Final Report

PARKS RECLAIMED WATER IRRIGATION FEASIBILITY STUDY

City of New Braunfels

July 2011

08012.03

City of New Braunfels
Parks Reclaimed Water Irrigation Feasibility Study

City of New Braunfels

STATE OF TEXAS
STEPHEN M. JENKINS
52552
REGISTERED PROFESSIONAL ENGINEER

Submitted By:

Espey Consultants, Inc.
2777 N. Stemmons Freeway, Suite 1102
Dallas, Texas 75207
Firm No. F-293

T (214) 951-0807
F (214) 951-0906

www.espeyconsultants.com

EC Project No. 08012.03

July 2011

Espey Consultants, Inc.
Environmental & Engineering Services

City of New Braunfels
Parks Reclaimed Water Irrigation Feasibility Study

Table of Contents

P:\active\08012.03_Parks_Water_FS\REPORT\FINAL REPORT\FINAL REPORT 07 15 11.doc

APPENDICES

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations and Acronyms

AF, ac-ft …………… Acre-Feet
AFY………………….Acre-Feet per Year
BFE………………… Base Flood Elevation
BOD_5……………….. Biochemical Oxygen Demand
$CBOD_5$……….……. Carbonaceous Biochemical Oxygen Demand
CFU………………… Colony Forming Units
CIP ……………..…… Capital Improvements Plan
City ………………… City of New Braunfels
COD ………..……...Chemical Oxygen Demand
EAA…………..…… Edwards Aquifer Authority
EARZ……………… Edwards Aquifer Recharge Zone
ET………………….. Evapotranspiration
FEMA……….……… Federal Emergency Management Agency
GBRA……..……... Guadalupe-Blanco River Authority
gpm………..…….. Gallons per Minute
HGL……….……... Hydraulic Grade Line
HP ………….……… Horsepower
IH…………….……… Interstate Highway
in ………….……… Inches
kgal ………….………Thousand Gallons
kwh……..……... Kilowatt Hours
LF………………….. Linear Feet
MGD……….……… Million Gallons per Day
mg/l ……….……... Milligrams per Liter
ml ……….………... Milliliter
NBU……….……… New Braunfels Utilities
NPDES…………….. National Pollutant Discharge Elimination System
NTU……….……... Nephelometric Turbidity Units
NWI……….……… National Wetlands Inventory
O&M……………….. Operations and Maintenance
PARD……..……... Parks and Recreation Department
PCN……….……... Pre-Construction Notification
PARD……….………. City of New Braunfels Parks and Recreation Department
POTW……..……... Publicly Owned Treatment Works
RC ……….………… Rainfall Credit
RWPF……….……… Reclaimed Water Production Facility
SCTRWPG……….… South Central Texas Regional Water Planning Group
TAC ……….……….. Texas Administrative Code
TCEQ……….……… Texas Commission on Environmental Quality
TPDES ……….…… .Texas Pollutant Discharge Elimination System
TPWD……….…... Texas Parks & Wildlife Department
TWDB……….…….. Texas Water Development Board
TSS ……….……….. Total Suspended Solids
TxDOT……….…… Texas Department of Transportation
USACE…………….. U.S. Army Corps of Engineers
USFWS……..…… U.S. Fish and Wildlife Service
WWTP……….…….. Wastewater Treatment Plant

THIS PAGE INTENTIONALLY LEFT BLANK

City of New Braunfels
Parks Reclaimed Water Irrigation
Feasibility Study

Executive Summary

The City of New Braunfels, in cooperation with New Braunfels Utilities (NBU), Guadalupe-Blanco River Authority (GBRA), and Edwards Aquifer Authority (EAA), acquired the services of Espey Consultants, Inc. (EC) to evaluate the feasibility of providing reclaimed water for irrigation of a major portion of the city's parks. The purpose of developing a reclaimed water system is to enhance the regional and local appeal of the city's parklands and to preserve limited water resources to serve a growing population. This study addressed direct reuse of wastewater effluent for a single user and does not analyze potential retail uses of reclaimed water other than park irrigation.

Of the city's total park area of 513.9 acres, the feasibility study examined a total of 172.8 acres of parkland that is presently irrigated, or will be irrigated in the future, located in Landa Park, Hinman Island, Prince Solms Park, Camp Comal, Fischer Park, HEB Soccer Complex, Walnut Avenue, Fredericksburg Fields, and a portion of the Landa Golf Course. This study addresses a set of key questions to indicate the extent to which a reclaimed water system is feasible:

1. How much water is needed for the city's parks?

Irrigation demands were developed using an evapotranspiration (ET) rate and three different methods for accounting for average annual rainfall. The irrigation demands assumed conditions of full average annual rainfall (100% rainfall credit), half the average annual rainfall (50% rainfall credit) and drought conditions (0% rainfall credit). The total annual irrigation demand is 147.2 MG for the 100% rainfall credit condition, 221.1 MG for the 50% rainfall credit condition, and 295 MG for the 0% rainfall credit condition.

Based on the information developed for this study, it is recommended that a reclaimed water system should be designed to meet the peak demand during drought conditions. This design criterion would provide a system capacity that will not only supply reclaimed water for optimal irrigation of the city's parks included in this study, but will also provide the ability to irrigate the Landa Golf Course at reduced irrigation rates during extreme drought conditions when water rights from the Comal River are not available.

2. How much water is available for reuse?

The maximum reclaimed water demand of 295 MG/yr. represents approximately 15 percent of the combined effluent of the three NBU WWTPs during the period of August

2009 through July 2010. Of the three wastewater treatment plants operated by NBU, the North and South Kuehler WWTPs each produce sufficient volumes of high quality effluent to meet the peak day demand for reclaimed water. With its present flow, the Gruene WWTP alone can not meet the projected peak day demand. The study reveals that either the North Kuehler or South Kuehler WWTP produce effluent volumes that will meet the reclaimed water demand of the city's parks. Based on the accessibility to the plant effluent, it was determined that the South Kuehler WWTP is most suited as the source of supply for reclaimed water.

3. What are the environmental considerations for reclaimed water?

Sensitive environmental features of the study area include the Edwards Aquifer Recharge Zone and Comal Springs. None of the area considered for irrigation with reclaimed water is located on the Recharge Zone. Discharge of reclaimed water to the Comal Springs or to any watercourse is prohibited by state regulation and safeguards will be part of any standard operating procedures for irrigation with reclaimed water.

Potential environmental benefits derived from irrigating parks with reclaimed water were also identified. The potential environmental benefits include:

- Reduced nutrient load in wastewater effluent, especially during summer months – diverting wastewater effluent to park irrigation will remove approximately 25 pounds of phosphorus from the wastewater plant effluent for each million gallons of reclaimed water.
- Reduced demand on the Edwards Aquifer during summer months.
- Irrigation of turf grass to provide vegetative buffers along the Comal River that will reduce sediment load and other contaminants in urban runoff.

4. What are the options for delivering reclaimed water?

Possible sources of reclaimed water supply include reclaimed water production facilities (RWPF), Gruene WWTP effluent, North Kuehler WWTP effluent, and South Kuehler WWTP effluent. RWPF (also known as satellite treatment plants) significantly reduce the construction of reclaimed water transmission pipelines, but require dedication of valuable park space for the facility and will also increase the concentration of BOD_5 and TSS at the NBU WWTP. A total of six alternatives were developed that use wastewater effluent from NBU's wastewater treatment plants. Evaluation of the cost and constructability of the alternatives revealed that Alternative 1: South Trib – Walnut Ave. is the lowest cost and least disruptive alternative.

The provision of storage for reclaimed water allows the supply and demand to be balanced, which minimizes transmission pipeline diameters and allows for an efficient pumping regime. Potential storage tank locations on public land were identified for both above-ground and underground ground storage tanks. Construction of underground storage provides a greater range of locations, but increases project costs by as much as 14% over the cost of using above-ground welded steel storage tanks.

5. What will it cost to build a reclaimed water system?

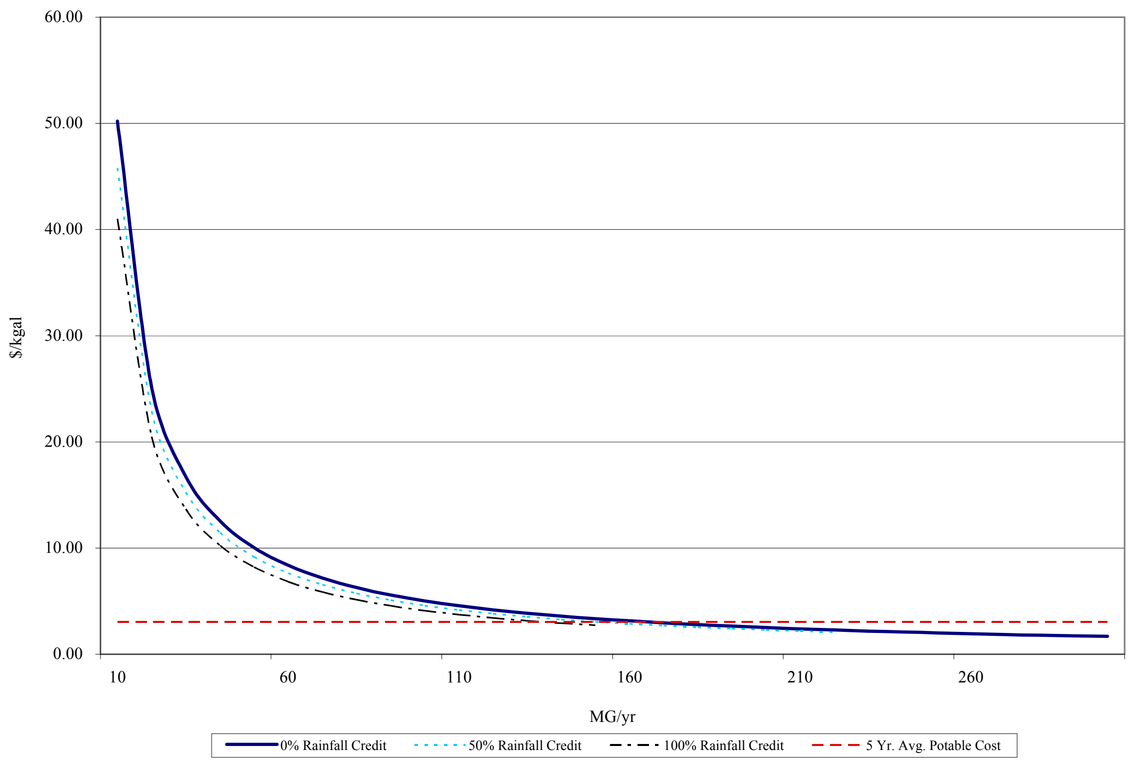
The probable project costs for Alternative 1: South Trib – Walnut Ave. is approximately $4.9 million for the highest capacity system (0% rainfall credit) and $4.5 million for the minimum capacity system (100% rainfall credit).

6. What will the water cost?

As a basis for comparison, the cost of potable water used for park irrigation for the years 2005 – 2009 was calculated using NBU's Irrigation/Landscape water rates in effect since 2007. It was determined that the average unit price for water for the five year period was $3.05/1,000 gallons.

Recognizing that with economies of scale, the average cost per unit ($ per thousand gallons) is reduced through increased production since fixed costs are shared over the increased volume of reclaimed water. As illustrated in Figure ES-1, the unit price of water declines as production approaches the design capacity of the system. Each curve in the graph represents the cost of reclaimed water production for a system capacity determined three assumptions of reclaimed water demand and includes capital and O&M costs.

Figure ES-1: Reclaimed Water Unit Cost



Based on the Alternative 1 system configuration (see Sec. 7.2.1), the cost of reclaimed water reaches the average cost of potable water ($3.05) as production reaches a volume of about 165 MG per year and a unit cost of $1.70 at full production of 295 MG per year. The actual pricing of reclaimed water, however, may include consideration of a variety of offsetting benefits of implementing a reclaimed water system as well as the costs. Potential benefits were found to include:

- Reduced demand on the Edwards Aquifer, particularly during the summer months
- Reduced nutrient load discharged by the WWTP to the Guadalupe River
- Preservation of turf grasses and shrubs in city parks
- Reduced sediment load to the Comal and Guadalupe Rivers

It should be noted that pricing of reclaimed water could be structured in a way that relates the cost of the commodity to the cost of potable water. For example, the price for reclaimed water provided by NBU to the Sundance Property Owners Association is, by contract, set to increase in 2012 to 75% from 50% of the Small Commercial Rate.

7. What are the options for funding, designing, building and operating a reclaimed water system to irrigate the city's parks?

As described in the implementation strategy developed as part of this study, the administrative framework of a reclaimed water system must be negotiated between the City of New Braunfels and NBU. In general, a reclaimed water system could be developed as a city-owned project, financed using general obligation bonds, or as a utility project financed with revenue bonds.

When considering questions regarding system ownership, management, and operation, there is a need to consider the underlying value of the public benefit afforded customers of both the City of New Braunfels and NBU. As a possible benefit to taxpayers by providing improved recreational facilities and its value as a water resource management strategy to utility customers, implementation of a reclaimed water system can be viewed as a community asset regardless of its organizational placement.

Summary

Increasing public use of the city's parks resulting from population growth and tourism, combined with recurring drought conditions produce conditions that stress the turf grasses and vegetation that also ultimately increase erosion. Irrigation of the city's parks enhances the public's experience in the parks by providing a durable and aesthetically pleasing environment. However, potable water for landscape and park irrigation will be interrupted during drought conditions. Reclaimed water provides a drought proof alternative to potable water that does not increase demand on the Edwards Aquifer or on the Guadalupe River.

Analysis of the various alternatives for delivering reclaimed water to the city's parks revealed that the lowest cost and least disruptive alternative is transporting effluent from the South Kuehler WWTP using the Alternative 1: South Trib – Walnut Ave. route. A comparison of the unit costs of reclaimed water resulting from three rainfall criteria reveal that capital and operational costs become less significant as the volume of reclaimed water increases. Applying the condition of zero credit for average annual rainfall in calculating the demand for reclaimed water provides the best opportunity to sustain the community's investment in public parks even during drought conditions. The projected probable construction cost of Alternative 1 under that condition is approximately $4.9 million. The annual cost of operation reaches the current average rate for potable water of $3.05/1,000 gal. as park irrigation approaches 165 MG per year.

The economic benefits of park irrigation using reclaimed water are relatively difficult to quantify due in large part to the assumed uninterrupted availability of potable water for irrigation. This assumption presents a set of economic advantages of potable water irrigation that do not exist in conditions where landscape irrigation, including parks, is restricted or eliminated in an effort to conserve limited potable supplies. As drought conditions increase, outdoor uses of potable water are reduced by ordinance. This reduction can reduce the cost of irrigation, but can increase the costs of replacing park vegetation and restoring damage resulting from the interruption of park irrigation. An economic analysis compared the net present value of potable water irrigation of the city's parks versus reclaimed water revealed that the net present value of reclaimed water maintains a distinct advantage over potable water irrigation. This advantage becomes more pronounced as drought conditions intensify.

THIS PAGE INTENTIONALLY LEFT BLANK

1 Introduction

The City of New Braunfels (the "City") received a Regional Water and Wastewater Planning Grant from the Texas Water Development Board (TWDB) to aid in evaluating the feasibility of developing a reclaimed water system to supply irrigation water for the city's parks. Reclaimed (or reuse) water is municipal wastewater that has been treated to a quality that is suitable for beneficial uses that include irrigation of landscaping, crops, and athletic fields. Reclaimed water is recognized in the South Central Texas Water Plan as a viable water supply alternative for meeting the region's growth. This study was prepared by Espey Consultants, Inc. (EC) to provide a detailed technical analysis of the potential for developing reclaimed water as an alternative supply source for irrigation of the city's parks.

Joining the City in conducting the feasibility study were New Braunfels Utilities (NBU), Guadalupe-Blanco River Authority (GBRA), and the Edwards Aquifer Authority (EAA). Unlike other feasibility studies that incorporate an analysis of the potential for marketing reclaimed water for anticipated uses, this study addresses the feasibility of developing a single user system. The irrigated area of the city's primary parklands provided the basis for determining the capacity of a reclaimed water system.

1.1 Background and Purpose

The City of New Braunfels is located in Comal County, Texas, north of San Antonio and south of Austin along IH 35 and at the confluence of the Comal and Guadalupe Rivers. The City encompasses a total of 29.2 square miles and has a current population of approximately 57,740 according to the 2010 Census. The city includes a broad range of single-family housing, apartments, and condominiums for both permanent residents and seasonal visitors from around the state and nation.

New Braunfels Utilities (NBU) has a diversified approach in supplying water to the New Braunfels service area. NBU owns and operates a surface water treatment plant and several groundwater wells that pump from the Edwards Aquifer. Most of the City's consumption of potable water occurs during the summer months for irrigation of city parks. Because of the growing demands on the Edwards Aquifer and surface water supplies in the region, the NBU water conservation plan calls for curtailment of outdoor irrigation in response to the recurring drought periods common in South Central Texas. Replacement of parks irrigation with reclaimed water can allow the City to maintain the landscaping and turf grasses in the public parks even during periods of drought in order to meet the recreational needs of a growing resident and visitor population.

In a continuing effort to meet the recreational needs of the city's growing population, the city has developed a capital improvements plan that includes over $40 million for parks improvement and expansion of the parks system. To conserve the limited water resources of the area, recurring drought cycles typically result in severe restriction or elimination of outdoor irrigation, including for public parks. Reclaimed water is an essentially drought proof alternative to water from the Edwards Aquifer or from surface water supplies from Canyon Lake for parks irrigation.

The goals of the study were to develop alternatives for treatment, storage and transmission of reclaimed water to the city's parks. The initial scope of the study included Landa Park, Prince Solms, Camp Comal, Hinman Island, and Fischer Park. Parks were added to the project scope as the need for irrigation and proximity of parks as the concept for reclaimed water facilities was developed. The study area, illustrated in Figure 1, added the HEB Soccer Complex, Walnut Ave. landscaping and park, and Fredericksburg Fields. This study area includes the majority of the city regional, community and special use parks. The study area includes approximately 335.3 acres of parkland.

The study tasks included developing conceptual plans for treatment and conveyance of reclaimed water in sufficient detail to evaluate capital and operating costs, benefits, feasibility and to develop strategies for implementation:

- Collection of Baseline Information;
- Analysis of the irrigation water demand;
- Water reclamation siting, storage, and pipeline routing analysis;
- Evaluation of available technologies for ensuring high quality recycled water;
- Review of Environmental Considerations;
- Conceptual Planning and Design;
- Develop preliminary opinions of probable project costs;
- Conduct benefit/cost analyses; and
- Prepare an implementation strategy for reclaimed water irrigation of the city's parks.

1.2 The Need for Reclaimed Water

Like most of the South Central Texas region, the City of New Braunfels is a growing community that offers residents and visitors exceptional recreational opportunities. Recognizing the importance of the city's parks in defining the local quality of life and tourist economy, the community works to maintain the excellence of such historically significant parks as Landa Park while developing new parks such as Fischer Park.

Irrigation is an important management practice for providing for increased use of limited park areas. Growth in the number of park visitors increases the need for park irrigation, especially during times of drought. With the limited availability of water resources and restrictions on outdoor irrigation during recurring drought periods, reclaimed water has the potential of providing an efficient and drought resistant source of water for park irrigation needed to preserve the investment in public parks and athletic playing fields.

Like park use, park irrigation increases during the months of March through September. This increase in irrigation coincides with the increased water demand for residential irrigation. Water from the Edwards Aquifer is pumped from NBU's wells to supplement the utility's surface water supplies to meet this seasonal peak demand. Shifting park irrigation from the potable water supply to reclaimed water will minimize the withdrawal of water from the Edwards Aquifer. During the summer months when water demand increases and flow in the Comal and Guadalupe Rivers can diminish, park irrigation affords an additional benefit in reducing the nutrient load in what would otherwise be discharged as wastewater effluent.

1.3 Water Reuse as a Water Management Strategy

Treated municipal wastewater effluent can be reused either directly or indirectly. Direct reuse, know as *flange-to-flange* reuse, involves transporting treated effluent from the wastewater treatment plant directly to an end user. Indirect reuse occurs when effluent is discharged to a stream or river and diverted from a downstream intake by an end user. The act of reclaiming effluent for indirect reuse is subject to legal considerations and a permitting process described in the Texas Water Code. For the purposes of this study, only direct reuse supply options are considered. This study evaluated the feasibility of a system in which reclaimed water is not discharged to the Guadalupe River, but remains in pipes or controlled storage from the wastewater treatment plant to the point of use at each park.

Enacted by the Texas Legislature in 1997, Senate Bill 1 (SB1) charges the TWDB with the responsibility for developing a comprehensive long-term plan for the development, conservation and management of water resources in the state. TWDB has divided the state into sixteen water planning regions, each with a planning group responsible for preparing a regional water plan. The regional water plans are incorporated into the state water plan and are updated on a five-year cycle. The 2011 South Central Regional Water Plan will be integrated into the Texas Water Plan in 2012. The regional water planning process has emphasized the efficient use of water resources throughout the state.

Recognizing the importance of water reuse in the management of water resources, direct reuse of treated effluent is acknowledged in the 2011 South Central Texas (Region L) Regional Water Plan as a viable water management strategy. In comparison to the development criteria of the Region L water plan, water reuse is noted to be a potentially important source of water that could meet up to 25 percent of the regional demand. That regional demand includes projected water supply shortages for New Braunfels of 907 ac-ft by 2020 and 4,044 ac-ft by 2030 (SCTRWPG, 2010).

Water reuse has also been adopted by regional water purveyors as a part of their policies for managing water resources. In the 2009 Water Conservation Plan for Wholesale Water Suppliers, the Guadalupe-Blanco River Authority (GBRA) encourages water reuse for irrigation as a means of extending the supply of surface water stored in the region's reservoirs. The GBRA Board policy identifies increasing the beneficial reuse and recycling of water as part of the Authority's role in leading water conservation efforts in the region.

1.4 Study Area

The City of New Braunfels is located along the boundary of the Edwards Aquifer Recharge Zone (EARZ) that runs southwest to northeast through the city. The New Braunfels city parklands that comprise the study area (Figure 1) are located southeast of the EARZ, generally between the Comal and Guadalupe Rivers. Much of the study area is located in the Transition Zone, an area defined by the Edwards Aquifer Authority (EAA) for the purpose of regulating underground petroleum storage tanks.

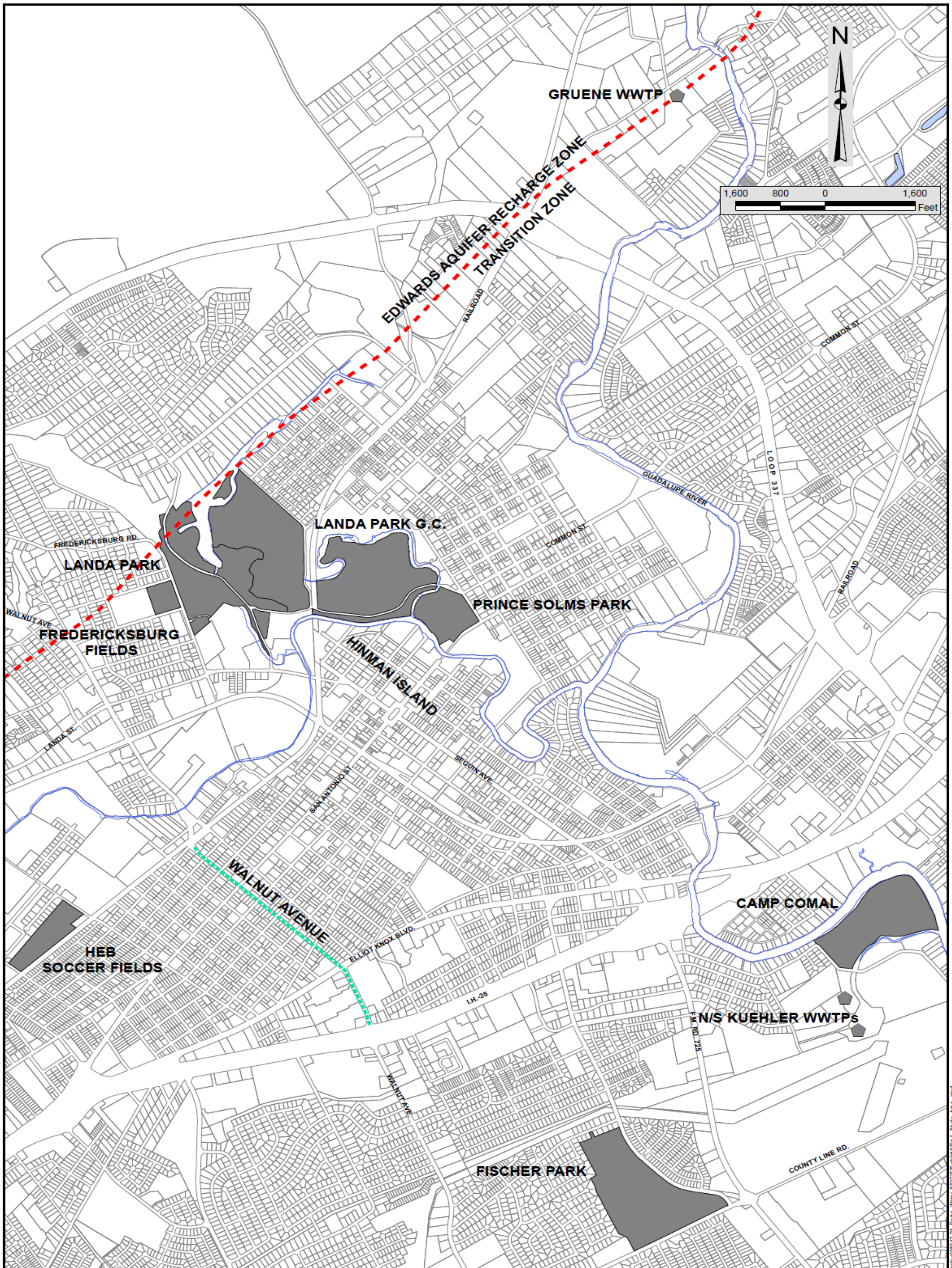
The climate in South Central Texas is characterized by mild winters and hot, dry summers. The average maximum temperatures of over 95^{o} F occur in August while the average minimum temperature of 35^{o} F occurs in January. Historically, the wettest month of the year has been May with an average rainfall of 3.76 inches. This study revealed that the five year period ending with 2009 was slightly drier than the historical average. With an average annual rainfall of just over 31 inches (Table 1), extended drought cycles have prompted utilities in the region to implement comprehensive water conservation programs.

Table 1: Average Annual Precipitation

Month	Precipitation 1940-2009 (in.)	Precipitation 2005-2009 (in.)
Jan.	1.75	1.79
Feb.	2.02	0.92
Mar.	1.95	3.47
Apr.	2.72	1.86
May	3.76	2.79
Jun.	3.49	1.86
Jul.	2.19	4.20
Aug.	2.50	3.07
Sep.	3.51	2.83
Oct.	3.49	2.71
Nov.	2.25	1.00
Dec.	1.86	1.14
TOTAL	**31.49**	**27.63**

Source: TWDB, Evaporation/Precipitation Data for Texas, 1940-2009

The two-year period of 2008 and 2009 was a relatively short, but intense drought cycle. Rainfall totals of 16.7 inches for 2008 and 28.7 inches in 2009 represented a shortfall of almost 28% of the average for the two year period.



City of New Braunfels

Espey Consultants, Inc.
Environmental & Engineering Services

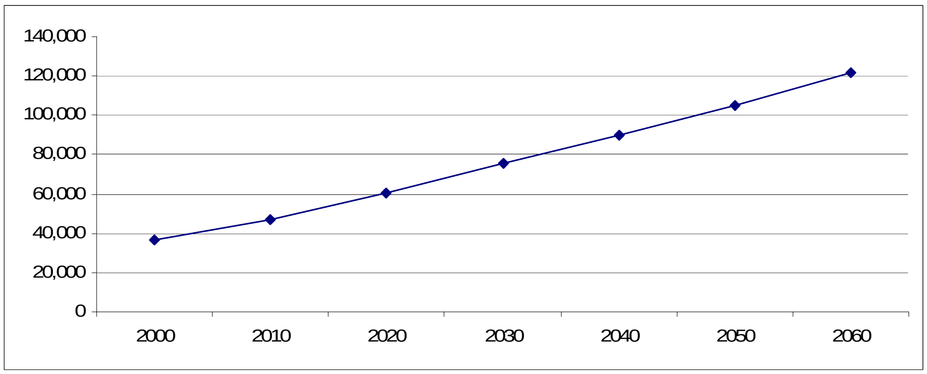
FIGURE 1
RECLAIMED WATER IRRIGATION STUDY AREA

MARCH 2011 P.N. 8012.03

1.4.1 Population

The City of New Braunfels has experienced significant growth in the past decade, with the city's population increasing by more than 58% since the 2000 Census. The City's planning for the anticipated growth from 57,740 citizens today to more than 70,000 by 2015 (Figure 2) is reflected in an aggressive capital improvements plan (CIP) that identifies the significant investment in infrastructure needed to fuel the local economy and meet the needs of the community's growing population.

Figure 2: Population Trend



Source: TWDB 2011 Regional Water Plan

New Braunfels is known throughout the state for its natural setting and festivals that attract thousands of visitors to the city each year, with many of those visits focused on the city's parks. The Comal River and the Guadalupe River are prime recreational destinations for visitors from all across Texas. In addition to residents, the city's recognition as a tourist destination contributes to an estimated 250,000 park visitors each year.

1.5 Park System Improvement and Expansion

The City of New Braunfels parks system is comprised of over 500 acres of dedicated parks and cemeteries (Figure 3). This primary focus of the study is on those regional and community parks and the special use areas that experience the heaviest use. These include Landa Park, Prince Solms Park, Hinman Island, Camp Comal, the HEB Soccer Complex and the Fredericksburg Fields. Since a master plan for Fisher Park has been completed and the design is in progress, the irrigation needs of this 62 acre community park are also included in the scope of the study. These parks make up almost two-thirds of the city's park acreage.

The city is actively planning for park and recreational facilities to meet the needs of current and future citizens and visitors. The city's 2009 – 2018 Capital Improvements Plan identifies more than $83 million in improvements for existing parks and construction of new park facilities. The city has also completed the Strategic Parks and

Recreation Master Plan. The master plan develops the goals, standards, and implementation strategies for parks and recreation facilities over the next ten years.

Figure 3: New Braunfels Parks System

Source: City of New Braunfels, PARD

New parks planned for construction during the next ten years includes construction of Fischer Park in the southern part of the city and development of Prince Solms Park on the Comal River. An additional 6.5 acres of parkland is presently under construction as part of the widening of Walnut Avenue. The inventory of park acreage is detailed in Table 2.

Table 2: Park Inventory

Park Name	Acreage	Park Name	Acreage
Neighborhood Parks		**Special Use Areas**	
Ernest Eikel Field	4.1	HEB Soccer Complex	14.5
Neighborhood Park	0.4	Fredericksburg Fields	5.5
Haymarket Plaza	2.2	Landa Golf Course	122.0
Jesse Garcia Park	1.0	Lindheimer Plaza	0.3
Hoffmann Park	0.9	Market Plaza	0.6
Solms Park	7.8	Main Plaza	0.6
Kraft Park	9.0	Faust Street Bridge	n/a
Morningside Park	16.0	Camp Comal	44.4
Torrey Park	5.13	Union St. Tubers Exit	n/a
Regional Parks		Garden St. Tubers Exit	n/a
Landa Park	51.0	Walnut Ave.	6.5
Community Parks		**Greenbelts**	
Cypress Bend	15.0	Panther Canyon	48.0
Fischer Park	62.3	Alves Lane	3.0
Hinman Island	10.0	Sunbelt Park	0.2
West Loop Park	9.0	River Acres Park	1.1
Prince Solms	19.1	Crest Lane Greenbelt	2.0
Cemeteries		Dry Comal Trails	22.6
New Braunfels Cemetery	4.7	**Total Acreage**	**513.9**
Comal Cemetery	25.0		

Source: City of New Braunfels, PARD

1.6 Historical Consumption

The records of potable water use for parks irrigation during the five-year period of 2005 through 2009 were compiled to provide a basis for comparison of projected irrigation demand. Monthly metered volumes obtained for the six parks revealed that parks were generally irrigated at a rate less than the 1-inch per week rule of thumb during that period (Table 3). A summary of the potable water consumption for parks irrigation is presented in Appendix A.

Table 3: Average Irrigation Rate (2005-2009)

Location	5-yr. Avg.	Irrigated Area (ac.)	Applied inches*
Hinman Island	420,500	7	0.1
Camp Comal	1,484,280	30.3	0.1
HEB Soccer	4,860,700	10.2	0.6
Landa Park	2,118,880	23	0.1
Prince Solms	282,240	16.8	0.02
Fredericksburg Fields	532,180	5	0.1

*assumes avg. 28 weeks of irrigation/yr.

2 Water Supply

2.1 Comal River

The City of New Braunfels holds a total of 300 ac-ft of water rights to the Comal River. A 1969 priority date for 100 ac-ft of water from the Comal River is available for irrigation of 50 acres of land. A 1914 priority date for 200 ac-ft for irrigation limits the use of for irrigation to Landa Park and the Landa Golf Course. Water from the Comal River is presently adequate for irrigation of the Landa Golf Course. However, these rights are interrupted during periods of diminished springflow.

2.2 Potable Water Supply

New Braunfels Utilities (NBU) is the municipal agency authorized by law to operate and manage the water and wastewater utilities owned by the city. NBU was established by the City of New Braunfels in 1942 and has operated the city's water and wastewater system since 1959. An annual demand of 3 billion gallons of water is met for the over 21,600 customers on the system. The potable water supply is furnished by ten wells that pump from the Edwards Aquifer and a surface water treatment plant on the Guadalupe River. The water system is operated using the surface water treatment plant to meet the base demand of the commercial, industrial and residential customers while the summer peak demand is met using groundwater from the Edward Aquifer.

2.3 Surface Water Supply

Operating its surface water plant to supply the average demand has enabled NBU to reduce its demand on the Edwards Aquifer by as much as 80 percent. The intake for the plant is located on the Guadalupe River, upstream of the confluence with the Comal River. Plans for construction of a 5 MGD water treatment plant within the next five to ten years will increase NBU's treatment capacity to 13 MGD. NBU holds both adjudicated and run of the river water rights from the Guadalupe River. The utility presently holds 16,672 acre-feet of surface water rights for municipal uses.

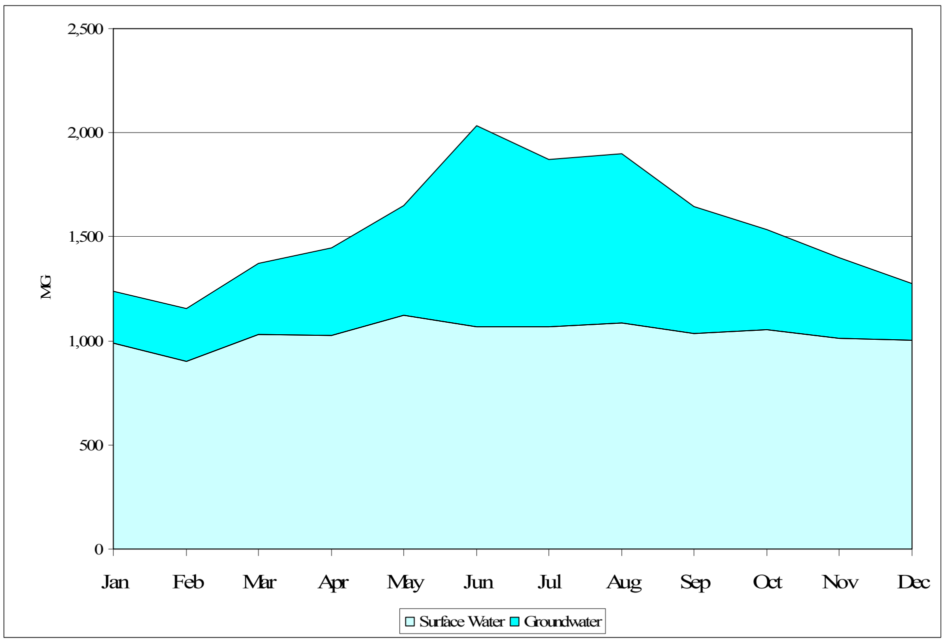
2.4 Groundwater Supply

Since 1993, management and regulation of the Edwards Aquifer has been under the jurisdiction of the Edwards Aquifer Authority (EAA). EAA regulates withdrawals from the aquifer as well as activities that can affect water quality. Pumping is limited to a total of 572,000 acre-feet through the issuance and monitoring of groundwater withdrawal permits. NBU operates ten groundwater wells on the Edwards Aquifer with a total limit of 9,269.9 acre-feet of pumping rights.

The combined annual production of water from the NBU surface WTP and wells averaged 3,703.57 MG/yr. between 2005 and 2009. Groundwater accounted for approximately 33% of the total annually during that five-year period, or about 1,225

MG/yr., with most well production occurring during the months of April through October to offset seasonal peak demands. Figure 4 provides a graphical representation of monthly water production during the years 2005 through 2009 and illustrates how water supply from the surface water treatment plant meets the base demand of the system. This allows the plant to be operated at an optimal efficiency while minimizing the system's reliance on groundwater.

Figure 4: NBU Water Production, 2005-2009



2.5 Water Conservation

NBU's water conservation and drought management plan is codified in Article IV- Water Conservation (City of New Braunfels, 2008) of the city ordinances and is overseen by NBU. The water conservation plan for New Braunfels is progressively restrictive on outdoor water uses according to the level of the J-17 well in San Antonio and the flow at Comal Springs. Important elements of NBU's water conservation plan include year round limits on landscape irrigation. Landscape watering is prohibited year-round between the hours of 10 AM and 8 PM every day except using a hand held hose, bucket, soaker hose or drip irrigation system.

The ordinance also prohibits irrigation of golf course irrigation using potable water. Specific water use reduction measures (Sec. 130-228) provide that the use of reuse water is not categorically permitted during specific conservation stages, but is a defense to prosecution under the ordinance for landscape irrigation.

2.6 Existing Water Reuse

NBU presently operates a reclaimed water system that furnishes water to a single customer. Sundance Park is a master-planned, mixed-use development on a 29 acre tract that was developed following closure of the Sundance Golf Course. The system that supplied reclaimed water to the golf course remains in service for the development. Sundance Park includes three ponds that store effluent from NBU's Gruene WWTP and an irrigation system for the rights-of-way and common area landscaping. The NBU contract provides for delivery of up to 2,000,000 gallons per month. Delivery of recycled water is through approximately 0.75 mile of 10-inch pipeline from the Gruene WWTP.

A study commissioned by NBU in 2003 evaluated the feasibility of reclaimed water for dust control in the limestone quarries located west of the city and for cooling water for a gas-fired generating plant. This study evaluated reclaimed water as a replacement for water pumped from the Edwards Aquifer for CEMEX quarries and for surface water from the Guadalupe River used by Texas Independent Energy. The 2003 study evaluated the costs of producing and transporting reclaimed water along with the regulatory issues associated with use of reclaimed water on the EARZ (NBU, 2003).

THIS PAGE INTENTIONALLY LEFT BLANK

3 Wastewater Collection and Treatment

The NBU wastewater system serves more than 18,900 customer connections. NBU operates three wastewater treatment plants with a total treatment capacity of 8.4 million gallons per day: The Gruene WWTP is located in the northeastern quadrant of the city on the Guadalupe River upstream of the confluence with the Comal River. The North and South Kuehler WWTPs are located south of IH 35 on the Guadalupe River below the confluence with the Comal River.

3.1 Gruene WWTP

The proposed TPDES permit parameters issued on April 19, 2010 for the Gruene WWTP are presented in Table 4.

Table 4: Gruene WWTP Effluent Parameters

Parameter	Avg. of Daily Avg. (07/03 – 05/09)	Proposed Permit 30-Day Avg.
Flow, mgd	0.38	1.1
$CBOD_5$, mg/l	3.4	5
TSS, mg/l	3.0	10
DO, mg/l (minimum)	4.1	4.0
E. coli, #/100 ml	--	126

3.2 North Kuehler WWTP

The proposed TPDES permit parameters for the North Kuehler WWTP issued on April 19. 2010 are presented in Table 5.

Table 5: North Kuehler WWTP Effluent Parameters

Parameter	Avg. of Daily Avg. (07/04 – 05/09)	Interim Phase Permit 30-Day Avg.
Flow, mgd	1.792	3.1
BOD_5, mg/l	3.25	10
TSS, mg/l	3.10	15
DO, mg/l (minimum)	--	5.0
E. coli, #/100 ml	--	126

3.3 South Kuehler WWTP

The proposed TPDES permit parameters for the South Kuehler WWTP issued on April 19. 2010 are presented in Table 6.

Table 6: South Kuehler WWTP Effluent Parameters

Parameter	Avg. of Daily Avg. (05/07 – 05/09)	Interim Phase Permit 30-Day Avg.
Flow, mgd	2.2	4.2
BOD_5, mg/l	2.8	10
TSS, mg/l	2.5	15
DO, mg/l (minimum)	--	4.0
E. coli, #/100 ml	--	126

3.4 Effluent Quality

Monthly variations in flow and effluent quality for the period August 2009 through July 2010 reveal a consistently high quality of effluent with some seasonal variations primarily due to rainfall events (Table 7).

Table 7: Average Monthly Effluent

Month	Gruene			North Kuehler		South Kuehler	
	Flow (mgd)	CBOD (mg/l)	Turbidity (NTU)	Flow (mgd)	BOD (mg/l)	Flow (mgd)	BOD (mg/l)
Aug-09	0.3879	2.24	2.08	1.817	2.15	2.118	1.75
Sep-09	0.5234	2.28	1.73	1.796	2.95	2.295	2.22
Oct-09	0.5130	2.54	1.92	1.967	2.89	3.029	3.23
Nov-09	0.4568	3.38	1.76	1.920	4.51	2.761	2.68
Dec-09	0.4563	4.60	2.93	1.874	6.72	2.781	3.24
Jan-10	0.4637	4.49	3.15	1.829	9.11	3.064	5.73
Feb-10	0.4833	4.51	4.63	2.198	4.99	3.195	3.02
Mar-10	0.4635	5.41	4.29	1.987	4.08	2.904	3.17
Apr-10	0.4209	5.07	4.09	1.905	2.81	2.660	2.41
May-10	0.5215	2.64	1.80	2.075	2.85	2.787	2.23
Jun-10	0.5842	2.84	2.07	2.083	3.34	3.152	5.47
Jul-10	0.4832	3.92	2.99	2.163	2.18	2.927	6.40

Source: NBU

While the quality criteria of BOD, turbidity, and bacteria are prescribed by state regulation to ensure suitability for human contact with reclaimed water, the suitability of the water to be used for irrigation as it relates to potential effects on the irrigated plants is also considered. Most important of these quality criteria is salinity. Salinity is determined by measuring the total dissolved solids (TDS) in mg/l or the electrical conductivity of the water. Conductivity data would be obtained by effluent testing as part of the implementation of a reclaimed water system.

In addition to salinity, various trace constituents found in reclaimed water may have detrimental effects on plants. EPA provides recommended limits for various trace constituents in reclaimed water used for irrigation (EPA, 2004). A comparison of those limits for long-term use with the results of NBU's 2009 pretreatment effluent monitoring results is presented in Table 8. It should be noted that values are presented for only those constituents for which samples revealed concentrations above detectible limits and for which EPA's possible cumulative long-term impacts are relative to park irrigation instead of crop irrigation.

