158	0.690	54.08	0.59	0.59
20.27896971	TX0093564	HUP041	2.239	109.06	1.64	1.64
20.812522	TX0095125	HUP085	3.935	0.60	2.21	0.60
21.15441866	TX0022071	HUP236	1.059	34.90	1.24	1.24
21.55140564	TX0102512	OP-04082401	3.337	14.40	1.75	1.75
22.84549175	TX0109622	HUP085	4.724	25.08	1.61	1.61
22.92833539	TX0022063	HUP029	2.979	28.49	3.00	3.00
23.0487422	TX0063461	OP-04012601	1.164	85.62	0.93	0.93
23.64899498	TX0027049	HUP035	1.651	8.26	1.65	1.65
23.66805255	TX0068845	HUP042	1.196	134.84	1.56	1.56
23.78997956	TX0020206	HUP172	2.165	41.91	2.50	2.50
24.50133262	TX0069469	HUP114	2.091	23.05	2.17	2.17
24.50193493	TX0091677	HUPAG1500023	9.661	18.86	5.03	5.03
25.44719424	TX0022268	HUPAG1500024	2.522	1311.41	3.16	3.16
28.19558039	TX0127108	OP03-0032	6.856	20.13	1.85	1.85
28.51394982	TX0084042	HUP108	1.256	108.56	0.64	0.64
28.99004124	TX0032514	HUP223	2.709	27.52	2.26	2.26
29.15468037	TX0068845	HUP221	1.062	133.28	1.12	1.12
30.63737406	TX0069469	HUPAG1500010	1.872	20.88	1.55	1.55
31.46043761	TX0127108	HUP025	2.722	18.28	0.66	0.66
31.57740409	TX0068845	HUP225	1.926	132.16	1.88	1.88
32.55707618	TX0022063	HUP115	1.719	25.49	1.22	1.22
33.73696677	TX0108553	OP03-0064	5.461	140.19	1.75	1.75
33.98389881	TX0022063	HUPAG1500009	5.473	24.28	3.71	3.71
35.35215258	TX0020206	HUP057	3.780	39.41	2.94	2.94
35.73761453	TX0027049	HUP162	1.266	6.61	0.84	0.84
36.21772539	TX0091715	OP03-0069	5.274	269.69	1.88	1.88
36.30150585	TX0109622	HUP014	3.985	23.47	1.18	1.18
36.71699374	TX0022063	HUP106	5.243	20.56	3.29	3.29
36.74057009	TX0068845	HUP045	1.760	130.27	1.48	1.48
37.433359	TX0068845	HUP064	4.321	128.79	3.57	3.57
37.88596656	TX0068845	HUP203	3.933	125.23	3.21	3.21
38.51910944	TX0020206	OP-04012302	3.171	36.47	2.26	2.26
39.12448764	TX0022063	HUP169	1.118	17.27	0.66	0.66

Rank	WWTP NPDES#	Well Permit Number	Distance	WWTP reliable capacity for this transaction	Well demand remaining for this transaction	Total Transaction
39.86436466	TX0072702	OP-04041601	2.347	53.49	1.01	1.01
42.10806514	TX0072702	OP03-0068	5.840	52.48	2.38	2.38
42.65571517	TX0108553	HUPAG1500006	3.761	138.44	0.95	0.95
44.65526891	TX0118818	HUPAG1500022	2.473	18.17	0.52	0.52
47.78922872	TX0032514	OP03-0018	3.314	25.26	1.68	1.68
51.66964697	TX0091677	HUP009	8.222	13.83	2.03	2.03
52.69297617	TX0108553	HUP220	2.855	137.48	0.59	0.59
53.25009394	TX0032514	HUP230	1.718	23.59	0.78	0.78
54.26716126	TX0091677	OP03-0011	8.222	11.80	1.93	1.93
55.87271769	TX0091715	OP03-0067	4.508	267.81	1.04	1.04
58.77285827	TX0025674	HUP117	1.770	76.37	0.88	0.88
66.0453582	TX0117706	OP-05042601	4.182	22.43	0.62	0.62
67.1733019	TX0068845	HUP224	1.404	122.02	0.65	0.65
69.02931685	TX0027049	OP-05100403	1.486	5.78	0.51	0.51
70.86638347	TX0117706	HUP120	5.285	21.80	0.74	0.74
72.9981143	TX0108553	HUPAG1500016	8.674	136.89	1.29	1.29
73.92391587	TX0072702	HUP207	3.302	50.11	0.77	0.77
74.68332155	TX0127108	HUP227	19.671	17.62	2.00	2.00
74.89046949	TX0068845	OP-05060601	2.895	121.37	1.19	1.19
83.44591962	TX0109622	HUP087	5.369	22.29	0.69	0.69
84.79631933	TX0109622	HUP092	5.402	21.60	0.68	0.68
93.30991964	TX0022071	HUP139	1.975	33.66	0.52	0.52
93.59455638	TX0117706	HUP026	5.118	21.07	0.54	0.54
105.3423014	TX0108553	OP02-0004	6.461	135.61	0.66	0.66
107.0003581	TX0091677	HUP099	8.177	9.87	0.98	0.98
109.1789819	TX0109622	OP03-0015	5.632	20.92	0.55	0.55
109.4444677	TX0069469	HUP206	3.334	19.33	0.77	0.77
109.5899141	TX0032514	HUP072	3.129	22.81	0.69	0.69
115.4017771	TX0022063	OP-05113001	3.812	16.61	0.76	0.76
125.0611541	TX0068845	HUP196	3.597	120.18	0.89	0.89
128.0044715	TX0022063	HUP202	3.975	15.85	0.72	0.72
144.0257085	TX0022063	HUP031	3.554	15.14	0.57	0.57
145.0731688	TX0022063	HUP204	6.574	14.57	1.04	1.04
149.1667561	TX0022063	HUP152	3.928	13.52	0.61	0.61
161.8174977	TX0091715	HUP239	9.447	266.77	0.75	0.75
182.2488308	TX0091677	HUPAG1500019	9.896	8.89	0.69	0.69
187.013675	TX0069469	OP-05100401	4.155	18.55	0.56	0.56
189.2321857	TX0091677	HUP215	9.739	8.20	0.66	0.66
193.5842502	TX0127108	HUP231	18.035	15.61	0.71	0.71
200.7564931	TX0091677	OP-05100404	10.280	7.54	0.65	0.65

WWTP used in more than one transaction
demand used in more than one transaction
distance between WWTP and Well is > 5 miles for this transaction

The maximum distance is 26.299 miles
31 transactions have a distance of > 5 miles
238 total transactions
only wells and WWTP with flows > 0.5 MGY were matched
These calculations do not take into account sharing of purple pipe capacity.

Future Effluent Reuse Potential

The year 2000 population in Montgomery County was 293,768 and the population is expected to increase to 1,331,286 by year 2060. This population growth is based on TWDB regional water planning population estimates. The Region H population estimates can be viewed in *Table 7.*

Table 7. Region H Population and Water Demand Estimates for Montgomery County*

Year	Population Estimate	Total Water Demand Estimates (ac-ft)
2000	293,768	56,277
2005**	351,689	66,772
2008**	383,193	72,649
2010	417,692	76,785
2013**	441,195	83,071
2020	542,051	102,300
2030	692,548	125,132
2040	858,410	149,737
2050	1,077,190	182,613
2060	1,331,286	221,286

*Region H Regional Water Plan 2006
**Interpolated population estimates and water demands

According to the Region H Regional Water Plan, this future growth and subsequent water demand is expected to be met by a combination of groundwater, surface water, reuse, and other water management strategies. The current potential wastewater effluent demands developed in Scenarios 1 through 3 were extrapolated to determine the potential reuse demands and supplies in the future based on past growth trends and water uses. The extrapolated potential water demands increased for all scenarios as follows.

Scenario 1	Potential water demands increased from 2,230 mgy in year 2005 to 8,441 mgy in year 2060.
Scenario 2	potential water demands increased from 1786 mgy in year 2005 to 6,759 mgy in year 2060.
Scenario 3	potential water demands increased from 1,615 mgy in year 2005 to 6112 mgy in year 2060.

