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

LIVE OAK HILLS SUBDIVISION
PWS ID# 1540012, CCN# 12463

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

AUGUST 2008

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AUGUST 2008

EXECUTIVE SUMMARY

INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Transportation Group Inc. (Parsons), was contracted by the Texas Commission on Environmental Quality (TCEQ) to conduct a project 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 Live Oak Hills Subdivision PWS, ID# 1540012, Certificate of Convenience and Necessity (CCN) # 12463, located in McCulloch County. The Live Oak Hills Subdivision PWS is a mobile home park located approximately 6 miles south of Brady, Texas, on State Highway 87 and County Road 201. The water system serves a population of 93 and has 31 connections. The water source for Live Oak Hills Subdivision comes from one groundwater well completed to a depth of 1,230 feet in the Hickory Aquifer. The Well #1 (G1540012A) is rated at 22 gallons per minute (gpm).

During the period of October 2001 to September 2004, Live Oak Hills Subdivision PWS recorded gross alpha activity values ranging from 15.0 to 21.3 pCi/L. Combined radium (226 + 228) values ranged from 5 pCi/L to 12 pCi/L between July 2002 and June 2007. These values are above the 15 pCi/L maximum contaminant level (MCL) for gross alpha activity and 5 pCi/L MCL for combined radium (Ra226 plus Ra228). Therefore, Live Oak Hills Subdivision faces compliance issues under the water quality standards for gross alpha activity and combined radium.

Basic system information for the Live Oak Hills PWS is shown in Table ES.1.

Table ES.1 Live Oak Hills PWS
Basic System Information

Population served	93
Connections	31
Average daily flow rate	0.0055 million gallons per day (mgd)
Peak demand flow rate	15.3 gallons per minute
Water system peak capacity	0.036 mgd
Typical gross alpha range	15.0 pCi/L – 21.3 pCi/L
Typical combined radium range	5 pCi/L to 12 pCi/L

STUDY METHODS

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

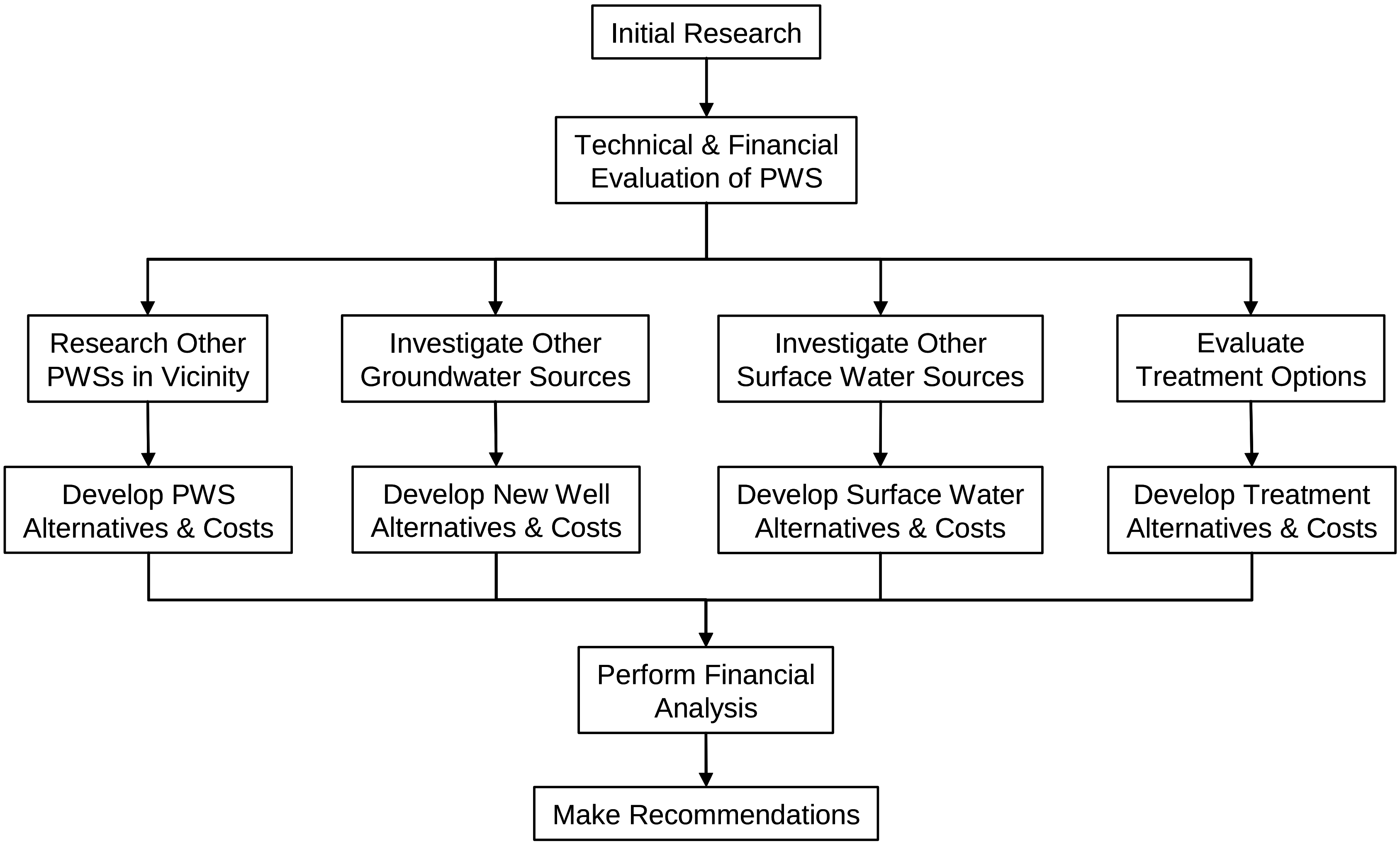
- Assess each of the potential alternatives with respect to economic and non-economic criteria;
- Prepare a feasibility report and present the results to the PWS.

This basic approach is summarized in Figure ES.1.

HYDROGEOLOGICAL ANALYSIS

The Live Oak Hills PWS obtains groundwater from the Hickory Aquifer. Gross alpha activity and combined radium are commonly found in area wells at concentrations greater than the MCLs. Three wells within 6.2 miles of the well have been shown to contain acceptable concentrations of combined radium, but none of them had recent sample results, and none of them had been tested for gross alpha particle activity. Before being considered as possible alternative water sources, these wells would need to be tested for both gross alpha and combined radium as well as other constituents of concern. Additionally, consideration should be given to casing the deeper portion of the Live Oak Hills PWS well or drilling a second well to obtain water from the shallower part of the aquifer, which has been shown locally to contain more consistently acceptable levels of combined radium. It may also be possible to do down-hole testing the well 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

Overall, the system had a marginal 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 dedicated owners. Areas of concern for the system included inability to meet operating expenses, lack of compliance with the radium standard, lack of long-term capital planning, and water loss.

There are several PWSs within 30 miles of Live Oak Hills. Many of these nearby systems also have water quality problems with, but there are some 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. There is a minimum of surface water available in the area. The Lohn Water Supply Corporation, the City of Richland Springs, and Richland Special Utility District are potential larger water suppliers.

Centralized treatment alternatives for radionuclide removal have been developed and were considered for this report, including reverse osmosis and Water Remediation Technologies, Inc. (WRT) adsorption. 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 close to Live Oak Hills is likely to be the best solution if compliant groundwater can be found. Having a new well close to Live Oak Hills 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 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.

FINANCIAL ANALYSIS

Financial analysis of the Live Oak Hills PWS indicated that current water rates are funding operations, and a rate increase is not necessary to meet operating expenses. The current average water bill 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. 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 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	$470	1.9
To meet current expenses	NA	$451	1.8
New well at Lohn WSC	100% Grant	$1,642	6.5
	Loan/Bond	$13,378	52.8
Central WRT Z-88 treatment	100% Grant	$1,414	5.6
	Loan/Bond	$1,896	7.5
Point-of-use	100% Grant	$1,286	5.1
	Loan/Bond	$1,385	5.5
Public dispenser	100% Grant	$1,567	6.2
	Loan/Bond	$1,612	6.4

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ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
AFY	acre-feet per year
BEG	Bureau of Economic Geology
BFZ	Balcones Fault Zone
BV	Bed volume
CCN	Certificate of Convenience and Necessity
CFR	Code of Federal Regulations
DWSRF	Drinking Water State Revolving Fund
ED	Electrodialysis
EDR	Electrodialysis reversal
FMT	Financial, managerial, and technical
GAM	Groundwater Availability Model
gpd	gallons per day
gpm/ft^2	gallons per minute per square foot
gpm	Gallons per minute
IX	Ion exchange
MCL	Maximum contaminant level
mg/L	Milligram per liter
mgd	Million gallons per day
MHI	Median household income
NMEFC	New Mexico Environmental Financial Center
NPDWR	National Primary Drinking Water Regulations
O&M	Operation and Maintenance
ORCA	Office of Rural Community Affairs
Parsons	Parsons Transportation Group, Inc.
pCi/L	Pico Curie per liter
POE	Point-of-entry
POU	Point-of-use
PWS	Public water system
RO	Reverse osmosis
SDWA	Safe Drinking Water Act
SUD	Special Utility District
SWAP	Source Water Protection Program
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids
TSS	Total suspended solids
TWDB	Texas Water Development Board

USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WAM	Water Availability Model
WRT	Water Remediation Technologies, Inc.
WSC	Water Supply Corporation

SECTION 1
INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Transportation Group Inc. (Parsons), were 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 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 project, 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 Live Oak Hills Subdivision Water System, PWS ID# 1540012, Certificate of Convenience and Necessity (CCN) #12463, located in McCulloch County, hereinafter referred to in this document as the "Live Oak Hills PWS." Recent sample results from the Live Oak Hills water system exceeded the MCL for gross alpha particle activity of 15 picoCuries per liter (pCi/L) and combined radium (Ra226 plus Ra228) of 5 pCi/L (USEPA 2008a; TCEQ 2004). The location of the Live Oak Hills Water System 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.

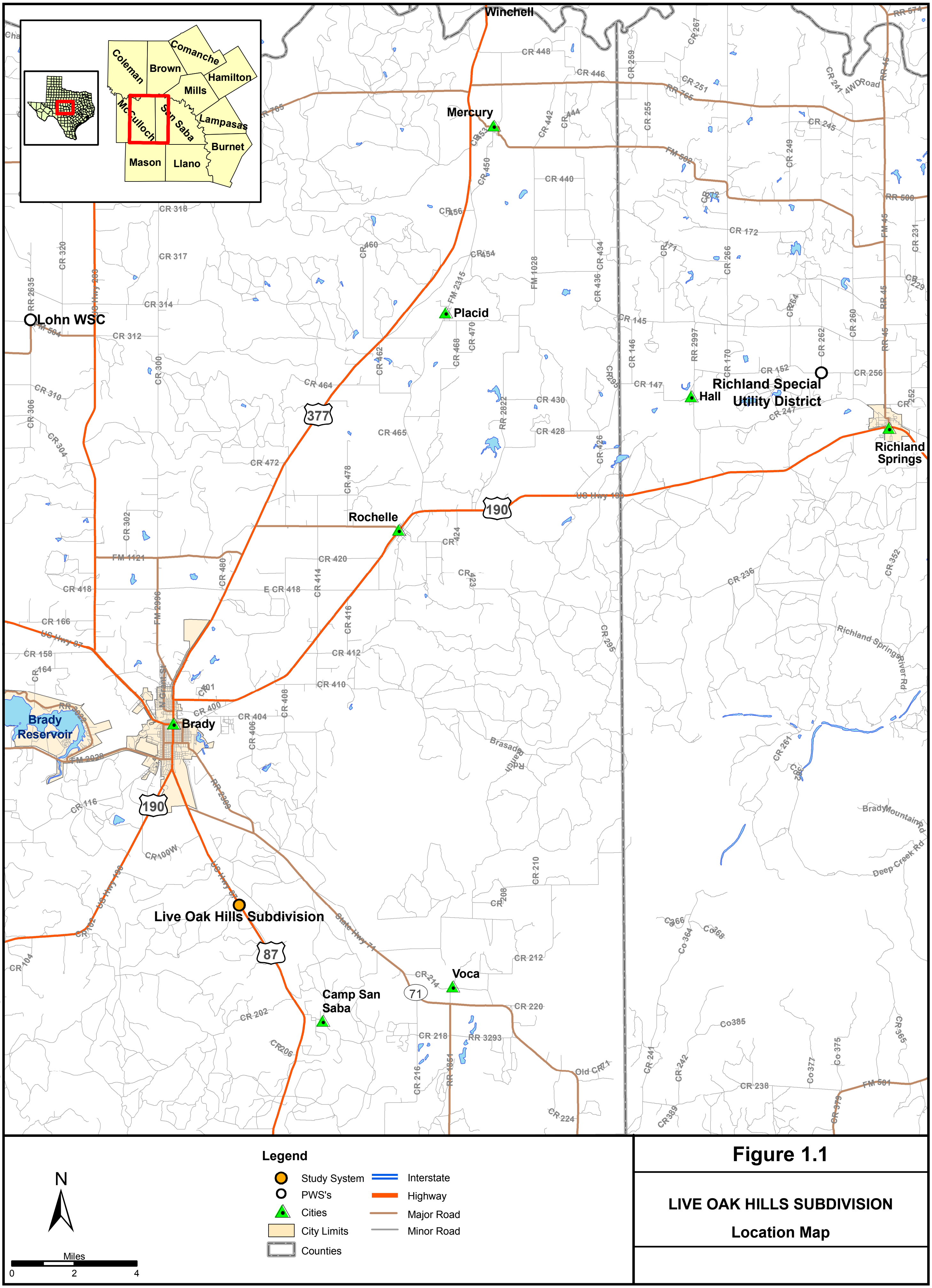

Figure 1.1

LIVE OAK HILLS SUBDIVISION

Location Map

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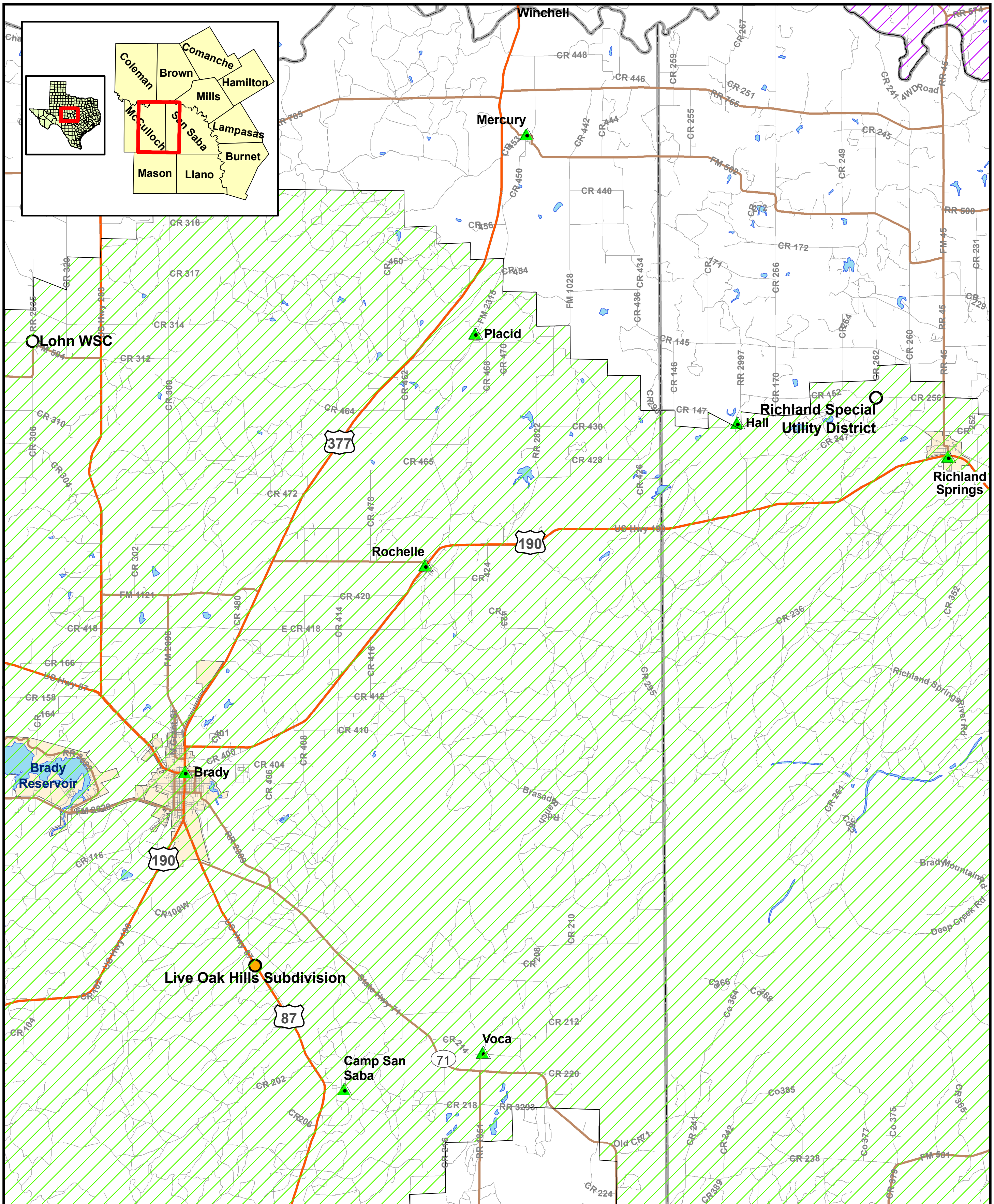

Legend

- Study System
- PWS's
- Cities
- City Limits
- Counties
- Interstate
- Highway
- Major Road
- Minor Road
- Hickory UWCD No. 1
- Fox Crossing Water District

N

Miles

0 2 4

Figure 1.2

LIVE OAK HILLS SUBDIVISION

Groundwater Conservation Districts

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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, the Live Oak Hills PWS had recent sample results exceeding the MCL for gross alpha and combined radium.

In general, contaminant(s) in drinking water above the MCL(s) can have both short-term (acute) and long-term or lifetime (chronic) effects. Long-term ingestion of drinking water containing any of the radionuclides (radium 226, radium 228, and/or gross alpha particle emitters) above the MCL may increase the risk of cancer (USEPA 2008b).

1.2 METHOD

The method for this project follows that of a pilot project performed by TCEQ, BEG, and Parsons. The pilot project evaluated water supply alternatives for PWSs that supplied drinking water with contaminant concentrations above U.S. Environmental Protection Agency (USEPA) and Texas drinking water standards. Three PWSs were evaluated in the pilot project 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 that was developed for the pilot project, and which was also used for subsequent projects.

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 abatement options for combined radium and gross alpha particle emitters. Section 2 describes the method used to develop and assess compliance alternatives. The groundwater sources of radionuclides are addressed in Section 3. Findings for the Live Oak Hills PWS, along with compliance alternatives development and evaluation, can be found in Section 4. Section 5 references the sources used in this report.

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 Live Oak Hills PWS involve combined radium and gross alpha. The following subsections explore alternatives considered as potential options for obtaining/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, flow rate, 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 selected to ensure 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 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:

- Existing data sources (see below) will be used to identify wells in the areas that have satisfactory quality. For the Live Oak Hills PWS, the following standards could be used in a rough screening to identify compliant groundwater in surrounding systems:
  - Nitrate (measured as nitrogen) concentrations less than 8 milligrams per liter (mg/L) (below the MCL of 10 mg/L);
  - Fluoride concentration less than 2.0 mg/L (below the Secondary MCL of 2 mg/L);
  - Arsenic concentration less than 0.008 mg/L (below the MCL of 0.01 mg/L);
  - Uranium concentration less than 0.024 mg/L (below the MCL of 0.030 mg/L; and
  - Selenium concentration less than 0.04 mg/L (below the MCL of 0.05 mg/L).
- The recorded well information will be reviewed 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.
- Wells of sufficient size are identified. Some may be 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 water 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 that 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 is 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 reduction of radium and gross alpha radioactivity to regulatory levels (*i.e.*, MCLs). The reduction of gross alpha activity typically is achieved by reducing radium which appears to be responsible for a major part of the gross alpha activity of the groundwater. Radium-226 and Radium-228 are cations (Ra^{2+}) dissolved in water and are not removed by particle filtration. A 2002 USEPA document (*Radionuclides in Drinking Water: A Small Entity Compliance Guide, EPA 815-R-02-001*) lists a number of small system compliance technologies that can remove radium (combined radium-226 and radium-228) from water. These technologies include ion exchange, reverse osmosis (RO), electrodialysis/electrodialysis reversal (ED/EDR), lime softening, greensand filtration, re-formed hydrous manganese oxide filtration ($KMnO_4$-filtration), and co-precipitation with barium sulfate. A relatively new process using the WRT Z-88 media that is specific for radium adsorption has been demonstrated to be an effective radium technology. Lime softening and co-precipitation with barium sulfate are technologies that are relatively complex and require chemistry skills that are not practical for small systems with limited resources and hence they are not evaluated further.

1.4.5 Description of Treatment Technologies

The application radium removal treatment technologies include ion exchange (IX), WRT-Z88™ media adsorption, RO, ED/EDR, and $KMnO_4$-greensand filtration. A description of these technologies follows.

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 the water. The process is based on the preferential adsorption of specific ions 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 (IX). When the resin becomes saturated with the contaminant ions, the bed must be regenerated by passing or pumping a concentrated sodium chloride solution over the resin, displacing the contaminant ions with sodium ions for cation exchange resins and chloride ions for anion exchange resins. Many different types of resins can be used depending on the specific contaminant to be removed.

The IX treatment train for groundwater typically consists of an ion exchange system containing cation or anion resin, chlorine disinfection, and clear well storage. The ion exchange system has provisions for regeneration with salt (sodium chloride) and generates approximately 2 to 4% of waste or "spent" regeneration solutions. Treatment trains for surface water may also include raw water pumps, debris screens, and filters for pre-treatment. Additional treatment or management of the spent regeneration salt solutions and the removed solids will be necessary prior to disposal, especially for radium removal resins which have elevated radioactivity.

For radium removal, a strong acid cation exchange resin in the sodium form can remove 95-99 percent of the radium. The strong acid resin has less capacity for radium on water with high hardness and it has the following adsorption preference: $Ra^{2+} > Ba^{2+} > Ca^{2+} > Mg^{2+} > Na^{+}$. Because of the selectivity radium and barium are much more difficult to remove from the resin during regeneration than calcium and magnesium. Economical regeneration removes most of the hardness ions, but radium and barium buildup on the resin after repeated cycles to the point where equilibrium is reached and then radium and barium will begin to breakthrough shortly after hardness. Regeneration of the sodium form strong acid resin for water with 200 mg/L of hardness with application of 6.5 lb $NaCl/ft^3$ resin would produce 2.4 bed volumes (BV) of 16,400 mg/L total dissolved solids (TDS) brine per 100 BV of product water. This results in waste liquids equaling about 2.4% of the volume of water treated. The radium concentration in the regeneration waste would be approximately 40 times the influent radium concentration in groundwater.

The strong acid cation exchange process produces a pleasing water supply that reduces scaling in pipes. However, it increases an average daily sodium intake by 200 to 400 mg compared to an estimated average daily intake of 2,000 to 7,000 mg. Increased sodium levels from all sodium chloride regenerated ion exchange process are a concern to some people, particularly those on low salt diets, but in most cases the increase will amount to no more than approximately 10% of the average dietary intake of sodium.

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.

Maintenance – The IX resin requires regular on-site regeneration, the frequency of which depends on raw water characteristics (especially hardness), 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 with radioactivity); occasional solids wastes (in the form of broken resin beads) which are backwashed during regeneration; and if used, spent filters and backwash wastewater.

Advantages

- Well established process for radium removal.
- Fully automated and highly reliable process.
- Suitable for small and large installations.
- Operates on demand
- Relatively insensitive to source water pH.

Disadvantages

- Requires salt storage; regular regeneration.
- Generates a brine liquid waste requiring disposal.
- Liquid spent regenerate brine can contain high levels of radium.
- Resins are sensitive to the presence of competing ions such as calcium and magnesium which reduces the effectiveness for radium removal.

In considering application of IX for inorganic, it is important to understand what the effect of competing ions will be, and to what extent the brine can be recycled. Conventional IX cationic resin removes calcium and magnesium in addition to radium and thus the capacity for radium removal and frequency of regeneration depend on the hardness of the water to be treated. Spent regenerant is produced during IX bed regeneration, and it may have concentrations of the sorbed contaminants which will be expensive to treat and/or dispose because of hazardous waste regulations.

1.4.5.2 WRT Z-88™ Media

Process – The WRT Z-88 radium treatment process is a proprietary process using a radium specific adsorption resin or zeolite supplied by Water Remediation Technologies, Inc. (WRT). The Z-88 process is similar to IX except that the radium ions are irreversibly adsorbed or attached to the Z-88 resin and no regeneration is conducted. The resin is disposed of upon exhaustion. The Z-88 does not remove calcium and magnesium and thus it can last for a long time relative to conventional ion exchange (2-3 years, according to WRT) before replacement is necessary. The process is operated in an upflow, fluidized mode with a surface loading rate of 10.5 gallons per minute per square foot (gpm/ft^2). Pilot testing of this technology has been conducted successfully for radium removal in many locations including in the State of Texas. Seven full-scale systems with capacities of 750 to 1,200 gpm have been constructed in the Village of Oswego, Illinois since July 2005. The treatment equipment is owned by WRT and the ownership of spent media would be transferred to an approved disposal site. The customer pays WRT based on an agreed upon treated water unit cost (*e.g.*, $1.00-6.70/kgal, depending on water characteristics, flow capacity and annual production for the water systems).

Dow Chemical Company produces a radium selective complexer resin (DOWEX RSC) which has similar characteristics.

Pretreatment – Pretreatment may be required to reduce excess amounts of TSS, iron, and manganese, which could plug the resin bed. Pretreatment typically includes media or carbon filtration. No chemical addition is required for radium removal.

Maintenance – Maintenance is relatively low for this technology as no regeneration or chemical handling is required. Periodical water quality monitoring and inspection of mechanical equipment are required.

Waste Disposal – The Z-88 media would be disposed of in an approved low level radioactive waste landfill by WRT once every 2-3 years. No liquid waste is generated for this process. However, if pretreatment filters are used then spent filters and backwash wastewater disposal is required. Generally since WRT owns the equipment and adsorption media, communities are not responsible for disposal of the spent media.

Advantages

- Simple and fully automated process.
- No liquid waste disposal.
- No chemical handling, storage, or feed systems.
- No change in water quality except radium reduction.

- Low capital cost as WRT owns the equipment.

Disadvantages

- Relatively new technology.
- Proprietary technology without much direct competition.
- Long term contract with WRT required.

From a small utilities point of view the Z-88 process is a desirable technology for radium removal as an operation and maintenance (O&M) effort is minimal and no regular liquid waste is generated. However, this technology has been in use for only 3 to 5 years and has limited long-term full-scale operating experience. But since the equipment is owned by WRT and the performance is guaranteed by WRT the financial risk to a community can be minimized.

