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A Charming Past. A Soaring Future.

INTEGRATED UTILITY MASTER PLAN & FINANCIAL PLAN

KIT

March 2019

INTEGRATED UTILITY MASTER PLAN AND FINANCIAL PLAN

Prepared For:

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Abbreviations and Acronyms

CBOD5	5-day Carbonaceous Biochemical Oxygen Demand
CIP	Capital Improvement Planning
DSC	Debt Service Coverage
EPS	Extended Period Simulation
EST	Elevated Storage Tank
ETJ	Extraterritorial Jurisdiction
FBC	Fort Bend County
FBSD	Fort Bend Subsidence District
GIS	Geographic Information System
gpcd	gallons per capita per day
gpm	gallons per minute
GRP	Groundwater Reduction Plan
GST	Ground Storage Tank
LS	Lift Station
MDD	Maximum Daily Demand
MG	Million Gallon
MGD	Million Gallons per Day
MUD	Municipal Utility District
PVC	Polyvinyl Chloride
SCADA	Supervisory Control and Data Acquisition
SWTP	Surface Water Treatment Plant
TSS	Total Suspended Solids
WP	Water Plant
WWTP	Wastewater Treatment Plant

Executive Summary

The City of Richmond (City) contracted with KIT Professionals, Inc. (KIT) to develop an Integrated Utility Master Plan and Financial Plan systemwide 10-year master plan to chart a path forward for future water supply, wastewater services, and reclaimed water usage, and compliance with Fort Bend Subsidence District (FBSD) groundwater reduction mandates. It also includes a utility financial plan, which provides comprehensive financial planning and projections for the City's water, wastewater, and surface water funds. This Master Plan builds on the City's Comprehensive Plan for growth and land use within City limits and the City's extraterritorial jurisdiction (ETJ) areas and incorporates an extensive collection of information from both City and external sources.

The City's water and wastewater service areas include customers within City limits and several municipal utility districts (MUDs) within the City's ETJ area. The water and wastewater service area population (23,900) is currently split roughly equally, with approximately 50% of the population within City limits and approximately 50% in the ETJ area. The service areas are experiencing rapid growth, with population expected to increase 50% by 2023 and 120% by 2027. Growth is anticipated to occur predominantly within the ETJ area, as several large master planned community and commercial developments occur.

Water Master Plan

Following modeling and evaluation of the existing and future water systems, rehabilitation and expansion projects were developed to maintain level of service for existing customers and expand the system to meet demands for new customers. Based on condition assessments performed at the City's water plant and elevated storage tank facilities, water system infrastructure was found to be in good overall condition. However, several Capital Improvement Plan (CIP) projects were developed to improve system efficiency and provide for rehabilitation of aging infrastructure. Although the City's water supply infrastructure is generally sufficient for current demands, the projected rapid growth in population and associated water demands will necessitate additional infrastructure for water supply and conveyance. Moreover, FBSD requirements for alternative water conversion are anticipated to increase from 30% to 60% in October 2025, and additional surface water supply and treatment will be needed to maintain compliance.

Key water system infrastructure improvements include new groundwater wells at three existing facilities, a new groundwater plant east of the Brazos River, an additional elevated storage tank in the southeast portion of the service area, new transmission lines to expand treated surface water conveyance, and two expansions of the Surface Water Treatment Plan (SWTP). The first SWTP expansion is driven largely by the anticipated increase in FBSD requirements, while the second expansion is proposed to maintain compliance as water demand increases due to development east of the Brazos River. The timing of this project, along with that for the proposed groundwater plant, is heavily dependent upon the timing and the rate of development east of the Brazos River. This development should be monitored, and the timing of the proposed CIP should be adjusted accordingly. Regardless, it is anticipated that the City will eventually need to procure land for the new groundwater plant, and it should monitor proposed development to determine the appropriate timing for the new plant.

Wastewater Master Plan

Similar to the Water Master Plan, both the existing and future wastewater systems were modeled and evaluated against a range of performance criteria. Condition assessments were performed at the City's 15 wastewater lift stations, and facilities were scored and ranked to prioritize rehabilitation and expansion projects. Gravity system capacity analysis was conducted to examine the performance of the collection system under average and stormflow conditions. Based on this analysis, potential pipeline surcharges and manhole overflows were documented, and collection system rehabilitation projects were developed to address these issues.

As with the water system, population and demand growth were key population drivers for several wastewater system projects. Key growth-related wastewater CIP projects include the construction of a new 0.75-million gallons per day (MGD) East Wastewater Treatment Plat (WWTP) to alleviate flows to and defer expansion of the City's Regional WWTP. The new plant, which is expandable to 3.0 MGD, would effectively split the wastewater system into two larger service areas and eliminate the need for force mains crossing the Brazos River, resulting in increased system resiliency. Four projects are proposed for the Regional WWTP: three projects would improve existing system processes, while the fourth project would expand the plant's capacity from 3.0 MGD to 4.5 MGD. It is recommended that that City purchase property for the new East WWTP and commence planning (e.g., State discharge permitting) and design of this facility. It is also recommended that the City purchase property and relocate the Greenwood Lift Station to a new site.

Reclaimed Water Master Plan

The Reclaimed Water Master Plan summarized the existing reclaimed water system and identified potential future reclaimed water customers and their corresponding demands. Based upon the relatively high potential reclaimed water demand and proximity to the Regional WWTP, incorporation of the Veranda Trails community was found to be the most cost-effective approach to expanding the reclaimed water system. Substantial improvements would be required at the Regional WWTP to increase reclaimed water system capacity, and a relatively short segment of reclaimed water transmission piping would be needed to convey reclaimed water to this community. Although several other potential customers were identified, reclaimed water transmission piping construction was found to be cost-prohibitive at the current time. However, once projects are implemented to expand reclaimed water treatment and pumpage capacity at the Regional WWTP, additional opportunities for expansion can be considered.

Groundwater Reduction Plan Update

As part of this Master Planning effort, the project team developed an update to the City's Groundwater Reduction Plan (GRP). This update charts a path forward to maintain compliance with FBSD alternative water conversion mandates through 2030. A summary of the GRP update is presented herein to document the key aspects of the plan. The GRP update incorporates the proposed expansion of the City's reclaimed water system presented in the Reclaimed Water Master Plan. However, reclaimed water supply and demand will not be adequate to meet the City's future alternative water requirements, and two expansions of the City' SWTP are proposed to maintain compliance with FBSD mandates. As discussed,

the first SWTP expansion will be required to maintain compliance when the FBSD conversion requirement increases from 30% to 60% alternative water, tentatively slated for October 2025. A second expansion from 4.0 MGD to 6.0 MGD will be needed to maintain FBSD compliance if new customers East of the Brazos River are incorporated into the system.

Financial Plan

The financial planning effort sought to develop a 10-year financial plan that sustains the long-term financial health of the water, wastewater, and surface water utilities. This plan aimed to achieve rate revenues sufficient to meet annual operating expenses and capital expenditures while incorporating reserve levels and coverage targets commensurate with industry best practices. The financial plan built upon the water, wastewater, and reclaimed water CIPs, along with existing fund balances, debt service, and operations and maintenance, to develop rate structures and debt issuance that will adequately fund CIP projects while maintaining financial goals. This plan tentatively projects modest increases to the City's water rate, with increases to the wastewater and surface water rates phased in over time. This plan also implements a rate for reclaimed water, which is financed out of the City's surface water fund.

Utility Master Plan Key Considerations

Although this Master Plan is based on a thorough analysis of the City's water, wastewater, and reclaimed water systems, the data contained herein represents a snapshot of the system in time, along with best projections of future growth in population and demands. It is intended that this Master Plan be considered a" living" document, with findings revisited as conditions change.

It is understood that CIP projects and their timing will be revisited over time based on the latest system conditions, financial constraints, and actual growth in population and demands. If growth occurs more quickly or slowly than originally projects, project timelines may shift accordingly. Similarly, any delay in the implementation of FBSD conversion requirements may result in deferment of SWTP expansions.

Along with projects, it is anticipated that utility rates will be reassessed on an annual basis to confirm that the projected increases align with the latest CIP and financial data. Through careful monitoring of system growth and other constraints, the City will be able to prioritize projects that balance level of service with maintenance of reasonable utility rates. It is further recommended that the City revisit this Utility Master Planning effort in approximately 5 years to more thoroughly update the utility models, CIPs, and rate structures based on the most current information.

1. Introduction

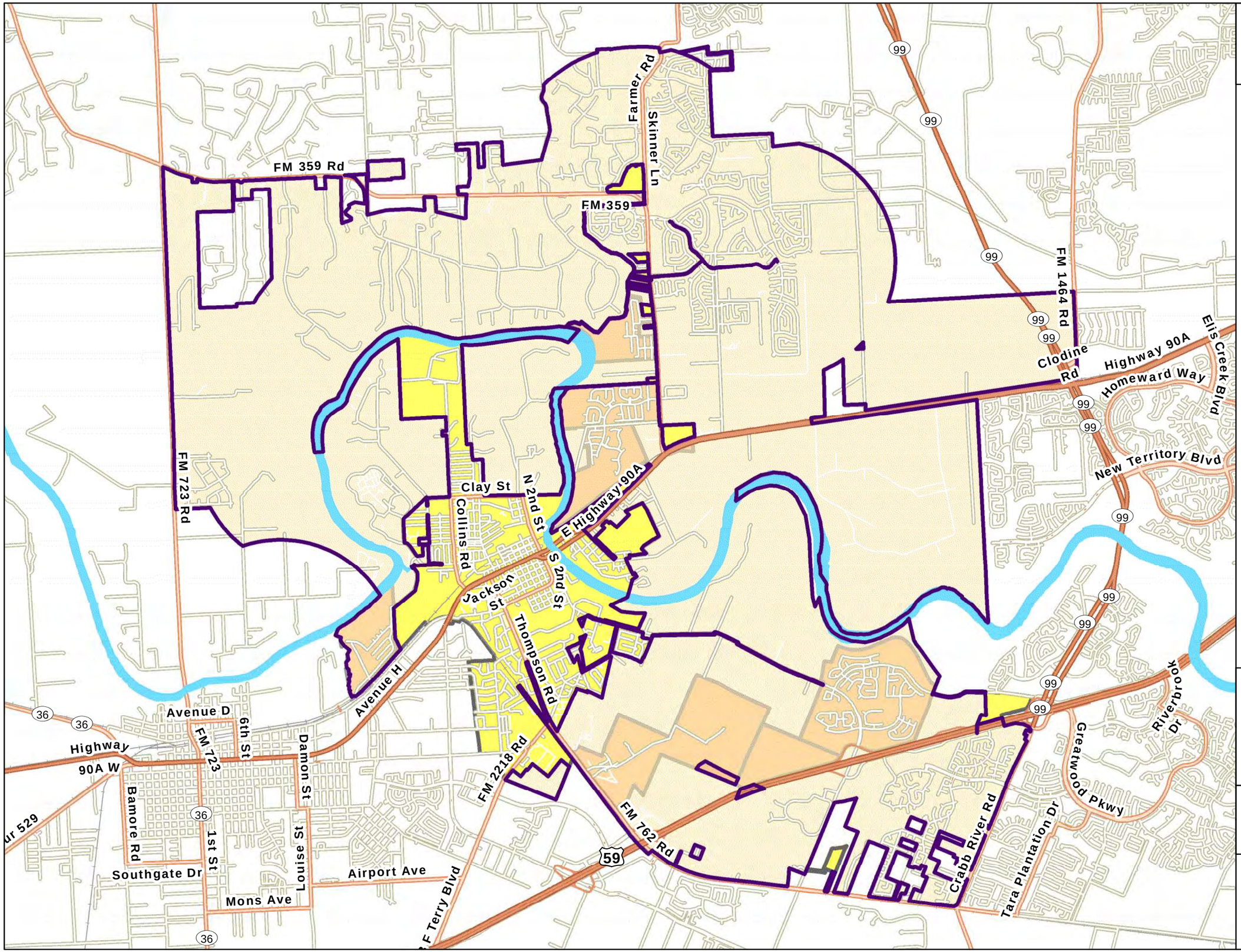
The City of Richmond (City) located in Fort Bend County, is on the Brazos River fifteen miles southwest of Houston. The City's major transportation links include U.S. Highways 59 and 90A, the Southern Pacific Railroad, Santa Fe Railway. The City's Planning and Zoning Department administers the Comprehensive Master Plan, ensuring the health, safety, and welfare of the citizens and property by regulating the use of land within the corporate limits of the City. The Public Works Department is responsible for the operation and maintenance of the City's public streets, drainage system, bridges, capital improvement projects, water and wastewater service. The City contracted with KIT Professionals, Inc. (KIT) to develop a systemwide 10-year master plan to guide the City through the future water supply, wastewater services, reclaimed water and groundwater reduction plan (GRP) update.

This Master Plan contains the development process, preliminary observations and recommendations on water, wastewater, reclaimed water systems master plans, a summary of the revised groundwater reduction plan, and the financial plan for the City's water and wastewater utilities for the near and future terms. The Master Plan discussion includes but not limited to the following:

- City and City Service Area current population
- Planned growth in near term (5-year period) and future term (10-year period)
- Historical water demands and demand projections
- Existing water system inventory including operational and maintenance
- Calibration and verification of the existing water and wastewater system hydraulic models
- Extended Period Simulation (EPS) modeling on water and wastewater services to develop capital improvement plan CIP projects for the near and future terms
- Existing reclaimed water system overview and provide recommendations
- Existing and projected water demands for GRP participants
- Provide recommendations on groundwater reduction approach
- Develop cost opinions and estimates for the recommended CIP projects
- Provide water, wastewater and groundwater financial plan
- Recommend cost of service to water and wastewater utilities

1.1. Background

The City provides drinking water and wastewater services to the residents within the City limits and the City service area. The City has more than 7,000 customers that include residential, commercial and industrial customers within City limits and within extraterritorial jurisdiction (ETJ) area. **Figure 1-1** shows the City and ETJ areas.



Legend

- City Limits
- ETJ Area
- City Current Service Area

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Figure 1-1

City Limits and ETJ Area

According to the City's 2014 Comprehensive Master Plan report, over the next 15 years, City anticipates growth within the City limits, and even faster-paced growth in the ETJ. The region is targeting all age groups, ranging from youth, college students, young professionals, families, empty nesters and retirees. Population projections are largely based on historic trends. Richmond's annexation policy will most significantly impact the ratio of City and County residents, as well as the growth rate of the City's residential base. About 30% of land within the City limits and 70% of land within ETJ is undeveloped according to 2014 Comprehensive Master Plan. The zoning districts within the City limits is predominantly classified as general residential. Area adjacent to Highway 90A and FM 1762 has mixed use and general commercial buildings. City contracted with KIT Professionals, Inc. (KIT) to prepare an integrated drinking water, wastewater and reclaimed water utility master and financial plans to reflect current growth and developmental projections. The planning period for this integrated utility master plan and financial plan is 10-years (i.e., 2027).

1.2. Plan Overview and Objectives

Figure 1-2 presents an overview of the Integrated Utility Master Planning effort. As can be seen in the figure, common land use, growth projections, and population projections (presented in **Section 2.1** of this Plan) informed subsequent planning efforts. Master planning for the City's water, wastewater, and reclaimed water systems, along with the GRP update, was performed in parallel using a shared approach. This approach included extensive existing system analysis to gain a thorough understanding of existing systems, any deficiencies that could be corrected via rehabilitation, and opportunities to improve system efficiency. Similarly, future system analysis was conducted to identify infrastructure that will be needed to accommodate future growth in the City's service areas.

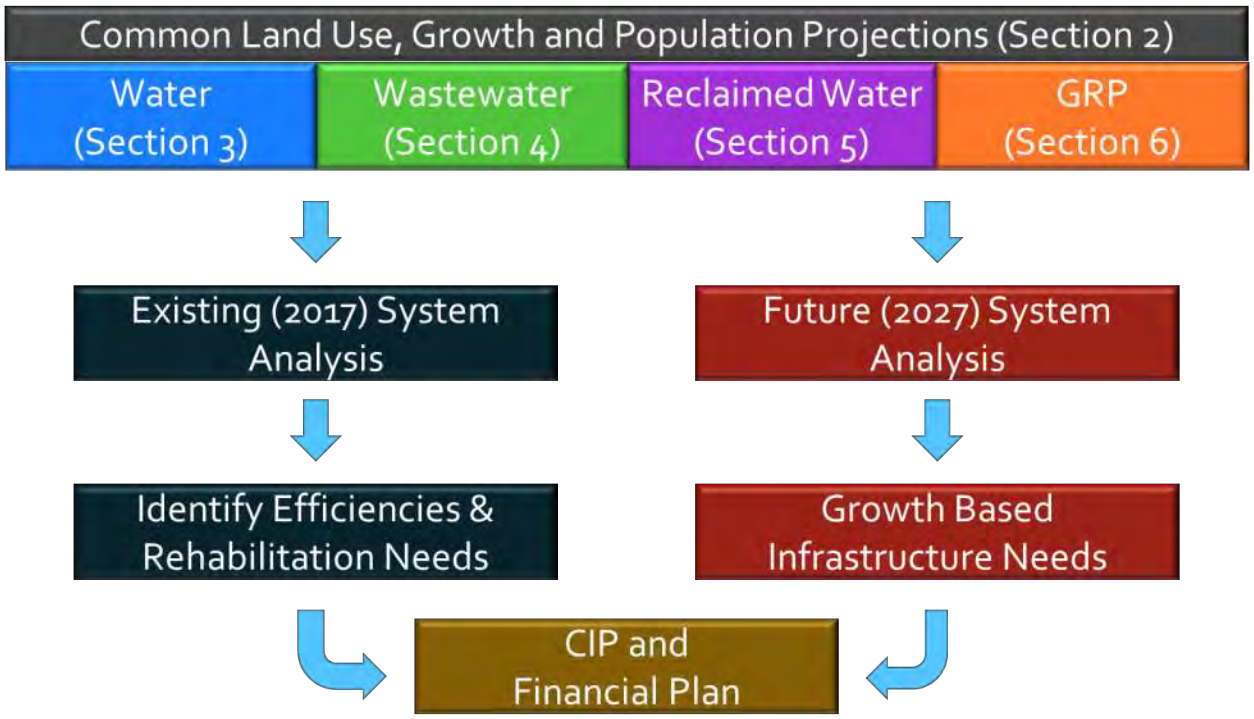

Figure 1-2. Integrated Utility Master Plan Overview

This Master Plan builds upon the City's 2014 Comprehensive Master Plan. Based on projections in the Comprehensive Plan and information obtained from district engineers for Municipal Utility Districts (MUDs) in the ETJ, the City population is expected to grow by 13% within the City limits and by approximately 240% within the City-served ETJ areas by 2027.

The project objectives are to provide the City with a comprehensive utility master plan and financial plan addressing the following needs at a minimum:

- Develop 10-year water, wastewater, reclaimed water master plans to accommodate the significant growth anticipated and meet planning criteria. These plans include capital improvement projects to improve the efficiency of existing systems and construct additional infrastructure to meet future system demands.
- Update groundwater reduction plan for the City to continue to currently meet the 30% alternate water conversion requirement and the 60% conversion requirement by 2025.
- Develop 10-year financial plans and rates that sustain the long-term financial health of the water, wastewater, and surface water utilities.

1.3. Planning Areas

1.3.1. Drinking Water

The City provides treated drinking water to customers within City limits, as well as to the following MUDs within the ETJ area listed in **Table 1-1**:

Table 1-1. Municipal Utility District within the City's Service Area for Water Utilities

Existing City Served MUD Areas	Additional Future City Served MUD Areas
Fort Bend County MUD 121 (MUD 121)	Fort Bend County MUD 207 (MUD 207)
Fort Bend County MUD 140 (MUD 140)	Fort Bend County MUD 215 (MUD 215)
Fort Bend County MUD 145 (MUD 145)	Williams Ranch MUD 1 (WR MUD 1)
Fort Bend County MUD 19 (MUD 19)	East of Brazos
Fort Bend County MUD 187 (MUD 187)	Shadow Grove Estates

These existing MUDs are connected directly to the City's system, and the City is responsible for water supply and pressure maintenance for these communities Additionally, the City supplies treated drinking water to MUD 121 (TX0790393). The City delivers drinking water with an air gap into MUD 121 ground storage tank (GST). Thus, while the City provides supply for MUD 121, this MUD provides storage, pumping, and pressure maintenance for its system. **Figure 1-3** shows the City served existing and future water service area map.

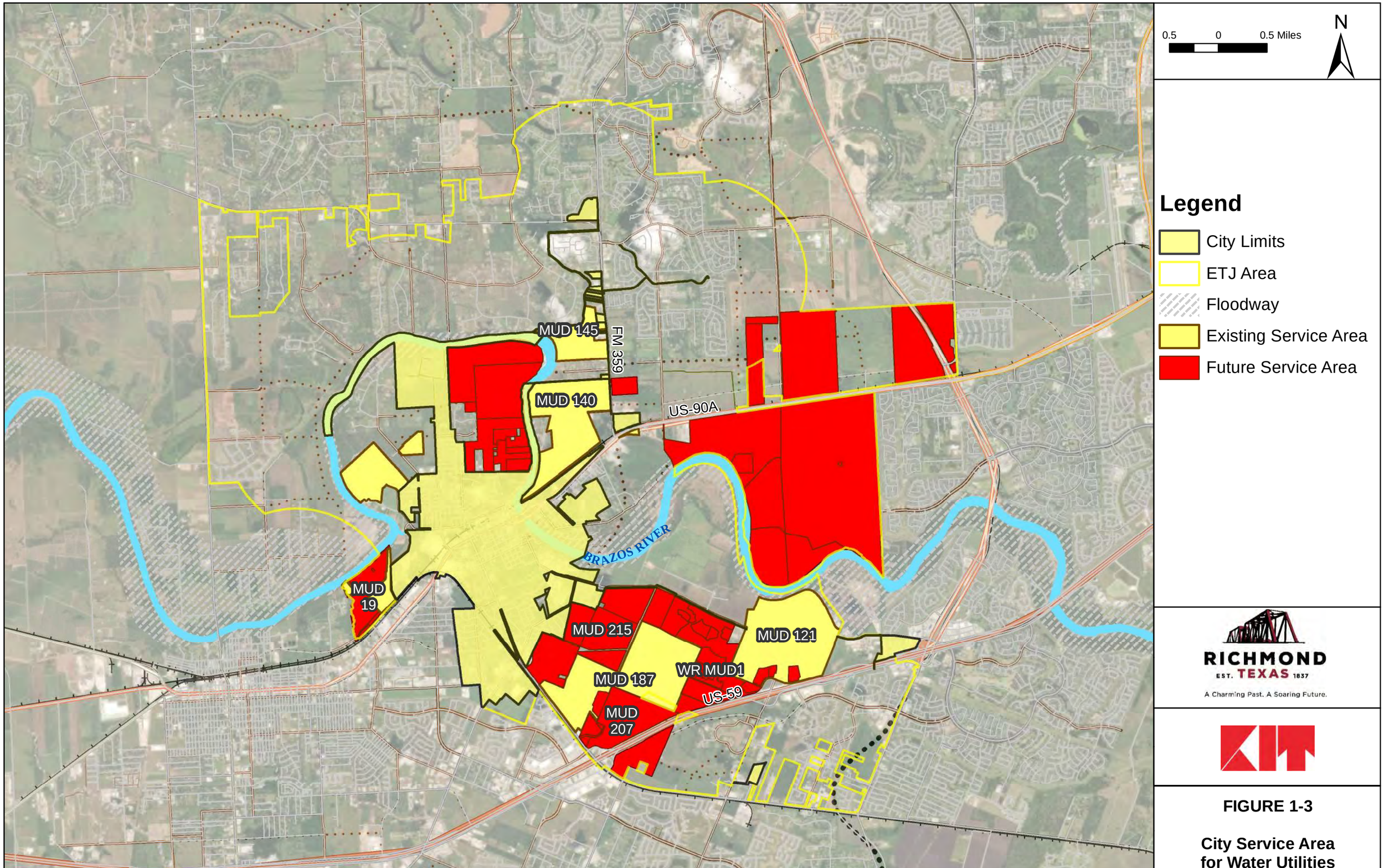

FIGURE 1-3

City Service Area for Water Utilities

1.3.2. Wastewater

The City's current wastewater service area includes customers within the City limits as well as several MUDs within the City's ETJ. The City's planned 2027 service area includes the addition of multiple MUDs, increasing the service area footprint by 100%. **Table 1-2** and **Figure 1-4** below lists the MUDs within the City's current and future service area.

Table 1-2. Municipal Utility District within the City's Service Area for Wastewater Utilities

Existing City served MUD Areas	Additional Future City served MUD Areas
MUD 121	MUD 207
MUD 140	MUD 215
MUD 145	WR MUD 1
MUD 19	East of Brazos
MUD 187	

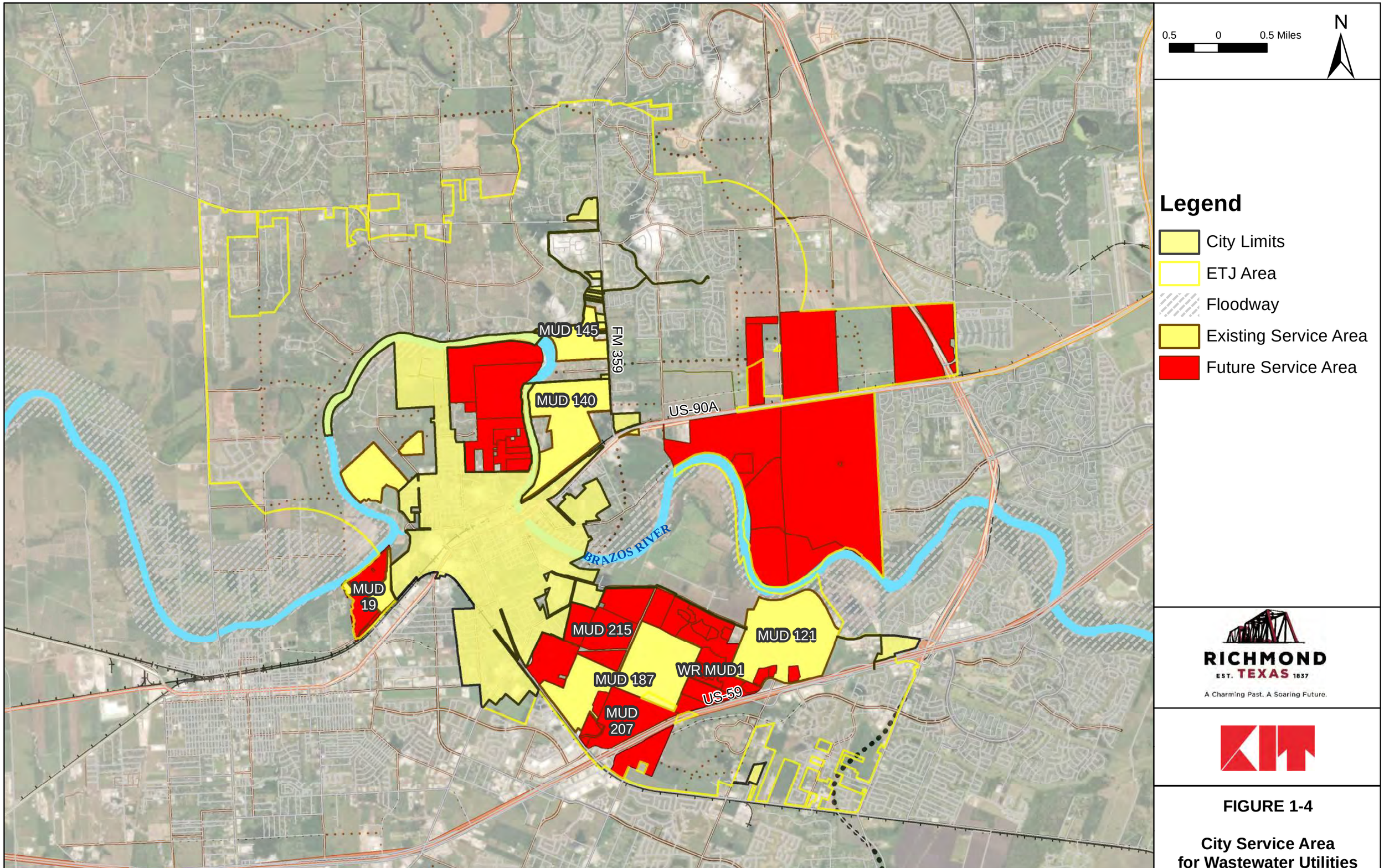

FIGURE 1-4

City Service Area for Wastewater Utilities

1.3.3. Reclaimed Water

The City currently owns and operates a reclaimed water system at its Regional WWTP. The reclaimed water system currently provides treated non-potable water for amenity lake filling and irrigation to two customers, the Del Webb community and the Fort Bend Country Club. The reclaimed water distribution system operates in an "on-demand" basis wherein system operation is based on customer demands.

1.3.4. Groundwater Reduction Plan

The City has partnered with fourteen other entities on the Groundwater Reduction Plan (GRP) aggregated permit that includes twenty-three (23) potable water wells. The City's GRP has been revised to comply with the Fort Bend Subsidence Districts (FBSD) 2013 Regulatory Plan. Fort Bend County Water Control and Improvement District No. 3 (FBWCID 3), FBWCID 8, Fort Bend County Municipal Utility District No. 116 (MUD 116) and Lamar Consolidated Independent School District (LCISD) are the GRP participants that do not obtain water from the City.

1.4. Data Sources

The consultant team collected data from the City, MUDs, and other resources to represent the configuration and operation of the existing utility systems. Data received is summarized in **Table 1-3.**

Table 1-3. Data Collection Summary

Data Type	Data Description	Data Used for
GIS Shapefiles	City and ETJ service areas, parcels, adopted land use plan, dated July 2017	Demand Projections
	Water and Wastewater Infrastructure, junction nodes, valves, water plants	Master Plan Modeling
Design and Operational Databases	Historical maintenance records and complaint logs related to distribution and wastewater collection systems	Water Master Plan Modeling
	Significant development in the City service area that are planned to occur over the next 10-year horizon	
	Design and operational information for key reclaimed water infrastructure such as pumping systems and transmission pipelines	
	Operational control logic and associated information for wells, surface water supply, valves, pumps, and storage facilities	
	Design and operational information for key wastewater infrastructure such as wastewater treatment plants, lift stations, and sanitary sewer lines. Available as-builts and construction record drawings and reports for key wastewater infrastructure	Wastewater Master Plan Modeling
	Operational control logic and associated information for lift stations and wastewater treatment plants	
	Applicable reports, technical memoranda, and findings of studies related to condition assessment for water and wastewater infrastructure	Water and Wastewater Master plan modeling
	Previous capacity assessment and master planning reports for drinking water, wastewater, and reclaimed water	
	Reclaimed water usage data	Reclaimed water demands
	Operational control logic and associated information for reclaimed water pump station	
Technical Reports	Previous GRP reports and submittals to Fort Bend Subsidence District Previous Water and Wastewater Master Plan reports	Water, Wastewater, GRP Update
Financial Databases	Financial data such as historical costs, operating budgets, revenue sources (including non-operating revenues), and reserve funds	Rate Study and Impact Analysis
	Existing and proposed debt, respective reserve policies, and annual coverage requirements.	
	Information related to pumpage fee, surface water fee, drinking water and wastewater rates.	

1.5. Report Structure

Richmond utility master plan and financial plan report provides the City with a tool for planning improvements needed for water, wastewater collection system, and reclaimed water. In this utility master plan, KIT in conjunction with Jones and Carter (J|C) and Raftelis, Inc. developed the following sections to document the master planning process, key findings, and recommendations:

- Introduction
- Planned Growth Projections
- Water System Master Plan
- Wastewater System Master Plan
- Reclaimed Water Master Plan
- Groundwater Reduction Plan
- Financial Plan and Rate Study

In addition to this Master Plan Report, the consultant team prepared the following deliverables as part of this utility master planning project:

- Alternative Capacity Requirements (ACR) report, which was submitted to the Texas Commission on Environmental Quality (TCEQ) for approval. The ACR approval letter received from the TCEQ is included in **Appendix A**.
- Groundwater Reduction Plan (GRP) Update Report (2019) to submit to the FBSD.
- Impact Fee Study Update Report (2019).

2. Planned Growth Projections

2.1. Population Growth

Based on the City's Comprehensive Plan, the current City population is 12,200, and the City service area population, including both the City and ETJ service areas, is approximately 24,000. The City population is expected to increase to approximately 12,800 by 2023 and to 13,200 by 2027 (approximately 5% and 8% increases, respectively). The service area population is expected to increase to 35,000 by 2023 and to 53,000 by 2027 (approximately 46% and 121% increases, respectively). This anticipated growth is driven primarily by development within the ETJ, where service area population is expected to increase by approximately 89% by 2023 and 238% by 2027. The area east of the Brazos River is anticipated to develop in the next 5 – 20 years. The 2027 population for east of Brazos, excluding the floodway zone, is projected to be approximately 11,000 people, which is one third of the ultimate population of approximately 34,000. **Table 2-1** summarizes the current, near (5-year), and future (10-year) term population growth. **Figure 2-1** shows graphical representation of the population projections.

Table 2-1. Existing and Projected Near-Term Future-Term Population

Entity	Current Population	2023 Population	2027 Population
City Limits	**12,200**	**12,800**	**13,200**
MUD 19	552	1,602	1,602
MUD 121	4,923	4,923	4,923
MUD 140	2,373	2,373	2,373
MUD 145	951	951	951
MUD 187[a]	2,686	3,552	3,838
MUD 207	-	1,400	6,209
MUD 215	70	5,600	5,600
WR MUD 1	175	1,715	2,996
Shadow Grove Estates[a]	-	111[b]	111[b]
East of Brazos	-	-	11,100
ETJ Service Area	**11,700**	**22,200**	**39,700**
Total City Service Area	**24,000**	**35,000**	**53,000**
Total Increase from Existing (%)		**~46%**	**~121%**

a – Current Shadow Grove Estates population is 111, but not currently in utility service areas

b – Water service area only

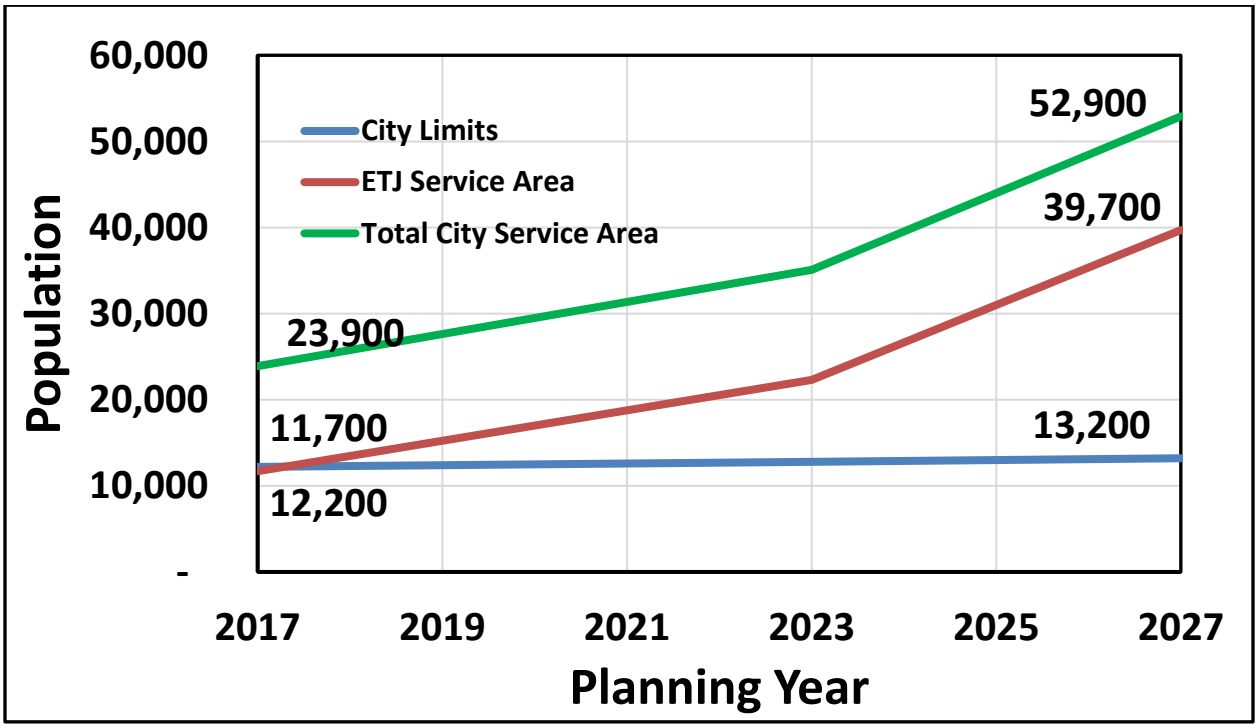

Figure 2-1. Population Growth in Near Term and Future Term

2.2. Land Use Plan

The City's Utility Master Plan is built on City's Comprehensive Plan (dated 2014) which included projections for growth and land use within the City limits and ETJ service areas. The zoning districts within the City limits are shown in **Figure 2-2**, is predominantly classified as general residential. Area adjacent to Highway 90A and FM 762 has mixed use and general commercial buildings. The future land use plan predominantly shows general and suburban residential area growth classification within the service area. There are a few commercial land use classifications along the Highway corridors of Alt 90 and along US 59 South. As per the City's Comprehensive Plan, general residential is the land classification for medium density that includes single family detached or attached homes, townhomes or patio homes and the suburban residential is the classification that includes single family residential lots that are typically one acre or larger. For commercial development areas, approximately 35 person / acre was assumed. The future land use plan is shown in **Figure 2-3**.