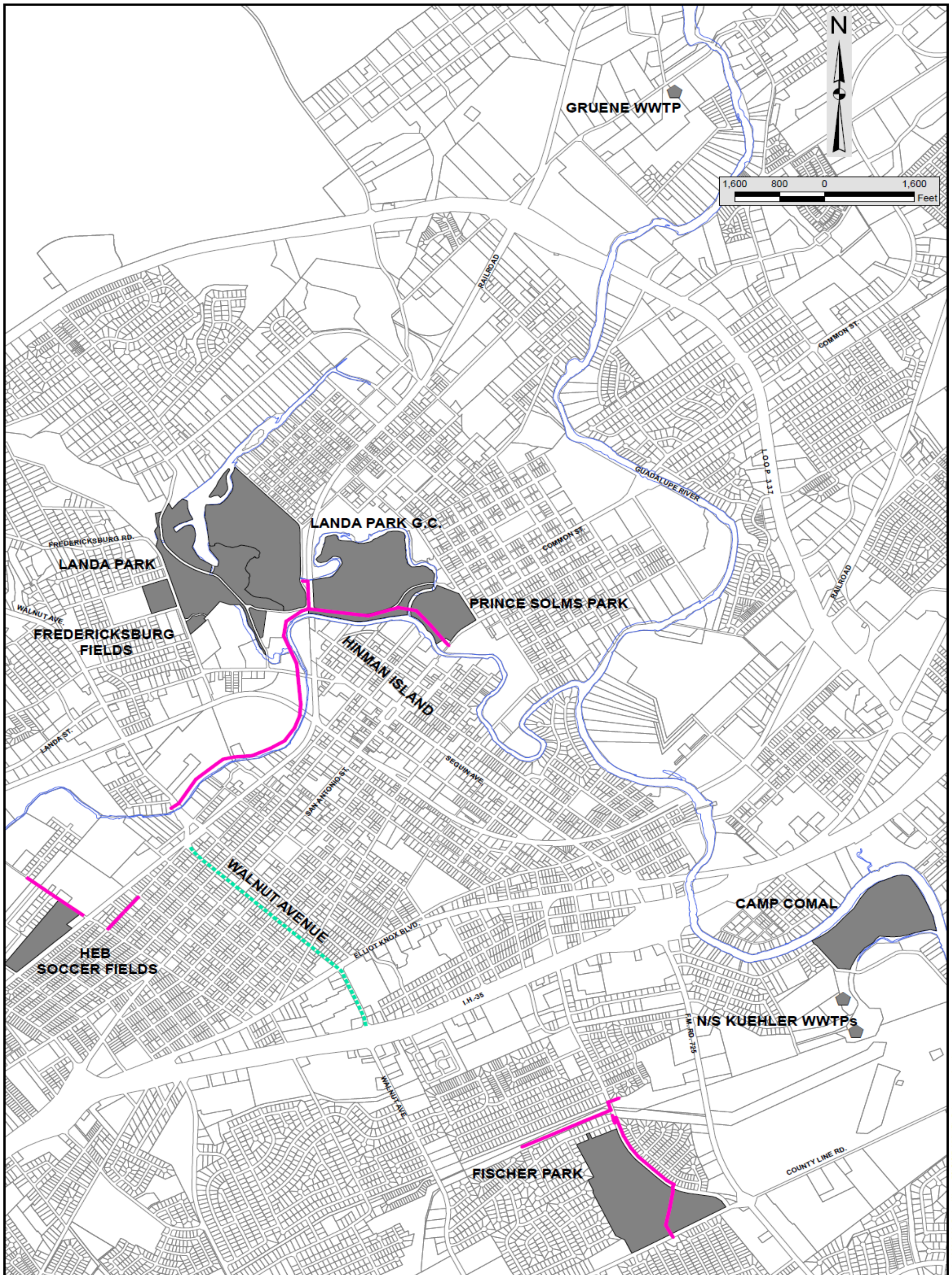
Table 8: Pretreatment Program Effluent Monitoring

Constituent	Long-Term Use (mg/l)	S. Kuehler (mg/l)	N. Kuehler (mg/l)	Gruene (mg/l)
Aluminum	5.0	0.016	0.021	0.02
Arsenic	0.10	--	--	0.002
Copper	0.2	0.005	0.01	0.013
Selenium	0.02	0.003	0.003	--
Zinc	2.0	0.054	0.066	0.098

Source: NBU

3.5 Major Collection System Interceptors

The NBU wastewater collection system contains approximately 330 miles of pipeline that ranges in size from 6-inches to 30-inches in diameter. All of the parks considered in this study were found to be near wastewater mains that are 12-inches in diameter or greater (Figure 5). Flows in the mains were not calculated as part of this study. NBU has, however, initiated development of a wastewater collection system model that will, once calibrated, provide data including the flow volumes in mains in the study area.



City of New Braunfels

Espey Consultants, Inc.
Environmental & Engineering Services

FIGURE 5
MAJOR INTERCEPTOR LOCATIONS

MARCH 2011 P.N. 8012.03

4 Regulatory and Environmental Considerations

4.1 Regulatory Considerations

The use of reclaimed water is regulated by the TCEQ under Title 30 of the *Texas Administrative Code*, Chapter 210 (30 TAC §210). The regulations provide for the quality criteria, design, and operational requirements for the beneficial use of reclaimed water. The use of reclaimed water requires notification and approval of the TCEQ under Chapter 210, with specific responsibilities assigned to the reclaimed water producer, the reclaimed water provider, and the reclaimed water user. The specific responsibilities of each party as designated by the Chapter 210 regulations are summarized in the following points.

The responsibilities of the reclaimed water **producer** include ensuring that the quality of the reclaimed water that leaves the treatment process meets the minimum quality prescribed by state regulations, and for sampling, analyzing, and reporting the quality of reclaimed water produced.

The reclaimed water **provider** is responsible for the delivery of reclaimed water to the user that meets the minimum quality prescribed by state regulations and for maintaining records of the volume and quality of reclaimed water delivered to the user.

The reclaimed water **user** is responsible for the proper use of reclaimed water.

4.1.1 Type I Reclaimed Water Use

The Chapter 210 rules regulate the quality, place and manner of use of effluent from wastewater treatment facilities to protect public health by minimizing risks of infection and disease transmission. Depending on the potential for human contact, Texas regulations provide for two types of reclaimed water. Type I reclaimed water can be used where human contact with the reclaimed water is likely. The potential uses for Type I reclaimed water include (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.

4.1.2 Type II Reclaimed Water Use

Type II reclaimed water can be used where human contact with the reclaimed water is unlikely. The potential uses for Type II reclaimed water include (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.
- Type I reclaimed water may be utilized for any of the Type II uses identified above.

4.1.3 Reclaimed Water Quality Standards

The following summarizes the quality parameters contained in 30 TAC §210.33.

Type I (30-day average) –	BOD5 or CBOD5 – 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) –	*(For any system other than a pond system)*
	BOD5 – 20 mg/l
	CBOD5 – 15 mg/l
	Fecal Coliform – 200 CFU/100 ml*
	Fecal Coliform (not to exceed) - 800 CFU/100 ml**
	(For pond systems)
	BOD5 – 30 mg/l
	Fecal Coliform – 200 CFU/100 ml*
	Fecal Coliform (not to exceed) - 800 CFU/100 ml**
	* geometric mean
	** single grab sample

Because public parks and athletic fields are areas where human contact with the reclaimed water is likely, only Type I reclaimed water quality was considered for the purposes of this study.

4.1.4 Reclaimed Water System Operations

Runoff of reclaimed water is to be prevented by the reclaimed water user (30 TAC §210.24) by avoiding excessive irrigation. Applying reclaimed water at the proper rate for the existing soil and atmospheric conditions is the principal means of avoiding runoff from irrigated sites. Maintenance of the irrigation system to correct sprinkler head and controller malfunctions is also an essential part of avoiding runoff from irrigated sites.

Chapter 210 regulations also require that storage of reclaimed water in ponds must be designed to prevent groundwater contamination. Reclaimed water may be stored in fabricated tanks (metal, concrete, plastic or fiberglass). Hose bibs, faucets, exposed piping (interior and outside) must be painted purple and labeled as non-potable. Purple pipe is typically used for all reclaimed water piping as one aspect of cross-connection control.

4.1.5 Reclaimed Water Production Facilities

In addition to supplying reclaimed water from the effluent of a publicly-owned treatment works (POTW), state regulations (30 TAC § 321, Subchapter P) establish a process for permitting a reclaimed water facility production (RWPF). A RWPF is defined as a facility that treats wastewater for reuse on an as-needed basis and is located at a different location from the permitted POTW. An example of a RWPF would be a satellite or "scalping" plant that is located near the point of reclaimed water use.

Sludge treatment at reclaimed water production facilities is prohibited so all solids must be returned to the collection system. A RWPF located within a building that is not equipped with exhaust air and odor control systems may not be located closer than 150 ft. to the nearest property line. Including exhaust air and odor control allows the building to be placed as close as 50 ft. from the property line – defined as an enhanced buffer zone. If the RWPF qualifies for an enhanced buffer zone designation, public notice is not required.

4.1.6 Water Rights Considerations

As the population of the state and nation grows, wastewater effluent makes up an increasing percentage of the water in streams and rivers. Some estimate that as much as sixty percent of the water that is distributed through a municipal water system for use as potable water is returned to Texas' streams and rivers as wastewater effluent (TWCA, 2004). These return flows can become part of the water to be appropriated from the watercourse or otherwise considered to be an important part of maintaining the aquatic environment. To appreciate the relationship between water reuse and water rights requires an understanding of some certain aspects of water law in Texas.

Under 30 TAC §297.1, TCEQ defines "reuse" as: *the authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.*

Reuse projects are defined in terms of either indirect or direct reuse. Direct reuse is known as "flange-to-flange" reuse in that treated effluent is drawn from the plant before it is discharged to a watercourse. Indirect reuse is when a water utility recaptures wastewater treatment plant effluent downstream from the point at which it was discharged to a watercourse.

The fundamental difference between direct and indirect water reuse in Texas is that direct reuse does not involve retrieving effluent from a stream or waterway. Indirect reuse involves a permitting process that may consider the potential negative impacts on downstream water rights holders whose water rights may be based on an assumed reliability or continuation of municipal return flows. Direct reuse, however, involves diversion of effluent for beneficial reuse without being released to a stream or waterway. State regulations provide the basis for utilities to reuse water without additional water rights permitting until that water is discharged from the wastewater treatment plants:

> ***Except as specifically provided otherwise in the water right, water*** *appropriated under a permit, certified filing, or certificate of adjudication* ***may, prior to its release into a watercourse or stream, be beneficially used and reused by the holder of a permit****, certified filing, or certificate of adjudication for the purposes and locations of use provided in the permit, certified filing, or certificate of adjudication.* ***Once water has been diverted under a permit, certified filing, or certificate of adjudication and then returned to a watercourse or stream, however, it is considered surplus water and therefore subject to reservation for instream uses or beneficial inflows or to appropriation by others*** *unless expressly provided otherwise in the permit, certified filing, or certificate of adjudication.* [30 TAC §11.046(c) emphasis added]

4.2 Environmental Considerations

A review of available environmental information was performed that considers endangered species, environmentally sensitive areas, and waters of the U.S. including wetlands. The review of environmental information does not include a detailed survey or detailed investigation of environmental features.

4.2.1 Environmental Features of the Study Area

The primary environmental features within the study area include the floodplains of the Comal and Guadalupe Rivers, wetlands, Comal Springs, and the Edwards Aquifer Recharge Zone. With the possible exception of a very small area of the northern portion of Landa Park, all of the parks are located outside of the Edwards Aquifer Recharge Zone boundary (see Figure 1). Located at the headwaters of the Comal River, Comal Springs is also in Landa Park.

4.2.2 Floodplain

The location and extent of floodplains were considered for the purposes of locating potential reclaimed water pumping and storage facilities. Using the base flood elevations (BFE) and flood insurance rate maps (FIRM) provided by FEMA under the National Flood Insurance Program, potential locations for pumps or storage were identified as being outside the regulatory floodplain.

4.2.3 Endangered Species

The Edwards Aquifer Recovery Implementation Program (EARIP) is a collaborative, consensus-based, regional stakeholder process tasked with the development of a plan to address U.S. Fish and Wildlife Service (USFWS) concerns over potential influence of water management strategies on the federally-listed endangered species while managing

Texas' Edwards Aquifer for the benefit of all. The EARIP is preparing an Incidental Take Permit supported by a Habitat Conservation Plan and Draft Environmental Impact Statement involving future strategies for water supply that minimize impact on endangered species, specifically species that are endemic to the Comal Springs and San Marcos Springs areas.

The USFWS and the Texas Parks and Wildlife Department (TPWD) both expressed concerns regarding the discharge of reclaimed water to the Comal Springs. Comal Springs is home to several rare and federally listed species including one fish, the fountain darter (*Etheostoma fonticola*), and three invertebrates: Comal Springs dryopid beetle (*Stygoparnus comalensis*), Comal Springs riffle beetle, and Peck's cave amphipod.

The USFWS and TPWD further expressed a desire that no reclaimed water infrastructure or application of reclaimed water on the Edwards Aquifer recharge zone or in karst formations. The feasibility study uses the Edwards Aquifer Authority (EAA) definition of recharge zone boundary and identifies all areas for irrigation and reclaimed water infrastructure as being located only in the Transition Zone.

Since the irrigation water will not be allowed to form runoff or enter into the Comal River, and is restricted to the transition zone of the Edwards Aquifer, the use of reclaimed water for park irrigation would not create an adverse water quality impact. Further, irrigation activities are downstream of Comal springs and therefore would not interfere or involve the activities of the EARIP. Any residuals of reclaimed water irrigation that could be introduced into Comal River by rainfall induced runoff would be diluted and moved downstream with the increased flow resulting from stormwater runoff from both the non-irrigated and irrigated areas within the watershed.

4.2.4 Environmentally Sensitive Areas

Edwards Aquifer Transition Zone

The transition zone of the Edwards Aquifer is described as a thin strip of land south and southeast of the recharge zone from San Antonio to Austin where limestone that overlies the Edwards formation are faulted and fractured and has caves and sinkholes. The delineation of the transition zone was established to regulate petroleum storage tanks, so there are places where the boundaries follow particular streets or railroad lines. The boundary between the recharge and transition zones transects the northwestern portion of New Braunfels just outside of the study area. The application of reclaimed water will be designed to match the evapotranspiration (ET) rates of the grasses and vegetation in the transition zone. These application rates should eliminate runoff and/or any percolation into the transition zone formation. In the unlikely event that percolation did occur the water would be subject to the same physical and chemical processes as any water moving through the saturate and/or unsaturated geology in an urbanized area of the transition zone of the Edwards Aquifer.

National Wetlands Inventory

Wetlands are defined for regulatory purposes under the Clean Water Act as [EPA Regulations listed at 40 CFR 230.3(t)]:

> *"…those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."*

A preliminary review of the USFWS National Wetlands Inventory revealed several isolated wetland areas may be located in the study area. Possible wetlands may exist in Landa Park, the area around the Dry Comal, and in the southern portions of the city (Appendix B). A detailed delineation of wetland areas in the project area will be conducted during the final design of a reclaimed water system. Utility crossings must comply with the terms of Nationwide Permit 12 (NWP-12) relating to activities required for the construction, maintenance, and repair of utility lines and associated facilities in waters of the United States. Avoidance of these wetland areas during construction can be addressed as part of the design process.

4.2.5 Water Quality

Aquatic habitats are associated with the riparian areas of the Comal and Guadalupe Rivers adjacent to some of the parks to be irrigated with reclaimed water. While direct discharge of reclaimed water to surface waters is regulated by TCEQ, there may be some concern that chemical constituents contained in municipal wastewater can be introduced into aquatic habitats.

Except for dilution, inadvertent runoff of reclaimed water during dry weather would be subject to the same natural processes as stormwater runoff. Recognized as a stormwater best management practice (BMP), flow across turf grasses (typical in maintained parks) can provide significant reductions of pollutants. An evaluation of Buffalo grass (Walsh *et al*, 1998) indicated a high removal efficiency of TSS (70% to 82%) and other pollutants (zinc, COD, nitrates, and total phosphorus) with higher efficiencies during the growing season.

Emerging Contaminants

In addition to the conventional chemical and biological contaminants associated with domestic wastewater, new contaminants continue to emerge as testing technologies improve and as potential environmental or health effects of the pollutants (or combinations of pollutants) are discovered. Examples include endocrine disrupting chemicals (EDCs), pharmaceuticals, and personal care products as pollutants that have been discussed in recent years as trace or emerging contaminants (Asano, 2007). Ongoing studies into the effects and fate of these chemicals have yet to define a single compound as an indicator due in part to the vast number of medical and personal care products linked to the emerging contaminants. Similarly, the various processes used in wastewater treatment provide a range of removal efficiencies for different compounds. These emerging pollutants are have in common limited scientific information due to low pollutant concentration levels, detection limitations, statistical error, complexity of the pollutants, limitations in treatment technologies, and lack of long-term epidemiological data.

A study of the City of San Marcos' wastewater treatment plant effluent (Foster, 2007) revealed that the San Marcos wastewater treatment plant removed up to 92% of those compounds most frequently detected in the city's raw wastewater. While the fate of trace contaminants after effluent has been filtered and applied to soil and plants is not yet known, there has been a significant amount of research into the fate of urban contaminants in stormwater.

Based on the current body of knowledge regarding dose-response relationships of various organisms to low level concentrations of EDCs, it may be several years before any water quality standards regarding EDCs and pharmaceutical compounds are promulgated. At the same time that the scientific study of the potential effects of low-level exposure to EDCs in humans and aquatic species is increasing, the EPA and other organizations are evaluating approaches for regulating EDCs. The use of reclaimed water for irrigation creates an additional field of study as it is recognized that the interaction of plants and soil can improve water quality. Regulatory agencies, the public, and lawmakers will have to weigh relative risks against real and perceived costs, increasing water demands, and in many cases, diminishing quality and quantity of raw water supplies relative to the costs of controlling the use or treatment for many types of emerging contaminants.

4.3 Potential Environmental Benefits

In describing the benefits of water recycling, EPA cites certain environmental benefits. Foremost among these is the potential for minimizing diversion of freshwater from sensitive ecosystems and reducing wastewater discharges. In the South Central Texas water planning region, these environmental benefits are of particular interest.

4.3.1 Peak Management of Groundwater Supply

Developing recycled water as a supply strategy is recognized in the Region L water plan as a viable alternative to both the Edwards Aquifer and surface water supplies in the region. The current NBU procedure of supplying the base system water demand using surface water supplies and meeting the seasonal peaks using groundwater is an example of optimizing the limited water resources of the region while still meeting the needs of a growing population.

By avoiding a single reliance on groundwater or surface water, NBU also minimizes diversions from both the Edwards Aquifer and the Guadalupe River. The addition of a reclaimed water system will serve to lessen an increase on the peak seasonal demands resulting from an increase in park visitors. The net result is that water otherwise drawn from the Edwards Aquifer for park irrigation would remain in the aquifer or, otherwise, supplement the flow of Comal Springs. This potential for minimizing the peak seasonal demand on the Edwards Aquifer can be illustrated by comparing the annual potable water production from groundwater and surface water sources.

The charts presented in Appendix C compare the monthly consumption of both surface water and groundwater during the years 2005 through 2009 and include the metered volume of potable water used by six parks. A portion of the peak demand is identified as that portion of the peak demand used for the irrigation of six of the city's parks. This highlights a potential benefit of preserving the peak groundwater pumping capacity for population growth by shifting the park irrigation demand to a reclaimed water system.

The question of potential benefit to the Edwards Aquifer by removing the summer demand on the aquifer associated with park irrigation was presented to the EAA Aquifer Science staff. While there are uncertainties with respect to the flow of groundwater in the vicinity of the Comal Springs and how seasonal pumping might affect those flow patterns relative to both the Comal and San Marcos Springs, it appears that reducing seasonal pumping demand would provide a direct benefit to springflow in one or both springs (EAA, 2011). Although regional population growth could be expected to mask the reduction of demand resulting from reclaimed water irrigation, the volume associated with park irrigation would not be a factor in future projections of seasonal groundwater demand.

4.3.2 Turf Grass Irrigation Benefits

Providing recycled water for the irrigation of turf grasses in public parks has an added benefit of preventing and reducing the runoff of urban contaminants to water bodies. Recycled water may contain nutrients, such as phosphorus that can provide a source of nutrients that reduces the need for synthetic fertilizers.

The ability to irrigate turf grasses in public parks is also a best management practice in erosion and sediment control. Vegetative buffers provide a combination of settlement, filtration and adhesion processes that remove urban pollutants from stormwater runoff. Vegetative buffers include trees along riparian zones, short grass filters in urban storm-water drains, and stiff turf grass at field edges or along waterways. Studies have considered the reduction of sediment delivery due to net deposition upslope of stiff grass buffers such as turf grasses. One study (Ghadiri et al, 2008) indicates a sediment removal efficiency of between 88% and 97% with the use of grass strips. The study indicates trapping efficiency is very high under subcritical flow conditions, decreasing somewhat with increasing slope and flow rate.

4.3.3 Phosphorus Removal

An additional potential benefit to the water quality of the Guadalupe River comes from removing a volume of nutrients from the effluent stream of the POTW. Based on the permit limit of 3 mg/l of phosphorus for the N/S Kuehler WWTP, each 1 MG of reclaimed water used for park irrigation would account for removing 25 pounds of phosphorus from the POTW effluent discharged to the Guadalupe River.

5 System Design Considerations

The size and capacity of each of the components of a conceptual system are determined by the calculation of the water demand for park irrigation. Developing a conceptual plan for a reclaimed water system includes developing the capacities of the primary system components:

1. production and treatment facilities; and
2. reclaimed water storage and transmission facilities.

TCEQ design criteria for wastewater systems are found in the Design Criteria for Domestic Wastewater Systems (30 TAC Chapter 217) and provide the basis for the facilities needed for municipal wastewater treatment. Operation of publicly owned treatment works (POTWs) under permits issued by the TCEQ allows NBU to discharge treated effluent to the Guadalupe River. The three plants owned and operated by NBU consistently produce a high quality effluent, but are not required to meet the parameters for Type I reclaimed water. Instead, additional treatment units can be added to the POTW to treat only the volume of effluent needed for direct nonpotable reuse. The size and capacity of the additional treatment units is determined by the projected demand for reclaimed water.

5.1 Reclaimed Water Demand

Developing the projected reclaimed water demand considers the area of land to be irrigated, rainfall, and evapotranspiration. Supplementing data from available mapping of the city's parklands with field measurements of impervious cover, the city's PARD developed an inventory of existing and proposed irrigated areas in each of the parks included in the study area. Of the total parkland area in the nine parks included in the study area, a total of 172.8 acres were identified as existing or future irrigated areas. This includes approximately 14 acres of a proposed expansion of irrigated area at the Landa Golf Course. The irrigated area within the study area is presented in Table 9.

Table 9: Irrigated Area

Park	Total Park Area	Irrigated Area
Camp Comal	44.4	30.3
Fischer Park	62.3	60.0
Fredericksburg Fields	5.5	5.0
HEB Soccer Complex	14.5	10.2
Hinman Island	10.0	7.0
Landa Park	51.0	23.0
Landa Golf Course	122.0	14.0
Prince Solms Park	19.1	16.8
Walnut Ave	6.5	6.5
TOTAL	335.3	172.8

Source: City of New Braunfels, PARD

Evapotranspiration (ET) is defined as the sum of evaporation and plant transpiration from the Earth's surface to the atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil and waterbodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through the plant. The ET rate can vary with the type of turf, soil type, shade, relative humidity, and wind. In calculating the water demand for parks irrigation, the ET rate for New Braunfels was estimated based on historical records of NOAA and TAMU.

Rainfall can be a major factor in determining reclaimed water demand for irrigation as the basic assumption for including rainfall can become a limiting factor during drought conditions. Three conditions were used to develop reclaimed water demand. The initial condition is that the system can be sized to supplement the average annual rainfall for the New Braunfels area. As the *100% Rainfall Credit* condition, the lowest volume of reclaimed water is required for irrigation.

The second condition is to size the system for half of the annual average rainfall. The *50% Rainfall Credit* condition increases the volume of reclaimed water by fifty percent. The third condition, *0% Rainfall Credit,* is that the system should be developed to supply reclaimed water under drought conditions. The impact of each condition on the reclaimed water demand is illustrated in the following tables. The projected reclaimed water demand range was from 147.24 MG assuming full credit for average annual rainfall (Table 10), 221.12 MG assuming a 50% rainfall credit (Table 11), and 295 MG assuming no credit for average rainfall (Table 12).

Table 10: Reclaimed Water Demand (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Reclaimed Water Demand (ac-ft)	Reclaimed Water Demand (MG)
Jan	172.8	1.75	2.03	4.03	1.31
Feb	172.8	2.02	2.71	9.94	3.24
Mar	172.8	1.95	4.35	34.56	11.26
Apr	172.8	2.72	5.29	37.01	12.06
May	172.8	3.76	7.56	54.72	17.83
Jun	172.8	3.49	8.24	68.40	22.29
Jul	172.8	2.19	8.19	86.40	28.15
Aug	172.8	2.50	8.14	81.22	26.46
Sep	172.8	3.51	6.20	38.74	12.62
Oct	172.8	3.49	4.94	20.88	6.80
Nov	172.8	2.25	3.11	12.38	4.04
Dec	172.8	1.86	2.11	3.60	1.17
TOTAL		**31.49**	**62.87**	**451.87**	**147.24**

Table 11: Reclaimed Water Demand (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Reclaimed Water Demand (ac-ft)	Reclaimed Water Demand (MG)
Jan	172.8	0.88	2.03	16.63	5.42
Feb	172.8	1.01	2.71	24.48	7.98
Mar	172.8	0.98	4.35	48.60	15.84
Apr	172.8	1.36	5.29	56.59	18.44
May	172.8	1.88	7.56	81.79	26.65
Jun	172.8	1.75	8.24	93.53	30.48
Jul	172.8	1.10	8.19	102.17	33.29
Aug	172.8	1.25	8.14	99.22	32.33
Sep	172.8	1.76	6.20	64.01	20.86
Oct	172.8	1.75	4.94	46.01	14.99
Nov	172.8	1.13	3.11	28.58	9.31
Dec	172.8	0.93	2.11	16.99	5.54
TOTAL		**15.75**	**62.87**	**678.60**	**221.12**

Table 12: Reclaimed Water Demand (0% Rainfall Credit)

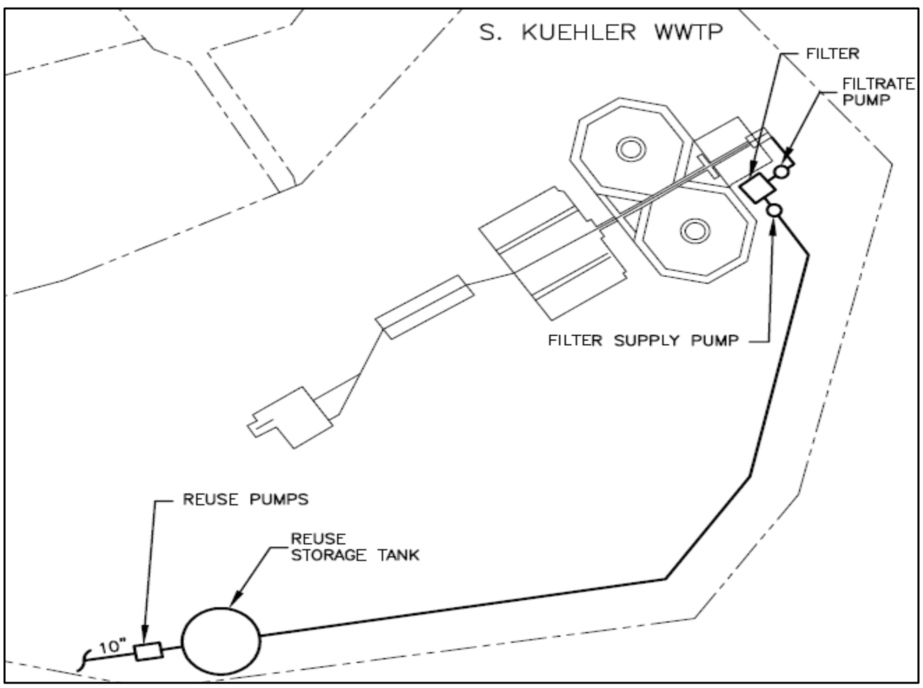
Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Reclaimed Water Demand (ac-ft)	Reclaimed Water Demand (MG)
Jan	172.8	0.00	2.03	29.23	9.53
Feb	172.8	0.00	2.71	39.02	12.72
Mar	172.8	0.00	4.35	62.64	20.41
Apr	172.8	0.00	5.29	76.18	24.82
May	172.8	0.00	7.56	108.86	35.47
Jun	172.8	0.00	8.24	118.66	38.66
Jul	172.8	0.00	8.19	117.94	38.43
Aug	172.8	0.00	8.14	117.22	38.19
Sep	172.8	0.00	6.20	89.28	29.09
Oct	172.8	0.00	4.94	71.14	23.18
Nov	172.8	0.00	3.11	44.78	14.59
Dec	172.8	0.00	2.11	30.38	9.90
TOTAL		**0.00**	**62.87**	**905.33**	**295.00**

5.2 Effluent Polishing

As previously discussed in Sec. 3.4, the North and South Kuehler WWTPs produce a high quality effluent, but that effluent will still require additional treatment primarily to consistently meet the quality standards of Type I reclaimed water. Further reduction of suspended solids and turbidity with additional filtration of the effluent is central to achieving virus removal and inactivation and preparing the reclaimed water for effective disinfection prior to distribution. Tertiary treatment of the entire volume of WWTP effluent is not a practical alternative as only a portion of the effluent is needed for supplying a reclaimed water system. The additional capital and O&M costs associated with tertiary treatment of all effluent would further increase the cost of the reclaimed water.

Two treatment technologies were considered to provide additional BOD and turbidity removal. Membrane bioreactor (MBR) and rotating disk filtration systems were considered for the supplemental treatment of wastewater effluent. Supplemental treatment or effluent polishing units draw effluent from the final treatment unit, the chlorine contact chamber, for supplemental treatment (Figure 6).

Figure 6: Reclaimed Water Pumping



MBR and rotating disk filtration treatment systems are capable of producing high quality reclaimed water. An MBR treatment unit is characterized by a relatively simple and efficient operation. In the MBR treatment process, wastewater effluent is pumped from the chlorine contact chamber to the MBR unit for filtration. MBR treatment relies on a low pressure microporous membrane that is used to separate solids and liquid in wastewater. Construction includes addition of a reactor tank in which the MBR unit is submerged and pumps to move effluent to the MBR and from the MBR to the bulk storage tank. Additional disinfection is provided as reclaimed water is pumped from the MBR to the bulk storage tank.

Capital costs for MBR construction is higher than conventional treatment processes and higher than the costs of rotating disk filtration. MBR units are not without operational considerations in that membranes can be clogged with grease or solids. However, placing the MBR unit at the end of the treatment process minimizes most of the operational considerations, leaving higher capital costs as the primary determining factor for effluent polishing.

Like MBR units, rotating disk filters can be easily integrated into the existing wastewater treatment plants without changing the current treatment processes for discharge permit compliance or requiring extensive construction on the WWTP site. The system considered for this application is a surface filtration system that consists of continuously rotating disk filters made of woven stainless steel mesh. Some units are manufactured so that the effluent side of the filter is partially submerged. Solids are removed during a backwash cycle and discharged from the filter back to the WWTP headworks.

5.3 Reclaimed Water Production Facilities

In addition to the use of treated wastewater effluent from the NBU POTWs, the potential use of satellite or reclaimed water production facilities (RWPF) was evaluated. These facilities are designed to provide compact, on-site treatment of wastewater to produce finished effluent that meets Type I reclaimed water quality. RWPF are located near a wastewater interceptor that has an average daily flow that will meet the peak reclaimed water demand. Various manufacturers of RWPF capable systems were considered for this study. RWPF technology is compact in nature, but localized production of reclaimed water requires a portion of parkland to be used for the RWPF facility and reclaimed water storage. For the purposes of this feasibility study, major interceptors identified in Sec. 3.5 were presumed to maintain average daily flows that would meet the reclaimed water demand.

5.3.1 Regulations

RWPF are authorized under 30 TAC Chapter 321, Subchapter P. By definition, RWPF is a facility that treats wastewater reuse on an as-needed basis and is not located at the POTW. RWPF employ the basic processes of wastewater treatment in a very compact facility, but have several limitations prescribed by state regulation. RWPF cannot:

- Discharge treated wastewater or pollutants to waters of the state;
- Operate at a flow rate that, individually or collectively, exceed the hydraulic capacity of the POTW authorized by permit;
- Treat or dispose of wastewater sludge; or
- Accept hauled wastes for treatment.

5.4 Operational Storage Requirements

Storage of reclaimed water allows balancing supply with water demand. During the periods of peak summer demand, reclaimed water can be produced continuously during a 24-hour period and pumped to storage. Storage allows irrigation of the city's parks during the hours of midnight to 6:00 AM without risking over-drafting the rate of wastewater treatment plant discharge. Production at a continuous rate also minimizes transmission pipeline diameters and allows for an efficient pumping regime.

The minimum storage volume used in this study is equal to the peak day irrigation demand. In addition to the significant concerns associated with evaporation and water quality deterioration, open storage reservoirs require a portion of the limited acreage of parklands. Structured storage, *i.e.* steel and concrete reservoirs, provides flexibility in the location of storage as well as essentially eliminating evaporative losses.

Considerations in the design of operational storage include the ability to discharge reclaimed water to the sewer system and locations that are compatible with existing land use. The system configurations considered in this study focused on reducing pumping capacity and transmission pipe diameter.

The system configurations considered involve locating storage near the areas of highest demand. One tank could be located in the general area of Landa Park and the other near Fischer Park. The tank sites considered are shown in Figure 7. Seven locations for operational storage were considered for this study. Four of these locations were evaluated on the basis of above-ground welded steel tanks and three were considered as underground concrete reservoirs. Only existing public property was considered as possible storage tank sites for the purpose of this study.

5.4.1 Above-Ground Storage

Above-ground storage can be welded steel or reinforced concrete ground storage tanks. Reclaimed water is pumped from the tank to the points of delivery.

Gruene WWTP

The existing Gruene WWTP site was considered for possible proximity to Landa Park. However, the location is not central to the system configurations that are supplied by the North or South Kuehler WWTPs.

N/S Kuehler WWTP

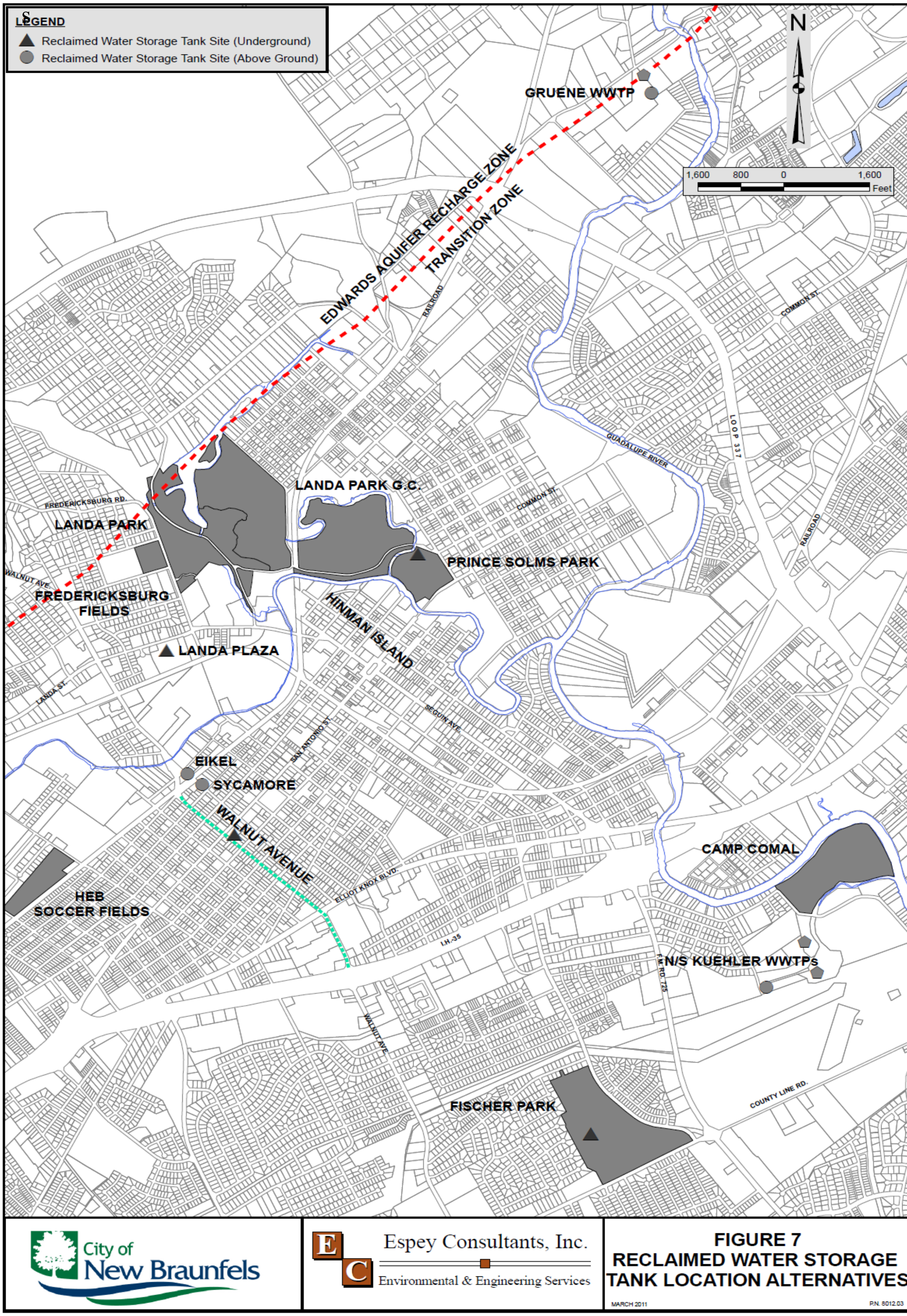
The advantages of this site include close proximity to both the source of reclaimed water as well as to the high demand area of Camp Comal and Fischer Park.

Sycamore St.

Right-of-way located between Bridge St. and railroad ROW. This location appears to function as drainage from Bridge St. to the railroad ROW and is located between two residences.

Eikel St.

The Sycamore St. ROW extends north of the railroad ROW and intersects with Eikel St. Much of the ROW functions as a drainage channel, but there appears to be adequate ROW for construction of a reservoir adjacent to commercial property.


LEGEND
Reclaimed Water Storage Tank Site (Underground)
Reclaimed Water Storage Tank Site (Above Ground)
N
1,600 800 0 1,600 Feet
GRUENE WWTP
EDWARDS AQUIFER RECHARGE ZONE
TRANSITION ZONE
RAILROAD
COMMON ST.
LOOP 337
GUADALUPE RIVER
LANDA PARK G.C.
FREDERICKSBURG RD.
LANDA PARK
PRINCE SOLMS PARK
WALNUT AVE.
FREDERICKSBURG FIELDS
HINMAN ISLAND
LANDA PLAZA
LANDA ST.
SAN ANTONIO ST.
SEGUIN AVE.
EIKEL
SYCAMORE
WALNUT AVENUE
CAMP COMAL
ELLIOT KNOX BLVD.
HEB SOCCER FIELDS
I.H.-35
N/S KUEHLER WWTPs
F.M. RD. 725
WALNUT AVE.
COUNTY LINE RD.
FISCHER PARK
City of New Braunfels
Espey Consultants, Inc.
Environmental & Engineering Services
FIGURE 7
RECLAIMED WATER STORAGE TANK LOCATION ALTERNATIVES
MARCH 2011
P.N. 8012.03

5.4.2 Underground Storage Alternatives

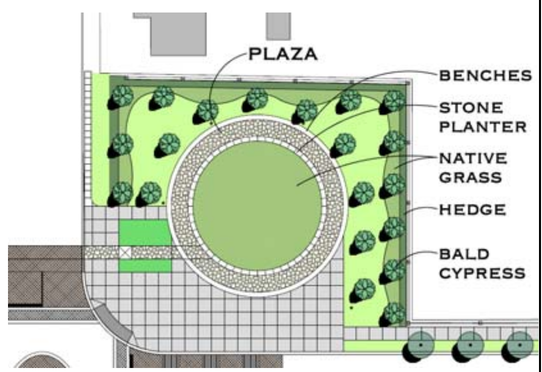
Reinforced concrete tanks are widely used as ground storage tanks for potable water storage. Concrete tanks can be designed to be placed above ground or underground. As an underground storage reservoir for reclaimed water, a concrete tank can provide efficient storage, minimal maintenance and discreet placement in parks or high traffic areas. Construction of an underground storage tank requires an area that allows excavation and storage of equipment and materials. The tank can be completely buried with up to two feet of soil covering the top to allow planting of grass and shrubs, or the top of the tank can be incorporated into the landscaping. The exposed roofs of buried concrete tanks have been used as basketball courts and have been designed with additional reinforcement to allow parking.

Three possible sites for underground storage of reclaimed water were considered in this study.

Walnut Ave.

ROW acquisition for the Walnut Ave. widening project included a 0.9 acre site at the intersection of San Antonio St. and Walnut Ave. Park development planned for this area includes a landscaped park with a circular planting area (Figure 8). Construction of an underground storage reservoir could be completed without significantly affecting the planned park development. However, coordinating the design and construction of a storage tank with the Walnut Ave. widening project would require delaying development of the park.

Figure 8: Walnut Ave. Widening Project



Landscape Architect: Chris Miller

Prince Solms Park

Prince Solms Park has a considerable area of open space that could be used for underground storage without eliminating or unduly limiting use of the area.

Landa Plaza

The site of the former Landa Plaza was purchased by the city for the future construction of a new city hall. An underground storage reservoir or a storage pond could be incorporated into the site plan for development of a municipal government center.

Fischer Park

An underground storage tank could be incorporated into the landscaping features of Fischer Park.

5.5 Additional Design Considerations

Irrigation of the city's parks occurs during the period of midnight to 6 AM. In sizing the pumping, transmission piping, and storage, it was determined that supply pumping should continue during the entire 24-hour period during peak demand. The storage tanks would be drawn down during the 6 hours of irrigation. The conceptual design is also based on a system pressure of 80 psi at each delivery point and that no backflow prevention or retail meters are included at the delivery points.

Additional measures for detecting and minimizing the loss of reclaimed water as a result of main breaks can be evaluated as part of the final design. As with systems supplied by potable water, irrigation systems that rely on reclaimed water function only when the delivery pressure is adequate to activate each zone of the system. An ability to detect the lack of sufficient pressure at the delivery points is a design feature that may be useful in detecting reclaimed water main breaks. The delivery pressure at each delivery point could be transmitted to the NBU SCADA system to initiate an alarm if minimum pressures indicate a possible line break between the distribution pump and delivery point. The feasibility of such a feature can be evaluated as part of the final design of a reclaimed water system.

Unlike tanks used for potable water, interior coating systems that are classified under ANSI/NSF 61 are not required for reclaimed water storage. This will allow a broader choice of interior coating systems in the design of storage tanks for reclaimed water that will enhance the durability and corrosion resistance when using welded steel tanks.

THIS PAGE INTENTIONALLY LEFT BLANK

6 Pipeline Route Evaluation Criteria

Routes for reclaimed water transmission pipelines were evaluated and compared on the basis of several factors. These factors include:

Accessibility**:** Accessibility for NBU employees for ease of maintenance. This requires making an effort to route the proposed sewer within public rights-of-way, as opposed to utility easements on private property.

User Impacts**:** User impacts include street access and traffic control needed during construction, property impacts associated with construction including obstruction of driveways and damage to landscaping, conflicts with existing utilities and possible need for utility adjustments or relocations, and restoration within streets and on private property. The aspects of the project that potentially impact the users of the project area were considered when comparing the various alternatives:

> *Traffic Control*: Since it is preferred that the reclaimed water system be located within public rights-of-way, streets will be impacted during construction. Adequate detours and/or proper staging are necessary to allow both emergency vehicles and local residents' access.
>
> *Private Property Impacts*: Construction activities may impact private properties and require restoration and/or compensation for any damage caused. These types of impacts include excavation within easements and may damage driveways and/or landscaping along street routes.
>
> *Utility Conflicts*: Many existing utilities are located along the various route alternatives. Coordination throughout the design and construction phases will be necessary to minimize damage to existing utilities and interruption of services. Relocations or adjustments at conflict areas will be necessary. Since relocations and adjustments will increase both design and construction costs, minimizing the number of conflicts is desired.
>
> *Restoration Needs*: Most of the alternative routes are located within public rights-of-way. The required restoration or street pavement, curb and gutter, and possibly landscaping.

