DRAFT FEASIBILITY REPORT
FEASIBILITY ANALYSIS OF WATER SUPPLY FOR SMALL PUBLIC WATER SYSTEMS

STONERIDGE LAKE SUBDIVISION
PWS ID# 0200624, CCN# 11982

Prepared for:

THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Prepared by:

THE UNIVERSITY OF TEXAS BUREAU OF ECONOMIC GEOLOGY

AND

PARSONS

Preparation of this report was financed by the Texas Commission on Environmental Quality through the Drinking Water State Revolving Fund Small Systems Assistance Program

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AUGUST 2006

EXECUTIVE SUMMARY

INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Infrastructure and Technology Group Inc. (Parsons), was contracted by the Texas Commission on Environmental Quality (TCEQ) to conduct a study to assist with identifying and analyzing alternatives for use by Public Water Systems (PWS) to meet and maintain Texas drinking water standards.

The overall goal of this project was to promote compliance using sound engineering and financial methods and data for PWSs that had recently recorded sample results exceeding maximum contaminant levels (MCL). The primary objectives of this project were to provide feasibility studies for PWSs and the TCEQ Water Supply Division that evaluate water supply compliance options, and to suggest a list of compliance alternatives that may be further investigated by the subject PWS for future implementation.

This feasibility report provides an evaluation of water supply alternatives for the Stoneridge Lake PWS, a subdivision with more than 20 connections located in Brazoria County, Texas. The Stoneridge Lake PWS recorded an arsenic concentration of 14 micrograms per liter (µg/L). This result is greater than the 10 µg/L MCL for arsenic that went into effect on January 23, 2006 (USEPA 2005a; TCEQ 2004a). Therefore, it is likely that the Stoneridge Lake PWS faces compliance issues under the new standard.

Basic system information for the Stoneridge Lake PWS is shown in Table ES.1.

Table ES.1
Stoneridge Lake
Basic System Information

Population served	66
Connections	22
Average daily flow rate	0.009 million gallons per day (mgd)
Peak demand flow rate	24 gallons per minute
Water system peak capacity	0.086 mgd
Average total arsenic	0.0137 mg/L

STUDY METHODS

The methods used for this study were based on a pilot study performed in 2004 and 2005 by TCEQ, BEG, and Parsons. Methods for identifying and analyzing compliance options were developed in the pilot study (a decision tree approach).

The process for developing the feasibility study used the following general steps:

- Gather data from the TCEQ and Texas Water Development Board databases, from TCEQ files, and from information maintained by the PWS;

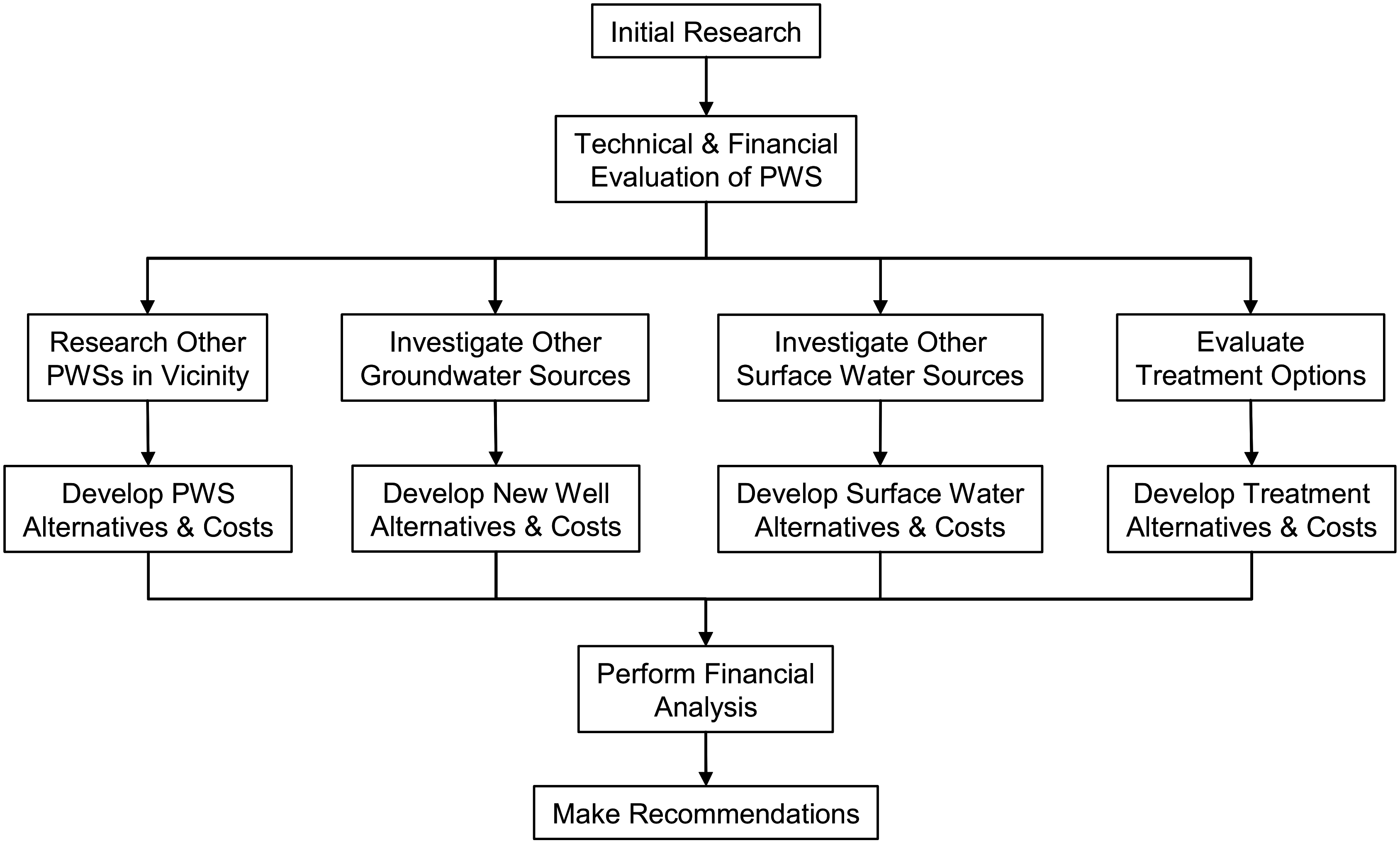
- Conduct financial, managerial, and technical (FMT) evaluations of the PWS;
- Perform a geologic and hydrogeologic assessment of the study area;
- Develop treatment and non-treatment compliance alternatives which, in general, consist of the following possible options:
- Connecting to neighboring PWSs via new pipeline or by pumping water from a newly installed well or an available surface water supply within the jurisdiction of the neighboring PWS;
- Installing new wells within the vicinity of the PWS into other aquifers with confirmed water quality standards meeting the MCLs;
- Installing a new intake system within the vicinity of the PWS to obtain water from a surface water supply with confirmed water quality standards meeting the MCLs;
- Treating the existing non-compliant water supply by various methods depending on the type of contaminant; and
- Delivering potable water by way of a bottled water program or a treated water dispenser as an interim measure only.
- Assess each of the potential alternatives with respect to economic and non-economic criteria;
- Prepare a feasibility report and present the results to the PWS.

This basic approach is summarized in Figure ES-1.

HYDROGEOLOGICAL ANALYSIS

The Stoneridge Lake PWS obtains groundwater from the Chicot subunit of the Gulf Coast aquifer. Arsenic is commonly found in area wells at concentrations greater than the MCL. Volcanic ash incorporated into the aquifer material may be the source of arsenic. Arsenic concentrations can vary significantly over relatively short distances; as a result, there could be good quality groundwater nearby. However, the variability of arsenic concentrations makes it difficult to determine where wells can be located to produce acceptable water. It may be possible to do down-hole testing on non-compliant wells to determine the source of the contaminants. If the contaminants derive primarily from a single part of the formation, that part could be excluded by modifying the existing well, or avoided altogether by completing a new well.

Figure ES-1
Summary of Project Methods



COMPLIANCE ALTERNATIVES

The Stoneridge Lake PWS is managed by Orbit Systems, Inc. (Orbit) an investor-owned utility that manages 33 PWSs in the region. Overall, the Stoneridge Lake PWS had an adequate level of FMT capacity. The system had some areas that needed improvement to be able to address future compliance issues; however, the system does have many positive aspects, including benefiting from economies of scale, and having a knowledgeable and dedicated staff. Areas of concern for the system included lack of sufficient revenues from the rate structure for long-term sustainability, and lack of budgeting.

There are several PWSs within 10 miles of the Stoneridge Lake PWS. Many of these nearby systems also have problems with arsenic, but there are several with good quality water. In general, feasibility alternatives were developed based on obtaining water from the nearest PWSs, either by directly purchasing water, or by expanding the existing well field. Another alternative considered is modifying the existing well or installing a new well at Stoneridge Lake PWS. There is a minimum of surface water available in the area, and obtaining a new surface water source is considered through an alternative where treated surface water is obtained from the Brazosport Water Authority (BWA). In addition to the BWA, the City of Alvin is a potential large regional water supplier, and there are plans for the Gulf Coast Water Authority to build a surface water treatment plant in Fort Bend County that could potentially supply water to the Stoneridge Lake PWS.

A number of centralized treatment alternatives for arsenic removal have been developed and were considered for this report, for example, ion exchange, iron-based adsorption, and coagulation/filtration. Point-of-use (POU) and point-of-entry treatment alternatives were also considered. Temporary solutions such as providing bottled water or providing a centralized dispenser for treated or trucked-in water, were also considered as alternatives.

Developing a new well at or near the Stoneridge Lake PWS is likely to be an attractive solution if compliant groundwater can be found. Having a new well at or near the Stoneridge Lake PWS is likely to be one of the lower cost alternatives since the PWS already possesses the technical and managerial expertise needed to implement this option. The preliminary cost estimates also indicate that pursuing a regional solution may be economically feasible. The cost of new well alternatives quickly increases with pipeline length, making proximity of the alternate source a key concern. A new compliant well or obtaining water from a neighboring compliant PWS has the advantage of providing compliant water to all taps in the system.

Central treatment can be cost-competitive with the alternative of new nearby wells, but would require significant institutional changes to manage and operate. Similar to obtaining an alternate compliant water source, central treatment would provide compliant water to all water taps.

POU treatment can be cost competitive, but does not supply compliant water to all taps. Additionally, significant efforts would be required for maintenance and monitoring of the POU treatment units.

Providing compliant water through a central dispenser is significantly less expensive than providing bottled water to 100 percent of the population, but a significant effort is required for clients to fill their containers at the central dispenser. This not considered a permanent solution by the TCEQ and EPA.

FINANCIAL ANALYSIS

Financial analysis of the Stoneridge Lake PWS indicated that current water rates are funding operations, and a rate increase would not be necessary to meet operating expenses. The current average water bill of $830 represents approximately 1.9 percent of the median household income (MHI). Table ES.2 provides a summary of the financial impact of implementing selected compliance alternatives, including the rate increase necessary to meet current operating expenses. The alternatives were selected to highlight results for the best alternatives from each different type or category.

Some of the compliance alternatives offer potential for shared or regional solutions. A group of PWSs could work together to implement alternatives for developing a new groundwater source or expanding an existing source, obtaining compliant water from a large regional provider, or for central treatment. Sharing the cost for implementation of these alternatives could reduce the cost on a per user basis. Additionally, merging PWSs or management of several PWSs by a single entity offers the potential for reduction in administrative costs.

Table ES.2
Selected Financial Analysis Results

Alternative	Funding Option	Average Annual Water Bill	Percent of MHI
Current	NA	$830	1.9
New well at Stoneridge Lake	100% Grant	$1,753	4.0
	Loan/Bond	$2,310	5.3
Central treatment – IX	100% Grant	$2,257	5.2
	Loan/Bond	$3,315	7.6
Point-of-use	100% Grant	$1,596	3.7
	Loan/Bond	$1,649	3.8

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ACRONYMS AND ABBREVIATIONS

µg/L	microgram per liter
AA	activated alumina
AFY	acre-feet per year
APU	arsenic package unit
BEG	Bureau of Economic Geology
BWA	Brazosport Water Authority
CA	chemical analysis
CCN	Certificate of Convenience and Necessity
CFR	Code of Federal Regulations
CO	Correspondence
EDR	Electrodialysis reversal
ETJ	extra territorial jurisdiction
FM	farm-to-market
FMT	Financial, managerial, and technical
ft^2	square foot
GAM	Groundwater Availability Model
gpm	Gallons per minute
HGCSD	Harris-Galveston Coastal Subsidence District
IX	Ion exchange
km	kilometer
kWH	kiloWatt hour
MCL	Maximum contaminant level
MF	microfiltration
mg/L	milligrams per Liter
mgd	million gallons per day
MHI	median household income
MOR	Monthly operating report
NMEFC	New Mexico Environmental Financial Center
NURE	National Uranium Resource Evaluation
O&M	Operation and Maintenance
ºF	degrees Fahrenheit
Orbit	Orbit Systems, Inc.
Parsons	Parsons Infrastructure and Technology Group Inc.
POE	Point-of-entry
POU	Point-of-use
ppb	parts per billion
PSOC	potential sources of contamination

PWS	public water system
RO	reverse osmosis
SDWA	Safe Drinking Water Act
SRL	Stoneridge Lake Subdivision PWS
SWAP	Source Water Assessment Program
TCEQ	Texas Commission on Environmental Quality
TDJC	Texas Department of Criminal Justice
TDS	Total dissolved solids
TSS	Total suspended solids
TWDB	Texas Water Development Board
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
WAM	water availability model
WC&ID	water control and improvement district
WTP	water treatment plant

SECTION 1
INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Infrastructure and Technology Group Inc. (Parsons), have been contracted by the Texas Commission on Environmental Quality (TCEQ) to assist with identifying and analyzing compliance alternatives for use by Public Water Systems (PWS) to meet and maintain Texas drinking water standards.

The overall goal of this project is to promote compliance using sound engineering and financial methods and data for PWSs that have recently had sample results that exceed maximum contaminant levels (MCL). The primary objectives of this project are to provide feasibility studies for PWSs and the TCEQ Water Supply Division that evaluate water supply compliance options, and to suggest a list of compliance alternatives that may be further investigated by the subject PWS with regard to future implementation. The feasibility studies identify a range of potential compliance alternatives, and present basic data that can be used for evaluating feasibility. The compliance alternatives addressed include a description of what would be required for implementation, conceptual cost estimates for implementation, and non-cost factors that could be used to differentiate between alternatives. The cost estimates are intended for comparing compliance alternatives, and to give a preliminary indication of potential impacts on water rates resulting from implementation.

It is anticipated that the PWS will review the compliance alternatives in this report to determine if there are promising alternatives, and then select the most attractive alternative(s) for more detailed evaluation and possible subsequent implementation. This report contains a decision tree approach that guided the efforts for this study, and also contains steps to guide a PWS through the subsequent evaluation, selection, and implementation of a compliance alternative.

This feasibility report provides an evaluation of water supply compliance options for the Stoneridge Lake Subdivision Public Water System, PWS ID# 0200624, located in Brazoria County (referred to as the Stoneridge Lake PWS). Recent sample results from the Stoneridge Lake PWS exceeded the MCL for arsenic of 10 micrograms per liter (µg/L) that went into effect January 23, 2006 (USEPA 2005; TCEQ 2004).

The location of the Stoneridge Lake PWS is shown on Figure 1.1. Various water supply and planning jurisdictions are shown on Figure 1.2. These water supply and planning jurisdictions are used in the evaluation of alternate water supplies that may be available in the area.

1.1 PUBLIC HEALTH AND COMPLIANCE WITH MCLS

The goal of this project is to promote compliance for PWSs that supply drinking water exceeding regulatory MCLs. This project only addresses those contaminants and does not address any other violations that may exist for a PWS. As mentioned above, Stoneridge Lake PWS had recent sample results that exceed the MCL for arsenic. Health concerns related to drinking water above MCL for this chemical are briefly described below.

In general, contaminant(s) in drinking water above the MCL(s) can have both short-term (acute) and long-term or lifetime (chronic) effects. Potential health effects from long-term ingestion of water with levels of arsenic above the MCL (0.01 milligrams per liter [mg/L]) include non-cancerous effects, such as cardiovascular, pulmonary, immunological, neurological and endocrine effects, and cancerous effects, including skin, bladder, lung, kidney, nasal passage, liver and prostate cancer (USEPA 2005).

1.2 METHOD

The method for this project follows that of the pilot study performed in 2004 and 2005 by TCEQ, BEG, and Parsons. The pilot study evaluated water supply alternatives for PWSs that supply drinking water with nitrate concentrations above U.S. Environmental Protection Agency (USEPA) and Texas drinking water standards. Three PWSs were evaluated in the pilot study to develop the method (*i.e.*, decision tree approach) for analyzing options for provision of compliant drinking water. This project is performed using the decision tree approach developed in the pilot study.

Other tasks of the feasibility study are as follows:

- Identifying available data sources;
- Gathering and compiling data;
- Conducting financial, managerial, and technical (FMT) evaluations of the selected PWSs;
- Performing a geologic and hydrogeologic assessment of the area;
- Developing treatment and non-treatment compliance alternatives;
- Assessing potential alternatives with respect to economic and non-economic criteria;
- Preparing a feasibility report; and
- Suggesting refinements to the approach for future studies.

The remainder of Section 1 of this report addresses the regulatory background, and provides a summary of arsenic abatement options. Section 2 describes the method used to develop and assess compliance alternatives. The groundwater sources of arsenic are addressed in Section 3. Findings for the Stoneridge Lake PWS, along with compliance alternatives development and evaluation, can be found in Section 4. Section 5 references the sources used in this report.

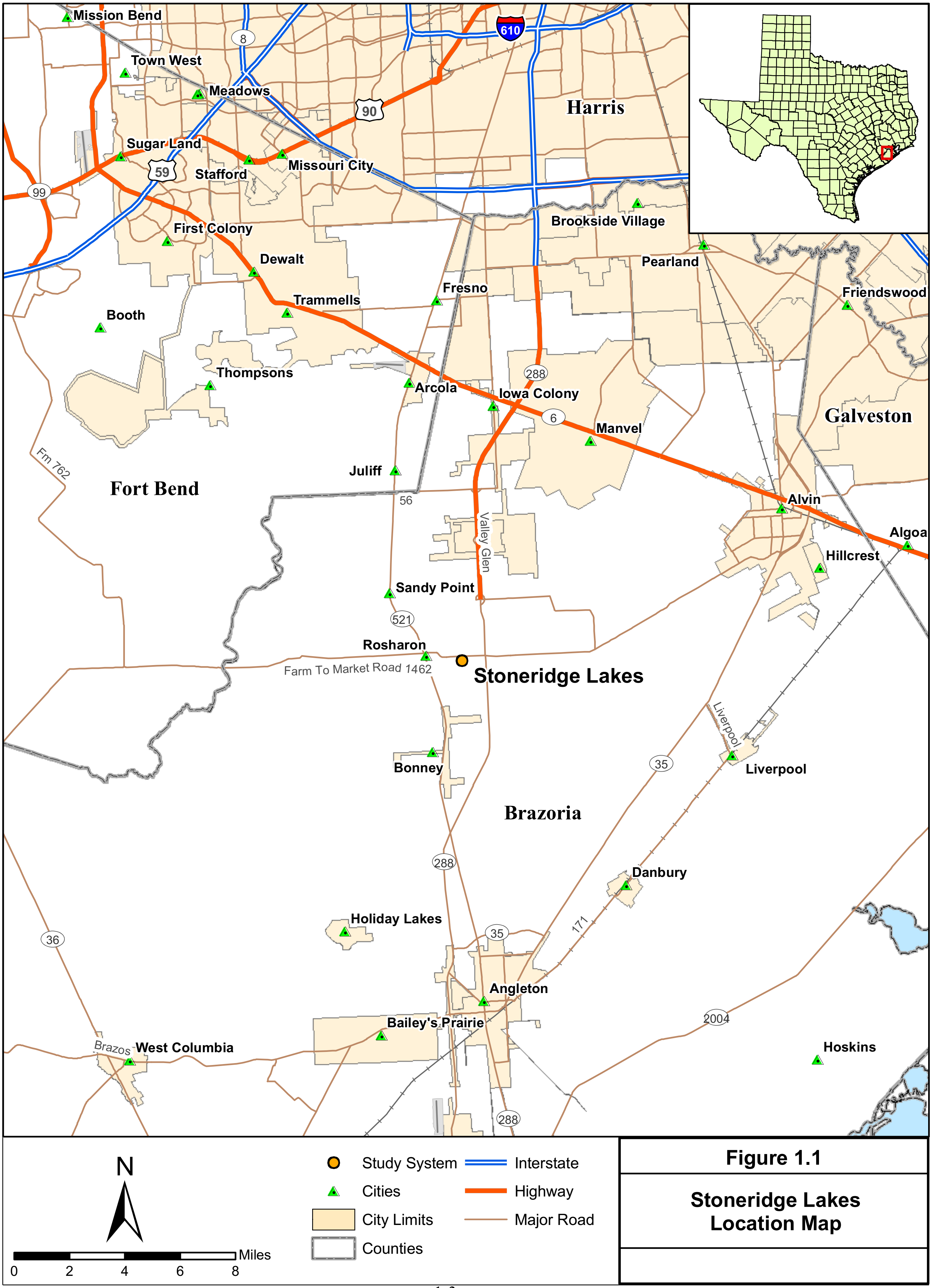

Figure 1.1

Stoneridge Lakes Location Map

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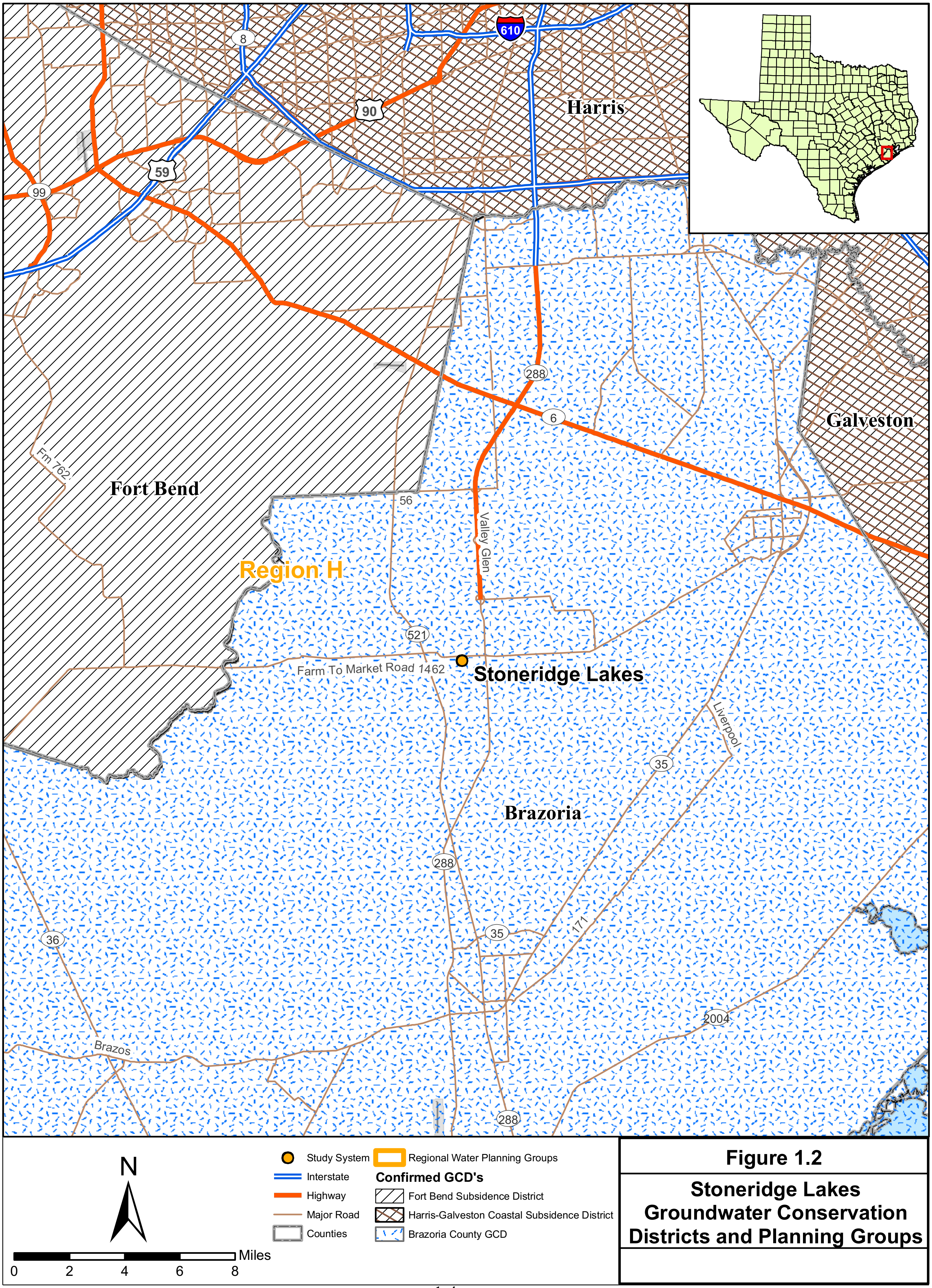

Figure 1.2

Stoneridge Lakes Groundwater Conservation Districts and Planning Groups

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1.3 REGULATORY PERSPECTIVE

The Utilities & Districts and Public Drinking Water Sections of the TCEQ Water Supply Division are responsible for implementing requirements of the Federal Safe Drinking Water Act (SDWA) which include oversight of PWSs and water utilities. These responsibilities include:

- Monitoring public drinking water quality;
- Processing enforcement referrals for MCL violators;
- Tracking and analyzing compliance options for MCL violators;
- Providing FMT assessment and assistance to PWSs;
- Participating in the Drinking Water State Revolving Fund program to assist PWSs in achieving regulatory compliance; and
- Setting rates for privately-owned water utilities.

This project was conducted to assist in achieving these responsibilities.

1.4 ABATEMENT OPTIONS

When a PWS exceeds a regulatory MCL, the PWS must take action to correct the violation. The MCL exceedances at the Stoneridge Lake PWS involve arsenic. The following subsections explore alternatives considered as potential options for obtain/providing compliant drinking water.

1.4.1 Existing Public Water Supply Systems

A common approach to achieving compliance is for the PWS to make arrangements with a neighboring PWS for water supply. For this arrangement to work, the PWS from which water is being purchased (supplier PWS) must have water in sufficient quantity and quality, the political will must exist, and it must be economically feasible.

1.4.1.1 Quantity

For purposes of this report, quantity refers to water volume, flowrate, and pressure. Before approaching a potential supplier PWS, the non-compliant PWS should determine its water demand on the basis of average day and maximum day. Peak instantaneous demands can be met through proper sizing of storage facilities. Further, the potential for obtaining the appropriate quantity of water to blend to achieve compliance should be considered. The concept of blending involves combining water with low levels of contaminants with non-compliant water in sufficient quantity that the resulting blended water is compliant. The exact blend ratio would depend on the quality of the water a potential supplier PWS can provide, and would likely vary over time. If high quality water is purchased, produced or otherwise obtained, blending can reduce the amount of high quality water required. Implementation of blending will require a control system to ensure the blended water is compliant.

If the supplier PWS does not have sufficient quantity, the non-compliant community could pay for the facilities necessary to increase the quantity to the extent necessary to supply the needs of the non-compliant PWS. Potential improvements might include, but are not limited to:

- Additional wells;
- Developing a new surface water supply,
- Additional or larger-diameter piping;
- Increasing water treatment plant capacity
- Additional storage tank volume;
- Reduction of system losses,
- Higher-pressure pumps; or
- Upsized, or additional, disinfection equipment.

In addition to the necessary improvements, a transmission pipeline would need to be constructed to tie the two PWSs together. The pipeline must tie-in at a point in the supplier PWS where all the upstream pipes and appurtenances are of sufficient capacity to handle the new demand. In the non-compliant PWS, the pipeline must tie in at a point where no down stream bottlenecks are present. If blending is the selected method of operation, the tie-in point must be at the proper point of the existing non-compliant PWS to ensure that all the water in the system is blended to achieve regulatory compliance.

1.4.1.2 Quality

If a potential supplier PWS obtains its water from the same aquifer (or same portion of the aquifer) as the non-compliant PWS, the quality of water may not be significantly better. However, water quality can vary significantly due to well location, even within the same aquifer. If localized areas with good water quality cannot be identified, the non-compliant PWS would need to find a potential supplier PWS that obtains its water from a different aquifer or from a surface water source. Additionally, a potential supplier PWS may treat non-compliant raw water to an acceptable level.

Surface water sources may offer a potential higher-quality source. Since there are significant treatment requirements, utilization of surface water for drinking water is typically most feasible for larger local or regional authorities or other entities that may provide water to several PWSs. Where PWSs that obtain surface water are neighbors, the non-compliant PWS may need to deal with those systems as well as with the water authorities that supply the surface water.

1.4.2 Potential for New Groundwater Sources

1.4.2.1 Existing Non-Public Supply Wells

Often there are wells not associated with PWSs that are located in the vicinity of the non-compliant PWS. The current use of these wells may be for irrigation, industrial purposes, domestic supply, stock watering, and other purposes. The process for investigating existing wells is as follows:

- Use existing data sources (see below) to identify wells in the areas that have satisfactory quality. For the Stoneridge Lake PWS, the following standards could be used in a rough screening to identify compliant groundwater in surrounding systems:
  - Arsenic concentrations less than 0.008 mg/L (below the MCL of 0.01 mg/L);
- Review the recorded well information to eliminate those wells that appear to be unsuitable for the application. Often, the “Remarks” column in the Texas Water Development Board (TWDB) hard-copy database provides helpful information. Wells eliminated from consideration generally include domestic and stock wells, dug wells, test holes, observation wells, seeps and springs, destroyed wells, wells used by other communities, *etc*.
- Identify wells of sufficient size which have been used for industrial or irrigation purposes. Often the TWDB database will include well yields, which may indicate the likelihood that a particular well is a satisfactory source.
- At this point in the process, the local groundwater control district (if one exists) should be contacted to obtain information about pumping restrictions. Also, preliminary cost estimates should be made to establish the feasibility of pursuing further well development options.
- If particular wells appear to be acceptable, the owner(s) should be contacted to ascertain their willingness to work with the PWS. Once the owner agrees to participate in the program, questions should be asked about the wells. Many owners have more than one well, and would probably be the best source of information regarding the latest test dates, who tested the water, flowrates, and other well characteristics.
- After collecting as much information as possible from cooperative owners, the PWS would then narrow the selection of wells and sample and analyze them for quality. Wells with good quality would then be potential candidates for test pumping. In some cases, a particular well may need to be refurbished before test pumping. Information obtained from test pumping would then be used in combination with information about the general characteristics of the aquifer to determine whether a well at this location would be suitable as a supply source.
- It is recommended that new wells be installed instead of using existing wells to ensure the well characteristics are known and the well meets construction standards.

- Permit(s) would then be obtained from the groundwater control district or other regulatory authority, and an agreement with the owner (purchase or lease, access easements, *etc*.) would then be negotiated.

1.4.2.2 Develop New Wells

If no existing wells are available for development, the PWS or group of PWSs has an option of developing new wells. Records of existing wells, along with other hydrogeologic information and modern geophysical techniques, should be used to identify potential locations for new wells. In some areas, the TWDB's Groundwater Availability Model (GAM) may be applied to indicate potential sources. Once a general area has been identified, land owners and regulatory agencies should be contacted to determine an exact location for a new well or well field. Pump tests and water quality tests would be required to determine if a new well will produce an adequate quantity of good quality water. Permits from the local groundwater control district or other regulatory authority could also be required for a new well.

1.4.3 Potential for Surface Water Sources

Water rights law dominates the acquisition of water from surface water sources. For a PWS, 100 percent availability of water is required, except where a back-up source is available. For PWSs with an existing water source, although it may be non-compliant because of elevated concentrations of one or more parameters, water rights may not need to be 100 percent available.

1.4.3.1 Existing Surface Water Sources

"Existing surface water sources" of water refers to municipal water authorities and cities that obtain water from surface water sources. The process of obtaining water from such a source is generally less time consuming and less costly than the process of developing a new source; therefore, it should be a primary course of investigation. An existing source would be limited by its water rights, the safe yield of a reservoir or river, or by its water treatment or water conveyance capability. The source must be able to meet the current demand and honor contracts with communities it currently supplies. In many cases, the contract amounts reflect projected future water demand based on population or industrial growth.

A non-compliant PWS would look for a source with sufficient spare capacity. Where no such capacity exists, the non-compliant PWS could offer to fund the improvements necessary to obtain the capacity. This approach would work only where the safe yield could be increased (perhaps by enlarging a reservoir) or where treatment capacity could be increased. In some instances water rights, where they are available, could possibly be purchased.

In addition to securing the water supply from an existing source, the non-compliant PWS would need to arrange for transmission of the water to the PWS. In some cases, that could require negotiations with, contracts with, and payments to an intermediate PWS (an intermediate PWS is one where the infrastructure is used to transmit water from a "supplier" PWS to a "supplied" PWS, but does not provide any additional treatment to the supplied water). The non-compliant PWS could be faced with having to fund improvements to the intermediate PWS in addition to constructing its own necessary transmission facilities.

1.4.3.2 New Surface Water Sources

Communication with the TCEQ and relevant planning groups from the beginning is essential in the process of obtaining a new surface water source. Preliminary assessment of the potential for acquiring new rights may be based on surface water availability maps located on the TWDB website. Where water rights appear to be available, the following activities need to occur:

- Discussions with TCEQ to indicate the likelihood of obtaining those rights. The TCEQ may use the Water Availability Model (WAM) to assist in the determination.
- Discussions with land owners to indicate potential treatment plant locations.
- Coordination with U.S. Army Corps of Engineers and local river authorities.
- Preliminary engineering design to determine the feasibility, costs, and environmental issues of a new treatment plant.

Should these discussions indicate that a new surface water source is the best option, the community would proceed with more intensive planning (initially obtaining funding), permitting, land acquisition, and detailed designs.

1.4.4 Identification of Treatment Technologies

Various treatment technologies were also investigated as compliance alternatives for treatment of arsenic to regulatory levels (*i.e*., MCL). According to a recent USEPA report for small PWSs with <10,000 customers (EPA/600/R-05/001) a number of drinking water treatment technologies are available to reduce arsenic concentrations in source water to below the new MCL of 10 µg/L, including:

- Ion exchange (IX);
- Reverse osmosis (RO);
- Electrodialysis reversal (EDR);
- Adsorption, and
- Coagulation/filtration.

1.4.5 Treatment Technologies Description

Many of the most effective arsenic removal processes available are iron-based treatment technologies such as chemical coagulation/filtration with iron salts, and adsorptive media with iron-based products. These processes are particularly effective at removing arsenic from aqueous systems because iron surfaces have a strong affinity for adsorbing arsenic. Other arsenic removal processes such as activated alumina and enhanced lime softening are more applicable to larger PWSs because of their operational complexity and cost. A description and discussion of arsenic removal technologies applicable to smaller systems follow.

1.4.5.1 Ion Exchange

Process – In solution, salts separate into positively-charged cations and negatively charged anions. Ion exchange is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that certain ions are preferentially adsorbed on the ion exchange resin. Operation begins with a fully charged cation or anion bed, having enough positively or negatively charged ions to carry out the cation or anion exchange. Usually a polymeric resin bed is composed of millions of spherical beads about the size of medium sand grains. As water passes the resin bed, the charged ions are released into the water, being substituted or replaced with the contaminants in the water (ion exchange). When the resin becomes exhausted of positively or negatively charged ions, the bed must be regenerated by passing a strong, sodium chloride, solution over the resin bed, displacing the contaminant ions with sodium ions for cation exchange and chloride ion for anion exchange. Many different types of resins can be used to reduce dissolved contaminant concentrations. The IX treatment train for groundwater typically includes cation or anion resin beds with a regeneration system, chlorine disinfection, and clear well storage. Treatment trains for surface water may also include raw water pumps, debris screens, and filters for pre-treatment. Additional treatment or management of the concentrate and the removed solids will be necessary prior to disposal. For arsenic removal, an anion exchange resin in the chloride form is used to remove arsenate [As(V)]. Because arsenite [As(III)] occurs in water below pH 9 with no ionic charge, As(III) is not consistently removed by the anionic exchange process.

Pretreatment – Pretreatment guidelines are available on accepted limits for pH, organics, turbidity, and other raw water characteristics. Pretreatment may be required to reduce excessive amounts of total suspended solids (TSS), iron, and manganese, which could plug the resin bed, and typically includes media or carbon filtration. In addition, chlorination or oxidation may be required to convert As(III) to As(V) for effective removal.

Maintenance – The IX resin requires regular on-site regeneration, the frequency of which depends on raw water characteristics, the contaminant concentration, and the size and number of IX vessels. Many systems have undersized the IX vessels only to realize higher than necessary operating costs. Preparation of the sodium chloride solution is required. If used, filter replacement and backwashing will be required.

Waste Disposal – Approval from local authorities is usually required for disposal of concentrate from the regeneration cycle (highly concentrated salt solution); occasional solid wastes (in the form of broken resin beads) which are backwashed during regeneration; and if used, spent filters and backwash wastewater.

Advantages (IX)

- Well established process for arsenic removal.
- Fully automated and highly reliable process.
- Suitable for small and large installations.

Disadvantages (IX)

- Requires salt storage; regular regeneration.
- Concentrate disposal.
- Resins are sensitive to the presence of competing ions such as sulfate.

In considering application of IX for inorganics removal, it is important to understand what the effect of competing ions will be, and to what extent the brine can be recycled. Similar to activated alumina, IX exhibits a selectivity sequence, which refers to an order in which ions are preferred. Sulfate competes with both nitrate and arsenic, but more aggressive with arsenic in anion exchange. Source waters with TDS levels above 500 mg/L or 120 mg/L sulfate are not amenable to IX treatment for arsenic removal. Spent regenerant is produced during IX bed regeneration, and this spent regenerant may have high concentrations of sorbed contaminants which can be expensive to treat and/or dispose. Research has been conducted to minimize this effect; recent research on arsenic removal shows that the brine can be reduced as many as 25 times.

1.4.5.2 Reverse Osmosis

<u>Process</u> – RO is a pressure-driven membrane separation process capable of removing dissolved solutes from water by means of particle size and electrical charge. The raw water is typically called feed; the product water is called permeate, and the concentrated reject is called concentrate. Common RO membrane materials include asymmetric cellulose acetate and polyamide thin film composite. Common RO membrane configurations include spiral wound hollow fine fiber but most of RO systems to date are of the spiral wound type. A typical RO installation includes a high pressure feed pump with chemical feed; parallel first and second stage membrane elements in pressure vessels; and valves and piping for feed, permeate, and concentrate streams. Factors influencing membrane selection are cost, recovery, rejection, raw water characteristics, and pretreatment. Factors influencing performance are raw water characteristics, pressure, temperature, and regular monitoring and maintenance. RO is capable of achieving over 97 percent removal of As(V) and 92 percent removal of As(III). The treatment process is relatively insensitive to pH. Water recovery is typically 60-80 percent, depending on the raw water characteristics. The concentrate volume for disposal can be significant.

<u>Pretreatment</u> – RO requires careful review of raw water characteristics and pretreatment needs to prevent membranes from fouling, scaling or other membrane degradation. Removal or sequestering of suspended and colloidal solids is necessary to prevent fouling, and removal of sparingly soluble constituents such as calcium, magnesium, silica, sulfate, barium, *etc*. may be

required to prevent scaling. Pretreatment can include media filters, ion exchange softening, acid and antiscalant feed, activated carbon of bisulfite feed to dechlorinate, and cartridge filters to removing any remaining suspended solids to protect membranes from upsets.

Maintenance – Monitoring rejection percentage is required to ensure contaminant removal below MCL. Regular monitoring of membrane performance is necessary to determine fouling, scaling, or other membrane degradation. Acidic or caustic solutions are regularly flushed through the system at high volume/low pressure with a cleaning agent to remove foulants and scalants. Frequency of membrane replacement is dependent on raw water characteristics, pretreatment, and maintenance.

Waste Disposal – Pretreatment waste streams, concentrate flows, spent filters and membrane elements all require approved disposal methods.

Advantages (RO)

- Can remove both As(III) and As(V) effectively
- Can remove other undesirable dissolved constituents and excessive TDS, if required.

Disadvantages (RO)

- Relatively expensive to install and operate.
- Need sophisticated monitoring systems.
- Need to handle multiple chemicals.
- Waste of water because of the significant concentrate flows
- High silica concentration limits water recovery rate
- Concentrate disposal required.

RO is an expensive alternative to remove arsenic and is usually not economically competitive with other processes unless nitrate and/or TDS removal is also required. The biggest drawback for using RO to remove arsenic is the waste of water through concentrate disposal which is also difficult or expensive because of the volume involved.

1.4.5.3 Electrodialysis Reversal

Process. EDR is an electrochemical process in which ions migrate through ion-selective semi-permeable membranes as a result of their attraction to two electrically charged electrodes. A typical EDR system includes a membrane stack with a number of cell pairs, each consisting of a cation transfer membrane, a demineralized flow spacer, an anion transfer membrane, and a concentrate flow spacer. Electrode compartments are at opposite ends of the stack. The influent feed water (chemically treated to prevent precipitation) and the concentrated reject flow in parallel across the membranes and through the demineralized and concentrate flow spaces, respectively. The electrodes are continually flushed to reduce fouling or scaling. Careful consideration of flush feed water is required. Typically, the membranes are cation or anion exchange resins cast in sheet form; the spacers are high density polyethylene; and the electrodes are inert metal. EDR stacks are tank-contained and often staged. Membrane selection is based on review of raw water characteristics. A single-stage EDR system usually removes 40-50 percent of arsenic and TDS. Additional stages are required to achieve higher removal efficiency if necessary. EDR uses the technique of regularly reversing the polarity of the electrodes, thereby freeing accumulated ions on the membrane surface. This process requires additional plumbing and electrical controls, but it increases membrane life, may require less added chemicals, and eases cleaning. The conventional EDR treatment train typically includes EDR membranes, chlorine disinfection, and clearwell storage. Treatment of surface water may also require pretreatment steps such as raw water pumps, debris screens, rapid mix with addition of a coagulant, slow mix flocculator, sedimentation basin or clarifier, and gravity filters. Microfiltration (MF) could be used in placement of flocculation, sedimentation and filtration. Additional treatment or management of the concentrate and the removed solids would be necessary prior to disposal.

Pretreatment. There are pretreatment requirements for pH, organics, turbidity, and other raw water characteristics. EDR typically requires chemical feed to prevent scaling, acid addition for pH adjustment, and a cartridge filter for prefiltration.

Maintenance. EDR membranes are durable, can tolerate a pH range from 1 to 10, and temperatures to 115 degrees Fahrenheit (ºF) for cleaning. They can be removed from the unit and scrubbed. Solids can be washed off by turning the power off and letting water circulate through the stack. Electrode washes flush out byproducts of electrode reaction. The byproducts are hydrogen, formed in the cathode space, and oxygen and chlorine gas, formed in the anode space. If the chlorine is not removed, toxic chlorine gas may form. Depending on raw water characteristics, the membranes would require regular maintenance or replacement. EDR requires reversing the polarity. Flushing at high volume/low pressure continuously is required to clean electrodes. If used, pretreatment filter replacement and backwashing would be required. The EDR stack must be disassembled, mechanically cleaned, and reassembled at regular intervals.