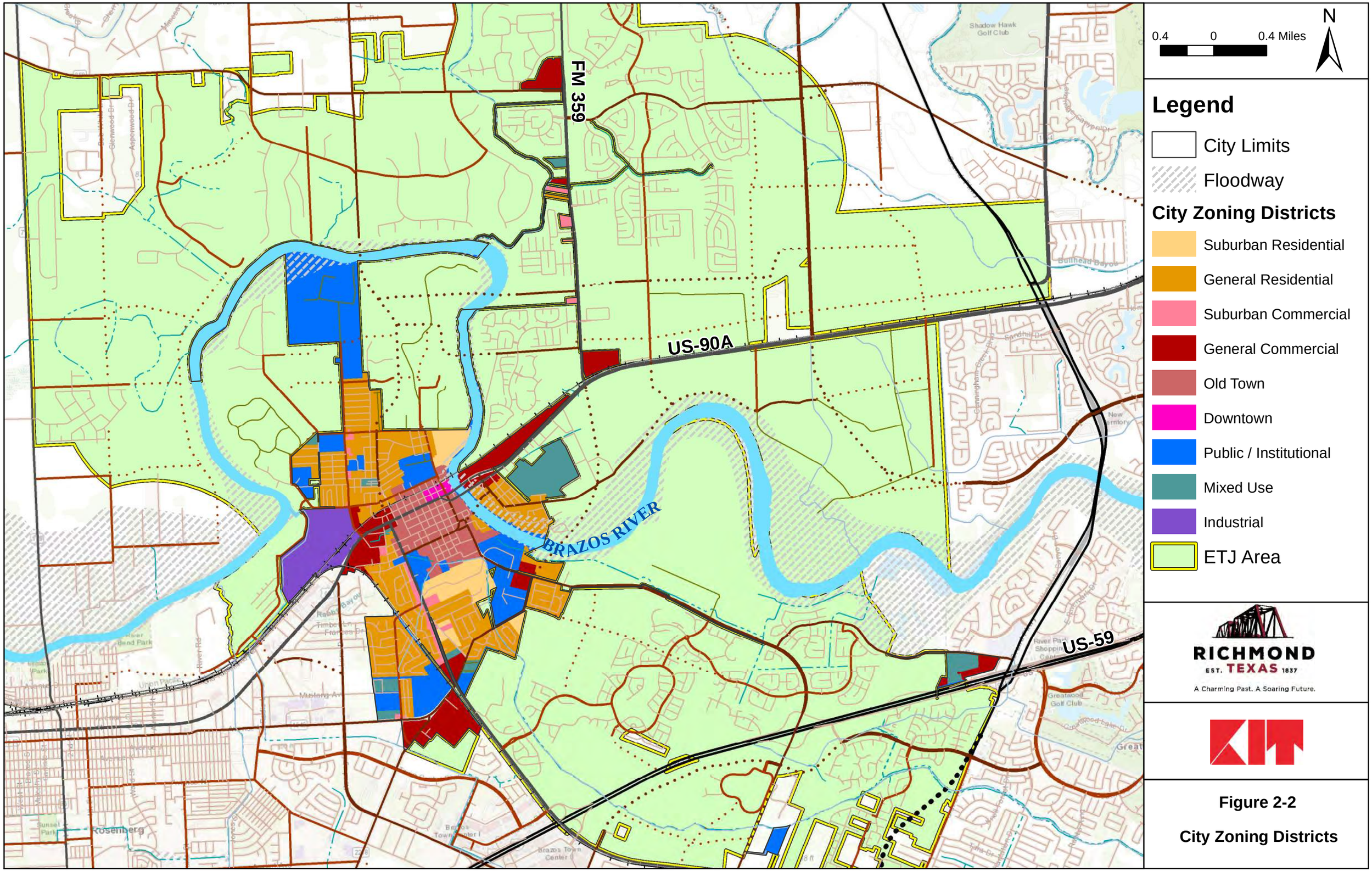

Figure 2-2

City Zoning Districts

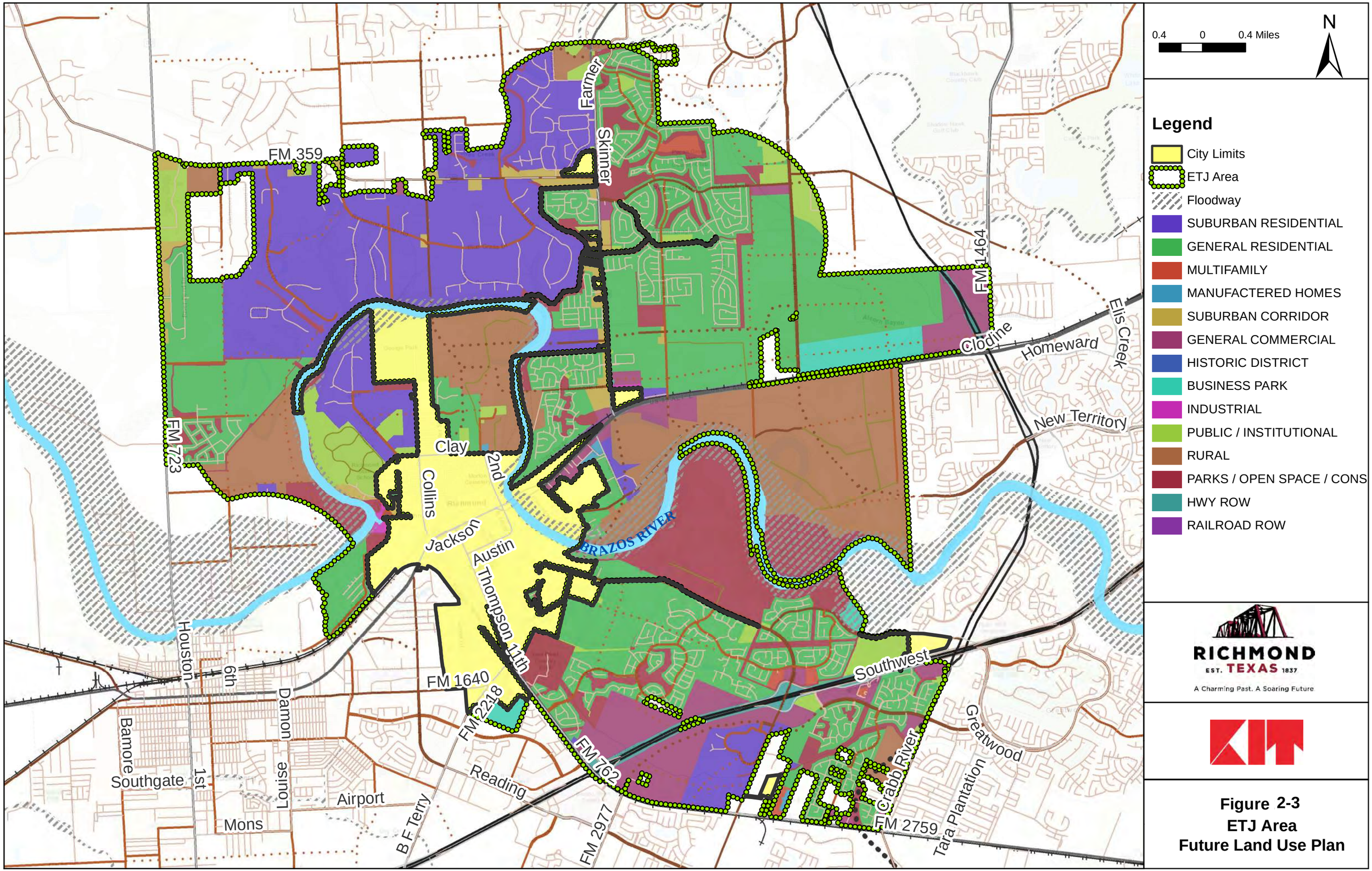

Figure 2-3
ETJ Area
Future Land Use Plan

Fort Bend Municipal Utility District MUD 121, MUD 140 and MUD 145 are completely developed in current conditions and MUD 140 and MUD 145 are receiving City's drinking water. In addition, MUD 19 is about 30% developed and MUD 187 is 70% developed and these will be fully developed in about three and eight years, respectively. MUD 215 and Shadow Grove Estates are anticipated to be fully developed by 2027. MUD 207, WR MUD1 and east of Brazos River Parcels are estimated to develop in 15 - 20 years from now. WR MUD 1 is classified as single family residential and commercial future growth, MUD 215, MUD 187, and MUD 19 are classified as residential future growth, and MUD 207 is a mix of medium to high density population and commercial growth. **Table 2-2** shows the City served MUD's within ETJ limits with the existing connection count and existing and future developed areas in percentages and estimated ultimate buildout timeline. Based on the received 2018 historical connections, City service area includes approximately 9,000 connections. By 2027, City is expected to have approximately 16,600 connections, which is an increase of connections by approximately 50%.

Table 2-2. Connection Counts for City Served Areas

MUD Name	Subdivision Name	Existing Connection Count (#)	2027 Total Connection Count (#)
City Limits[a]	City of Richmond	4,474[a]	4,800
MUD 19	Riverwood Village	184	458
MUD 121	Riverpark West	1,122	1,122
MUD 140	River's Edge	845	845
MUD 145	Rio Vista	424	424
MUD 187[b]	Del Webb	1,321	1,535
MUD 207	Berry Place	3	1,774
MUD 215	Veranda Trails	439	1,600
WR MUD 1	Williams Ranch	121	856
Shadow Grove Estates		0	32
East of Brazos		0	3,171
Total		**~9,000**	**~16,600**

N/A – Not Applicable

a. Existing connection count of 4,474 include both single family residential (3,358 connections) and multi-family dwelling units (1,116 connections)

b. Del Webb Community in MUD 187 is predominantly old age community

3. Water System Master Plan

3.1. System Inventory

3.1.1. Water Plants and Pumping Facilities

This section summarizes the water system inventory, water demand projections, existing and future system. The City's existing facilities include groundwater wells, storage tanks, booster pumps, elevated storage tanks, and surface water treatment plant. There are five (5) groundwater plants (WPs) and a surface water treatment plant (SWTP). Downtown WP has two (2) wells and two (2) booster pumps, Winston WP has one (1) well and one (1) booster pump, Richmond Parkway WP has one (1) well and three (3) booster pumps, Wessendorff WP has one (1) well and three (3) booster pumps, Edgar WP has one (1) well and five (5) booster pumps, and the SWTP has four (4) booster pumps. **Table 3-1** summarizes the City's existing groundwater plant well and pumpage capacities. The existing groundwater plants can supply a total of 11.6 MGD, and the SWTP can produce approximately 2 MGD.

Table 3-1. Existing Water Plant Production and Pumping Capacities

Facility Type	Production Capacity (MGD)	Booster Pumping Capacity (MGD)
Downtown WP	1.7	1.4
Winston WP	0.9	0.7
Richmond Parkway WP	1.3	3.1
Wessendorff WP	3.0	2.8
Edgar WP	4.7	8.7
Surface Water Treatment Plant	2.0	4.9
Storage	**13.6**	**27.6**

3.1.2. Ground Storage and Elevated Storage Facilities

The City has five (5) groundwater storage tanks (GSTs) and three (3) elevated storage tanks (ESTs). The total ground storage capacity is 3.41 Million Gallons (MG) and elevated storage capacity is 0.71 MG. The capacities of the storage tanks are shown in **Table 3-2**.

Table 3-2. Existing Ground Storage and Elevated Storage Tank Capacities

Facility	Ground Storage Tank Capacity (MG)	Elevated Storage Tank Capacity (MG)
Downtown WP	0.30	0.11
Winston WP	0.11	
Richmond Parkway WP[1]	1.00	0.30
Wessendorff WP	1.00	
Edgar WP	1.00	
George Tower EST	-	0.30
Surface Water Treatment Plant	1.00	
Total Capacity	**4.41**	**0.71**

Note 1. Richmond Parkway WP has two GSTs of 0.5 MG each

3.1.3. Transmission and Distribution Waterlines

The City's water transmission and distribution pipeline sizes range from 0.8-inch to 20-inch in diameter. There are several segments of old metal pipelines ranging from 3/4-inch to 4-inch in diameter, located within the City limits. A 20-inch transmission line extends from SWTP, south along FM 762 transitioning to a 16-inch pipeline. Another 16-inch transmission main at the east side is along Richmond Parkway / Williams Way Boulevard serving MUD 215, MUD 121, WRMUD 1 and MUD 187. **Table 3-3** summarizes the existing pipe inventory, including size, material, and length. **Figure 3-1** shows the existing water Infrastructure and facilities.

Table 3-3. Existing Water Transmission and Distribution Pipeline Summary

Pipe Diameter (inches)	Pipe Material	Pipe Length (feet)
0.8	PVC	263
1	Cast Iron, PVC	2,076
1.3	Cast Iron, PVC	976
1.5	Cast Iron, PVC	1,793
2	Cast Iron, PVC	45,844
2.5	PVC	279
3	PVC	768
4	Cast Iron, PVC	41,436
6	Cast Iron, Ductile, PVC	154,381
8	Cast Iron, Ductile, PVC	182,187
12	Cast Iron, Ductile, PVC	99,130
16	Cast Iron, Ductile, PVC	53,351
20	PVC	19,330
	Total Length (feet)	**602,000**

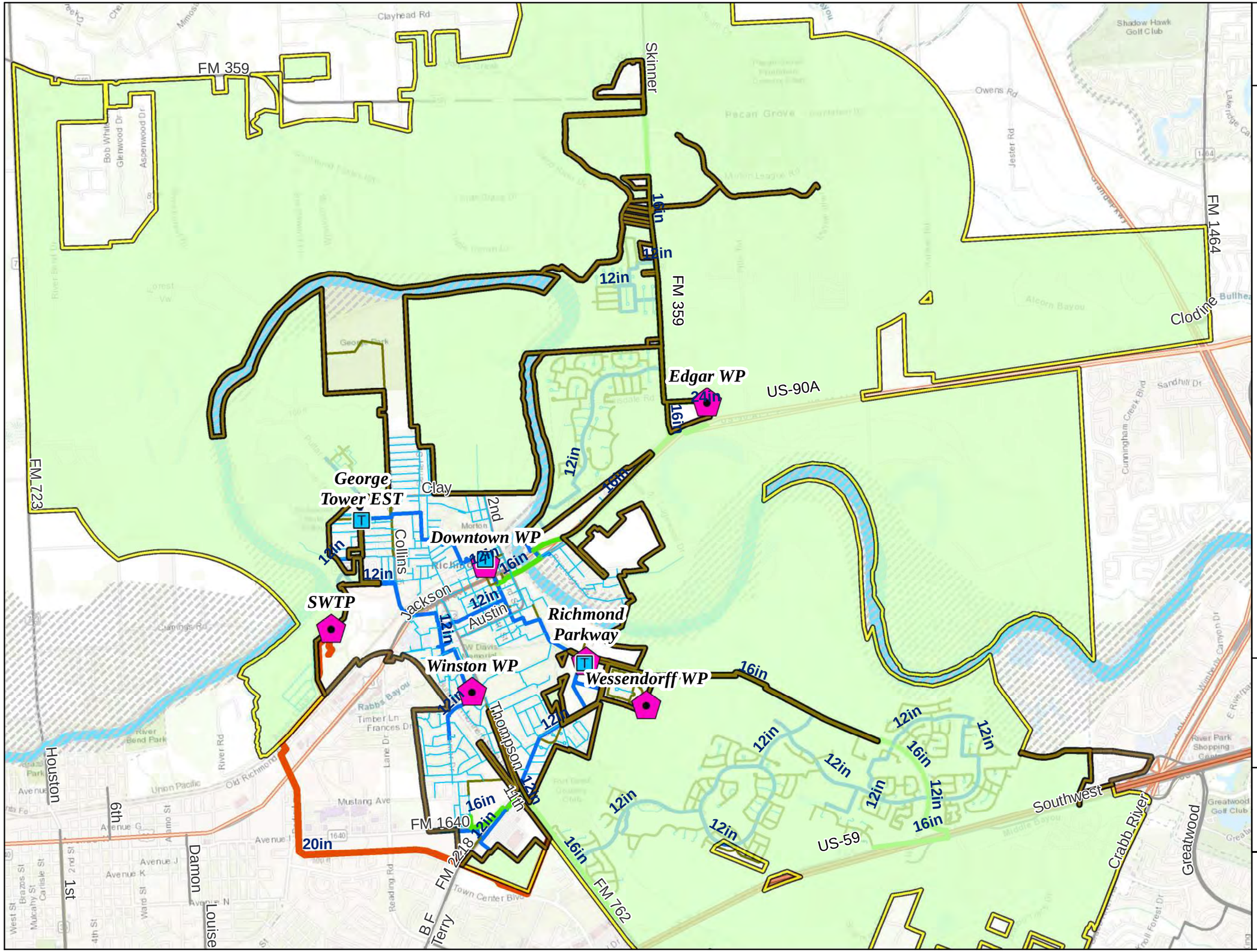

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Figure 3-1
Existing Key Water Infrastructure

3.2. Water Demands and Demand Projections

Beginning in March 2018, the City integrated treated water from the SWTP. The treated water from SWTP is pumped directly into the distribution system. A summary of City's historical average and maximum daily water demand for the last 36 months (September 2015 – August 2018) is shown in **Table 3-4**. These values are based on historical water production data for the City's WPs and therefore include system water losses. Based on the production data, the maximum daily demand (MDD) of 4.86 MGD for this three-year period occurred on July 24, 2018.

Table 3-4. Historical Daily Water Demand Summary

Year	2015[a]	2016	2017	2018[b]
Maximum Daily Flow (MGD)	3.64	3.57	4.13	4.86
Maximum Daily Flow (gpm)	2,528	2,479	2,868	3,373
Average Daily Flow (MGD)	2.25	2.19	2.20	2.57
Average Daily Flow (gpm)	1,559	1,521	1,528	1,781

a - September through December 2015 only
b - January through August 2018 only

Historical billing and monthly production data received from the City was used to establish the system's current average and maximum water demands. Years 2011 and 2015 showed high water demands and production resulting in gallons per capita per day (gpcd) values of 245 and 200, respectively. A gpcd value of 225 was considered for the master planning purposes. From the historical daily production data, the maximum daily demand of 4.86 MGD and the average daily demand of 2.4 MGD were used as the current demand conditions for water modeling. This resulted in a maximum to average day peaking factor of 2.0. For 2027, the maximum day water demand was estimated to be approximately 11.9 MGD based on 225 gpcd, as shown in **Table 3-5**.

Table 3-5. Current and Future Water Demand Projections

Year	City System Population	Average Day Water Demand[b] (MGD)	Maximum Day Water Demand[c] (MGD)
Current[a]	23,900	2.40	4.86
2023	35,100	4.07	7.90
2027	52,900	6.14	11.90

a. current average and maximum day demands are based on the historical production data
b. 2023 and 2027 average day demands are based on gpcd value of 116
c. 2023 and 2027 maximum day demands are based on gpcd value of 225

Figure 3-2 shows the demand allocation of existing demand from 2018 EPS Model. Some of the top customers that receive City's supply include Fort Bend County Jail, Texas Department Aging and Disability, Oak Bend Medical Center, and Richmond Regional WWTP.

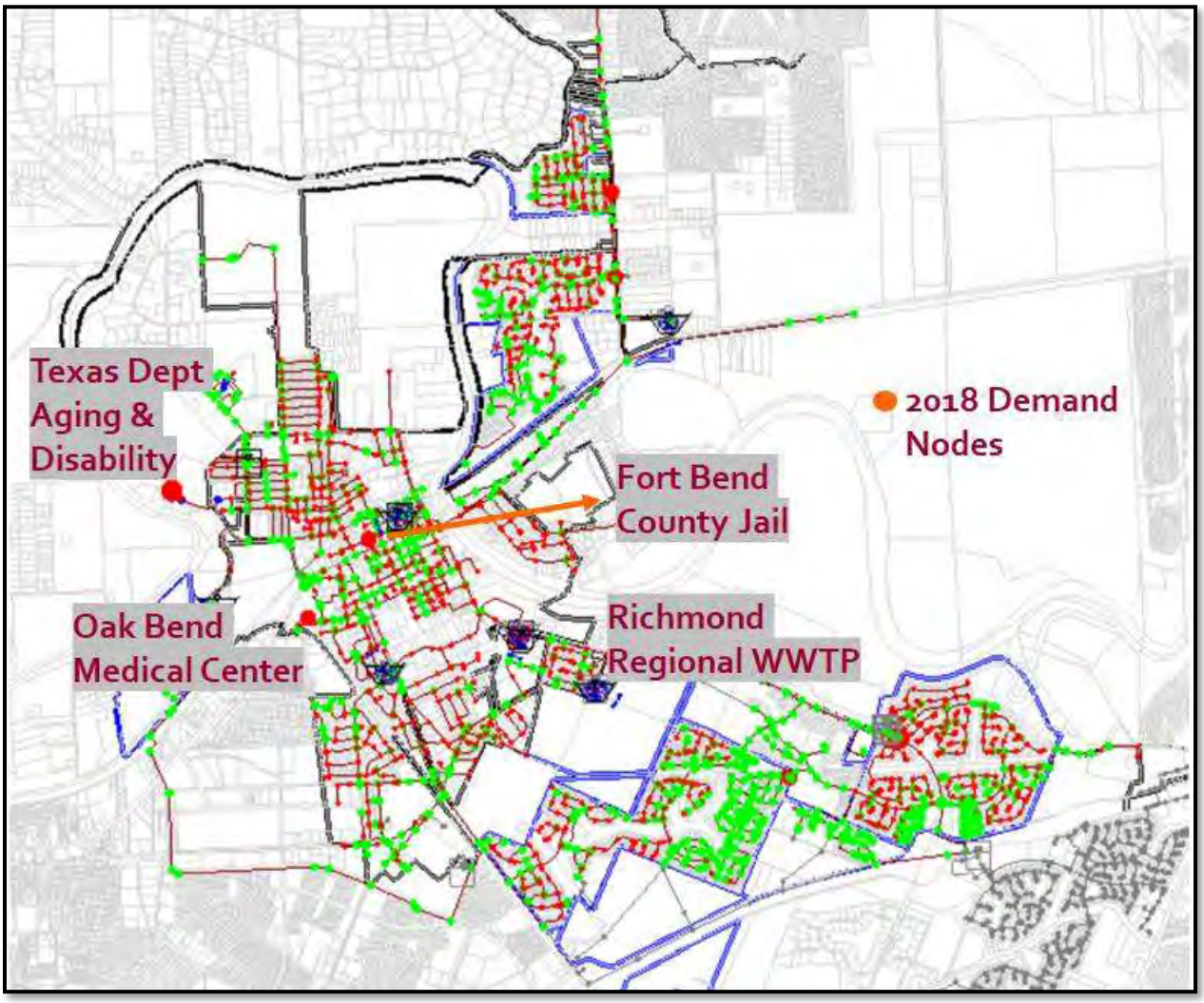


Figure 3-2. Water Demand Allocation from 2018 EPS Water Model for Max Day Demand Conditions

3.3. Existing System Evaluation

3.3.1. Planning and Evaluation Criteria

Table 3-6 shows a list of water system planning parameters and criteria. Various parameters are used in the evaluation of water system hydraulic models. Hydraulic modeling was performed to confirm that the values are within this range. These criteria were established based on regulatory requirements and in discussions with City staff.

Table 3-6. Summary of Planning Parameters and Criteria

Planning Parameter	Planning Criteria
Minimum System Pressure	35 psi, 50 psi for transmission lines
Maximum System Pressure	80 psi, goal of 65 psi
Maximum Water Velocity	8 fps
Maximum Head Loss Gradient in Pipes of 16-inch or Greater Diameter	2 ft/1,000 ft of pipe
Maximum Head Loss Gradient in Pipes of Less than 16-inch Diameter	7 ft/1,000 ft of pipe
Fire Flow Capacity	Minimum system pressure of 20 psi for fires, including at higher elevations; ability to handle multiple fires in residential and commercial areas

psi – pressure per square inch
fps – feet per second
ft - feet

3.3.2. EPS Water Model Development

The City water system was modeled using WaterGEMS, a computer model developed by Bentley Systems. As part of the modeling effort, the existing water infrastructure received from the City was verified, updated, and imported into WaterGEMS. This model is compatible with the City's Geographic Information System (GIS). An Extended Period Simulation (EPS), that reflects the variation of the system attributes over time was developed for current and future conditions. Summarized below are the steps involved in developing the EPS Water Model. Details on existing model development are attached in **Appendix A**.

i. Reviewed City's GIS utility data for waterlines, blow offs, hydrants, reducers and valves.
ii. Incorporated network and waterline data into WaterGEMS Model using 'ModelBuilder'.
iii. Analyzed three (3) years of historical billing data within City service area and computed demands from water consumption data.
iv. Incorporated water demands into the model using point load data from WaterGEMS 'LoadBuilder' assigned to the nearest node.
v. Developed a diurnal pattern using Supervisory Control and Data Acquisition (SCADA) data to represent the variation of demand throughout the day. **Figure 3-3** shows systemwide diurnal pattern for average day demand condition.

vi. Added sources for five water plant facilities with GST patterns received from SCADA data along with two-point design points at the pumps.
vii. Added operational range parameters for ESTs based on the tank inspection data received from the City in April, 2018.
viii. SWTP booster plant curves have been revised based on the updated drawings. Two of four pump curves have a design point of 825 gpm at 120 feet head and the other two with design flow of 1,000 gpm at 120 feet head.
ix. Hazen-Williams method was used for the analysis of head loss in the system.
x. Existing model was calibrated based on the April 2018 SCADA data that represents average day demand conditions. Calibrating to maximum day conditions was not possible because SWTP was not online until Spring of 2018. The water master plan was developed using the calibrated water model.

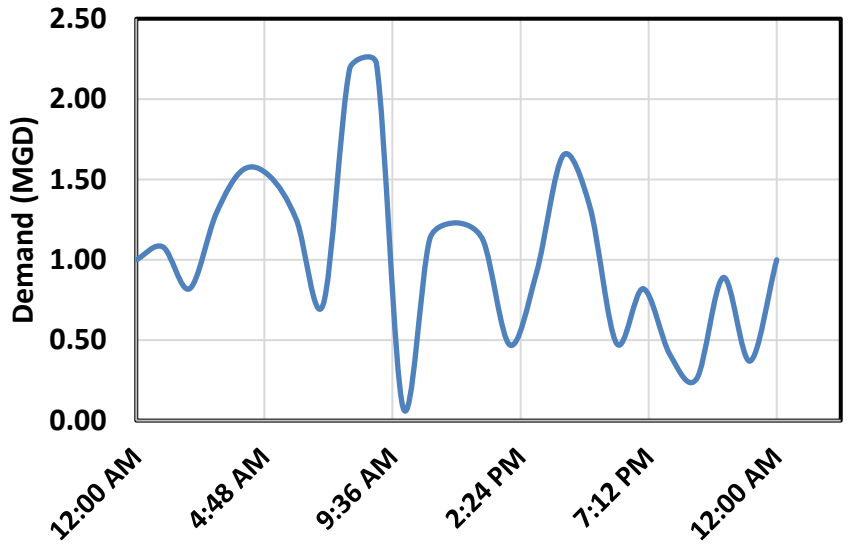


Figure 3-3. Systemwide Water Demand Diurnal Pattern for 2018 Average Day Demand Condition

3.3.3. EPS Water Model Validation

The EPS Model was calibrated and verified with field (SCADA) data from April 2018, which was characteristic of typical average day demand conditions. The pumping data showed 2.4 MGD of production supply for that day, which was matched in the model. The EPS Water Model was executed over a 24-hour period, with the Hazen-Williams method for head loss. System pressures at the pump discharge, EST levels, hydraulic grades and flow discharge predicted by the model were compared with the field data. Adjustments to the model in terms of diurnal demand factors, pump operation, and elevations were made as necessary to bring the model and field data into agreement. The model was also verified for static pressures observed in the field on October 10, 2018 for two conditions, first with no pumps at SWTP running and second with one pump at SWTP running. Model pressures were close to what was measured in the field. The calibrated model was then set as a base for the future scenario modeling. Existing condition average day calibration model results are shown in **Appendix A**.

3.3.4. EPS Water Model Results

Once the model was calibrated/verified, the water demand was scaled to represent maximum day demand conditions, which was previously determined to be 3,318 gpm (4.8 MGD), pump controls were adjusted based on the tank levels and troubleshooted to represent typical operation under maximum day demand conditions, and the model was rerun for simulating an existing maximum day demand conditions scenario. **Figure 3-4** below shows the water demand and supply profiles from the EPS Water Model for 24-hour time period.

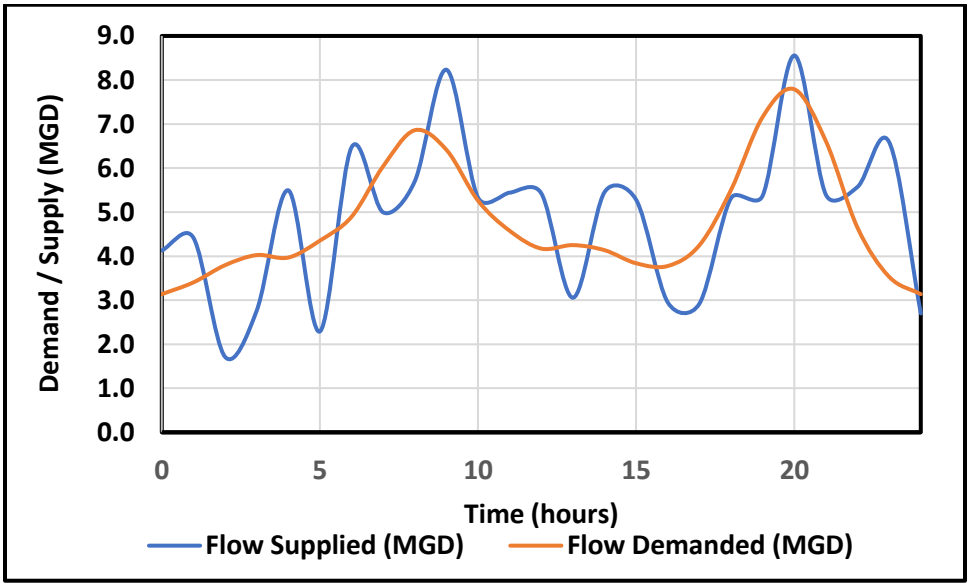


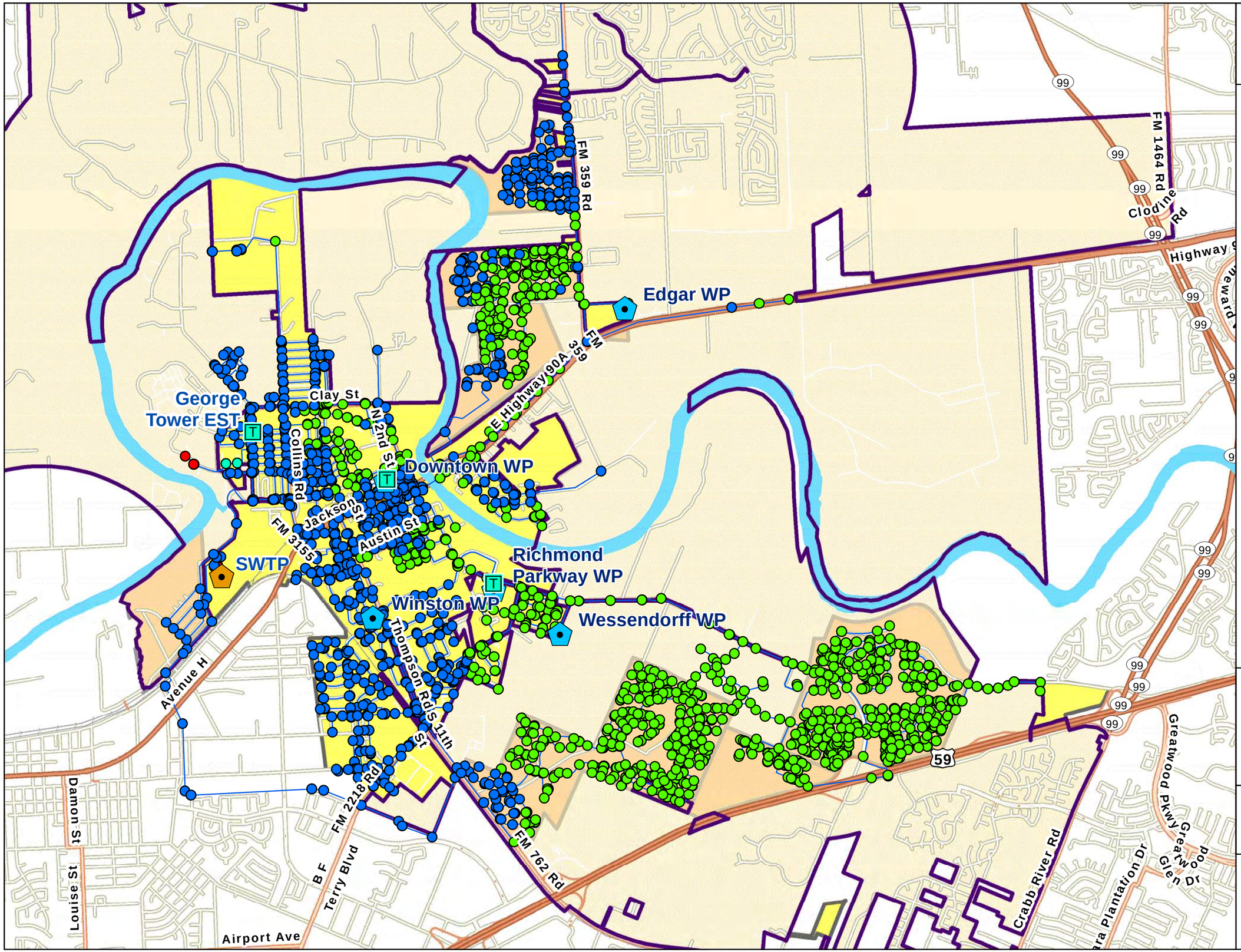
Figure 3-4. Water Demand and Supply Profiles for 2018 Maximum Day Demand Condition

During maximum day demand conditions, results show that the George Tower tank levels drop rapidly at peak times during the day which indicates insufficient supply and conveyance at the north side of the system. **Table 3-7** summarize the total available and pump supply from EPS model for average day and maximum day conditions. Although the existing pumps are capable of providing necessary supply, the City is experiencing issues with few of water plants due to its condition and age, and are recommended to rehabilitate. The condition assessment of existing facilities is detailed in **Section 3.5.1.**

Table 3-7. 2018 Total Available and Model Pump Supply (MGD)

Facility	2018 Available Well Supply (MGD)	2018 Available Pump Supply (MGD)	2018 Average Day Model Supply (MGD)	2018 Maximum Day Model Supply (MGD)
Downtown WP	1.7	1.4	0.17	1.13
Winston WP	0.9	0.7	0.04	0.00
Richmond Parkway WP	1.3	3.1	0.22	1.03
Wessendorff WP	3.0	2.8	0.38	0.59
Edgar WP	4.7	8.7	0.82	0.79
SWTP	2.0	4.9	0.98	1.96
Total	**13.6**	**21.6**	**2.61**	**5.50**

Figure 3-5 shows minimum pressures at junctions for existing maximum day demand conditions. The pressures within the distribution system generally range between 60 to 70 psi. **Figure 3-6** shows the head loss gradient in transmission and distribution system pipelines, which determines the pressure loss due to friction along a given length of pipe based on the average velocity of the fluid flow for the recommended scenario. As shown in the Figure 3-6, a few small diameter pipes that are less than 6-inch do not meet the head loss gradient criteria which indicate a need of additional pipes or upsizing existing pipes that provide sufficient capacity.



Legend

Minimum Pressure

- < 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area
- Existing EST
- Groundwater Plant

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Figure 3-5
2018 EPS Model Base
Maximum Day Conditions
Minimum Junction Pressures

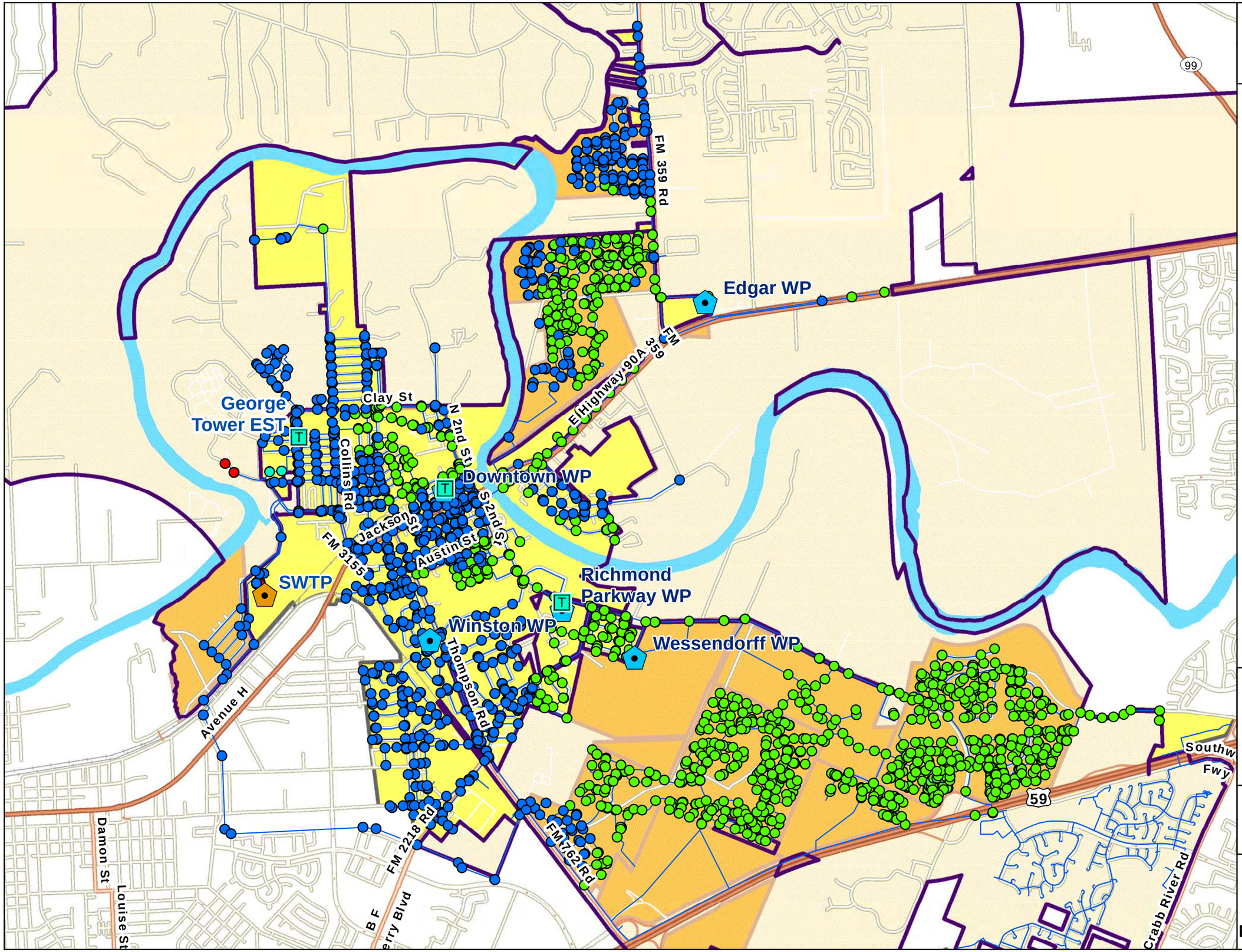

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Figure 3-6
2018 EPS Model Base
Maximum Day Demand
Maximum Head Loss Gradient

3.3.5. Fire Flow Analysis

Four different locations were analyzed to determine that fire flows needed in the system could be met without the distribution system pressure dropping below 20 psi. The locations of the fire flow junctions are shown in **Figure 3-7**. The consultant team conducted a fire flow analysis and simulation using the hydraulic water model. WaterGEMS' fire flow analysis tool was used to determine that fire flows needed at different locations in the system could be met without the distribution system pressure dropping below 20 psi. The results of this analysis are shown in **Table 3-8**.

Table 3-8. 2018 EPS Model Maximum Day Conditions Fire Flow Analysis Results

Node Label	Fire Flow Needed (gpm)	Distribution System Lower Limit Pressure Constraint (psi)	Minimum Distribution System Pressure at Total Fire Flow Supplied (psi)	Junction with Minimum Pressure	Satisfies Fire Flow Constraints?
J-8657 (MUD 140)	1,500	20	42	J-6965	TRUE
J-9048 (North of Clay St.)	1,500	20	42	J-6965	TRUE
J-8044 (West of FM 762)	1,000	20	42	J-6965	TRUE
J-9199 (MUD 215)	1,500	20	42	J-6965	TRUE
J-7892 (MUD 187)	1,500	20	42	J-6965	TRUE

The results shown for the fire flow analysis are for individual fire flow events. The consultant team also simulated the fire flow events occurring simultaneously by conducting a 2-hour extended period simulation. This simulation incorporates the above specified fire flows into the maximum day demand scenario. **Figure 3-8** shows the fire flow locations and minimum node pressures experienced during the simulation. The minimum pressures in the distribution system do not drop below 20 psi, which is the minimum fire flow criteria specified in 30 TAC §290.45. The minimum pressure experienced in the system for this scenario is 42 psi. The results of the fire flow analysis and the 2-hour simultaneous fire flow simulation indicate that the system is capable of meeting fire flow needs at the minimum required pressure given its existing production and storage capacity.

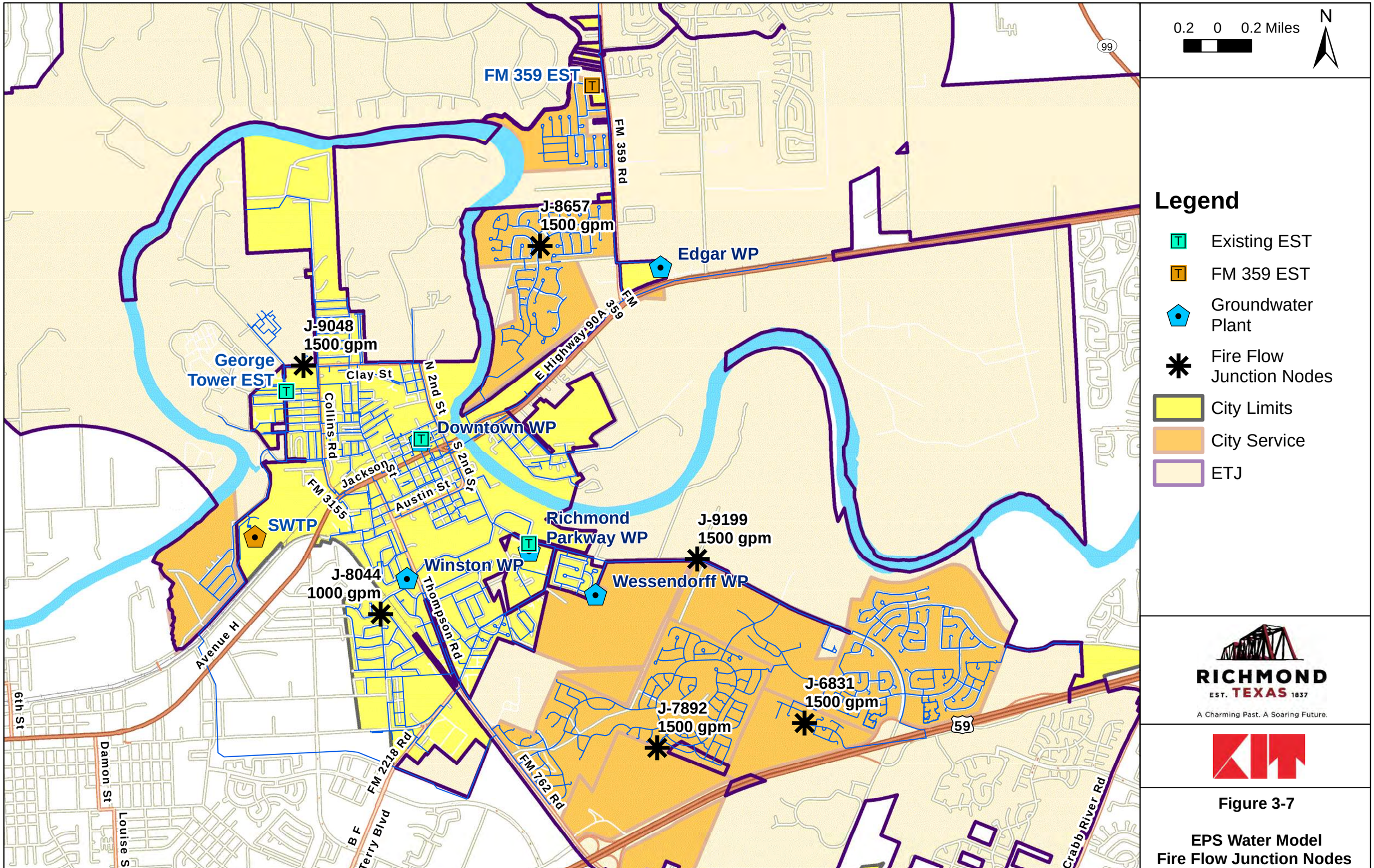
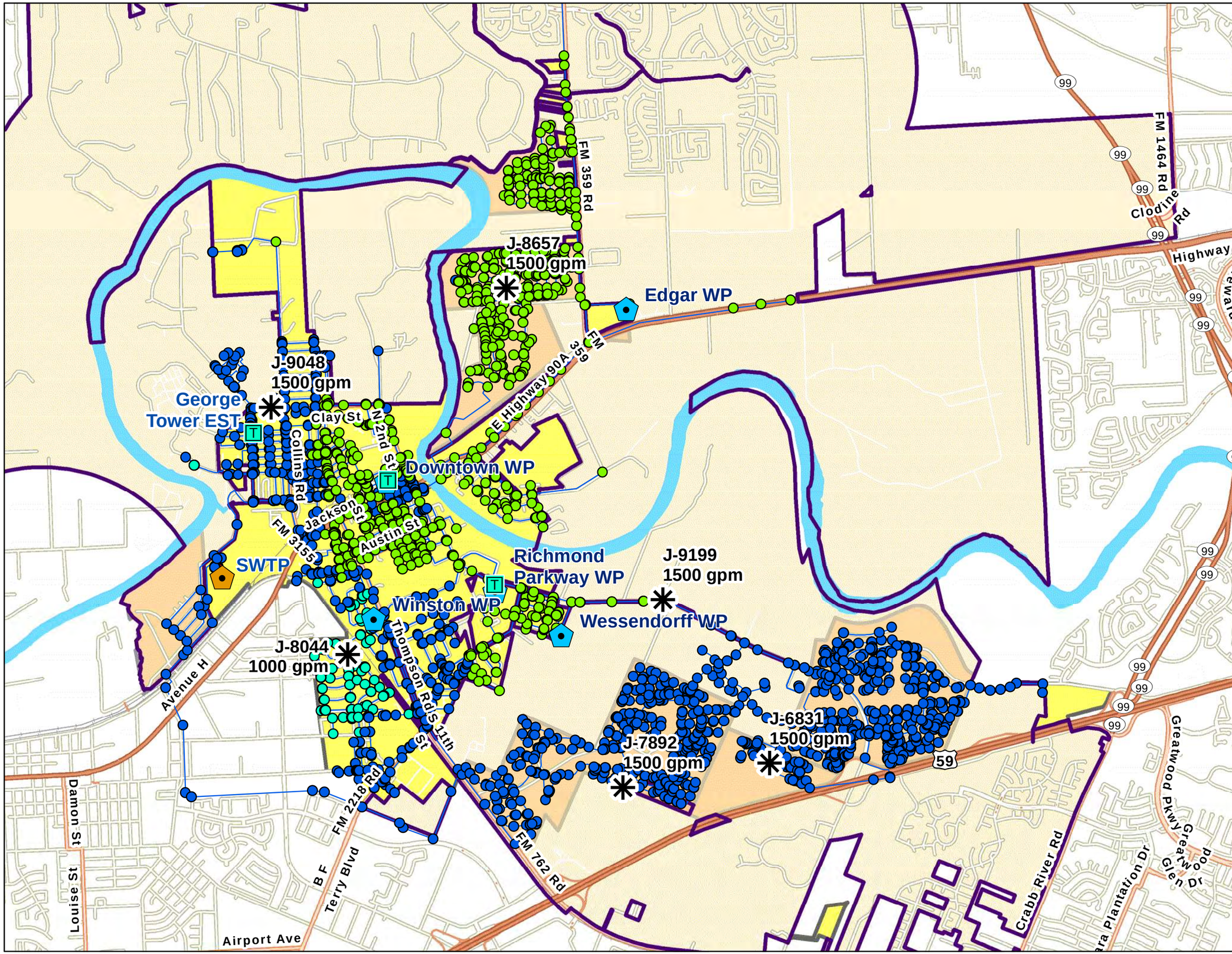


Figure 3-7

EPS Water Model
Fire Flow Junction Nodes



Legend

Minimum Pressure

- < 20 psi
- 21 - 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area
- Existing EST
- Groundwater Plant
- Fire Flow Junction Nodes

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Figure 3-8
2018 EPS Model Base with Fire Flow Condition Minimum Junction Pressures

3.3.6. Alternative Capacity Requirements

The regulations set forth under 30 TAC §290.45 – "Minimum Water System Capacity Requirements" requires that PWSs with more than 250 connections shall meet the following requirements:

- Supply of 0.6 gpm per connection
- A total storage capacity of 200 gallons (gal) per connection
- An elevated storage capacity of 100 gal per connection or a pressure tank capacity of 20 gal per connection

Public water systems may request approval to meet alternative capacity requirements (ACRs) in lieu of the minimum capacity requirements specified in 30 TAC §290.45. While developing this Water Master Plan, KIT developed and submitted an ACR request to the TCEQ.