1.4.5.3 Reverse Osmosis

Process – RO is a pressure-driven membrane separation process capable of removing dissolved solutes from water by means of ion 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 and hollow fine fiber but most 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 valving 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 95 percent removal of radium. The treatment process is relatively insensitive to pH. Water recovery is 60-80 percent, depending on the raw water characteristics. This means that for every 100 gallons of water entering the system, 60 to 80 gallons of product water and 20 to 40 gallons of "concentrate" or waste are produced. Disposal of the concentrate can have a significant cost depending on options available.

The RO process is not selective for radium and gross alpha removal. A majority of salts and dissolved materials in the water are removed. This is an advantage if the water has high concentrations of TDSs.

Pretreatment – 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. Iron and manganese must be removed prior to RO. Pretreatment can include media filters, ion exchange softening, acid and antiscalant feed, activated carbon or bisulfite feed to dechlorinate, and cartridge filters to remove 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 required approved disposal methods. The disposal of the significant volume of the concentrate stream is a problem for many utilities.

Advantages

- Can remove radium effectively.
- Can remove other undesirable dissolved constituents.

Disadvantages

- Relatively expensive to install and operate.
- Needs sophisticated monitoring systems.
- Needs to handle multiple chemicals.
- Concentrate disposal.
- Waste of water because of the significant concentrate flows.

RO is an expensive alternative to remove radium 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 radium is the waste of water through concentrate disposal which is also difficult or expensive because of the relatively large volume involved.

1.4.5.4 Electrodialysis/Electrodialysis Reversal

Process – ED is an electrochemical separation process in which ions migrate through ion-selective semi-permeable membranes as a result of their attraction to two electrically charged electrodes. The driving force for ion transfer is direct electric current. ED is different from RO in that it removes only dissolved inorganics but not particulates, organics, and silica. EDR is an improved form of ED in which the polarity of the direct current is changed approximately every 15 minutes. The change of polarity helps to reduce the formation of scale and fouling films and thus a higher water recovery can be achieved. EDR has been the dominant form of ED system used for the past 25-30 years. A typical EDR system includes a membrane stack with a number of cell pairs, each consisting of a cation transfer membrane, a demineralized water 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 concentrate reject flow in parallel across the membranes and through the demineralized water and concentrate flow spacers, 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 the dissolved salts including radium, and multiple stages may be required to meet the MCL if radium concentration is high. The conventional EDR treatment train typically includes EDR membranes, chlorine disinfection, and clearwell storage.

Pretreatment – Guidelines are available on acceptable limits on pH, organics, turbidity, and other raw water characteristics. EDR typically requires acid and antiscalant feed to prevent scaling and a cartridge filter for prefiltration. Treatment of surface water may also require pretreatment steps such as raw water pumps, debris screens, rapid mix with addition of a coagulant, flocculation basin, sedimentation basin or clarifier, and gravity filters. Microfiltration could be used in place of flocculation, sedimentation, and filtration.

Maintenance – EDR membranes are durable, can tolerate pH from 1-10, and temperatures to 115^{o}F for cleaning. The 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 spacer. If the chlorine is not removed, toxic chlorine gas may form. Depending on raw water characteristics, the membranes will require regular maintenance or replacement. If used, pretreatment filter replacement and backwashing will 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 require approved disposal methods. Pretreatment process residuals and spent materials also require approved disposal methods.

Advantages

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

Disadvantages

- Not specific to radium, also removes many TDS constituents.
- Not suitable for high levels of iron, manganese, hydrogen sulfide, and hardness.
- Relatively expensive process and high energy consumption.
- Does not remove particulates, organics, or silica.

EDR can be quite expensive to run because of the energy it uses. If radium removal is the only purpose it is probably more expensive than other technologies. However, if nitrate and/or TDS removal is also required, then EDR is a competitive process.

1.4.5.5 Potassium Permanganate Greensand Filtration

Process – Manganese dioxide, (MnO_2) has capacity to adsorb radium from water. MnO_2 can be formed by oxidation of Mn^{2+} occurring in natural waters and/or reduction of potassium permanganate ($KMnO_4$) added to the water. The MnO_2 is in the form of colloidal MnO_2 which has a large surface area for adsorption. The MnO_2 does not adsorb calcium and magnesium so hardness is not a factor but iron and manganese and other heavy metal cations can compete strongly with radium adsorption. If these cations are present it would be necessary to install a good iron and manganese removal process before the MnO_2- filtration process to ensure that MnO_2 is still available for radium sorption. The $KMnO_4$-greensand filtration process can accomplish this purpose as the greensand is coated with MnO_2, which is regenerated by the continuous feeding of $KMnO_4$. Many operating treatment systems utilizing continuous feed $KMnO_4$, 30-minute contact time, and manganese greensand remove radium to concentrations below the MCL. The treatment system equipment includes a $KMnO_4$ feed system, a pressurized reaction tank, and a manganese greensand filter. Backwashing of the greensand filter is usually required but periodic regeneration is not required. The overall radium removal is typically 65 to 95%.

Pretreatment – The $KMnO_4$-greensand filtration process usually does not require pretreatment except if the turbidity is very high. The greensand filter usually has an anthracite layer to filter larger particles while the greensand adsorbs dissolved cations such as radium.

Maintenance – The greensand requires periodic backwashing to rid of suspended materials and metal oxides. $KMnO_4$ is usually supplied in the powder form and preparation of $KMnO_4$ solution is required. Occasional monitoring to ensure no overfeeding of $KMnO_4$ (pink water) is important to avoid problems in distribution system and household fixtures.

Waste Disposal – Approval from local authorities is usually required for the backwash wastewater. If local sewer is not available, a backwash water storage and settling tank would be required to recycle settled water to the process and disposed of the settled solids periodically.

Advantages

- Well established process for radium removal.
- No regeneration waste generated.
- Low pressure operation and no repumping required.
- No additional process for iron and manganese removal.

Disadvantages

- Need to handle powdered KMnO4, which is an oxidant.
- Need to monitor and backwash regularly.
- Need to manage backwash
- Disposal of settled solids is required.

- Limited effectiveness if $KMnO_4$ is under dosed.

The $KMnO_4$-greensand filtration is a well established iron and manganese removal process and is effective for radium removal. It is suitable for small and large systems and is cost competitive with other alternative technologies.

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

Point-of-entry (POE) and Point-of-use (POU) treatment devices or systems rely on many of the same treatment technologies used in central treatment plants. However, while central treatment plants treat all water distributed to consumers to the same level, POU and POE treatment devices are designed to treat only a portion of the total flow. POU devices treat only the water intended for direct consumption, typically at a single tap or limited number of taps, while POE treatment devices are typically installed to treat all water entering a single home, business, school, or facility. POU and POE treatment systems may be an option for PWSs where central treatment is not affordable. Updated USEPA guidance on use of POU and POE treatment devices is provided in "*Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems,*" EPA 815-R-06-010, April 2006 (USEPA 2006).

Point-of-entry and POU treatment systems can be used to provide compliant drinking water. These systems typically use small adsorption or reverse osmosis treatment units installed "under the sink" in the case of POU, and where water enters a house 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 to meet regulatory requirements, making purchase and installation more expensive. Point-of-entry and POU treatment units would be purchased and owned by the PWS. These solutions are decentralized in nature, and require utility personnel entry into houses or at least onto private property for installation, maintenance, and testing. Due to the large 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 level of compliance.

The National Primary Drinking Water Regulations (NPDWR), 40 CFR Section 141.100, covers criteria and procedures for PWSs using POE devices and sets limits on the use of these devices. According to the regulations (July 2005 Edition), the PWS must develop and obtain TCEQ approval for a monitoring plan before POE devices are installed for compliance with an MCL. Under the plan, POE devices must provide health protection equivalent to central water treatment meaning the water must meet all NPDWR and would be of acceptable quality similar to water distributed by a well-operated central treatment plant. In addition, monitoring must include physical measurements and observations such as total flow treated and mechanical condition of the treatment equipment. The system would have to track the POE flow for a given time period, such as monthly, and maintain records of device inspection. The monitoring plan should include frequency of monitoring for the contaminant of concern and number of units to be monitored. For instance, the system may propose to monitor every POE device during the first year for the contaminant of concern and then monitor one-third of the units annually, each on a rotating schedule, such that each unit would be monitored every three years. To satisfy the requirement that POE devices must provide health protection, the water system may be required to conduct a pilot study to verify the POE device can provide treatment equivalent to central treatment. Every building connected to the system must have a POE device installed, maintained, and properly monitored. Additionally, TCEQ must be assured that every building is subject to treatment and monitoring, and that the rights and responsibilities of the PWS customer convey with title upon sale of property.

Effective technology for POE devices must be properly applied under the monitoring plan approved by TCEQ and the microbiological safety of the water must be maintained. TCEQ requires adequate certification of performance, field testing, and, if not included in the certification process, a rigorous engineering design review of the POE devices. The design and application of the POE devices must consider the tendency for increase in heterotrophic bacteria concentrations in water treated with activated carbon. It may be necessary to use frequent backwashing, post-contactor disinfection, and Heterotrophic Plate Count monitoring to ensure that the microbiological safety of the water is not compromised.

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, relevant to MCL compliance are:

- POU and POE treatment units must be owned, controlled, and maintained by the water system, although the utility may hire a contractor to ensure proper O&M and MCL compliance. The water system must retain unit ownership and oversight of unit installation, maintenance and sampling; the utility ultimately is the responsible party for regulatory compliance. The water system 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 the quality and quantity of the water supplied to the community resides with the water system, and the utility must monitor all contractors closely. Responsibility for 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 would 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 (ANSI) 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.

The following observations with regard to using POE and POU devices for SDWA compliance were made by Raucher, *et al.* (2004):

- 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 the SDWA, USEPA indicates that POU treatment devices should not be used to treat for radon or for most volatile organic contaminants (VOC) 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 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).

SECTION 2
EVALUATION METHOD

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 that 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 water systems, utilities, and districts at its headquarters in Austin, Texas. The files are organized under two identifiers: a PWS identification number and a 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.

TREE 1 – EXISTING FACILITY ANALYSIS

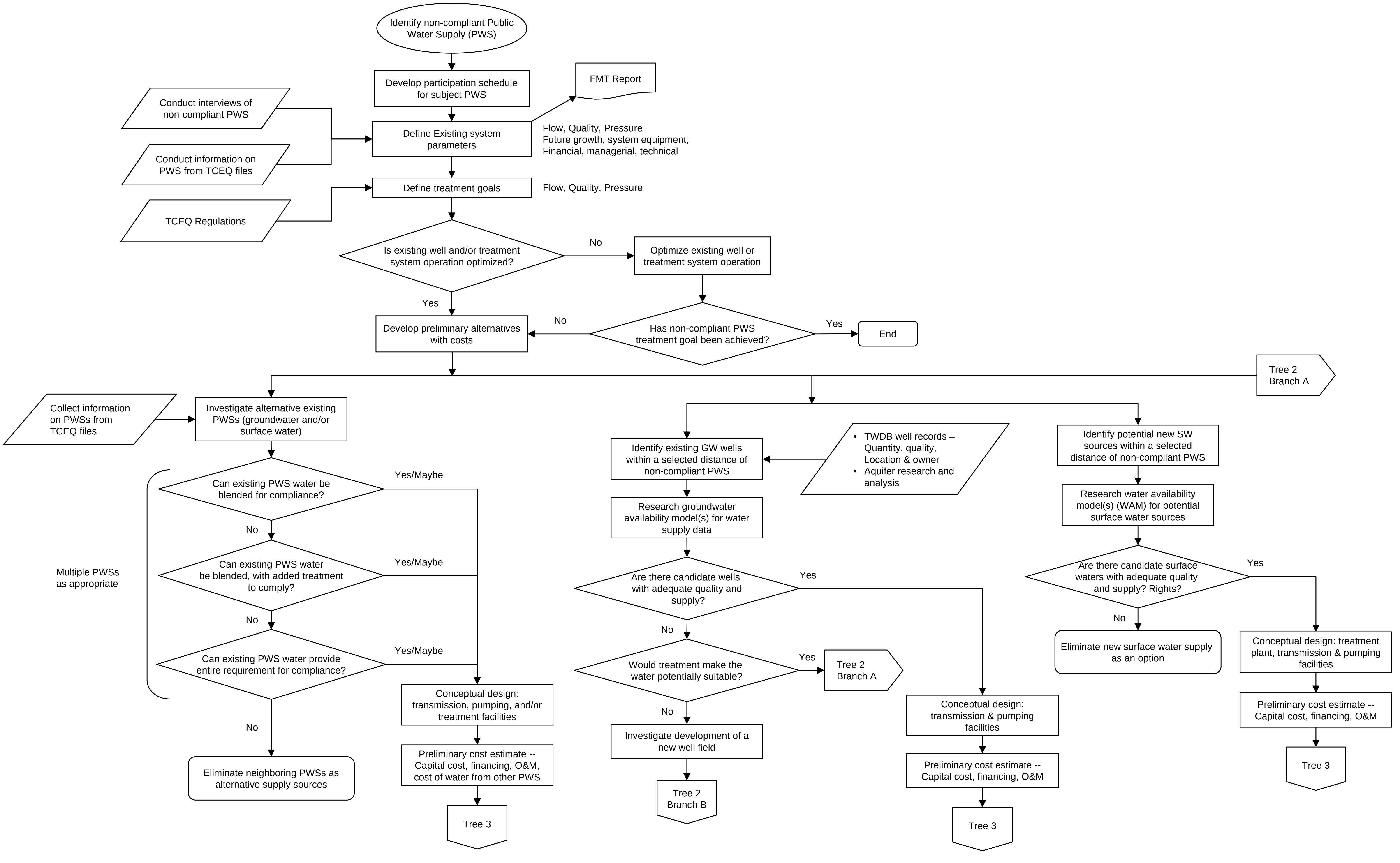


Figure 2.2
TREE 2 – DEVELOP TREATMENT ALTERNATIVES

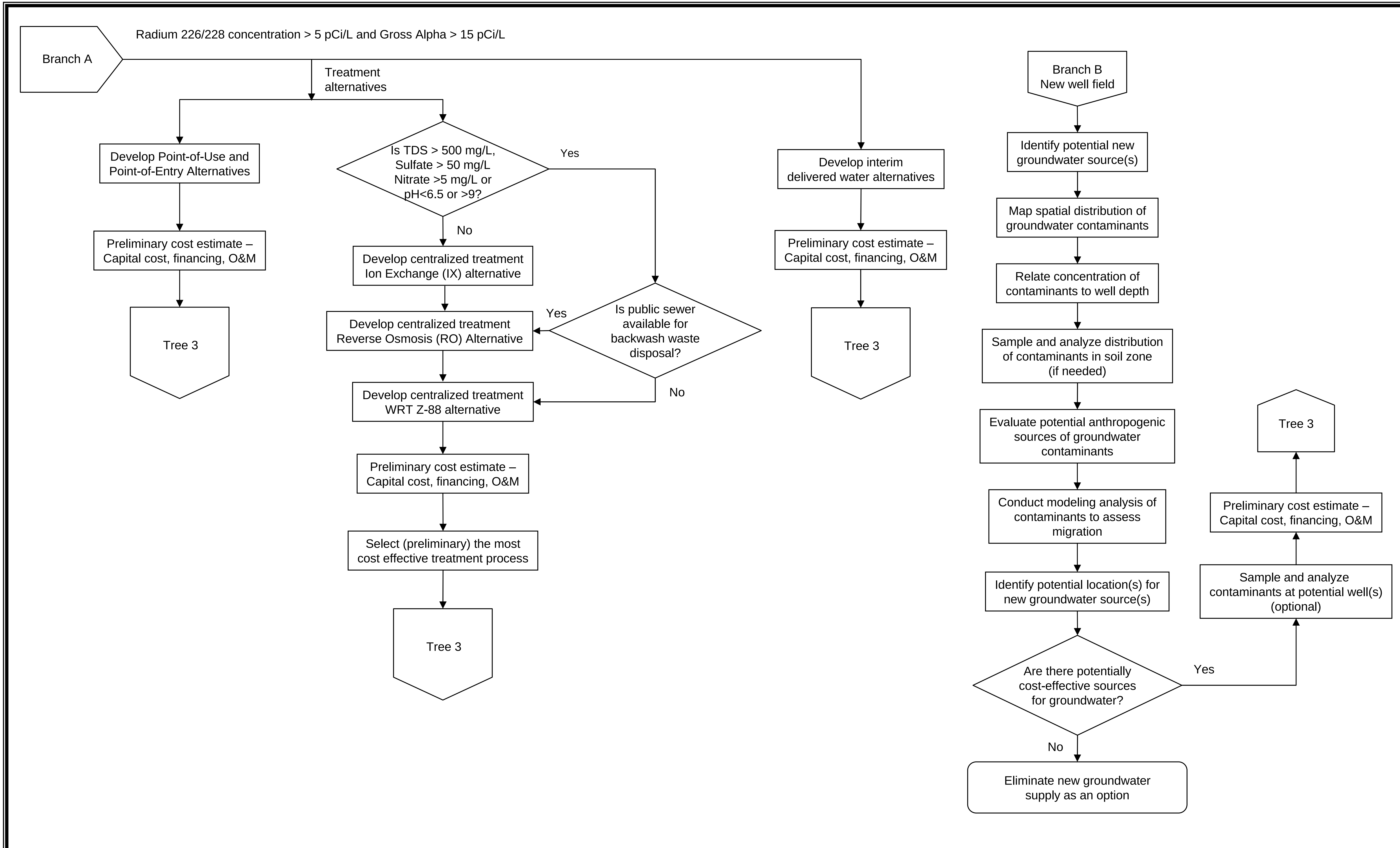


Figure 2.3
Tree 3 – PRELIMINARY ANALYSIS

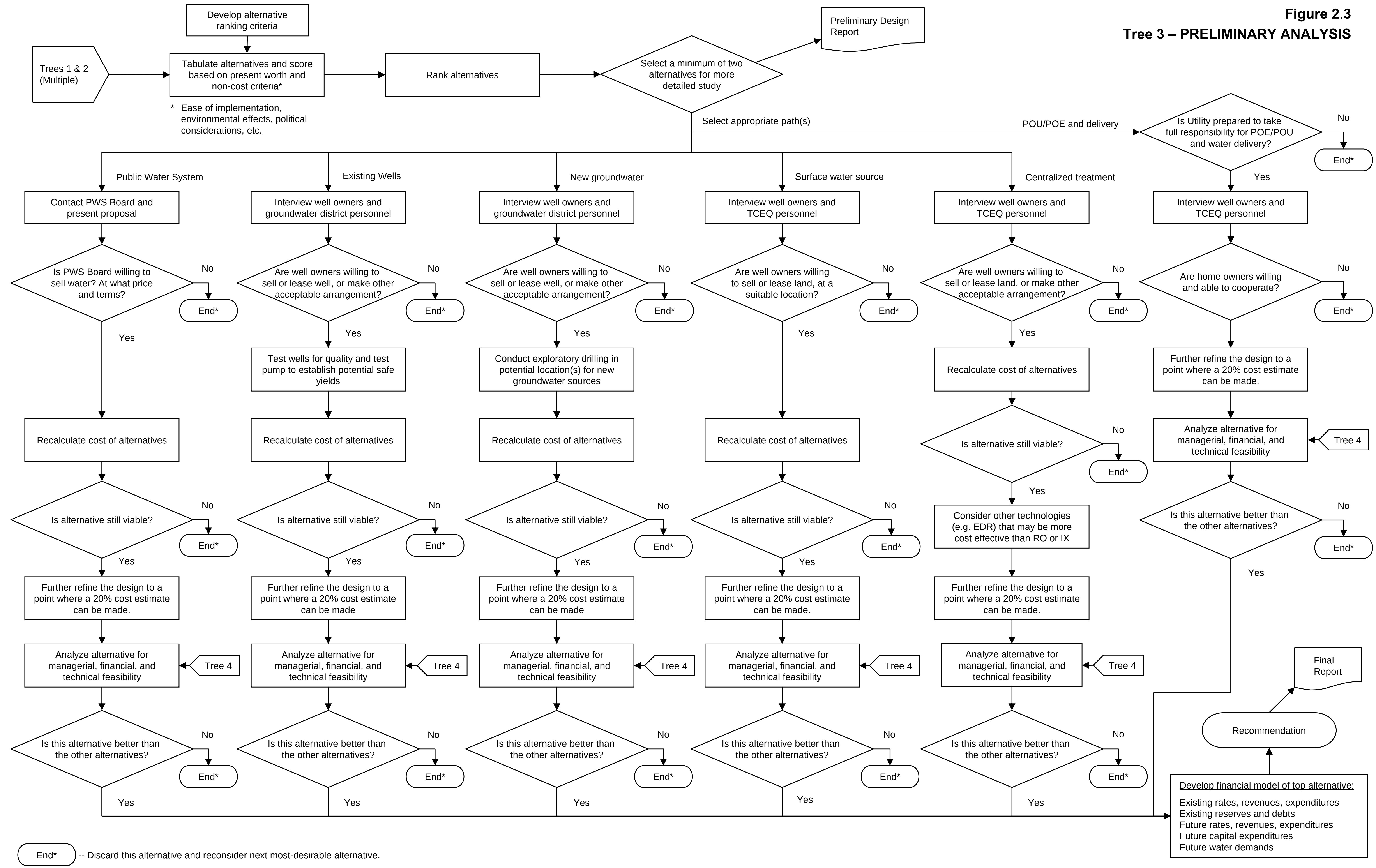
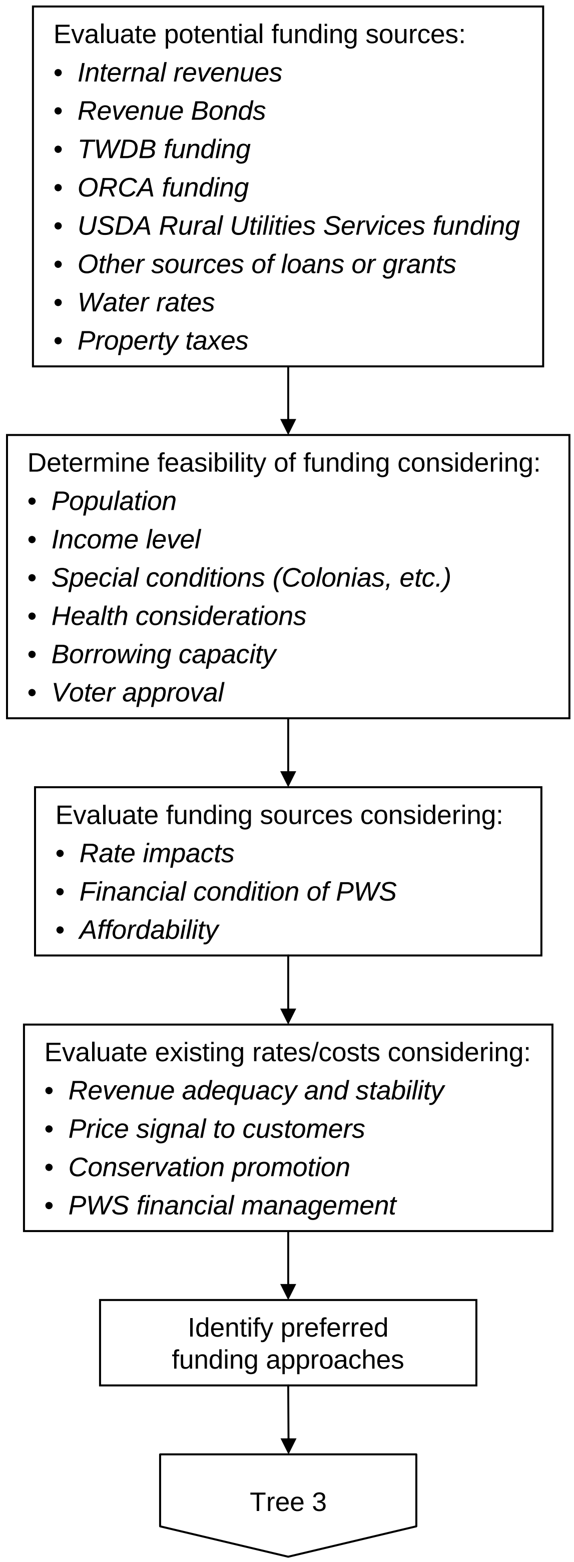


Figure 2.4
TREE 4 – FINANCIAL



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.tceq.state.tx.us/iwud/.
- 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. A GAM is currently under development for three aquifers of the Llano uplift region that supply groundwater in McCulloch County (Ellenburger-San Saba, Hickory and Marble Falls aquifers), but simulation data are not yet available.

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 one 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

An evaluation of existing data will yield an up-to-date assessment of the financial condition of the water system. As part of a site visit, financial data were collected in various forms such as electronic files, hard copy documents, and focused interviews. 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

Capacity assessment is the industry standard term for evaluation of a water system'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 water system'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 water system, including but not limited to, revenue sufficiency, credit worthiness, and fiscal controls.

Managerial capacity is the ability of a water system 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 water system, including but not limited to, ownership accountability, staffing and organization, and effective relationships with customers and regulatory agencies.

Technical capacity is the physical and operational ability of a water system to achieve and maintain compliance with SDWA regulations. It refers to the physical infrastructure of the water system, 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 water system 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 operation. A system that is able to meet both its immediate and long-term challenges demonstrates that it has sufficient FMT capacity.

Assessment of FMT capacity of the PWS was based on an approach developed by the New Mexico Environmental Finance Center (NMEFC), which is consistent with the 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 water system 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 water system. 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 water system 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 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 30 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 project to determine conclusively whether new wells could be installed to provide compliant drinking water. 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 radium removal are IX, WRT Z-88™ media, RO, EDR, and $KMnO_4$-greensand filtration. RO and EDR are membrane processes that produce a considerable amount of 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. Because the TDS is not high the use of RO or EDR would be considerably more expensive than the other potential technologies. And thus RO and EDR are not considered further. However, RO is considered for POU and POE alternatives. IX, WRT Z-88™ media, and $KMnO_4$-greensand filtration are considered as alternative central treatment technologies. 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 increase 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 an 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. It has been suggested by agencies such as USEPA that federal and state programs consider several criteria to determine "disadvantaged communities" with one based on the typical residential water bill as a percentage of MHI.

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 (items that could be converted to cash) divided by current liabilities (accounts payable, accrued expenses, and debt) 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 (total amount of money borrowed) divided by net worth (total assets minus total liabilities) 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. 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 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 > 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 are presented in a Table 4.4 which shows the percentage of MHI represented by the annual water bill that results from any rate increases necessary to maintain financial viability over time. In some cases, this may require rate increases even without implementing a compliance alternative (the no action alternative). The table shows any increases such as these separately. The results table shows the total increase in rates necessary, including both the no-action alternative increase and any increase required for the alternative. For example, if the no action alternative requires a 10 percent increase in rates and the results table shows a rate increase of 25 percent, then the impact from the alternative is an increase in water rates of 15 percent. Likewise, the percentage of household income in the table reflects the total impact from all rate increases.