Waste Disposal. Highly concentrated reject flows, electrode cleaning flows, and spent membranes required approved disposal methods. Pretreatment processes and spent materials also required approved disposal methods.

Advantages (EDR)

- EDR can operate with minimal fouling or scaling, or chemical addition.
- Low pressure requirements; typically quieter than RO.
- Long membrane life expectancy; EDR extends membrane life and reduces maintenance.
- More flexible than RO in tailoring treated water quality requirements.

Disadvantages (EDR)

- Not suitable for high levels of iron, manganese, and hydrogen sulfide.
- High energy usage at higher TDS water.

EDR can be quite expensive to run because of the energy it uses. However, because it is generally automated and allows for small systems. It can be used to simultaneously reduce arsenic and TDS.

1.4.5.4 Adsorption

Process – The adsorptive media process is a fixed-bed process by which ions in solution, such as arsenic, are removed by available adsorptive sites on an adsorptive media. When the available adsorptive sites are filled, spent media may be regenerated or simply thrown away and replaced with new media. Granular activated alumina (AA) was the first adsorptive media successfully applied for the removal of arsenic from water supplies. More recently, other adsorptive media (mostly iron-based) have been developed and marketed for arsenic removal. Recent USEPA studies have demonstrated that iron-based adsorption media typically have higher arsenic removal capacities compared to alumina-based media. In the USEPA-sponsored Round 1 full-scale demonstration of arsenic removal technologies for small PWS program, the selected arsenic treatment technologies included nine adsorptive media systems, one IX system, one coagulation/filtration system, and one process modification.

The selected adsorptive media systems used four different adsorptive media, including three iron-based media (*e.g.*, ADI's G2, Severn Trent and AdEdge's E33, and US Filter's GFH), and one iron-modified AA media (*e.g.*, Kinetico's AAFS50, a product of Alcan). The G2 media is a dry powder of diatomaceous earth impregnated with a coating of ferric hydroxide, developed by ADI specifically for arsenic adsorption. ADI markets G2 for both As(V) and As(III) removal but it preferentially removes As(V). G2 media adsorbs arsenic most effectively at pH values within the 5.5 to 7.5 range, and less effectively at a higher pH value.

The Bayoxide® E33 media was developed by Bayer AG for the removal of arsenic from drinking water supplies. It is a dry granular iron oxide media designed to remove dissolved arsenic via adsorption onto its ferric oxide surface. Severn Trent markets the media in the U.S. for As(III) and As(V) removal as Sorb-33, and offers several arsenic package units (APU) with flowrates ranging from 150 to 300 gallons per minute (gpm). Another company, AdEdge, provides similar systems using the same media (marketed as AD-33) with flowrates ranging from 5 gpm to 150 gpm. E33 adsorbs arsenic and other ions, such as antimony, cadmium, chromate, lead, molybdenum, selenium and vanadium. The adsorption is effective at pH values ranging between 6.0 and 9.0. At greater than 8.0 to 8.5, pH adjustment is recommended to maintain its adsorption capacity. Two competing ions that can reduce the adsorption capacity are silica (at levels greater than 40 mg/L) and phosphate (at levels greater than 1 mg/L).

GFH is a moist granular ferric hydroxide media produced by GEH Wasserchemie GmbH of Germany and marketed by US Filter under an exclusive marketing agreement. GFH is capable of adsorbing both As(V) and As(III). GFH media adsorb arsenic with a pH range of

5.5 to 9.0, but less effectively at the upper end of this range. Competing ions such as silica and phosphate in source water can adsorb onto GFH media, thus reducing the arsenic removal capacity of the media.

The AAFS50 is a dry granular media of 83 percent alumina and a proprietary iron-based additive to enhance the arsenic adsorption performance. Standard AA was the first adsorptive media successfully applied for the removal of arsenic from water supplies. However, it often requires pH adjustment to 5.5 in order to achieve optimum arsenic removal. The AAFS50 product is modified with an iron-based additive to improve its performance and to increase the pH range within which it can achieve effective removal. Optimum arsenic removal efficiency is achieved with a pH of the feed water less than 7.7. Competing ions such as fluoride, sulfate, silica, and phosphate can adsorb onto AAFS50 media, and potentially can reduce its arsenic removal capacity. The adsorption capacity of AAFS50 can be impacted by both high levels of silica (>40 mg/L) and phosphate (>1 mg/L). The vendor recommended that the system be operated in a series configuration to minimize the chance for arsenic breakthrough to impact drinking water quality.

All of the iron-based or iron-modified adsorptive media are of the throwaway type after exhaustion. The operations of these adsorption systems are quite similar and simple. Some of the technologies such as the E33 and GFH media have been operated successfully on large scale plants in Europe for several years.

<u>Pretreatment</u> – The adsorptive media are primarily used to remove dissolved arsenic and not for suspended solids removal. Pretreatment to remove TSS may be required if raw water turbidity is >0.3 NTU. However, most well waters are low in turbidity and hence pre-filtration is usually not required. Pre-chlorination may be required to oxidize As(III) to As(V) if the proportion of As(III) is high. No pH adjustment is required unless pH is relatively high.

<u>Maintenance</u> – Maintenance for the adsorption media system is minimal if no pretreatment is required. Backwash is required infrequently (monthly) and replacement and disposal of the exhausted media occurs between one to 3 years, depending on average water consumption, the concentrations of arsenic and competing ions in the raw water, and the media bed volume.

<u>Waste Disposal</u> – If no pretreatment is required there is minimal waste disposal involved with the adsorptive media system. Disposal of backwash wastewater is required especially during startup. Regular backwash is infrequent and disposal of the exhausted media occurs once every one to three years, depending on operation conditions. The exhausted media are usually considered non-hazardous wastes.

Advantages (Adsorption)

- Some adsorbents can remove both As(III) and As(V); and
- Very simple to operate.

Disadvantages (Adsorption)

- Relatively new technology; and
- Need replacement of adsorption media when exhausted.

The adsorption media process is the most simple and requires minimal operator attention, compared to other arsenic removal processes. The process is most applicable to small wellhead systems with low or moderate arsenic concentrations with no treatment process in place (*e.g.*, iron and manganese removal; if treatment facilities for iron and/or manganese removal are already in place, incorporating ferric chloride coagulation in the existing system would be a more cost-effective alternative for arsenic removal). The choice of media will depend on raw water characteristics, life cycle cost, and experience of the vendor. Many of the adsorption media are at the field-trial stage, but others are already being used in full-scale applications throughout Europe and the United States. Pilot testing may or may not be necessary prior to implementation depending on the experience of the vendor with similar water characteristics.

1.4.5.5 Coagulation/Filtration and Iron Removal Technologies

Process – Iron removal processes can be used to removal arsenic from drinking water supplies. Iron removal processes involved the oxidation of soluble iron and As(III), adsorption and/or co-precipitation of As(V) onto iron hydroxides, and filtration. The filtration can be accomplished with granular media filter or microfilter. When iron in the raw water is inadequate to accomplish arsenic removal an iron salt such as ferric chloride is added to the water to form ferric hydroxide. The iron removal process is commonly called coagulation/filtration because iron in the form of ferric chloride is a common coagulant. The actual capacity to remove arsenic during iron removal depends on a number of factors, including the amount of arsenic present, arsenic speciation, pH, amount and form of iron present, and existence of competing ions, such as phosphate, silicate, and natural organic matter. The filters used in groundwater treatment are usually pressure filters feeding directly by the well pumps. The filter media can be regular dual media filters or proprietary media such as the engineered ceramic filtration media, Macrolite®, developed by Kinetico. Macrolite is a low-density, spherical media and is designed to allow for filtration rates up to 10 gpm/ft^2, which is a higher loading rate than commonly used for conventional filtration media.

Pretreatment – Pre-chlorination to oxidize As(III) to As(V) is usually required for most groundwater sources. The adjustment of pH is required only for relatively high pH value. Coagulation with the feed of ferric chloride is required for this process. Sometimes a 5-minute contact tank is required ahead the filters if the pH is high.

Maintenance – Maintenance is mainly to handle ferric chloride chemical and feed system, and for regular backwash of the filters. No filter replacement is required for this process.

Waste Disposal – The waste from the coagulation/filtration process is mainly the iron hydroxide sludge with adsorbed arsenic in the backwash water. The backwash water can be discharged to a public sewer if it is available. If a sewer is not available, the backwash water can be discharged to a storage and settling tank from where the supernatant is recycled in a controlled rate to the front of the treatment system and the settled sludge can be disposed of periodically to a landfill. The iron hydroxide sludge is usually not classified as hazardous waste.

Advantages (Coagulation/Filtration)

- Very established technology for arsenic removal; and
- Most economical process for arsenic removal.

Disadvantages (Coagulation/Filtration)

- Need to handle chemical;
- Need to dispose of regular backwash wastewater; and
- Need to dispose of sludge.

The coagulation/filtration process is usually the most economical arsenic removal alternative, especially if a public sewer is available for accepting the discharge of the backwash water. However, because of the regular filter backwash requirements more operation and maintenance attention is required from the utilities. Because of potential interference by competing ions bench-scale or pilot scaling testing may be required to ensure that the arsenic MCL can be met with this process alternative.

1.4.6 Point-of-Entry and Point-of-Use Treatment Systems

Point-of-entry (POE) and point-of-use (POU) treatment systems can be used to provide compliant drinking water. For arsenic removal, these systems typically use small RO treatment units installed "under the sink" in the case of POU, and where water enters a residence or building in the case of POE. It should be noted that the POU treatment units would need to be more complex than units typically found in commercial retail outlets in order to meet regulatory requirements, making purchase and installation more expensive. POE and POU treatment units would be purchased and owned by the PWS. These solutions are decentralized in nature, and require utility personnel to enter into houses or at least onto private property for installation, maintenance, and testing. Due to the small number of treatment units that would be employed and would be largely out of the control of the PWS, it is very difficult to ensure 100 percent compliance. Prior to selection of a POE or POU program for implementation, consultation with TCEQ would be required to address measurement and determination of the level of compliance.

The SDWA [§1412(b)(4)(E)(ii)] regulates the design, management, and operation of POU and POE treatment units used to achieve compliance with an MCL. These restrictions include:

- POU and POE treatment units must be owned, controlled, and maintained by the PWS, although the utility may hire a contractor to ensure proper operation and maintenance (O&M) and compliance with MCLs. The PWS must retain unit ownership and oversight of unit installation, maintenance and sampling; the utility ultimately is the responsible party when it comes to regulatory compliance. The

PWS staff need not perform all installation, maintenance, or management functions, as these tasks may be contracted to a third party, but the final responsibility for quality and quantity of the water supplied to the community resides with the PWS, and the utility must monitor all contractors closely. Responsibility for the O&M of POU or POE devices installed for SDWA compliance may not be delegated to homeowners.

- POU and POE units must have mechanical warning systems to automatically notify customers of operational problems. Each POU or POE treatment device must be equipped with a warning device (*e.g.,* alarm, light) that will alert users when their unit is no longer adequately treating their water. As an alternative, units may be equipped with an automatic shut-off mechanism to meet this requirement.
- If the American National Standards Institute has issued product standards for a specific type of POU or POE treatment unit, only those units that have been independently certified according to those standards may be used as part of a compliance strategy.

With regard to using POE and POU devices for SDWA compliance, the following observations were made (Raucher2004):

- If POU devices are used as an SDWA compliance strategy, certain consumer behavioral changes will be necessary (*e.g.,* encouraging people to drink water only from certain treated taps) to ensure comprehensive consumer health protection.
- Although not explicitly prohibited in SDWA, USEPA indicates that POU treatment devices should not be used to treat for radon or for most volatile organic contaminants to achieve compliance, because POU devices do not provide 100 percent protection against inhalation or contact exposure to those contaminants at untreated taps (*e.g*., shower heads).
- Liability – PWSs considering unconventional treatment options (POU, POE, or bottled water) must address liability issues. These could be meeting the drinking water standards, property entry and ensuing liabilities, and damage arising from improper installation or improper function of the POU and POE devices.

1.4.7 Water Delivery or Central Drinking Water Dispensers

Current USEPA regulations (40 Code of Federal Regulations [CFR] 141.101) prohibit the use of bottled water to achieve compliance with an MCL, except on a temporary basis. State regulations do not directly address the use of bottled water. Use of bottled water at a non-compliant PWS would be on a temporary basis. Every 3 years, the PWSs that employ interim measures are required to present the TCEQ with estimates of costs for piping compliant water to their systems. As long as the projected costs remain prohibitively high, the bottled water interim measure is extended. Until USEPA amends the noted regulation, the TCEQ is unable to accept water delivery or central drinking water dispensers as compliance solutions.

Central provision of compliant drinking water would consist of having one or more dispensers of compliant water where customers could come to fill containers with drinking water. The centralized water source could be from small to medium-sized treatment units or could be compliant water delivered to the central point by truck.

Water delivery is an interim measure for providing compliant water. As an interim measure for a small impacted population, providing delivered drinking water may be cost effective. If the susceptible population is large, the cost of water delivery would increase significantly.

Water delivery programs require consumer participation to a varying degree. Ideally, consumers would have to do no more than they currently do for a piped-water delivery system. Least desirable are those systems that require maximum effort on the part of the customer (*e.g.,* customer has to travel to get the water, transport the water, and physically handle the bottles). Such a system may appear to be lowest-cost to the utility; however, should a consumer experience ill effects from contaminated water and take legal action, the ultimate cost could increase significantly.

The ideal system would:

- Completely identify the susceptible population. If bottled water is only provided to customers who are part of the susceptible population, the utility should have an active means of identifying the susceptible population. Problems with illiteracy, language fluency, fear of legal authority, desire for privacy, and apathy may be reasons that some members of the susceptible population do not become known to the utility, and do not take part in the water delivery program.
- Maintain customer privacy by eliminating the need for utility personnel to enter the home.
- Have buffer capacity (*e.g.,* two bottles in service, so when one is empty, the other is being used over a time period sufficient to allow the utility to change out the empty bottle).
- Provide for regularly scheduled delivery so that the customer would not have to notify the utility when the supply is low.
- Use utility personnel and equipment to handle water containers, without requiring customers to lift or handle bottles with water in them.
- Be sanitary (*e.g.*, where an outside connection is made, contaminants from the environment must be eliminated).
- Be vandal-resistant.
- Avoid heating the water due to exterior temperatures and solar radiation.
- Avoid freezing the water.

SECTION 2
EVALUATION METHODS

2.1 DECISION TREE

The decision tree is a flow chart for conducting feasibility studies for a non-compliant PWS. The decision tree is shown in Figures 2.1 through 2.4. The tree guides the user through a series of phases in the design process. Figure 2.1 shows Tree 1, which outlines the process for defining the existing system parameters, followed by optimizing the existing treatment system operation. If optimizing the existing system does not correct the deficiency, the tree leads to six alternative preliminary branches for investigation. The groundwater branch leads through investigating existing wells to developing a new well field. The treatment alternatives address centralized and on-site treatment. The objective of this phase is to develop conceptual designs and cost estimates for the six types of alternatives. The work done for this report follows through Tree 1 and Tree 2, as well as a preliminary pass through Tree 4.

Tree 3, which begins at the conclusion of the work for this report, starts with a comparison of the conceptual designs, selecting the two or three alternatives that appear to be most promising, and eliminating those alternatives which are obviously infeasible. It is envisaged that a process similar to this would be used by the study PWS to refine the list of viable alternatives. The selected alternatives are then subjected to intensive investigation, and highlighted by an investigation into the socio-political aspects of implementation. Designs are further refined and compared, resulting in the selection of a preferred alternative. The steps for assessing the financial and economic aspects of the alternatives (one of the steps in Tree 3) are given in Tree 4 in Figure 2.4.

2.2 DATA SOURCES AND DATA COLLECTION

2.2.1 Data Search

2.2.1.1 Water Supply Systems

The TCEQ maintains a set of files on public PWSs, utilities, and districts at its headquarters in Austin, Texas. The files are organized under two identifiers: a PWS identification number and a Certificate of Convenience and Necessity (CCN) number. The PWS identification number is used to retrieve four types of files:

- CO – Correspondence,
- CA – Chemical analysis,
- MOR – Monthly operating reports (quality/quantity), and
- FMT – Financial, managerial and technical issues.

Figure 2.1
TREE 1 – EXISTING FACILITY ANALYSIS

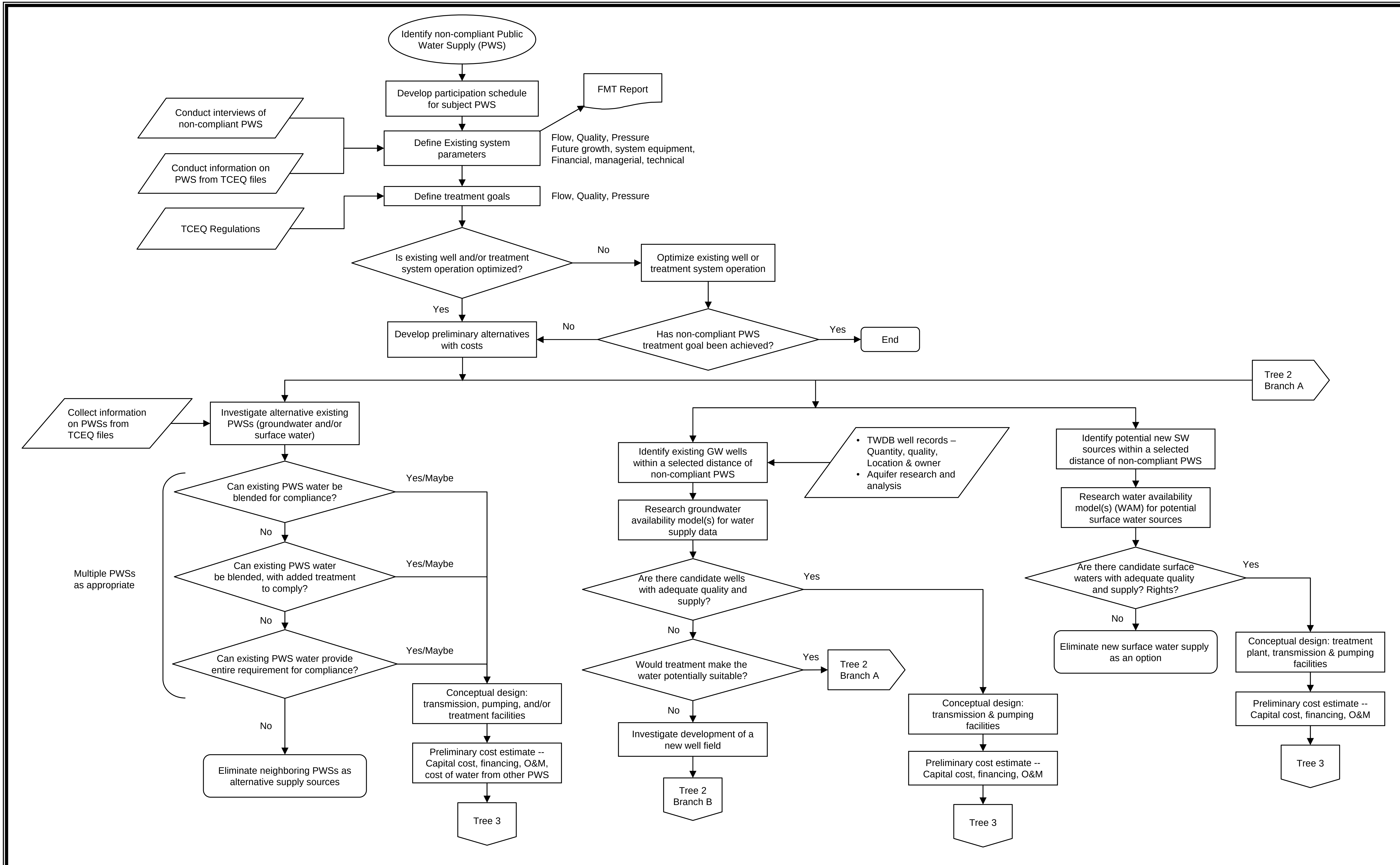
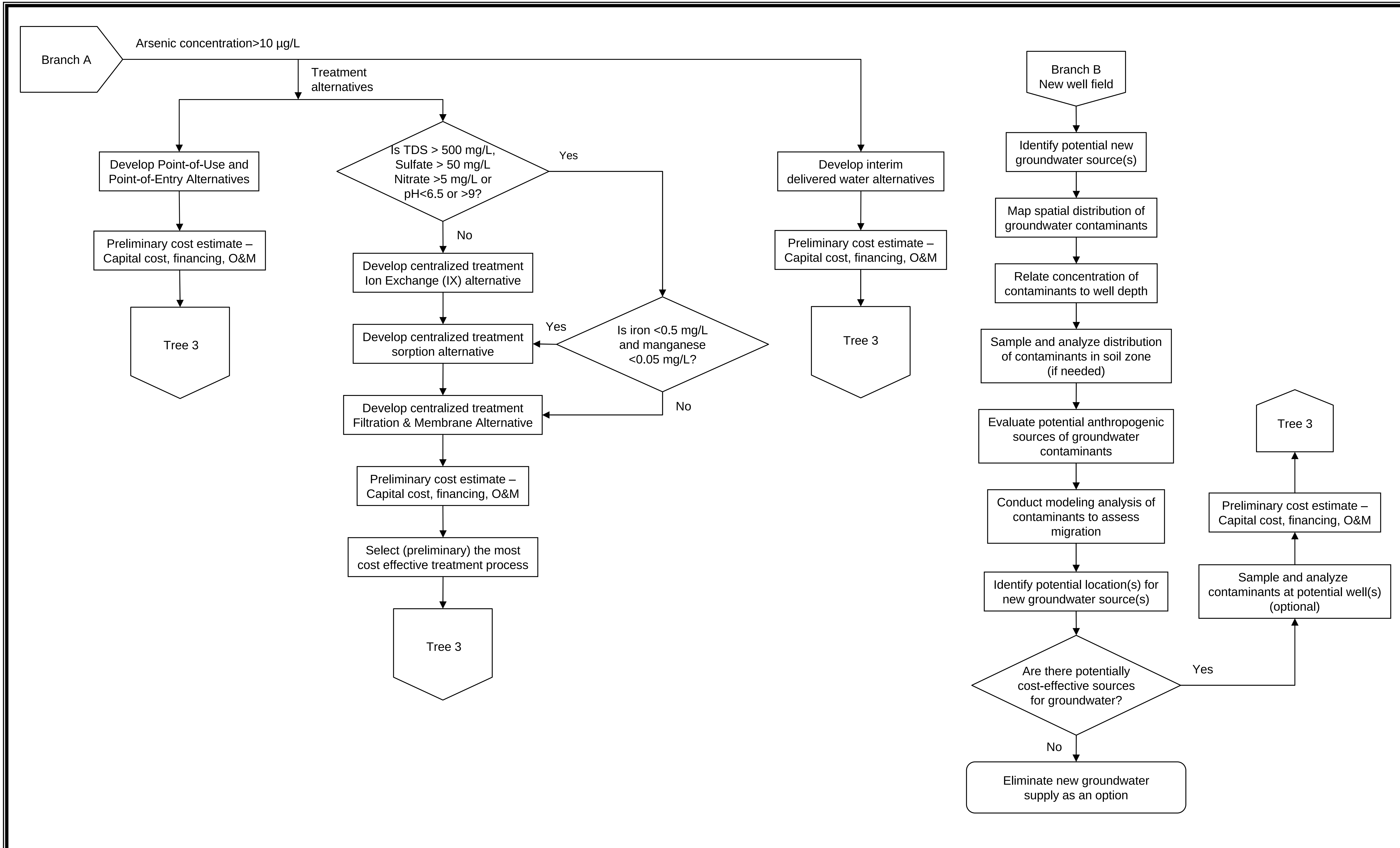


Figure 2.2
TREE 2 – DEVELOP TREATMENT ALTERNATIVES



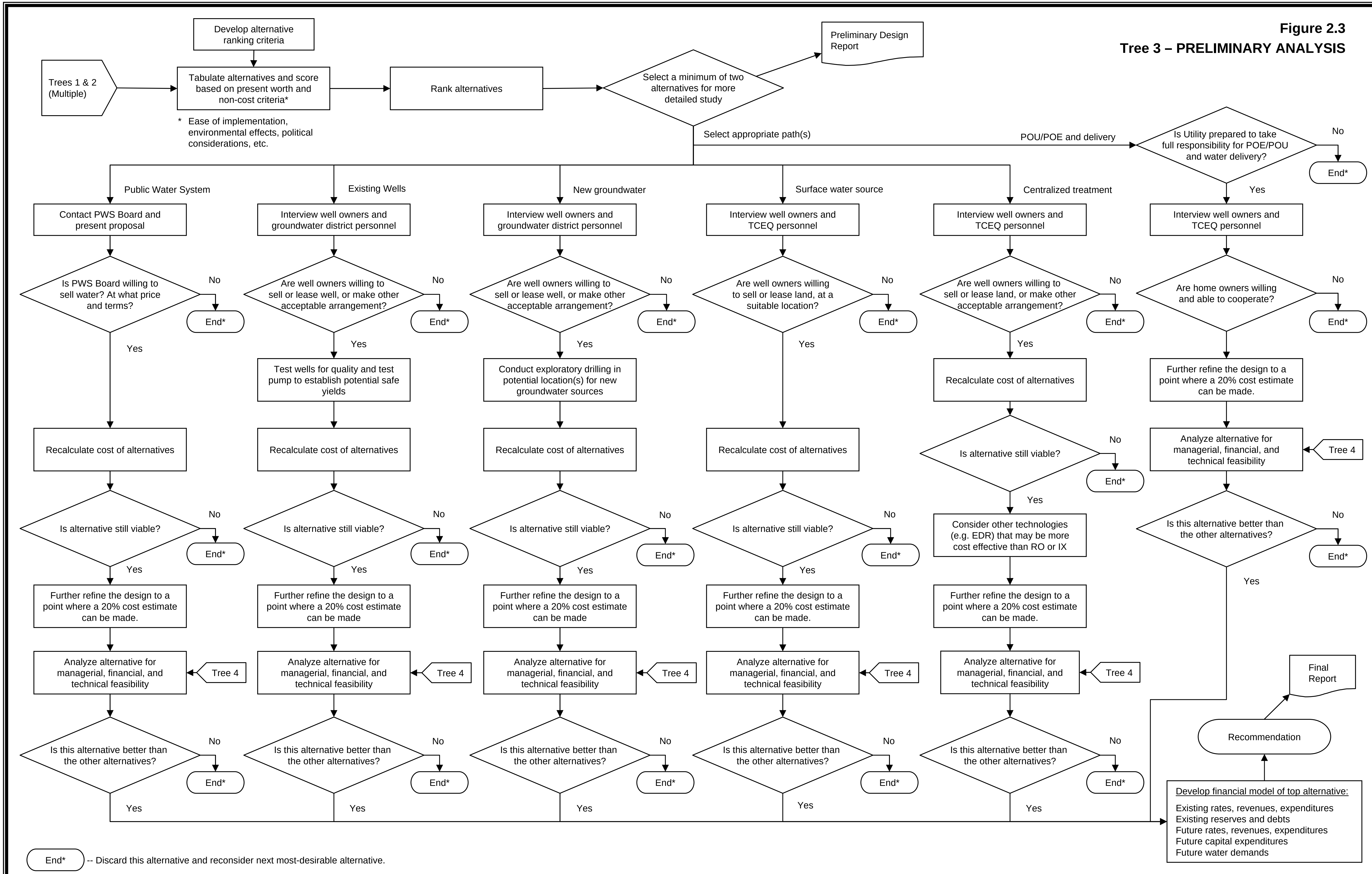
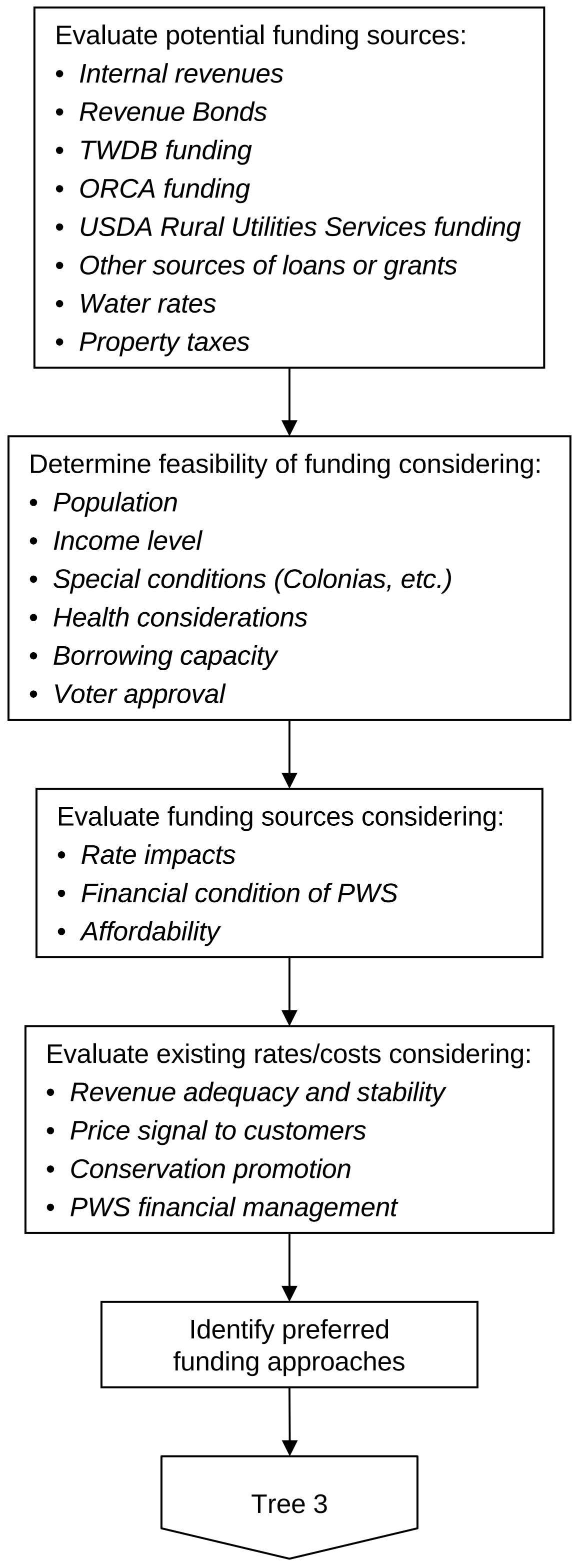


Figure 2.3
Tree 3 – PRELIMINARY ANALYSIS

Figure 2.4
TREE 4 – FINANCIAL



The CCN files generally contain a copy of the system's Certificate of Convenience and Necessity, along with maps and other technical data.

These files were reviewed for the PWS and surrounding systems.

The following websites were consulted to identify the water supply systems in the area:

- Texas Commission on Environmental Quality www3.tnrcc.state.tx.us/iwud/pws/index.cfm?. Under "Advanced Search", type in the name(s) of the county(ies) in the area to get a listing of the public water supply systems.
- USEPA Safe Drinking Water Information System www.epa.gov/safewater/data/getdata.html

Groundwater Control Districts were identified on the TWDB web site, which has a series of maps covering various groundwater and surface water subjects. One of those maps shows groundwater control districts in the State of Texas.

2.2.1.2 Existing Wells

The TWDB maintains a groundwater database available at www.twdb.state.tx.us that has two tables with helpful information. The "Well Data Table" provides a physical description of the well, owner, location in terms of latitude and longitude, current use, and for some wells, items such as flowrate, and nature of the surrounding formation. The "Water Quality Table" provides information on the aquifer and the various chemical concentrations in the water.

2.2.1.3 Surface Water Sources

Regional planning documents were consulted for lists of surface water sources.

2.2.1.4 Groundwater Availability Model

GAMs, developed by the TWDB, are planning tools and should be consulted as part of a search for new or supplementary water sources. The GAM for the northern part of the Gulf Coast aquifer was investigated as a potential tool for identifying available and suitable groundwater resources.

2.2.1.5 Water Availability Model

The WAM is a computer-based simulation predicting the amount of water that would be in a river or stream under a specified set of conditions. WAMs are used to determine whether water would be available for a newly requested water right or amendment. If water is available, these models estimate how often the applicant could count on water under various conditions (*e.g.*, whether water would be available only 1 month out of the year, half the year, or all year, and whether that water would be available in a repeat of the drought of record).

WAMs provide information that assist TCEQ staff in determining whether to recommend the granting or denial of an application.

2.2.1.6 Financial Data

Financial data were collected through a site visit. Data sought included:

- Annual Budget
- Audited Financial Statements
  - Balance Sheet
  - Income & Expense Statement
  - Cash Flow Statement
  - Debt Schedule
- Water Rate Structure
- Water Use Data
  - Production
  - Billing
  - Customer Counts

2.2.1.7 Demographic Data

Basic demographic data were collected from the 2000 Census to establish incomes and eligibility for potential low cost funding for capital improvements. Median household income (MHI) and number of families below poverty level were the primary data points of significance. If available, MHI for the customers of the PWS should be used. In addition, unemployment data were collected from current U.S. Bureau of Labor Statistics. These data were collected for the following levels: national, state, and county.

2.2.2 PWS Interviews

2.2.2.1 PWS Capacity Assessment Process

A capacity assessment is the industry standard term for an evaluation of a PWS's FMT capacity to effectively deliver safe drinking water to its customers now and in the future at a reasonable cost, and to achieve, maintain and plan for compliance with applicable regulations. The assessment process involves interviews with staff and management who have a responsibility in the operations and management of the system.

Financial, managerial, and technical capacity are individual yet highly interrelated components of a system's capacity. A system cannot sustain capacity without maintaining adequate capability in all three components.

Financial capacity is a PWS's ability to acquire and manage sufficient financial resources to allow the system to achieve and maintain compliance with SDWA regulations. Financial capacity refers to the financial resources of the PWS, including but not limited to revenue sufficiency, credit worthiness, and fiscal controls.

Managerial capacity is the ability of a PWS to conduct its affairs so the system is able to achieve and maintain compliance with SDWA requirements. Managerial capacity refers to the management structure of the PWS, including but not limited to ownership accountability, staffing and organization, and effective relationships to customers and regulatory agencies.

Technical capacity is the physical and operational ability of a PWS to achieve and maintain compliance with the SDWA regulations. It refers to the physical infrastructure of the PWS, including the adequacy of the source water, treatment, storage and distribution infrastructure. It also refers to the ability of system personnel to effectively operate and maintain the system and to otherwise implement essential technical knowledge.

Many aspects of PWS operations involve more than one component of capacity. Infrastructure replacement or improvement, for example, requires financial resources, management planning and oversight, and technical knowledge. A deficiency in any one area could disrupt the entire effort. A system that is able to meet both its immediate and long-term challenges demonstrates that it has sufficient financial, managerial, and technical capacity.

Assessment of the FMT capacity of the PWS was based on an approach developed by the New Mexico Environmental Finance Center (NMEFC), which is consistent with TCEQ FMT assessment process. This method was developed from work the NMEFC did while assisting USEPA Region 6 in developing and piloting groundwater comprehensive performance evaluations. The NMEFC developed a standard list of questions that could be asked of PWS personnel. The list was then tailored slightly to have two sets of questions – one for managerial and financial personnel, and one for operations personnel (the questions are included in Appendix A). Each person with a role in the FMT capacity of the system was asked the applicable standard set of questions individually. The interviewees were not given the questions in advance and were not told the answers others provided. Also, most of the questions are open ended type questions so they were not asked in a fashion to indicate what would be the "right" or "wrong" answer. The interviews lasted between 45 minutes to 75 minutes depending on the individual's role in the system and the length of the individual's answers.

In addition to the interview process, visual observations of the physical components of the system were made. A technical information form was created to capture this information. This form is also contained in Appendix A. This information was considered supplemental to the interviews because it served as a check on information provided in the interviews. For example, if an interviewee stated he or she had an excellent preventative maintenance schedule and the visit to the facility indicated a significant amount of deterioration (more than would be expected for the age of the facility) then the preventative maintenance program could be further investigated or the assessor could decide that the preventative maintenance program was inadequate.

Following interviews and observations of the facility, answers that all personnel provided were compared and contrasted to provide a clearer picture of the true operations at the PWS. The intent was to go beyond simply asking the question, "Do you have a budget?" to actually finding out if the budget was developed and being used appropriately. For example, if a PWS manager was asked the question, "Do you have a budget?" he or she may say, "yes" and the capacity assessor would be left with the impression that the system is doing well in this area. However, if several different people are asked about the budget in more detail, the assessor may find that although a budget is present, operations personnel do not have input into the budget, the budget is not used by the financial personnel, the budget is not updated regularly, or the budget is not used in setting or evaluating rates. With this approach, the inadequacy of the budget would be discovered and the capacity deficiency in this area would be noted.

Following the comparison of answers, the next step was to determine which items noted as a potential deficiency truly had a negative effect on the system's operations. If a system had what appeared to be a deficiency, but this deficiency was not creating a problem in terms of the operations or management of the system, it was not considered critical and may not have needed to be addressed as a high priority. As an example, the assessment may have revealed an insufficient number of staff members to operate the facility. However, it may also have been revealed that the system was able to work around that problem by receiving assistance from a neighboring system, so no severe problems resulted from the number of staff members. Although staffing may not be ideal, the system does not need to focus on this particular issue. The system needs to focus on items that are truly affecting operations. As an example of this type of deficiency, a system may lack a reserve account which can then lead the system to delay much-needed maintenance or repair on its storage tank. In this case, the system needs to address the reserve account issue so that proper maintenance can be completed.

The intent was to develop a list of capacity deficiencies with the greatest impact on the system's overall capacity. Those were the most critical items to address through follow-up technical assistance or by the system itself.

2.2.2.2 Interview Process

PWS personnel were interviewed by the project team, and each was interviewed separately. Interview forms were completed during each interview.

2.3 ALTERNATIVE DEVELOPMENT AND ANALYSIS

The initial objective for developing alternatives to address compliance issues is to identify a comprehensive range of possible options that can be evaluated to determine which are the most promising for implementation. Once the possible alternatives are identified, they must be defined in sufficient detail so a conceptual cost estimate (capital and O&M costs) can be developed. These conceptual cost estimates are used to compare the affordability of compliance alternatives, and to give a preliminary indication of rate impacts. Consequently, these costs are pre-planning level and should not be viewed as final estimated costs for alternative implementation. The basis for the unit costs used for the compliance alternative cost estimates is summarized in Appendix B. Other non-economic factors for the alternatives, such as reliability and ease of implementation, are also addressed.

2.3.1 Existing PWS

The neighboring PWSs were identified, and the extents of their systems were investigated. PWSs farther than 15 miles from the non-compliant PWSs were not considered because the length of the pipeline required would make the alternative cost prohibitive. The quality of water provided was also investigated. For neighboring PWSs with compliant water, options for water purchase and/or expansion of existing well fields were considered. The neighboring PWSs with non-compliant water were considered as possible partners in sharing the cost for obtaining compliant water either through treatment or developing an alternate source.

The neighboring PWSs were investigated to get an idea of the water sources in use and the quantity of water that might be available for sale. They were contacted to identify key locations in their systems where a connection might be made to obtain water, and to explore on a preliminary basis their willingness to partner or sell water. Then, the major system components that would be required to provide compliant water were identified. The major system components included treatment units, wells, storage tanks, pump stations, and pipelines.

Once the major components were identified, a preliminary design was developed to identify sizing requirements and routings. A capital cost estimate was then developed based on the preliminary design of the required system components. An annual O&M cost was also estimated to reflect the change in O&M expenditures that would be needed if the alternative was implemented.

Non-economic factors were also identified. Ease of implementation was considered, as well as the reliability for providing adequate quantities of compliant water. Additional factors were whether implementation of an alternative would require significant increase in the management or technical capability of the PWS, and whether the alternative had the potential for regionalization.

2.3.2 New Groundwater Source

It was not possible in the scope of this study to determine conclusively whether new wells could be installed to provide compliant drinking water. In order to evaluate potential new groundwater source alternatives, three test cases were developed based on distance from the PWS intake point. The test cases were based on distances of 10 miles, 5 miles, and 1 mile. It was assumed that a pipeline would be required for all three test cases, and a storage tank and pump station would be required for the 10-mile and 5-mile alternatives. It was also assumed that new wells would be installed, and that their depths would be similar to the depths of the existing wells, or other existing drinking water wells in the area.

A preliminary design was developed to identify sizing requirements for the required system components. A capital cost estimate was then developed based on the preliminary design of the required system components. An annual O&M cost was also estimated to reflect the change (*i.e.*, from current expenditures) in O&M expenditures that would be needed if the alternative was implemented.

Non-economic factors were also identified. Ease of implementation was considered, as well as the reliability for providing adequate quantities of compliant water. Additional factors were whether implementation of an alternative would require significant increase in the management or technical capability of the PWS, and whether the alternative had the potential for regionalization.

2.3.3 New Surface Water Source

New surface water sources were investigated. Availability of adequate quality water was investigated for the main rivers in the area, as well as the major reservoirs. TCEQ WAMs were inspected, and the WAM was run, where appropriate.

2.3.4 Treatment

Treatment technologies considered potentially applicable to arsenic removal are IX, RO, EDR, adsorption and coagulation/filtration. Because of the relatively low TDS and sulfate concentrations in the well water, IX is a viable central treatment alternative. Adsorption and coagulation/filtration processes remove arsenic only without significantly affect TDS and are viable central treatment alternatives. Both RO and EDR treatment produce a liquid waste: a reject stream from RO treatment and a concentrate stream from EDR treatment. As a result, the treated volume of water is less than the volume of raw water that enters the treatment system. The amount of raw water used increases to produce the same amount of treated water if RO or EDR treatment is implemented. RO and EDR are considerably more expensive than the other treatment technologies if TDS removal is not required and hence they are not evaluated further. IX, adsorption and coagulation filtration treatment produce periodic backwash wastewater (and regenerant waste for IX) for disposal. The treatment units were sized based on flow rates, and capital and annual O&M cost estimates were made based on the size of the treatment equipment required. Neighboring non-compliant PWSs were identified to look for opportunities where the costs and benefits of central treatment could be shared between systems.

Non-economical factors were also identified. Ease of implementation was considered, as well as the reliability for providing adequate quantities of compliant water. Additional factors were whether implementation of an alternative would require significant increases in the management or technical capability of the PWS, and whether the alternative had the potential for regionalization.

2.4 COST OF SERVICE AND FUNDING ANALYSIS

The primary purpose of the cost of service and funding analysis is to determine the financial impact of implementing compliance alternatives, primarily by examining the required rate increases, and also the fraction of household income that water bills represent. The current financial situation is also reviewed to determine what rate increases are necessary for the PWS to achieve or maintain financial viability.

2.4.1 Financial Feasibility

A key financial metric is the comparison of average annual household water bill for a PWS customer to the MHI for the area. MHI data from the 2000 Census are used, at the most detailed level available for the community. Typically, county level data are used for small rural water utilities due to small population sizes. Annual water bills are determined for existing, base conditions, including consideration of additional rate increases needed under current conditions. Annual water bills are also calculated after adding incremental capital and operating costs for each of the alternatives to determine feasibility under several potential funding sources.