Constructability: Constructability concerns include the depth of construction and required construction methods. It is preferred to maintain a minimum construction depth to limit the area of construction and related impacts. The construction methods necessary for construction of the reclaimed water system will be based on existing easement restrictions, right-of-way limits, proximity to existing infrastructure, and maintaining emergency access to all properties.

Construction Depth: The depths of the proposed reclaimed water system is estimated based on existing contour information available through the city's GIS system. A depth range of approximately 4 ft. to 6 ft. deep, with greater depth where necessary to avoid conflicts with existing infrastructure, would be appropriate for reclaimed water transmission piping.

Construction Methods: Several factors are considered when identifying appropriate construction methods. Crossing features such as rivers, creeks, highways, and major utilities will dictate construction methods. Potential inconvenience to residents and businesses along each route alternative will also impact how the reclaimed water system is constructed. Soil conditions will also influence the choice of construction methods for various sections of the project.

Three construction methods were considered:

- Open Cut is the conventional excavation of a trench for pipe placement. It is generally the least expensive method; however, it can be the most disruptive and requires the greatest amount of restoration.

- Boring and Jacking is a trenchless construction method for pushing a casing pipe through the ground instead of open trench excavation. It is used where open trenching is very difficult, such as a river or creek crossing, or where disturbance to an existing feature is not allowed, such as a highway crossing. This method usually consists excavation of a access pits and then jacking a casing or carrier pipe into the soil. Soil is then removed from the casing with an auger. This method is usually more expensive than open trenching.

- Microtunneling is a trenchless process for boring a pipe through the ground in lieu of open cutting. Similar to bore and jack, it is also used where open trenching is very difficult, such as a creek or river crossing, or where disturbance to an existing feature is not allowed, such as a highway crossing. This method is similar to bore and jack in that a pipe is installed through a horizontal hole in the ground. However, with this method there is control of grade and direction so the pipe can be adjusted to keep tunneling on grade. This method is preferred for longer lengths of piping and provides greater control of sewer direction to the contractor. This method is more expensive than traditional open cut excavation.

Land acquisition: It is preferred to construct the reclaimed water system within public rights-of-way or within existing utility easements. Minimizing the acquisition of easements would reduce the impact to private properties, coordination of construction and related costs.

Agency Coordination: For various potential permits associated with construction, coordination will be required with various agencies. This includes TxDOT, railroads, TCEQ, and the U.S. Army Corps of Engineers.

7 Project Alternatives

The alternatives for delivering reclaimed water to the City's parks required an evaluation of three project elements: source of supply, storage and transmission piping. Three reclaimed water sources were considered: RWPF, effluent from the North or South Kuehler WWTP, and Greune WWTP effluent. The N/S Kuehler and Gruene sources produced a total of six alternatives that were considered. Of these six alternatives, four relied on N/S Kuehler for the supply of reclaimed water. One alternative used both N/S Kuehler and the Gruene WWTP for supply and one route considered only Gruene as the source of reclaimed water.

The following sections describe each of the project alternatives and the related capital and operation and maintenance costs. Detailed preliminary opinions of probable project costs are presented in Appendix E.

7.1 Reclaimed Water Production Facilities (RWPF)

As previously discussed (Sec. 4.1.5 and 4.6), there are specific space requirements when considering RWPF technology. Both buffers from buildings and the space required for the RWPF and storage are significant negative aspects of the technology when considered for existing parklands. As an alternative, RWPF were considered as possible sources of reclaimed water for single parks and as centrally located units for multiple parks.

Combining parks using RWPF as the reclaimed water source created a total of five groups. Each system would be sized according to the peak demand and incremental capacity of the RWPF treatment unit.

Table 13: RWPF Deployment

Group	Parks & Recreational Areas	Rainfall Credit	Cumulative Daily Peak Demand (gpd)	Proposed System (gpd)
1	Land Park & Fredericksburg Fields	100%	143,970	150,000
		50%	170,827	200,000
		0%	205,286	200,000
2	Golf Course, Prince Solms, & Hinman Island	100%	194,360	200,000
		50%	230,616	250,000
		0%	277,136	300,000
3	Fischer Park	100%	308,507	300,000
		50%	366,057	350,000
		0%	439,899	450,000
4	Camp Comal	100%	155,796	150,000
		50%	184,859	200,000
		0%	222,149	250,000
5	HEB Soccer Complex & Walnut Ave.	100%	85,868	100,000
		50%	101,886	100,000
		0%	122,439	150,000

7.1.1 RWPF Technology

A representative list of system capacity and treatment technologies were evaluated for cost and suitability for location in parks. Three processes were considered as viable RWPF alternatives. These were:

- Sequencing Batch Reactor (SBR)
- Membrane Biological Reactors (MBR)
- Continuous Backwash Upflow Media (CBUM)

Sequencing Batch Reactor

Sequencing batch reactors (SBR) consist of two tanks with a common inlet. Wastewater is drawn into one tank for aeration while the other tank is decanting. A variation of the SBR technology allows influent flow to continue into a basin during the settle and decant phases or at any time during the operating cycle. This design variation allows the inflow to be continuously aerated, settled, and decanted for a controlled time period, enhancing the flow capacity of the treatment system and reducing the system footprint.

Membrane Biological Reactor

MBR technology includes both self-contained flat sheet membrane panels that are submerged in a tank and hollow fiber membranes. Advantages of hollow fiber membranes over the flat sheet membranes are higher packing density and better clean-in-place chemical circulation resulting in reduced footprint and maintenance downtime.
Some manufacturers provide an anoxic basin and aeration basin prior to the membrane basin or aeration and membrane basins combined into a single basin. Membranes require periodic maintenance including clean-in-place and external cleaning.

Continuous Backwash Upflow Media

CBUM technology is a modular approach to treating wastewater that relies on polymer-conditioned sand media filtration along a suspended-media process. Solids are separated from the liquid stream in the preliminary separator and compacted using a screw conveyor. The liquid stream then passes through the first-stage filtration tank, which contains a polymer-conditioned sand media removing finer solids. The effluent first-stage filtration tank flows under gravity to the bio tank. Dissolved organic matter is treated in the bio tank and another filtration follows the biological treatment. In this second-stage filtration tank, excess and dead micro-organisms and remaining fine solids are trapped in the polymer-conditioned sand media. The effluent of second-stage filtration tank is either stored in a tank for disinfection or additional treatment as required.

7.1.2 RWPF Costs

RWPF technology offers certain advantages in locating treatment facilities near the point of use in order to eliminate the need for construction of large scale reclaimed water pumping and transmission facilities. However, certain distinct aspects of RWPF technology would require additional analysis before such systems could be considered for producing reclaimed water for park irrigation in New Braunfels. The factors that would require additional analysis include:

- Wastewater interceptor flow rate: Besides the initial concern that the nearest interceptor provides sufficient water to meet the peak day demand, solids deposition in the sewer is an operational concern that would require diurnal flow monitoring during summer months.
- On-site storage of reclaimed water: Peak day demands of 100,000 gallons to 250,000 gallons would require construction of multiple reclaimed water storage facilities in or near parks.
- Space requirement and aesthetic considerations: In an established park, adding a RWPF and related storage would have the effect of reducing the park area available for recreational use. Adding these facilities to a park would also require landscape architectural design to integrate the facilities with the surroundings.
- Concentration of solids: The return of solids to the wastewater interceptor has the potential of increasing the influent strength at the POTW. The treatment process and capacity would need to be analyzed in light of an increasing influent BOD and TSS load.
- RWPF Costs: The construction of a decentralized reclaimed water system substitutes the capital cost of centralized pumping, storage and transmission with multiple treatment units. Operation and maintenance (O&M) costs vary with both flow volume and type of system. However, the additional operator labor to monitor the status of each of the systems is not included in the table.

RWPF were sized for the peak day capacity. The RWPF are typically highly compact facilities that are designed to treat base loads with minimal peaking factors and little or no redundant equipment. With peaking flows and equipment redundancy not critical to the design, construction costs can be minimized. Probable cost projections for RWPF using various technologies are shown in Table 14.

Table 14: RWPF Costs

RWPF Technology	Plant Capacity (GPD)	Capital Cost	Plant Footprint Width (ft)	Plant Footprint Length (ft)	Annual Chemical Cost	Annual Power Cost
SBR	50,000	$ 425,500	8	40	$ 400	$ 5,301
	100,000	$ 851,000	16	40	$ 800	$ 10,601
	150,000	$ 1,276,500	16	80	$ 1,200	$ 15,902
	200,000	$ 1,702,000	16	80	$ 1,600	$ 21,202
CBUM	60,000	$ 1,650,000	22	45.83	$ 6,480	$ 969
	120,000	$ 3,300,000	44	45.83	$ 12,960	$ 1,938
	250,000	$ 1,750,000	44	91.66	$ 36,500	$ 1,453
Membrane - Hollow Fiber	50,000	$ 780,000	16.5	40.83	$ 800	$ 6,000
	100,000	$ 875,000	16.5	93.5	$ 1,600	$ 12,000
	150,000	$ 1,530,000	33	76.66	$ 2,400	$ 18,000
	200,000	$ 1,630,000	46.75	83.33	$ 3,200	$ 14,000
	250,000	$ 1,682,000	46.75	83.33	$ 4,000	$ 17,500
Membrane - Flat Sheet	50,000	$ 368,000	6	28.5	$ 1,450	$ 2,993
	100,000	$ 486,000	6	43.5	$ 2,538	$ 5,877
	150,000	$ 704,000	11	33.5	$ 3,625	$ 8,432
	200,000	$ 767,000	11	38.5	$ 4,351	$ 9,344
	250,000	$ 1,019,000	25	28.5	$ 5,801	$ 10,914

RWPF systems are expanded by specific capacity increments. The manufacturer of the CBUM process, for example, produces units with either 60,000 gpd or 250,000 gpd capacity. A 300,000 gpd capacity would require construction of both a 250,000 gpd plant and a 60,000 gpd plant, or acceptance of a 250,000 gpd limit of capacity.

Table 15: RWPF System Costs

RWPF Technology	Capital Cost (50,000 gpd)	Capital Cost (100,000 gpd)	Capital Cost (200,000 gpd)
SBR	$ 425,500	$ 851,000	$ 1,702,000
MBR	$ 400,000	$ 690,000	$ 1,170,000
MBR	$ 780,000	$ 875,000	$ 1,630,000
CBUM[1]	$1,650,000	$ 3,300,000	$ 1,750,000

[1] Standard capacities are based on multiples of 60,000 or 250,000 base units.

Full consideration of RWPF for uses in producing reclaimed water for parks irrigation, actual flow metering of the major interceptors identified in Sec. 3.5 would be needed. It is assumed for the purposes of comparing RWPF with effluent supply alternatives that the interceptors located in the vicinity of the RWPF would be adequate. However, due to the close proximity of Camp Comal to the N/S Kuehler WWTP, effluent from the WWTP was considered as a replacement for RWPF construction for that area.

Table 16: RWPF Service Area Costs

Irrigation Area	Parks	Peak Day Demand (gpd)	RWPF Capacity (gpd)	RWPF Capital Cost
1	Land Park & Fredericksburg Fields	205,286	200,000	$1,380,000
2	Golf Course, Prince Solms, & Hinman Island	277,136	300,000	$1,880,000
3	Fischer Park	439,899	450,000	$2,670,000
4	Camp Comal	222,149	250,000	$1,500,000
5	HEB Soccer Complex & Walnut Ave.	122,439	150,000	$940,000

7.2 North or South Kuehler WWTP Effluent

Both the North and South Kuehler WWTP have adequate capacity to supply the required volume of reclaimed water. However, since the chlorine contact chamber at the South Kuehler WWTP provides a more open area for installation of effluent polishing equipment than North Kuehler, the alternatives consider the South Kuehler WWTP as the source of reclaimed water.

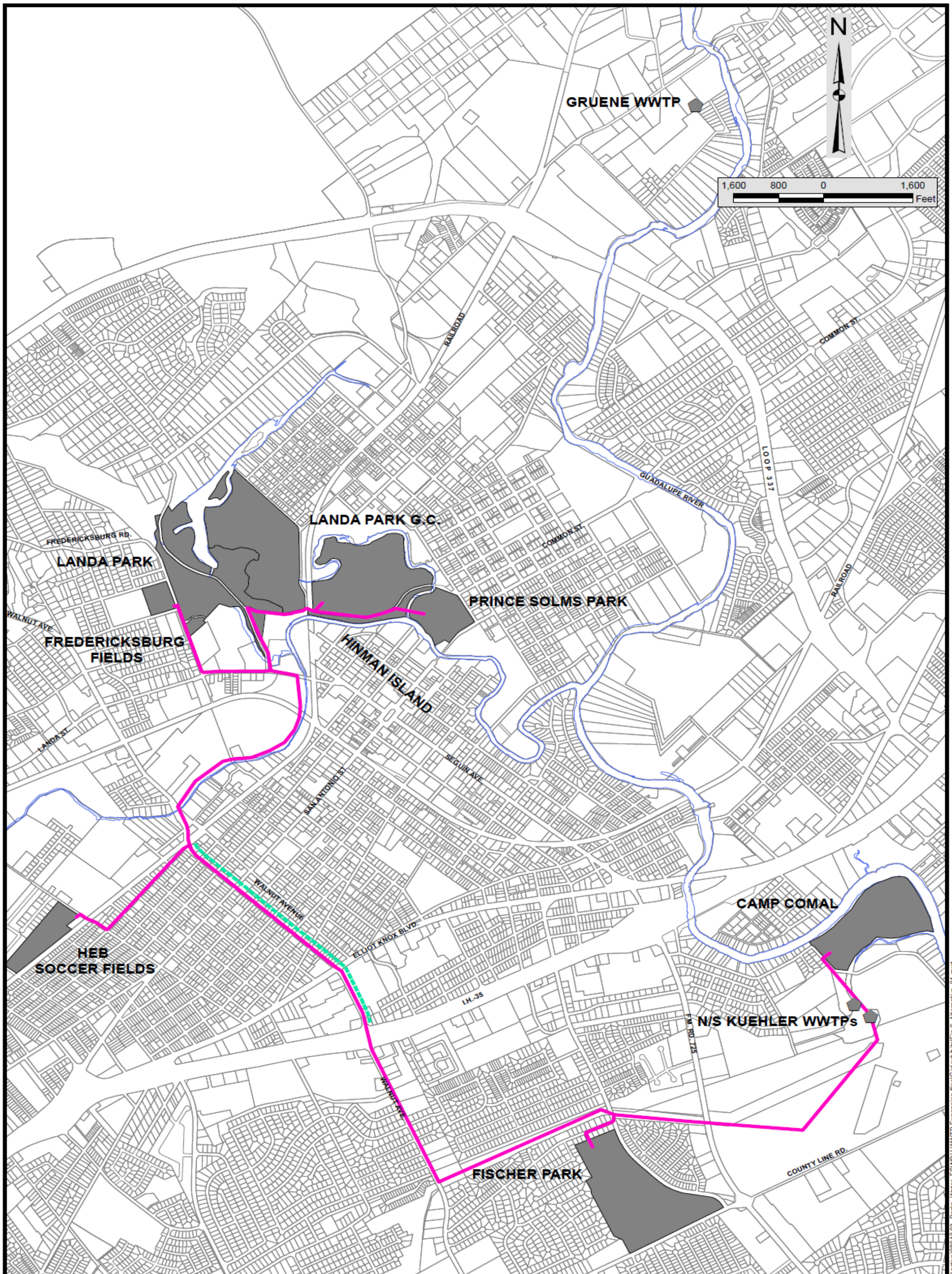
7.2.1 Alternative 1: South Trib. – Walnut Ave. Route

This alternative (Figure 9) takes advantage of the existing South Tributary ("Trib") Channel right-of-way and has the shortest overall pipeline length of all of the WWTP supply alternatives. The reclaimed water transmission pipeline between IH 35 and Landa St. is shown as part of the Walnut Ave. widening project, but can be located to a parallel route along Sycamore or Hickory without a significant increase in the total length of pipe.

Key features in the evaluation of this alternative included:

1. Accessibility: This route is entirely within public ROW. Location within the South Trib ROW has the additional advantage of minimizing traffic conflicts with construction and O&M.

2. User Impacts: The volume of traffic along Walnut Ave. between the South Trib channel and IH 35 is significant in terms of access to businesses, neighborhoods and schools in the area. Construction detours, especially if construction occurs during the school year, will have a noticeable effect. However, scheduling of the project could avoid conflicts with school traffic. Alternative construction methods that limit construction disturbance, such as



City of New Braunfels

Espey Consultants, Inc.
Environmental & Engineering Services

FIGURE 9
ALTERNATIVE 1
SOUTH TRIB.-WALNUT AVE.

MARCH 2011 P.N. 8012.03

microtunneling, could also be considered in the final design. This alternative minimizes the need for pavement restoration by using the South Trib ROW.

3. Constructability: Open trench construction is feasible for all areas in Alternative 1 except for river and creek crossings and crossings of TxDOT and railroad ROW where boring will be required.

4. Land Acquisition: The pipeline route is located completely within public rights-of-way so no land acquisition is anticipated.

5. Agency Coordination: Wetland areas will be delineated as part of the design phase to determine if construction might require a pre-construction notice (PCN) under the Nationwide 12 provisions. Since most wetland areas can be avoided, permitting should not be an issue. State highway ROW crossings will require permits from TxDOT. Crossing railroad ROW will require a permit from the railroad company.

7.2.2 Alternative 2: Merriweather St. – Walnut Ave. Route

Alternative 2 creates a shorter pipeline from the South Kuehler WWTP to Landa Park, but the overall length of pipeline construction is almost one mile longer than Alternative 1 due to the separate transmission pipeline to Fischer Park through the South Trib.

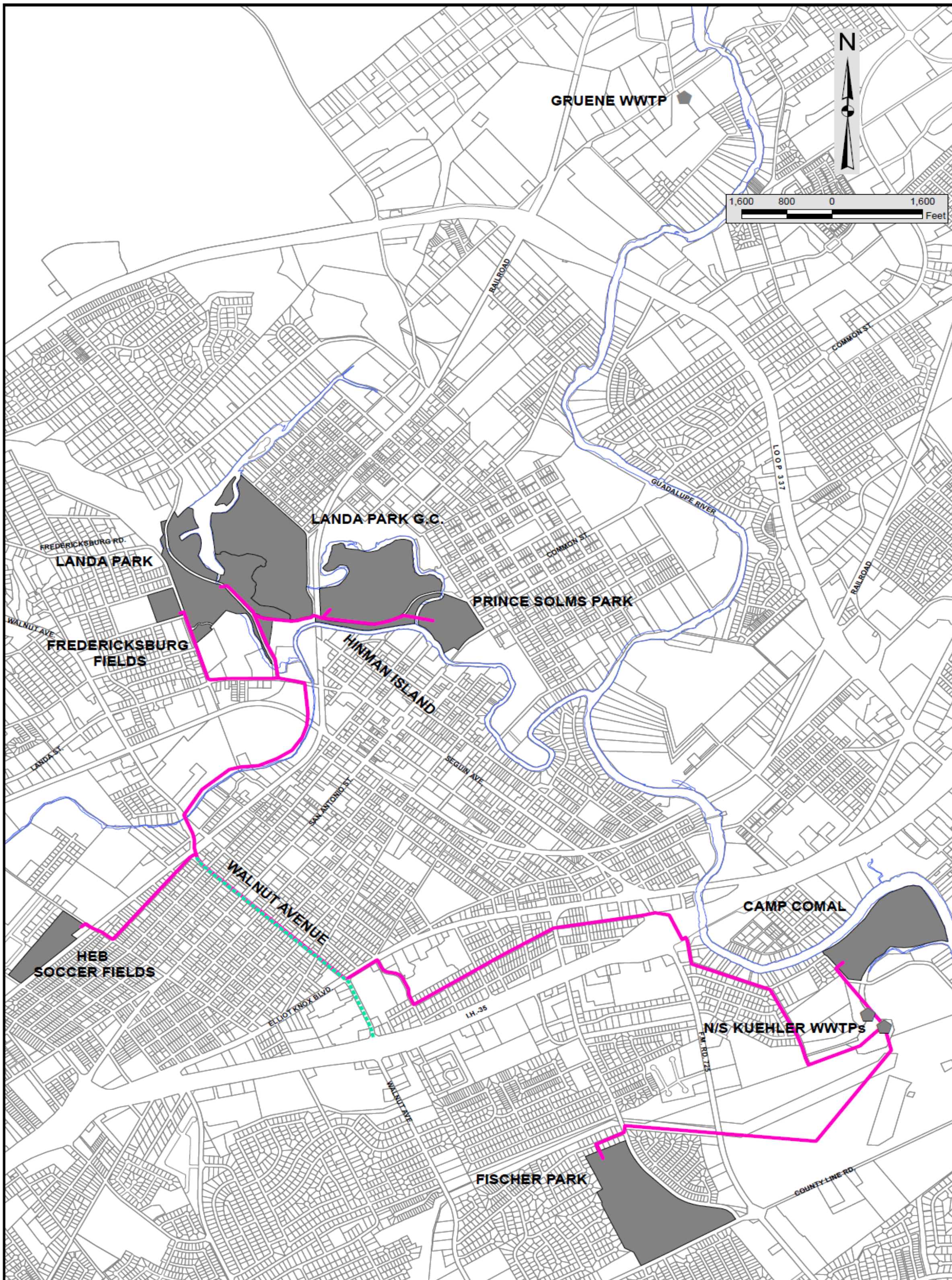
Key features in the evaluation of this alternative include:

1. Accessibility: This route is also entirely within public right of way, providing accessibility for maintenance.

2. User Impacts: A substantial portion of this alternative is located along residential streets. Construction would cause short-term neighborhood disruptions.

3. Constructability: With much of the transmission pipeline for Alternative 2 located within residential areas, open cut construction can be used with minimal neighborhood disruption. Crossings of TxDOT and railroad ROW will require boring, as will creek and river crossings.

4. Land Acquisition: The pipeline route is located completely within public rights-of-way so no land acquisition is anticipated.



City of New Braunfels

Espey Consultants, Inc.
Environmental & Engineering Services

FIGURE 10
ALTERNATIVE 2
MERRIWEATHER ST. - WALNUT AVE.

MARCH 2011

P.N. 6012.03

7.2.3 Alternative 3: Guadalupe River Route

This alternative (Figure 11) follows a route along the east side of the Guadalupe River from the South Kuehler WWTP to Prince Solms Park. A separate pipeline transports reclaimed water to Fischer Park. This alternative was developed to incorporate an underground storage tank that would be located at Prince Solms Park.

Key features in the evaluation of this alternative include:

1. Accessibility: The pipeline route for Alternative 3 relies on existing NBU utility easements between Camp Comal and Cross River St. Verification of the availability of space for construction within the existing easement would be verified as part of the project design.

2. User Impacts: The pipeline route for Alternative 3 was defined to avoid direct construction impact on Union St. or Common St., except for crossing Union St. Construction would temporarily affect traffic in the neighborhood along Washington Ave. and South St.

3. Constructability: Most of the pipeline construction in Alternative 3 would be by open trench construction. However, this alternative has an additional boring across the Guadalupe River that was not part of Alternatives 1 and 2.

4. Land Acquisition: Use of the existing NBU utility easements does not ensure adequate room for construction. Temporary construction easements may be required.

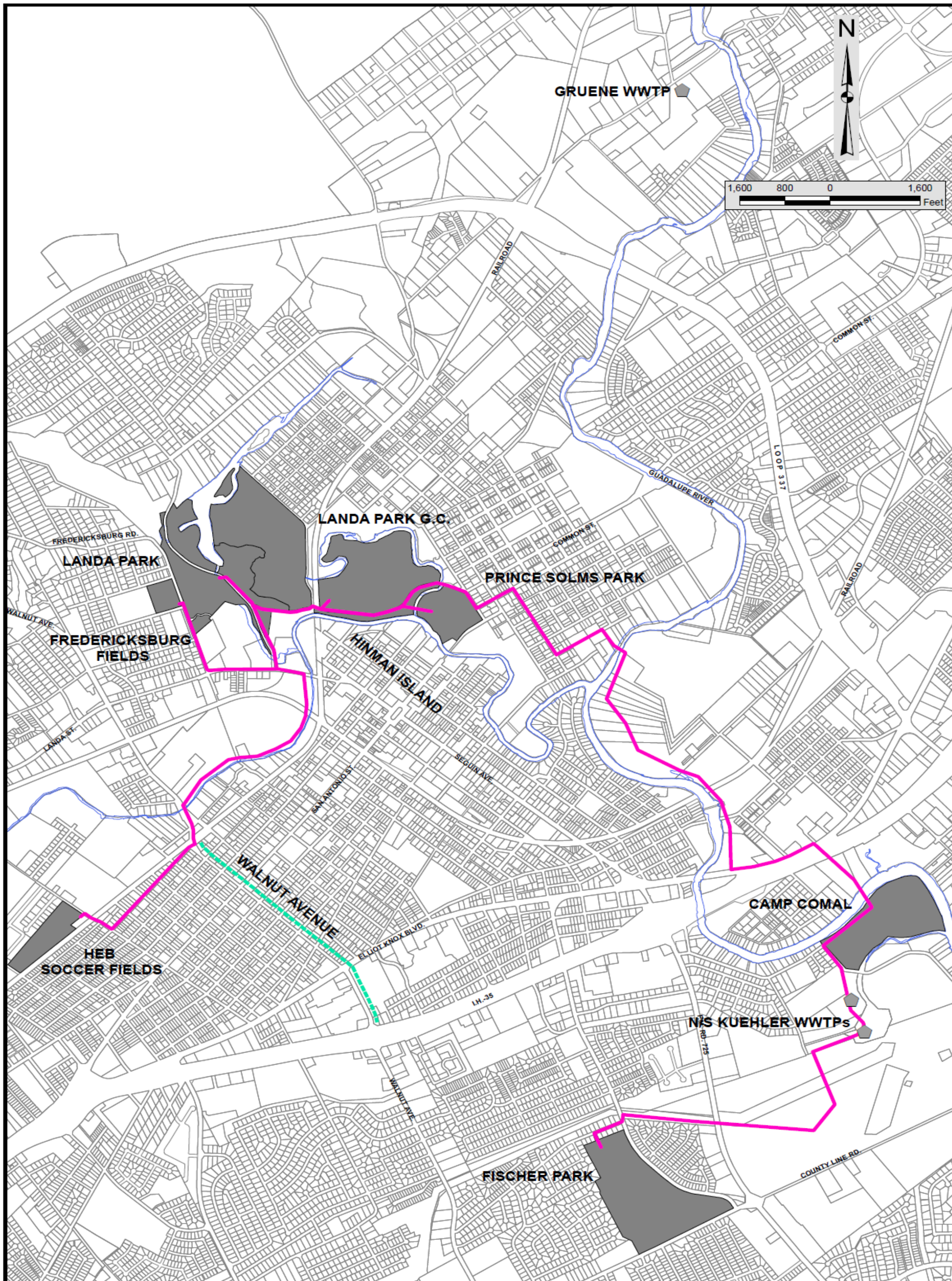
7.2.4 Alternative 4: Kuehler - Comal Ave. Route

The reclaimed water transmission pipeline for Alternative 4 (Figure 12) is routed along the west side of the Guadalupe River from the South Kuehler WWTP, across IH 35 to Comal Ave. with a secondary pipeline to serve Fischer Park.

Key features in the evaluation of this alternative include:

1. Accessibility: The reclaimed water transmission pipeline route is located primarily along residential streets, allowing access for construction and maintenance with only temporary traffic disruptions.

2. User Impacts: Most of the pipeline route for this alternative is located along residential. Construction would cause short-term neighborhood disruptions.



City of New Braunfels

Espey Consultants, Inc.
Environmental & Engineering Services

FIGURE 11
ALTERNATIVE 3
GUADALUPE RIVER

MARCH 2011

P.N. 6012.03

3. Constructability: Open trench construction can be used for construction of the reclaimed water transmission pipeline, except for crossings of TxDOT and railroad ROW and river and creek crossings.

4. Land Acquisition: The pipeline route is located completely within public rights-of-way so no land acquisition is anticipated.

7.3 Gruene WWTP Effluent

With an average daily flow of 380,000 gallons, the Gruene WWTP is the smallest of the three NBU wastewater treatment plants. The projected peak day demand for park irrigation ranges from 880,000 gallons to 1,266,900 gallons, depending on the rainfall assumption.

7.3.1 Alternative 5: Kuehler–Gruene WWTP

Alternative 5 (Figure 13) was developed to consider use of both the South Kuehler and Gruene WWTP effluent. This system would supply reclaimed water to Fischer Park and Camp Comal using South Kuehler WWTP effluent while the demand from all other parks would be met with Gruene WWTP effluent.

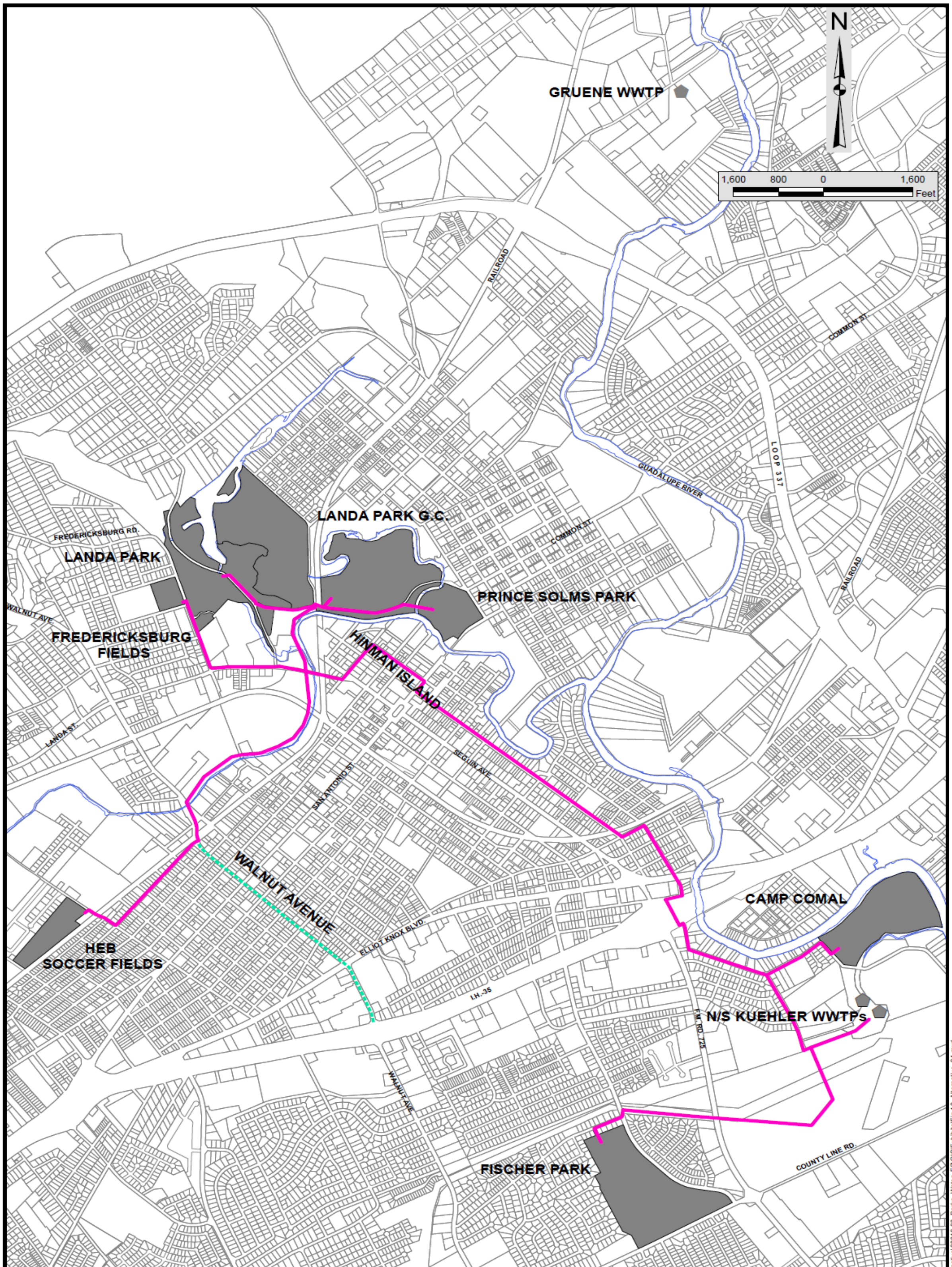
Key aspects in the evaluation of this alternative include:

1. Accessibility: This route is also entirely within public right of way, providing accessibility for maintenance. There would be no pipeline construction on private property.

2. User Impacts: The reclaimed water transmission pipeline route along residential streets between the Gruene WWTP to Prince Solms Park would create temporary neighborhood disruptions.

3. Constructability: With most of the pipeline in Alternative 5 located along low residential streets, open trench construction would be used. Trenchless construction would be used at state highway, railroad, river and creek crossings.

4. Land Acquisition: The pipeline route is located completely within public rights-of-way so no land acquisition is anticipated.



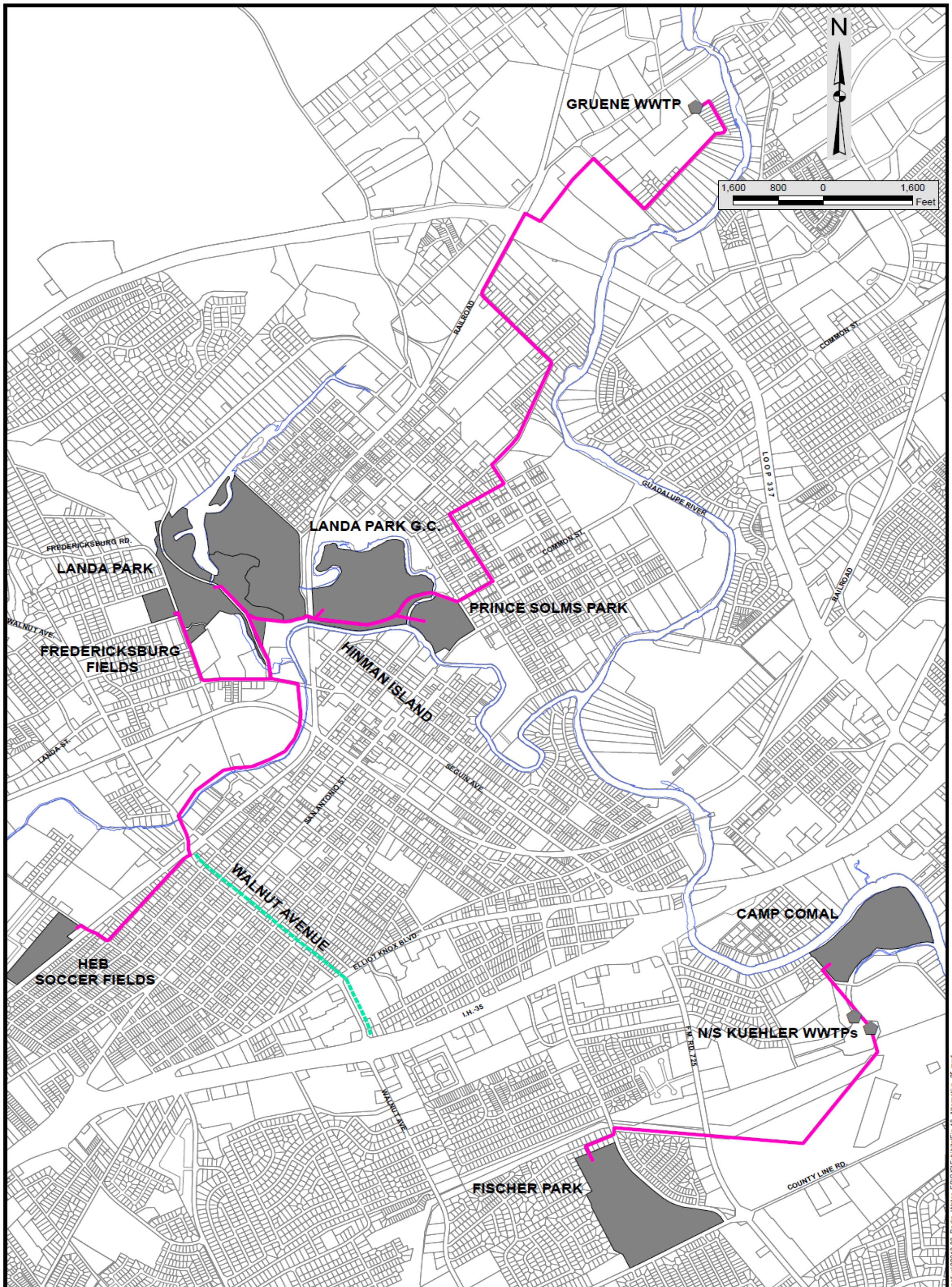
City of New Braunfels

Espey Consultants, Inc.
Environmental & Engineering Services

FIGURE 12
ALTERNATIVE 4
KUEHLER - COMAL AVE.

MARCH 2011

P.N. 8012.03



City of New Braunfels

Espey Consultants, Inc.

Environmental & Engineering Services

FIGURE 13
ALTERNATIVE 5
KUEHLER - GRUENE WWTP

MARCH 2011 P.N. 8012.03

7.3.2 Alternative 6: Gruene WWTP

According to a planning study of the NBU wastewater system (NBU, 2007), the Gruene WWTP is projected to reach a flow rate of 1 MGD as early as the year 2016. Alternative 6 (Figure 14) was developed to recognize that changes in land use occurring after 2007 that would increase flow to the Gruene WWTP could make it a viable source for supplying reclaimed water for park irrigation. Alternative 6 relies solely on supply from the Gruene WWTP effluent, making the pipeline lengths the longest of any of the alternatives considered.

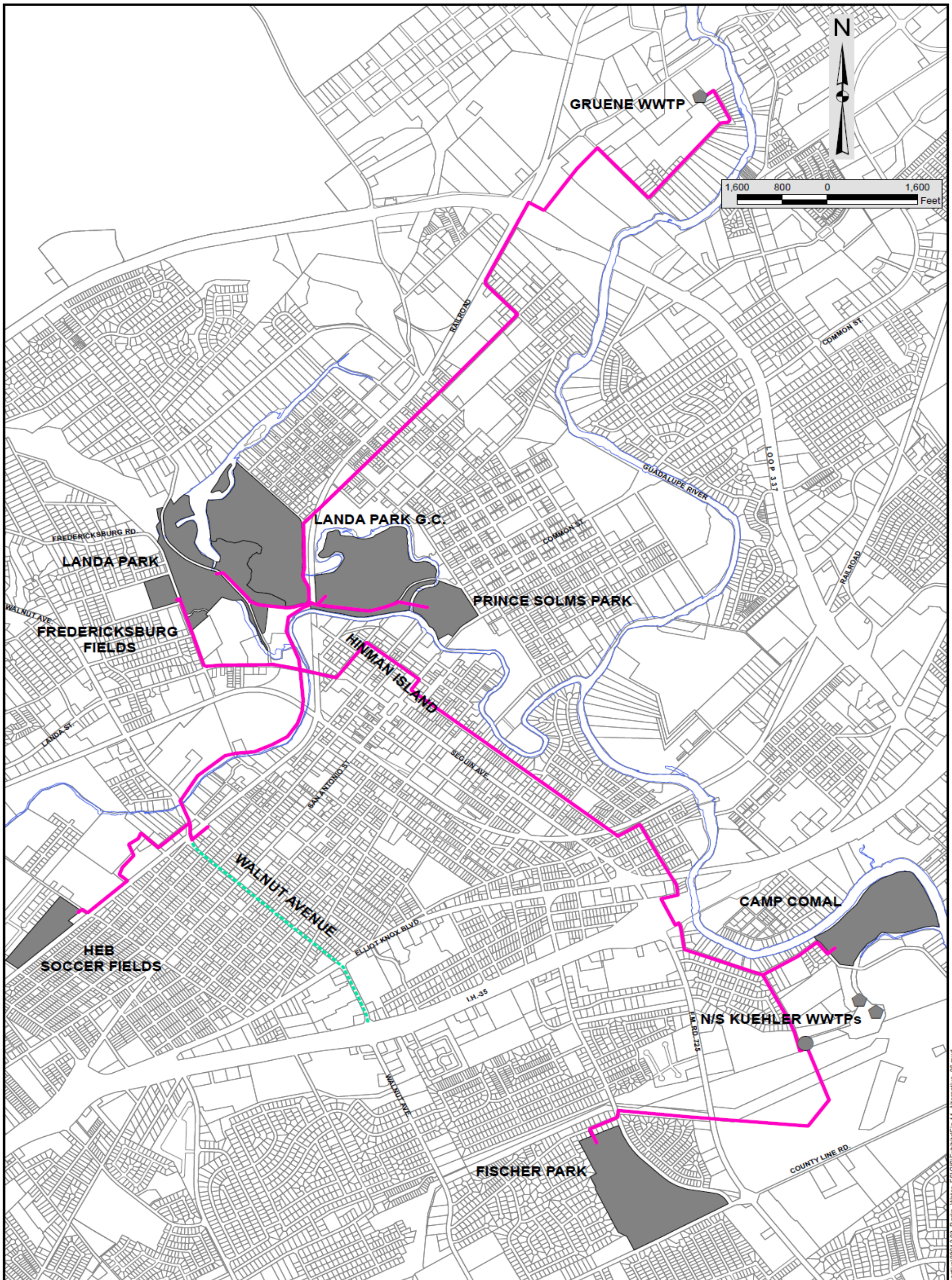
Key features in the evaluation of this alternative include:

1. Accessibility: The route of the reclaimed water transmission pipeline allows construction and maintenance accessibility by being located in existing public rights-of-way.

2. User Impacts: With Route 6 being the longest of the routes and mostly along public streets, traffic disruptions can be minimized by detours and notifying area residents in advance of construction.

3. Constructability: With most of the pipeline route for Alternative 6 located along low traffic streets, traditional open cut installation can used. Boring will be required when crossing Loop 337, IH-35, Business 35, railroad rights-of-way, as well as creek and river crossings.

4. Land Acquisition: The entire route is currently aligned within public rights-of-way or existing utility easements, eliminating the need to acquire easements.



City of New Braunfels

Espey Consultants, Inc.
Environmental & Engineering Services

FIGURE 14
ALTERNATIVE 6
GRUENE WWTP

MARCH 2011

P.N. 8012.03

7.4 Project Cost Summary

The capital cost of a reclaimed water project varies depending on the peak irrigation demand and the pump and piping infrastructure required. This study explored the possibilities of sizing a reclaimed water system in three different ways, depending on how annual average rainfall is included in the total irrigation demand for city parklands, and on the source of supply. The costs of these alternatives vary based on the source of supply, the sizing of the system, and size and location of necessary storage.

Based on the cost estimates presented for the three conditions of rainfall credit and pipeline infrastructure, the total capital construction cost for the project alternatives was developed. Table 17 presents the summary of probable costs for each project alternative.

Table 17: Probable Construction Cost Summary

Project Alternative	Project Cost		
	100% RC	50% RC	0% RC
Alternative 1	$4,445,490	$4,720,700	$4,941,250
Alternative 2	$4,945,090	$5,076,820	$5,259,250
Alternative 3	$4,652,350	$4,784,740	$5,140,220
Alternative 4	$4,890,360	$5,005,390	$5,233,720
Alternative 5	$5,009,720	$5,180,280	$5,369,740
Alternative 6	$6,905,580	$7,235,980	$7,543,240
RCWPF	$6,394,770	$6,986,020	$7,997,750

The total project capital cost estimated for the reclaimed water system is based on the total capital construction costs, with the addition of contingencies and allowances for design and construction management costs.

7.5 Summary of Project Alternatives

While construction of RWPF requires a relatively small area of ground committed to the production of reclaimed water, removing that area from the inventory of useable parkland is a negative aspect of the technology. Using RWPF to produce reclaimed water for irrigation also carries higher capital and operations costs than some of the effluent source alternatives.

