San Jacinto River Authority
P.O. Box 329 Conroe, Texas 77305-0329

March 2, 2009

Ms. Kathy Jones
General Manager
Lone Star Groundwater Conservation District
207 W. Phillips
Suite 300
Conroe, Texas 77305

Ref: San Jacinto River Authority Joint WRAP Part II

Dear Ms. Jones:

We are pleased to submit to you three (3) printed copies and one (1) disk with electronic copy of the San Jacinto River Authority Joint Water Resources Assessment Plan (WRAP) Part II. The document is submitted on behalf of the 198 Large Volume Groundwater Users (LVGUs), who are participants in this Joint WRAP, in fulfillment of the Lone Star Groundwater Conservation District (LSGCD) District Regulatory Plan (DRP) Phase II (A). As you are aware, as part of our continual effort to keep the development of this Joint WRAP transparent, the basic plan and results contained herein were presented in a public workshop conducted by the SJRA at the Lone Star Convention Center on January 26, 2009. As of this date the SJRA has not received any formal written correspondence regarding the plan from the LVGUs. As previously conveyed, any changes in the key assumptions of this Joint WRAP Part II, including but not limited to the final LSGCD DRP, the actual LVGUs who ultimately participate in a joint program led by the SJRA, and available financing options may have significant impacts on the final plan that is implemented.

We appreciate the commitment of time and resources that you, your staff and your consultants devoted to the development of this Joint WRAP II, particularly the numerous progress meetings and workshops conducted throughout the process to assure this WRAP was compliant to your DRP. Please let us know if you have any questions.

Sincerely,

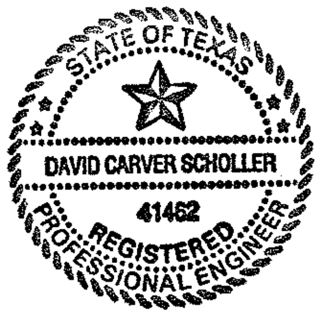
Reed Eichelberger, P.E.
General Manager
San Jacinto River Authority

(936) 588-1111 Conroe (936) 447-5260 Metro Fax (936) 588-3043

San Jacinto River Authority

Joint Water Resources Assessment Plan
Part – II

Montgomery County
Alternative Water Supply Program



David C. Scholler, P.E.

2/25/09
Date

TBPE Firm Registration No. 1046

February 2009

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Executive Summary

This Joint Water Resources Assessment Plan – Part II (Joint WRAP) is submitted by the San Jacinto River Authority (SJRA) to the Lone Star Groundwater Conservation District (LSGCD) in compliance with the requirements of the District Regulatory Plan Phase II(A) (DRP Phase II(A)) adopted by the LSGCD on February 12, 2008. It includes planning data and other required information for 198 permittees of the LSGCD and is intended to meet the regulatory requirements for a Joint WRAP submission on behalf of all 198 Participants as authorized in Subsection (C)(2) of the DRP. The term "Participant" is used throughout this Joint WRAP to indicate those entities described by the LSGCD as "participating in a single WRAP submitted on behalf of two or more Large Volume Groundwater Users." **Exhibit 1** shows where Participants are located in Montgomery County as well as the three Regulated Users that are not participating in this Joint WRAP. The 198 Participants that joined this Joint WRAP are listed in **Appendix B**.

<u>Introduction and Background</u>

As discussed in Section 6 Financing Alternatives the premise for the Montgomery County Surface Water Conversion Program outlined in this Joint WRAP is based on SJRA having the authority to impose a countywide fee on water used by all large volume groundwater users (LVGU) who choose to join this program to comply with LSGCD rules. This fee authority for SJRA is included in proposed legislation to be offered to the 81st Texas Legislature. If the legislation to grant SJRA the authority to impose a fee on water used is not successfully passed, then the basis for financing and funding the program and schedule proposed in this Joint WRAP are invalid.

To begin reducing groundwater demand and encourage the conjunctive use of surface water with groundwater supplies, the Lone Star Groundwater Conservation District (LSGCD) has adopted regulations that require certain groundwater users to conduct long-term planning. The LSGCD District Regulatory Plan (DRP) Phase II (A) requires LVGU (well permittees that produce 10 million gallons or more annually) to submit a Water Resources Assessment Plan (WRAP) composed of two major parts.

WRAP Components and Due Dates

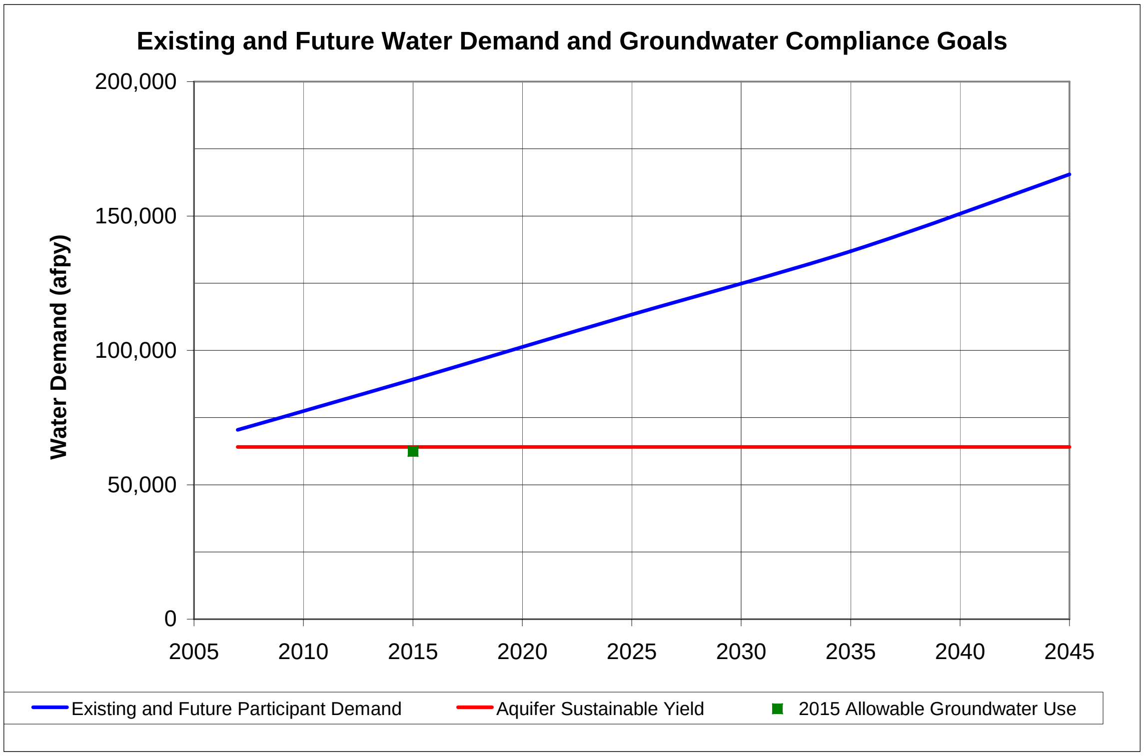
Part I. Information about current and projected water demands; identification of current water supplies; and description of current well capacities. *COMPLETED: August 28, 2008*

Part II. Identification of new water supply sources to meet projected water demands; description of infrastructure needed to deliver new supplies; timeline and cost estimate to develop new supplies; and a letter from the supplier confirming the availability of the new supplies. *COMPLETED: With this Submittal*

The SJRA responded to this need by developing a long-term countywide approach that will provide a better solution that is faster to implement and cheaper for all the LVGU in the county as a whole. This countywide approach is the basis of this Joint WRAP representing almost 200 regulated users.

The following figure illustrates the total demand for the Joint WRAP Participants and future regulated users.

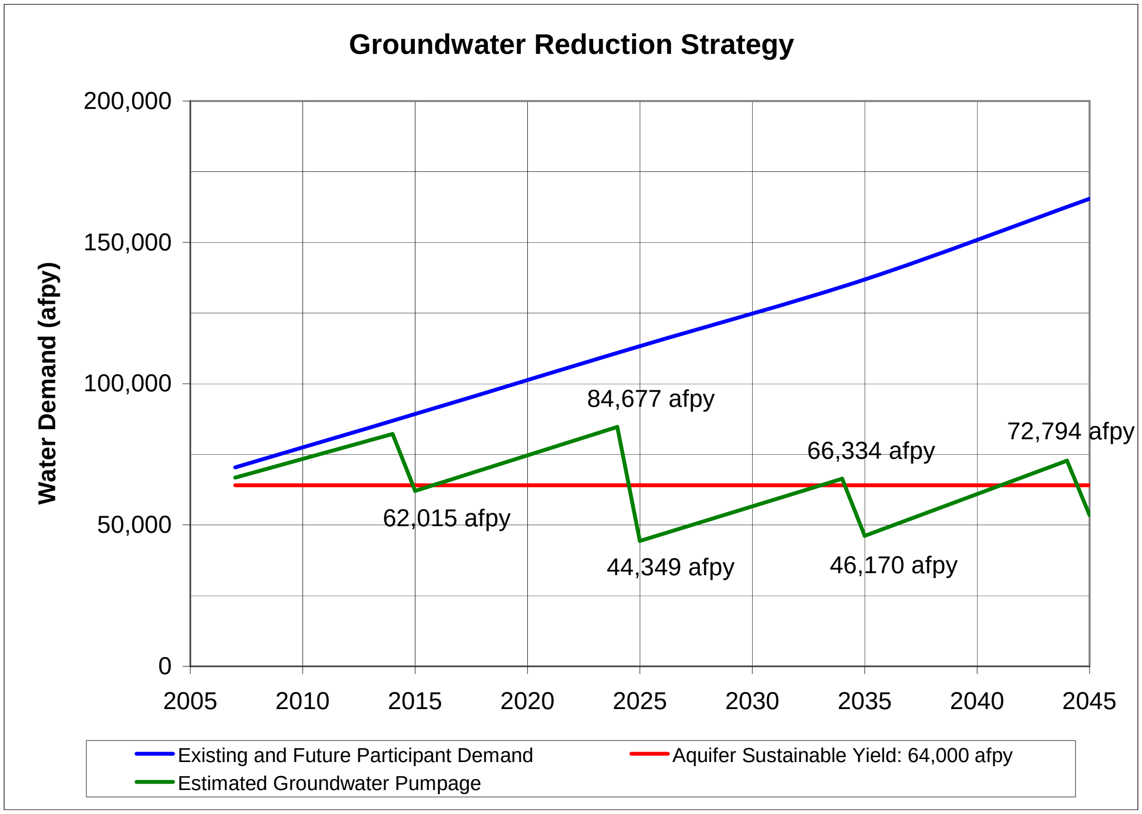
Figure ES.1
Existing and Future Water Demand and Groundwater Compliance Goals



A broad range of water supply sources were considered including groundwater and surface water in both the San Jacinto and Trinity River Basins. ***Studies conducted as part of the preparation of this Joint WRAP determined that the most cost-effective source-water supply alternative is the use of SJRA water rights in Lake Conroe plus the City of Houston's water in Lake Conroe via a long-term water supply contract***.

The LSGCD regulations require that groundwater use comprise no more than 70% of water demand in 2015. During the planning period from 2015 through 2045, compliance is measured by supplying surface water – or other alternative water (such as reuse for irrigation) – in sufficient quantity that the average groundwater use during the planning period is less than or equal to 64,000 afpy. The following figure illustrates a strategy that meets the regulatory requirements by expanding surface water capacity and reducing groundwater use at ten year intervals.

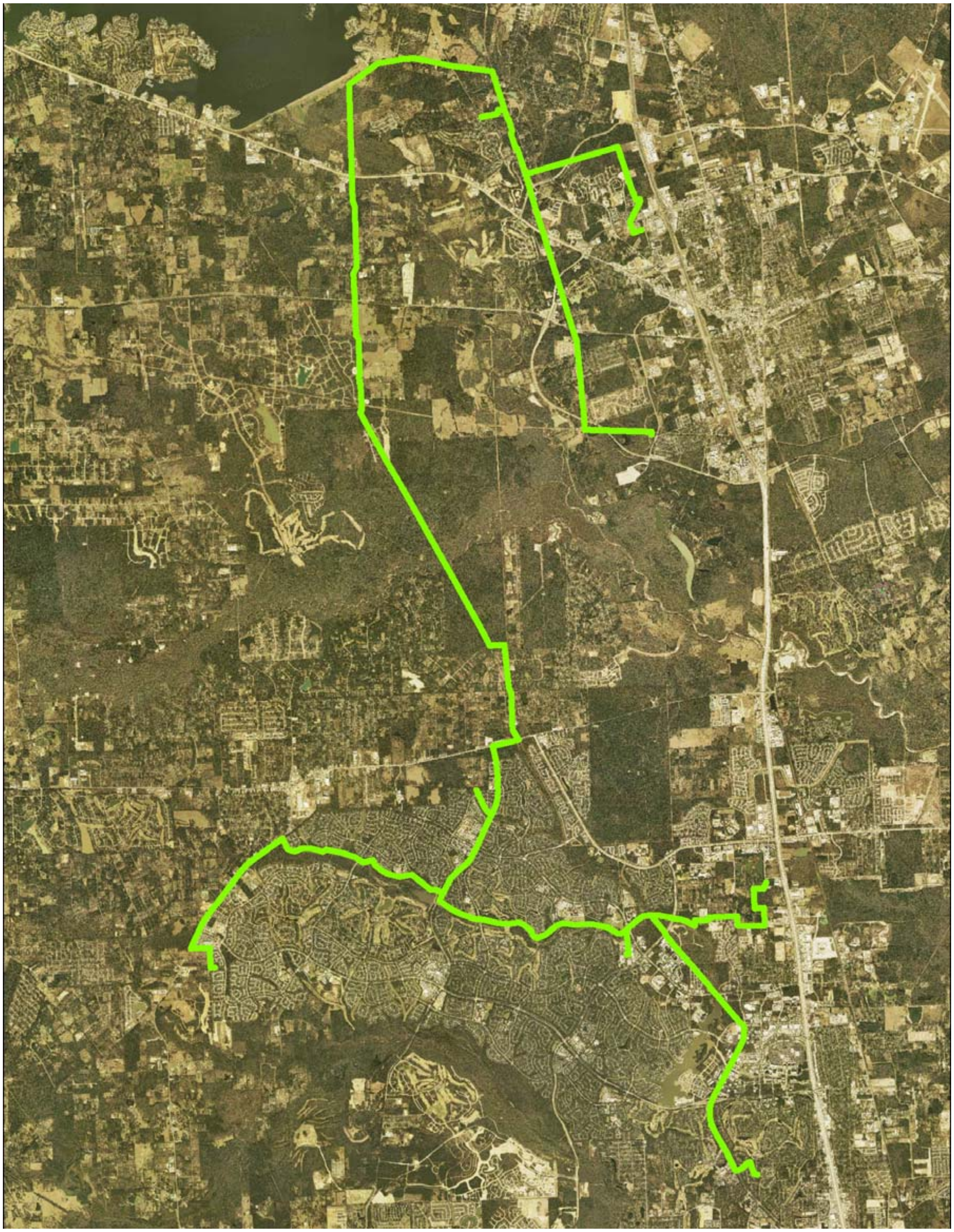
Figure ES.2
Groundwater Reduction Strategy



The infrastructure required in the first implementation phase to treat and convey surface water from a water treatment plant located at Lake Conroe to selected Joint WRAP Participants has been investigated. A preliminary environmental review of potential waterline corridors was also performed to investigate four 1,000-feet wide north-south corridors between a possible treatment plant site and The Woodlands, three east-west corridors joining the five groundwater plants within The Woodlands, and two corridors from the treatment plant to various existing groundwater plants within the City of Conroe. The evaluation considered existing soils, vegetation, floodplains and waters of the U.S., archeological sites, potential presence of hazardous materials, transportation corridors, schools, cemeteries, parks and other public land, and number of affected parcels.

Based on the potential waterline corridors investigated and the Joint WRAP Participant water demands, alternative pipeline systems were developed and hydraulic modeling was used to further quantify infrastructure requirements by determining the sizes of proposed transmission mains. Twenty-four alternative transmission systems were developed and evaluated on the basis of the present worth of their capital, operation, and maintenance costs. The evaluation process is described in the separate report, "Joint Water Resources Assessment Plan –Alternative Analysis". For the purpose of this WRAP, **Alternative T2C1W1** is the preferred alternative as shown below.

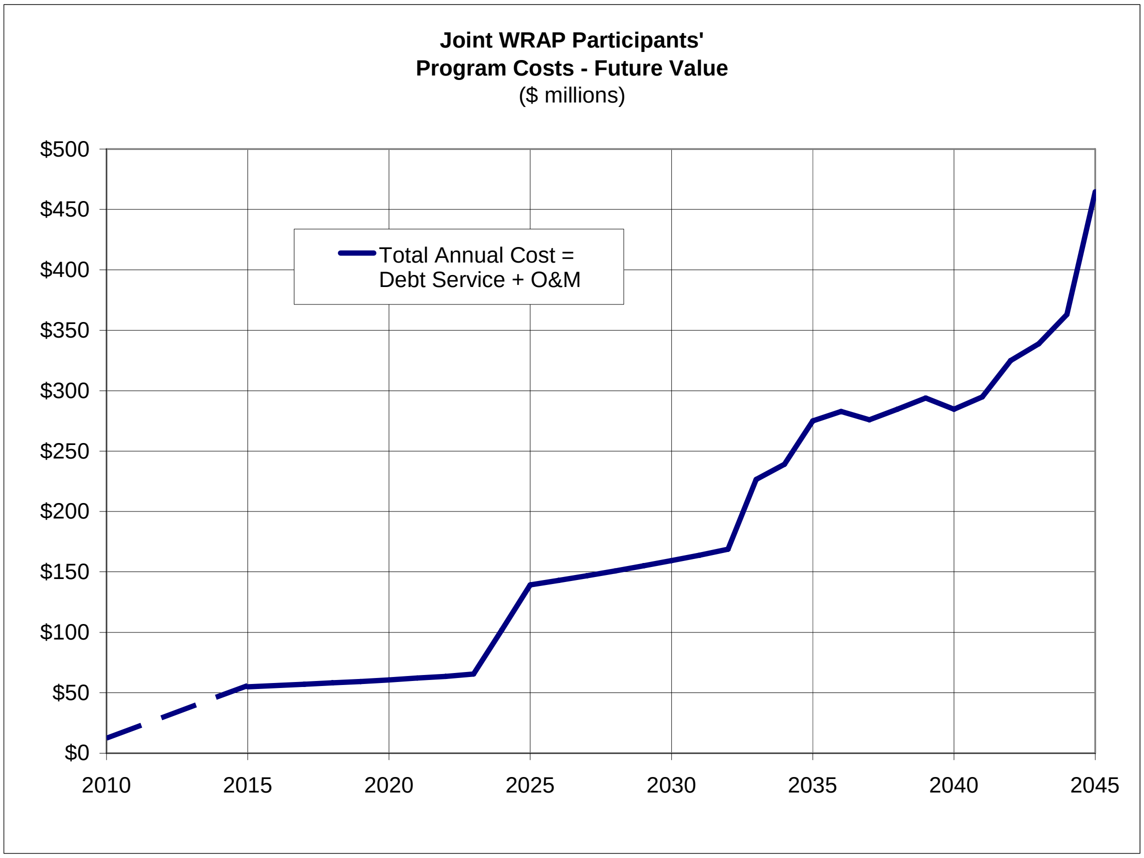
Figure ES.3
Preliminary 2015 Water Lines



After the infrastructure capacity requirements were defined, unit costs were applied in order to calculate the costs of treatment and transmission facilities. In addition, other 'soft' costs associated with planning, design, bidding and financing projects such as program management, engineering, surveying, geotechnical studies, construction management, materials testing and contingency, financial, and legal costs were included.

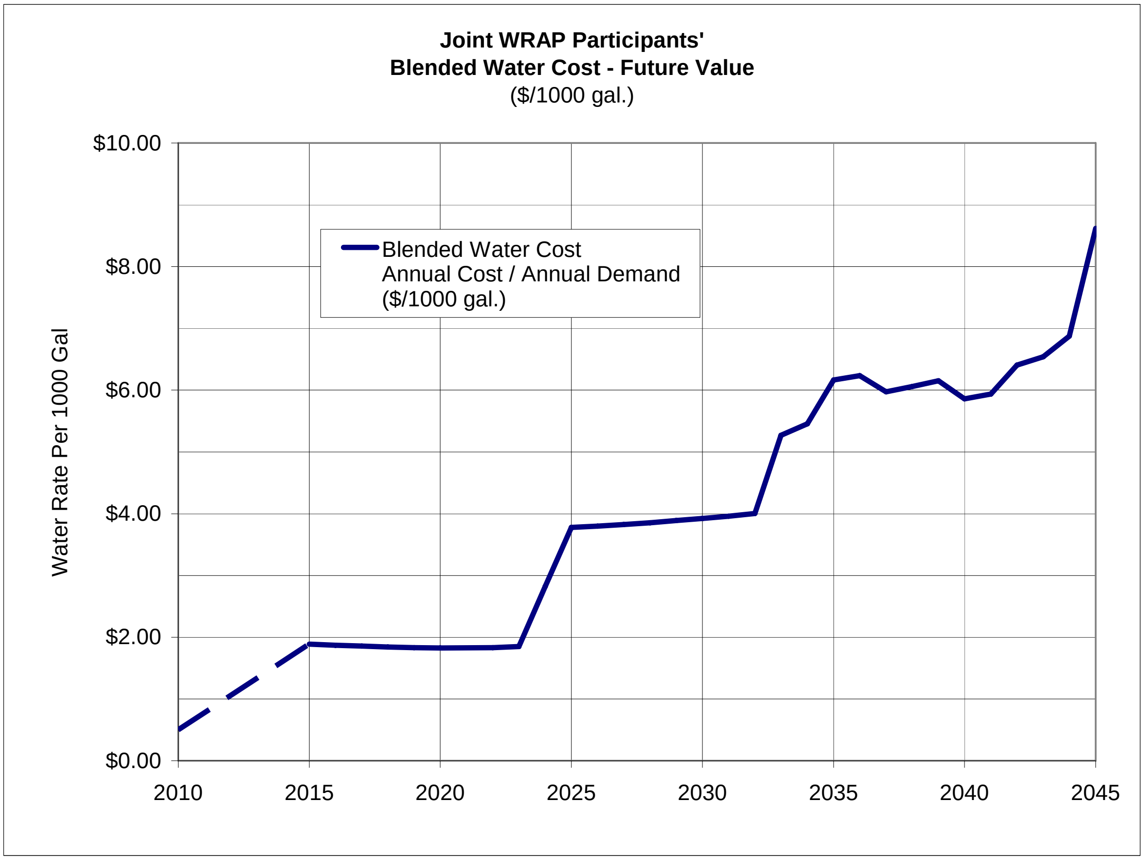
Costs were inflated 5% annually during the planning period. The annual debt service is estimated based on a bond or interest rate of 5%. The preliminary estimated annual costs for **Alternative T2C1W1** through 2045 are shown in the following figure.

Figure ES.4
Joint WRAP Participants' Program Costs – Future Value



The total annual costs (i.e., debt service, O&M, raw water costs) will be financed through fees or water rates charged to Joint WRAP Participants. The total annual costs will be allocated or charged on the basis of total water used; both groundwater and surface water. The 'blended' (i.e., groundwater and surface water) rate required is determined by dividing the total annual costs by the average annual water demand and is shown in the following figure.

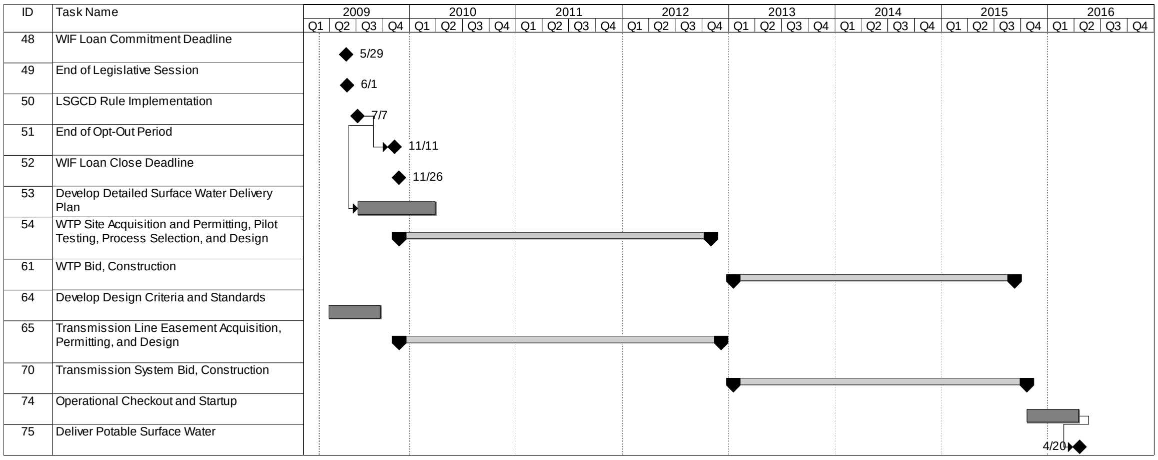
Figure ES.5
Joint WRAP Participants' Blended Water Cost – Future Value



Two schedules were developed to illustrate two potential paths forward after completion of the current Joint WRAP. Both schedules are based on the LSGCD's implementation of new Rules at mid-year, 2009, as the beginning of the next phase of planning and eventual implementation. There are costs that are unique to each schedule that must be developed and compared in order to select the most cost-effective direction for the project in the future.