Additionally, the use of standard ratios provides insight into the financial condition of any business. Three ratios are particularly significant for water utilities:

- Current Ratio = current assets divided by current liabilities provides insight into the ability to meet short-term payments. For a healthy utility, the value should be greater than 1.0.
- Debt to Net Worth Ratio = total debt divided by net worth shows to what degree assets of the company have been funded through borrowing. A lower ratio indicates a healthier condition.
- Operating Ratio = total operating revenues divided by total operating expenses show the degree to which revenues cover ongoing expenses. The value is greater than 1.0 if the utility is covering its expenses.

2.4.2 Median Household Income

The 2000 U.S. Census is used as the basis for MHI. In addition to consideration of affordability, the annual MHI may also be an important factor for sources of funds for capital programs needed to resolve water quality issues. Many grant and loan programs are available to lower income rural areas, based on comparisons of local income to statewide incomes. In the 2000 Census, MHI for the State of Texas was $39,927, compared to the U.S. level of $41,994. For service areas with a sparse population base, county data may be the most reliable, and for many rural areas corresponds to census tract data. The census broke down MHIs geographically by block group and ZIP code. The MHIs can vary significantly for the same location, depending on the geographic subdivision chosen. The MHI for each PWS was estimated by selecting the most appropriate value based on block group or ZIP code based on results of the site interview and a comparison with the surrounding area.

2.4.3 Annual Average Water Bill

The annual average household water bill was calculated for existing conditions and for future conditions incorporating the alternative solutions. Average residential consumption is estimated and applied to the existing rate structure to estimate the annual water bill. The estimates are generated from a long-term financial planning model that details annual revenue, expenditure, and cash reserve requirements over a 30-year period.

2.4.4 Financial Plan Development

The financial planning model uses available data to establish base conditions under which the system operates. The model includes, as available:

- Accounts and consumption data
- Water tariff structure
- Beginning available cash balance
- Sources of receipts:
    - Customer billings
    - Membership fees
    - Capital Funding receipts from:
        - Grants
        - Proceeds from borrowing
- Operating expenditures:
    - Water purchases
    - Utilities
    - Administrative costs
    - Salaries
- Capital expenditures
- Debt service:
    - Existing principal and interest payments
    - Future principal and interest necessary to fund viable operations
- Net cash flow
- Restricted or desired cash balances:
    - Working capital reserve (based on 1-4 months of operating expenses)
    - Replacement reserves to provide funding for planned and unplanned repairs and replacements

From the model, changes in water rates are determined for existing conditions and for implementing the compliance alternatives.

2.4.5 Financial Plan Results

Results from the financial planning model are summarized in two areas: percentage of household income and total water rate increase necessary to implement the alternatives and maintain financial viability.

2.4.5.1 Funding Options

Results are summarized in a table that shows the following according to alternative and funding source:

- Percentage of the median annual household income that the average annual residential water bill represents.
- The first year in which a water rate increase would be required
- The total increase in water rates required, compared to current rates

Water rates resulting from the incremental capital costs of the alternative solutions are examined under a number of funding options. The first alternative examined is always funding from existing reserves plus future rate increases. Several funding options were analyzed to frame a range of possible outcomes.

- Grant funds for 100 percent of required capital. In this case, the PWS is only responsible for the associated O&M costs.
- Grant funds for 75 percent of required capital, with the balance treated as if revenue bond funded.
- Grant funds for 50 percent of required capital, with the balance treated as if revenue bond funded.
- State revolving fund loan at the most favorable available rates and terms applicable to the communities.
- If local MHI is more than 75 percent of state MHI, standard terms, currently at 3.8 percent interest for non-rated entities. Additionally:
    - If local MHI = 70-75 percent of state MHI, 1 percent interest rate on loan.
    - If local MHI = 60-70 percent of state MHI, 0 percent interest rate on loan.
    - If local MHI = 50-60 percent of state MHI, 0 percent interest and 15 percent forgiveness of principal.
    - If local MHI less than 50 percent of state MHI, 0 percent interest and 35 percent forgiveness of principal.
- Terms of revenue bonds assumed to be 25-year term at 6.0 percent interest rate.

2.4.5.2 General Assumptions Embodied in Financial Plan Results

The basis used to project future financial performance for the financial plan model includes:

- No account growth (either positive or negative).
- No change in estimate of uncollectible revenues over time.
- Average consumption per account unchanged over time.
- No change in unaccounted for water as percentage of total (more efficient water use would lower total water requirements and costs).
- No inflation included in the analyses (although the model has provisions to add escalation of O&M costs, doing so would mix water rate impacts from inflation with the impacts from the alternatives being examined).
- Minimum working capital fund established for each district, based on specified months of O&M expenditures.
- O&M for alternatives begins 1 year after capital implementation.
- Balance of capital expenditures not funded from primary grant program is funded through debt (bond equivalent).
- Cash balance drives rate increases, unless provision chosen to override where current net cash flow is positive.

2.4.5.3 Interpretation of Financial Plan Results

Results from the financial plan model for each alternative are presented in Table 4.7 in Section 4 of this report. The model used six funding alternatives: paying cash up front (all revenue); 100 percent grant; 75 percent grant; 50 percent grant, State Revolving Fund (SRF); and obtaining a Loan/Bond. Table 4.7 shows the projected average annual water bill, the maximum percent of household income, and the percentage rate increase over current rates.

2.4.5.4 Potential Funding Sources

A number of potential funding sources exist for rural utilities. Both state and federal agencies offer grant and loan programs to assist rural communities in meeting their infrastructure needs.

Within Texas, the following state agencies offer financial assistance if needed:

- TWDB;
- Office of Rural Community Affairs; and
- Texas Department of Health (Texas Small Towns Environment Program).

Small rural communities can also get assistance from the federal government. The primary agencies providing aid are:

- United States Department of Agriculture, Rural Utilities Service; and
- United States Housing and Urban Development.

SECTION 3
UNDERSTANDING SOURCES OF CONTAMINANTS

3.1 ARSENIC IN THE GULF COAST AQUIFER

The Gulf Coast aquifer parallels the Texas Gulf Coast and extends from the Texas-Louisiana border to the Rio Grande. Subunits of the Gulf Coast aquifer are from oldest to youngest, the Jasper, Evangeline, and Chicot aquifers. The aquifer is a leaky artesian system composed of middle to late Tertiary and younger interbedded and hydrologically connected layers of clay, silt, sand, and gravel (Ashworth and Hopkins 1995). The PWS wells of concern in Brazoria and Chambers Counties are completed in the Chicot aquifer. Groundwater arsenic concentrations in the Gulf Coast aquifer are based on the TWDB database (Figure 3.1) and the National Geochemical Database, also known as the National Uranium Resource Evaluation (NURE) database (Figure 3.2).

Figure 3.1 Most Recent Arsenic Concentrations in Groundwater of the Gulf Coast Aquifer (TWDB Database, 1,095 Samples from 1987 to 2005)

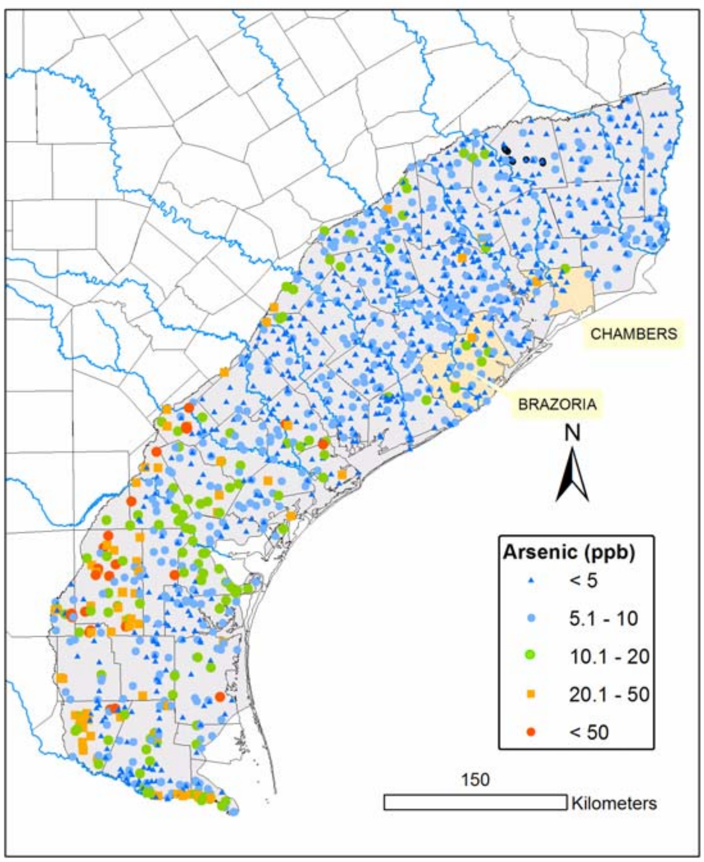
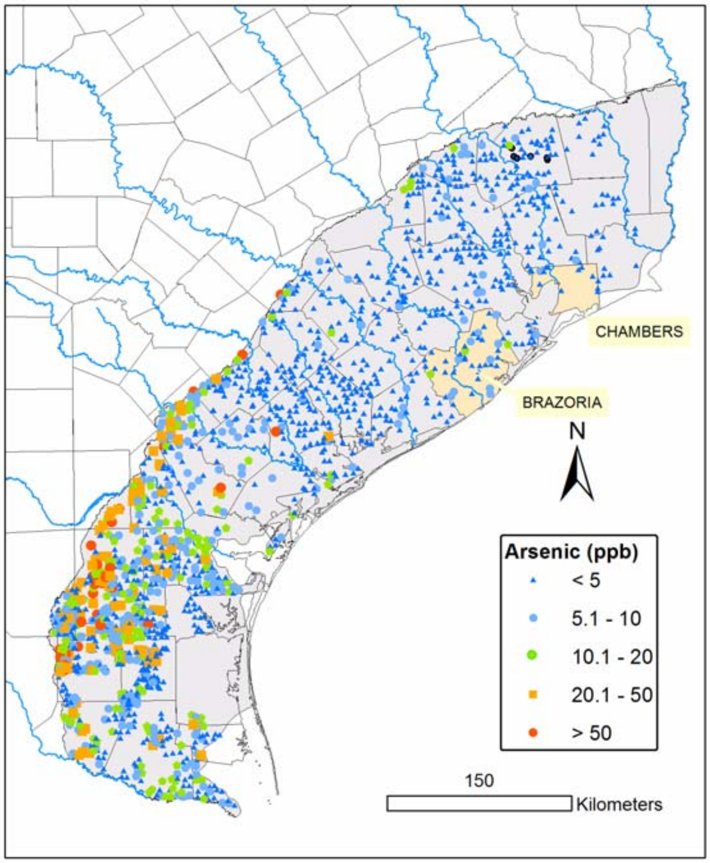


Figure 3.2 Detectable Arsenic Concentrations in Groundwater (NURE Database, 3,467 Samples from 1976 to 1980)



Both databases show higher arsenic concentrations in the south western part of the aquifer. East of the Colorado River wells with arsenic levels higher then the 10 parts per billion (ppb) (10 μg/L), the new MCL for arsenic, are relatively rare. Within this region wells in the northern part of the aquifer, completed in the Jasper subunit are more likely to have higher arsenic levels (Figures 3.1 and 3.2). The distribution of high levels of arsenic in the Chicot subunit in the central and northern Gulf Coast aquifer is spatially variable. Within this region the number of wells where arsenic ≥10 ppb in Brazoria County is relatively high.

3.2 GEOLOGY OF BRAZORIA, CHAMBERS, AND GALVESTON COUNTIES

Subsurface geologic deposits in Brazoria and Chambers Counties and Galveston County in between consist mainly of sediments of Tertiary (Pliocene) and Quaternary (Pleistocene) age making up the last progradation wedges in the Gulf Coast. Gulf Coast sediments consist of several progradation wedges of Tertiary and Quaternary age composed of alternating sandstone and clay corresponding to variations in sea level and in inland sediment input, as well as in other factors. Those wedges are approximately parallel to the current shoreline, and the deposition process is still active today (*e.g.*, Mississippi River and delta). In the Gulf Coast lowlands, these deposits are generally divided into six or more operational units: the Fleming formation of Miocene age whose base includes the Oakville Sandstone, the Goliad/Willis formations of Pliocene age, and the Lissie and Beaumont formations of Pleistocene age. The Willis Sand is more or less equivalent to the Alta Loma Sand (Kreitler, *et al*. 1977). The Lissie formation is sometimes divided into a lower unit (Lissie sandstone or Bentley) and an upper unit, the Montgomery formation. The general dip of the formations toward the Gulf of Mexico is 0.01 ft/ft or less on average and increases with depth because wedge thicknesses increase toward the Gulf of Mexico. Several salt domes pierce through the Pliocene formations (Mace, *et al.* 2006), do not seem to alter the regional structure of the Upper Tertiary formations but have the ability to locally degrade water quality. The Beaumont formation and more recent Holocene units (alluvium, barrier-island deposits) are exposed in and cover all of Brazoria, Galveston, and Chambers Counties.

The Gulf Coast aquifer is recognized as a major aquifer in the State of Texas (Ashworth and Hopkins 1995; Mace, *et al*. 2006). In the Tertiary Gulf Coast system, the general flow system consists of water infiltrating in the outcrop areas of the more permeable formations, some of it discharging into rivers and springs along short flow paths, and some of it flowing downdip into the deeper sections of the aquifers. The fate of that slowly moving water is to percolate up by cross-formational flow and discharge into the ocean. This process is necessary to maintain mass balance in the regional flow system although, because of heavy pumping in some areas, the natural upward flow has been locally reversed. The Catahoula formation of mostly Oligocene age is generally recognized as the low-permeability unit marking the base of the Gulf Coast aquifer, although it can locally produce water and thus be part of the Gulf Coast aquifer. Hydrostratigraphic units, solely concerned with permeability and connectivity of permeable bodies, do not always coincide with stratigraphic units defined by age and depositional environments. The other hydrostratigraphic units of the Coastal Plain, from deeper to shallower, are the Jasper aquifer, the Burkeville confining system, and the Evangeline and Chicot aquifers (Baker 1979). The Jasper aquifer comprises the base of the Fleming formation; that is, the Oakville Sandstone, as well as the Catahoula Sandstone hydraulically connected to them. The upper part of the Fleming formation makes up the Burkeville confining system. The Evangeline aquifer includes mostly the Goliad Sand but also the upper sections of the Fleming formation when permeable. The remainder and younger formations of the section (Willis Sand, Lissie and Beaumont formations) make up the Chicot aquifer (Kasmarek and Robinson 2004).

In the Brazoria-Chambers County area, the base of the Jasper aquifer is at a depth of 4,000 to >6,000 feet below ground surface. The Oakville formation, forming the bulk of the Jasper aquifer, consists of fluvial fine- to coarse-grained, partially consolidated sand with silt and clay intercalations becoming a volumetrically important downdip. Its thickness ranges from 1,200 to >3,000 feet (increasing downdip) in the Brazoria-Chambers County area (Baker 1979). The net sand thickness varies in the 400-700-foot range with a sand fraction in the 15-30 percent range (Galloway, *et al*. 1986). The Goliad formation, approximately equivalent to the Evangeline aquifer, unconformably overlies the top of the Fleming formation, which is composed mostly of clay with some calcareous sand. This formation acts as a leaky confining layer between the Jasper and the Evangeline aquifers ("Burkeville confining system") and has an approximate thickness of 600 feet in the Brazoria-Chambers County area. Goliad sand is medium- to coarse-grained and unconsolidated with intercalations of calcareous clay and marl.

The fluvial and deltaic sand of the Goliad formation suggest another small retreat of the shoreline toward the Gulf. Their thickness is in the 2,000-3,500-foot range. Goliad Sand grades into the generally coarse-grained Willis Sand whose depositional system arrangement is similar to that of the Goliad Sand. The Willis Sand makes up the Chicot aquifer with the overlying fine- to coarse-grained Lissie Sand. The top of the Lissie formation, with a higher clay content, and the Beaumont Clay generally pressurize the more permeable sand of the Willis and Bentley formations, confining the Chicot aquifer. The base of the Chicot aquifer is in the 800-1,200-foot depth range, and the thickness of the sand-rich lower section is approximately 400-800 feet.

Well yield is generally high in the Gulf Coast aquifer in northeast Texas, including in Brazoria and Chambers Counties; however, water quality is variable because of sea water intrusion and presence of shallow salt domes. Groundwater in the Chicot and upper section of the Evangeline aquifers is mostly fresh in Brazoria County, but contains several areas with brackish water in Chambers County (Aronow 1971). The lower section of the Evangeline aquifer could also be brackish in both counties. The Jasper aquifer is mostly slightly brackish in the study area, just northwest of Brazoria, Galveston, and Chambers Counties. Major cones of depression centered on and due to urbanization in neighboring Harris and Galveston Counties and heavy groundwater pumping from the Chicot and Evangeline aquifers extend into Chambers and Brazoria Counties despite their predominantly rural nature.

3.3 GENERAL TRENDS IN ARSENIC CONCENTRATIONS

The geochemistry of arsenic is described in Appendix E. A general analysis of arsenic trends in the vicinity of Brazoria and Chambers Counties was conducted to assess spatial trends as well as correlations with other water quality parameters. Arsenic measurements from the TWDB database (Figure 3.3), the TCEQ database, and from a subset of the NURE database (Figure 3.4), were used to assess the spatial distribution of arsenic.

Figure 3.3 Spatial Distribution of Arsenic Concentrations (TWDB Database)

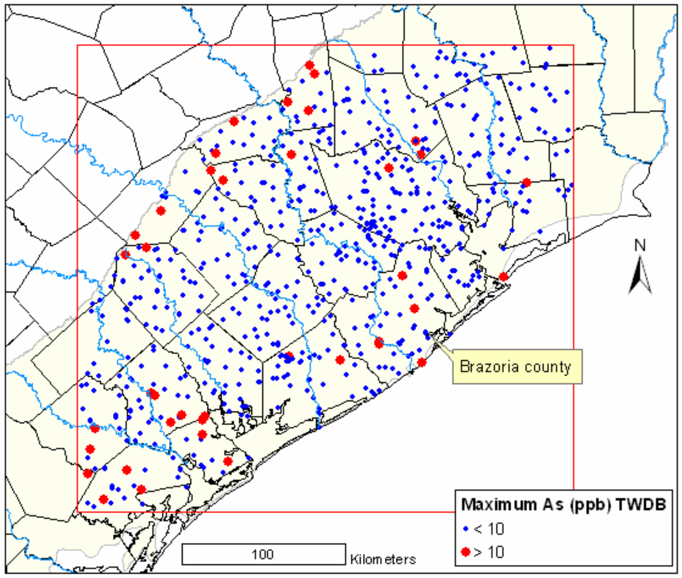
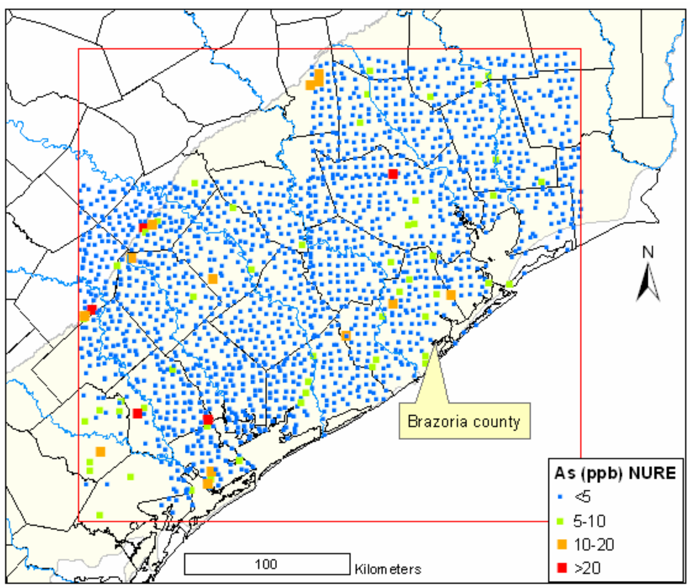


Figure 3.4 Spatial Distribution of Arsenic Concentrations (NURE Database)



The databases were queried in an area delineated by the following coordinates (bottom left: -97.45, 28.18; top right: -94.30, 30.64). From the TWDB database 730 measurements were extracted, representing the most recent arsenic measurement taken at a specific well. Wells not in the Gulf Coast aquifer were excluded. The NURE database contained 2,118 groundwater (sample type 03) arsenic measurements within the defined boundary, the wells do not have an aquifer identifier; therefore, no measurements were excluded.

Relationships between arsenic and well depth, pH, sulfate, fluoride, chloride, total dissolved solids (TDS), dissolved oxygen, phosphorus, iron, selenium, boron, vanadium, uranium, and molybdenum were evaluated using data from the NURE database and from the TWDB database separately. Correlations between arsenic concentrations and these parameters were weak (R^2 values ≤ 0.1); nevertheless a trend of increasing probability for finding high arsenic concentrations in wells that show high molybdenum concentrations was found (Figures 3.5 and 3.6). The relationship between the probability of arsenic >10 µg/L and molybdenum concentrations are shown for the NURE (Figure 3.5) and TWDB (Figure 3.6) databases.

Figure 3.5 Relationship Between arsenic and Molybdenum (NURE Database)

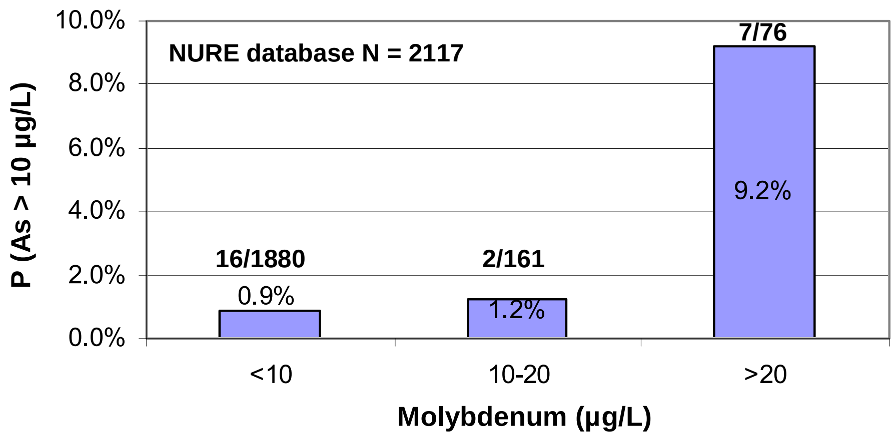
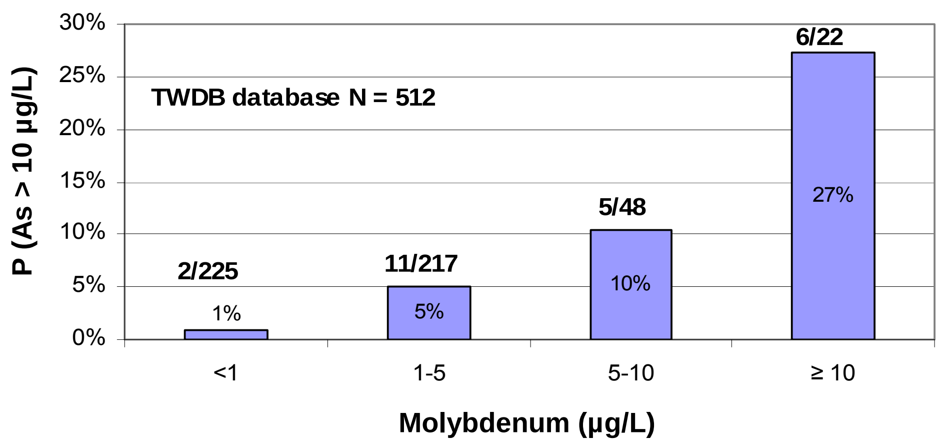


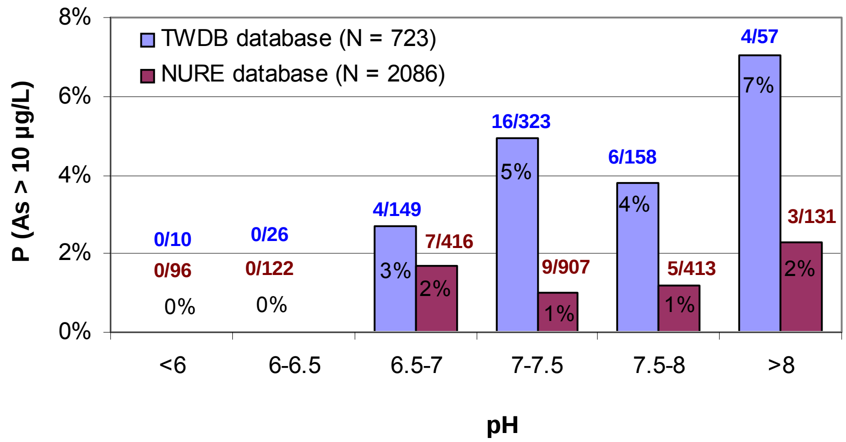
Figure 3.6 Relationship Between Arsenic and Molybdenum (TWDB Database)



N represents number of measurements used from each database. Numbers on top of the graph columns show number of arsenic measurements >10 µg/L and total number of measurements in each bin. For example "7/76" in the bin for molybdenum >20 ppb means that seven out of 76 arsenic measurements were greater than 10 µg/L.

Elevated arsenic concentrations and pH are also related (Figure 3.7). The absence of high arsenic concentrations (>10 µg/L) at pH less than 6.5 is notable.

Figure 3.7 Relationship Between High Arsenic Concentrations and pH



The relation between high arsenic concentrations and high molybdenum concentration and pH (similar relations exist between arsenic and TDS – not shown) suggest natural sources of elevated arsenic in Brazoria and Chambers Counties; however, there are insufficient data to make this conclusion definitive, and anthropogenic sources should be explored as well.

3.3.1 Arsenic and Point Sources of Contamination

Information regarding location of Potential Sources of Contamination (PSOC) was collected as part of the TCEQ Source Water Assessment Program (SWAP). Arsenic concentrations from TWDB (Figure 3.8) and NURE (Figure 3.9) databases were compared to the PSOC coverage. A density map of the PSOCs was generated (number of PSOCs per km^2) and the PSOC density values were compared with arsenic concentrations from the NURE database.

Figure 3.8 Potential Sources of Arsenic Contamination and Arsenic Concentrations from the TWDB Database

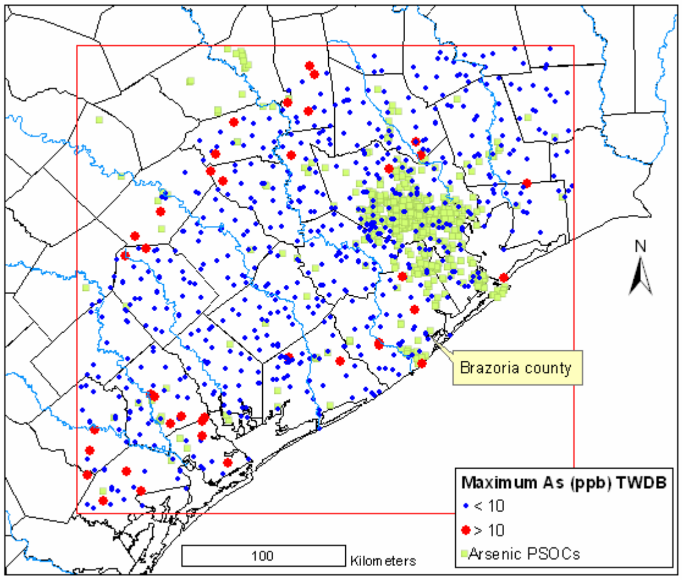
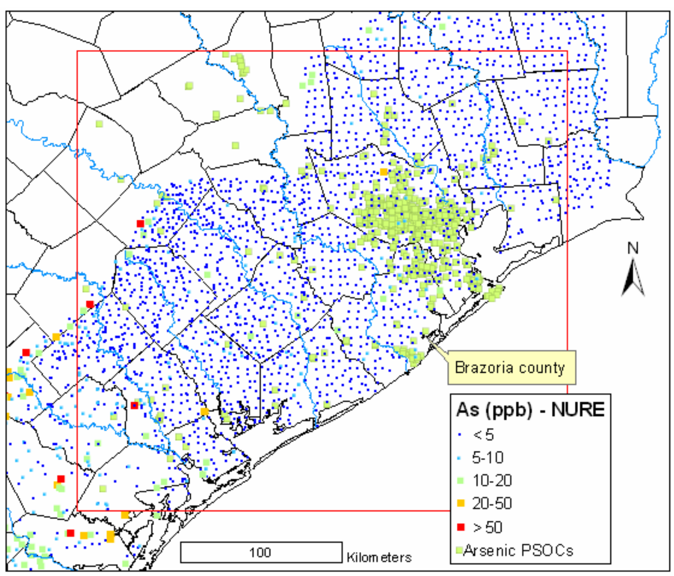


Figure 3.9 Potential Sources of Arsenic Contamination and Arsenic Concentrations from the NURE Database

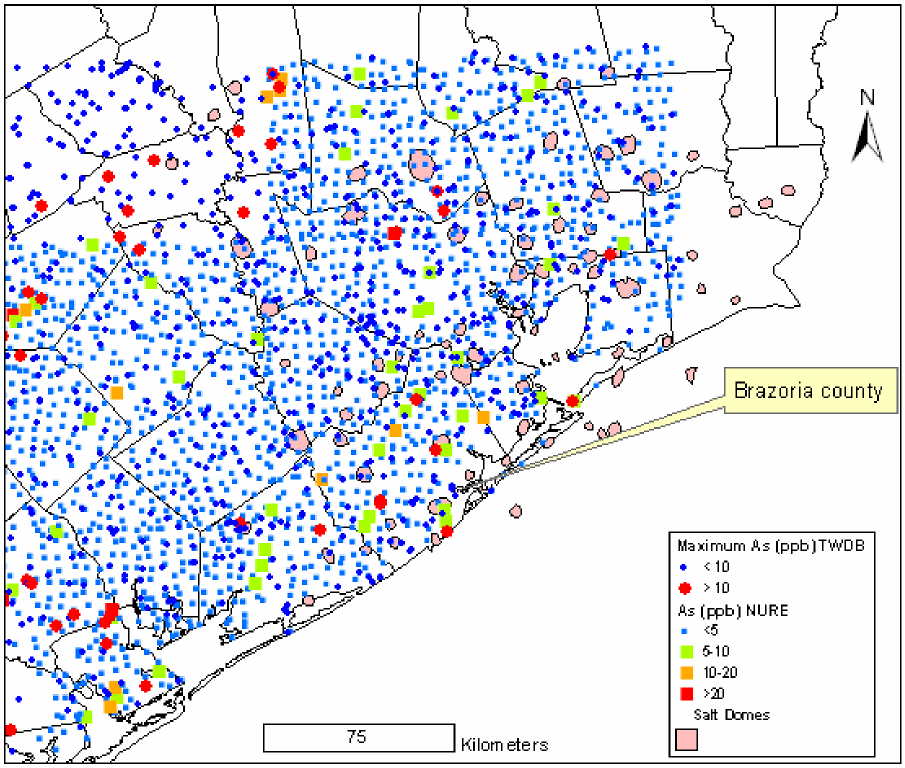


No general correlation was found between high arsenic concentrations and density of potential sources of contamination. This strengthens the conclusion that the majority of arsenic sources in this area are natural. Specific PSOCs near the PWS systems will be analyzed in more detail in Subsection 3.4.

3.3.2 Salt domes

Elevated arsenic concentrations were not correlated with salt dome locations (Figure 3.10).

Figure 3.10 Salt Dome Locations and Arsenic Concentrations From TWDB and NURE Databases

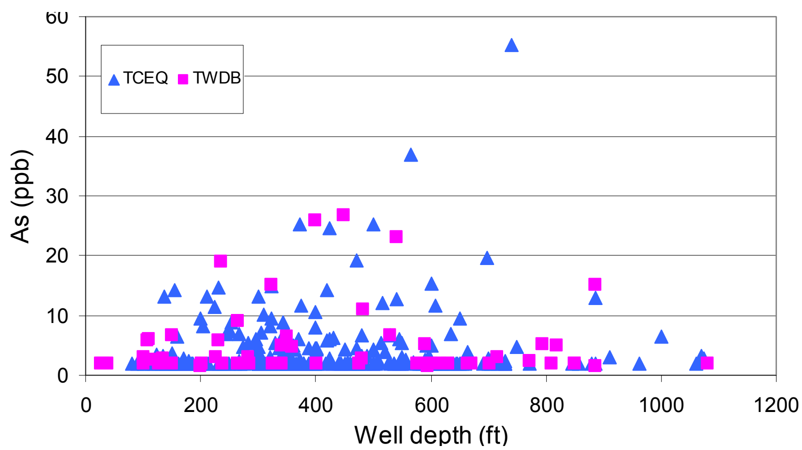


3.3.3 Arsenic Levels and Correlation With Well Depth in Brazoria, Galveston, and Chambers Counties

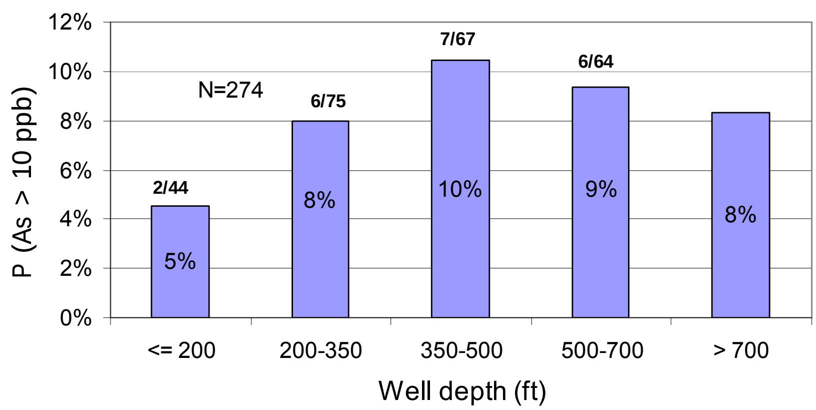
Arsenic concentrations were compared to well depth in a smaller region which includes only Brazoria, Galveston, and Chambers Counties to infer more representative statistics for the PWS systems being analyzed. Well depth was used in this area instead of absolute altitude (surface elevation – well depth) because the surface elevation data are not complete, it contains more errors, and variability in it in these three counties is relatively small (0-60 feet). Sixty-two most recent samples from the TWDB data set that were taken after March 1997 (because the arsenic detection limit from earlier samples was commonly 10 µg/L while the median in this area is less than 2 µg/L). Two hundred seventy-four most recent arsenic samples from the three counties (1996-2005) from the TCEQ database that can be related to a single well were used for this analysis (Figure 3.11). The TCEQ database designates 271 out of the 274 wells to the Chicot aquifer without further details whereas the TWDB database has further classifications within the Chicot (*e.g.,* 112CHCTU – Chicot Upper Sand, 112CHCTL – Chicot Lower Sand).

Figure 3.11 Relationship Between Arsenic Concentrations and Well Depth in Wells from Brazoria, Galveston, and Chambers Counties

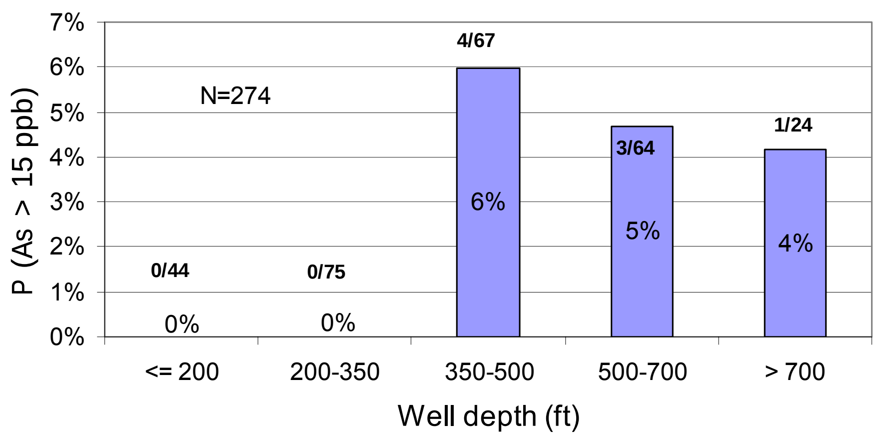
a)



b)



c)



In Figures 3.11b and c, N represents the total number of samples in the analysis (274 - TCEQ database), and the numbers above each column represent the number of arsenic measurements >10 µg/L (11b) or >15 µg/L (11c) relative to the total number of analyses in the bin. For example 4/67 in Figure 3.11c represents four samples where arsenic >15 µg/L out of 67 samples taken from wells with depths between 350-500 feet.

Groundwater arsenic levels in this area are low, with an average of 4.2 µg/L in the TCEQ wells and 4.8 µg/L in the TWDB wells (concentrations of 2 µg/L in TCEQ and 2.04 µg/L in the TWDB databases were assigned for samples <2 µg/L and <2.04 so these averages are an upper boundary for the real averages). The medians for the three counties in both data sets are below the aforementioned detection-limits *i.e*., <2 µg/L.

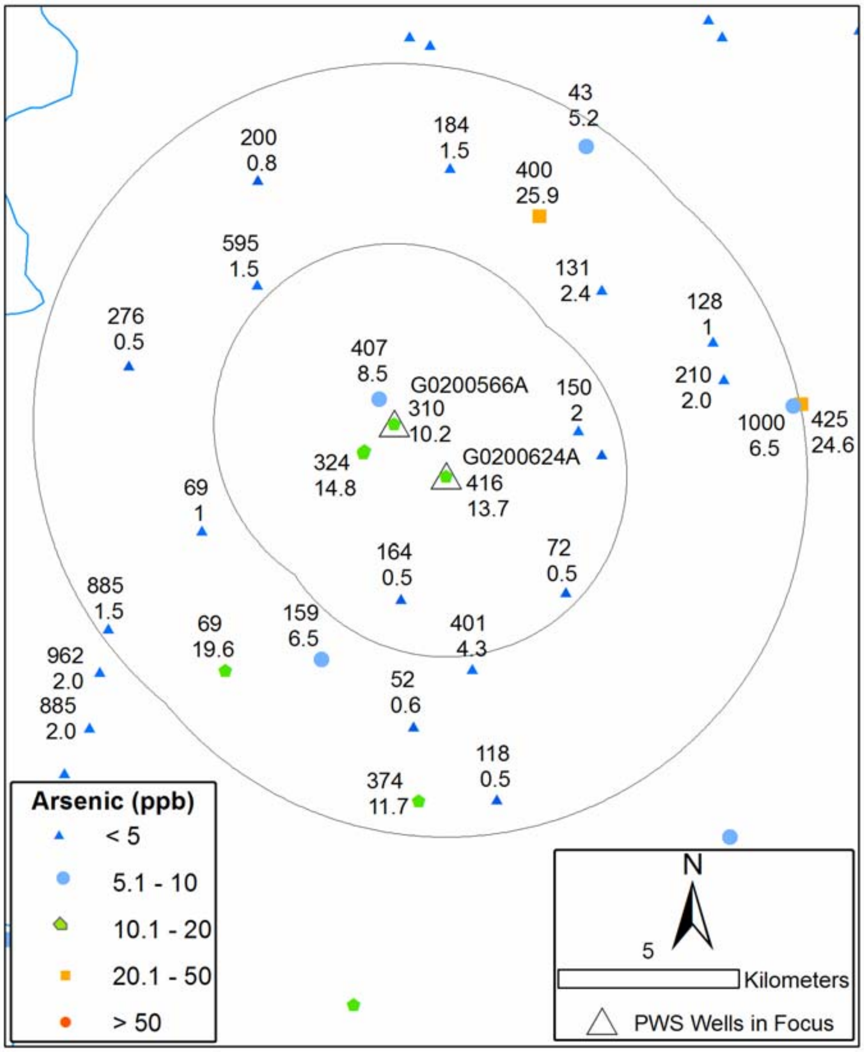
There is a tendency toward higher densities of elevated arsenic concentrations at depths between 300 and 700 relative to shallower and deeper wells Figure 3.11a shows. The probability analyses of As >10 and As >15 in Figures 3.11b and 3.11c confirms this tendency (only TCEQ data). The medium range wells 350-500 feet deep are the most likely to have high arsenic concentration. In this area where most wells have very low arsenic concentrations, the option of blending high and low arsenic water is more feasible; therefore, recognizing the very low probability of As >15 in wells shallower than 350 feet is significant (Figure 3.11c).

3.4 DETAILED ASSESSMENT FOR STONERIDGE LAKE PWS AND OAK MEADOWS PWS

These two PWSs each have a single well (G0200266A and G0200624A) that are 2,100 meters apart (Figure 3.12). Both PWSs have arsenic concentrations slightly above the new MCL (*i.e.*, 10 – 15 µg/L). As a result, a single detailed assessment is applicable for both of these two PWSs.

This analysis was prepared for reports that address the Stoneridge Lake PWS and the Oak Meadows Estates PWS (Oak Meadows PWS) and, consequently, both appear in the text, tables, and figures in this section.

Figure 3.12 Most Recent Arsenic Concentrations in Wells Within 5 and 10 km Buffers of the Stoneridge Lake PWSs and Oak Meadows PWS



The upper number near each well is its depth and the lower is the arsenic concentration in µg/L (data from the TCEQ, TWDB and NURE databases)

As it was discussed earlier in the analysis of arsenic concentration versus well depth in Brazoria, Galveston, and Chambers Counties (Figure 3.11) the medium well depths seem to have the highest concentrations of arsenic also in the vicinity of the two systems discussed in this section. Concentrating on the 10 kilometer (km) buffer in Figure 3.12 depths of seven out of eight wells in which the arsenic concentration was higher than 8 µg/L are in the depth range of 310-425 feet. Two exceptions can be found south and southwest of the PWS systems being evaluated, where in one 400 ft deep well the arsenic concentration was 4.3 µg/L and another well only 69 feet deep where the arsenic level was 19.6 µg/L (NURE well). In the 5-km buffer and north and east within the 10 km buffer, the tendency of low arsenic in shallow wells (<220 feet) and high arsenic in medium depth wells (310- 425 feet) is maintained with no exceptions. Deep wells in this area (*i.e.*, >590 feet) all show concentrations <7 µg/L (Figure 3.12, Table 3.1).