Table 8 – Future Conditions and *Figure 1 – Interpolated WWTP Discharges and Irrigation Demands Based on Population* show the estimates of population, supply, and demand extrapolation to the year 2060.

The Draft Regulatory Study and Facilities Implementation Plan for Lone Star Groundwater Conservation District and San Jacinto River Authority (*Facilities Plan*), dated June 2006, evaluated various alternatives for reducing groundwater pumpage to sustainable levels. The study indicated that introduction of surface water along with conservation measures including reuse could reduce pumpage on the aquifer to the identified sustainable level of 64,000 ac-ft/yr. The earliest

Table 8 – Future Conditions

Year	Population[1]	Percent of 2005 Population	Potential Reuse Water Demand (ignoring questionnaire responses)[2]	Potential Reuse Water Demand Adjusted[3]	Potential Reuse Water Demand w. Interested Responses[4]	**Reuse Supply** - WWTP Discharge Reliable Flow[5]	Reusing All Available Water (minimum of reuse supply and demand)	Total Water Demand[6]	Total Water Demand	Alternative Source Requirements[7,8]	Alternative Source Requirements[7,8]	Combined Flow: Alternative Source Requirement with Reuse	Reuse Postponement Potential
year	# people	%	MGY	MGY	MGY	MGY	MGY	ac-ft	MGY	mgd	MGY	MGY	years
2000	**293,768**	84%	1,863	1,492	1,349	5,474		**56,277**	18,338		3,242	5,105	4.5
2005	351,689	100%	**2,230**	**1,786**	**1,615**	**6,553**		66,772	21,758		5,334	7,564	4.8
2008	383,193	109%	2,430	1,946	1,759	7,140	2,430	72,649	23,673	18	6,697	9,127	5.0
2010	**417,692**	119%	2,649	2,121	1,918	7,783	2,649	**76,785**	25,020	21	7,651	10,299	5.2
2013	441,195	125%	2,798	2,240	2,026	8,221	2,798	83,071	27,069	**25**	9,131	11,929	5.2
2020	**542,051**	154%	3,437	2,752	2,489	10,101	3,437	**102,300**	33,335	**35.6**	13,003	16,440	5.8
2030	**692,548**	197%	4,391	3,516	3,180	12,905	4,391	**125,132**	40,774	**52.4**	19,139	23,530	6.3
2040	**858,410**	244%	5,443	4,358	3,941	15,996	5,443	**149,737**	48,792	**72**	26,298	31,741	6.9
2050	**1,077,190**	306%	6,830	5,469	4,946	20,072	6,830	**182,613**	59,505	94	34,303	41,133	7.7
2060	**1,331,286**	379%	8,441	6,759	6,112	24,807	8,441	**221,286**	72,106	118	43,220	51,662	8.7

[1]From TWDB website (www.twdb.state.tx.us): Data, Population and Water Demand Data, Population Projections Data, County Population Projections in Texas; unbolded values are a quadratic interpolation

[2]From Estimated Irrigation Demand from *Potential Reuse Demands* Table, unbolded based on population percentage of year 2005

[3]From Maximum Estimated Irrigation Demand from *Potential Reuse Demands* Table, unbolded based on population percentage of year 2005

[4]From Minimum Estimated Irrigation Demand from *Potential Reuse Demands* Table, unbolded based on population percentage of year 2005

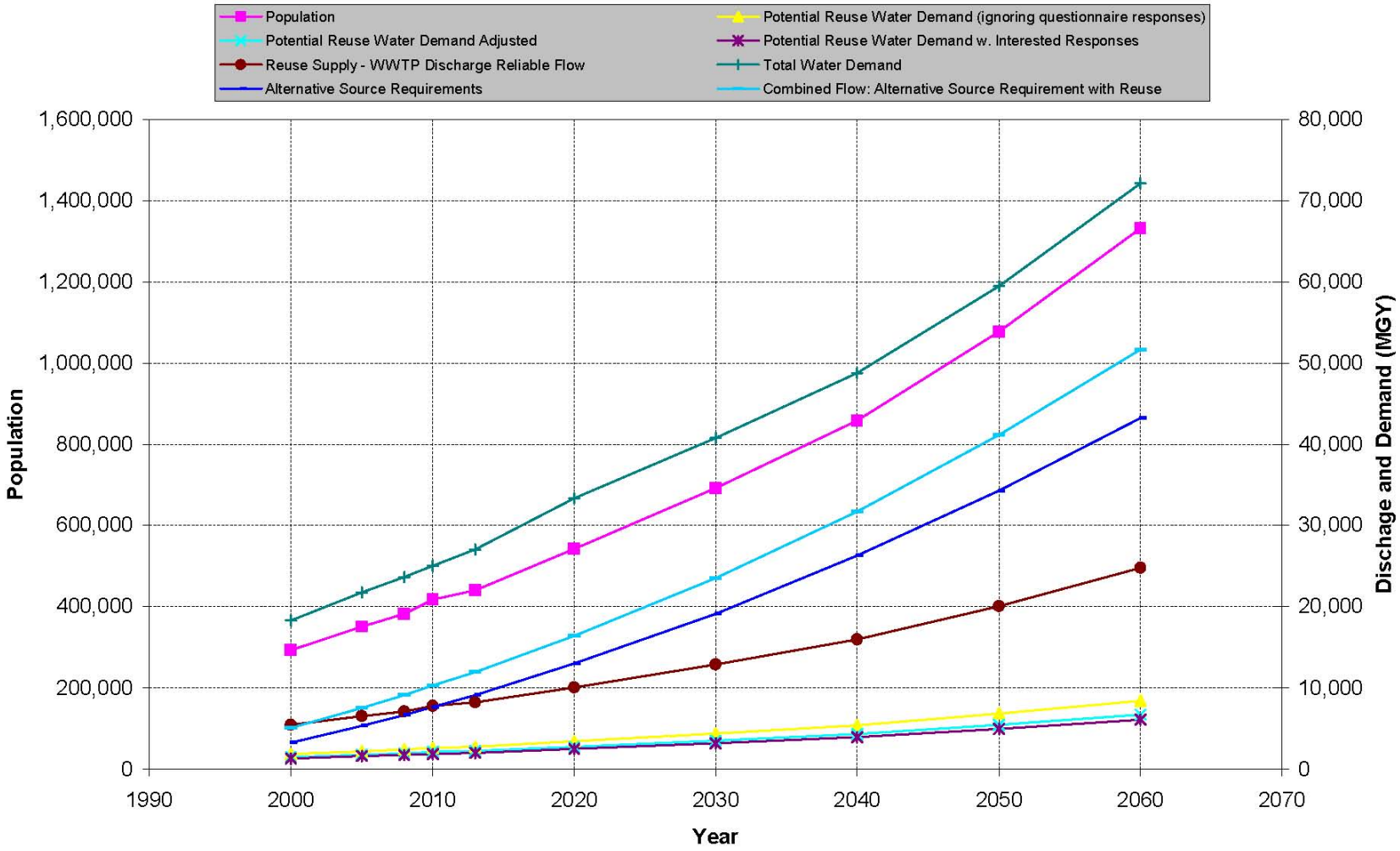
[5]From Total from *Identified Wastewater Discharges and Estimated Reliable Flows* Table, unbolded based on population percentage of year 2005

[6]From TWDB website (www.twdb.state.tx.us): Data, Population and Water Demand Data, Water Demand Projections Data, County Water Demand Projections, unbolded values are a quadratic interpolation

[7]From *Table 13: Alternative Source Requirements by Phase and Zone* of ***Regulatory Study and Facilities Implementation Plan for Lone Star Groundwater Conservaton District and San Jacinto River Authority***, unbolded values are a quadratic extrapolation

[8]Numbers for 2008 and 2010 are estimations only as it is not a requirement until 2013.