The TCEQ approved the City's request in December 2018, granting the City an equivalency ratio (i.e., a multiplier) of 0.83 that reduces the City's water supply, total storage, and elevated storage requirements to the following values:

- Supply of 0.49 gpm per connection
- A total storage capacity of 166 gal per connection
- An elevated storage capacity of 83 gal per connection

With the completion of the SWTP, the City has more than adequate supply and total storage volume with current infrastructure relative to the approved ACRs.

Table 3-9 summarizes the elevated storage volume that would be required under default TCEQ requirements and those granted under the approved ACR request. As can be seen in the table, the City currently has enough elevated storage volume to meet the ACR. Although one or more additional ESTs will be required to meet this requirement in the future, this ACR approval allows the City to maintain compliance with state regulations until the previously planned and designed Rio Vista EST can be constructed, and the lowered requirements reduce the additional EST volume that will be required in the future.

Table 3-9. ACR Calculations for Elevated Storage (2018)

Parameter	Volume (MG)
Elevated Storage requirement at 100 gal/connection (Default requirement)	0.78
Elevated Storage ACR at 83 gal/connection (TCEQ-approved ACR)	0.65
Currently Available Elevated Storage	0.71

3.4. Future System Evaluation

3.4.1. Supply and Demand Projections

The City's current total available supply of 13.6 MGD, 11.6 MGD of groundwater and 2 MGD of surface water, is adequate to meet the exiting maximum daily water demands. The FBSD GRP mandate requires 60% of water demands to be met using alternate water (other than groundwater) beginning October 2025. To meet this GRP mandate, the City would need to expand the SWTP capacity to 4 MGD by 2025. If City experiences growth in the east of Brazos River area or adds new GRP partners then an additional expansion of SWTP to 6 MGD will be needed. **Table 3-10** and **Figure 3-9** show current, and future maximum day water demands and available water supplies. **Table 3-11** summarize the breakdown of demand and supply at Brazos River.

Table 3-10. Water Supply and Demand Projections

Year	Maximum Day Water Demand (MGD)	Groundwater Supply (MGD)	Surface Water Supply (MGD)	Total Supply (MGD)
Current	4.9	11.6	2.0	13.6
2023	7.9	11.6	2.0	13.6
2025	9.0	11.6	4.0	15.6
2027	11.9	11.6	4.0	15.6

Table 3-11. 2027 Supply and Demand Projections

Location	Service Areas	2027 Maximum Day Water Demand (MGD)	Water Plants	2027 Total Available Water Supply (MGD)
East of Brazos	MUD 140, MUD 145, Shadow Grove Estates, East of Brazos	**3.3**[1]	Edgar WP	4.7
			Total East of Brazos	**4.7**
West of Brazos	City Limits, WRMUD 1, MUD 19, MUD 187, MUD 207 and MUD 215	**8.6**	Downtown WP	1.7
			Winston WP	0.9
			Richmond Parkway WP	1.3
			Wessendorff WP	3.0
			Surface Water Treatment Plant	4.0
			Total West of Brazos	**10.9**

Note 1. Maximum day demand includes the service areas MUD 140, MUD 141, Shadow Grove Estates and one third growth east of Brazos River

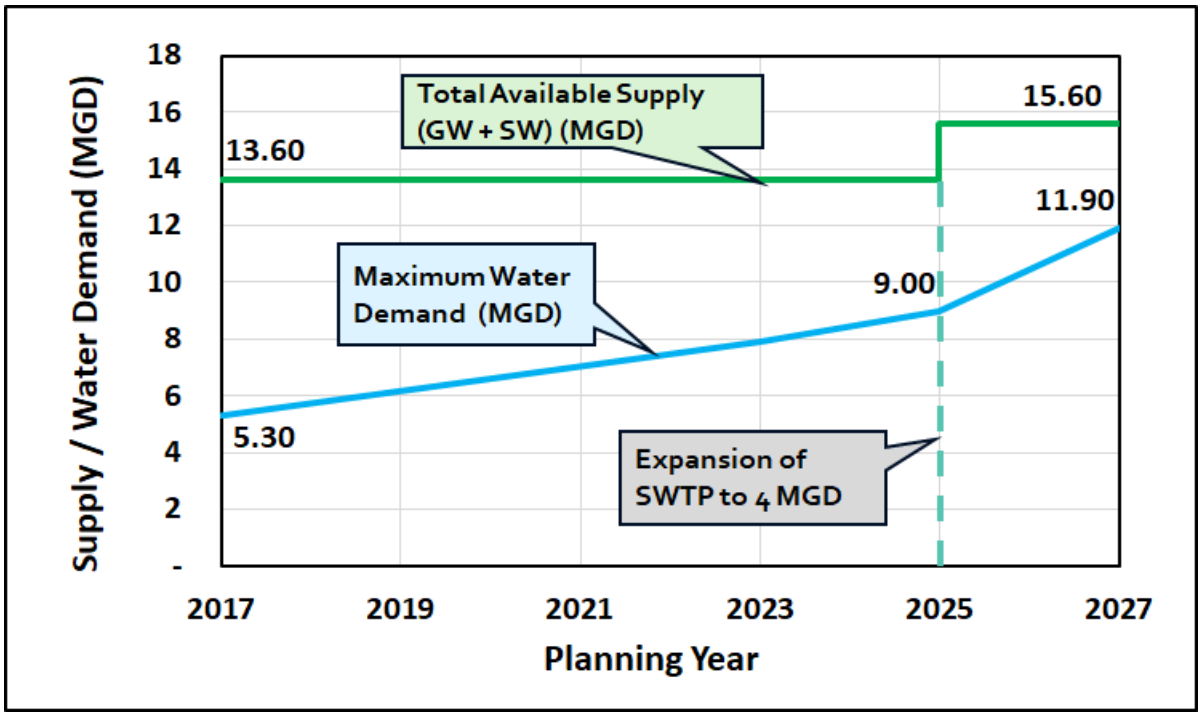


Figure 3-9. Total Available Water Supply and Maximum Demand

3.4.2. 2027 EPS Base Model

2027 EPS Base Model was analyzed to verify if the existing system is capable of handling 2027 needs by meeting the constrains defined in the planning criteria under maximum day conditions. 2027 EPS Base Model was run for a 24-hour period simulation with the below assumptions:

1. Allocated 2027 maximum day demands based on future land use plan
2. New 0.5 MG EST along FM 359 in Rio Vista Subdivision
3. Incorporated attitude valves to control flow in and out of the existing EST's that include Downtown EST, Richmond Parkway EST, and George Tower EST
4. Adjusted pump operational settings based on storage tank levels

Figure 3-10 shows the additional or new demand nodes for 2027 simulation. A few of the demand nodes represent wholesale customer demands (e.g. MUD 207, MUD 215, WR MUD 1).

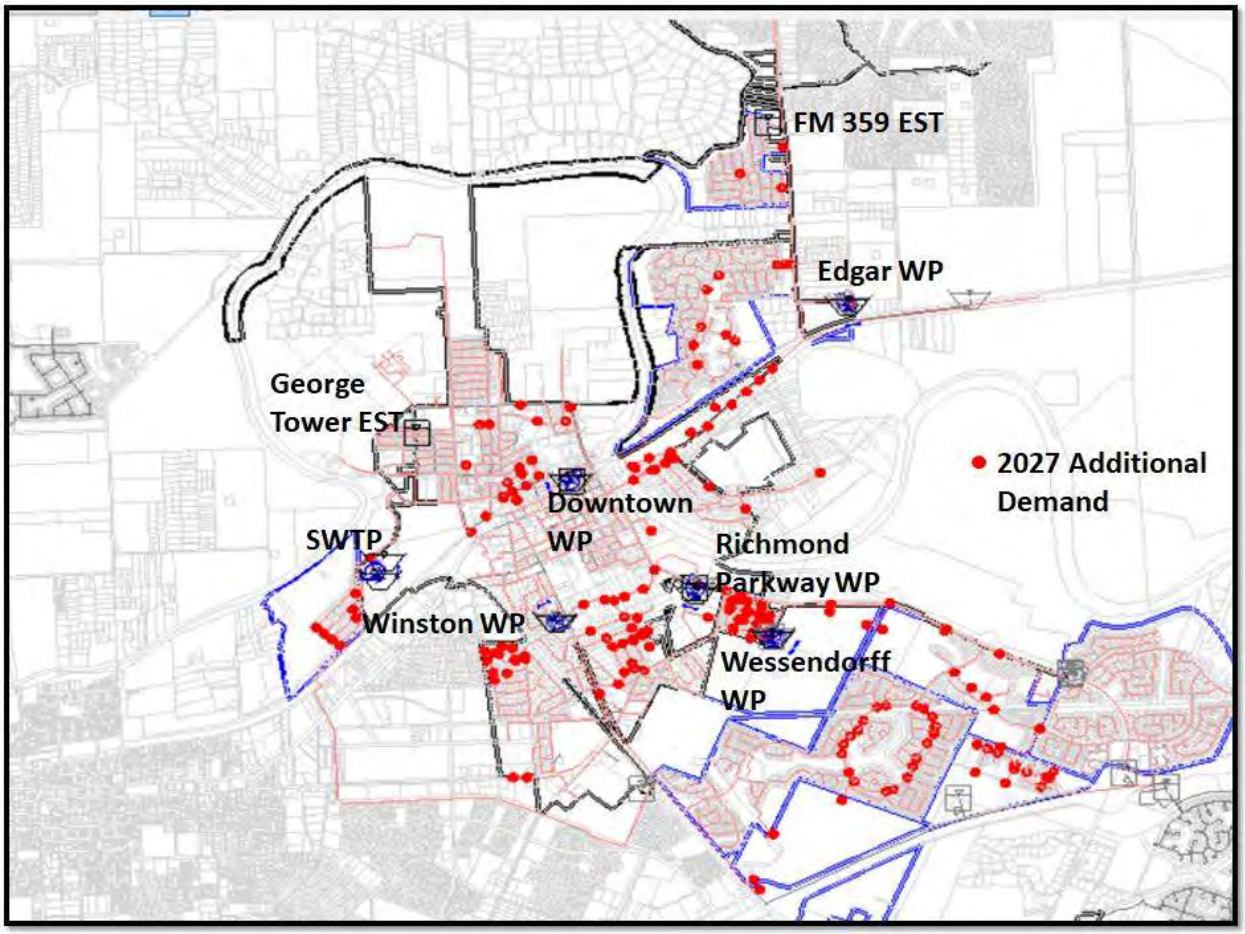


Figure 3-10. 2027 Additional or New Demand Nodes

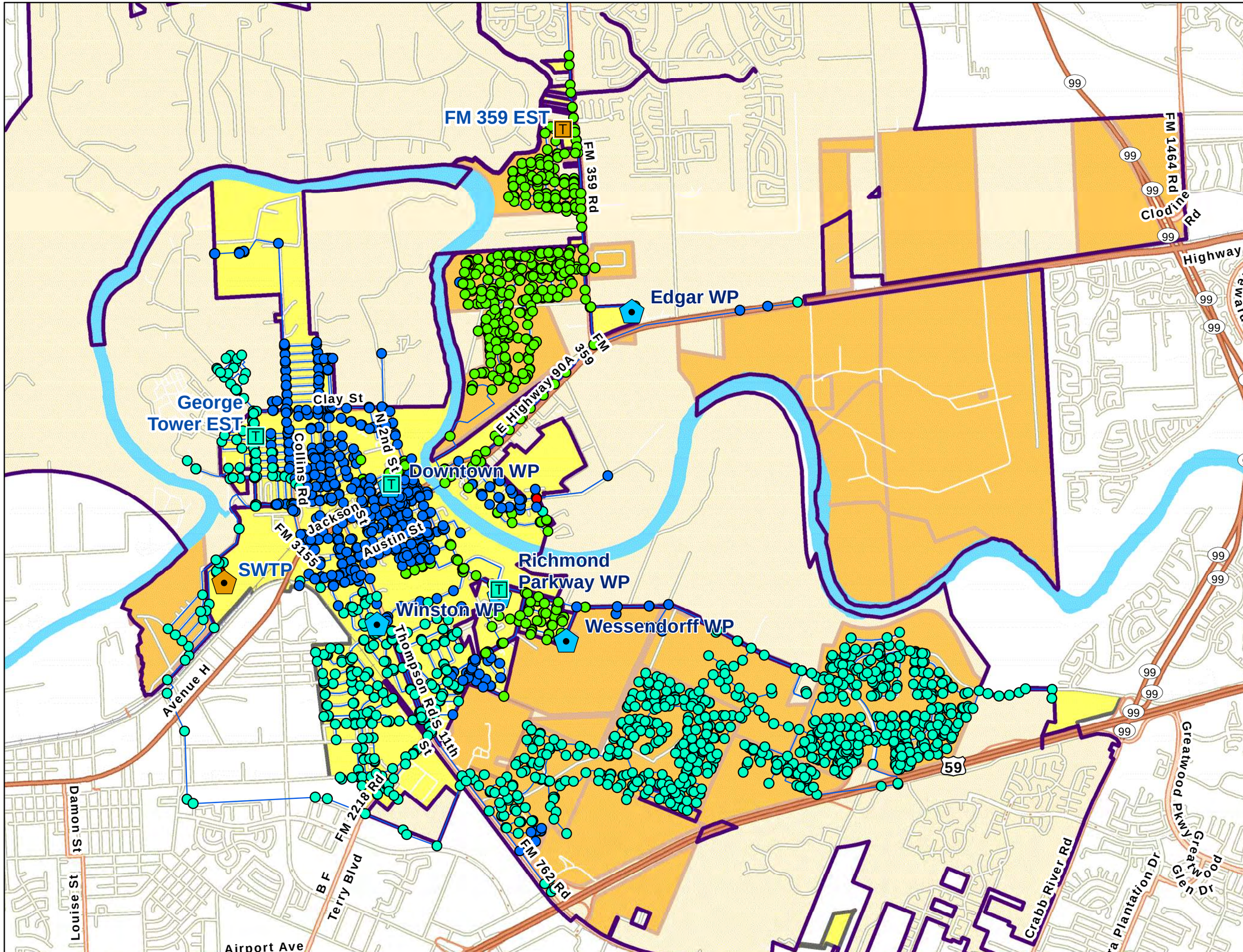
Pump supply, discharge pressures and hydraulic grade from each water plant of base model are shown in **Table 3-12**. Sufficient systemwide supply, 12.1 MGD was shown to be delivered to meet the flow demand of 11.9 MGD. In the modeling scenario, the SWTP production is limited to approximately 2 MGD.

Table 3-12. 2027 Base Maximum Day Model Pump Supply and Pump Discharge Pressures

Facility	Maximum Day Model Supply (MGD)	Maximum Discharge Pressure (psi)	Maximum Hydraulic Grade (feet)
Downtown WP	1.87	60	230
Winston WP	0.32	59	228
Richmond Parkway WP	2.69	62	226
Wessendorff WP	2.23	64	228
Edgar WP	3.48	69	241
SWTP	1.35	54	223
Total Supply (MGD)	**11.94**		
Flow Demand (MGD)	**11.90**		

The results from 2027 base model were checked for minimum pressures and maximum head loss gradient criteria. **Figure 3-11** and **Figure 3-12** show minimum junction pressures and maximum head loss gradient within the distribution system. Pressures throughout the system were above minimum criteria of 35 psi. Pressures below 40 psi were noticed in northwest portion of City limits, MUD 19, MUD 207, MUD 187, and WR MUD 1. As shown in **Figure 3-12**, several small diameter pipes show higher head loss gradients, that indicates insufficient existing capacities. Based on the observations from the model, the following improvements are recommended:

1. Upsize heavy metal, small diameter pipelines within the City limits to 6-inch or higher pipes
2. Connect the loops within the City limits that allows circulation of the water and eliminates the dead-end issue
3. Complete the loop of transmission line along Highway 59 Corridor that alleviates low pressures and balance the system



0.2 0 0.2 Miles

N

Legend

- Existing EST
- FM 359 EST
- Groundwater Plant

Minimum Pressure

- < 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area

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Figure 3-11
2027 EPS Model Base
Maximum Day Conditions
Minimum Junction Pressures

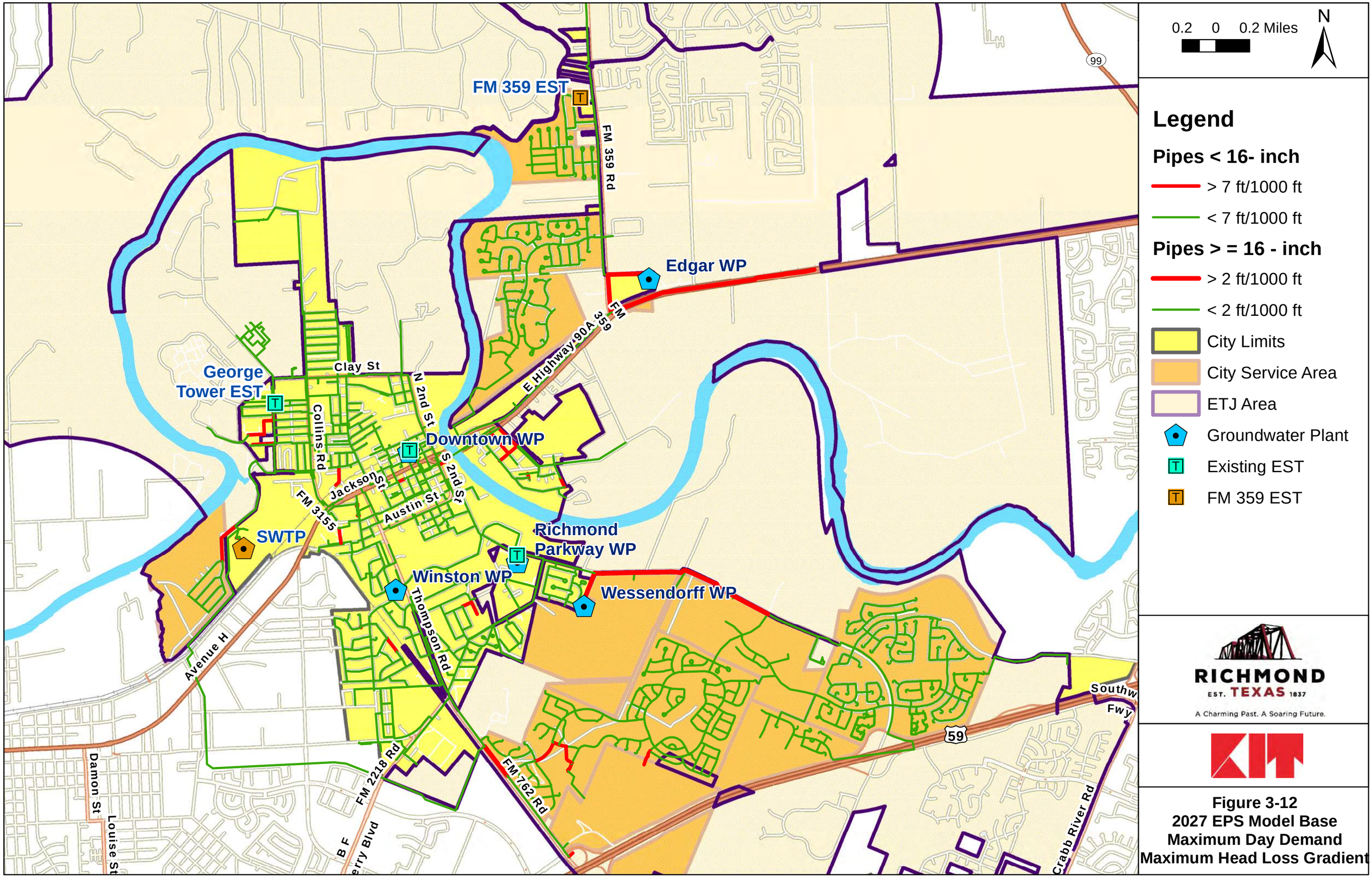


Figure 3-12
2027 EPS Model Base
Maximum Day Demand
Maximum Head Loss Gradient

3.4.3. Alternative Capacity Requirements

As discussed in Section 3.3.6, the TCEQ granted the City ACRs for supply, total storage, and elevated storage based on an equivalency ratio 0.83. The City's ACRs are as follows:

- Supply of 0.49 gpm per connection
- A total storage capacity of 166 gal per connection
- An elevated storage capacity of 83 gal per connection

Based on the population projections detailed in Section 2.1, it is anticipated that the City currently has enough supply and total storage to comply with the approved ACRs through 2027. However, additional alternative water (i.e., surface water and reclaimed water) supply will be needed to comply with FBSD groundwater reduction mandates and to increase system reliability and resiliency. Additional ground storage tanks may also be required based on plant hydraulics and TCEQ disinfection requirements. Thus, projects providing for additional supply and/or ground storage tanks are based on other factors beyond TCEQ capacity requirements.

While the City currently has adequate elevated storage to meet the approved ACR, additional ESTs will be required to maintain compliance as additional customers are connected. **Figure 3-13** summarizes the projected elevated storage requirements based on the approved ACR. MUD 121 has its own pressure maintenance facilities and is considered to be a separate system for ACR purposes. The connection counts used to develop Figure 3-13 therefore differ from those presented in Table 2-2.

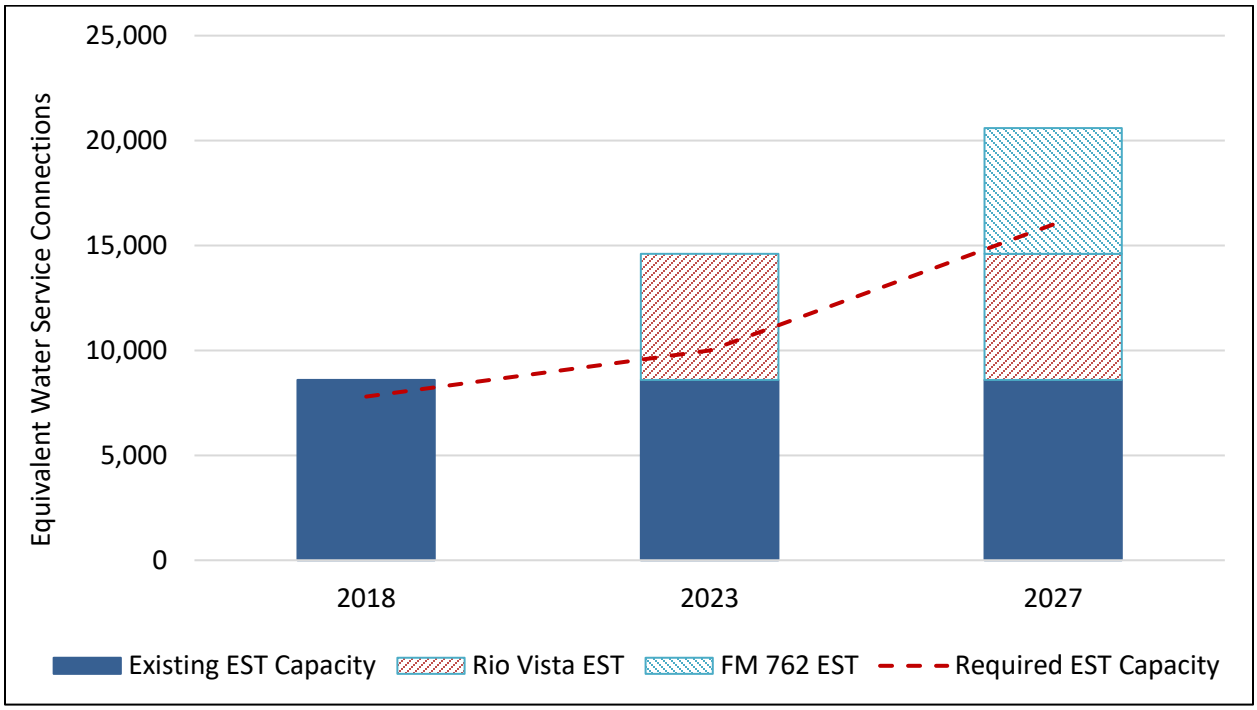


Figure 3-13. Existing and Projected Elevated Storage Requirements

As can be seen in Figure 3-13, the 0.5-MG on Rio Vista EST, which is currently being constructed, is needed to meet the elevated storage ACR in the near future. Based on population projections, it is anticipated that additional elevated storage will be required by approximately 2026. As a result, an additional 0.5-million-gallon EST is proposed along the 16-inch water main located on FM 762. In addition to maintaining compliance with the TCEQ-approved ACR, this EST would also enhance pressure maintenance and fire flow capability in the southeastern portion of the service area.

Table 3-13 summarizes the projected elevated storage volume that would be required under default TCEQ requirements and the approved ACR. As can be seen in the table and **Figure 3-13**, the proposed FM 762 EST is more than adequate to meet anticipated growth under the approved ACR.

Table 3-13. ACR Calculations for Elevated Storage (2027)

Parameter	Volume (MG)
Elevated Storage requirement at 100 gal/connection (Default requirement)	1.60
Elevated Storage ACR at 83 gal/connection (TCEQ-approved ACR)	1.33
Currently Available Elevated Storage	1.71

3.5. Project Development

3.5.1. Condition Assessment Summary

As part of Master Planning, KIT conducted site visits to each of the City's five groundwater plants and the George Tower EST to assess the condition of their infrastructure. In addition to mechanical equipment (e.g., pumps, chemical feeds, etc.), KIT assessed and recorded deficiencies related to storage tanks, electrical/instrumentation and controls equipment, and general site conditions. Where direct observation was not possible (e.g., well conditions, the inside of storage tanks, etc.), KIT based assessments on observations and other information obtained from City staff. Given that all equipment and structures were new at the SWTP, a thorough assessment was not performed at this plant. However, all equipment appeared to be in good working order during the site visit.

The City's water infrastructure was generally found to be in good to excellent condition, with a few notable deficiencies. During site visits, the City was preparing for conversion from free chlorine to chloramine disinfection. As a result, chemical feed systems had recently been upgraded, with several WPs having newly installed ammonia and/or phosphate feeds. Although these feeds were not yet in operation, post-implementation water quality data demonstrated that these feeds are in proper working order. A summary of condition assessment findings is presented in **Table 3-14**.

Table 3-14. Water Facility Condition Assessment Summary

Facility Name / Infrastructure	Old Downtown WP	Winston Terrace WP	Richmond Parkway WP	Wessendorff WP	Edgar WP	Surface Water Treatment Plant	George Tower EST
Potable Water Wells	Minor	Minor	Major	None	None	N/A	N/A
Chemical Feed Systems	None	None	None	None	None	None	N/A
GSTs	None	Minor	Minor	Minor	None	None	N/A
Motor Control Center	Major	Major	Major	None	None	None	N/A
Booster Pumps	None	None	None	None	None	None	N/A
ESTs	Minor	N/A	Minor	N/A	N/A	N/A	Minor
Backup Power Generator	N/A	N/A	Minor	None	None	None	N/A
SCADA	None	N/A	None	None	None	None	N/A
Fencing	None	None	None	None	None	None	None
Driveway	None	None	None	None	None	None	None
Grading	None	None	None	None	None	None	None
Drainage	None	None	None	None	None	None	None

Several facilities (Old Downtown, Winston Terrace, and Richmond Parkway WPs) have aging potable water wells with declining yields. These wells cannot be further rehabilitated and are therefore approaching the ends of their useful lives. It is recommended that new wells be installed at the Downtown and Richmond Parkway WPs. However, given the relatively low production capacity at the Winston Terrace WP, as well as several other deficiencies, it is recommended that a new well not be installed at this facility. It is instead recommended that rehabilitation funds be used to address other facilities and that Winston Terrace WP be removed from service when the well reaches its end of useful life and other facilities have been expanded to meet demands. Although the well at the Edgar WP currently has no observed deficiencies, it is recommended that a project be planned to rehabilitate the well as its yield declines over time.

The Winston Terrace WP, Richmond Parkway WP, and Wessendorff WP GSTs have minor deficiencies. The Winston WP GST leans slightly to one side, but given that this plant will eventually be removed from service, no corrective actions are planned. However, the Richmond Parkway WP and Wessendorff WP GSTs have minor interior and/or exterior rusting that will need to be addressed. It is recommended that the City implement a project for GST maintenance to address this rusting and other minor deficiencies that develop in the City's GSTs over time. While the City's ESTs are in good condition, it is similarly recommended that funds be earmarked for rehabilitation of ESTs to address deficiencies that occur over time and to ensure that ESTs are maintained in good working condition.

The motor control centers (MCCs) at the City's three oldest WPs (Old Downtown, Winston Terrace, and Richmond Parkway) have reached the end of their useful life. Replacement of the Old Downtown WP and Richmond Parkway WP MCCs has already been budgeted for fiscal year 2019. However, given that Winston Terrace WP will eventually be removed from service, replacement of its MCC is not recommended.

The City's three ESTs were found to be in good condition. However, these tanks are not equipped with altitude valves, which provide improved control of tank operation, or mixing equipment, which circulate tank contents and maintains water quality. Further, similar to GSTs, these tanks require periodic maintenance and recoating to maintain their service life. It is recommended that funding is planned for EST maintenance and upgrades to maintain and improve the functionality of these tanks.

3.5.2. List of Rehabilitation Projects

Based on condition assessment findings, several rehabilitation projects were developed to address documented deficiencies and maintenance of infrastructure necessary to maintain level of service. **Table 3-15** provides a summary of water system rehabilitation projects. The timeline and costs related to these projects are discussed in **Section 3.7**.

Table 3-15. Water Rehabilitation Projects List

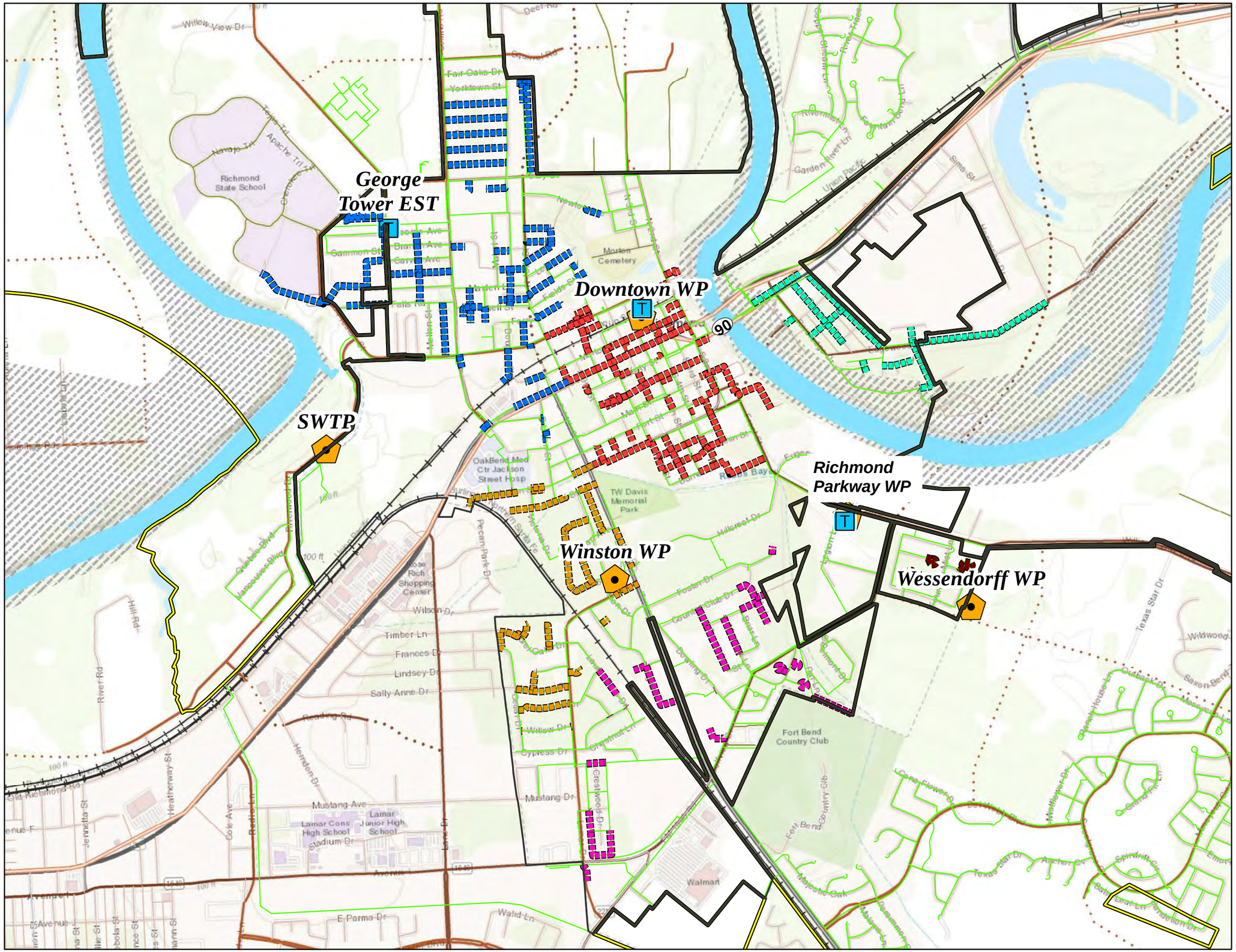
Project Number	Projects Description	Project Drivers	Trigger(s)
W-7	Ground Storage Tank (GST) Rehabilitation	Aging Infrastructure / Reliability / Resilience	None, routine maintenance
W-8	Motor Control Center Rehabilitation		Aging equipment
W-9	Well Rehabilitation (Edgar WP)		None, routine maintenance
W-10	Elevated Storage Tank (EST) Rehabilitation		None, routine maintenance

3.5.3. Small Diameter Pipeline Replacement Projects

To maintain level of service, it is recommended to upsize all existing small diameter, pipes less than 6-inches within City limits to 6-inch diameter PVC lines. In addition, new pipelines are recommended at the loops to maintain continuity of flow within the system. **Table 3-16** and **Figure 3-14** show the summary of the proposed small diameter pipeline replacement projects and the project drivers. Project W-1 is the highest priority small diameter project due to possible presence of pipelines with lead joints. The timeline and costs related to these projects are discussed in **Section 3.7**.

Table 3-16. Small Diameter Pipeline Replacement Projects

Project Number	Projects Description	Project Drivers
W-1	Heavy Metal Joint Pipe Replacement - Segment W-1	• Continue to provide the same level of service to existing customers within the City limits • Replace aging, potentially problematic metal pipes with new, PVC pipelines • Improve pressure maintenance and enhance delivered water quality • Increase fire flow capabilities within the City service area • City has flexibility with respect to implementation timelines and coordination with other development for these rehabilitation projects
W-2	Small Diameter Pipe Replacement - Segment W-2	
W-3	Small Diameter Pipe Replacement - Segment W-3	
W-4	Small Diameter Pipe Replacement - Segment W-4	
W-5	Small Diameter Pipe Replacement - Segment W-5	
W-6	Small Diameter Pipe Replacement - Segment W-6	



Legend

- City Limits
- ETJ Area
- Floodway
- Water Plant
- Elevated Storage Tank

Small Diameter Replacement Projects

- Segment W-1
- Segment W-2
- Segment W-3
- Segment W-4
- Segment W-5
- Segment W-6

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Figure 3-14

2027 Small Diameter Waterline Projects

3.5.4. Water System Expansion Projects

Based on analysis of water supplies and demands, review of system hydraulics, capacity requirements mandated by State, and maintaining customer service to existing and future City customers, the following projects are recommended:

1. Extending the 16-inch water transmission line along the Highway 59 South corridor to meet the demands from the future growth within MUD 207 and WRMUD 1 (**Project W-14**). This 16-inch transmission line is necessary to reliably supply water for fire-fighting and emergencies to the commercial development which will occur along the Highway 59 South corridor. Although hydraulic analysis was conducted to demonstrate the necessity of this project (see Section 3.6), precise quantification of the project trigger is difficult due to the planned commercial and multi-family residential development in this area. It is estimated that existing infrastructure could support an additional 500 – 1,000 single family residential connections in this area, but it is expected that the true connection count that infrastructure can support is substantially lower. To ensure that adequate fire and emergency flows are maintained in this area, it is therefore recommended that this project be implemented in the relatively near future, before substantial completion of commercial and multi-family residential development along Highway 59.
2. The FBSD GRP mandate requires 60% of water demands to be met using alternate water (other than groundwater) beginning October 2025. To meet this GRP mandate, the City would need to expand the SWTP capacity to 4 MGD by 2025 (**Project W-16**). Details of GRP requirements are in Section 6.
3. Adding a new 16-inch transmission line maximizing the surface water delivery to north and east downtown areas. This new line starts at SWTP extends north connecting through George Tower tank, then extends east along Clay Street, and south along N 2nd Street before connecting to existing 16-inch line. This existing 16-inch line crosses Brazos River along Liberty Street / US Highway 90 Alt East. The new 16-inch transmission line from SWTP to the existing 16-inch line (**Project W-13**) will be needed when the SWTP is expanded by 2 MGD in 2025 (Project W-16).
4. Master plan recommends new wells for Richmond Parkway WP and Main Street WP. The existing wells at these water plants have reached their end of useful life and experiencing significant declines in water production (or yield). Drilling new wells will increase the overall system supply and reliability (**Projects W-11 and W-17**).
5. The source water to SWTP is Brazos River water which experiences seasonal fluctuations in water quality that are driven by the water levels in the river. For example, during low flows in the river, the contributions from the sediment can be higher which results in increased chloride and salinity levels of the water. Master plan recommends integrating a new 2 MGD well to increase reliability of supply as well as assist with blending during water quality episodes (**Project W-19**). Integration of new well at SWTP will allow the City to phase out the Winston WP which is expected to reach its end of useful life over the next 10 years.
6. If City experiences growth in the east of Brazos River area or integrates new GRP partners, then

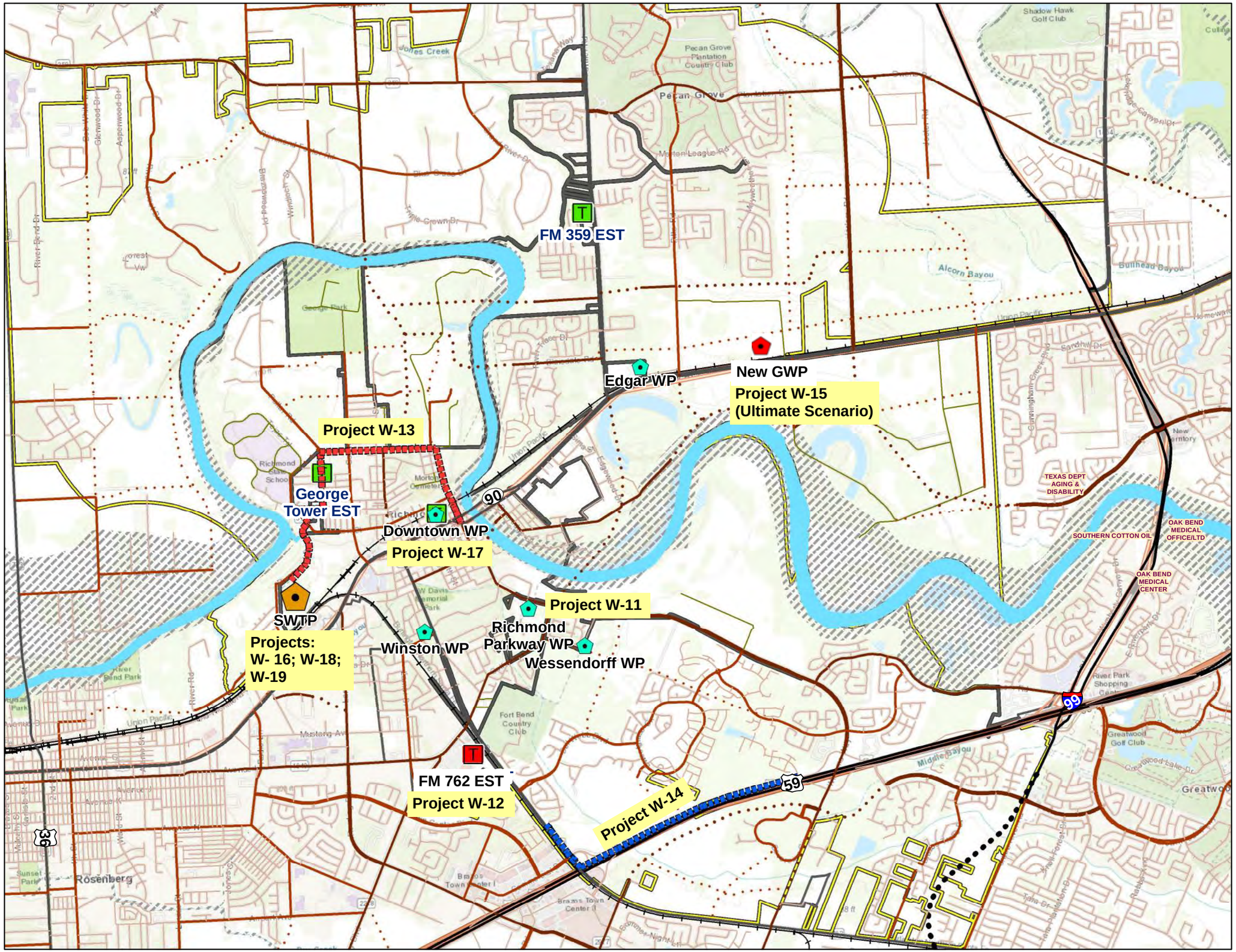
an additional expansion of SWTP to 6 MGD will be needed (**Project W-18**). Although the timing of this project will depend on a number of factors, including the City's bank of alternative water credits, actual reclaimed water usage, and the rate of population growth, it is currently anticipated that Project W-18 would need to be completed before additional demands from new development east of the Brazos River reach 1.0 MGD, or approximately 2,500 new connections (based on an average GPCD of 116 and 3.5 residents per residential connection). Details of GRP requirements are in Section 6.