Table 3.1 Arsenic Concentrations and Hydrogeologic Well Data from a 10-km Buffer Around Stoneridge Lake and Oak Meadows PWS Wells (in bold italics)

Database	State well number	Aquifer	Well depth (ft)	Opening top (ft)	Opening bottom (ft)	Sampling date	Arsenic (µg/L)
TWDB	6537703	112CHCTL	595	545	585	4/16/1997	<1.5
TWDB	6537904	112CHCT	400			4/27/2005	25.9
TWDB	6545110	112CHCT	324			4/28/2005	15.1
TWDB	6545307	112CHCT	150			5/12/2005	<2.0
	Well id						
TCEQ	G0200597A	112CHCT	401	385	400	6/16/2004	4.3
TCEQ	G0200527B	112CHCT	159			10/16/2003	6.5
TCEQ	***G0200624A***	***112CHCT***	***416***			***3/11/2004***	***13.7***
TCEQ	G0200036A	112CHCT	324	307	323	2/17/2005	14.8
TCEQ	***G0200566A***	***112CHCT***	***310***			***2/17/2005***	***10.2***
TCEQ	G0200389A	112CHCT	374			2/24/2005	11.7
	Record number						
NURE	1148772		118	102		1978/02/01	<0.5
NURE	1148773		92			1978/02/01	0.6
NURE	1148858		43	36		1978/01/20	<0.5
NURE	1148866		43	20		1978/01/24	5.2
NURE	1148867		184	164		1978/01/24	1.5
NURE	1148869		407	397		1978/01/24	8.5
NURE	1148870		131			1978/01/24	2.4
NURE	1148875		164	69		1978/01/25	<0.5
NURE	1148876		72	62		1978/01/25	<0.5
NURE	1148877		52	39		1978/01/25	0.6
NURE	1148915		200			1978/01/17	0.8
NURE	1148920		69			1978/01/20	19.6
NURE	1148921		69			1978/01/20	1.0

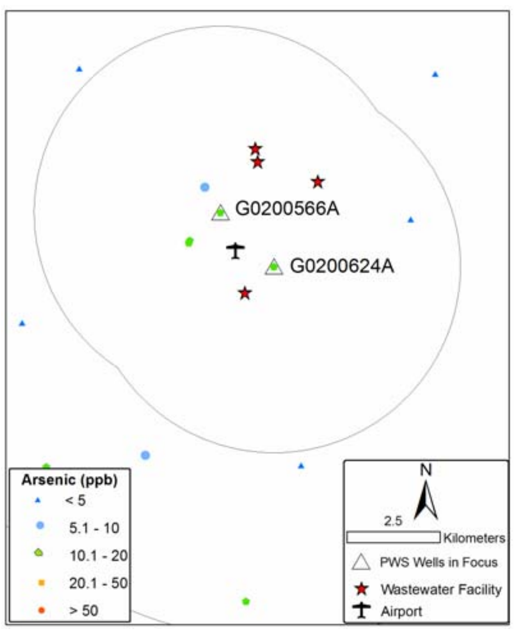
Table 3.2 shows that arsenic concentrations in the Oak Meadows PWS well (G0200566A) fluctuate in time around the 10 µg/L MCL level. There is only one arsenic measurement available for Stoneridge Lake PWS well (G0200624A).

Table 3.2 History of Arsenic Concentrations in Stoneridge Lake and Oak Meadows PWS Wells

Well	Sampling Date	Arsenic (μg/L)
G0200566A	05/16/01	10.3
G0200566A	03/11/04	9.4
G0200566A	05/14/97	9.4
G0200566A	02/17/05	10.2
G0200624A	03/11/04	13.7

PSOCs of arsenic are abundant in this area. Four wastewater facilities and an airport are within the 5-km buffer of the PWS wells of concern (Figure 3.13). The head-gradient in this area is relatively small and toward the Houston depression at the north (based on the GAM report see Figure 55 in Kasmarek and Robinson 2004). The PSOCs in Figure 3.13 are at the range of 1 km, which is probably beyond the radius of significant influence of pumping in the PWS wells. In addition, the fact that shallower wells in this area are usually less contaminated with arsenic than medium depth wells leads to the conclusion that the effect of the arsenic PSOCs drawn in Figure 3.13 is small (or non-existent) relative to geological sources of arsenic.

Figure 3.13 Arsenic Potential Sources of Contamination and Arsenic Concentrations in Wells within a 5-km Buffer of the Stoneridge Lake and Oak Meadows PWSs



3.4.1 Summary of Alternative Groundwater Sources for the Stoneridge Lake PWS

The single well in this system had an arsenic level of 13.7 μg/L in November 2004. Blending this water with low level arsenic water will decrease the arsenic concentration so it complies with the 10 µg/L MCL. In the nearby areas and north and east of this well, all wells with arsenic >8 µg/L are between 310-425 feet deep, while shallower (<220 feet) and deeper (>590 feet) wells have lower arsenic concentrations. Therefore, if a transmissive interval shallower than 220 feet can be found in this well log, screening such an interval may provide low arsenic water and dilute the deeper water entering the well through the existing screen. Other options for dilution include drilling a new shallow well (<220 feet) or importing water from an existing well in the area. The nearest well with low arsenic found in the three databases analyzed in this study is 3.7 km south-southwest of the Stoneridge Lake PWS well. As the NURE database reveals, many wells in the area that are not in the TWDB and TCEQ databases, may have a nearer well with low arsenic concentrations. Deepening the existing PWS well or drilling a new deep well (>600 feet) may also be an option.

SECTION 4
ANALYSIS OF THE STONERIDGE LAKE PWS

4.1 DESCRIPTION OF EXISTING SYSTEM

4.1.1. Existing System

The Stoneridge Lake (SRL) PWS location is shown in Figure 4.1. The Stoneridge Lake PWS is owned and operated by Orbit Systems, Inc. The Stoneridge Lake PWS serves a residential subdivision of 66 people. Currently, the system has 22 connections.

The water source for this PWS is one well, completed in the Chicot aquifer (Code 112CHCT). The well is located in Brazoria County and is 416 feet deep. The production of the well is 0.086 mgd. Disinfection with chlorine gas is performed at the wellhead before water is pumped into pressure tanks prior to entering the distribution system. Polyphosphate is also added as an inhibitor.

The treatment employed for disinfection is not appropriate or effective for removal of arsenic, so optimization is not expected to be effective in increasing removal of this contaminant. It may be possible to identify arsenic-producing strata through comparison of well logs or through sampling of water produced by various strata intercepted by the well screen.

Basic system information is as follows:

- Population served: 66
- Connections: 22
- Average daily flow: 0.009 mgd
- Total production capacity: 0.086 mgd

Basic system raw water quality data is as follows:

- Typical arsenic value: 0.0137 mg/L
- Typical nitrate value: 0.01 mg/L
- Typical total dissolved solids value: 405 mg/L
- Typical pH value: 7.8
- Typical calcium value: 12.4 mg/L
- Typical magnesium value: 4.03 mg/L
- Typical sodium value: 142 mg/L
- Typical chloride value: 84 mg/L

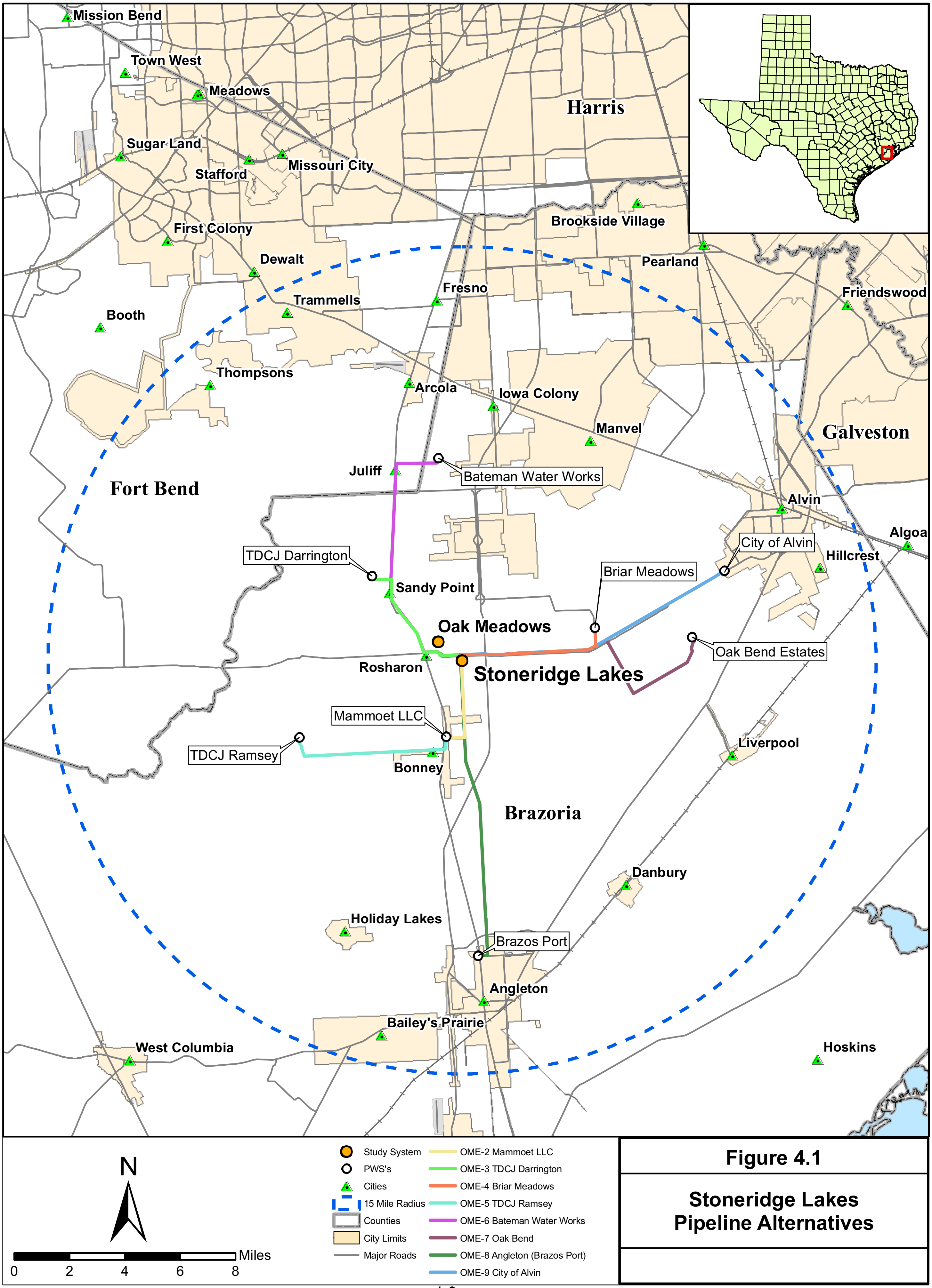


Figure 4.1

Stoneridge Lakes Pipeline Alternatives

J:\744\744655_BEG_2006\GIS_06\mxd\Fig4-1\stoneridge4-1.mxd - 8/25/2006 @ 4:31:41 PM

- Typical bicarbonate (HCO_3) value: 312 mg/L
- Typical fluoride value: 0.7 mg/L
- Typical iron value: 0.093 mg/L
- Typical manganese value: 0.33 mg/L
- Typical conductivity value: 787 µS/cm

4.1.2 Capacity Assessment for Stoneridge Lake PWS

The project team conducted a capacity assessment of the Stoneridge Lake PWS. The results of this evaluation are separated into four categories: general assessment of capacity, positive aspects of capacity, capacity deficiencies, and capacity concerns. The general assessment of capacity describes the overall impression of technical, managerial, and financial capability of the PWS. The positive aspects of capacity describe those factors the PWS is performing well. These factors should provide opportunities for the system to build upon in order to improve capacity deficiencies. The capacity deficiencies noted are those aspects that are creating a particular problem for the system related to long-term sustainability. Primarily, these problems are related to the system's ability to meet current or future compliance, ensure proper revenue to pay the expenses of running the system, and to ensure the proper operation of the system. The last category is titled capacity concerns. These are items that in general are not causing significant problems for the system at this time. However, the system may want to address them before these issues have the opportunity to cause problems.

The project team interviewed Peggy Paul, Engineer for Orbit Systems, Inc.

4.1.2.1 General Structure

Stoneridge Lake PWS is one of 33 systems owned and operated by Orbit, an investor-owned utility. Management includes the company president, operations supervisor, and an engineer who handles all the management, engineering, and financial issues. There are three certified water operators. In addition, the operations supervisor and the engineer are also certified. Orbit also has two contract general laborers and a contract office worker.

The Stoneridge Lake PWS is a subdivision with 22 connections serving approximately 66 people. The system consists of a well and a pressure tank. There is a single rate structure for all of the systems owned and operated by Orbit. The company is currently in the public comment phase of a rate case. They have requested an increase in the rates to a base rate of $24.00 that will not include any water, and a usage charge of $2.25 per 1,000 gallons.

4.1.2.2 General Assessment of Capacity

Based on the team's assessment, this system has an adequate level of capacity. There are several positive managerial, financial and technical aspects of the PWS, but there are also some areas that need improvement. The deficiencies noted could prevent the PWS from being able to meet compliance now or in the future and may also impact the PWS's long-term sustainability.

4.1.2.3 Positive Aspects of Capacity

In assessing a system's overall capacity, it is important to look at all aspects – positive and negative. It is important for systems to understand those characteristics that are working well, so that those activities can be continued or strengthened. In addition, these positive aspects can assist the system in addressing the capacity deficiencies or concerns. The factors that were particularly important for the Stoneridge Lake PWS are listed below.

- **Benefits from Economies of Scale** – The Stoneridge PWS is one of 33 systems owned and operated by Orbit. This structure allows a very small PWS to benefit from the pool of operators and construction and maintenance crews. Orbit is able to maintain an inventory of spare parts in a central location. All of the systems have a single rate structure. As new compliance rules and regulations are introduced that will require more complex and expensive treatment, or as system upgrades and improvements are needed, the ability to take advantage of the economies of scale offered by a single rate structure is critical to maintaining affordability for the small systems. The system maintains a good set of maps and uses them regularly. The maps are updated as the system is changed.
- **Knowledgeable and Dedicated Staff –** The system is owned and managed by one family. As such, the system has been able to maintain the same President, Engineer, and Operator/Operations Supervisor for over 20 years. This longevity in staff creates a long-term memory of the system components and system characteristics. The staff is very dedicated to the system. Other than the general operators, the system has experienced little turnover. The system has an engineer on staff that is able to meet the system's engineering needs. There is toll-free number customers can call after hours.

4.1.2.4 Capacity Deficiencies

The following capacity deficiencies were noted in conducting the assessment and seriously impact the ability of the PWS to meet compliance with current and future regulations and to ensure long-term sustainability.

- **Lack of Sufficient Revenues from Rate Structure for Long-Term Sustainability** – While Orbit has filed a rate case to increase the rates, the new rate structure will not provide funds for arsenic treatment or for significant emergencies. In addition, the current and proposed rate structure does not encourage water conservation. Conservation reduces the demand on the source, reduces chemical and electrical costs, and minimizes wear and tear on equipment, such as pumps. Currently, emergencies or other conditions that cause a shortfall in funding are covered through private funding by the President. This practice has been able to sustain the system in the past, but it may not be a sustainable practice for the future. Orbit should consider some other means of covering these emergencies, such as reserve accounts.
- **Financial Accounting** – While the company does have an accounting software program, they do not have an actual budget. Also, there are no budgets for each of

the individual systems to track what is needed by each system. An annual financial statement is generated in house for the facilities. However, because there is no budget, there is nothing to evaluate the annual financial statements against. Without tracking expenses and revenues specifically for the PWS, it is not possible to know if the revenue collected through user charges is sufficient to cover the cost of current operation, repair and replacement, compliance with the arsenic regulations and provide a reserve fund. The lack of a method to track revenues and expenses could negatively impact the system's ability to develop a rate structure that will provide for the system's long term needs. The system does have an annual financial audit that is presented at the annual meeting, but there does not appear to be a way to check expenses against revenues.

4.1.2.5 Potential Capacity Concerns

The following items were concerns regarding capacity but no specific operational, managerial, or financial problems can be attributed to these items at this time. The system should address the items listed below to further improve technical, managerial, and financial capabilities and to improve the system's long-term sustainability.

- **Lack of Written Long-Term Capital Improvements Plan –** While there appears to be some process in place to plan for future improvements, there is no formal written plan. There is some information in the annual report Orbit prepares for TCEQ. The lack of a long-term written plan could negatively impact the system's ability to develop a budget and associated rate structure that will provide for the system's long term needs.

- **Written Operational Procedures** – There are no written operational procedures for the staff. Currently, due to the family nature of the business and the longevity of the staff, no problems are created by a lack of these procedures. However, if there is a turnover in staff, the lack of written procedures could be a major problem for the system.

- **Lack of Preventative Maintenance Program –** While there is some preventative maintenance done on the system, Orbit agreed that it could be done better. A regular schedule of preventative maintenance could help in system reliability.

- **Lack of Emergency Plan** – The system does not have a written emergency plan, except as part of their drought contingency plan, nor does it have emergency equipment such as generators. The system should have an emergency or contingency plan that outlines what actions will be taken and by whom. The emergency plan should meet the needs of the facility, the geographical area, and the nature of the likely emergencies. Conditions such as storms, floods, major line breaks, electrical failure, drought, system contamination or equipment failure should be considered. The emergency plan should be updated annually, and larger facilities should practice implementation of the plan annually.

4.2 ALTERNATIVE WATER SOURCE DEVELOPMENT

4.2.1 Identification of Alternative Existing Public Water Supply Sources

Table 4.1 is a list of the existing groundwater-supplied public PWSs within approximately 15 miles of the Stoneridge Lake PWS. From these PWSs, eight were selected for further evaluation based on factors such as water quality, distance from the Stoneridge Lake PWS, sufficient total production capacity for selling or sharing water, and willingness of the system to sell or share water or drill a new well. The PWSs selected for further evaluation are shown in Table 4.2.

Table 4.1 Surrounding Public Water Systems

System Name	Approximate Distance from SRL (miles)	Comments/Issues
Grasslands	0.3	Small system with WQ issues: As; Owned by Orbit.
Oak Meadows Estates Subdivision	1.1	Small system with WQ issues: As, Fe
Schlumberger Reservoir Comp	1.4	WQ issues: As, Mn.
Rosharon Township	1.5	Small system with WQ issues: As, Mn; Owned by Orbit.
Exxon Mobile-Thompson Field	1.8	No WQ issues; low total production.
Yellow Rose Tavern	2.4	No WQ issues (but limited analyses); low total production.
Mammoet USA, Inc.	2.8	WQ within acceptable range; unknown total production. Evaluate further.
Sandy Meadow Estates Subdivision	2.7	Small system with WQ issues: As, Mn; Owned by Orbit.
Rosharon Road Estates Subdivision	3.9	Small system with WQ issues: As, Mn
Susie's Corner	4.1	WQ issues: Fe, Mn; low total production.
TDCJ ID Darrington Unit	4.6	WQ acceptable, adequate production, excess capacity. ***Evaluate further***.
Briar Meadows	5.0	WQ is acceptable, owned by Orbit, no excess capacity. ***Evaluate further***.
Diamond Mini Mart 316	5.9	WQ issues: As, Mn; low total production.
TDCJ Ramsey Area	6.7	WQ issues: Fe. ***Evaluate further***.
The Bend at Brazoria Golf	7.2	WQ issues: Mn; unknown total production.
Bateman Water Works	7.4	WQ issues: Mn; low total production. ***Evaluate further***.
Brazoria Cnty Detention	7.5	WQ issues: As.
JMP Utilities Inc	7.7	WQ issues: Mn; low total production. Possible excess capacity.
Sam's Country Store	7.7	WQ issues: Mn; low total production.
Bayou Shadows Water	8.1	WQ issues: As, Mn; low total production.
Monsanto Park Chocolate Bayou	8.3	WQ issues: Mn; unknown total production.

System Name	Approximate Distance from SRL (miles)	Comments/Issues
Wolf Glen PWS	8.3	WQ issues: TDS, Fe, Mn; low total production.
Oak Bend Estates	8.4	WQ issues: Mn; low total production. Consider installing a well. Evaluate further.
Riverside Estates	8.6	WQ issues: Mn; low total production.
Oak Manor Municipal Utility	8.7	WQ issues: As, Mn; low total production.
Brandi Estates	8.9	WQ issues: Mn; low total production.
Alvin Food Mart 2	9.0	WQ within acceptable range; low total production.
Alameda Water Well Service	9.3	WQ issues: Fe, Mn.
Anglecrest Subdivision	9.3	WQ issues: Mn; low total production.
Beachwood Subdivision	9.3	WQ issues: Fe, Mn; low total production.
Cross Country Stores	9.5	WQ issues: As, Mn; low total production.
Mark V Estates	9.5	WQ issues: As; Owned by Orbit.
Red Oak 102 Chevron	9.6	WQ issues: Mn; low total production.
PT Food Mart	9.7	WQ issues: Fe, Mn; unknown total production.
TPWD Brazos Bend State Park 2	9.7	WQ issues: Fe; low total production.
Best Sea Pack	9.7	No WQ issues, no excess capacity, willing to drill new well.
Southwood Estates Inc	9.8	WQ issues: Fe, Mn; low total production.
City of Manvel	9.8	WQ issues: Mn; low total production.
Colony Cove Subdivision PWS	9.9	WQ issues: Mn; low total production.
City of Danbury	10.1	Small system with WQ issues: As, Fe, Mn.
Lee Ridge Subdivision	10.3	WQ issues: Mn; low total production.
Coastal Mini Mart 335	10.3	WQ issues: Mn; low total production.
City of Liverpool	10.4	WQ issues: As; low total production.
Country Meadows	10.5	WQ issues: Mn; low total production.
TPWD Brazos Bend State Park 1	10.7	No WQ issues; low total production.
Country Acres Estates	10.7	WQ issues: Mn; low total production.
City of Angleton/Brazosport Water Authority	10.7	The City purchases supplemental treated water from BWA. BWA has excess capacity and is willing to sell. There is an 18-inch BWA main to north of city. Evaluate further.
City of Holiday Lake	10.8	WQ issues: Fe, TDS;
Bedrock Café	10.8	WQ issues: Fe, Mn; low total production.
Columbus Club Association	10.9	WQ issues: Mn; low total production.
Sienna Plantation MUD 1	11.0	WQ acceptable, adequate total production.
Houston Southwest Airport	11.0	WQ issues: Mn; distance; low total production.
Weybridge Subdivision	11.0	WQ issues: Mn; distance; low total production.
Arcola Food Market	11.2	WQ issues: Fe, Mn; distance; low total production.
Willow Wood Duplex	11.2	WQ issues: Mn; distance; low total production.
Anchor Road Mobile Home	11.3	WQ issues: Fe, Mn; distance; low total production.

System Name	Approximate Distance from SRL (miles)	Comments/Issues
Wolfe Air Park	11.4	Water quality within acceptable range; distance; low total production.
Wee Mart	11.5	WQ acceptable; distance; low total production.
Teleview Terrace Subdivision	11.6	WQ issues: Fe, Mn; distance; low total production.
Brazoria Cnty Parks Brazos Rvr Pk	11.6	WQ issues: As, Mn; distance; low total production.
Alvin Country Club	11.6	No WQ issues; distance; unknown total production.
Hot Market	11.8	WQ issues: Fe, Mn; distance; unknown total production.
Malt n Burger	11.8	WQ issues: Mn; distance; unknown total production.
Fresno Food Market	12.0	Water quality within acceptable range; distance; low total production.
Kickin Up at Eddies	12.0	WQ issues: Fe, Mn; distance; low total production.
Calico Farms Subdivision	12.1	WQ issues: Mn; distance; low total production.
Schmidt Manufacturing	12.2	WQ issues: As, Fe, Mn; distance; low total production.
Halliburton Services Fresno	12.3	WQ issues: Mn; distance; low total production.
Ashley Oaks Mobile Home	12.3	WQ issues: Mn; distance; low total production.
Niagara Public Water Supply	12.5	WQ issues: Fe, Mn; distance; low total production.
Spin N Market 11	12.5	WQ issues: Mn; distance; low total production.
City of Alvin	12.5	WQ within acceptable range, excess capacity, and willing to sell. Evaluate further.
Almost Heaven Campground	12.6	WQ issues: Fe, Mn; distance; low total production.
Fresno Mobile Home Park	12.8	WQ issues: Mn; distance; low total production.
Pleasant Meadows Subdivision	12.8	WQ issues: Mn; distance; low total production.
Sandy Ridge Subdivision	12.9	WQ issues: Mn; distance; low total production.
Pleasantdale Subdivision	12.9	WQ issues: Mn; distance; low total production.
Crossroad Market	13.0	WQ issues: Fe, Mn; distance; unknown total production.
Behavior Training Research	13.1	No WQ issues; distance; low total production.
Meadowland Subdivision	13.1	WQ issues: Mn; distance; low total production.
Country Creek Estates	13.1	WQ issues: Mn; distance; low total production.
Turner Water Service	13.2	WQ issues: Mn; distance; low total production.
Champion Technologies Inc	13.2	WQ acceptable; distance; low total production.
Westwood Subdivision	13.3	WQ issues: Mn; distance; low total production.
City of Hillcrest Village	13.3	WQ acceptable, adequate total production, distance may be a limiting factor.
Johnson's Water Service	13.4	WQ issues: Mn; distance; low total production.
Heights Country Subdivision	13.4	WQ issues: Mn; distance; low total production.
Angle Acres PWS	13.4	WQ issues: Fe, Mn; distance; low total production.
Windsong Subdivision	13.5	WQ issues: Mn; distance; low total production.
Centennial Place	13.7	WQ acceptable; distance; low total production.
Pine Colony Mobile Home Park	13.7	WQ issues: Mn; distance; low total production.
Meadowview Subdivision	13.8	WQ issues: Mn; distance; low total production.

System Name	Approximate Distance from SRL (miles)	Comments/Issues
Country Oaks Arbor MHP	13.9	WQ issues: Fe, Mn; distance; low total production.
Cedar Grove Park	13.9	WQ acceptable; distance; low total production.
Moreland Subdivision Block 3&4	13.9	WQ issues: Mn; distance; low total production.
Johns Countryette	14.0	No WQ issues; distance; low total production.
Frontier Water Co.	14.0	WQ issues: Fe, Mn; distance; low total production.
Palmetto Subdivision	14.0	WQ issues: Mn; distance; low total production.
Custom Food Group	14.0	WQ acceptable; distance; low total production.
Village Trace PWS	14.1	WQ acceptable; distance; low total production.
Flora 7	14.1	WQ issues: Mn; distance; low total production.
Mooreland Subdivision Water	14.1	WQ issues: Mn; distance; low total production.
Moreland Subdivision Block 1&2	14.2	WQ issues: Fe; distance; low total production.
Ryan Long Subdivision 2 Water	14.2	WQ issues: Mn; distance; low total production.
Coronado Country	14.2	WQ issues: Mn; distance; low total production.
West Lea PWS	14.4	WQ issues: Mn; distance; low total production.
Brazoria Co Parks - Resort Pk	14.4	Water quality within acceptable range; distance; low total production.
Quail Meadows Subdivision	14.6	WQ issues: Mn; distance; low total production.
Meadowlark Subdivision	14.6	WQ issues: Mn; distance; low total production.
Sharondale Subdivision	14.6	WQ issues: Mn; distance; low total production.
Racetrac Petroleum 527	14.7	WQ issues: Mn; distance; unknown total production.
Blue Sage Gardens	14.7	WQ issues: Mn; distance; low total production.
Manvel Road Terrace	14.7	WQ issues: Mn; distance; low total production.
Coastal Mini Mart 338	14.7	No WQ issues; distance; unknown total production.
Flora 6	14.8	WQ issues: Fe, Mn; distance; low total production.
Gene's Country Store	14.8	WQ issues: Mn, TDS; distance; unknown total production.
End of the Trail	14.9	WQ issues: Mn; distance; low total production.
A Place to Grow Day Care	15.0	WQ issues: Mn; distance; low total production.

After the PWSs in Table 4.1 with water quality problems were eliminated from further consideration, the remaining PWSs were screened by proximity to Stoneridge Lake PWS and water production capacity. The nearest PWSs with acceptable water quality were selected for further consideration regardless of size. A few more distant PWSs were also selected for further consideration if they were large water suppliers in the area.

Table 4.2 Existing Public Water Systems within 15 miles of Stoneridge Lake Selected for Further Evaluation

System Name	Pop	Conn	Total Production (mgd)	Avg Daily Demand (mgd)	Approx. Dist. From Stoneridge Lake (mile)	Comments/ Other Issues
Mammoet USA, Inc.	25	2	0.029	na	2.8	No excess capacity. However, based on WQ data and proximity to the Stoneridge Lake PWS, this PWS may provide a suitable location for a new well. (WQ: Marginal Mn)
TCDJ ID Darrington Unit	2,037	1,250	1.886	0.51	4.6	Adequate production with excess capacity.
Briar Meadows	111	37	0.101	0.015	5.0	No excess capacity. However, based on WQ data and proximity to the Stoneridge Lake PWS, this PWS may provide a suitable location for a new well. (WQ: Marginal Fe)
TCDJ Ramsey Area	6,000	2,000	1.919	1.263	6.7	Adequate production with excess capacity. (WQ: Elevated Fe)
Bateman Water Works	72	24	0.086	na	7.4	No excess capacity. However, based on WQ data and proximity to SRL, this PWS may provide a suitable location for a new well. (WQ: Elevated Mn)
Oak Bend Estates	114	38	0.055	0.015	8.4	No excess capacity. However, based on WQ data and proximity to SRL, this PWS may provide a suitable location for a new well. (WQ: Elevated Mn)
City of Angleton/BWA	19,167	6,389	5.112	1.910	10.7	The City purchases supplemental treated water from BWA. BWA has excess capacity and is willing to sell water. There is an 18-inch BWA main to north of city.
City of Alvin	17,916	5,817	8.739	1.307	12.5	Excess capacity and willing to sell water.

n/a (not applicable); na (not available); WQ (water quality); Fe (iron); Mn (manganese).

4.2.1.1 Mammoet USA, Inc.

Mammoet USA, Inc. is located off State Highway 288B in Bonney, Texas, approximately 2.8 miles south of SRL. The PWS is operated by Mammoet USA, Inc. and serves a population of 25 with two connections. The well is 270 feet deep with a rated capacity of 0.029 mgd. The water is used primarily for industrial and agricultural purposes. The water is hypochlorinated for disinfection before distribution. The system has one 310 gallon pressure tank. Water is used for industrial and agricultural purposes. The quality of the water is good with an average arsenic concentration of 0.002 mg/L based on two sample results.

There is not sufficient excess capacity at Mammoet USA to supplement the SRL existing supply; however, based on the available water quality data, the location may be a suitable point for a new groundwater well.

4.2.1.2 TDCJ Darrington Unit

The Texas Department of Criminal Justice (TDCJ) operates the Darrington Unit prison located 4.6 miles northwest of SRL. The TDCJ Darrington Unit PWS serves a population of 2,037 with 1,250 connections. The PWS is supplied by three local groundwater wells, two of which are completed in the Lower Chicot aquifer, and one of which is completed in the Evangeline aquifer. The wells G0200204A, G0200204B, and G0200204C were drilled to depths of 595 feet, 537 feet and 1,140 feet, respectively. The tested flow rates of each well are 360, 350 and 600 gpm for a total system production capacity of 1.886 mgd. The treatment process consists of sequestration and chlorination. The average daily demand is 0.51 mgd which means the TDCJ Darrington PWS is utilizing approximately 27 percent of total system capacity.

This water supply system has excess capacity to supplement the Stoneridge Lake PWS. No water quality issues are reported for the TDCJ Darrington PWS in the TCEQ database.

4.2.1.3 Briar Meadows

Briar Meadows is located on farm-to-market road (FM) 1462, 5.0 miles to the east-northeast of the Stoneridge Lake PWS. The Briar Meadows PWS is owned by Orbit, and is supplied by a single groundwater well. The well, completed in the Chicot aquifer, is 210 feet deep and rated for 0.086 mgd. The system has 5,000 gallons of storage capacity. The Briar Meadows PWS serves a population of 111 with 37 metered connections. The water delivery system has a total peak production of 0.101 mgd and water is hypochlorinated and treated with polyphosphate before distribution.

The estimated average and maximum daily demand is 0.015 mgd and 0.059 mgd, respectively. The well does not have enough capacity to meet the peak demand flow rate of SRL. However, based on water quality data of the Briar Meadows PWS and its proximity to SRL, the Briar Meadows PWS may provide a suitable location for a new well.

4.2.1.4 TDCJ Ramsey Area

The TDCJ also operates the Ramsey Area prison, located 6.7 miles to the southwest of SRL. The TDCJ Ramsey Area PWS serves a population of 6,000 with 2,000 metered connections. The PWS is supplied by five groundwater wells.

The average consumption for the system is 1.263 mgd, the maximum capacity is 2.203 mgd, and the service pump capacity is 5.4 mgd. The total storage capacity is 1,350,000 gallons with elevated storage of 200,000 gallons. The quality of the water is good with an average arsenic concentration of 0.002 mg/L based on four samples collected between March 1999 and November 2003. However, iron concentrations have exceeded the SMCL of 0.3 mg/L based on two samples collected between March 1999 and April 2002.

There is sufficient excess capacity at the TDCJ Ramsey Area PWS to supplement the Stoneridge Lake PWS existing supply.

4.2.1.5 Bateman Water Works

Bateman Water Works is located 7.4 miles north of SRL. The water source is one 320-foot deep well that has a total production of 0.086 mgd. The system has 24 connections and serves approximately 75 people. The system has experienced some problems with the presence of manganese at levels in excess of the SMCL. Treatment consists of sequestration and hypochlorination.

There is not sufficient excess capacity at Bateman Water Works to supplement the SRL existing supply. Manganese is sometimes above the SMCL, which requires sequestering; however, based on the overall water quality data and the proximity to SRL, the location may be a suitable point for a new groundwater well.

4.2.1.6 Oak Bend Estates

Oak Bend Estates is located on County Road 864A off County Road 172, approximately 8.4 miles east of SRL. The PWS is operated by Southwest Utilities, Inc., in El Campo, Texas. Oak Bend Estates serves a population of 114 with 38 connections. The well is 145 feet deep with a rated capacity of 0.05 mgd. The system has a 21,000-gallon ground storage tank, two 125 gpm service pumps, and one 2,500-gallon pressure tank. The water delivery system has a total peak production of 0.055 mgd. The estimated average and maximum daily demand is 0.015 mgd and 0.06 mgd, respectively. Manganese is above the SMCL and the water is treated before distribution. The well has no excess capacity.

There is not sufficient excess capacity at Oak Bend Estates to supplement the SRL existing supply. However, based on overall water quality data, the location may be a suitable point for a new groundwater well.

4.2.1.7 City of Angleton/Brazosport Water Authority

The City of Angleton is located 10.7 miles south of SRL. The PWS is supplied by six local groundwater wells, which are supplemented by treated surface water purchased from the BWA. The BWA is a wholesale water provider that operates a WTP located in the City of Lake Jackson and supplies many communities in Brazoria County with treated water. Its primary water source is the Brazos River.

The City of Angleton's six wells draw water from the Chicot aquifer (Code 112CHCT), are between 650 and 960 feet deep, and have a total production of 5.112 mgd. Well water is aerated and treated with polyphosphate and chlorine before being discharged to two storage tanks. The City uses the purchased water from BWA to mix with water from the wells. The City of Angleton serves a population of 19,200 and has approximately 6,400 metered connections. It is currently not in a position to sell water to third parties.

The BWA has up to 5 mgd of excess treated water capacity it is willing to sell, assuming that suitable arrangements can be negotiated. The BWA has an 18-inch supply line that terminates on the north side of the City of Angleton, near the corner of Vasquez and

Henderson. The BWA requires that all its customers provide for a minimum of 8 hours storage capacity to sustain supply in the event of BWA's maintenance activities. Based on recent experience with Dow Chemical, the negotiation and approval process could take up to 2 years; however, it is expected the process would be less difficult for another PWS.

4.2.1.8 City of Alvin

The City of Alvin is located 12.5 miles northeast of SRL. The PWS is supplied by four groundwater wells, three of which are completed in the Lower Chicot aquifer (Code 112CHCTL) and one of which is completed in the Evangeline aquifer (Code 121EVGL). The four wells are between 688 and 711 feet deep, and have a total production of 8.739 mgd. Well water is treated with polyphosphate and hypochlorite before being discharged to several ground and elevated storage tanks. The City serves a population of 17,916 and has 5,817 metered connections. The reported average daily demand is 1.307 mgd.

The City of Alvin currently provides finished water to several small PWSs within its extra-territorial jurisdiction (ETJ) and is building lines out toward Manvel, located to the west along Highway 6. The City plans to build lines past Manvel and a new plant and storage tank in that region sometime between 2006-2008. Currently, the City has up to 4 mgd of excess capacity, and is willing to negotiate to sell water to other PWSs outside its ETJ.

The Gulf Coast Water Authority also plans to build a 150 mgd water treatment plant (WTP) to treat Brazos River water. The Stoneridge Lake PWS may be able to connect to this regional WTP distribution system within the City of Alvin. The new WTP may be built on 80 acres of land currently owned by the Fort Bend County Water Control & Improvement District (WC&ID) No. 2 (http://www.fortbendcountywcid2.com/WaterSource.htm). This would be a regional WTP that may serve west Harris County, City of Sugar Land, City of Missouri City, City of Arcola, City of Pearland, City of Alvin, City of Manvel, City of Friendswood, and the area within the boundaries of Fort Bend County WC&ID No. 2, which includes the City of Stafford.

4.2.2 Potential for New Groundwater Sources

4.2.2.1 Installing New Compliant Wells

Developing new wells or well fields is likely to be an attractive alternative, provided good quality groundwater in sufficient quantity can be identified. Since a number of PWSs in the area also have problems with arsenic and/or manganese, it should be possible to share in the cost and effort of identifying compliant groundwater and constructing well fields. Additionally, the assessment in Section 3 indicates there is a possibility for finding compliant water at the Stoneridge Lake PWS location by installing a shallower or deeper well.

Installation of a new well in the vicinity of the system intake point is likely to be an attractive option provided compliant groundwater can be found, since the PWS is already familiar with operation of a water well. As a result, existing nearby wells with good water quality should be investigated. Re-sampling and test pumping would be required to verify and determine the quality and quantity of water at those wells.

The use of existing wells should probably be limited to use as indicators of groundwater quality and availability. If a new groundwater source is to be developed, it is recommended that a new well or wells be installed instead of using existing wells. This would ensure the well characteristics are known and the well construction meets standards for drinking water wells.

Some of the alternatives suggest new wells be drilled in areas where existing wells are compliant. In developing the cost estimates, it is assumed the aquifer in these areas would produce the required amount of water with only one well. Site investigations and geological research, which are beyond the scope of this study, could indicate whether the aquifer at a particular site and depth would provide the amount of water needed or if more than one well would need to be drilled in separate areas. Two wells are used in cases where the PWS is large enough that two wells are required by TCEQ rules.

4.2.2.2 Results of Groundwater Availability Modeling

Regional groundwater withdrawal in the PWS area is extensive and is likely to steadily increase over the next decades. In Brazoria County, the Chicot aquifer constitutes the primary groundwater source for public supplies. This aquifer is the upper unit of the Gulf Coast aquifer system that extends along the entire Texas coastal region. Throughout the northern part of the Gulf Coast aquifer system, large groundwater withdrawals since the 1900s have resulted in declines in the aquifer's potentiometric surface from tens to hundreds of feet. The largest declines have occurred in the Harris-Galveston Coastal Subsidence District (HGCSD), around the Houston metropolitan area, whose area of influence encompasses most of Brazoria County.

A GAM for the northern part of the Gulf Coast aquifer was recently developed by the TWDB. Modeling was performed by the U.S. Geological Survey (USGS) to simulate historical conditions (Kasmerek and Robinson 2004), and to develop long-term groundwater projections (Kasmerek, Reece, and Houston 2005). Two projections were evaluated, a TWDB scenario based on 50-year regional projections by regional user groups, and a HGCSD scenario that incorporates 30-year projections by the HGCSD for the Houston Metropolitan area. Modeling of both projections anticipate extensive groundwater use and drop in aquifer levels, with far more critical groundwater availability conditions anticipated under the 30-year HGCSD scenario.

Under the more conservative HGCSD scenario, withdrawals from the Chicot aquifer and underlying Evangeline aquifer would increase by 2030 to an estimated 1,520 million gallons per day (mgd), a 74 percent increase relative to 1995 conditions. Modeling of these projections indicate a significant increase in the aquifer's cone of depression by 2030, with depth increases of over 200 feet relative to current conditions (Kasmerek, Reece, and Houston 2005). The percent of withdrawals supplied by net aquifer recharges would also steadily decrease, from an estimated 72 percent in 1995 to 43 percent projected in 2030 (Kasmerek, Reece, and Houston 2005). In Brazoria County, the projected 30-year drop in water levels would range from 50 to 100 feet.

Under the TWDB scenario, long-term withdrawals from the Chicot aquifer and underlying Evangeline aquifer would moderately increase or remain at current levels over the 50-year simulation period; the largest increase in withdrawal would occur between 2000 and 2010, with an 8 percent increase from 850 to 920 mgd per day (Kasmerek, Reece, and Houston 2005). Modeling of the TWDB scenario showed relatively little change in elevation of the Chicot aquifer's potentiometric surface. In Matagorda County, however, a drop of elevation from 50 to 100 feet would occur under 2010 withdrawal conditions. The simulated net recharge of the aquifer, in contrast with the HGCSD scenario, would moderately increase under the TWDB scenario (Kasmerek, Reece, and Houston 2005).

The GAM of the northern part of the Gulf Coast aquifer was not run for the SRL system as groundwater availability would reflect regional conditions driven by HGCSD groundwater withdrawal. Water use by the small PWS would represent a minor addition to the regional water use, making potential changes in aquifer levels well beyond the spatial resolution of the regional GAM model.

4.2.3 Potential for New Surface Water Sources

There is a low potential for development of new surface water sources for the SRL system as indicated by limited water availability within the site vicinity. The system is located within the San Jacinto-Brazos Basin where current surface water availability is expected to remain at current levels over the next 50 years according to the Texas Water Development Board's 2002 Water Plan (at approximately 47,700 acre-feet per year (AFY) during drought conditions). Approximately 10 miles west of the site, the San Jacinto-Brazos Basin transitions into the Brazos Basin where water availability is expected to decrease up to 17 percent over the next 50 years.

The vicinity of the SRL system has a minimum availability of surface water for new uses. The TCEQ availability map for the San Jacinto-Brazos Basin and Brazos Basin indicates that, over a 20-mile radius of the site, unappropriated flows for new uses are typically available less than 50 percent of the time. This supply is inadequate as the TCEQ requires 100 percent supply availability for a PWS.

4.2.4 New Water Source Options for Detailed Consideration

The initial review of existing PWS sources results in the following options for more-detailed consideration:

1. Installing a new, deeper well at Stoneridge Lake PWS that would produce compliant water in place of the water produced by the existing active well (Alternative SRL-1).

2. Drill a new well near Mammoet USA; install a storage tank, pump station, and pipeline (Alternative SRL-2).

3. Drill a new well near TDCJ Darrington Unit; install a storage tank, pump station, and pipeline (Alternative SRL-3).

4. Drill a new well near Briar Meadows; install a storage tank, pump station, and pipeline (Alternative SRL-4).

5. Drill a new well near TDCJ Ramsey Area; install a storage tank, pump station, and pipeline (Alternative SRL-5).

6. Drill a new well near Bateman Water Works; install a storage tank, pump station, and pipeline (SRL-6).

7. Drill a new well near Oak Bend Estates; install a storage tank, pump station, and pipeline (Alternative SRL-7).

8. Purchase treated surface water from the BWA; install a storage tank, pump station, and pipeline to tie into existing BWA main north of the City of Angleton (Alternative SRL-8).

9. Purchase treated groundwater from the City of Alvin; install a storage tank, pump station, and pipeline (Alternative SRL-9).

10. Installing a new well within 10, 5, or 1 mile of the Stoneridge Lake PWS that would produce compliant water in place of the water produced by the existing well (Alternatives SRL-10, SRL-11, and SRL-12).