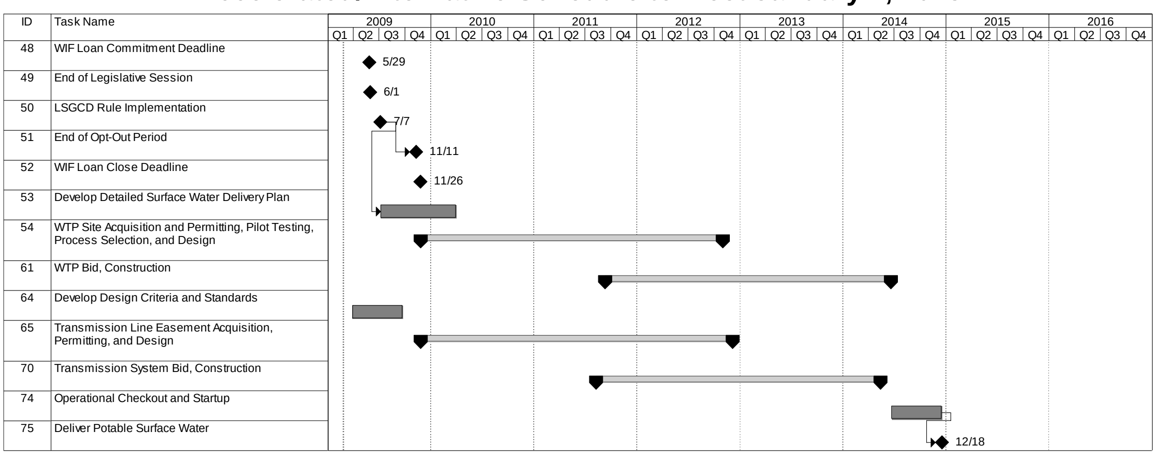
The first schedule is based on traditional project delivery methods and assumes that six or more years are required to complete the many tasks necessary following a normal and orderly process. This schedule assumes LSGCD is cognizant of the necessity of implementing this program in a cost-effective and orderly process and will establish a realistic regulatory deadline for groundwater reduction. Implementation of the program following this schedule, illustrated in the following figure, may impact overall costs with additional inflation.

Figure ES.6
Traditional Schedule



The second schedule assumes that the LSGCD retains a regulatory deadline of 2015. In order to meet this very constraining deadline, efforts such as alternative project delivery and/or accelerating design and construction schedules are used to compress the planning, permitting, land/easement acquisition, design, bidding, and construction efforts. This second schedule, illustrated in the following figure, may include significant impacts to overall program costs.

Figure ES.7
Accelerated/Alternative Schedule to Meet January 1, 2015



Section 1
Introduction

1.1 Background

In 2001, the Texas Legislature created the Lone Star Groundwater Conservation District (LSGCD) to conserve, protect, and enhance the groundwater resources of Montgomery County. Studies conducted by the LSGCD have since confirmed the reports of many water suppliers in Montgomery County that water levels are declining at an alarming rate. Results of computer modeling of future reliance on groundwater showed continued water-level declines and new problem areas for water suppliers in other parts of Montgomery County where water levels are not currently of concern. It is evident that the existing groundwater supply cannot meet the growing water demands of Montgomery County and that the use of groundwater cannot continue to be allowed to exceed the sustainable yield of the Northern Gulf Coast Aquifer system.

A preliminary estimate of 64,000 acre feet per year (afpy) as the sustainable yield for the aquifer in Montgomery County has been developed based on an assumed recharge rate of approximately 1.1 inches per year over the 697,600 acre area of the county. In 2003, the LSGCD adopted the 64,000 afpy estimate for the purposes of its Groundwater Management Plan (GMP).

The Texas Water Development Board (TWDB) is using the Northern Gulf Coast Aquifer Groundwater Availability Model (GAM) to study the aquifer and recently released preliminary results indicating the recharge rate could be considerably less than 64,000 afpy. The LSGCD has chosen not to adopt the TWDB GAM data at this time. Instead, the LSGCD is waiting for the results of a three-year US Geological Survey (USGS) study (under contract to the LSGCD) of the recharge rate. Results of that study will not be available until 2010.

In the interim, to begin reducing groundwater demand and encourage the conjunctive use of surface water with groundwater supplies, the LSGCD has adopted regulations that require certain groundwater users to conduct long-term planning. The result of that planning, a Water Resources Assessment Plan (WRAP), assesses future water needs and describes how alternative water supplies may be acquired to meet future demands and groundwater reduction requirements established by the LSGCD. Requirements for the WRAP are set forth in the LSGCD’s District Regulatory Plan (DRP) Phase II (A) and are based on the DRP Phase I regulatory target to reduce groundwater withdrawals in Montgomery County to 64,000 acre-feet per year by January 2015.

The LSGCD DRP Phase II (A) requires large volume groundwater users (LVGU) to submit WRAPs that are composed of two major parts. LVGUs are groundwater well permittees that currently produce 10 million gallons or more of groundwater annually. Part I of the WRAP includes information about current and projected water demands;

identification of current water supplies; and description of current well capacities. Part II includes identification of new water supply sources to meet projected water demands; description of infrastructure needed to deliver new supplies; timeline and cost estimate to develop new supplies; and a letter from the supplier confirming the availability of the new supplies.

The LSGCD DRP allows multiple LVGUs to submit a Joint WRAP addressing plans to meet LSGCD requirements on behalf of all LVGUs that are part of the Joint WRAP. After much hard work, the SJRA was joined by 198 of the 201 LVGUs in Montgomery County and submitted a Joint WRAP Part I to the LSGCD in August 2008. The 198 LVGUs that joined this Joint WRAP are listed in **Appendix B**.

1.2 Purpose and Approach

The purpose of this study is to recommend a surface water treatment and transmission system to serve Joint WRAP Participants that will supply enough treated surface water to meet the regulatory requirement of the LSGCD to reduce groundwater use to less than 64,000 afpy. The term “Participant” is used throughout this Joint WRAP to indicate those entities described by the LSGCD as “participating in a single WRAP submitted on behalf of two or more Large Volume Groundwater Users.” **Exhibit 1** shows where Participants are located in Montgomery County as well as the three Regulated Users that are not participating in this Joint WRAP.

This report fulfills the LSGCD’s requirements for WRAP Part II that is to be completed by March 2, 2009. The plan presented in this report provides a feasible system to establish a basis for future costs and financing needs to meet the requirements of the LSGCD for a Joint WRAP Part II.

In the future, proposed legislation will determine whether a countywide fee authority will support project financing, the current USGS study will confirm the sustainable yield of the aquifer, the Participants that are part of the plan may change, and LSGCD will adopt final Rules. All of these will require additional consideration to determine their impact on existing plans and to establish the proper plan to implement surface water use among Participants in Montgomery County.

This study has investigated the following major areas:

- Water Demand, Water Sources, and Conversion Strategy (Section 2)
- Evidence of the Availability and Willingness to Supply Water (Section 3)
- Infrastructure (Section 4)
- Program Costs (Section 5)
- Financing Alternatives (Section 6)
- Program Schedule (Section 7)

Finally, this Joint WRAP Part II builds on and advances previous efforts on behalf of the LSGCD and the Joint WRAP Participants. Whereas previous investigations may be compared to a 100,000 foot level 'fly-over', this study decreases the altitude and improves the clarity of features in the emerging plan by looking more closely at alternatives related to potential surface water sources and the transmission system and its costs to convey treated surface water to Joint WRAP Participants. However, further studies beyond this Joint WRAP study will be required before the final plan can be developed.

Section 2
Water Demand

2.1 Water Demand

Water demand for Participants in the SJRA Joint WRAP is primarily for municipal purposes with significant industrial demand for power generation. Municipal demand is characterized by residential use with a significant seasonal irrigation component and commercial uses. The seasonal irrigation includes lawn watering and golf course irrigation. In addition, the City of Conroe has a large industrial water use component.

SJRA's Joint WRAP Part I submitted to the LSGCD on August 28, 2008 projected water demands based on population. The Joint WRAP Part I compared two projections of future population, one developed by the Houston-Galveston Area Council (HGAC) and one by the Region H Water Planning Group (Region H) based on Texas Water Development Board (TWDB) projections. On average, the HGAC projection is approximately 8% greater than the Region H projection. Based on a history of actual population growth exceeding past projections for Montgomery County, the Joint WRAP Part I proposed to use the higher HGAC projections for planning. However, to use the higher HGAC projections, the Region H projections would have to be modified by adjusting the underlying assumptions regarding rates of migration, birth rates, mortality rates, etc. and providing detailed documentation for these adjustments.

The TWDB recognizes a need to adjust the short-term projection for 2010 upward by approximately 8% to account for recent rapid growth in Montgomery County. How that adjustment may extend to projections beyond 2010 is to be determined by the TWDB. LSGCD and TWDB require that planning efforts use TWDB projections of future water demand. Therefore, for the purposes of this Joint WRAP II the Region H/TWDB projections of population and water demand are used. **Table 2.1** shows the Region H/ TWDB projection of future population and water demand in acre-feet per year (afpy).

Table 2.1
Region H/TWDB
Montgomery County Population and Water Demand Projections

	2015	2025	2035	2045
Population	479,872	617,300	775,479	967,800
Demand (afpy)	89,543	113,716	137,435	166,175

SJRA's efforts in preparing the Joint WRAP I secured the participation of 198 of 201 large volume groundwater users (LVGU) in Montgomery County. The three LVGUs that will develop their own WRAPs and therefore are not included in the Joint WRAP are Conroe Country Club, Wedgewood Golf Course, and the City of Houston. Conroe Country Club and Wedgewood Golf Course are both golf course irrigation uses and no permanent residential population is served. The City of Houston water production from wells in Montgomery County in 2007 is disproportionate in comparison to the City's population in the County because the City's wells supply a larger population in adjacent Harris County.

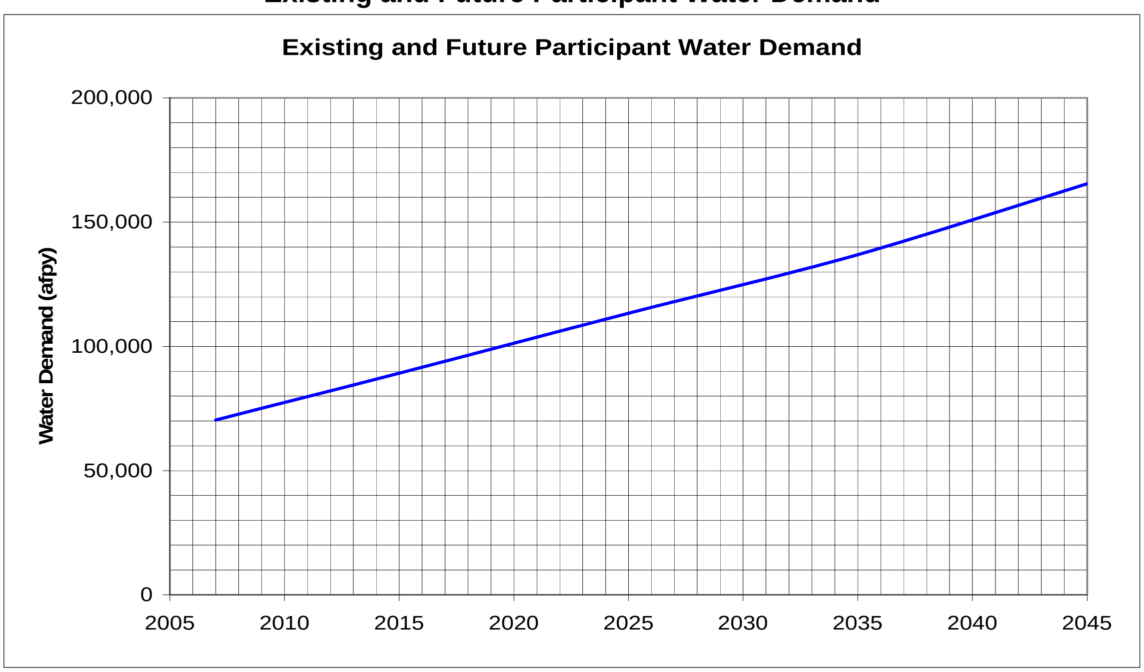
Table 2.2 summarizes water demand for the 198 Participants in SJRA's Joint WRAP as well as future regulated users that are assumed to join this Joint WRAP. This demand is based on the Region H/TWDB demands for Montgomery County minus the regulated users not participating in this Joint WRAP. The water demand for Conroe Country Club and Wedgewood Golf Course are based on their average production in recent years for which data was available. The water demand for the City of Houston in Montgomery County over the planning period is based on Region H/TWDB projections.

Table 2.2
Total Water Demand (afpy) for SJRA Joint WRAP Participants

	2007	2015	2025	2035	2045
Total County Demand	70,633	89,543	113,716	137,435	166,175
City of Houston	136.0	221.5	314.0	445.5	610.0
Conroe Country Club	22.4	22.4	22.4	22.4	22.4
Wedgewood Golf Course	89.6	89.6	89.6	89.6	89.6
Subtotal	248.0	333.5	426.0	557.5	722.0
Existing and Future Participant Demand	70,385	89,209	113,290	136,877	165,453

As can be seen from **Table 2.2** the projected water demand for existing and future Joint WRAP Participants exceeds 99% of the total county water demand throughout the planning period. **Figure 2.1** illustrates future water demand for Joint WRAP Participants.

Figure 2.1
Existing and Future Participant Water Demand



2.1.1 Individual Participant Demands

To meet the surface water conversion requirement, the existing and future surface water demands need to be located within the county. For the purpose of this Joint WRAP, the evaluations and analyses described in this section were conducted to achieve these objectives.

The total water demand for SJRA Joint WRAP Participants presented in **Table 2.2** is based on Region H/TWDB projections. Further analysis was conducted to estimate the individual contributions to the demand by each of the 198 Joint WRAP Participants. The Region H/TWDB data included water demand projections for approximately 30 water user groups (WUGs) that are among the Joint WRAP Participants. A water user group is defined by the TWDB as a city with a population of 500 or more, a utility providing 280 afpy of water for municipal use, or a group of utilities with a common association.

Among the WUGs, the City of Conroe is notable because approximately 50% of the City's water demand is for commercial and industrial accounts. Commercial/industrial water demand is very specific to the nature of the business or industry and its particular water needs. In addition, while the City of Conroe works to attract business and industry, there is little ability to predict the future success of those efforts with any certainty. For these reasons, it is difficult to forecast industrial water demand very far into the future. Conroe's existing unit demand is approximately 200 gpcd due to its relatively large commercial / industrial component of total water demand. While the commercial / industrial demand will grow, water demand associated with the supporting residential population base is expected to grow more quickly. The result is that unit demand is expected to decrease from the current 200 gpcd to approximately 160 gpcd by 2045. Future planning work will continue to evaluate commercial and industrial water demand in the City.

In addition, four WUGs are private utilities that operate numerous utilities serving Joint WRAP Participants. The total demand for these four WUGs was allocated to the individual Participants within them in proportion to their 2007 groundwater pumpage.

The remaining 170 Joint WRAP Participants are not part of a WUG defined by Region H/TWDB and are therefore included in "County-Other" by Region H/TWDB. For the purpose of this Joint WRAP, water demand for these Participants was estimated based on the best information available, including utilizing HGAC projections of population. During the Joint WRAP Part I effort, HGAC population projections were used to develop projections of water demand for individual Joint WRAP Participants. The HGAC projections for Montgomery County are based on a land use model that utilizes a 1,000-foot by 1,000-foot grid. GIS tools were utilized to overlay the grid with the boundaries for Joint WRAP Participants in order to develop projections of future population for each of the Joint WRAP Participants. These projections of where future population is expected to occur were used as the best estimate available of where future water demand is expected to occur and potentially be supplied with surface water. This assumption essentially allocates or distributes the Region H 'County-Other' population to individual Joint WRAP Participants.

To estimate Participant's future water demands based on the best information available required an analysis of the many potential combinations of information from various sources as shown in **Table 2.3**. There were five types of information including:

1. The 'character' of the demand and whether the Participant supplies water primarily to a residential population or the water demand is based on land use (LU). All Participants were characterized as either "Muni" for municipal (i.e. the demand is based primarily on the population served) or "LU" for land use (e.g. industry, golf courses, etc.) in column 2 of **Table 2.3**.
2. Number of connections based on responses to questionnaires returned by Participants characterized as "Muni". Questionnaires were sent to all Joint WRAP Participants and requested projections of future population and water demand in addition to other data. A sample of the questionnaire is provided in Appendix A. The information of greatest interest is actual connections in 2007 to determine current unit water demand (gallons per capita per day, gpcd). If a population was not provided in the questionnaire response, a population of three people per connection was assumed. Whether connection information was available or not from the questionnaire was indicated by "Y" for yes or "N" for no in column 3 of **Table 2.3**.
3. Projected water demand in 2045 based on Participants' responses to questionnaires. Whether information was available for projected 2045 water demand based on the Participant's questionnaire was indicated by "Y" or "N" in column 4 of **Table 2.3**.
4. Projected water demand in 2045 based on TWDB projections of future water demand for WUGs. Whether information was available for projected 2045 water demand based on TWDB projections was indicated by "Y" or "N" in column 5 of **Table 2.3**.
5. Groundwater pumpage based on LSGCD records for 2005, 2006 and 2007 used to determine current unit water demand (gpcd). Groundwater pumpage for 2005 through 2007 was available for most Participants. Whether 2005 through 2007 pumpage was available was indicated by "Y" or "N" in column 6 of **Table 2.3**.

For the five types of information, there are thirty-two possible combinations of "Muni"/"LU" and "Y"/"N" indicators, however, only fifteen of the combinations actually occur for Participants' information. **Table 2.3** categorizes these combinations of information and provides a count of the Participants that fall within each category as shown in column 1. Column 7 provides the number of Joint WRAP Participants that are included in each Category. Column 8, "Key to Future Demand" describes the method used to estimate the Participants' projected water demand. A complete table containing the specific information for each Joint WRAP Participant is included in Appendix B – Participant Water Demand Analysis.

Table 2.3
Analysis of Joint WRAP Participant Water Demand

		Questionnaire					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Category	Demand Basis	2007 Connect's	2045 Demand	TWDB WUG	LSGCD 2005 - 2007 Pumpage	Count of Particip's	Key to Future Demand
1	Muni	Y	Y	N	Y	62	1
2	Muni	Y	Y	Y	Y	25	2
3	Muni	N	N	N	Y	25	3
4	Muni	Y	N	N	Y	20	3
5	Muni	N	N	Y	Y	15	2
6	Muni	Y	N	Y	Y	8	2
7	Muni	N	Y	N	Y	4	1
8	Muni	N	N	N	N	2	4
9	Muni	N	Y	N	N	2	5
10	LU	N	N	N	Y	12	6
11	LU	Y	Y	N	Y	11	1
12	LU	Y	N	N	Y	6	6
13	LU	N	N	N	N	3	7
14	LU	N	Y	N	Y	2	1
15	LU	N	N	Y	Y	1	8
					Total Participant Count	198	

The following numbered descriptions correspond to the "Key to Future Demand" in **Table 2.3** to explain how future demand is estimated in each category.

1. Demand is interpolated between 2005 - 2007 average pumpage and 2045 demand from questionnaire or 2005 - 2007 average pumpage, whichever is larger. Using the larger value corrects a few cases where 2005 - 2007 average pumpage exceeds projected 2045 demand.
2. Demand is interpolated between 2005 - 2007 average pumpage and 2045 WUG demand or 2005 - 2007 average pumpage, whichever is larger. Using the larger value corrects a few cases where 2005 - 2007 average pumpage exceeds projected 2045 demand.
3. Demand is interpolated between 2005 - 2007 average pumpage reported to LSGCD and Unit Demand (UD) x HGAC population in 2045 (UD equals to 2005 - 2007 Average Pumpage divided by estimated 2005 - 2007 average population) or 2005 - 2007 average pumpage, whichever is larger. Using the larger value corrects a few cases where 2005 - 2007 average pumpage exceeds projected 2045 demand.
4. Demand equals 128 gpcd times HGAC population for all years.
5. Demand equals 128 gpcd times HGAC population in 2015, then interpolated between 2015 and 2045 demand from questionnaire.

6. Demand equals 2005 - 2007 average pumpage for all future years.
7. Demand is based on use by similar entities.
8. Demand is based on input from the regional power generator indicating increased demand to current contract amount of 7 million gallons per day (mgd). Water demand from 2025 to 2045 equals TWDB projection.

2.1.2 Potential to Reduce Treated Surface Water Infrastructure

Reducing water demand and providing sources of water other than surface water will extend the surface water available for municipal potable water supply and potentially reduce the infrastructure required thus reducing costs. Reducing water demand may be achieved through conservation and drought contingency methods. Conservation efforts implement water saving devices and practices to accomplish long-term savings and reduction in water demand. In contrast, drought contingency measures seek to reduce water demand in the early stages of drought in order to reduce long-term effects of drought and extend the life of water supplies during the drought. Other sources of water include wastewater reuse and raw surface water for irrigation and industrial process applications.

For the purposes of the development of the SJRA Joint WRAP, reducing demand through conservation and/or utilizing alternatives to treated surface water are assumed not to impact the size and location of the treated surface water infrastructure. The greatest obstacle to implementing any of these strategies is their cost relative to the cost of existing water supplies. As the cost of compliance with existing regulations increases, the incentive to conserve water will increase as will the cost-effectiveness of alternative water supplies. Before the potential impacts of these strategies can be adequately quantified to include them in development of plans for future infrastructure, the following must be considered:

- Customer behavior – how retail water customers will react to and accept various water conservation and drought contingency measures.
- Public acceptance – how the public will accept water reuse as a water management strategy.
- Customer's interest to pursue potential projects and their ability or willingness to share in the cost of those projects.
- Cost sharing – should all Joint WRAP Participants share in project costs because the project is part of an overall strategy that achieves regulatory compliance for all customers?
- What will happen to existing wastewater treatment plants that are the supply for a reuse project that may be abandoned when that utility is annexed?

Despite these current uncertainties, all these strategies may play some role in future plans. The potential benefits of these strategies include:

- May reduce the capacity and, therefore, cost of the surface water conveyance system that is required.
- May postpone when future expansions of capacity are required and, therefore, delay future expenditures.
- May extend the available supply of surface water.