Figure 1. Interpolated WWTP Discharges and Irrigation Demands Based on Population



year identified for surface water conversion was 2013. Using the groundwater conversion targets identified in the Facilities Plan, which are provided in *Table 9*, the full utilization of potential reuse demands (ignoring all questionnaires responses) could delay the need for the surface water conversion infrastructure by up to 5 years. However, LSGCD does not currently have a mechanism or program in place to support and promote effluent reuse or other means of conservation. Potential programs and incentives are discussed in the following sections.

Table 9. Alternative Source Requirements by Phase and Zone

Zone	Phase I - 2013		Phase II - 2020		Phase III - 2030		Phase IV - 2040	
	Conversion Target	SW Required	Conversion Target	SW Required	Conversion Target	SW Required	Conversion Target	SW Required
Southwest	57%	25 mgd	65%	35 mgd	71%	46 mgd	75%	55 mgd
Southeast	-	-	4%	0.6 mgd	30%	6 mgd	46%	12 mgd
Northwest	-	-	-	-	2%	0.4 mgd	22%	5 mgd
Northeast	-	-	-	-	-	-	-	-

Maximizing Reuse Potential

High Potential Projects

Table 6, as discussed previously, ranks potential projects based on supply, demand, and distance between the provider and user of reclaimed water. This section focuses on potential transactions in several areas where reclaimed water demand is high due to the presence of golf courses and master planned communities: two areas in The Woodlands (northwest near Woodlands Parkway and south near Grogans Mill including Montgomery County WCID No. 1) and one area on the west side of Lake Conroe (Bentwater). These do not represent all high potential projects, but provide examples where large reclaimed water demands can be supplied by nearby WWTPs.

The first potential Woodlands area project involves the SJRA as the reclaimed water producer and provider, and The Woodlands Commercial Properties Co., L.P. and The Woodlands Land Development Company, L.P. as the users. *Exhibit 3* shows a map of the WWTP and the golf courses. *Table 10* lists the reclaimed water volumes that could potentially be involved. The SJRA WWTP can reliably supply up to 494.1 mgy. Based on average reported pumpage from 2003 to 2005, the volume of reclaimed water that could be purchased from SJRA to irrigate these three golf courses is 322.7 mgy (990 acre-ft/year). This demand does not take into account permitted amounts in their historic use permits (HUPs) for The Woodlands Commercial Properties that are significantly higher than recent reported pumpage. As of the writing of this report, the HUP volumes have not been officially adopted by LSGCD and are subject to change.

Table 10. Northwest Woodlands Golf Course Irrigation

Producer/ Provider	**Reclaimed Water Available** (mgy)	**User**	**Well Permit Number**	**Transaction Amount** (mgy)
SJRA (TX0091715)	494.1	The Woodlands Land Development Co.	HUP248	214.3
SJRA (TX0091715)	279.8	The Woodlands Commercial Properties	HUP246	85.3
SJRA (TX0091715)	194.5	The Woodlands Commercial Properties	HUP254	23.1
			Total	322.7

The other Woodlands project involves SJRA as the producer/provider and The Woodlands Commercial Properties Co. L.P. as the user. *Exhibit 4* shows a map of the WWTP and golf courses. *Table 11* lists the reclaimed water volumes that could potentially be involved. The SJRA WWTP can reliably supply up to 1,165.8 mgy. Based on average reported pumpage from 2003 to 2005, the volume of reclaimed water that could be purchased from SJRA to irrigate these two golf courses is 116.1 mgy (356 acre-ft/year). As in the previous example, the HUP permitted volumes for The Woodlands Commercial Properties is significantly higher than the reported pumpage, but the HUP volumes have not been officially accepted by LSGCD.

Table 11. South Woodlands Golf Course Irrigation

Producer/ Provider	Reclaimed Water Available (mgy)	User	Well Permit Number	Transaction Amount (mgy)
SJRA (TX0054186)	1,165.8	The Woodlands Commercial Properties	HUP253	95.7
SJRA (TX0054186)	1,070.1	The Woodlands Commercial Properties	HUP246	20.4
			Total	116.1

The third project is on the western shore of Lake Conroe and involves Montgomery County MUD 18 supplying water to itself and to Bentwater Yacht & Country Club. The MUD No. 18 WWTP can reliably supply 65.5 mgy, which can be fully utilized to irrigate a portion of Bentwater's three golf courses as well as a portion of the Bentwater subdivision's green space. *Exhibit 5* shows the location of the MUD No. 18 WWTP as well as two of the three Bentwater golf courses. *Table 12* lists the entities involved and the potential transaction amounts.

Table 12. Bentwater Country Club and MUD No. 18 Irrigation

Producer/ Provider	Reclaimed Water Available (mgy)	User	Well Permit Number	Transaction Amount (mgy)
Montgomery County MUD No. 18 (TX0100331)	65.5	Bentwater Yacht and Country Club	HUP030/ OP-05122701	37.8
Montgomery County MUD No. 18 (TX0100331)	27.7	Montgomery County MUD No. 18	HUP138/ OP-05060201	27.7
			Total	**65.5**

Other high potential projects on the western shore of Lake Conroe involve Del Lago Resort golf courses, Walden subdivision and Walden Golf and Country Club, and April Sound Country Club. As mentioned previously, DL Utilities is evaluating using reclaimed water to irrigate Del Lago Golf Resort. Also mentioned previously, WCIA and MUD Nos. 8 and 9 investigated reclaimed water projects to irrigate Walden subdivision green space and eventually Walden Golf and Country Club. South of Del Lago is April Sound Country Club, which could potentially be irrigated by reclaimed water from Aqua Utilities Inc. WWTP (TX0117137) and Montgomery County MUD No. 3 WWTP.

Reclaimed Water Incentives for Groundwater Reduction

The concept of reclaiming wastewater for irrigation and non-potable uses typically has widespread public approval as a morally and socially acceptable method of preserving "natural" water resources. While the social acceptance to the layman is a motivation to investigate alternatives for a reuse program, unless formal regulations dictate otherwise, project economics will dictate the extent of actual implementation of any such programs.

Of the nine reuse programs investigated in Montgomery County to date, the principal reason that most of these projects were not actually implemented is simply that it costs more than it does to use groundwater. In general, groundwater production costs range in the order of $0.40 to $0.80 per 1,000 gallons and another approximately $0.40 per 1,000 gallons for operations. Comparatively, the reuse

programs evaluated in the greater Houston area had costs ranging from $0.57 to $2.86 per 1,000 gallons, with an average cost of $1.47 per 1,000 gallons. On a unit per unit cost basis therefore, there is little incentive to implement the reuse programs.

However, based on the previous investigations by the LSGCD, it appears likely sometime in the next decade, a wholesale surface water supply system in Montgomery County will become a reality. The investigation of the Facilities Plan indicates the cost for surface water will be closer to $2.50 per 1,000 gallons. When compared to this cost, the economics of reuse become competitive. Even with this cost neutrality, communities desiring to implement a reuse system face additional costs and risks that require them to front capital costs with an anticipated commitment that future users will in fact take the reclaimed water. Incentives for communities to seriously consider reuse as an alternative supply will be necessary to successfully result in measurable amounts of reclaimed water being used in the county.

No single water agency exists in Montgomery County to mandate the source of water supply to any community. Each water district or city operates and pays for its own retail supply system. The SJRA, while maintaining the rights of raw water in Lake Conroe, does not supply treated surface water to any community in the county and cannot do so without some form of interlocal agreement between the provider (SJRA) and the user (community). The LSGCD has authority to protect the groundwater resources of the county, but does not stipulate from where a community gets its supply. On the assumption that LSGCD will impose a permitting structure or regulatory program designed to discourage the excessive use of groundwater, it likely will not be able to dictate the manner by which each community decides to comply with the LSGCD program, whether that be by the use of surface water, reuse or advanced water conservation.