2.4.5.4 Potential Funding Sources

A number of potential funding sources exist for rural utilities, which typically provide service to less than 50,000 people. Both state and federal agencies offer grant and loan programs to assist rural communities in meeting their infrastructure needs. Most are available to "political subdivisions" such as counties, municipalities, school districts, special districts, or authorities of the state with some programs providing access to private individuals. Grant funds and lower interest rates are made more available with demonstration of economic stress, typically indicated with MHI below 80 percent that of the state. The funds may be used for planning, design, and construction of water supply construction projects including, but not limited to, line extensions, elevated storage, purchase of well fields, and purchase or lease of rights to produce groundwater. Interim financing of water projects and water quality enhancement projects such as wastewater collection and treatment projects are also eligible. Some funds are used to enable a rural water provider to obtain water or wastewater service supplied by a larger utility or to finance the consolidation or regionalization of neighboring utilities. Of the three Texas agencies that offer financial assistance for water infrastructure the TWDB is the primary agencies that offers financing for privately owned water systems.

TWDB has several programs that offer loans at interest rates lower than the market offers to finance projects for drinking water systems that facilitate compliance with primary drinking water regulations. Additional subsidies may be available for disadvantaged communities. Low interest rate loans with short and long-term finance options at tax exempt rates for water or water-related projects give an added benefit by making construction purchases qualify for a sales tax exemption. Generally, the program targets customers with eligible water supply projects for all political subdivisions of the state and Water Supply Corporations with projects, but Drinking Water State Revolving Fund (DWSRF) is available to privately owned systems. Other programs with agencies such as Office of Rural Community Affairs (ORCA) and the U.S. Department of Agriculture Rural Development Texas (Texas Rural Development) coordinates federal assistance to rural Texas to help rural Americans improve their quality of life. Although, the programs with these agencies are for public systems specials cases have been addressed where in need communities can receive funds by way of public entities (e.g., county). A public entity can apply for state funds and private water system be the recipient of the services (all agency criteria would still have to be met by the benefiting community).

The application process, eligibility requirements, and funding structure vary for each of these programs. There are many conditions that must be considered by each agency to determine eligibility and ranking of projects. The principal factors that affect this choice are population, percent of the population under the state MHI, health concerns, compliance with standards, Colonia status, and compatibility with regional and state plans.

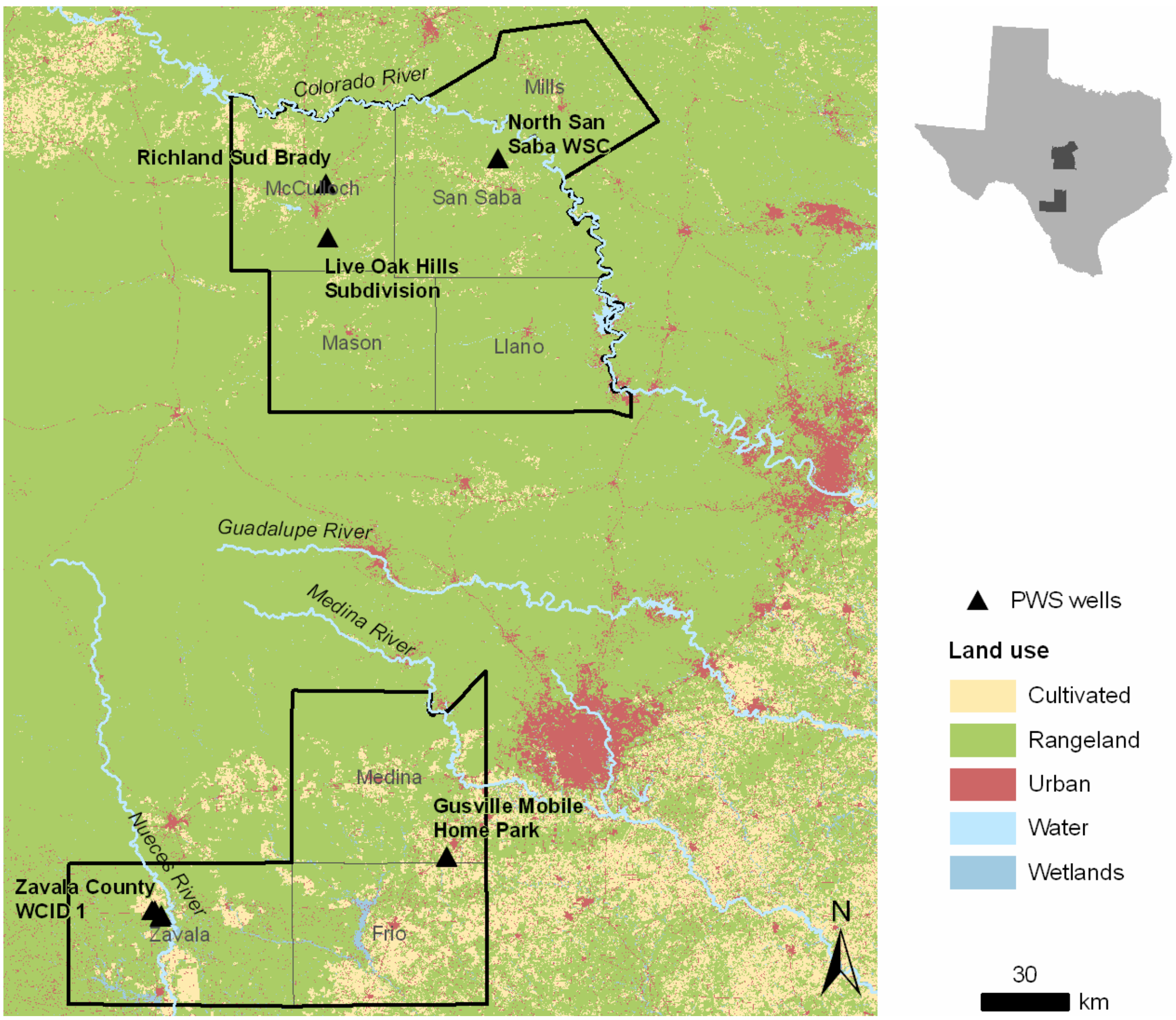
SECTION 3
UNDERSTANDING SOURCES OF CONTAMINANTS

3.1 REGIONAL ANALYSIS

3.1.1 Overview of the Study Area

The regional overview below includes data from eight counties in central Texas: Frio, Llano, Mason, McCulloch, Medina, Mills, San Saba, and Zavala counties (Figure 3.1). Land uses shown here are based on the National Land Cover Database for 2001 (USDA SCA 2007).

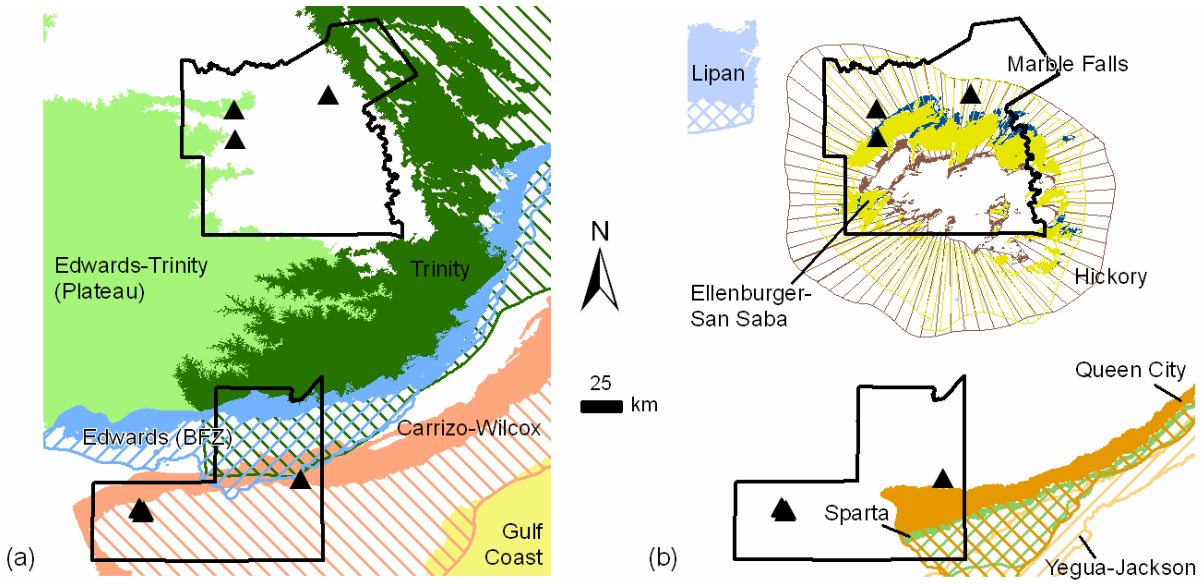
Figure 3.1 Regional Study Area and Locations of the PWS Wells Assessed in this Report



There are several major and minor aquifers within the study area (Figure 3.2). Major aquifers include the Carrizo-Wilcox aquifer, the Edwards (Balcones Fault Zone [BFZ]) aquifer, the Edwards-Trinity (Plateau) aquifer, and the Trinity aquifer. Minor aquifers include the

Ellenburger-San Saba aquifer, the Hickory aquifer, the Marble Falls aquifer, the Queen City aquifer, the Sparta aquifer, and the Yegua-Jackson aquifer. All PWS wells in the northern part of the study area draw water from the Hickory aquifer, while all PWS wells in the southern part of the study area draw water from the Carrizo-Wilcox aquifer. The geology and hydrogeology of the area are described in more detail below.

Figure 3.2 Major (a) and Minor (b) Aquifers in the Study Area



Solid indicates a portion of an aquifer that lies at the land surface. Hatched indicates a portion of an aquifer that underlies other formations.

Water chemistry data used for this study were obtained from two sources:

- Texas Water Development Board groundwater database available at www.twdb.state.tx.us. The database includes information on the location and construction of wells throughout the state as well as historical measurements of water chemistry and levels in the wells.
- Texas Commission on Environmental Quality Public Water Supply database (not publicly available). The database includes information on the location, type, and construction of water sources used by PWS in Texas, along with historical measurements of water levels and chemistry.

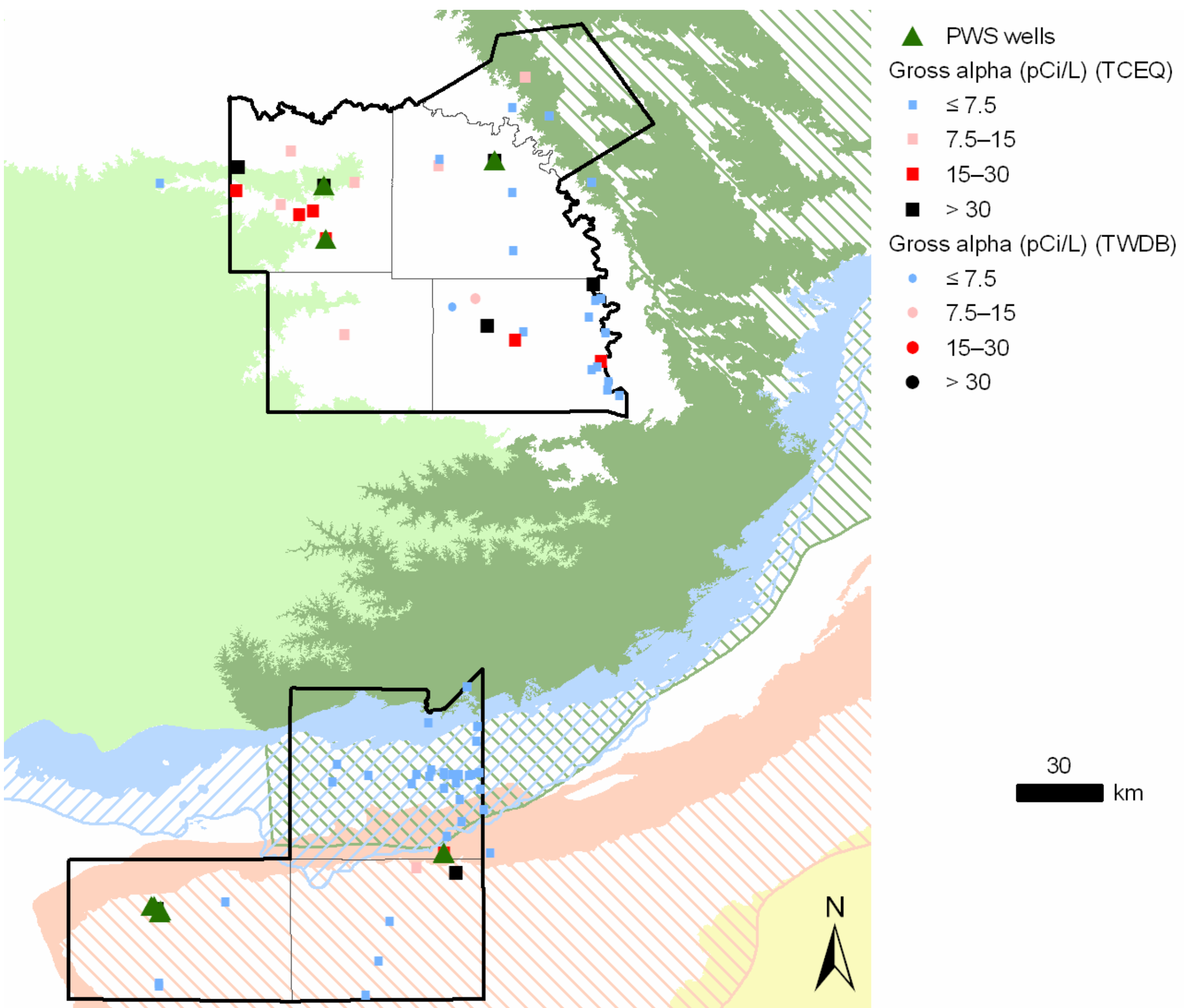
3.1.2 Contaminants of Concern in the Study Area

Contaminants addressed are combined radium and gross alpha. Groundwater sources from each PWS assessed in Section 2 have been found to contain levels of these contaminants in excess of USEPA's MCL. The database or databases used to assess each constituent are those with the most readily available measurements. For individual wells that have been sampled for a given constituent multiple times, the most recent measurement is shown.

Gross Alpha

In general, gross alpha concentrations are low in the southern part of the study area, while many wells in the northern part of the study area have concentrations above the MCL (15 pCi/L) (Figure 3.3). All but two of the measurements in Figure 3.3 are from the TCEQ database, which commonly includes samples that are a mixture of water from multiple wells. Therefore, a quantitative assessment of how gross alpha concentrations vary with aquifer or well depth is not possible. Based on the aquifer locations shown in Figure 3.2, levels of gross alpha are likely higher in the Hickory and Ellenburger-San Saba aquifers than in the Carrizo-Wilcox, Edwards (BFZ), and Trinity aquifers.

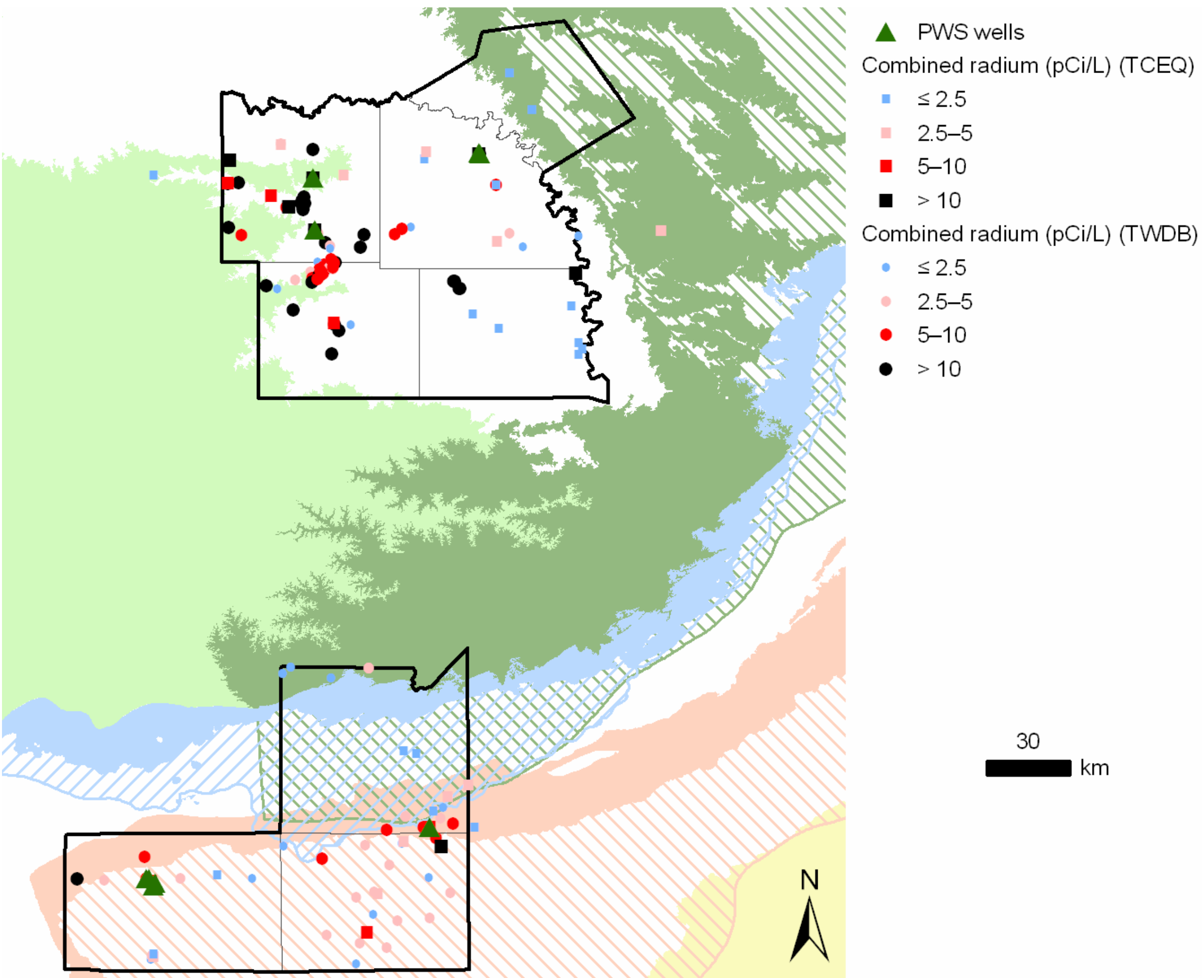
Figure 3.3 Spatial Distribution of Gross Alpha Concentrations in the Study Area



Combined Radium

The concentration of combined radium, which refers to radium 226 plus radium 228, commonly exceeds the MCL (5 pCi/L) in wells throughout the study area, with a larger number of high values in the northern part of the study area (Figure 3.4). The values shown in this analysis represent an upper limit of the possible concentration, because in wells that contained less than 1 pCi/L of radium 228 (the detection limit), 1 pCi/L was used in the combined concentration.

Figure 3.4 Spatial Distribution of Combined Radium Concentrations in the Study Area



A comparison of available measurements of combined radium by aquifer shows that over three-fourths of wells in the Hickory aquifer and other aquifers exceed the MCL, while only 27 percent of wells in the Carrizo-Wilcox aquifer exceed the MCL (Table 3.1). There are too few measurements from wells in the Ellenburger-San Saba, Trinity, and Queen City aquifers to discern any trends in these aquifers.

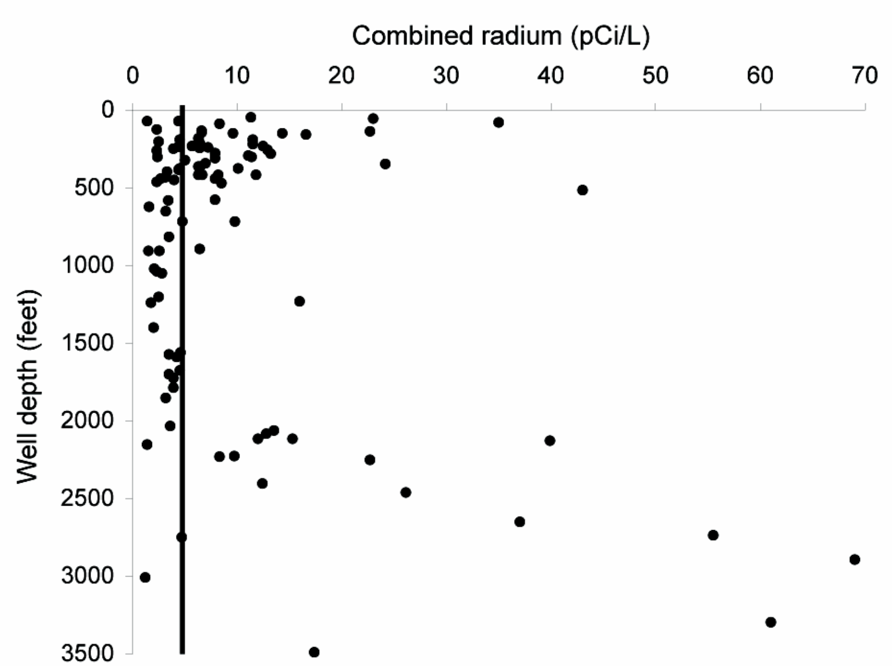
Table 3.1 Summary of Wells that Exceed the MCL for Combined Radium, by Aquifer

Aquifer	Wells with measurements	Wells that exceed 5 pCi/L	Percentage of wells that exceed 5 pCi/L
Carrizo-Wilcox	30	8	27
Ellenburger-San Saba	1	0	0
Hickory	48	37	77
Trinity	4	0	0
Queen City	1	0	0
other	14	11	79

Data from the TWDB Database.

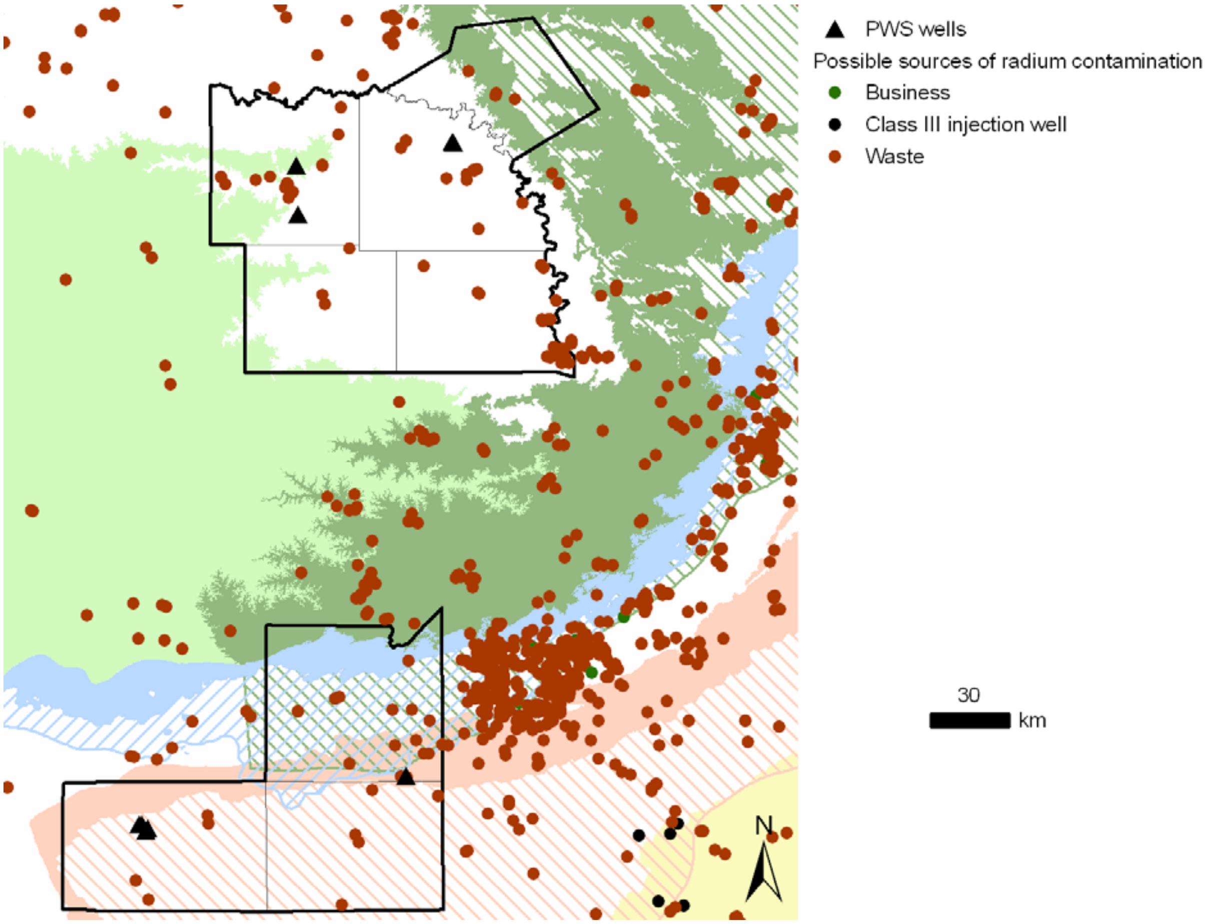
Combined radium levels were compared to well depths (Figure 3.5). Concentrations of combined radium are below the MCL in most wells between 1,000 and 2,000 feet deep. Wells shallower or deeper than this range appear much more likely to exceed the MCL.

Figure 3.5 Combined Radium Concentrations and Well Depths within the Study Area



In addition to these geologic trends, high radium concentrations can also be caused by anthropogenic sources of contamination. The TCEQ Source Water Protection Program (SWAP) has compiled a database of potential sources of radium contamination, including certain businesses, injection wells related to oil production, and waste disposal sites (Figure 3.6).

Figure 3.6 Locations of Possible Sources of Radium Contamination in the Study Area



3.1.3 Regional Hydrogeology

The PWS considered in this study overlie three aquifers. These are the Hickory and Ellenburger-San Saba aquifers in the northern part of the study area, and the Carrizo-Wilcox aquifer in the southern part of the study area. The Hickory and Ellenburger-San Saba aquifers are located in the area of the Llano Uplift, a structural dome made up of Precambrian igneous and metamorphic rocks surrounded by more recent geologic units that dip away from the center of the uplift (Bluntzer 1992). The Carrizo-Wilcox aquifer is one of several aquifers composed of sedimentary units that lie parallel to the Gulf of Mexico coastline (Ashworth and Hopkins 1995).

The Hickory aquifer is composed of the Hickory Sandstone Member of the Cambrian aged Riley Formation. It is found on top and on the sides of the dome of Precambrian rocks that form the center of the Llano Uplift. Within McCulloch County, the thickness of the Hickory Sandstone Member averages 360 feet in the outcrop area and 400 feet where it is located in the subsurface (Mason 1961). The sand beds that make up the member vary in grain size and are typically cemented with iron oxide or clay. Groundwater can be found in the Hickory aquifer down to 4,500 feet beneath the land surface (Ashworth and Hopkins 1995).

The Ellenburger-San Saba aquifer lies above the Hickory aquifer and is separated from it by units of shale, limestone, and sandstone that are not known to yield significant quantities of water (Mason 1961). The aquifer consists of the San Saba Member of the late Cambrian aged Wilberns Formation along with the early Ordovician aged Ellenburger Group. The Ellenburger Group includes the Honeycut, Gorman, and Tanyard formations (Ashworth and Hopkins 1995). The San Saba Member is composed primarily of glauconitic limestone. The Ellenburger Group is made up of texturally variable limestone and dolomite that commonly contain fossils and chert. Within McCulloch County, the average thickness of the Ellenburger Group is 450 feet (Mason 1961). Much of the water movement in the aquifer takes place through fractures and cavities in the rock. Where it dips beneath other geologic units, the Ellenburger-San Saba aquifer can be found at depths of up to 3,000 feet (Ashworth and Hopkins 1995).