4.3 TREATMENT OPTIONS

4.3.1 Centralized Treatment Systems

Centralized treatment of the well field water is identified as a potential alternative for Stoneridge Lake PWS. IX, iron-based adsorption, and coagulation/filtration treatments are potential applicable processes. IX, iron-based adsorption, and coagulation/filtration treatments can remove arsenic to produce compliant water. The central IX treatment alternative is Alternative SRL-13, the central iron-based adsorption treatment is Alternative SRL-14, and the central coagulation/filtration treatment is Alternative SRL-15.

4.3.2 Point-of-Use Systems

POU treatment using IX technology is valid for arsenic removal. The POU treatment alternative is SRL-16.

4.3.3 Point-of-Entry Systems

POE treatment using IX technology is valid for arsenic removal. The POE treatment alternative is SRL-17.

4.4 BOTTLED WATER

Provision of bottled water is considered an interim measure to be used until a compliance alternative is implemented. Even though the community is small and people know each other; it would be reasonable to require a quarterly communication advising customers of the need to take advantage of the bottled water program. An alternative to providing delivered bottled water is to provide a central, publicly accessible dispenser for treated drinking water. Alternatives addressing bottled water are SRL-18, SRL-19, and SRL-20.

4.5 ALTERNATIVE DEVELOPMENT AND ANALYSIS

A number of potential alternatives have been identified. Each potential alternative is described in the following subsections. It should be noted that the cost information given is the capital cost and change in O&M costs associated with implementing the particular alternative. Appendix C contains cost estimates for the compliance alternatives. These compliance alternatives represent a range of possibilities, and a number of them are likely not feasible. However, all have been presented to provide a complete picture of the range of alternatives considered. It is anticipated that a PWS will be able to use the information contained herein to select the most attractive alternative(s) for more detailed evaluation and possible subsequent implementation.

Some of the alternatives suggest new wells be drilled in areas where existing wells are compliant with the arsenic MCL of 10 μg/L. In developing the cost estimates, Parsons assumed the aquifer in these areas would produce the required amount of water with only one well. Site investigations and geological research, which is beyond the scope of this study, may indicate that the aquifer at a particular site and depth may not provide the amount of water needed or more than one well would need to be drilled in separate areas.

4.5.1 Alternative SRL-1: New Well at the Current Stoneridge Lake PWS Location

This alternative involves completing a new, deeper well at the current Stoneridge Lake PWS site, and tying it into the existing PWS. The new well would be 600 feet deep. Based on the water quality data in the TCEQ database, it is expected that groundwater from this location at a different depth may be compliant with drinking water MCLs.

The estimated capital cost for this alternative includes completing the new well, constructing the connection piping, and a new storage tank and feed pump set to supply water to the existing system. The estimated capital cost for this alternative is $153,580, and the estimated O&M cost for this is $20,587.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative would be characterized as easy to operate and repair, since O&M and repair of the current system is well understood, and Orbit personnel currently operate it. If the decision were made to perform blending, then the operational complexity would increase.

Obtaining agreements is not necessary for implementing this option, and should not impact the feasibility of this alternative.

4.5.2 Alternative SRL-2: New Well near Mammoet USA, Inc.

The SRL-2 alternative consists of drilling a new well near the Mammoet USA well in Bonney, Texas. Records indicate there is no detectable amount of arsenic in the Mammoet USA well water. Treatment may be required for manganese which is marginally high at times.

This alternative would require drilling a new well and installing a ground storage tank, a pump station, a pipeline to the SRL system, and a new storage tank and feed pump set at SRL. One of the two pumps in the pump station would be used for backup in the event the other pump fails. The pipeline would be a 4-inch pipeline 3.6 miles long. The required pump horsepower is 1 hp.

This alternative presents a limited regional solution since other PWSs in the area also need compliant water. Some regionalization could be accomplished by sharing the cost of drilling the well with other non-compliant PWSs in the area.

The estimated capital cost for this alternative includes the costs for a new well and small ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. The estimated O&M cost for this alternative includes labor and material costs to operate the well field, to maintain the pipeline, and to operate the pump station. The estimated capital cost for this alternative is $989,881 and the estimated annual O&M cost is $41,763.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations are well understood, and Orbit currently operates pipelines and a pump station.

The feasibility of this alternative is dependent on finding a suitable well site.

4.5.3 Alternative SRL-3: New Well near TDCJ Darrington Unit

The SRL-3 alternative consists of drilling a new well near the TDCJ Darrington well field. Records indicate there is no detectable amount of arsenic in the TDCJ Darrington Unit well water.

This alternative would require drilling a new well and installing a well pump, small ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. One of the two pumps in the pump station would be for backup in the event the other pump fails. The pipeline would be a 4-inch line 5.5 miles long. The required pump horsepower is 2 hp.

This alternative presents a limited regional solution since other PWSs in the area also need compliant water. Some regionalization could be accomplished by sharing the cost of drilling the well with other non-compliant PWSs in the area.

The estimated capital cost for this alternative includes the costs for a new well and small ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and new storage tank and feed pump set at SRL. The estimated O&M cost for this alternative includes labor and material costs to operate the well field, to maintain the pipeline, and to operate the pump station. The estimated capital cost for this alternative is $1.42 million and the estimated annual O&M cost is $42,332.

Reliability of supply of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative would be characterized as easy to operate and repair since Orbit currently operates pipelines and a pump station.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations is well understood, and Orbit currently operates pipelines and a pump station.

The feasibility of this alternative is dependent on finding a suitable well site.

4.5.4 Alternative SRL-4: New Well Near Briar Meadows

The SRL-4 alternative consists of drilling a new well in the Briar Meadows area to supplement the existing capacity at SRL. Records indicate that water from the Briar Meadows PWS is meeting the MCL for arsenic, and the SMCL for iron and manganese. It is expected that groundwater from a new well in the area will also be compliant with drinking water standards.

This alternative would require drilling a new well and installing a ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. One of the two pumps in the pump station would be for backup in the event the other pump fails. The pipeline would be constructed of 4-inch pipe and would be 5.9 miles long and discharge to the existing storage tank at SRL. The required pump horsepower is 2 hp.

The SRL and Briar Meadows PWS are owned and operated by Orbit. This alternative presents a good opportunity for a regional solution, since there are other PWSs in the area, including those owned and operated by Orbit, that need compliant water. Regionalization would allow the sharing of the cost of drilling the well(s) at the Briar Meadows well field.

The estimated capital cost for this alternative includes drilling a new well and installing a well pump, small ground storage tank, pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tanks and feed pump set at SRL. The estimated O&M cost for this alternative includes maintenance cost for the pipeline, and power and O&M labor and materials for the pump station minus the cost SRL currently pays to operate its well field. The estimated capital cost for this alternative is $1.49 million, and the estimated annual O&M cost is $42,336.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations are well understood, and Orbit currently operates pipelines and a pump station. Additionally, both SRL PWS and Briar Meadows PWS are owned and operated by Orbit.

The feasibility of this alternative is dependent on finding a suitable well site.

4.5.5 Alternative SRL-5: New Well near TDCJ Ramsey Area

The SRL-5 alternative consists of drilling a new well near the TDCJ Ramsey Area well field. Records indicate there is no detectable amount of arsenic in the TDCJ Ramsey Area well water. However, iron exceeds the SMCL of 0.3 mg/L.

This alternative would require drilling a new well and installing a well pump, small ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. One of the two pumps would be for backup in the event the other pump fails. The pipeline would be a 4-inch line 9.8 miles long. The required pump horsepower is 2 hp.

This alternative presents a limited regional solution since other PWSs in the area also need compliant water. Some regionalization could be accomplished by sharing the cost of drilling the well with other non-compliant PWSs in the area.

The estimated capital cost for this alternative includes the costs for a new well and small ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. The estimated O&M cost for this alternative includes labor and material costs to operate the well field, to maintain the pipeline, and to operate the pump station. The estimated capital cost for this alternative is $2.30 million and the estimated annual O&M cost is $43,197.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations is well understood, and Orbit currently operates pipelines and a pump station.

The feasibility of this alternative is dependent on finding a suitable well site.

4.5.6 Alternative SRL-6: New Well near Bateman Water Works

The SRL-6 alternative consists of drilling a new well near Bateman Water Works. Records indicate that water from the system is meeting the MCL for arsenic and the SMCL for iron, but exceeding the SMCL for manganese. Treatment includes sequestering for manganese.

This alternative would require drilling a new well and installing a ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. One of the two pumps in the pump station would be used for backup in the event the other pump fails. The pipeline would be a 4-inch pipeline approximately 10.4 miles long. The required pump horsepower is 2 hp.

This alternative presents a limited regional solution since other PWSs in the area also need compliant water. Some regionalization could be accomplished by sharing the cost of the pump station and pipeline with other non-compliant PWSs in the area.

The estimated capital cost for this alternative includes the costs for a new well and small ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and new storage tank and feed pump set at SRL. The estimated O&M cost for this alternative includes labor and material costs to operate the well field, to maintain the pipeline, and to operate the pump station. The estimated capital cost for this alternative is $2.46 million and the estimated annual O&M cost is $43,368.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations are well understood, and Orbit currently operates pipelines and a pump station.

The feasibility of this alternative is dependent on finding a suitable well site.

4.5.7 Alternative SRL-7: New Well near Oak Bend Estates

Alternative SRL-7 consists of drilling a new well in the Oak Bend Estates area. Records indicate that arsenic is not above the MCL in the Oak Bend Estates well water; however, manganese is above the SMCL.

This alternative would require drilling a new well and installing a ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. One of the two pumps in the pump station would be for backup in the event the other pump fails. The pipeline would be a 4-inch line 11.1 miles long. The required pump horsepower is 2 hp.

This alternative presents a limited regional solution, since other PWSs in the area also need compliant water. Some regionalization could be accomplished by sharing the cost of drilling the well with other non-compliant PWS in the area.

The estimated capital cost for this alternative includes the cost to drill a new well and install a small ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. The estimated O&M cost for this alternative includes maintenance cost for the pipeline, and power and O&M labor and materials for the pump station minus the cost the SRL currently pays to operate its well field. The estimated capital cost for this alternative is $2.62 million, and the estimated annual O&M cost is $43,425.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations are well understood, and Orbit currently operates pipelines and a pump station.

The feasibility of this alternative is dependent on finding a suitable well site.

4.5.8 Alternative SRL-8: Purchased Water from Brazosport Water Authority

The SRL-8 alternative involves the purchase of treated surface water from the BWA. BWA currently has sufficient excess capacity for this alternative to be feasible and is willing to negotiate an agreement to supply water to PWSs in the area.

This alternative would require installing a ground storage tank and constructing a pipeline from the BWA 18-inch water main, located adjacent to State Highway 227 north of the City of Angleton, to the existing intake point at SRL. A pump station would also be required to overcome pipe friction and elevation differences between Angleton and SRL. A new storage tank and feed pump set would be required at SRL. The pipeline would be 11.1 miles long and constructed of 4-inch pipe. The required pump horsepower is 2 hp.

The pump station would be housed in a building and would include two pumps. One of the two pumps would be for backup. It is assumed the pumps and piping would be installed with capacity to meet all water demand for SRL even if blending is planned, since the incremental cost would be relatively small and would provide operational flexibility.

The estimated capital cost for this alternative includes construction of a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. The estimated O&M cost for this alternative includes the purchase price for the treated water plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump station minus the cost the SRL currently pays to operate its well field. The estimated capital cost for this alternative is $2.58 million, and the estimated annual O&M cost is $39,022.

The reliability of adequate amounts of compliant water under this alternative should be good. BWA provides treated surface water on a large scale, facilitating adequate O&M resources. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations are well understood, and Orbit currently operates pipelines and a pump station.

The feasibility of this alternative is dependent on an agreement being reached with BWA to purchase treated drinking water.

There are several small PWSs relatively near the Stoneridge Lake PWS that have water quality problems that would be good candidates for sharing the cost for obtaining water from BWA. The cost to SRL for this alternative could be reduced if the other PWSs would be willing to share the costs. The analysis for a shared solution is presented in Appendix G. This analysis shows that SRL could expect to save between $1.8 million to $2.2 million on the capital cost for this alternative, which is a saving of between 75 and 87 percent.

4.5.9 Alternative SRL-9: Purchased Water from City of Alvin

The SRL-9 alternative consists of connecting directly to the City of Alvin PWS. The PWS is supplied by four local groundwater wells having a total capacity 8.739 mgd. The reported average daily demand is 1.307 mgd. The peak demand is estimated to be 5.228 mgd. Water is treated with polyphosphate and hypochlorite before being discharged to several ground and elevated storage tanks.

This alternative would require installation of a ground storage tank, a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. One of the two pumps in the pump station would be for backup in the event the other pump fails. The pipeline would be a maximum of 10.6 miles long, and would be a 4-inch line. The required pump horsepower is 3 hp.

This alternative presents a regional solution, since other PWSs in the area also need compliant water. The City is already building lines to supply other small systems within its ETJ and is willing to negotiate to sell water to other PWSs outside its ETJ. Additionally, the regional surface water treatment plant proposed by the Gulf Coast Water Authority will replace some groundwater from wells in the Alvin area in the near future.

The estimated capital cost for this alternative includes construction of a pump station, a pipeline to the Stoneridge Lake PWS, and a new storage tank and feed pump set at SRL. The estimated O&M cost for this alternative includes the purchase price for treated water plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump station minus the cost SRL currently pays to operate its well field. The estimated capital cost for this alternative is $2.51 million, and the estimated annual O&M cost is $39,145.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of Orbit, this alternative is characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations are well understood, and Orbit currently operates pipelines and a pump station.

There are several small PWSs relatively near the Stoneridge Lake PWS that have water quality problems that would be good candidates for sharing the cost for obtaining water from the City of Alvin. The cost to SRL for this alternative could be reduced if the other PWSs would be willing to share the costs. The analysis for a shared solution is presented in

Appendix G. This analysis shows that SRL could expect to save between $1.9 million to $2.3 million on the capital cost for this alternative, which is a saving of between 76 and 89 percent.

4.5.10 Alternative SRL-10: New Well at 10 miles

This alternative consists of installing one new well within 10 miles of SRL that would produce compliant water in place of the water produced by the SRL well field. At this level of study, it is not possible to positively identify an existing well or the location where a new well could be installed.

This alternative would require construction of one new 310-foot deep well, a new pump station with storage tank near the new well, a pipeline from the new well/tank to the SRL system, and a new storage tank and feed pump set at SRL. The pump station and storage tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 10 miles long, and would be a 4-inch line. The pump station would include two pumps, including one standby, and would be housed in a building.

Depending on well location and capacity, this alternative could present some options for a more regional solution. It may be possible to share water and costs with another nearby system.

The estimated capital cost for this alternative includes installing the wells, and constructing the pipeline and pump station. The estimated O&M cost for this alternative includes O&M for the pipeline and pump station. The estimated capital cost for this alternative is $2.56 million, and the estimated annual O&M cost for this alternative is $43,246.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From the perspective of Orbit, this alternative would be similar to operating the existing system. Orbit has experience with O&M of wells, pipelines, and pump stations.

The feasibility of this alternative is dependent on the ability to find an adequate existing well or success in installing a well that produces an adequate supply of compliant water. It is likely an alternate groundwater source would not be found on SRL-controlled land, so landowner cooperation would likely be required.

4.5.11 Alternative SRL-11: New Well at 5 Miles

This alternative consists of installing one new well within 5 miles of SRL that would produce compliant water in place of the water produced by the SRL well field. At this level of study, it is not possible to positively identify an existing well or the location where a new well could be installed.

This alternative would require constructing one new 310-foot deep well, a new pump station with storage tank near the new well, a pipeline from the new well/tank to the SRL system, and a new storage tank and feed pump set at SRL. The pump station and storage tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 5 miles long, and would be a 4-inch line. The pump station would include two pumps, including one standby, and would be housed in a building.

Depending on well location and capacity, this alternative could present options for a more regional solution. It may be possible to share water and costs with another nearby system.

The estimated capital cost for this alternative includes installing the wells and constructing the pipeline and pump station. The estimated O&M cost for this alternative includes O&M for the pipeline and pump station. The estimated capital cost for this alternative is $1.44 million, and the estimated annual O&M cost for this alternative is $42,124.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations, and pipelines are commonly employed. From the perspective of Orbit, this alternative would be similar to operating the existing system. Orbit has experience with O&M of wells, pipelines, and pump stations.

The feasibility of this alternative is dependent on the ability to find an adequate existing well or success in installing a well that produces an adequate supply of compliant water. It is likely an alternate groundwater source would not be found on the SRL's controlled land, so landowner cooperation would likely be required.

4.5.12 Alternative SRL-12: New Well 1 Mile Away

This alternative consists of installing one new well within 1 mile of SRL that would produce compliant water in place of the water produced by the SRL well field. At this level of study, it is not possible to positively identify an existing well or the location where a new well could be installed.

This alternative would require construction of one new 310-foot deep well, a new pump station with storage tank near the new well, a pipeline from the new well/tank to the SRL system, and a new storage tank and feed pump set at SRL. The pump station and storage tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 1 mile long, and would be a 4-inch line. The pump station would include two pumps, including one standby, and would be housed in a building.

Depending on well location and capacity, this alternative could present some options for a more regional solution. It may be possible to share water and costs with another nearby system.

The estimated capital cost for this alternative includes installing the wells and constructing the pipeline and pump station. The estimated O&M cost for this alternative includes O&M for the pipeline and pump station. The estimated capital cost for this alternative is $362,123, and the estimated annual O&M cost for this alternative is $20,698.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From the perspective of Orbit, this alternative would be similar to operating the existing system. Orbit has experience with O&M of wells, pipelines, and pump stations.

The feasibility of this alternative is dependent on the ability to find an adequate existing well or success in installing a well that produces an adequate supply of compliant water. It is likely that an alternate groundwater source would not be found on SRL-controlled land, so landowner cooperation would likely be required.

4.5.13 Alternative SRL-13: Central IX Treatment

This system would continue to pump water from the existing Stoneridge Lake PWS well, and would treat the water through an IX system prior to distribution. For this option, a fraction (70%) of the raw water would be treated and the blended with the untreated stream to obtain overall compliant water. Water in excess of that currently produced would be required for backwashing and regeneration of the resin bed.

The IX treatment plant, located at the Stoneridge Lake PWS well site, features a 400 square feet (ft^2) building with a paved driveway; the pre-constructed IX equipment on a skid; a 24"x50" commercial brine drum with regeneration equipment; two transfer pumps, a 5,000-gallon tank for storing the treated water, a 2,000-gallon tank for storing spent backwash water, and a 2,000-gallon tank for storing regenerant waste. The spent backwash water would be discharged to the sewer at a controlled rate, and regenerant waste would be disposed off-site. The treated water would be chlorinated and stored in the new treated water tank prior to being pumped into the distribution system. The entire facility is fenced.

The estimated capital cost for this alternative is $291,740, and the estimated annual O&M cost is $31,454.

The reliability of adequate amount of compliant water under this alternative is good, since IX treatment is a common and well-understood treatment technology. IX treatment does not require high pressure, but can be affected by interfering constituents in the water. The O&M efforts required for the central IX treatment plant may be significant, and O&M personnel would require training with IX. The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.14 Alternative SRL-14: Central Iron-Based Adsorption Treatment

The system would treat groundwater from the existing well using an iron-based adsorption system prior to distribution. This alternative consists of constructing the adsorption treatment plant at or near the well site. The plant comprises a 400 ft^2 building with a paved driveway, the pre-constructed adsorption system on a skid (*e.g*., one AdEdge APU-100 package units), a 5,000-gal backwash wastewater equalization tank, and a treated water storage tank and feed pump set. The entire facility would be fenced. The water would be pre-chlorinated to oxidize AS(III) to AS(V) and post chlorinated for disinfection prior to flowing to the distribution system. Backwash would be required monthly with raw well water supplied directly by the well pump. The backwash would be equalized in the 5,000-gallon tank and discharged to the sewer at a controlled rate.. The adsorption media are expected to last approximately two years before replacement and disposal. The media replacement cost would be approximately $12,000.

The estimated capital cost for this alternative is $385,990, and the estimated annual O&M cost is $31,494 which includes the annualized media replacement cost of $6,000. Reliability of supply of adequate amounts of compliant water under this alternative is good as the adsorption technology has been demonstrated effective in full-scale and pilot-scale facilities. The technology is simple and requires minimal O&M effort.

4.5.15 Alternative SRL-15: Central Coagulation/Filtration Treatment

The system would treat groundwater from the existing well using a coagulation/filtration system prior to distribution. This alternative consists of constructing the coagulation/filtration plant at or near the well site. The plant comprises a 400 ft^2 building with a paved driveway, the pre-constructed coagulation/filtration system on a skid (*e.g.,* two Macrolite filters from Kinetico), a ferric chloride feed and storage system, a 5,000-gallon backwash wastewater equalization tank, and a treated water storage tank and feed pump set. The entire facility would be fenced. The water would be pre-chlorinated to oxidize As(III) to As(V) and post-chlorinated for disinfection prior to flowing to the distribution system. Ferric chloride solution would be fed to the well water after pre-chlorination and before entering the filters. The filters would be backwashed every one to two days by well water directly from the well pump. The backwash wastewater would be equalized in the 5,000-gal tank and discharged to the sewer at a controlled rate. The Macrolite media do not need replacement.

The estimated capital cost for this alternative is $372,360, and the estimated annual O&M cost is $37,804. This alternative requires more O&M labor cost and sludge disposal than the adsorption alternative. Reliability of supply of adequate amounts of compliant water under this alternative is good as the coagulation/filtration process is a well-established technology for arsenic removal. The technology is simple but requires significant effort for chemical handling and backwash monitoring. The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.16 Alternative SRL-16: Point-of-Use Treatment

This alternative consists of the continued operation of the SRL well, plus treatment to remove arsenic from water to be used for drinking or food preparation at the POU. The purchase, installation, and maintenance of POU treatment systems to be installed "under the sink" would be necessary for this alternative. Blending is not an option in this alternative.

This alternative would require installation of the POU treatment units in dwellings and other buildings that provide potable water. SRL would be responsible for purchasing and maintaining the treatment units, including media and filter replacement, periodic sampling, and necessary repairs. In residences, the most convenient point for installation of the treatment units is typically under the kitchen sink, with a separate tap installed for dispensing treated water. Installation of the treatment units in kitchens would require entry of SRL or contract personnel into the houses of customers. As a result, the cooperation of customers would be important for success in implementing this alternative. The treatment units could be installed so they could be accessed without house entry, but that would complicate installation and increase costs.

Point-of-use arsenic treatment processes typically produce spent media that require disposal and possibly a small backwash waste stream. The backwash waste stream results in a slight increase in the overall volume of water used. POU systems have the advantage of using a minimum volume of water for human consumption only. This minimizes size of the treatment units, the increase in water required, and waste for disposal. For this alternative, it is assumed an increase in water consumption would be insignificant in terms of supply cost, and that the backwash waste stream could be discharged to the house septic or sewer system.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes the cost of purchasing and installing the POU treatment systems. The estimated O&M cost for this alternative includes the purchase and replacement of filters and media, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $14,520, and the estimated annual O&M cost for this alternative is $17,215. For the cost estimate, it is assumed that one POU treatment unit would be required for each of the 22 existing connections to the SRL system. It should be noted that the POU treatment units would need to be more complex than units typically found in commercial retail outlets in order to meet regulatory requirements, making purchase and installation more expensive.

The reliability of adequate amounts of compliant water under this alternative is fair, since it relies on the active cooperation of the customers for system installation, use, and maintenance, and only provides compliant water to single tap within a residence. Additionally, the O&M efforts required for the POU systems would be significant, and Orbit personnel are inexperienced in this type of work. From the perspective of Orbit this alternative would be characterized as more difficult to operate due to the in-home requirements and the large number of individual units.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.17 Alternative SRL-17: Point-of-Entry Treatment

This alternative consists of the continued operation of the SRL well, plus treatment of water as it enters residences to remove arsenic. The purchase, installation, and maintenance of the treatment systems at the POE to households would be necessary for this alternative. Blending is not an option in this alternative.

This alternative would require installation of the POE treatment units at dwellings and other buildings that provide potable water. SRL would be responsible for purchasing and maintaining the treatment units, including media and filter replacement, periodic sampling, and necessary repairs. It may also be desirable to modify piping so water for non-consumptive uses could be withdrawn upstream of the treatment unit. The POE treatment units would be installed outside the houses, so entry would not be necessary for O&M. Some cooperation from customers would be necessary for installation and maintenance of the treatment systems.

Point-of-entry arsenic treatment processes typically produce spent adsorption media as a waste, as well as possibly backwash water that requires disposal. The backwash water stream results in a slight increased overall volume of water used. Point-of-entry systems treat a greater volume of water than POU systems. For this alternative, it is assumed the increase in water consumption would be insignificant in terms of supply cost, and the backwash waste stream can be discharged to the house septic or sewer system.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes purchasing and installing the POE treatment systems. The estimated O&M cost for this alternative includes the purchase and replacement of filters and media, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $254,100, and the estimated annual O&M cost is 34,265$. For the cost estimate, it is assumed that one POE treatment unit would be required for each of the 22 existing connections to the SRL system.

The reliability of adequate amounts of compliant water under this alternative are fair, but better than POU systems since it relies less on the active cooperation of the customers for system installation, use, and maintenance, and compliant water is supplied to all taps within a house. Additionally, the O&M efforts required for the POE systems would be significant, and Orbit personnel are inexperienced in this type of work. From the perspective of Orbit, this alternative would be characterized as more difficult to operate due to the on-property requirements and the large number of individual units.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.18 Alternative SRL-18: Public Dispenser for Treated Drinking Water

This alternative consists of the continued operation of the SRL well, plus dispensing treated water for drinking and cooking at a publicly accessible location. Implementing this alternative would require purchasing and installing a treatment unit where customers would be able to come to fill their own containers. This alternative also includes notifying customers of the importance of obtaining drinking water from the dispenser. In this way, only a relatively small volume of water requires treatment, but customers would be required to pick up and deliver their own water.

Blending is not an option in this alternative. It should be noted that this alternative would be considered an interim measure until a compliance alternative is implemented.

Orbit would be responsible for maintenance of the treatment unit, including media replacement, periodic sampling, and necessary repairs. The spent media would require disposal. This alternative relies on a great deal of cooperation and action from the customers in order to be effective.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes purchasing and installing the treatment system to be used for the drinking water dispenser. The estimated O&M cost for this alternative includes purchasing and replacing filters and media, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $11,600, and the estimated annual O&M cost for this alternative is $22,399.

The reliability of adequate amounts of compliant water under this alternative is fair, because of the large amount of effort required from the customers and the associated inconvenience. Orbit has not provided this type of service in the past. From the perspective of Orbit, this alternative would be characterized as relatively easy to operate, since these types of treatment units are highly automated, and there is only one unit.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.19 Alternative SRL-19: 100 Percent Bottled Water Delivery

This alternative consists of the continued operation of the SRL well, but compliant drinking water would be delivered in containers to customers. This alternative involves setting up and operating a bottled water delivery program to serve all customers in the system. It is expected that SRL would find it most convenient and economical to contract a bottled water service. The bottle delivery program would need to be flexible enough to allow for delivery of smaller containers should customers be incapable of lifting and manipulating 5-gallon bottles. Blending is not an option in this alternative. It should be noted that this alternative would be considered an interim measure until a compliance alternative is implemented.

This alternative does not involve capital costs for construction, but would require initial costs for system set up, and then ongoing costs to furnish the bottled water. It is assumed for this alternative that bottled water would be provided to 100 percent of SRL's customers.

This alternative does not present options for a regional solution.

The estimated initial capital cost is for setting up the program. The estimated O&M cost for this alternative includes program administration and purchase of the bottled water. The estimated capital cost for this alternative is $36,509, and the estimated annual O&M cost for this alternative is $72,061. For the cost estimate, it is assumed that each person requires 1 gallon of bottled water per day.

The reliability of adequate amounts of compliant water under this alternative is fair, since it relies on the active cooperation of customers to order and utilize the water. Management and administration of the bottled water delivery program would require attention from Orbit.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.20 Alternative SRL-20: Public Dispenser for Trucked Drinking Water

This alternative consists of continued operation of the SRL well, plus dispensing compliant potable water at a publicly accessible location. The compliant water would be purchased from BWA, and delivered by truck to a tank at a central location where customers would be able to fill their own containers. This alternative also includes notifying customers of the importance of obtaining drinking water from the dispenser. In this way, only a relatively small volume of water would need to be purchased, but customers would be required to pick up and deliver their own water. Blending is not an option in this alternative. It should be noted that this alternative would be considered an interim measure until a compliance alternative is implemented.

SRL would purchase a truck that would be suitable for hauling potable water, and install a storage tank. It is assumed the storage tank would be filled once a week, and that the chlorine residual would be tested for each truckload. The truck would need to meet requirements for potable water, and each load would be treated with bleach. This alternative relies on a great deal of cooperation and action from the customers for it to be effective.

This alternative presents limited options for a regional solution if two or more systems share the purchase and operation of the water truck.

The estimated capital cost for this alternative includes purchasing a water truck and constructing a storage tank to be used for the drinking water dispenser. The estimated O&M cost for this alternative includes O&M for the truck, maintenance for the tank, water quality testing, record keeping, and water purchase. The estimated capital cost for this alternative is $102,986, and the estimated annual O&M cost for this alternative is $20,817.

The reliability of adequate amounts of compliant water under this alternative is fair because of the large amount of effort required from the customers and the associated inconvenience. Orbit has not provided this type of service in the past. From the perspective of Orbit, this alternative would be characterized as relatively easy to operate, but water hauling and storage would have to be done with care to ensure sanitary conditions.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.21 Summary of Alternatives

Table 4.3 provides a summary of the key features of each alternative for the Stoneridge Lake PWS.

Table 4.3 Summary of Compliance Alternatives for Stoneridge Lake Public Water System

Alt No.	Alternative Description	Major Components	Capital Cost [1]	Annual O&M Cost	Total Annualized Cost [2]	Reliability	System Impact	Remarks
SRL-1	Drill new, deeper well at SRL	- New well (600 ft) - Ground storage tank - Pump station	$153,580	$20,587	$33,977	Good	N	New, deeper well on-site. Sharing cost with neighboring systems may be possible.
SRL-2	Drill new well near Mammoet USA, Inc.	- New well (270 ft) - Ground storage tank - Pump station with two transfer pumps - 3.9-mile pipeline	$989,881	$41,763	$128,065	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-3	Drill new well near TDCJ Darrington Unit	- New well (600 ft) - Pump station with two transfer pumps - 5.6-mile pipeline	$1,422,617	$42,332	$166,363	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-4	Drill new well near Briar Meadows	- New well (215 ft) - Ground storage tank - Pump station with two transfer pumps - 6.1-mile pipeline	$1,489,527	$42,336	$172,200	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-5	Drill new well near TDCJ Ramsey Area	- New well (270 ft) - Ground storage tank - Pump station with two transfer pumps - 10.0-mile pipeline	$2,300,043	$43,197	$243,726	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-6	Drill new well at Bateman Water Works	- New well (310 ft) - Ground storage tank - Pump station with two transfer pumps - 10.7 mile pipeline	$2,460,677	$43,368	$257,901	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-7	Drill new well near Oak Bend Estates	- New well (150 ft) - Ground storage tank - Pump station with two transfer pumps - 8.3-mile pipeline	$2,620,146	$43,425	$271,861	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-8	Purchase treated surface water from BWA	- Ground storage tank - Pump station with two transfer pumps - 11.4-mile pipeline	$2,578,716	$39,022	$263,846	Good	N	BWA expects to sell all excess capacity within the next 5 years.
SRL-9	Purchased treated groundwater from City of Alvin	- Ground storage tank - Pump station with two transfer pumps - 14.5-mile pipeline	$2,508,532	$39,145	$257,850	Good	N	Alternative assumes City of Alvin will sell water.

Alt No.	Alternative Description	Major Components	Capital Cost [1]	Annual O&M Cost	Total Annualized Cost [2]	Reliability	System Impact	Remarks
SRL-10	Install new compliant well within 10 miles	- New well - Ground storage tank - Pump station with two transfer pumps - 10-mile pipeline	$2,599,860	$43,246	$269,914	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-11	Install new compliant well within 5 miles	- New well - Ground storage tank - Pump station with two transfer pumps - 5-mile pipeline	$1,437,434	$42,124	$167,446	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-12	Install new compliant well within 1 mile	- New well - Ground storage tank - Pump station with two transfer pumps - 1-mile pipeline	$362,123	$20,698	$52,269	Good	N	Alternative assumes land and adequate quantity of compliant groundwater are available.
SRL-13	Continued use of existing wells with central IX treatment	- Central IX treatment plant	$291,740	$31,454	$56,889	Good	T	Costs could possibly be shared with nearby small systems.
SRL-14	Continued use of existing wells with central iron-based adsorption treatment	One central iron-based adsorption treatment unit.	$385,990	$31,494	$65,146	Good	T	There are nearby systems that could possibly share in treatment plant cost.
SRL-15	Continued use of existing wells with central coagulation / filtration treatment	One central coagulation/filtration treatment unit	$372,360	$37,804	$70,268	Good	T	There are nearby systems that could possibly share in treatment plant cost.
SRL-16	Continued use of existing wells with POU treatment	Small adsorption treatment unit for each customer	$14,520	$17,215	$18,481	Fair	T, M	Alternative assumes cooperation from all customers for entry into houses and businesses for installation and maintenance of treatment systems. Does not provide compliant water to all taps.
SRL-17	Continued use of existing wells with POE treatment	Small adsorption treatment unit for each customer	$254,100	$34,265	$56,419	Good	T, M	Alternative assumes cooperation from all customers for installation and maintenance of treatment systems. Provides compliant water to all taps.
SRL-18	Continued use of existing wells with public dispenser for treated drinking water	Install medium size iron-based adsorption treatment system, storage tank, and public dispenser	$11,600	$22,399	$23,410	Fair / interim measure	T	Does not provide compliant water to home or building taps; requires considerable effort by customers.

Alt No.	Alternative Description	Major Components	Capital Cost [1]	Annual O&M Cost	Total Annualized Cost [2]	Reliability	System Impact	Remarks
SRL-19	Continued use of existing wells with bottled water delivery for all customers	Set up bottled water delivery system	$36,509	$72,021	$75,204	Fair / interim measure	M	Does not provide compliant water to home or building taps; requires considerable effort by customers to order and use delivered water. Management and administration of program may be significant.
SRL-20	Continued use of existing wells with public dispenser for trucked drinking water	Install storage tank and public dispenser. Buy delivery truck	$102,986	$20,817	$29,796	Fair / interim measure	M	Does not provide compliant water to building taps; requires considerable effort by customers.

Notes: *N – No significant increase required in technical or management capability*
T – Implementation of alternative will require increase in technical capability
M – Implementation of alternative will require increase in management capability
1 – See cost breakdown in Appendix C
2 – 20-year return period and 6 percent interest

4.6 COST OF SERVICE AND FUNDING ANALYSIS

To evaluate the financial impact of implementing compliance alternatives, a 30-year financial planning model was developed. This model can be found in Appendix D. The financial model is based on estimated cash flows, with and without implementation of the compliance alternatives. Data for such models are typically derived from established budgets, audited financial reports, published water tariffs, and consumption data. Orbit Systems manages 33 small rural PWSs and three wastewater treatment plants. The financial data made available was a consolidated Profit and Loss Statement and a Water and Wastewater Utilities Annual Report for 2005. The Water Utility Tariff and water usage records for all 33 Orbit PWSs were also available.

4.6.1 Stoneridge Lake PWS Financial Data

Since Orbit Systems does not keep separate financial records for each of the 33 PWSs it manages, revenues and expenses had to be estimated for Stoneridge Lake PWS. Total revenues and expenses for Orbit Systems were obtained from a consolidated 2005 Income and Expense statement. The annual revenue for Stoneridge Lake PWS was estimated based on its percentage water usage of 2.5 percent as shown by Appendix F. The resultant 2005 annual revenue of $18,266 was entered into the financial model and is presented in Table 4.4.

Table 4.4 Summary of Orbit Systems 2005 Estimated Water Revenues

PWS Name	2005 Water Usage	No. Connections	2005 Water Revenue
Stoneridge Lake Subdivision	3,131,700 gals	22	$ 18,266
Oak Meadow Estates	1,365,500 gals	29	$ 8,037
Other Systems - Water	123,295,400 gals	1,692	$704,353
Total	127,792,600 gals	1,743	$730,656

Using the estimated water usage rates as noted above, the current average annual water bill for Stoneridge customers is estimated at $830 or about 1.8 percent of the Zip Code 77583 Tract median household income (MHI) of $43,718.

Annual expenses for Stoneridge Lake PWS were estimated based on its percentage water usage of 2.5 percent as shown by Appendix F. This resulted in 2005 expenses of $17,199 compared to $687,950 total expenses for Orbit Systems as summarized in Table 4.5.

Table 4.5 Summary of Orbit Systems 2005 Estimated Expenses

PWS Name	2005 Water Usage (gallons)	% Water Usage	2005 Water Expenses
Stoneridge Lake Subdivision	3,131,700	2.5	$17,199
Oak Meadow Estates	1,365,500	1.1	$7,568
Other Systems	123,295,400	98.2	$663,183
Total	**127,792,600**	**100.0**	**$687,950**

4.6.2 Current Financial Condition

4.6.2.1 Cash Flow Needs

Table 4.6 shows the 2005 estimated revenues and expenses for Stoneridge Lake PWS compared to other Orbit Systems PWSs. Based on current operations, Stoneridge Lake PWS is operating at the break–even point where revenues are just sufficient to cover the operating expenses. This does not include any capital expenditures to address the arsenic problem. Hence, Orbit Systems is not currently charging its Stoneridge Lake PWS customers enough for water usage to sustain this portion of the operation.

Table 4.6 Summary of Orbit Systems 2005 Operations

PWS Name	2004 Water Expenses	2004 Water Revenue	Over / (Under)
Stoneridge Lake	$17,199	$18,266	$1067
Oak Meadow Estates	$7,568	$8,037	$469

4.6.2.2 Ratio Analysis

Current Ratio

The Current Ratio for the Stoneridge Lake PWS could not be determined due to lack of necessary financial data to determine this ratio.

Debt to Net Worth Ratio

A Debt-to-Net-Worth Ratio also could not be determined owing to lack of the necessary financial data to determine this ratio.

Operating Ratio =1.06

An Operating Ratio of 1.06 means that a utility is collecting just enough money to meet expenses; indicating that Orbit should raise its water rates for its Stoneridge Lake PWS customers in the future to cover the costs of implementing any treatment alternatives.

4.6.3 Financial Plan Results

Each compliance alternative for Stoneridge Lake PWS was evaluated, with emphasis on the impact on affordability (expressed as a percentage of household income), and the overall increase in water rates necessary to pay for the improvements. Each alternative was examined under the various funding options described in Section 2.4.

For State Revolving Fund funding options, customer median household income (MHI) compared to the state average determines the availability of subsidized loans. According to 2000 U.S. Census data, Brazoria County, where Stoneridge Lake PWS water system is located, had an annual MHI of $48,632 which is greater than the statewide MHI of $39,927.

Communities with an MHI greater than 75% of the statewide MHI may qualify for a State Revolving Fund (SRF) of 3.8 percent. The 3.8 percent was used to calculate loan repayment under the SRF program. In the event SRF funding is unavailable, Orbit Systems would have to rely on obtaining funding through the sale of bonds.

Results of the financial impact analysis are provided in Table 4.7 and Figure 4.2. Table 4.7 presents rate impacts assuming that any deficiencies in reserve accounts are funded immediately in the year following the occurrence of the deficiency, which would cause the first few years' water rates to be higher than they would be if the reserve account was built-up over a longer period of time. Figure 4.2 provides a bar chart that in terms of the yearly billing to an average customer that includes the following:

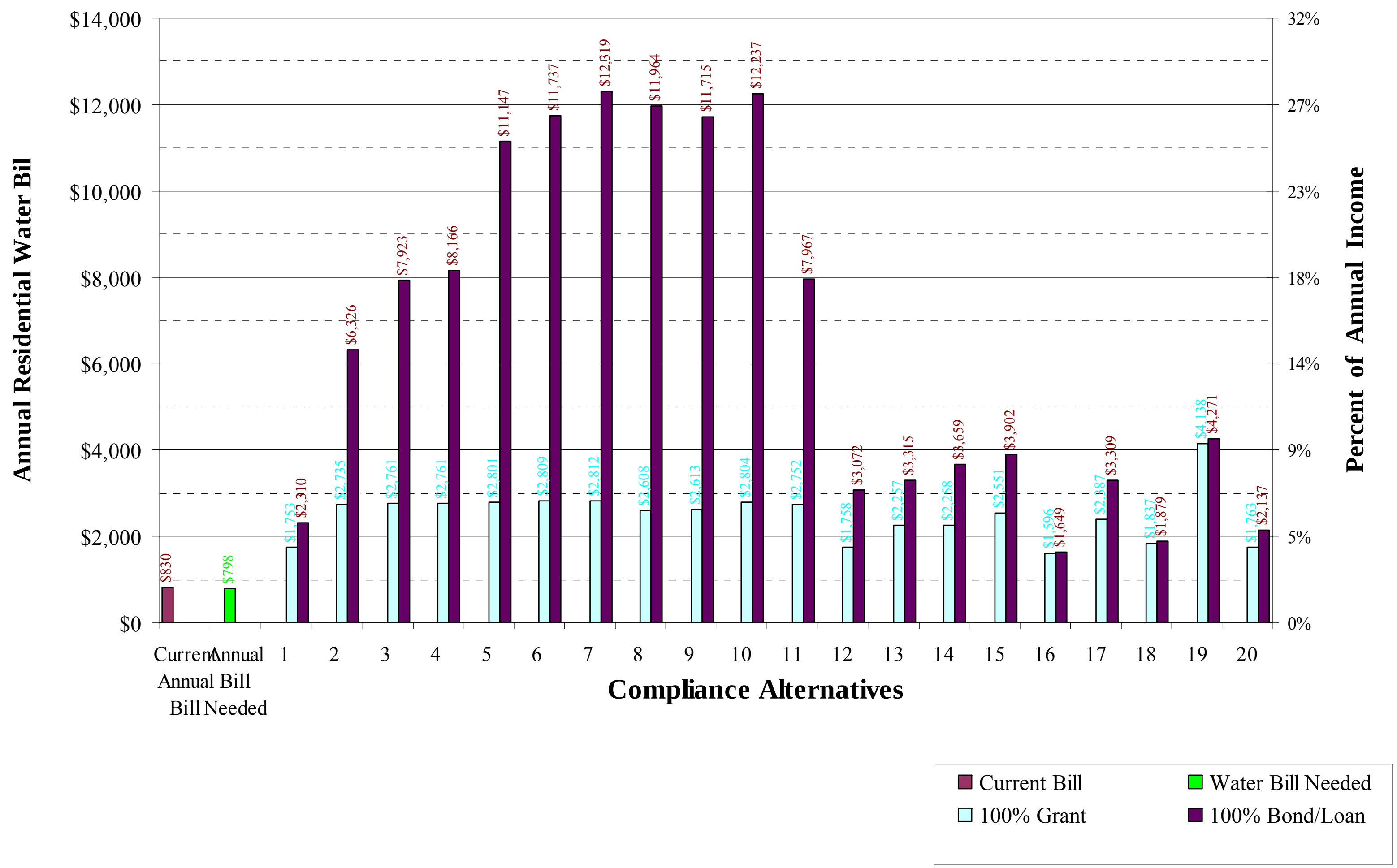
- Current annual average bill,
- Projected annual average bill including rate increase, if needed, to match existing expenditures, and
- Projected annual bill including rate increases needed to fund implementation of a compliance alternative (this does not include funding for reserve accounts).