As the LSGCD moves forward with its regulatory program, it is important to recognize that reuse water is one of the key strategies to the future water supply in the county to complement the use of groundwater and surface water. However, absent any centralized authority to implement water strategies, communities can be encouraged to consider reuse though a series of incentive programs. These programs can be considered both in the planning, design and construction phases of any program. Given that reuse is a component of the future water supply of the county, there are still some significant differences between a surface water program and a reuse program. These include as a minimum:

- A reuse system is a very localized activity as compared to a surface water system, which is a more regional wholesale supply system.
- Because reuse is more localized, it can be implemented in a much shorter time frame. It is anticipated most reuse programs could be implemented in 18 months as opposed to the seven years expected for a surface water system.
- If reuse is implemented in the areas where the groundwater demand needs to be reduced, then it is possible to defer the requirement for surface water by several years.
- The cost of reuse will vary widely from application to application based on the availability of the effluent and the proximity and volume of the end user.
- The objective of reuse, like surface water, is to reduce the demand for groundwater. However, if reuse is designed to irrigate areas that are not currently irrigated, then this merely represents a new and expanded use for water and is not effective in reducing the overall use of water.

As the LSGCD regulatory program is enacted, it is likely that the regulated communities will individually decide how it best meets the requirement to reduce its demand on groundwater. These decisions are anticipated to be made based on the most cost-effective approach that community feels can meet any such requirement. It can be assumed, therefore, if the community has to pay more to build a water reuse program than it does to participate in a surface water system, it will opt to

participate in the surface water system. For cost analysis purposes the options to incentive programs offered herein assume that the cost for a water reuse system will be equal to the cost of surface water (on a gallon produced basis).

There are several cooperative mechanisms that can be offered to a community at little or no cost to the LSGCD. First of these is the LSGCD reputation as a water resource planning agency. Several grant programs exist via the TWDB and the US Environmental Protection Agency (USEPA) oriented to the effective use of reclaimed water as a strategy for water conservation. In most cases, it is attractive and in some cases mandatory that any program be regional in nature, with regional being defined as applicable to two or more public entities. LSGCD can cooperate with a local community as a minimum in securing the grant and even consider participating in the cost of the planning activity if it deems the application to benefit its overall purpose. Should the LSGCD do so, it should be careful to place the responsibility for implementing the project on the community since funds often have to be returned to the TWDB or USEPA if the program is not implemented.

A second incentive opportunity lies in the potential strength in bonding capacity potentially available to the LSGCD that could prove advantageous to the community desiring the reuse program. The security of groundwater pumpage fees might provide a higher bond rating than the community itself and in so pledging its resources, the LSGCD might be able to achieve a lower bond rating than the community can. A major negative to this approach is in fact the obligation the LSGCD would have against any debt that is incurred.

A third incentive opportunity lies in the LSGCD role as regulator for managing the withdrawal of groundwater. As a formal program for limiting the amount of groundwater production is put in place, a fee structure that penalizes communities who over pump and do not adhere to the regulations could become part of that program as a disincentive to system violators. These funds could be accrued by the LSGCD and be used to fund candidate projects in reuse that are deemed practical, cost effective and achieve the goal of reducing groundwater.

A fourth mechanism for consideration would be for the LSGCD to dedicate a portion of its permitting fee structure toward the development of reclaimed water systems. On the assumption that reclaimed water will represent about 10 percent of the overall water supply (about 7,000 acre-ft) in the county and its cost would be equivalent to surface water (or about $2.65 per 1,000 gal), this means in today's environment the reclaimed water systems could cost approximately $1.8 million annually. Distributed over the entire groundwater permitting fee community, this is about $0.08 per 1,000 gallons. So, the LSGCD could decide to fund all or some portion of that cost through its permit fee system.

The remaining incentives assume that the LSGCD will somehow become a participant in the future water supply solution for Montgomery County and go beyond just the regulatory authority.

The future water supply system in Montgomery County will comprise groundwater, surface water, and reclaimed water systems. Of these, the groundwater and reclaimed water systems will likely remain retail systems with a single provider collecting monthly fees from end user customers. The surface water system will become a wholesale supply system with the provider (LSGCD, SJRA or some other agency) providing treated surface water to the retail providers who in turn will provide non-potable water to its end user customer. But, in any case, there will be a cost associated with each supply component. Moreover, current groundwater users are going to need some form of incentive to transition away from groundwater to either surface water or reclaimed water. This incentive will have to prove at least economically neutral or perhaps economically advantageous to switch to a different source of water supply.

If the current planning for a single Management Zone is implemented, it also means that any fee structure or incentive/disincentive fee structure would likely be applied uniformly across the county. Many communities have HUPs and many of these communities will fall under the regulation of

groundwater just like those communities that don't have an HUP. So potentially, the future fee structure for water supply could include a groundwater pumpage fee, a surface water use fee, a surface water incentive, a groundwater disincentive, a reclaimed water incentive, a lease fee to purchase HUP, and a fee to sell HUP. These fees/incentives would be above and beyond the current permitting fee in place today. Because the LSGCD has a relationship with all of the public water supply systems in the county though its permitting fee program, the LSGCD is in a position to be, as a minimum, the financial administrator of any regional water supply program that might be implemented.

As an example, assume that LSGCD requires all public water supply systems to limit their total groundwater allocation to 70 percent of their total demand. In other words, each community would have to secure 30 percent of their supply from an alternative source. One source could be treated surface water. Another could be a reclaimed water system. Moreover, if one community could actually exceed its 30 percent requirement through reclaimed water or surface water, it could sell credits to another community that chooses not to reduce its dependency on groundwater as a means of complying with the regulation. *Tables 13* through *15* depict several options for implementing economic incentive programs depending on how the future supply for water is actually implemented. *Table 13* assumes that only the users of surface water pay for surface water and only the users for reclaimed water pay for it. *Table 14* assumes the cost of surface water is distributed evenly across the county, even though not all parties will pay for the water, but that reclaimed water is paid for only by those entities using the reclaimed water. *Table 15* assumes that a regional authority pays for both the surface and reclaimed water systems.

Table 13 considers how cost and incentive credits would be applied to a series of communities all of whom use 100 mgy. Different sources of supply are available and each community might consider a different combination of sources to meet the regulatory plan requirement. In this case, it is assumed that surface water users pay for surface water, but that credits are returned by the LSGCD to these users of surface water as an incentive to convert from groundwater. Likewise incentives are provided to communities who use reclaimed water. So, in addition to its current permitting fee, LSGCD would impose a pumpage fee ($0.80 per 1,000 gallons) for groundwater users. LSGCD would then distribute these funds to surface water and reclaimed water users as incentives.

Table 14 assumes that the cost of surface water is distributed across all water users in the county, but the cost of reclaimed water is borne by the users of the reclaimed water. In this scenario, someone (LSGCD) would need to collect sufficient fees from all water users to pay for the surface water system. This would be done in part through collecting one set of fees from surface water users and pumpage fees from groundwater users. A portion of the fees collected could be paid to reclaimed water users as an incentive to offset the higher costs associated with those systems.

If a regional cost approach is taken that shares the cost of water equally across all users, regardless of source, then the cost of reclaimed water as part of the future water supply solution to the county, could be incorporated into the overall water cost (*Table 15*). This solution takes the initial burden of cost off the community seeking to implement the reclaimed water system and shares that cost across other users. Much like the surface water system that has been proposed, specific users gain benefit from actually receiving reclaimed water but others help pay for it for the privilege of staying on groundwater. It assumes that a regional authority (LSGCD) collects fees for and pays for all alternative water sources to groundwater. Since the cost for reclaimed water varies significantly, it is assumed that the cost for reclaimed water and surface water is equivalent and a single water use fee ($1.40 for capital and $0.26 for O&M) would be applied. In this case, it is necessary to have pumpage fee ($0.80 per 1,000 gallons) for groundwater users, but no incentives are provided since the systems are effectively paid for by the regional authority. Should this approach be taken, there is an increased burden on the LSGCD to make sure the reclaimed water system is cost effective and efficient in reducing groundwater demand.