In places, the Hickory and Ellenburger-San Saba aquifers are hydraulically connected to each other and to the Marble Falls and Trinity aquifers. Significant movement between these aquifers can occur where confining layers between them are thin or absent and where fault movement has positioned formations next to each other (Bluntzer 1992).

The Carrizo-Wilcox aquifer includes the Tertiary age Wilcox Group, which includes the Calvert Bluff, Simsboro, and Hooper formations, and the overlying Carrizo Formation. These units are located along a band that follows the Gulf of Mexico coastline and extends into Mexico and Louisiana. These geologic units are composed primarily of sand, with interbedded layers of gravel, silt, clay, and lignite. The aquifer is up to 3,000 feet thick (Ashworth and Hopkins 1995). Sediment texture and permeability within the aquifer vary based on depositional facies, with channel-fill deposits forming thick, highly permeable sections of the aquifer (McCoy 1991). In general, the Carrizo Formation provides higher well yields and higher quality water than the Wilcox Group (Klemt and others 1976).

3.2 DETAILED ASSESSMENT FOR THE LIVE OAK HILLS SUBDIVISION

The Live Oak Hills Subdivision PWS has one well: G1540012A. It was drilled in the Hickory aquifer and is 1,230 feet deep. Water from this PWS has been sampled from an entry point near the well and from a point within the distribution system. Table 3.2 summarizes measured concentrations of gross alpha and combined radium.

Between 1997 and 2007, all eight measurements of gross alpha and all 10 measurements of combined radium exceed the MCLs for these constituents (15 pCi/L and 5 pCi/L, respectively). The distribution of gross alpha and combined radium concentrations in nearby wells are shown in Figures 3.7 and 3.8, respectively.

Table 3.2 Gross Alpha and Combined Radium Concentrations in the Live Oak Hills Subdivision PWS

Date	Gross alpha (pCi/L)	Combined radium (pCi/L)	Source sampled
7/30/97	-	12.3	distribution system
5/21/01	24.5	12.3	G1540012A
10/16/02	19.4	12.1	G1540012A
10/15/03	23.0	13.0	G1540012A
8/10/05	24.6	11.1	G1540012A
1/19/06	21.3	13.2	G1540012A
5/23/06	21.6	11.2	G1540012A
9/13/06	24.9	11.6	G1540012A
10/27/06	20.8	15.7	G1540012A
3/19/07	-	12.5	G1540012A

Data from the TCEQ PWS Database

Figure 3.7 Gross Alpha Concentrations within 5- and 10-km Buffers around the Live Oak Hills Subdivision PWS

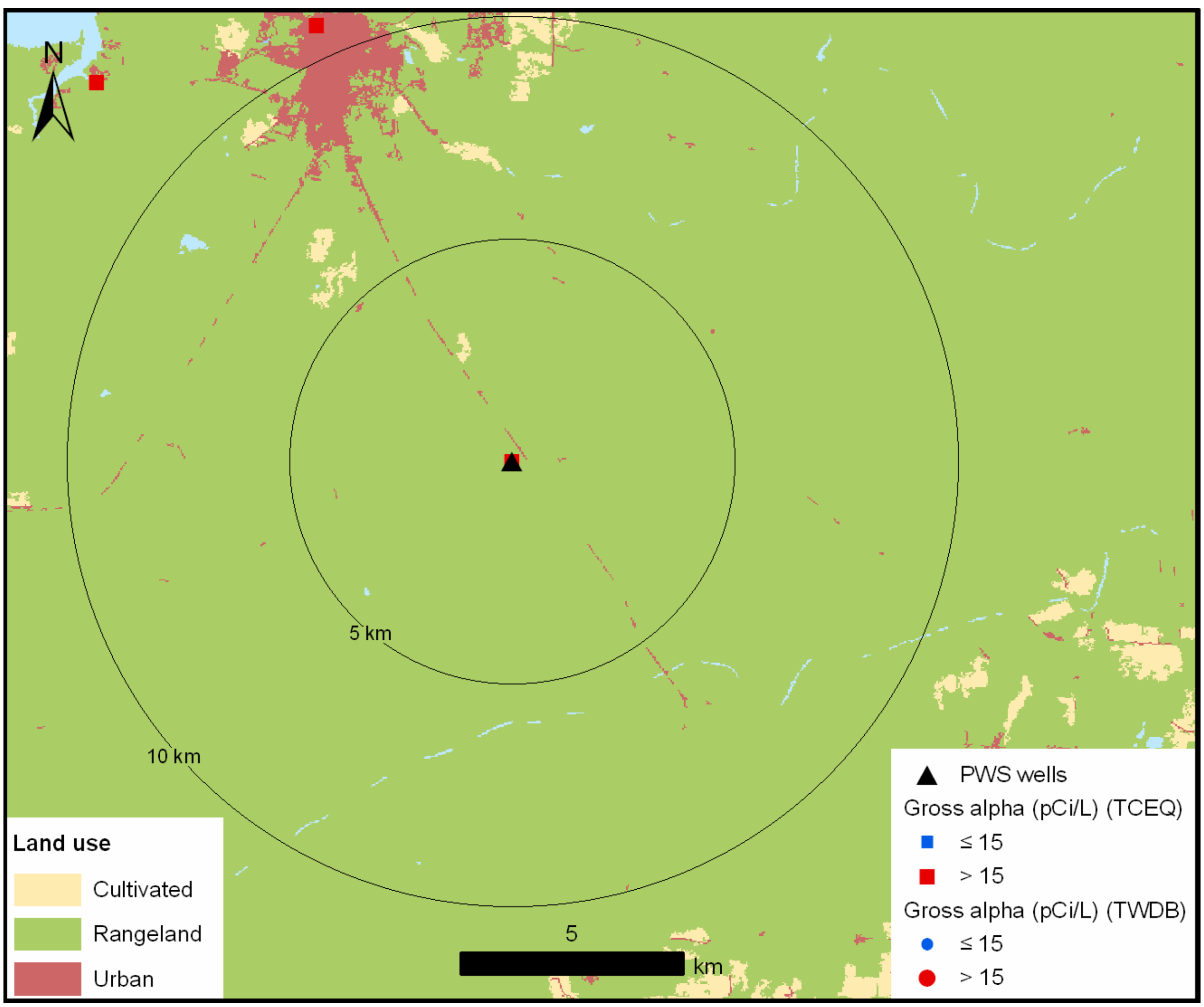
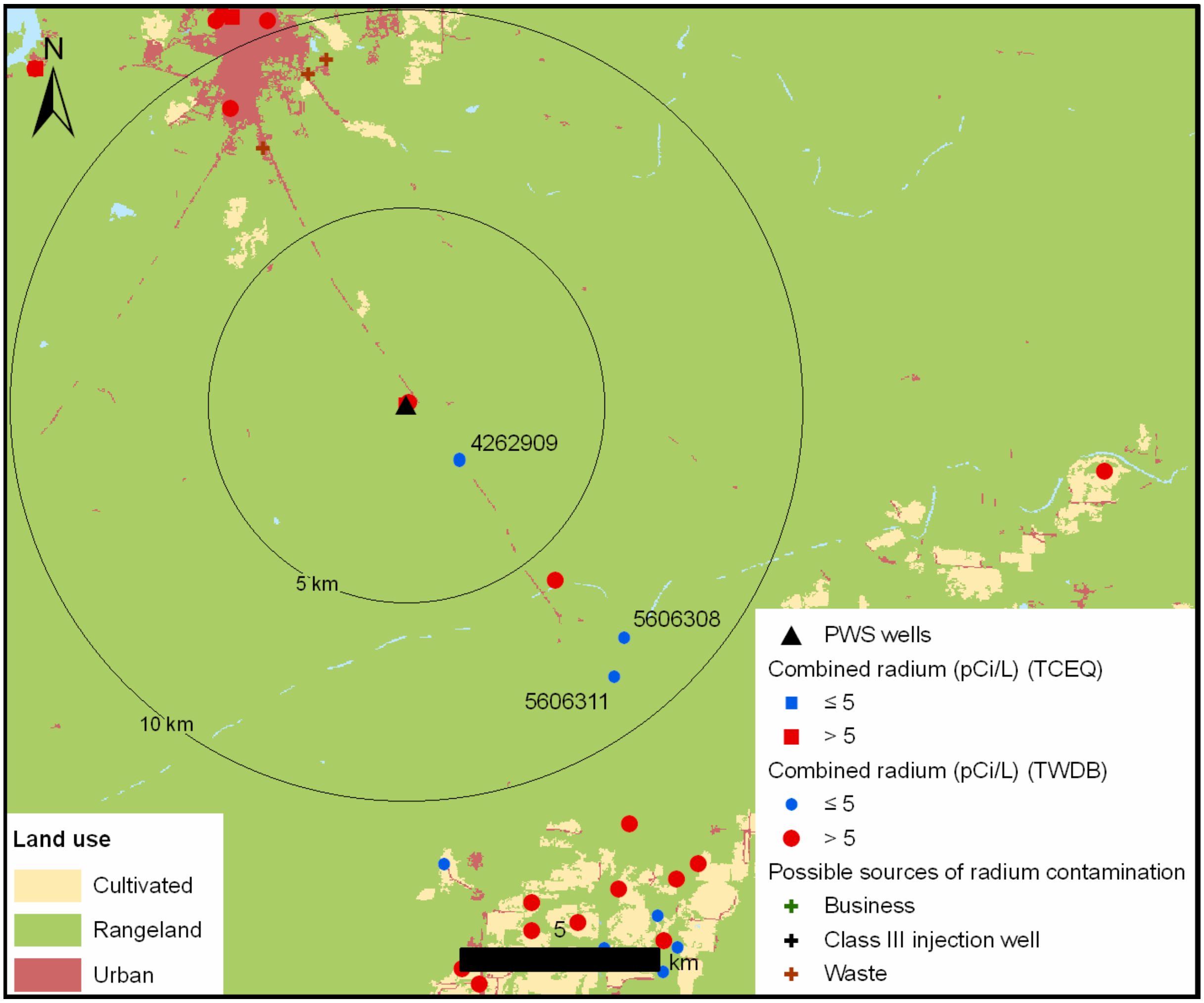


Figure 3.8 Combined Radium Concentrations within 5- and 10-km Buffers around the Live Oak Hills Subdivision PWS



Data are from the TCEQ and TWDB databases. Two types of samples were included in the analysis. Samples from the TCEQ database (shown as squares on the map) represent the most recent sample taken at a PWS, which can be raw samples from a single well or entry point samples that may combine water from multiple sources. Samples from the TWDB database are taken from single wells (shown as circles in the map). Where more than one measurement has been made from a source, the most recent concentration is shown.

No measurements of gross alpha were found in the area around the Live Oak Hills Subdivision PWS well. However, three wells within 6.2 miles of the well have been shown to contain acceptable concentrations of combined radium. Information about these wells is summarized in Table 3.3. Before being considered as possible alternative water sources, these wells should be tested for both gross alpha and combined radium as well as other constituents of concern.

Table 3.3 Most Recent Concentrations of Select Constituents in Potential Alternative Water Sources

Well	Owner	Depth (ft)	Aquifer	Use	Date	Gross alpha (pCi/L)	Combined radium (pCi/L)
4262909	Texas Water Development Board	1398	Ellenburger Group and Cambrian rocks	unused test hole	9/5/1990	-	2
5606308	Tommy Brook Estate (Marie Brook)	430	Hickory	stock	7/21/1987	-	3.1
5606311	Wau-Ban-See Ranch (Jacqueline Golemon)	300	Hickory	domestic	7/24/1987	-	2.4

In addition, the relatively shallow depths of Wells 5606308 and 5606311 suggest that casing the deeper portion of the PWS well, or drilling a new and shallower well, might lead to decreased levels of gross alpha and combined radium. However, the regional analysis showed that wells less than 1,000 feet deep commonly exceed the MCL for combined radium (Figure 3.5). Depth-specific sampling could help to assess whether these are possible options.

3.2.1 Summary of Alternative Groundwater Sources for the Live Oak Hills Subdivision PWS

One possibility is to consider casing the deeper portion of the PWS well or drilling a second well to obtain water from the shallower part of the aquifer, which has been shown locally to contain more consistently acceptable levels of combined radium. Information about three nearby wells that contain acceptable levels of combined radium is provided in Table 2-4. However, these wells have not been tested for gross alpha and so should be tested for this and other constituents of concern before being considered as possible alternative sources of water.

SECTION 4
ANALYSIS OF THE LIVE OAK HILLS PWS

4.1 DESCRIPTION OF EXISTING SYSTEM

4.1.1 Existing System

The Live Oak Hills PWS is shown in Figure 4.1. The Live Oak Hills Subdivision PWS is located approximately 6 miles south of Brady, Texas, on State Highway 87 and County Road 201. The water system serves a population of 93 and has 31 connections. Live Oak Hills is a subdivision of mobile homes where the lots are owned by the home owners.

The water source for this subdivision water system is one well, completed in the Hickory Aquifer (Code 371HCKR), that is approximately 1,230 feet deep and has a total production 0.036 mgd. The well pumps to a ground storage tank, and from there, service pumps pump to the distribution system. Chlorination is done ahead of the ground storage tanks, and there is a pressure tank that floats on the system. The well (G1540012A) is rated at 22 gallons per minute (gpm).

The treatment employed for disinfection is not appropriate or effective for removal of radium or gross alpha particle activity, so optimization is not expected to be effective for increasing removal of these contaminants. However, there is a potential opportunity for system optimization to reduce contaminant concentrations. It may be possible to identify contaminant-producing strata through comparison of well logs or through sampling of water produced by various strata intercepted by the well screen.

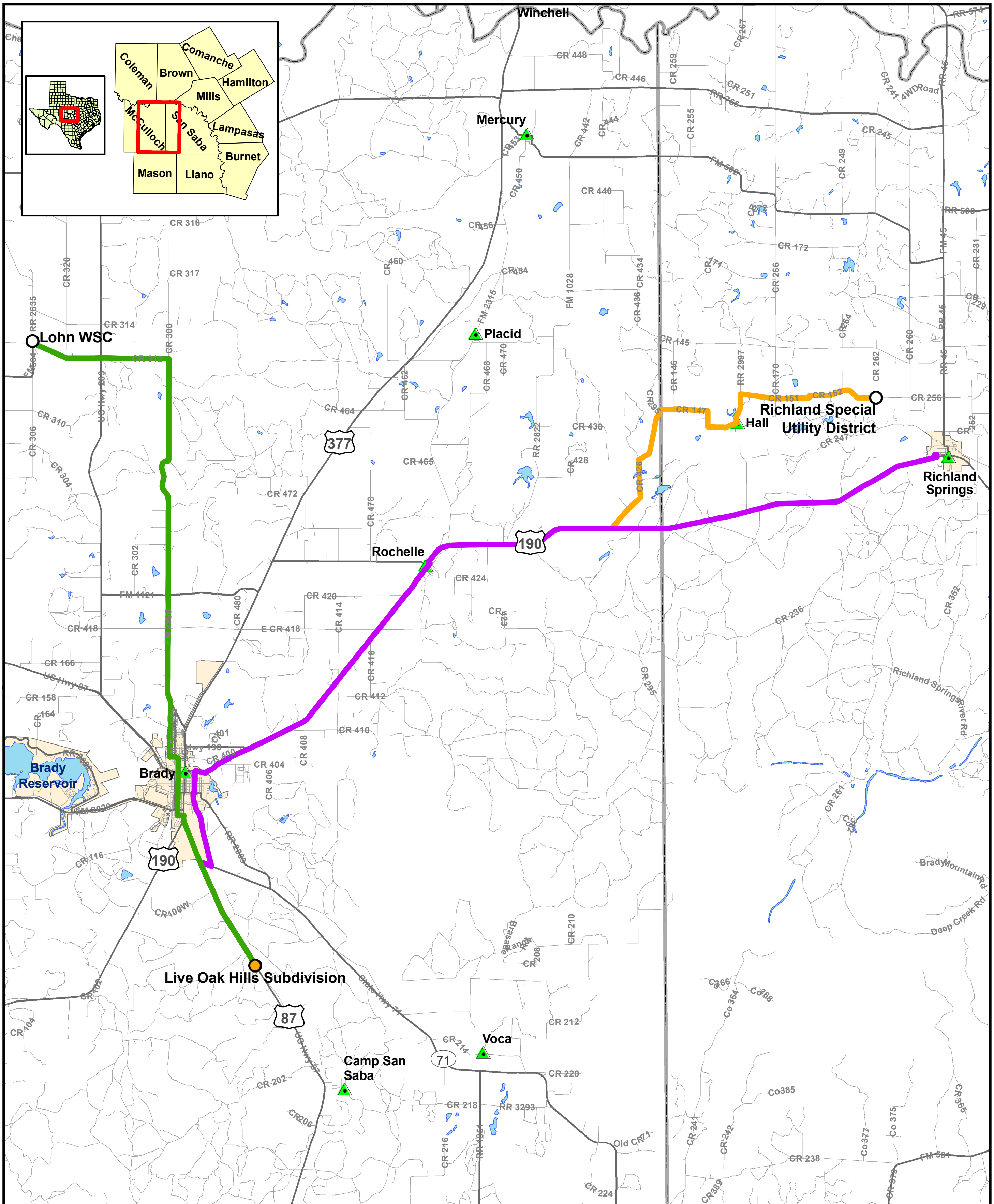
During the period of October 2001 to September 2004, Live Oak Hills Subdivision PWS recorded gross alpha activity values ranging from 15.0 to 21.3 pCi/L. Combined radium values ranged from 5 pCi/L to 12 pCi/L between July 2002 and June 2007. These values are above the 15 pCi/L MCL for gross alpha activity and 5 pCi/L MCL for combined radium (226 + 228). Therefore, Live Oak Hills Subdivision faces compliance issues under the water quality standards for gross alpha activity and combined radium.

Basic system information is as follows:

- Population served: 93
- Connections: 31
- Average daily flow: 0.0055 mgd
- Total production capacity: 0.036 mgd

Basic system raw water quality data are as follows:

- Typical combined radium range: 5 – 12 pCi/L
- Typical gross alpha range: 15 – 21.3 pCi/L



Legend

- Study System
- PWS's
- Cities
- City Limits
- Counties
- Major Road
- Minor Road
- CRMWA Pipeline
- Lubbock Pipeline
- Grass Valley Pipeline
- LO-1 Lohn WSC - 23.8 Miles
- LO-2 City of Richland Springs - 33 Miles
- LO-3 Richland Special Utility District - 34.8 Miles

N

Miles

0 2 4

Figure 4.1

LIVE OAK HILLS SUBDIVISION

Pipeline Alternative

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- Typical arsenic: <0.0022 mg/L
- Typical calcium range: 61.5 – 69 mg/L
- Typical chloride range: 23 – 26 mg/L
- Typical fluoride range: 0.8 – 0.9 mg/L
- Typical iron range: 0.03 – 0.05 mg/L
- Typical magnesium range: 32 – 40 mg/L
- Typical manganese: <0.008 mg/L
- Typical nitrate range: 0.05 – 0.07 mg/L
- Typical selenium: <0.0032 mg/L
- Typical sodium range: 23 – 26.1 mg/L
- Typical sulfate: 45 mg/L
- Typical pH range: 7.3 – 7.5
- Typical bicarbonate (HCO_3) range: 349 – 359 mg/L
- Typical total dissolved solids range: 374 to 376 mg/L

The typical ranges for water quality data listed above are based on a TCEQ database that contains data updated through the beginning of 2005.

4.1.2 Capacity Assessment for the Live Oak Hills PWS

The project team conducted a capacity assessment of the Live Oaks Subdivision water system on July 30, 2008. 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 FMT capability of the water system. The positive aspects of capacity describe the strengths of the system. These factors can provide the building blocks for the system 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, those 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 ensure the proper operation of the system. The last category, capacity concerns, includes items that are not causing significant problems for the system at this time. However, the system may want to address them before they become problematic.

Because of the challenges facing very small water systems, it is increasingly important for them to develop the internal capacity to comply with all state and federal requirements for public drinking water systems. For example, it is especially important for very small water systems to develop long-term plans, set aside money in reserve accounts, and track system expenses and revenues because they cannot rely on increased growth and economies of scale to offset their costs. In addition, it is crucial for the owner, manager, and operator of a very small water system to understand the regulations and participate in appropriate training. Providing safe drinking water is the responsibility of every public water system, including those very small water systems that face increased challenges with compliance.

The project team interviewed Bill and Addie Wootan, owners of the water system.

4.1.2.1 General Information about the Water System

The Live Oaks Subdivision water system is located approximately 55 miles from Llano, Texas. Mr. and Mrs. Wootan have owned the water system for 10 years. Mr. Wootan's father was a partner in the initial development of the subdivision approximately 25 years ago. The lots are individually owned and the Wootan's own one acre where the well is located, and the distribution system components. The system has 31 connections and serves about 93 residents. Mrs. Wootan is a licensed operator and takes the monthly water sample. She also sends out the monthly bills and keeps the financial records. Mr. Wootan assists with repairs and maintenance, as well as collections. Any repairs or upgrades to the water system are paid for by loans. The last two rate increases were in 1997 and 2002. The current rate is $25 for the monthly minimum charge, which includes 3,000 gallons of water. There is a charge of $3.50 per 1,000 gallons from 3,001 to 10,000, and a charge of $4.50 per 1,000 gallons over 10,001. Mrs. Wootan is currently working with an accountant to file an application for a rate increase. She stated they haven't filed rate increases regularly because the last request was denied. Both Mr. and Mrs. Wootan stated that they would like to sell the system and get out of the water business, but have been unable to find a buyer. The system exceeds the standard for radium and is under a Compliance Order with TCEQ.

4.1.2.2 General Assessment of Capacity

Based on the team's assessment, this system has a marginal level of capacity. There are several positive FMT aspects of the water system, but there are also some areas that need improvement. The deficiencies noted could prevent the water system from being able to meet compliance now or in the future and may also impact the water system'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 those activities can be continued or strengthened. In addition, those positive aspects can assist the system in addressing the capacity deficiencies or concerns. The factor particularly important for Live Oaks water system is described below.

- **Dedicated Owners –** The owners are working hard to provide safe drinking water. Because it is a 110-mile round trip for the owners to visit the water system, they contract with one of the residents who is retired to check the chlorine daily, read the master meter, check the storage tank, and alert them if there is a problem. In addition, by paying a monthly fee to have a well service on call, they have been able to address problems more quickly than in the past.

4.1.2.4 Capacity Deficiencies

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

- **Inability to Meet Operating Expenses –** Because of cash flow issues, the owners do not pay the full bill for the quarterly laboratory analysis and instead make payments over time. Because of this, they do not receive the results until the total fees have been paid. Delays in receiving information could increase the risk to public health.
- **Lack of Compliance with Radium Standard -** The water system is not in compliance with the radium standard and is under a Compliance Order.

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 FMT capabilities and to improve the system's long-term sustainability.

- **Lack of Long Term Capital Planning for Compliance and Sustainability –** While the owners state that the system needs an additional well, more storage, and a more efficient chlorination system, there does not appear to be a long term plan in place for these improvements. The owners stated that they take out a bank loan for emergencies or large expenditures. Without some type of planning process, the owners are not able to identify the revenue needed to make system improvements, add treatment processes, and ensure sustainability.
- **Water Loss** - the system reported a 21% percent water loss in 2007. A reduction in water loss could significantly reduce the amount of water that must be pumped and/or treated.

4.2 ALTERNATIVE WATER SOURCE DEVELOPMENT

4.2.1 Identification of Alternative Existing Public Water Supply Sources

Using data drawn from the TCEQ drinking water and TWDB groundwater well databases, the PWSs surrounding the Live Oak Hills PWS were reviewed with regard to their reported drinking water quality and production capacity. PWSs that appeared to have water supplies with water quality issues were ruled out from evaluation as alternative sources, while those without identified water quality issues were investigated further. Small systems were only considered if they were within 10 miles of the Live Oaks PWS. Large systems or systems capable of producing greater than four times the daily volume produced by the study system were considered if they were within 30 miles of the study system. A distance of 30 miles was considered to be the upper limit of economic feasibility for constructing a new water line. Table 4.1 is a list of the selected PWSs based on these criteria for large and small PWSs within 30 miles of the Live Oaks Subdivision. If it was determined these PWSs had excess supply capacity and might be willing to sell the excess, or might be a suitable location for a new groundwater well, the system was taken forward for further consideration and identified with "EVALUATE FURTHER" in the comments column of Table 4.1.

Table 4.1 Selected Public Water Systems within 30 Miles of the Live Oak Hills

PWS ID	PWS Name	Distance from Live Oak Hills (miles)	Comments/Other Issues
1540001	BRADY CITY OF	6.23	Larger SW/GW system. WQ issues: radium and gross alpha
1540007	LAKELAND SERVICES	11.11	Small GW system. Secondary WQ issues, including 2000 mg/L TDS
1540008	RICHLAND SPECIAL UTIL DIST BRADY	11.29	Larger GW system. WQ issues: radium and gross alpha
1540004	ROCHELLE WATER SUPPLY CORP	13.21	Larger GW system. WQ issue: radium
0480015	MILLERSVIEW DOOLE WSC	17.42	Larger GW system. WQ issues: radium and gross alpha
1540003	CITY OF MELVIN	19.53	Larger GW system. WQ issue: radium
1540002	LOHN WATER SUPPLY CORP	19.98	Larger GW system. No WQ issues. **Evaluate Further**
1600001	CITY OF MASON	21.36	Larger GW system. WQ issues: radium and gross alpha
2060002	CITY OF RICHLAND SPRINGS	26.13	Larger SW system. No WQ issues. **Evaluate Further**
2060012	RICHLAND SPECIAL UTILITY DISTRICT	27.25	Larger SW system. No WQ issues. **Evaluate Further**

WQ = water quality
GW = groundwater

After the PWSs in Table 4.1 with water quality problems were eliminated from further consideration, the remaining PWSs were screened by proximity to Live Oak Hills PWS and sufficient total production capacity for selling or sharing water. Based on the initial screening summarized in Table 4.1, three alternatives were selected for further evaluation. These alternatives are summarized in Table 4.2. These include installation of a new well at Lohn WSC, connecting to the City of Richland Springs, and connecting to the Richland Special Utility District (SUD). Descriptions of the Lohn Water Supply Corporation (WSC), the City of Richland Springs, and the Richland SUD follow Table 4.2.

Table 4.2 Public Water Systems Within the Vicinity of the Live Oak Hills PWS Selected for Further Evaluation

PWS ID	PWS Name	Pop	Connections	Total Production (mgd)	Average Daily Usage (mgd)	Approx. Dist. from Live Oak Hills (miles)	Comments/ Other Issues
1540002	LOHN WSC	200	66	0.112	0.023	20	Larger SW system. No WQ issues.
2060002	CITY OF RICHLAND SPRINGS	350	225	0.36	0.1	26.13	Larger SW system. No WQ issues.
2060012	RICHLAND SPECIAL UTILITY DISTRICT	1170	468	0.374	0.125	27.25	Larger SW system. No WQ issues.