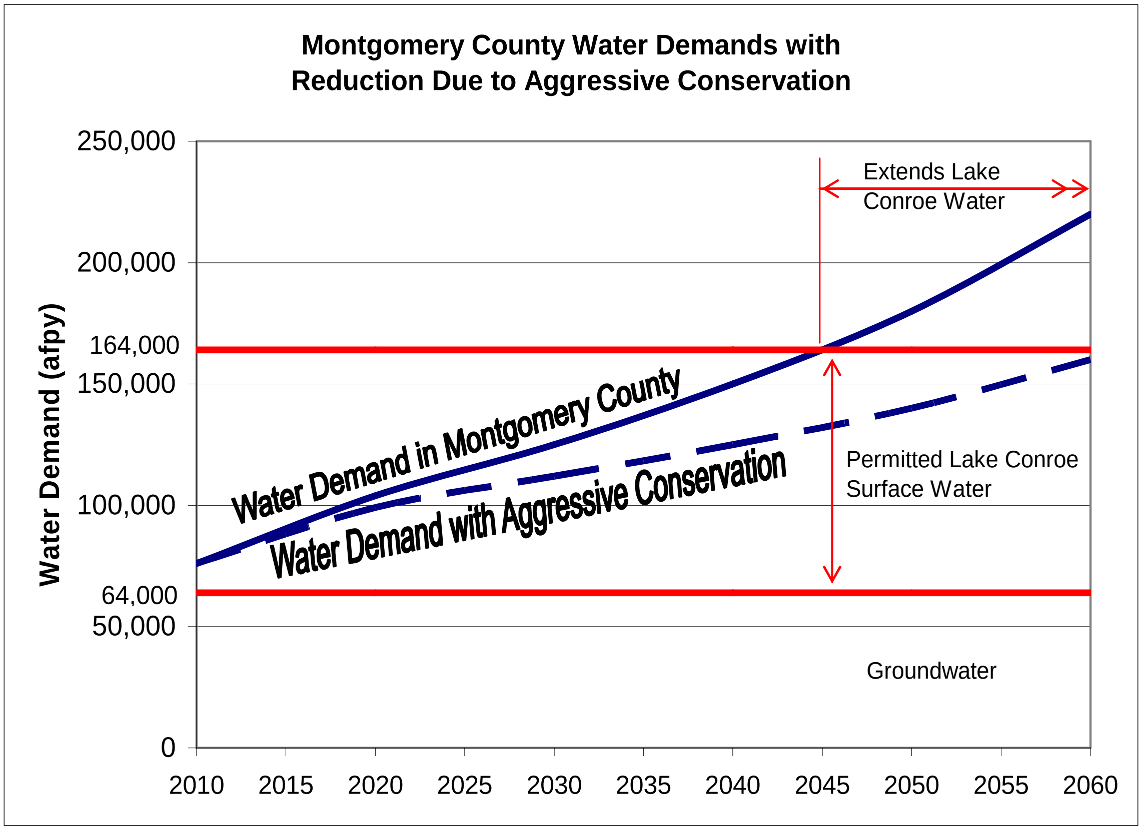
Water Conservation and Drought Contingency Management

The potential benefits of water conservation and drought contingency management include:

- Cost savings to Joint WRAP Participants due to deferred construction of treatment and conveyance infrastructure.
- Savings to customers in pumpage fees, chemical, power, and maintenance costs of groundwater wells.
- Savings to end users (retail customers) in both water bills and possibly wastewater charges.
- Potential reduction in capacity of surface water treatment and conveyance infrastructure.
- Reduction in peak water demand, which reduces the least utilized portion of capacity.

Figure 2.2 illustrates some of the changes to future plans that may occur depending on the degree of conservation realized.

Figure 2.2
Montgomery County Water Demands with Aggressive Conservation



The potential benefits will not be realized unless all parties diligently pursue plans to ensure the success of water conservation and drought contingency efforts. Many Joint WRAP Participants may already have a water conservation plan in place but the degree of success in reducing water demand varies widely. The elements of water conservation plans typically address two major areas: 1) goals, and 2) methods of conservation.

Conservation goals may include, but are not limited to:

- Goals to reduce unit demand (gallons per person per day);
- Goals to minimize inefficiencies and losses, especially unaccounted-for water;
- Goals to improve or maximize the efficiency of the transmission and/or distribution systems.

Methods to encourage and help achieve these conservation goals include, but are not limited to:

- Water rate structure;
- Public information and education;
- Metering and record management practices;
- Meter testing, repair and replacement practices;
- Leak detection and line repair to minimize conveyance losses;
- Placing contractual requirements on customers;
- Fixture retrofit efforts;

Most Participants have a drought contingency plan. The elements of drought contingency plans typically address two major areas: 1) stage trigger points, and 2) target water demand reduction for each stage.

While the SJRA will continue to encourage aggressive conservation, assess the viability of conservation projects, and evaluate the success of conservation efforts, as stated previously, for the purpose of developing this Joint WRAP, water conservation is assumed to have no impact on planning for proposed facilities to meet the requirements for groundwater reduction. The possible success of current or future efforts is too uncertain to rely on those efforts. Instead, their impacts are more certain to increase and become significant as the cost of water increases in the future. The impact of reduced demand will be to delay the need for new infrastructure and/or to reduce the size of future infrastructure.

Use of Reclaimed Wastewater

Numerous potential users of reclaimed wastewater have been identified among the 198 Participants in the Joint WRAP. Possible users of reclaimed water that provide the greatest potential include golf courses, property owners associations, MUDs that currently use groundwater for amenity lake maintenance and/or irrigation, and other irrigated areas such as school athletic fields, and public and commercial landscaping. In addition to simply reusing water, Joint WRAP Participants are encouraged to implement water conserving landscaping practices. The identified potential users are shown on **Exhibit 2**.

All wastewater treatment plants were identified as potential sources of reclaimed water based on information for wastewater discharges permitted by the Texas Commission on Environmental Quality (TCEQ). The identified potential sources are also shown on **Exhibit 2**.

Factors affecting the viability of connecting a potential user with a potential source were investigated including distance and whether the quantity of reclaimed water at the source is adequate to meet the demands of the potential user. Based on this analysis, 25 potential users are highlighted on **Exhibit 2**. To be included in a future, more comprehensive, overall groundwater reduction plan, the use of reclaimed wastewater should be technically feasible, cost competitive and dependable. For these reasons, further analysis is recommended before specific projects are incorporated in future groundwater reduction plans. Use of reclaimed water is a realistic alternative to providing additional infrastructure included in plans for future transmission mains.

Use of Raw Water

Existing development near Lake Conroe was investigated to identify potential uses of untreated surface water for irrigation purposes. Thirty-six potential users of raw water for irrigation were identified on the shore of Lake Conroe. The thirty-six include five that currently purchase raw water from SJRA. Those five are: April Sound, Bentwater, Del Lago, Walden, and West Palm Villas. These users are shown on **Exhibit 3**.

It is estimated that more than two to as much as five million gallons per day (mgd) is used to satisfy the irrigation needs of these five entities. A detailed evaluation of the infrastructure requirements and costs to supply raw surface water to any of these entities is needed to determine the viability of supplying raw surface water and will be evaluated in greater detail in future planning efforts.

Drought Management Strategies

Many drought contingency or drought management plans consist of two major parts. The first major part is “trigger conditions” or stages of severity of the drought as indicated by an appropriate means of measurement. Stages are typically expressed as “Mild”, “Moderate”, “Severe”, and “Critical” or other similar descriptions. Means of measuring drought conditions may consist of comparison of recent rainfall to “normal” rainfall for similar periods, lake levels, the volume of water pumped in comparison to pump or system capacity, and other measures.

The second part is the steps to be taken when each of the trigger conditions are met. Steps typically begin with voluntary action on the part of consumers and increased monitoring on the part of the water supplier. As drought conditions worsen and additional trigger conditions are met, steps typically increase to mandatory reductions in water use, increased efforts to identify and eliminate leaks, operating at reduced pressure, restrictions and potentially prohibitions on certain water using activities, and similar steps.

In addition to these parts, drought management plans may have other elements such as the means of notification of parties that are to act and of the general public, public information and education components, procedures for granting variances, enforcement and penalties, and requirements for updating the plan.

The key point for the purposes of the Joint WRAP is that all Joint WRAP Participants are encouraged to adopt drought management plans so that the water resources of all Joint WRAP Participants are used prudently and preserved for as long as possible during emergency conditions.

2.2 Water Sources

2.2.1 Potential Source Study

The LSGCD DRP Phase II (A) requires certain large volume groundwater users (LVGU) to submit a Water Resources Assessment Plan (WRAP) which includes identification of new water supply sources to meet projected water demands. To satisfy this requirement, the SJRA conducted a "Potential Source Study" that investigated nine alternative water supply sources. The purpose of the study was to identify potential alternative water sources available to Montgomery County to reduce groundwater use and meet projected water demands, evaluate those potential sources, and select a source to be used as the basis for the SJRA Joint WRAP Part II study. Through a preliminary screening process, four of the nine alternatives were identified for further evaluation. The four alternatives are:

- SJRA enters into a Long-Term Water Supply Contract with City of Houston for Lake Conroe raw surface water.
- SJRA enters into a Long-Term Water Supply Contract with Trinity River Authority for raw surface water diverted from Trinity River near Huntsville.
- SJRA enters into a Long-Term Water Supply Contract with City of Houston for Lake Conroe raw surface water plus Long-Term Water Supply Contract with Trinity River Authority for raw surface "replacement" water diverted from Trinity River near Huntsville.
- SJRA enters into a Long-Term Water Supply Contract for imported groundwater.

Based on the present worth of the alternatives, SJRA's Potential Source Study concluded that the most cost-effective water supply alternative is to use SJRA's water rights in Lake Conroe plus the City of Houston's water in Lake Conroe via a long-term water supply contract. The study recommended that the permitted yield of Lake Conroe be utilized to supply surface water in Montgomery County prior to the conveyance of water from additional sources into the county and that a long-term water supply contract with the City of Houston be executed in a timely manner. This selected water supply alternative was used for the purpose of this Joint WRAP. A complete electronic copy of the SJRA Potential Source Study is included in **Appendix E** and is incorporated by reference as part of this Joint WRAP.

2.3 Conversion Strategy

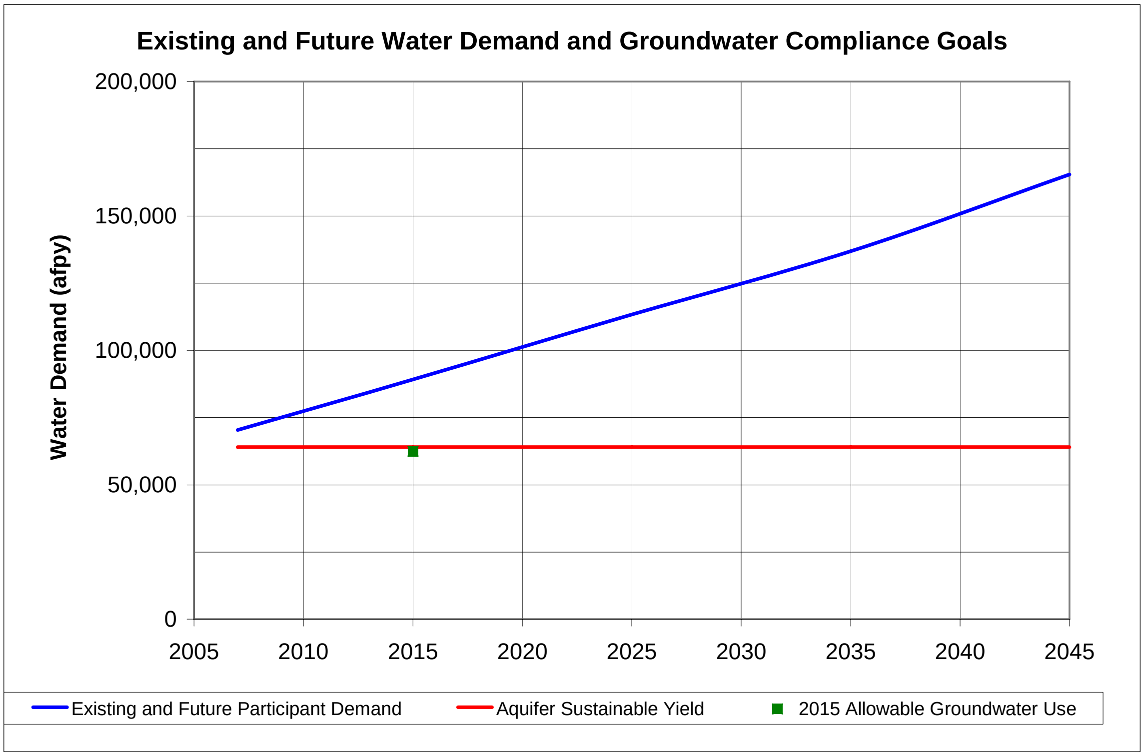
For the purposes of the development of the SJRA Joint WRAP, reducing demand through conservation and/or utilizing alternatives to treated surface water are assumed not to impact the size and location of the treated surface water infrastructure.

The key goal of the LSGCD District Regulatory Plan (DRP) is to reduce withdrawal of groundwater in Montgomery County to less than the sustainable yield of the aquifer. Phase II (A) of the DRP adopted February 12, 2008 requires that groundwater production authorized under permits issued by the District be reduced to no more than 70 percent of total water demand on January 1, 2015. Therefore, based on this regulation, in 2015 the maximum allowable groundwater use by Joint WRAP Participants is 62,446 afpy (55.7 mgd) (89,209 x 70% = 62,446). Under subsection B.4(b) of the Regulatory Plan, WRAPs with multiple groundwater to alternative water conversion projects may provide for growth (of demand) on groundwater between conversions if the Joint WRAP timely meets the initial 70/30 percent conversion requirement in 2015 and the overall average groundwater use for the planning period from 2015 to 2045 is equal to or less than 64,000 acre-feet/year (afpy) (57.1 mgd).

The LSGCD Groundwater Management Plan (GMP), adopted in 2003, assumed the sustainable groundwater yield for Montgomery County is 64,000 afpy based on an annual deep recharge to the Northern Gulf Coast Aquifer System of approximately 1.1 inches per year applied to the area of the county in acres (697,600 acres). The Texas Water Development Board (TWDB) has recently released preliminary results of the Northern Gulf Coast Aquifer Groundwater Availability Model (GAM) which indicate the recharge rate could be considerably less than 64,000 afpy. The LSGCD has contracted with the US Geological Survey (USGS) to conduct a three year study of the recharge rate. Results of that study will not be available until 2010. The LSGCD has chosen not to adopt the TWDB GAM data at this time, but rather wait until the USGS study results are available. For the purposes of this Joint WRAP, the value of 64,000 afpy will be used.

Figure 2.3 illustrates the total demand for the Joint WRAP Participants and their allowable groundwater use in 2015 in relation to the 64,000 afpy (57.1 mgd) allowable average groundwater use from 2015 to 2045. In addition, the area between the total water demand and allowable groundwater use (64,000 afpy) lines represents the 'goal' for surface water use.

Figure 2.3
Existing and Future Water Demand and Groundwater Compliance Goals



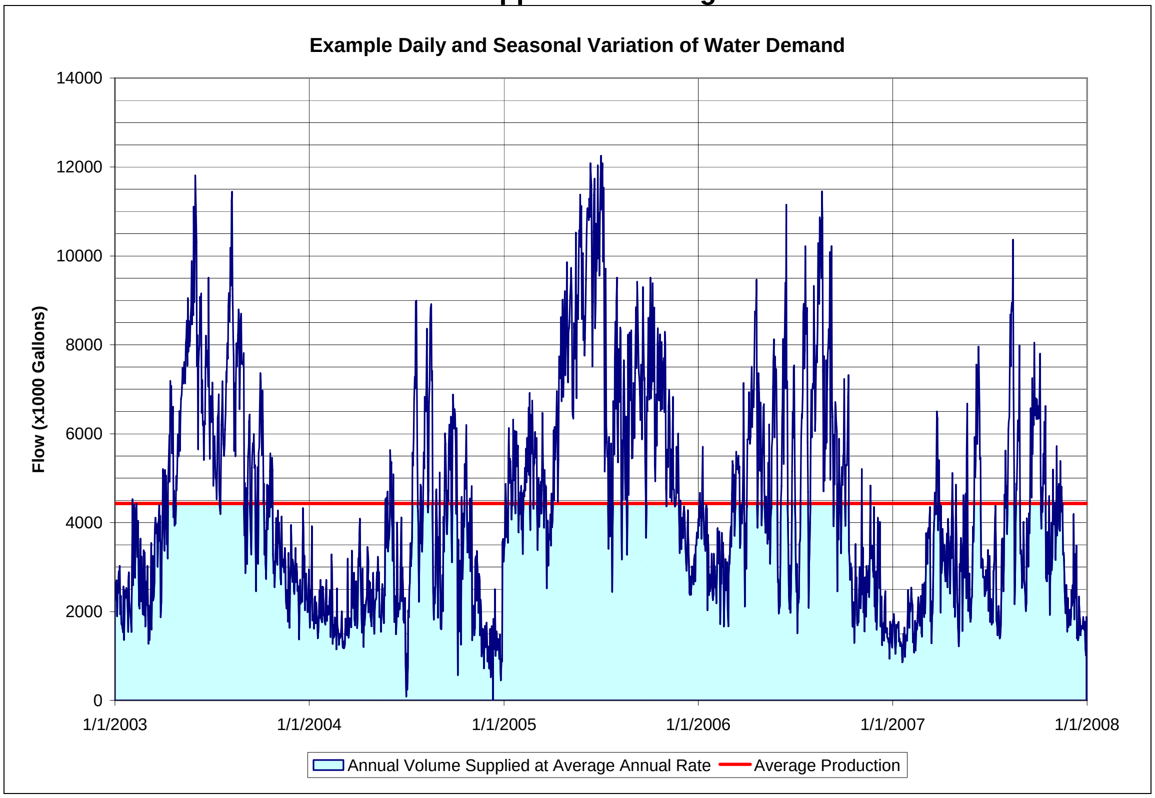
To achieve compliance with LSGCD, Joint WRAP Participants must supply a quantity of alternative water (assumed to be entirely or mostly surface water) equal to the difference between the total Joint WRAP Participants' water demand (blue line in **Figure 2.3**) of 89,209 afpy (79.6 mgd) and the allowable groundwater use (green dot) of 62,446 afpy (55.7 mgd). Therefore, based on LSGCD's current regulation and implementation schedule in 2015, surface water use must equal at least 26,765 afpy (23.9 mgd). For the planning period from 2025 through 2045, compliance is measured by supplying alternative water in sufficient quantity that the average groundwater use during the planning period is less than or equal to 64,000 afpy (57.1 mgd). The strategy to accomplish this is described in Section 2.3.2 Conversion Strategy.

2.3.1 Compliance Assurance Factor

A critical factor to correctly size elements of the surface water delivery system is the daily and seasonal variation of demand throughout the year. It is essential to understand the relationship between daily and seasonal demand and annual volume of water in order to correctly size facilities to deliver surface water at a rate that provides the volume necessary on an annual basis to meet the regulatory goal.

As an example, **Figure 2.4** illustrates daily groundwater pumpage data for 10 wells in Montgomery County for 2002 through 2006. **Figure 2.4** illustrates that there are periods of time when water use is low. During these times, demand may be less than the average rate at which surface water must be delivered to meet the goal for groundwater reduction on an annual basis.

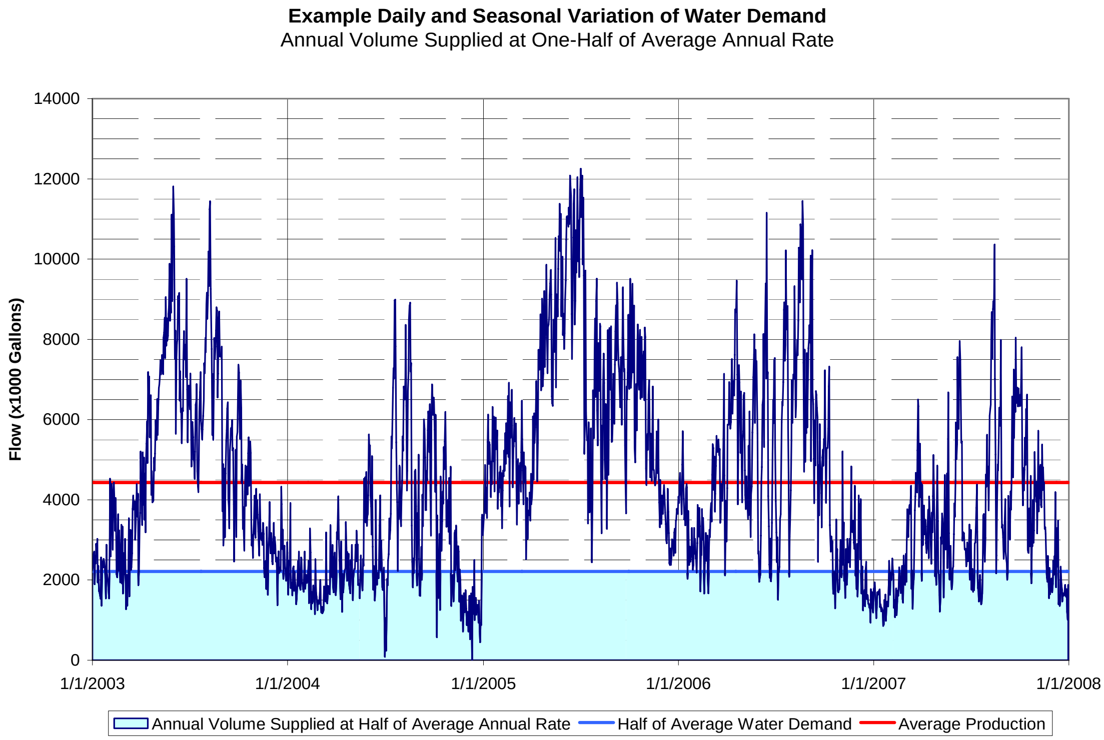
Figure 2.4
Example Daily and Seasonal Variation of Water Demand
Annual Volume Supplied at Average Annual Rate



As seen from **Figure 2.4** the average flow is 4.4 mgd but the daily flows vary from less than 1.0 mgd in the winter months to as high as 12.0 mgd during the summer months. If the treatment and transmission facilities were designed to provide an average flow of 4.4 mgd there are significant periods of time during the year, especially in the summer, where the facilities could not meet the demand. Similarly, there are periods of time during the year, especially during the winter, where the amount of surface water available is greater than the demand. Therefore in order to deliver 100% of the annual demand the treatment and transmission facilities would have to be sized for 12.0 mgd which is 2.7 times the average. This would be cost prohibitive.

Understanding the relationship between the variation in a user's daily demand and the fraction of the user's annual volume of water used is necessary to develop a plan that assures sufficient surface water is utilized to meet the regulatory conversion requirements without unnecessarily over-sizing infrastructure. For comparison, **Figure 2.5** illustrates the volume of average demand supplied if surface water is delivered at a rate equal to one-half of the average day water demand.

Figure 2.5
Example Daily and Seasonal Variation of Water Demand
Annual Volume Supplied at One-Half of Average Annual Rate



The complete relationship between the rate at which flow is delivered and the percentage of annual volume defines a curve. Figures of daily pumpage and CAF curves developed in this analysis are included in an Appendix C to this report. For simplicity, the variation in daily demand is expressed in terms of the average day demand (i.e., average day = 1.0). The term 'compliance assurance factor' (CAF) is used to describe the maximum rate at which surface water must be provided to entities receiving surface water. Based on review of all the CAF figures included in Appendix C, a CAF of 1.0 typically provides approximately 70% to 90% of the annual water demand volume as surface water. Therefore, an 80% conversion was assumed for existing and future regulated users based on supplying surface water at a maximum rate equal to the Participant's average daily water demand. Future study will identify potential impacts on infrastructure assets involved in the supply of water in order to confirm the assumption that replacing 80% of existing groundwater supplies with surface water is operationally feasible and economically sensible.

The CAF is not a peaking rate, rather it expresses the relationship between the maximum rate that surface water is supplied as a factor of average day demand and the percent of the annual volume that occurs and could be supplied at and below that rate or factor. Therefore, when water demand exceeds average daily demand, Participants' groundwater wells will be required to supply that 'peak' water demand that exceeds average demand.

In addition, it is important to understand that introducing surface water as a new source of supply will not change a utility's requirements for storage nor will it adversely affect current storage and pumping operations. Also, receiving surface water will not adversely impact a utility's ability to meet fire flow requirements assuming the utility currently has adequate storage and booster pump capacity.

Adequate storage will be maintained at the surface water treatment plant only for temporary events that force a short-term shut down of a portion or all of the production capacity. Storage at the surface water plant will be sized to provide a cost-effective amount of storage, and if an event should last longer that the amount of storage available, then Participants' wells must be placed in service to provide an uninterrupted supply of water.

2.3.2 Groundwater Reduction

198 Joint WRAP Participants joined together, as allowed by LSGCD's Regulatory Plan, to develop a Joint WRAP because a joint approach provides the following benefits:

- Removes the burden of compliance from 'small' entities not equipped to meet the regulatory requirements on their own.
- Allows Participants to develop the most cost-effective solution to meet regulatory goals.
- Takes advantage of the economy of scale that can be realized by building larger treatment and transmission facilities at lower cost per unit of capacity.

The most cost-effective solution is based on over-converting large concentrations of groundwater use for the benefit of all Participants, especially small, remote, users to which it would be cost prohibitive to convey surface water. An important key to this approach is replacing a large portion of the groundwater used by The Woodlands and the City of Conroe; the two largest groundwater producers centrally located in Montgomery County.