7. If City continues to experience growth in the east of Brazos River area then an additional groundwater plant of 2 MGD capacity will be needed to augment the current supply from Edgar WP (**Project W-15**). At the current time, it is projected that Edgar WP flows can satisfy demands east of the Brazos River through 2027. However, the project is included in this Master Plan for two reasons: 1) the project will be required to satisfy long-term (beyond 10 years) demands in this area, and 2) the City should consider procuring land for this project before development accelerates and increases land costs.

Table 3-17 and **Figure 3-15** provide an overview of water system expansion projects. The timeline and costs related to these projects are presented in **Section 3.7**.

Table 3-17. Water System Expansion Projects List

Proj. No.	Project Description	Project Drivers	Trigger(s)
W-11	New Well at Richmond Parkway WP	Reliability/ Redundancy	Declining yield from existing well; increased system reliability
W-12	New Elevated Storage Tank along FM 762 16-inch waterline	Growth within City service area; address fire flow requirements and capacity requirements from State	Development of MUD 207 and WRMUD 1; TCEQ Capacity Requirement (approximately 14,500 service connections)
W-13	New Transmission Lines (SWTP to North Downtown)	Maximize the surface water delivery to north and east downtown areas of the existing customers of the City	SWTP Expansion to 4 MGD
W-14	New Transmission Lines (MUD 207 and WRMUD 1)	Growth in the MUD 207 and WRMUD 1	Development of MUD 207 and WRMUD 1
W-15	New Groundwater Plant East of Brazos River (2 MGD)	To meet future demands from growth east of Brazos River. CIP includes procuring land for this plant at $500,000	Development of east of Brazos River
W-16	Surface Water Treatment Plant Expansion by 2 MGD	FBSD mandate of 60% alternate water by October 2025	Implementation of FBSD 60% alternate water requirement
W-17	New Well(s) at Main Street WP	Aging infrastructure/ increase reliability and overall system resilience	Declining yields from existing wells
W-18	SWTP Expansion by an Additional 2 MGD	Potential continued growth and new GRP partners	Development east of Brazos or incorporation of new GRP partners (approximately 2,500 new connections)
W-19	New 2 MGD Well at SWTP	To address water quality issues from source water	Fluctuations in water quality and supply from Brazos River
W-20	Update Utility Master Plan	Planning	Planned 5-year update



0.3 0 0.3 Miles

N

Legend

- City Limits
- ETJ Area
- Floodway
- Existing EST
- Existing WP

Expansion Projects

- W-12 (FM 762 EST)
- W-15 (New GWP in Ultimate Scenario)
- W-16 / W-18 / W-19 (SWTP Expansion)
- W-13
- W-14

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Figure 3-15

2027 Water System Expansion Projects

3.6. 2027 EPS Model Scenarios

The consultant team analyzed various scenarios and prioritized the projects to be implemented in preliminary 10-year CIP plan. The focus of the plan is to replace aging and heavy metal pipes, maintain the existing level of service for the City residents by rehabilitating existing water plants, maximize the surface water delivery efficiency to the City customers, meet GRP compliance, and account for fire flow requirements. The future condition scenarios analyzed during the preliminary phase dictate the need and timing of proposed projects in adopted plan. The general criteria verified from the model results, as summarized in **Table 3-6**, include minimum pressures at junctions, maximum head loss gradient along the pipes that shows any undersized pipes, as well as ensuring that the storage tank levels are properly cycled to avoid water quality related issues.

3.6.1. 2027 EPS Model Scenario 1

2027 EPS Model Scenario 1 was analyzed by incorporating the following improvements to the base model:

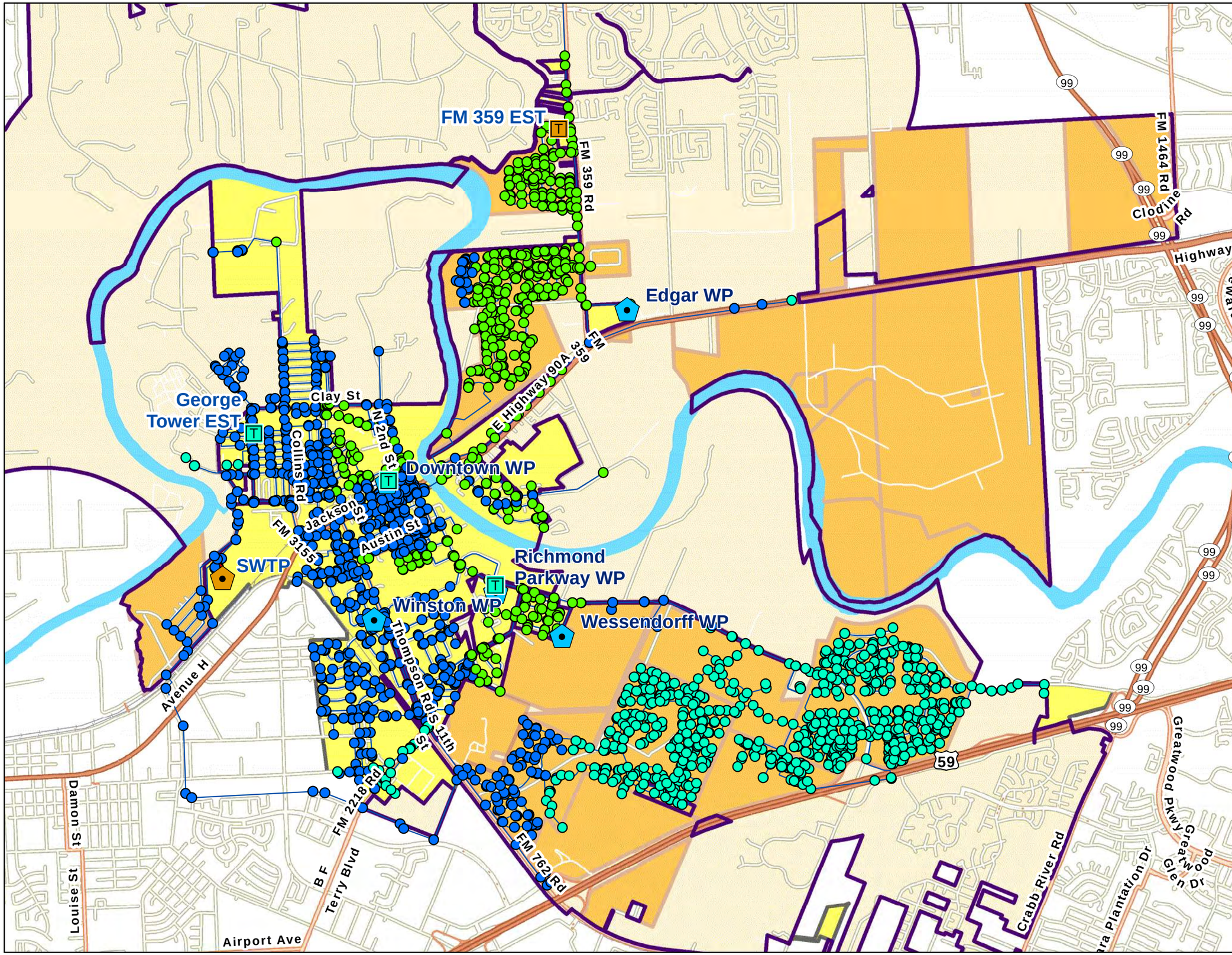
1. **Projects W-1 to W-6,** small diameter pipeline replacement
2. **Project W-11**, new well at Richmond Parkway WP
3. **Project W-19**, 2-MGD well at SWTP
4. **Project W-13**, 16-inch transmission line from SWTP to North Downtown

The EPS Water Model was run to simulate a 24-hour period and reviewed the dynamic water supply and demand to ensure that peak day demands are met with the available water supplies. Pump supply, discharge pressures and hydraulic grade results from Scenario 1 are shown in **Table 3-18**. Sufficient systemwide supply is delivered to meet demand of 11.9 MGD. SWTP delivered supply is 3.7 MGD with discharge pressure of 57 psi. Minimum pressures at the junctions and maximum head loss gradient results are within the minimum criteria as shown in **Figure 3-16** and **Figure 3-17**, respectively.

Table 3-18. 2027 Scenario 1 Maximum Day Model Pump Supply and Pump Discharge Pressures

Facility	Available Pump Supply (MGD)	Maximum Day Model Supply (MGD)	Maximum Discharge Pressure (psi)	Maximum Hydraulic Grade (feet)
Downtown WP	1.4	1.34	60	228
Winston WP[1]	0.7	0.0	58	224
Richmond Parkway WP	3.1	2.36	62	226
Wessendorff WP	2.8	1.99	63	226
Edgar WP	8.7	2.55	68	240
SWTP	4.9	3.71	57	228
Total Supply (MGD)	**21.6**	**11.95**		
Flow Demand (MGD)		**11.90**		

Note: 1. Winston WP is assumed to reach its end useful life by 2027.



0.2 0 0.2 Miles

N

Legend

Minimum Pressure

- < 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area
- Existing EST
- FM 359 EST
- Groundwater Plant

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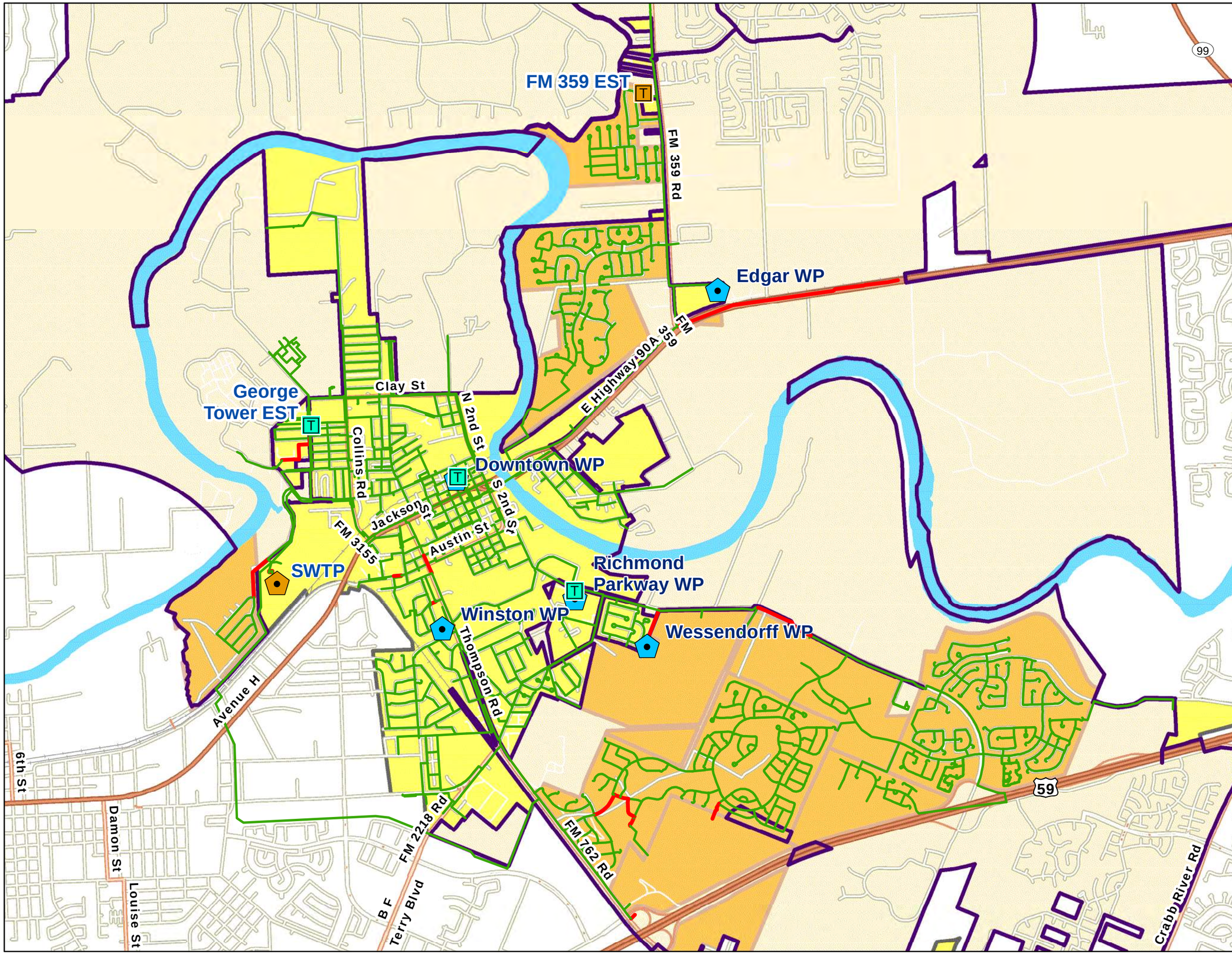
Figure 3-16
2027 EPS Model Scenario 1
Maximum Day Conditions
Minimum Junction Pressures



0.2 0 0.2 Miles

N

Legend

Pipes < 16- inch

- > 7 ft/1000 ft
- < 7 ft/1000 ft

Pipes > = 16 - inch

- > 2 ft/1000 ft
- < 2 ft/1000 ft
- City Limits
- City Service Area
- ETJ Area
- Existing EST
- FM 359 EST
- Groundwater Plant

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Figure 3-17
2027 EPS Model Scenario 1
Maximum Day Demand
Maximum Head Loss Gradient

3.6.2. 2027 Scenario 1 with Fire Flow Model

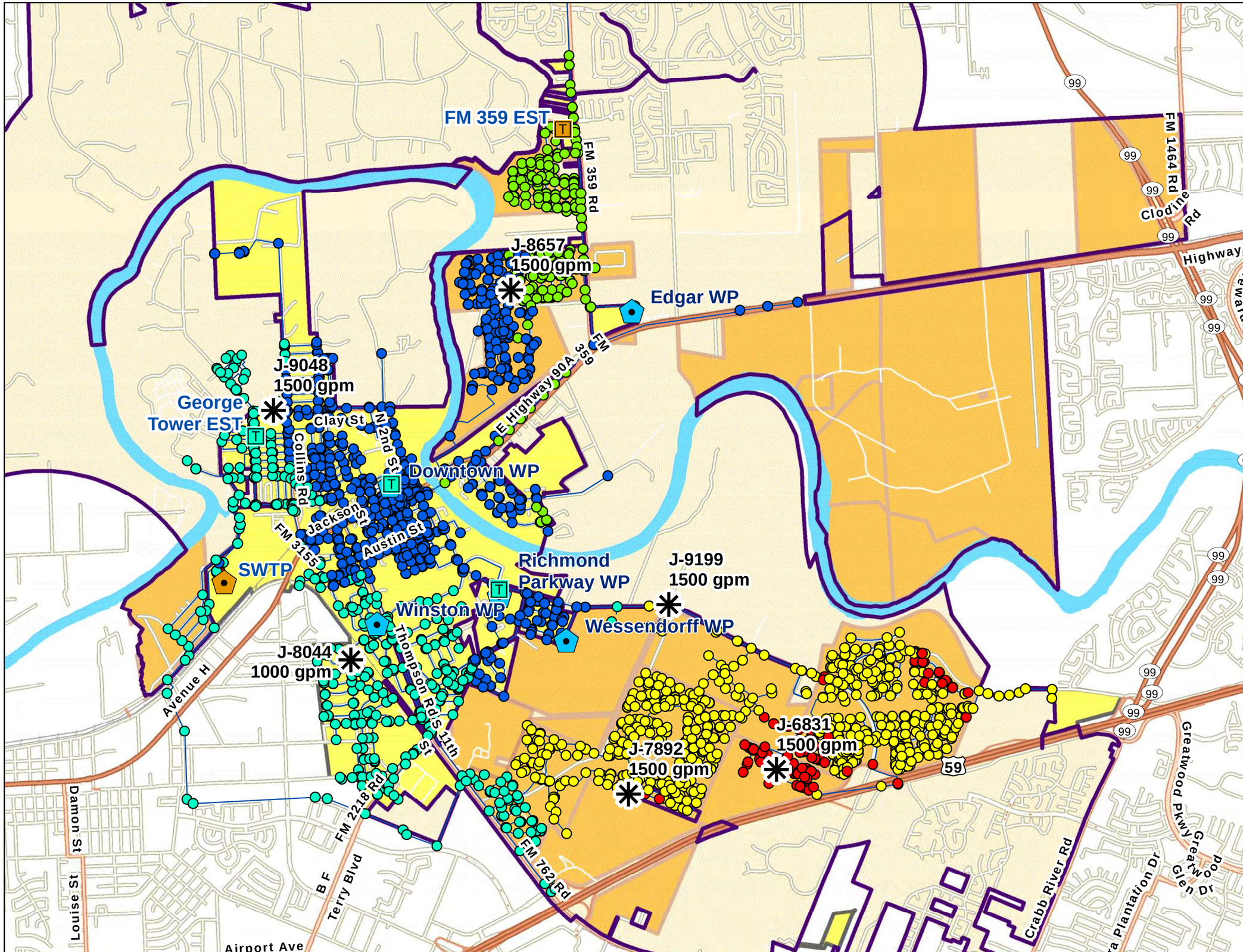
A fire flow analysis was performed for the 2027 Scenario 1 in order to determine that fire flows needed at different locations in the system could be met without the distribution system pressure dropping below 20 psi, as mandated by the State. The results of the fire flow analysis indicated that fire flows needed at different locations in the system could be met without the distribution system pressure dropping below minimum fire flow criteria.

Table 3-19. 2027 Fire Flow Analysis Results

Node Label	Fire Flow Needed (gpm)	Distribution System Lower Limit Pressure Constraint (psi)	Minimum Distribution System Pressure at Total Fire Flow Supplied (psi)	Junction with Minimum Pressure	Satisfies Fire Flow Constraints?
J-7892 (MUD 187)	1,500[1]	20	16[2]	J-6820	FALSE
J-6831 (WR MUD 1)	1,500[1]	20	16[2]	J-6820	FALSE

Notes: 1. Fire flow report from the EPS Model shows that there is no fire flow available to meet the fire flow needed.
2. Minimum distribution system pressures drop below 20 psi

The fire flow analysis results shown in the **Table 3-19** are for individual fire flow events. In addition, model simulations were performed with multiple fire events occurring simultaneously. This simulation incorporated the above specified fire flows into the projected maximum day demand scenario. **Figure 3-18** shows the fire flow locations and minimum node pressures experienced during the simulation. The minimum pressures in the distribution system drop below 20 psi, which does not meet the minimum fire flow criteria specified in 30 TAC §290.45. The minimum pressure experienced in the system for this scenario is 16 psi. The results of the fire flow analysis and the 2-hour simultaneous fire flow simulation indicate that the Scenario 1 is not capable of meeting fire flow needs at the minimum required pressure given its existing and planned production and storage capacity.



0.2 0 0.2 Miles

N

Legend

Minimum Pressure

- < 20 psi
- 21 - 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area
- Existing EST
- FM 359 EST
- Groundwater Plant
- Fire Flow Junction Nodes

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Figure 3-18
2027 EPS Model Scenario 1 with Fire Flow Condition Minimum Junction Pressures

3.6.3. 2027 EPS Model Scenario 2 with Fire Flow

2027 EPS Model Scenario 2 was simulated with an addition of new 16-inch transmission line along I-59 (**Project W-14**). 8-inch connection lines extending from 16-inch transmission line are assumed to connect to MUD 215 and WR MUD 1 systems. This will alleviate the minimum pressure issues by providing continuity of flow and hydraulics within the distribution system. Model Scenario 2 improvements are shown in **Figure 3-19**.

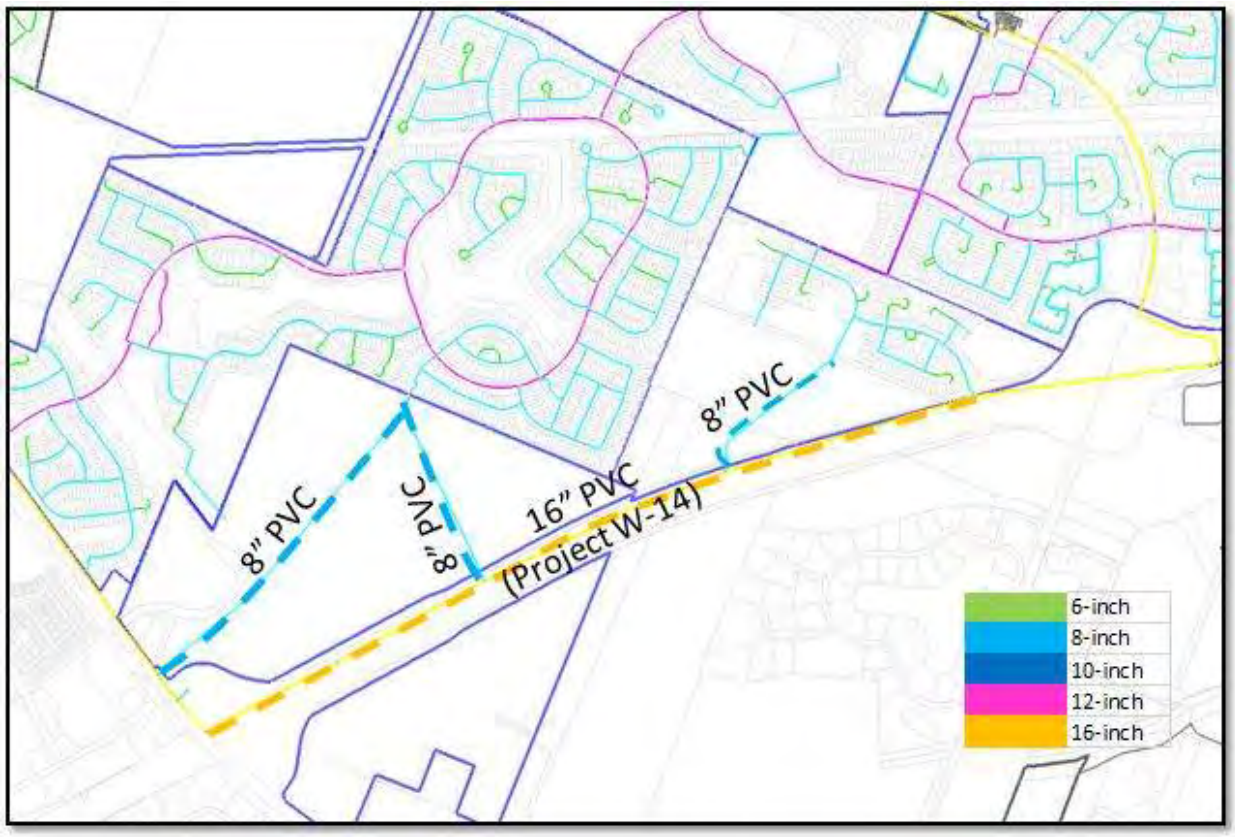


Figure 3-19. 2027 EPS Model Scenario 2 Improvements

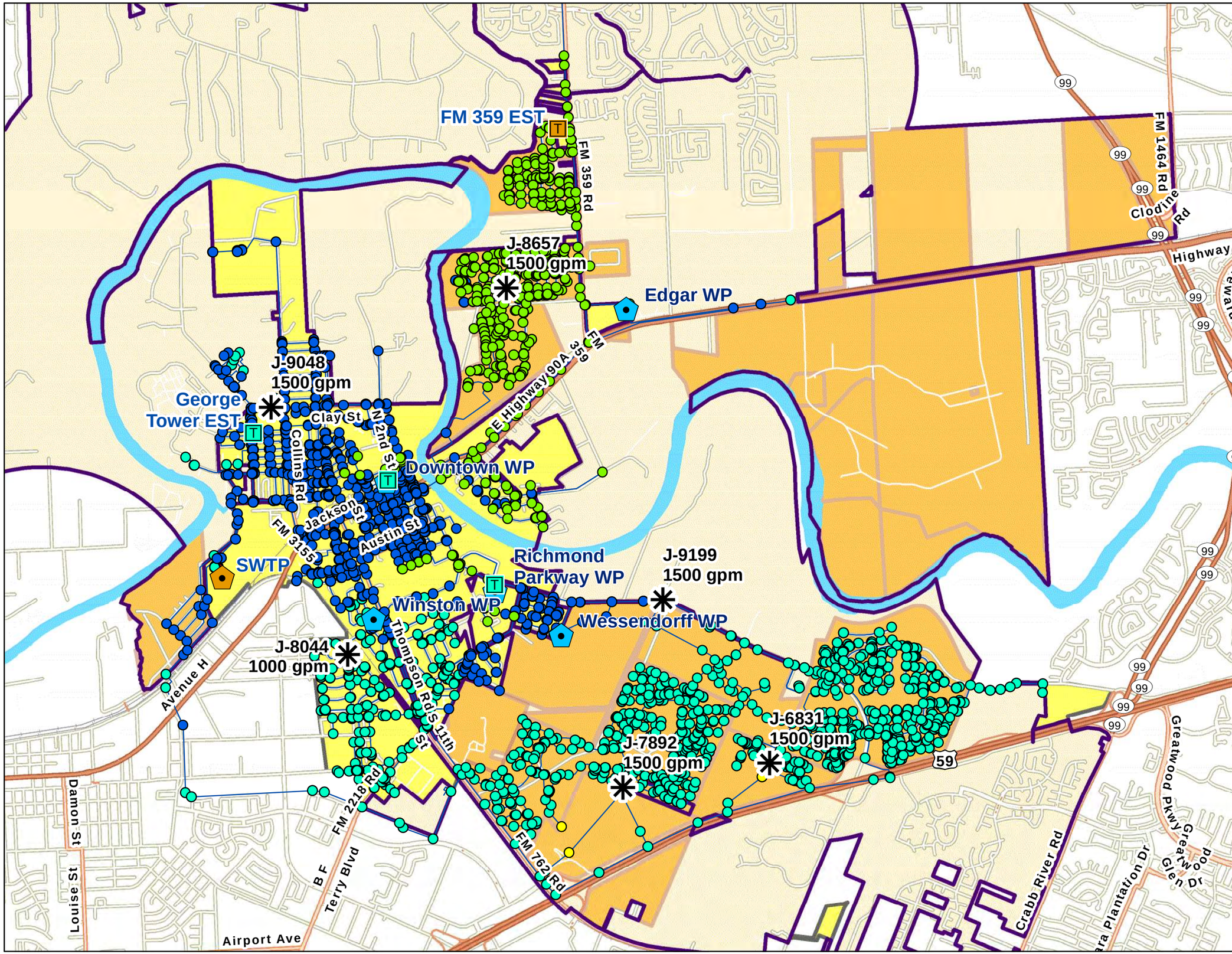
The results for individual fire flow events are shown in **Table 3-20.** The results show that the minimum fire flow pressure criteria of 20 psi have been met. However, the two nodes at MUD 187 and WR MUD 1 do not have available flow to meet the fire flow needed which indicates a need for an additional EST to provide necessary supply to meet fire flow conditions. Additional hydraulic assessments are recommended to determine the timing for the new EST along FM 762 to provide the needed fire/emergency supply.

Table 3-20. 2027 Fire Flow Analysis Results

Node Label	Fire Flow Needed (gpm)	Distribution System Lower Limit Pressure Constraint (psi)	Minimum Distribution System Pressure at Total Fire Flow Supplied (psi)	Junction with Minimum Pressure	Satisfies Fire Flow Constraints?
J-7892 (MUD 187)	1,500[1]	20	33	J-6965	FALSE
J-6831 (WR MUD 1)	1,500[1]	20	33	J-6965	FALSE

Notes: 1. Fire flow report from the EPS Model shows that there is no fire flow available to meet the fire flow needed.

Figure 3-20 shows the fire flow locations and minimum node pressures experienced during the simulation. The low-pressure issues from Scenario 1 has been improved significantly. The minimum pressure experienced in the system for this scenario is 33 psi, which is above the minimum fire flow criteria.



0.2 0 0.2 Miles

N

Legend

Minimum Pressure

- < 20 psi
- 21 - 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area
- Existing EST
- FM 359 EST
- Groundwater Plant
- Fire Flow Junction Nodes

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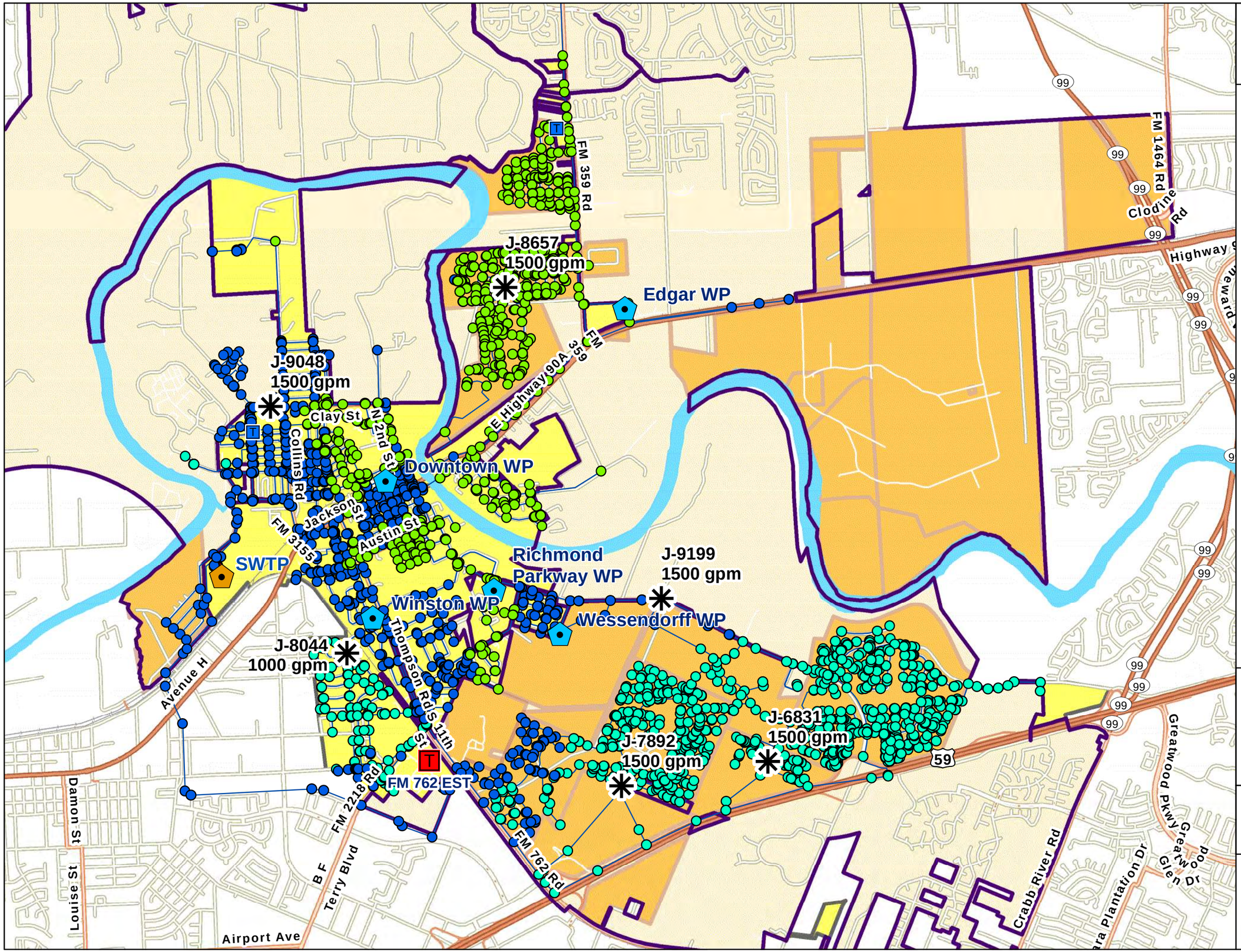
Figure 3-20
2027 EPS Model Scenario 2 with Fire Flow Condition Minimum Junction Pressures

3.6.4. 2027 EPS Model Scenario 3 with Fire Flow

2027 EPS Model Scenario 3 was simulated with an addition of new EST (**Project W-12**) to Scenario 2. 0.5 MG EST that connects to the 16-inch waterline along FM-762 will assist with fire flow and emergency supply (i.e., during main breaks) and meet the TCEQ requirements. The candidate location for the EST is shown in **Figure 3-21**. The proposed site is a City-owned property and does not require procurement of any additional land.

Figure 3-21. New Elevated Storage Tank at City-Owned Property

Minimum pressures at junction nodes were plotted and shown in **Figure 3-22**. The minimum pressures at all nodes are above 20 psi, which is the minimum fire flow criteria specified in 30 TAC §290.45. The minimum pressure experienced in the system for this scenario is 38 psi.



Legend

Minimum Pressure

- < 20 psi
- 21 - 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area
- Groundwater Plant
- FM 762 EST
- Fire Flow Junction Nodes

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Figure 3-22
2027 EPS Model Scenario 3 with Fire Flow Condition Minimum Junction Pressures

3.6.5. 2027 EPS Model Scenario 3 (Recommended)

2027 Scenario 3 Model assumes all improvements specified below:

1. **Projects W-1 to W-6,** small diameter pipeline replacement
2. **Project W-11**, new well at Richmond Parkway WP
3. **Project W-19**, 2MGD well at SWTP
4. **Project W-13**, 16-inch transmission line from SWTP to North Downtown
5. **Project W-14,** 16-inch transmission line connecting to MUD 207 and WR MUD 1
6. **Project W-12,** new EST along FM 762

The recommended 2027 scenario with the above projects optimizes the system operations by meeting the constraints defined in the planning criteria under maximum day demand conditions. The recommended Scenario 3 assumed main line connections within the distribution system to optimize conveyance and to reduce head loss gradient issues in the transmission lines. As shown in **Figure 3-23**, 12-inch line connections were included from Wessendorff WP, and from existing 16-inch transmission line along Richmond Parkway / Williams Way Boulevard for better continuity of flow and hydraulics within the system.

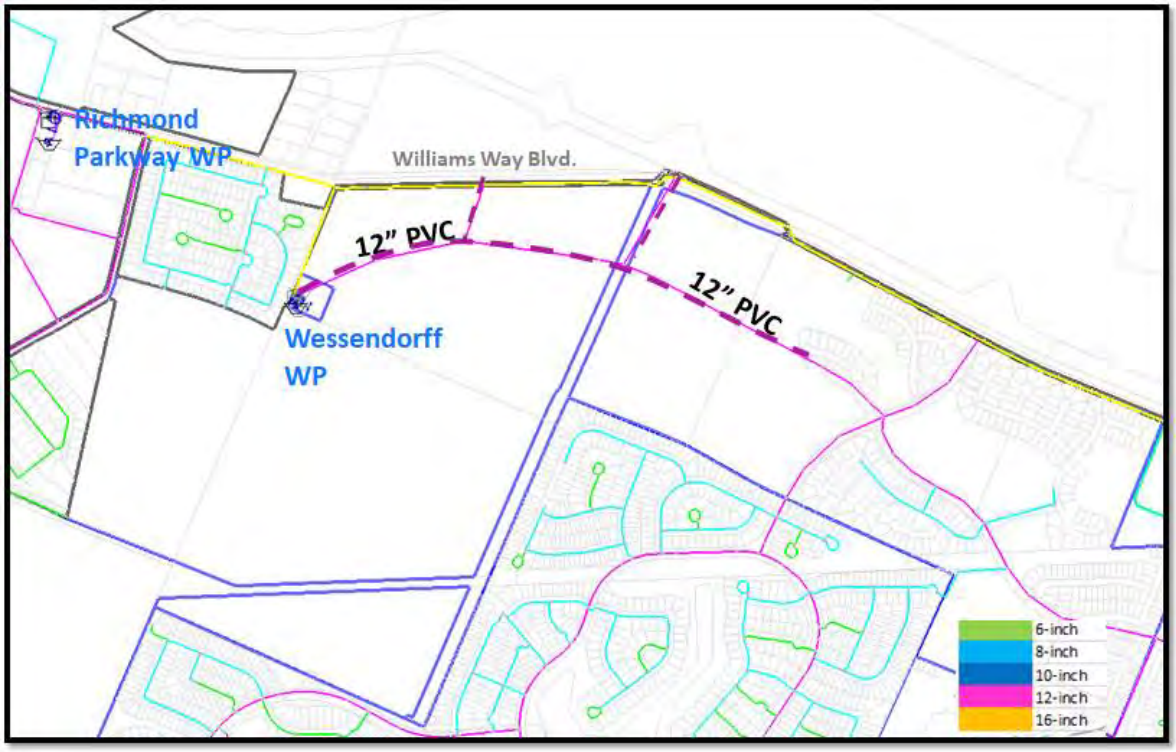


Figure 3-23. Flow Demand and Supply for 2027 Maximum Day Demand Conditions

A 12-inch line connection was assumed from Edgar WP to supply 2027 demand at the east side of Brazos River as shown in **Figure 3-24**.

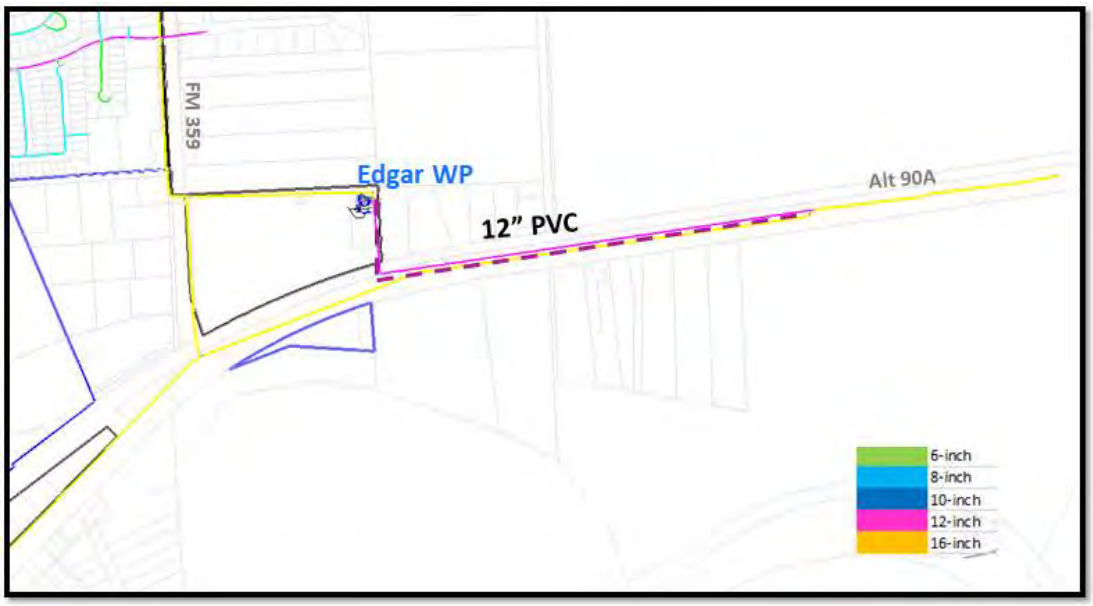


Figure 3-24. Flow Demand and Supply for 2027 Maximum Day Demand Conditions

The EPS Water Model was run to simulate a 24-hour period and reviewed the dynamic water supply and demand to ensure that peak day demands are met with available supplies. As shown in **Figure 3-25,** there are a few times during the day when demand exceeds supply, but the system storage is adequate and can provide the equalization needed during peak hourly demands.