The distinguishing factors between the effluent source alternatives are user impact and capital cost. Of the six alternatives considered, the use of the South Trib ROW in Alternative 1: South Trib – Walnut Ave. would remove a significant portion of the pipeline construction from streets and reduce the cost of construction. As shown in Table 17, Alternative 1: South Trib-Walnut Ave. also provides the lowest capital cost alternative using all three water demand conditions. The use of the 0% rainfall credit condition has the highest initial capital cost, but provides the most reliability during drought periods.

8 Project Feasibility Evaluation

This chapter provides a summary of the evaluation of the feasibility developing a reclaimed water system to provide water for parks irrigation. From the list of project alternatives, Alternative 1: South Trib – Walnut Ave. was selected for evaluation as the least cost and least disruptive alternative. The evaluation also considers that the facilities will be sized for an annual volume of reclaimed water based on an irrigation water demand that includes a 0% rainfall credit. The evaluation of project feasibility includes a projection of probable construction and operations cost, a comparison of the unit costs of potable and reclaimed water, and an evaluation of potential benefits of developing reclaimed water for irrigation of the city's parks.

8.1 Existing Water Rate Structure and Rates

As a basis of comparison, the cost of reclaimed water was compared with the current cost of potable water. NBU provides water service to five user classes:

- Residential
- Multi-Unit
- Landscape/Irrigation
- Small Commercial
- Large Commercial

Of these five user classes, the parks potable water irrigation meters are billed as Small Commercial and Landscape/Irrigation and the existing reclaimed water customer is billed as a percentage of the Small Commercial rates. The customer charges for those two rate classes are summarized in the tables below:

Table 18: Water Rates – Landscape/Irrigation

Meter Size	Customer Charge
5/8 inch and smaller	$ 5.97
1 inch	6.91
1 ½ inch	7.54
2 inch	9.10
3 inch	13.19
4 inch and greater	15.71
Usage in Gallons	**Rate per 1,000 Gallons**
0 - 7,500	$ 2.356
7,501 - 25,000	2.749
Excess of 25,000	4.124

Source: NBU Water Rates, Effective Dec. 1, 2007

Reclaimed water is presently sold to the Sundance Property Owners Association at a contract rate of 50% of the small commercial rate, increasing to 75% of the small commercial rate in 2012.

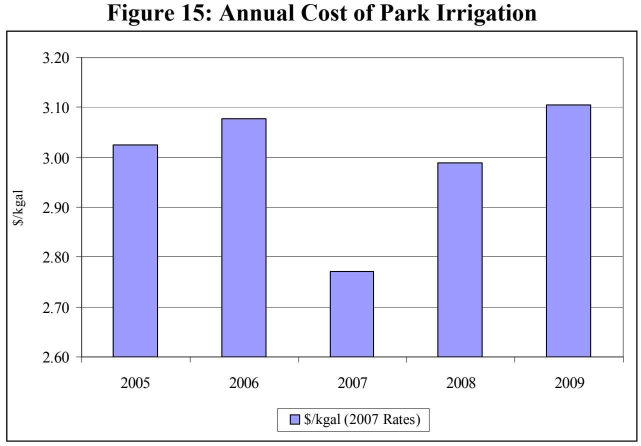
Table 19: Water Rates – Small Commercial

Meter Size	Customer Charge
5/8 inch and smaller	$ 11.62
1 inch	12.56
1 ½ inch	16.33
2 inch	20.73
3 inch	31.40
4 inch	47.74
6 inch and greater	82.90
Usage in Gallons	**Rate per 1,000 Gallons**
0 - 5,000	$ 1.885
5,001 - 50,000	1.946
50,001 - 200,000	2.009
Excess of 200,000	2.135

Source: NBU Water Rates, Effective Dec. 1, 2007

The cost of potable water metered during the period of 2005 – 2009 was evaluated using 17 meters serving six parks – Landa, Prince Solms, Camp Comal, HEB Soccer Complex, and Fredericksburg Fields. An average cost of water per thousand gallons was calculated using the block rates established in 2007 and shown in Table 16 above. While water consumption in the years 2005 through 2007 was charged at different rates, the current 2007 rate tariff was used to provide a basis for comparison of the costs of consumption. The results, summarized in Figure 15, reveal that the average annual cost of water supplied to the six parks for which consumption data were reviewed averaged $3.05 per thousand gallons.

Figure 15: Annual Cost of Park Irrigation



8.2 Opinion of Probable Costs

The preliminary opinion of probable project costs for each alternative is presented in Appendix E. In developing the capital costs, debt service for all facilities was annualized over 20 years at an annual interest rate of 5 percent.

Operations and maintenance costs included electrical power for pumping and a rotating disk filtration unit. Based on discussions with NBU, it was assumed that costs for utility engineering, reclaimed water transmission system O&M, and reclaimed water production would cost $6,000 per year. The analysis of annual operating costs also includes a cost for the purchase of treated effluent for the reclaimed water system. This cost is assumed to be equivalent to the cost of raw Edwards Aquifer, a viable substitute, for the same volume (905 ac-ft), or about $0.11/1,000 gallons.

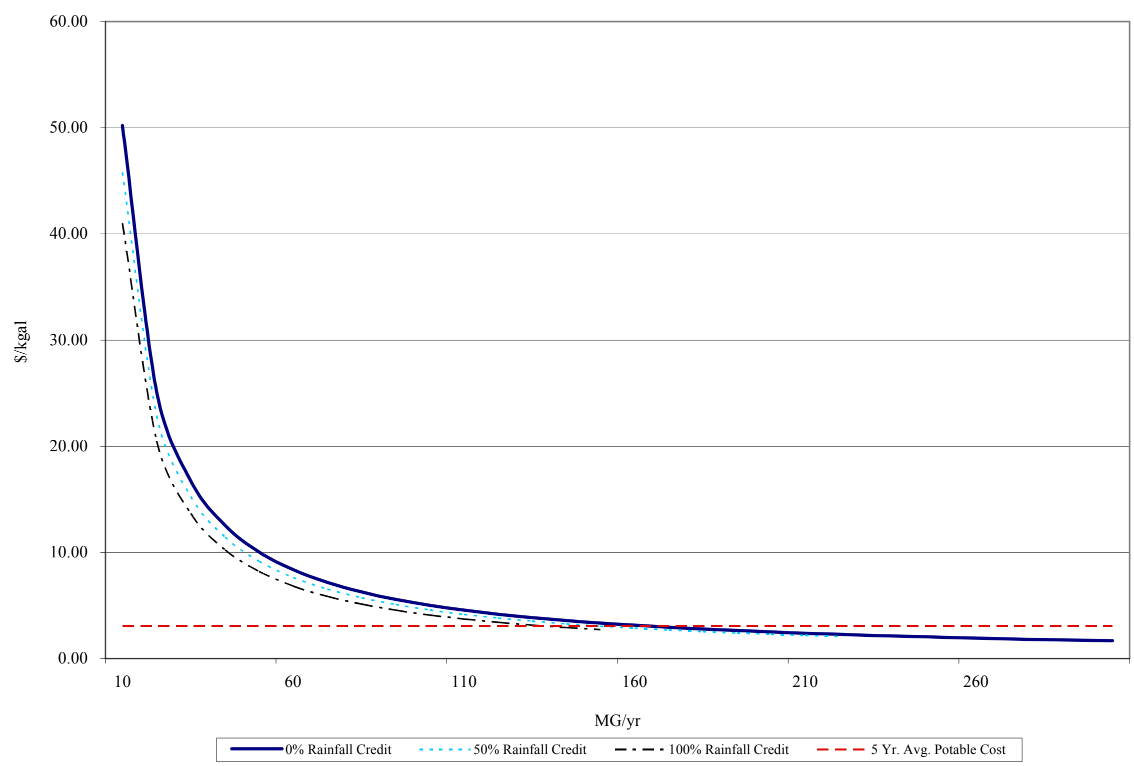
Table 20: Project Cost Summary

Peak System Demand (MGD)	1.29
Capital Cost ($MM)	$4.94
Debt Service ($/yr)	$391,320
O&M ($/yr)	$23,450
Electricity ($/yr)	$53,925
Effluent Purchase ($/kgal)	$0.11
Total Unit Cost ($/kgal)	$1.70[1]

[1]Full annual utilization (295 MG)

As shown in Figure 16, the unit cost of producing reclaimed water decreases as production of reclaimed water increases. These curves also reveal that the rain credit assumption has a relatively minor impact on the overall rainfall production cost.

Figure 16: Reclaimed Water Unit Cost



8.2.1 Underground Storage of Reclaimed Water

Costs for storage were developed as part of the probable costs of construction for a reclaimed water system using above ground, welded steel ground storage tanks. Additional estimates were developed using an option of underground, reinforced concrete storage tanks. A comparison of the additional cost of underground storage with steel tank construction is presented in Table 21.

Table 21: Underground Storage Tank Costs

System Design Basis	Tank Capacity (gal.)	Steel Tank Cost	Underground Tank Cost	Difference
100% Rainfall Credit	425,000	$212,500	$637,500	$425,000
50% Rainfall Credit	505,000	$252,500	$757,500	$505,000
0% Rainfall Credit	600,000	$300,000	$885,000	$585,000

Use of underground storage for a reclaimed water system can add to the initial project cost, but can also be incorporated into the landscaping of parklands and still provide open landscaped areas or recreational features.

8.3 Economic Analysis Methodology

A present value analysis was conducted to determine the relative expense of developing reclaimed water for park irrigation compared to the baseline alternative of continued potable water irrigation. An alternative is preferable in this form of analysis when its present value is lower in absolute terms relative to other alternatives. The analysis forecasts the costs of each alternative over a 25-year horizon, and assumes a discount rate of 4.125%. The analysis horizon of 25 years has been selected because it corresponds to the maximum period of debt service that the community might assume. The discount rate of 4.125% was utilized in this analysis, following the guidance of the U.S. Water Resources Council (*http://www.economics.nrcs.usda.gov/cost/priceindexes/rates.html*).

It should be recognized that this analysis does not attempt to make a "full social cost accounting" of benefits and costs. However, while these benefits and costs are not measured or calculated as a part of the analysis, they are expected to accrue above and beyond the benefits described herein. Some of the qualitative aspects of these additional benefits are presented at the end of this section.

8.3.1 Use of Probability-based Simulation

As described in greater detail in the ensuing sections, this analysis utilizes a probabilistic simulation model to account for uncertainty in major components. Throughout this analysis, results are presented in terms of percent chance non-exceedance, or in some instances as percentile, or probability.[1] This quantity indicates how often a value of the magnitude observed is seen, its degree of "unusualness". A value of 0 means that zero percent of the other values in the record do not exceed that value, or in other words, that all other values exceed that value, so that the value in question is so low that it seldom if

[1] Although they are to be considered synonymous, the use of the term percentile is associated with processes in the analysis where a rank and percentile of output data was performed.

ever occurs. A value of 50 indicates that half of the historical values are higher and 50 percent are lower. A value of 75 indicates that 75 percent of the values are as low as this value, or conversely, that only 25 percent of the values are higher than the given value. A value of 99 means that 99 percent of the observed values are lower, and that this value is in the top 1 percent of all values. Values near 50 are not unusual; values near 0 or 100 are very unusual.

8.3.2 Calculating the Annual Costs of the Baseline Scenario

The baseline scenario is defined as the cost of meeting the irrigation demand with potable source water each year of the analysis horizon to maintain the health and integrity of the park. Because a major element of uncertainty – relative evapotranspiration stress (drought) – is a large driver of the cost, a probability-based simulation model is employed to normalize the wide range of possible costs and achieve a rational comparison between alternatives. The following equation (Equation 1) describes the components of consideration in estimating the cost of the baseline scenario:

Equation 1

$$pC_{potable} = (\$3.05/\text{kgal} \times pI \times 325.8\ \text{kgal/ac-ft}) + pR_{veg} + pR_{rev} + pS_{emerg}$$

Where:

$pC_{potable}$ is the variable describing the probable cost of supplying potable water to meet irrigation demand.

$3.05/kgal is a constant value, the average unit cost to supply potable water based on analysis of historical irrigation meter data.

pI is the variable for irrigation demand;

325.8 kgal/ac-ft is a conversion coefficient;

pR_{veg} is the variable for the replacement cost of vegetation in severe drought;

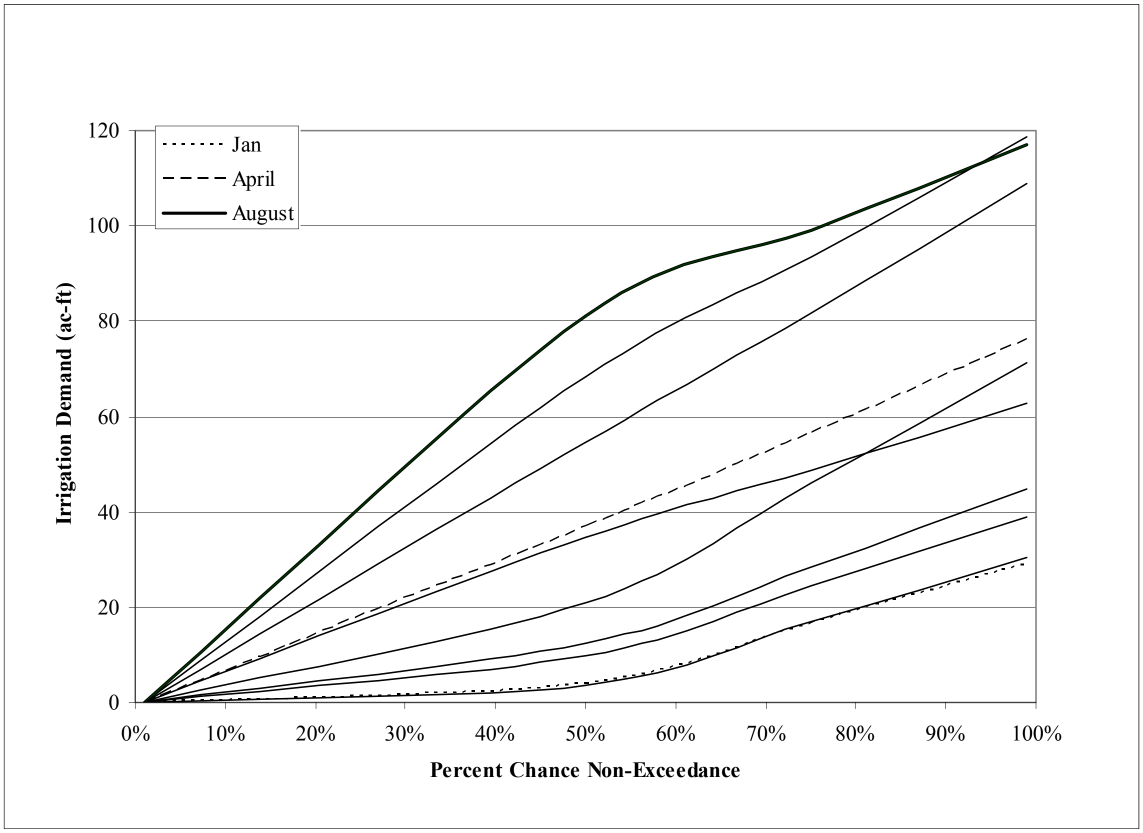
pR_{rev} is the variable for lost revenue in periods of severe drought;

pS_{emerg} is the variable for the provision of emergency water supply in times of extreme drought.

Irrigation Demand

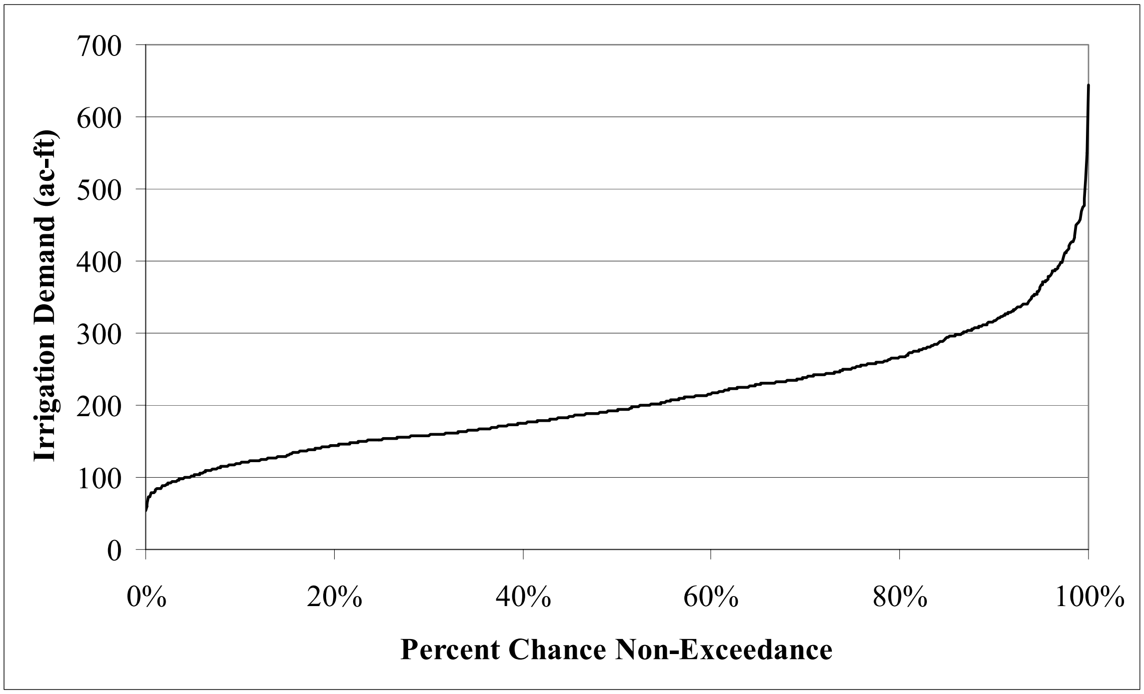
The first step is to understand the range and likelihood of irrigation demand that might be encountered in any given year. The calculation of pI is based upon a series of monthly probability functions that relate the demand volume to the probability of need and rates of evapotranspiration. Within the simulation, for each month in a random two year period, an irrigation demand is calculated from the statistical relationship between the 1st percentile, 50th percentile, and 99th percentile evaporation rates for that given month. In other words, there is a relationship between the amount of irrigation water required in a given month and the probability of experiencing a certain level of drought. A random number generator within the model selects a chance of occurrence based on the historical likelihood of that drought level occurring. The model then selects the monthly irrigation demand value corresponding to that level of drought stress. This function is described graphically in Figure 17 (note that for reporting purposes not all months are labeled discretely):

Figure 17: Probability of Monthly Irrigation Demand (ac-ft)



This process is repeated thousands of times in the simulation model, and the statistically most likely values to occur are developed to create a function (curve) representing the chance in any given year that the irrigation demand (volume, in ac-ft) will not be exceeded (Figure 18).

Figure 18: Probability of Annual Irrigation Demand Volume, (*pI*)



Replacement cost of vegetation

The variable pR_{veg} represents the replacement cost of vegetation during periods. This function is driven by the same random number generation that determines irrigation demand. If the simulation randomly produces two consecutive months of drought at or above the 75th percentile, a cost is incurred to replace vegetation in the park at $0.10/square yard.

Loss of park revenue

The variable pR_{rev} is the variable for lost revenue in periods of severe drought. The random number generation that determines irrigation demand in the simulation also drives this function. If the simulation produces two consecutive months of drought at or above the 75th percentile, it is assumed that the Parks Department loses the revenue it would otherwise collect. Based on revenue data from the Parks Department, a loss of $1,411/acre is incurred.

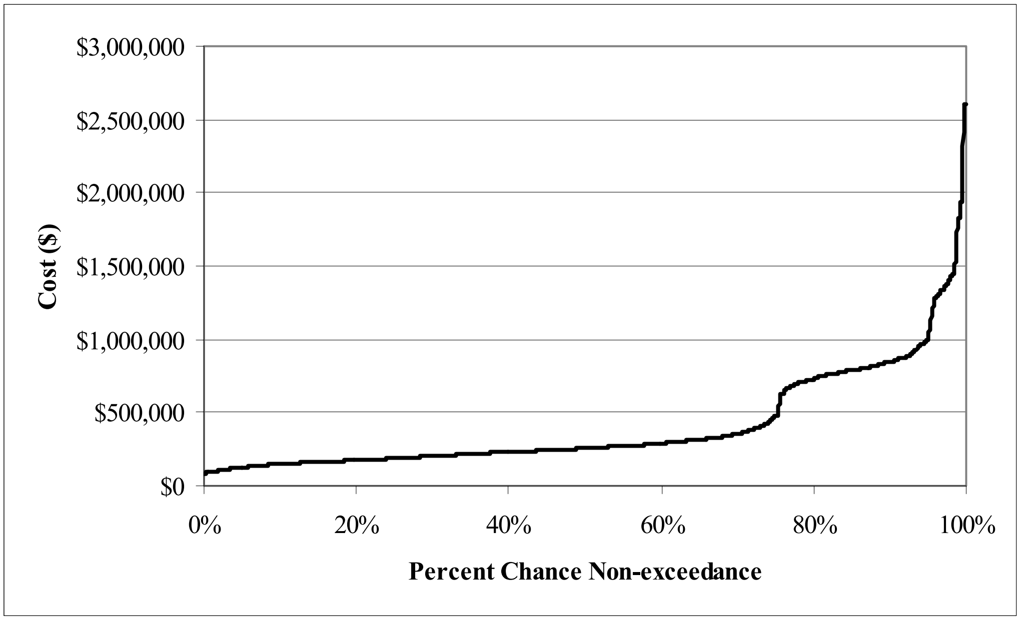
Emergency water supply

pS_{emerg} is the variable for the provision of emergency water supply in times of extreme drought. If the simulation produces two consecutive months of drought at or above the 85th percentile, a cost is assumed to haul water in by truck, as the City had to do in 2009. This cost, when incurred under the simulation, is equivalent to the volume of water that can be hauled in a month (2.76 ac-ft) at a rate of $21,000 per acre foot (Source: State Water Plan and City of New Braunfels)

8.3.3 Cost of Potable Water Source Irrigation Demand

The simulation model iterates the above-described functions more than 1,000 times to yield a relationship between the probability of occurrence and the cost associated with meeting demand, $pC_{potable}$. This cost function is described with the following Figure 19.

Figure 19: Probability of Annual Cost to Supply Potable Water ($pC_{potable}$)



8.3.4 Calculating the Present Value of the Baseline Scenario

In order to compare the costs of the baseline scenario to the alternative scenario, each scenario being comprised of differing series of cost accruing over the life of the project, a present value approach is employed. This approach applies the principle of discounting to the stream of flows, converting them to a single present value. The present value "accounts for the absolute size and the timing of a proposed action" (Mikesell, 1995 p.231). The basic equation for computing net present value is as follows in Equation 2:

Equation 2

$NPV = \sum_{t}^{T} \frac{(B_t - C_t)}{(1+r)^t}$; where T= the life of the project and r = the discount rate.

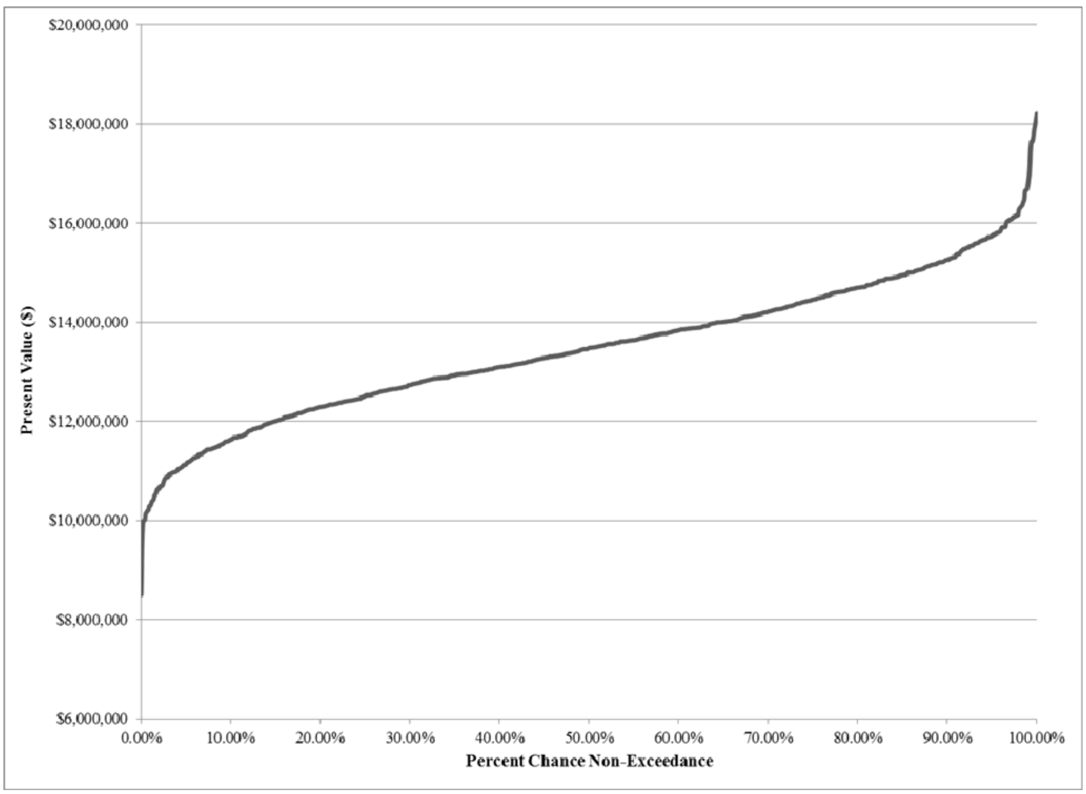
As described above, in the baseline scenario, the annual costs are variable and highly dependent on the severity of drought. This relationship is described in the probability function $pC_{potable}$, which can be substituted into the basic equation for present value as follows, including an assumption about the project life and a discount rate, and a fixed unit cost assumption (C_{WWP}) about the development of additional water supply[2]:

Equation 3

$$NPV = \sum_{t}^{25} \frac{pC_{potable} + C_{WWP}}{(1+.08)^t}$$

A simulation of multiple iterations is used to develop a probability function of the present value of the baseline scenario, Figure 20 below.

Figure 20: Net Present Value of Cost to Supply Potable Water



In other words, in each of the 25 years of the project life, an annual cost is generated based on the probability of its occurrence as defined in Figure 19, and in years 2020

---

[2] Table 4B.2.5-9, 2011 South Central Texas Regional Water Plan, Volume I, September 2010. The current Regional Water Plan anticipates additional supply to the City of New Braunfels via purchase from GBRA at a cost of $1,389 per acre-foot, beginning in 2020. The proportion of this new supply attributable to park irrigation is assumed to be the mean annual irrigation demand, which is derived from the function *pI*. The fact that this fixed cost is placed in addition to the existing rates is a reasonable assumption, since the unit cost of potable supply in this model does not increase over time, yet the demand is expected to increase simply to keep pace with population growth, thereby necessitating an increase in supply community-wide.

through 2037, a fixed cost for the proportion of additional supply purchase (as envisioned in the Regional Water Plan) is added. The simulation generates over 1,000 possible present value outcomes that are then ranked and placed into percentile. It is then possible to interpret a range of costs to supply potable water to the park system based on the likelihood of different drought scenarios, discounted to present value. This is summarized in the following Table 22 for outcomes ranging from average to extreme:

Table 22: Present Value of Baseline Alternative

Percent Chance Non-Exceedance		
50%	75%	99%
$13,480,768	$14,458,125	$16,763,861

8.3.5 Calculating the Present Value of the Primary Alternative Scenario

The primary alternative scenario is the proposed project cost for Alternative 1: South Trib – Walnut Avenue, as described in Section 7.2.1 and subsequent sections of this report. Three capital cost scenarios have been evaluated for this Alternative, each assuming different sizing to meet demand under three probability scenarios: the 100% rain credit, the 50% rain credit, and the 0% rain credit scenario. These scenarios are related to the non-exceedance values in this economic analysis as follows. The 100% rain credit scenario is based upon the average annual rainfall; therefore, it can be compared to the 50% chance non-exceedance or 50th percentile. The 50% rain credit scenario assumes half as much rainfall as the 100% rain credit; therefore it can be compared to the 75% chance non-exceedance or 75th percentile. Finally, the 0% rain credit assumes the most extreme drought conditions (i.e. zero rainfall); therefore, at the extreme end it is compared to the 99% chance non-exceedance or 99th percentile.

Capital project costs for each rain credit scenario associated with Alternative 1 are provided in Appendix E.

Annual costs include the cost of power, disinfection, laboratory expenses, basic operations and maintenance expense (O&M), as well as annual debt service. These costs are summarized in Appendix E. While it could be argued that the non-debt service costs will increase over time with inflation, and the cost of electricity in a deregulated market may even increase beyond the inflation rate, for the sake of comparison and simplicity, these cost components are assumed to remain constant from year to year.

Discounting each rain credit scenario at 8% over a project life of 25 years yields the following results.

Table 23: Summary of Present Value for the Primary Alternative (Alternative 1)

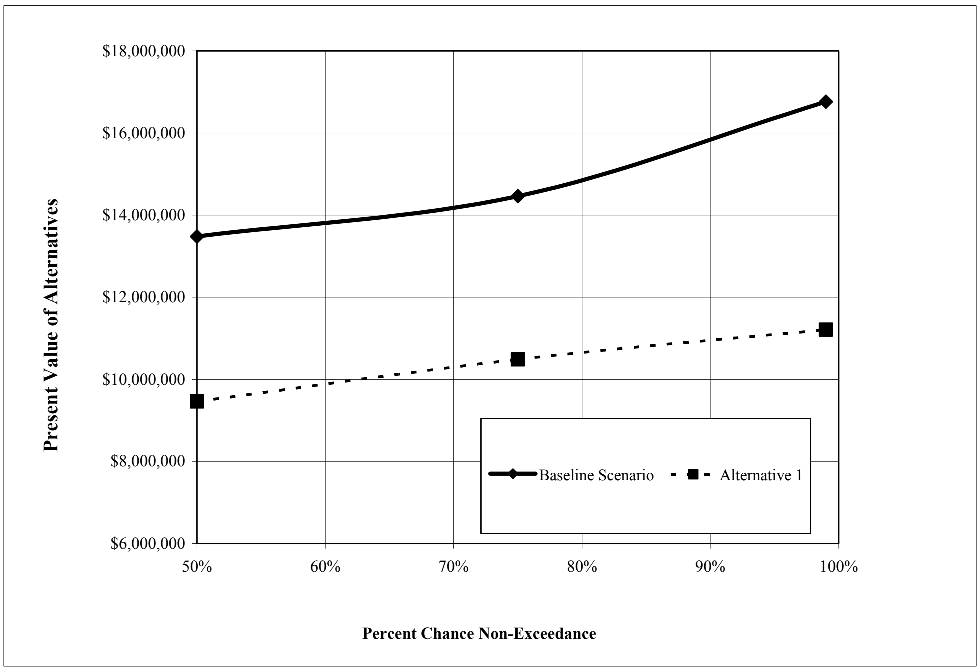
Percent Chance Non-Exceedance		
50%	75%	99%
Rain Credit Scenario		
100% RC	50% RC	0% RC
$9,460,389	$10,487,772	$11,211,534

8.3.6 Comparison of Baseline Scenario and Primary Alternative

Table 22 above provides a summary of the Present Value of the Baseline Scenario while Table 23 provides a summary of the Present Value of the Primary Alternative. In each of the cases analyzed comparatively (50%, 75%, and 99% percent chance non-exceedance), and generally during periods of less than average annual rainfall, the Primary Alternative is preferable in terms of expected cost.

This is summarized in the following Figure 21.

Figure 21: Comparison of Present Value



8.4 Benefits of Reclaimed Water Irrigation

Although the economic analysis above demonstrates the economic preference for reclaimed water, there are a number of specific social and environmental benefits which accrue to different entities and stakeholders in the community which may be either difficult to quantify, or may only be described qualitatively. These benefits accrue directly and indirectly to the City of New Braunfels, NBU, the Edwards Aquifer Authority, the environment, and the general community. In many cases, since these benefits extend across entities they are also difficult to quantify in financial terms. Using the template provided by the WateReuse Foundation (Raucher, 2006), these benefits are outlined below.

8.4.1 Financial Benefits

Deferral of Additional Potable System Capacity

As the city's population grows and the utility system ages, the design of water main replacements will consider historical demand, as well as records of low pressure and high demand. Shifting park irrigation to reclaimed water will remove significant historical and future demands in the area of the parks irrigated with reclaimed water and preserve potable water system capacity for future population growth.

A similar benefit is gained in the capacity and maintenance of potable water storage. While capacity in existing storage tanks is gained for population growth by shifting park irrigation to reclaimed water, storage tanks are added for reclaimed water. However, maintenance costs for these structures is lower than for potable water tanks as the coating systems and maintenance are not required to meet drinking water standards.

Reduced Potable Water Demand

A key benefit from developing a reclaimed water system for park irrigation is to eliminate a current and future potable demand. Replacing potable water for park irrigation with reclaimed water results in a savings of potable water for the demands associated with population growth. Replacing this demand will also reduce demand on the Edwards Aquifer during the summer months, providing an incremental reduction in the cost of developing additional water supplies.

Long-Term Sustainability of Parklands

Developing public parks is a significant investment by the current generation to ensure that the city's parks meet the needs of the present without compromising the ability of future generations to meet their own needs. Preserving vegetation in the parks provides both an inviting developed environment for people and a means of preventing damage due to erosion of surfaces worn by increasing use.

8.4.2 Environmental Benefits

Reduction in Nutrient Load to Guadalupe River

Diverting wastewater effluent prior to discharge and supplying reclaimed water for park irrigation demand will reduce the nutrient load to the Guadalupe River. Based on the permit limits for the South Kuehler WWTP, for example, each million gallons of reclaimed water would remove as much as 25 pounds of phosphorus from the annual WWTP discharge. This reduction in loading could have affect future permitting of the WWTP by potentially deferring future increases in nutrient limits in permit renewals. It is more likely, however, that nutrient reduction would result in reduced treatment costs.

When used for irrigation, the nutrients in reclaimed water can decrease the amount of fertilizer needed for plant maintenance.

Reduced demand on the Edwards Aquifer

A major benefit of reclaimed water is the reduction of demand on the Edwards Aquifer, particularly during the summer months of peak demand. This reduction in peak summer demand on Edwards Aquifer will minimize the impact on springflow and extending flows needed for maintenance of critical aquatic habitat.

Stormwater Water Quality Improvement

Maintenance of turf grasses, shrubs and trees in the city's parks provide a vegetative buffer along the Comal and Guadalupe Rivers that filters stormwater runoff to improve water quality. Maintaining vegetation in areas adjacent to the rivers reduces sediment load as well contaminants in urban runoff.

8.4.3 Social Benefits

Improved community aesthetics and quality of life

The design of city parks incorporates a variety of plants and grasses to provide shade, visual enjoyment and playing surfaces. Reliable sources of water are necessary to ensure plant maintenance and to provide for recreational opportunities that enhance the local quality of life.

Supports community values associated with recreation

Summer recreational programs provide opportunities for a healthy lifestyle. Improving the durability of grass areas in public parks increases the capacity of the parks for recreational activities.

THIS PAGE INTENTIONALLY LEFT BLANK

9 Implementation Strategy

The objective of this study is to evaluate the feasibility of implementing a reclaimed water system for parks irrigation. The single-user and single-purpose nature of such a system precludes certain implementation elements commonly associated with reclaimed water systems, most notably identifying potential users, reclaimed water market analysis, and project phasing. In this case, transmission piping and water storage account for the bulk of the capital costs. While pump capacity could be increased in phases, delayed construction of elements of transmission or storage facilities would only serve to increase the overall project costs.

This chapter presents a summary of potential funding opportunities for developing a reclaimed water system, and a discussion of the administrative issues to be addressed as part of reclaimed water implementation.

9.1 Summary of Funding Opportunities

The terms "financial" and "economic" analysis are often used interchangeably when discussing project implementation. However the terms describe very different aspects of project implementation in that a project can be economically viable, but due to lack of funds, financially infeasible. Economic analysis refers to the evaluation on a societal level of costs and benefits of a project. When benefits equal or exceed costs for a project, the project is deemed economically viable. To be financially viable, a project must have the funds necessary for implementation including construction, operation and maintenance (O&M), and recurring costs.

This summary of funding opportunities is intended to address the financial viability of a reclaimed water system for park irrigation by identifying and describing funding sources that can assist in funding the implementation of a reclaimed water project.

It should be noted that timing is a significant factor when seeking multiple funding sources. Funding sources may not have available funds or the application dates may occur before a project has the necessary information available to submit an application.

This section summarizes the major funding sources with potential for application in implementing recycled water projects. The local, state, and Federal government funding mechanisms for reclaimed water projects are summarized below.

Project funding mechanisms for capital projects typically involve:

- Cash (collected as user fees or general revenue)
- Bonds and Certificates of Obligation
- State Revolving Funds (Loans)

- Grants

These types of funding mechanisms are also applicable to recycled water projects. A brief description of these types of funding mechanisms is provided below.

Cash: Cash includes revenues from operations and ad valorem taxes plus interest income minus operating expenses and debt service charges. The sources of revenues could include utility service charges and property taxes.

Bonds and Certificates of Obligation - There are two types of debt instruments available to support reclaimed water projects. The most common type of tax-exempt revenue bonds are those funded by the service fees and charges paid by the NBU customers. General obligation bonds that are guaranteed by the property taxing authority of the city are another common debt instrument. Cities can issue certificates of obligation (CO) under Chapter 271 of the Local Government Code. COs are guaranteed by the taxing authority of the city.

Loans: Loans are available from a variety of sources including the state Clean Water Revolving Fund (CWSRF) and the Water Infrastructure Fund (WIF). SRF loans are administered by the Texas Water Development Board and are intended to fund a variety of projects. SRF programs can offer low or zero interest loans, as well as provide guarantees of repayment, bond insurance, and refinancing of existing debt under certain conditions.

Grants: Grants are typically money from governmental agencies for specific projects and require no repayment.

TABLE 24: Potential Additional Funding Mechanisms

Name	Description
Reclaimed Water Fees	Fees assessed to recycled water users can be used to fund all or a portion of the project.
Grant	Project funding with money from state or Federal government that requires no repayment.
Utility Service Charges	Charges assessed to utility service users can be used to fund all or a portion of the project.
Revenue Bond Long Term Debt	Future revenues from the project's operation are pledged as collateral for a bond, which is used to fund the project.
Direct Federal Appropriations	The project can be funded by the Federal budget through a direct appropriation from Congress.
Pay-as-you-go	Project is funded through annual tax and other revenue sources.

9.1.1 Potential State Funding Mechanisms

State funding programs managed by the Texas Parks and Wildlife Department and the Texas Water Development Board were evaluated for the potential benefit in the implementation of water reuse projects. Texas Parks and Wildlife grant programs consider the potential benefit to endangered species. The Edwards Aquifer Authority also administers a program to fund water conservation programs that may include water reuse. The following sections describe the specific state programs that may be available for implementing a reclaimed water system for parks irrigation.

Texas Water Development Board (TWDB)

Clean Water State Revolving Fund

The Clean Water State Revolving Fund provides loans at below-market interest rates and principal forgiveness for planning, designing, and constructing wastewater infrastructure. Eligible applicants are wastewater treatment management agencies, including cities, commissions, counties, and river authorities that have authority to dispose of sewage.

The Clean Water State Revolving Fund offers fixed and variable rate loans at subsidized interest rates. The maximum repayment period for a loan is 30 years from the completion of project construction. A cost-recovery loan origination fee of 1.85 percent is imposed to cover administrative costs of operating the Clean Water State Revolving Fund. Applicants have the option to finance the origination fee in their loan. Individual entities will be limited to funding in an amount not to exceed 15 percent of the total funds available.

Prospective loan applicants submit project information to TWDB that describes their existing wastewater facilities, facility needs, the nature of the project being considered, and project cost estimates. This information is used to rate each proposed project and place prospective projects in priority order on the project priority list in the Intended Use Plan. A fundable projects list is established, and available funds are distributed in accordance with the funding order specified in the Intended Use Plan. All applicants on the fundable projects list will be notified and invited to submit complete applications within three months of the date of the invitation letter. All applicants are encouraged to schedule a preapplication conference that will guide them through the Clean Water State Revolving Fund application process. The fundable projects list is revised as projects decline or funding becomes available. Invitations are then sent to the next eligible applicant on the list.

Water Infrastructure Fund (WIF)

Projects must be specifically recommended water management strategies in the most recent TWDB approved regional water plan or approved State Water Plan. A semi-annual priority rating process applies. Loans for planning, design, and construction can be funded through the WIF. All loans through the WIF are offered at a subsidized interest rate that is 2 percent below the TWDB's cost of funds. Repayment periods are a maximum of 20 years.

State Loan Program Texas Water Development Fund II (DFund)

The DFund can be used for planning, acquisition and construction of water related infrastructure, including water supply, wastewater treatment, stormwater and nonpoint source pollution control, flood control, reservoir construction, storage acquisition, and agricultural water conservation projects, and municipal solid waste facilities. This is essentially a pure state loan program that does not receive Federal subsidies, and is the more streamlined of the agency programs.

The interest rate on a Texas Water Development Fund loan varies depending on market conditions. The lending rate scales are set 0.35 percent above the TWDB's borrowing cost. 4.61% now until funds are depleted.

Edwards Aquifer Authority (EAA)

Conservation Grants

The Authority's Groundwater Conservation Grant Program, introduced in 2009, is an annual program to improve water use efficiency across the region. Through this program, municipal Edwards Aquifer permit holders can apply to the Authority for grant funding to cover up to half the projected costs of qualified conservation programs and Best Management Practices (BMPs) that result in savings of Edwards groundwater.

The application deadline for the current year is April 30, for the first grant process and August 31, for the second application process.

U.S. Bureau of Reclamation (Reclamation)

Reclamation Wastewater and Groundwater Study and Facilities (Title XVI)

Reclamation provides funding for both the planning and construction of water recycling projects. Planning funds may be made available for either appraisal or feasibility level study efforts. Currently, Reclamation funds for water recycling and reuse are appropriated under the authority of the Reclamation Wastewater and Groundwater Study and Facilities Act of 1992 (Title XVI of Public Law 102-575 as amended). Reclamation funding for Title XVI is subject to the availability of congressionally appropriated funds. Generally, Title XVI authorizes the Federal government to fund up to 25 percent of the capital cost of authorized water recycling projects, up to a maximum of $20 million per project.

Federal construction funds are provided only for projects specifically authorized by Congress pursuant to the various sections of Title XVI. Reclamation makes funding recommendations on construction of authorized projects in the President's annual budget request to Congress. Projects not yet authorized for construction require specific congressional authorization before Congress can appropriate funds through the Title XVI program.

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

- A feasibility report that complies with the provision of Title XVI must be completed by Reclamation or the non-Federal project sponsor.

- The Secretary of Interior has determined that the non-Federal project sponsor is financially capable of funding its share of the project costs.
- Project compliance with the National Environmental Policy Act and other environmental laws.
- The Secretary of Interior has approved a cost-sharing agreement with the non-Federal project sponsor that commits the non-Federal project sponsor to funding its proportionate share of the project construction costs on an annual basis.

For FY10, Title XVI and the WaterSMART program was introduced as a competitive grant program. While the majority of funding under Title XVI has gone to California projects, approximately $3.5 million has been funded in Texas and Oklahoma.

Because Congress appropriates the requested funds, several things are important to remember. There are a number of projects that were authorized directly in the Title XVI legislation that have not been funded or completed. Since the program's budget has been flat and is now declining, new projects will need specific congressional authorization written into future budgets to receive funding.