To determine new surface water treatment capacity that must be built and in service by the initial conversion date, this Joint WRAP takes advantage of the fact that the regional power generator already uses surface water in the process of generating electric power. The regional power generator currently has a contract with SJRA for approximately 7 mgd of surface water. A portion of that is captured as runoff before reaching Lake Conroe and the remaining amount is pumped from Lake Conroe to Lewis Creek Reservoir just east of Lake Conroe. Use of surface water to support power generation in Montgomery County is expected to increase through the planning period as indicated in the Region H Water Plan. The regional power generator made information available to the SJRA regarding its existing groundwater wells and their typical use. **Table 2.4** shows projected total water demand and typical groundwater use to estimate future untreated surface water needs for power generation in Montgomery County.

Table 2.4
Power Generation Water Demand (afpy)

	2015	2025	2035	2045
Total Water Demand (Region H)	7,840	9,259	10,861	12,814
Typical Groundwater Use	807	807	807	807
Estimated Future Surface Water Demand	7,033	8,452	10,054	12,007

The alternative water supply strategy proposed for this Joint WRAP uses the power generator's "Estimated Future Surface Water Demand" above to reduce the capacity of future surface water treatment facilities by an equal amount.

Referring back to **Figure 2.3**, the surface water required is represented by the area between the water demand (the blue line) and 64,000 afpy (the red line). However, as described in Section 2.3, subsection B.4(b) of the LSGCD's Regulatory Plan allows WRAPs to provide for growth (of demand) on groundwater between conversions. Therefore, the strategy utilized in this Joint WRAP proposes that groundwater use will grow between expansions of surface water treatment and conveyance capacity.

For the purposes of this Joint WRAP, the average surface water to be delivered at 10 year milestones is: 18 mgd in 2015, 54 mgd in 2025, 72 mgd in 2035, and 89 mgd in 2045. The above treatment capacities in mgd are equal to 20,164 afpy in 2015, 60,492 afpy in 2025, 80,656 afpy in 2035, and 100,000 afpy in 2045. These capacities coincide with the assumed 80% conversion of annual volume described earlier. To meet the groundwater reduction requirement, the surface water treatment and conveyance systems must have a capacity equal to 125% percent of the average surface water to be delivered. The proposed treatment plant design capacity is addressed in Section 4, Infrastructure. Based on delivering the above average volume of surface water annually, **Table 2.5** illustrates the proposed groundwater reduction strategy.

Table 2.5
Groundwater Reduction Strategy (afpy)

	2015	2025	2035	2045
Existing and Future Participant Demand	89,209	113,290	136,877	165,453
Power Generation Estimated Surface Water Demand	7,033	8,452	10,054	12,007
Average Treated Surface Water Delivered	20,164	60,492	80,656	100,000
Groundwater Use	62,012	44,346	46,167	53,446

Figure 2.6 also graphically illustrates the groundwater reduction strategy with the graph showing the total groundwater pumpage on an annual basis.

Figure 2.6
Joint WRAP Groundwater Reduction Strategy

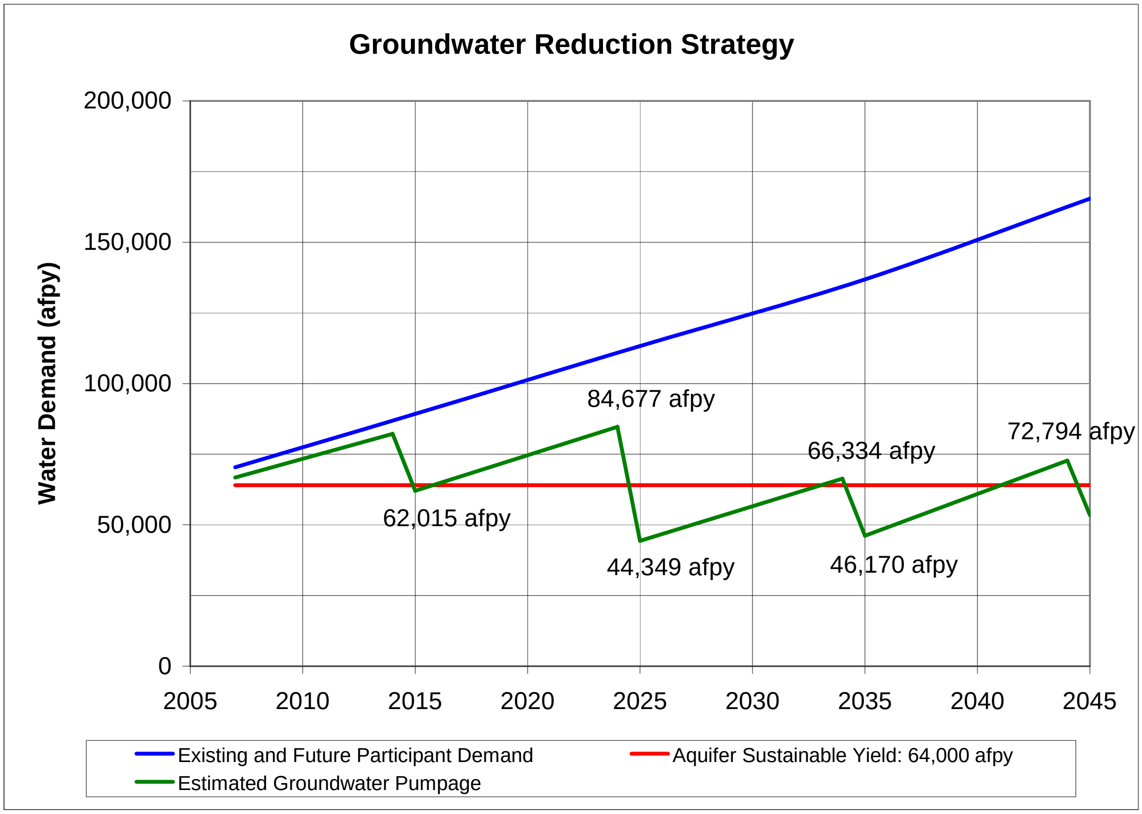


Figure 2.6 shows the maximum and minimum groundwater use prior to and following major expansions of surface water treatment capacity upon which the groundwater reduction strategy is based. These values provide the foundation for **Table 2.6** demonstrating that average groundwater use over the planning period is less than 64,000 afpy as required by LSGCD. The calculated average for the 30 year planning period (2015 through 2044) is less than 64,000 afpy, as required. Adding the groundwater used in 2045 only decreases the average because additional surface water capacity is utilized in 2045 and groundwater use will be less than 64,000 afpy.

Table 2.6
Confirmation that Proposed Groundwater is Less Than 64,000 afpy

Year	Groundwater Used (afpy)	Year	Groundwater Used (afpy)
2015	62,015	2030	56,563
2016	64,533	2031	59,006
2017	67,051	2032	61,449
2018	69,569	2033	63,892
2019	72,087	2034	66,334
2020	74,605	2035	46,170
2021	77,123	2036	49,128
2022	79,641	2037	52,087
2023	82,159	2038	55,045
2024	84,677	2039	58,003
2025	44,349	2040	60,961
2026	46,792	2041	63,919
2027	49,235	2042	66,877
2028	51,678	2043	69,836
2029	54,120	2044	72,794
		Total	1,881,702
		Average	**62,723**

The conversion strategy also addressed identifying Participant facilities to which to deliver surface water. As stated previously, the approach pursued in this Joint WRAP is to develop the most cost affective solution to meet regulatory goals. A major tactic in developing the most cost-effective solution is to over-convert large concentrations of groundwater use. Therefore, The Woodlands is converted to approximately 80% surface water by delivering surface water to all five existing water plants in The Woodlands. In addition, the majority of the City of Conroe's water demand west of Interstate Highway 45 (IH 45) is converted to surface water by delivering enough surface water to replace approximately 80% of the annual water production of the City's water plants west of IH 45. For the initial 2015 conversion, water plants were added to each alternative until 80% of their average water demand equaled the required conversion of 30% of total demand for all Participants including the regional power generator's use of untreated surface water. In the selection of Participant water plants, consideration was given to:

- minimizing the length of water line,
- avoiding the additional cost associated with crossing IH 45,
- delivering surface water to all of a Participants groundwater storage facilities (not wells pumping directly to the distribution system or to elevated storage),
- delivering surface water to groups of Participants in relatively close proximity to one another.

For conversions after 2015, projected 2045 water demands were considered in the determination of facilities to add to the ultimate conversion strategy. Again, facilities were added to each alternative until 80% of their average water demand equaled the required conversion amount indicated as “Proposed Surface Water Treatment Capacity” in **Table 2.6**, above. The same considerations apply to future phases except that it becomes necessary to cross IH 45.

Section 3
Evidence of Availability and Willingness to Supply Water

The SJRA and City of Houston are currently negotiating a Memorandum of Understanding (MOU) regarding elements of a future long-term water supply agreement to purchase the City's share of capacity in Lake Conroe. The agreement will be subject to the approval of the SJRA Board of Directors as well as the Houston City Council. Key elements of the MOU regard:

1. The annual reservation fee to secure Houston's share of Lake Conroe surface water.
2. The untreated water rate to be paid for raw surface water.
3. The term of the agreement and possible renewals.
4. Other considerations.

A copy of a letter of availability from the City of Houston is provided in **Appendix D**.

Section 4
Infrastructure

The approach to determine the preferred surface water transmission system through a process of identifying potential corridors, developing competing alternatives, estimating their costs, and selecting the most economical is described in the separate report, "Joint Water Resources Assessment Plan –Alternative Analysis" (Alternative Analysis). The following paragraphs summarize many results of that study and the reader is referred there for additional information. A complete electronic copy of the Alternative Analysis is included on a disc located in **Appendix E** and is incorporated in this report by reference.

4.1 Water Treatment Facilities

This Joint WRAP Part II provides preliminary information regarding capacity of surface water treatment infrastructure and treatment processes. For the purpose of this Joint WRAP Part II, the water treatment plant is assumed to be located at the Lake Conroe dam. Final process selection is only possible after additional study is performed in a number of areas including the determination of the potential to form various disinfection byproducts based on the source water quality and different disinfectants. Until additional quality and treatability studies are performed, utilization of demonstrated, multi-barrier technology in the form of conventional treatment processes is assumed. In addition, assuming conventional treatment at this time, results in a conservatively large plant site requirements for current planning. The following paragraphs provide a basic description of conventional treatment unit processes including flocculation, sedimentation, filtration, and disinfection.

Flocculation

With the proposed water treatment plant located at Lake Conroe, no pre-sedimentation is planned. The flocculation process removes suspended solids and precipitates some dissolved compounds sometimes present in raw surface waters. Various chemicals selected for their ability to perform these functions will be thoroughly mixed with the raw water stream before continuing to the flocculation zone where gentle mixing continues. Selection of the proper chemicals and chemical dose is essential to remove organic matter in order to minimize the potential formation of undesirable disinfection byproducts.

Sedimentation

Precipitates and flocculated particles settle out of the slowly flowing stream in large basins. Traditional sedimentation employs large basins and gravity to settle sediments to the bottom of the basin. High rate sedimentation processes employ additional mechanical and/or physical methods to enhance sedimentation and, therefore, employ smaller basins than traditional sedimentation. Following sedimentation, the clarified water is filtered, but may also be disinfected before being filtered.

Filtration

After additional study, later preliminary design will select a conservative filter loading rate to ensure that the filters operate effectively to meet more stringent water quality regulations. Filtered water continues to a clearwell designed to provide sufficient detention time for the disinfection process.

Disinfection

Primary disinfection is critical to inactivate organic matter that has not been removed in previous treatment processes. The disinfectant must not be allowed to combine with organic matter to form significant disinfection byproducts. For this reason, chlorine is usually avoided as the disinfectant and chloramine is frequently chosen for its lower potential to form undesirable byproducts. An alternative disinfectant, chlorine dioxide, could be generated on site for use in this application. Still, it is assumed that chloramine will be used to provide disinfectant residual in the distribution system.

Advanced Treatment

As future regulations require treated water to meet more stringent standards of quality, ‘advanced’ treatment in addition to conventional treatment may be required. Advanced treatment may use a membrane process to provide additional solids removal or add disinfection using ultraviolet radiation or ozone.

In addition to the processes described above, treatment plant operations will require supporting facilities including laboratory testing facilities and office space, lockers and restrooms for staff. Lab facilities will allow staff to perform the chemical analyses necessary to optimize the treatment process, test, and report water quality. In addition, space will be required for tool and parts storage as well as working area to conduct routine maintenance. Costs for these supporting facilities are included in Region H estimates for water treatment plant capital costs.

Major components such as raw water intake and pump station, the treatment units, storage tanks, and high service pump station may be designed, bid and constructed as separate projects. The following discussion is primarily concerned with the capacity required for these components so they are addressed generally or as a whole rather than individually.

The raw water intake structure draws water from various lake depths to enhance the effectiveness of the treatment process and quality of the treated water. In addition, it must ‘reach’ water when lake levels may be low. The raw water intake is often considered as part of the raw water pump station because both functions often are performed by the same physical structure. Backup power is desirable for the proposed water treatment and pumping facilities to ensure their continued operation in the event of a loss of normal power.

Ground storage tanks for treated water are assumed to be constructed of steel or prestressed concrete at ground level. For purposes of this Joint WRAP Report, four 10 million gallon storage tanks are assumed at the proposed water treatment plant.

A booster pump station will deliver water to Joint WRAP Participants. Pump station costs are influenced by many factors including the type, size and number of pumps, structural design of facilities, complexity of electrical, instrumentation and control systems, and site conditions among others. All of these must be addressed in detail in future investigations.

Conversion Strategy, as described in Section 2.3, outlined the regulatory requirements for surface water treatment capacity to be provided. The conversion strategy went a step further to provide estimates of future groundwater use based on the average rate at which surface water must be treated and delivered. Section 2.3 also introduced the concept of the Compliance Assurance Factor that addresses the relationship between the rate of demand (expressed as a fraction of average day demand) and the percent of annual water volume that occurs at or below that rate. It was found that by supplying surface water at a rate equal to a Participant's average day demand (CAF = 1.0), surface water would be approximately 80% of the volume of the Participant's annual water demand.

In other words, due to the daily and seasonal variation in water demand, the water supply system must be designed to convey 125% of the average daily surface water to be delivered to meet the groundwater reduction regulations. The system capacity in excess of the average annual water demand is not used to supply additional treated surface water to individual water users as a peaking factor for daily or seasonal peaks. Each water user will continue to use groundwater to meet daily and seasonal peak demands in excess of the average annual water demand rate. Instead, more water plants would receive treated surface water in order to ensure that the regulatory requirements are met.

Table 4.1 summarizes information regarding required surface water, average surface water treatment rate, and proposed surface water treatment capacity. For the purpose of estimating costs for this Joint WRAP, no standby treatment modules or capacity were assumed. Instead it is assumed that groundwater pumpage would be increased during periods in which process trains are taken out of service for maintenance, repair or other temporary periods. Treatment plant costs are based on the capacity constructed and not on the capacity of individual treatment modules or trains.

Above it was stated that the water supply system must be designed to convey 125% of the average daily surface water to be delivered to meet the groundwater reduction regulations. In 2015, 20,164 afpy is equivalent to 18 mgd. Assuming two treatment modules are constructed to provide the total capacity, then 125% of 9 mgd requires treatment modules of 11.25 mgd capacity. For the purposes of this study, 12 mgd treatment modules were assumed that will provide 6 to 7 percent additional capacity. This surplus capacity provides a buffer to ensure that the desired water quality is attained and can be used to generate over-conversion credits if LSGCD adopts a policy regarding credits. The values for 'Proposed Surface Water Treatment Capacity' in **Table 4.1** reflect the assumption that capacity will be constructed in increments of 12 mgd (13,443 afpy) modules.

Table 4.1
Surface Water Treatment Capacity (afpy)

	2015	2025	2035	2045
Estimated Treated Surface Water Required	19,730	40,838	62,823	89,446
Average Treated Surface Water Delivered	20,164	60,492	80,656	100,000
Proposed Surface Water Treatment Capacity (12 mgd modules)	26,885	80,656	107,541	134,426

4.2 Water Transmission System

Water demands for Joint WRAP Participants were identified in Section 2.1 – Water Demand. As described in the Alternative Analysis Report, alternative pipeline systems were laid out based on the corridors investigated, and hydraulic modeling was used to size proposed transmission mains. The hydraulic analysis was performed assuming flow rates consistent with the projected demand in the year 2045. In addition to supplying treated surface water to delivery points in the City of Conroe and The Woodlands, hydraulic models included connections to approximately 50 existing users along ten lateral water lines. A discussion of lateral water lines for future phases is in the Alternative Analysis Report.

The investigation of the corridors included a preliminary investigation of engineering considerations, for example, urban vs. rural construction environment, potential underground and overhead conflicts, stream and transportation crossings, and other surface impacts (i.e., schools, commercial areas). In addition, the environmental assessments identified and/or described conditions in each of the following areas:

- soils and major vegetation communities,
- threatened or endangered species
- potential waters of the United States,
- cultural resources, historic, and archeological resources,
- hazardous materials, and
- existing land uses.

Costs were applied to each alternative and the present worth of future annual costs including debt service, purchased water, and operation and maintenance were determined. The alternative with the lowest present worth, T2C1W1, was selected as the preferred alternative and its costs are the basis for this Joint WRAP Part II. **Exhibit 4** shows the preliminary system of 2015 water lines.

Estimates of cost were based on the conservative assumption that easements are purchased rather than being within the public or private right-of-way. The possibility of co-locating proposed water lines within existing corridors (i.e., gas/petrochemical pipeline, overhead electric power transmission, etc.), is unlikely because there is typically insufficient space to construct a large diameter water main in the corridor. In addition, the existing easement holder may anticipate the need to expand the capacity of their utility in the future and would not allow a water line to be constructed in their easement.

When the present worth of the alternatives was determined, the difference between alternatives is less than 5% due to so many of the underlying costs being common to or at least similar in all alternatives. As an additional measure of the cost-effectiveness of alternatives, capital costs of the first, 2015, phase of conversion were ranked. Alternative T2C1W1 ranks first by both measures of cost-effectiveness.

Because costs for alternatives are similar, no alternative should be entirely removed from future consideration. However, Alternative T2C1W1 is used as the basis for the Joint WRAP Part II to meet the regulatory requirements of the LSGCD and is described in the following paragraphs.

4.3 Description of Preferred Alternative

For the purposes of this Joint WRAP, Alternative T2C1W1 was selected as the preferred alternative based on the economic analysis that included preliminary sizing of water lines and estimates of construction, operation, and maintenance costs. **Figure 4.1** shows preferred Alternative T2C1W1 with future lateral pipes to serve additional Joint WRAP Participants through 2045. In addition, **Figure 4.2**, a 20-sheet set of maps provides detail at a scale of 1” = 1,000’ of the preliminary water lines proposed for the 2015 phase of conversion to surface water.

In this alternative, there will ultimately be three primary surface water transmission lines:

- To the east, serving the City of Conroe and other adjacent or nearby Participants to the north, south and east of Conroe.
- To the south, serving The Woodlands and other adjacent or nearby Participants to the north, east, south, and west of The Woodlands.
- To the west, serving Participants on the west side of Lake Conroe, including the City of Montgomery.

The following sections describe the proposed transmission main system including water lines constructed after 2015.

East Transmission Line

The east transmission line of the preferred alternative follows the C1 corridor, which proceeds east from the water treatment plant, and then turns in a southerly direction, parallel to an energy corridor occupied by Copano (natural gas) and overhead electric power lines. From a point near the intersection of SH 3083 and Longmire Road, the corridor turns east and generally follows parcels one-half mile north of Loop 336 on the north side of the City of Conroe. Corridor C1 runs directly past existing City of Conroe

Water Plants 8, 12 and 14. Lateral pipelines will later deliver treated surface water to existing City of Conroe Water Plants 5, 6, 7, 15, 18, and 20.

Treated surface water will also be delivered to other Participants via other lateral pipelines or extension of the lateral pipelines serving the City of Conroe Water Plants.

- Participants in the area east of Lake Conroe, including the City of Panorama Village, would be served by a network of lateral pipelines that initially run in a northerly direction parallel to the energy corridor occupied by Copano (natural gas) and overhead electric power lines.
- Participants to the north of the City of Conroe, including the City of Willis would be served by a network of lateral pipelines that initially run in a northerly direction from the lateral line which will serve Conroe Water Plant 15.
- Participants to the south of the City of Conroe, including the River Plantation MUD would be served by a network of lateral pipelines that initially run in a southerly direction from the lateral line which will serve Conroe Water Plant 18.

Based on estimated Participant water demands and preliminary sizing of the system, the East transmission line system:

- conveys more than 20 mgd of treated surface water (average annual demand)
- serves 15 Participants
- delivers surface water to more than 20 existing water plants (8 locations in Conroe)

South Transmission Line

The south transmission line of the preferred alternative follows the North-South T2 corridor. A water transmission line in this corridor would initially run south from the water treatment plant generally along property lines to and then parallel with an underground hydrocarbon pipeline corridor occupied by ConocoPhillips and Magellan. The southern end of the corridor briefly follows SH 1488 and the future Kuykendahl Road (or the parallel Buck Shot Lane) to The Woodlands Water Plant 3.

Distribution to the other four water plants within The Woodlands and other nearby Participants would follow the hybrid alignment that combines elements of the original W1 and W3 corridors. From The Woodlands Water Plant 3, the transmission line initially runs in a southerly direction along Kuykendahl Road to the Bear Branch corridor. From that point, lateral pipelines would run both westerly and easterly along the existing flowage easement for Bear Branch. Within The Woodlands, the western lateral would serve Water Plant 4, and the eastern lateral would serve Water Plants 1, 2, and 5.

Treated surface water would also be delivered to other nearby Participants via additional lateral pipelines constructed after 2015.

- A lateral pipeline would serve Participants in the Carriage Hills area north of SH 1488 directly from the T2 pipeline.
- Participants in the area to the northwest of The Woodlands (near the intersection of SH 1488 and SH 2978) would be served by a lateral from the western Bear Branch pipeline.
- Participants in the area east and southeast of The Woodlands, including the City of Shenandoah and eleven other Participants east of IH 45 would be served from a lateral pipeline near the eastern end of the W1 corridor. There are two likely locations for the crossing, where existing water plants are located both west and east of the Interstate within one mile of each other:
  - North of the Research Forest Drive interchange, between the western and eastern Shenandoah water plants
  - North of the Rayford Road / Sawdust Road interchange, between the Montgomery County MUD 19 and South Montgomery County MUD water plants
- Participants in the area south of The Woodlands, west of IH 45, and east of Spring Creek, served by an extension of the lateral pipeline to The Woodlands Water Plant 1.