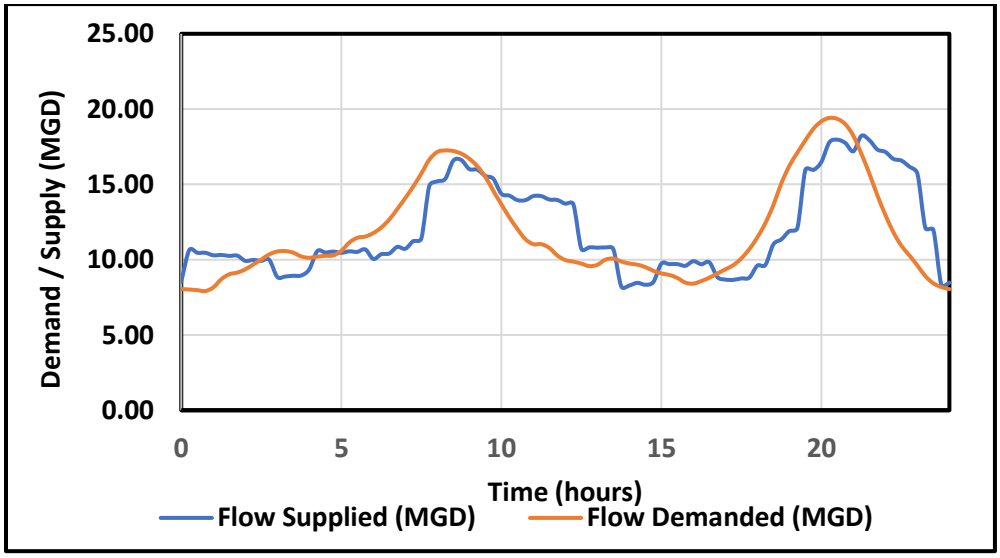


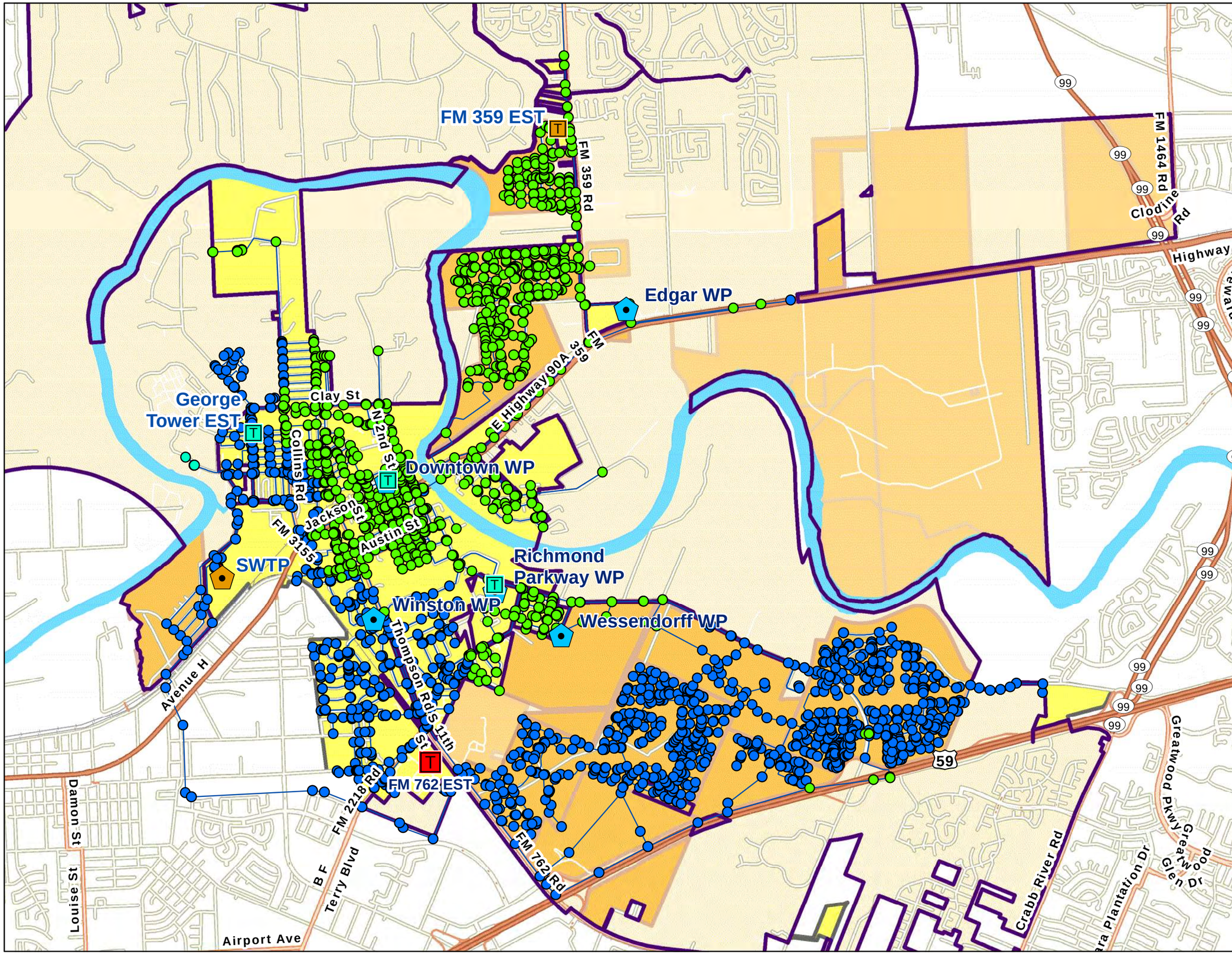
Figure 3-25. Flow Demand and Supply for 2027 Maximum Day Demand Conditions

The EPS Water Model shows that the ESTs maintain the operating range levels of hydraulic head i.e., system pressures. **Figure 3-26** show minimum junction pressures from the 2027 EPS Water Model for the recommended scenario. The minimum pressures meet the planning criteria range, with the minimum pressure node being 40 psi. As shown in the **Figure 3-27**, the maximum head loss gradient is within the planning range with the recommended upsizes. Pump supply, discharge pressures and hydraulic grade results from Scenario 3 are shown in **Table 3-21**.

Table 3-21. 2027 Scenario 3 Maximum Day Model Pump Supply and Pump Discharge Pressures

Facility	Existing Available Pump Supply (MGD)	Maximum Day Model Supply (MGD)	Maximum Discharge Pressure (psi)	Maximum Hydraulic Grade (feet)
Downtown WP	1.4	0.73	60	230
Winston WP[1]	0.7	0.00	56	222
Richmond Parkway WP	3.1	2.17	62	226
Wessendorff WP	2.8	1.23	62	224
Edgar WP	8.7	3.80	67	238
SWTP	4.9	4.26	59	233
Total Supply (MGD)	**21.6**	**12.19**		
Flow Demand (MGD)		**11.90**		

Note: 1. Winston WP is assumed to reach its end useful life by 2027.



0.2 0 0.2 Miles

N

Legend

Minimum Pressure

- < 35 psi
- 36 - 45 psi
- 46 - 55 psi
- 56 - 65 psi
- > 65 psi
- City Limits
- City Service Area
- ETJ Area
- Existing EST
- FM 359 EST
- Groundwater Plant
- FM 762 EST

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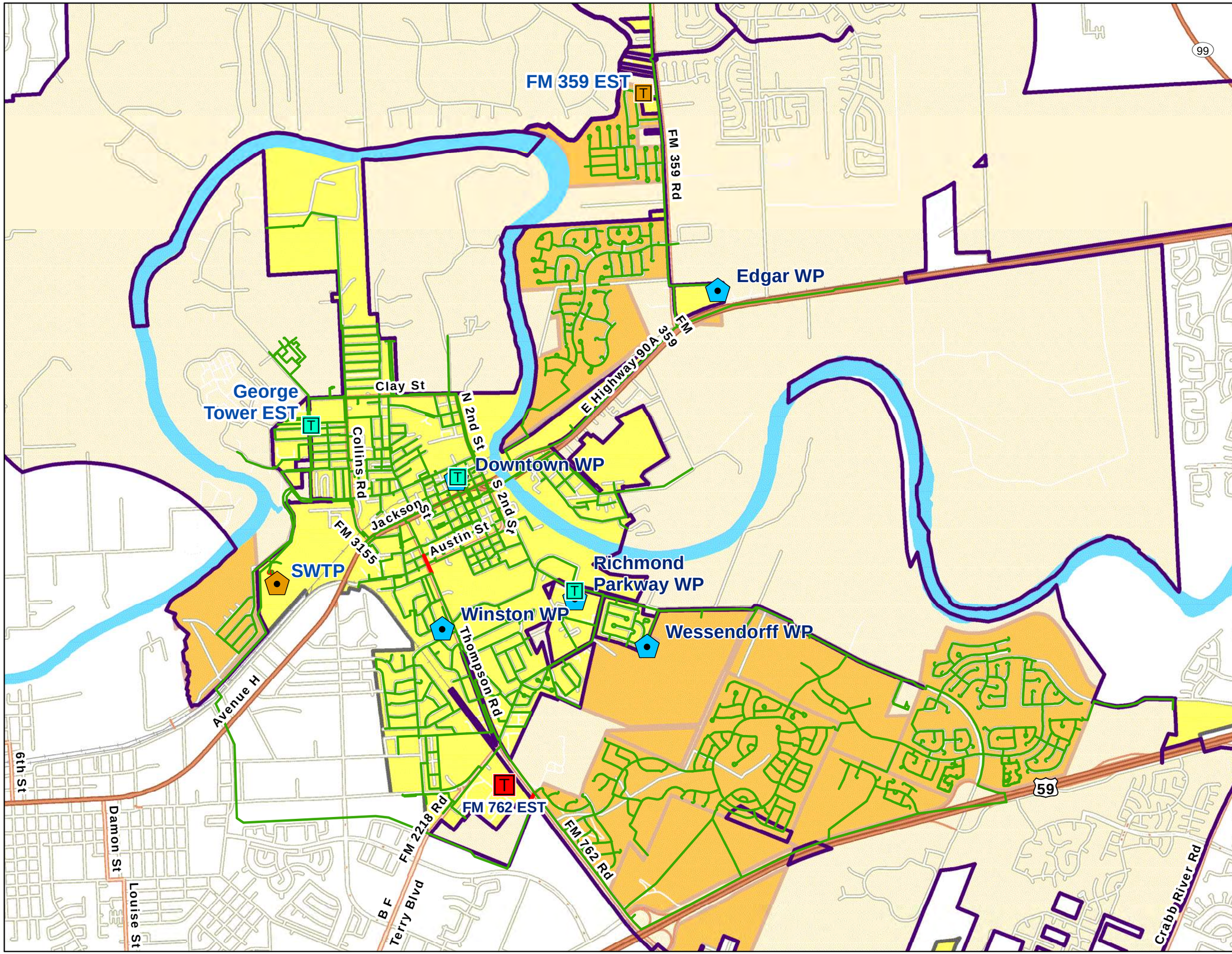
Figure 3-26
2027 EPS Model Scenario 3
Maximum Day Conditions
Minimum Junction Pressures



0.2 0 0.2 Miles

N

Legend

Pipes < 16- inch

- > 7 ft/1000 ft
- < 7 ft/1000 ft

Pipes > = 16 - inch

- > 2 ft/1000 ft
- < 2 ft/1000 ft
- City Limits
- City Service Area
- ETJ Area
- Groundwater Plant
- Existing EST
- FM 359 EST
- FM 762 EST

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Figure 3-27
2027 EPS Model Scenario 3
Maximum Day Conditions
Maximum Head Loss Gradient

3.6.6. Ultimate Scenario

A new 2 MGD groundwater plant (**Project W-15**) is recommended on the east side of Brazos River to meet the future demands beyond 2027 when there is substantial development in the ETJ area. For the new WP, City will need approximately 5 acres of land. The Master Plan conservatively assumed a land cost of $500,000 for a 5-acre parcel. **Table 3-22** and **Table 3-23** summarize 2027 storage tank design volumes/ facility capacity and elevated storage tank design volumes, respectively. **Figure 3-28** shows the candidate locations for the new groundwater plant.

Table 3-22. 2027 Water Plant GST Storage and Booster Pumping Capacity

Water Plant Facility	2027 GST Storage (MG)	2027 Booster Pumping Capacity (MGD)
Downtown WP	0.3	1.4
Winston WP[1]	0.1	0.7
Richmond Parkway WP	1.0	3.1
Wessendorff WP	1.0	2.8
Edgar WP	1.0	10.8
Surface Water Treatment Plant	3.0	12.0
Future Groundwater Plant	1.0	2.5
Total Volume / Capacity	**7.4**	**33.3**

Note: 1. Winston WP is assumed to reach its end useful life by 2027.

Table 3-23. 2027 Elevated Storage Tank Capacity

Elevated Storage Tank	2027 Storage Volume (MG)
Downtown EST	0.11
Richmond Parkway EST	0.3
George Elevated Tower EST	0.3
Future Rio Vista EST[1]	0.5
Future FM 762 Corridor EST	0.5
Total	**1.71**

Note 1. Rio Vista EST is under construction.

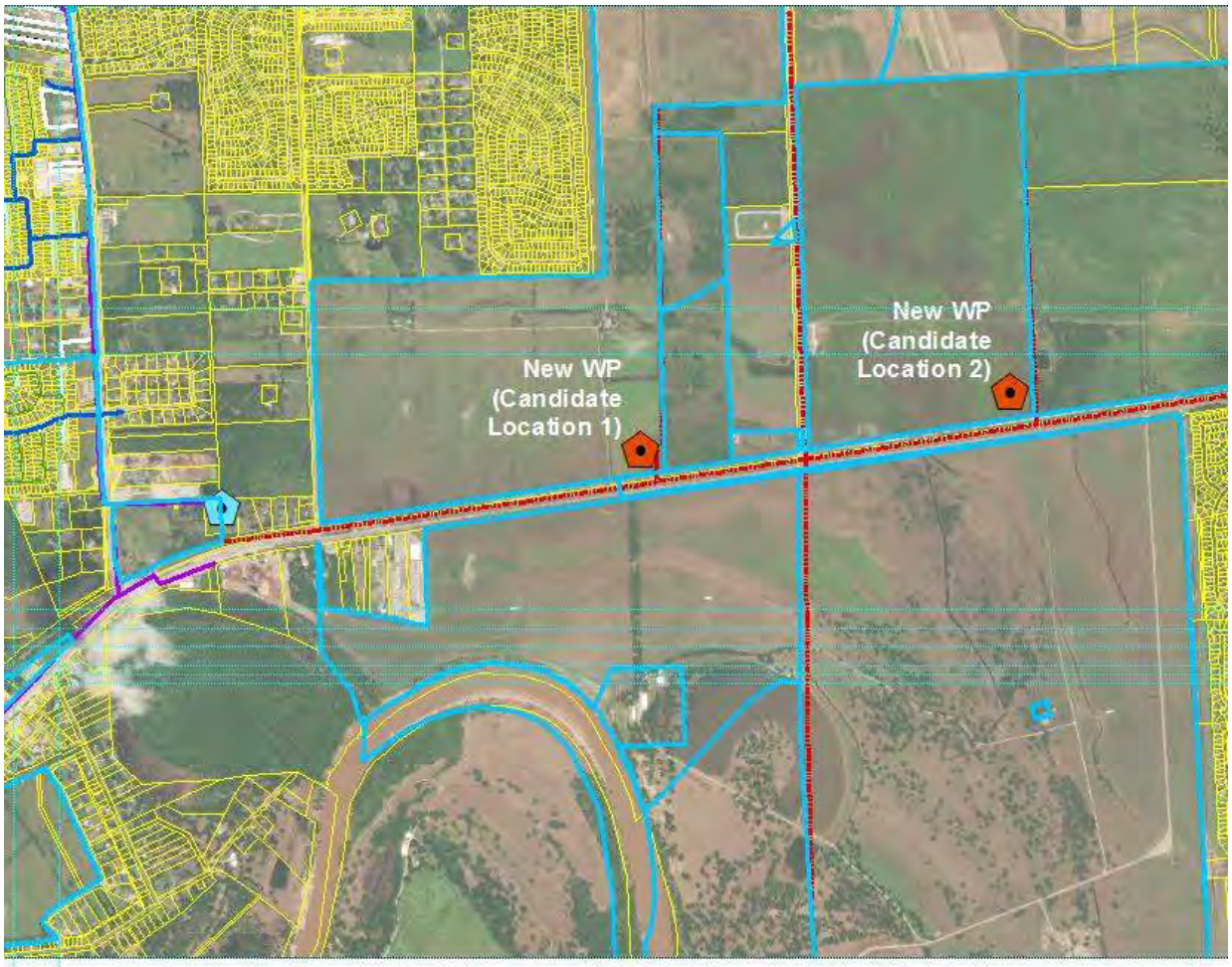

Figure 3-28. Candidate Locations for New Groundwater Plant East of Brazos River

3.7. Water System Capital Improvement Plan (CIP)

3.7.1. Cost Assumptions

Budgetary cost opinions were developed for all of the CIP projects. Budgetary cost opinions are commensurate with the Association of Advancement of Cost Engineering (AACE) level estimates. The developed costs rely on comparable feasibility studies or construction costs. When equivalent construction costs are not available, cost is based on cost curves, the Texas Water Development Board (TWDB) Unified Costing Model, professional judgement and other resources.

It is important to note that these high-level cost estimates do not involve any engineering concept development. At this stage of project development, there are still many unknowns, and further investigation is required to develop refined cost estimates for project and capital planning once projects are selected. As such, the costs presented in this document are intended for use with long-range planning purposes. The level of accuracy ranges from the low end of +/- 20 to 50 percent to the upper range of +/- 30 to 100 percent. Capital costs include direct project costs as well as indirect project costs summarized below:

- **Contingency and other project costs –** assumed to be 30 percent of the direct project costs for engineering and feasibility studies, legal assistance, bond counsel, and other contingencies. The contingency allowance also accounts for unforeseen circumstances and for variances in design elements.
- **Permits, bonds and insurance –** assumed to be 13 percent of the direct project costs to account for permitting costs, sales tax, general contractor bonds, builders insurance, and general liability insurance.
- **Mobilization and Demobilization –** assumed to be 5 percent of the direct project costs for mobilization and demobilization of the contractor's equipment and labor to the construction site.
- **Contractor overhead (OH) and profit –** assumed to be 15 percent of the direct project costs to cover contractor overhead costs and allow a fair profit on the project.
- **Engineering and Design –** assumed to be 15 percent of the direct project costs for engineering and design of capital improvement projects.

3.7.2. 5-year CIP

The goal of the capital improvement projects is to address existing deficiencies in the system and provide capacity for future conditions in the water collection system. This section presents recommended five-year capital improvement projects for the City's water system based on the analysis and findings presented in **Section 3.4.2**. These improvements include proposed small diameter pipeline replacement, tank and well rehabilitation, and new capacity expansion projects. The capital improvement projects (CIP) presented in **Table 3-24** summarizes recommended improvements (projects) for the next 5-year term (2019-2023), original project cost in 2018 dollars and escalated cost. Project costs are broken out by year using various assumptions. For typical design-bid-build projects, it was assumed that 15% of costs would be incurred in

the first year for design and permitting, with the remaining 85% incurred during the second year. Several larger capital projects (i.e., water and wastewater plant construction or expansion) spread construction over two years to match expected construction timelines. Some rehabilitation projects extend over a longer period (3 -5 years), with costs evenly distributed over that span. Escalated costs assume an inflation rate of 3% per year beyond the costs in 2018 dollars. **Table 3-24** also shows the source of funding for each project.

Table 3-24. 5-Year CIP Projects List

Project Type	Proj. No.	Project Description	Project Drive	Fund*	Total Project Cost (2018 $)	Escalated Cost ($)
Small Diameter Pipeline Replacement	W-1	Heavy Metal Joint Pipe Replacement - Segment W-1	Aging Infrastructure/ Reliability/ Resilience	SW	$4,966,000	$5,245,000
	W-2	Small Diameter Pipe Replacement - Segment W-2		W	$1,649,000	$1,848,000
	W-3	Small Diameter Pipe Replacement - Segment W-3		W	$6,311,000	$7,502,000
Rehabilitation Projects	W-7	Ground Storage Tank (GST) Rehabilitation	Aging Infrastructure/ Reliability/ Resilience	W	$1,459,000	$1,596,000
	W-8	Motor Control Center Rehabilitation		W	$499,000	$514,000
	W-9	Well Rehabilitation (Edgar WP)		W	$356,000	$388,000
	W-10	Elevated Storage Tank (EST) Rehabilitation		W	$449,000	$506,000
Expansion Projects	W-11	New Well at Richmond Parkway WP	Reliability/ Redundancy	W	$2,848,000	$3,098,000
	W-14	New Transmission Lines (MUD 207 and WR MUD 1)	Growth	W/SW	$5,552,000	$6,222,000
	W-16	Surface Water Treatment Plant Expansion by 2 MGD	Regulatory	SW	$10,550,000	$12,703,000
	W-19	New 2 MGD Well at SWTP	Reliability/ Resilience	SW	$2,136,000	$2,393,000
	W-20	Update Utility Master Plan	Planning	W/SW	$250,000	$290,000

* W – Water; SW – Surface Water; EXT – External Funding (Grant Funding)

3.7.3. 10-year CIP

This section presents recommended ten-year capital improvement projects for the City's water system based on the analysis and findings presented in **Section 3.4.2**. These improvements include proposed small diameter pipeline replacement and new capacity expansion projects. **Table 3-25** summarizes recommended improvements (projects) for the next 5-year term (2024-2028), original project costs in 2018 dollars and escalated costs. Project cost allocations and escalated costs are calculated consistent with those in **Section 3.7.2**. **Table 3-25** also shows the source of funding for each project.

Table 3-25. 10-Year CIP Projects List

Project Type	Proj. No.	Project Description	Project Drive	Fund*	Total Project Cost (2018 $)	Escalated Cost ($)
Small Diameter Pipeline Replacement	W-4	Small Diameter Pipe Replacement - Segment W-4	Aging Infrastructure/ Reliability / Resilience	W	$2,420,000	$3,052,000
	W-5	Small Diameter Pipe Replacement - Segment W-5		W	$2,426,000	$3,246,000
	W-6	Small Diameter Pipe Replacement - Segment W-6		W	$302,000	$404,000
Expansion Projects	W-12	New Elevated Storage Tank along FM 762	Growth; Regulatory	W	$3,810,000	$4,665,000
	W-13	New Transmission Lines (SWTP to North Downtown)	Growth; Regulatory	SW	$6,868,000	$7,696,000
	W-15	New Groundwater Plant East of Brazos River (2 MGD)	Growth	W	$9,680,000	$11,655,000
	W-17	New Well(s) at Main Street WP	Aging Infrastructure/ Reliability / Resilience	W	$2,136,000	$2,858,000
	W-18	SWTP Expansion by an Additional 2 MGD	Growth; Regulatory	SW	$20,000,000	$25,549,000

* W – Water; SW – Surface Water

A tentative implementation timeline for both the 5-year CIP and 10-year CIP projects is presented in **Table 3-26**. This timeline presents anticipated timeline and escalated costs for each project in the proposed CIP. A complete CIP project table combining the 5-year and 10-year CIP projects is presented in **Appendix B**, along with cost opinions for each CIP project.

3.8. Water System Recommendations

To maintain compliance with FBSD mandates, it is recommended that the City continue coordination with the Brazos River Authority (BRA), which controls water rights for Brazos River raw surface water. The City has already submitted a request and is on the BRA waitlist for an additional 5,000 acre-feet (approximately 4.5 MGD) of water rights. This quantity will provide adequate supply to operate the anticipated SWTP expansions while providing for losses that occur during treatment processes. The City plans to replace small-diameter pipelines throughout the system to improve system efficiency by reducing pressure losses and to provide increased fire flow capacity. It is recommended that the City prioritize older, metal pipelines in the downtown area, as these pipes are more likely to have heavy metal joints, which may be more likely to have detrimental water quality impacts if these pipes experience corrosion issues related to surface water conversion. It is further recommended that the City purchase approximately 5 acres of land east of the Brazos River for the construction of a new groundwater plant (project W-15). This plan conservatively assumes land cost of $100,000 per acre. It was assumed that a new EST (project W-12) could be constructed on City-owned property southwest of the Fort Bend Country Club near FM 762.

Table 3-26. Water System CIP Implementation Timeline

Project Type	Project Number	Project Description	Project Driver	Trigger(s)	Fund	Project Duration	Estimated Project Cost										
							Total Project Cost	Fiscal Year									
								2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Small Diameter Pipeline Replacement	W-1	Heavy Metal Joint Pipe Replacement - Segment W-1	Aging Infrastruture/ Reliability/Resilience	Replacement of small-diameter lines with heavy metal joints	SW	2-Year	$5,245,000	$767,000	$4,478,000								
	W-2	Small Diameter Pipe Replacement - Segment W-2			W[a]	2-Year	$1,848,000			$270,000	$1,578,000						
	W-3	Small Diameter Pipe Replacement - Segment W-3			W	2-Year	$7,502,000					$1,097,000	$6,405,000				
	W-4	Small Diameter Pipe Replacement - Segment W-4		Replacement of small-diameter lines for increased system reliability	W	2-Year	$3,052,000							$446,000	$2,606,000		
	W-5	Small Diameter Pipe Replacement - Segment W-5			W	2-Year	$3,246,000									$475,000	$2,771,000
	W-6	Small Diameter Pipe Replacement - Segment W-6			W	2-Year	$404,000									$59,000	$345,000
Rehabilitation Projects	W-7	Ground Storage Tank (GST) Rehabilitation	Aging Infrastruture/ Reliability/Resilience	None, routine maintenance	W	5-Year	$1,596,000	$301,000	$310,000	$319,000	$328,000	$338,000					
	W-8	Motor Control Center Rehabilitation		Aging equipment	W	2-Year	$514,000	$514,000									
	W-9	Well Rehabilitation (Edgar WP)		None, routine maintenance	W	2-Year	$388,000		$57,000	$331,000							
	W-10	Elevated Storage Tank (EST) Rehabilitation		None, routine maintenance	W	3-Year	$506,000			$164,000	$168,000	$174,000					
Expansion Projects	W-11	New Well at Richmond Parkway WP	Reliability/ Redundancy	Declining yield from existing well; increased system reliability	W	2-Year	$3,098,000		$453,000	$2,645,000							
	W-12	New Elevated Storage Tank along FM 762	Growth; Regulatory	Development of MUD 207 and WR MUD 1; TCEQ Capacity Req.	W	2-Year	$4,665,000						$682,000	$3,983,000			
	W-13	New Transmission Lines (SWTP to North Downtown)	Growth; Regulatory	Growth on east side of City; GRP Compliance	SW	2-Year	$8,410,000						$1,230,000	$7,180,000			
	W-14	New Transmission Lines (MUD 207 and WR MUD 1)	Growth	Development of MUD 207 and WR MUD 1	W/SW	2-Year	$6,222,000			$910,000	$5,312,000						
	W-15	New Groundwater Plant East of Brazos River (2 MGD)	Growth	Development of East of Brazos	W	3-Year	$12,736,000								$1,839,000	$5,368,000	$5,529,000
	W-16	Surface Water Treatment Plant Expansion by 2 MGD	Regulatory Driver	GRP Compliance	SW	3-Year	$12,703,000					$1,835,000	$5,354,000	$5,514,000	★		
	W-17	New Well(s) at Main Street WP	Aging Infrastruture/ Reliability/Resilience	Declining yields from existing wells	W	2-Year	$2,858,000									$418,000	$2,440,000
	W-18	SWTP Expansion by an Additional 2 MGD	Growth; Regulatory Driver	Parcels at East of Brazos, GRP Compliance	SW	3-Year	$25,549,000							$3,690,000	$10,768,000	$11,091,000	
	W-19	New 2 MGD Well at SWTP	Reliability/Resiliency	None	SW	2-Year	$2,393,000			$350,000	$2,043,000						
	W-20	Update Utility Master Plan	Planning	Planned 5-year Update	W/SW	1-Year	$290,000					$290,000					
Total Water Project Costs							$103,225,000	$1,582,000	$5,298,000	$4,989,000	$9,429,000	$3,734,000	$13,671,000	$20,813,000	$15,213,000	$17,411,000	$11,085,000

Acronyms

W	Water	EXT	External funding (grant funding)	gpm	gallons per minute	SW	Surface Water	WP	Water Plant
WW	Wastewater	FBCMUD	Fort Bend County Municipal Utility District	MG	million gallons	SWTP	Surface Water Treatment Plant	WWTP	Wastewater Treatment Plant
RW	Reclaimed Water	GRP	Groundwater Reduction Plan	MGD	million gallons per day	TCEQ	Texas Commission on Environmental Quality		

KEY

External funding (WW-2, WW-3, WW-10, WW-25) excluded from totals

East of Brazos Development Projects - W-15, W-18, WW-13, WW-15, WW-26

★ Critical Project Schedule

4. Wastewater System Master Plan

4.1. System Inventory

The City's wastewater system currently serves and maintains facilities within the City limits, FBCMUD 121, FBCMUD 187, FBCMUD 140, FBCMUD 145, WRMUD 1 and also receives flow from FBCMUD 19. The City's current wastewater facilities consist of one Regional Wastewater Treatment Plant (WWTP) and fifteen publicly owned and maintained lift stations (LS) located within the City limits and adjacent MUDs. **Appendix C** presents an Overall Sanitary Sewer System Layout – Existing (2017) that shows the location of the existing LSs, the Regional WWTP, and the system of gravity sanitary sewers and force mains. The system was split into twenty-three (23) Gravity Service Areas (GSAs) as presented in **Appendix C**. **Figure 4-1** – Sanitary Sewer Flow Diagram – Existing (2017) System presents a flow diagram schematic of the system's collection areas and path of flow to the Regional WWTP.

4.1.1. Gravity Collection System

The City's sanitary sewer system consists of approximately 423,000 linear feet (LF) of gravity sewer ranging in sizes from 6-inches to 36-inches in diameter and includes approximately 2,050 manholes. The collection system is comprised of sanitary sewer lines of varying ages and materials.

The City has major trunklines going into the WWTP and the North 2nd LS. The trunklines leading into the WWTP vary in diameter from 15-inches to 36-inches. The three (3) major gravity lines into the WWTP are an 18-inch (west), a 36-inch (north), and 36-inch (east). The trunklines into the North 2nd LS consist of 15-inch and 18-inch gravity sewers that serve the North 2nd C, North 2nd N, George Park and Pultar GSAs (see Exhibit 4-1).

4.1.2. Lift Stations (LS) and Force Mains

The City's system consists of fifteen (15) LSs located both within the City limits and within adjacent MUDs. Of these fifteen (15) LSs, two (2) act as Regional LSs: Brazos River LS and North 2nd LS. The Brazos River LS is the sole LS that pumps across the Brazos River serving the portion of the City's service area east of the river. The force main is an old converted waterline attached to a bridge that eventually ties into the North 2nd LS force main. The North 2nd LS is located at previously abandoned WWTP site and collects flow from the northern region of the City. Record drawings were available for all LSs, except the North 7th and North 2nd LSs. City staff conducted wet well draw down tests to confirm pumping capacity at 11 of the LSs. See attached **Appendix C** for the LS condition assessment summary and LS facilities summary. The City's system consists of approximately 63,000 LF of force mains ranging in sizes from 2-inches to 14-inches. See **Figure 4-1** for details of the force main lines sizes associated with each LS.

4.1.3. Wastewater Treatment Plant(s)

The Regional WWTP, located at 218 Legion Drive, Richmond, Texas 77469, was expanded to a 3.0 MGD plant in 2009. The existing WWTP treats wastewater by way of conventional treatment process and

includes a LS, headworks, aeration basin, four (4) conventional clarifiers, chlorine contact basin, aerobic digesters, belt press, and five (5) horizontal centrifugal blowers. The WWTP is permitted for 3.0 MGD average daily flow (ADF) and 6,388 gallons per minute (9.199 MGD) 2-hour peak flow per TPDES Permit No. WQ0010258003 (renewed on July 8, 2009). The current permit also has two (2) additional planned phases for expansion to 4.5 MGD and 6.0 MGD. Based on monthly WWTP operating reports, the City had an ADF condition of 1.459 MGD in 2017. Daily and hourly flows were not available for analysis at the time of this report. See **Appendix C** for the WWTP Permit.

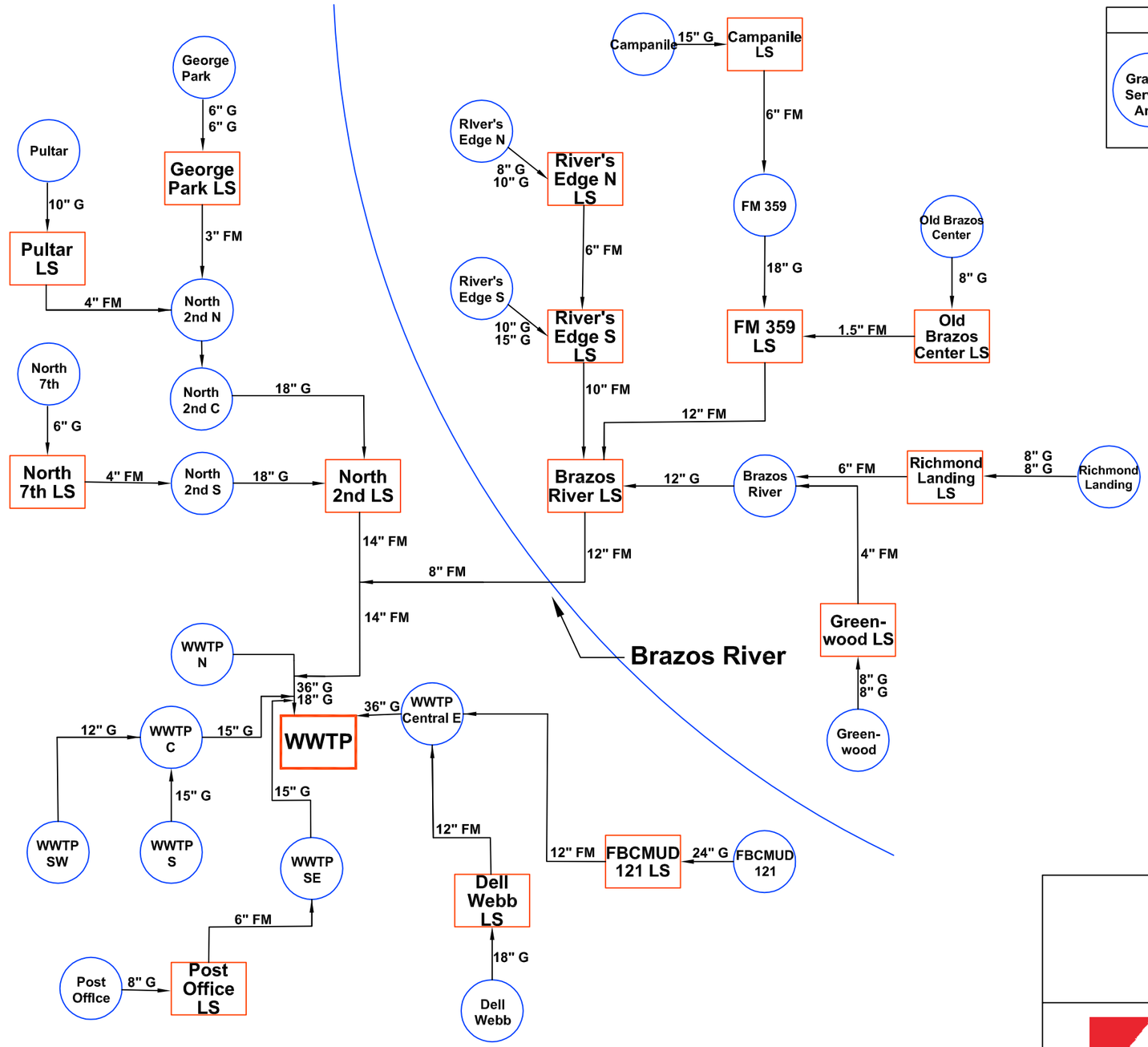

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FIGURE 4–1
SANITARY SEWER FLOW DIAGRAM
EXISTING (2017) SYSTEM

4.2. Wastewater Flows and Flow Projections

4.2.1. Existing Wastewater Flows

Existing system wastewater flows were determined from the water demands presented in **Section 3.2** and the application of a return factor. The wastewater flows were confirmed using the reported 2017 daily average flows at the WWTP. As presented in **Section 3**, the City has a water ADF of 2.38 MGD based on a system population of 23,500 in 2017. The City reported a daily average flow condition of 1.49 MGD in 2017 at the WWTP. A system wide return factor of 0.75 was applied to individual customers' average day water demands based on 2017 water meter data. Using a return factor based on average day WWTP flows, the calculated flows contain some component of infiltration and are not truly dry weather conditions. Average day diurnal patterns (see **Appendix C** for diurnal patterns) were applied to the existing flows by the type of connection which include single family residential, commercial, and industrial. Diurnal patterns were developed based on *Wastewater Collection System Modeling and Design (2017)* by Bentley Institute Press and adjusted based on knowledge of local conditions. Based on water meter data, the City's largest individual flow contributors are the County Jail and the State School. A unique diurnal pattern was developed for these users reflecting their expected peak use times.

The City conducts sample testing twice a week on their influent and effluent flows. The WWTP Influent and Effluent Concentrations Summary (presented in **Appendix C**) shows the summary of 2017 influent organic loading reports and effluent concentration reports. The influent flow the City currently receives has a high BOD and solids content with maximums well above the plant's design parameters.

4.2.2. Methodology of Wastewater Flow Projections

The projected wastewater flows for future developments were derived from the projected population and water demands presented in **Section 3.2** and were added to the existing system wastewater flows. For all future growth-related flows allocated within the existing system infrastructure, the return factor of 0.75 was applied equating to 87 gpcd. For future flows within a new development with new infrastructure such as FBCMUD 207, a return factor of 0.6 was applied equating to 70 gpcd. The lower return factor considers less inflow and infiltration (I&I) for the new infrastructure. Diurnal patterns were applied to the projected flows based on projected land uses.

4.2.3. Average Dry Weather Wastewater Flows

Dry weather flows typically consist of flows that are intentional discharges into the collection system, absent of I&I. The reported 2017 average day flow condition was 1.45 MGD at the wastewater treatment plant which included some component of infiltration. Average day flows were geospatially allocated within the wastewater model according to water meter locations and applied to the nearest manhole.

4.2.4. Wet Weather Wastewater Flows

No rainfall data and coinciding wastewater flow data was available for this study. To evaluate wet weather events, two storm events were applied: a 2-year, 24-hour storm event and a 100-year, 2-hour storm event.

The storms were developed from the US Department of Agriculture Natural Resources Conservation Service (NRCS) Type III hyetograph for the Gulf Coast area and the Fort Bend County Drainage District (revised 2011) standard rainfall intensities. A Fort Bend County 2-year, 24-hour storm event and a 100-year, 2-hour storm yield a total rainfall amount of 4.9 inches and 6.1 respectively. The storm events can be found in **Appendix C**. I&I rates were adjusted by GSA based on the condition of the pipes (e.g. age, developments, parks, density) to achieve a system wide peak flow. The Regional WWTP has a permitted peak flow of 3Q, a flow rate three times the permitted flow rate. I&I rates were adjusted to model a system wide 2-hour peak flow of 3Q during the 100-year storm.

Future flow monitoring data can be used to determine peak flows within GSAs, percentage of I&I and determine problematic areas. An I&I study was conducted in 2014 by ADS Environmental Services on the northern portion of downtown which reported wet weather peaking factors ranging from 3.53 – 8.89 before any rehabilitation. Systemwide flow monitoring can be used to calibrate the system for more accurate results.

The existing system flows are summarized in **Table 4-1**.

Table 4-1. Existing Wastewater System Flow

	Daily Average (MGD)	2-year, 24-hour Storm (MGD)	100-year, 2-hour Storm (MGD)
Existing (2017)	1.45	3.49	2.87

4.2.5. Projected Wastewater Flows

In the 2027 system, the City is projected to serve 52,900 people with a total anticipated average day flow of 4.45 MGD, approximately 300% increase of the system's current average day condition. The same two storm events were used to evaluate wet weather conditions, and I&I amounts were adjusted by gravity service area to achieve a peak 2-hour flow of 3Q in the 100-year storm event. The projected wastewater flows modeled are summarized in **Table 4-2** below.

Table 4-2. Projected Wastewater System Flow

	Daily Average (MGD)		2-year, 24-hour Storm (MGD)		100-year, 2-hour Storm (MGD)	
Future (2027) (w/ East WWTP)	*Regional*	*East*	*Regional*	*East*	*Regional*	*East*
	3.25	1.24	5.00	1.54	4.43	1.68

4.3. Existing System Evaluation

4.3.1. Planning and Evaluation Criteria

The existing system was evaluated over a 24-hour period by analyzing three (3) different scenarios: ADF and two (2) Wet Weather Wastewater Flow scenarios (2-year, 24-hour storm event and 100-year, 2-hour storm event). The gravity collection system was evaluated for capacity, pipe surcharges and any overflows during a wet weather event. Capacity in the gravity lines was determined by the peak flow rate versus the full flow capacity, with a criterion of maximum 75% full during the average day peak flow. Gravity lines greater than 75% full were identified for upsizing. Any gravity lines with greater than 100% capacity at peak flow indicate surcharging in the system which should be prevented in accordance with TCEQ §217.53(j)(3). Mitigating surcharges and overflows were assessed during the wet weather events.