Depending on the number of funding requests, a delay of several years may be expected due to the Congressional pace and schedule. Continuation of funding from one fiscal year to the next may also be an issue as it is at the discretion of Congress. Also, due to limited budgets, not all projects may receive a full 25 percent federal participation. In accordance with Title XVI and other federal laws, priority will be given by Reclamation to projects that:

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

U.S. Fish and Wildlife Service

Conservation Grants

Conservation grants provide financial assistance to States and Territories to implement conservation projects for listed and non listed species, such as habitat restoration, species status surveys, public education and outreach, captive propagation and reintroduction, nesting surveys, genetic studies and development of management plans. Federal participation can be 75% for projects involving a single State.

Habitat Conservation Planning Assistance
Habitat Conservation Planning Assistance can provide financial assistance to States and Territories to support the development of Habitat Conservation Plans (HCPs) that provide for the conservation of imperiled species while allowing economic activities to proceed. Federal participation can be 75% for projects involving a single State.

U.S. Army Corps of Engineers - Army Corps of Engineers

Civil Works Projects
The U.S. Army Corps of Engineers' Civil Works Directorate has a number of environmental responsibilities. Not only is the USACE the largest provider of water-based recreation facilities, it also administers a major environmental permitting program and operates hydropower facilities that provide 24 percent of the electricity for the nation. For funding from the USACE, major projects require congressional approval; however, the USACE can provide project funding through its Continuing Authority Program (CAP).

The USACE budget includes about $500 million a year on environmental activities. Depending upon the type of project, cost sharing varies. For most assistance, pre-application consultation and coordination is essential. The USACE application process most commonly consists of a letter to the District Engineer, indicating clear intent to provide all required local participation. State and local governments can work with the USACE District Engineer to define environmentally sensitive project objectives and identify realistic sources of the non-Federal portion of the cost share for the project. The WRDA Section 1135 programs are the most relevant potential funding sources from the USACE for water recycling projects.

9.2 Project Implementation Considerations

This section discusses the actions necessary to develop and implement a reclaimed water system for irrigation of New Braunfels' parks. The successful implementation of a reclaimed water system in New Braunfels can be measured in terms of:

- Public support
- Political support
- Enhancement of parks
- Timing of the availability of reclaimed water with the implementation of parks projects identified in the CIP
- Positive return on investment

The interdependence of these criteria is such that the failure of a reclaimed water project in any one area could negatively impact the successful implementation of a project. In characterizing the successful implementation of a reclaimed water project, it could be said that a reclaimed water project should have:

1. Public and political acceptance and support of the importance park irrigation, the planned reclaimed water facilities, water quality parameters, and irrigation procedures.

2. An overall acceptance of the capability of the City and NBU to successfully build and operate the project.

3. A well defined project purpose of enhancing the city's parklands during cycles of normal weather patterns and drought cycles, minimizing potable water use, and reducing the nutrient load into the Guadalupe River.

4. Ability to supply a portion of the demand for Landa Park Golf Course during severe droughts when water supply from the Comal River is curtailed.

5. Success in obtaining capital funding for construction.

6. Long-term project performance that meets or exceeds expectations.

9.2.1 Administrative Framework

Implementing a plan to develop the system will involve the development of certain policies or amendment of ordinances in order to provide the administrative framework for a project. It will also require a clear definition of, not only the ownership of the system, but also the responsibilities for management of the system development, construction and operation.

Memorandum of Understanding

A Memorandum of Understanding (MOU) between the City and NBU could provide the mechanism for defining the responsibilities for funding, designing, and operating a reclaimed water system. The elements of the MOU should address:

- Which agency should lead the development of a reclaimed water system.
- How the ownership and operations of a reclaimed water system will be structured.
- Capital funding.
- The price of reclaimed water.
- The cost recovery mechanism.
- The reclaimed water delivery points and volume of water to be provided.
- Facilities construction financing and responsibility.

- System pressure.
- Mechanism for measuring reclaimed water delivery volume.

The draft MOU presented in Appendix F is included as an example that incorporates these elements.

9.2.2 Reclaimed Water System Ownership, Management, and Operation

A reclaimed water system can be developed as either an NBU utility or as City-owned infrastructure. For the purpose of this discussion, it is presumed that the City would not duplicate NBU staffing for the operation and maintenance of a reclaimed water system, but would instead take advantage of existing NBU staff through one of the two alternatives discussed below.

In each of the alternatives of system ownership, management, and operation, there is a need to consider the underlying value of the public benefit afforded customers of both the City of New Braunfels and NBU. As a possible benefit to taxpayers by providing improved recreational facilities and its value as a water resource management strategy to utility customers, implementation of a reclaimed water system can be viewed as a community asset regardless of its organizational placement.

1. NBU Reclaimed Water Utility

The additional treatment required for the reclaimed water system would be incorporated into NBU's WWTP infrastructure and operations. Since the pumps, pipes, and storage tanks of a reclaimed water system are similar in nature to the potable water distribution system, NBU water distribution personnel could be available for the operations and maintenance of the reclaimed water system. The City would connect the park irrigation system to the reclaimed water system at the point of delivery for each park. As a single user system, individual meters at each park are not necessary, nor are backflow prevention devices at the point of delivery. These differences between the delivery of potable water for irrigation and reclaimed water allow a slight increase in the pressure of delivery without additional costs of pumping.

2. City-Owned Reclaimed Water System

An alternative to NBU financing of the system is City issuance of general obligation debt to finance the design and construction of a reclaimed water system. Operations and maintenance could be under contract with NBU.

9.2.3 Policies and Procedures

The following list provides several of the policies and procedures that may be developed as part of the project implementation.

- Reclaimed water system design specifications.

- Cross-connection control requirements.
- Cost recovery policies and pricing structure.
- Reclaimed water system standard operating procedures.
- System record keeping and reporting procedures.
- Emergency procedures plan.
- Park irrigation standard operating procedures.

9.2.4 Reclaimed Water Notification and Authorization

State regulations (30 TAC §210) require notification and approval of the TCEQ for the use of reclaimed water. The Chapter 210 regulations assign specific responsibilities to the reclaimed water producer, the reclaimed water provider, and the reclaimed water user. The specific responsibilities of each party as designated by the Chapter 210 regulations are summarized in the following points.

- The responsibilities of the reclaimed water producer include ensuring that the quality of the reclaimed water that leaves the treatment processes meets the minimum quality prescribed by state regulations, and for sampling, analyzing, and reporting the quality of reclaimed water produced.

- The reclaimed water provider is responsible for the delivery of reclaimed water to the user that meets the minimum quality prescribed by state regulations and for maintaining records of the volume and quality of reclaimed water delivered to the user.

- The reclaimed water user is responsible for the proper use of reclaimed water.

Clearly the City will be the reclaimed water user and, as the operator and discharge permit holder of the facility that treats municipal wastewater, NBU will be the reclaimed water producer. However, the role of reclaimed water provider is subject to definition by agreement between the City and NBU.

9.3 Reclaimed Water Cost Recovery

Presently, NBU's sale of reclaimed water to the Sundance Property Owners Association is according to a contract that specifies the maximum available volume at a rate that is a percentage of the small commercial tariff. While simply expanding this tariff to the implementation of a reclaimed water system for parks irrigation, there are alternatives for accounting for the annual costs of reclaimed water production and delivery. These alternatives depend in large part on the ownership of the system and whether the reclaimed water system is financed through the city's general fund or through the issuance of utility revenue bonds by NBU.

Assuming the system is financed using revenue bonds, debt service and costs of operation and maintenance could be recovered through a base amount charged by NBU annually plus a negotiated unit price for reclaimed water delivered. The unit price could include the projected costs of service based on delivery of an estimated annual volume. Payments of the annual debt service and unit price would be made on a monthly basis as reclaimed water is delivered. An adjustment in the form of an additional payment or credit at the end of each year would account for the actual volume of reclaimed water delivered and actual costs of delivery. The advantage of this arrangement is that the debt service and minimum operational costs of the system are covered in years of abundant rainfall and the unit price decreases as the volume approaches the design capacity of the system.

In a traditional utility option, reclaimed water would be sold to the City at a rate that includes the system operation and maintenance costs, as well as recovery of the capital cost and debt service. As with potable water rates, a reclaimed water rate could be based on the projected annual sales of reclaimed water with rates adjusted periodically based on costs of service.

9.3.1 Reclaimed Water Pricing

However, there are certain aspects of developing reclaimed water rates that makes the process considerably different from that of potable water rate design. The rate-making process is different for reclaimed water in one respect since potable water is a readily available substitute for reclaimed water. With a choice of equal commodities, the logical response is for a consumer to use that which has the lowest price (Casey, 2006). Rate-making for potable water generally a process for determining the full cost associated with providing service and allocating those costs to the various customer classes. However, most utilities providing reclaimed water service have established rates that are designed to encourage reclaimed water use (AWWA, 2008).

In their 2008 survey of reclaimed water rates, AWWA reported that most utilities were recovering less than 25 percent of the annual operating costs for reclaimed water utilities through rates. The primary reason that utilities employ reclaimed water rates that allocate significant costs associated with developing reclaimed water back to the water and wastewater utility rates is to maintain an economic incentive for using reclaimed water. If reclaimed water is priced at its full cost, the fact that the cost will likely be higher than that for potable water would all but eliminate the incentive to develop reclaimed water as a water source for uses that do not need potable water quality.

The fact that potable water for specific uses can be restricted during times of high water demand or drought is generally insufficient justification to price reclaimed water at or above the price of potable water. The impacts of such restrictions are viewed as temporary and the impacts are absorbed by the users. While water users can absorb short-term impacts of water restrictions, utilities must consider reclaimed water as just one element of water source planning.

In determining what revenue sources besides reclaimed water rates can be employed to fund the development of reclaimed water, it is important to define the benefits and policy issues to be considered in developing reclaimed water pricing (AWWA, 2008).

As a supplement to potable water, reclaimed water can provide a drought-resistant water source that can benefit future water utility customers by removing the parks irrigation water demand from the summer peak met by pumping from the Edwards Aquifer. This has the effect of extending NBU's Edwards capacity and, to some extent, preserving the utility's surface water capacity. Future customers could be expected to share in the cost of developing a reclaimed water system as part of the overall cost of securing water sources for the future potable water demand.

By minimizing the demand for potable water, all utility customers realize the benefits of effective water management. Similar to the benefits derived by future water utility customers, existing water utility customers can realize benefits of a reclaimed water system by extending the time that construction of the second NBU surface water treatment plant will needed. Both existing and future water utility customers will also benefit from improved park maintenance, particularly during drought periods.

9.3.2 Reclaimed Water Rate Design

The key considerations in developing rates for reclaimed water are:

1. What are the overall goals and objectives of developing a reclaimed water system?
2. What is the desired level of cost recovery?

Like the definition of the goals and objectives, the appropriate level of cost recovery for reclaimed water is a policy decision that would be addressed by the NBU Board and the New Braunfels City Council. Utilities have established reclaimed water rates that are, on average, between 50 percent and 100 percent of the potable water rate (AWWA, 2008). By contract, NBU established an initial rate for reclaimed water for the Sundance POA at 50 percent of the Small Commercial Rate that escalates to 75 percent of the potable water rate after 5 years. The Small Commercial Rate and the contract rates are presented in Table 25. Each is an inclining block rate structure where the cost per thousand gallons of

Table 25: Existing Rate Structures

Small Commercial Rate		Reclaimed Water Rate [1]		Reclaimed Water Rate [2]	
Usage in Gallons	Rate per 1,000 gal.	Usage in Gallons	Rate per 1,000 gal.	Usage in Gallons	Rate per 1,000 gal.
0 - 5,000	$1.885	0 - 5,000	$0.943	0 - 5,000	$1.414
5,001 - 50,000	1.946	5,001 - 50,000	$0.973	5,001 - 50,000	$1.460
50,001 - 200,000	2.009	50,001 - 200,000	$1.005	50,001 - 200,000	$1.507
Excess of 200,000	2.135	Excess of 200,000	$1.068	Excess of 200,000	$1.601

[1] Sundance POA contract rate at 50% of Small Commercial Rate.

[2] Sundance POA contract rate adjusts to 75% of Small Commercial Rate on June 29, 2012.

consumption increases as the volume of consumption increases in an attempt to encourage conservation.

One alternative for the rate design for the conceptual reclaimed water system developed in this study is to apply the existing reclaimed water contract rates to the projected demand for park irrigation. Using this existing rate structure could be considered in the context of the previous discussion of cost recovery and the system-wide benefits of developing diversified sources of water supply in that a portion of the cost of reclaimed water service would be shared through the potable water and wastewater rates.

Table 26 presents the calculated cost recovery using the existing Small Commercial rate structure assuming conditions of low, medium, and high annual consumption of reclaimed water. In their 2008 survey report, AWWA reported that presently only a small percentage of utilities use an inclining block rate structure for reclaimed water.

Table 26: Reclaimed Water Cost Recovery – Existing Contract Rates

Annual Usage (MG)	50% of Small Commercial	75% of Small Commercial
147	$146,186	$219,278
221	$219,776	$329,663
295	$293,366	$440,049

Instead, the large majority of utilities use a uniform rate structure. A uniform rate structure is one in which the cost per unit of water does not increase with consumption. As a single-user system, the reclaimed water rate can be charged on a system-wide basis. Monthly consumption measured in millions of gallons instead of thousands significantly exceeds the rate blocks used in the Small Commercial Rate making the use of a uniform rate structure a simpler and reasonable approach for a reclaimed water rate structure.

As previously discussed, one of the primary considerations in developing a reclaimed water rate is the desired level of cost recovery. An alternative to the Small Commercial Rate structure is a contract rate that is adjusted at year end to generate a percentage of the fixed costs of the reclaimed water system. Fixed costs are those costs that do not vary with the volume of water produced, such as debt service. Variable costs are those that vary with the volume of water produced, such as electricity and chemicals for disinfection.

For Alternative 1, the categorization of costs as fixed and variable are shown in Table 27.

Table 27: Annual Cost Categories

Fixed Costs		Variable Costs	
Engr, Distr., Production	$6,000	Electricity	$24,681
Annual Debt Service	352,060	Disinfection	6,905
TOTAL	$358,060	Laboratory	3,600
		Effluent Purchase	16,719
		TOTAL	$51,905

Assuming a target cost recovery of 50 percent for fixed costs and 100 percent for variable costs, the reclaimed water rate structure would be an annual charge of $179,030 and a volumetric rate of $0.2349 per thousand gallons.

9.4 Implementation Steps

Implementation of a reclaimed water system should proceed in a logical, step-by-step approach, beginning with a public and political consensus on the need for the project and the framework in which the project would be developed. The initial steps toward implementation should include:

1. Gaining public acceptance of both the purpose of the system and the project costs is crucial.
2. Schedule meetings of City and NBU staff to discuss the framework of implementing the development of a reclaimed water system. Key questions to be addressed in the framework include:
    a. Which will be the lead agency charged with developing a reclaimed water system?
    b. What are the viable alternatives for project funding? The possible funding sources for design, construction, and O&M depend in large part on the jurisdictional requirements of the project.
    c. How will the ownership and operations of a reclaimed water system be structured?
3. Prepare draft revisions to Chapter 130 of the municipal code of ordinances to identify a reclaimed water system as either a utility owned and operated by NBU or as a reclaimed water system dedicated to serve the city's parklands.

Actual amendment of the city code, if required, would be concurrent with the completion of construction of the project.

4. Prepare a Memorandum of Understanding (MOU) that can be presented to the City Council and NBU Board for acceptance.

5. Once the framework for development of the project is established, the actual project development could begin with incorporating the project into the City or NBU CIP.

6. Public outreach should continue throughout the implementation process with the following key elements:

   a. Involve the public throughout the project implementation with opportunities for comment. Managing expectations becomes more than answering whether the project is on budget and on schedule, it is also important to provide a clear reminder that the primary purpose of the project is to irrigate parklands for the benefit of the community and not to market reclaimed water to consumers or industry.

   b. Public concerns that arise should be addressed with complete candor using all available scientific and regulatory information.

   c. Public outreach information should address the fundamental relationships between developing and maintaining parks and water conservation.

9.4.1 Reclaimed Water System Implementation

Year 1

1. Conduct a review of the Feasibility Study by the City Council and NBU Board of Directors.
2. Disseminate public information and conduct public hearings on the findings of the feasibility study.
3. Conduct meetings of City and NBU staff to discuss the framework of implementing the development of a reclaimed water system.
4. Prepare draft revisions to Chapter 130 of the municipal code of ordinances.
5. Negotiate a Memorandum of Understanding (MOU) to be presented to the City Council and NBU Board for acceptance.
6. Perform testing of wastewater effluent (conductivity, nitrogen, and phosphorus) to provide data for development of park irrigation standard operating procedures.
7. Begin development of project funding plan, including debt issuance schedule and application for state or federal grants and/or loans.
8. Incorporate the reclaimed water system project into the City or NBU CIP.
9. Amend parks CIP projects to incorporate the use of reclaimed water.

Year 2

1. Disseminate public information regarding project schedule.
2. Complete project funding plan. Establish schedule for debt issuance and applications for state or federal grants and/or loans.
3. Begin and complete preliminary design of the reclaimed water system.
4. Survey existing park irrigation systems for potable water separation points and backflow preventer locations.
5. Develop park irrigation standard operating procedures.
6. Finalize reclaimed water storage facility locations.
7. Perform environmental permitting.
8. Obtain TxDOT and railroad permits for pipeline crossings.
9. Obtain Chapter 210 authorizations.
10. Install park irrigation pumping.

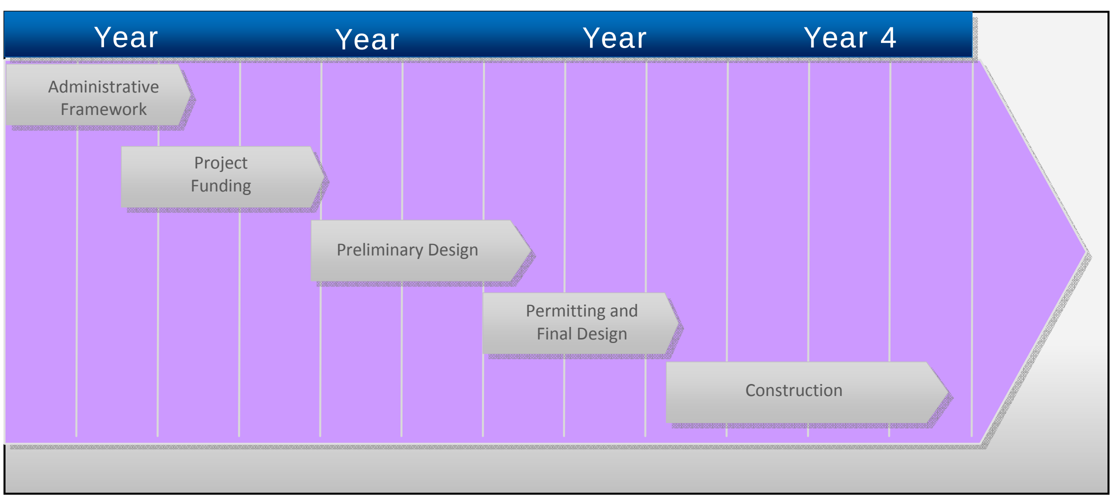
Year 3

1. Begin and complete final design of the reclaimed water system.

Year 4

1. Begin and complete construction of the reclaimed water system.
2. Begin park irrigation.

Figure 22: Project Implementation Timeline



THIS PAGE INTENTIONALLY LEFT BLANK

10 References

American Water Works Association. Planning for the Distribution of Reclaimed Water - M24, Third Edition, 2009, Denver, CO: American Water Works Association.

American Water Works Association. Water Reuse Rates and Charges Survey Results, 2008, Denver, CO; American Water Works Association.

Asano, Takashi, 2007. Water reuse: issues, technologies and applications, New York: McGraw-Hill.

Bureau of Reclamation, U.S. Department of the Interior, “Guidelines for Preparing, Reviewing, and Processing Water Reclamation and Reuse Project Proposals Under Title XVI of Public Law 102-575, as Amended,” (December 2010).

California Department of Public Health, Division of Drinking Water and Environmental Management, 2009, Treatment Technology Report for Recycled Water, Carpinteria, CA: Recycled Water Unit/Technical Operations Section/Technical Programs Branch.

Casey, C., R. Schmalz, R. Lockridge, T. Cristiano. “The Grass is Always Greener…Building Consensus on Reclaimed Water Pricing for Jointly Operated Municipal Reclaimed Water Systems.” 2006, Water Environment Federation.

City of New Braunfels, TX, Landa Park Irrigation Demand Analysis, Bolin Consulting, August 2009.

City of New Braunfels, TX, Our Parks-Our Heritage-Our Future, Halff Associates, Inc., September 2010.

City of New Braunfels, TX, 2008, New Braunfels, Texas Code of Ordinances, Chapter 130, Article IV, Division 5 - Water Conservation. www.Municode.com.

Diehl, K., M. Howard, C. Norris, N. Pence, T. Votteler, 2010. Selection of Top Restoration and Mitigation Actions for the Comal Springs Ecosystem and the San Marcos Springs Ecosystem: Edwards Aquifer Recovery Implementation Program. Prepared by Ecosystem Restoration Subcommittee for the Steering Committee of the Edwards Aquifer Recovery Implementation Program.

Drewes, J.E. and Shore, L.S., 2001. Concerns about pharmaceuticals in water reuse, groundwater recharge, and animal waste. In: Ch. Daughton and T.L. Jones-Lepp, Eds., American Chemical Society Symposium Series 791, “Pharmaceuticals and personal care products in the environment" No. 791, Washington, D.C., p. 206-228.

Ecosystem Restoration Subcommittee, 2009, Restoration and Mitigation Actions for the Comal Springs Ecosystem. Steering Committee of the Edwards Aquifer Recovery Implementation Program.

Edwards Aquifer Authority (EAA), 2008, Edwards Aquifer Authority Rules, San Antonio, TX.

Edwards Aquifer Authority (EAA), 2008, Groundwater Conservation Plan, San Antonio, TX.

Edwards Aquifer Authority (EAA), 2011. Schindel, Geary. Email communication.

Foster, A.L., 2007, Occurrence and Fate of Endocrine Disruptors through the San Marcos Wastewater Treatment Plant. Thesis for Master of Science, Texas State University, December 2007.

Ghadiri, H., J. Hussein, C.W. Rose, and B. Yu, 2008, Predicting vegetation buffer efficiency in reducing runoff transport of sediments and nutrients. Conference Publication: 15th International Soil Conservation Conference, Budapest, Hungary, 23 May 2008. Available at: http//www98.griffith.edu.au/dspace/bitstream/10072/24084/1/52339_1.pdf. Accessed: 25 October 2010.

South Central Texas Regional Water Planning Group (SCTRWPG), 2011 South Central Texas Regional Water Plan. September 2010.

Mikesell, J. Fiscal Administration: Analysis and Applications for the Public Sector, Wadsworth, 1995

National Toxicology Program's Report of the Endocrine Disruptors Low Dose Peer Review; National Institute of Environmental Health Sciences, NEIHS, National Toxicology Program, August 2001. Available at: http://ntp.niehs.nih.gov/ntp/htdocs/liason/LowDosePeerFinalRpt.pdf

New Braunfels Utilities (NBU), "Water Reuse Feasibility Study," Pape-Dawson Engineers, Inc., September 2003.

New Braunfels Utilities (NBU), "Wastewater Capacity Planning Study Report," TCB-AECOM, October 2007.

Norvell, S. and Shaw, S. "Socioeconomic Impacts of Projected Water Shortages for the South Central Texas Regional Water Planning Area (Region L)", June 2010, Texas Water Development Board.

Raucher, Robert S., An Economic Framework for Evaluating the Benefits and Costs of Water Reuse, Water Reuse Foundation, 2006.

Recharge Facility Feasibility Subcommittee, 2009. Findings, Determinations and Recommendations Regarding Five Charges in Subsection (n) of Section 1.26A of the Edwards Aquifer Authority Act. Steering Committee and Stakeholders of the Edwards Aquifer Recovery Implementation Program.

Region C Water Planning Group. "Direct, Non-Potable Reuse Guidance Document," April 2009.

Rochelle, Martin C., Meeting Water Supply Needs: Planning, Permitting, and Implementation. Essentials of Texas Water Resources, Ed., Mary K. Sahs, Austin, TX: Environmental and Natural Resources Law Section of the State Bar of Texas, 2009.

South Central Texas Regional Water Planning Group, "2011 Regional Water Plan" Texas Water Development Board, San Antonio River Authority, HDR Engineering, Inc., September 2010.

South Central Texas Regional Water Planning Group, "2006 Regional Water Plan" Texas Water Development Board, San Antonio River Authority, HDR Engineering, Inc., January 2006.

Texas Administrative Code (TAC) Title 30, Part 1, Chapter 210, Use of Reclaimed Water.

Texas Administrative Code (TAC) Title 30, Part 1, Chapter 217. Design Criteria for Domestic Wastewater Systems.

Texas Administrative Code (TAC) Title 30, Part 1, Chapter 321, Subchapter P, Reclaimed Water Production Facilities.

Texas Administrative Code (TAC) Title 30, Part 1, Chapter 344, Subchapter F, Standards for Designing, Installing, and Maintaining Landscape Irrigation Systems

Texas Commission on Environmental Quality (TCEQ), "Study of the Methods for Disposing of Unused Pharmaceuticals", SFR-098, December 2010.

Texas Parks and Wildlife Department (TPWD), Annotated County Lists of Rare Species. Accessed February 23, 2010.

Texas Water Conservation Association (TWCA), "Texas Water Rights and Wastewater Reuse," Whitepaper, 2004.

Texas Water Development Board (TWDB), "Water Conservation Best Management Practices Guide," Water Conservation Implementation Task Force, Report 362. November 2004.

Texas Water Development Board (TWDB), "Water Reuse". Available at: https://www.twdb.state.tx.us/iwt/reuse.asp

U.S. Environmental Protection Agency (EPA), "Water Recycling and Reuse: The Environmental Benefits". Available at: http://www.epa.gov/region9/water/recycling/

U.S. Environmental Protection Agency (EPA), Municipal Support Division, Office of Wastewater Management, 2004, Guidelines for Water Reuse (EPA/625/R-04/108), Washington, DC: Technology Transfer and Support Division.

U.S. Fish and Wildlife Service (USFWS), "National Wetlands Inventory." Available at: http://www.fws.gov/wetlands/Data/Mapper.html

Walsh, P.M., M.E. Barrett, J.F. Malina, and R.J. Charbeneau, 1998, Use of Vegetative Controls for Treatment of Highway Runoff, Research Report 2954-2, Research Project 7-2954 Texas Department of Transportation. Prepared by Center for Transportation Research at The University of Texas at Austin.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix A

Parks Metered Consumption Data
2005 - 2009

Park Metered Consumption (2005 – 2009)

Location	METER #	ACCT #	2005 (gal)	2006 (gal)	2007 (gal)	2008 (gal)	2009 (gal)
Hinman Island	70029553	19342-50	378,600	572,300	307,400	307,600	536,600
Camp Comal	20493193	11882-50	1,610,400	1,795,100	1,149,500	1,813,900	1,052,500
HEB Soccer Complex	60414553	8246-50	4,715,000	5,131,000	1,615,000	4,947,500	6,599,900
	79388044		384,800	355,200	12,300	143,000	399,800
Park Office	60450748	19362-50	195,600	172,200	32,500	260,000	347,000
Landa Park	80943741	19382-50	55,700	55,400	51,300	40,100	31,100
Fredericksburg Baseball Fields	60428762	26016-50	806,500	512,500	93,000	609,000	639,900
Landa Park	80942528	26018-50	83,800	122,200	55,300	109,900	93,700
Landa Park	80942530	26020-50	10,900	20,100	6,500	85,000	279,700
Landa Park	60414554	26022-50	37,000	34,500	56,200	256,300	466,300
Landa Park	60428731	26026-50	351,500	239,000	151,000	253,000	484,500
Landa Park	49551390	26028-50	56,900	52,800	2,200	92,600	107,500
Landa Park	80942531	26030-50	8,700	10,300	500	14,900	31,700
Landa Park	49551391	26032-50	95,100	69,000	103,500	168,700	166,400
Landa Park	60428733	26034-50	310,600	270,000	45,000	437,300	523,500
Landa Park	60428729	26036-50	452,400	606,000	328,000	968,500	1,235,000
Prince Solms	26084419	19076-50	96,100	353,400	67,300	313,200	581,200
TOTAL			**9,649,600**	**10,371,000**	**4,076,500**	**10,820,500**	**13,576,300**

5 Yr. Average Unit Cost per Thousand Gallons
(2007 Rates)

Location	Meter #	Rate Schedule	5-Yr. Vol. (gal.)	5-Yr. Cost	5-Yr. Avg Cost ($/kgal)
Hinman Island	70029553	SC	2,102,500	$4,100	$1.95
Camp Comal	20493193	SC	7,421,400	14,805	1.99
HEB Soccer Complex	60414553	LI	23,008,400	92,960	4.04
	79388044		1,295,100	4,217	3.26
Landa Park	80943741	SC	233,600	442	1.89
Fredericksburg Baseball Fields	60428762	SC	2,660,900	5,226	1.96
Landa Park	80942528	SC	464,900	893	1.92
Landa Park	80942530	SC	402,200	781	1.94
Landa Park	60414554	SC	850,300	1,672	1.97
Landa Park	60428731	SC	1,479,000	2,872	1.94
Landa Park	49551390	SC	312,000	599	1.92
Landa Park	80942531	SC	66,100	125	1.90
Landa Park	49551391	SC	602,700	1,161	1.93
Landa Park	60428733	SC	1,586,400	3,097	1.95
Landa Park	60428729	SC	3,589,900	7,071	1.97
Prince Solms	26084419	LI	1,411,200	4,942	3.50
TOTAL			**47,486,600**	**$144,963**	**$ 3.05**

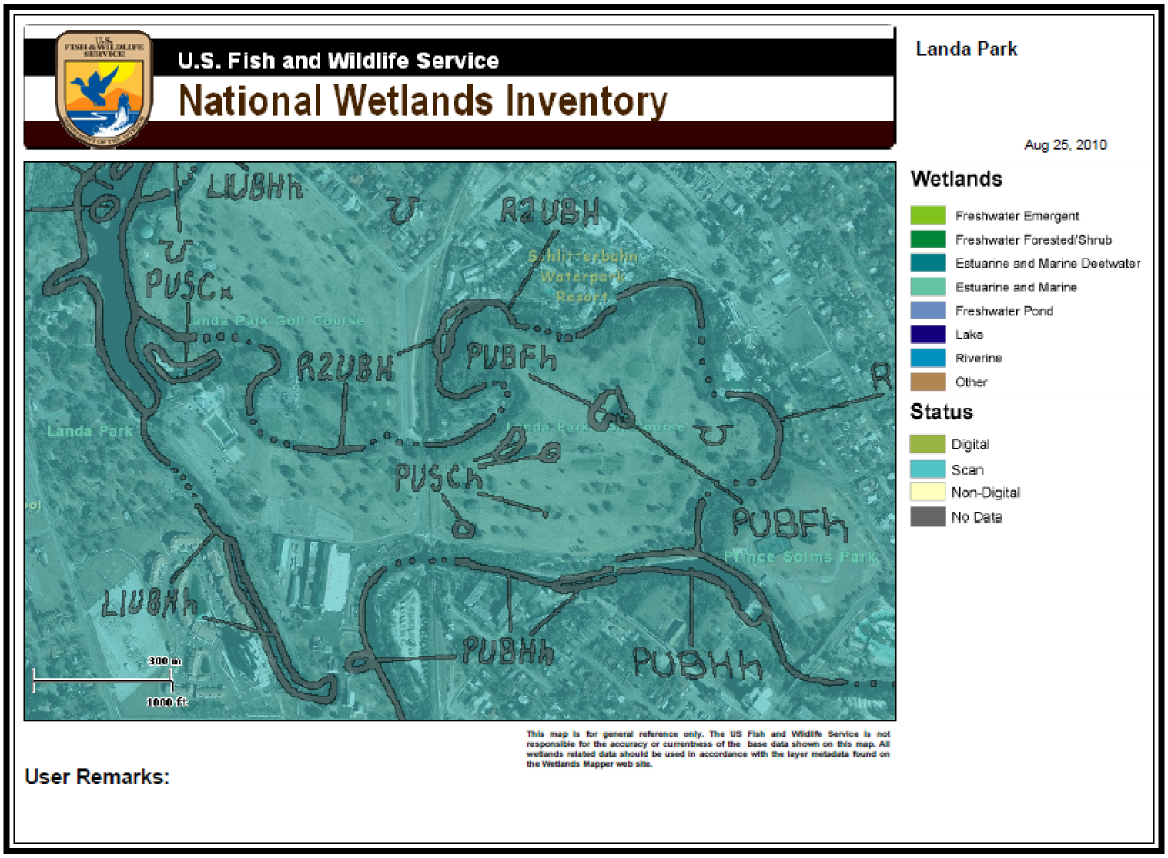
SC: Small Commercial

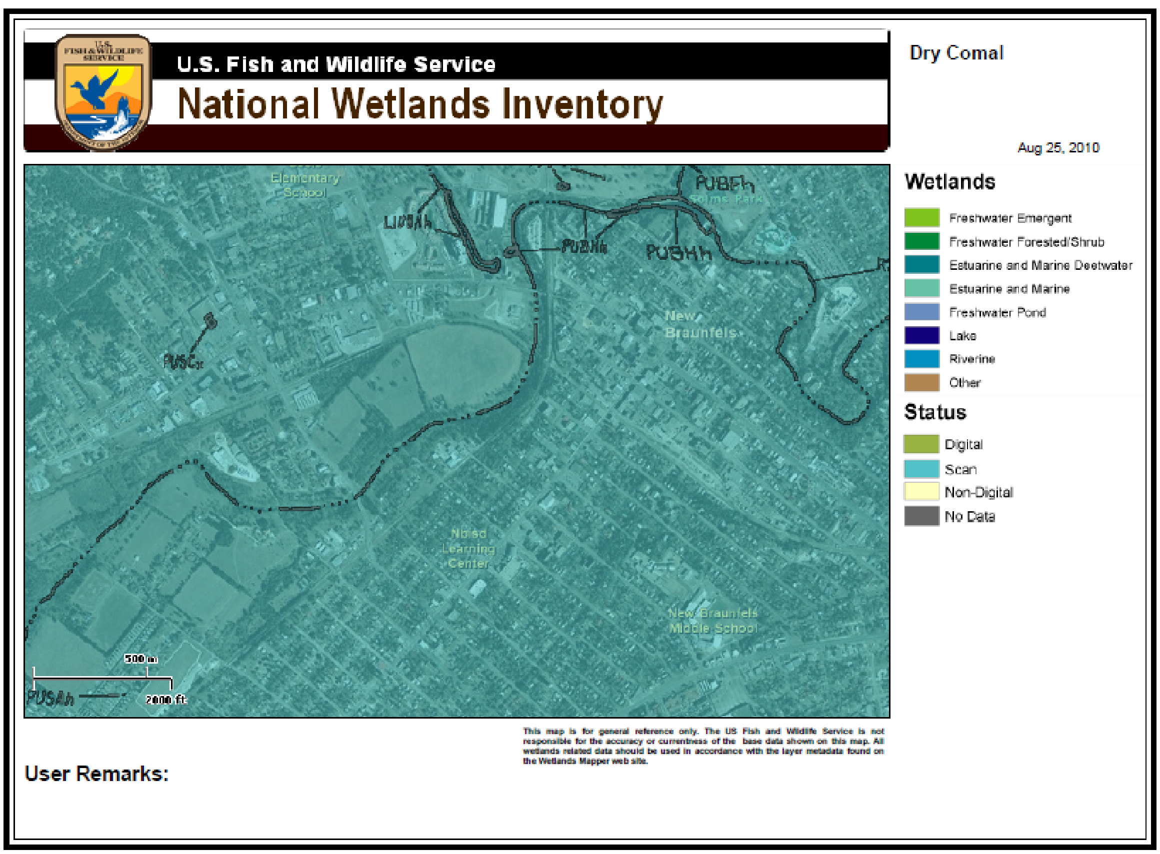
LI: Landscape/Irrigation

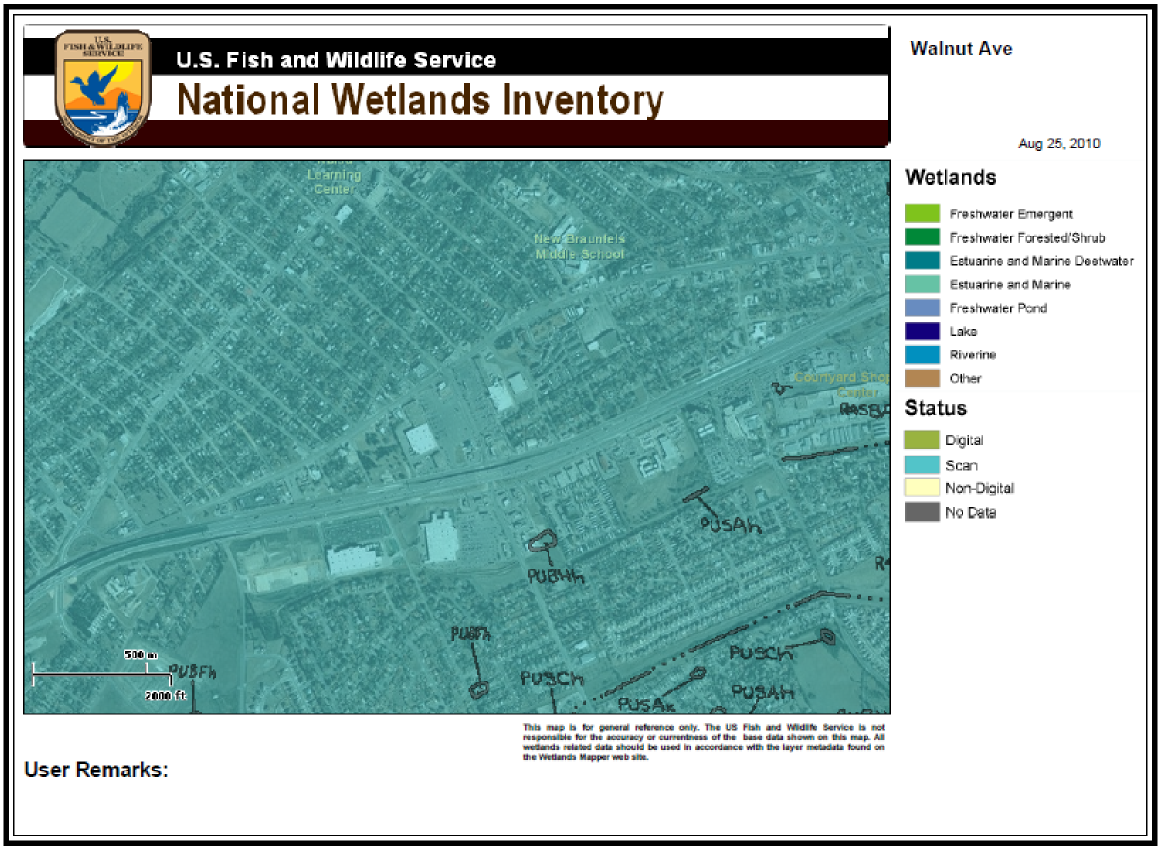
THIS PAGE INTENTIONALLY LEFT BLANK

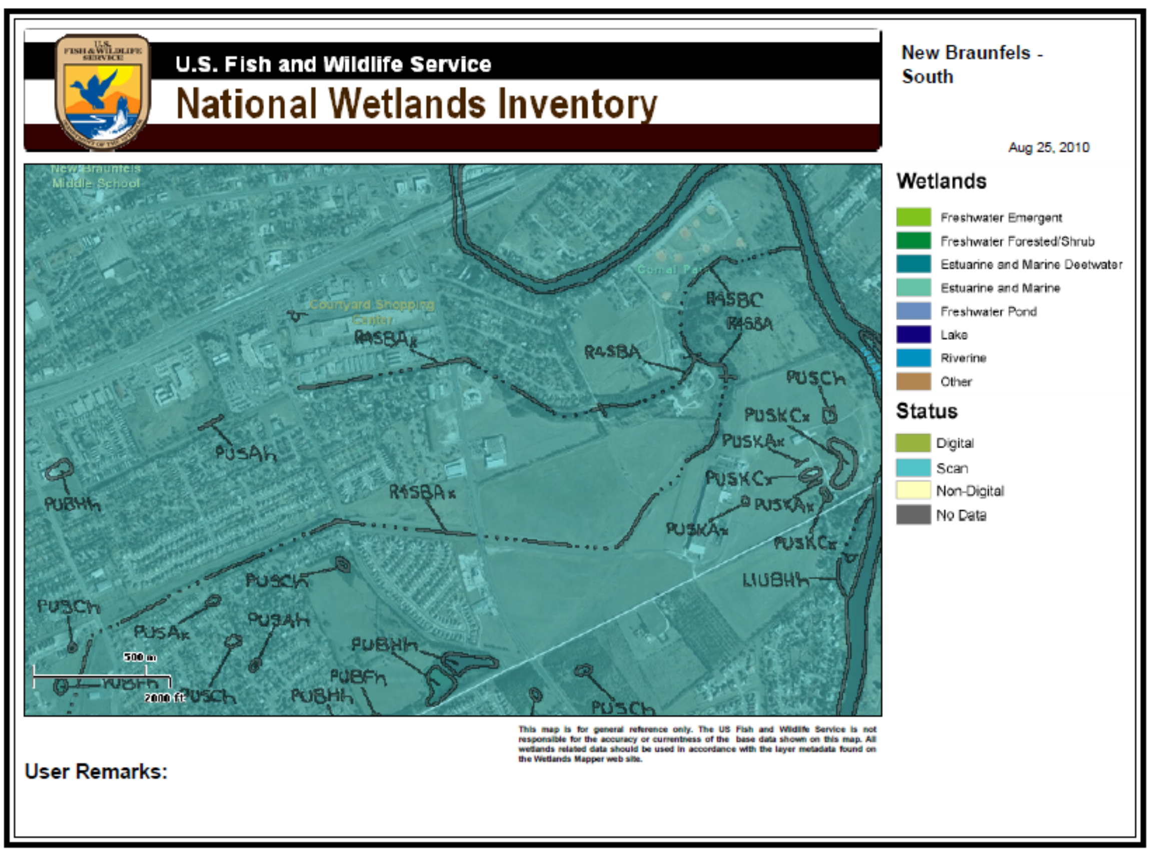
Appendix B

National Wetlands Inventory


U.S. Fish and Wildlife Service
National Wetlands Inventory
Landa Park
Aug 25, 2010
Wetlands
Freshwater Emergent
Freshwater Forested/Shrub
Estuarine and Marine Deepwater
Estuarine and Marine
Freshwater Pond
Lake
Riverine
Other
Status
Digital
Scan
Non-Digital
No Data
L1UBHh
R2UBH
PUSCh
R2UBH
PUBFh
PUSCh
PUBFh
L1UBHh
PUBHh
PUBHh
Landa Park
Prince Solms Park
300 m
1000 ft
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.
User Remarks:


U.S. Fish and Wildlife Service
National Wetlands Inventory
Dry Comal
Aug 25, 2010
Wetlands
Freshwater Emergent
Freshwater Forested/Shrub
Estuarine and Marine Deepwater
Estuarine and Marine
Freshwater Pond
Lake
Riverine
Other
Status
Digital
Scan
Non-Digital
No Data
PUBFh
PUBHh
PUBHh
New Braunfels
New Braunfels Middle School
500 m
2000 ft
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.
User Remarks:


U.S. Fish and Wildlife Service
National Wetlands Inventory
Walnut Ave
Aug 25, 2010
Wetlands
Freshwater Emergent
Freshwater Forested/Shrub
Estuarine and Marine Deepwater
Estuarine and Marine
Freshwater Pond
Lake
Riverine
Other
Status
Digital
Scan
Non-Digital
No Data
New Braunfels Middle School
500 m
2000 ft
PUSAh
PUBHh
PUSCh
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.
User Remarks:

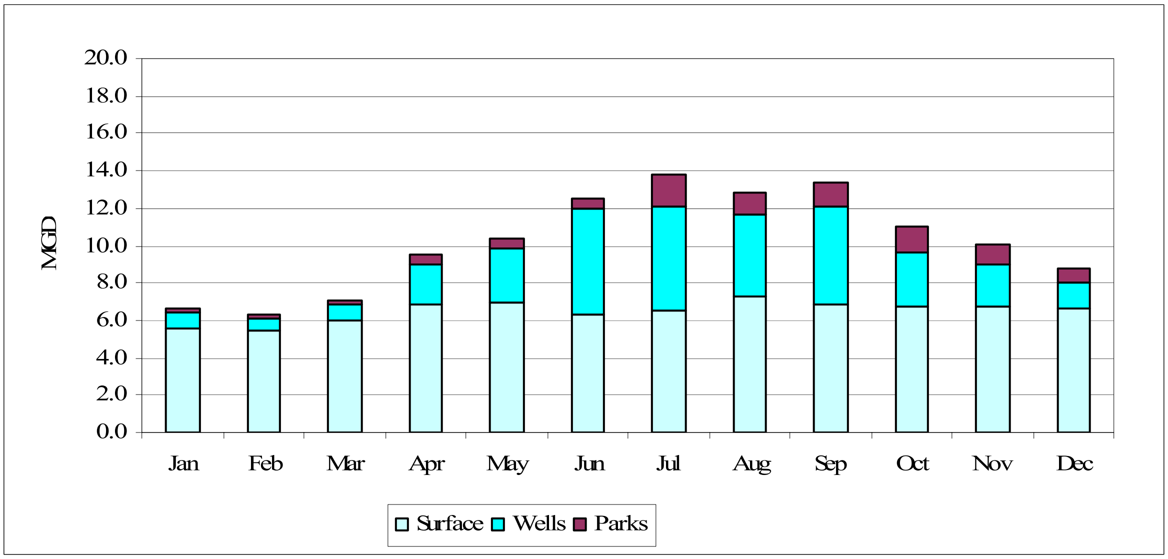

U.S. Fish and Wildlife Service
National Wetlands Inventory
New Braunfels - South
Aug 25, 2010
Wetlands
Freshwater Emergent
Freshwater Forested/Shrub
Estuarine and Marine Deepwater
Estuarine and Marine
Freshwater Pond
Lake
Riverine
Other
Status
Digital
Scan
Non-Digital
No Data
R4SBC
R4SBA
PUSCh
PUSAh
PUBHh
L1UBHh
500 m
2000 ft
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.
User Remarks:

THIS PAGE INTENTIONALLY LEFT BLANK

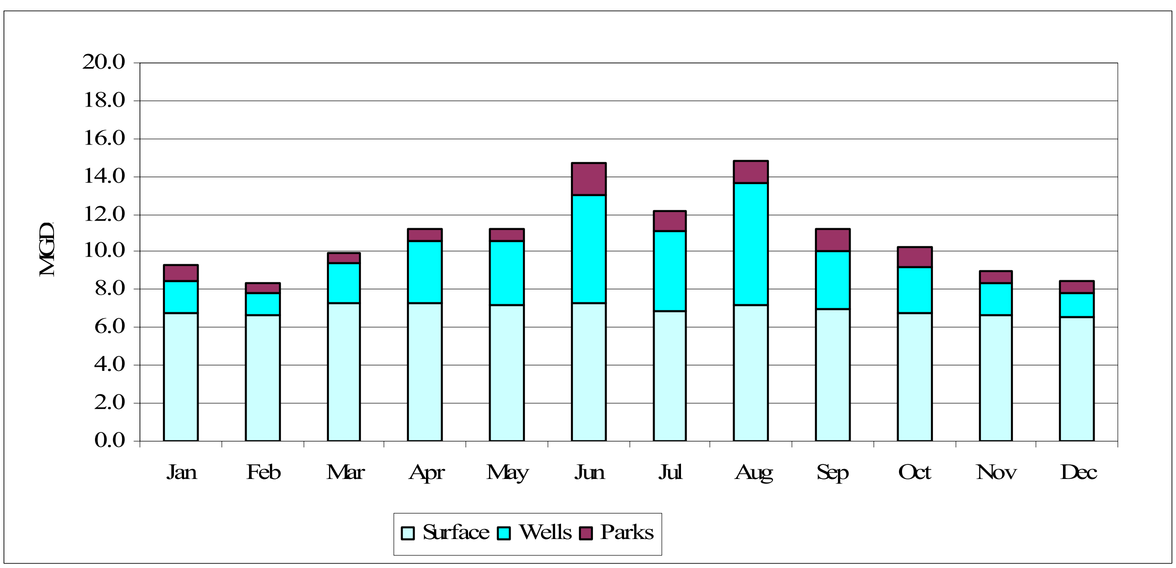
Appendix C

Comparison of Potable Water Production With Parks Consumption 2005 - 2009

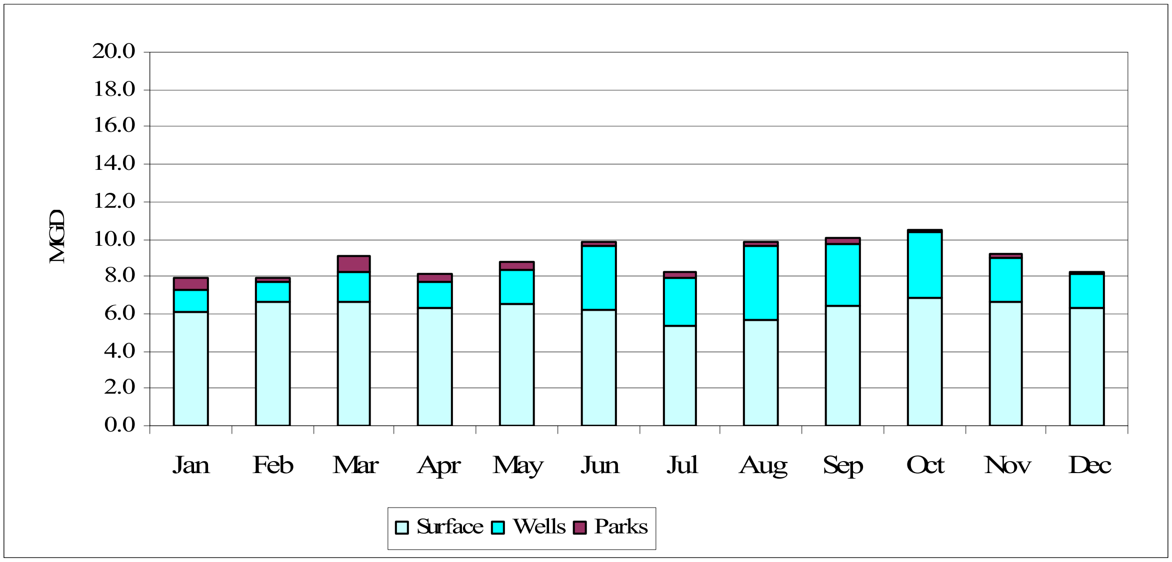
Parks Water Consumption vs. Potable Water Production – 2005



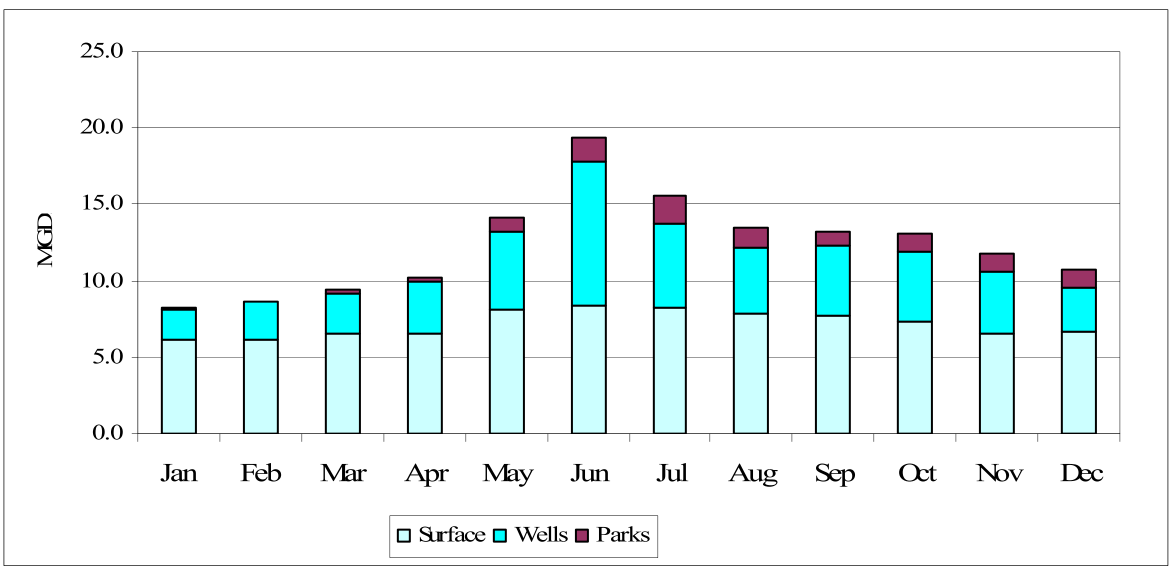
Parks Water Consumption vs. Potable Water Production – 2006



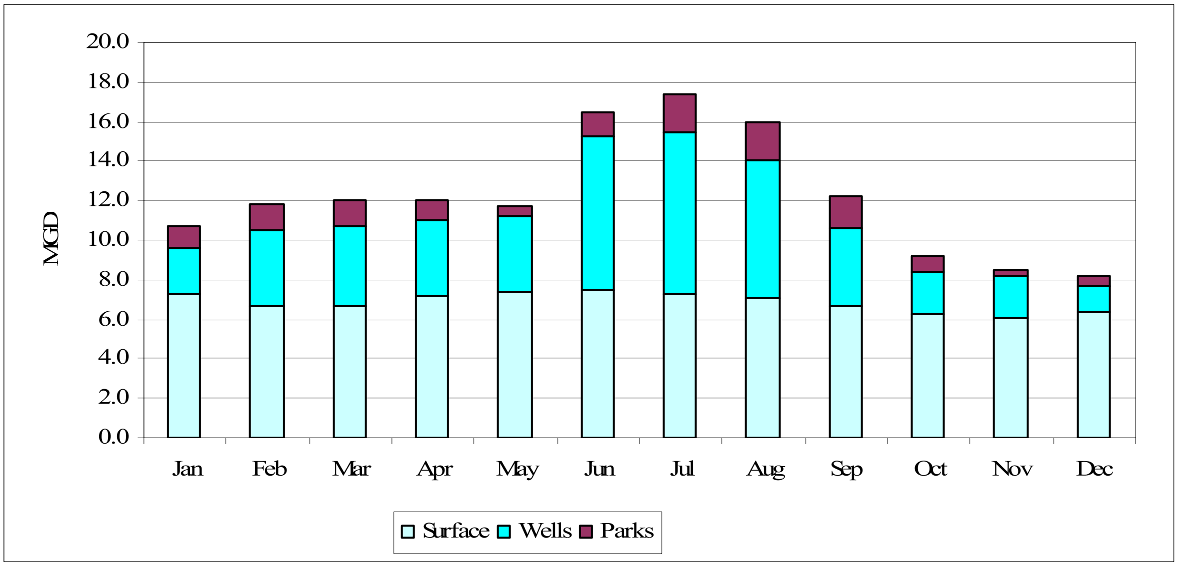
Parks Water Consumption vs. Potable Water Production – 2007



Parks Water Consumption vs. Potable Water Production – 2008



Parks Water Consumption vs. Potable Water Production – 2009



Appendix D

Park Irrigation Demand

Irrigation Demand – Study Area (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	172.8	1.75	2.03	4.03	1.31	42,382	117.73	88.29
Feb	172.8	2.02	2.71	9.94	3.24	115,630	321.20	240.90
Mar	172.8	1.95	4.35	34.56	11.26	363,270	1009.08	756.81
Apr	172.8	2.72	5.29	37.01	12.06	401,969	1116.58	837.43
May	172.8	3.76	7.56	54.72	17.83	575,178	1597.72	1198.29
Jun	172.8	3.49	8.24	68.40	22.29	742,938	2063.72	1547.79
Jul	172.8	2.19	8.19	86.40	28.15	908,175	2522.71	1892.03
Aug	172.8	2.50	8.14	81.22	26.46	853,685	2371.35	1778.51
Sep	172.8	3.51	6.20	38.74	12.62	420,738	1168.72	876.54
Oct	172.8	3.49	4.94	20.88	6.80	219,476	609.65	457.24
Nov	172.8	2.25	3.11	12.38	4.04	134,511	373.64	280.23
Dec	172.8	1.86	2.11	3.60	1.17	37,841	105.11	78.83
TOTAL		31.49	62.87	451.87	147.24			

Irrigation Demand – Study Area (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	172.8	0.88	2.03	16.63	5.42	174,824	485.62	364.22
Feb	172.8	1.01	2.71	24.48	7.98	284,886	791.35	593.51
Mar	172.8	0.98	4.35	48.60	15.84	510,849	1419.02	1064.27
Apr	172.8	1.36	5.29	56.59	18.44	614,683	1707.45	1280.59
May	172.8	1.88	7.56	81.79	26.65	859,739	2388.17	1791.12
Jun	172.8	1.75	8.24	93.53	30.48	1,015,870	2821.86	2116.40
Jul	172.8	1.10	8.19	102.17	33.29	1,073,918	2983.10	2237.33
Aug	172.8	1.25	8.14	99.22	32.33	1,042,888	2896.91	2172.68
Sep	172.8	1.76	6.20	64.01	20.86	695,234	1931.20	1448.40
Oct	172.8	1.75	4.94	46.01	14.99	483,603	1343.34	1007.51
Nov	172.8	1.13	3.11	28.58	9.31	310,470	862.42	646.81
Dec	172.8	0.93	2.11	16.99	5.54	178,608	496.13	372.10
TOTAL		15.75	62.87	678.60	221.12			

Irrigation Demand – Study Area (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	172.8	0.00	2.03	29.23	9.53	307,266	853.52	640.14
Feb	172.8	0.00	2.71	39.02	12.72	454,142	1261.51	946.13
Mar	172.8	0.00	4.35	62.64	20.41	658,427	1828.96	1371.72
Apr	172.8	0.00	5.29	76.18	24.82	827,398	2298.33	1723.75
May	172.8	0.00	7.56	108.86	35.47	1,144,301	3178.61	2383.96
Jun	172.8	0.00	8.24	118.66	38.66	1,288,802	3580.01	2685.00
Jul	172.8	0.00	8.19	117.94	38.43	1,239,660	3443.50	2582.62
Aug	172.8	0.00	8.14	117.22	38.19	1,232,091	3422.48	2566.86
Sep	172.8	0.00	6.20	89.28	29.09	969,730	2693.69	2020.27
Oct	172.8	0.00	4.94	71.14	23.18	747,731	2077.03	1557.77
Nov	172.8	0.00	3.11	44.78	14.59	486,429	1351.19	1013.39
Dec	172.8	0.00	2.11	30.38	9.90	319,375	887.15	665.36
TOTAL		0.00	62.87	905.33	295.00			

Irrigation Demand - Camp Comal (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	30.3	1.75	2.03	0.71	0.23	7,431	20.64	15.48
Feb	30.3	2.02	2.71	1.74	0.57	20,275	56.32	42.24
Mar	30.3	1.95	4.35	6.06	1.97	63,698	176.94	132.71
Apr	30.3	2.72	5.29	6.49	2.11	70,484	195.79	146.84
May	30.3	3.76	7.56	9.60	3.13	100,856	280.16	210.12
Jun	30.3	3.49	8.24	11.99	3.91	130,272	361.87	271.40
Jul	30.3	2.19	8.19	15.15	4.94	159,246	442.35	331.76
Aug	30.3	2.50	8.14	14.24	4.64	149,691	415.81	311.86
Sep	30.3	3.51	6.20	6.79	2.21	73,775	204.93	153.70
Oct	30.3	3.49	4.94	3.66	1.19	38,484	106.90	80.18
Nov	30.3	2.25	3.11	2.17	0.71	23,586	65.52	49.14
Dec	30.3	1.86	2.11	0.63	0.21	6,635	18.43	13.82
TOTAL		31.49	62.87	79.23	25.82			

Irrigation Demand - Camp Comal (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	30.3	0.88	2.03	2.92	0.95	30,655	85.15	63.86
Feb	30.3	1.01	2.71	4.29	1.40	49,954	138.76	104.07
Mar	30.3	0.98	4.35	8.52	2.78	89,576	248.82	186.62
Apr	30.3	1.36	5.29	9.92	3.23	107,783	299.40	224.55
May	30.3	1.88	7.56	14.34	4.67	150,753	418.76	314.07
Jun	30.3	1.75	8.24	16.40	5.34	178,130	494.81	371.10
Jul	30.3	1.10	8.19	17.91	5.84	188,308	523.08	392.31
Aug	30.3	1.25	8.14	17.40	5.67	182,868	507.97	380.97
Sep	30.3	1.76	6.20	11.22	3.66	121,907	338.63	253.97
Oct	30.3	1.75	4.94	8.07	2.63	84,799	235.55	176.66
Nov	30.3	1.13	3.11	5.01	1.63	54,440	151.22	113.42
Dec	30.3	0.93	2.11	2.98	0.97	31,318	87.00	65.25
TOTAL		15.75	62.87	118.99	38.77			

Irrigation Demand - Camp Comal (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	30.3	0.00	2.03	5.13	1.67	53,878	149.66	112.25
Feb	30.3	0.00	2.71	6.84	2.23	79,633	221.20	165.90
Mar	30.3	0.00	4.35	10.98	3.58	115,453	320.70	240.53
Apr	30.3	0.00	5.29	13.36	4.35	145,082	403.01	302.25
May	30.3	0.00	7.56	19.09	6.22	200,650	557.36	418.02
Jun	30.3	0.00	8.24	20.81	6.78	225,988	627.74	470.81
Jul	30.3	0.00	8.19	20.68	6.74	217,371	603.81	452.86
Aug	30.3	0.00	8.14	20.55	6.70	216,044	600.12	450.09
Sep	30.3	0.00	6.20	15.66	5.10	170,039	472.33	354.25
Oct	30.3	0.00	4.94	12.47	4.06	131,113	364.20	273.15
Nov	30.3	0.00	3.11	7.85	2.56	85,294	236.93	177.70
Dec	30.3	0.00	2.11	5.33	1.74	56,002	155.56	116.67
TOTAL		0.00	62.87	158.75	51.73			

Irrigation Demand - Fischer Park (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	60	1.75	2.03	1.40	0.46	14,716	40.88	30.66
Feb	60	2.02	2.71	3.45	1.12	40,149	111.53	83.64
Mar	60	1.95	4.35	12.00	3.91	126,135	350.38	262.78
Apr	60	2.72	5.29	12.85	4.19	139,572	387.70	290.78
May	60	3.76	7.56	19.00	6.19	199,715	554.76	416.07
Jun	60	3.49	8.24	23.75	7.74	257,965	716.57	537.43
Jul	60	2.19	8.19	30.00	9.78	315,339	875.94	656.96
Aug	60	2.50	8.14	28.20	9.19	296,418	823.38	617.54
Sep	60	3.51	6.20	13.45	4.38	146,089	405.80	304.35
Oct	60	3.49	4.94	7.25	2.36	76,207	211.69	158.76
Nov	60	2.25	3.11	4.30	1.40	46,705	129.74	97.30
Dec	60	1.86	2.11	1.25	0.41	13,139	36.50	27.37
TOTAL		31.49	62.87	156.90	51.13			

Irrigation Demand - Fischer Park (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	60	0.88	2.03	5.78	1.88	60,703	168.62	126.46
Feb	60	1.01	2.71	8.50	2.77	98,919	274.77	206.08
Mar	60	0.98	4.35	16.88	5.50	177,378	492.72	369.54
Apr	60	1.36	5.29	19.65	6.40	213,432	592.87	444.65
May	60	1.88	7.56	28.40	9.25	298,521	829.22	621.92
Jun	60	1.75	8.24	32.48	10.58	352,733	979.81	734.86
Jul	60	1.10	8.19	35.48	11.56	372,888	1035.80	776.85
Aug	60	1.25	8.14	34.45	11.23	362,114	1005.87	754.40
Sep	60	1.76	6.20	22.23	7.24	241,401	670.56	502.92
Oct	60	1.75	4.94	15.98	5.21	167,918	466.44	349.83
Nov	60	1.13	3.11	9.93	3.23	107,802	299.45	224.59
Dec	60	0.93	2.11	5.90	1.92	62,017	172.27	129.20
TOTAL		15.75	62.87	235.63	76.78			

Irrigation Demand - Fischer Park (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	60	0.00	2.03	10.15	3.31	106,690	296.36	222.27
Feb	60	0.00	2.71	13.55	4.42	157,688	438.02	328.52
Mar	60	0.00	4.35	21.75	7.09	228,621	635.06	476.29
Apr	60	0.00	5.29	26.45	8.62	287,291	798.03	598.52
May	60	0.00	7.56	37.80	12.32	397,327	1103.69	827.76
Jun	60	0.00	8.24	41.20	13.43	447,501	1243.06	932.29
Jul	60	0.00	8.19	40.95	13.34	430,437	1195.66	896.74
Aug	60	0.00	8.14	40.70	13.26	427,810	1188.36	891.27
Sep	60	0.00	6.20	31.00	10.10	336,712	935.31	701.48
Oct	60	0.00	4.94	24.70	8.05	259,629	721.19	540.89
Nov	60	0.00	3.11	15.55	5.07	168,899	469.16	351.87
Dec	60	0.00	2.11	10.55	3.44	110,894	308.04	231.03
TOTAL		0.00	62.87	314.35	102.43			

Irrigation Demand - Fredericksburg Fields (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	5	1.75	2.03	0.12	0.04	1,226	3.41	2.55
Feb	5	2.02	2.71	0.29	0.09	3,346	9.29	6.97
Mar	5	1.95	4.35	1.00	0.33	10,511	29.20	21.90
Apr	5	2.72	5.29	1.07	0.35	11,631	32.31	24.23
May	5	3.76	7.56	1.58	0.52	16,643	46.23	34.67
Jun	5	3.49	8.24	1.98	0.64	21,497	59.71	44.79
Jul	5	2.19	8.19	2.50	0.81	26,278	73.00	54.75
Aug	5	2.50	8.14	2.35	0.77	24,702	68.62	51.46
Sep	5	3.51	6.20	1.12	0.37	12,174	33.82	25.36
Oct	5	3.49	4.94	0.60	0.20	6,351	17.64	13.23
Nov	5	2.25	3.11	0.36	0.12	3,892	10.81	8.11
Dec	5	1.86	2.11	0.10	0.03	1,095	3.04	2.28
TOTAL		31.49	62.87	13.08	4.26			

Irrigation Demand - Fredericksburg Fields (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	5	0.88	2.03	0.48	0.16	5,059	14.05	10.54
Feb	5	1.01	2.71	0.71	0.23	8,243	22.90	17.17
Mar	5	0.98	4.35	1.41	0.46	14,782	41.06	30.79
Apr	5	1.36	5.29	1.64	0.53	17,786	49.41	37.05
May	5	1.88	7.56	2.37	0.77	24,877	69.10	51.83
Jun	5	1.75	8.24	2.71	0.88	29,394	81.65	61.24
Jul	5	1.10	8.19	2.96	0.96	31,074	86.32	64.74
Aug	5	1.25	8.14	2.87	0.94	30,176	83.82	62.87
Sep	5	1.76	6.20	1.85	0.60	20,117	55.88	41.91
Oct	5	1.75	4.94	1.33	0.43	13,993	38.87	29.15
Nov	5	1.13	3.11	0.83	0.27	8,984	24.95	18.72
Dec	5	0.93	2.11	0.49	0.16	5,168	14.36	10.77
TOTAL		15.75	62.87	19.64	6.40			

Irrigation Demand - Fredericksburg Fields (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	5	0.00	2.03	0.85	0.28	8,891	24.70	18.52
Feb	5	0.00	2.71	1.13	0.37	13,141	36.50	27.38
Mar	5	0.00	4.35	1.81	0.59	19,052	52.92	39.69
Apr	5	0.00	5.29	2.20	0.72	23,941	66.50	49.88
May	5	0.00	7.56	3.15	1.03	33,111	91.97	68.98
Jun	5	0.00	8.24	3.43	1.12	37,292	103.59	77.69
Jul	5	0.00	8.19	3.41	1.11	35,870	99.64	74.73
Aug	5	0.00	8.14	3.39	1.11	35,651	99.03	74.27
Sep	5	0.00	6.20	2.58	0.84	28,059	77.94	58.46
Oct	5	0.00	4.94	2.06	0.67	21,636	60.10	45.07
Nov	5	0.00	3.11	1.30	0.42	14,075	39.10	29.32
Dec	5	0.00	2.11	0.88	0.29	9,241	25.67	19.25
TOTAL		0.00	62.87	26.20	8.54			

Irrigation Demand - HEB Soccer Complex (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	10.2	1.75	2.03	0.24	0.08	2,502	6.95	5.21
Feb	10.2	2.02	2.71	0.59	0.19	6,825	18.96	14.22
Mar	10.2	1.95	4.35	2.04	0.66	21,443	59.56	44.67
Apr	10.2	2.72	5.29	2.18	0.71	23,727	65.91	49.43
May	10.2	3.76	7.56	3.23	1.05	33,951	94.31	70.73
Jun	10.2	3.49	8.24	4.04	1.32	43,854	121.82	91.36
Jul	10.2	2.19	8.19	5.10	1.66	53,608	148.91	111.68
Aug	10.2	2.50	8.14	4.79	1.56	50,391	139.98	104.98
Sep	10.2	3.51	6.20	2.29	0.75	24,835	68.99	51.74
Oct	10.2	3.49	4.94	1.23	0.40	12,955	35.99	26.99
Nov	10.2	2.25	3.11	0.73	0.24	7,940	22.06	16.54
Dec	10.2	1.86	2.11	0.21	0.07	2,234	6.20	4.65
TOTAL		31.49	62.87	26.67	8.69			

Irrigation Demand - HEB Soccer Complex (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	10.2	0.88	2.03	0.98	0.32	10,319	28.67	21.50
Feb	10.2	1.01	2.71	1.45	0.47	16,816	46.71	35.03
Mar	10.2	0.98	4.35	2.87	0.93	30,154	83.76	62.82
Apr	10.2	1.36	5.29	3.34	1.09	36,283	100.79	75.59
May	10.2	1.88	7.56	4.83	1.57	50,749	140.97	105.73
Jun	10.2	1.75	8.24	5.52	1.80	59,965	166.57	124.93
Jul	10.2	1.10	8.19	6.03	1.97	63,391	176.09	132.06
Aug	10.2	1.25	8.14	5.86	1.91	61,559	171.00	128.25
Sep	10.2	1.76	6.20	3.78	1.23	41,038	113.99	85.50
Oct	10.2	1.75	4.94	2.72	0.88	28,546	79.29	59.47
Nov	10.2	1.13	3.11	1.69	0.55	18,326	50.91	38.18
Dec	10.2	0.93	2.11	1.00	0.33	10,543	29.29	21.96
TOTAL		15.75	62.87	40.06	13.05			

Irrigation Demand - HEB Soccer Complex (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	10.2	0.00	2.03	1.73	0.56	18,137	50.38	37.79
Feb	10.2	0.00	2.71	2.30	0.75	26,807	74.46	55.85
Mar	10.2	0.00	4.35	3.70	1.20	38,865	107.96	80.97
Apr	10.2	0.00	5.29	4.50	1.47	48,839	135.67	101.75
May	10.2	0.00	7.56	6.43	2.09	67,546	187.63	140.72
Jun	10.2	0.00	8.24	7.00	2.28	76,075	211.32	158.49
Jul	10.2	0.00	8.19	6.96	2.27	73,174	203.26	152.45
Aug	10.2	0.00	8.14	6.92	2.25	72,728	202.02	151.52
Sep	10.2	0.00	6.20	5.27	1.72	57,241	159.00	119.25
Oct	10.2	0.00	4.94	4.20	1.37	44,137	122.60	91.95
Nov	10.2	0.00	3.11	2.64	0.86	28,713	79.76	59.82
Dec	10.2	0.00	2.11	1.79	0.58	18,852	52.37	39.27
TOTAL		0.00	62.87	53.44	17.41			

Irrigation Demand - Hinman Island (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	7	1.75	2.03	0.16	0.05	1,717	4.77	3.58
Feb	7	2.02	2.71	0.40	0.13	4,684	13.01	9.76
Mar	7	1.95	4.35	1.40	0.46	14,716	40.88	30.66
Apr	7	2.72	5.29	1.50	0.49	16,283	45.23	33.92
May	7	3.76	7.56	2.22	0.72	23,300	64.72	48.54
Jun	7	3.49	8.24	2.77	0.90	30,096	83.60	62.70
Jul	7	2.19	8.19	3.50	1.14	36,790	102.19	76.64
Aug	7	2.50	8.14	3.29	1.07	34,582	96.06	72.05
Sep	7	3.51	6.20	1.57	0.51	17,044	47.34	35.51
Oct	7	3.49	4.94	0.85	0.28	8,891	24.70	18.52
Nov	7	2.25	3.11	0.50	0.16	5,449	15.14	11.35
Dec	7	1.86	2.11	0.15	0.05	1,533	4.26	3.19
TOTAL		31.49	62.87	18.31	5.96			

Irrigation Demand - Hinman Island (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	7	0.88	2.03	0.67	0.22	7,082	19.67	14.75
Feb	7	1.01	2.71	0.99	0.32	11,541	32.06	24.04
Mar	7	0.98	4.35	1.97	0.64	20,694	57.48	43.11
Apr	7	1.36	5.29	2.29	0.75	24,900	69.17	51.88
May	7	1.88	7.56	3.31	1.08	34,827	96.74	72.56
Jun	7	1.75	8.24	3.79	1.23	41,152	114.31	85.73
Jul	7	1.10	8.19	4.14	1.35	43,504	120.84	90.63
Aug	7	1.25	8.14	4.02	1.31	42,247	117.35	88.01
Sep	7	1.76	6.20	2.59	0.84	28,163	78.23	58.67
Oct	7	1.75	4.94	1.86	0.61	19,590	54.42	40.81
Nov	7	1.13	3.11	1.16	0.38	12,577	34.94	26.20
Dec	7	0.93	2.11	0.69	0.22	7,235	20.10	15.07
TOTAL		15.75	62.87	27.49	8.96			

Irrigation Demand - Hinman Island (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	7	0.00	2.03	1.18	0.39	12,447	34.58	25.93
Feb	7	0.00	2.71	1.58	0.52	18,397	51.10	38.33
Mar	7	0.00	4.35	2.54	0.83	26,672	74.09	55.57
Apr	7	0.00	5.29	3.09	1.01	33,517	93.10	69.83
May	7	0.00	7.56	4.41	1.44	46,355	128.76	96.57
Jun	7	0.00	8.24	4.81	1.57	52,208	145.02	108.77
Jul	7	0.00	8.19	4.78	1.56	50,218	139.49	104.62
Aug	7	0.00	8.14	4.75	1.55	49,911	138.64	103.98
Sep	7	0.00	6.20	3.62	1.18	39,283	109.12	81.84
Oct	7	0.00	4.94	2.88	0.94	30,290	84.14	63.10
Nov	7	0.00	3.11	1.81	0.59	19,705	54.74	41.05
Dec	7	0.00	2.11	1.23	0.40	12,938	35.94	26.95
TOTAL		0.00	62.87	36.67	11.95			

Irrigation Demand - Landa Park (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	23	1.75	2.03	0.54	0.17	5,641	15.67	11.75
Feb	23	2.02	2.71	1.32	0.43	15,391	42.75	32.06
Mar	23	1.95	4.35	4.60	1.50	48,352	134.31	100.73
Apr	23	2.72	5.29	4.93	1.61	53,503	148.62	111.46
May	23	3.76	7.56	7.28	2.37	76,557	212.66	159.49
Jun	23	3.49	8.24	9.10	2.97	98,886	274.68	206.01
Jul	23	2.19	8.19	11.50	3.75	120,880	335.78	251.83
Aug	23	2.50	8.14	10.81	3.52	113,627	315.63	236.72
Sep	23	3.51	6.20	5.16	1.68	56,001	155.56	116.67
Oct	23	3.49	4.94	2.78	0.91	29,213	81.15	60.86
Nov	23	2.25	3.11	1.65	0.54	17,904	49.73	37.30
Dec	23	1.86	2.11	0.48	0.16	5,037	13.99	10.49
TOTAL		31.49	62.87	60.15	19.60			

Irrigation Demand - Landa Park (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	23	0.88	2.03	2.21	0.72	23,269	64.64	48.48
Feb	23	1.01	2.71	3.26	1.06	37,919	105.33	79.00
Mar	23	0.98	4.35	6.47	2.11	67,995	188.87	141.66
Apr	23	1.36	5.29	7.53	2.45	81,816	227.27	170.45
May	23	1.88	7.56	10.89	3.55	114,433	317.87	238.40
Jun	23	1.75	8.24	12.45	4.06	135,214	375.59	281.70
Jul	23	1.10	8.19	13.60	4.43	142,940	397.06	297.79
Aug	23	1.25	8.14	13.21	4.30	138,810	385.58	289.19
Sep	23	1.76	6.20	8.52	2.78	92,537	257.05	192.79
Oct	23	1.75	4.94	6.12	2.00	64,369	178.80	134.10
Nov	23	1.13	3.11	3.80	1.24	41,324	114.79	86.09
Dec	23	0.93	2.11	2.26	0.74	23,773	66.04	49.53
TOTAL		15.75	62.87	90.32	29.43			

Irrigation Demand - Landa Park (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	23	0.00	2.03	3.89	1.27	40,898	113.60	85.20
Feb	23	0.00	2.71	5.19	1.69	60,447	167.91	125.93
Mar	23	0.00	4.35	8.34	2.72	87,638	243.44	182.58
Apr	23	0.00	5.29	10.14	3.30	110,128	305.91	229.43
May	23	0.00	7.56	14.49	4.72	152,309	423.08	317.31
Jun	23	0.00	8.24	15.79	5.15	171,542	476.51	357.38
Jul	23	0.00	8.19	15.70	5.12	165,001	458.34	343.75
Aug	23	0.00	8.14	15.60	5.08	163,994	455.54	341.65
Sep	23	0.00	6.20	11.88	3.87	129,073	358.54	268.90
Oct	23	0.00	4.94	9.47	3.09	99,524	276.46	207.34
Nov	23	0.00	3.11	5.96	1.94	64,745	179.85	134.88
Dec	23	0.00	2.11	4.04	1.32	42,509	118.08	88.56
TOTAL		0.00	62.87	120.50	39.27			

Irrigation Demand - Landa Golf Course (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	14	1.75	2.03	0.33	0.11	3,434	9.54	7.15
Feb	14	2.02	2.71	0.81	0.26	9,368	26.02	19.52
Mar	14	1.95	4.35	2.80	0.91	29,432	81.75	61.32
Apr	14	2.72	5.29	3.00	0.98	32,567	90.46	67.85
May	14	3.76	7.56	4.43	1.44	46,600	129.44	97.08
Jun	14	3.49	8.24	5.54	1.81	60,192	167.20	125.40
Jul	14	2.19	8.19	7.00	2.28	73,579	204.39	153.29
Aug	14	2.50	8.14	6.58	2.14	69,164	192.12	144.09
Sep	14	3.51	6.20	3.14	1.02	34,088	94.69	71.02
Oct	14	3.49	4.94	1.69	0.55	17,782	49.39	37.04
Nov	14	2.25	3.11	1.00	0.33	10,898	30.27	22.70
Dec	14	1.86	2.11	0.29	0.10	3,066	8.52	6.39
TOTAL		31.49	62.87	36.61	11.93			

Irrigation Demand - Landa Golf Course (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	14	0.88	2.03	1.35	0.44	14,164	39.34	29.51
Feb	14	1.01	2.71	1.98	0.65	23,081	64.11	48.09
Mar	14	0.98	4.35	3.94	1.28	41,388	114.97	86.23
Apr	14	1.36	5.29	4.59	1.49	49,801	138.34	103.75
May	14	1.88	7.56	6.63	2.16	69,655	193.49	145.11
Jun	14	1.75	8.24	7.58	2.47	82,304	228.62	171.47
Jul	14	1.10	8.19	8.28	2.70	87,007	241.69	181.27
Aug	14	1.25	8.14	8.04	2.62	84,493	234.70	176.03
Sep	14	1.76	6.20	5.19	1.69	56,327	156.46	117.35
Oct	14	1.75	4.94	3.73	1.21	39,181	108.84	81.63
Nov	14	1.13	3.11	2.32	0.75	25,154	69.87	52.40
Dec	14	0.93	2.11	1.38	0.45	14,471	40.20	30.15
TOTAL		15.75	62.87	54.98	17.91			

Irrigation Demand - Landa Golf Course (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	14	0.00	2.03	2.37	0.77	24,894	69.15	51.86
Feb	14	0.00	2.71	3.16	1.03	36,794	102.21	76.65
Mar	14	0.00	4.35	5.08	1.65	53,345	148.18	111.13
Apr	14	0.00	5.29	6.17	2.01	67,035	186.21	139.66
May	14	0.00	7.56	8.82	2.87	92,710	257.53	193.14
Jun	14	0.00	8.24	9.61	3.13	104,417	290.05	217.54
Jul	14	0.00	8.19	9.56	3.11	100,435	278.99	209.24
Aug	14	0.00	8.14	9.50	3.09	99,822	277.28	207.96
Sep	14	0.00	6.20	7.23	2.36	78,566	218.24	163.68
Oct	14	0.00	4.94	5.76	1.88	60,580	168.28	126.21
Nov	14	0.00	3.11	3.63	1.18	39,410	109.47	82.10
Dec	14	0.00	2.11	2.46	0.80	25,875	71.88	53.91
TOTAL		0.00	62.87	73.35	23.90			

Irrigation Demand - Prince Solms Park (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	16.8	1.75	2.03	0.39	0.13	4,120	11.45	8.58
Feb	16.8	2.02	2.71	0.97	0.31	11,242	31.23	23.42
Mar	16.8	1.95	4.35	3.36	1.09	35,318	98.11	73.58
Apr	16.8	2.72	5.29	3.60	1.17	39,080	108.56	81.42
May	16.8	3.76	7.56	5.32	1.73	55,920	155.33	116.50
Jun	16.8	3.49	8.24	6.65	2.17	72,230	200.64	150.48
Jul	16.8	2.19	8.19	8.40	2.74	88,295	245.26	183.95
Aug	16.8	2.50	8.14	7.90	2.57	82,997	230.55	172.91
Sep	16.8	3.51	6.20	3.77	1.23	40,905	113.63	85.22
Oct	16.8	3.49	4.94	2.03	0.66	21,338	59.27	44.45
Nov	16.8	2.25	3.11	1.20	0.39	13,077	36.33	27.24
Dec	16.8	1.86	2.11	0.35	0.11	3,679	10.22	7.66
TOTAL		31.49	62.87	43.93	14.32			

Irrigation Demand - Prince Solms Park (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	16.8	0.88	2.03	1.62	0.53	16,997	47.21	35.41
Feb	16.8	1.01	2.71	2.38	0.78	27,697	76.94	57.70
Mar	16.8	0.98	4.35	4.73	1.54	49,666	137.96	103.47
Apr	16.8	1.36	5.29	5.50	1.79	59,761	166.00	124.50
May	16.8	1.88	7.56	7.95	2.59	83,586	232.18	174.14
Jun	16.8	1.75	8.24	9.09	2.96	98,765	274.35	205.76
Jul	16.8	1.10	8.19	9.93	3.24	104,409	290.02	217.52
Aug	16.8	1.25	8.14	9.65	3.14	101,392	281.64	211.23
Sep	16.8	1.76	6.20	6.22	2.03	67,592	187.76	140.82
Oct	16.8	1.75	4.94	4.47	1.46	47,017	130.60	97.95
Nov	16.8	1.13	3.11	2.78	0.91	30,185	83.85	62.88
Dec	16.8	0.93	2.11	1.65	0.54	17,365	48.24	36.18
TOTAL		15.75	62.87	65.98	21.50			

Irrigation Demand - Prince Solms Park (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	16.8	0.00	2.03	2.84	0.93	29,873	82.98	62.24
Feb	16.8	0.00	2.71	3.79	1.24	44,153	122.65	91.98
Mar	16.8	0.00	4.35	6.09	1.98	64,014	177.82	133.36
Apr	16.8	0.00	5.29	7.41	2.41	80,442	223.45	167.59
May	16.8	0.00	7.56	10.58	3.45	111,251	309.03	231.77
Jun	16.8	0.00	8.24	11.54	3.76	125,300	348.06	261.04
Jul	16.8	0.00	8.19	11.47	3.74	120,522	334.78	251.09
Aug	16.8	0.00	8.14	11.40	3.71	119,787	332.74	249.56
Sep	16.8	0.00	6.20	8.68	2.83	94,279	261.89	196.42
Oct	16.8	0.00	4.94	6.92	2.25	72,696	201.93	151.45
Nov	16.8	0.00	3.11	4.35	1.42	47,292	131.37	98.52
Dec	16.8	0.00	2.11	2.95	0.96	31,050	86.25	64.69
TOTAL		0.00	62.87	88.02	28.68			

Irrigation Demand - Walnut Avenue (100% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	6.5	1.75	2.03	0.15	0.05	1,594	4.43	3.32
Feb	6.5	2.02	2.71	0.37	0.12	4,350	12.08	9.06
Mar	6.5	1.95	4.35	1.30	0.42	13,665	37.96	28.47
Apr	6.5	2.72	5.29	1.39	0.45	15,120	42.00	31.50
May	6.5	3.76	7.56	2.06	0.67	21,636	60.10	45.07
Jun	6.5	3.49	8.24	2.57	0.84	27,946	77.63	58.22
Jul	6.5	2.19	8.19	3.25	1.06	34,162	94.89	71.17
Aug	6.5	2.50	8.14	3.06	1.00	32,112	89.20	66.90
Sep	6.5	3.51	6.20	1.46	0.47	15,826	43.96	32.97
Oct	6.5	3.49	4.94	0.79	0.26	8,256	22.93	17.20
Nov	6.5	2.25	3.11	0.47	0.15	5,060	14.05	10.54
Dec	6.5	1.86	2.11	0.14	0.04	1,423	3.95	2.97
TOTAL		31.49	62.87	17.00	5.54			

Irrigation Demand - Walnut Avenue (50% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	6.5	0.88	2.03	0.63	0.20	6,576	18.27	13.70
Feb	6.5	1.01	2.71	0.92	0.30	10,716	29.77	22.33
Mar	6.5	0.98	4.35	1.83	0.60	19,216	53.38	40.03
Apr	6.5	1.36	5.29	2.13	0.69	23,122	64.23	48.17
May	6.5	1.88	7.56	3.08	1.00	32,340	89.83	67.37
Jun	6.5	1.75	8.24	3.52	1.15	38,213	106.15	79.61
Jul	6.5	1.10	8.19	3.84	1.25	40,396	112.21	84.16
Aug	6.5	1.25	8.14	3.73	1.22	39,229	108.97	81.73
Sep	6.5	1.76	6.20	2.41	0.78	26,152	72.64	54.48
Oct	6.5	1.75	4.94	1.73	0.56	18,191	50.53	37.90
Nov	6.5	1.13	3.11	1.08	0.35	11,679	32.44	24.33
Dec	6.5	0.93	2.11	0.64	0.21	6,718	18.66	14.00
TOTAL		15.75	62.87	25.53	8.32			

Irrigation Demand - Walnut Avenue (0% Rainfall Credit)

Month	Irrigated Area (acres)	Precipitation (in.)	ET (in.)	Irrigation Demand (ac-ft)	Irrigation Demand (MG)	Irrigation Demand (GPD)	6-hr. Interval (gpm)	8-hr. Interval (gpm)
Jan	6.5	0.00	2.03	1.10	0.36	11,558	32.11	24.08
Feb	6.5	0.00	2.71	1.47	0.48	17,083	47.45	35.59
Mar	6.5	0.00	4.35	2.36	0.77	24,767	68.80	51.60
Apr	6.5	0.00	5.29	2.87	0.93	31,123	86.45	64.84
May	6.5	0.00	7.56	4.10	1.33	43,044	119.57	89.67
Jun	6.5	0.00	8.24	4.46	1.45	48,479	134.66	101.00
Jul	6.5	0.00	8.19	4.44	1.45	46,631	129.53	97.15
Aug	6.5	0.00	8.14	4.41	1.44	46,346	128.74	96.55
Sep	6.5	0.00	6.20	3.36	1.09	36,477	101.33	75.99
Oct	6.5	0.00	4.94	2.68	0.87	28,126	78.13	58.60
Nov	6.5	0.00	3.11	1.68	0.55	18,297	50.83	38.12
Dec	6.5	0.00	2.11	1.14	0.37	12,014	33.37	25.03
TOTAL		0.00	62.87	34.05	11.10			

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix E

Preliminary Opinion of Project Costs
and
Projected Annual Operating Costs

Preliminary Opinion of Probable Project Cost
Alternative 1 : South Trib - Walnut Ave.
(100% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,916	LF	20	118,320
2	PIPE, 6" DIA. (PVC C-900)	11,954	LF	30	358,620
3	PIPE, 8" DIA. (PVC C-900)	1,578	LF	40	63,120
4	PIPE, 10" DIA. (PVC C-900)	19,000	LF	50	950,100
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@ WWTP)	470,000	GAL	0.50	235,000
8	Ground Storage Tank	425,000	GAL	0.50	212,500
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	200	LF	65	13,000
11	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
12	Sawcut & replace pavement	8,683	SY	25	217,069
13	Concrete thrust blocks	2.25	CY	60	135
14	Trench Safety	37,158	LF	1.00	37,158
15	Erosion & Sediment control	37,158	LF	1.00	37,158
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	9	EA	6,000	54,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	3.6	TN	4,000	14,400
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	323,318	323,308
				Subtotal	**$3,556,390**
				Engineering & Survey @ 10%	$355,640
				Contingency @ 15%	$533,460
				TOTAL	**$4,445,490**

Projected Annual Operating Costs

Item No.	Description	Annual Cost
1	Electricity	$ 24,681
2	Disinfection	6,905
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	16,719
	O&M Subtotal	$ 57,900
6	Annual Debt Service	352,060
	Total	$ 409,960

Preliminary Opinion of Probable Project Cost
Alternative 1 : South Trib - Walnut Ave.
(50% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,916	LF	20	118,320
2	PIPE, 8" DIA. (PVC C-900)	13,535	LF	40	541,400
3	PIPE, 10" DIA. (PVC C-900)	19,000	LF	50	950,000
4	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
5	Enclosed Pump Structure	380	SF	70	26,600
6	Ground Storage Tank (@WWTP)	551,000	GAL	0.50	275,500
7	Ground Storage Tank	505,000	GAL	0.50	252,500
8	Highway Bore with Steel Casing	700	LF	65	45,500
9	Railroad Bore with Steel Casing	200	LF	65	13,000
10	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
11	Sawcut & replace pavement	8,683	SY	25	217,069
12	Concrete thrust blocks	2.25	CY	60	135
13	Trench Safety	37,158	LF	1.00	37,158
14	Erosion & Sediment control	37,158	LF	1.00	37,158
15	Traffic control plan	1	LS	5,000	5,000
16	Gate/Blocking valves	11	EA	1,500	16,500
17	Comb. Air/Vac Valves & Vault	9	EA	6,000	54,000
18	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
19	Master Meter	2	EA	2,000	4,000
20	Fittings	3.6	TN	4,000	14,400
21	Treatment (Rotating, Disk Filter; Chlorinator)	1	LS	592,000	592,000
22	Mobilization/bonds/insurance	1	LS	343,324	343,324
				Subtotal	**$3,776,560**
				Engineering & Survey @ 10%	$377,660
				Contingency @ 15%	$566,480
				TOTAL	**$4,720,700**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	38,859
2	Disinfection	10,377
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	25,108
	O&M Subtotal	$ 83,940
6	Annual Debt Service	$ 373,850
	Total	$ 457,790

Preliminary Opinion of Probable Project Cost
Alternative 1 : South Trib - Walnut Ave.
(0% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,916	LF	20	118,320
2	PIPE, 8" DIA. (PVC C-900)	13,535	LF	40	541,400
3	PIPE, 10" DIA. (PVC C-900)	12,690	LF	50	634,500
4	PIPE, 12" DIA. (PVC C-900)	6,315	LF	60	378,900
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@ WWTP)	650,000	GAL	0.50	325,000
8	Ground Storage Tank	600,000	GAL	0.50	300,000
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	200	LF	65	13,000
11	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
12	Sawcut & replace pavement	8,683	SY	25	217,069
13	Concrete thrust blocks	2.25	CY	60	135
14	Trench Safety	37,158	LF	1.00	37,158
15	Erosion & Sediment control	37,158	LF	1.00	37,158
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	9	EA	6,000	54,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	3.6	TN	4,000	14,400
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	359,364	359,364
				Subtotal	**$3,953,000**
				Engineering & Survey @ 10%	$395,300
				Contingency @ 15%	$592,950
				TOTAL	**$4,941,250**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	53,925
2	Disinfection	13,849
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	33,497
	O&M Subtotal	$ 110,870
6	Annual Debt Service	$ 391,320
	Total	$ 502,190

Preliminary Opinion of Probable Project Cost
Alternative 2 : Merriweather St. - Walnut Ave.
(100% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,916	LF	20	118,316
2	PIPE, 6" DIA. (PVC C-900)	1,578	LF	30	47,353
3	PIPE, 8" DIA. (PVC C-900)	16,248	LF	40	649,911
4	PIPE, 10" DIA. (PVC C-900)	17,614	LF	50	880,718
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@WWTP)	470,000	GAL	0.50	235,000
8	Ground Storage Tank	425,000	GAL	0.50	212,500
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	200	LF	65	13,000
11	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
12	Sawcut & replace pavement	14,326	SY	25	358,162
13	Concrete thrust blocks	2.5	CY	60	150
14	Trench Safety	41,356	LF	1.00	41,356
15	Erosion & Sediment control	41,356	LF	1.00	41,356
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	4	TN	4,000	16,000
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	359,642	359,642
				Subtotal	**$3,956,070**
				Engineering & Survey @ 10%	$395,610
				Contingency @ 15%	$593,410
				TOTAL	**$4,945,090**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	24,681
2	Disinfection	6,905
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	16,719
	O&M Subtotal	$ 57,900
6	Annual Debt Service	$ 391,620
	Total	$ 449,520

Preliminary Opinion of Probable Project Cost
Alternative 2 : Merriweather St. - Walnut Ave.