The two bars shown for each compliance alternative represent the rate changes necessary for revenues to match total expenditures assuming 100 percent grant funding and 100 percent loan/bond funding. Most funding options will fall between 100 percent grant and 100 percent loan/bond funding, with the exception of 100 percent revenue financing. Establishing or increasing reserve accounts would require an increase in rates. If existing reserves are insufficient to fund a compliance alternative, rates would need to be raised before implementing the compliance alternative. This would allow for accumulation of sufficient reserves to avoid larger but temporary rate increases during the years the compliance alternative was being implemented.

Table 4.7 Financial Impact on Households

Alternative	Description		All Revenue	100% Grant	75% Grant	50% Grant	SRF	Bond
1	Drill a New Well at Stoneride Lake Subdivision	Max % of HH Income	21%	8%	8%	9%	10%	10%
		Max % Rate Increase Compared to Current	995%	302%	336%	369%	420%	436%
		Average Water Bill Required by Alternative	$ 8,520	$ 3,047	$ 3,303	$ 3,560	$ 3,948	$ 4,072
2	Drill a New Well at Mammoet USA	Max % of HH Income	112%	13%	17%	21%	27%	29%
		Max % Rate Increase Compared to Current	5805%	578%	794%	1011%	1339%	1443%
		Average Water Bill Required by Alternative	$ 45,842	$ 5,080	$ 6,731	$ 8,382	$ 10,887	$ 11,684
3	Drill a New Well at TDCJ Darrington Unit	Max % of HH Income	158%	13%	19%	25%	34%	37%
		Max % Rate Increase Compared to Current	8226%	585%	896%	1207%	1679%	1829%
		Average Water Bill Required by Alternative	$ 64,646	$ 5,135	$ 7,508	$ 9,880	$ 13,480	$ 14,626
4	Drill a New Well at Briar Meadows	Max % of HH Income	165%	13%	19%	25%	35%	38%
		Max % Rate Increase Compared to Current	8600%	585%	911%	1236%	1730%	1887%
		Average Water Bill Required by Alternative	$ 67,549	$ 5,135	$ 7,620	$ 10,104	$ 13,872	$ 15,073
5	Drill a New Well at TDCJ Ramsey Area	Max % of HH Income	251%	13%	23%	32%	47%	51%
		Max % Rate Increase Compared to Current	13133%	597%	1099%	1602%	2364%	2607%
		Average Water Bill Required by Alternative	$ 102,759	$ 5,218	$ 9,054	$ 12,890	$ 18,709	$ 20,563
6	Drill a New Well at Bateman Water Works	Max % of HH Income	268%	13%	23%	34%	49%	54%
		Max % Rate Increase Compared to Current	14032%	599%	1137%	1674%	2490%	2750%
		Average Water Bill Required by Alternative	$ 109,738	$ 5,234	$ 9,338	$ 13,442	$ 19,668	$ 21,651
7	Drill a New Well at Oak Bend Estates	Max % of HH Income	285%	13%	24%	35%	52%	57%
		Max % Rate Increase Compared to Current	14923%	600%	1172%	1745%	2613%	2890%
		Average Water Bill Required by Alternative	$ 116,660	$ 5,240	$ 9,610	$ 13,980	$ 20,609	$ 22,720
8	Purchase Water from BWA	Max % of HH Income	280%	12%	23%	34%	50%	55%
		Max % Rate Increase Compared to Current	14663%	542%	1106%	1669%	2524%	2796%
		Average Water Bill Required by Alternative	$ 114,647	$ 4,817	$ 9,118	$ 13,419	$ 19,943	$ 22,021
9	Purchase Water from the City of Alvin	Max % of HH Income	273%	12%	23%	33%	49%	54%
		Max % Rate Increase Compared to Current	14272%	544%	1092%	1640%	2472%	2736%
		Average Water Bill Required by Alternative	$ 111,608	$ 4,829	$ 9,013	$ 13,197	$ 19,543	$ 21,564
10	New Well at 10 Miles	Max % of HH Income	283%	13%	24%	35%	51%	56%
		Max % Rate Increase Compared to Current	14809%	597%	1165%	1733%	2595%	2870%
		Average Water Bill Required by Alternative	$ 115,771	$ 5,223	$ 9,559	$ 13,895	$ 20,473	$ 22,567
11	New Well at 5 Miles	Max % of HH Income	160%	13%	19%	25%	34%	37%
		Max % Rate Increase Compared to Current	8308%	583%	897%	1211%	1687%	1839%
		Average Water Bill Required by Alternative	$ 65,279	$ 5,115	$ 7,512	$ 9,910	$ 13,546	$ 14,705
12	New Well at 1 Mile	Max % of HH Income	43%	8%	9%	11%	13%	14%
		Max % Rate Increase Compared to Current	2161%	303%	383%	462%	582%	620%
		Average Water Bill Required by Alternative	$ 17,574	$ 3,058	$ 3,662	$ 4,266	$ 5,182	$ 5,474
13	Central Treatment - IX	Max % of HH Income	37%	10%	12%	13%	15%	15%
		Max % Rate Increase Compared to Current	1838%	444%	507%	571%	668%	699%
		Average Water Bill Required by Alternative	$ 15,046	$ 4,091	$ 4,577	$ 5,064	$ 5,802	$ 6,037
14	Central Treatment - Adsorption	Max % of HH Income	47%	10%	12%	14%	16%	17%
		Max % Rate Increase Compared to Current	2365%	444%	529%	613%	741%	782%
		Average Water Bill Required by Alternative	$ 19,137	$ 4,094	$ 4,738	$ 5,382	$ 6,358	$ 6,669
15	Central Treatment - Coag-Filt	Max % of HH Income	46%	12%	13%	15%	17%	18%
		Max % Rate Increase Compared to Current	2330%	526%	608%	689%	813%	852%
		Average Water Bill Required by Alternative	$ 18,854	$ 4,700	$ 5,321	$ 5,942	$ 6,884	$ 7,184
16	Point-of-Use Treatment	Max % of HH Income	7%	7%	7%	7%	7%	7%
		Max % Rate Increase Compared to Current	258%	258%	261%	264%	269%	271%
		Average Water Bill Required by Alternative	$ 2,767	$ 2,723	$ 2,748	$ 2,772	$ 2,809	$ 2,820
17	Point-of-Entry Treatment	Max % of HH Income	33%	11%	12%	13%	15%	15%
		Max % Rate Increase Compared to Current	1646%	480%	536%	591%	676%	702%
		Average Water Bill Required by Alternative	$ 13,550	$ 4,360	$ 4,784	$ 5,208	$ 5,851	$ 6,056
18	Public Dispenser for Treated Drinking Water	Max % of HH Income	8%	8%	8%	8%	8%	8%
		Max % Rate Increase Compared to Current	326%	326%	328%	331%	335%	336%
		Average Water Bill Required by Alternative	$ 3,256	$ 3,221	$ 3,241	$ 3,260	$ 3,289	$ 3,299
19	Supply Bottled Water to 100% of Population	Max % of HH Income	20%	20%	21%	21%	21%	21%
		Max % Rate Increase Compared to Current	972%	972%	980%	988%	1000%	1004%
		Average Water Bill Required by Alternative	$ 8,094	$ 7,985	$ 8,046	$ 8,107	$ 8,199	$ 8,229
20	Central Trucked Drinking Water	Max % of HH Income	15%	8%	8%	9%	9%	9%
		Max % Rate Increase Compared to Current	714%	305%	327%	350%	384%	395%
		Average Water Bill Required by Alternative	$ 6,336	$ 3,069	$ 3,241	$ 3,413	$ 3,673	$ 3,756

Figure 4-2 Alternative Cost Summary



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APPENDIX A
PWS INTERVIEW FORM

CAPACITY DEVELOPMENT ASSESSMENT FORM

*Prepared By*___________________________________ *Date*___________________________

Section 1. Public Water System Information

1. PWS ID # [ ] 2. Water System Name [ ]

3. County [ ]

4. Owner [ ] Address [ ]
   Tele. [ ] E-mail [ ]
   Fax [ ] Message [ ]

5. Admin [ ] Address [ ]
   Tele. [ ] E-mail [ ]
   Fax [ ] Message [ ]

6. Operator [ ] Address [ ]
   Tele. [ ] E-mail [ ]
   Fax [ ] Message [ ]

7. Population Served [ ] 8. No. of Service Connections [ ]

9. Ownership Type [ ] 10. Metered (Yes or No) [ ]

11. Source Type [ ]

12. Total PWS Annual Water Used [ ]

13. Number of Water Quality Violations (Prior 36 months)

    Total Coliform [ ] Chemical/Radiological [ ]

    Monitoring (CCR, Public Notification, etc.) [ ] Treatment Technique, D/DBP [ ]

A. Basic Information

1. Name of Water System:

2. Name of Person Interviewed:

3. Position:

4. Number of years at job:

5. Number of years experience with drinking water systems:

6. Percent of time (day or week) on drinking water system activities, with current position (how much time is dedicated exclusively to the water system, not wastewater, solid waste or other activities):

7. Certified Water Operator (Yes or No):

   If Yes,
   7a. Certification Level (water):

   7b. How long have you been certified?

8. Describe your water system related duties on a typical day.

B. Organization and Structure

1. Describe the organizational structure of the Utility. Please provide an organizational chart. (Looking to find out the governance structure (who reports to whom), whether or not there is a utility board, if the water system answers to public works or city council, etc.)

2. If not already covered in Question 1, to whom do you report?

3. Do all of the positions have a written job description?

   3a. If yes, is it available to employees?

   3b. May we see a copy?

C. Personnel

1. What is the current staffing level (include all personnel who spend more than 10% of their time working on the water system)?

2. Are there any vacant positions? How long have the positions been vacant?

3. In your opinion, is the current staffing level adequate? If not adequate, what are the issues or staffing needs (how many and what positions)?

4. What is the rate of employee turnover for management and operators? What are the major issues involved in the turnover (e.g., operator pay, working conditions, hours)?

5. Is the system staffed 24 hours a day? How is this handled (on-site or on-call)? Is there an alarm system to call an operator if an emergency occurs after hours?

D. Communication

1. Does the utility have a mission statement? If yes, what is it?

2. Does the utility have water quality goals? What are they?

3. How are your work priorities set?

4. How are work tasks delegated to staff?

5. Does the utility have regular staff meetings? How often? Who attends?

6. Are there separate management meetings? If so, describe.

7. Do management personnel ever visit the treatment facility? If yes, how often?

8. Is there effective communication between utility management and state regulators (e.g., NMED)?

9. Describe communication between utility and customers.

E. Planning and Funding

1. Describe the rate structure for the utility.

2. Is there a written rate structure, such as a rate ordinance? May we see it?

    2a. What is the average rate for 6,000 gallons of water?

3. How often are the rates reviewed?

4. What process is used to set or revise the rates?

5. In general, how often are the new rates set?

6. Is there an operating budget for the water utility? Is it separate from other activities, such as wastewater, other utilities, or general city funds?

7. Who develops the budget, how is it developed and how often is a new budget created or the old budget updated?

8. How is the budget approved or adopted?

9. In the last 5 years, how many budget shortfalls have there been (i.e., didn't collect enough money to cover expenses)? What caused the shortfall (e.g., unpaid bills, an emergency repair, weather conditions)?

    9a. How are budget shortfalls handled?

10. In the last 5 years how many years have there been budget surpluses (i.e., collected revenues exceeded expenses?

    10a. How are budget surpluses handled (i.e., what is done with the money)?

11. Does the utility have a line-item in the budget for emergencies or some kind of emergency reserve account?

12. How do you plan and pay for short-term system needs?

13. How do you plan and pay for long- term system needs?

14. How are major water system capital improvements funded? Does the utility have a written capital improvements plan?

15. How is the facility planning for future growth (either new hook-ups or expansion into new areas)?

16. Does the utility have and maintain an annual financial report? Is it presented to policy makers?

17. Has an independent financial audit been conducted of the utility finances? If so, how often? When was the last one?

18. Will the system consider any type of regionalization with any other PWS, such as system interconnection, purchasing water, sharing operator, emergency water connection, sharing bookkeeper/billing or other?

F. Policies, Procedures, and Programs

1. Are there written operational procedures? Do the employees use them?

2. Who in the utility department has spending authorization? What is the process for obtaining needed equipment or supplies, including who approves expenditures?

3. Does the utility have a source water protection program? What are the major components of the program?

4. Are managers and operators familiar with current SDWA regulations?

5. How do the managers and operators hear about new or proposed regulations, such as arsenic, DBP, Groundwater Rule? Are there any new regulations that will be of particular concern to the utility?

6. What are the typical customer complaints that the utility receives?

7. Approximately how many complaints are there per month?

8. How are customer complaints handled? Are they recorded?

9. (If not specifically addressed in Question 7) If the complaint is of a water quality nature, how are these types of complaints handled?

10. Does the utility maintain an updated list of critical customers?

11. Is there a cross-connection control plan for the utility? Is it written? Who enforces the plan's requirements?

12. Does the utility have a written water conservation plan?

13. Has there been a water audit of the system? If yes, what were the results?

14. (If not specifically answered in 11 above) What is the estimated percentage for loss to leakage for the system?

15. Are you, or is the utility itself, a member of any trade organizations, such as AWWA or Rural Water Association? Are you an active member (i.e., attend regular meetings or participate in a leadership role)? Do you find this membership helpful? If yes, in what ways does it help you?

G. Operations and Maintenance

1. How is decision-making authority split between operations and management for the following items:

    a. Process Control

    b. Purchases of supplies or small equipment

    c. Compliance sampling/reporting

    d. Staff scheduling

2. Describe your utility's preventative maintenance program.

3. Do the operators have the ability to make changes or modify the preventative maintenance program?

4. How does management prioritize the repair or replacement of utility assets? Do the operators play a role in this prioritization process?

5. Does the utility keep an inventory of spare parts?

6. Where does staff have to go to buy supplies/minor equipment? How often?

    6a. How do you handle supplies that are critical, but not in close proximity (for example if chlorine is not available in the immediate area or if the components for a critical pump are not in the area)

7. Describe the system's disinfection process. Have you had any problems in the last few years with the disinfection system?

    7a. Who has the ability to adjust the disinfection process?

8. How often is the disinfectant residual checked and where is it checked?

    8a. Is there an official policy on checking residuals or is it up to the operators?

9. Does the utility have an O & M manual? Does the staff use it?

10. Are the operators trained on safety issues? How are they trained and how often?

11. Describe how on-going training is handled for operators and other staff. How do you hear about appropriate trainings? Who suggests the trainings – the managers or the operators? How often do operators, managers, or other staff go to training? Who are the typical trainers used and where are the trainings usually held?

12. In your opinion is the level of your on-going training adequate?

13. In your opinion is the level of on-going training for other staff members, particularly the operators, adequate?

14. Does the facility have mapping of the water utility components? Is it used on any routine basis by the operators or management? If so, how is it used? If not, what is the process used for locating utility components?

15. In the last sanitary survey, were any deficiencies noted? If yes, were they corrected?

16. How often are storage tanks inspected? Who does the inspection?

    16a. Have you experienced any problems with the storage tanks?

H. SDWA Compliance

1. Has the system had any violations (monitoring or MCL) in the past 3 years? If so, describe.

2. How were the violations handled?

3. Does the system properly publish public notifications when notified of a violation?

4. Is the system currently in violation of any SDWA or state regulatory requirements, including failure to pay fees, fines, or other administrative type requirements?

5. Does the utility prepare and distribute a Consumer Confidence Report (CCR)? Is it done every year? What type of response does the utility get to the CCR from customers?

I. Emergency Planning

1. Does the system have a written emergency plan to handle emergencies such as water outages, weather issues, loss of power, loss of major equipment, etc?

2. When was the last time the plan was updated?

3. Do all employees know where the plan is? Do they follow it?

4. Describe the last emergency the facility faced and how it was handled.

Attachment A

A. Technical Capacity Assessment Questions

1. Based on available information of water rights on record and water pumped has the system exceeded its water rights in the past year? YES ☐ NO ☐

   In any of the past 5 years? YES ☐ NO ☐ How many times? _____

2. Does the system have the proper level of certified operator? *(Use questions a – c to answer.)*
   YES ☐ NO ☐

   a. What is the Classification Level of the system by NMED? _____

   b. Does the system have one or more certified operator(s)? [20 NMAC 7.4.20]

   YES ☐ NO ☐

   c. If YES, provide the number of operators at each New Mexico Certification Level. [20 NMAC 7.4.12]

   _____NM Small System _____Class 2

   _____NM Small System Advanced _____Class 3

   _____Class 1 _____Class 4

3. Did the system correct any sanitary deficiency noted on the most recent sanitary survey within 6 months of receiving that information? [20 NMAC 7.20.504]

   YES ☐ NO ☐ No Deficiencies ☐

   What was the type of deficiency? *(Check all that are applicable.)*

   Source ☐ Storage ☐

   Treatment ☐ Distribution ☐

   Other _____

   From the system's perspective, were there any other deficiencies that were not noted on the sanitary survey? Please describe.

4. Will the system's current treatment process meet known future regulations?

   Radionuclides YES ☐ NO ☐ Doesn't Apply ☐

   Arsenic YES ☐ NO ☐ Doesn't Apply ☐

   Stage 1 Disinfectants and Disinfection By-Product (DBP)

   YES ☐ NO ☐ Doesn't Apply ☐

   Surface Water Treatment Rule YES ☐ NO ☐ Doesn't Apply ☐

5. Does the system have a current site plan/map? [20 NMAC 7.10.302 A.1.]

   YES ☐ NO ☐

6. Has the system had a water supply outage in the prior 24 months?

YES ☐ NO ☐

What were the causes of the outage(s)? *(Include number of outages for each cause.)*

Drought _____ Limited Supply _____

System Failure _____ Other _____

7. Has the system ever had a water audit or a leak evaluation?

YES ☐ NO ☐ Don't Know ☐

If YES, please complete the following table.

Type of Investigation	Date Done	Water Loss (%)	What approach or technology was used to complete the investigation?	Was any follow-up done? If so, describe

8. Have all drinking water projects received NMED review and approval? [20 NMAC 7.10.201]

YES ☐ NO ☐

If NO, what types of projects have not received NMED review and approval.

Source ☐ Storage ☐

Treatment ☐ Distribution ☐

Other ☐ _____

9. What are the typical customer complaints that the utility receives?

10. Approximately how many complaints are there per month? _____

11. How are customer complaints handled? Are they recorded?

12. What is the age and composition of the distribution system? ***(Collect this information from the Sanitary Survey)***

Pipe Material	Approximate Age	Percentage of the system	Comments
			Sanitary Survey Distribution System Records Attached

13. Are there any dead end lines in the system?

YES ☐ NO ☐

14. Does the system have a flushing program?

YES ☐ NO ☐

If YES, please describe.

15. Are there any pressure problems within the system?

YES ☐ NO ☐

If YES, please describe.

16. Does the system disinfect the finished water?

YES ☐ NO ☐

If yes, which disinfectant product is used? ______

Interviewer Comments on Technical Capacity:

B. Managerial Capacity Assessment Questions

17. Has the system completed a 5-year Infrastructure Capital Improvement Plan (ICIP) plan?

YES ☐ NO ☐

If YES, has the plan been submitted to Local Government Division?

YES ☐ NO ☐

18. Does the system have written operating procedures?

YES ☐ NO ☐

19. Does the system have written job descriptions for all staff?

YES ☐ NO ☐

20. Does the system have:

A preventative maintenance plan?
YES ☐ NO ☐
A source water protection plan?
YES ☐ NO ☐ N/A ☐
An emergency plan?
YES ☐ NO ☐
A cross-connection control program?
YES ☐ NO ☐
An emergency source?
YES ☐ NO ☐
System security measures?
YES ☐ NO ☐

21. Does the system report and maintain records in accordance with the drinking water regulations concerning:

Water quality violations
YES ☐ NO ☐

Public notification
YES ☐ NO ☐

Sampling exemptions
YES ☐ NO ☐

22. Please describe how the above records are maintained:

23. Describe the management structure for the water system, including board and operations staff. Please include examples of duties, if possible.

24. Please describe type and quantity of training or continuing education for staff identified above.

25. Describe last major project undertaken by the water system, including the following: project in detail, positive aspects, negative aspects, the way in which the project was funded, any necessary rate increases, the public response to the project, whether the project is complete or not, and any other pertinent information.

26. Does the system have any debt? YES ☐ NO ☐

If yes, is the system current with all debt payments?
YES ☐ NO ☐

If no, describe the applicable funding agency and the default.

27. Is the system currently contemplating or actively seeking funding for any project?
YES ☐ NO ☐

If yes, from which agency and how much?

Describe the project?

Is the system receiving assistance from any agency or organization in its efforts?

28. Will the system consider any type of regionalization with other PWS? *(Check YES if the system has already regionalized.)*

YES ☐ NO ☐

If YES, what type of regionalization has been implemented/considered/discussed? *(Check all that apply.)*

- System interconnection ☐
- Sharing operator ☐
- Sharing bookkeeper ☐
- Purchasing water ☐
- Emergency water connection ☐
- Other: _____

29. Does the system have any of the following? *(Check all that apply.)*

- Water Conservation Policy/Ordinance ☐
- Current Drought Plan ☐
- Water Use Restrictions ☐
- Water Supply Emergency Plan ☐

Interviewer Comments on Managerial Capacity:

C. Financial Capacity Assessment

30. Does the system have a budget?

YES ☐ NO ☐

If YES, what type of budget?

Operating Budget ☐

Capital Budget ☐

31. Have the system revenues covered expenses and debt service for the past 5 years?

YES ☐ NO ☐

If NO, how many years has the system had a shortfall? _____

32. Does the system have a written/adopted rate structure?

YES ☐ NO ☐

33. What was the date of the last rate increase? _____

34. Are rates reviewed annually?

YES ☐ NO ☐

IF YES, what was the date of the last review? _____

35. Did the rate review show that the rates covered the following expenses? *(Check all that apply.)*

Operation & Maintenance ☐

Infrastructure Repair & replacement ☐

Staffing ☐

Emergency/Reserve fund ☐

Debt payment ☐

36. Is the rate collection above 90% of the customers?

YES ☐ NO ☐

37. Is there a cut-off policy for customers who are in arrears with their bill or for illegal connections?

YES ☐ NO ☐

If yes, is this policy implemented?

38. What is the residential water rate for 6,000 gallons of usage in one month. _____

39. In the past 12 months, how many customers have had accounts frozen or dropped for non-payment? _____

[Convert to % of active connections

Less than 1% ☐ 1% - 3% ☐ 4% - 5% ☐ 6% - 10% ☐

11% - 20% ☐ 21% - 50% ☐ Greater than 50% ☐]

40. The following questions refer to the process of obtaining needed equipment and supplies.

a. Can the water system operator buy or obtain supplies or equipment when they are needed?

YES ☐ NO ☐

b. Is the process simple or burdensome to the employees?

c. Can supplies or equipment be obtained quickly during an emergency?

YES ☐ NO ☐

d. Has the water system operator ever experienced a situation in which he/she couldn't purchase the needed supplies?

YES ☐ NO ☐

e. Does the system maintain some type of spare parts inventory?

YES ☐ NO ☐

If yes, please describe.

41. Has the system ever had a financial audit?

YES ☐ NO ☐

If YES, what is the date of the most recent audit? ______

42. Has the system ever had its electricity or phone turned off due to non-payment? Please describe.

Interviewer Comments on Financial Assessment:

43. What do you think the system capabilities are now and what are the issues you feel your system will be facing in the future? In addition, are there any specific needs, such as types of training that you would like to see addressed by NMED or its contractors?

APPENDIX B
COST BASIS

This section presents the basis for unit costs used to develop the conceptual cost estimates for the compliance alternatives. Cost estimates are conceptual in nature (+50%/-30%), and are intended to make comparisons between compliance options and to provide a preliminary indication of possible rate impacts. Consequently, these costs are pre-planning level and should not be viewed as final estimated costs for alternative implementation. Capital cost includes an allowance for engineering and construction management. It is assumed that adequate electrical power is available near the site. The cost estimates specifically do not include costs for the following:

- Obtaining land or easements.
- Surveying.
- Mobilization/demobilization for construction.
- Insurance and bonds

In general, unit costs are based on recent construction bids for similar work in the area; when possible, consultations with vendors or other suppliers; published construction and O&M cost data; and USEPA cost guidance. Unit costs used for the cost estimates are summarized in Table B.1.

Unit costs for pipeline components are based on 2006 RS Means Building Construction Cost Data. The number of borings and encasements and open cuts and encasements is estimated by counting the road, highway, railroad, stream, and river crossings for a conceptual routing of the pipeline. The number of air release valves is estimated by examining the land surface profile along the conceptual pipeline route. It is assumed gate valves and flush valves would be installed, on average, every 5,000 feet along the pipeline. Pipeline cost estimates are based on use of C-900 PVC pipe. Other pipe materials could be considered for more detailed development of attractive alternatives.

Pump station unit costs are based on experience with similar installations. The cost estimate for the pump stations include two pumps, station piping and valves, station electrical and instrumentation, minor site improvement, installation of a concrete pad, fence and building, and tools. Construction cost of a storage tank is based on 2006 RS Means Building Construction Cost Data.

Labor costs are estimated based on RS Means Building Construction Data specific to each region.

Electrical power cost is estimated to be $0.136 per kiloWatt hour (kWH). The annual cost for power to a pump station is calculated based on the pumping head and volume, and includes 11,800 kWH for pump building heating, cooling, and lighting, as recommended in USEPA publication, *Standardized Costs for Water Supply Distribution Systems* (1992).

In addition to the cost of electricity, pump stations have other maintenance costs. These costs cover: materials for minor repairs to keep the pumps operating; purchase of a maintenance vehicle, fuel costs, and vehicle maintenance costs; utilities; office supplies, small tools and equipment; and miscellaneous materials such as safety, clothing, chemicals, and paint. The non-power O&M costs are estimated based on the USEPA publication, *Standardized Costs for Water Supply Distribution Systems* (1992), which provides cost curves for O&M components. Costs from the 1992 report are adjusted to 2006 dollars based on the ENR construction cost index.

Pipeline maintenance costs include routine cleaning and flushing, as well as minor repairs to lines. The unit rate for pipeline maintenance is calculated based on the USEPA technical report, *Innovative and Alternate Technology Assessment Manual MCD 53* (1978). Costs from the 1978 report are adjusted to 2006 dollars based on the ENR construction cost index.

Storage tank maintenance costs include cleaning and renewal of interior lining and exterior coating. Unit costs for storage tank O&M are based on USEPA publication *Standardized Costs for Water Supply Distribution Systems* (1992). Costs from the 1992 report are adjusted to 2006 dollars based on the ENR construction cost index.

The purchase price for POU water treatment units is based on vendor price lists for treatment units, plus installation. O&M costs for POU treatment units are also based on vendor price lists. It is assumed that a yearly water sample would be analyzed for the contaminant of concern.

The purchase price for POE water treatment units is based on vendor price lists for treatment units, plus an allowance for installation, including a concrete pad and shed, piping modifications, and electrical connection. O&M costs for POE treatment units are also based on vendor price lists. It is assumed that a yearly water sample would be analyzed for the contaminant of concern.

Central treatment plant costs, for both adsorption and coagulation/filtration, include pricing for buildings, utilities, and site work. Costs are based on pricing given in the various R.S. Means Construction Cost Data References, as well as prices obtained from similar work on other projects. Pricing for treatment equipment was obtained from vendors.

Well installation costs are based on quotations from drillers for installation of similar depth wells in the area. Well installation costs include drilling, a well pump, electrical and instrumentation installation, well finishing, piping, and water quality testing. O&M costs for water wells include power, materials, and labor. It is assumed that new wells located more than 1 mile from the intake point of an existing system would require at least one storage tank and pump station.

Purchase price for the treatment unit dispenser is based on vendor price lists, plus an allowance for installation at a centralized public location. The O&M costs are also based on vendor price lists. It is assumed that weekly water samples would be analyzed for the contaminant of concern.

Costs for bottled water delivery alternatives are based on consultation with vendors that deliver residential bottled water. The cost estimate includes an initial allowance for set-up of the program, and a yearly allowance for program administration.

The cost estimate for a public dispenser for trucked water includes the purchase price for a water truck and construction of a storage tank. Annual costs include labor for purchasing the water, picking up and delivering the water, truck maintenance, and water sampling and testing. It is assumed the water truck would be required to make one trip per dispenser each week, and that chlorine residual would be determined for each truck load.

Table B.1
Summary of General Data
Stoneridge Lake Water System
PWS # 0200624
General PWS Information

Service Population 66
Total PWS Daily Water Usage 0.009 (mgd)
Number of Connections 22
Source Calculated using assumed 130 gpcd

Unit Cost Data
EAST TEXAS

General Items	Unit	Unit Cost
Treated water purchase cost	*See alternative*	
Water purchase cost (trucked)	$/1,000 gals	$ 1.80
Contingency	20%	n/a
Engineering & Constr. Management	25%	n/a
Procurement/admin (POU/POE)	20%	n/a
Pipeline Unit Costs	**Unit**	**Unit Cost**
PVC water line, Class 200, 04"	LF	$ 27
Bore and encasement, 10"	LF	$ 60
Open cut and encasement, 10"	LF	$ 35
Gate valve and box, 04"	EA	$ 370
Air valve	EA	$ 1,000
Flush valve	EA	$ 750
Metal detectable tape	LF	$ 0.15
Bore and encasement, length	Feet	200
Open cut and encasement, length	Feet	50
Pump Station Unit Costs	**Unit**	**Unit Cost**
Pump	EA	$ 7,500
Pump Station Piping, 04"	EA	$ 4,000
Gate valve, 04"	EA	$ 405
Check valve, 04"	EA	$ 595
Electrical/Instrumentation	EA	$ 10,000
Site work	EA	$ 2,000
Building pad	EA	$ 4,000
Pump Building	EA	$ 10,000
Fence	EA	$ 5,870
Tools	EA	$ 1,000
Well Installation Unit Costs	**Unit**	**Unit Cost**
Well installation	*See alternative*	
Water quality testing	EA	$ 1,500
Well pump	EA	$ 7,500
Well electrical/instrumentation	EA	$ 5,000
Well cover and base	EA	$ 3,000
Piping	EA	$ 2,500
Storage Tank - 5,000 gals	EA	$ 7,025
Electrical Power	$/kWH	$ 0.136
Building Power	kWH	11,800
Labor	$/hr	$ 46
Materials	EA	$ 1,200
Transmission main O&M	$/mile	$ 200
Tank O&M	EA	$ 1,000
POU/POE Unit Costs		
POU treatment unit purchase	EA	$ 250
POU treatment unit installation	EA	$ 150
POE treatment unit purchase	EA	$ 3,000
POE - pad and shed, per unit	EA	$ 2,000
POE - piping connection, per unit	EA	$ 1,000
POE - electrical hook-up, per unit	EA	$ 1,000
POU treatment O&M, per unit	$/year	$ 225
POE treatment O&M, per unit	$/year	$ 1,000
Contaminant analysis	$/year	$ 100
POU/POE labor support	$/hr	$ 46
Dispenser/Bottled Water Unit Costs		
Treatment unit purchase	EA	$ 3,000
Treatment unit installation	EA	$ 5,000
Treatment unit O&M	EA	$ 500
Administrative labor	hr	$ 61
Bottled water cost (inc. delivery)	gallon	$ 1.60
Water use, per capita per day	gpcd	1.0
Bottled water program materials	EA	$ 5,000
Storage Tank - 5,000 gals	EA	$ 7,025
Site improvements	EA	$ 4,000
Potable water truck	EA	$ 60,000
Water analysis, per sample	EA	$ 100
Potable water truck O&M costs	$/mile	$ 1.00

Central Treatment Unit Costs	Unit	Unit Cost
General		
Site preparation	acre	$ 4,000
Slab	CY	$ 1,000
Building	SF	$ 60
Building electrical	SF	$ 8.00
Building plumbing	SF	$ 8.00
Heating and ventilation	SF	$ 7
Fence	LF	$ 15
Paving	SF	$ 2
Chlorination point	EA	2000
Building power	kwh/yr	$ 0.136
Equipment power	kwh/yr	$ 0
Labor, O&M	hr	$ 40
Analyses	test	200
Ion exchange		
Electrical	JOB	$ 50,000
Piping	JOB	$ 20,000
Ion exchange package plant	UNIT	$ 30,000
Transfer pumps (5 hp)	EA	$ 5,000
Clean water tank	gal	$ 1.00
Regenerant tank	gal	$ 1.50
Backwash tank	gal	$ 2
Sewer connection fee	EA	15000
Ion exchange materials	year	$ 1,000
Ion exchange chemicals	year	$ 1,000
Backwash discharge to sewer	1000 gal/yr	$ 5
Waste haulage truck rental	days	$ 700
Mileage charge	mile	$ 1
Adsorption		
Electrical	JOB	$ 50,000
Piping	JOB	$ 20,000
Adsorption package plant	UNIT	$ 80,000
Backwash tank	GAL	2
Sewer connection fee	EA	$ 15,000
Spent media disposal	CY	20
Adsorption materials replacement	year	$ 6,000
Backwash discharge to sewer	MG/year	$ 5,000
Coagulation/filtration		
Electrical	JOB	$ 45,000
Piping	JOB	$ 15,000
Coagulation package plant	UNIT	$ 80,000
Backwash tank	GAL	$ 2.00
Coagulant tank	GAL	$ 3.00
Sewer connection fee	EA	$ 15,000
Coagulation/Filtration Materials	year	$ 1,000
Chemicals, Coagulation	year	$ 1,500
Backwash discharge to sewer	MG/year	$ 5,000

APPENDIX C
COMPLIANCE ALTERNATIVE CONCEPTUAL COST ESTIMATES

This appendix presents the conceptual cost estimates developed for the compliance alternatives. The conceptual cost estimates are given in Tables C.1 through C.20. The cost estimates are conceptual in nature (+50%/-30%), and are intended for making comparisons between compliance options and to provide a preliminary indication of possible water rate impacts. Consequently, these costs are pre-planning level and should not be viewed as final estimated costs for alternative implementation.

Table C.1

PWS Name *Stoneridge Lake Water System*
Alternative Name *Drill a New Well at Stoneride Lake Subdivision*
Alternative Number *SRL-1*

Distance from PWS to new well location	0.06	miles
Estimated well depth	600	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	0	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	-	n/a	n/a	n/a
PVC water line, Class 200, 04"	300	LF	$ 27.00	$ 8,100
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	-	LF	$ 35.00	$ -
Gate valve and box, 04"	0	EA	$ 370.00	$ 22
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 45
Metal detectable tape	300	LF	$ 0.15	$ 45
Subtotal				**$ 8,212**
Pump Station(s) Installation				
Pump	2	EA	$ 7,500	$ 15,000
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 61,705**
Well Installation				
Well installation	600	LF	$ 25	$ 15,000
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 36,000**
Subtotal of Component Costs				**$ 105,917**
Contingency	20%			$ 21,183
Design & Constr Management	25%			$ 26,479
TOTAL CAPITAL COSTS				**$ 153,580**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	0.1	mile	$ 200	$ 11
Subtotal				**$ 11**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.136	$ 1,605
Pump Power	-	kWH	$ 0.136	$ -
Materials	1	EA	$ 1,200	$ 1,200
Labor	365	Hrs	$ 46	$ 16,699
Tank O&M	1	EA	$ 1,000	$ 1,000
Subtotal				**$ 20,504**
Well O&M				
Pump power	691	kWH	$ 0.136	$ 94
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,529**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 20,587**

Table C.2

PWS Name	***Stoneridge Lake Water System***
Alternative Name	***Drill a New Well at Mammoet USA***
Alternative Number	***SRL-2***

Distance from PWS to new well location	3.60	miles
Estimated well depth	270	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	4	n/a	n/a	n/a
PVC water line, Class 200, 04"	19,015	LF	$ 27.00	$ 513,405
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	200	LF	$ 35.00	$ 7,000
Gate valve and box, 04"	4	EA	$ 370.00	$ 1,407
Air valve	4	EA	$ 1,000.00	$ 4,000
Flush valve	4	EA	$ 750.00	$ 2,852
Metal detectable tape	19,015	LF	$ 0.15	$ 2,852
Subtotal				**$ 531,517**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	270	LF	$ 25	$ 6,750
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 27,750**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	3.6	mile	$ 200	$ 720
Subtotal				**$ 720**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	318	kWH	$ 0.136	$ 43
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,050**
Well O&M				
Pump power	104	kWH	$ 0.136	$ 14
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,449**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**

Subtotal of Component Costs		**$ 682,677**
Contingency	20%	$ 136,535
Design & Constr Management	25%	$ 170,669
TOTAL CAPITAL COSTS		**$ 989,881**

TOTAL ANNUAL O&M COSTS **$ 41,763**

Table C.3

PWS Name ***Stoneridge Lake Water System***
Alternative Name ***Drill a New Well at TDCJ Darrington Unit***
Alternative Number ***SRL-3***

Distance from PWS to new well location	5.49	miles
Estimated well depth	600	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	13	n/a	n/a	n/a
PVC water line, Class 200, 04"	29,004	LF	$ 27.00	$ 783,108
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	650	LF	$ 35.00	$ 22,750
Gate valve and box, 04"	6	EA	$ 370.00	$ 2,146
Air valve	5	EA	$ 1,000.00	$ 5,000
Flush valve	6	EA	$ 750.00	$ 4,351
Metal detectable tape	29,004	LF	$ 0.15	$ 4,351
Subtotal				**$ 821,705**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	600	LF	$ 25	$ 15,000
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 36,000**
Subtotal of Component Costs				**$ 981,115**
Contingency	20%			$ 196,223
Design & Constr Management	25%			$ 245,279
TOTAL CAPITAL COSTS				**$ 1,422,617**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.5	mile	$ 200	$ 1,099
Subtotal				**$ 1,099**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	1,596	kWH	$ 0.136	$ 217
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,224**
Well O&M				
Pump power	230	kWH	$ 0.136	$ 31
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,466**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 42,332**

Table C.4

PWS Name	***Stoneridge Lake Water System***
Alternative Name	***Drill a New Well at Briar Meadows***
Alternative Number	***SRL-4***

Distance from PWS to new well location	5.86	miles
Estimated well depth	215	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	7	n/a	n/a	n/a
PVC water line, Class 200, 04"	30,950	LF	$ 27.00	$ 835,650
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	350	LF	$ 35.00	$ 12,250
Gate valve and box, 04"	6	EA	$ 370.00	$ 2,290
Air valve	6	EA	$ 1,000.00	$ 6,000
Flush valve	6	EA	$ 750.00	$ 4,643
Metal detectable tape	30,950	LF	$ 0.15	$ 4,643
Subtotal				**$ 877,475**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	215	LF	$ 25	$ 5,375
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 26,375**
Subtotal of Component Costs				**$ 1,027,260**
Contingency	20%			$ 205,452
Design & Constr Management	25%			$ 256,815
TOTAL CAPITAL COSTS				**$ 1,489,527**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.9	mile	$ 200	$ 1,172
Subtotal				**$ 1,172**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	1,230	kWH	$ 0.136	$ 167
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,174**
Well O&M				
Pump power	83	kWH	$ 0.136	$ 11
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,446**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 42,336**

Table C.5

PWS Name *Stoneridge Lake Water System*
Alternative Name *Drill a New Well at TDCJ Ramsey Area*
Alternative Number *SRL-5*

Distance from PWS to new well location	9.78	miles
Estimated well depth	270	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	7	n/a	n/a	n/a
PVC water line, Class 200, 04"	51,612	LF	$ 27.00	$ 1,393,524
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	350	LF	$ 35.00	$ 12,250
Gate valve and box, 04"	10	EA	$ 370.00	$ 3,819
Air valve	10	EA	$ 1,000.00	$ 10,000
Flush valve	10	EA	$ 750.00	$ 7,742
Metal detectable tape	51,612	LF	$ 0.15	$ 7,742
Subtotal				**$ 1,435,077**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	270	LF	$ 25	$ 6,750
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 27,750**
Subtotal of Component Costs				**$ 1,586,237**
Contingency	20%			$ 317,247
Design & Constr Management	25%			$ 396,559
TOTAL CAPITAL COSTS				**$ 2,300,043**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	9.8	mile	$ 200	$ 1,955
Subtotal				**$ 1,955**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	1,785	kWH	$ 0.136	$ 243
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,250**
Well O&M				
Pump power	104	kWH	$ 0.136	$ 14
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,449**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 43,197**

Table C.6

PWS Name *Stoneridge Lake Water System*
Alternative Name *Drill a New Well at Bateman Water Works*
Alternative Number *SRL-6*

Distance from PWS to new well location	10.44	miles
Estimated well depth	310	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	15	n/a	n/a	n/a
PVC water line, Class 200, 04"	55,111	LF	$ 27.00	$ 1,487,997
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	750	LF	$ 35.00	$ 26,250
Gate valve and box, 04"	11	EA	$ 370.00	$ 4,078
Air valve	10	EA	$ 1,000.00	$ 10,000
Flush valve	11	EA	$ 750.00	$ 8,267
Metal detectable tape	55,111	LF	$ 0.15	$ 8,267
Subtotal				**$ 1,544,859**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	310	LF	$ 25	$ 7,750
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 28,750**

Subtotal of Component Costs			**$ 1,697,019**
Contingency	20%		$ 339,404
Design & Constr Management	25%		$ 424,255
TOTAL CAPITAL COSTS			**$ 2,460,677**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	10.4	mile	$ 200	$ 2,088
Subtotal				**$ 2,088**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	2,052	kWH	$ 0.136	$ 279
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,286**
Well O&M				
Pump power	119	kWH	$ 0.136	$ 16
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,451**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 43,368**

Table C.7

PWS Name *Stoneridge Lake Water System*
Alternative Name *Drill a New Well at Oak Bend Estates*
Alternative Number *SRL-7*

Distance from PWS to new well location	11.11	miles
Estimated well depth	150	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	17	n/a	n/a	n/a
PVC water line, Class 200, 04"	58,672	LF	$ 27.00	$ 1,584,144
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	850	LF	$ 35.00	$ 29,750
Gate valve and box, 04"	12	EA	$ 370.00	$ 4,342
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	12	EA	$ 750.00	$ 8,801
Metal detectable tape	58,672	LF	$ 0.15	$ 8,801
Subtotal				**$ 1,658,837**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	150	LF	$ 25	$ 3,750
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 24,750**
Subtotal of Component Costs				**$ 1,806,997**
Contingency	20%			$ 361,399
Design & Constr Management	25%			$ 451,749
TOTAL CAPITAL COSTS				**$ 2,620,146**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	11.1	mile	$ 200	$ 2,222
Subtotal				**$ 2,222**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	1,536	kWH	$ 0.136	$ 209
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,216**
Well O&M				
Pump power	58	kWH	$ 0.136	$ 8
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,443**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 43,425**

Table C.8

PWS Name	***Stoneridge Lake Water System***
Alternative Name	***Purchase Water from BWA***
Alternative Number	***SRL-8***