LSs were evaluated for ability to handle peak flows with firm pumping capacity in accordance with TCEQ §217.61(c). Firm pumping capacity is defined as the maximum pumping capacity with the largest pump out of service. Force main sizes were evaluated based on the ability to maintain a minimum 3 feet per second (fps) velocity while keeping a maximum velocity below 8 fps. Minimum 3 fps velocities through force mains scour any solids that may have settled out.

4.3.2. Wastewater Collection System Model Development

A sanitary sewer model was created in SewerGEMS V8i Edition by Bentley Systems, Inc. This model is a tool to analyze performance and predict future behavior of the sanitary sewer system. The purpose was to develop a fully dynamic computer model of the City's wastewater system that calculates flows, velocities, and depths within the system over extended periods of time. The existing system sanitary sewer model was created with information from the City's existing GIS database. The GIS data included collection lines, force mains, diameters, manholes, invert elevations and lift stations. Manhole rim elevations were set by terrain contours and missing invert elevations were populated from record drawings, adjacent inverts, TCEQ defined minimum slopes, and engineering judgement. LSs were built from available record drawings and confirmed with known conditions obtained from City staff and condition assessment site visits. Pump curves, configurations and controls were input from record drawings when available or known design points. LS pumping capacity testing was performed for 11 lift stations by City staff and those pumping capacities were used in the model.

The North 7th LS was excluded from the model because no record drawings of the LS were available, and the LS is relatively small, only serving six (6) houses with a single pump. The residential flow generated within the service area was allocated to nearby manholes within the gravity system. The WWTP and influent LS were not included in the model, instead they were modeled as an outfall.

4.3.3. Wastewater System Model Validation

The wastewater system imported from the City's GIS system was compared to available record drawings from the City and adjacent MUDs. A site visit was conducted in December 2017 to confirm depths of few

key manholes, confirm line sizes and flow directions. Discussions with the City staff helped solve outstanding issues regarding flow direction, manhole depths, force main locations and tie-ins. The modeled LSs were compared to actual LS run times provided by the City, LS wet well draw down tests, and known conditions of LSs. The total system flow was compared to the historical average day wastewater flow at the City's WWTP. Daily and hourly data was not available at the time of the report to calibrate the model for 2-hour peak flow conditions and for I&I during wet weather events. For a true calibration, flow monitoring is recommended to be collected for 90 days, and pump testing, daily LS and WWTP meter data is recommended to be collected for at least one full year.

4.3.4. Collection System Model Results

Figure 4-2, Figure 4-3, and **Figure 4-4** show the modeled existing system daily peak results during the average day condition, 2-year, 24-hour storm event and the 100-year, 2-hour storm events. The average day exhibits show the gravity lines' capacity used, expressed as a percentage, during the peak hour. The majority of the gravity lines are at less than 20% capacity during peak hour condition, however the 15-inch/18-inch trunklines into the WWTP are between 40%-60% full. The wet weather condition exhibits show the gravity line surcharges and potential for manholes to overflow during the storm event. During the 2-year, 24-hour storm scenario, approximately 8% of the total gravity sewer system is surcharged, mostly in the downtown and north downtown area. During the 100-year, 2-hour storm scenario, approximately 55% of the total gravity sewer system surcharges, and 100 manholes overflow (approximately 5% of the total 2,168 system manholes).

4.3.5. Facilities Model Results

Appendix C presents the modeled flows for each LS during the existing condition scenarios. The North 2nd LS and Greenwood LS both see flows higher than their design capacity during storm events. All of the other LSs have flows below their firm capacity.

Table 4-3 shows the modeled flows at the WWTP for the existing conditions. The modeled flow at the WWTP exceeds the permitted average day flow during the 2-year, 24-hour storm event but stays below the permitted flow during the 100-year, 2-hour storm event. This is largely due to overflowing within the system during the 100-year, 2-hour storm event.

Table 4-3. Existing Modeled WWTP Flows

WWTP	Average Day (MGD)	2-year, 24-hour Storm (MGD)	100-year, 2-hour Storm (MGD)
Richmond Regional WWTP	1.48	3.49	2.87

4.4. Future System Evaluation

4.4.1. 2027 Wastewater Collection System Modeling Scenarios

In 2027, the City is projected to have 52,900 people with an anticipated 4.45 MGD wastewater average day flows. The three (3) scenarios evaluated for the existing system conditions were analyzed for the future system: daily average, 2-year, 24-hour storm event, and 100-year, 2-hour storm event. These scenarios were used to evaluate the existing system infrastructure with the projected 2027 wastewater flows to identify improvements needed. After determining required system improvements, the future 2027 system with improvements was modeled and the daily peak results were evaluated in the three (3) scenarios.

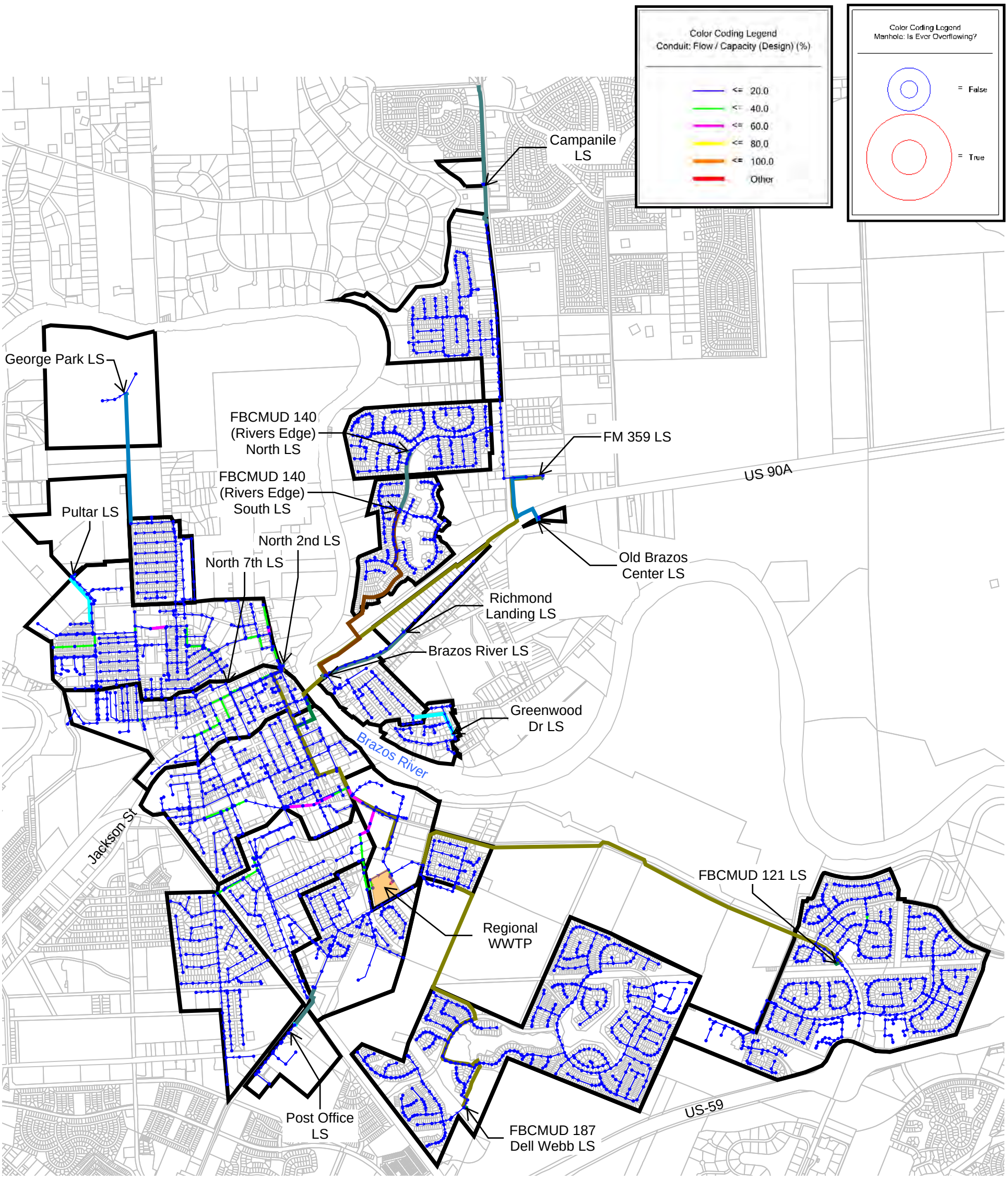

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Figure 4-2
Gravity System Capacity Analysis
Existing (2017)
Average Day Condition

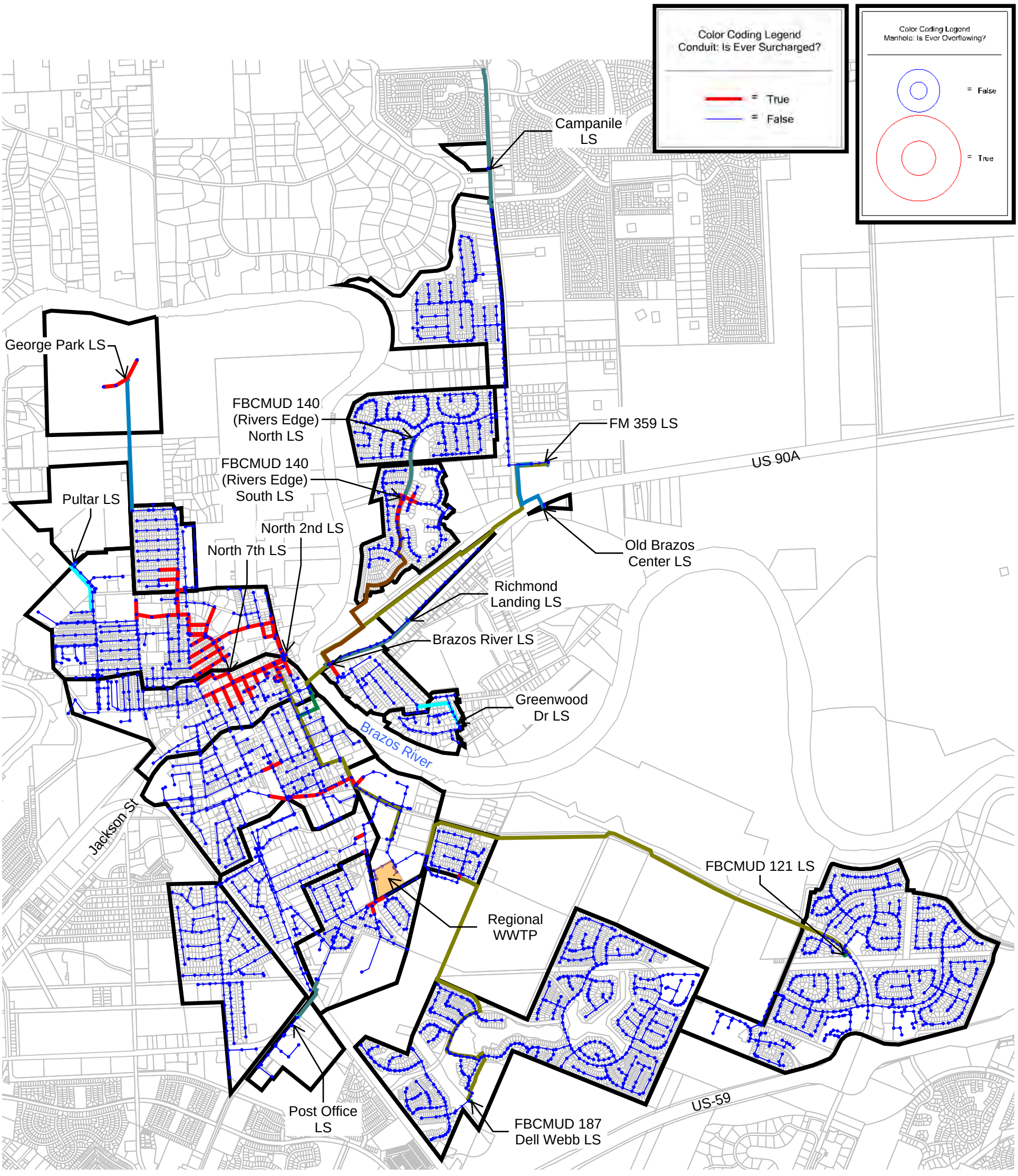

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Figure 4-3
Gravity System Capacity Analysis
Existing (2017)
2 Year 24 Hour Storm

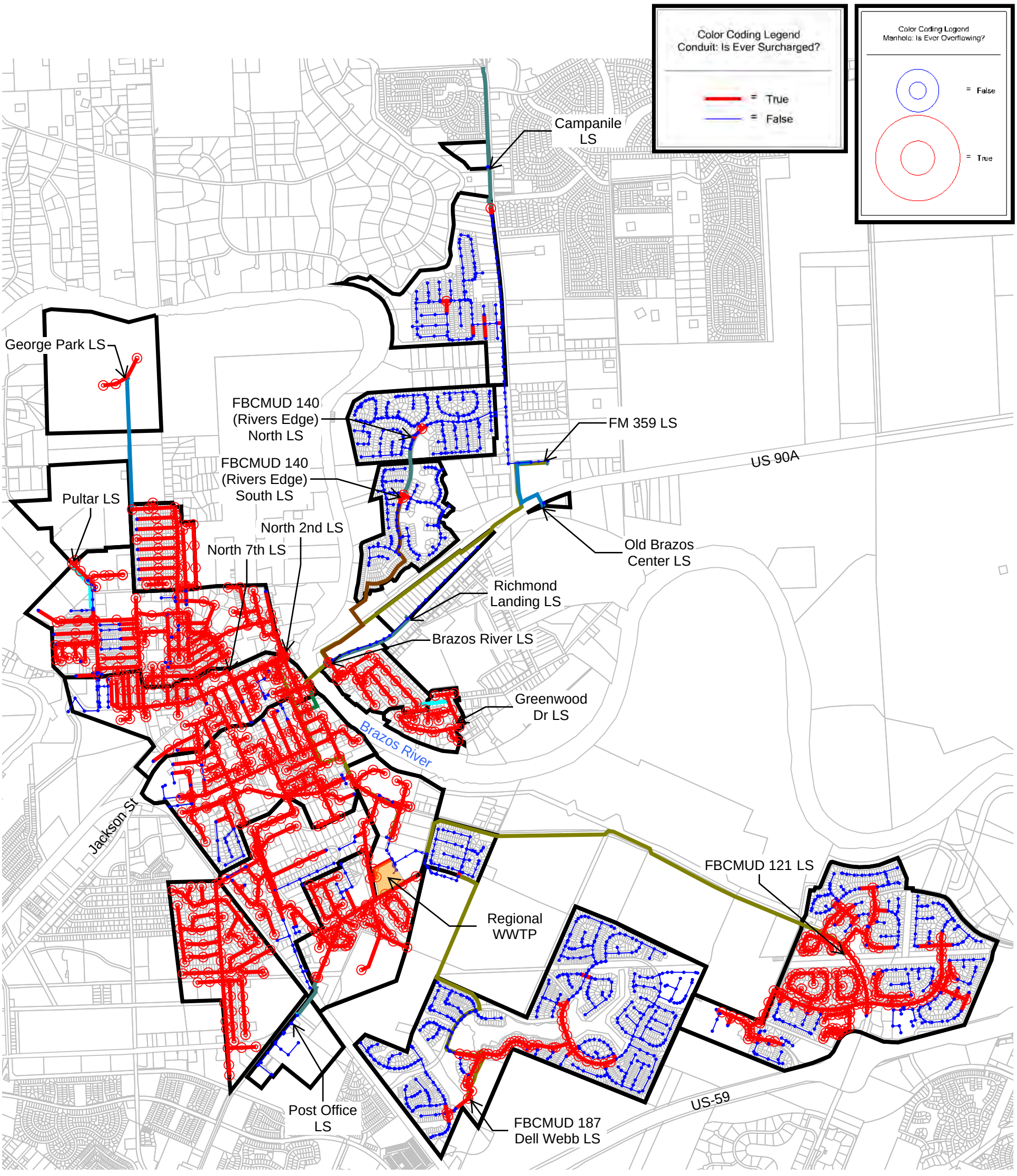

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Figure 4-4
Gravity System Capacity Analysis
Existing (2017)
100 Year 2 Hour Storm

4.4.2. 2027 Wastewater Facilities Plan

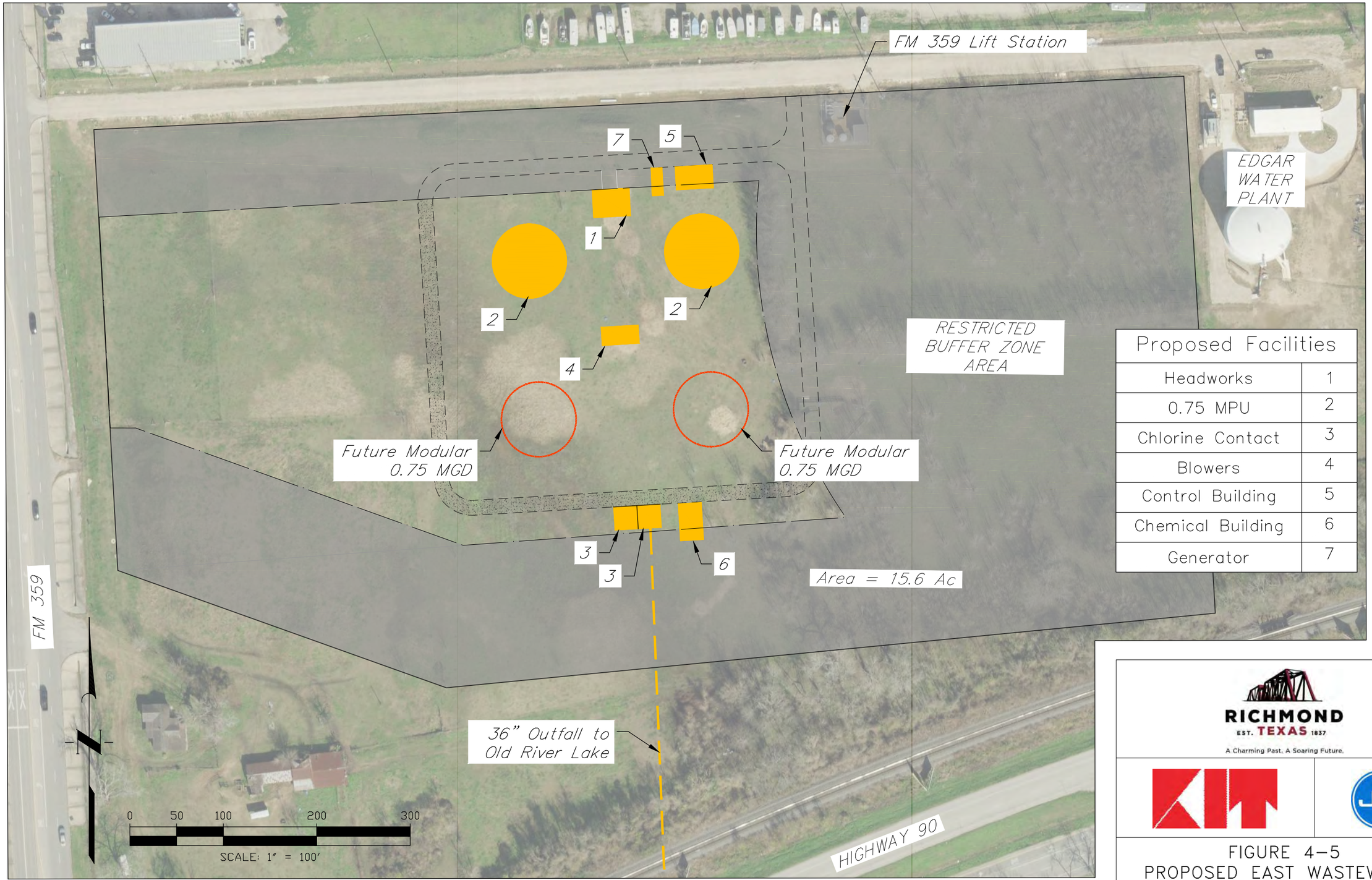
The total projected flow that the City system is anticipated to have will exceed the permitted 3.0 MGD average day flow condition at the Regional WWTP. The system is projected to have significant growth east of the Brazos River. The entire existing system east of the Brazos river flows to the Brazos River LS and is pumped across the river through an old 12-inch waterline attached to the bridge. The area surrounding the Brazos River LS is prone to flooding during significant rain events causing the LS to be inaccessible. With the significant growth east of the Brazos River, a second WWTP east of the Brazos River was evaluated. An East WWTP gives the system much needed redundancy, alleviates the flood-prone Brazos River LS as a system bottleneck, and delays a Regional WWTP expansion required to treat the full future system flow. For the East WWTP to treat all 2027 flows east of the Brazos River, the plant would be sized for 1.5 MGD ADF. This would allow the Regional WWTP to treat the remaining 3.21 MGD average day flow. Peak flows are based on the City's existing permitted peak flow of 3Q. Further evaluation of the City's historical 2-hour peak flow is required prior to design of the proposed East WWTP. See **Table 4-4** for future modeled WWTP flows.

Table 4-4. Future Modeled WWTP Flows

Facility	Average Day (MGD)	2-year, 24-hour Storm (MGD)	100-year, 2-hour Storm (MGD)	2-hour Peak Flow (gpm)
Regional WWTP	3.21	5.00	4.43	6,646
Proposed East WWTP	1.24	1.54	1.68	2,419

As the City's system continues to grow and new developments come online, expansion of the City's treatment capabilities are required. TCEQ §305.126 requires a WWTP permit holder to initiate engineering and financial planning for expansion when the sewage flows reach 75% of permitted average daily flows (2.25 MGD) for 3 consecutive months. The permit holder must also obtain necessary authorization to commence construction for additional facilities when the flows reach 90% of permitted average daily flows.

The proposed East WWTP could be located on the vacant property northeast of the intersection of FM 359 and US-90A, and directly adjacent to the FM 359 LS. The plant would use conventional circular modular equipment for treatment and use an expanded FM 359 LS as the on-site LS. A 36-inch outfall would discharge into Old River Lake, south of US-90A. The plant can be built in two phases: 1) initial phase of 0.75 MGD, 2) second phase of 1.5 MGD. The initial phase of the plant would be used to postpone expanding the Regional WWTP, and flows from east of the river can be diverted over time. The initial phase is large enough to handle the 2027 flows east of the river. The second phase would be a direct response to the development that would occur east of the river and would only need to happen as the tract begins to develop. See attached **Figure 4-5** for proposed site location and layout. Note that the 2027 population projections and flows account for only 1/3 of ultimate buildout of the parcels east of the river.



Proposed Facilities	
Headworks	1
0.75 MPU	2
Chlorine Contact	3
Blowers	4
Control Building	5
Chemical Building	6
Generator	7

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FIGURE 4–5
PROPOSED EAST WASTEWATER TREATMENT PLANT SITE LAYOUT

K:\09913\09913-0004-00 Water_Wastewater Master Planning and Rat\2 Design Phase\WWTP Facilities Exhibit\WWTP Facilities Layout 20181112.dwg

As the parcels continue to build past 2027, flows and treatment capacity at the East WWTP need to be re-evaluated. **Figure 4-6** below shows the City system's projected average daily wastewater flows through 2027 and proposed treatment facility capacity upgrades.

The Regional WWTP would need to be expanded to 4.5 MGD even with the East WWTP to meet TCEQ §305.126. This expansion can be broken into a few projects, starting with the improvements recommended by *Wastewater Treatment Plant Evaluation (2017)* report. Other projects include sludge process improvements and disinfection improvements. The plant currently uses conventional activated sludge treatment methods. The expansion would continue using the existing treatment process but would take a large portion of the available space on the plant site. See attached **Figure 4-7** for proposed layout.

The City is projected to reach 75% of its permitted treatment capacity on an average day basis as early as 2019 and reach 90% in 2021. The figure shows the East WWTP 0.75 MGD Phase I coming online in 2021 to meet the TCEQ rule while deferring expansion at the Regional WWTP. In 2024, the projected system flows are close to 90% of the treatment capacity. The East WWTP 0.75 MGD Second Phase is recommended to come online in 2025 prior to receiving flows from development east of the Brazos River. The Regional WWTP is shown to expand in 2024 to accommodate projected flows at the plant.

An alternative treatment method could be used to reduce the space required on the Regional WWTP site. The AquaNereda granular activated sludge utilizes high rate activated sludge process for advanced treatment. This process would allow the existing clarifiers to be repurposed for sludge equalization and thickening, and the existing aeration basins repurposed for flow equalization.

Splitting the system into two service areas also requires redirecting flow from LSs east of the Brazos river to the proposed East WWTP location. See **Figure 4-8** for the proposed 2027 Sanitary Sewer Flow Diagram. Many of these projects are described in the Capital Improvements Plan, **Section 4.6**. With the redirections, **Appendix C** presents the modeled projected flows at each LS. The North 2nd LS, Del Webb LS, FM 359 LS, Greenwood LS all require expansions to handle the projected 2027 flows.

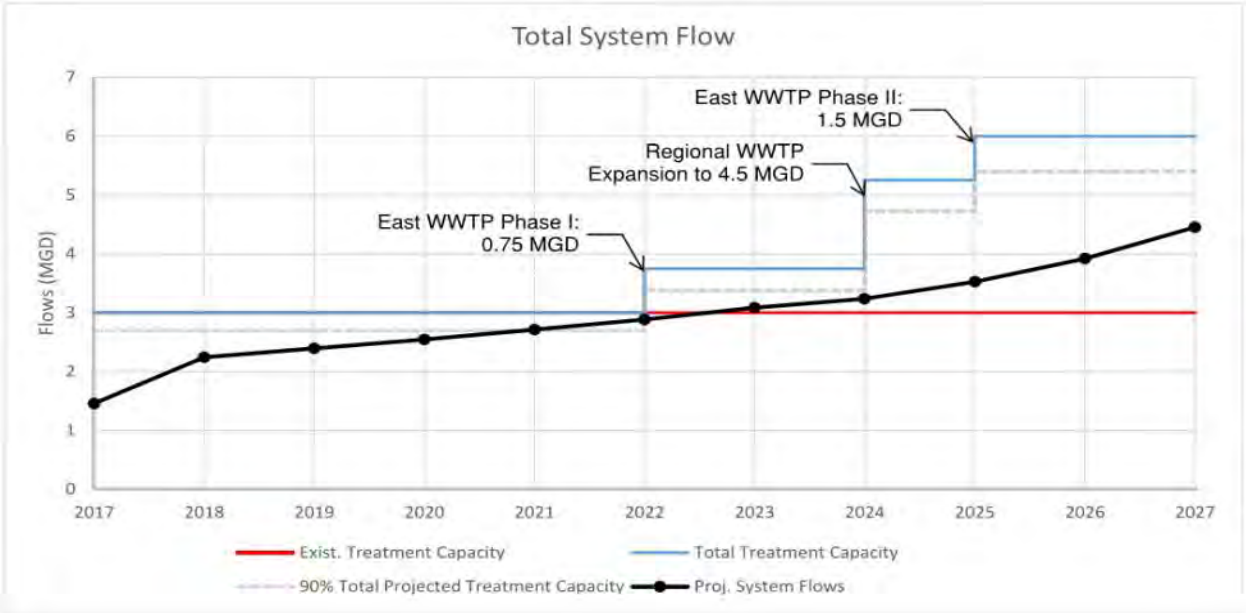
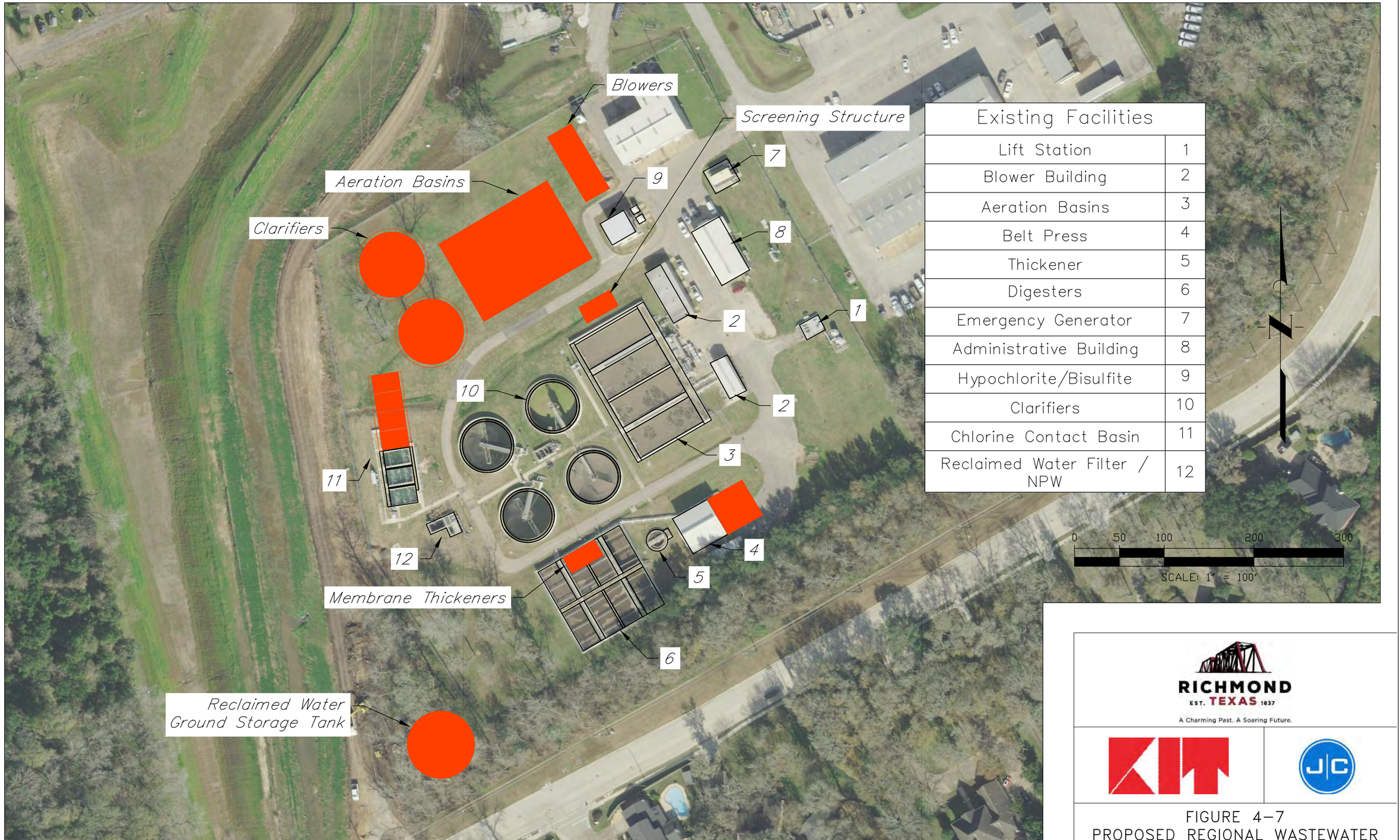


Figure 4-6. Projected Average Day Flows and Treatment Capacity



Existing Facilities	
Lift Station	1
Blower Building	2
Aeration Basins	3
Belt Press	4
Thickener	5
Digesters	6
Emergency Generator	7
Administrative Building	8
Hypochlorite/Bisulfite	9
Clarifiers	10
Chlorine Contact Basin	11
Reclaimed Water Filter / NPW	12

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FIGURE 4–7
PROPOSED REGIONAL WASTEWATER TREATMENT PLANT EXPANSION SITE LAYOUT

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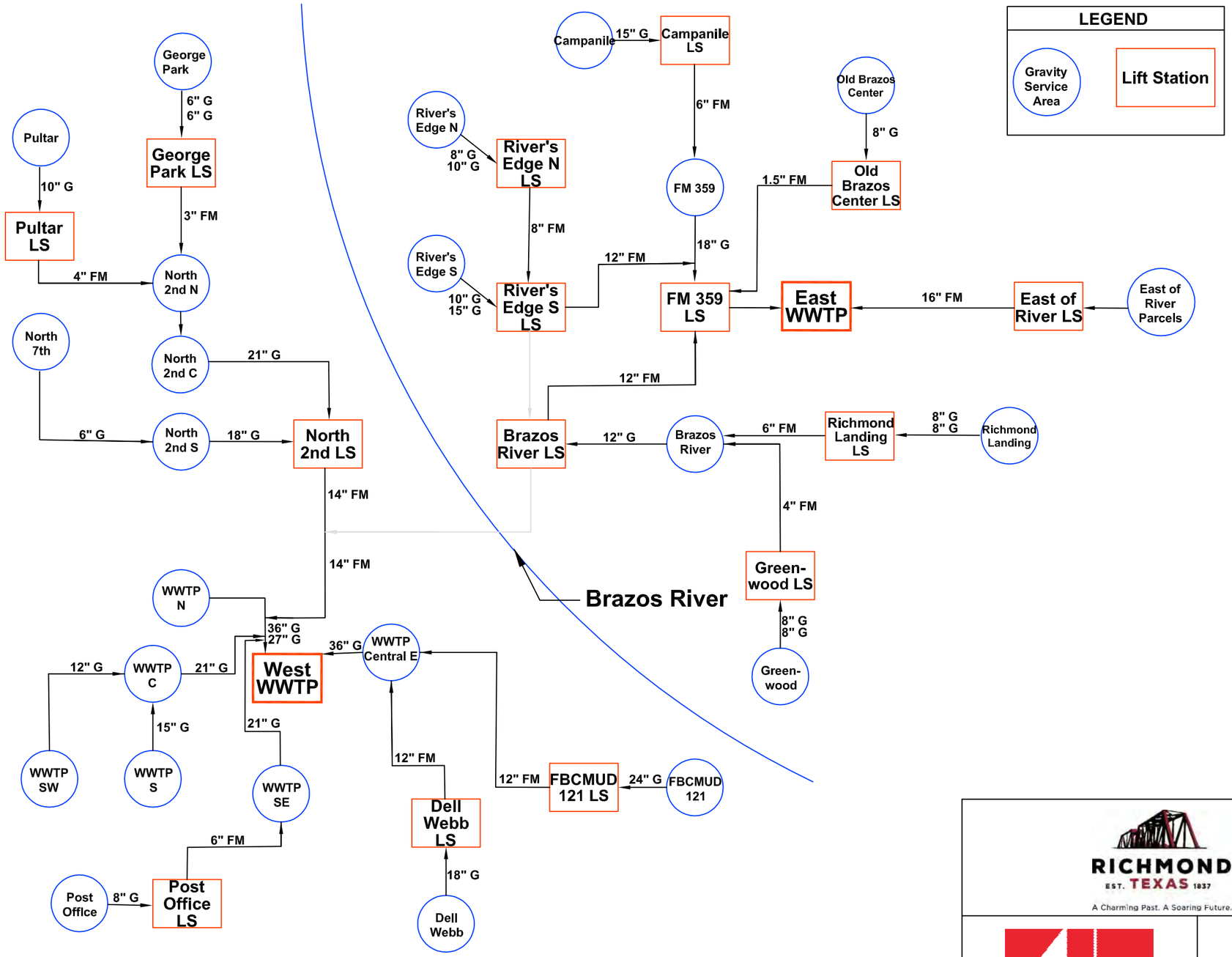

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FIGURE 4–8
SANITARY SEWER FLOW DIAGRAM
2027 SYSTEM

4.4.3. 2027 Wastewater Collection System Network

The project team analyzed the hydraulic model scenarios with and without the recommended improvements. The future flows were applied to the existing system to help determine which improvement projects are needed.

WWTP Gravity Service Areas

With the 2027 flows in the existing system, the influent 15-inch/18-inch trunklines to the WWTP are modeled to have capacity and surcharging issues. The 18-inch ranges from 60% to over 100% full during the 2027 daily average scenario without improvements. The 15-inch surcharges during the 2-year, 24-hour storm event, as well as the 100-year, 2-hour storm event.

It is recommended that the trunklines into the WWTP along the drainage channel and creek be expanded to increase capacity to better serve the existing flows and to serve the projected growth. Upsizing the trunklines, to 21-inch and 27-inch, in some areas more than doubles the capacity during peak dry weather wastewater flows. With improvements, the trunklines into the WWTP are modeled without surcharging during the 2-year, 24-hour storm event scenario.

North 2nd Gravity Service Areas

With the 2027 flows in the existing system, the major trunklines going into the North 2nd LS are projected to have capacity and surcharging issues. The large diameter sewer lines range from 40% to 80% full. A large portion of the North 2nd GSA is modeled to surcharge during the 2-year, 24-hour storm event, as well as the 100-year, 2-hour storm event. The North 2nd LS is undersized and, as a result, the wet well is projected to overflow causing the surrounding system to surcharge during the modeled 100-year storm event (peak flow). During the 100-year, 2-hour storm event, the majority of North Downtown is projected to surcharge with some areas projected to have overflowing manholes.

A proposed LS expansion will address some of the surcharging. It is recommended that gravity lines along North 2nd St, Commerce St, and Preston St be upsized to improve future capacities and alleviate surcharging during storm events. Expansions are needed to serve the existing flow and projected growth.

See **Figure 4-9** for the 2027 System Improvement Project locations. **Figure 4-10**, **Figure 4-11**, and **Figure 4-12** show the results of the 2027 flow applied to the system with the improvements. **Figure 4-11** and **Figure 4-12** show some surcharging and overflows in the gravity lines, even with system improvements. The model has not been calibrated with flow monitoring so I&I and peak flow rates were assumed across the system. With the assumptions, the model may not truly represent how the system would react in the storm events so improvements were not identified to fix every modeled surcharge and overflow across the system in the wet weather scenarios. Localized areas may still experience surcharges and overflows in storm events after improvements have been made.