Based on estimated Participant water demands and preliminary sizing of the system, the South transmission line system:

- conveys approximately 55 mgd of treated surface water (average annual demand)
- serves 26 Participants
- delivers surface water to more than 30 existing water plants

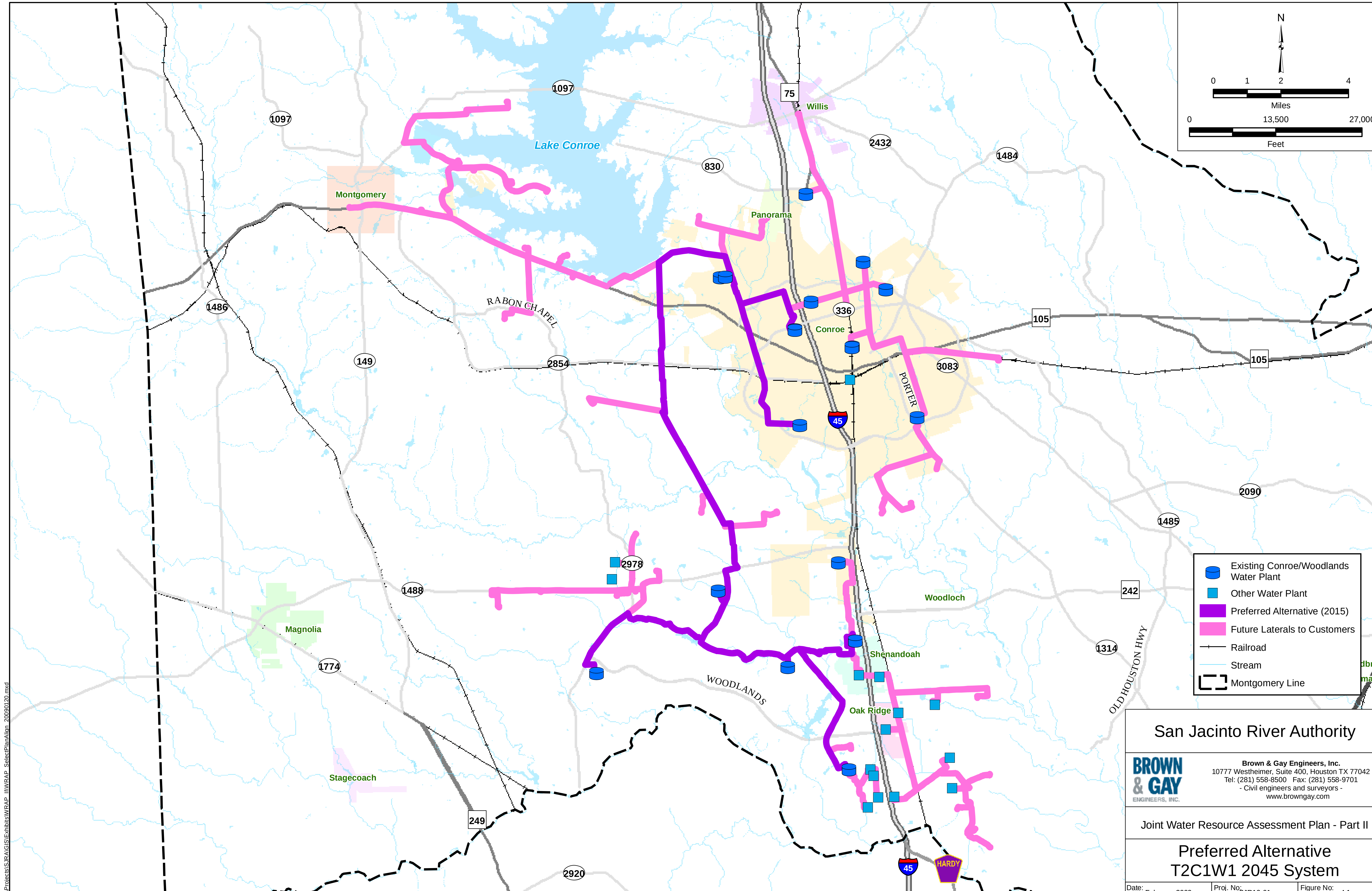
West Transmission Line

This pipeline, which would not be constructed until after 2015, proceeds in a westerly direction parallel to SH 105 from the water treatment plant at the Lake Conroe dam. Participants include the City of Montgomery and 14 other water users located on the west side of Lake Conroe that will be served by laterals from the west transmission line.

Based on estimated Participant water demands and preliminary sizing of the system, the West transmission line system:

- conveys approximately 16 mgd of treated surface water (average annual demand)
- serves 15 Participants by delivering surface water to 15 existing water plants

Figure 4.1 shows preferred Alternative T2C1W1 with future lateral pipes to serve additional Joint WRAP Participants through 2045.



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Other Water Plant
Preferred Alternative (2015)
Future Laterals to Customers
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Stream
Montgomery Line
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Preferred Alternative
T2C1W1 2045 System
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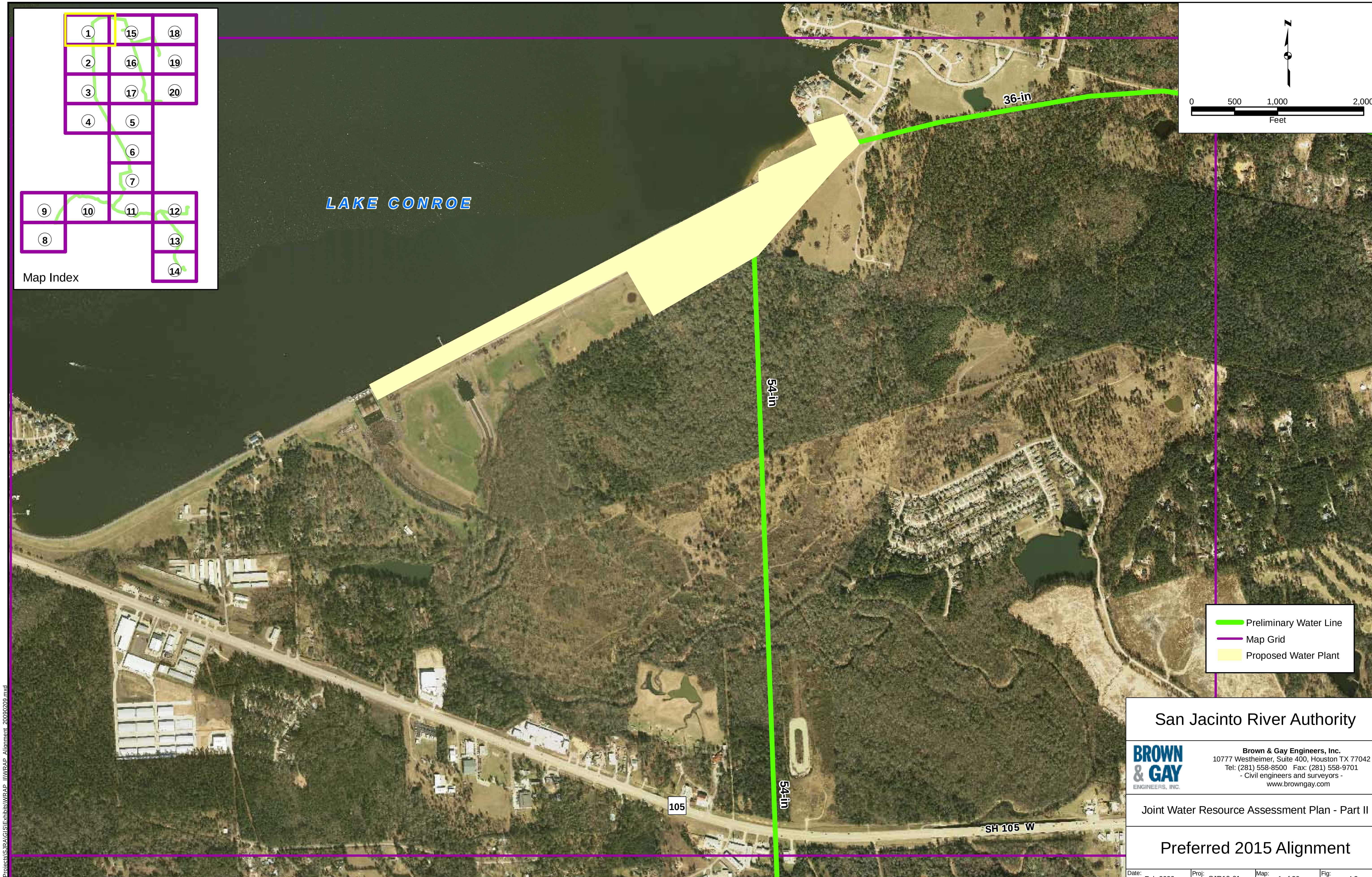

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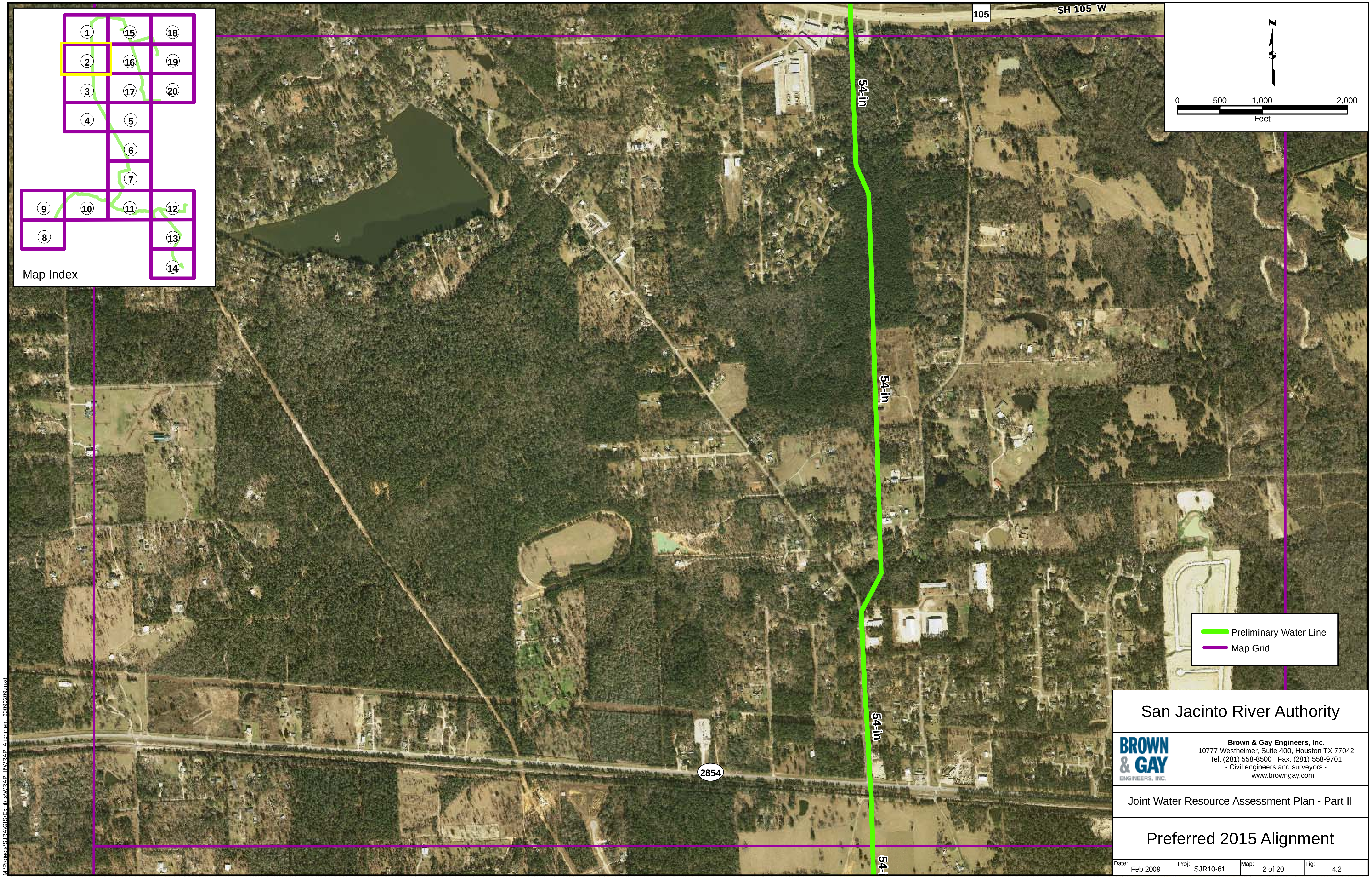

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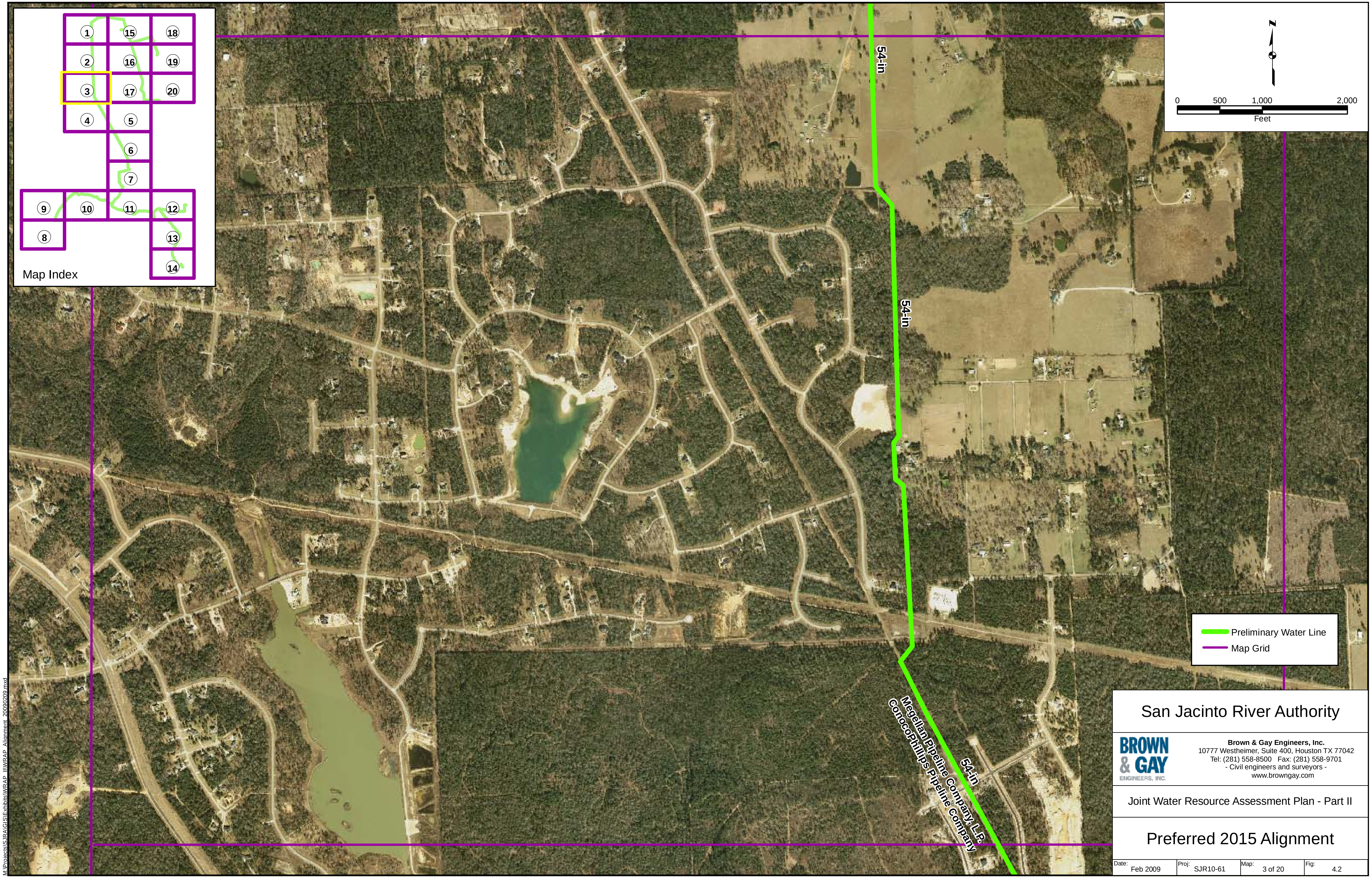

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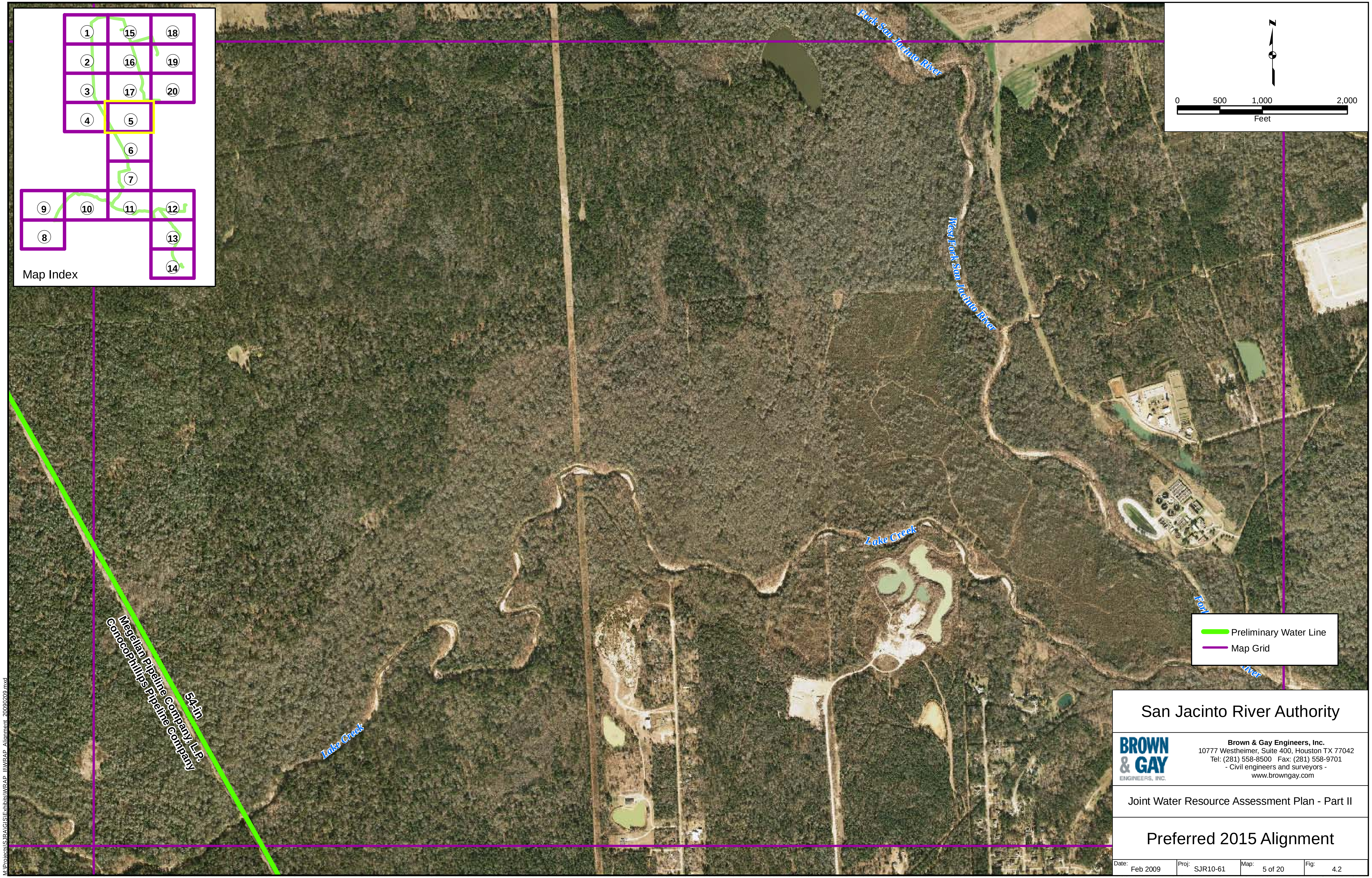

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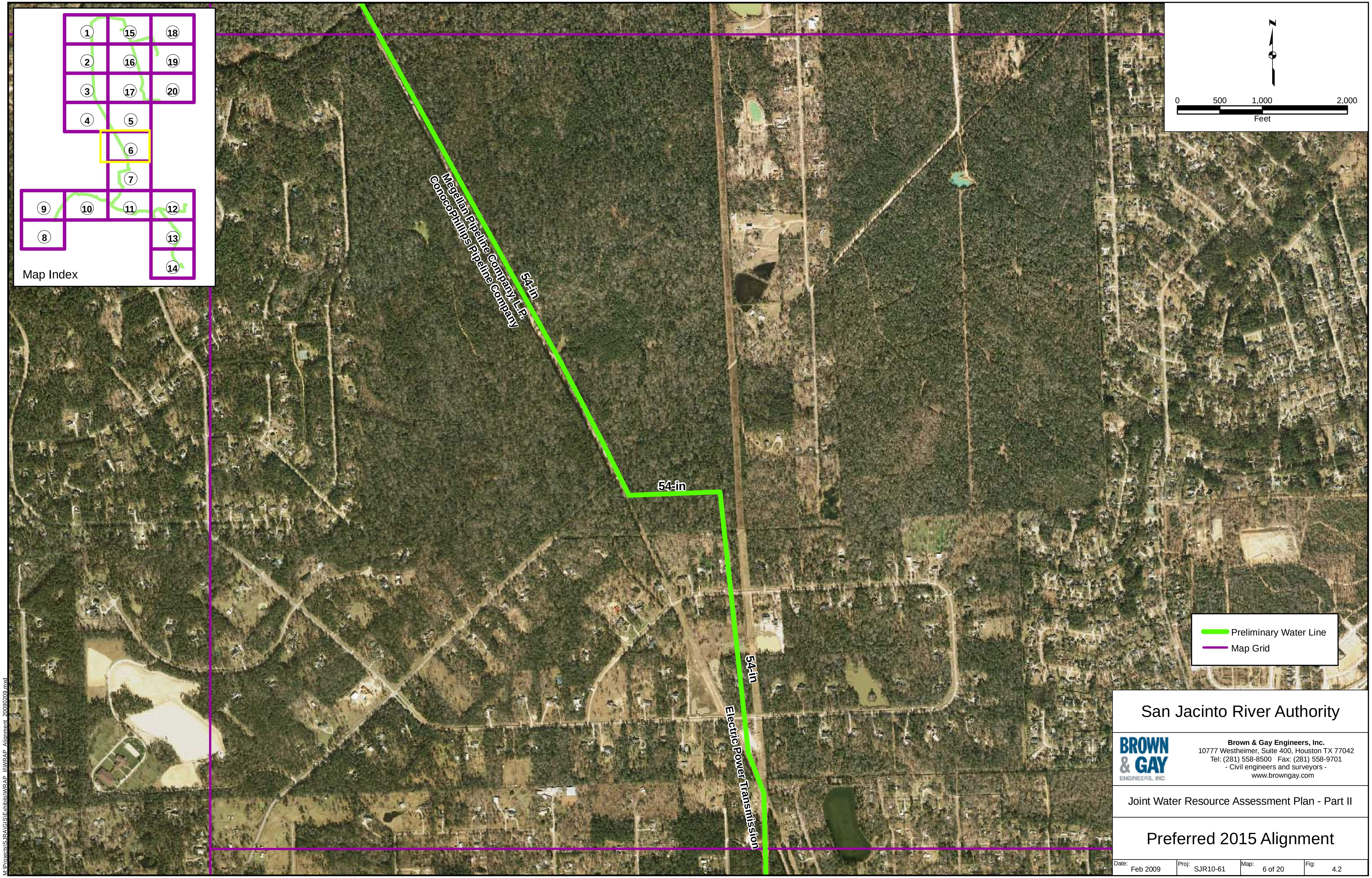

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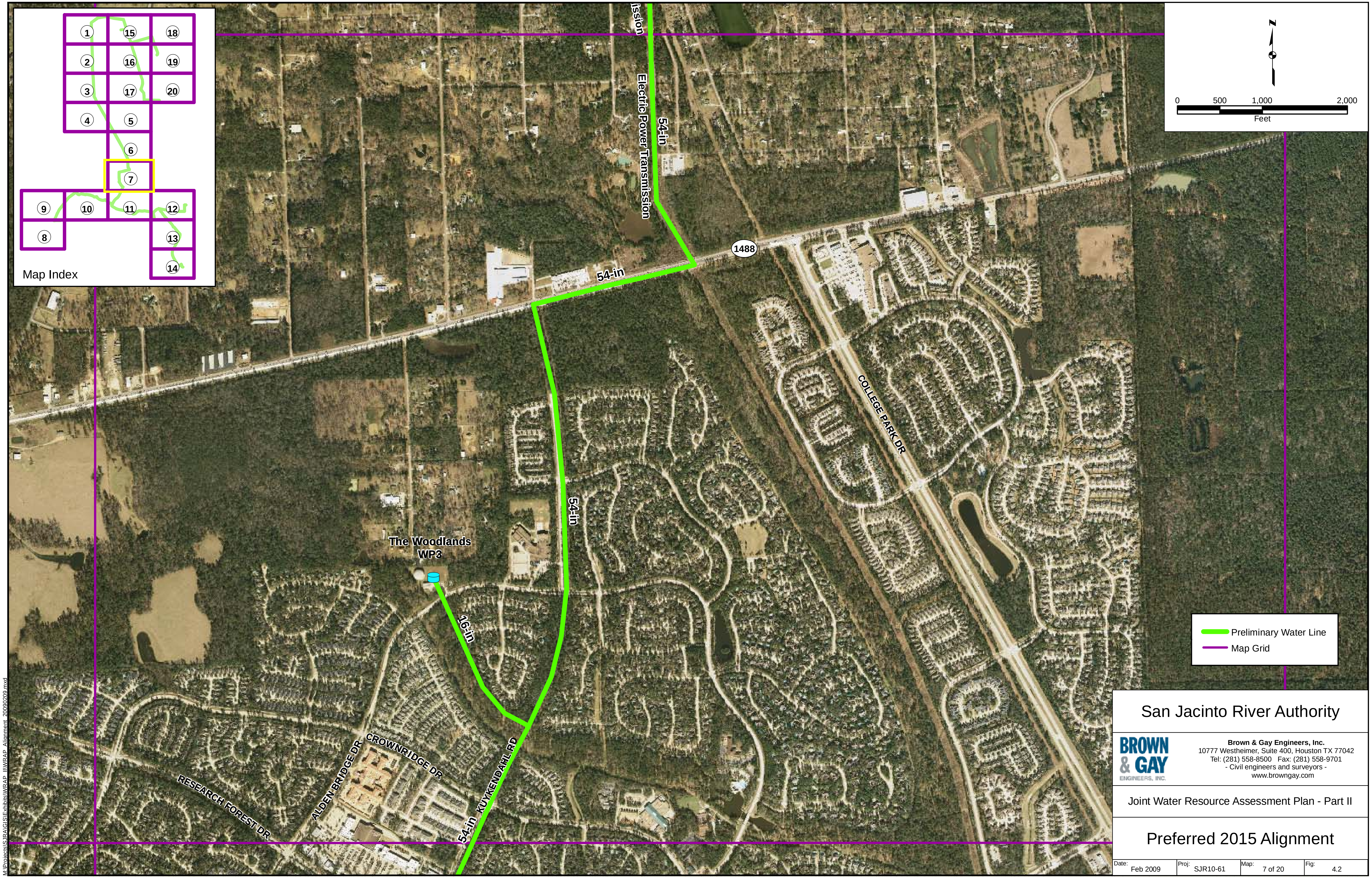