Distance from Alternative to PWS (along pipe)	11.1	miles
Total PWS annual water usage	3.139	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	12	n/a	n/a	n/a
PVC water line, Class 200, 04"	58,852	LF	$ 27.00	$ 1,589,004
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	600	LF	$ 35.00	$ 21,000
Gate valve and box, 04"	12	EA	$ 370.00	$ 4,355
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	12	EA	$ 750.00	$ 8,828
Metal detectable tape	58,852	LF	$ 0.15	$ 8,828
Subtotal				**$ 1,655,015**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Subtotal of Component Costs				**$ 1,778,425**
Contingency	20%			$ 355,685
Design & Constr Management	25%			$ 444,606
TOTAL CAPITAL COSTS				**$ 2,578,716**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	11.1	mile	$ 200	$ 2,229
Subtotal				**$ 2,229**
Water Purchase Cost				
From BWA	3,139	1,000 gal	$ 1.60	$ 5,022
Subtotal				**$ 5,022**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	1,616	kWH	$ 0.136	$ 220
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,227**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 39,022**

Table C.9

PWS Name *Stoneridge Lake Water System*
Alternative Name *Purchase Water from the City of Alvin*
Alternative Number *SRL-9*

Distance from Alternative to PWS (along pipe)	10.6	miles
Total PWS annual water usage	3.139	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	2	n/a	n/a	n/a
Number of Crossings, open cut	20	n/a	n/a	n/a
PVC water line, Class 200, 04"	56,134	LF	$ 27.00	$ 1,515,618
Bore and encasement, 10"	400	LF	$ 60.00	$ 24,000
Open cut and encasement, 10"	1,000	LF	$ 35.00	$ 35,000
Gate valve and box, 04"	11	EA	$ 370.00	$ 4,154
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	11	EA	$ 750.00	$ 8,420
Metal detectable tape	56,134	LF	$ 0.15	$ 8,420
Subtotal				**$ 1,606,612**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Subtotal of Component Costs				**$ 1,730,022**
Contingency	20%			$ 346,004
Design & Constr Management	25%			$ 432,506
TOTAL CAPITAL COSTS				**$ 2,508,532**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	10.6	mile	$ 200	$ 2,126
Subtotal				**$ 2,126**
Water Purchase Cost				
City of Alvin	3,139	1,000 gal	$ 1.65	$ 5,179
Subtotal				**$ 5,179**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	2,126	kWH	$ 0.136	$ 289
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,296**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 39,145**

Table C.9

PWS Name *Stoneridge Lake Water System*
Alternative Name *New Well at 10 Miles*
Alternative Number *SRL-9*

Distance from PWS to new well location	10.0	miles
Estimated well depth	310	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	14	n/a	n/a	n/a
Number of Crossings, open cut	10	n/a	n/a	n/a
PVC water line, Class 200, 04"	52,800	LF	$ 27.00	$ 1,425,600
Bore and encasement, 10"	2,800	LF	$ 60.00	$ 168,000
Open cut and encasement, 10"	500	LF	$ 35.00	$ 17,500
Gate valve and box, 04"	11	EA	$ 370.00	$ 3,907
Air valve	10	EA	$ 1,000.00	$ 10,000
Flush valve	11	EA	$ 750.00	$ 7,920
Metal detectable tape	52,800	LF	$ 0.15	$ 7,920
Subtotal				**$ 1,640,847**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	310	LF	$ 25	$ 7,750
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 28,750**
Subtotal of Component Costs				**$ 1,793,007**
Contingency	20%			$ 358,601
Design & Constr Management	25%			$ 448,252
TOTAL CAPITAL COSTS				**$ 2,599,860**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	10.0	mile	$ 200	$ 2,000
Subtotal				**$ 2,000**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	1,801	kWH	$ 0.136	$ 245
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,252**
Well O&M				
Pump power	119	kWH	$ 0.136	$ 16
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,451**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 43,246**

Table C.10

PWS Name	***Stoneridge Lake Water System***
Alternative Name	***New Well at 5 Miles***
Alternative Number	***SRL-10***

Distance from PWS to new well location	5.0	miles
Estimated well depth	310	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	7	n/a	n/a	n/a
Number of Crossings, open cut	5	n/a	n/a	n/a
PVC water line, Class 200, 04"	26,400	LF	$ 27.00	$ 712,800
Bore and encasement, 10"	1,800	LF	$ 60.00	$ 108,000
Open cut and encasement, 10"	100	LF	$ 35.00	$ 3,500
Gate valve and box, 04"	5	EA	$ 370.00	$ 1,954
Air valve	5	EA	$ 1,000.00	$ 5,000
Flush valve	5	EA	$ 750.00	$ 3,960
Metal detectable tape	26,400	LF	$ 0.15	$ 3,960
Subtotal				**$ 839,174**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 04"	2	EA	$ 4,000	$ 8,000
Gate valve, 04"	8	EA	$ 405	$ 3,240
Check valve, 04"	4	EA	$ 595	$ 2,380
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Storage Tank - 5,000 gals	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 123,410**
Well Installation				
Well installation	310	LF	$ 25	$ 7,750
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 28,750**
Subtotal of Component Costs				**$ 991,334**
Contingency	20%			$ 198,267
Design & Constr Management	25%			$ 247,833
TOTAL CAPITAL COSTS				**$ 1,437,434**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.0	mile	$ 200	$ 1,000
Subtotal				**$ 1,000**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.136	$ 3,210
Pump Power	901	kWH	$ 0.136	$ 122
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 46	$ 33,398
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 41,130**
Well O&M				
Pump power	119	kWH	$ 0.136	$ 16
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,451**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 42,124**

Table C.11

PWS Name *Stoneridge Lake Water System*
Alternative Name *New Well at 1 Mile*
Alternative Number *SRL-11*

Distance from PWS to new well location	1.0	miles
Estimated well depth	310	feet
Number of wells required	1	
Well installation cost (location specific)	$25	per foot
Number of pump stations needed	0	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	5,280	LF	$ 27.00	$ 142,560
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	1	EA	$ 370.00	$ 391
Air valve	1	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 792
Metal detectable tape	5,280	LF	$ 0.15	$ 792
Subtotal				**$ 159,285**
Pump Station(s) Installation				
Pump	2	EA	$ 7,500	$ 15,000
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 61,705**
Well Installation				
Well installation	310	LF	$ 25	$ 7,750
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 28,750**
Subtotal of Component Costs				**$ 249,740**
Contingency	20%			$ 49,948
Design & Constr Management	25%			$ 62,435
TOTAL CAPITAL COSTS				**$ 362,123**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	1.0	mile	$ 200	$ 200
Subtotal				**$ 200**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.136	$ 1,605
Pump Power	-	kWH	$ 0.136	$ -
Materials	1	EA	$ 1,200	$ 1,200
Labor	365	Hrs	$ 46	$ 16,699
Tank O&M	1	EA	$ 1,000	$ 1,000
Subtotal				**$ 20,504**
Well O&M				
Pump power	119	kWH	$ 0.136	$ 16
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 46	$ 8,235
Subtotal				**$ 9,451**
O&M Credit for Existing Well Closure				
Pump power	160	kWH	$ 0.136	$ (22)
Well O&M matl	1	EA	$ 1,200	$ (1,200)
Well O&M labor	180	Hrs	$ 46	$ (8,235)
Subtotal				**$ (9,457)**
TOTAL ANNUAL O&M COSTS				**$ 20,698**

Table BR.13

PWS Name — ***Stoneridge Lake Water System***
Alternative Name — ***Central Treatment - IX***
Alternative Number — ***SRL-13***

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Ion Exchange Unit Purchase/Installation				
Site preparation	0.50	acre	$ 4,000	$ 2,000
Slab	15	CY	$ 1,000	$ 15,000
Building	400	SF	$ 60	$ 24,000
Building electrical	400	SF	$ 8	$ 3,200
Building plumbing	400	SF	$ 8	$ 3,200
Heating and ventilation	400	SF	$ 7	$ 2,800
Fence	600	LF	$ 15	$ 9,000
Paving	2,500	SF	$ 2	$ 5,000
Electrical	1	JOB	$ 50,000	$ 50,000
Piping	1	JOB	$ 20,000	$ 20,000
Ion exchange package including:				
Regeneration system				
Brine tank				
Ion exchange resins & vessels	1	UNIT	$ 30,000	$ 30,000
Transfer pumps (5 hp)	2	EA	$ 5,000	$ 10,000
Clean water tank	5,000	gal	$ 1	$ 5,000
Regenerant tank	2,000	gal	$ 2	$ 3,000
Backwash Tank	2,000	gal	$ 2	$ 4,000
Sewer Connection Fee	1	EA	$ 15,000	$ 15,000
Subtotal of Component Costs				**$ 201,200**
Contingency	20%			$ 40,240
Design & Constr Management	25%			$ 50,300
TOTAL CAPITAL COSTS				**$ 291,740**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Ion Exchange Unit O&M				
Building Power	9,000	kwh/yr	$ 0.136	$ 1,224
Equipment power	5,000	kwh/yr	$ 0.136	$ 680
Labor	400	hrs/yr	$ 46	$ 18,400
Materials	1	year	$ 1,000	$ 1,000
Chemicals	1	year	$ 1,000	$ 1,000
Analyses	24	test	$ 200	$ 4,800
Backwash discharge to sewer	10	MG/yr	$ 5.00	$ 50
Subtotal				**$ 27,154**
Haul Regenerant Waste and Brine				
Waste haulage truck rental	4	days	$ 700	$ 2,800
Mileage charge	300	miles	$ 1.00	$ 300
Subtotal				**$ 3,100**
Waste disposal fee	6	kgal/yr	$200	**$1,200**
TOTAL ANNUAL O&M COSTS				**$ 31,454**

Table C.14

PWS Name *Stoneridge Lake Water System*
Alternative Name *Central Treatment - Adsorption*
Alternative Number *SRL-14*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Adsorption Unit Purchase/Installation				
Site preparation	0.50	acre	$ 4,000	$ 2,000
Slab	15	CY	$ 1,000	$ 15,000
Building	400	SF	$ 60	$ 24,000
Building electrical	400	SF	$ 8	$ 3,200
Building plumbing	400	SF	$ 8	$ 3,200
Heating and ventilation	400	SF	$ 7	$ 2,800
Fence	600	LF	$ 15	$ 9,000
Paving	2,500	SF	$ 2	$ 5,000
Electrical	1	JOB	$ 50,000	$ 50,000
Piping	1	JOB	$ 20,000	$ 20,000
Adsorption package including:				
4 Adsorption vessels				
E33 Iron oxide media				
Controls & instruments	1	UNIT	$ 80,000	$ 80,000
Backwash Tank	5,000	GAL	$ 2	$ 10,000
Sewer Connection Fee	1	EA	$ 15,000	$ 15,000
Transfer pumps	2	EA	$ 5,000	$ 10,000
Storage tank	5,000	gal	$ 3	$ 15,000
Chlorination Point	1	EA	$ 2,000	$ 2,000
Subtotal of Component Costs				**$ 266,200**
Contingency	20%			$ 53,240
Design & Constr Management	25%			$ 66,550
TOTAL CAPITAL COSTS				**$ 385,990**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Adsorption Unit O&M				
Building Power	9,000	kwh/yr	$ 0.136	$ 1,224
Equipment power	5,000	kwh/yr	$ 0.136	$ 680
Labor	400	hrs/yr	$ 46	$ 18,400
Media replacement	1	year	$ 6,000	$ 6,000
Analyses	24	test	$ 200	$ 4,800
Backwash discharge to sewer	0.03	MG/yr	$ 5,000	$ 150
Spent Media Disposal	12	CY	$ 20	$ 240
Subtotal				**$ 31,494**
TOTAL ANNUAL O&M COSTS				**$ 31,494**

Table C.15

PWS Name ***Stoneridge Lake Water System***
Alternative Name ***Central Treatment - Coag-Filt***
Alternative Number ***SRL-15***

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Coagulation/Filtration Unit Purchase/Installation				
Site preparation	0.50	acre	$ 4,000	$ 2,000
Slab	15	CY	$ 1,000	$ 15,000
Building	400	SF	$ 60	$ 24,000
Building electrical	400	SF	$ 8	$ 3,200
Building plumbing	400	SF	$ 8	$ 3,200
Heating and ventilation	400	SF	$ 7	$ 2,800
Fence	600	LF	$ 15	$ 9,000
Paving	2,500	SF	$ 2	$ 5,000
Electrical	1	JOB	$ 45,000	$ 45,000
Piping	1	JOB	$ 15,000	$ 15,000
Coagulant/filter package including:				
Chemical feed system				
Pressure ceramic filters				
Controls & Instruments	1	UNIT	$ 80,000	$ 80,000
Backwash Tank	5,000	GAL	$ 2	$ 10,000
Coagulant Tank	200	GAL	$ 3	$ 600
Sewer Connection Fee	1	EA	$ 15,000	$ 15,000
Transfer pumps	2	EA	$ 5,000	$ 10,000
Storage tank	5,000	gal	$ 3	$ 15,000
Chlorination Point	1	EA	$ 2,000	$ 2,000
Subtotal of Component Costs				**$ 256,800**
Contingency	20%			$ 51,360
Design & Constr Management	25%			$ 64,200
TOTAL CAPITAL COSTS				**$ 372,360**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Coagulation/Filtration Unit O&M				
Building Power	9,000	kwh/yr	$ 0.136	$ 1,224
Equipment power	5,000	kwh/yr	$ 0.136	$ 680
Labor	600	hrs/yr	$ 46	$ 27,600
Materials	1	year	$ 1,000	$ 1,000
Chemicals	1	year	$ 1,500	$ 1,500
Analyses	24	test	$ 200	$ 4,800
Backwash discharge to sewer	0.2	MG/yr	$ 5,000	$ 1,000
Subtotal				**$ 37,804**
TOTAL ANNUAL O&M COSTS				**$ 37,804**

Table C.16

PWS Name	***Stoneridge Lake Water System***
Alternative Name	***Point-of-Use Treatment***
Alternative Number	***SRL-16***

Number of Connections for POU Unit Installation 22

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POU-Treatment - Purchase/Installation				
POU treatment unit purchase	22	EA	$ 250	$ 5,500
POU treatment unit installation	22	EA	$ 150	$ 3,300
Subtotal				**$ 8,800**
Subtotal of Component Costs				**$ 8,800**
Contingency	20%			$ 1,760
Design & Constr Management	25%			$ 2,200
Procurement & Administration	20%			$ 1,760
TOTAL CAPITAL COSTS				**$ 14,520**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POU materials, per unit	22	EA	$ 225	$ 4,950
Contaminant analysis, 1/yr per unit	22	EA	$ 100	$ 2,200
Program labor, 10 hrs/unit	220	hrs	$ 46	$ 10,065
Subtotal				**$ 17,215**
TOTAL ANNUAL O&M COSTS				**$ 17,215**

Table C.17

PWS Name ***Stoneridge Lake Water System***
Alternative Name ***Point-of-Entry Treatment***
Alternative Number ***SRL-17***

Number of Connections for POE Unit Installation 22

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POE-Treatment - Purchase/Installation				
POE treatment unit purchase	22	EA	$ 3,000	$ 66,000
Pad and shed, per unit	22	EA	$ 2,000	$ 44,000
Piping connection, per unit	22	EA	$ 1,000	$ 22,000
Electrical hook-up, per unit	22	EA	$ 1,000	$ 22,000
Subtotal				**$ 154,000**
Subtotal of Component Costs				**$ 154,000**
Contingency	20%			$ 30,800
Design & Constr Management	25%			$ 38,500
Procurement & Administration	20%			$ 30,800
TOTAL CAPITAL COSTS				**$ 254,100**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POE materials, per unit	22	EA	$ 1,000	$ 22,000
Contaminant analysis, 1/yr per unit	22	EA	$ 100	$ 2,200
Program labor, 10 hrs/unit	220	hrs	$ 46	$ 10,065
Subtotal				**$ 34,265**
TOTAL ANNUAL O&M COSTS				**$ 34,265**

Table C.18

PWS Name ***Stoneridge Lake Water System***
Alternative Name ***Public Dispenser for Treated Drinking Water***
Alternative Number ***SRL-18***

Number of Treatment Units Recommended 1

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Public Dispenser Unit Installation				
POE-Treatment unit(s)	1	EA	$ 3,000	$ 3,000
Unit installation costs	1	EA	$ 5,000	$ 5,000
Subtotal				**$ 8,000**
Subtotal of Component Costs				**$ 8,000**
Contingency	20%			$ 1,600
Design & Constr Management	25%			$ 2,000
TOTAL CAPITAL COSTS				**11,600**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Treatment unit O&M, 1 per unit	1	EA	$ 500	$ 500
Contaminant analysis, 1/wk per ui	52	EA	$ 100	$ 5,200
Sampling/reporting, 1 hr/day	365	HRS	$ 46	$ 16,699
Subtotal				**$ 22,399**
TOTAL ANNUAL O&M COSTS				**$ 22,399**

Table C.19

PWS Name ***Stoneridge Lake Water System***
Alternative Name ***Supply Bottled Water to Population***
Alternative Number ***SRL-19***

Service Population	66	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	24,090	gallons

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Implementation				
Initial program set-up	500	hours	$ 61	$ 30,424
Subtotal				**$ 30,424**
Subtotal of Component Costs				**$ 30,424**
Contingency	20%			$ 6,085
TOTAL CAPITAL COSTS				**$ 36,509**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water purchase costs	24,090	gals	$ 1.60	$ 38,544
Program admin, 9 hrs/wk	468	hours	$ 61	$ 28,477
Program materials	1	EA	$ 5,000	$ 5,000
Subtotal				**$ 72,021**
TOTAL ANNUAL O&M COSTS				**$ 72,021**

Table C.20

PWS Name *Stoneridge Lake Water System*
Alternative Name *Central Trucked Drinking Water*
Alternative Number *SRL-20*

Service Population	66	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	24,090	gallons
Travel distance to compliant water source (roundtrip)	25	miles

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Storage Tank Installation				
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Site improvements	1	EA	$ 4,000	$ 4,000
Potable water truck	1	EA	$ 60,000	$ 60,000
Subtotal				**$ 71,025**
Subtotal of Component Costs				**$ 71,025**
Contingency	20%			$ 14,205
Design & Constr Management	25%			$ 17,756
TOTAL CAPITAL COSTS				**$ 102,986**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water delivery labor, 4 hrs/wk	208	hrs	$ 46	$ 9,516
Truck operation, 1 round trip/wk	1,300	miles	$ 1.00	$ 1,300
Water purchase	24	1,000 gals	$ 1.80	$ 43
Water testing, 1 test/wk	52	EA	$ 100	$ 5,200
Sampling/reporting, 2 hrs/wk	104	hrs	$ 46	$ 4,758
Subtotal				**$ 20,817**
TOTAL ANNUAL O&M COSTS				**$ 20,817**

APPENDIX D
EXAMPLE FINANCIAL MODEL

Table D.1 Example Financial Model

Water System	Stoneridge Lakes
Funding Alternative	Bond
Alternative Description	Purchase Water from BWA

Sum of Amount		Year																					
Group	Type	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Capital Expenditures	Capital Expenditures-Funded fro	$ -	$ -	$ -	########	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Expenditures-Funded fro	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Expenditures-Funded fro	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Expenditures-Funded fro	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Expenditures Sum		$ -	$ -	$ -	########	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service	Revenue Bonds				$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724
	State Revolving Funds				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service Sum					$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724	$ 201,724
Operating Expenditures	Other Operating Expenditures 1			$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199	$ 17,199
	O&M Associated with Alternative					$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022	$ 39,022
Operating Expenditures Sum				$ 17,199	$ 17,199	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221	$ 56,221
Residential Operating Revenues	Residential Base Monthly Rate			$ 17,901	$ 17,901	$ 217,166	$ 467,427	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424
	Residential Tier 1 Monthly Rate			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Tier2 Monthly Rate			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Tier3 Monthly Rate			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Tier4 Monthly Rate			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Unmetered Monthly Rate			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Residential Operating Revenues Sum				$ 17,901	$ 17,901	$ 217,166	$ 467,427	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424

Location_Name	Stoneridge Lakes
Alt_Desc	Purchase Water from BWA

		Current_Year																					
Funding_Alt	Data	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Bond	Sum of Beginning_Cash_Bal	$ 8,483	$ 5,471	$ (199,265)	$ (250,262)	$ (50,997)	$ 199,265	$ 449,527	$ 699,788	$ 950,050	$ 1,200,312	$ 1,450,574	$ 1,700,836	$ 1,951,098	$ 2,201,359	$ 2,451,621	$ 2,701,883	$ 2,952,145	$ 3,202,407	$ 3,452,668	$ 3,702,930	$ 3,953,192	$ 4,203,454
	Sum of Total_Expenditures	$ 17,199	$ 2,797,639	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945	$ 257,945
	Sum of Total_Receipts	$ 17,901	$ 2,596,617	$ 217,166	$ 467,427	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424	$ 518,424
	Sum of Net_Cash_Flow	$ 702	$ (201,023)	$ (40,780)	$ 209,482	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479	$ 260,479
	Sum of Ending_Cash_Bal	$ 9,185	$ (195,551)	$ (240,045)	$ (40,780)	$ 209,482	$ 459,744	$ 710,006	$ 960,267	$ 1,210,529	$ 1,460,791	$ 1,711,053	$ 1,961,315	$ 2,211,577	$ 2,461,838	$ 2,712,100	$ 2,962,362	$ 3,212,624	$ 3,462,886	$ 3,713,147	$ 3,963,409	$ 4,213,671	$ 4,463,933
	Sum of Working_Cap	$ 2,867	$ 2,867	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370	$ 9,370
	Sum of Repl_Resv	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847	$ 847
	Sum of Total_Reqd_Resv	$ 3,714	$ 3,714	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217	$ 10,217
	Sum of Net_Avail_Bal	$ 5,471	$ (199,265)	$ (250,262)	$ (50,997)	$ 199,265	$ 449,527	$ 699,788	$ 950,050	$ 1,200,312	$ 1,450,574	$ 1,700,836	$ 1,951,098	$ 2,201,359	$ 2,451,621	$ 2,701,883	$ 2,952,145	$ 3,202,407	$ 3,452,668	$ 3,702,930	$ 3,953,192	$ 4,203,454	$ 4,453,716
	Sum of Add_Resv_Needed	$ -	$ (199,265)	$ (250,262)	$ (50,997)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Sum of Rate_Inc_Needed	0%	1113%	115%	11%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0
	Sum of Percent_Rate_Increase	0%	0%	1113%	2511%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%	2796%

APPENDIX E
GENERAL ARSENIC GEOCHEMISTRY

Geochemistry of arsenic is complex because of the possible coexistence of two or even three redox states, because of the complex chemistry of organo-arsenicals, and because of the strong interaction of most arsenic compounds with soil particles, particularly iron oxides (and to a lesser degree aluminum and manganese oxides). The fully deprotonated arsenate AsO_4^{-3} is the expected form of arsenic in most soils under aerobic conditions only at high pH (Figure E.1). At more neutral and acid pH's, the $HAsO_4^{-2}$ and $H_2AsO_4^{-1}$ forms, respectively, are dominant. The general understanding of arsenic mobility in soil and aquifers is that it will increase with increasing pH and phosphate concentration and with decreasing clay and iron oxide content. As pH increases, the negative charge of the arsenate ion increases making it less likely to sorb on negatively charged soil particles. Phosphates have a chemical structure very similar to arsenates and sorb to soils preferentially to them in some conditions. Nitrogen also belongs to the same group in the periodic table but does not show the same competing behavior as phosphate. Other structurally similar oxyanions, sulfate and selenate, are also weak sorbers. Under less oxidizing conditions, the arsenite ion H_3AsO_3 is most stable. The lack of charge renders the ion more mobile and less likely to sorb to soil particles. Its pH stability spread ranges from acid to alkaline. The first deprotonated form $H_2AsO_3^{-1}$ exists at significant concentrations only above a pH of approximately 9. The redox processes seem to be mediated by microorganisms (Welch, *et al*. 2000) and to take place next to mineral surfaces.

Under even more reducing conditions, arsenide is the stable ionic form of arsenic. Arsenic has a complex geochemistry with sulfur both in solution where several thioarsenic ions can form and in the associated minerals. Arsenic metal –As(0)- rarely occurs. Methylated arsenic compounds are generally present at low aqueous concentrations (<1 ppb), if at all, except maybe when there is an abundance of organic matter (Welch, *et al.* 2000).

As(V) and As(III) minerals are fairly soluble and do not control arsenic solubility in oxidizing and mildly reducing conditions except maybe if barium is present (Henry, *et al.* 1982). This is in contrast to other companion oxyanions which are not as mobile under reducing conditions, except vanadium. In reducing conditions, arsenic precipitates as arsenopyrite (FeAsS) but more commonly in solid solution with pyrite. Realgar (AsS) and orpiment (As_2S_3) require a high sulfur activity and are unlikely in the southern Gulf Coast.

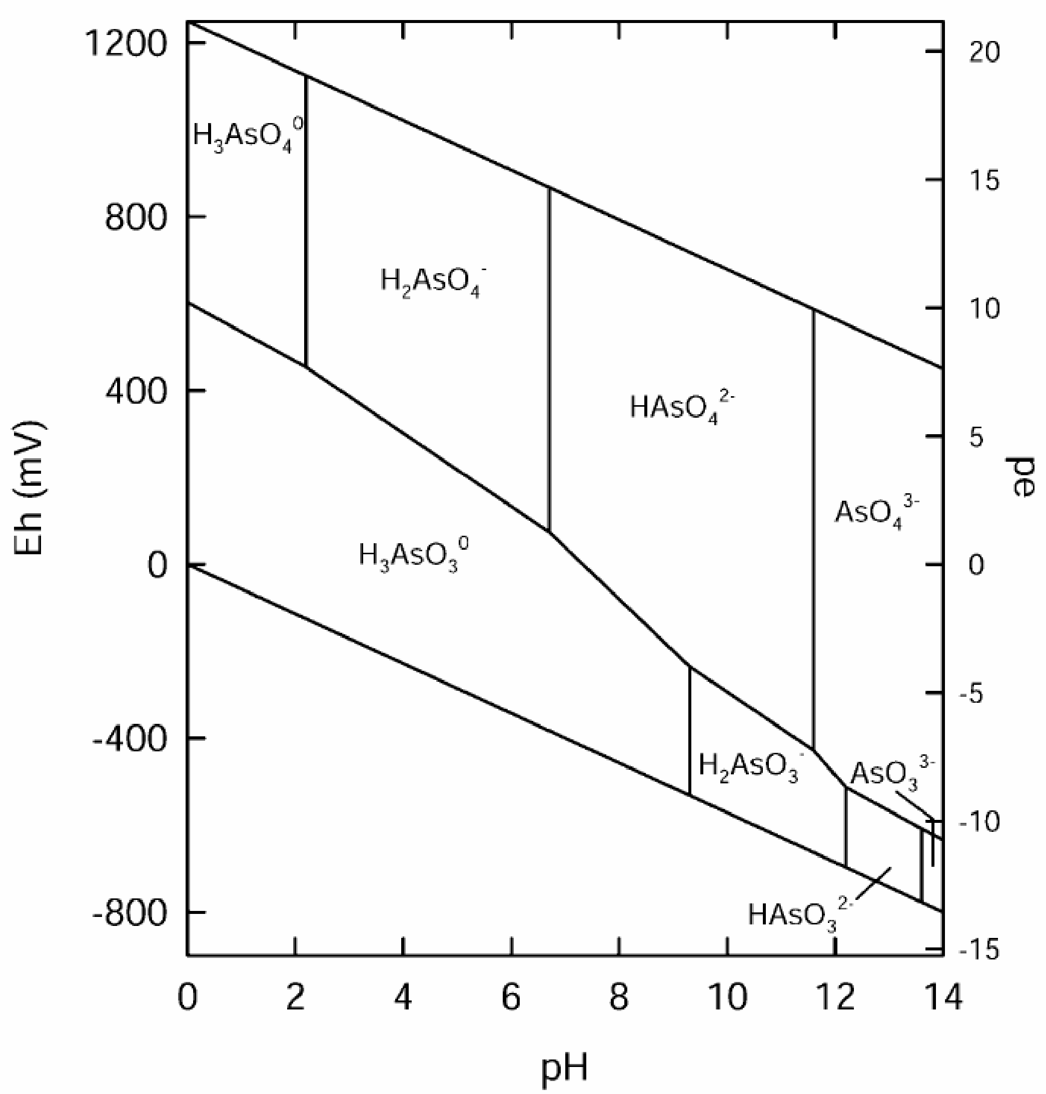

Figure E.1 Eh-pH Diagram for Arsenic Aqueous Species in the As-O_2-H_2O System at 25°C and 1 Bar (from Smedley and Kinniburgh 2002)

APPENDIX F
ORBIT SYSTEMS WATER USAGE

Orbit Systems, Inc.
2004 Water Usage

No.	System Name	2004 Water Usage (gal/yr)	% Water Usage %	No. Connections #	Usage Per Connection (gal/yr)	No. Customers #	Annual Usage Per Customer (gal/yr)	Daily Usage Per Customer (gpcd)
1	Coronado Country	2,083,300	1.7	44	47,348	132	15,783	43.2
2	Country Acres	6,766,800	5.4	88	76,895	264	25,632	70.2
3	Colony Cove	4,239,800	3.4	48	88,329	144	29,443	80.7
4	Country Meadows	3,446,900	2.7	48	71,810	144	23,937	65.6
5	Blue Sage Gardens	2,976,800	2.4	43	69,228	129	23,076	63.2
6	Brandi Estates	3,524,700	2.8	43	81,970	129	27,323	74.9
7	Sandy Meadows	3,735,400	3.0	68	54,932	204	18,311	50.2
8	Rosharon Road Estates	5,455,900	4.3	76	71,788	228	23,929	65.6
9	Grasslands	12,465,400	9.9	171	72,897	513	24,299	66.6
10	Rosharon Township	8,055,400	6.4	99	81,368	297	27,123	74.3
11	Demi-John Island	3,973,000	3.2	99	40,131	297	13,377	36.6
12	San Bernard River	4,595,500	3.7	49	93,786	147	31,262	85.6
13	Angle Acres	3,330,500	2.7	44	75,693	132	25,231	69.1
14	Spanish Bait	672,000	0.5	8	84,000	24	28,000	76.7
15	Briarmeadow	5,231,700	4.2	41	127,602	123	42,534	116.5
16	Mooreland	4,605,600	3.7	48	95,950	144	31,983	87.6
17	Raynlong	2,736,600	2.2	32	85,519	96	28,506	78.1
18	Snug Harbor	2,030,600	1.6	33	61,533	99	20,511	56.2
19	Bernard Oaks	4,280,000	3.4	71	60,282	213	20,094	55.1
20	Demi-John Place	2,844,500	2.3	88	32,324	264	10,775	29.5
21	Teleview Terrace	5,997,600	4.8	47	127,609	141	42,536	116.5
22	Wolf Glen	2,809,900	2.2	35	80,283	105	26,761	73.3
23	Larkspur	420,000	0.3	5	84,000	15	28,000	76.7
24	Wilco Water	4,037,100	3.2	49	82,390	147	27,463	75.2
25	Beechwood	5,655,000	4.5	73	77,466	219	25,822	70.7
26	Oak Meadows	1,542,000	1.2	33	46,727	99	15,576	42.7
27	Mark V	7,178,900	5.7	94	76,371	282	25,457	69.7
28	Riverside Estates	3,695,400	2.9	48	76,988	144	25,663	70.3
29	Lee Ridge	1,926,900	1.5	22	87,586	66	29,195	80.0
30	Quail Valley Ranches IV	785,600	0.6	8	98,200	24	32,733	89.7
31	Paloma Acres	1,484,500	1.2	25	59,380	75	19,793	54.2
32	Colony Trails	2,254,100	1.8	45	50,091	135	16,697	45.7
33	Other	725,000	0.6	19	38,158	57	12,719	34.8
	TOTAL	**125,562,400**	**100**	**1,744**		**5,232**		
	AVERAGE				**74,504**		**24,835**	**68.0**

APPENDIX G
ANALYSIS OF SHARED SOLUTIONS FOR OBTAINING WATER FROM BWA AND CITY OF ALVIN

G.1 Overview of Method Used

There are a number of small PWSs with water quality problems located in the vicinity of Stoneridge Lake that could benefit from joining together and cooperating to share the cost for obtaining compliant drinking water. This cooperation could involve creating a formal organization of individual PWSs to address obtaining compliant drinking water, consolidating to form a single PWS, or having the individual PWSs be taken over or bought out by a larger regional entity.

The small PWSs with water quality problems near the Stoneridge Lake PWS are listed in Table G.1, along with their average water consumption and estimates of the capital cost for each PWS to construct an individual pipeline. All the PWSs are owned by Orbit. It is assumed for this analysis that all the systems would participate in a shared solution.

This analysis focuses on compliance alternatives related to obtaining water from large water providers interested in providing water outside their current area, either by wholesaling to PWSs, or by expanding their service areas. This type of solution is most likely to have the best prospects for sustainability, and a reliable provision of compliant drinking water.

The purpose of this analysis is to approximate the level of capital cost savings that could be expected from pursuing a shared solution versus a solution where the study PWS obtains compliant drinking water on its own. Regardless of the form a group solution would take, water consumers would have to pay for the infrastructure needed for obtaining compliant water. To keep this analysis as straightforward and realistic as possible, it is assumed the individual PWSs would remain independent, and would share the capital cost for the infrastructure required. Also, to maintain simplicity, this analysis is limited to estimating capital cost savings related to pipeline construction, which is likely to be by far the largest component of the overall capital cost. A shared solution could also produce savings in O&M expenses as a result of reduction in redundant facilities and the potential for shared O&M resources, and these savings would have to be evaluated if the PWSs are interested in implementing a shared solution.

There are many ways pipeline capital costs could be divided between participating PWSs, and the final apportioning of costs would likely be based on negotiation between the participating entities. At this preliminary stage of analysis it is not possible to project results from negotiations regarding cost sharing. For this reason, three methods are used to allocate cost between PWSs in an effort to give an approximation of the range of savings that might be attainable for an individual PWS.

Method A is based on allocating capital cost of the shared pipeline solution proportionate to the amount of water used by each PWS. In this case, the capital cost for the shared pipeline and the necessary pump stations is estimated, and then this total capital cost is allocated based on the fraction of the total water used by each PWS. For example, PWS#1 has an average daily water use of 0.1 mgd and PWS#2 has an average daily use of 0.3 mgd. Using this method, PWS#1 would be allocated 25 percent of the capital cost of the shared solution. This method is a reasonable method for allocating cost when all of the PWSs are different in size but are relatively equidistant from the shared water source.

Method B is also based on allocating capital cost of the shared pipeline solution proportionate to the amount of water used by the PWSs. However, rather than allocating the *total* capital cost of the shared solution between each participating PWS, this approach splits the shared pipeline into segments and allocates flow-proportional costs to the PWSs using each segment. Costs for a pipeline segment are not shared by a PWS if the PWS does not use that particular segment. For example, PWS#1 has an average daily water use of 0.3 mgd and PWS#2 has an average daily use of 0.2 mgd. A 3-mile long pipeline segment is common to both PWSs, while PWS#2 requires an additional 4-mile segment. Using this method, PWS#2 would be allocated 40 percent of the cost of the 3-mile segment and 100 percent of the cost of the 4-mile segment. This method is a reasonable method for allocating cost when all of the PWSs are different in size and are located at different distances from the shared water source.

Method C is based on allocating capital cost of the shared pipeline solution proportionate to the cost each PWS would have to pay to obtain compliant water if it were to implement an individual solution. In this case, the total capital cost for the shared pipeline and the necessary pump stations is estimated as well as the capital cost each PWS would have for obtaining its own pipeline. The total capital cost for the shared solution is then allocated between the participating PWSs based on what each PWS would have to pay to construct its own pipeline. For example, the individual solution cost for PWS#1 is $4 million and the individual solution cost for PWS#2 is $1 million. Using this method, PWS#1 would be allocated 80 percent of the cost of the shared solution. This method is a reasonable method for allocating cost when the PWS are located at different distances from the water source.

For any given PWS, all three of these methods should generate costs for the shared solution that produce savings for the PWS over an individual solution. However, for different PWSs participating in a shared solution, each of these three methods can produce savings of varying magnitudes: for one PWS, Method A might show the best cost savings while for another Method C might provide the best savings. For this reason, this range is considered to be representative of possible savings that could result from an agreement that should be fair and equitable to all parties involved.

G.2 Shared Solution for Obtaining Water from City of Alvin

This alternative would consist of constructing a main pipeline from the southwest part of the City of Alvin that would run southwest and west along FM 1462 to Rosharon Township. Each PWS would connect to this main with a spur line. Spur lines would convey the water from the main line to the storage tanks of each PWS. The main pipeline starts out as 6 inches in diameter, and reduces to 4 inches in diameter at the end. All of the spur pipelines are

4 inches in diameter. It is assumed two pump stations would be required to transfer the water from the City of Alvin to the end of the pipeline. The pipeline routing is shown in Figure G.1.

The capital costs for each pipe segment and the total capital cost for the shared pipeline are summarized in Table G.2. Table G.3 shows the capital costs allocated to each PWS using Method A. Table G.4 shows the capital costs allocated to each PWS using Method B. Table G.5 shows the allocation of pipeline capital costs to each of the PWSs using Method C, as described above, and Table G.6 provides a summary of the pipeline capital costs estimated for each PWS, and the savings that could be realized compared to developing individual pipelines. More detailed cost estimates for the pipe segments are shown at the end of this appendix in Tables G.12 through G.29.

Based on these estimates, the range of pipeline capital cost savings to Stoneridge Lake PWS could be between $1.9 million and $2.3 million, or 76 to 89 percent, if they were to implement a shared solution like this. These estimates are hypothetical and are only provided to approximate the magnitude of potential savings if this shared solution is implemented as described.

G.3 Shared Solution for Obtaining Water from Brazosport Water Authority

This alternative would consist of constructing a main pipeline that starts at the north part of the City of Angleton where the BWA line currently terminates. The line would run north along Highway 288 to Rosharon Township and turn to run east along FM 1462 to Rosharon Road Estates. Spur lines would convey the water from the main line to the storage tanks. The main pipeline starts out as 6 inches in diameter, and reduces to 4 inches in diameter at the end. All of the spur pipelines are 4 inches in diameter. It is assumed three pump stations would be required to transfer the water from the BWA line to the end of the pipeline. The pipeline routing is shown in Figure G.2.

The capital costs for each pipe segment and the total capital cost for the shared pipeline are summarized in Table G.7. Table G.8 shows the capital costs allocated to each PWS using Method A. Table G.9 shows the capital cost allocated to each PWS using Method B. Table G.10 shows the allocation of pipeline capital costs to each of the PWSs using Method C, as described above and Table G.11 provides a summary of the pipeline capital costs estimated for each PWS, and the savings that could be realized compared to developing individual pipelines. More detailed cost estimates for the pipe segments are shown at the end of this appendix in Tables G.12 through G.17 and G.30 through G.41.

Based on these estimates, the range of capital cost savings to Stoneridge Lake PWS could be between $1.8 million and $2.2 million, or 75 to 87 percent, if they were to implement a shared solution like this. These estimates are hypothetical and are only provided to approximate the magnitude of potential savings if this shared solution is implemented as described.