4.2.1.1 Lohn WSC (PWS 1540002)

Lohn WSC is located in the City of Lohn, approximately 20 miles northwest of the Live Oak Hills PWS. The system is supplied by a single groundwater well completed in the Hickory Sandstone formation. The well is 2,746 feet deep and has a total production of 0.112 million gallons per day (mgd). Water is disinfected with chlorine before being sent to two 2,500-gallon storage tanks. Total service pump capacity is 0.576 mgd, and total storage is 0.050 million gallons. The system serves a population of 200, and has an approximate average daily usage of 0.023 mgd to 66 metered connections.

This WSC does not have sufficient excess capacity to supplement the Live Oak Hills PWS; however, based on the available water quality data, the location may be a suitable point for a new groundwater well.

4.2.1.2 City of Richland Springs (2060002)

Richland Springs is located approximately 26 miles northeast from the Live Oak Hills PWS. Its total groundwater production capacity is 0.360 MGD for a population of about 350 people or 225 connections. Richland Springs has one well in a natural spring. It has an emergency connection from Richland SUD, which has never been used. According to available information on this PWS, there are no reported exceedances for constituents of concern above the associated MCLs and the city reports no issues with infrastructure. Richland Springs water demand can be met with the existing infrastructure, which includes a new elevated storage tank. However, operators believe there is not much excess capacity. There have been several attempts to drill wells in the past, but none were successful. The existing well does have structural deficiencies that restrict production. If Richland Springs needs additional capacity it is likely to be provided by the Richland SUD rather than developing additional production capacity on its own.

4.2.1.3 Richland Special Utility District (2060012)

Richland SUD is located approximately 27 miles northeast from Live Oak Hills PWS. The SUD's total groundwater production capacity is 0.374 mgd for a population of about 1,170 people or 468 connections. Richland SUD is a regional provider of water for several communities in McCulloch and San Saba Counties. Richland SUD owns two wells (250 and 750 gpm). The second well may have contaminants that exceed their respective MCLs. There are current efforts to use Texas Water Development Board grant funds to construct a pipeline to blend water from its new well with its older well water. The SUD is also looking for a source of surface water. Richland SUD is willing to entertain discussions on providing water to neighboring communities.

4.2.2 Potential for New Groundwater Sources

4.2.2.1 Installing New Compliant Wells

Developing new wells or well fields is recommended, provided good quality groundwater available in sufficient quantity can be identified. Since a number of water systems in the area have water quality problems, it should be possible to share in the cost and effort of identifying compliant groundwater and constructing well fields.

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 well characteristics are known and meet standards for drinking water wells.

Some of the alternatives suggest new wells be drilled in areas where existing wells have acceptable water quality. 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 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.

4.2.2.2 Results of Groundwater Availability Modeling

Three overlapping, low-yield aquifers that surround the Llano uplift region of central Texas are the source of potable water wells located throughout McCulloch County. Those, aquifers are, from the upper hydrogeological unit to the deepest, the Marble Falls Aquifer, Ellenburger-San Saba Aquifer, and Hickory Aquifer.

The Hickory Aquifer is the groundwater source for the Live Oak Hills Subdivision. A search was conducted using TCEQ's Public Water Supply database of registered wells to evaluate groundwater sources for wells located within a 10-mile radius of the PWS. The search indicated that, within the search area, the Hickory Aquifer is the predominantly used water source for domestic and public supplies. The Ellenburger-San Saba Aquifer is largely used for livestock watering. There are no wells listed for the Marble Falls Aquifer. There is a small amount of groundwater utilization for irrigation or industrial use.

Key features of the two main groundwater sources in the PWS vicinity are discussed below, followed by a summary of groundwater availability.

Groundwater Supply

The *Hickory Aquifer*, the water source of the PWS, is classified by the TWDB as minor on the basis of potential water production. Pockets of water-bearing rock layers of the aquifer that appear at the land surface (outcrop) are scattered mostly throughout Llano, McCulloch and San Saba counties. Deeper aquifer formations, the down dip, extend over 12 counties, including the entire San Saba County. Most of the water pumped from the Hickory aquifer is used for irrigation, although some high capacity wells are used for municipal supplies. Slight water level fluctuations occur seasonally in irrigated areas (TWDB 2007).

Wells completed in the Hickory Aquifer commonly yield as much as 1,000 gallons per minute. Aquifer utilization in the previous two decades has ranged from about 17,000 to 28,000 AFY, with an estimated value of 17,634 AFY for 2000 (Mace and Angle 2004). The 2007 Texas Water Plan indicates that the groundwater supplies from the Hickory Aquifer, with implementation of water management strategies, will steadily increase during the 50-year planning period, from about 50,000 AFY in 2010 to about 62,000 AFY in the year 2060.

The *Ellenburger-San Saba Aquifer*, a second source of groundwater in the PWS vicinity, crops out from Llano County in a circular pattern and dips radially into the subsurface of 12 adjacent counties. Most of aquifer outcrop is located in southeastern McCulloch County, where the PWS is located, as well as southwestern Mason County and most of San Saba County. Municipal supply is the primary use of water pumped from the Ellenburger-San Saba Aquifer, with the remainder used for irrigation and livestock.

Wells completed in the Ellenburger-San Saba Aquifer commonly yield between 200 and 500 gallons per minute (USGS, 2006). Total aquifer utilization was estimated at 5,853 AFY for 2000, a value similar to those reported over the two previous two decades (Mace and Angle 2004). The 2007 Texas Water Plan indicates that the groundwater supplies from the aquifer, with implementation of water management strategies, will remain near its current value of about 22,500 AFY during the 2010-2060 planning period. Over the last years, water levels in the aquifer have not experienced significant declines (TWDB 2007).

Groundwater Availability

Groundwater utilization in McCulloch County was estimated at 7,137 AFY for 2000, representing over 96 percent of the total water use in the county (Mace and Angle 2004). Over a 50-year planning period, the 2007 State Water Plan estimates indicate that the water supply will have a moderate deficit relative to the increasing water demand in McCulloch County. The need for additional water supply in the county was estimated in 870 AFY for the year 2010, increasing to 913 AFY in the year 2060.

In the Llano uplift area, water level declines in the Hickory Aquifer have occurred in Gillespie and Mason Counties; small water declines have also been reported for the Ellenburger-San Saba Aquifer (Smith 2004). A GAM is not currently available for aquifers of the Llano uplift region that supply groundwater in McCulloch County. As a basis for future development of a combined GAM for the Ellenburger-San Saba, Hickory and Marble Falls aquifers, the TWDB recently completed the evaluation of aquifer structure and water elevation contour surfaces of the Llano Uplift region (Standen and Ruggiero 2007).

4.2.3 Potential for New Surface Water Sources

There is a minimum potential for development of new surface water sources for the PWS because water availability is very limited over the entire river basin, at the county level, and within the site vicinity.

The PWS is located in the middle reach of the Colorado Basin, within a relatively arid region of Texas that has a low surface water yield. The Texas State Water Plan, updated in 2007 by the TWDB, estimates that the average yield over the entire basin is 1.2 inches per year. Surface water rights are assigned primarily to municipal use and irrigation (66% and 25%, respectively). Over a 50-year planning period, the plan anticipates that availability will steadily decrease as a result of an increasing water demand. A projected 2010 surface water supply value of 1,110,000 acre-feet per year (AFY) for the Colorado Basin is expected to decrease over 10 percent by the year 2060. This decrease takes into account the implementation of various long-term water management strategies proposed in the State Water Plan.

The McCulloch County water is almost entirely for municipal water use. Groundwater utilization in McCulloch County was estimated at 7,137 AFY for 2000, representing over 96 percent of the total water use in the county (Mace and Angle 2004). Over a 50-year planning period, the 2007 State Water Plan estimates indicate that the water supply will have a moderate deficit relative to the increasing water demand in McCulloch County. The need for additional water supply in the county was estimated in 870 AFY for the year 2010, increasing to 913 AFY in the year 2060

The TWDB developed a surface water availability model for the Colorado Basin as a tool to determine, at a regional level, the maximum amount of water available during the drought of record over the simulation period, regardless of whether the supply is physically or legally available. For the PWS vicinity, simulation data indicate that there is a minimum availability of surface water for new uses. Surface water availability maps were developed by TCEQ for the Colorado Basin, illustrating percent of months of flow per year. Availability maps indicate that in the site vicinity, and over all of McCulloch County, unappropriated flows for new applications are typically available less than 25 percent of the time. This availability is inadequate for development of new municipal water supplies as a 100 percent year-round availability is required by TCEQ for new surface water source permit applications.

4.2.4 Options for Detailed Consideration

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

1. Lohn WSC. A new groundwater well would be completed in the vicinity of the well at Lohn WSC. A pipeline would be constructed and the water would be piped to Live Oak Hills PWS (Alternative LO-1)

2. Richland Springs. A new groundwater well would be completed in the vicinity of the well at Richland Springs. A pipeline would be constructed and the water would be piped to Live Oak Hills PWS (Alternative LO-2).

3. Richland Special Utility District. Water would be purchased from Richland Special Utility District to be used by the Live Oak Hills PWS. A pipeline would be constructed and the water would be piped to Live Oak Hills PWS (Alternative LO-3).

4. New Wells at 10, 5, and 1 mile. Installing a new well within 10, 5, or 1 mile of the Live Oak Hills PWS may produce compliant water in place of the water produced by the existing active well. A pipeline and pump station would be constructed to transfer the water to the Live Oak Hills PWS (Alternatives LO-4, LO-5, and LO-6).

4.3 TREATMENT OPTIONS

4.3.1 Centralized Treatment Systems

Centralized treatment of the well water is identified as a potential option. RO and WRT Z-88 are potentially applicable processes. The central RO treatment alternative is Alternative LO-7, and the WRT Z-88 treatment alternative is Alternative LO-8.

4.3.2 Point-of-Use Systems

POU treatment using RO technology is valid for combined radium and gross alpha activity removal. The POU treatment alternative is LO-9.

4.3.3 Point-of-Entry Systems

POE treatment using RO technology is valid for combined radium and gross alpha activity removal. The POE treatment alternative is LO-10.

4.4 BOTTLED WATER

Providing 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 LO-11, LO-12, and LO-13.

4.5 ALTERNATIVE DEVELOPMENT AND ANALYSIS

A number of potential alternatives for compliance with the MCL for combined radium and gross alpha have been identified. Each of the potential alternatives 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.

4.5.1 Alternative LO-1: New Well in the Vicinity of Lohn WSC

This alternative involves completing a new well in the vicinity of Lohn WSC, and constructing a pump station and pipeline to transfer the pumped groundwater to the Live Oak Hills PWS. Based on the water quality data in the TCEQ database, it is expected that groundwater from this well would be compliant with drinking water MCLs. An agreement would need to be negotiated with Lohn WSC to expand its well field.

This alternative would require completing a new 2,746-foot well at Lohn WSC, and constructing a pipeline from that well to the existing groundwater storage tank for the Live Oak Hills PWS. A pump station and a 5,000 gallon feed tank would also be required to overcome pipe friction and the elevation differences between Lohn WSC and Live Oak Hills. The required pipeline would be 4inches in diameter and would follow Highway 87, FM 2996, CR 312, and several minor roads north and west to Live Oak Hills Subdivision. Using this route, the pipeline required would be approximately 23.8 miles long.

The pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the pumps and piping would be installed with capacity to meet all water demand for the Live Oak Hills PWS, since the incremental cost would be relatively small, and it would provide operational flexibility.

The estimated capital cost for this alternative includes completing the new well, constructing the pipeline, feed tank, and pump station. The estimated O&M cost for this alternative includes the maintenance cost for the pipeline, and power and O&M labor and materials for the pump station. The estimated capital cost for this alternative is $4.65 million, with an estimated annual O&M cost of $36,900. If the purchased water was used for blending rather than for the full water supply, the annual O&M cost for this alternative could be reduced because of reduced pumping costs and reduced water purchase costs. However, additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of the Live Oak Hills PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations is well understood, and Live Oak Hills personnel currently operate pipelines and a pump station. If the decision was made to perform blending then the operational complexity would increase.

The feasibility of the Lohn WSC alternative would be dependent on Live Oak Hills being able to reach an agreement with Lohn WSC to install a new groundwater well.

4.5.2 Alternative LO-2: New Well in the Vicinity of the City of Richland Springs

This alternative involves completing a new well in the vicinity of the City of Richland Springs, and constructing a pump station and pipeline to transfer the pumped groundwater to the Live Oak Hills PWS. Based on the water quality data in the TCEQ database, it is expected that groundwater from this well would be compliant with drinking water MCLs. An agreement would need to be negotiated with the City of Richland Springs to expand its well field.

This alternative would require completing a new 330-foot well at the City of Richland Springs, constructing a pipeline from that well to the existing ground storage tank located at the Live Oak Hills PWS. Two pump stations including feed tanks would be require to overcome friction and elevation differences between the City of Richland Springs and Live Oak Hills PWS. The required pipeline would be 4-inches in diameter, approximately 33 miles long, and follow Highway 87, Highway 190 and several minor roads to Live Oak Hills PWS.

By definition this alternative could involve regionalization, since Live Oak Hills PWS would be obtaining drinking water from an existing larger supplier. Also, other PWSs near Live Oak Hills PWS are in need of compliant drinking water and could share in implementation of this alternative.

The estimated capital cost for this alternative includes constructing the pipeline, pump stations, and buildings. The estimated O&M cost for this alternative includes the purchase price for the water minus the cost related to current operation of the Live Oak Hills PWS's wells, plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump stations. The estimated capital cost for this alternative is $5.60 million, with an estimated annual O&M cost of $59,800. If the purchased water was used for blending rather than for the full water supply, the annual O&M cost for this alternative could be reduced because of reduced pumping costs and reduced water purchase costs. However, additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

The reliability of adequate amounts of compliant water under this alternative should be good. The City of Richland Springs provides treated surface water on a large scale, facilitating adequate O&M resources. From the perspective of the Live Oak Hills PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pumps are well understood. If the decision were made to perform blending then the operational complexity would increase.

The feasibility of this alternative is dependent on an agreement being reached with the City of Richland Springs to purchase treated drinking water.

4.5.3 Alternative LO-3: Purchase Water from Richland Special Utility District

This alternative involves purchasing potable water from the Richland Special Utility District, which will be used to supply the Live Oak Hills PWS. The Richland Special Utility District currently has sufficient excess capacity for this alternative to be feasible. It is assumed that Live Oak Hills PWS would obtain all its water from the Richland Special Utility District.

This alternative would require constructing a pipeline from the Richland Special Utility District water main to the existing ground storage tank located at the Live Oak Hills PWS. Two pump stations including feed tanks would be require to overcome friction and elevation differences between the Richland Special Utility District and Live Oak Hills PWS. The required pipeline would be 4-inches in diameter, approximately 35 miles long, and follow Highway 87, Highway 190 and several minor roads to Live Oak Hills PWS.

By definition this alternative could involve regionalization, since Live Oak Hills PWS would be obtaining drinking water from an existing larger supplier. Also, other PWSs near Live Oak Hills PWS are in need of compliant drinking water and could share in implementation of this alternative.

The estimated capital cost for this alternative includes constructing the pipeline, pump stations, and buildings. The estimated O&M cost for this alternative includes the purchase price for the water minus the cost related to current operation of the Live Oak Hills PWS's wells, plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump stations. The estimated capital cost for this alternative is $5.73 million, with an estimated annual O&M cost of $48,000. If the purchased water was used for blending rather than for the full water supply, the annual O&M cost for this alternative could be reduced because of reduced pumping costs and reduced water purchase costs. However, additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

The reliability of adequate amounts of compliant water under this alternative should be good. The Richland Special Utility District provides treated surface water on a large scale, facilitating adequate O&M resources. From the perspective of the Live Oak Hills PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pumps are well understood. If the decision were made to perform blending then the operational complexity would increase.

The feasibility of this alternative is dependent on an agreement being reached with the Richland Special Utility District to purchase treated drinking water. There are several small PWSs relatively close to the Live Oak Hills PWS that have water quality problems that would be good candidates for sharing the cost for obtaining water from the Richland Special Utility District. The cost to the Live Oak Hills supply system 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 E. This analysis shows that the Live Oaks Hills system could expect to save between $1.65 million and $5.47 million on the capital cost for this alternative, which is a saving of between 29 and 95 percent.

4.5.4 Alternative LO-4: New Well at 10 miles

This alternative consists of installing one new well within 10 miles of the Live Oak Hills subdivision that would produce compliant water in place of the water produced by the existing well. 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 1230-foot well, a new pump station with a 5,000-gallon feed tank near the new well, and a pipeline from the new well/feed tank to the existing ground storage tank for the Live Oak Hills system. The pump station and feed 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 4-inches in diameter. The pump station would include a feed tank, two transfer 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 well, constructing the pipeline, the pump stations, feed tank, and pump house. The estimated O&M cost for this alternative includes O&M for the pipeline and pump stations. The estimated capital cost for this alternative is $2.01 million, and the estimated annual O&M cost for this alternative is $28,500.

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 the Live Oak Hills Subdivision, this alternative would be similar to operate as the existing system. Live Oak Hills personnel have 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 land owned by Live Oak Hills, so landowner cooperation would likely be required.

4.5.5 Alternative LO-5: New Well at 5 miles

This alternative consists of installing one new well within 5 miles of the Live Oak Hills that would produce compliant water in place of the water produced by the existing well. 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 1230-foot well, a new pump station with 5,000 gallon feed tank near the new well, and a pipeline from the new well/feed tank to the existing ground storage tank for the Live Oak Hills system. The pump station and feed tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be 4-inches in diameter, and approximately 5 miles long. The pump station near the well would include two transfer 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 well, and constructing the pipeline, feed tank, 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 $1.17 million, and the estimated annual O&M cost for this alternative is $26,900.

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 the Live Oak Hills PWS, this alternative would be similar to operate as the existing system. Live Oak Hills personnel have 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 land owned by Live Oak Hills, so landowner cooperation would likely be required.

4.5.6 Alternative LO-6: New Well at 1 mile

This alternative consists of installing one new well within 1 mile of Live Oak Hills PWS that would produce compliant water in place of the water produced by the existing well. 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 1230-foot well and a pipeline from the new well to the existing intake point for the Live Oak Hills system. Since the new well is relatively close, a pump station would not be necessary. For this alternative, the pipeline is assumed to be 4 inches in diameter, approximately 1 mile long, and would discharge to the existing storage tank.

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 well, and constructing the pipeline. The estimated O&M cost for this alternative includes O&M for the pipeline. The estimated capital cost for this alternative is $418,500, and the estimated annual O&M cost for this alternative is $300.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells and pipelines are commonly employed. From the perspective of the Live Oak Hills PWS, this alternative would be similar to operate as the existing system. Live Oak Hills personnel have 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 possible an alternate groundwater source would not be found on land owned by Live Oak Hills, so landowner cooperation may be required.

4.5.7 Alternative LO-7: Central RO Treatment

This system would continue to pump water from the existing well, and would treat the water through an RO system prior to distribution. For this option, 100 percent of the raw water would be treated to obtain compliant water. The RO process concentrates impurities in the reject stream which would require disposal. It is estimated the RO reject generation would be approximately 1,800 gallons per day (gpd) when the system is operated at the average daily consumption (0.006 mgd).

This alternative consists of constructing the RO treatment plant near the existing well. The plant is composed of a 200 square foot building with a paved driveway; a skid with the pre-constructed RO plant; transfer pumps, a 3,000-gallon tank for storing the treated water, and a 55,000-gallon pond for storing reject water. 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 $329,900, and the estimated annual O&M cost is $36,700.

The reliability of adequate amount of compliant water under this alternative is good, since RO treatment is a common and well-understood treatment technology. However, O&M efforts required for the central RO treatment plant may be significant, and O&M personnel would require training with RO. The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.8 Alternative LO-8: Central WRT Z-88 Treatment

The system would continue to pump water from the Live Oak Hills Subdivision well, and would treat the water through the WRT Z-88 adsorption system prior to distribution. The full flow of raw water would be treated by the WRT Z-88 system as the media specifically adsorb radium and do not affect other constituents. There is no liquid waste generated in this process. The Z-88 media would be replaced and disposed by WRT in an approved low-level radioactive waste landfill after 2-3 years of operation.

This alternative consists of installing the WRT Z-88 treatment system near the existing Live Oak Hills Subdivision well. WRT owns the Z-88 equipment and the Subdivision would pay for construction for the treatment unit and auxiliary facilities. The plant is composed of a 180 square foot building with a paved driveway; the pre-fabricated Z-88 adsorption system owned by WRT; and piping system. The entire facility would be fenced. The treated water would be chlorinated prior to distribution. It is assumed the well pumps would have adequate pressure to pump the water through the Z-88 system to the ground storage tanks without requiring new pumps.

The estimated capital cost for this alternative is $191,000, and the estimated annual O&M cost is $29,800.

Based on many pilot testing results and some full-scale plant data, this technology appears to be reliable. It is very simple to operate and the media replacement and disposal would be handled by WRT. Because WRT owns the equipment, the capital cost is relatively low. The main operating cost would be WRT's fee for the treated water. One concern with this technology is the potential health effect on O&M personnel because of the level of radioactivity accumulated in the Z-88 vessel after the media have been operating for a long time.

4.5.9 Alternative LO-9: Point-of-Use Treatment

This alternative consists of the continued operation of the Live Oak Hills Subdivision well field, plus treatment of water to be used for drinking or food preparation at the point of use to remove combined radium and gross alpha. 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 case.

This alternative would require installing the POU treatment units in residences and other buildings that provide drinking or cooking water. Live Oak Hills staff would be responsible for purchase and maintenance of the treatment units, including membrane and filter replacement, periodic sampling, and necessary repairs. In houses, 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 will require the entry of Live Oak Hills or contract personnel into the houses of customers. As a result, cooperation of customers would be important for success implementing this alternative. The treatment units could be installed for access without house entry, but that would complicate the installation and increase costs.

Treatment processes would involve RO. Treatment processes produce a reject waste stream. The reject waste streams result in a slight increase in the overall volume of water used. POU systems have the advantage that only a minimum volume of water is treated (only that for human consumption). This minimizes the size of the treatment units, the increase in water required, and the waste for disposal. For this alternative, it is assumed the increase in water consumption is insignificant in terms of supply cost, and that the reject 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 POU treatment systems. The estimated O&M cost for this alternative includes the purchase and replacement of filters and membranes, as well as periodic sampling and record keeping as required by the Texas Administrative Code (Title 30, Part I, Chapter 290, Subchapter F, Rule 290.106). The estimated capital cost for this alternative is $39,400, and the estimated annual O&M cost for this alternative is $25,900. For the cost estimate, it is assumed that one POU treatment unit will be required for each of the 31 connections in the Live Oak Hills system. It should be noted that the POU treatment units would need to be more complex than units typically found in commercial retail outlets to meet regulatory requirements, making purchase and installation more expensive. Additionally, capital cost would increase if POU treatment units are placed at other taps within a home, such as refrigerator water dispensers, ice makers, and bathroom sinks. In school settings, all taps where children and faculty receive water may need POU treatment units or clearly mark those taps suitable for human consumption. Additional considerations may be necessary for preschools or other establishments where individuals cannot read.

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 house. Additionally, the O&M efforts (including monitoring of the devices to ensure adequate performance) required for the POU systems will be significant, and the current personnel are inexperienced in this type of work. From the perspective of the Live Oak Hills PWS, this alternative would be characterized as more difficult to operate owing 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.

4.5.10 Alternative LO-10: Point-of-Entry Treatment

This alternative consists of the continued operation of the Live Oak Hills well field, plus treatment of water as it enters residences to remove combined radium and gross alpha. The purchase, installation, and maintenance of the treatment systems at the point of entry to a household would be necessary for this alternative. Blending is not an option in this case.

This alternative would require the installation of the POE treatment units at houses and other buildings that provide drinking or cooking water. Every building connected to the system must have a POE device installed, maintained, and adequately monitored. TCEQ must be assured the system has 100 percent participation of all property and or building owners. A way to achieve 100 percent participation is through a public announcement and education program. Example public programs are provided in the document "*Point-of-Use or Point-of-Entry" Treatment Options for Small Drinking Water Systems*" published by USEPA. The property owner's responsibilities for the POE device must also be contained in the title to the property and "run with the land" so subsequent property owners understand their responsibilities (USEPA 2006).

Live Oak Hills would be responsible for purchase, operation, and maintenance of the treatment units, including membrane and filter replacement, periodic sampling, and necessary repairs. It may also be desirable to modify piping so water for non-consumptive uses can be withdrawn upstream of the treatment unit. The POE treatment units would be installed outside the residences, so entry would not be necessary for O&M. Some cooperation from customers would be necessary for installation and maintenance of the treatment systems.

POE treatment for combined radium and gross alpha would involve RO. Treatment processes produce a reject stream that requires disposal. The reject water stream results in a slight increase in overall volume of water used. POE systems treat a greater volume of water than POU systems. For this alternative, it is assumed the increase in water consumption is insignificant in terms of supply cost, and that the backwash reject 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 membranes, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $471,900, and the estimated annual O&M cost for this alternative is $66,500. For the cost estimate, it is assumed that one POE treatment unit will be required for each of the 31 existing connections to the Live Oak Hills 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 will be significant, and the current personnel are inexperienced in this type of work. From the perspective of the Live Oak Hills PWS, this alternative would be characterized as more difficult to operate owing 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.

4.5.11 Alternative LO-11: Public Dispenser for Treated Drinking Water

This alternative consists of the continued operation of the Live Oak Hills Subdivision 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 and 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 case. It should be noted that this alternative would be considered an interim measure until a compliance alternative is implemented.

Live Oak Hills personnel would be responsible for maintenance of the treatment unit, including media or membrane replacement, periodic sampling, and necessary repairs. The spent media or membranes will 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 or membranes, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $17,800, and the estimated annual O&M cost for this alternative is $34,600.

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. Live Oak Hills Subdivision PWS has not provided this type of service in the past. From Live Oak Hills' perspective 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.

4.5.12 Alternative LO-12: 100 Percent Bottled Water Delivery

This alternative consists of the continued operation of the Live Oak Hills Subdivision wells, but compliant drinking water will be delivered to customers in containers. This alternative involves setting up and operating a bottled water delivery program to serve all customers in the system. It is expected that Live Oak Hills would find it most convenient and economical to contract a bottled water service. The bottle delivery program would have to be flexible enough to allow the delivery of smaller containers should customers be incapable of lifting and manipulating 5-gallon bottles. Blending is not an option in this case. 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 cost for construction, but would require some initial costs for system setup, and then ongoing costs to have the bottled water furnished. It is assumed for this alternative that bottled water is provided to 100 percent of the Live Oak Hills Subdivision PWS 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 $27,000, and the estimated annual O&M cost for this alternative is $66,900. For the cost estimate, it is assumed that each person requires one 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 will require attention from Live Oak Hills.