Table 13 - Users of Surface and Reclaimed Water Systems Pay

Assumptions:

Groundwater Production Capital Cost	$0.40	per 1000 g	
Groundwater Production O&M	$0.40	per 1000 g	
Surface Water System Capital Cost	$2.65	per 1000 g	everyone pays
Surface Water System O&M	$0.26	per 1000 g	
Reuse System Capital Cost	$2.65	per 1000 g	
Reuse System O&M	$0.11	per 1000 g	
LSGCD Permitting Fee	$0.06	per 1000 g	
LSGCD Pumpage Fee	$0.80	per 1000 g	
LSGCD Reuse Incentive Credit	$1.10	per 1000 g	
LSGCD Surface Water Incentive	$1.25	per 1000 g	

Note:

1) It is assumed that if a reuse system were to cost more than surface water, people will use surface water. It is possible that reuse water could cost less than surface water, which then provides the initial incentive to reuse water as an
2) Regulation will be based on the percentage of groundwater usage against the total usage. In this model, it is assumed that 70% of the total water usage will be from groundwater. The total usage of ground, surface and reuse water is 100 %
3) For the privilege of using groundwater, LSGCD will require groundwater users to pay a surcharge which will be used to offset the cost of additional water supplies
4) Assume Example Districts all use 100 MGY
5) LSGCD will establish credits for using alternative sources of water
6) Reuse systems, particularly in new developments, initially will not have as much water demand and consequently the unit cost for the reuse system is higher. In existing developments, it is assumed the demand will be available at the outset.
7) In new developments, reuse could reach as much as 12-15% of the demand, whereas in existing systems it is assumed the percentage will be on the order of 7%.
8) In new developments, a blend of sources could be ground and reuse or surface and reuse, but likely not ground and surface and reuse.
9) LSGCD will charge a pumpage fee per 1000 g based on the final determined differential between groundwater and surface water (at this time ($1.40-$0.80-$0.07 = $ 0.80)
10) During the first few years, until demand is available for reuse, the LSCGD will discount the total pumpage by the amount promised for future reuse until such time as that demand is on line.

	New Water District					Existing Water District					
	100% Ground water	100% Surface Water	Blend of water sources (85/0/15)	Blend of water sources (0/85/15)	Blend of water sources (70/0/30)	100% Ground water	100% Surface Water	Blend of water sources (93/0/07)	Blend of water sources (0/93/07)	Blend of sources (70/30/0)	Blend of sources (70/23/7)
Groundwater Usage (MGY)	100	0	85	0	70	100	0	93	0	70	70
Surface Water Usage (MGY)	0	100	0	85	0	0	100	0	93	30	23
Reclaimed Water Usage (MGY)	0	0	15	15	30	0	0	7	7	0	7
LSGCD Permitting Fee	$6,000	$0	$5,100	$0	$4,200	$6,000	$0	$5,580	$0	$4,200	$4,200
Groundwater Capital Cost	$40,000	$0	$34,000	$0	$28,000	$40,000	$0	$37,200	$0	$28,000	$28,000
Groundwater O&M Cost	$40,000	$0	$34,000	$0	$28,000	$40,000	$0	$37,200	$0	$28,000	$28,000
Surface Water Capital Fee	$0	$265,000	$0	$225,250	$0	$0	$265,000	$0	$246,450	$79,500	$60,950
Surface Water O&M Fee	$0	$26,000	$0	$22,100	$0	$0	$26,000	$0	$24,180	$7,800	$5,980
Reuse Capital Cost	$0	$0	$39,750	$39,750	$79,500	$0	$0	$18,550	$18,550	$0	$18,550
Reuse O&M Cost	$0	$0	$1,650	$1,650	$3,300	$0	$0	$770	$770	$0	$770
LSGCD pumpage fee	$80,000	$0	$68,000	$0	$56,000	$80,000	$0	$74,400	$0	$56,000	$56,000
LSGCD reuse incentive credit	$0	$0	($16,500)	($16,500)	($33,000)	$0	$0	($7,700)	($7,700)	$0	($7,700)
LSGCD sw incentive credit	$0	($125,000)	$0	($106,250)	$0	$0	($125,000)	$0	($116,250)	($37,500)	($28,750)
Total Cost to District/ City	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000
Cost of groundwater											
This represents a 60% increase in current production costs											
LSGCD Fee Collected	$86,000	$291,000	$73,100	$247,350	$60,200	$86,000	$291,000	$79,980	$270,630	$147,500	$127,130
LSGCD incentives awarded	$0	($125,000)	($16,500)	($122,750)	($33,000)	$0	($125,000)	($7,700)	($123,950)	($37,500)	($36,450)
Net Fees Collected	$86,000	$166,000	$56,600	$124,600	$27,200	$86,000	$166,000	$72,280	$146,680	$110,000	$90,680

Table 14 - Entire County Pays for Surface and Reclaimed Water Systems

Assumptions:

Groundwater Production Capital Cost	$0.40	per 1000 g		0.7	0.8	0.56	
Groundwater Production O&M	$0.40	per 1000 g		0.1	2.76	0.276	
Surface Water System Capital Cost	$1.40	per 1000 g	everyone pays	0.2	2.76	0.552	
Surface Water System O&M	$0.26	per 1000 g				1.388	cost for water
Reuse System Capital Cost	$2.65	per 1000 g					
Reuse System O&M	$0.11	per 1000 g					
LSGCD Permitting Fee	$0.06	per 1000 g					
LSGCD Pumpage Fee	$0.80	per 1000 g					
LSGCD Reuse Incentive Credit	$1.10	per 1000 g	Assumption 1 : Districts/City				
LSGCD Surface Water Incentive	$0.86	per 1000 g					

Note:

1) It is assumed that if a reuse system were to cost more than surface water, people will use surface water. It is possible that reuse water could cost less than surface water, which then provides the initial incentive to reuse water as an alternative.
2) Regulation will be based on the percentage of groundwater usage against the total usage. In this model, it is assumed that 70% of the total water usage will be from groundwater. The total usage of ground, surface and reuse water is 100 %
3) For the privilege of using groundwater, LSGCD will require groundwater users to pay a surcharge which will be used to offset the cost of additional water supplies
4) Assume Example Districts all use 100 MGY
5) LSGCD will establish credits for using alternative sources of water
6) Reuse systems, particularly in new developments, initially will not have as much water demand and consequently the unit cost for the reuse system is higher. In existing developments, it is assumed the demand will be available at the outset.
7) In new developments, reuse could reach as much as 12-15% of the demand, whereas in existing systems it is assumed the percentage will be on the order of 7%.
8) In new developments, a blend of sources could be ground and reuse or surface and reuse, but likely not ground and surface and reuse.
9) LSGCD will charge a pumpage fee per 1000 g based on the final determined differential between groundwater and surface water (at this time ($1.40-$0.80-$0.07 = $ 0.80)
10) During the first few years, until demand is available for reuse, the LSCGD will discount the total pumpage by the amount promised for future reuse until such time as that demand is on line.