(50% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,916	LF	20	118,316
2	PIPE, 8" DIA. (PVC C-900)	17,826	LF	40	713,040
3	PIPE, 10" DIA. (PVC C-900)	17,614	LF	50	880,700
4	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
5	Enclosed Pump Structure	380	SF	70	26,600
6	Ground Storage Tank (@ WWTP)	551,000	GAL	1	275,500
7	Ground Storage Tank	503,350	GAL	1	251,675
8	Highway Bore with Steel Casing	700	LF	65	45,500
9	Railroad Bore with Steel Casing	200	LF	65	13,000
10	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
11	Sawcut & replace pavement	14,326	SY	25	358,154
12	Concrete thrust blocks	2.5	CY	60	150
13	Trench Safety	41,356	LF	1	41,356
14	Erosion & Sediment control	41,356	LF	1	41,356
15	Traffic control plan	1	LS	5,000	5,000
16	Gate/Blocking valves	11	EA	1,500	16,500
17	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
18	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
19	Master Meter	2	EA	2,000	4,000
20	Fittings	4	TN	4,000	16,000
21	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
22	Mobilization/bonds/insurance	1	LS	369,185	369,185
				Subtotal	**$4,061,030**
				Engineering & Survey @ 10%	$406,100
				Contingency @ 15%	$609,150
				TOTAL	**$5,076,280**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	38,859
2	Disinfection	10,377
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	25,108
	O&M Subtotal	$ 83,940
6	Annual Debt Service	$ 402,010
	Total	$ 485,950

Preliminary Opinion of Probable Project Cost
Alternative 2 : Merriweather St. - Walnut Ave.
(0% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,916	LF	20	118,316
2	PIPE, 8" DIA. (PVC C-900)	17,826	LF	40	713,040
3	PIPE, 10" DIA. (PVC C-900)	12,593	LF	50	629,650
4	PIPE, 12" DIA. (PVC C-900)	5,021	LF	60	301,260
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@ WWTP)	637,550	GAL	0.50	318,775
8	Ground Storage Tank	582,500	GAL	0.50	291,250
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	200	LF	65	13,000
11	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
12	Sawcut & replace pavement	14,326	SY	25	358,154
13	Concrete thrust blocks	2.5	CY	60	150
14	Trench Safety	41,356	LF	1.00	41,356
15	Erosion & Sediment control	41,356	LF	1.00	41,356
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	4	TN	4,000	16,000
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	382,491	382,491
				Subtotal	**$4,207,400**
				Engineering & Survey @ 10%	$420,740
				Contingency @ 15%	$631,110
				TOTAL	**$5,259,250**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	53,925
2	Disinfection	13,849
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	33,497
	O&M Subtotal	$ 110,870
6	Annual Debt Service	$ 416,500
	Total	$ 527,370

Preliminary Opinion of Probable Project Cost
Alternative 3 - Guadalupe River
(100% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	8,744	LF	30	262,315
3	PIPE, 8" DIA. (PVC C-900)	14,330	LF	40	573,187
4	PIPE, 10" DIA. (PVC C-900)	10,671	LF	50	533,535
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@WWTP)	470,000	GAL	0.50	235,000
8	Ground Storage Tank	425,000	GAL	0.50	212,500
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	300	LF	65	19,500
11	Creek/River Crossing Bore with Steel Casing	500	LF	65	32,500
12	Sawcut & replace pavement	13,605	SY	25	340,125
13	Concrete thrust blocks	2.4	CY	60	144
14	Trench Safety	39,273	LF	1.00	39,273
15	Erosion & Sediment control	39,273	LF	1.00	39,273
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	4	TN	4,000	16,000
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	338,353	338,353
				Subtotal	**$3,721,880**
				Engineering & Survey @ 10%	$372,190
				Contingency @ 15%	$558,280
				TOTAL	**$4,652,350**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	41,926
2	Disinfection	6,905
3	Laboratory	3,600
4	Effluent Purchase	16,719
	O&M Subtotal	$69,150
5	Annual Debt Service	$368,440
	Total Annual Obligation	$437,590

Preliminary Opinion of Probable Project Cost
Alternative 3 - Guadalupe River
(50% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	7,165	LF	30	214,962
3	PIPE, 8" DIA. (PVC C-900)	15,908	LF	40	636,325
4	PIPE, 10" DIA. (PVC C-900)	10,671	LF	50	533,535
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@WWTP)	551,000	GAL	0.50	275,500
8	Ground Storage Tank	505,000	GAL	0.50	252,500
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	300	LF	65	19,500
11	Creek/River Crossing Bore with Steel Casing	500	LF	65	32,500
12	Sawcut & replace pavement	13,605	SY	25	340,125
13	Concrete thrust blocks	2.4	CY	60	144
14	Trench Safety	39,273	LF	1.00	39,273
15	Erosion & Sediment control	39,273	LF	1.00	39,273
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	4	TN	4,000	16,000
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	347,981	347,981
				Subtotal	**$3,827,790**
				Engineering & Survey @ 10%	$382,780
				Contingency @ 15%	$574,170
				TOTAL	**$4,784,740**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	66,700
2	Disinfection	10,377
3	Laboratory	3,600
4	Effluent Purchase	25,108
	O&M Subtotal	$105,790
5	Annual Debt Service	$378,930
	Total Annual Obligation	$484,720

Preliminary Opinion of Probable Project Cost
Alternative 3 - Guadalupe River
(0% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	852	LF	30	25,560
3	PIPE, 8" DIA. (PVC C-900)	15,908	LF	40	636,325
4	PIPE, 10" DIA. (PVC C-900)	11,963	LF	50	598,150
5	PIPE, 12" DIA. (PVC C-900)	5,021	LF	60	301,260
6	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
7	Enclosed Pump Structure	380	SF	70	26,600
8	Ground Storage Tank (@WWTP)	637,600	GAL	0.50	318,800
9	Ground Storage Tank	582,500	GAL	0.50	291,250
10	Highway Bore with Steel Casing	700	LF	65	45,500
11	Railroad Bore with Steel Casing	300	LF	65	19,500
12	Creek/River Crossing Bore with Steel Casing	500	LF	65	32,500
13	Sawcut & replace pavement	13,605	SY	25	340,125
14	Concrete thrust blocks	2.4	CY	60	144
15	Trench Safety	39,273	LF	1.00	39,273
16	Erosion & Sediment control	39,273	LF	1.00	39,273
17	Traffic control plan	1	LS	5,000	5,000
18	Gate/Blocking valves	11	EA	1,500	16,500
19	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
20	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
21	Master Meter	2	EA	2,000	4,000
22	Fittings	4	TN	4,000	16,000
23	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
24	Mobilization/bonds/insurance	1	LS	373,834	373,834
				Subtotal	**$4,112,170**
				Engineering & Survey @ 10%	$411,220
				Contingency @ 15%	$616,830
				TOTAL	**$5,140,220**

Item No.	Description	Annual Cost
1	Electricity	93,502
2	Disinfection	13,849
3	Laboratory	3,600
4	Effluent Purchase	33,497
	O&M Subtotal	$144,450
5	Annual Debt Service	$387,860
	Total Annual Obligation	$532,310

Preliminary Opinion of Probable Project Cost
Alternative 4 - Kuehler - Comal Ave.

(100% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	10,413	LF	30	312,388
3	PIPE, 8" DIA. (PVC C-900)	16,726	LF	40	669,029
4	PIPE, 10" DIA. (PVC C-900)	10,671	LF	50	533,535
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@WWTP)	464,500	GAL	0.50	232,250
8	Ground Storage Tank	424,200	GAL	0.50	212,100
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	300	LF	65	19,500
11	Creek/River Crossing Bore with Steel Casing	300	LF	65	19,500
12	Sawcut & replace pavement	15,013	SY	25	375,325
13	Concrete thrust blocks	2.5	CY	60	150
14	Trench Safety	43,338	LF	1.00	43,338
15	Erosion & Sediment control	43,338	LF	1.00	43,338
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	4	TN	4,000	16,000
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	355,663	355,663
				Subtotal	**$3,912,290**
				Engineering & Survey @ 10%	$391,230
				Contingency @ 15%	$586,840
				TOTAL	**$4,890,360**

Item No.	Description	Annual Cost
1	Electricity	42,070
2	Disinfection	6,905
3	Laboratory	3,600
4	Effluent Purchase	16,719
	O&M Subtotal	$69,290
5	Annual Debt Service	$387,290
	Total Annual Obligation	$456,580

Preliminary Opinion of Probable Project Cost
Alternative 4 - Kuehler - Comal Ave.

(50% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	10,413	LF	30	312,388
3	PIPE, 8" DIA. (PVC C-900)	16,726	LF	40	669,029
4	PIPE, 10" DIA. (PVC C-900)	10,671	LF	50	533,535
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@WWTP)	551,000	GAL	0.50	275,500
8	Ground Storage Tank	505,000	GAL	0.50	252,500
9	Highway Bore with Steel Casing	700	LF	65	45,500
10	Railroad Bore with Steel Casing	300	LF	65	19,500
11	Creek/River Crossing Bore with Steel Casing	300	LF	65	19,500
12	Sawcut & replace pavement	15,013	SY	25	375,325
13	Concrete thrust blocks	2.5	CY	60	150
14	Trench Safety	43,338	LF	1.00	43,338
15	Erosion & Sediment control	43,338	LF	1.00	43,338
16	Traffic control plan	1	LS	5,000	5,000
17	Gate/Blocking valves	11	EA	1,500	16,500
18	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
19	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
20	Master Meter	2	EA	2,000	4,000
21	Fittings	4	TN	4,000	16,000
22	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
23	Mobilization/bonds/insurance	1	LS	364,028	364,028
				Subtotal	**$4,004,310**
				Engineering & Survey @ 10%	$400,430
				Contingency @ 15%	$600,650
				TOTAL	**$5,005,390**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	67,051
2	Disinfection	10,377
3	Laboratory	3,600
4	Effluent Purchase	25,108
	O&M Subtotal	$106,140
5	Annual Debt Service	$396,400
	Total Annual Obligation	$502,540

Preliminary Opinion of Probable Project Cost
Alternative 4 - Kuehler - Comal Ave.
(0% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	5,874	LF	30	176,207
3	PIPE, 8" DIA. (PVC C-900)	21,265	LF	40	850,603
4	PIPE, 10" DIA. (PVC C-900)	6,929	LF	50	346,452
5	PIPE, 12" DIA. (PVC C-900)	3,742	LF	60	224,500
6	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
7	Enclosed Pump Structure	380	SF	70	26,600
8	Ground Storage Tank (@WWTP)	640,000	GAL	0.50	320,000
9	Ground Storage Tank	582,500	GAL	0.50	291,250
10	Highway Bore with Steel Casing	700	LF	65	45,500
11	Railroad Bore with Steel Casing	300	LF	65	19,500
12	Creek/River Crossing Bore with Steel Casing	300	LF	65	19,500
13	Sawcut & replace pavement	15,013	SY	25	375,325
14	Concrete thrust blocks	2.5	CY	60	150
15	Trench Safety	43,338	LF	1.00	43,338
16	Erosion & Sediment control	43,338	LF	1.00	43,338
17	Traffic control plan	1	LS	5,000	5,000
18	Gate/Blocking valves	11	EA	1,500	16,500
19	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
20	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
21	Master Meter	2	EA	2,000	4,000
22	Fittings	4	TN	4,000	16,000
23	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
24	Mobilization/bonds/insurance	1	LS	380,634	380,634
				Subtotal	**$4,186,970**
				Engineering & Survey @ 10%	$418,700
				Contingency @ 15%	$628,050
				TOTAL	**$5,233,720**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	94,038
2	Disinfection	13,849
3	Laboratory	3,600
4	Effluent Purchase	33,497
	O&M Subtotal	$144,980
5	Annual Debt Service	$414,480
	Total Annual Obligation	$559,460

Preliminary Opinion of Probable Project Cost
Alternative 5 - Kuehler - Gruene WWTP
(100% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	8,744	LF	30	262,315
3	PIPE, 8" DIA. (PVC C-900)	15,977	LF	40	639,090
4	PIPE, 10" DIA. (PVC C-900)	10,671	LF	50	533,535
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@Kuehler WWTP)	464,500	GAL	0.50	232,250
8	Ground Storage Tank (@Gruene WWTP)	424,200	GAL	0.50	212,100
9	Ground Storage Tank	424,200	GAL	0.50	212,100
10	Highway Bore with Steel Casing	500	LF	65	32,500
11	Railroad Bore with Steel Casing	200	LF	65	13,000
12	Creek/River Crossing Bore with Steel Casing	300	LF	65	19,500
13	Sawcut & replace pavement	14,175	SY	25	354,375
14	Concrete thrust blocks	2.5	CY	60	150
15	Trench Safety	40,921	LF	1.00	40,921
16	Erosion & Sediment control	40,921	LF	1.00	40,921
17	Traffic control plan	1	LS	5,000	5,000
18	Gate/Blocking valves	11	EA	1,500	16,500
19	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
20	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
21	Master Meter	2	EA	2,000	4,000
22	Fittings	4	TN	4,000	16,000
23	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
24	Mobilization/bonds/insurance	1	LS	364,343	364,343
				Subtotal	**$4,007,770**
				Engineering & Survey @ 10%	$400,780
				Contingency @ 15%	$601,170
				TOTAL	**$5,009,720**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	42,250
2	Disinfection	6,905
3	Laboratory	3,600
4	Effluent Purchase	16,719
	O&M Subtotal	$69,470
5	Annual Debt Service	$396,740
	Total Annual Obligation	$466,210

Preliminary Opinion of Probable Project Cost
Alternative 5 - Kuehler - Gruene WWTP

(50% Rainfall Credit)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	5,529	LF	20	110,576
2	PIPE, 6" DIA. (PVC C-900)	8,744	LF	30	262,315
3	PIPE, 8" DIA. (PVC C-900)	15,977	LF	40	639,090
4	PIPE, 10" DIA. (PVC C-900)	10,671	LF	50	533,535
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Enclosed Pump Structure	380	SF	70	26,600
7	Ground Storage Tank (@Kuehler WWTP)	551,000	GAL	0.50	275,500
8	Ground Storage Tank (@Gruene WWTP)	505,000	GAL	0.50	252,500
9	Ground Storage Tank	505,000	GAL	0.50	252,500
10	Highway Bore with Steel Casing	500	LF	65	32,500
11	Railroad Bore with Steel Casing	200	LF	65	13,000
12	Creek/River Crossing Bore with Steel Casing	300	LF	65	19,500
13	Sawcut & replace pavement	14,175	SY	25	354,375
14	Concrete thrust blocks	2.5	CY	60	150
15	Trench Safety	40,921	LF	1.00	40,921
16	Erosion & Sediment control	40,921	LF	1.00	40,921
17	Traffic control plan	1	LS	5,000	5,000
18	Gate/Blocking valves	11	EA	1,500	16,500
19	Comb. Air/Vac Valves & Vault	10	EA	6,000	60,000
20	Comb. Rate of Flow & Pressure Reducing Valve	6	EA	10,000	60,000
21	Master Meter	2	EA	2,000	4,000
22	Fittings	4	TN	4,000	16,000
23	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
24	Mobilization/bonds/insurance	1	LS	376,748	376,748
				Subtotal	**$4,144,230**
				Engineering & Survey @ 10%	$414,420
				Contingency @ 15%	$621,630
				TOTAL	**$5,180,280**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	67,453
2	Disinfection	10,377
3	Laboratory	3,600
4	Effluent Purchase	25,108
	O&M Subtotal	$ 106,540
5	Annual Debt Service	$ 410,250
	Total Annual Obligation	$ 516,790

Preliminary Opinion of Probable Project Cost
Alternative 6: Gruene WWTP
(100% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	6,150	LF	20	123,000
2	PIPE, 6" DIA. (PVC C-900)	7,725	LF	30	231,750
3	PIPE, 8" DIA. (PVC C-900)	16,186	LF	40	647,440
4	PIPE, 10" DIA. (PVC C-900)	24,331	LF	50	1,216,550
5	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
6	Pump (Vert. Turbine)	1	EA	80,000	80,000
7	Enclosed Pump Structure	570	SF	70	39,900
8	Ground Storage Tank (@ WWTP)	888,500	GAL	0.50	444,250
9	Ground Storage Tank (@ Coco Dr.)	464,300	GAL	0.50	232,150
10	Ground Storage Tank (@ Prince Solms Park)	424,200	GAL	0.75	318,150
11	Highway Bore with Steel Casing	700	LF	65	45,500
12	Railroad Bore with Steel Casing	400	LF	65	26,000
13	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
14	Sawcut & replace pavement	21,579	SY	25	539,484
15	Concrete thrust blocks	3.3	CY	60	198
16	Trench Safety	54,392	LF	1.00	54,392
17	Erosion & Sediment control	54,392	LF	1.00	54,392
18	Traffic control plan	1	LS	5,000	5,000
19	Gate/Blocking valves	12	EA	1,500	18,000
20	Comb. Air/Vac Valves & Vault	14	EA	6,000	84,000
21	Comb. Rate of Flow & Pressure Reducing Valve	7	EA	10,000	70,000
22	Master Meter	3	EA	2,000	6,000
23	Fittings	5.27	TN	4,000	21,080
24	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
25	Mobilization/bonds/insurance	1	LS	502,224	502,224
				Subtotal	**$5,524,460**
				Engineering & Survey @ 10%	$552,450
				Contingency @ 15%	$828,670
				TOTAL	**$6,905,580**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	24,681
2	Disinfection	6,905
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	16,719
	O&M Subtotal	$ 57,900
6	Annual Debt Service	$ 546,890
	Total	$ 604,790

Preliminary Opinion of Probable Project Cost
Alternative 6 : Gruene WWTP
(50% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	PIPE, 4" DIA. (PVC C-900)	6,150	LF	20	122,996
2	PIPE, 6" DIA. (PVC C-900)	6,097	LF	30	182,910
3	PIPE, 8" DIA. (PVC C-900)	17,813	LF	40	712,520
4	PIPE, 10" DIA. (PVC C-900)	21,683	LF	50	1,084,163
5	PIPE, 12" DIA. (PVC C-900)	2,647	LF	60	158,845
6	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
7	Pump (Vert. Turbine)	1	EA	80,000	80,000
8	Enclosed Pump Structure	570	SF	70	39,900
9	Ground Storage Tank (@ WWTP)	1,054,300	GAL	0.50	527,150
10	Ground Storage Tank (@ Coco Dr.)	503,500	GAL	0.50	251,750
11	Ground Storage Tank (@ Prince Solms Park)	551,000	GAL	0.75	413,250
12	Highway Bore with Steel Casing	700	LF	65	45,500
13	Railroad Bore with Steel Casing	400	LF	65	26,000
14	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
15	Sawcut & replace pavement	21,579	SY	25	539,484
16	Concrete thrust blocks	3.3	CY	60	198
17	Trench Safety	54,390	LF	1.00	54,390
18	Erosion & Sediment control	54,390	LF	1.00	54,390
19	Traffic control plan	1	LS	5,000	5,000
20	Gate/Blocking valves	12	EA	1,500	18,000
21	Comb. Air/Vac Valves & Vault	14	EA	6,000	84,000
22	Comb. Rate of Flow & Pressure Reducing Valve	7	EA	10,000	70,000
23	Master Meter	3	EA	2,000	6,000
24	Fittings	5.27	TN	4,000	21,080
25	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
26	Mobilization/bonds/insurance	1	LS	526,253	526,253
				Subtotal	**$5,788,780**
				Engineering & Survey @ 10%	$578,880
				Contingency @ 15%	$868,320
				TOTAL	**$7,235,980**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	38,859
2	Disinfection	10,377
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	25,108
	O&M Subtotal	$ 83,940
6	Annual Debt Service	$ 573,050
	Total	$ 656,990

Preliminary Opinion of Probable Project Cost
Alternative 6: Gruene WWTP
(0% Rainfall Credit; Steel Storage Tanks)

Item No.	Description	Qty.	Unit	Unit Price	Total Price
1	PIPE, 4" DIA. (PVC C-900)	6,150	LF	20	122,996
2	PIPE, 6" DIA. (PVC C-900)	4,538	LF	30	136,141
3	PIPE, 8" DIA. (PVC C-900)	19,373	LF	40	774,901
4	PIPE, 10" DIA. (PVC C-900)	21,683	LF	50	1,084,163
5	PIPE, 12" DIA. (PVC C-900)	2,647	LF	60	158,845
6	Pumps (Horiz. End Suction, 2 locations)	4	EA	40,000	160,000
7	Pump (Vert. Turbine)	1	EA	80,000	80,000
8	Enclosed Pump Structure	570	SF	70	39,900
9	Ground Storage Tank (@ WWTP)	1,250,000	GAL	0.50	625,000
10	Ground Storage Tank (@ Coco Dr.)	650,000	GAL	0.50	325,000
11	Ground Storage Tank (@ Prince Solms Park)	600,000	GAL	0.75	450,000
12	Highway Bore with Steel Casing	700	LF	65	45,500
13	Railroad Bore with Steel Casing	400	LF	65	26,000
14	Creek/River Crossing Bore with Steel Casing	200	LF	65	13,000
15	Sawcut & replace pavement	21,579	SY	25	539,484
16	Concrete thrust blocks	3.3	CY	60	198
17	Trench Safety	54,391	LF	1.00	54,391
18	Erosion & Sediment control	54,391	LF	1.00	54,391
19	Traffic control plan	1	LS	5,000	5,000
20	Gate/Blocking valves	12	EA	1,500	18,000
21	Comb. Air/Vac Valves & Vault	14	EA	6,000	84,000
22	Comb. Rate of Flow & Pressure Reducing Valve	7	EA	10,000	70,000
23	Master Meter	3	EA	2,000	6,000
24	Fittings	5.27	TN	4,000	21,080
25	Treatment (Rotating Disk Filter; Chlorinator)	1	LS	592,000	592,000
26	Mobilization/bonds/insurance	1	LS	548,599	548,599
				Subtotal	**$6,034,590**
				Engineering & Survey @ 10%	$603,460
				Contingency @ 15%	$905,190
				TOTAL	**$7,543,240**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	53,925
2	Disinfection	13,849
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
5	Effluent Purchase	33,497
	O&M Subtotal	$ 110,870
6	Annual Debt Service	$ 597,380
	Total	$ 708,250

Preliminary Opinion of Probable Project Cost
RWPF Option
(100% Rainfall Credit)

Item No.	Description	Qty.	Unit	Unit Price	Total Price
1	PIPE, 6" DIA. (PVC C-900)	2,650	LF	30	79,500
2	PIPE, 8" DIA. (PVC C-900)	1,579	LF	40	63,160
3	PIPE, 10" DIA. (PVC C-900)	1,560	LF	50	78,000
4	Pumps (Horiz. End Suction, 5 locations)	9	EA	40,000	360,000
5	Enclosed Pump Structure	1710	SF	70	119,700
6	Sawcut & replace pavement	21,579	SY	25	539,484
7	Concrete thrust blocks	2	CY	60	120
8	Trench Safety	3,139	LF	1.00	3,139
9	Erosion & Sediment control	3,139	LF	1.00	3,139
10	Traffic control plan	1	LS	5,000	5,000
11	Gate/Blocking valves	9	EA	1,500	13,500
12	Master Meter	5	EA	2,000	10,000
11	RWPF - 60,000 GPD	1	LS	400,000	400,000
12	RWPF - 100,000 GPD	1	LS	486,000	486,000
13	RWPF - 150,000 GPD	1	LS	704,000	704,000
14	RWPF - 200,000 GPD	1	LS	767,000	767,000
15	RWPF - 250,000 GPD	1	LS	1,019,000	1,019,000
16	Mobilization/bonds/insurance	1	LS	465,074	465,074
				Subtotal	**$5,115,820**
				Engineering & Survey @ 10%	$511,580
				Contingency @ 15%	$767,370
				TOTAL	**$6,394,770**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	37,560
2	Disinfection	17,765
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
	O&M Subtotal	$ 64,930
5	Annual Debt Service	$ 506,430
	Total	$ 571,360

Preliminary Opinion of Probable Project Cost
RWPF Option
(50% Rainfall Credit)

Item No.	Description	Qty.	Unit	Unit Price	Total Price
1	PIPE, 6" DIA. (PVC C-900)	2,650	LF	30	79,500
2	PIPE, 8" DIA. (PVC C-900)	1,579	LF	40	63,160
3	PIPE, 10" DIA. (PVC C-900)	1,560	LF	50	78,000
4	Pumps (Horiz. End Suction, 5 locations)	9	EA	40,000	360,000
5	Enclosed Pump Structure	1710	SF	70	119,700
6	Sawcut & replace pavement	21,579	SY	25	539,484
7	Concrete thrust blocks	2	CY	60	120
8	Trench Safety	3,139	LF	1.00	3,139
9	Erosion & Sediment control	3,139	LF	1.00	3,139
10	Traffic control plan	1	LS	5,000	5,000
11	Gate/Blocking valves	9	EA	1,500	13,500
12	Master Meter	5	EA	2,000	10,000
13	RWPF - 100,000 GPD	1	LS	486,000	486,000
14	RWPF - 200,000 GPD	3	LS	767,000	2,301,000
15	RWPF - 250,000 GPD	1	LS	1,019,000	1,019,000
16	Mobilization/bonds/insurance	1	LS	508,074	508,074
				Subtotal	**$5,588,820**
				Engineering & Survey @ 10%	$558,880
				Contingency @ 15%	$838,320
				TOTAL	**$6,986,020**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	44,823
2	Disinfection	21,392
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
	O&M Subtotal	$ 75,820
5	Annual Debt Service	$ 553,260
	Total	$ 629,080

Preliminary Opinion of Probable Project Cost
RWPF Option
(0% Rainfall Credit)

Item No.	Description	Qty.	Unit	Unit Price	Total Price
1	PIPE, 8" DIA. (PVC C-900)	4,229	LF	40	169,160
2	PIPE, 10" DIA. (PVC C-900)	1,560	LF	50	78,000
3	Pumps (Horiz. End Suction, 5 locations)	9	EA	40,000	360,000
4	Enclosed Pump Structure	1710	SF	70	119,700
5	Sawcut & replace pavement	21,579	SY	25	539,484
6	Concrete thrust blocks	2	CY	60	120
7	Trench Safety	5,789	LF	1.00	5,789
8	Erosion & Sediment control	5,789	LF	1.00	5,789
9	Traffic control plan	1	LS	5,000	5,000
10	Gate/Blocking valves	9	EA	1,500	13,500
11	Master Meter	5	EA	2,000	10,000
12	RWPF - 100,000 GPD	1	LS	486,000	486,000
13	RWPF - 150,000 GPD	1	LS	704,000	704,000
14	RWPF - 200,000 GPD	3	LS	767,000	2,301,000
15	RWPF - 250,000 GPD	1	LS	1,019,000	1,019,000
16	Mobilization/bonds/insurance	1	LS	581,654	581,654
				Subtotal	**$6,398,200**
				Engineering & Survey @ 10%	$639,820
				Contingency @ 15%	$959,730
				TOTAL	**$7,997,750**

Projected Annual Costs

Item No.	Description	Annual Cost
1	Electricity	53,255
2	Disinfection	25,017
3	Laboratory	3,600
4	Egr., Distr., Production	6,000
	O&M Subtotal	$ 87,870
5	Annual Debt Service	$ 633,380
	Total	$ 721,250

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix F

Draft Reclaimed Water Service Agreement

DRAFT

MEMORANDUM OF UNDERSTANDING

for

RECLAIMED WATER SERVICE

Effective Date:_________________________

PROVIDER: New Braunfels Utilities (NBU)
CITY: City of New Braunfels (City)

For the consideration provided herein, NBU agrees to supply and City agrees to accept and use reclaimed water in accordance with the terms and conditions of this Memorandum of Understanding (the "MOU"). This MOU incorporates and is subject to all of the terms and conditions set out herein as well as all of the following:

- All applicable Attachments and Appendices attached hereto;
- NBU Installation Policy;
- NBU Policies and Procedures;
- NBU Cross Connection and Backflow Prevention Program;
- All applicable local, state, and federal statutes, ordinances, and regulations, as they may be amended, now or hereafter in effect ("Applicable Laws"), including without limitation, Chapter 210 of Title 30 of the Texas Administrative Code.

1. Use

a. General.
City shall use reclaimed water supplied by NBU under this MOU (the "Reclaimed Water") only as authorized by Applicable Laws, including, without limitation, Sections 210.22 (General Requirements), 210.24 (Irrigation Using Reclaimed Water), and 210.32 (Specific Uses of Reclaimed Water) of Title 30 of the Texas Administrative Code.

b. Specific
City agrees to use the Reclaimed Water only for the purposes and in the locations described in Attachment A hereto. City agrees to inform NBU's in writing prior to using the Reclaimed Water for a purpose or at a location not described in Attachment A. Any changes to the purpose and location of use of the Reclaimed Water will be reflected in a substitute Attachment A and attached hereto. City agrees to take steps to minimize the risk of inadvertent human exposure to the Reclaimed Water. NBU may terminate this MOU immediately, in its sole discretion, if NBU determines that City has failed to use the Reclaimed Water in accordance with Applicable Laws, this MOU, and/or Attachment A.

DRAFT

c. Prohibited Uses:
City hereby agrees to the following:

i. The Reclaimed Water shall not be used for drinking, food preparation, domestic purposes or any type of human consumption, but Reclaimed Water may be used for landscape irrigation and toilet or urinal flush water in City facilities, if noted as a purpose in Attachment A, hereto.

ii. The Reclaimed Water shall not be sold or supplied to any other person for any purposes whatsoever.

iii. Except as City may otherwise be expressly authorized by the TCEQ, Reclaimed Water may not be discharged into or adjacent to the waters in the State.

iv. There shall be no nuisance conditions resulting from the distribution, use and/or storage of the Reclaimed Water.

2. Quantity
a. Annual Amount: ___________________________________

3. Delivery
a. Reclaimed Water Pumping, Storage and Distribution
NBU is responsible for delivery of reclaimed water to delivery points described in Attachment A at a pressure of ___ PSI.

4. Quality
a. State Standards
NBU agrees to transfer to City, at the time and point of delivery, Reclaimed Water of at least the minimum quality required by State standards for Type I usage as set forth in Section 210.33 of Title 30 of the Texas Administrative Code, as such may be amended or superseded from time to time. Pursuant to Section 210.33(1), the minimum Reclaimed Water quality for Type I water initially will be equal to or less than:

BOD5 or CBOD5 5 mg/L
Turbidity 3 NTU
Fecal Coliform 20 CFU/100 ml*
Fecal Coliform 75 CFU/100 ml**
* geometric mean
** single grab sample (not to exceed)

b. Warranties
City understands and agrees that the quality of the Reclaimed Water is different from that of City's normal potable water supply. City understands and agrees that the NBU makes no warranties as to the quality of the Reclaimed Water beyond those contained in

Sections 3a and 4a. All other warranties whether express or implied, including, without limitation, the implied warranty for fitness for a particular purpose or the implied warranty of merchantability are hereby excluded.

5. Reclaimed Water Use Requirements

a. General

The use of Reclaimed Water is regulated by the Texas Commission on Environmental Quality ("TCEQ") and Article VII of Chapter 35 of the City Code. A copy of Article VII of Chapter 35 is included as Attachment C. City shall fully inform itself of applicable requirements for the use of Reclaimed Water and abide by all Applicable Laws. Delivery of Reclaimed Water may, at NBU's sole discretion, be terminated for violation of the provisions of any Applicable Laws.

b. Reclaimed Water Supervisor

i. City shall designate an individual as City's Reclaimed Water Supervisor. The Reclaimed Water Supervisor shall be City's coordinator and the direct contact person between NBU and the City. The City agrees that the Reclaimed Water Supervisor shall be responsible for the proper operation of City's Reclaimed Water system, implementing the requirements of this MOU relative to the onsite use of reclaimed water, monitoring of City's Reclaimed Water system for prevention of potential hazards, and coordination with NBU and other regulatory agencies. NBU will assist in the training of City's Reclaimed Water Supervisor as time and resources permit; however, it shall be the non-delegable responsibility of City to assure its Reclaimed Water Supervisor is trained in the use and handling of Reclaimed Water in accordance with all Applicable Laws.

ii. City shall inform NBU in writing of the name, position and daytime and nighttime telephone numbers of City's Reclaimed Water Supervisor and shall promptly inform NBU in writing of any changes of designee and/or phone numbers during the term of this MOU.

c. Onsite Facilities

If modifications are necessary to City's onsite facilities to conform to Reclaimed Water use requirements, City shall submit its plans and specifications for such modifications to NBU which shall approve same before construction commences and which approval shall not unreasonably be withheld. All modifications required in City's onsite facilities shall be the sole cost and responsibility of the City. NBU shall assist the City in identifying the modifications and/or changes required in City's onsite facilities. It shall be the City's responsibility to construct the modifications in accordance with the approved plans and specifications, and with all Applicable Laws.

DRAFT

d. Notifications

i. City shall provide proper notification to City's employees and to the public that Reclaimed Water is being used on the Site in accordance with all Applicable Laws.

ii. Prior to City's commencement of the use of Reclaimed Water under this MOU, NBU will notify the Executive Director of the TCEQ and obtain approval for such use in accordance with Section 210.4 of Chapter 210 of Title 30 of the Texas Administrative Code.

iii. Upon completion of all onsite modifications and changes to City's Reclaimed Water and potable water systems, City shall provide NBU with as-built drawings of City's completed Reclaimed Water system and potable water system on City's site. The drawings shall show at a minimum, the locations of all pipelines, controllers, valves, buildings, structures, property boundaries, and any other features important to the onsite use of Reclaimed Water.

iv. City agrees to notify NBU by telephone or fax of any Reclaimed Water use not authorized by this MOU, including, but not limited to, spills, leaks, discharges, or releases of a material volume of Reclaimed Water into or adjacent to the waters of the State. The only exception is when the discharge or spill is caused by rainfall events or in accordance with a permit issued by the TCEQ.

Telephone or faxed notice must be given to NBU within 24 hours of obtaining knowledge of any such spill, leak, discharge, or release. NBU personnel will then assist in (1) assessing the extent of the unauthorized discharge and (2) aid in determining what reports, if any, need to be made as well as assist in making the reports. NBU will then provide written notice to TCEQ within 5 working days of obtaining knowledge of any such spill, leak, discharge or release.

Notification contacts are (list):

7. Price and Payment for Use of Reclaimed Water

a. Rates and Fees

City shall pay NBU for Reclaimed Water (to be determined)________________.

b. Payment

Each month City shall make a payment to NBU based on the applicable rate for the amounts of Reclaimed Water received by City for the preceding month ("Monthly Payments").

8. Permission to Enter

City hereby grants to NBU and regulatory agencies, acting through their duly authorized employees, agents, or contractors, access at all reasonable times to enter the Site for the purpose of observing construction or modification of reclaimed water facilities, for maintaining and repairing NBU-installed facilities, for meter reading, and for observing and verifying that City is properly operating is reclaimed water facilities in accordance with the terms and conditions of this MOU, and Applicable Laws. When entering City's premises, NBU or the regulatory agencies shall not unreasonably interfere with City's operations and its use of the premises.

9. Interruption of Service

NBU may interrupt Reclaimed Water service at any time if NBU determines that City is in breach of any provision in this MOU. If NBU interrupts service pursuant to this subsection, City shall have 30 days to cure the breach to the satisfaction of NBU. If City fails to cure the breach to the satisfaction of NBU in the period provided, NBU shall have the right to immediately terminate the MOU. The provisions of this Section are not intended to limit the rights of NBU contained in Section 10 of this MOU.

10. Liability, Indemnification and Force Majeure

a. City's Liability
City shall be solely responsible for any and all claims, damages, deaths, losses, injury, fines, penalties, suits and liability of every kind, including environmental liability, arising from the use, distribution or discharge of the Reclaimed Water, whether such us is intended or accidental, or authorized by this MOU and Applicable Laws or otherwise. City shall be solely responsible for any and all claims, damages, deaths, losses, injury, fines, penalties, suits and liability of every kind arising from or relating to the design, installation, construction, connection, maintenance, operation and modification of the Onsite System, regardless as to whether the Onsite System was released for service by NBU.

b. Force Majeure
If by reason of Force Majeure, NBU shall be rendered unable wholly or in part to carry out its obligations under this MOU to deliver Reclaimed Water, it shall not be required to deliver Reclaimed Water, and its failure to deliver Reclaimed Water in accordance with the terms and conditions of this MOU, shall not be considered a breach of this MOU. The term "Force Majeure" as used in this MOU shall mean acts of God, strikes, lock-

outs, or other industrial disturbances, acts of the public enemy, orders of any kind of the federal or state government or any civil or military authority, insurrection, riots, epidemics, landslides, lightning, earthquakes, fires, hurricanes, storms, floods, washouts, droughts, power failures, arrests, restraint of government and people, civil disturbances, explosions, breakage or accidents to machinery, pipelines or canals, the partial or entire failure of the NBU Reclaimed Water System, unsuitable Reclaimed Water quality, or other causes. Nothing herein shall be construed to enlarge the duty or liability of NBU beyond that imposed by law.