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

4.5.13 Alternative LO-13: Public Dispenser for Trucked Drinking Water

This alternative consists of continued operation of the Live Oak Hills Subdivision wells, plus dispensing compliant water for drinking and cooking at a publicly accessible location. The compliant water would be purchased from the City of Richland Springs, 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 requires treatment, but customers are required to pick up and deliver their own water. Blending is not an option in this case. It should be noted that this alternative would be considered an interim measure until a compliance alternative is implemented.

Live Oak Hills would purchase a truck 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 have 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 construction of the 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 $127,700, and the estimated annual O&M cost for this alternative is $40,100.

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. Current personnel have not provided this type of service in the past. From the perspective of Live Oak Hills, this alternative would be characterized as relatively easy to operate, but the 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.

4.5.14 Summary of Alternatives

Table 4.3 provides a summary of the key features of each alternative for Live Oak Hills PWS.

1 **Table 4.3 Summary of Compliance Alternatives for Live Oak Hills PWS**

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
LO-1	New well Lohn WSC	- New well - 1 pump station / feed tank - 23.8-mile pipeline	$4,650,800	$36,900	$442,400	Good	N	Agreement must be successfully negotiated with Lohn WSC, or land must be purchased. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
LO-2	New well at Richland Springs	- New well - 2 pump stations / feed tanks - 33-mile pipeline	$5,595,400	$59,800	$547,600	Good	N	Agreement must be successfully negotiated with Richland Springs, or land must be purchased. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
LO-3	Purchase water from Richland Springs SUD	- 2 pump stations / feed tanks - 34.8-mile pipeline	$5,733,600	$48,000	$547,900	Good	N	Agreement must be successfully negotiated with Richland Springs SUD. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
LO-4	Install new compliant well within 10 miles	- New well - Pump station / feed tank - 10-mile pipeline	$2,009,300	$28,500	$203,700	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
LO-5	Install new compliant well within 5 miles	- New well - Pump station / feed tank - 5-mile pipeline	$1,167,500	$26,900	$128,700	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
LO-6	Install new compliant well within 1 mile	- New well - 1-mile pipeline	$418,500	$300	$36,800	Good	N	May be difficult to find well with good water quality.
LO-7	Continue operation of Live Oak Hills well field with central RO treatment	- Central RO treatment plant	$329,900	$36,700	$65,500	Good	T	Costs could possibly be shared with nearby small systems.
LO-8	Continue operation of Live Oak Hills well field with central WRT Z-88 treatment	- Central WRT Z-88 treatment plant	$191,000	$29,800	$46,500	Good	T	Costs could possibly be shared with nearby small systems.
LO-9	Continue operation of Live Oak Hills r well field, and POU treatment	- POU treatment units.	$39,400	$25,900	$29,300	Fair	T, M	Only one compliant tap in home. Cooperation of residents required for installation, maintenance, and testing.
LO-10	Continue operation of Live Oak Hills well field, and POE treatment	- POE treatment units.	$471,900	$66,500	$107,600	Fair (*better than POU*)	T, M	All home taps compliant and less resident cooperation required.

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
LO-11	Continue operation of Live Oak Hills well field, but furnish public dispenser for treated drinking water	- Water treatment and dispenser unit	$17,800	$34,600	$36,200	Fair/interim measure	T	Does not provide compliant water to all taps, and requires a lot of effort by customers.
LO-12	Continue operation of Live Oak Hills well field, but furnish bottled drinking water for all customers	- Set up bottled water system	$27,000	$66,900	$69,300	Fair/interim measure	M	Does not provide compliant water to all taps, and requires customers to order and use. Management of program may be significant.
LO-13	Continue operation of Live Oak Hills well field, but furnish public dispenser for trucked drinking water.	- Construct storage tank and dispenser - Purchase potable water truck	$127,700	$40,100	$51,200	Fair/interim measure	M	Does not provide compliant water to all taps, and requires a lot of 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 the 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. Live Oak Hills is a mobile home park with 31 connections, serving a population of approximately 93. Information that was used to complete the financial analysis was based on available financial information that included actual revenues and expenses and water usage records from a Water and Wastewater Utilities Annual Report for Live Oak Hills Water System submitted to TCEQ for Calendar Year December 31, 2007. Annual water usage for the Live Oak Hills was reported to be 2 million gallons.

This analysis will need to be performed in a more detailed fashion and applied to alternatives deemed attractive and worthy of more detailed evaluation. A more detailed analysis should include additional factors such as:

- Cost escalation,
- Price elasticity effects where increased rates may result in lower water consumption,
- Costs for other system upgrades and rehabilitation needed to maintain compliant operation.

4.6. 1 Live Oak Hills Subdivision Financial Data

According to the available financial reports, annual operating revenue was $14,575 for 2007, as well other non-operating revenue. This value was entered into the financial model, along with the 2007 expenditures of $14,031.

4.6. 2 Current Financial Condition

4.6. 2.1 Cash Flow Needs

Based on the 2007 annual revenue, the current average annual water bill was estimated to be $470, or 1.9 percent of the annual household income of $25,347. A review of the actual water revenues and the actual operating expenses for the Live Oak Hills PWS suggest that revenues are adequate to sustain operations, but may not be sufficient to fund reserve accounts or capital improvements. Revenues exceed operating expenses exceed by $594.

4.6. 2.2 Ratio Analysis

Financial data were not obtained for assets and liabilities, so the current ratio and debt to net worth ratio could not be calculated.

Current Ratio

The Current Ratio for the Live Oak Hills water system 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 = 1.04

The Operating Ratio is a financial term defined as a company's revenues divided by the operating expenses. An operating ratio of 1.0 means that a utility is collecting just enough money to meet expenses. In general, an operating ratio of 1.25 or higher is desirable. Based on expenditure estimates, the system's operating revenue of approximately $14,575 exceeds operating expenditures, with a resulting operating ratio of 1.04, indicating revenues are sufficient the current level of expenses, but may not be sufficient for funding reserve accounts.

4.6.3 Financial Plan Results

Each compliance alternative for the Live Oak Hills 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.

Results of the financial impact analysis are provided in Table 4.4 and Figure 4.2. Table 4.4 and Figure 4.2 present rate impacts assuming that revenues match expenses, without funding reserve accounts, and that operations and implementation of compliance alternatives are funded with revenue and are not paid for from reserve accounts. Figure 4.2 provides a bar chart that, in terms of the yearly billing to an average customer, shows the following:

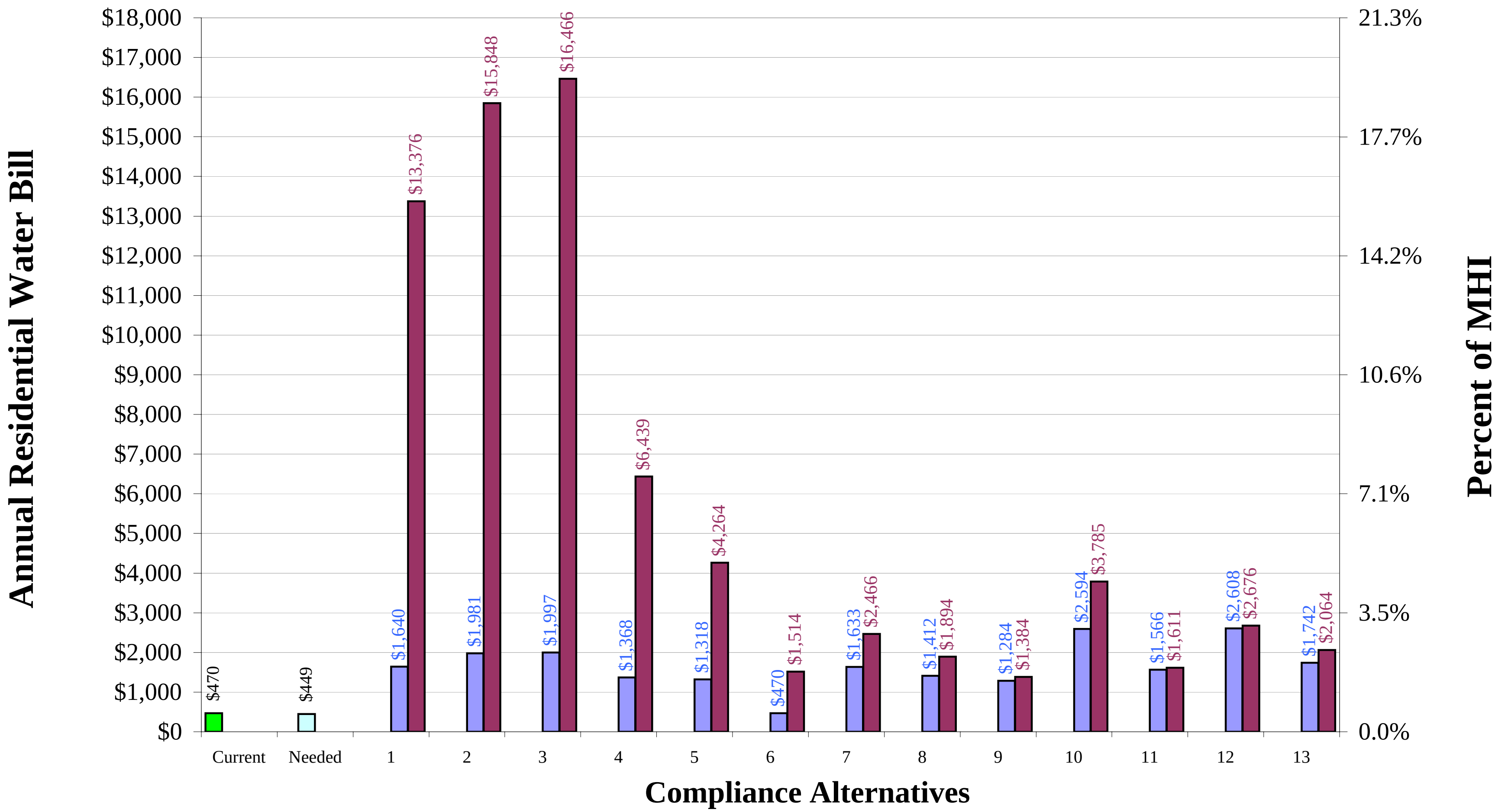
- Current annual average bill,
- Projected annual average bill including rate increase, if needed, to match existing expenditures, and
- Projected annual bill including rate increases needed to fund implementation of a compliance alternative (this does not include funding for reserve accounts).

Live Oak Hills Subdivision

Table 4.4 Financial Impact on Households

Alternative	Description		All Revenue	100% Grant	75% Grant	50% Grant	SRF	Bond
1	New Well at Lohn WSC	Maximum % of MHI	593.7%	6.5%	18.1%	29.6%	36.1%	52.8%
		Percentage Rate Increase Compared to Current	31904%	249%	873%	1497%	1845%	2745%
		Average Annual Water Bill	$150,478	$1,642	$4,576	$7,510	$9,143	$13,378
2	Purchase Water from Richland Springs	Maximum % of MHI	701.1%	7.8%	21.5%	35.2%	42.8%	62.5%
		Percentage Rate Increase Compared to Current	37697%	322%	1059%	1796%	2207%	3271%
		Average Annual Water Bill	$177,717	$1,982	$5,449	$8,916	$10,846	$15,849
3	Purchase Water from Richland Special Utility District	Maximum % of MHI	731.5%	7.9%	22.2%	36.4%	44.4%	65.0%
		Percentage Rate Increase Compared to Current	39332%	325%	1094%	1864%	2292%	3402%
		Average Annual Water Bill	$185,405	$1,999	$5,616	$9,233	$11,247	$16,467
4	New Well at 10 Miles	Maximum % of MHI	257.5%	5.4%	10.4%	15.4%	18.2%	25.4%
		Percentage Rate Increase Compared to Current	13781%	191%	461%	731%	881%	1270%
		Average Annual Water Bill	$65,267	$1,370	$2,638	$3,905	$4,611	$6,440
5	New Well at 5 Miles	Maximum % of MHI	150.4%	5.2%	8.1%	11.0%	12.6%	16.8%
		Percentage Rate Increase Compared to Current	8006%	181%	337%	494%	581%	807%
		Average Annual Water Bill	$38,112	$1,320	$2,057	$2,793	$3,203	$4,266
6	New Well at 1 Mile	Maximum % of MHI	55.0%	1.9%	2.9%	3.9%	4.5%	6.0%
		Percentage Rate Increase Compared to Current	2867%	0%	54%	110%	141%	222%
		Average Annual Water Bill	$13,949	$470	$724	$988	$1,135	$1,516
7	Central Treatment - RO	Maximum % of MHI	43.8%	6.5%	7.3%	8.1%	8.5%	9.7%
		Percentage Rate Increase Compared to Current	2259%	248%	292%	336%	361%	425%
		Average Annual Water Bill	$11,091	$1,635	$1,843	$2,051	$2,167	$2,467
8	Central Treatment - WRT Z-88	Maximum % of MHI	26.1%	5.6%	6.1%	6.5%	6.8%	7.5%
		Percentage Rate Increase Compared to Current	1306%	201%	226%	252%	266%	303%
		Average Annual Water Bill	$6,613	$1,414	$1,534	$1,655	$1,722	$1,896
9	Point-of-Use Treatment	Maximum % of MHI	6.8%	5.1%	5.2%	5.3%	5.3%	5.5%
		Percentage Rate Increase Compared to Current	266%	174%	179%	184%	187%	195%
		Average Annual Water Bill	$1,722	$1,286	$1,311	$1,336	$1,350	$1,385
10	Point-of-Entry Treatment	Maximum % of MHI	61.8%	10.2%	11.4%	12.6%	13.2%	14.9%
		Percentage Rate Increase Compared to Current	3233%	452%	515%	579%	614%	705%
		Average Annual Water Bill	$15,672	$2,596	$2,894	$3,191	$3,357	$3,787
11	Public Dispenser for Treated Drinking Water	Maximum % of MHI	6.2%	6.2%	6.2%	6.3%	6.3%	6.4%
		Percentage Rate Increase Compared to Current	233%	233%	236%	238%	239%	243%
		Average Annual Water Bill	$1,567	$1,567	$1,579	$1,590	$1,596	$1,612
12	Supply Bottled Water to 100% of Population	Maximum % of MHI	10.3%	10.3%	10.4%	10.4%	10.5%	10.6%
		Percentage Rate Increase Compared to Current	455%	455%	459%	462%	464%	470%
		Average Annual Water Bill	$2,610	$2,610	$2,627	$2,644	$2,653	$2,678
13	Central Trucked Drinking Water	Maximum % of MHI	18.0%	6.9%	7.2%	7.5%	7.7%	8.1%
		Percentage Rate Increase Compared to Current	872%	271%	288%	305%	315%	339%
		Average Annual Water Bill	$4,571	$1,743	$1,824	$1,904	$1,949	$2,065

Figure 4.2
Alternative Cost Summary: Live Oak Hills Subdivision



Current Average Monthly Bill = $39.18
Mediuan Household Income = $25347
Average Monthly Residential Usage = 5397 gallons

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.

4.6.4 Evaluation of Potential Funding Options

There are limited funding programs available to entities as described in Section 2.4. Live Oak Hills PWS is most likely to obtain funding from programs administered by the TWDB. This report contains information that would be used for an application for funding. Information such as financial analyses, water supply assessment, and records demonstrating health concerns, failing infrastructure, and financial need, may be required by these agencies. This section describes the candidate funding agencies and their appropriate programs as well as information and steps needed to begin the application process.

This report should serve to document the existing water quality issues, infrastructure need and costs, and water system information needed to begin the application process with the TWDB. Although this report is at the conceptual level, it demonstrates that significant funding will be needed to meet Safe Drinking Water Standards. The information provided in this report may serve as the needed documentation to justify a project that may only be possible with significant financial assistance.

The program most available to the privately owned system is the Drinking Water State Revolving Fund. The DWSRF offers net long-term interest lending rates below the rate the borrower would receive on the open market for a period of 20 years. Because the Live Oak Hills PWS is a “disadvantaged community,” it can receive a 30-year loan term. A cost-recovery loan origination charge is imposed to cover the administrative costs of operating the DWSRF, but an additional interest rate subsidy is offered to offset the charge. The terms of the loan typically require a revenue or tax pledge. Depending on how the origination charge is handled, interest rates can be as low as 0.95 percent below market rates with the possibility of additional federal subsidies for total interest rates 1.95 percent below market rates. Disadvantaged communities may obtain loans at interest rates between 0 percent and 1 percent.

The loan application process has several steps: pre-application, application and commitment, loan closing, funding and construction monitoring, and any other special requirements. In the pre-application phase, prospective loan applicants are asked to submit a brief DWSRF Information Form to the TWDB that describes the applicant’s existing water facilities, additional facility needs and the nature of projects being considered for meeting those needs, project cost estimates, and “disadvantaged community” status. The TCEQ assigns a priority rating that includes an applicant’s readiness to proceed. TWDB staff notify prospective applicants of their priority rating and encourage them to schedule a pre-planning conference for guidance in preparing the engineering, planning, environmental, financial, and water conservation portions of the DWSRF application.

Additional information can be found online at the TWDB website under the Assistance tab, Financial Assistance section, Public Works Infrastructure Construction subsection, and under the links "Clean Water State Revolving Fund Loan Program."

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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 2008 RS Means Site Work & Landscape 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 that gate valves and flush valves would be installed, on average, every 5,000 feet along the pipeline. Pipeline cost estimates are based on the 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. The number of pump stations is based on calculations of pressure losses in the proposed pipeline for each alternative. Back-flow prevention is required in cases where pressure losses are negligible, and pump stations are not needed. Construction cost of a storage tank is based on consultations with vendors and 2007 RS Means Site Work & Landscape Cost Data.

Labor costs are estimated based on 2008 RS Means Site Work & Landscape Cost Data specific to the Taylor County region.

Electrical power cost is estimated to be $0.165 per kWH, as supplied by Caprock Energy Co. 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 2008 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 2008 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 2008 dollars based on the ENR construction cost index.

The purchase price for point-of-use (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 point-of-entry (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 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 a 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 each week, and that chlorine residual would be determined for each truck load.

Table B.1
Summary of General Data
Live Oak Hills Subdivision
1540012
General PWS Information

Service Population	93	**Number of Connections**	31
Total PWS Daily Water Usage	0.006 (mgd)	**Source**	Site visit list

Unit Cost Data

General Items	**Unit**	**Unit Cost**
Treated water purchase cost	*See alternative*	
Water purchase cost (trucked)	$/1,000 gals	$ 11.26
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	$ 12
Bore and encasement, 10"	LF	$ 240
Open cut and encasement, 10"	LF	$ 130
Gate valve and box, 04"	EA	$ 710
Air valve	EA	$ 2,050
Flush valve	EA	$ 1,025
Metal detectable tape	LF	$ 2.00
Bore and encasement, length	Feet	200
Open cut and encasement, length	Feet	50
Pump Station Unit Costs	**Unit**	**Unit Cost**
Pump	EA	$ 8,000
Pump Station Piping, 04"	EA	$ 550
Gate valve, 04"	EA	$ 710
Check valve, 04"	EA	$ 755
Electrical/Instrumentation	EA	$ 10,250
Site work	EA	$ 2,560
Building pad	EA	$ 5,125
Pump Building	EA	$ 10,250
Fence	EA	$ 6,150
Tools	EA	$ 1,025
5,000 gal feed tank	EA	$ 10,000
Backflow preventer, 4"	EA	$ 2,295
Backflow Testing/Certification	EA	$ 105
Well Installation Unit Costs	**Unit**	**Unit Cost**
Well installation	*See alternative*	
Water quality testing	EA	$ 1,280
25 HP Well Pump	EA	$ 7,550
Well electrical/instrumentation	EA	$ 5,635
Well cover and base	EA	$ 3,075
Piping	EA	$ 3,075
5,000 gal ground storage tank	EA	$ 10,000
Electrical Power	$/kWH	$ 0.165
Building Power	kWH	11,800
Labor	$/hr	$ 60
Materials	EA	$ 1,540
Transmission main O&M	$/mile	$ 275
Tank O&M	EA	$ 1,025
POU/POE Unit Costs		
POU treatment unit purchase	EA	$ 615
POU treatment unit installation	EA	$ 155
POE treatment unit purchase	EA	$ 5,125
POE - pad and shed, per unit	EA	$ 2,050
POE - piping connection, per unit	EA	$ 1,025
POE - electrical hook-up, per unit	EA	$ 1,025
POU Treatment O&M, per unit	$/year	$ 230
POE Treatment O&M, per unit	$/year	$ 1,540
Treatment analysis	$/year	$ 205
POU/POE labor support	$/hr	$ 40
Dispenser/Bottled Water Unit Costs		
POE-Treatment unit purchase	EA	$ 7,175
POE-Treatment unit installation	EA	$ 5,125
Treatment unit O&M	EA	$ 2,050
Administrative labor	hr	$ 45
Bottled water cost (inc. delivery)	gallon	$ 1.20
Water use, per capita per day	gpcd	1.0
Bottled water program materials	EA	$ 5,125
5,000 gal ground storage tank	EA	$ 10,000
Site improvements	EA	$ 3,075
Potable water truck	EA	$ 75,000
Water analysis, per sample	EA	$ 205
Potable water truck O&M costs	$/mile	$ 3.00

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	$ 7.00
Fence	LF	$ 15
Paving	SF	$ 2.00
General O&M		
Building power	kwh/yr	$ 0.165
Equipment power	kwh/yr	$ 0.165
Labor, O&M	hr	$ 40
Analyses	test	$ 200
Reject Pond		
Reject pond, excavation	CYD	$ 3
Reject pond, compacted fill	CYD	$ 7
Reject pond, lining	SF	$ 1.50
Reject pond, vegetation	SY	$ 1.50
Reject pond, access road	LF	$ 30
Reject water haulage truck	EA	$ 100,000
Reverse Osmosis		
Electrical	JOB	$ 30,000
Piping	JOB	$ 16,000
RO package plant	UNIT	$ 48,000
Transfer pumps (3 hp)	EA	$ 3,000
Permeate tank	gal	$ 3
RO materials and chemicals	kgal	$ 0.75
RO chemicals	year	$ 2,000
Backwash disposal mileage cost	miles	$ 1.50
Backwash disposal fee	1,000 gal/yr	$ 5.00
WRT Z-88 package		
Electrical	JOB	$ 25,000
Piping	JOB	$ 14,000
WRT Z-88 package plant	UNIT	$ 58,000
(Initial setup *cost for WRT Z-88 package*)		
WRT treated water charge Well No.1	1,000 gal/yr	$ 4.75

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.13. 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	***Live Oak Hills Subdivision***
Alternative Name	***New Well at Lohn WSC***
Alternative Number	***LO-1***

Distance from PWS to new well location	23.8	miles
Estimated well depth	2746	feet
Number of wells required	1	
Well installation cost (location specific)	$143	per foot
Pump Stations needed w/ 1 feed tank each	1	
On site storage tanks / pump sets needed	0	

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	66	n/a	n/a	n/a
PVC water line, Class 200, 04"	125,607	LF	$ 12.00	$ 1,507,284
Bore and encasement, 10"	1,800	LF	$ 240.00	$ 432,000
Open cut and encasement, 10"	3,300	LF	$ 130.00	$ 429,000
Gate valve and box, 04"	25	EA	$ 710.00	$ 17,836
Air valve	31	EA	$ 2,050.00	$ 63,550
Flush valve	25	EA	$ 1,025.00	$ 25,749
Metal detectable tape	125,607	LF	$ 2.00	$ 251,214
Subtotal				**$ 2,726,634**
Pump Station(s) Installation				
Pump	2	EA	$ 8,000	$ 16,000
Pump Station Piping, 04"	1	EA	$ 550	$ 550
Gate valve, 04"	4	EA	$ 710	$ 2,840
Check valve, 04"	2	EA	$ 755	$ 1,510
Electrical/Instrumentation	1	EA	$ 10,250	$ 10,250
Site work	1	EA	$ 2,560	$ 2,560
Building pad	1	EA	$ 5,125	$ 5,125
Pump Building	1	EA	$ 10,250	$ 10,250
Fence	1	EA	$ 6,150	$ 6,150
Tools	1	EA	$ 1,025	$ 1,025
5,000 gal feed tank	1	EA	$ 10,000	$ 10,000
5,000 gal ground storage tank	-	EA	$ 10,000	$ -
Backflow Preventor	0	EA	$ 2,295	$ -
Subtotal				**$ 66,260**
Well Installation				
Well installation	2,746	LF	$ 143	$ 392,678
Water quality testing	2	EA	$ 1,280	$ 2,560
Well pump	1	EA	$ 7,550	$ 7,550
Well electrical/instrumentation	1	EA	$ 5,635	$ 5,635
Well cover and base	1	EA	$ 3,075	$ 3,075
Piping	1	EA	$ 3,075	$ 3,075
Subtotal				**$ 414,573**
Subtotal of Component Costs				**$ 3,207,467**
Contingency	20%			$ 641,493
Design & Constr Management	25%			$ 801,867
TOTAL CAPITAL COSTS				**$ 4,650,827**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	23.8	mile	$ 275	$ 6,542
Subtotal				**$ 6,542**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.165	$ 1,948
Pump Power	3,131	kWH	$ 0.165	$ 517
Materials	1	EA	$ 1,540	$ 1,540
Labor	365	Hrs	$ 60.00	$ 21,900
Tank O&M	1	EA	$ 1,025	$ 1,025
Backflow Cert/Test	0	EA	$ 105	$ -
Subtotal				**$ 26,930**
Well O&M				
Pump power	40,725	kWH	$ 0.165	$ 6,724
Well O&M matl	1	EA	$ 1,540	$ 1,540
Well O&M labor	180	Hrs	$ 60	$ 10,800
Subtotal				**$ 19,064**
O&M Credit for Existing Well Closure				
Pump power	19,900	kWH	$ 0.165	$ (3,285)
Well O&M matl	1	EA	$ 1,540	$ (1,540)
Well O&M labor	180	Hrs	$ 60	$ (10,800)
Subtotal				**$ (15,625)**
TOTAL ANNUAL O&M COSTS				**$ 36,910**

Table C.2

PWS Name	***Live Oak Hills Subdivision***
Alternative Name	***New Well at Richland Springs***
Alternative Number	***LO-2***

Distance from PWS to new well location	33.0	miles
Estimated well depth	330	feet
Number of wells required	1	
Well installation cost (location specific)	$143	per foot
Pump Stations needed w/ 1 feed tank each	2	
On site storage tanks / pump sets needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	15	n/a	n/a	n/a
Number of Crossings, open cut	54	n/a	n/a	n/a
PVC water line, Class 200, 04"	174,266	LF	$ 12.00	$ 2,091,192
Bore and encasement, 10"	3,000	LF	$ 240.00	$ 720,000
Open cut and encasement, 10"	2,700	LF	$ 130.00	$ 351,000
Gate valve and box, 04"	35	EA	$ 710.00	$ 24,746
Air valve	42	EA	$ 2,050.00	$ 86,100
Flush valve	35	EA	$ 1,025.00	$ 35,725
Metal detectable tape	174,266	LF	$ 2.00	$ 348,532
Subtotal				**$ 3,657,294**
Pump Station(s) Installation				
Pump	4	EA	$ 8,000	$ 32,000
Pump Station Piping, 04"	2	EA	$ 550	$ 1,100
Gate valve, 04"	8	EA	$ 710	$ 5,680
Check valve, 04"	4	EA	$ 755	$ 3,020
Electrical/Instrumentation	2	EA	$ 10,250	$ 20,500
Site work	2	EA	$ 2,560	$ 5,120
Building pad	2	EA	$ 5,125	$ 10,250
Pump Building	2	EA	$ 10,250	$ 20,500
Fence	2	EA	$ 6,150	$ 12,300
Tools	2	EA	$ 1,025	$ 2,050
5,000 gal feed tank	2	EA	$ 10,000	$ 20,000
5,000 gal ground storage tank	-	EA	$ 10,000	$ -
Backflow Preventor	0	EA	$ 2,295	$ -
Subtotal				**$ 132,520**
Well Installation				
Well installation	330	LF	$ 143	$ 47,190
Water quality testing	2	EA	$ 1,280	$ 2,560
Well pump	1	EA	$ 7,550	$ 7,550
Well electrical/instrumentation	1	EA	$ 5,635	$ 5,635
Well cover and base	1	EA	$ 3,075	$ 3,075
Piping	1	EA	$ 3,075	$ 3,075
Subtotal				**$ 69,085**