			New Water District					Existing Water District					
			100% Ground water	100% Surface Water	Blend of water sources (85/0/15)	Blend of water sources (0/85/15)	Blend of water sources (70/0/30)	100% Ground water	100% Surface Water	Blend of water sources (93/0/07)	Blend of water sources (0/93/07)	Blend of sources (70/30/0)	Blend of sources (70/23/7)
Groundwater Usage (MGY)			100	0	85	0	70	100	0	93	0	70	70
Surface Water Usage (MGY)			0	100	0	85	0	0	100	0	93	30	23
Reclaimed Water Usage (MGY)			0	0	15	15	30	0	0	7	7	0	7
LSGCD Permitting Fee			$6,000	$0	$5,100	$0	$4,200	$6,000	$0	$5,580	$0	$4,200	$4,200
Groundwater Capital Cost			$40,000	$0	$34,000	$0	$28,000	$40,000	$0	$37,200	$0	$28,000	$28,000
Groundwater O&M Cost			$40,000	$0	$34,000	$0	$28,000	$40,000	$0	$37,200	$0	$28,000	$28,000
LSGCD Surface Water Capital Fee			$0	$140,000	$0	$119,000	$0	$0	$140,000	$0	$130,200	$42,000	$32,200
LSGCD Surface Water O&M Fee			$0	$26,000	$0	$22,100	$0	$0	$26,000	$0	$24,180	$7,800	$5,980
Reuse Capital Cost			$0	$0	$39,750	$39,750	$79,500	$0	$0	$18,550	$18,550	$0	$18,550
Reuse O&M Cost			$0	$0	$1,650	$1,650	$3,300	$0	$0	$770	$770	$0	$770
LSGCD pumpage fee			$80,000	$0	$68,000	$0	$56,000	$80,000	$0	$74,400	$0	$56,000	$56,000
LSGCD incentive credit	1.00		$0	$0	($16,500)	($16,500)	($33,000)	$0	$0	($7,700)	($7,700)	$0	($7,700)
Total Cost to District/ City			$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000
This represents a 60% increase in current production costs													
Fees collected by LSGCD			$80,000	$166,000	$84,500	$157,600	$89,000	$80,000	$166,000	$82,100	$162,080	$105,800	$101,880
Average													$115,905

Table 15 - Regional Water Authority Pays for Surface and Reclaimed Water Systems

Assumptions:

Groundwater Production Capital Cost	$0.40	per 1000 g		0.7	0.8	0.56
Groundwater Production O&M	$0.40	per 1000 g		0.1	2.76	0.276
LSGCD Alternaitve Source Capital Cost	$1.40	per 1000 g	everyone pays	0.2	2.76	0.552
LSGCD Alternative Water System O&M	$0.26	per 1000 g				1.388 cost for water
LSGCD Permitting Fee	$0.06	per 1000 g				
LSGCD Pumpage Fee	$0.80	per 1000 g				
LSGCD Reuse Incentive Credit	$0.00	per 1000 g				

Assumption 1 : Districts/City

Note:

1) It is assumed that if a reuse system were to cost more than surface water, people will use surface water. It is possible that reuse water could cost less than surface water, which then provides the initial incentive to reuse water as an alternative.
2) Regulation will be based on the percentage of groundwater usage against the total usage. In this model, it is assumed that 70% of the total water usage will be from groundwater. The total usage of ground, surface and reuse water is 100%
3) For the privilege of using groundwater, LSGCD will require groundwater users to pay a surcharge which will be used to offset the cost of additional water supplies
4) Assume Example Districts all use 100 MGY
5) LSGCD will establish credits for using alternative sources of water
6) Reuse systems, particularly in new developments, initially will not have as much water demand and consequently the unit cost for the reuse system is higher. In existing developments, it is assumed the demand will be available at the outset.
7) In new developments, reuse could reach as much as 12-15% of the demand, whereas in existing systems it is assumed the percentage will be on the order of 7%.
8) In new developments, a blend of sources could be ground and reuse or surface and reuse, but likely not ground and surface and reuse.
9) LSGCD will charge a pumpage fee per 1000 g based on the final determined differential between groundwater and surface water (at this time ($1.40-$0.80-$0.07 = $ 0.80)
10) During the first few years, until demand is available for reuse, the LSCGD will discount the total pumpage by the amount promised for future reuse until such time as that demand is on line.

			New Water District					Existing Water District					
			100% Ground water	100% Surface Water	Blend of water sources (85/0/15)	Blend of water sources (0/85/15)	Blend of water sources (70/0/30)	100% Ground water	100% Surface Water	Blend of water sources (93/0/07)	Blend of water sources (0/93/07)	Blend of sources (70/30/0)	Blend of sources (70/23/7)
Groundwater Usage (MGY)			100	0	85	0	70	100	0	93	0	70	70
Surface Water Usage (MGY)			0	100	0	85	0	0	100	0	93	30	23
Reclaimed Water Usage (MGY)			0	0	15	15	30	0	0	7	7	0	7
LSGCD Permitting Fee			$6,000	$0	$5,100	$0	$4,200	$6,000	$0	$5,580	$0	$4,200	$4,200
Groundwater Capital Cost			$40,000	$0	$34,000	$0	$28,000	$40,000	$0	$37,200	$0	$28,000	$28,000
Groundwater O&M Cost			$40,000	$0	$34,000	$0	$28,000	$40,000	$0	$37,200	$0	$28,000	$28,000
LSGCD Water Use Fee			$0	$140,000	$21,000	$140,000	$42,000	$0	$140,000	$9,800	$140,000	$42,000	$42,000
LSGCD Water O&M Fee			$0	$26,000	$3,900	$26,000	$7,800	$0	$26,000	$1,820	$26,000	$7,800	$7,800
Reuse Capital Cost			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reuse O&M Cost			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
LSGCD pumpage fee			$80,000	$0	$161,500	$0	$56,000	$80,000		$74,400	$0	$56,000	$56,000
LSGCD incentive credit	1.00		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Cost to District/City			$166,000	$166,000	$259,500	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000
This represents a 60% increase in current production costs													
Fees collected by LSGCD			$80,000	$166,000	$186,400	$166,000	$105,800	$80,000	$166,000	$86,020	$166,000	$105,800	$105,800
Average													$128,529

As stated previously, the driving motivation for reclaimed water systems will be economics. If a reclaimed water system can be implemented at lower cost than a surface water supply system, a community will likely give consideration to its implementation. If the cost is higher, then the community will choose for the surface water approach. However, should the LSGCD want to promote reclaimed water, it could provide a credit system greater than 1:1. For example, if a 1.5:1 credit system were implemented, a community would only need to provide 20 percent of its water through reclaimed systems to achieve a requirement of 30 percent supply from alternative sources.

In either case, the LSGCD must anticipate that its fee structure would pay not only for the surface water system but the reclaimed water system also. Since the assumption is that the unit cost for reclaimed water will be no more than that of surface water, this means a reduced demand on surface water that is compensated for by reclaimed water. If a total of 30 percent reduction in groundwater is desired, then 20 percent of it could be from surface water and 10 percent (a reasonable compromise between 7 percent for existing communities and 15 percent for newly developed communities) from reclaimed water. The net cost of the surface water system is lowered somewhat, but is offset by the cost of the reclaimed water systems.

The forgoing discussion has demonstrated the complexity of the issues facing the LSGCD Board and staff as they look at the options for conversion from groundwater and attempt to consider the implementation of reclaimed water to supplant water from the potable supply for non-potable uses. The discussion above is highly technical and takes a considerable amount of time to digest and apply. For this reason, it is recommended that at least one and possibly a series of interactive workshop be considered at various locations throughout the LSGCD regulatory area to present the results of the latest cost estimates for surface water, to present the basic framework and the options for “leveling” the cost of water whether groundwater or surface water and to discuss the potential support for reuse systems that could be applied to stimulate construction of reuse systems to reduce the demand on the groundwater aquifers.

Conclusion and Recommendations

Currently, there are 106 individual WWTP permits issued with a total permitted discharge of 6.5 BGY or 20,100 acre-feet annually. The effluent permit limits for these WWTPs at a minimum meet the Type II reuse criteria for water quality. There are approximately 230 groundwater well permits that either list irrigation as a water use or irrigate from the potable water system. The practical application of reuse for year 2005 is approximately 1.6 BGY or 5,000 acre-feet annually, which represents approximately 7 percent of the year 2005 water demand. Therefore, the amount of reuse in Montgomery County to meet non-potable demands is demand limited.

The geographic areas of Montgomery County that offer the greatest opportunity for water reuse as a mechanism to reduce groundwater pumpage for non-potable uses were identified as southern Montgomery County near the Woodlands and areas near Lake Conroe, particularly along the western shoreline of the lake.

The volume of potential demand for reuse along with the overall goals for reduced groundwater pumpage in Montgomery County make a reuse program a viable alternative to delaying the need for surface water conversion. The full utilization of potential reuse demands (ignoring all questionnaires responses) could delay the need for the surface water conversion infrastructure by up to 5 years. It should be noted that questionnaire responses came prior to widespread realization of the need for surface water conversion with its associated increased costs.