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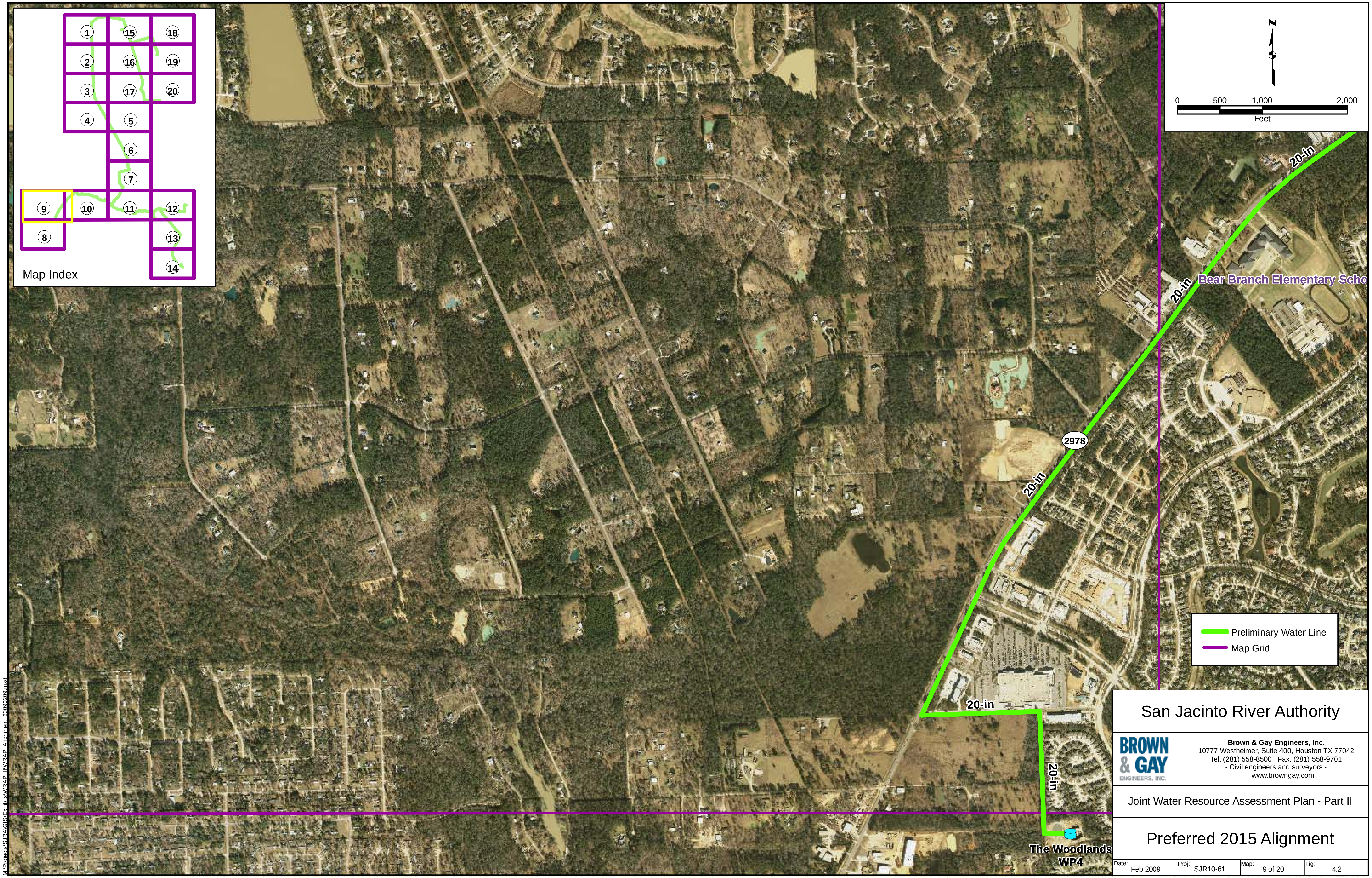

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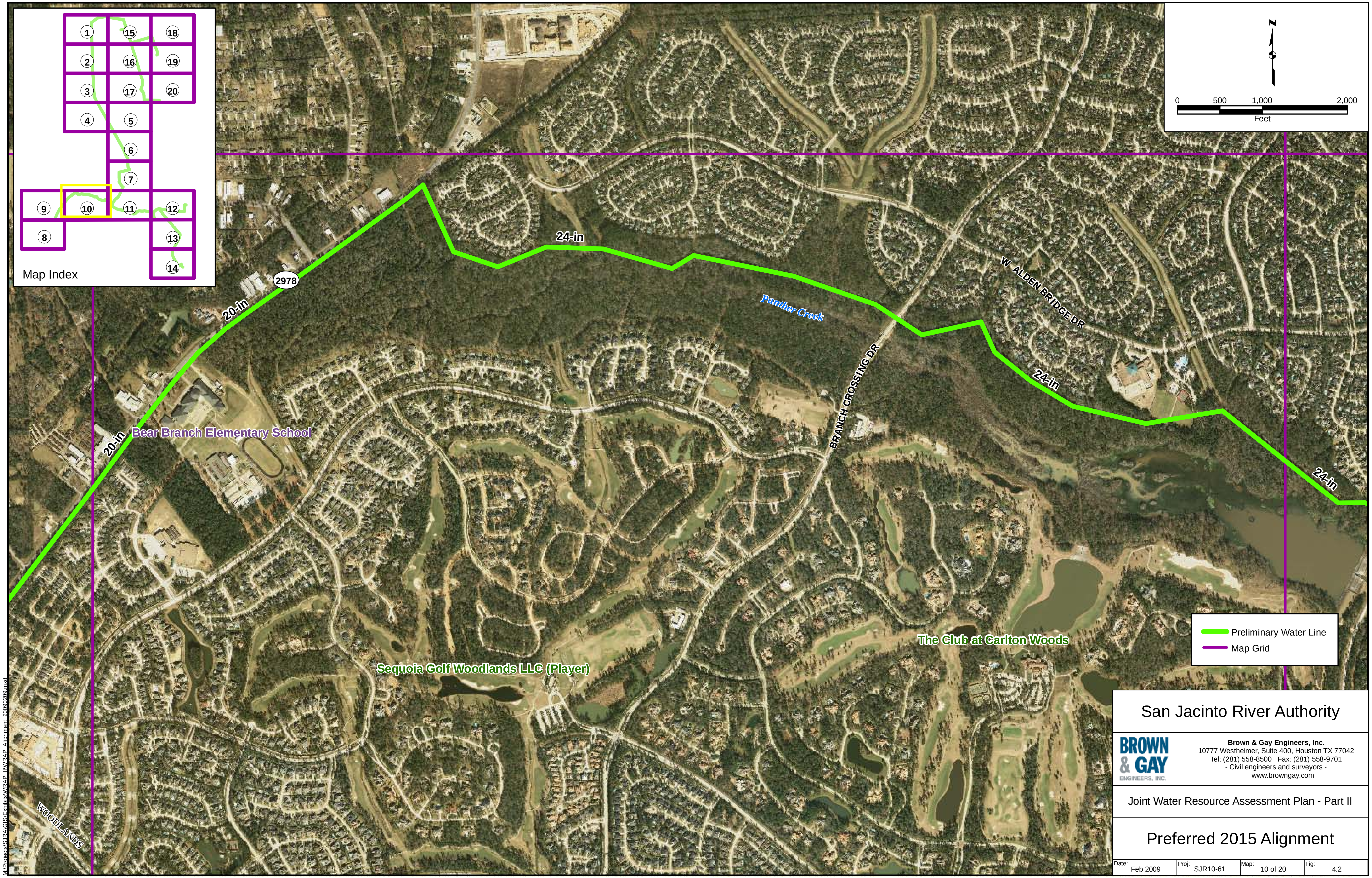

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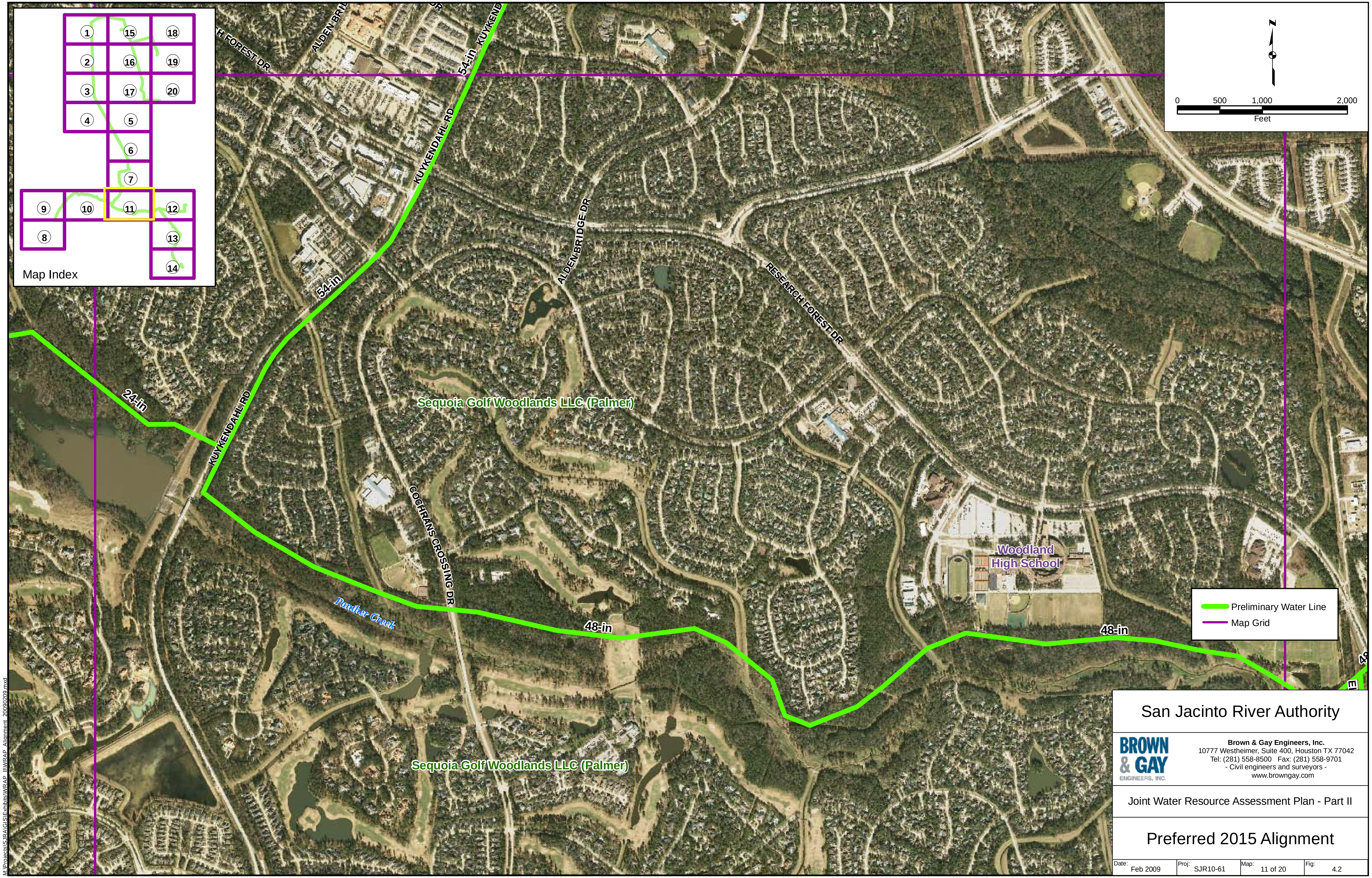

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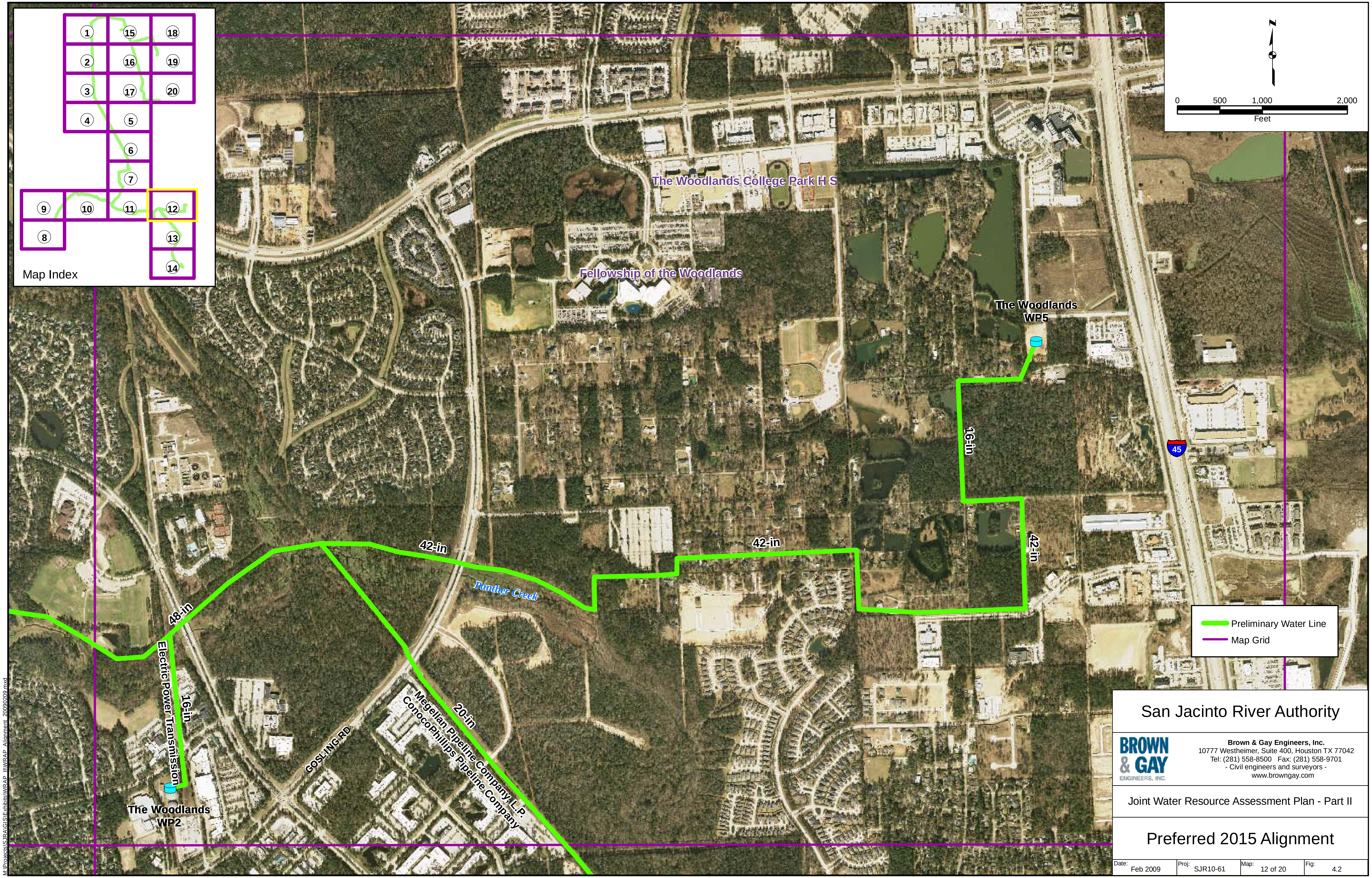

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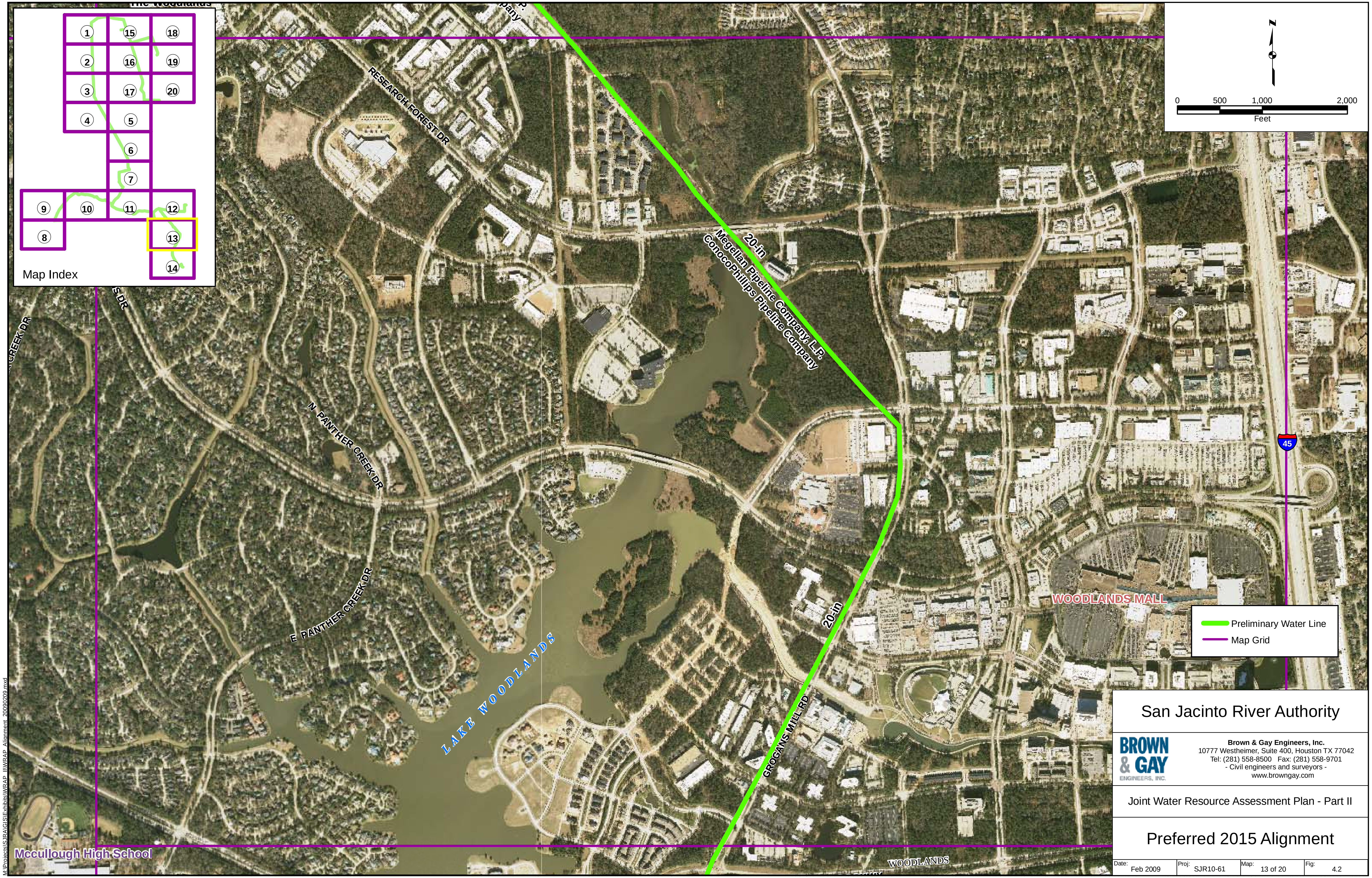

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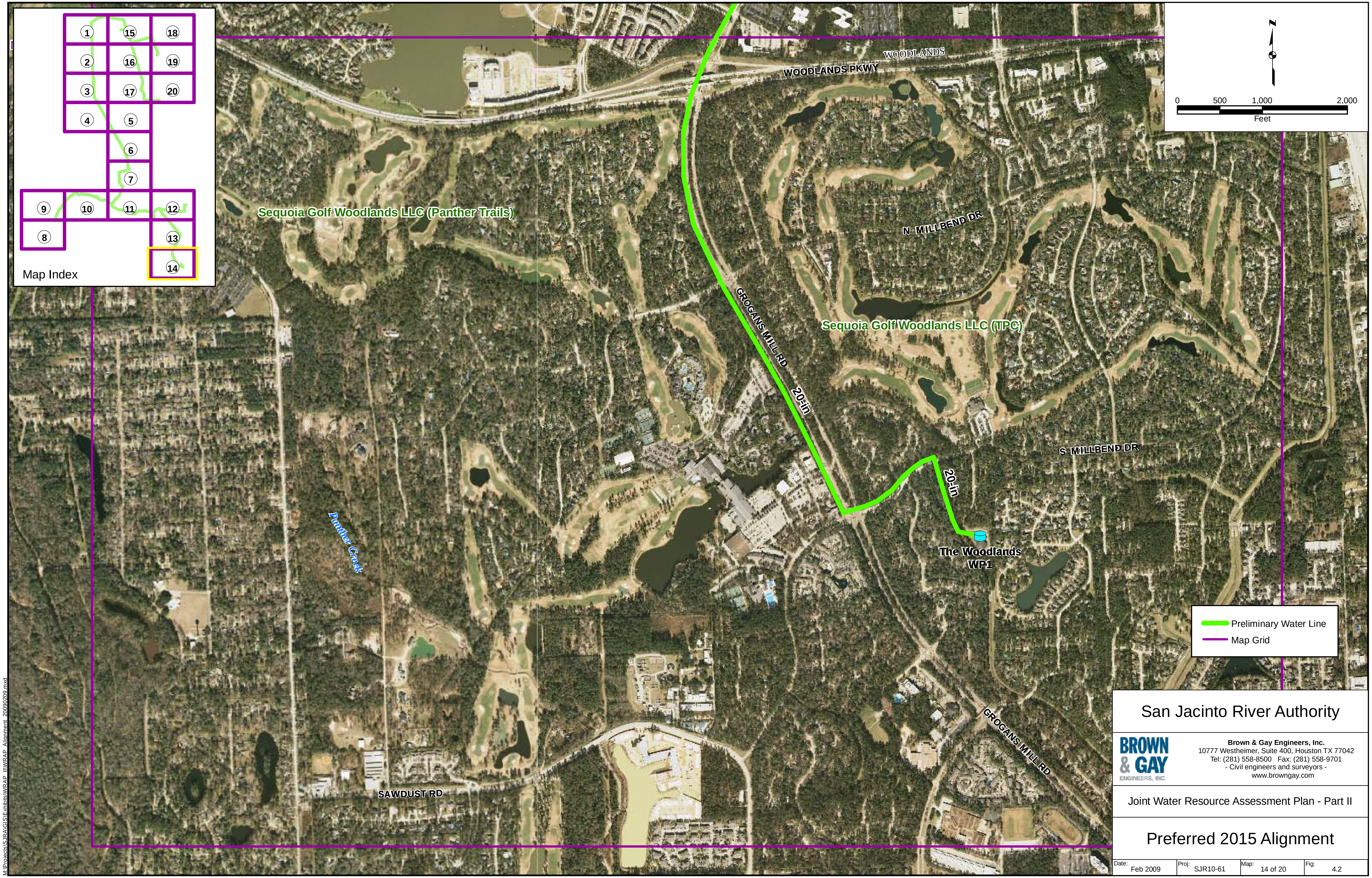
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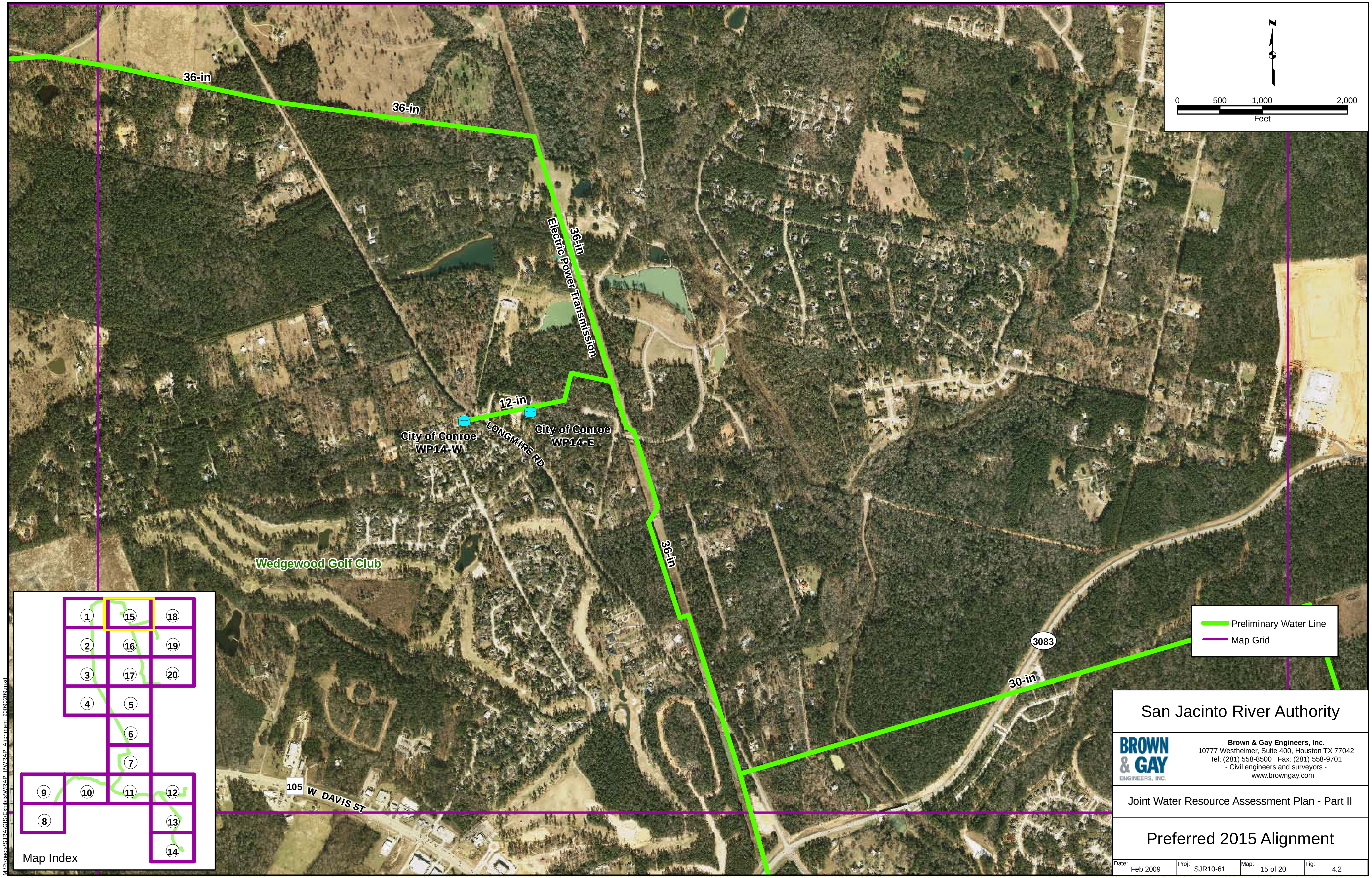