Major Wastewater Projects	
WW-1	North 2nd LS Expansion to 3,500 gpm (Firm Capacity)
WW-2	River's Edge South LS Rehabilitation to 840 gpm (Firm Capacity) and Force Main Re-Route
WW-4	Greenwood LS Replacement
WW-5	Post Office LS Replacement
WW-10	Dell Webb LS Expansion to 2,300 gpm (Firm Capacity)
WW-12	Brazos River LS Rehabilitation and Force Main Reversal
WW-13	FM 359 LS Expansion to 4,350 gpm (Firm Capacity)
WW-14	New 0.75 MGD East WWTP
WW-15	East WWTP Expansion to 1.5 MGD
WW-16	Regional WWTP Rehabilitation
WW-17	Regional WWTP Chlorine Contact Basin Expansion
WW-18	Regional WWTP Sludge Improvements
WW-19	Regional WWTP Capacity Expansion to 4.5 MGD
WW-20	WWTP Trunklines
WW-21	North 2nd Trunkline and Extension
WW-22	North 2nd Central GSA Gravity Line Replacements
WW-23	WWTP North GSA Gravity Line Replacements
WW-24	FBCMUD 181 and 207 Graviy Line Replacements and Extension
WW-25	North 7th Elimination and Gravity Line Connection
WW-26	Dompier LS and Force Main to East WWTP

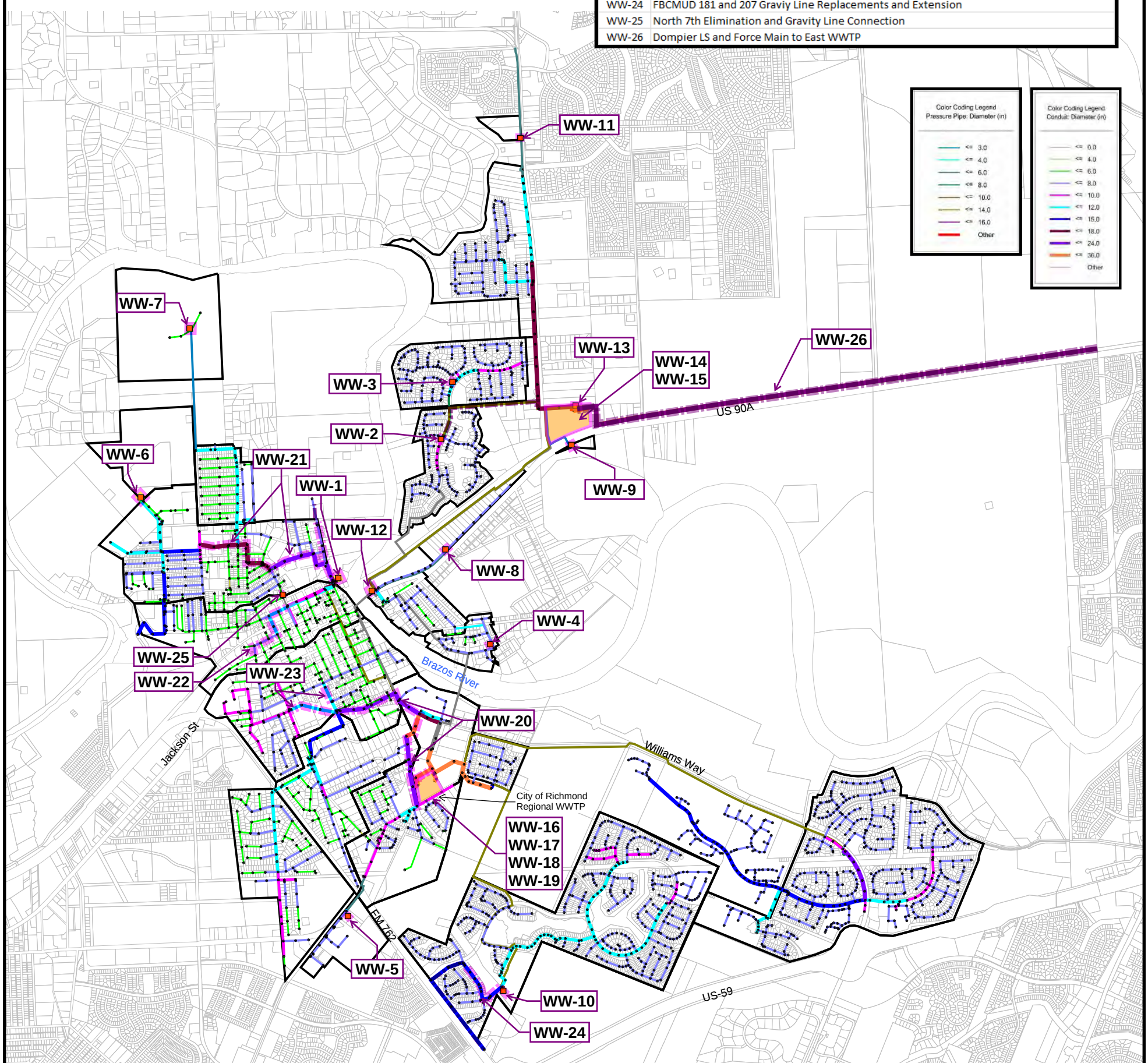

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Figure 4-9
2027 Sanitary Sewer Improvement Project Locations

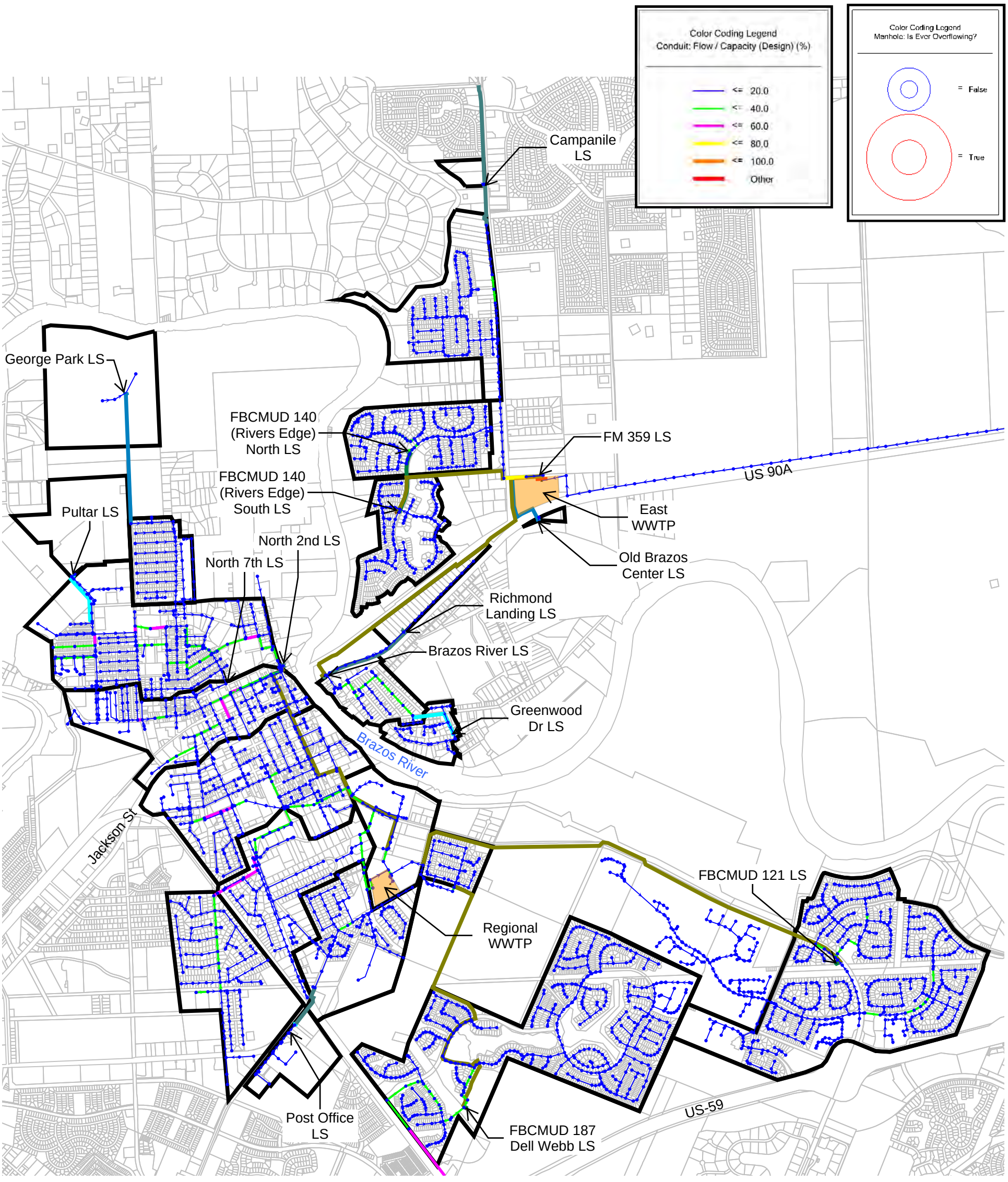

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Figure 4-10
Gravity System Capacity Analysis
Future with Improvements (2027)
Average Day Condition

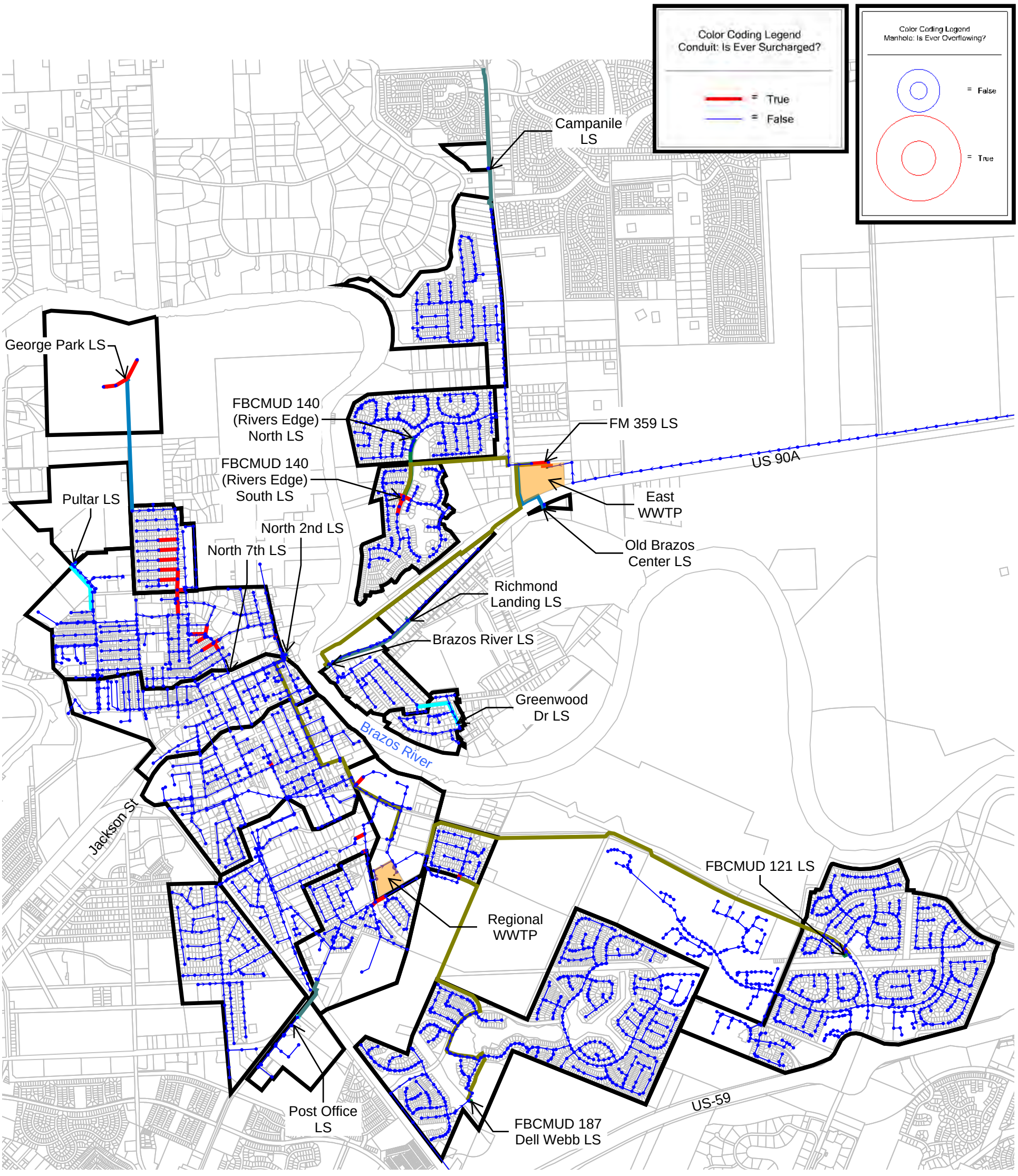

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Figure 4-11
Gravity System Capacity Analysis
Future with Improvements (2027)
2 Year 24 Hour Storm

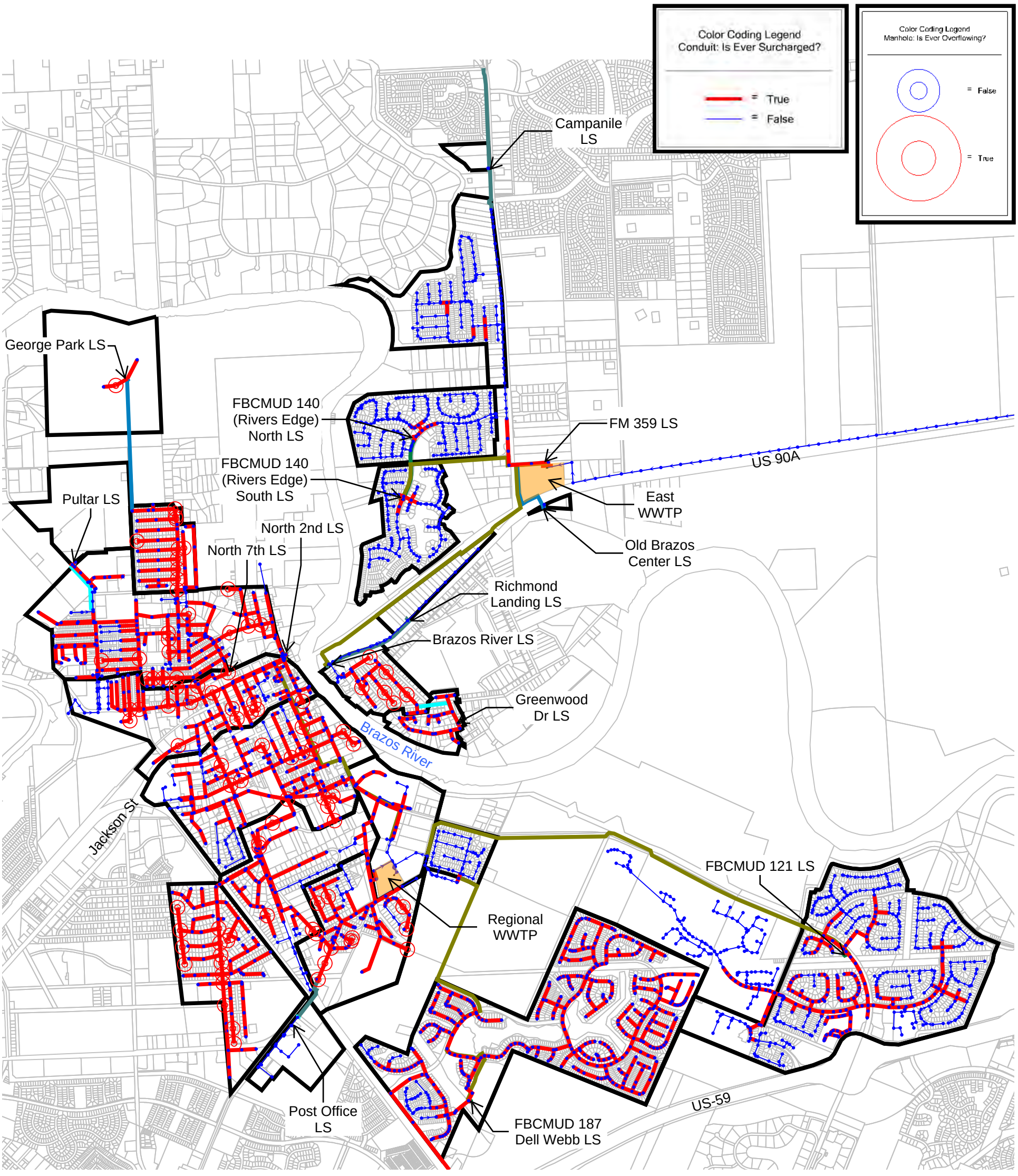

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Figure 4-12
Gravity System Capacity Analysis
Future with Improvements (2027)
100 Year 2 Hour Storm

4.5. Condition Assessment Summary

4.5.1. Lift Station Condition Assessment

During site visits conducted in August 2017, each LS within the City's wastewater system was inspected. Each LS was evaluated on the condition of their site, safety, pumps, piping, wet well, electrical and chemical equipment, and an on-site building if applicable. The LSs were given a ranking from 1 to 5 in each of the different categories, with a score of 5 meaning no work needs to be done. The lower the total score, the more work is required for the LS. Condition scores ranged from 26% requiring the most work to 89% requiring the least amount of work. The Greenwood, Post Office and North 7th LSs require the most improvements. The newest LSs, Campanile, Rivers Edge North and Rivers Edge South, all scored the highest and currently require the least amount of rehabilitation. A summary of the condition scores is located in **Appendix C**.

4.5.2.Richmond Regional Wastewater Treatment Plant Condition Assessment

An inspection of the Regional WWTP was performed in August, 2017. Photos from the inspection are shown in **Appendix C**.

The *Wastewater Treatment Plant Evaluation (2017)* condition assessment report found that improvements are needed throughout the facility.

Although the WWTP is currently experiencing flows of about 1.5 MGD, the chemical and biological strength of the influent is greater than the plant's original design basis. Stronger concentrations of influent water are due to low flow fixtures installed in customers' homes and businesses (i.e. toilets, washing machines, etc.). Current WWTP flows have Carbonaceous Biochemical Oxygen Demand (CBOD5), Total suspended solids (TSS), and ammonia concentrations of 217 mg/L, 163 mg/L, and 30 mg/L, respectively. Allowing one standard deviation to represent the variability of wastewater quality, the plant is experiencing concentrations of these constituents of 309 mg/L, 247 mg/L, and 38 mg/L, respectively. Plants built in the time of the Regional WWTP were not designed to treat concentrations that high. Plants were designed to treat concentrations of CBOD5 and TSS constituents of 200 mg/L and 200 mg/L, respectively, much lower than the concentrations the plant is currently experiencing, with little or no allowance for ammonia. The WWTP's current organic treatment capacity is estimated to be approximately 2.5 MGD, compared to the permitted and design flow of 3.0 MGD. This loss of treatment capacity needs to be made up as part of the WWTP's proposed expansion projects for growth.

The Regional WWTP has experienced multiple permit violations related to disinfection. The existing chlorine contact basins are poorly baffled which results in poor diffusion of chlorine into the flow. These shortfalls can be addressed as part of an expansion of the basins to meet the growth in flows. However, they need to be addressed in the near term to avoid additional violations.

The Regional WWTP should be expanded to a capacity of 4.5 MGD to meet the 2027 west system flows. This capacity matches the current Interim Phase 2 permit capacity of 4.5 MGD. The Regional WWTP does

not have to be expanded to the current ultimate permit phase of 6.0 MGD, based on the 2027 projections outlined in this report, if an additional WWTP is built on the east of Brazos River.

New facilities at the Regional WWTP would include:

- Preliminary screening or maceration equipment at the on-site lift station
- New headworks with fine mechanical screens and flow splitting control to replace the existing screens
- 1.5 MGD aeration basins with fine-bubble diffusers, secondary clarifiers, recycle and waste sludge pumps, and centrifugal blowers
- Expansion of the existing chlorine contact basin, with baffling improvements in the existing cells and new mechanical mixers for chlorine diffusion
- Increasing digester volume with in-basin membrane thickening equipment, and addition of dedicated digester blowers
- Expansion of the belt press building to include a second belt press, redundant sludge feed pumps, replacement polymer equipment, and re-configuration of the conveyors and sludge loading system
- Upgrade electrical service and distribution gear, and a second diesel generator with paralleling functionality
- Replacement of aging existing clarifier mechanism, blowers, aeration diffusers at Basins 3 and 4

The priority of these improvements is recommended to be:

- Highest priority – Disinfection and sludge improvements
- Medium priority – Existing equipment rehabilitation or replacement
- Low priority – Based on growth, organic capacity expansion in conjunction with additional flow capacity, screening improvements, electrical system improvements

4.5.3. List of Rehabilitation Projects

Rehabilitation projects were identified for LSs based on results from the condition assessment. The following projects are for LSs that do not require firm capacity to be expanded.

Project WW-2: River's Edge South LS Rehabilitation to 840 gpm (Firm Capacity) and Force Main Re-Route ($1,338,000)

This project includes the rehabilitation of the River's Edge South LS to restore the original design pumping capacity of 840 gpm. The existing lift station firm capacity was tested to be 542 gpm. The project also includes a new force main that ties into the existing 18-inch gravity sewer along FM 359 in order to route flows to the proposed East WWTP. The LS scored an 80% on the condition assessment and requires some minor work to restore to like new condition. The rehabilitation portion of the project will be funded by FBCMUD 140 ($621,000) while the force main will be funded by the City's wastewater fund ($1,338,00). The LS rehabilitation driver is aging infrastructure while the force main re-route driver is growth and redundancy. Construction of the force main re-route should be completed shortly after the construction

of the East WWTP is completed. The lift station diversion will be used to postpone expanding the Regional WWTP.

Project WW-3: River's Edge North LS Rehabilitation to 670 gpm (Firm Capacity) ($491,000)

This project includes the rehabilitation of the River's Edge North LS to restore the original design pumping capacity of 670 gpm. The recommended expansion is sized to pump existing and projected peak dry and wet weather flows, as projected by the wastewater model analysis. The LS scored an 83% on the condition assessment and requires some minor work to restore to like new condition. This project will be funded by FBCMUD 140. The LS rehabilitation project driver is aging infrastructure and the project is routine maintenance that does not have a specific trigger.

Project WW-4: Greenwood LS Replacement ($1,807,000)

This project includes the relocation and replacement of the existing Greenwood LS to a 250 gpm LS. The existing LS is in poor condition and is the site prone to flooding. The project would decommission the existing LS, build a new LS across and further north along Greenwood Drive, and include force main and gravity improvements. Cost for the project includes a budgeted cost for land acquisition which can vary. This project is anticipated to be primarily FEMA funded. Approximately 25% of the project cost will be from City wastewater fund. The project driver is flood prone aging infrastructure. The project does not have a specific trigger but is replacing a potentially problematic facility.

Project WW-5: Post Office LS Rehabilitation ($705,000)

This project includes the rehabilitation of the Post Office LS with a new firm capacity of 125 gpm. The existing LS is located very close to the highway, is in poor condition and requires major site improvements. The project would include new pumps, rehabilitation of the wet well and piping, electrical, site work and odor control. The Post Office LS scored second worst in the condition assessment inspections and requires rehabilitation work in the near future. The LS rehabilitation project driver is aging facilities and the project is routine maintenance that does not have a specific trigger.

Projects WW-6, WW-7, WW-8, WW-9, and WW-11: LS Rehabilitation ($529,000 Total)

These projects include rehabilitation of the Pultar LS, George Park LS, Richmond Landing LS, Old Brazos Center LS, Del Webb LS, and Campanile LS. These LSs conditions scores ranged 63% - 89% and required mostly minor rehabilitation with a few exceptions. The LS rehabilitation projects drivers are aging infrastructure and the projects are routine maintenance that do not have specific triggers.

Project WW-16: Regional WWTP Rehabilitation ($3,026,000)

This project includes the rehabilitation of the Regional WWTP based on the recommendations from the *Wastewater Treatment Plant Evaluation (2017) report*. The lift station and motor control center rehabilitation that are currently being designed. The remaining improvements will be implemented in future projects.

Project WW-17: Regional WWTP Chlorine Contact Basin Expansion ($3,138,000)

This project includes expanding the chlorine contact basin, baffling improvements in the existing cells, and

new mechanical mixers for chlorine diffusion. The project drivers and triggers are addressing TCEQ violation issues and improving operations.

Project WW-18: Regional WWTP Sludge Improvements ($9,402,000)

This project includes in-basin membrane thickening equipment, addition of dedicated blowers, expansion of the belt press building to include a second belt press, redundant sludge feed pumps, replacement polymer equipment and re-configuration of the conveyors and sludge loading system. The project drivers and triggers are replacing aging infrastructure, improving operations and adding redundancy.

Project WW-27: Flow Monitoring ($222,000)

This project includes setting up flow monitors within the system, monitoring the system over a period of 90 days, and a comprehensive report. The flow monitoring should be used to better establish peak flows within system, identify potential locations of I&I, determine locations of future collection system rehabilitation projects. Flow monitoring can also be used to recalibrate the wastewater model in the future. The project driver is determining problematic areas within the collection system and setting up collection system rehabilitation projects. The project is routine maintenance that does not have a specific trigger.

Projects WW-28 – WW-32: Collection System Rehabilitation ($4,734,000 total)

These projects are for ongoing rehabilitation within the gravity collection system. The projects can include manhole rehabilitation, smoke testing, cleaning and televising, point repairs, cast in place pipe (CIPP), sliplining or pipe bursting. Scope, locations and limits of the projects are at the City's discretion and can be determined through a flow monitoring study. The projects drivers are aging infrastructure and reducing wet weather peak flows at the lift stations and WWTPs. The projects are routine maintenance that do not have specific triggers.

4.6. Wastewater System Capital Improvement Plan

4.6.1. Cost Assumptions

The cost estimates are a Class 5 Opinion of Probable Cost for Construction (OPCC). Class 5 estimates are approximate for feasibility and budgeting purposes. Each OPCC has 30% for contingency, approximately 5% for mobilization and demobilization, and 13% for permits, bonds, and insurance. There is also an additional 15% for contractor overhead and profit and 15% for engineering, surveying, and construction service. All project costs are initially presented in 2018 dollars and do not include inflation.

4.6.2. 5-year CIP

Project WW-1: North 2nd Lift Station Expansion to 3,500 gpm (Firm Capacity) ($4,522,000)

This project includes the expansion of the North 2nd LS to a firm capacity of 3,500 gpm from 2,036 gpm (based on well draw down test). The existing LS is currently at capacity, and the recommended expansion is sized to alleviate lack of capacity to convey existing peak dry and wet weather wastewater flows, as evidenced and projected by the wastewater model analysis. Expansion of this lift station includes adding

a new wet well and pumps for wet weather wastewater flows and future flows. This expansion will have limited impact to the station's footprint within the old wastewater treatment plant property, and a majority of the City-owned property surrounding the lift station can be made available for re-development, if the City seems it beneficial. The project driver is expanding to handle wet weather flows and also accommodate growth within the service area.

Project WW-10: Del Webb Lift Station Expansion to 2,300 gpm (Firm Capacity) ($669,000)

This project includes the expansion of the Del Webb LS to a firm capacity of 2,300 gpm from approximately 1,160 gpm (based on well draw down test). The recommended expansion is sized to convey the projected 2027 peak wastewater flows from the existing Del Webb GSA and the future FBCMUD 207 flows. This project will be developer-funded. The project driver is growth within FBCMUD 207 and the triggers are 2-hour peak flow of 1163 gpm or having approximately 1,800 connections between the two districts.

Project WW-12: Brazos River Lift Station Rehabilitation and Force Main Reversal ($1,934,000)

This project includes the rehabilitation of the Brazos River LS, and FM 359 LS force main reversal to pump towards the FM 359 LS and the proposed East WWTP (Project WW-15). The existing 12-inch force main will be able to adequately convey existing and projected flows. While the Brazos River LS service area is projected to grow, flow to the LS will decrease by removing FBCMUD 140 from the service area. The project should occur after the East WWTP construction has been completed. The project can be used to defer expansion at the Regional WWTP as growth continues and the WWTP receives increased flows. A project trigger is when the Regional WWTP has a 3-month average daily flow of 2.25 MGD after the East WWTP has been constructed and the River's Edge diversion has been completed.

Project WW-14: New 0.75 MGD East WWTP ($8,160,000)

This project includes permitting, design and construction of a new 0.75 MGD WWTP northeast of the FM 359 and US-90A intersection. This phase of the WWTP can handle all existing and projected flows from the City's existing service areas through 2027. The FM 359 LS rehabilitation is included as part of this project. Cost includes land acquisition. Project should begin permitting and design when the Regional WWTP has a 3-month average daily flow of 2.25 MGD, projected for 2019 to have an operational plant by 2021/2022.

Project WW-20: WWTP Trunklines ($3,289,000)

This project includes the construction of replacement gravity sewer trunklines going to the Regional WWTP. Approximately 3,200 LF of existing 15-inch is to be replaced with 21-inch along Rabbs Bayou and Richmond Parkway / Williams Way and southwest of the WWTP. Approximately 1,400 LF of existing 18-inch is to be replaced with 21-inch along Richmond Parkway / Williams Way north of the WWTP. Additionally, 1,700 LF of existing 18-inch is to be replaced with 27-inch southwest of Richmond Parkway / Williams Way, north of the WWTP. The recommended lines are sized to add capacity to convey peak dry and wet weather wastewater flows, as described in **Section 4.3.3**. Additionally, the lines are sized to serve future growth south and southwest of Downtown. The gravity lines are currently modeled to surcharge during peak flows and should be upsized soon to prevent surcharges and overflows. See **Figure 4-9** for the

project limits.

Project WW-21: North 2nd Trunkline and Extension ($2,604,000)

This project includes the construction of replacement trunklines going towards the North 2nd LS and a gravity line extension to serve a future development. Approximately 2,500 LF of existing 15-inch is to be replaced with 18-inch in the North 2nd Central GSA around N 10th St and Jerry St. Approximately 2,600 LF of existing 18-inch is to be replaced with 21-inch north of the North 2nd LS. Additionally, 800 LF of 4-inch is to be replaced with 8-inch along North 2nd St, and the extension of 800 LF of 8-inch gravity lines. The recommended trunklines are sized to add capacity to convey peak wet weather wastewater flows, as described in **Section 4.3.3**. Additionally, the lines are sized to serve future growth north of downtown and in FBCMUD 19. The gravity lines are currently modeled to surcharge during wet weather events. The project does not have a specific trigger but should be completed to eliminate surcharges and prevent overflows. See **Figure 4-9** for the project limits.

Project WW-23: WWTP North Gravity Service Area Gravity Line Replacements ($1,379,000)

This project includes the replacement of approximately 2,000 LF of existing 10-inch gravity lines with 12-inch in the WWTP Central GSA. The recommended lines are sized to serve future developments in south and southwest downtown and to convey peak wet weather wastewater flows in the WWTP North GSA. The gravity lines are currently modeled to surcharge during wet weather events. The project does not have a specific trigger but should be completed to eliminate surcharges and prevent overflows. See **Figure 4-9** for the project limits.

Project WW-24: FBCMUD 187 and 207 Gravity Line Replacements and Extension ($1,990,000)

This project includes the replacement of approximately 1,800 LF of existing 8-inch with 15-inch gravity sanitary sewer in the Del Webb GSA and the extension of 3,400 LF of 15-inch to FBCMUD 207. The recommended lines are sized to serve future development in FBCMUD 2017, south of FBCMUD 187, and convey projected peak wet weather wastewater flows, as projected by the wastewater model analysis. The project should be completed prior to receiving flows from FBCMUD 207. See **Figure 4-9** for the project limits.

Project WW-25: North 7th Lift Station Elimination and Gravity Line Connection ($301,000)

This project includes building a by-pass gravity sewer to eliminate the need for the North 7th LS. The existing North 7th LS is in poor condition and serves a small gravity service area. The project entails decommission and demolition of the North 7th LS as well as the construction of a 6-inch gravity line to connect the existing 6-inch influent line to a manhole along Fields Street. The project cost does not include easement acquisition. The project driver is to reduce City operations and maintenance costs and does not have a specific trigger.

The 5-year CIP projects for the City's wastewater system are summarized in **Table 4-5**.

Table 4-5. 5-Year CIP Projects List

Project Type	Project No.	Project Description	Project Driver	Fund	Total Project Cost (2018 $)	Escalated Cost[1]
Lift Station Rehabilitation and Expansion	WW-1	North 2nd LS Expansion to 3,500 gpm (Firm Capacity)	Growth	WW	$4,227,000	$4,522,000
	WW-2	River's Edge South Force Main Re-route		WW	$1,194,000	$1,338,000
		River's Edge South LS Rehabilitation		EXT	$554,000	$621,000
	WW-3	River's Edge North LS Rehabilitation	Aging Infrastructure / Reliability / Resilience	EXT	$425,000	$491,000
	WW-4	Greenwood LS Replacement		WW	$1,661,500	$1,807,000
	WW-5	Post Office LS Rehabilitation		WW	$629,000	$705,000
	WW-10	Del Webb LS Expansion to 2,300 gpm (Firm Capacity)	Growth	EXT	$579,000	$669,000
	WW-12	Brazos River LS Rehabilitation and Force Main Reversal	Aging Infrastructure / Reliability / Resilience	WW	$1,675,000	$1,934,000
WWTP Expansion	WW-14	New 0.75 MGD East WWTP	Growth; Redundancy	WW	$7,604,000	$8,160,000
	WW-16	Regional WWTP Rehabilitation	Aging Infrastructure / Reliability / Resilience	WW	$2,700,000	$3,026,000
	WW-17	Regional WWTP Chlorine Contact Basin Expansion		WW	$2,800,000	$3,138,000
	WW-18	Regional WWTP Sludge Improvements		WW	$8,146,000	$9,402,000
Collection System Expansion	WW-20	WWTP Trunklines	Growth	WW	$2,984,840	$3,289,000
	WW-21	North 2nd Trunkline and Extension		WW	$2,323,880	$2,604,000
	WW-23	WWTP North GSA Gravity Line Replacements		WW	$1,194,910	$1,379,000
	WW-24	FBCMUD 181 and 207 Gravity Line Replacements and Extension		WW	$1,829,560	$1,990,000
	WW-25	North 7th LS Elimination and Gravity Line Connection	Aging Infrastructure / Reliability / Resilience	EXT	$284,970	$301,000
Collection System Rehab.	WW-27	Flow Monitoring		WW	$200,000	$222,000
				Total EXT (e.g., MUD, FEMA-funded) Projects	**$3,088,970**	**$3,438,000**
				Total WW Fund Projects	**$38,723,690**	**$42,585,000**

Note 1. Costs escalated for inflation to the midpoint of implementation timelines.

4.6.3. 10-year CIP

Project WW-13: FM 359 Lift Station Expansion to 4,350 gpm (Firm Capacity) ($4,868,000)

This project includes the expansion of the FM 359 LS to a firm capacity of 4,350 gpm from approximately 1,450 gpm (based on well draw down test). The recommended LS expansion will serve the growth within the proposed East WWTP's service area, serve as the influent LS for the East WWTP, and address the condition related issues found in the LS condition assessment. The project trigger is development of the tracts east of Brazos River.

Project WW-15: East WWTP Expansion to 1.5 MGD ($19,161,000)

This project includes the expansion of the East WWTP from 0.75 MGD to 1.5 MGD (East WWTP Phase II). This project trigger is to serve the developments of parcels that are east of Brazos River as they are developed. The plant is sized to serve projected growth through 2027. The City should monitor flows closely at the East WWTP to determine if further treatment capacity is needed as the parcels east of Brazos River are developed.

Project WW-19: Regional WWTP Capacity Expansion to 4.5 MGD ($15,941,00)

This project includes the expansion of the Regional WWTP from 3.0 MGD to 4.5 MGD. The plant is sized to serve projected growth through 2027. The project trigger is when the Regional WWTP has a 3 month daily average flow of 2.25 MGD or above after the East WWTP has been constructed and the River's Edge LS has been diverted. The City should monitor closely the flows at the Regional WWTP as growth continues within the City's ETJ and flow is being diverted to the East WWTP.

Project WW-22: North 2nd Central GSA Gravity Line Replacements ($948,000)

This project includes the replacement of approximately 1,100 LF of existing 8-inch around Preston St and S 8th St with 12-inch and 1,000 LF of existing 6-inch along Morton St with 8-inch in the North 2nd South GSA. The lines are sized to serve future growth north of downtown and to convey projected peak wet weather wastewater flows, as projected by the wastewater model analysis. The gravity lines are currently modeled to surcharge during wet weather events. The project does not have a specific trigger but should be completed to eliminate surcharges and prevent overflows. See **Figure 4-9** for the project limits.

Project WW-26: East of Brazos River Lift Station and Force Main to East WWTP ($10,150,000)

This project includes the construction of a 2,200 gpm firm capacity LS and force main to serve the parcels east of the river. The east of Brazos River parcels will send flows into the FM 359 LS. The 16-inch force main is approximately 17,400 LF along US-90A with crossings of the railroad track the project should be completed prior to east of Brazos River development. The project trigger is development of the tracts east of Brazos River.

The 10-year CIP projects for the City's wastewater system are summarized in **Table 4-6**.

Table 4-6. 10-Year CIP Projects List

Project Type	Project No.	Project Description	Project Drive	Fund	Total Project Cost (2018 $)	Escalated Cost[1]
Lift Station Rehabilitation	WW-6	Pultar LS Rehabilitation	Aging Infrastructure / Reliability / Resilience	WW	$95,000	$128,000
	WW-7	George Park LS Rehabilitation			$60,000	$81,000
	WW-8	Richmond Landing LS Rehabilitation			$125,000	$158,000
	WW-9	Old Brazos Center LS Rehabilitation			$60,000	$81,000
	WW-11	Campanile LS Rehabilitation			$60,000	$81,000
WWTP Expansion	WW-13	FM 359 LS Expansion to 4,350 gpm (Firm Capacity)	Growth		$3,860,000	$4,868,000
	WW-15	East WWTP Expansion to 1.5 MGD	Growth; Redundancy		$15,000,000	$19,161,000
	WW-19	Regional WWTP Capacity Expansion to 4.5 MGD	Growth		$13,637,000	$15,941,000
Collection System Expansion	WW-22	North 2nd Central GSA Gravity Line Replacements			$773,540	$948,000
	WW-26	East of Brazos River LS and Force Main to East WWTP			$8,047,000	$10,150,000
Collection System Rehab.	WW-28	Collection System Rehabilitation	Aging Infrastructure / Reliability / Resilience		$750,000	$891,000
	WW-29	Collection System Rehabilitation			$750,000	$918,000
	WW-30	Collection System Rehabilitation			$750,000	$946,000
	WW-31	Collection System Rehabilitation			$750,000	$975,000
	WW-32	Collection System Rehabilitation			$750,000	$1,004,000
				Total WW Fund Projects	**$45,467,540**	**$56,331,000**

Note 1. Costs escalated for inflation to the midpoint of implementation timelines.

A tentative implementation timeline for both the 5-year CIP and 10-year CIP projects is presented in **Table 4-7**. This timeline presents anticipated timeline and escalated costs for each project in the proposed CIP. A complete CIP project table combining the 5-year and 10-year CIP projects is presented in **Appendix B**, along with cost opinions for each CIP project.

4.7. Recommendations

The City's wastewater service area is expanding rapidly to serve approximately 3 times more flow in the next 10 years. The City should purchase property for the proposed East WWTP, begin a new TPDES permit application and begin design for the 0.75 MGD phase in 2019. This will help defer expanding the Regional WWTP as the City's service area continues to grow. The City should also purchase property for the Greenwood LS and Post Office LS replacements. The North 7th LS elimination with gravity sewer could also be designed and constructed. Flow monitoring should be conducted to properly determine flow rates by GSA, I&I and peak flows within the system. Flow projections and timing of the growth of parcels east of Brazos River should continue to be re-assessed annually to determine timing of the East WWTP phasing. Projects slated for 2019, including the N 2nd LS Expansion and Post Office LS Replacement, should be prioritized.

Table 4-7. Wastewater System CIP Implementation Timeline

Project Type	Project Number	Project Description	Project Duration	Total Project Cost	Estimated Project Cost – Fiscal Year 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Lift Station Rehabilitation	WW-1	North 2nd: Expansion to 3,500 gpm Firm Capacity	3-Year	$4,522,000	$653,000	$1,906,000	$1,963,000							
	WW-2	River's Edge South: Force Main Re-Route	2-Year	$1,338,000			$196,000	$1,142,000						
		River's Edge South: Rehab to 840 gpm Firm Capacity		$621,000			$91,000	$530,000						
	WW-3	River's Edge North: Rehab to 670 gpm Firm Capacity	2-Year	$491,000				$72,000	$419,000					
	WW-4	Greenwood: Replacement with 250 gpm Firm Capacity Lift Station	2-Year	$1,807,000		$264,000	$1,543,000							
	WW-5	Post Office: Rehabilitation	2-Year	$705,000			$103,000	$602,000						
	WW-6	Pultar: Rehabilitation	2-Year	$128,000									$19,000	$109,000
	WW-7	George Park: Rehabilitation	2-Year	$81,000									$12,000	$69,000
	WW-8	Richmond Landing: Rehabilitation	2-Year	$158,000							$23,000	$135,000		
	WW-9	Old Brazos Center: Rehabilitation	2-Year	$81,000									$12,000	$69,000
	WW-10	Del Webb: Rehabilitation and Expansion to 2,300 gpm	2-Year	$669,000				$98,000	$571,000					
	WW-11	Campanile: Rehabilitation	2-Year	$81,000									$12,000	$69,000
	WW-12	Brazos River: Rehabilitation and Force Main Reversal	2-Year	$1,934,000				$283,000	$1,651,000					
WWTP Expansion	WW-13	FM 359 Lift Station: Expansion to 4,350 gpm Firm Capacity	2-Year	$4,868,000							$712,000	$4,156,000		
	WW-14	New 0.75 MGD East WWTP	4-Year	$8,160,000	$2,284,000	$1,008,000	$4,155,000	$713,000						
	WW-15	East WWTP Expansion to 1.5 MGD	3-Year	$19,161,000							$2,767,000	$8,076,000	$8,318,000	
	WW-16	Regional WWP Rehabilitation	2-Year	$3,026,000			$443,000	$2,583,000						
	WW-17	Regional WWTP Chlorine Contact Basin Expansion	2-Year	$3,138,000			$459,000	$2,679,000						
	WW-18	Regional WWTP Sludge Improvements	2-Year	$9,402,000				$1,375,000	$8,027,000					
	WW-19	Regional WWTP Capacity Expansion to 4.5 MGD	3-Year	$15,941,000				$2,302,000	$6,719,000	$6,920,000				
Collection System Expansion	WW-20	WWTP Trunkline	3-Year	$3,289,000		$475,000	$1,386,000	$1,428,000						
	WW-21	North 2nd Trunkline and Extension	2-Year	$2,604,000			$381,000	$2,223,000						
	WW-22	North 2nd Central Gravity Service Area	2-Year	$948,000						$139,000	$809,000			
	WW-23	WastewaterTreatment Plant - N Gravity Service Area	2-Year	$1,379,000				$202,000	$1,177,000					
	WW-24	FBCMUD 207	2-Year	$1,990,000		$291,000	$1,699,000							
	WW-25	North 7th Lift Station Force Main Replacement	2-Year	$301,000	$44,000	$257,000								
	WW-26	East of Brazos Lift Station & Force Main to East WWTP	2-Year	$10,150,000							$1,485,000	$8,665,000		
Collection System Rehabilitation	WW-27	Flow Monitoring	2-Year	$222,000			$109,000	$113,000						
	WW-28	Collection System Rehabilitation	2-Year	$891,000					$130,000	$761,000				
	WW-29	Collection System Rehabilitation	2-Year	$918,000						$134,000	$784,000			
	WW-30	Collection System Rehabilitation	2-Year	$946,000							$138,000	$808,000		
	WW-31	Collection System Rehabilitation	2-Year	$975,000								$143,000	$832,000	
	WW-32	Collection System Rehabilitation	2-Year	$1,004,000									$147,000	$857,000
		CITY's Wastewater Project Costs		$99,847,000	$2,937,000	$3,944,000	$12,437,000	$15,645,000	$17,704,000	$7,954,000	$6,718,000	$21,983,000	$9,352,000	$1,173,000

Acronyms

WW	Wastewater	EXT	External funding (grant funding)	gpm	gallons per minute	MUD	Municipal Utility District	WWTP	Wastewater Treatment Plant
RW	Reclaimed Water	FBCMUD	Fort Bend County Municipal Utility District	MGD	million gallons per day	TCEQ	Texas Commission on Environmental Quality		

KEY

External funding (WW-2, WW-3, WW-10, WW-25) excluded from totals
East of Brazos Development Projects - W-15, W-18, WW-13, WW-15, WW-26

5. Reclaimed Water Master Plan

This section provides information related to the development of the reclaimed water master plan, including projected reclaimed water demands and proposed CIP projects.

5.1. Existing System Overview

The City owns and operates a reclaimed water system at its Regional WWTP. The reclaimed water system provides treated non-potable water for amenity lake filling and irrigation to two customers, the Del Webb community and the Fort Bend Country Club. The existing reclaimed water system treatment train consists of a cloth filtration system that filters treated WWTP effluent to produce highly-purified TCEQ Type 1 reclaimed water that is suitable for uses in which human contact is possible. Following filtration, booster pumps deliver the reclaimed water to customer take-points. The reclaimed water distribution system operates in an "on-demand" basis wherein system operation is based on customer demands. Specifically, the system has pressure set-points that dictate equipment startup and shutdown. The existing system has no storage facilities, with the result that the system capacity is limited by the booster pump capacity. Existing reclaimed water system pipelines are shown in **Figure 5-1**.