Effluent can effectively be reused to reduce pumpage in the district if the following conditions are met.

- Appropriate incentives are offered
- Groundwater pumpers participate in the program
- Identified estimated available reuse demand is converted to reuse.

The primary incentive to use reclaimed water is economics. However, moral and social incentives may provide further incentive to participate in getting current groundwater users to convert to effluent reuse. Economic incentives include:

- LSGCD cooperation with one or more local communities to secure TWDB or US Environmental Protection Agency grants. LSGCD could also participate in funding the planning activity if it deems the application will benefit its overall purpose.
- LSGCD could help a community achieve a more favorable bond rating due to the security of groundwater pumpage fees collected by the District. The downside to this option is LSGCD's obligation against any debt that is incurred.
- LSGCD could adopt a disincentive fee structure that penalizes communities that overpump and do not adhere to the regulations. Funds accrued under this program could be used to fund candidate projects in reuse that are deemed practical, cost-effective, and achieve the goal of reducing groundwater pumpage.
- LSGCD could dedicate a portion of its permitting fee structure toward the development of reclaimed water systems.
- Other incentives that assume LSGCD will go beyond its role as a regulatory authority and somehow become a participant in the future water supply solution for Montgomery County. These incentives can consider a mix of reclaimed water and surface water use and will have to provide, at a minimum, economically neutral options for a groundwater user to switch to an alternative supply.

Future studies which would need to be performed to determine the most feasible economic incentives for both the LSGCD and the groundwater users in Montgomery County could include:

- Using the GAM to determine economic impacts as a result of the increase in drawdown as a result of over pumpage of the aquifer.
- Conduct a study to determine the financial savings associated with the surface water conversion infrastructure as a result of the delay and/or reduced capacity as a result of reuse. This study would be performed after the costs associated with the surface water conversion are complete and the facility planning documents identify the size and locations of the surface water conversion infrastructure.

In addition to the studies noted above, one or more workshops will be needed in the LSGCD area to provide an opportunity to educate the public and the water purveyors concerning the issues noted above. This workshop or series of workshops should include a facilitator as well as materials suitable for distribution to the general public to provide education on the alternatives as well as on the potential support that could be provided to spur growth in the reuse area. Once the alternative and competing mechanisms are understood, it will be possible for people to make informed decisions about reclaimed water projects and whether or not it makes sense to implement them locally.

Reclaimed water in Montgomery County is a viable alternative to reducing groundwater pumpage within the jurisdiction of Lone Star Groundwater Conservation District.

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Lone Star GCD Effluent Reuse Study

Exhibits

(See Separate pdf document)

Appendices

Appendix A

WWTP Effluent Discharge Limits

(not contained within this pdf)

Appendix B

Scope of Work

Appendix B – Scope of Work

An analysis was performed to determine the ability for effluent reuse to be implemented as a strategy within Montgomery County to reduce current and future groundwater pumpage. As part of the existing effluent reuse potential evaluation, the following tasks were conducted:

Identify Existing Conditions

1. Quantified the extent to which reclaimed water is currently being used in Montgomery County for irrigation or industrial use.

    a) Searched TCEQ records to establish which WWTP plants have Chapter 210 reuse authorizations, and determined reuse as a percentage of ADF.

    b) Searched TWDB data for reuse project information and usage reported.

    c) Developed Reuse Questionnaire and evaluated responses.

2. Identified potential opportunities to use reclaimed water productively for irrigation and other non-potable use which would result in reduced groundwater demand.

    a) Collected and reviewed other effluent reuse studies being performed in the region.

    b) Based on review of collected studies, developed a summary of planning parameters to be used for developing information for purposes of this study. Planning parameters may include the following:

        i) Minimum effluent flow as a function of permitted capacity and/or observed flows.

        ii) Golf course irrigation demands as a function of total golf course acreage or other planning metric (e.g., population).

        iii) Irrigation demands from residential developments (i.e., esplanades, parks, and other public spaces) as a function of total development acreage, per capita, or other planning metric.

        iv) Amenity pond maintenance demand as a function of pond acreage or other planning metric.

Quantify Reuse Potential

1. Identified and quantified potential effluent reuse opportunities in the LSGCD for existing development projects.

    a) Identified the location and capacity of wastewater plants in the area, including geographic location of outfall, monthly flow records, and effluent criteria as is typically reported to TCEQ.

    b) Identified the location and demand of prospective points of application.

    c) Matched potential opportunities for wastewater effluent resource to the prospective points of application.

    d) Estimated the total volume of water savings that could be achieved through the implementation of reuse programs.

    e) Quantified the savings in terms of gallons per capita or connection and type of user.

2. Considered how incentives can be used to promote reclaimed water and water reuse in developing the Groundwater Regulatory Plan.

    a) Identified the extent to which water reuse can defer any timelines for wholesale surface water supply.

    b) Identified geographic areas within the county that offer the best opportunity for water reuse as a primary strategy for meeting groundwater use goals.

    c) Discussed options on how reuse as a quantitative value can be used as an incentive in creating rules for a regulatory program.

Maximizing Reuse Potential

1. Provided options for the LSGCD to participate in potential projects.

    a) Discussed potential roles for LSGCD in actual water reuse programs, ranging from incentives to grants and loans.

    b) Identified what changes would be necessary in the current rules to allow the LSGCD to undertake such roles.

    c) Developed an understanding of potential issues and constraints, as well as possible advantages, in developing effluent reuse projects in the county.

    d) Identified potential regulatory, technical, and administrative issues and constraints in developing effluent reuse projects in the county or under the auspices of the LSGCD. Issues to be considered could include:

        i) Reuse on individual lots

        ii) Water quality issues.

        iii) Development and perception issues.

        iv) Incentives to promote effluent reuse.

        v) Retrofit versus new development opportunities.

    e) Identified and quantified, where applicable, possible advantages in the development of effluent reuse projects in the county and within the auspices of the LSGCD. Advantages to be considered could include:

        i) Future reductions in required alternative water demands.

        ii) Impacts to alternative water supply systems (plants and distribution) as a result of regional effluent reuse initiatives.

        iii) Possible cost avoidance and/or delay in alternative water conveyance facilities.

    f) Developed recommendations for future effluent reuse initiatives and/or additional studies for the LSGCD.

Appendix C

Water Reuse Questionnaire

Appendix C – Water Reuse Questionnaire

The questionnaire sent to all water purveyors and WWTP operators within the LSGCD jurisdiction boundaries included the following questions:

1. In 2005, what was your estimated total water pumpage (in gallons)?

2. What volume or percentage of the total 2005 water pumpage was used to irrigate amenity type area (i.e., green spaces, golf courses, make-up water for lakes, etc.)?

3. At the beginning of 2005, what was the approximate number of connections?

    i. Residential

    ii. Other

4. At the end of 2005, what was the approximate number of connections?

    i. Residential?

    ii. Other?

5. Do you currently operate a wastewater treatment plant? (yes or no)

6. If yes, what is the permitted discharge of the plant and what was the total discharge in 2005 (mgd)?

    i. Permitted?

    ii. 2005 Actual?

7. If yes, does your discharge permit (or a separate 210 authorization) provide for the diversion of effluent for irrigation or other purposes?

8. Do you currently employ treated wastewater effluent for irrigation or other purposes? If so, can you describe the activity (who uses the water, how is it used) and the approximate volume of water reuse used (gallons per day)?

9. Have you previously evaluated the opportunity to use water reuse?

10. If so, what was the outcome of the study effort and what are the reasons that the program was not implemented?

11. Are you currently planning to explore water reuse as a conservation measure in the next two years? If so, can you describe the activity?

Appendix D

White Paper

Lone Star Groundwater Conservation District
White Paper on Issues of Wastewater Reuse

Introduction

At the regular Board meeting on February 13, 2007, the Lone Star Board of Directors heard a summary of the reuse study that was commissioned by the Board. Copies of the draft were provided to each Board member and a brief presentation of the report was made. In the course of discussion it was requested that TCB be more specific in terms of recommending the form of incentives to encourage new and existing developments to implement water reuse that should be adopted by the LSGCD Board rather than just specifying options. As a result of this discussion, the Board directed TCB staff to come back with recommendations on this subject at the next Board meeting. This white paper is intended to fulfill that request.