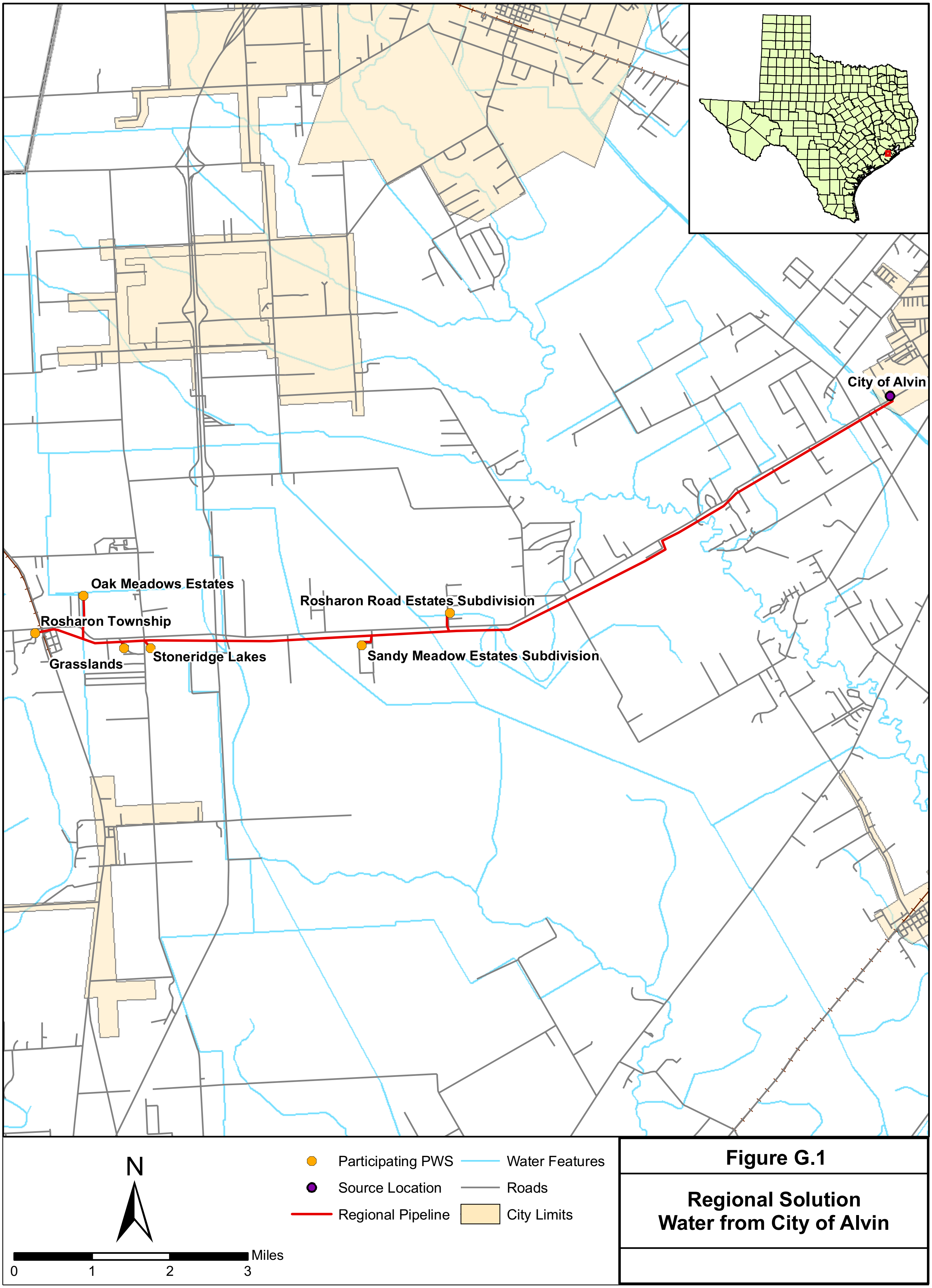

Figure G.1

Regional Solution
Water from City of Alvin

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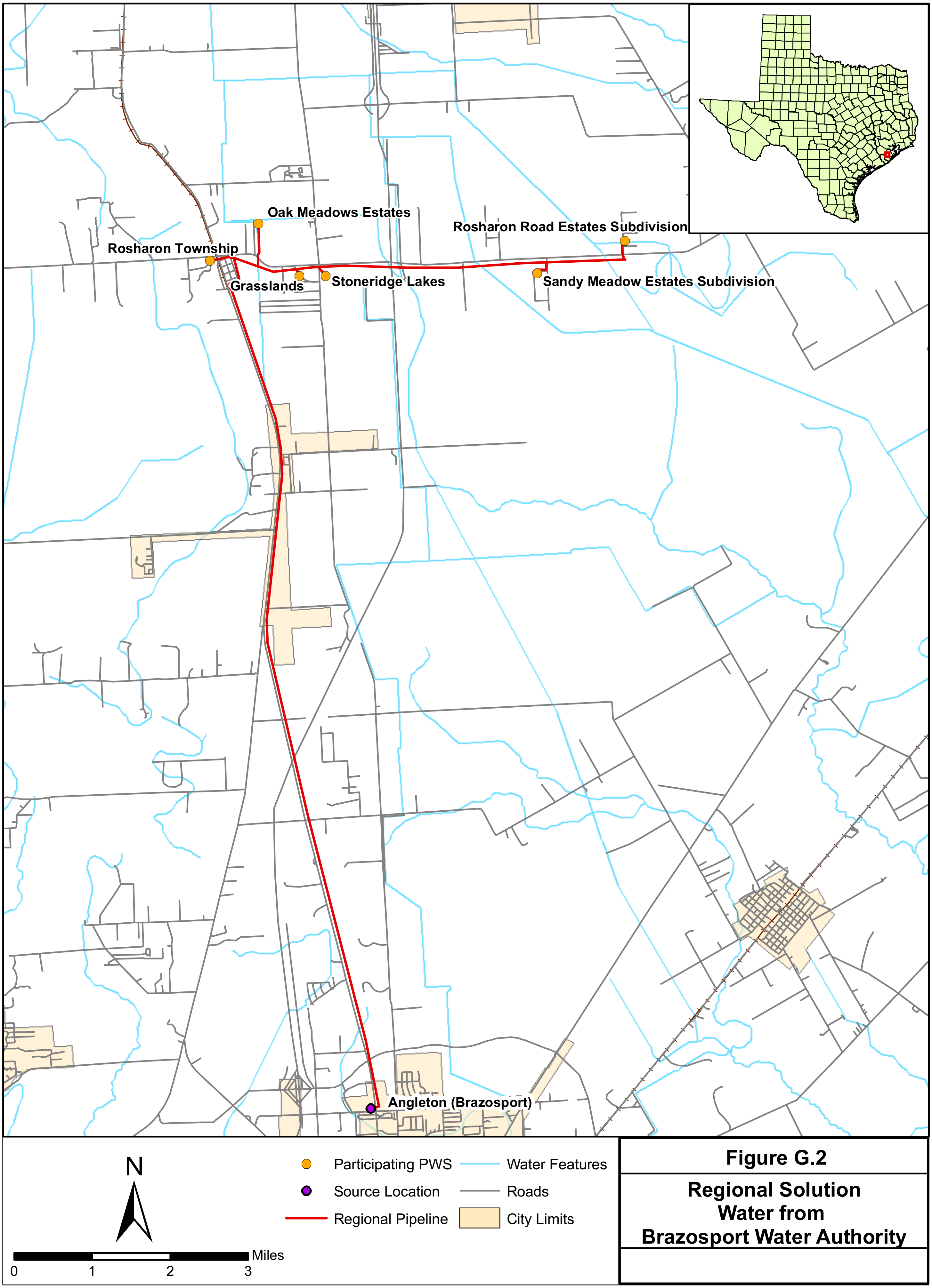

Figure G.2

Regional Solution
Water from
Brazosport Water Authority

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Table G.1
Summary Information for PWSs Participating in Shared Solution

PWS Names	PWS #	Average Water Demand, gpm	Water Demand as Percent of Total Demand	Pipeline Capital Cost for Individual Solutions from Alvin	Percent of sum of capital costs for individual solutions from Alvin	Pipeline Capital Cost for Individual Solutions from BWA	Percent of sum of capital costs for individual solutions from BWA
Rosharon Township	200036	13	18%	$ 2,851,163	20%	$ 2,540,184	15%
Oak Meadows	200566	5	6%	$ 2,810,908	20%	$ 2,703,899	16%
Grasslands	200360	27	37%	$ 2,601,709	18%	$ 2,557,190	15%
Stoneridge Lake	200624	6	8%	$ 2,565,286	18%	$ 2,537,109	15%
Sandy Meadow	200335	11	15%	$ 1,877,491	13%	$ 3,239,135	19%
Rosharon Road Estates	200346	10	14%	$ 1,660,177	12%	$ 3,359,289	20%
	Totals	**73**	**100%**	**$ 14,366,734**	**100%**	**$ 16,936,807**	**100%**

Table G.2
Capital Cost for Shared Pipeline from Alvin

Pipe Segment	Capital Cost
Pipe 1	$ 1,853,132
Pipe 2	$ 229,653
Pipe 3	$ 754,021
Pipe 4	$ 61,798
Pipe 5	$ 112,665
Pipe 6	$ 85,750
Pipe A	$ 71,596
Pipe B	$ 121,080
Pipe C	$ 20,558
Pipe D	$ 50,932
Pipe E	$ 53,423
Pipe F	$ 80,624
Total	**3,495,232**

Table G.3
Pipeline Capital Cost Allocation by Method A
Shared Pipeline Assessment for City of Alvin Water

PWS	PWS #	Flow Weighted Percent Use	Allocated Capital Cost
Rosharon Township	200036	18%	$ 639,270
Oak Meadows	200566	6%	$ 225,920
Grasslands	200360	37%	$ 1,305,315
Stoneridge Lake	200624	8%	$ 287,169
Sandy Meadow	200335	15%	$ 535,514
Rosharon Road Estates	200346	14%	$ 502,044
	Totals	**100%**	**$ 3,495,232**

Table G.4
Breakdown of Pipeline Capital Cost for Each PWS under Method B
Shared Pipeline Assessment for City of Alvin Water

Pipeline Segment	Pipe Segment Capital Cost	Rosharon Road Estates		Sandy Meadows		Stoneridge Lake		Grasslands		Oak Meadows		Rosharon Township	
		Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost
Pipe 1	$ 1,853,132	14%	$266,178	15%	$283,923	8%	$152,254	37%	$ 692,063	6%	$ 119,780	18%	$ 338,933
Pipe 2	$ 229,653	0%	$ -	18%	$ 41,087	10%	$ 22,033	44%	$ 100,151	8%	$ 17,334	21%	$ 49,048
Pipe 3	$ 754,021	0%	$ -	0%	$ -	12%	$ 88,104	53%	$ 400,474	9%	$ 69,313	26%	$ 196,130
Pipe 4	$ 61,798	0%	$ -	0%	$ -	0%	$ -	60%	$ 37,165	10%	$ 6,432	29%	$ 18,201
Pipe 5	$ 112,665	0%	$ -	0%	$ -	0%	$ -	0%	$ -	26%	$ 29,419	74%	$ 83,246
Pipe 6	$ 85,750	0%	$ -	0%	$ -	0%	$ -	0%	$ -	0%	$ -	100%	$ 85,750
Pipe A	$ 71,596	0%	$ -	0%	$ -	0%	$ -	0%	$ -	0%	$ -	100%	$ 71,596
Pipe B	$ 121,080	0%	$ -	0%	$ -	0%	$ -	0%	$ -	100%	$ 121,080	0%	$ -
Pipe C	$ 20,558	0%	$ -	0%	$ -	0%	$ -	100%	$ 20,558	0%	$ -	0%	$ -
Pipe D	$ 50,932	0%	$ -	0%	$ -	100%	$ 50,932	0%	$ -	0%	$ -	0%	$ -
Pipe E	$ 53,423	0%	$ -	100%	$ 53,423	0%	$ -	0%	$ -	0%	$ -	0%	$ -
Pipe F	$ 80,624	100%	$ 80,624	0%	$ -	0%	$ -	0%	$ -	0%	$ -	0%	$ -
Total	**$ 3,495,232**		$346,802		$378,434		$313,323		$ 1,250,410		$ 363,358		$ 842,905

Table G.5
Pipeline Capital Cost Allocation by Method C
Shared Pipeline Assessment for City of Alvin Water

PWS	PWS #	Cost for Individual Pipelines	Percent of Sum of Capital Costs for Individual Pipelines	Allocated Capital Cost
Rosharon Township	200036	$ 2,851,163	20%	$ 693,649
Oak Meadows	200566	$ 2,810,908	20%	$ 683,856
Grasslands	200360	$ 2,601,709	18%	$ 632,961
Stoneridge Lake	200624	$ 2,565,286	18%	$ 624,099
Sandy Meadow	200335	$ 1,877,491	13%	$ 456,768
Rosharon Road Estates	200346	$ 1,660,177	12%	$ 403,899
	Totals	**$ 14,366,734**	**100%**	**$ 3,495,232**

Table G.6
Pipeline Capital Cost Summary
Shared Pipeline Assessment for City of Alvin Water

PWS	Individual Pipeline Capital Costs	Shared Solution Capital Cost Allocation			Shared Solution Savings			Shared Solution Percent Savings		
		Method A	Method B	Method C	Method A	Method B	Method C	Method A	Method B	Method C
Rosharon Township	$ 2,851,163	$ 639,270	$ 842,905	$ 693,649	$ 2,211,893	$ 2,008,258	$ 2,157,513	78%	70%	76%
Oak Meadows	$ 2,810,908	$ 225,920	$ 363,358	$ 683,856	$ 2,584,988	$ 2,447,550	$ 2,127,052	92%	87%	76%
Grasslands	$ 2,601,709	$ 1,305,315	$ 1,250,410	$ 632,961	$ 1,296,394	$ 1,351,298	$ 1,968,748	50%	52%	76%
Stoneridge Lake	$ 2,565,286	$ 287,169	$ 313,323	$ 624,099	$ 2,278,117	$ 2,251,963	$ 1,941,187	89%	88%	76%
Sandy Meadow	$ 1,877,491	$ 535,514	$ 378,434	$ 456,768	$ 1,341,977	$ 1,499,057	$ 1,420,723	71%	80%	76%
Rosharon Road Estates	$ 1,660,177	$ 502,044	$ 346,802	$ 403,899	$ 1,158,133	$ 1,313,374	$ 1,256,278	70%	79%	76%
Totals	**$ 14,366,734**	**$ 3,495,232**	**$ 3,495,232**	**$ 3,495,232**	**$ 10,871,501**	**$ 10,871,501**	**$ 10,871,501**	**76%**	**76%**	**76%**

Table G.7
Capital Cost for Shared Pipeline from BWA

Pipe Segment	Capital Cost
Pipe 1	$ 2,902,178
Pipe 2	$ 148,720
Pipe 3	$ 109,291
Pipe 4	$ 65,489
Pipe 5	$ 768,765
Pipe 6	$ 233,344
Pipe A	$ 71,596
Pipe B	$ 121,080
Pipe C	$ 20,558
Pipe D	$ 50,932
Pipe E	$ 53,423
Pipe F	$ 80,624
Total	**4,626,001**

Table G.8
Pipeline Capital Cost Allocation by Method A
Shared Pipeline Assessment for BWA Water

PWS	PWS #	Flow Weighted Percent Use	Allocated Capital Cost
Rosharon Township	200036	18%	$ 846,085
Oak Meadows	200566	6%	$ 299,009
Grasslands	200360	37%	$ 1,727,607
Stoneridge Lake	200624	8%	$ 380,074
Sandy Meadow	200335	15%	$ 708,762
Rosharon Road Estates	200346	14%	$ 664,464
	Totals	**100%**	**$ 4,626,001**

Table G.9
Breakdown of Cost for Each PWS under Method B
Shared Pipeline Assessment for BWA Water

Pipeline Segment	Pipe Segment Capital Cost	Rosharon Town		Oak Meadows		Grasslands		Stoneridge		Sandy Meadow		Rosharon Road	
		Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost	Cost Allocation Based on Water Use	Allocated Cost
Pipe 1	$ 2,902,178	18%	$ 530,802	6%	$ 187,587	37%	$ 1,083,836	8%	$ 238,444	15%	$ 444,651	14%	$ 416,860
Pipe 2	$ 148,720	0%	$ -	8%	$ 11,764	46%	$ 67,973	10%	$ 14,954	19%	$ 27,886	18%	$ 26,143
Pipe 3	$ 109,291	0%	$ -	0%	$ -	50%	$ 54,242	11%	$ 11,933	20%	$ 22,253	19%	$ 20,862
Pipe 4	$ 65,489	0%	$ -	0%	$ -	0%	$ -	22%	$ 14,197	40%	$ 26,474	38%	$ 24,819
Pipe 5	$ 768,765	0%	$ -	0%	$ -	0%	$ -	0%	$ -	52%	$ 396,782	48%	$ 371,983
Pipe 6	$ 233,344	0%	$ -	0%	$ -	0%	$ -	0%	$ -	0%	$ -	100%	$ 233,344
Pipe A	$ 71,596	100%	$ 71,596	0%	$ -	0%	$ -	0%	$ -	0%	$ -	0%	$ -
Pipe B	$ 121,080	0%	$ -	100%	$ 121,080	0%	$ -	0%	$ -	0%	$ -	0%	$ -
Pipe C	$ 20,558	0%	$ -	0%	$ -	100%	$ 20,558	0%	$ -	0%	$ -	0%	$ -
Pipe D	$ 50,932	0%	$ -	0%	$ -	0%	$ -	100%	$ 50,932	0%	$ -	0%	$ -
Pipe E	$ 53,423	0%	$ -	0%	$ -	0%	$ -	0%	$ -	100%	$ 53,423	0%	$ -
Pipe F	$ 80,624	0%	$ -	0%	$ -	0%	$ -	0%	$ -	0%	$ -	100%	$ 80,624
Total Cost	**$ 4,626,001**		**$ 602,398**		**$ 320,431**		**$ 1,226,608**		**$ 330,459**		**$ 971,468**		**$ 1,174,636**

Table G.10
Pipeline Capital Cost Allocation by Method C
Shared Pipeline Assessment for BWA

PWS	PWS #	Cost for Individual Pipelines	Percent of Sum of Capital Costs for Individual Pipelines	Allocated Capital Cost
Rosharon Township	200036	$ 2,540,184	15%	$ 693,808
Oak Meadows	200566	$ 2,703,899	16%	$ 738,524
Grasslands	200360	$ 2,557,190	15%	$ 698,453
Stoneridge Lake	200624	$ 2,537,109	15%	$ 692,968
Sandy Meadow	200335	$ 3,239,135	19%	$ 884,715
Rosharon Road Estates	200346	$ 3,359,289	20%	$ 917,533
	Totals	**$ 16,936,807**	**100%**	**$ 4,626,001**

Table G.11
Pipeline Capital Cost Summary
Shared Pipeline Assessment for BWA

PWS	Individual Pipeline Capital Costs	Shared Solution Capital Cost Allocation			Shared Solution Savings			Shared Solution Percent Savings		
		Method A	Method B	Method C	Method A	Method B	Method C	Method A	Method B	Method C
Rosharon Township	$ 2,540,184	$ 846,085	$ 602,398	$ 693,808	$ 1,694,099	$ 1,937,786	$ 1,846,376	67%	76%	73%
Oak Meadows	$ 2,703,899	$ 299,009	$ 320,431	$ 738,524	$ 2,404,890	$ 2,383,468	$ 1,965,375	89%	88%	73%
Grasslands	$ 2,557,190	$ 1,727,607	$ 1,226,608	$ 698,453	$ 829,583	$ 1,330,582	$ 1,858,737	32%	52%	73%
Stoneridge Lake	$ 2,537,109	$ 380,074	$ 330,459	$ 692,968	$ 2,157,036	$ 2,206,650	$ 1,844,141	85%	87%	73%
Sandy Meadow	$ 3,239,135	$ 708,762	$ 971,468	$ 884,715	$ 2,530,373	$ 2,267,667	$ 2,354,421	78%	70%	73%
Rosharon Road Estates	$ 3,359,289	$ 664,464	$ 1,174,636	$ 917,533	$ 2,694,825	$ 2,184,653	$ 2,441,757	80%	65%	73%
Totals	**$ 16,936,807**	**$ 4,626,001**	**$ 4,626,001**	**$ 4,626,001**	**$ 12,310,806**	**$ 12,310,806**	**$ 12,310,806**	**73%**	**73%**	**73%**

Table G.12

Region solution Area

Alternative Name	***Purchase Water from main line to RoshTownship***
Pipe #	***A***

Distance from Alternative to PWS (along pipe)	0.3	miles
Total PWS annual water usage	6.972	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	3	n/a	n/a	n/a
PVC water line, Class 200, 04"	1,612	LF	$ 27.00	$ 43,524
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	150	LF	$ 35.00	$ 5,250
Gate valve and box, 04"	0	EA	$ 370.00	$ 119
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 242
Metal detectable tape	1,612	LF	$ 0.15	$ 242
Subtotal				**$ 49,377**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 49,377**
Contingency	20%			$ 9,875
Design & Constr Management	25%			$ 12,344
TOTAL CAPITAL COSTS				**$ 71,596**

Table G.13

Region solution Area
Alternative Name ***Purchase Water from main line to Oak Meadow***
Pipe # ***B***

Distance from Alternative to PWS (along pipe)	0.6	miles
Total PWS annual water usage	2.464	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	2,950	LF	$ 27.00	$ 79,650
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	1	EA	$ 370.00	$ 218
Air valve	1	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 443
Metal detectable tape	2,950	LF	$ 0.15	$ 443
Subtotal				**$ 83,503**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 83,503**
Contingency	20%			$ 16,701
Design & Constr Management	25%			$ 20,876
TOTAL CAPITAL COSTS				**$ 121,080**

Table G.14

Region solution Area
Alternative Name ***Purchase Water from main line to Grassland***
Pipe # ***C***

Distance from Alternative to PWS (along pipe)	0.1	miles
Total PWS annual water usage	14.235	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	454	LF	$ 27.00	$ 12,258
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	0	EA	$ 370.00	$ 34
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 68
Metal detectable tape	454	LF	$ 0.15	$ 68
Subtotal				**$ 14,178**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 14,178**
Contingency	20%			$ 2,836
Design & Constr Management	25%			$ 3,544
TOTAL CAPITAL COSTS				**$ 20,558**

Table G.15

Region solution Area

Alternative Name ***Purchase Water from main line to Stoneridge***

Pipe # ***D***

Distance from Alternative to PWS (along pipe)	0.1	miles
Total PWS annual water usage	3.132	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	3	n/a	n/a	n/a
PVC water line, Class 200, 04"	653	LF	$ 27.00	$ 17,631
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	150	LF	$ 35.00	$ 5,250
Gate valve and box, 04"	0	EA	$ 370.00	$ 48
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 98
Metal detectable tape	653	LF	$ 0.15	$ 98
Subtotal				**$ 35,125**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 35,125**
Contingency	20%			$ 7,025
Design & Constr Management	25%			$ 8,781
TOTAL CAPITAL COSTS				**$ 50,932**

Table G.16

Region solution Area
Alternative Name ***PurchaseWater from mainline to SandyMeadow***
Pipe # ***E***

Distance from Alternative to PWS (along pipe)	0.2	miles
Total PWS annual water usage	5.840	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	1,282	LF	$ 27.00	$ 34,614
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	0	EA	$ 370.00	$ 95
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 192
Metal detectable tape	1,282	LF	$ 0.15	$ 192
Subtotal				**$ 36,843**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 36,843**
Contingency	20%			$ 7,369
Design & Constr Management	25%			$ 9,211
TOTAL CAPITAL COSTS				**$ 53,423**

Table G.17

Region solution Area
Alternative Name ***Purchase Water from main line to Rosh Road***
Pipe # ***F***

Distance from Alternative to PWS (along pipe)	0.3	miles
Total PWS annual water usage	5.475	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	2	n/a	n/a	n/a
PVC water line, Class 200, 04"	1,465	LF	$ 27.00	$ 39,555
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	100	LF	$ 35.00	$ 3,500
Gate valve and box, 04"	0	EA	$ 370.00	$ 108
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 220
Metal detectable tape	1,465	LF	$ 0.15	$ 220
Subtotal				**$ 55,603**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 55,603**
Contingency	20%			$ 11,121
Design & Constr Management	25%			$ 13,901
TOTAL CAPITAL COSTS				**$ 80,624**

Table G.18

Region area solution

Alternative Name ***Purchase Water from Alvin to Rosharon Road***

Pipe Number ***1***

Distance from Alternative to PWS (along pipe)	6.7	miles
Total PWS annual water usage	38.117	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	4	n/a	n/a	n/a
Number of Crossings, open cut	14	n/a	n/a	n/a
PVC water line, Class 200, 06"	35,285	LF	$ 32.00	$ 1,129,120
Bore and encasement, 10"	800	LF	$ 60.00	$ 48,000
Open cut and encasement, 10"	700	LF	$ 35.00	$ 24,500
Gate valve and box, 06"	7	EA	$ 465.00	$ 3,282
Air valve	7	EA	$ 1,000.00	$ 7,000
Flush valve	7	EA	$ 750.00	$ 5,293
Metal detectable tape	35,285	LF	$ 0.15	$ 5,293
Subtotal				**$ 1,222,487**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 06"	1	EA	$ 4,000	$ 4,000
Gate valve, 06"	4	EA	$ 590	$ 2,360
Check valve, 06"	2	EA	$ 890	$ 1,780
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 55,535**
Subtotal of Component Costs				**$ 1,278,022**
Contingency	20%			$ 255,604
Design & Constr Management	25%			$ 319,506
TOTAL CAPITAL COSTS				**$ 1,853,132**

Table G.19

Region area solution

Alternative Name ***Purchase Water from Alvin to Sandy Meadow***

Pipe Number ***2***

Distance from Alternative to PWS (along pipe)	1.0	miles
Total PWS annual water usage	32.642	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	5,247	LF	$ 27.00	$ 141,669
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	1	EA	$ 370.00	$ 388
Air valve	1	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 787
Metal detectable tape	5,247	LF	$ 0.15	$ 787
Subtotal				**$ 158,381**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 158,381**
Contingency	20%			$ 31,676
Design & Constr Management	25%			$ 39,595
TOTAL CAPITAL COSTS				**$ 229,653**

Table G.20

Region area solution

Alternative Name ***Purchase Water from Alvin to Stoneridge***

Pipe Number ***3***

Distance from Alternative to PWS (along pipe)	2.9	miles
Total PWS annual water usage	26.802	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	3	n/a	n/a	n/a
Number of Crossings, open cut	3	n/a	n/a	n/a
PVC water line, Class 200, 04"	15,400	LF	$ 27.00	$ 415,800
Bore and encasement, 10"	600	LF	$ 60.00	$ 36,000
Open cut and encasement, 10"	150	LF	$ 35.00	$ 5,250
Gate valve and box, 04"	3	EA	$ 370.00	$ 1,140
Air valve	3	EA	$ 1,000.00	$ 3,000
Flush valve	3	EA	$ 750.00	$ 2,310
Metal detectable tape	15,400	LF	$ 0.15	$ 2,310
Subtotal				**$ 465,810**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 520,015**
Contingency	20%			$ 104,003
Design & Constr Management	25%			$ 130,004
TOTAL CAPITAL COSTS				**$ 754,021**

Table G.21

Region area solution

Alternative Name ***Purchase Water from Alvin to Grassland***

Pipe Number ***4***

Distance from Alternative to PWS (along pipe)	0.3	miles
Total PWS annual water usage	23.670	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	1,493	LF	$ 27.00	$ 40,311
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	0	EA	$ 370.00	$ 110
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 224
Metal detectable tape	1,493	LF	$ 0.15	$ 224
Subtotal				**$ 42,619**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 42,619**
Contingency	20%			$ 8,524
Design & Constr Management	25%			$ 10,655
TOTAL CAPITAL COSTS				**$ 61,798**

Table G.22

Region area solution

Alternative Name	***Purchase Water from Alvin to Oak Meadows***
Pipe Number	***5***

Distance from Alternative to PWS (along pipe)	0.5	miles
Total PWS annual water usage	9.435	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	2,738	LF	$ 27.00	$ 73,926
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	1	EA	$ 370.00	$ 203
Air valve	1	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 411
Metal detectable tape	2,738	LF	$ 0.15	$ 411
Subtotal				**$ 77,700**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 77,700**
Contingency	20%			$ 15,540
Design & Constr Management	25%			$ 19,425
TOTAL CAPITAL COSTS				**$ 112,665**

Table G.23

Region area solution
Alternative Name ***Purchase Water from Alvin to Rosharon Township***
Pipe Number ***6***

Distance from Alternative to PWS (along pipe)	0.3	miles
Total PWS annual water usage	6.972	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	-	n/a	n/a	n/a
PVC water line, Class 200, 04"	1,722	LF	$ 27.00	$ 46,494
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	-	LF	$ 35.00	$ -
Gate valve and box, 04"	0	EA	$ 370.00	$ 127
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 258
Metal detectable tape	1,722	LF	$ 0.15	$ 258
Subtotal				**$ 59,138**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 59,138**
Contingency	20%			$ 11,828
Design & Constr Management	25%			$ 14,785
TOTAL CAPITAL COSTS				**$ 85,750**

Table G.24

	Alvin to each PWS
Alternative Name	***Purchase Water from Alvin to Rosharon Road***
Alternative Number	***RR***

Distance from Alternative to PWS (along pipe)	7.0	miles
Total PWS annual water usage	5.475	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	4	n/a	n/a	n/a
Number of Crossings, open cut	17	n/a	n/a	n/a
PVC water line, Class 200, 04"	36,750	LF	$ 27.00	$ 992,250
Bore and encasement, 10"	800	LF	$ 60.00	$ 48,000
Open cut and encasement, 10"	850	LF	$ 35.00	$ 29,750
Gate valve and box, 04"	7	EA	$ 370.00	$ 2,720
Air valve	7	EA	$ 1,000.00	$ 7,000
Flush valve	7	EA	$ 750.00	$ 5,513
Metal detectable tape	36,750	LF	$ 0.15	$ 5,513
Subtotal				**$ 1,090,745**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,144,950**
Contingency	20%			$ 228,990
Design & Constr Management	25%			$ 286,237
TOTAL CAPITAL COSTS				**$ 1,660,177**

Table G.25

	Alvin to each PWS
Alternative Name	***Purchase Water from Alvin to Sandy Meadow***
Alternative Number	***SM***

Distance from Alternative to PWS (along pipe)	7.9	miles
Total PWS annual water usage	5.840	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	5	n/a	n/a	n/a
Number of Crossings, open cut	16	n/a	n/a	n/a
PVC water line, Class 200, 04"	41,814	LF	$ 27.00	$ 1,128,978
Bore and encasement, 10"	1,000	LF	$ 60.00	$ 60,000
Open cut and encasement, 10"	800	LF	$ 35.00	$ 28,000
Gate valve and box, 04"	8	EA	$ 370.00	$ 3,094
Air valve	8	EA	$ 1,000.00	$ 8,000
Flush valve	8	EA	$ 750.00	$ 6,272
Metal detectable tape	41,814	LF	$ 0.15	$ 6,272
Subtotal				**$ 1,240,616**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,294,821**
Contingency	20%			$ 258,964
Design & Constr Management	25%			$ 323,705
TOTAL CAPITAL COSTS				**$ 1,877,491**

Table G.26

	Alvin to each PWS
Alternative Name	***Purchase Water from Alvin to Stoneridge***
Alternative Number	***SR***

Distance from Alternative to PWS (along pipe)	10.7	miles
Total PWS annual water usage	3.132	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	10	n/a	n/a	n/a
Number of Crossings, open cut	20	n/a	n/a	n/a
PVC water line, Class 200, 04"	56,585	LF	$ 27.00	$ 1,527,795
Bore and encasement, 10"	2,000	LF	$ 60.00	$ 120,000
Open cut and encasement, 10"	1,000	LF	$ 35.00	$ 35,000
Gate valve and box, 04"	11	EA	$ 370.00	$ 4,187
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	11	EA	$ 750.00	$ 8,488
Metal detectable tape	56,585	LF	$ 0.15	$ 8,488
Subtotal				**$ 1,714,958**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,769,163**
Contingency	20%			$ 353,833
Design & Constr Management	25%			$ 442,291
TOTAL CAPITAL COSTS				**$ 2,565,286**

Table G.27

	Alvin to each PWS
Alternative Name	***Purchase Water from Alvin to Grasslands***
Alternative Number	***Grass***

Distance from Alternative to PWS (along pipe)	11.0	miles
Total PWS annual water usage	14.235	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	9	n/a	n/a	n/a
Number of Crossings, open cut	20	n/a	n/a	n/a
PVC water line, Class 200, 04"	57,941	LF	$ 27.00	$ 1,564,407
Bore and encasement, 10"	1,800	LF	$ 60.00	$ 108,000
Open cut and encasement, 10"	1,000	LF	$ 35.00	$ 35,000
Gate valve and box, 04"	12	EA	$ 370.00	$ 4,288
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	12	EA	$ 750.00	$ 8,691
Metal detectable tape	57,941	LF	$ 0.15	$ 8,691
Subtotal				**$ 1,740,077**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,794,282**
Contingency	20%			$ 358,856
Design & Constr Management	25%			$ 448,570
TOTAL CAPITAL COSTS				**$ 2,601,709**

Table G.28

	Alvin to each PWS
Alternative Name	***Purchase Water from Alvin to Oak Meadows***
Alternative Number	***OM***

Distance from Alternative to PWS (along pipe)	12.0	miles
Total PWS annual water usage	5.475	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	9	n/a	n/a	n/a
Number of Crossings, open cut	20	n/a	n/a	n/a
PVC water line, Class 200, 04"	63,175	LF	$ 27.00	$ 1,705,725
Bore and encasement, 10"	1,800	LF	$ 60.00	$ 108,000
Open cut and encasement, 10"	1,000	LF	$ 35.00	$ 35,000
Gate valve and box, 04"	13	EA	$ 370.00	$ 4,675
Air valve	12	EA	$ 1,000.00	$ 12,000
Flush valve	13	EA	$ 750.00	$ 9,476
Metal detectable tape	63,175	LF	$ 0.15	$ 9,476
Subtotal				**$ 1,884,352**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,938,557**
Contingency	20%			$ 387,711
Design & Constr Management	25%			$ 484,639
TOTAL CAPITAL COSTS				**$ 2,810,908**

Table G.29

	Alvin to each PWS
Alternative Name	***Purchase Water from Alvin to RosharonTownship***
Alternative Number	***RT***

Distance from Alternative to PWS (along pipe)	12.0	miles
Total PWS annual water usage	6.972	MG
Treated water purchase cost	$ 1.65	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	10	n/a	n/a	n/a
Number of Crossings, open cut	23	n/a	n/a	n/a
PVC water line, Class 200, 04"	63,559	LF	$ 27.00	$ 1,716,093
Bore and encasement, 10"	2,000	LF	$ 60.00	$ 120,000
Open cut and encasement, 10"	1,150	LF	$ 35.00	$ 40,250
Gate valve and box, 04"	13	EA	$ 370.00	$ 4,703
Air valve	12	EA	$ 1,000.00	$ 12,000
Flush valve	13	EA	$ 750.00	$ 9,534
Metal detectable tape	63,559	LF	$ 0.15	$ 9,534
Subtotal				**$ 1,912,114**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,966,319**
Contingency	20%			$ 393,264
Design & Constr Management	25%			$ 491,580
TOTAL CAPITAL COSTS				**$ 2,851,163**

Table G.30

Area wide solution

Alternative Name	***Purchase Water from Angleton to RoshTownship***
Pipe Number	***1***

Distance from Alternative to PWS (along pipe)	11.1	miles
Total PWS annual water usage	38.117	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	2	n/a	n/a	n/a
Number of Crossings, open cut	9	n/a	n/a	n/a
PVC water line, Class 200, 06"	58,507	LF	$ 32.00	$ 1,872,224
Bore and encasement, 10"	400	LF	$ 60.00	$ 24,000
Open cut and encasement, 10"	450	LF	$ 35.00	$ 15,750
Gate valve and box, 06"	12	EA	$ 465.00	$ 5,441
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	12	EA	$ 750.00	$ 8,776
Metal detectable tape	58,507	LF	$ 0.15	$ 8,776
Subtotal				**$ 1,945,967**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 06"	1	EA	$ 4,000	$ 4,000
Gate valve, 06"	4	EA	$ 590	$ 2,360
Check valve, 06"	2	EA	$ 890	$ 1,780
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 55,535**
Subtotal of Component Costs				**$ 2,001,502**
Contingency	20%			$ 400,300
Design & Constr Management	25%			$ 500,376
TOTAL CAPITAL COSTS				**$ 2,902,178**

Table G.31

Area wide solution

Alternative Name ***Purchase Water from Angelton to Oak Meadow***

Pipe Number ***2***

Distance from Alternative to PWS (along pipe)	0.6	miles
Total PWS annual water usage	31.145	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	3,208	LF	$ 27.00	$ 86,616
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	1	EA	$ 370.00	$ 237
Air valve	1	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 481
Metal detectable tape	3,208	LF	$ 0.15	$ 481
Subtotal				**$ 102,566**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 102,566**
Contingency	20%			$ 20,513
Design & Constr Management	25%			$ 25,641
TOTAL CAPITAL COSTS				**$ 148,720**

Table G.32

Area wide solution

Alternative Name	***Purchase Water from Angelton to Grassland***
Pipe Number	***3***

Distance from Alternative to PWS (along pipe)	0.5	miles
Total PWS annual water usage	28.682	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	2,653	LF	$ 27.00	$ 71,631
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	1	EA	$ 370.00	$ 196
Air valve	1	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 398
Metal detectable tape	2,653	LF	$ 0.15	$ 398
Subtotal				**$ 75,373**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 75,373**
Contingency	20%			$ 15,075
Design & Constr Management	25%			$ 18,843
TOTAL CAPITAL COSTS				**$ 109,291**

Table G.33

Area wide solution

Alternative Name ***Purchase Water From Angelton to Stoneridge***

Pipe Number ***4***

Distance from Alternative to PWS (along pipe)	0.3	miles
Total PWS annual water usage	14.447	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	1,586	LF	$ 27.00	$ 42,822
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	0	EA	$ 370.00	$ 117
Air valve	-	EA	$ 1,000.00	$ -
Flush valve	0	EA	$ 750.00	$ 238
Metal detectable tape	1,586	LF	$ 0.15	$ 238
Subtotal				**$ 45,165**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 45,165**
Contingency	20%			$ 9,033
Design & Constr Management	25%			$ 11,291
TOTAL CAPITAL COSTS				**$ 65,489**

Table G.34

Area wide solution
Alternative Name ***Purchase Water From Angelton to Sandy Meadow***
Pipe Number ***5***

Distance from Alternative to PWS (along pipe)	2.9	miles
Total PWS annual water usage	11.315	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	4	n/a	n/a	n/a
Number of Crossings, open cut	2	n/a	n/a	n/a
PVC water line, Class 200, 04"	15,397	LF	$ 27.00	$ 415,719
Bore and encasement, 10"	800	LF	$ 60.00	$ 48,000
Open cut and encasement, 10"	100	LF	$ 35.00	$ 3,500
Gate valve and box, 04"	3	EA	$ 370.00	$ 1,139
Air valve	3	EA	$ 1,000.00	$ 3,000
Flush valve	3	EA	$ 750.00	$ 2,310
Metal detectable tape	15,397	LF	$ 0.15	$ 2,310
Subtotal				**$ 475,977**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 530,182**
Contingency	20%			$ 106,036
Design & Constr Management	25%			$ 132,546
TOTAL CAPITAL COSTS				**$ 768,765**

Table G.35

Area wide solution

Alternative Name ***Purchase Water from Angelton to Rosharon Road***

Pipe Number ***6***

Distance from Alternative to PWS (along pipe)	1.0	miles
Total PWS annual water usage	5.475	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	5,340	LF	$ 27.00	$ 144,180
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 04"	1	EA	$ 370.00	$ 395
Air valve	1	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 801
Metal detectable tape	5,340	LF	$ 0.15	$ 801
Subtotal				**$ 160,927**
Pump Station(s) Installation				
Pump	-	EA	$ 7,500	$ -
Pump Station Piping, 04"	-	EA	$ 4,000	$ -
Gate valve, 04"	-	EA	$ 405	$ -
Check valve, 04"	-	EA	$ 595	$ -
Electrical/Instrumentation	-	EA	$ 10,000	$ -
Site work	-	EA	$ 2,000	$ -
Building pad	-	EA	$ 4,000	$ -
Pump Building	-	EA	$ 10,000	$ -
Fence	-	EA	$ 5,870	$ -
Tools	-	EA	$ 1,000	$ -
Storage Tank - 5,000 gals	-	EA	$ 7,025	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 160,927**
Contingency	20%			$ 32,185
Design & Constr Management	25%			$ 40,232
TOTAL CAPITAL COSTS				**$ 233,344**

Table G.36

	Angleton to each PWS
Alternative Name	***Purchase Water from Angleton to RoshTownship***
Alternative Number	***RT***

Distance from Alternative to PWS (along pipe)	11.4	miles
Total PWS annual water usage	6.972	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	2	n/a	n/a	n/a
Number of Crossings, open cut	12	n/a	n/a	n/a
PVC water line, Class 200, 04"	59,971	LF	$ 27.00	$ 1,619,217
Bore and encasement, 10"	400	LF	$ 60.00	$ 24,000
Open cut and encasement, 10"	600	LF	$ 35.00	$ 21,000
Gate valve and box, 04"	12	EA	$ 370.00	$ 4,438
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	12	EA	$ 750.00	$ 8,996
Metal detectable tape	59,971	LF	$ 0.15	$ 8,996
Subtotal				**$ 1,697,646**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,751,851**
Contingency	20%			$ 350,370
Design & Constr Management	25%			$ 437,963
TOTAL CAPITAL COSTS				**$ 2,540,184**

Table G.37

	Angleton to each PWS
Alternative Name	***Purchase Water from Angleton to Oak Meadow***
Alternative Number	***OM***

Distance from Alternative to PWS (along pipe)	12.1	miles
Total PWS annual water usage	2.464	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	2	n/a	n/a	n/a
Number of Crossings, open cut	11	n/a	n/a	n/a
PVC water line, Class 200, 04"	64,123	LF	$ 27.00	$ 1,731,321
Bore and encasement, 10"	400	LF	$ 60.00	$ 24,000
Open cut and encasement, 10"	550	LF	$ 35.00	$ 19,250
Gate valve and box, 04"	13	EA	$ 370.00	$ 4,745
Air valve	12	EA	$ 1,000.00	$ 12,000
Flush valve	13	EA	$ 750.00	$ 9,618
Metal detectable tape	64,123	LF	$ 0.15	$ 9,618
Subtotal				**$ 1,810,553**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,864,758**
Contingency	20%			$ 372,952
Design & Constr Management	25%			$ 466,190
TOTAL CAPITAL COSTS				**$ 2,703,899**

Table G.38

	Angleton to each PWS
Alternative Name	***Purchase Water from Angleton to Grasslands***
Alternative Number	***Grass***

Distance from Alternative to PWS (along pipe)	11.4	miles
Total PWS annual water usage	14.235	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline Construction				
Number of Crossings, bore	3	n/a	n/a	n/a
Number of Crossings, open cut	11	n/a	n/a	n/a
PVC water line, Class 200, 04"	60,025	LF	$ 27.00	$ 1,620,675
Bore and encasement, 10"	600	LF	$ 60.00	$ 36,000
Open cut and encasement, 10"	550	LF	$ 35.00	$ 19,250
Gate valve and box, 04"	12	EA	$ 370.00	$ 4,442
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	12	EA	$ 750.00	$ 9,004
Metal detectable tape	60,025	LF	$ 0.15	$ 9,004
Subtotal				**$ 1,709,374**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,763,579**
Contingency	20%			$ 352,716
Design & Constr Management	25%			$ 440,895
TOTAL CAPITAL COSTS				**$ 2,557,190**

Table G.39

	Angleton to each PWS
Alternative Name	***Purchase Water from Angleton to Stoneridge***
Alternative Number	***SR***

Distance from Alternative to PWS (along pipe)	11.1	miles
Total PWS annual water usage	3.132	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	4	n/a	n/a	n/a
Number of Crossings, open cut	15	n/a	n/a	n/a
PVC water line, Class 200, 04"	58,825	LF	$ 27.00	$ 1,588,275
Bore and encasement, 10"	800	LF	$ 60.00	$ 48,000
Open cut and encasement, 10"	750	LF	$ 35.00	$ 26,250
Gate valve and box, 04"	12	EA	$ 370.00	$ 4,353
Air valve	11	EA	$ 1,000.00	$ 11,000
Flush valve	12	EA	$ 750.00	$ 8,824
Metal detectable tape	58,825	LF	$ 0.15	$ 8,824
Subtotal				**$ 1,695,526**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 1,749,731**
Contingency	20%			$ 349,946
Design & Constr Management	25%			$ 437,433
TOTAL CAPITAL COSTS				**$ 2,537,109**

Table G.40

	Angleton to each PWS
Alternative Name	***Purchase Water from Ang to Sandy Meadow***
Alternative Number	***SM***

Distance from Alternative to PWS (along pipe)	14.2	miles
Total PWS annual water usage	5.840	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	7	n/a	n/a	n/a
Number of Crossings, open cut	15	n/a	n/a	n/a
PVC water line, Class 200, 04"	75,087	LF	$ 27.00	$ 2,027,349
Bore and encasement, 10"	1,400	LF	$ 60.00	$ 84,000
Open cut and encasement, 10"	750	LF	$ 35.00	$ 26,250
Gate valve and box, 04"	15	EA	$ 370.00	$ 5,556
Air valve	14	EA	$ 1,000.00	$ 14,000
Flush valve	15	EA	$ 750.00	$ 11,263
Metal detectable tape	75,087	LF	$ 0.15	$ 11,263
Subtotal				**$ 2,179,682**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 2,233,887**
Contingency	20%			$ 446,777
Design & Constr Management	25%			$ 558,472
TOTAL CAPITAL COSTS				**$ 3,239,135**

Table G.41

	Angleton to each PWS
Alternative Name	***Purchase Water from Ang to Roasharon Road***
Alternative Number	***RR***

Distance from Alternative to PWS (along pipe)	14.6	miles
Total PWS annual water usage	5.475	MG
Treated water purchase cost	$ 1.60	per 1,000 gals
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	9	n/a	n/a	n/a
Number of Crossings, open cut	17	n/a	n/a	n/a
PVC water line, Class 200, 04"	77,073	LF	$ 27.00	$ 2,080,971
Bore and encasement, 10"	1,800	LF	$ 60.00	$ 108,000
Open cut and encasement, 10"	850	LF	$ 35.00	$ 29,750
Gate valve and box, 04"	15	EA	$ 370.00	$ 5,703
Air valve	15	EA	$ 1,000.00	$ 15,000
Flush valve	15	EA	$ 750.00	$ 11,561
Metal detectable tape	77,073	LF	$ 0.15	$ 11,561
Subtotal				**$ 2,262,546**
Pump Station(s) Installation				
Pump	1	EA	$ 7,500	$ 7,500
Pump Station Piping, 04"	1	EA	$ 4,000	$ 4,000
Gate valve, 04"	4	EA	$ 405	$ 1,620
Check valve, 04"	2	EA	$ 595	$ 1,190
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 54,205**
Subtotal of Component Costs				**$ 2,316,751**
Contingency	20%			$ 463,350
Design & Constr Management	25%			$ 579,188
TOTAL CAPITAL COSTS				**$ 3,359,289**