12. General Conditions

a. This MOU shall be construed and interpreted in accordance with the laws of the State of Texas, and venue of any litigation hereunder shall be in a court competent jurisdiction sitting in Comal County, Texas.
b. This MOU and the attachments thereto contain all the agreements of the parties with regard to this MOU and cannot be enlarged, modified or changed in any respect except by written agreement between the parties.

c. The unenforceability, invalidity or illegality of any provisions of this MOU shall not render the other provisions unenforceable, invalid or illegal, but the parties shall negotiate as to the effect of said unenforceability, invalidity or illegality on the rights and obligations of the parties.

d. NBU and City will each use their best efforts to fully cooperate with one another as may be necessary to diligently obtain and maintain in effect any required permits and all other approvals and records required by regulatory requirements that may be necessary for NBU and City to perform under, or take advantage of, the terms and conditions of this MOU.

e. The captions, titles and headings in this MOU are merely for the convenience of the parties and shall neither limit nor amplify the provisions of the MOU itself.

f. Notices to be given by either party to the other relative to this MOU shall be in writing. Both parties agree that any such notice shall be effective when personally delivered or deposited, postage paid, in the

U.S. Mail addressed by certified mail, return receipt request, as follows:

NBU: City:
Address 1 ______________________________________
Address 2 ______________________________________
Address 3 ______________________________________

DRAFT

ATTACHMENT A
PURPOSE AND LOCATION OF USE

Effective Date of this Delivery Location: ______________________________

1. Describe the boundaries within which the reclaimed water will be used. Attach a map showing approximate meter and location of reclaimed water use.

2. Describe the hours of operation.

Does this Attachment A supersede a previous Attachment A?

If yes, what is the Effective Date of superseded Attachment A?

DRAFT

ATTACHMENT B
ANNUAL AMOUNT AND MONTHLY VOLUMES

1. City's total maximum annual quantity of reclaimed water ("Annual Amount"): ________________ acre feet/year (detailed for each delivery point)

2. Peak usage required ______________ gallons per minute (detailed for each delivery point)

3. Projected monthly volumes:

MONTH	Approximate Usage (1000 gallons/month)
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

4. Required delivery pressure:

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix G

Public Meetings

Public Meeting No. 1

August 11, 2010

Meeting: New Braunfels Park Water Reuse Irrigation Feasibility Study
First Public Meeting
TWDB Grant #1004831078

Date & Time: August 11, 2010 @ 6:00 PM

11 Notes

1. No published agenda.
2. Approximately 27 attendees total.
3. Robert Camareno, CNB Asst. City Manager welcomed crowd and introduced the “participants” in the grant process. This included Matt Nelson (TWDB), Roger Biggers (NBU), Bob Hall (EAA), James Murphy (GBRA) and Stephen Jenkins from Espey Consultants as the lead for the contractor.
4. Stephen Jenkins took over the meeting and presented the concept to the audience.
5. CNB is studying $80M in long term park improvements. Using reuse water to protect the landscape investment in those park improvements is the basis for the study.
6. The study will consider the entire package for reuse water in New Braunfels. This will include:
    a. need for additional treatment
    b. transport
    c. storage
    d. possibility of a “scalping plant”
    e. addition of new parks requires more irrigation
    f. environmental concerns
7. Questions to be answered include:
    a. How much irrigation water is required to sustain the parks?
    b. How much water is available for reuse?
    c. What are the environmental considerations?
    d. What are the delivery options?
    e. What are the physical plant and piping requirements?
    f. What will the water cost from a “scalping plant?”
    g. Will it be affordable?
8. Questions from the crowd:
    a. “If I want to open a water park, will I be able to outbid the NB for this water?” Efforts were made to explain to this person that the CNB owns their effluent, so they could only be outbid for it if they wanted to take bids.
    b. “I am a downstream person. If you take this water out of the stream, the stream will be “short” of water. How will you protect my water rights and maintain instream requirements?” Efforts were made to explain Texas water rights and the fact that the downstream water user has no rightful claim to CNB wastewater prior to it being discharged.
    c. “Sundance golf course currently uses treated wastewater on its golf course. Where the water ponds for several days, it stinks. Can you

guarantee that this water will not stink?" No, that is a maintenance issue that can only be addressed by proper irrigation.

   d. If scalping plants work, why aren't there any in Texas?" Because water in Texas has been cheap, for years. Scalping plants are becoming much more common in California and places where water is expensive.

9. Schedule for the Project
   a. Draft to CNB around Jan-Feb, 2011.
   b. Final to CNB July, 2011.
10. Next meeting will be scheduled Jan or Feb, 2011.

Consultant touts use of effluent

Posted: Wednesday, August 11, 2010 10:50 pm

By Greg Bowen The Herald-Zeitung | 0 comments

NEW BRAUNFELS — No real opposition surfaced Wednesday night regarding using recycled water, or effluent, from the city's sewer plants to irrigate parks and playing fields in New Braunfels.

While many questions were asked by citizens during a public hearing to kick-off a $175,000 study into the feasibility of using effluent to irrigate parks, only one questioner asked about the touchy issues that might be expected to arise in discussions about effluent.

He said recycled water used to irrigate the old Sundance golf course sometimes pooled in low spots "and it was really quite stinetimes." The questioner wondered if the same situation could be avoided in the par.

Study leader Stephen Jenkins of Espey Consultants said if standing water were to become a problem, it could be taken care of by re-grading the ground to keep the water from ponding.

Jenkins told the crowd of about 30 meeting at Landa Haus that the recycled water, while "not treated to the level where it can be consumed, is safe for contact with the public and with food crops."

Bexar and Collin counties are using tens of millions of gallons of recycled water daily as a water-conservation measure, he said, adding regional water planners have identified the use of reclaimed water as one of the "best management practices" for water conservation.

Recycled water is also "essentially drought-proof," he said, which will allow for continued watering of parklands during droughts, when the use of the drinking water is restricted. That means using recycled water would improve the ability of the park system to meet the demands of more and more use from a growing population, he said.

Jenkins said the study, which will be completed next July, will look into such questions as:

• What will the cost be and is it affordable?

• How much water is needed to sustain the par

• How much recycled water is available?

• What are the environmental considerations?

• What are the options for moving the water from one or more of the city's wastewater treatment plants to the targeted par

He said pipelines could be used, or a small sewer-treatment plant ight be built near "where the need is" to avoid having to install long pipelines. No such small plants have been built in Texas, he said.

Wednesday's public hearing was the first in a series of three. Jenkins said a draft study will be the topic of a second meeting in January or February. The findings of the completed study will be unveiled in a final meeting in July 2011.

Then it’ll be up to city council to make a decision on whether to implement the study.

“It’ll be a balancing of the investment in the maintenance costs,” he said. “We’re going to try to put it all together in a nice neat little package so it’ll be easy to say ‘We’re comfortable with this cost’ or ‘This is simply not the time to do this yet.’”

Texas Water Development Board representative David Meesey said TWDB can finance or help finance such projects.

The recycled water would be used to irrigate Landa Park, Prince Solms Park, Hinman Island, Landa Park Golf Course, the HEB soccer complex, the Camp Comal softball complex and the future Walnut Avenue hike and bike trail.

The study is being funded by the Texas Water Development Board, City of New Braunfels, New Braunfels Utilities and Guadalupe-Blanco River Authority. Edwards Aquifer Authority is also a study participant.

Ignoring effluent lets water go down the drain

Posted: Friday, August 20, 2010 5:53 pm

On any given day, the residents of New Braunfels use 4.5 million to 5 million gallons of wastewater a day. Until now, that was literally water - and money - down the drain (or toilet).

The wastewater heads to one of the three treatment plants operated by New Braunfels Utilities - North Kuehler, South Kuehler and the Gruene wastewater treatment plants. Among them, the three plants have the capability to treat 8.4 million gallons a day, according to Gretchen Reuwer, spokesperson for NBU.

Meanwhile, the City of New Braunfels irrigates its parks to the tune of one inch of water each week. In Landa Park alone, there are 23 acres of irrigated property - at one inch per week ends up being 624,521 gallons of water per week during the peak season, according to Wade Tomlinson, City of New Braunfels Park Development Manager.

This past week, the City of New Braunfels opened a public discussion about the possibility of New Braunfels' parks department using recycled water from the city's sewer plants to irrigate the parks and playing fields in New Braunfels.

The recycled water would be used to irrigate Landa Park, Prince Solms Park, Hinman Island, Landa Park Golf Course, the HEB soccer complex, the Camp Comal softball complex and the future Walnut Avenue hike and bike trail.

As long as the infrastructure remains affordable to build and maintain, the idea is a good one - especially in a time of drought when using drinking water to keep our parks green and our trees alive is no longer an possible. To even have the option on the table is forward thinking for a community that will someday have water troubles in its future as the community and surrounding metropolitan areas continue to grow and pull more and more water from the Edwards and Trinity aquifers.

But installing a system to move effluent from one or more of the city's wastewater treatment plants to the city's parks is a long-term investment, and no doubt a sizeable one.

The first expense is the feasibility study. Espey Consultants is being paid $175,000 to study the pros and cons of using effluent to irrigate city parks.

The study is funded by the Texas Water Development Board, City of New Braunfels, New Braunfels Utilities and Guadalupe-Blanco River Authority. Edwards Aquifer Authority is also a study participant.

The study will be completed next July and go before the council for approval. If the cost of installing such a system seems logical to the council considering the study's findings, Texas Water Development Board representative David Meesey has said his agency can finance or help finance such projects.

Stephen Jenkins told the crowd of about 30 meeting at last week's meeting that recycled water, while "not treated to the level where it can be consumed, is safe for contact with the public and with food crops."

Bexar and Collin counties use millions of gallons of recycled water daily, he said, adding regional water planners have identified the use of reclaimed water as one of the "best management practices" for water conservation. Recycled water is also "essentially drought-proof," he said, which should be good news to the about 50 volunteers who hand-watered trees in Landa Park during the most recent drought.

Reuwer of NBU said the amount of effluent the utility could provide to the city is only limited by production. (And by a contract with the current owners of the property that was once the Sundance Golf Course. The contract allows the owners to use a maximum of 2 million gallons of effluent from NBU.)

As neighboring counties have already found, building a recycled water distribution system could be the key to a healthy future for New Braunfels water - replacing our unsustainable dependence on drinking water to keep lawns and trees alive.

Public Meeting No. 2

December 7, 2010

AGENDA
CITY OF NEW BRAUNFELS
PARKS AND RECREATION ADVISORY BOARD
REGULAR MEETING, DECEMBER 7, 2010
Landa Haus, 6:00 PM

1. **Call to Order**
2. **Roll Call**
3. **Approval of Minutes**
4. **Citizens' Communications**
5. **Discussion and Action**
    - A. **Cemetery Committee Appointment**
6. **Information Items**
    - A. **Park Water Reuse Study Public Meeting**
    - B. **Recreation Update**
        - i. **Wassailfest**
        - ii. **Breakfast With Santa**
    - C. **Park Project Update**
        - i. **South Tributary Trail Naming**
        - ii. **Volunteer Tree Planting Event**
        - iii. **Landa Park Playground Lawn Project**
    - D. **Landa Park 75th Birthday Celebration Update**
    - E. **PARD Public Information Distribution**
    - F. **Park Fees Update**
7. **Agenda Items for the Next Meeting**
8. **Adjournment**

I herby certify the above Notice of Meeting was posted on the Bulletin Board at the New Braunfels Municipal Building on
________________, 2010 at ________p.m.

____
Ann Smith, City Secretary

NOTE: Persons with disabilities who plan to attend this meeting and who may need auxiliary aids or service such as interpreter for persons who are deaf or hearing impaired, readers, or large print, are requested to contact the City Secretary's Office at 221-4010 at least two (2) work days prior to the meeting so that appropriate arrangements can be made.

City of
New Braunfels

Public Meeting Sign-In Sheet
New Braunfels Parks Water Reuse Irrigation Feasibility Study
December 7, 2010

Name	Address
Bob Hall	Edwards Aq. Auth. SA. TX 78215
TOMMY THOMPSON NBU	263 MAIN PLAZA NB TX
MIKE KENNEDY	875 NORTHVIEW 78130
Steve Fletcha	822 Twin Oaks
Gale Pospisil	6 Mission Dr

Name	Address
Linda Ray	524 Elm Creek Rd
Suzanne R. Williams	1008 Dunlap Dr
Lina Goerges	1065 Borneville

City of New Braunfels

Public Meeting Sign-In Sheet
New Braunfels Parks Water Reuse Irrigation Feasibility Study
December 7, 2010

VLADIMIR POSPISIL	4 MISSION DR NB
Tim Barker	465 Fredericksburg Rd
Elisabet Barker	—— " ——

Parks Water Reuse Irrigation Feasibility Study

The project's focus is on potential water reuse to facilitate the achievement of regional water conservation goals for the Guadalupe River and Edwards Aquifer. Study participants include the City of New Braunfels, New Braunfels Utilities (NBU), Guadalupe-Blanco River Authority (GBRA), Edwards Aquifer Authority (EAA) and the Texas Water Development Board. Several public meetings have been held as part of the process to obtain input for the study partners.

This feasibility study is designed to give an analysis of the viability of the idea to use reuse water for parkland irrigation. It will provide an evaluation of the potential benefits associated with such a project and also a basis for answering the essential question of whether we should proceed with the proposed project idea.

The study will give focus to the potential project and outline alternatives while providing detailed information needed for decision making.

At a public meeting held on December 7, 2010 in Landa Park, Espey Consultants, Inc. reported on the status of the study. They addressed the following topics:

- Water Quality
- Environmental Considerations
- Historical Consumption
- Projected Water Demand
- Reclaimed Water Delivery
- Transmission System Route Options
- Reclaimed Water Storage Options
- Probable Costs

Click here for a list of questions and answers generated following this presentation.

For more information on the study, contact the Parks & Recreation Administrative Office at 830-221-4350.

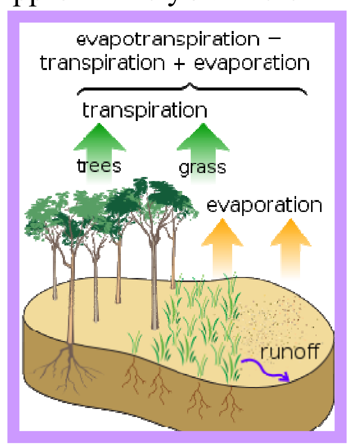
FAQ (http://www.nbtexas.org/DocumentView.aspx?DID=1702)

- **What areas are being considered for irrigation with reclaimed water?**
  The study is intended to evaluate the feasibility of irrigating about 173 acres of city parks. The park areas are:

Landa Park	Fredericksburg Fields	a portion of Landa Park Golf Course
Prince Solms	HEB Soccer Fields	landscaping along Walnut Ave.
Hinman Island	Camp Comal	Fischer Park

- **Is this a grey water system?**
  The feasibility study addresses irrigation of the city's parks using *reclaimed* water (also known as *reuse* or *recycled* water). This is highly treated effluent that meets state stream standards. *Grey* water is untreated water from domestic showers, sinks and clothes washers and is not considered as an appropriate water supply for parks irrigation.

- **How much reclaimed water will it take to irrigate the city's parks?**
  The volume of reclaimed water required to irrigate the city's parks depends on the total acreage to be irrigated, average annual rainfall, and the ET rate. The volume of reclaimed water needed to irrigate 173 acres of parklands is approximately 904 acre-feet, or 295 million gallons per year.



- **What does "ET" stand for?**
  "ET" is the abbreviation for *evapotranspiration*. This is the process by which water is evaporated from the soil surface and water is transpired by plants growing on that surface.

- **How would reclaimed water be delivered to the parks?**
  A reclaimed water system would be designed and operated similar to a drinking water system. Effluent from the wastewater treatment plant receives additional treatment before being pumped to storage tanks to be delivered to the parks irrigation systems.

- **What is the capacity of the storage tanks?**
  Storage tank capacity ranges from a total of 895,000 gallons to 1,250,000 gallons, depending on the annual production of reclaimed water. The ET assumption that produces the highest irrigation demand would require two storage tanks of approximately 600,000 gallons and 650,000 gallons.

- **What about using ponds for storage?**
  Ponds are a viable storage alternative. However, tanks require less land area for a comparable volume of storage and also provide advantages for maintaining water quality.

- **Where are the reclaimed water pipes placed – above or below ground?**

All pipes will be buried - similar to water distribution and wastewater collection mains. Reclaimed water pipe is purple to contrast with the pipe colors used for potable water and wastewater.

- **If it rains a lot then isn't reclaimed water expensive?**
  The unit cost of producing reclaimed water decreases as the volume of water produced increases. While the converse is true that the unit cost of reclaimed water increases as the volume decreases, the system would be designed according to <u>average</u> rainfall conditions. During the projected 50-year life of the reclaimed water system the number of drought periods will balance out periods of abundant rainfall to approach the average condition.

- **Who owns the reclaimed and stored water?**
  State regulations define the responsibilities of the reclaimed water producer and the reclaimed water user.

- **Is there currently enough reuse water being generated to handle the estimated use level?**
  The South Kuehler Wastewater Treatment Plant presently produces approximately 3,140 acre-feet of effluent per year. With a total projected irrigation demand of 904 acre-feet per year, the reclaimed water system requires an annual average of about 29% of the total annual flow from the South Kuehler WWTP. However, irrigation of the city's parks using reclaimed water may require as much as 42% of the plant's effluent during peak irrigation periods in the summer months.

- **What happens if another entity wants to use the reclaimed water?**
  The purpose of the feasibility study is to consider a single user system with a well defined demand – that being 173 acres in nine city parks. As such, no marketing or market development is included in the analysis as a driver for system capacity. The capacity for potential users other than the parks identified in the study, as well as the process of supplying additional customers would be considered if a reclaimed water project moves forward into the design process.

- **Is the cost of raw water included in any of your projections?**
  The current cost projections include the cost of additional treatment, pumping, storage and transmission of reclaimed water. Adding a market cost for acquiring the effluent is presently being evaluated and will be addressed in the final analysis.

- **Does San Antonio use reclaimed water in their parks?**
  The city of San Antonio irrigates five municipal golf courses with reclaimed water along with the grounds of Brackenridge Park. Reclaimed water is also used for augmentation of the River Walk.

- **Are parks greener because of the availability of reclaimed water or because of additional nutrients in that water?**

Areas irrigated with reclaimed water primarily benefit from the availability of water. Reclaimed water does contain small amounts of nitrogen and phosphorus that can reduce the amount of fertilizers used for sustaining plant health.

- **If it was a "go" how soon would the funding be needed?**
  The schedule for a project such as this could take up to 3 ½ years from initiation to completion of construction. This schedule would include securing funding, design, permitting and construction.

- **Is there a benefit in a phased approach?**
  The concept is developed as a single construction project for the purposes of the feasibility study. As a single user system, building the system incrementally or in phases may actually increase the overall system cost.

- **Does the study look at the effect of water rights (to the Comal River) on the golf course?**
  The feasibility study considers irrigation of 14 acres of the golf course acreage that is not currently irrigated with water from the Comal River. The feasibility study does not address irrigation of the entire golf course using reclaimed water.

- **Will irrigation of the city's parks with reclaimed water affect the Edwards Aquifer?**
  The use of reclaimed water on the Edwards Aquifer recharge zone is not part of the feasibility study. However, one of the environmental benefits of using reclaimed water to irrigate the city's parks could be that the demand for potable water from the aquifer would be reduced during summer months. According to the Edwards Aquifer Authority: "*Use of recycled water from sewage treatment plants can defer large amounts of Edwards Aquifer pumpage during critical times, thereby helping to maintain springflow levels and preserve endangered species habitats*."

Public Meeting No. 3

July 5, 2011

AGENDA
CITY OF NEW BRAUNFELS
PARKS AND RECREATION ADVISORY BOARD
REGULAR MEETING, JULY 5, 2011
Landa Haus, 6:00 PM

1. **Call to Order**
2. **Roll Call**
3. **Approval of Minutes**
4. **Citizens' Communications**
5. **Information Items**
   - **A. Reclaimed Water Feasibility Study**
   - **B. Introduction of Intern**
   - **C. Introduction of Park Superintendent**
   - **D. Fourth of July/Grill Ban/Other Fire Hazard Measures**
   - **E. Facility Tour Sunday, July 10, 2011**
   - **F. Park Project Updates**
     - **i. HEB Soccer Complex**
     - **ii. South Tributary – County Line Memorial Trail**
6. **Discussion and Action Items**
   - **A. Parks and Recreation Advisory Board By-Laws**
7. **Agenda Items for the Next Meeting**
8. **Adjournment**

I herby certify the above Notice of Meeting was posted on the Bulletin Board at the New Braunfels Municipal Building on ________________, 2011 at ________p.m.

____
Patrick Aten, City Secretary

NOTE: Persons with disabilities who plan to attend this meeting and who may need auxiliary aids or service such as interpreter for persons who are deaf or hearing impaired, readers, or large print, are requested to contact the City Secretary's Office at 221-4010 at least two (2) work days prior to the meeting so that appropriate arrangements can be made.

Public Meeting Sign-In Sheet
New Braunfels Parks Water Reuse Irrigation Feasibility Study
July 5, 2011

Name	Address
Kirk & Rosemarie Gregory	636 Lakeview Blvd, N.B. TX
Dolores Schumann	549 Lakeview Cr.
VanDa Bobecik	2338 Brittany Cove
Juan Blanchard	204 Ann Dr
Myles Pennemann	120 Buccones Av
Greg [illegible]	NB H-Z
Gale & Vladimir Pospisil	
Earl Koester	173 Lakeview
Kathy + Alan Snodgrass	427 River Bend New Braunfels
Cale Unterberg	625 Magdalena Lane N.B. TX 78132
Tom Wibert	NBPD
Suzanne R. Williams	NBU

Public Meeting Sign-In Sheet
New Braunfels Parks Water Reuse Irrigation Feasibility Study
July 5, 2011

Name	Address
MATT NELSON	TWDB 1700 Congress Ave
Delitha Guenzel	762 Laurel Lane NB TX 78130
MARIE OFFERMAN	1352 PATIO DRIVE N.B., TX 78130
TIM & ELISABET BARKER	465 Fredericksburg Rd 78130
John Davis	1238 Common ST NBTX 78130

Public Meeting No. 4

July 11, 2011

CITY OF NEW BRAUNFELS, TEXAS
CITY COUNCIL MEETING

CITY HALL - COUNCIL CHAMBERS
424 S. CASTELL AVENUE

MONDAY, JULY 11, 2011 at 6:00 P.M.

Gale Pospisil, Mayor
Richard Zapata, Councilmember (District 1)
Mark Goodner, Mayor Pro Tem (District 2)
Mike Ybarra, Councilmember (District 3)
Sandy Nolte, Councilmember (District 4)
Bryan Miranda, Councilmember (District 5)
Steven Digges, Councilmember (District 6)
Michael Morrison, City Manager

MISSION STATEMENT
The City of New Braunfels will add value to our community by planning for the future, providing quality services, encouraging Community involvement and being responsive to those we serve.

A G E N D A

CALL TO ORDER: July 11, 2011 @ 6:00 P.M.

CALL OF ROLL: City Secretary

PLEDGE OF ALLEGIANCE/SALUTE TO THE TEXAS FLAG

INVOCATION: Councilmember Bryan Miranda

PROCLAMATION: Parks and Recreation Month

PRESENTATION: Presentation and discussion regarding findings from a feasibility study on parks reclaimed water irrigation.
(R. Camareno, Assistant City Manager) Page

Update on the status of the North Tributary Drainage Project.
(J. Klein, City Engineer) Page

REQUEST ALL PAGERS AND PHONES BE TURNED OFF, EXCEPT EMERGENCY ON-CALL PERSONNEL.

1. **MINUTES**
Consider approving the minutes of the special and regular meetings of June 27, 2011.
(*P. Aten, City Secretary) Page*

2. **CITIZENS' COMMUNICATIONS**
This time is for citizens to address the City Council on issues and items of concern not on this agenda. There will be no City Council action at this time.
(Mayor Pospisil) Page

Reclaimed water project a necessary investment

Posted: Tuesday, July 12, 2011 5:58 pm

AT ISSUE

A recent study shows how New Braunfels could use reclaimed water to irrigate city parks.

OUR VIEW

Concept is a forward-thinking solution in this drought-prone part of Texas.

DECIDE FOR YOURSELF

A draft copy of the Parks Reclaimed Water Irrigation Feasibility Study is available for public view at the New Braunfels Public Library.

There's too much truth in the oft-repeated saying "Whiskey's for drinking, water's for fighting." As yet another drought reminds us, water is precious, it's source is as unpredictable as the weather and everyone wants some.

On Monday night, Espey Consultants presented a study to the New Braunfels City Council that looked at the possibility of using reclaimed wastewater effluent for irrigation of a majority of the city's parks.

The study proposes a $4.5 million project to replace the drinking water now used to irrigate park lands with treated water that is safe for irrigation but not for consumption.

The importance of this project could easily be lost by focusing on the price tag.

Creating the infrastructure to reuse treated water for irrigation is about so much more than the immediate price tag. It's about more than even the current drought.

This study and this approach is about forward thinking - planning for a growing community in a drought-prone part of Texas where springs dry up, where whole cities spring up in the course of a few years and calls for water conservation only go so far.

The City of New Braunfels, New Braunfels Utilities, GBRA and the Edwards Aquifer Authority - who jointly funded the $175,000 study - should be applauded and encouraged for this effort to take some strain off the aquifer and our supply of drinking water.

The study supposes using as much as 295 million gallons per year of recycled water to irrigate 173 acres of parklands, including Landa Park, Prince Solms Park, Hinman Island, the HEB soccer complex, the Camp Comal and Fredericksburg Road ball fields, a portion of Landa Park Golf Course, the new Fischer Park and the landscaped park areas being built as part of the Walnut Avenue reconstruction project.

At Monday's council meeting, Councilor Richard Zapata suggested that the concept could be expanded beyond parks irrigation.

And he's right. If the entities involved move forward with this project - which they should - they should examine the scope and boundaries beyond parks irrigation.

Could it be used for residential irrigation? Where else could serve to cut back on potable water consumption?

Once the infrastructure is in place, it will be more expensive to ask those questions.

According to the U.S. Environmental Protection Agency, landscape irrigation is estimated to account for almost one-third of all residential water use.

According to Stephen Jenkins of Espey Consultants, using recycled sewer water to irrigate the city's parks would result in a relatively drought-proof water supply source.

The recycled water also would cut demand on the Edwards Aquifer, he said, be unaffected by staged water restrictions, and increase park capacity by making more grassy lands available for use.

The idea is still only on paper, merely in the discussion phase. It's still unclear which agency would take the lead, how it would be funded and on what scale.

One thing is clear.

The $4.5 million price tag is a considerable, but necessary investment to help ensure the sustainability of the water supply for this growing community.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix H

Comments to Draft Final Report and Response to Comments

Attachment I
City of New Braunfels
Parks Reclaimed Water Irrigation Feasibility Study
(TWDB Contract No. 1004831078) Draft Report Review Comments

General:

1. Please include a section in the final report describing the required public meetings (outlined in scope of work tasks 1, 2, 4, 6, and 8), information discussed, and comments received. This could include meeting hand-outs and attendance sign-in sheets.

2. Please submit all GIS datasets and electronic files developed under this contract with the final report.

Section 8.3 "Economic Analysis Methodology":

3. Pages 58 and 60: The draft report chooses a discount rate of 8% for costs incurred beyond the initial investment in construction (p. 60). The interest rate chosen for debt service is 5% (p. 58). Since no inflation was assumed in the estimation of future costs, the discount rate should function to reflect only the time value of money. The debt-service interest rate is clearly a nominal (without adjustment for inflation) rate, so the discount rate should also be nominal. The draft report states, however, that the discount rate "assumes inflation above the historical average." Please consider a correction to this discussion and the use of a lower discount rate in the final report.

4. The draft report further asserts that the discount rate is "discretionary" because each compared scenario uses the same rate. However, this is not a correct statement. A higher discount rate emphasizes initial construction costs, whereas a lower rate emphasizes annual recurring costs. The baseline scenario includes no construction costs. The choice of discount rate therefore has an impact on which scenario appears to be most cost effective. The only analysis where the choice of discount rate does not matter is one where discounting is not necessary. Please consider deleting this discussion in the final report.

5. Please consider changing the phrase "Net Present Value" (NPV) to "Present Value" throughout the final report. NPV refers to the discounted stream of benefits less costs, yet no benefits are quantified in the draft report. In NPV analysis, the costs of the proposed project would be subtracted from the costs of the baseline scenario that would be averted by the proposed project. Instead, the draft report compares the discounted costs of two alternatives.

Section 9:

6. Please include in the final report the recycled water irrigation rate design and draft agreement for recycled water service as stated in task 8 of the contract scope of work.

Response to TWDB Comments – Draft Final Report

1. Public meetings were conducted on August 11, 2010; December 7, 2010; and July 5, 2011. A final public presentation was made before the New Braunfels City Council on July 11, 2011. Information regarding the public meetings is included in the Final Report as **Appendix G.**

2. All GIS datasets and electronic files developed under this contract are included as part of the submittal of the final report.

3. The analysis has been performed using a discount rate of 4.125%, consistent with the U.S. Water Resources Council guideline for 2011 (http://www.economics.nrcs.usda.gov/cost/priceindexes/rates.html). The discussion has been rewritten to account for this change to the analysis and assumptions.

4. The analysis has been performed using a discount rate of 4.125%. The discussion has been rewritten to account for this change to the analysis and assumptions.

5. The text of the report has been changed to reflect "Present Value."

6. The development of the irrigation rate design has been included in Section 9.3.2. A framework for a reclaimed water service agreement has been included as Appendix F.

TPWD Comments on City of New Braunfels Preliminary Report "Parks Reclaimed Water Irrigation Feasibility Study"
June 18, 2011

Texas Parks and Wildlife Department (TPWD) Water Resources Branch staff has reviewed the City of New Braunfels Preliminary Report entitled "Parks Reclaimed Water Irrigation Feasibility Study" prepared by Espey Consultants, Inc. and offers the following comments.

The City of New Braunfels is proposing the direct reuse of treated effluent to irrigate local parklands, including Landa Park, Hinman Island, Prince Solms, Camp Comal, Fisher Park, and several other City owned parklands. The identified source of the reclaimed water is the South Kuehler Wastewater Treatment Plant. The purpose of reusing treated effluent to irrigate these lands is to enhance local and regional appeal of parklands and to preserve limited water resources.

The report does a good job of outlining alternatives, treatment standards, and technologies available to meet Type I reuse water quality standards. While the area proposed for irrigation is within the Edwards Aquifer Transition zone and not the recharge or contributing zone, concerns still exist regarding the potential for runoff and excessive nutrients into the Comal Springs ecosystem as many of the proposed parks area adjacent to Comal Springs and the downstream ecosystem that provides habitat for several endangered species.

Elevated nutrient concentrations (primarily Phosphorous and Nitrate) can lead to excessive plant growth and eventual die-off that creates water quality concerns (i.e. low dissolved oxygen) which may in turn impact the endangered species. The report outlines the state standards, proposes means of meeting the state standards, and states that "irrigation water will not be allowed to form runoff or enter into the Comal River, and is restricted to the transition zone of the Edwards Aquifer…". The report also states that "diverting wastewater effluent to park irrigation will remove approximately 25 pounds of Phosphorous from the WWTP effluent for each million gallons of reclaimed water."

While TPWD supports the reuse of treated effluent for irrigation purposes, concerns exist that nutrients may enter the Comal Springs ecosystem, especially during periods of excessive rainfall when runoff amounts are greatest. A primary concern is the potential for an increase in nutrient load in areas that are currently unimpacted by wastewater discharge. Based on Figure 1 in the report, it appears that the all three City wastewater treatment plants currently discharge to the Guadalupe River. By irrigating parkland throughout the city, there is a potential for increased nutrient loading to the Comal River and to areas of the Guadalupe River upstream of the S. Kuehler wastewater treatment plant discharge, that currently do not receive wastewater. In addition, the proposed application rates seem excessive, which could in turn lead to excessive runoff. For a dry year scenario, the plan is to irrigate 172.9 acres of parkland with 905 a-ft of reuse water which equates to 5.2 acre-feet of water per acre if irrigation is evenly spaced out over the course of 12 months. For comparison, the wet year scenario envisions the use of 2.6 a-ft/acre with an even distribution pattern. If the amount of water that they are applying is excessive and promotes runoff or lateral movement of the treated water into the Comal system, an area where the effluent has not previously been discharged, then the addition of phosphorus and other nutrients could have an impact.

Nutrient and chlorophyll-*a* concentrations for the Guadalupe River and the Comal River are generally low (Table 1, Figure1). Average chlorophyll-*a* values are smallest at the Comal River station below Clemons Dam, similar at the two Guadalupe River stations and largest at the Dry Comal Creek station. For the Dry Creek and downstream Guadalupe River stations, differences between the average and the median, large standard deviations, and maximum reported values (117 µg/l at Station 12570 and 64 µg/l at Station 12596) suggest occasional blooms at those locations. Average chlorophyll-*a*, nitrate, ammonia and total phosphorus measurements are below the statewide freshwater stream screening criteria at all sites. (85^{th} percentile values are 14.1 µg/l, 1.95 mg/l, 0.33 mg/l, and 0.69 mg/l, respectively.) The data collectively present a picture of a system with good water quality that may be experiencing some stress. Given the tendency of parts of the area to have algal blooms and the relatively high nitrate levels already present in some areas, it seems likely that runoff of irrigation water or release of nutrients through accumulation in the soil will cause problems.

The report estimates that 25 lbs of phosphorus will be removed for each million gallons of water irrigated. This corresponds to an effluent concentration of about 3 mg/l.

The report does not provide any analysis of nutrients, including the ability of the crop to take up available nutrients and the potential for nutrient buildup in the soil. There is no provision for soil testing to ensure that nutrients are being applied in quantities and at rates the crop can use. The report should address:

1) Average concentrations of nitrogen and phosphorus in the S. Kuehler wastewater treatment plant effluent proposed to be used for irrigation
2) A nutrient balance for the irrigated crop, presumably turf grass, to demonstrate that the crop can utilize the nitrogen and phosphorus at the rates provided. It is typical to specify a certain number of cuttings per year, with removal of the cut material, to ensure that excess nutrients are removed from the system. It is not adequate to simply do a hydraulic balance. For examples, see Texas Commission on Environmental Quality (TCEQ) rules at 30 TAC 309.20(b)(3)(C) or the Texas State Soil and Water Conservation Board (http://www.tsswcb.state.tx.us/en/cnmp).
3) Long-term plans must also demonstrate that there will be no inappropriate buildup of nutrients in the soil. Excessive levels of nutrients in the soil may contribute to nutrient runoff. This requires soil testing before application of wastewater and periodically thereafter.

TPWD staff recommends the report be revised to include a nutrient management plan that accounts for source and soil nutrient concentrations, crop uptake and required cuttings, and ensures that there will be no buildup of nutrients in the soil. When a nutrient management plan has been completed, the allowable loading rates obtained using the nutrient balance can be compared with the hydraulic loading rate, and the lower of the two rates will determine the maximum allowable water reuse.

TPWD staff also recommends some form of water quality monitoring be performed during the initial phases of the project, especially during "wet" periods to ensure excessive nutrients are not being introduced to the Comal Springs or River. If excessive nutrient concentrations are found, TPWD staff recommends some means of removing excess nutrients to ensure the Critical Habitat of the listed species is not negatively impacted. Examples of means for removing excess nutrients include natural methods (constructed wetlands or ponds) or mechanical methods (i.e. treatment plants).

Finally, TPWD staff recommends that Section 6 Pipeline Route Evaluation Criteria include environmental concerns as a consideration for routing. Proposed routes should be evaluated for potential impacts to the high quality aquatic habitat and wetlands in the area.

Figure 1. TCEQ monitoring station locations in and near New Braunfels. Also shown is the S. Kuehler wastewater treatment plant (Google Earth).

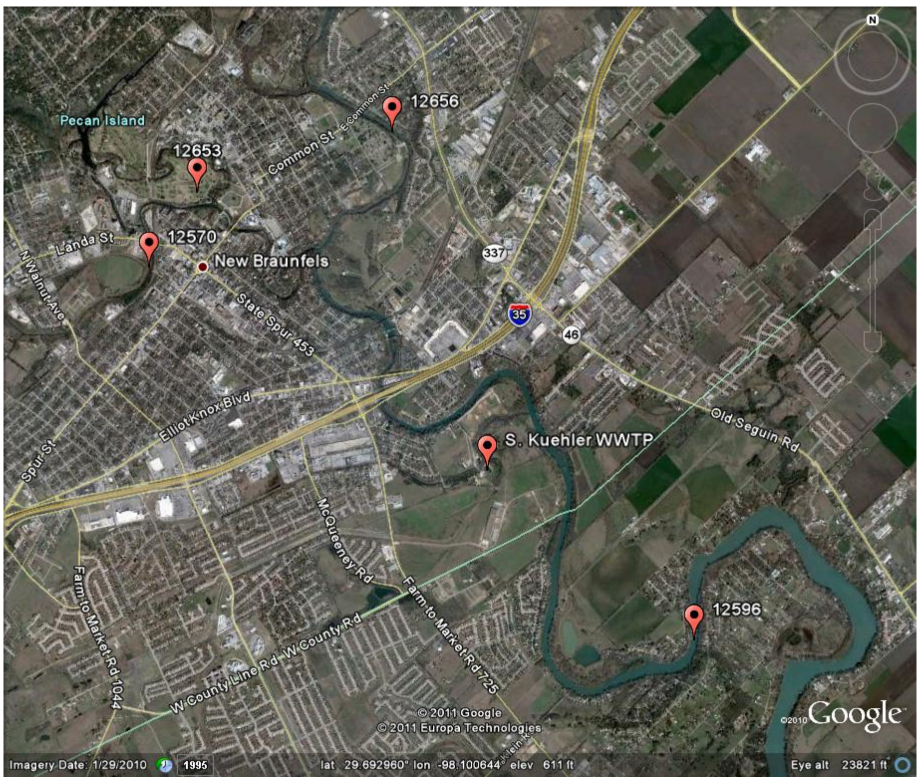


Table 1. Nutrient and field measurements for the Comal and Guadalupe Rivers near New Braunfels. Average, median, standard deviation (σ) and number of measurements (N) for the period 2000-2010. Data obtained by query of TCEQ Surface Water Quality Monitoring Information System.

		12570 - Comal R. at Dry Comal Ck.				12653 - Comal R. below Clemons Dam				12656 - Guadalupe R. at Cypress Bend Park				12596 - Guadalupe R. at ACS (Lake Dunlap)			
Code	Parameter	N	Avg	Med	σ	N	Avg	Med	σ	N	Avg	Med	σ	N	Avg	Med	σ
00061	Instantaneous flow (cfs)	132	4.5	2.0	7.2	119	340.0	352.0	68.4	16	380.3	272.5	565.1	110	908.2	589.0	953.3
00094	Specific conductance (µS/cm)	133	700	693	143	138	569	572	27	18	464	476	38	127	529	535	44
00300	Dissolved oxygen (mg/l)	133	9.66	9.45	2.71	127	9.98	9.96	0.99	18	10.88	10.95	1.29	127	9.73	9.60	1.50
00400	pH (standard units)	133	7.6	7.6	0.2	127	7.6	7.6	0.2	18	8.1	8.2	0.2	128	7.9	7.9	0.2
00610	Ammonia-nitrogen (mg/l as N)	64	0.08	0.05	0.07	63	0.06	0.03	0.05	16	0.06	0.05	0.01	69	0.06	0.04	0.05
00620	Nitrate-nitrogen (mg/l as N)	69	0.83	0.81	0.26	70	1.75	1.79	0.30	16	0.28	0.26	0.07	70	1.20	1.27	0.31
00625	Total Kjeldahl nitrogen (mg/l as N)	18	0.55	0.48	0.31	18	0.26	0.20	0.10					29	0.33	0.26	0.21
00630	Nitrite + nitrate -nitrogen, total (mg/l as N)	38	0.55	0.50	0.24	38	1.02	0.85	0.54					38	0.75	0.73	0.35
00631	Nitrite + nitrate -nitrogen, diss (mg/l as N)	20	0.78	0.76	0.28	20	1.67	1.67	0.26					20	1.11	1.12	0.35
00593	Nitrite+nitrate, total, Whatman GF/F (mg/L)									17	0.59	0.52	0.33				
00665	Total phosphorus (mg/l as P)	128	0.08	0.05	0.07	128	0.05	0.05	0.03	16	0.06	0.06	0.01	128	0.07	0.05	0.04
00671	Orthophosphate-phosphorus, dissolved, field filtered<15 min, (mg/L as P)									16	0.038	0.040	0.008				
70953	Chlorophyll-*a*, fluorometric, (µg/l)									16	3.3	3.0	0.6				
32211	Chlorophyll-a, spectrophotometric, (µg/l)	127	6.0	2.5	13.5	127	1.3	1.0	1.0					128	2.8	1.0	8.3
00078	Secchi depth (m)									18	1.58	1.50	1.02				

Response to TPWD Comments – Draft Final Report

1. TPWD Line 34 - 36: Comment addressed with edit of Sec. 4.2.3.
   "Any residuals of reclaimed water irrigation that could be introduced into Comal River by rainfall induced runoff would be diluted and moved downstream with the increased flow resulting from stormwater runoff from both the non-irrigated and irrigated areas within the watershed."

2. TPWD Line 43 - 50: The rate at which reclaimed water would be applied and the potential for runoff are addressed in Sec. 4.1.4 – "Runoff of reclaimed water is to be prevented by the reclaimed water user (30 TAC §210.24) by avoiding excessive irrigation. Applying reclaimed water at the proper rate for the existing soil and atmospheric conditions is the principal means of avoiding runoff from irrigated sites. Maintenance of the irrigation system to correct sprinkler head and controller malfunctions is also an essential part of avoiding runoff from irrigated sites."
3. TPWD Line 104 – 107: A detailed delineation of wetlands in the project area would be conducted as part of the final design of a reclaimed water system (Sec. 4.2.4).

Edwards Aquifer Authority (EAA) Comments on City of New Braunfels Preliminary Report "Parks Reclaimed Water Irrigation Feasibility Study" June 1, 2011

1. **What measures are available to minimize the discharge of reclaimed water in the event of a pipeline break? (Pg. 30)**

   The following text has been added to Sec. 5.5 of the draft report:
   "Additional measures for detecting and minimizing the loss of reclaimed water as a result of main breaks can be evaluated as part of the final design. As with systems supplied by potable water, irrigation systems that rely on reclaimed water function only when the delivery pressure is adequate to activate each zone of the system. An ability to detect the lack of sufficient pressure at the delivery points is a design feature that may be useful in detecting reclaimed water main breaks. The delivery pressure at each delivery point could be transmitted to the NBU SCADA system to initiate an alarm if minimum pressures indicate a possible line break between the distribution pump and delivery point. The feasibility of such a feature can be evaluated as part of the final design of a reclaimed water system."

2. **Section 4.2.5 compares inadvertent runoff of reclaimed water with stormwater runoff but does not consider temperature of the reclaimed water.**

   It is known that the temperature of raw wastewater is higher than the temperature of surface waters in the Comal River and its tributary creeks. However, there is no data available regarding the temperature of wastewater effluent from the S. Kuehler WWTP. Furthermore, it is reasonable to infer that the process of aeration during treatment, followed by storage and transportation of reclaimed water through almost three miles of underground piping, will provide a significant thermal transfer opportunity. At the point of delivery, it is unlikely that the temperature of reclaimed water will significantly differ from that of potable water.

3. **What measures are available to minimize corrosion of welded steel storage tanks?**

   The following text has been added to Sec. 5.5 of the draft report:
   "Unlike tanks used for potable water, interior coating systems that are classified under ANSI/NSF 61 are not required for reclaimed water storage. This will allow a broader choice of interior coating systems in the design of storage tanks for reclaimed water that will enhance the durability and corrosion resistance when using welded steel tanks."

New Braunfels Utilities (NBU) Comments on City of New Braunfels Preliminary Report "Parks Reclaimed Water Irrigation Feasibility Study" June 2, 2011

1. **Locations of additional treatment and piping for reclaimed water must consider the fact that the limited available space at the POTWs will be critical in future plant expansions.**

   Final design of a reclaimed water system will necessarily consider the location of plant piping and existing limits of NBU property ownership in the design of the reclaimed water supply piping and the location of the rotating disk filter system.

2. **Defining the responsibilities for design, funding, construction and operation between the City of New Braunfels and NBU is a significant factor in any implementation plan for reclaimed water.**

   Section 9.2 of the draft report touches on some of the inter-agency coordination questions associated with the implementation of a reclaimed water system. Central to the implementation plan will be adoption of an administrative framework as a basis for implementation .

EC