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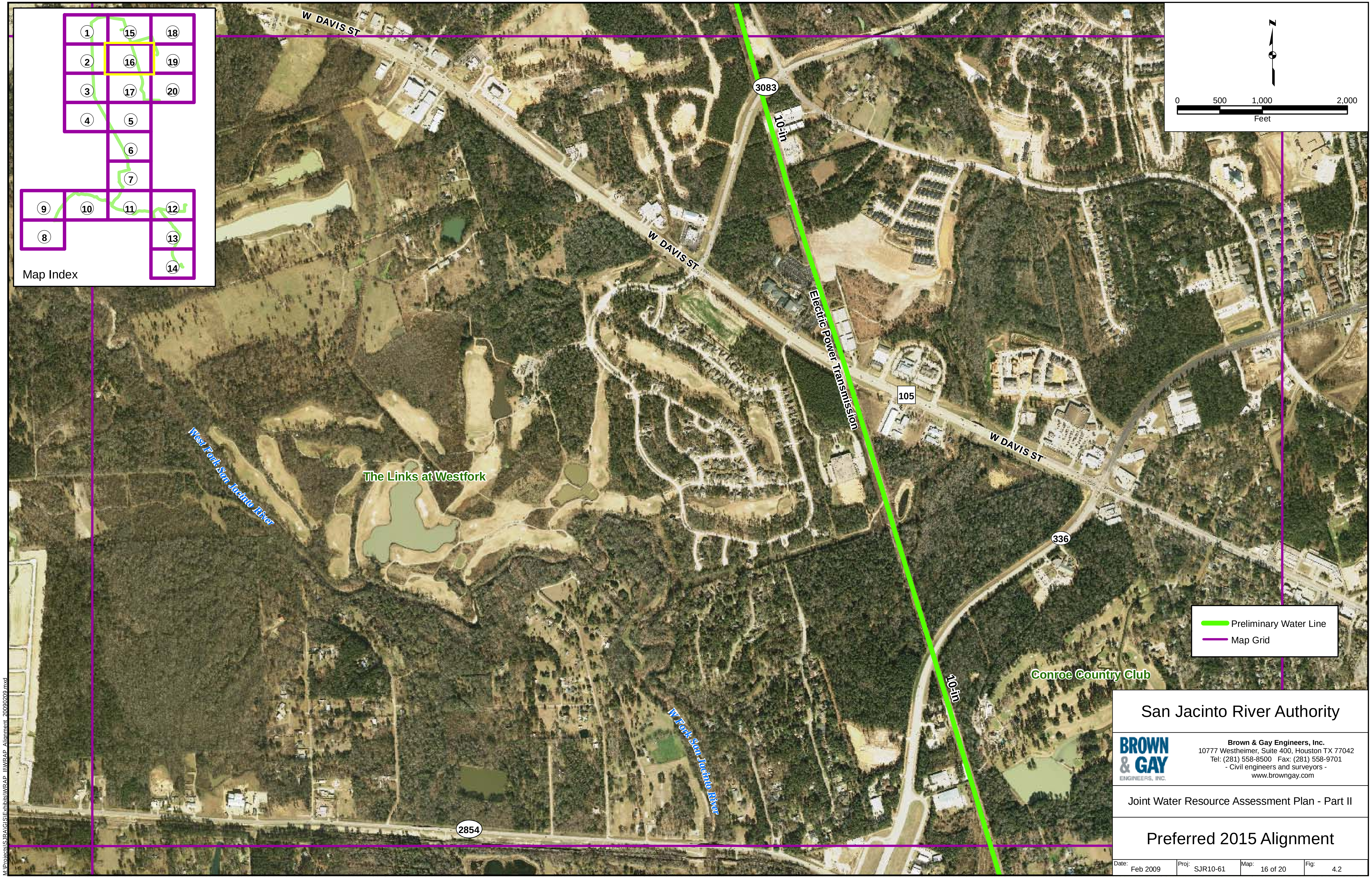

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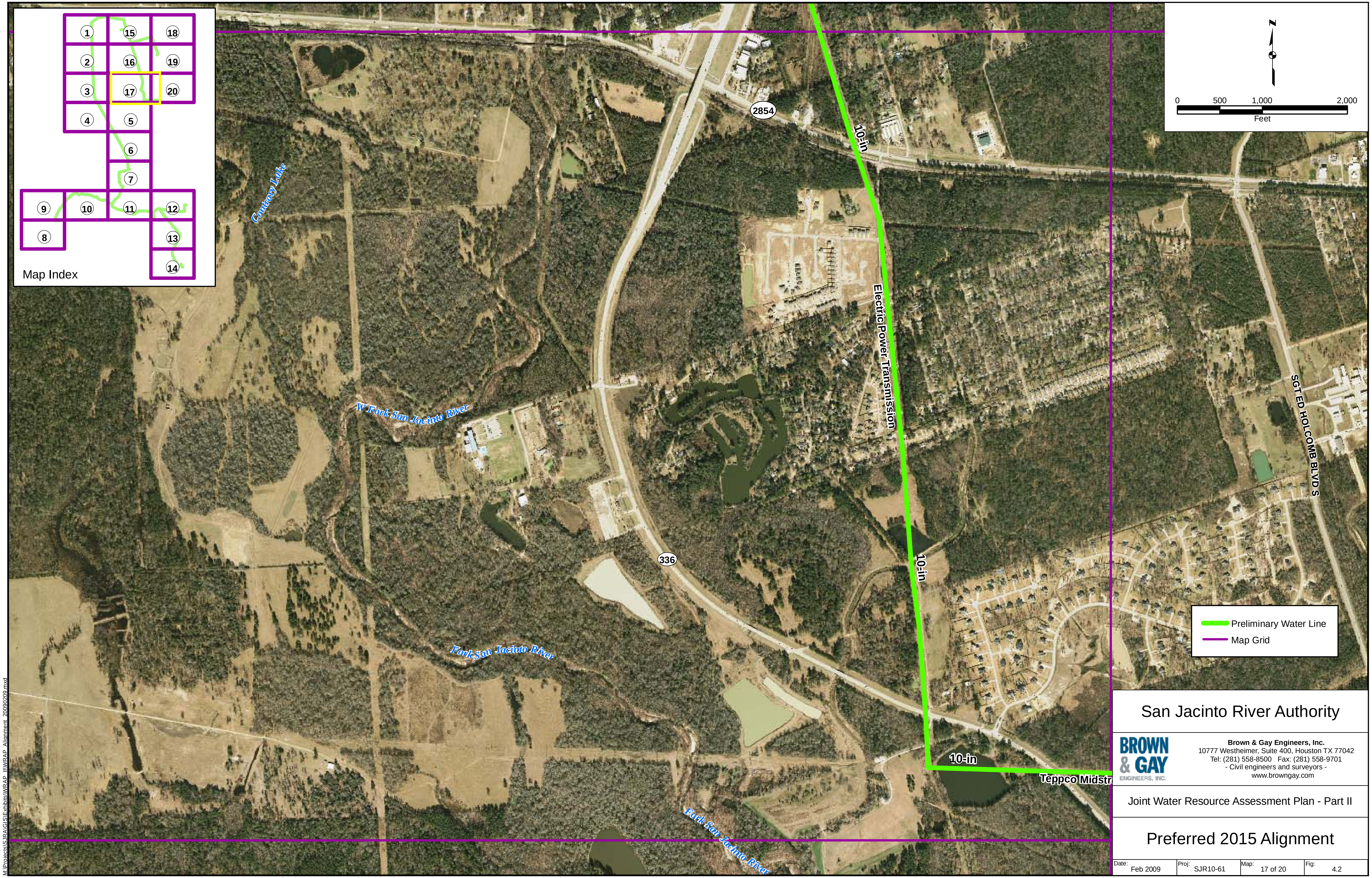

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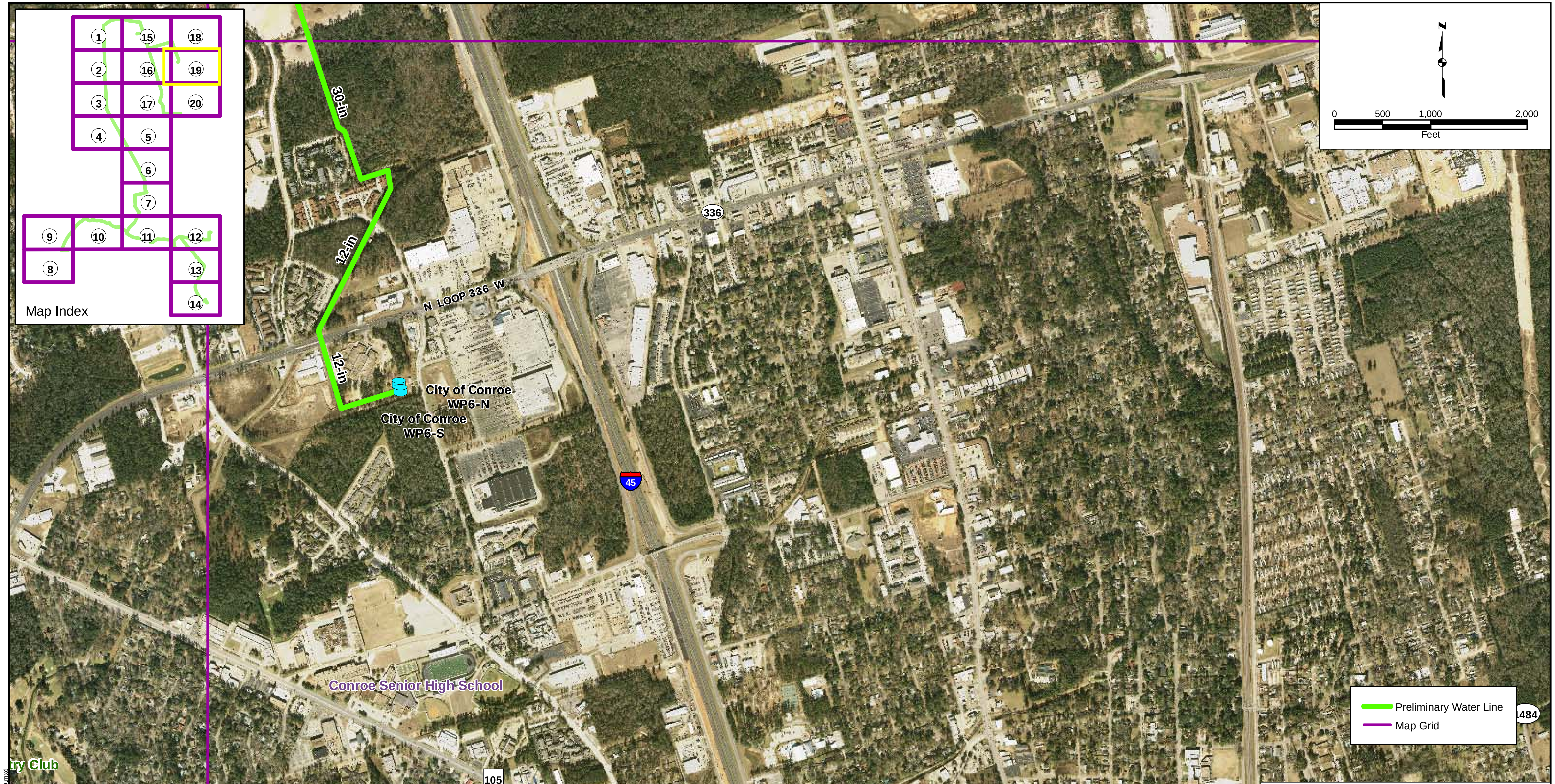

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Section 5
Program Costs

The approach to determine the cost of the preferred surface water transmission system based on investigation of bid tabulations to determine appropriate unit prices, and through the use of Region H cost tables is described in the separate report, "Joint Water Resources Assessment Plan – Alternative Analysis" (Alternative Analysis). The following paragraphs summarize selected results and expand on discussion in that study.

5.1 Cost of Water Treatment Facilities

Water treatment infrastructure includes several major components that are often designed, bid and constructed as separate projects. The approach to develop preliminary costs for these components is described in the following sections regarding raw water intake and pump station, the water treatment plant, storage tanks for treated water, and high service pump station to distribute treated water. It is too early at this preliminary level of planning to know how these may be implemented in future plans that will have to address numerous factors. Therefore, cost estimates are based on the work of Region H Water Planning Group, which are appropriate for the current level of study.

Raw Water Intake and Pump Station

The purposes of a raw water intake structure include:

- drawing water from various lake depths to enhance the effectiveness of the treatment process and quality of the treated water, and
- to 'reach' water when lake levels may be low.

The raw water intake is grouped with the raw water pump station because both functions often are performed by the same physical structure. Region H estimates that the total cost for the water intake adds approximately 20 percent to the construction cost of the pump station. Of that 20 percent, approximately 10 percent is related to the structure and the remaining 10 percent is for mechanical equipment including trash rack and rack cleaning equipment as well as other screens.

In addition, backup or emergency power is provided for critical water system components to ensure that facilities remain operational in the event of a loss of normal power. In some cases a second electric power transmission supply is brought on site, but most often in an emergency, power is produced using a standby generator. Backup power is estimated to add 35 percent to the overall cost of pump station construction.

Proposed Water Treatment Plant

Until treatability studies of Lake Conroe surface water are performed and finished water quality is defined, it is assumed that the proposed water treatment plant will utilize conventional treatment processes. The primary processes in conventional treatment include flocculation, sedimentation, filtration, and disinfection. Proposed facilities on the site will be laid out in a way that provides flexibility by allowing the addition of other processes once their need is determined based on the timing and direction of future planning.

Future treatability studies and finished water quality criteria will determine whether additional ‘advanced’ treatment is required to ensure compliance with Stage 2 Disinfection Byproducts Rule (DBP2) and Long Term 2 Enhanced Surface Water Treatment Rule (LT2) water quality regulations. Advanced treatment might include other forms of disinfection such as ozonation or ultraviolet (UV) radiation and may include membrane filtration to achieve greater solids removal.

Finished Water Storage

Cost estimates for ground storage tanks for treated water assume that tanks will be constructed of steel or prestressed concrete at ground level. Estimates are based on the work of Region H, which includes construction costs that vary from approximately $0.78/gallon of capacity for a 1 million gallon tank to $0.35/gallon of capacity for a 10 million gallon tank. These costs were also compared with tank costs in recent construction projects of SJRA, WHCRWA and NHCRWA. For purposes of this Joint WRAP Report, four 10 million gallon storage tanks are assumed at the proposed water treatment plant.

High Service Pump Station

Following the finished water ground storage tanks, a booster pump station will be necessary to deliver water at adequate pressure to Joint WRAP Participants. Pump station cost ultimately depends on many factors including the type, size, and number of pumps; structural design of building; complexity of electrical, instrumentation, and disinfection control systems; and site conditions, among others. All of these must be addressed in detail in future investigations.

For the purposes of this Joint WRAP Part II Report, the work of Region H is used. Region H estimates of pump station costs are based on station horsepower and, therefore, require assumptions regarding design flow rate and pump head requirements. A discharge pressure of 100 pounds per square inch (psi) has been used in the hydraulic and analysis and assumed for the purposes of determining horsepower and to estimate the cost of the high service pump station. The proposed high service pump station is also proposed to have backup power. Again, 35 percent of pump station construction cost is added to account for the cost of backup power. These costs were also compared with pump station costs in recent construction projects of SJRA, WHCRWA and NHCRWA.

5.2 Water Transmission System

5.2.1 Capital Costs

<u>Transmission Mains</u>

The development of unit costs for the construction of large diameter water transmission mains is described in the Alternative Analysis. Unit costs were based on analysis of bidding information for 35 water line projects bid between 2001 and 2008. The size of pipe in the projects varied from less than 12 inches to 60 inches in diameter. Project information was provided by the North Harris County Regional Water Authority, West Harris County Regional Water Authority, and the City of Houston. The Engineering News Record Construction Cost Index (ENR CCI) was used to adjust the bid tab data for each project to October 2008 dollars based on when the projects were bid.

Projects were categorized as "Urban" or "Rural" construction based on quantities of pavement, curb, construction exits, clearing & grubbing, fence replacement, inlet protection, use of sod to restore residential areas, utility relocations, and traffic control. Categorizing projects as "Urban" or "Rural" allows the costs developed to be compared with the unit costs developed by the Texas Water Development Board Region H (Region H). Aerial photography and GIS mapping were used to determine the level of development along the preferred alternative. Sections of pipe in developed areas were considered to have higher costs associated with construction in urban areas. Conversely, pipelines in minimally developed areas were assumed to have lower costs associated with simpler construction in rural areas.

Unit costs for rural and urban construction are summarized in **Table 5.1**. In addition, **Table 5.1** provides estimated costs for trenchless construction. As with the rural and urban construction methods, costs for trenchless construction were determined from existing bid tabs and applied to the crossings for Alternative T2C1W1.

Table 5.1
Unit Costs for Water Line Construction

Pipe Diameter Inches	Cost/LF ($)		
	Open Cut		Trenchless
	Rural	Urban	
8	95	95	225
10	115	125	290
12	130	155	350
16	165	210	475
20	200	270	595
24	240	330	720
30	290	415	905
36	345	500	1,095
42	400	590	1,280
48	450	675	1,465
54	505	765	1,650
60	560	850	1,835
66	615	940	2,025

Pipe unit costs do not include 'soft' costs associated with planning, design, bidding and financing projects such as program management, engineering, surveying, geotechnical studies, construction management, materials testing and contingency, financial, and legal costs. Soft costs related to planning and construction are estimated as 30 percent of construction costs and this value is added to the cost of intake structure and treatment plant construction including ground storage. Financial and legal costs are estimated as a percentage of estimated bond sales. A contingency of 35% is placed on costs associated with WTP planning and construction.

For transmission mains, the contingency is reduced to 25% because water line projects are less complex and have less uncertainty associated with them than WTP construction. Again, 30% of the estimated construction is added to account for the soft costs associated with their planning and construction.

<u>Water Line Easements</u>

Alternative T2C1W1 is assumed to be constructed in easements adjacent to existing rights-of-way. Easements are assumed to be 20 feet for pipe up to 36 inches in diameter and 30 feet for larger pipe. Permanent easement widths for all transmission mains not adjacent to existing rights-of-way or other easements are assumed to be 30 feet. Twenty feet for easements is adequate for the majority of locations where the proposed water lines will be adjacent either to public right-of-way or to other corridors such as gas/petrochemical or electric power transmission facilities.

An additional 10 to 20 feet of temporary construction easement may be acquired where beneficial. Easement costs were estimated based on available land values from the Montgomery County Appraisal District (MCAD) and by using GIS to identify potentially affected parcels along each corridor. To be conservative, because the parcel data is incomplete and to allow for acquisition of temporary construction easements, the weighted average value was increased by 25% and rounded to the nearest $0.05 per square foot ($/sf). In addition, if the estimate was less than $0.25 per square foot ($10,900/acre), then a minimum value of $0.25/sf was used.

In addition to the value of the land, there is significant cost associated with the acquisition process, such as title acquisition, engineering and legal support, boundary surveys, offer and negotiation activities, recording fees, and, on occasion, the condemnation process. A value of $8,000/parcel for easement acquisition was adopted for the purpose of this study. The estimated number of parcels should be considered very preliminary because the number of parcels in a 1,000 feet buffer is expected to overestimate the number of parcels, however, the incomplete nature of the MCAD parcel data is expected to underestimate the number of parcels. Overall, the total cost of easements (land and acquisition) for transmission mains is potentially in the range of $5,000,000 to $10,000,000.

Participant Water Supply Plant Sites

Where future water lines reach existing water supply plants, two additional costs apply. First, a cost of $250,000 (including contingency) was added as the estimated cost of meter and control valve facilities at each water supply plant. These are facilities that will be owned, operated, and maintained by the SJRA. This cost applies at each water supply plant and is applied in the economic analysis in the appropriate year.

The second cost is for work including conversion of disinfection systems from chlorine to chloramine, yard piping, and storage tank modifications at the point of connection. These water supply plant costs may be incurred by the water supply plant owner and potentially reimbursed by the SJRA or incurred by the SJRA directly depending on policy decisions yet to be made. These additional costs are estimated to average approximately $250,000 (including contingency) per water supply plant site. Therefore, the total cost associated with delivering surface water to existing and future water supply plants for meter/control valve station and site improvements and modifications is estimated to be approximately $500,000 per water supply plant.

Based on the various costs described above, Table 5.2 provides the estimated total project capital costs in future dollars for this Joint WRAP Part II plan.