Background

The purpose of the LSGCD is to provide for the conservation, preservation, protection, recharging, and prevention of waste of ground-water, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI, Texas Constitution,

According to TWDB estimates, Montgomery County has a limited supply of groundwater that can be produced for use, and studies have shown that the amount that can be reliably produced on an annual basis is approximately 64,000 acre-feet. In December 2006, the LSGCD established Phase I of its District Regulatory Program (DRP). The DRP establishes January 1, 2015 as a date whereby the sum total of all groundwater permits issued within the county will be limited to a maximum of 64,000 acre feet annually. It is anticipated that the total water demand in the county will exceed 100,000 acre-ft by the date the regulation is enforced. Phase I also established a single Management Zone that encompasses the entire county, thereby requiring all permitted users to comply with the regulation. Phase II of the DRP, which will establish the rules for complying with the DRP, will be issued not later than July 1, 2008.

Three methods of augmenting the groundwater consumption are anticipated in order to meet the total water needs while complying with the regulation: water conservation; surface water; and water reuse.

Wastewater Reuse Incentives

Water reuse is an effective method of reducing the dependency on groundwater provided that the reuse application is intended to replace a current or projected use of groundwater and is not merely an additional application of water demand. Incentives discussed in the

current report range from crediting reuse towards regulatory compliance to providing various methods of financial support to a public water supply entity who is actually implementing a reuse system.

Groundwater credits work on the basis that for every gallon of reuse water used, an equal amount, or even a multiple of equal amount, is credited towards the amount of groundwater reduction. As an example, assume a water district uses 100 million gallons of water annually and they pay the LSGCD a groundwater pumpage fee of $1 per 1000 gallons. This would mean the water district pays LSGCD $100,000 annually. If the water district reduces its dependency on groundwater by providing 20 million gallons of reuse and only uses 80 million gallons of groundwater then, in a 1 for 1 credit, they would only pay LSGCD $80,000. But, if the LSGCD opted to provide say a 1:5 to 1 credit, then the reuse would count as if it were providing 30 million gallons and only 70 million gallons of groundwater were used (even though in reality 80 million gallons would be used). Under this option, the water district would only pay the LSGCD $70,000.

While the reuse program will be an important component of the overall strategy for complying with the DRP it is still our opinion that surface water will be the predominant portion of the solution. It is important to note that the LSGCD is the "Regulatory Authority" to implement the groundwater management program. It has not yet been determined if, or to what extent, the LSGCD may also play a role in helping implement the overall solution. It would be inappropriate therefore to assume the LSGCD should financially support implementation of a reuse program beyond the credits it can provide through reduced pumpage fees.

Comparison to Other Areas

A suggestion was made at the Board meeting that the experience of other areas be adopted without further study to spur the installation of reuse systems during this interim period. As a result of that suggestion, the programs established by both the Harris-Galveston Subsidence District (HGSD) and the Fort Bend Subsidence District (FBSD) were reviewed. The programs of the HGSD are mature at this time, with Areas 1 and 2 being fully converted and attention being currently focused on Area 3 which shares a common border with Montgomery County. Effluent reuse projects are given a 1 to 1 credit, with each gallon of reuse that is accomplished being credited as water provided from an alternative source and counting against the conversion requirements in 2010, as well as in 2020 and 2030. The regulatory requirements set up by the HGSD were based primarily on the prevention of subsidence issues. The Gulf Coast aquifer is configured such that even though the static and pumping water levels in the wells were dropping, there was still water available in the aquifer for the users who needed it. Cost of production was higher, but no areas were being left without usable groundwater. For this reason, there was an ability on the part of the HGSD to allow some variations in the conversion requirements by accumulation of credits and other methods to delay the implementation of surface water conversion.

Similarly, the FBSD is dealing with issues similar to the HGSD. There is a considerable amount of water in storage to meet the needs of the various users that can be managed over time to reduce the demand on the aquifer and allow the controls built in for subsidence to work. The FBSD is currently providing an incentive to its water users by allowing a 1.5 to 1 credit for effluent reuse, meaning that one gallon of effluent reuse is equivalent to 1.5 gallons of groundwater use in analyzing the condition of compliance for the FBSD's regulated entities. In addition, The North Fort Bend Water Authority has completed a study of their own, and is offering credits of $.39 per 1000 gallons to provide a further incentive, based on their studies of their own area of influence which is much less diverse in usage and smaller in size than Montgomery County. The calculation of the credit is based on the ability to push surface water conversion further into the future and achieving reduced costs both in the sizing and the timing of the surface water lines when they are installed.

In each of the cases noted above the primary concern is subsidence as opposed to water availability because the aquifer extends well to the north of the Fort Bend, Harris and Galveston County areas. There is a significant amount of water in storage to make sure that existing communities on groundwater will have available supply as the subsidence regulations are implemented. Delays of 1 to 5 years even would not severely hinder the accomplishment of the aims of these subsidence districts. However, Montgomery County is on the upper extent of the Gulf Coast Aquifer, with lesser amounts of saturated thickness and generally more variability in pore size and transmissivities. As a result, the overriding concern in Montgomery County is to reduce the total pumpage to the amount available as quickly as possible. In this instance, 2015 was chosen as the first conversion date based solely on how quickly a surface water system could be implemented. If it were possible to accomplish the conversion sooner than that, it would be beneficial to do so. For this reason, there are no cost savings to be calculated from delaying the implementation of the surface water system. The only possible benefit from encouraging effluent reuse is from the standpoint of sizing the surface water lines that are being investigated now.

Incentives

As a result of the preceding analysis and issues explored, TCB is recommending to the LSGCD Board of Directors the adoption of incentives with very specific requirements that must be met in order to make them effective for Montgomery County. These incentives will be in two tiers, with Tier 1 being the most time restrictive and Tier 2 incentives being available throughout the groundwater reduction process.

Tier 1 incentives will be the use of a conversion credit of 1.5 gallons of credit per gallon of wastewater reuse if the following conditions are met:

1. The reuse project contemplated must have a plan submitted to the LSGCD no later than January 1, 2008. In addition, the project must be implemented no later than January 1, 2010. These dates must be met in order to effect a

meaningful change in the size of the surface water system in order to justify the incentive credit.

2. This plan must include an overall description of the project, including the fact that it is water that would have otherwise been used from the potable ground water supply
3. The project must be located in the service area that is finally determined as part of the 2015 conversion requirements.
4. The applicant must provide assurance that the project will continue to be operated throughout the life of the surface water conversion system.
5. If the project is not operated for any period during the life of the surface water conversion system, the applicant must agree to pay a pumpage fee and/or any disincentive fees for the water that was otherwise to have been provided.

Tier 2 incentives will be on a 1 to 1 basis for all projects that are initiated after January 1, 2008. All projects will be on a stand alone basis, and no further monetary incentive will be provided at this time. As further information is developed, decisions are made, and costs are better refined, then this issue may be reopened and examined to determine if further incentives are warranted.

Conclusions

The studies that have been done to date indicate that conservation and reuse alone are not sufficient to achieve the 30 percent conversion from local groundwater supplies required in 2015. Wastewater effluent reuse has been demonstrated to be a viable alternative for meeting some of the conversion demand. While all of the factors are not yet fully known, there is a compelling need to establish an incentive immediately in order for it to be included in planning for the first phase of surface water conversion in order to impact the size of the facilities. There is only a narrow window of opportunity to reduce sizes of the first phase of surface water conversion, with that window closing on January 1, 2008. For that reason, an incentive credit of 1.5 gallons for each gallon of wastewater reuse to reduce existing potable ground water demand is recommended to the Board of Directors of the LSGCD. Credits after January 1, 2008 for both existing systems and those systems to be constructed in the future are recommended at a 1 for 1 basis.