Subtotal of Component Costs		**$ 3,858,899**
Contingency	20%	$ 771,780
Design & Constr Management	25%	$ 964,725
TOTAL CAPITAL COSTS		**$ 5,595,404**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	33.0	mile	$ 275	$ 9,076
Subtotal				**$ 9,076**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.165	$ 3,896
Pump Power	7,213	kWH	$ 0.165	$ 1,191
Materials	2	EA	$ 1,540	$ 3,080
Labor	730	Hrs	$ 60.00	$ 43,800
Tank O&M	2	EA	$ 1,025	$ 2,050
Backflow Cert/Test	0	EA	$ 105	$ -
Subtotal				**$ 54,017**
Well O&M				
Pump power	-	kWH	$ 0.165	$ -
Well O&M matl	1	EA	$ 1,540	$ 1,540
Well O&M labor	180	Hrs	$ 60	$ 10,800
Subtotal				**$ 12,340**
O&M Credit for Existing Well Closure				
Pump power	19,900	kWH	$ 0.165	$ (3,285)
Well O&M matl	1	EA	$ 1,540	$ (1,540)
Well O&M labor	180	Hrs	$ 60	$ (10,800)
Subtotal				**$ (15,625)**
TOTAL ANNUAL O&M COSTS				**$ 59,808**

Table C.3

PWS Name	***Live Oak Hills Subdivision***
Alternative Name	***Purchase Water from Richland Special Utility District***
Alternative Number	***LO-3***

Distance from PWS to new well location	34.8	miles
Estimated well depth	304	feet
Number of wells required	0	
Well installation cost (location specific)	$143	per foot
Pump Stations needed w/ 1 feed tank each	2	
On site storage tanks / pump sets needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	16	n/a	n/a	n/a
Number of Crossings, open cut	49	n/a	n/a	n/a
PVC water line, Class 200, 04"	183,928	LF	$ 12.00	$ 2,207,136
Bore and encasement, 10"	3,200	LF	$ 240.00	$ 768,000
Open cut and encasement, 10"	2,450	LF	$ 130.00	$ 318,500
Gate valve and box, 04"	37	EA	$ 710.00	$ 26,118
Air valve	47	EA	$ 2,050.00	$ 96,350
Flush valve	37	EA	$ 1,025.00	$ 37,705
Metal detectable tape	183,928	LF	$ 2.00	$ 367,856
Subtotal				**$ 3,821,665**
Pump Station(s) Installation				
Pump	4	EA	$ 8,000	$ 32,000
Pump Station Piping, 04"	2	EA	$ 550	$ 1,100
Gate valve, 04"	8	EA	$ 710	$ 5,680
Check valve, 04"	4	EA	$ 755	$ 3,020
Electrical/Instrumentation	2	EA	$ 10,250	$ 20,500
Site work	2	EA	$ 2,560	$ 5,120
Building pad	2	EA	$ 5,125	$ 10,250
Pump Building	2	EA	$ 10,250	$ 20,500
Fence	2	EA	$ 6,150	$ 12,300
Tools	2	EA	$ 1,025	$ 2,050
5,000 gal feed tank	2	EA	$ 10,000	$ 20,000
5,000 gal ground storage tank	-	EA	$ 10,000	$ -
Backflow Preventor	0	EA	$ 2,295	$ -
Subtotal				**$ 132,520**
Well Installation				
Well installation	-	LF	$ 143	$ -
Water quality testing	-	EA	$ 1,280	$ -
Well pump	-	EA	$ 7,550	$ -
Well electrical/instrumentation	-	EA	$ 5,635	$ -
Well cover and base	-	EA	$ 3,075	$ -
Piping	-	EA	$ 3,075	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 3,954,185**
Contingency	20%			$ 790,837
Design & Constr Management	25%			$ 988,546
TOTAL CAPITAL COSTS				**$ 5,733,568**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	34.8	mile	$ 275	$ 9,580
Subtotal				**$ 9,580**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.165	$ 3,896
Pump Power	7,294	kWH	$ 0.165	$ 1,204
Materials	2	EA	$ 1,540	$ 3,080
Labor	730	Hrs	$ 60.00	$ 43,800
Tank O&M	2	EA	$ 1,025	$ 2,050
Backflow Test/Cert	-	EA	$ 105	$ -
Subtotal				**$ 54,031**
Well O&M				$ -
Pump power	-	kWH	$ 0.165	$ -
Well O&M matl	-	EA	$ 1,540	$ -
Well O&M labor	-	Hrs	$ 60	**$ -**
Subtotal				
O&M Credit for Existing Well Closure				
Pump power	19,900	kWH	$ 0.165	$ (3,285)
Well O&M matl	1	EA	$ 1,540	$ (1,540)
Well O&M labor	180	Hrs	$ 60	$ (10,800)
Subtotal				**$ (15,625)**
TOTAL ANNUAL O&M COSTS				**$ 47,985**

Table C.4

PWS Name *Live Oak Hills Subdivision*
Alternative Name *New Well at 10 Miles*
Alternative Number *LO-4*

Distance from PWS to new well location	10.0	miles
Estimated well depth	1230	feet
Number of wells required	1	
Well installation cost (location specific)	$143	per foot
Pump Stations needed w/ 1 feed tank each	1	
On site storage tanks / pump sets needed	0	

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	15	n/a	n/a	n/a
PVC water line, Class 200, 04"	52,800	LF	$ 12.00	$ 633,600
Bore and encasement, 10"	1,000	LF	$ 240.00	$ 240,000
Open cut and encasement, 10"	750	LF	$ 130.00	$ 97,500
Gate valve and box, 04"	11	EA	$ 710.00	$ 7,498
Air valve	13	EA	$ 2,050.00	$ 26,650
Flush valve	11	EA	$ 1,025.00	$ 10,824
Metal detectable tape	52,800	LF	$ 2.00	$ 105,600
Subtotal				**$ 1,121,672**
Pump Station(s) Installation				
Pump	2	EA	$ 8,000	$ 16,000
Pump Station Piping, 04"	1	EA	$ 550	$ 550
Gate valve, 04"	4	EA	$ 710	$ 2,840
Check valve, 04"	2	EA	$ 755	$ 1,510
Electrical/Instrumentation	1	EA	$ 10,250	$ 10,250
Site work	1	EA	$ 2,560	$ 2,560
Building pad	1	EA	$ 5,125	$ 5,125
Pump Building	1	EA	$ 10,250	$ 10,250
Fence	1	EA	$ 6,150	$ 6,150
Tools	1	EA	$ 1,025	$ 1,025
5,000 gal feed tank	1	EA	$ 10,000	$ 10,000
5,000 gal ground storage tank	-	EA	$ 10,000	$ -
Backflow preventer, 4"	-	EA	$ 2,295	$ -
Subtotal				**$ 66,260**
Well Installation				
Well installation	1,230	LF	$ 143	$ 175,890
Water quality testing	2	EA	$ 1,280	$ 2,560
Well pump	1	EA	$ 7,550	$ 7,550
Well electrical/instrumentation	1	EA	$ 5,635	$ 5,635
Well cover and base	1	EA	$ 3,075	$ 3,075
Piping	1	EA	$ 3,075	$ 3,075
Subtotal				**$ 197,785**
Subtotal of Component Costs				**$ 1,385,717**
Contingency	20%			$ 277,143
Design & Constr Management	25%			$ 346,429
TOTAL CAPITAL COSTS				**$ 2,009,289**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	10.0	mile	$ 275	$ 2,750
Subtotal				**$ 2,750**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.165	$ 1,948
Pump Power	2,138	kWH	$ 0.165	$ 353
Materials	1	EA	$ 1,540	$ 1,540
Labor	365	Hrs	$ 60.00	$ 21,900
Tank O&M	-	EA	$ 1,025	$ -
Subtotal				**$ 25,741**
Well O&M				
Pump power	19,900	kWH	$ 0.165	$ 3,285
Well O&M matl	1	EA	$ 1,540	$ 1,540
Well O&M labor	180	Hrs	$ 60	$ 10,800
Subtotal				**$ 15,625**
O&M Credit for Existing Well Closure				
Pump power	19,900	kWH	$ 0.165	$ (3,285)
Well O&M matl	1	EA	$ 1,540	$ (1,540)
Well O&M labor	180	Hrs	$ 60	$ (10,800)
Subtotal				**$ (15,625)**
TOTAL ANNUAL O&M COSTS				**$ 28,491**

Table C.5

PWS Name *Live Oak Hills Subdivision*
Alternative Name *New Well at 5 Miles*
Alternative Number *LO-5*

Distance from PWS to new well location	5.0	miles
Estimated well depth	1230	feet
Number of wells required	1	
Well installation cost (location specific)	$143	per foot
Pump Stations needed w/ 1 feed tank each	1	
On site storage tanks / pump sets needed	0	

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	8	n/a	n/a	n/a
PVC water line, Class 200, 04"	26,400	LF	$ 12.00	$ 316,800
Bore and encasement, 10"	400	LF	$ 240.00	$ 96,000
Open cut and encasement, 10"	400	LF	$ 130.00	$ 52,000
Gate valve and box, 04"	5	EA	$ 710.00	$ 3,749
Air valve	7	EA	$ 2,050.00	$ 14,350
Flush valve	5	EA	$ 1,025.00	$ 5,412
Metal detectable tape	26,400	LF	$ 2.00	$ 52,800
Subtotal				**$ 541,111**
Pump Station(s) Installation				
Pump	2	EA	$ 8,000	$ 16,000
Pump Station Piping, 04"	1	EA	$ 550	$ 550
Gate valve, 04"	4	EA	$ 710	$ 2,840
Check valve, 04"	2	EA	$ 755	$ 1,510
Electrical/Instrumentation	1	EA	$ 10,250	$ 10,250
Site work	1	EA	$ 2,560	$ 2,560
Building pad	1	EA	$ 5,125	$ 5,125
Pump Building	1	EA	$ 10,250	$ 10,250
Fence	1	EA	$ 6,150	$ 6,150
Tools	1	EA	$ 1,025	$ 1,025
5,000 gal feed tank	1	EA	$ 10,000	$ 10,000
5,000 gal ground storage tank	-	EA	$ 10,000	$ -
Backflow preventer, 4"	-	EA	$ 2,295	$ -
Subtotal				**$ 66,260**
Well Installation				
Well installation	1,230	LF	$ 143	$ 175,890
Water quality testing	2	EA	$ 1,280	$ 2,560
Well pump	1	EA	$ 7,550	$ 7,550
Well electrical/instrumentation	1	EA	$ 5,635	$ 5,635
Well cover and base	1	EA	$ 3,075	$ 3,075
Piping	1	EA	$ 3,075	$ 3,075
Subtotal				**$ 197,785**
Subtotal of Component Costs				**$ 805,156**
Contingency	20%			$ 161,031
Design & Constr Management	25%			$ 201,289
TOTAL CAPITAL COSTS				**$ 1,167,476**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.0	mile	$ 275	$ 1,375
Subtotal				**$ 1,375**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.165	$ 1,948
Pump Power	1,069	kWH	$ 0.165	$ 177
Materials	1	EA	$ 1,540	$ 1,540
Labor	365	Hrs	$ 60.00	$ 21,900
Tank O&M	-	EA	$ 1,025	$ -
Subtotal				**$ 25,565**
Well O&M				
Pump power	19,900	kWH	$ 0.165	$ 3,285
Well O&M matl	1	EA	$ 1,540	$ 1,540
Well O&M labor	180	Hrs	$ 60	$ 10,800
Subtotal				**$ 15,625**
O&M Credit for Existing Well Closure				
Pump power	19,900	kWH	$ 0.165	$ (3,285)
Well O&M matl	1	EA	$ 1,540	$ (1,540)
Well O&M labor	180	Hrs	$ 60	$ (10,800)
Subtotal				**$ (15,625)**
TOTAL ANNUAL O&M COSTS				**$ 26,940**

Table C.6

PWS Name *Live Oak Hills Subdivision*
Alternative Name *New Well at 1 Mile*
Alternative Number *LO-6*

Distance from PWS to new well location	1.0 miles
Estimated well depth	1230 feet
Number of wells required	1
Well installation cost (location specific)	$143 per foot
Pump Stations needed w/ 1 feed tank each	0
On site storage tanks / pump sets 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	2	n/a	n/a	n/a
PVC water line, Class 200, 04"	5,280	LF	$ 12.00	$ 63,360
Bore and encasement, 10"	-	LF	$ 240.00	$ -
Open cut and encasement, 10"	100	LF	$ 130.00	$ 13,000
Gate valve and box, 04"	1	EA	$ 710.00	$ 750
Air valve	1	EA	$ 2,050.00	$ 2,050
Flush valve	1	EA	$ 1,025.00	$ 1,082
Metal detectable tape	5,280	LF	$ 2.00	$ 10,560
Subtotal				**$ 90,802**
Pump Station(s) Installation				
Pump	-	EA	$ 8,000	$ -
Pump Station Piping, 04"	-	EA	$ 550	$ -
Gate valve, 04"	-	EA	$ 710	$ -
Check valve, 04"	-	EA	$ 755	$ -
Electrical/Instrumentation	-	EA	$ 10,250	$ -
Site work	-	EA	$ 2,560	$ -
Building pad	-	EA	$ 5,125	$ -
Pump Building	-	EA	$ 10,250	$ -
Fence	-	EA	$ 6,150	$ -
Tools	-	EA	$ 1,025	$ -
5,000 gal feed tank	-	EA	$ 10,000	$ -
5,000 gal ground storage tank	-	EA	$ 10,000	$ -
Subtotal				**$ -**
Well Installation				
Well installation	1,230	LF	$ 143	$ 175,890
Water quality testing	2	EA	$ 1,280	$ 2,560
Well pump	1	EA	$ 7,550	$ 7,550
Well electrical/instrumentation	1	EA	$ 5,635	$ 5,635
Well cover and base	1	EA	$ 3,075	$ 3,075
Piping	1	EA	$ 3,075	$ 3,075
Subtotal				**$ 197,785**
Subtotal of Component Costs				**$ 288,587**
Contingency	20%			$ 57,717
Design & Constr Management	25%			$ 72,147
TOTAL CAPITAL COSTS				**$ 418,451**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	1.0	mile	$ 275	$ 275
Subtotal				**$ 275**
Pump Station(s) O&M				
Building Power	-	kWH	$ 0.165	$ -
Pump Power	-	kWH	$ 0.165	$ -
Materials	-	EA	$ 1,540	$ -
Labor	-	Hrs	$ 60.00	$ -
Tank O&M	-	EA	$ 1,025	$ -
Subtotal				**$ -**
Well O&M				
Pump power	19,900	kWH	$ 0.165	$ 3,285
Well O&M matl	1	EA	$ 1,540	$ 1,540
Well O&M labor	180	Hrs	$ 60	$ 10,800
Subtotal				**$ 15,625**
O&M Credit for Existing Well Closure				
Pump power	19,900	kWH	$ 0.165	$ (3,285)
Well O&M matl	1	EA	$ 1,540	$ (1,540)
Well O&M labor	180	Hrs	$ 60	$ (10,800)
Subtotal				**$ (15,625)**
TOTAL ANNUAL O&M COSTS				**$ 275**

Table C.7

PWS Name *Live Oak Hills Subdivision*
Alternative Name *Central Treatment - Reverse Osmosis*
Alternative Number *LO-7*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Reverse Osmosis Unit Purchase/Installation				
Site preparation	0.20	acre	$ 4,000	$ 800
Slab	10	CY	$ 1,000	$ 10,000
Building	200	SF	$ 60	$ 12,000
Building electrical	200	SF	$ 8	$ 1,600
Building plumbing	200	SF	$ 8	$ 1,600
Heating and ventilation	200	SF	$ 7	$ 1,400
Fence	200	LF	$ 15	$ 3,000
Paving	2,000	SF	$ 2	$ 4,000
Electrical	1	JOB	$ 30,000	$ 30,000
Piping	1	JOB	$ 16,000	$ 16,000
Reverse osmosis package including:				
High pressure pumps - 20 hp				
Cartridge filters and vessels				
RO membranes and vessels				
Control system				
Chemical feed systems				
Freight cost				
Vendor start-up services	1	UNIT	$ 48,000	$ 48,000
Transfer pumps	2	EA	$ 3,000	$ 6,000
Permeate tank	-	gal	$ 3	$ -
Feed Tank	3,000	gal	$ 3	$ 9,000
Reject pond:				
Excavation	450	CYD	$ 3.00	$ 1,350
Compacted fill	360	CYD	$ 7.00	$ 2,520
Lining	900	SF	$ 1.50	$ 1,350
Vegetation	600	SY	$ 1.50	$ 900
Access road	300	LF	$ 30.00	$ 9,000
Subtotal of Design/Construction Costs				**$ 158,520**
Contingency	20%			$ 31,704
Design & Constr Management	25%			$ 39,630
Reject water haulage truck	1	EA	$ 100,000	$ 100,000
TOTAL CAPITAL COSTS				**$ 329,854**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Reverse Osmosis Unit O&M				
Building Power	3,000	kwh/yr	$ 0.165	$ 495
Equipment power	12,000	kwh/yr	$ 0.165	$ 1,980
Labor	600	hrs/yr	$ 40.00	$ 24,000
RO materials and Chemicals	2,000	kgal	$ 0.75	$ 1,500
Analyses	12	test	$ 200	$ 2,400
Subtotal				**$ 30,375**
Reject (brine) disposal				
Disposal truck mileage	2,000	miles	$ 1.50	$ 3,000
Reject (brine) disposal fee	666	kgal/yr	$ 5.00	$ 3,329
Subtotal				**$ 6,329**
TOTAL ANNUAL O&M COSTS				**$ 36,704**

Table C.8

PWS Name *Live Oak Hills Subdivision*
Alternative Name *Central Treatment - WRT Z-88*
Alternative Number *LO-8*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
WRT Z-88 Unit Purchase/Installation				
Site preparation	0.20	acre	$ 4,000	$ 800
Slab	11	CY	$ 1,000	$ 10,500
Building	210	SF	$ 60	$ 12,600
Building electrical	210	SF	$ 8	$ 1,680
Building plumbing	210	SF	$ 8	$ 1,680
Heating and ventilation	210	SF	$ 7	$ 1,470
Fence	200	LF	$ 15	$ 3,000
Paving	1,500	SF	$ 2	$ 3,000
Electrical	1	JOB	$ 25,000	$ 25,000
Piping	1	JOB	$ 14,000	$ 14,000
WRT Z-88 package including:				
Z-88 vessels				
Adsorption media	1	UNIT	$ 58,000	$ 58,000
(Initial Setup Cost for WRT Z-88 package plant)				
Subtotal of Component Costs				**$ 131,730**
Contingency	20%			$ 26,346
Design & Constr Management	25%			$ 32,933
TOTAL CAPITAL COSTS				**$ 191,009**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Adsorption unit				
Building Power	3,000	kwh/yr	$ 0.165	$ 495
Equipment power	4,000	kwh/yr	$ 0.165	$ 660
Labor	360	hrs/yr	$ 40	$ 14,400
Analyses	24	test	$ 200	$ 4,800
WRT treated water charge	1,997	kgal/yr	$ 4.750	$ 9,487
Subtotal				**$ 29,842**
TOTAL ANNUAL O&M COSTS				**$ 29,842**

Table C.9

PWS Name ***Live Oak Hills Subdivision***
Alternative Name ***Point-of-Use Treatment***
Alternative Number ***LO-9***

Number of Connections for POU Unit Installation 31 connections

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POU-Treatment - Purchase/Installation				
POU treatment unit purchase	31	EA	$ 615	$ 19,065
POU treatment unit installation	31	EA	$ 155	$ 4,805
Subtotal				**$ 23,870**
Subtotal of Component Costs				**$ 23,870**
Contingency	20%			$ 4,774
Design & Constr Management	25%			$ 5,968
Procurement & Administration	20%			$ 4,774
TOTAL CAPITAL COSTS				**$ 39,386**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POU materials, per unit	31	EA	$ 230	$ 7,130
Contaminant analysis, 1/yr per unit	31	EA	$ 205	$ 6,355
Program labor, 10 hrs/unit	310	hrs	$ 40	$ 12,400
Subtotal				**$ 25,885**
TOTAL ANNUAL O&M COSTS				**$ 25,885**

Table C.10

PWS Name *Live Oak Hills Subdivision*
Alternative Name *Point-of-Entry Treatment*
Alternative Number *LO-10*

Number of Connections for POE Unit Installation 31 connections

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POE-Treatment - Purchase/Installat				
POE treatment unit purchase	31	EA	$ 5,125	$ 158,875
Pad and shed, per unit	31	EA	$ 2,050	$ 63,550
Piping connection, per unit	31	EA	$ 1,025	$ 31,775
Electrical hook-up, per unit	31	EA	$ 1,025	$ 31,775
Subtotal				**$ 285,975**
Subtotal of Component Costs				**$ 285,975**
Contingency	20%			$ 57,195
Design & Constr Management	25%			$ 71,494
Procurement & Administration	20%			$ 57,195
TOTAL CAPITAL COSTS				**$ 471,859**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POE materials, per unit	31	EA	$ 1,540	$ 47,740
Contaminant analysis, 1/yr per unit	31	EA	$ 205	$ 6,355
Program labor, 10 hrs/unit	310	hrs	$ 40	$ 12,400
Subtotal				**$ 66,495**
TOTAL ANNUAL O&M COSTS				**$ 66,495**

Table C.11

PWS Name *Live Oak Hills Subdivision*
Alternative Name *Public Dispenser for Treated Drinking Water*
Alternative Number *LO-11*

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	$ 7,175	$ 7,175
Unit installation costs	1	EA	$ 5,125	$ 5,125
Subtotal				**$ 12,300**
Subtotal of Component Costs				**$ 12,300**
Contingency	20%			$ 2,460
Design & Constr Management	25%			$ 3,075
TOTAL CAPITAL COSTS				**17,835**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Treatment unit O&M, 1 per unit	1	EA	$ 2,050	$ 2,050
Contaminant analysis, 1/wk per ui	52	EA	$ 205	$ 10,660
Sampling/reporting, 1 hr/day	365	HRS	$ 60	$ 21,900
Subtotal				**$ 34,610**
TOTAL ANNUAL O&M COSTS				**$ 34,610**

Table C.12

PWS Name *Live Oak Hills Subdivision*
Alternative Name *Supply Bottled Water to 100% of Population*
Alternative Number *LO-12*

Service Population	93	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	33,945	gallons

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Implementation				
Initial program set-up	500	hours	$ 45	$ 22,500
Subtotal				**$ 22,500**
Subtotal of Component Costs				**$ 22,500**
Contingency	20%			$ 4,500
TOTAL CAPITAL COSTS				**$ 27,000**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water purchase costs	33,945	gals	$ 1.20	$ 40,734
Program admin, 9 hrs/wk	468	hours	$ 45	$ 21,060
Program materials	1	EA	$ 5,125	$ 5,125
Subtotal				**$ 66,919**
TOTAL ANNUAL O&M COSTS				**$ 66,919**

Table C.13

PWS Name ***Live Oak Hills Subdivision***
Alternative Name ***Central Trucked Drinking Water***
Alternative Number ***LO-13***

Service Population	93	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	33,945	gallons
Travel distance to compliant water source	33	miles

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Storage Tank Installation				
5,000 gal ground storage tank	1	EA	$ 10,000	$ 10,000
Site improvements	1	EA	$ 3,075	$ 3,075
Potable water truck	1	EA	$ 75,000	$ 75,000
Subtotal				**$ 88,075**
Subtotal of Component Costs				**$ 88,075**
Contingency	20%			$ 17,615
Design & Constr Management	25%			$ 22,019
TOTAL CAPITAL COSTS				**$ 127,709**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water delivery labor, 4 hrs/wk	208	hrs	$ 60	$ 12,480
Truck operation, 1 round trip/wk	3,432	miles	$ 3.00	$ 10,296
Water purchase	34	1,000 gals	$ 11.26	$ 382
Water testing, 1 test/wk	52	EA	$ 205	$ 10,660
Sampling/reporting, 2 hrs/wk	104	hrs	$ 60	$ 6,240
Subtotal				**$ 40,058**
TOTAL ANNUAL O&M COSTS				**$ 40,058**

APPENDIX D
EXAMPLE FINANCIAL MODEL

Appendix D
General Inputs

Live Oak Hills Subdivision

Number of Alternatives 11 Selected from Results Sheet

Input Fields are Indicated by:

General Inputs		
Implementation Year	2009	
Months of Working Capital	0	
Depreciation	$ -	
Percent of Depreciation for Replacement Fund	0%	
Allow Negative Cash Balance (yes or no)	No	
Median Household Income	$ 25,347	Live Oak Hills Subdivision
Median HH Income -- Texas	$ 39,927	
Grant Funded Percentage	0%	Selected from Results
Capital Funded from Revenues	$ -	

	Base Year Growth/Escalation	2007
Accounts & Consumption		
Metered Residential Accounts		
Number of Accounts	0.0%	31
Number of Bills Per Year		12
Annual Billed Consumption		2,007,500
Consumption per Account Per Pay Period	0.0%	5,397
Consumption Allowance in Rates		100,000
Total Allowance		37,200,000
Net Consumption Billed		(35,192,500)
Percentage Collected		100.0%
Unmetered Residential Accounts		
Number of Accounts	0.0%	0
Number of Bills Per Year		12
Percentage Collected		100.0%
Metered Non-Residential Accounts		
Number of Accounts	0.0%	0
Number of Bills Per Year		12
Non-Residential Consumption		-
Consumption per Account	0.0%	-
Consumption Allowance in Rates		-
Total Allowance		-
Net Consumption Billed		-
Percentage Collected		0.0%
Unmetered Non-Residential Accounts		
Number of Accounts	0.0%	0
Number of Bills Per Year		12
Percentage Collected		100.0%
Water Purchase & Production		
Water Purchased (gallons)	0.0%	-
Average Cost Per Unit Purchased	0.0%	$ -
Bulk Water Purchases	0.0%	$ -
Water Production	0.0%	2,007,500
Unaccounted for Water		-
Percentage Unaccounted for Water		0.0%

Live Oak Hills Subdivision

Number of Alternatives 11 Selected from Results Sheet

Input Fields are Indicated by:

Residential Rate Structure	Allowance within Tier	
	-	
Estimated Average Water Rate ($/1000gallons)		$ 7.26
Non-Residential Rate Structure		
	-	
Estimated Average Water Rate ($/1000gallons)		$ -
INITIAL YEAR EXPENDITURES	Inflation	Initial Year
Operating Expenditures:		
Salaries & Benefits	0.0%	-
Contract Labor	0.0%	-
Water Purchases	0.0%	-
Chemicals, Treatment	0.0%	-
Utilities	0.0%	-
Repairs, Maintenance, Supplies	0.0%	-
Repairs	0.0%	-
Maintenance	0.0%	-
Supplies	0.0%	-
Administrative Expenses	0.0%	
Accounting and Legal Fees	0.0%	-
Insurance	0.0%	-
Automotive and Travel	0.0%	-
Professional and Directors Fees	0.0%	-
Bad Debts	0.0%	-
Garbage Pick-up	0.0%	-
Miscellaneous	0.0%	-
Other 3	0.0%	14,031
Other 4	0.0%	-
Incremental O&M for Alternative	0.0%	-
Total Operating Expenses		14,031
Non-Operating Income/Expenditures		
Interest Income	0.0%	-
Other Income	0.0%	50
Other Expense	0.0%	-
Transfers In (Out)	0.0%	-
Net Non-Operating		50

Esisting Debt Service		
Bonds Payable, Less Current Maturities		$ -
Bonds Payable, Current		
Interest Expense		$ 32

Debt Service for Live Oak Hills Subdivision
Alternative Number = 11
Funding Source = Loan/Bond

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Existing Debt Service	$ -	-	-	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Principal Payments		-	(32)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Payment	0.00%	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Term	25																															
Revenue Bonds		-	-	17,835	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%	-	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	17,835	17,510	17,165	16,800	16,413	16,003	15,568	15,106	14,618	14,099	13,550	12,968	12,351	11,697	11,004	10,269	9,490	8,664	7,788	6,861	5,877	4,834	3,729	2,558	1,316	0	0	0	0
Principal		-	-	325	345	365	387	410	435	461	489	518	549	582	617	654	693	735	779	826	875	928	984	1,043	1,105	1,171	1,242	1,316	-	-	-	-
Interest	6.00%	-	-	1,070	1,051	1,030	1,008	985	960	934	906	877	846	813	778	741	702	660	616	569	520	467	412	353	290	224	153	0	0	0	0	0
Total Debt Service		-	-	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,316	0	0	0	0
New Balance		-	-	17,510	17,165	16,800	16,413	16,003	15,568	15,106	14,618	14,099	13,550	12,968	12,351	11,697	11,004	10,269	9,490	8,664	7,788	6,861	5,877	4,834	3,729	2,558	1,316	0	0	0	0	0
Term	20																															
State Revolving Fund		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%	-	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest	0.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term	10																															
Bank/Interfund Loan				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%	-	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest	8.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term	25																															
RUS Loan			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%		-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest	5.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Cashflow Projections for Live Oak Hills Subdivision
Alternative Number = 11
Funding Source = Loan/Bond

Estimated At Sept. 30 of Each Year

	Growth/	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
	Escalation	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
CASH FLOW PROJECTIONS																																
Beginning Unrestricted Cash Balance		$ -	595	595	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	0	0	0
RECEIPTS																																
Operating Revenues																																
Water Base Rate-- Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 1 -- Res	100,000	14,576	14,576	15,376	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,907	48,591	48,591	48,591	48,591
Water: Tier 2 -- Res	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 3 -- Res	200,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 4 -- Res	300,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unmetered Residential		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Base Rate - Non Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 1 -- NR	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 2 -- NR	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 3 -- NR	200,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 4 -- NR	300,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unmetered Non Residential		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sewer Sales		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other 1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other 2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other 3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Revenues		$ 14,576	$ 14,576	$ 15,376	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,986	$ 49,907	$ 48,591	$ 48,591	$ 48,591	$ 48,591
Capital Receipts																																
Grants Received		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SRF Proceeds		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank/Interfund Loan Proceeds		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RUS Loan Proceeds		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bond Proceeds		-	-	17,835	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Receipts		-	-	17,835	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Receipts		14,576	14,576	33,211	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,907	48,591	48,591	48,591	48,591
EXPENDITURES																																
Operating Expenditures:																																
Salaries & Benefits	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contract Labor	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Purchases	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chemicals, Treatment	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utilities	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repairs, Maintenance, Supplies	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Repairs	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maintenance	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Supplies	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Administrative Expenses	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Accounting and Legal Fees	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Insurance	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Automotive and Travel	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Professional and Directors Fees	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bad Debts	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Garbage Pick-up	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miscellaneous	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other 3	0.0%	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031	14,031
Other 4	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental O&M for Alternative	0.0%	-	-	-	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610	34,610
Total Operating Expenses		14,031	14,031	14,031	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641	48,641
Non-Operating Income/Expenditures																																
Interest Income	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Income	0.0%	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Other Expense	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transfers In (Out)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Non-Operating		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Debt Service																																
Existing		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed:																																
Revenue Bonds		-	-	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,316	0	0	0	0
State Revolving Fund		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Loan		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RUS Loan		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,395	1,316	0	0	0	0
Capital Expenditures	$ 17,835																															
Funded From Revenues/Reserves	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded From Grants	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded From SRF Loans		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded from Bank/Interfund Loans		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded from RUS Loan		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded from Bonds		-	-	17,835	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Expenditures		-	-	17,835	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Expenditures		13,981	13,981	33,211	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,986	49,907	48,591	48,591	48,591	48,591
What Water Rev Needs to be		(13,981)	(13,981)	(15,376)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,986)	(49,907)	(48,591)	(48,591)	(48,591)	(48,591)
Water Rate Increase		0.00%	0.00%	5.49%	225.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.16%	-2.64%	0.00%	0.00%	0.00%
Net Cash Flow		595	595	-	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	0	0	0	0
Reserves:																																
Working Capital (Months O&M)	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Replacement Reserve		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Required Reserves		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average Annual Water Bill	$ 1,612	$ 470	$ 470	$ 496	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,612	$ 1,610	$ 1,567	$ 1,567	$ 1,567	$ 1,567
Median Household Income		$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347	$ 25,347
Maximum % of MHI	6.4%	1.9%	1.9%	2.0%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.2%	6.2%	6.2%	6.2%
Percentage Rate Increase Compared to Current	242.9%		0.0%	5.5%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.9%	242.4%	233.4%	233.4%	233.4%	233.4%

APPENDIX E
ANALYSIS OF SHARED SOLUTIONS FOR OBTAINING WATER FROM RICHLAND SUD

E.1 OVERVIEW OF METHOD USED

There are a few small PWSs with water quality problems located in the vicinity of the Live Oak Hills Subdivision PWS 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 taken over or bought out by a larger regional entity.

The small PWSs with water quality problems near the Live Oak Hills Subdivision PWS are listed in Table E.1, along with their average water consumption and estimates of the capital cost for each PWS to construct an individual pipeline. 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 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 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.

E.2 SHARED SOLUTION FOR OBTAINING WATER FROM RICHLAND SUD

This alternative would consist of constructing an 18-mile 8-inch joint pipeline from the Richland Special Utility District to Rochelle Water Supply Corp. Then a 2.5-mile 6-inch pipeline will run to a split where a 5.5-mile 6-inch pipeline will continue to Richland SUD Brady and a second 18-mile 4-inch line will continue to Live Oak Hills Subdivision. The pipeline routing is shown in Figure E.1 at the end of this appendix. It is assumed five pump stations would be required to transfer the water from the Richland SUD to the Rochelle Water Supply Corp and then to Richland SUD Brady and Live Oak Hills Subdivision.

The capital costs for each pipe segment and the total capital cost for the shared pipeline are summarized in Table E.2. Table E.3 shows the capital costs allocated to each PWS using Method A. Table E.4 shows the capital costs allocated to each PWS using Method B. Table E.5 shows the allocation of pipeline capital costs to each of the PWSs using Method C, as described above. Table E.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 E.7 through E.12.

Based on these estimates, the range of pipeline capital cost savings to Richland SUD Brady could be between $1.65 million and $5.47 million if they were to implement a shared solution like this, which would be a savings between 29 to 95 percent. These estimates are hypothetical and are only provided to approximate the magnitude of potential savings if this shared solution is implemented as described.

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

PWS	PWS #	Average Water Demand (gpd)	Water Demand as Percent of Total	Pipeline Capital Cost for Individual Solutions for Richland SUD	Percent of Sum of Capital Costs for Individual Solutions for Richland SUD
Richland SUD Brady	1540008	180,000	84%	$ 5,658,491	40%
Rochelle	1540004	28,000	13%	$ 2,847,330	20%
Live Oak Hills	1540012	5,500	3%	$ 5,733,568	40%
Totals		**213,500**	**100%**	**$ 14,239,389**	**100%**

Notes: (a) Costs for Rochelle to Richland SUD are provided in Table E.12. Costs for Richland SUD Brady and Live Oak Hills to Richland SUD (one of the alternatives for the PWS) are provided in Appendix C.

Table E.2
Capital cost for Shared Pipeline from Richland SUD

Pipe Segment	Capital Cost
Pipe 1	$ 4,479,127
Pipe 2	$ 576,056
Pipe A	$ 1,012,390
Pipe B	$ 804,392
Pipe C	$ 3,272,698
Totals	**$ 10,144,663**

Notes: (b) Pipes 1 and 2 are identified as Main Links 1 and 2, respectively, and are common to both PWSs. The lettered pipes connect each PWS to the Main Links.

Table E.3
Pipeline Capital Cost Allocation by Method A
Shared Pipeline Assement for Live Oak Hills and Richland SUD Brady

PWS	PWS #	Percentage Based On Flow	Total Costs
Richland SUD Brady	1540008	84%	$ 8,552,877
Rochelle	1540004	13%	$ 1,330,448
Live Oak Hills	1540012	3%	$ 261,338
	Totals	**100%**	**$ 10,144,663**

Table E.4
Pipeline Capital Cost Allocation by Method B
Shared Pipeline Assesment for Live Oak Hills and Richland SUD Brady

Pipeline Segment	Pipe Segment Capital Cost	Richland SUD Brady		Rochelle		Live Oak Hills	
		Percent Allocation Based on Water Use	Allocated Cost	Percent Allocation Based on Water Use	Allocated Cost	Percent Allocation Based on Water Use	Allocated Cost
Pipe 1	$ 4,479,127	84%	$ 3,776,313	13%	$ 587,426	3%	$ 115,387
Pipe 2	$ 576,056	0%	$ -	84%	$ 481,480	16%	$ 94,576
Pipe A	$ 1,012,390	100%	$ 1,012,390	0%	$ -	0%	$ -
Pipe B	$ 804,392	0%	$ -	100%	$ 804,392	0%	$ -
Pipe C	$ 3,272,698	0%	$ -	0%	$ -	100%	$ 3,272,698
Totals	**$ 10,144,663**		**$ 4,788,703**		**$ 1,873,298**		**$ 3,482,662**

Table E.5
Pipeline Capital Cost Allocation by Method C
Shared Pipelilne Assessment for Live Oak Hills and Richland SUD Brady

PWS	PWS #	Cost for Individual Pipelines	Percentage based on Individual Solutions	Allocated Capital Cost
Richland SUD Brady	1540008	$ 5,658,491	40%	$ 4,031,316
Rochelle	1540004	$ 2,847,330	20%	$ 2,028,542
Live Oak Hills	1540012	$ 5,733,568	40%	$ 4,084,804
	Totals	**$ 14,239,389**	**100%**	**$ 10,144,663**

Table E.6
Pipeline Capital Cost Summary
Shared Pipelilne Assessment for Live Oak Hills and Richland SUD Brady

PWS	Individual Pipeline Capital Costs	Shared Solution Capital Cost Allocation			Shared Solution Cost Savings			Shared Solution Percentage Savings		
		Method A	**Method B**	**Method C**	**Method A**	**Method B**	**Method C**	**Method A**	**Method B**	**Method C**
1540008	$ 5,658,491	$ 8,552,877	$ 4,788,703	$ 4,031,316	$ (2,894,386)	$ 869,788	$ 1,627,175	-51%	15%	29%
1540004	$ 2,847,330	$ 1,330,448	$ 1,873,298	$ 2,028,542	$ 1,516,883	$ 974,032	$ 818,788	53%	34%	29%
1540012	$ 5,733,568	$ 261,338	$ 3,482,662	$ 4,084,804	$ 5,472,230	$ 2,250,907	$ 1,648,764	95%	39%	29%
Totals	**$ 14,239,389**	**$ 10,144,663**	**$ 10,144,663**	**$ 10,144,663**	**$ 4,094,727**	**$ 4,094,727**	**$ 4,094,727**			

Table E.7

Main Link # 1
Total Pipe Length 18.11 miles
Number of Pump Stations Needed 2
Pipe Size 08" inches

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	8	n/a	n/a	n/a
Number of Crossings, open cut	14	n/a	n/a	n/a
PVC water line, Class 200, 08"	95,647	LF	$ 27	$ 2,582,469
Bore and encasement, 12"	1,600	LF	$ -	$ -
Open cut and encasement, 12"	700	LF	$ -	$ -
Gate valve and box, 08"	20	EA	$ 785	$ 15,700
Air valve	19	EA	$ 2,050	$ 38,950
Flush valve	20	EA	$ 1,025	$ 20,500
Metal detectable tape	95,647	LF	$ 2.00	$ 191,294
Subtotal				**$ 2,848,913**
Pump Station(s) Installation				
Pump	4	EA	$ 8,000	$ 32,000
Pump Station Piping, 08"	4	EA	$ 1,315	$ 5,260
Gate valve, 08"	8	EA	$ 785	$ 6,280
Check valve, 08"	4	EA	$ 1,470	$ 5,880
Electrical/Instrumentation	2	EA	$ 10,250	$ 20,500
Site work	2	EA	$ 2,560	$ 5,120
Building pad	2	EA	$ 5,125	$ 10,250
Pump Building	2	EA	$ 10,250	$ 20,500
Fence	2	EA	$ 6,150	$ 12,300
Tools	2	EA	$ 1,025	$ 2,050
50,000 gal ground storage tank	2	EA	$ 60,000	$ 120,000
Subtotal				**$ 240,140**
Subtotal of Component Costs				**$ 3,089,053**
Contingency	20%			$ 617,811
Design & Constr Management	25%			$ 772,263
TOTAL CAPITAL COSTS				**$ 4,479,127**

Table E.8

Main Link # 2
Total Pipe Length 2.53 miles
Number of Pump Stations Needed 1
Pipe Size 06" inches

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	6	n/a	n/a	n/a
PVC water line, Class 200, 06"	13,356	LF	$ 18	$ 240,408
Bore and encasement, 10"	200	LF	$ -	$ -
Open cut and encasement, 10"	300	LF	$ -	$ -
Gate valve and box, 06"	3	EA	$ 805	$ 2,415
Air valve	3	EA	$ 2,050	$ 6,150
Flush valve	3	EA	$ 1,025	$ 3,075
Metal detectable tape	13,356	LF	$ 2.00	$ 26,712
Subtotal				**$ 278,760**
Pump Station(s) Installation				
Pump	2	EA	$ 8,000	$ 16,000
Pump Station Piping, 06"	2	EA	$ 835	$ 1,670
Gate valve, 06"	4	EA	$ 805	$ 3,220
Check valve, 06"	2	EA	$ 1,135	$ 2,270
Electrical/Instrumentation	1	EA	$ 10,250	$ 10,250
Site work	1	EA	$ 2,560	$ 2,560
Building pad	1	EA	$ 5,125	$ 5,125
Pump Building	1	EA	$ 10,250	$ 10,250
Fence	1	EA	$ 6,150	$ 6,150
Tools	1	EA	$ 1,025	$ 1,025
50,000 gal ground storage tank	1	EA	$ 60,000	$ 60,000
Subtotal				**$ 118,520**
Subtotal of Component Costs				**$ 397,280**
Contingency	20%			$ 79,456
Design & Constr Management	25%			$ 99,320
TOTAL CAPITAL COSTS				**$ 576,056**

Table E.9

Segment A

Richland SUD Brady

Private Pipe Size	06"	
Total Pipe Length	5.46	miles
Total PWS annual water usage	65.7	MG
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	27	n/a	n/a		n/a	
PVC water line, Class 200, 06"	28,820	LF	$	18	$	518,760
Bore and encasement, 10"	1,800	LF	$	-	$	-
Open cut and encasement, 10"	1,350	LF	$	-	$	-
Gate valve and box, 06"	6	EA	$	805	$	4,830
Air valve	6	EA	$	2,050	$	12,300
Flush valve	6	EA	$	1,025	$	6,150
Metal detectable tape	28,820	LF	$	2.00	$	57,640
Subtotal					**$**	**599,680**
Pump Station(s) Installation						
Pump	2	EA	$	8,000	$	16,000
Pump Station Piping, 06"	2	EA	$	835	$	1,670
Gate valve, 06"	4	EA	$	805	$	3,220
Check valve, 06"	2	EA	$	1,135	$	2,270
Electrical/Instrumentation	1	EA	$	10,250	$	10,250
Site work	1	EA	$	2,560	$	2,560
Building pad	1	EA	$	5,125	$	5,125
Pump Building	1	EA	$	10,250	$	10,250
Fence	1	EA	$	6,150	$	6,150
Tools	1	EA	$	1,025	$	1,025
30,000 gal ground storage tank	1	EA	$	40,000	$	40,000
Subtotal					**$**	**98,520**
Subtotal of Component Costs					**$**	**698,200**
Contingency	20%				$	139,640
Design & Constr Management	25%				$	174,550
TOTAL CAPITAL COSTS					**$**	**1,012,390**

Table E.10

Segment B

Rochelle

Private Pipe Size	04"	
Total Pipe Length	0.06	miles
Total PWS annual water usage	10.2	MG
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost		Total Cost	
Pipeline Construction						
Number of Crossings, bore	8	n/a	n/a		n/a	
Number of Crossings, open cut	14	n/a	n/a		n/a	
PVC water line, Class 200, 04"	297	LF	$	12	$	3,564
Bore and encasement, 10"	1,600	LF	$	240	$	384,000
Open cut and encasement, 10"	700	LF	$	130	$	91,000
Gate valve and box, 04"	1	EA	$	710	$	710
Air valve	1	EA	$	2,050	$	2,050
Flush valve	1	EA	$	1,025	$	1,025
Metal detectable tape	297	LF	$	2.00	$	594
Subtotal					**$**	**482,943**
Pump Station(s) Installation						
Pump	2	EA	$	8,000	$	16,000
Pump Station Piping, 04"	2	EA	$	550	$	1,100
Gate valve, 04"	4	EA	$	710	$	2,840
Check valve, 04"	2	EA	$	755	$	1,510
Electrical/Instrumentation	1	EA	$	10,250	$	10,250
Site work	1	EA	$	2,560	$	2,560
Building pad	1	EA	$	5,125	$	5,125
Pump Building	1	EA	$	10,250	$	10,250
Fence	1	EA	$	6,150	$	6,150
Tools	1	EA	$	1,025	$	1,025
10,000 gal ground storage tank	1	EA	$	15,000	$	15,000
Subtotal					**$**	**71,810**
Subtotal of Component Costs					**$**	**554,753**
Contingency	20%				$	110,951
Design & Constr Management	25%				$	138,688
TOTAL CAPITAL COSTS					**$**	**804,392**

Table E.11

Segment C

Live Oak Hills

Private Pipe Size	04"	
Total Pipe Length	14.16	miles
Total PWS annual water usage	2.0	MG
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost		Total Cost	
Pipeline Construction						
Number of Crossings, bore	16	n/a	n/a		n/a	
Number of Crossings, open cut	49	n/a	n/a		n/a	
PVC water line, Class 200, 04"	74,782	LF	$	12	$	897,384
Bore and encasement, 10"	3,200	LF	$	240	$	768,000
Open cut and encasement, 10"	2,450	LF	$	130	$	318,500
Gate valve and box, 04"	15	EA	$	710	$	10,650
Air valve	15	EA	$	2,050	$	30,750
Flush valve	15	EA	$	1,025	$	15,375
Metal detectable tape	74,782	LF	$	2.00	$	149,564
Subtotal					**$**	**2,190,223**
Pump Station(s) Installation						
Pump	2	EA	$	8,000	$	16,000
Pump Station Piping, 04"	2	EA	$	550	$	1,100
Gate valve, 04"	4	EA	$	710	$	2,840
Check valve, 04"	2	EA	$	755	$	1,510
Electrical/Instrumentation	1	EA	$	10,250	$	10,250
Site work	1	EA	$	2,560	$	2,560
Building pad	1	EA	$	5,125	$	5,125
Pump Building	1	EA	$	10,250	$	10,250
Fence	1	EA	$	6,150	$	6,150
Tools	1	EA	$	1,025	$	1,025
5,000 gal ground storage tank	1	EA	$	10,000	$	10,000
Subtotal					**$**	**66,810**
Subtotal of Component Costs					**$**	**2,257,033**
Contingency	20%				$	451,407
Design & Constr Management	25%				$	564,258
TOTAL CAPITAL COSTS					**$**	**3,272,698**

Table E.12

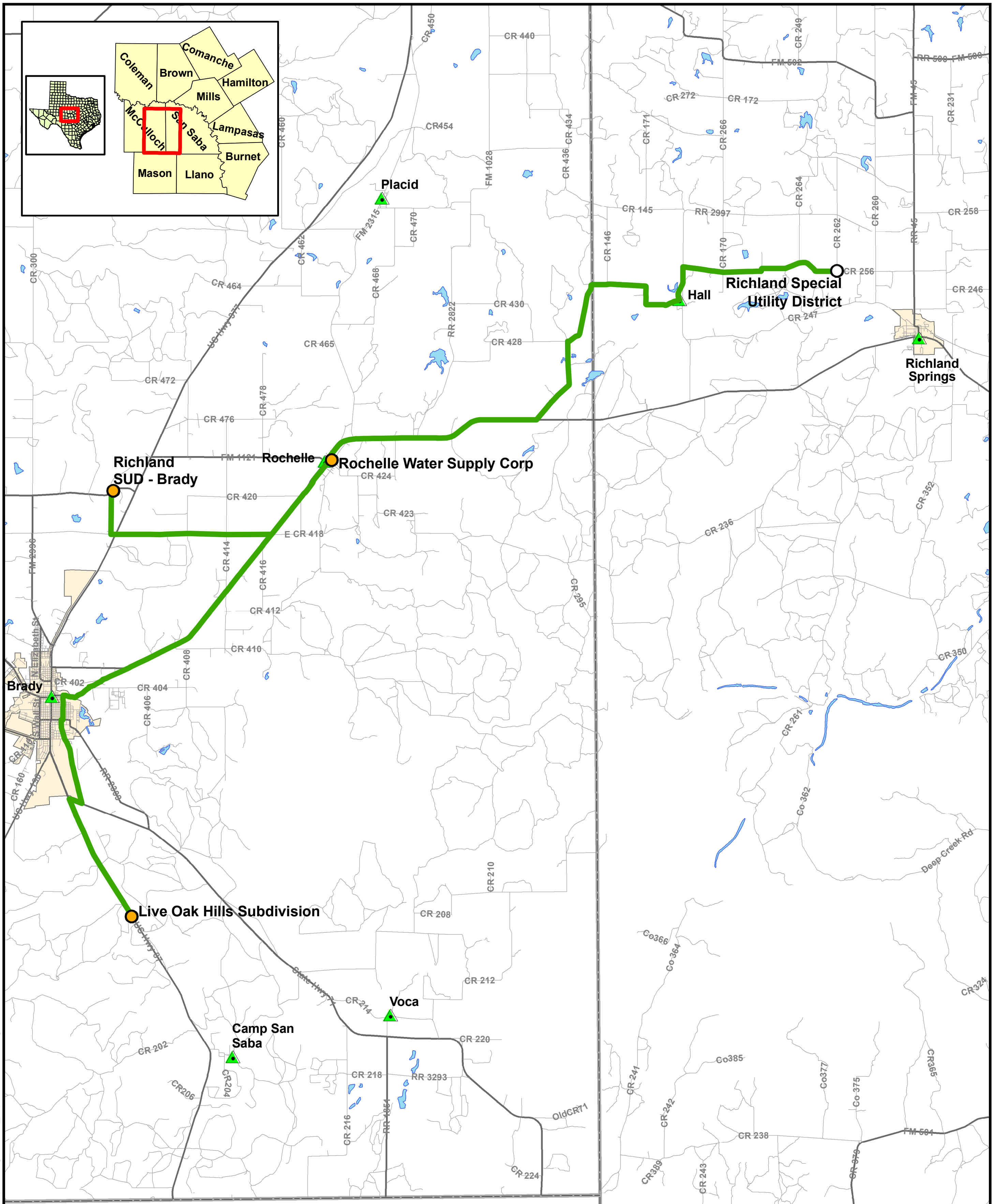
Cost for just Rochelle

Rochelle

Private Pipe Size	04"	
Total Pipe Length	18.17	miles
Total PWS annual water usage	10.2	MG
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	
Pipeline Construction						
Number of Crossings, bore	8	n/a	n/a		n/a	
Number of Crossings, open cut	14	n/a	n/a		n/a	
PVC water line, Class 200, 04"	95,944	LF	$	12	$	1,151,328
Bore and encasement, 10"	1,600	LF	$	240	$	384,000
Open cut and encasement, 10"	700	LF	$	130	$	91,000
Gate valve and box, 04"	20	EA	$	710	$	14,200
Air valve	19	EA	$	2,050	$	38,950
Flush valve	20	EA	$	1,025	$	20,500
Metal detectable tape	95,944	LF	$	2.00	$	191,888
Subtotal					**$**	**1,891,866**
Pump Station(s) Installation						
Pump	2	EA	$	8,000	$	16,000
Pump Station Piping, 04"	2	EA	$	550	$	1,100
Gate valve, 04"	4	EA	$	710	$	2,840
Check valve, 04"	2	EA	$	755	$	1,510
Electrical/Instrumentation	1	EA	$	10,250	$	10,250
Site work	1	EA	$	2,560	$	2,560
Building pad	1	EA	$	5,125	$	5,125
Pump Building	1	EA	$	10,250	$	10,250
Fence	1	EA	$	6,150	$	6,150
Tools	1	EA	$	1,025	$	1,025
10,000 gal ground storage tank	1	EA	$	15,000	$	15,000
Subtotal					**$**	**71,810**
Subtotal of Component Costs					**$**	**1,963,676**
Contingency	20%				$	392,735
Design & Constr Management	25%				$	490,919
TOTAL CAPITAL COSTS					**$**	**2,847,330**



Legend

- Study System
- PWS's
- Cities
- City Limits
- Counties
- Major Road
- Minor Road
- CRMWA Pipeline
- Lubbock Pipeline
- Grass Valley Pipeline
- LO/RS/RL - 1

N

Miles
0 1.5 3

Figure E.1

LIVE OAK HILLS SUBDIVISION, RICHLAND SUD - BRADY & ROCHELLE WSC TO RICHLAND SUD
Shared Pipeline Alternative

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