Table 5.2
Total Project Capital Costs
Future Costs ($ millions)

2015	2025	2035	2045
$480	$509	$712	$809

5.2.2 Annual Costs

Annual Operation and Maintenance (O&M) costs include:

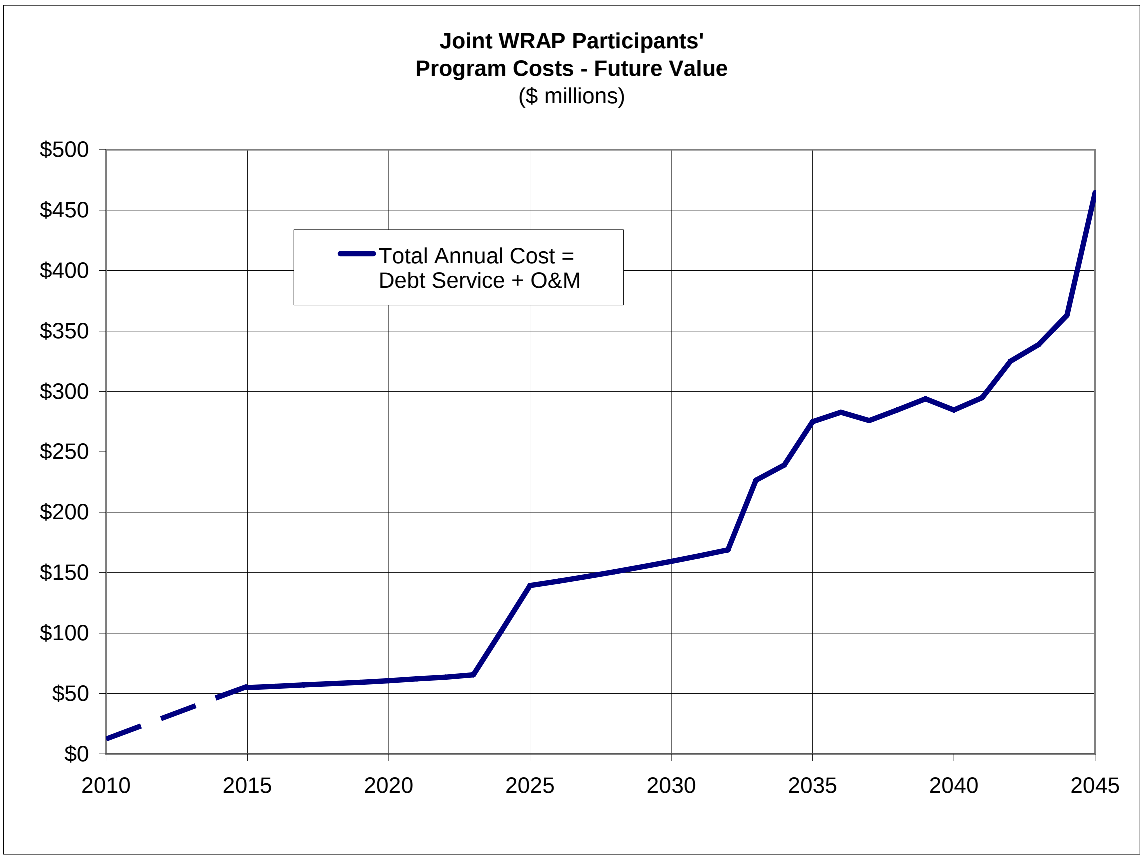
- Debt service,
- Reserve funds (e.g., debt service reserve, operating reserve)
- Operating costs for the treatment plant (e.g., chemicals, power), and an operator to oversee daily operations,
- Maintenance of water treatment plant and transmission mains and their repair,
- Purchased water (including reservation fees)
- Program management
- Engineering, legal, and financial support

Debt service is determined based on the amount of the bond sale(s) (including legal, financial advisor and other fees) required to fund the total project cost including construction and soft costs. For the purpose of this Joint WRAP Part II, it is assumed that 25-year bonds are sold at 5%. Despite current market conditions in which the rate on bonds sold publicly may exceed 7%, there is no requirement to assume that this rate will persist over the long-term. Therefore, the economic analysis uses 5% as the assumed rate on bonds. Future planning may adopt a higher rate, if appropriate, as the time for the first sale of bonds approaches.

The cost of water treatment plant operations are based on Region H estimates adjusted to current, 2008 dollars. Transmission mains were assumed to require an annual O&M expenditure of 1% of the total construction cost of the pipelines. This assumption is based on Region H planning information that also includes 2.5 percent of the total estimated construction costs for intake structures and pump stations.

Figure 5.1 illustrates the estimated future annual costs of the proposed plan. The next section, Section 6, addresses financing alternatives available to the SJRA to implement the plan and also discusses the funding mechanisms available to sustain the plan.

Figure 5.1
Joint WRAP Participants' Program Costs – Future Value



5.2.3 Other Costs

In addition to the capital and annual costs described above, there are other potential future costs. These costs are associated more with issues of contracting with Participants, uncertainty about future LSGCD regulations, and schedule than they are with planning, engineering, construction, and annual O&M. These costs may include, but are not limited to the following:

- Incentives paid to contractors for early completion of construction projects.
- Increased bid prices due to demand for construction as a result of the large number of water main projects to build during a short time span.
- Increased bond issuance fees and interest rates on debt depending on the manner in which Participants are contracted and repayment of debt is pledged.

These costs are described in Sections 6 and 7 regarding financing and schedule, respectively.

Section 6
Financing Alternatives

The following alternatives are available to the SJRA to finance the preferred water supply project:

1. Texas Water Development Board (TWDB) Water Infrastructure Fund (WIF) Loans
    a. TWDB WIF Deferred Payment for Planning, Design, and Permitting Costs
    b. TWDB WIF Construction Loan (non-deferred)
2. Other State and/or Federal programs
3. Sale of bonds on the open market.

To repay the debt service incurred through any of these financing methods, the SJRA has the following funding options:

1. Legislated fee authority.
2. Individual long-term water supply agreement with each Joint WRAP Participant.

These financing and funding options are described in the following paragraphs with a few of their advantages and disadvantages.

TWDB Water Infrastructure Fund Loans

Water infrastructure fund (WIF) money is state financial assistance available to political subdivisions of the state including municipalities, counties, river authorities, special law districts, water improvement districts, water control and improvement districts, irrigation districts, and groundwater districts.

The TWDB allocates WIF Deferred money for pre-construction activities including planning, permitting, and design. Non-deferred WIF money is allocated for pre-construction activities, easement/land acquisition, and construction. Because large water supply projects often have long development periods where the applicant must spend considerable time and money before water is delivered and the accompanying revenue stream materializes, for pre-construction loans the TWDB allows the deferral of principal and interest payments until construction is completed and water is delivered or 10 years, whichever occurs first. In addition, interest does not accrue during the deferral period.

Most other components of WIF pre-construction (deferred) and construction (non-deferred) loans are the same. Key elements of WIF loans are:

- Projects must be a recommended strategy in the Regional Water Plan,
- Loans are currently subsidized at 2% below the TWDB's cost of funds,
- Life of loans is in excess of 20 years,
- Loans are amortized with level debt service over:
  - 20 years for construction loans,
  - the remaining life of the loan after deferral of principal and interest, but not less than 10 years, for pre-construction loans,
- Various funding structures are available for different portions of projects.
- The applicant must close the loan within one year of the date of commitment,
- Applications must be received by the first business day in January or July.
- Applications are prioritized relative to other applications received for that round of funding.
- Projects are prioritized based on:
  - development of a new, usable supply of water,
  - projects which have received previous Board funding for facility planning, design, or permitting for the project;
  - projects with the earliest identified need, as identified in the water plan,
  - entities that have demonstrated significant water conservation savings; or will achieve significant water conservation savings by implementing the proposed project.
- The TWDB considers all types of pledges that applicants have legal authority to pledge. The most common pledges are revenue, tax, combined revenue and tax, and contract revenue.
- Applications include a preliminary engineering feasibility report and known environmental information, as well as general, fiscal and legal application information.
- No administrative cost recovery fees
- A Pre-Design Funding option is available which allows the applicant to apply for funding prior to completing engineering feasibility and environmental studies.
- Availability of WIF funds is contingent on debt service appropriations from the Legislature for bonds issued by the TWDB.

Other State and/or Federal programs

An example of a Federally-funded program is the Drinking Water State Revolving Fund (DWSRF) loans that are available to political subdivisions of the state and can be used for planning, design, and construction of projects to upgrade or replace water supply infrastructure, correct exceedances of Safe Drinking Water Act (SDWA) health standards, consolidate water supplies, purchase capacity in water systems, and can also be used to purchase land integral to the project

Projects for which funding is sought must be in the annual Intended Use Plan (IUP). To be placed in the IUP, prospective applicants submit an information form to the TWDB for inclusion in an IUP for that year. The information describes the applicant's existing water facilities, additional facility needs, the nature of projects being considered for meeting those needs, and project cost estimates.

The maximum life of most DWSRF loans is 20 years and the interest rate is subsidized at 1.2 percent below the market rate at the time of closing. 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. More information regarding the DWSRF loan program may be found on the TWDB's website at http://www.twdb.state.tx.us/assistance/financial/fin_infrastructure/dwsrf.asp.

Sale of Bonds on the Open Market

For the purpose of this WRAP Part II Report, it is assumed that program costs are financed through the sale of bonds. Two reasons to select bond financing for the purpose of this WRAP Part II Report over WIF funding (described next) are:

- bonds are a more conservative approach in terms of cost, and
- the State/TWDB is not obligated to fund the WIF program, therefore, WIF funds may not be available in the year(s) that financing is needed, whereas, there is commonly a market for bonds.

As described in Section 5, the assumptions associated with the sale of bonds include:

- Interest rate equal to 5%,
- Life of bonds equal 25 years,
- Bond preparation and issuance costs were estimated at 2.5% as follows:
    - Legal Fees equal 1.00% of the amount of the bond sale over $1,000,000,
    - Financial Advisor Fees equal to 0.75% of the amount of the bond sale, and
    - Other fees and expenses equal to 0.75% of the amount of the bond sale.

Other financing methods will be evaluated as the program moves forward to obtain the most cost effective and readily available financing at the time.

Funding Options

To repay the debt service incurred as part of financing the planning, design, permitting, and construction as well as to pay the various annual operating, maintenance and repair costs, the SJRA has two funding options. The preferred option is for an appropriate entity integrally involved in the program to have the authority to impose a fee, most likely on water used, to raise the funds necessary to pay for the program.

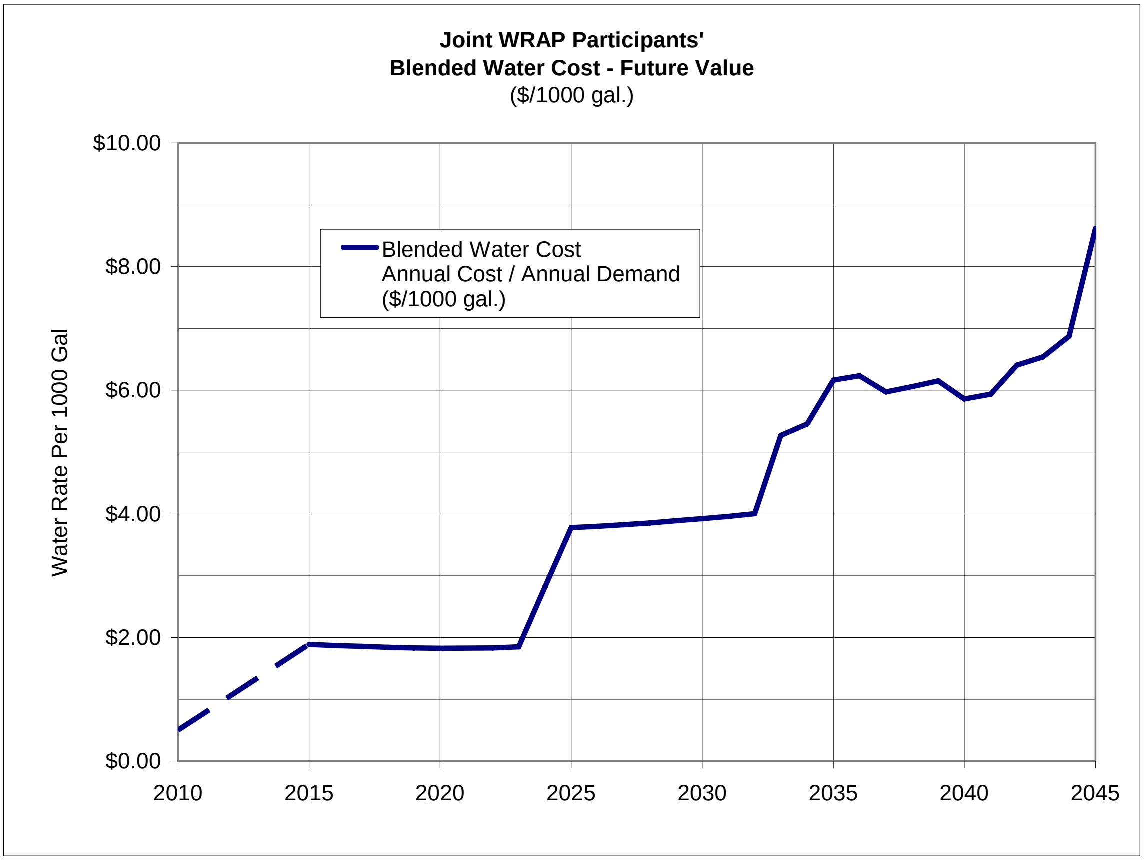
This ‘fee authority’ is preferable compared to engaging in individual long-term water supply agreements with each Joint WRAP Participant. The process required to develop water supply contracts with potentially 200 Participants has disadvantages that increase both the time/schedule and cost of the alternative conversion program. It is anticipated that the effort would be more difficult than the previous process to secure the participation of the current 198 Participants in this WRAP. In addition, the disadvantages include:

- Use of SJRA staff time and other resources with the associated potential that the SJRA could withdraw from its current leadership role to focus on meeting the regulatory requirements for SJRA alone.
- The time required to again secure Participants’ participation in the program will delay planning, design, and start of construction, which will also result in higher costs due to inflation.
- Bond issuance fees and interest rates on debt will increase due to the number of underlying contracts as underwriters and bond purchasers will have to assess the risk associated with potentially 200 underlying contracts – instead of assessing the risk associated with a single entity with statutory fee authority.

As an example of the potential increased cost of bond financing based on numerous underlying contracts, for the 2015 phase project costs, a 1% increase in interest rate increases annual debt service approximately $3.3M or almost $67M over the life of the bonds.

For the purpose of this Joint WRAP, it is assumed that a single entity will have the fee authority necessary to impose a fee on water used countywide. The fee will be used to pay for costs due to the alternative water program. Based on the costs identified in Section 5, the annual cost of water is calculated by dividing the total program costs by the estimated water demand for each year. Thus, the cost of water calculated in this way is the 'blended' cost of water regardless of the source of the water – whether groundwater or surface water. **Figure 6.1** illustrates the blended cost of water.

Figure 6.1
Joint WRAP Participants' Blended Water Cost



The SJRA recognizes that there are costs associated with the production of groundwater that users of groundwater will continue to pay while Participants that receive surface water will save those costs. To reduce or eliminate this inequity, it is anticipated that separate rates (dollars per thousand gallons) will be established for groundwater pumped and surface water received. The lower cost for groundwater pumped may be based on the typical costs of power and chemicals associated with the production of groundwater. Therefore, any incentive or disincentive for receiving surface water or remaining on groundwater may be removed.

In addition to the cost of producing groundwater, introducing surface water partially ‘idles’ groundwater production capacity in which Participants have significant investment and continue to pay any existing debt service. While some Participants believe that compensation for this lost productivity is appropriate, other Participants are pleased to have the productivity of their well increased as decreases in groundwater levels are reversed and the useful life of their asset is prolonged. Additional study of these important issues is required during the next phase of planning to determine the potential impacts on all infrastructure assets involved in the supply of water.

These issues, the cost differential between groundwater and surface water and to what degree compensation for lost productivity is justified, will be addressed in future investigations.

Section 7
Program Schedule

Project Schedules

This section presents two potential schedules to develop and deliver the alternative water treatment and conveyance system. The first schedule is based on a 'traditional' project delivery approach that will likely not meet the 2015 regulatory deadline. The second schedule is based on accelerating the schedule to meet the 2015 regulatory deadline. The inter-related issues of schedule and cost are addressed below. The potential economic impacts to the project are described in general terms. The cost impacts ultimately depend on the outcome of the milestone events described later in this section.

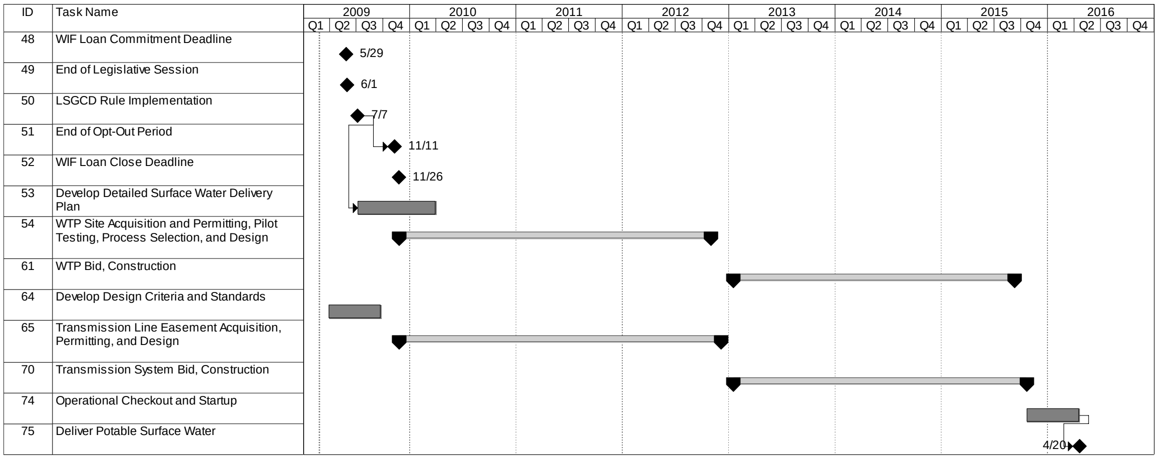
An important factor to understand is that any delay in either schedule increases costs due to inflation. For each year's delay, those costs are approximately the rate of inflation (5%) times the total capital cost (soft costs and construction costs including contingency) for the phase of conversion. For the 2015 phase, the increased cost due to inflation is approximately $24,000,000 ($24M) for each year's delay.

Traditional Project Delivery Schedule

The first schedule is based on a 'traditional' project delivery approach utilizing sequential design, bidding, and construction phases. In this schedule, the design, permitting, and bidding phases of the water treatment plant require approximately 3 years from late 2009 through late 2012. This is followed by construction of the water treatment plant beginning early in 2013 and continuing through most of 2015.

Construction of water transmission mains follows a similar schedule. When both water treatment plant and water mains are complete, approximately 6 months are allowed for 'operational checkout and startup' of the systems with the first treated surface water delivered toward the end of April, 2016. This approximately six-year schedule allows sufficient time to ensure an orderly process for each phase of design through construction. **Figure 7.1** shows the schedule for traditional project delivery.

Figure 7.1
Traditional Project Delivery Schedule



Accelerated / Alternative Project Delivery Schedule

The second schedule is based on accelerating the schedule through "Design/Build" or other alternative project delivery methods. The design/build approach is most applicable to design and construction of the water treatment plant and would probably not be applied to design and construction of water mains.

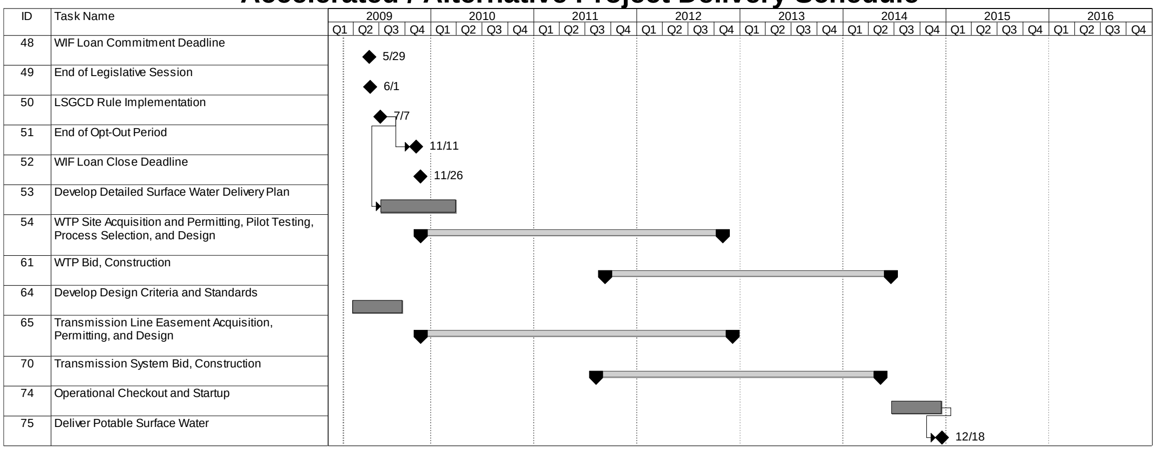
For water mains, the engineering aspects of design are more easily accelerated than are easement acquisition, environmental, and permitting aspects of the project. To accelerate the overall process for the water transmission system, the easement acquisition, environmental, and permitting tasks will begin as early as possible, before the engineering design.

During the construction phase of water line projects, there is the potential to accelerate schedules by providing contractors incentives to complete construction before a target date. Offering contractors incentives will increase project costs. In addition, it is anticipated that prices bid for water line construction will increase due to decreased competition as available construction crews are fully utilized for the large number of projects underway in a relatively short span of time. **Figure 7.2** shows the schedule for accelerated/alternative project delivery.

In the accelerated/alternative delivery schedule, as for traditional project delivery, the design, permitting, and bidding phases of the water treatment plant require approximately 3 years from late 2009 through late 2012. However, in the design/build approach, construction of the water treatment plant begins in mid 2011, before final design is complete, and construction is completed in mid 2014.

Construction of water transmission mains follows a similar schedule. When both water treatment plant and water mains are complete, approximately 6 months are allowed for 'operational checkout and startup' of the systems and the first treated surface water is delivered toward the end of December, 2014, in time to meet the 2015 deadline.

Figure 7.2
Accelerated / Alternative Project Delivery Schedule



Critical to both schedules are the following important events, which are anticipated to occur during 2009:

1. WIF Loan Commitment Deadline — May 30.
2. End of Legislative Session — June 1.
3. LSGCD Rule Implementation — July 7 (assumed).
4. End of Opt-Out Period — November 11 (approximate).
5. WIF Loan Close Deadline — November 26.

The following paragraphs provide additional information regarding these events to help provide a general understanding of the significant issues at work.

Legislative Session and Opt-Out Period

A proposed bill has been drafted for consideration in the current session of the legislature that includes two major provisions that impact upcoming planning following this WRAP. The first provision designates that all entities subject to the groundwater reduction requirements of the LSGCD are also subject to the countywide GRP fee unless an entity 'opts-out' during a specified period. The legislation ties the opt-out period directly to the LSGCD Rule implementation and the opt-out period will begin with the implementation of the LSGCD rules. The second provision provides the SJRA the power to assess charges and/or fees, including setting groundwater pumpage fees and surface water rates that are adequate to fund the costs of the system. The fate of the legislation will be known no later than the end of the session on June 1.

LSGCD Rule Implementation

It is anticipated that the earliest that the LSGCD will adopt Phase II (B) of the District Regulatory Plan (DRP) is in mid 2009. The LSGCD Phase II (A) rules state that, *"The District will use the planning and technical information gathered through the WRAP process to determine the most appropriate regulatory approach for groundwater reductions by new and historic users when it adopts Phase II (B) of the DRP, which may include additional management zone delineations. While Phase II (A) primarily establishes a detailed planning process for Large Volume Groundwater Users, as defined herein, Phase II (B) will set forth the actual regulatory requirements designed to achieve the District's long-term groundwater management goals. In addition to establishing requirements for reductions in groundwater use, Phase II (B) may also include preliminary requirements, such as the submittal of a Groundwater Reduction Plan, to establish milestones and a schedule for meeting the required groundwater reductions."* Knowledge of the Phase II (B) rules will be critical to proper planning for future infrastructure to meet the requirements for groundwater reduction.

WIF Loan Close Deadline

In November 2008, the SJRA applied for a Water Infrastructure Fund (WIF) – Deferred loan and the Texas Water Development Board (TWDB) committed funds to continue the necessary planning for the alternative water program. The SJRA has until May 30, 2009, to commit to the loan and until November 26, 2009, to close on the loan. Therefore, the SJRA must decide whether it will close on the loan by May, 2009, when the TWDB plans to sell bonds. The difficulty imposed by this timing is that if the legislation fails, there will be insufficient time to identify Participants that will remain part of the current plan. Without knowing which Participants will participate in the plan, the SJRA may have to decline the loan.

Section 8
Joint WRAP Participant Agreements

The LSGCD Phase II (A) Rules require that Joint WRAPs include copies of agreements for all Participants. Copies of those agreements are included in **Appendix E.**