5.2. Reclaimed Water Users and Demands

Several data sources were assessed to identify potential future reclaimed water users and projected reclaimed water demands. A majority of the projected demands were derived from the City billing data. These data were analyzed using two different methods to ensure that a complete list of potential future reclaimed water customers was developed. The first approach, the "minimum-month" method, assumed that each customer's minimum monthly water usage represented indoor demands and subtracted this usage off of the consumption data for other months. The remaining consumption was assumed to represent outdoor usage that could potentially be met with reclaimed supplies. The second approach considered only consumption for specific rate classes: commercial irrigation, irrigation system, and cooling towers. There data were assumed to consist entirely of outdoor or industrial uses that could potentially be met with reclaimed supplies. The projected flows derived from the irrigation and cooling tower customer accounts were generally substantially higher than those calculated from the minimum month method and were considered to more accurately capture potential reclaimed water demands, and these values were used in subsequent calculations. For one customer, Veranda Trails, projected demands were provided by the MUD 215 District Engineer. Projected demands for the Henderson-Wessendorff Foundation were calculated based on information obtained from the customer (anticipated amenity lake based on size of) and historical evaporation and precipitation data.

The locations of existing reclaimed water users and top potential reclaimed water customers, based on data analysis results, are shown in **Figure 5-1.** Prospective reclaimed water customers and projected reclaimed water demands are listed in **Table 5-1**. The City has a non-potable water system at the Regional WWTP that supplies flows for equipment washdown. Although these flows are included in reclaimed

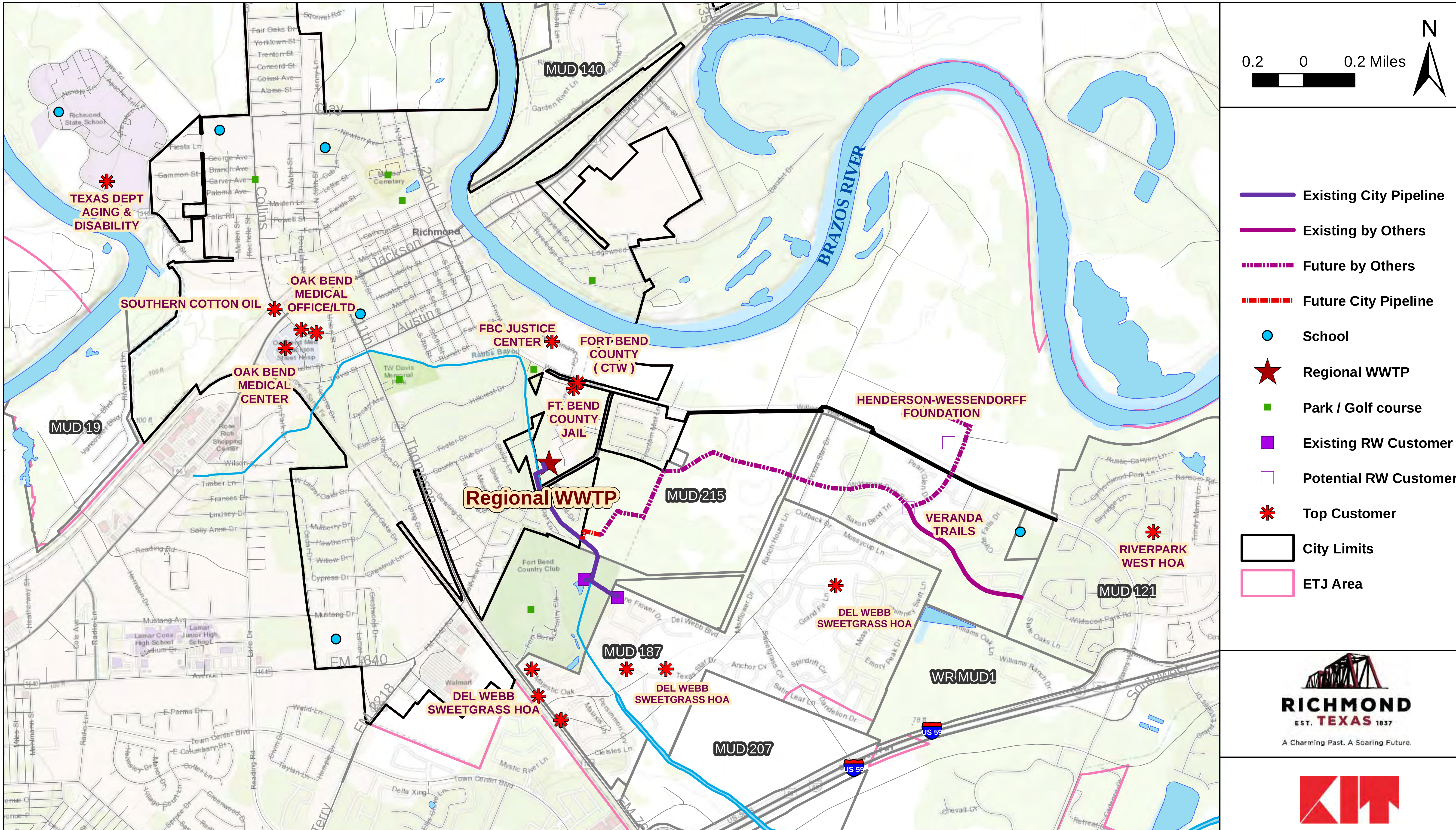


Figure 5-1

Existing and Potential Reclaimed Water Customers

water projections for GRP purposes, this system is separate from the City's reclaimed water system (co-located at the Regional WWTP), and these flows are therefore omitted from subsequent tables.

Table 5-1. Prospective Reclaimed Water Customers and Projected Demands

Prospective Reclaimed Water Customers	Annual Average Reclaimed Water Demand (gpd)	Maximum Monthly Reclaimed Water Demand (gpd)	Data Source
Veranda Trails	387,800	613,800	1
Existing Del Webb Reclaimed Water	84,700	362,800	2
Del Webb Sweet Grass HOA	16,700	127,200	2
FBC Justice Center	13,900	31,500	2
Fort Bend (CTW)	8,600	36,700	2
Fort Bend County Jail	1,200	3,000	2
Oak Bend Medical Center	18,600	37,900	2
Oak Bend Medical Office/Ltd.	4,000	12,700	2
Southern Cotton Oil	35,100	70,900	2
Henderson Wessendorff	5,200	35,600	3
TOTAL	**575,800**	**1,064,000**	

Data Sources:
1 – FBCMUD 215 District Engineer
2 – City billing data
3 – Calculated based on customer information

A preliminary reclaimed water pipe network was developed to connect the customers in **Table 5-1** with the City's reclaimed water system. Based on the costs for constructing reclaimed water pipelines and the resulting impacts to the projected reclaimed water rate, it was determined that the reclaimed water demands for customers north of the Regional WWTP were insufficient to achieve a reasonable payoff period for the reclaimed water pipelines. Expansion of the City's reclaimed water system was therefore refined to target the more proximal, higher demand customers to the east and south of the Regional WWTP. **Table 5-2** lists existing and future customers for the proposed future reclaimed water system.

Table 5-2. Customers for Proposed Reclaimed Water System

Customers for Proposed Reclaimed Water	Annual Average Reclaimed Water Demand (gpd)	Maximum Monthly Reclaimed Water Demand (gpd)
Veranda Trails	387,800	613,800
Existing Del Webb Reclaimed Water	84,700	362,800
Del Webb Sweet Grass HOA	16,700	127,200
Henderson Wessendorff	5,200	14,400
TOTAL	**494,000**	**1,064,000**

The Fort Bend Country Club was excluded from **Table 5-2**, as demands for this area are included in the projected demands for Veranda Trails.

5.3. Planning Criteria and Assumptions

As mentioned, the City's existing reclaimed water system operates in an "on-demand" basis based on pressures in the reclaimed water distribution piping. However, existing pumping facilities are not sufficient to meet current demands if both existing customers (Del Webb and the Fort Bend Country Club) are taking water simultaneously. However, given that each existing customer has on-site storage in the form of an amenity lake, these customers have flexibility with regards to the timing of reclaimed water flows. However, Del Webb has additional reclaimed water demands beyond their current agreement with the City. These demands are currently being met with potable water, but could be met with reclaimed water if facilities were improved to provide additional supply. Similarly, the incorporation of any additional customers to the system will require improvements to ensure that pressures can be maintained under increased reclaimed water demands.

System sizing calculations were based on the projected demands in **Table 5-2**. A model was developed to determine the resulting reclaimed water yield that could be achieved for these customers under various treatment capacities. In this analysis, it was assumed that peak demands would exceed maximum monthly demands by a factor of two. **Figure 5-2** shows the reclaimed treatment capacity versus projected annual average reclaimed water yield. As can be seen in the figure, approximately 1.75 MGD of treatment is sufficient to meet the projected demands for the customers in **Table 5-2**. Thus, the existing 3-MGD treatment capacity is sufficient to supply existing and proposed future customers, and no additional treatment capacity is required. Further, the system has additional treatment capacity that can be used to supply additional customers in the future.

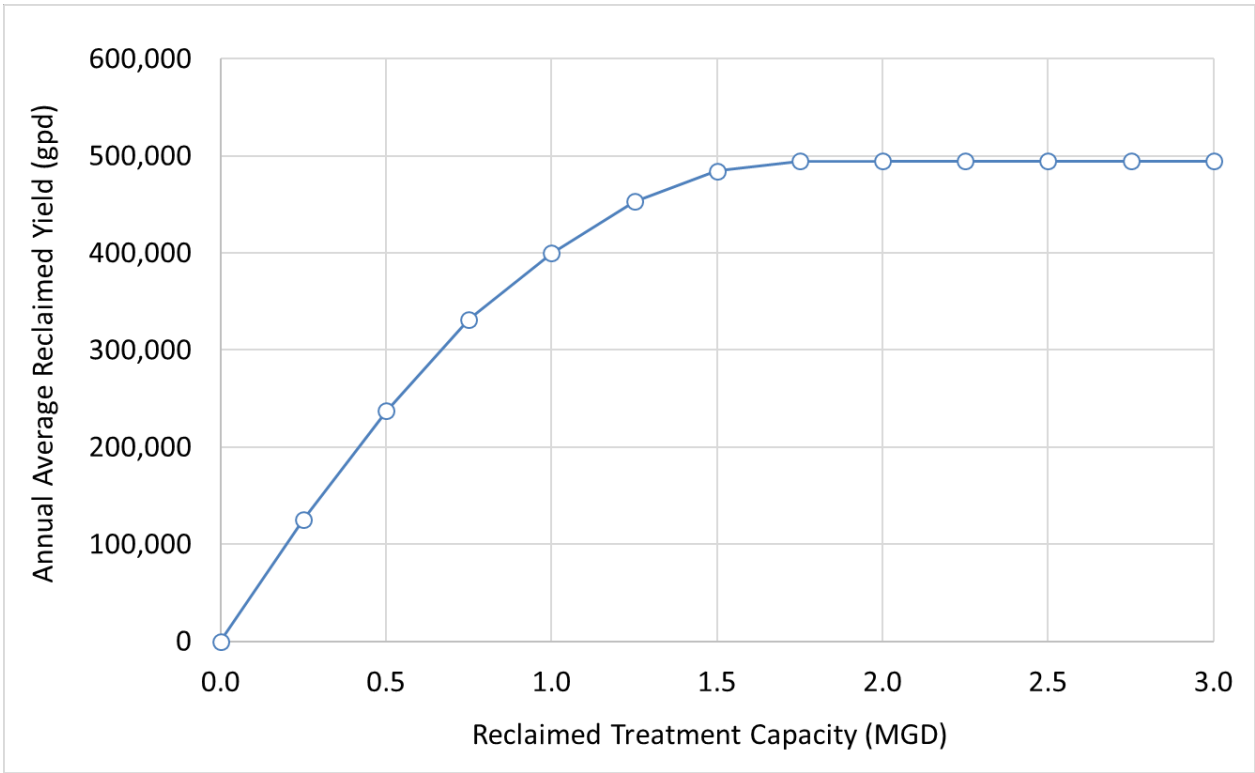


Figure 5-2. Reclaimed Water Treatment Capacity Versus Yield

5.4. Expansion of Reclaimed Water System

The incorporation of Veranda Trails into the City's reclaimed water system requires improvements to the system at the Regional WWTP and approximately 500 feet of reclaimed water piping to convey the water to the customer take-point. The additional demands for Del Webb can be met with improvements at the Regional WWTP and modifications to existing piping. Although the existing piping is adequately sized to convey the projected flows, the open-air discharge point causes distribution system pressure to drop when Del Webb is receiving reclaimed water. Modifications to existing piping to maintain pressure (e.g., pressure-sustaining valve) are required for both the Del Webb and the Fort Bend Country Club take-points). It is assumed that the Henderson-Wessendorff Foundation connection will be made to the Veranda Trails reclaimed pipe network, not to City piping, and would be constructed by the customer. Given the relatively long distance between this potential customer and the Richmond WWTP, coupled with relatively low projected flows, head losses would be too high to efficiently convey reclaimed water directly to this facility. By extending off of the Veranda Trails network, the distance of relatively small-diameter conveyance piping and resulting friction losses are greatly reduced.

To increase reclaimed water production and distribution, it is recommended that the City increase the system's pumping capabilities and construct on-site storage. On-site storage will enable the system to operate even during periods with little to no reclaimed water demand and will provide a reservoir of treated water that can be utilized during peak demand periods (e.g., morning and evening irrigation) when

reclaimed water treatment is insufficient to fully satisfy demands.

A 1.0-MG GST is recommended for reclaimed water storage at the Regional WWTP. This capacity will provide approximately 12 hours of storage under peak flow conditions, allowing adequate reclaimed supply under peak flow conditions.

Additional pumps are recommended for the reclaimed water treatment structure to increase flows. Under future operation, discharges for all pumps at this structure will be delivered to the GST, not the distribution system. A 2.0-MGD pump station is recommended to convey reclaimed water from the GST to customer take-points under peak flow conditions.

5.5. Reclaimed Water System Capital Improvement Plan

5.5.1. Cost Assumptions

Budgetary cost opinions were developed for all of the CIP projects. Budgetary cost opinions are commensurate with the AACE Level 5 estimates. The developed costs rely on comparable feasibility studies or construction costs. When equivalent construction costs are not available, cost is based on cost curves, the Texas Water Development Board (TWDB) Unified Costing Model, professional judgement and other resources.

It is important to note that these high-level cost estimates do not involve any engineering concept development. At this stage of project development, there are still many unknowns, and further investigation is required to develop refined cost estimates for project and capital planning once projects are selected. As such, the costs presented in this document are intended for use with long-range planning purposes. The level of accuracy ranges from the low end of +/- 20 to 50 percent to the upper range of +/- 30 to 100 percent. Capital costs include direct project costs as well as indirect project costs summarized below:

- **Contingency and other project costs –** assumed to be 30 percent of the direct project costs for engineering and feasibility studies, legal assistance, bond counsel, and other contingencies. The contingency allowance also accounts for unforeseen circumstances and for variances in design elements.
- **Permits, bonds and insurance –** assumed to be 13 percent of the direct project costs to account for permitting costs, sales tax, general contractor bonds, builders insurance, and general liability insurance.
- **Mobilization and Demobilization –** assumed to be 5 percent of the direct project costs for mobilization and demobilization of the contractor's equipment and labor to the construction site.
- **Contractor overhead (OH) and profit –** assumed to be 15 percent of the direct project costs to cover contractor overhead costs and allow a fair profit on the project.
- **Engineering and Design –** assumed to be 15 percent of the direct project costs for engineering and design of capital improvement projects.

5.5.2. CIP Projects

Based upon reclaimed water system analysis, including potential customer identification, demand projections, hydraulic calculations, and cost considerations, two capital projects are proposed for the reclaimed water system, as shown in **Table 5-3**. Both of these projects are projected to occur within the next five years to deliver water to future customers including Veranda Trails, which is currently constructing its reclaimed water pipe network.

The first project, RW-1 provides for the construction of an east reclaimed water pipe segment to convey reclaimed water to Veranda Trails and the Henderson-Wessendorff Foundation. Project RW-2 includes improvements to the existing system to increase system yield to accommodate additional customers and increased flows. These improvements include additional facilities (e.g., storage and pumpage) at the Regional WWTP and modifications to existing piping to mitigate pressure losses at existing customer take-points.

Costs for these projects were developed in 2018 U.S. dollars as described in **Section 5.5.1**. Detailed cost opinions are provided in **Appendix B**. Project costs were escalated based on proposed design/construction timelines and a 3%/year inflation rate, consistent with the water and wastewater CIP costs presented in previous sections of this Plan. Given that expansion of the reclaimed water system is being conducted to obtain GRP conversion credits with the FBSD, these projects would be financed out of the City's Surface Water fund. It is noted that the City can explore partnerships with high-volume reclaimed water users to cover a portion of these project costs. Such arrangements may prove to be beneficial for the City and should be considered. However, any such agreements should be evaluated with the financial rate model to ensure that any potential reductions in reclaimed water revenues (e.g., through discounts or credits) are adequately offsite by project funding contributions. This Master Plan conservatively assumes that projects will be funded wholly out of the City's surface water fund.

Table 5-3. Reclaimed Water CIP Projects List

Project Type	Project Number	Projects Description	Fund	Total Project Cost (2018 $)	Escalated Cost
Expansion Projects	RW-1	East Segment	SW	$364,000	$396,000
	RW-2	Richmond Wastewater Treatment Plant – Improvements for Reclaimed Water Supply	SW	$5,505,000	$5,989,000

A tentative implementation timeline for the CIP projects is presented in **Table 5-4**. This timeline presents anticipated timeline and escalated costs for each project. A complete CIP project table combining the water, reclaimed water, and wastewater systems is presented in **Appendix B**.

Table 5-4. Reclaimed Water CIP Implementation Timeline

Project Number	Projects Description	Project Duration	Estimated Project Cost			
			Total Project Cost	Fiscal Year		
				2019	2020	2021
RW - 1	East Segment	2-Year	$396,000	--	$58,000	$338,000
RW - 2	Regional Wastewater Treatment Plant - Improvements for Reclaimed Water Supply	2-Year	$5,989,000	--	$876,000	$5,113,000
Total Reclaimed Water Project Costs			**$6,385,000**	**$0**	**$934,000**	**$5,451,000**

5.6. Reclaimed Water System Recommendations

It is recommended that the proposed reclaimed water projects be implemented prior to the FBSD's increased alternative water mandate in 2025. Although the City's surface water supplies are sufficient to meet current GRP conversion requirements, excess conversion will allow the City to bank conversion credits that can be applied in the future. During preliminary engineering for reclaimed water projects, it is recommended that customer demands be revisited to ensure that projected demands, particularly those for Veranda Trails, are current and accurate. Given that non-potable demands have a higher seasonal variability than indoor demands, it is important to design a system that can meet demands during peak flows and continue to function under relatively low demand (e.g., winter) conditions. An updated accounting of customer demands and peaking factors will ensure that the system is properly sized based on the most current information.

6. Groundwater Reduction Plan

This section provides an overview of GRP compliance and discusses the measures that the City needs to implement.

6.1. Regulatory Requirements

In 2010, the City previously completed a GRP identifying methods to meet the Fort Bend Subsidence District (FBSD) regulatory plan. The GRP has been updated as part of the Master Utility Plan project with revised population projections and water demands. The full updated GRP will be submitted under separate cover.

The City supplies potable water to customers within the City limits, to multiple MUDs, and to other limited areas within the City's ETJ. The City has agreed to partner with 14 other entities (MUD's, Homeowner's Associations, Fort Bend Country Club) to implement a GRP for the aggregated permit that includes twenty-three (23) water wells in accordance with the FBSD 2013 Regulatory Plan.

The City's GRP was last submitted in 2010 and has been revised for submittal to the FBSD for compliance with the FBSD 2013 Regulatory Plan. Richmond is located within the Regulatory Area A and Richmond/Rosenberg Subarea. The Regulatory Plan required that the City submit the GRP for certification prior to the FBSD Aggregated Well Permit renewal in 2010 and that the City utilize an alternative water source, other than groundwater, for 30% of their annual water demand through September 2025. In October of 2025, the City will be required to convert 60% of its alternative sources.

The City has constructed a 2.0-MGD SWTP potable water supplies that was commissioned in March of 2018 to help meet the 30% conversion requirement. In addition to the SWTP, the City constructed a 20-inch water transmission line to convey surface water to the tie-in locations within the distribution system. As the City and the City's GRP participants continue to grow in population, additional conversion will be required to continue to meet the 30% requirement and the 60% requirement beginning in October 2025.

6.2. Existing and Projected Water Demands

6.2.1. GRP Participants

The City GRP Partners include the following entities:

- City of Richmond
- Fort Bend County MUD No. 19 – Riverwood (FB19)
- Fort Bend County MUD No. 121 – RiverPark West (FB121)
- Fort Bend County MUD No. 140 – Rivers Edge (FB140)
- Fort Bend County MUD No. 145 – Rio Vista (FB145)
- Fort Bend County MUD No. 187 – Del Webb (FB187)
- Fort Bend County MUD No. 207 – George Foundation
- Fort Bend County MUD No. 215 – Wessendorff Foundation

- Williams Ranch MUD No. 1 (WRMUD1)
- Fort Bend County MUD No. 116 – Canyon Gate (FB116)*
- Fort Bend County W.C.I.D. No. 3 – Texana (FBW3)*
- Fort Bend County W.C.I.D. No. 8 – Westcreek (FBW8)*
- Lamar Consolidated Independent School District (LCISD)*
- RiverPark West HOA (RPWHOA)*
- Texana HOA (TxHOA)*
- Fort Bend Country Club (FBCC)*

* *Not currently served by the City's water system.*

The locations of the City GRP Partners are shown in **Figure 6-1**. The City is anticipating adding Shadow Grove to the City's water service system as well as development east of the Brazos River. These developments are planned to be added as GRP Partners in the near future.

6.2.2. Existing Water Demands

The potable water demands for the GRP Partners has been estimated based on information provided by each entity. While the City is not obligated to provide water to the GRP Partners, under the terms of the GRP Agreements, the City is obligated to produce adequate alternative source water to meet the FBSD requirements related to groundwater withdrawal for the GRP Partners. **Table 6-1** presents the current population within the City limits, the City's water system service area, and within its GRP.

Table 6-1. Existing Population

Year	City Limits	City Service Area	GRP
2018	12,200	23,930	30,437

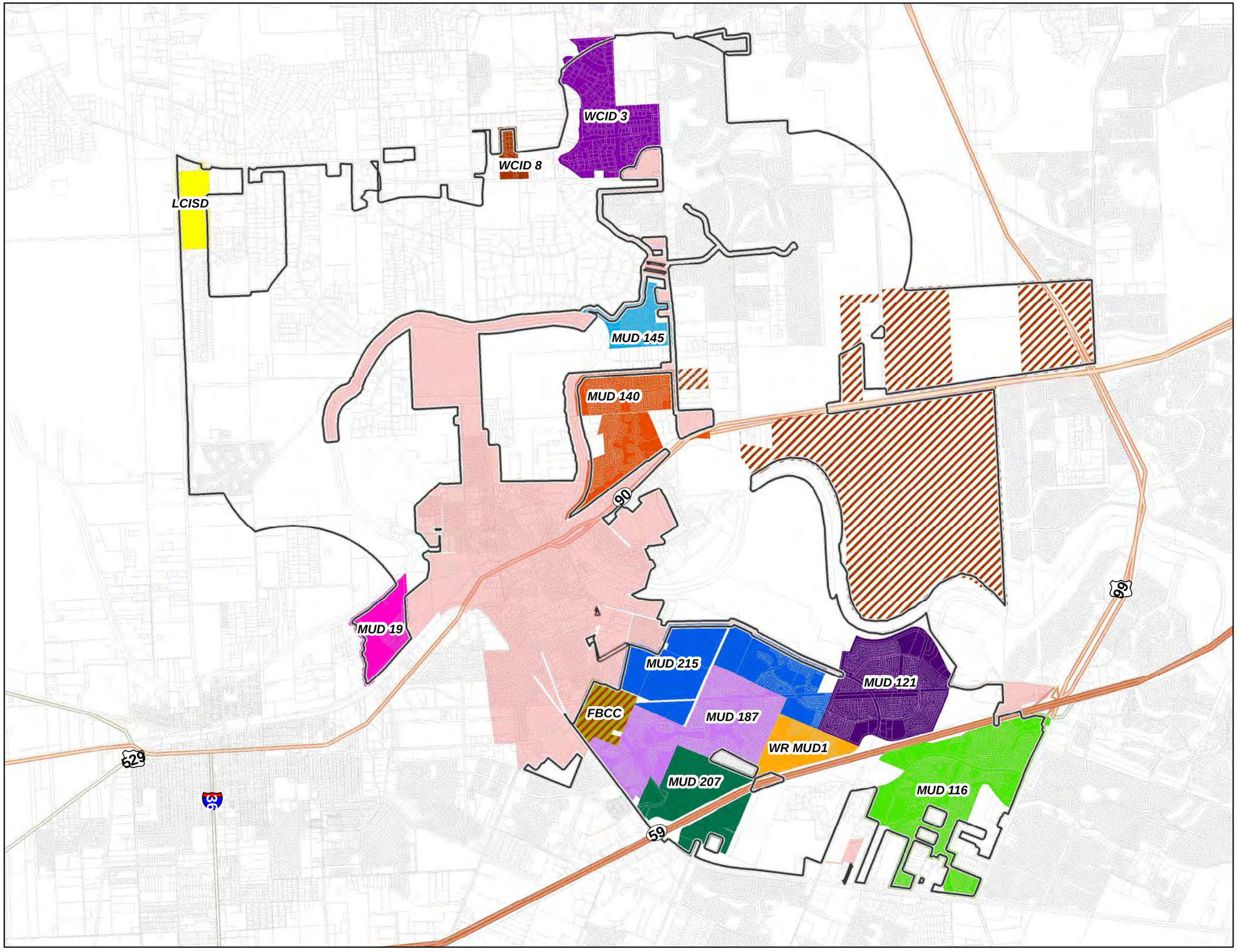
Table 6-2 presents the existing water demands within the City limits, the City's water system service area and within its GRP based on the current population and a historical average water consumption (or demand) factor of 116 gpcd.

Table 6-2. Existing Water Demands

Year	City Limits (MGD)	City Service Area (MGD)	Total GRP (MGD)
2017	1.42	2.78	3.51

6.2.3. Projected Water Demands

The projected populations are based on the information provided by the GRP Partners and on undeveloped areas available for build out or redevelopment within the City. All of the existing MUDs are projected to be fully developed prior to 2030. Areas within the ETJ that are served by other utilities, by individual water wells, or are not planned to develop in the foreseeable future are not included in the City GRP. **Table 6-3** presents the population projections within the City limits, the City's water system service area and within its GRP.



0.3 0 0.3 Miles

N

Legend

City Limits

ETJ Area

Future GRP Service Area

Served by COR Water System

- MUD 121
- MUD 1
- MUD207
- MUD140
- MUD145
- MUD187
- MUD19
- MUD215

Not Served by City Water System

- WCID 3
- WCID 8
- MUD 116
- LCISD

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A Charming Past. A Soaring Future.

Figure 6-1

GRP Service Area Map

Table 6-3. Population Projections.

Year	City Limits	City System	GRP
2020	12,488	28,887	35,394
2023	12,776	35,003	41,867
2025	12,968	43,933	47,295
2030	13,448	66,258	73,122

Table 6-4 presents the projected water demands within the City limits, the City's water system service area and within its GRP service area. The water demands are based on the population projections and 116 gpcd demand within the City's service area and a water demand of 113 gpcd for areas outside of the service area but within the GRP service area.

Table 6-4. Projected Water Demands.

Year	City Limits (MGD)	City System (MGD)	Total GRP (MGD)
2020	1.449	3.351	4.086
2023	1.482	4.060	4.836
2025	1.504	4.690	5.466
2030	1.560	7.686	8.462

6.3. Groundwater Reduction Approach

The City has contracted with the BRA to purchase 2,932 acre-feet per year (AFY) of water in the Brazos River System. With treatment and river losses, this contract amount is adequate to supply approximately 1.80 MGD of treated water. Based on the population and water demand projections, the GRP will require approximately 1.76 MGD of surface water to comply with the estimated 30% conversion through September 2025. The City requested an additional 5,000 AFY of water supply from BRA in 2018 in anticipation of expanding the SWTP.

To meet the 60% conversion requirement with the current population projections and water usages, the SWTP should be expanded to 4.0 MGD by October 2025 and distribution system improvements should be constructed to increase the conversion area of the City's system. An additional expansion to 6.0 MGD may be needed as early as 2027 if substantial development occurs in east of the Brazos River or if City decides to incorporate additional GRP participants. **Figure 6-2** below shows the groundwater reduction requirements and timing of projects as population water demands increases.

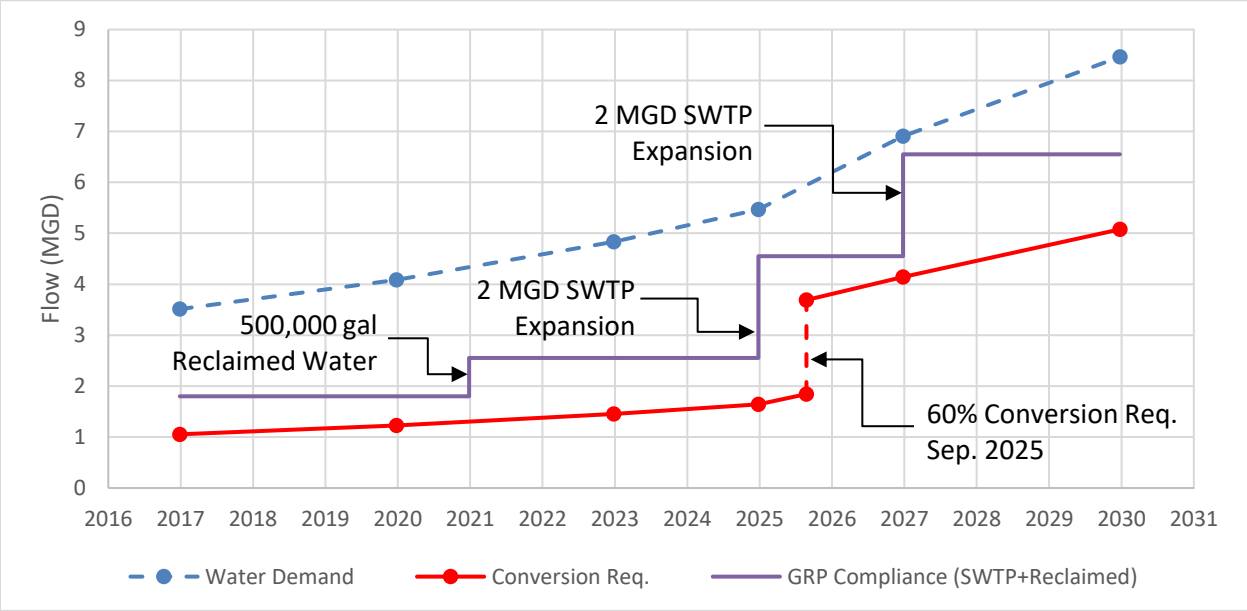

Figure 6-2. Groundwater Reduction Compliance

The City also constructed a 1.5-MGD cloth membrane filtration system at the Regional WWTP capable of providing Type I effluent reuse. The system is expandable to 3.0 MGD with the installation of additional pumpage. The City is working towards annual purchase contracts in the amount of 494,000 GPD of reclaimed water for irrigation and amenity lake use. Because operation costs are much lower with the Reclaimed Water System, additional users and contracts are being sought with surrounding entities. Reclaimed water credits will be used to defer construction of the second phase of the SWTP. If an average annual reclaimed water usage of 1.3 MGD can be utilized on a consistent basis, expansion of the surface water plant can be delayed and the ultimate size reduced to 4.0 MGD.

6.4. Infrastructure Financing

The City's cost for the 30% conversion compliance was $24,660,127 which included the SWTP design and construction, land acquisition, 20" transmission line, chloramine conversion and reclaimed water facilities at the WWTP. An additional $38,247,000 for the 2025 FBSD 60% conversion deadline is proposed for SWTP expansion, new 2 MGD well at the SWTP, additional surface water transmission lines, metallic pipe replacement and reclaimed water facilities and distribution system expansion. Another 2 MGD plant expansion is proposed for 2027 to continue to meet the 60% conversion with an estimated cost of $25,549,000. In addition to the project costs, the City GRP anticipates spending an average of $1,200,000 a year in operation, maintenance and raw water. The total cost for surface water compliance through 2028 is $88,456,127.

The City GRP will provide funding for the surface water conversion improvements. Currently, the financing plan includes increases in metered water rates, the sale of revenue bonds and funding from GRP Partners through a pumpage fee to pay for conversion costs. The 2018 pumpage fee is $2.20 per thousand gallons

and the fee is expected to increase to $2.42 per thousand gallons in 2019 and approximately $3.50 per thousand gallons by 2025 to cover rising costs.

6.5. GRP Update Recommendations

In the near term, it is anticipated that the City will continue to meet FBSD requirements with existing strategies. Unless the anticipated 60% conversion requirement in 2025 is delayed or reduced, the City will need to expand the SWTP from 2 MGD to 4 MGD by 2025 to meet this threshold. It is recommended that the City closely track the status of these anticipated requirements, as well as the status of development east of the Brazos River. Potential development in this area substantially impacts the need for and timing of an additional (second) expansion of the SWTP from 4 MGD to 6 MGD. More generally, the incorporation of additional partners into the GRP strongly impacts SWTP expansion needs, and the ability to meet conversion requirements should be vetted before any partners are added to the GRP in the future.

7. Financial Plan and Rate Study

This section discusses the financial analysis and updates to city's water, wastewater and reclaimed water rates.

7.1. Financial Planning Study Background

The City serves approximately 6,800 water and 6,500 wastewater customer accounts in the Richmond area. The customers include residential, commercial, and MUDs. Additionally, the City is within the FBSD. The City has therefore created a GRP to meet the subsidence district's goals. The City's GRP calls for a per-thousand-gallon rate to charge participants in return for groundwater credit and compliance.

7.1.1. Objectives of Financial Planning Study

Key objectives of financial planning are:

- Create a financial plan for the City's water, wastewater and surface water utilities
- Evaluate the revenue sufficiency of each utility's existing rate structure
- Ensure capital projects are funded with the optimal mix of rate revenue and debt to minimize impacts to customers
- Develop recommendations on rates and new rate structures

A major component of the analysis included the development of a Rate Model to forecast annual revenue requirements, water consumption, revenues, and rates over a 10-year study period, from fiscal year[1] (FY) 2019 to FY 2028. The Rate Model incorporates a projection of operating and maintenance (O&M) expenses based on the FY 2018 Budget, the 10-year CIP from FY 2019 to FY 2028, and existing and proposed debt service. These inputs are utilized to create financial and rate projections over the 10-year study period. The Rate Model was designed to be user-friendly, so that the City can update it in the future.

7.1.2. Summary Results

Projected revenues under existing rates for each utility are insufficient to meet annual revenue requirements throughout the study period. **Table 7-1** summarizes the recommended annual rate revenue adjustments for each utility. These recommendations are projected to maintain the financial solvency of each utility given certain assumptions detailed later in this report.

[1] The City's fiscal year is from October 1 to September 30. "FY 2019" refers to the 12 months ending September 30, 2019.

Table 7-1. Summary Recommended Rate Revenue Adjustments

Fiscal Year	Water	Wastewater[a]	Surface Water[a]
FY 2019	3.0%	10.0%	10.0%
FY 2020	3.0%	10.0%	10.0%
FY 2021	3.0%	10.0%	10.0%
FY 2022	3.0%	10.0%	6.0%
FY 2023	3.0%	3.0%	3.0%
FY 2024	0.0%	3.0%	3.0%
FY 2025	0.0%	3.0%	3.0%
FY 2026	0.0%	3.0%	3.0%
FY 2027	0.0%	0.0%	0.0%
FY 2028	0.0%	0.0%	0.0%

a – Recommended rate adjustments capped at 10% annually based on input from the City, not as an output from rate analysis. This criterion is subject to change as future rate increases are considered.

7.1.3. Reliance on City-Provided Data

During this project, the City provided a variety of technical information, including cost and revenue data. This data was utilized in the formulation of key findings and subsequent recommendations. There are often differences between actual and projected data. Some of the assumptions used in this report will not be realized, and unanticipated events and circumstances may occur. Therefore, there are likely to be differences between the data or results projected in this report and actual results achieved, and those differences may materialize in the future. It is recommended that the City update the utility financial plans annually to reflect current estimates of revenue, operating expenses, capital improvement needs, and maintenance of reserve targets, and to determine whether the projected increases are still appropriate.

7.2. Financial Plan

The City uses self-supporting enterprise funds to account for its water and wastewater fund and surface water fund. While the water and wastewater utilities are accounted for on a combined basis by the City for legal and reporting purposes, industry best practices advocate for the separation of each utility for financial planning and rate setting purposes. Accordingly, the consultant team separated the water and wastewater utilities into individual funds in the Rate Model for financial planning and rate analysis. Under this approach, water revenues are intended to support exclusively water-related revenue requirements, and similarly for wastewater, with the goal to achieve self-sustaining utilities.

7.2.1. Assumptions

This section presents the major assumptions used in this study, as summarized in **Table 7-2**. Changes in these assumptions could materially impact the results of the findings and conclusions.

Table 7-2. Financial Study Assumptions

Category	Assumed Value
Annual Escalation Factors	
Salaries	3.0%
Insurance	5.0%
Commodity Costs	4.0%
Other Operating / Maintenance	3.0%
Capital Costs	3.0%
Operating Cash Flow, Unrestricted Cash Beginning Balance	
Water	$1.5 million
Wastewater	$1.4 million
Surface Water	$4.3 million
Capital Cash Flow, Restricted Cash Beginning Balance	
Water	$3.2 million
Wastewater	$5.5 million
Surface Water	$ 0 million
Annual Systemwide Account Growth	
FY 2019 – FY 2023	7.9%
FY 2024 – FY 2028	8.6%
Future Revenue Bond Debt Issuances	
Term	20 years
Interest Rate	4.0%
Issuance Expense	1.5%
Debt Service Reserve Requirement	Debt Funded Reserve of Average Annual Debt Service

The Integrated Utility Master Plan projects population figures, and resulting systemwide growth factors are summarized in **Table 7-3** below:

Table 7-3. Population Projections

Estimated Population			
Location	**2017**	**2023**	**2027**
City	12,200	12,776	13,160
MUDs	11,730	22,227	39,703
Total	23,930	35,003	52,863
Systemwide Growth		7.9%	8.6%

7.2.2. Financial Planning Targets

The financial targets for the water, wastewater, and surface water utilities are intended to provide structure for the financial plan, mitigate risk, and drive decision making that is at the core of the City's operations. The consultant team has reviewed "common industry practices" related to each financial metric and how they relate to the City's operations. Based on this review, we have provided recommendations regarding several financial metrics and practices that are included in the financial plan.

Fund Reserves

Reserves are the core measure of a utility's aversion to risk. They enable the utilities to maintain financial solvency and mitigate financial risks associated with revenue instability, volatile capital costs and emergencies. The consultant team recommends that each utility target an operating reserve equal to 90 days of annual operating expenses. Maintaining reserve balances within enterprise funds is consistent with industry standards and is a primary measure assessed by rating agencies for local government utilities when evaluating credit.

Debt Service Coverage

Debt service coverage (DSC) is another key financial planning metric that measures a utility's ability to meet annual debt service payments. The DSC calculation is as follows:

$$DSC = \frac{(Operating\ Revenues - Operating\ Expenses\ (less\ depreciation))}{Annual\ Debt\ Service\ Payment}$$

Table 7-4 and **Table 7-5** summarize Standard and Poor's (S&P) and Moody's rating scorecard for evaluating water and wastewater utilities DSC.

Table 7-4. S&P DSC Scorecard

S&P Rating	DSC
1 – Extremely Strong	Above 1.60 times
2 – Very Strong	1.40 to 1.60 times
3 – Strong	1.20 to 1.40 times
4 – Adequate	1.10 to 1.20 times
5 – Vulnerable	1.00 to 1.10 times
6 – Highly Vulnerable	Below 1.00 times

Table 7-5. Moody's DSC Scorecard

Moody's Rating	DSC
Aaa	Above 2.00 times
Aa	1.70 to 2.00 times
A	1.25 to 1.70 times
Baa	1.00 to 1.25 times
Ba	0.70 to 1.00 times
B and Below	Below 0.70 times

The City currently has Certificates of Obligation (CO) debt outstanding that are supported by water and wastewater fund proceeds. While the CO debt is supported from a combination of the levy and collection of ad valorem tax and the surplus net revenues of the City's water and sewer fund, the intent of the City is to fully fund the water and wastewater fund's portion of annual debt service from utility revenues.

The consultant team recommends that the financial plan and associated projected increases in user charge revenues, should be based on achieving a DSC ratio on the annual debt service payment in the range of 1.25x. This target is an "All-In" DSC approach, which includes all annual debt service payments. This will allow the City to consider issuing Revenue Bonds that are fully supported by the water and wastewater fund in the future.

7.2.3. Water and Wastewater Fund Allocations

The City has one combined fund for the water and wastewater utilities but tracks some water and wastewater specific expenses separately. For the purpose of developing a financial plan and recommended rates, the water and wastewater funds were separated into individual funds within the Rate Model to enable the development of a plan for each utility to be self-sustaining in the long-run. Expenses common to both utilities, such as account and customer service charges were allocated between the two utilities based on number of customer accounts or proportion of each utility's rate revenue. **Table 7-6** below summarizes the allocation of expenses between the water and wastewater fund by account/expense type.

Table 7-6. Water and Wastewater Fund Expense Allocation

Account/Expense Description	Account Number	Allocation Method	Water	Wastewater
Account & Collection	20-5200	Accounts	51%	49%
Customer Service	20-5210	Accounts	51%	49%
Meter	20-5215	Accounts	51%	49%
Water	20-5220	Utility Specific	100%	0%
Wastewater	20-5230	Utility Specific	0%	100%
Water Production	20-5260	Utility Specific	100%	0%
Water Distribution	20-5265	Utility Specific	100%	0%
Wastewater Collection	20-5270	Utility Specific	0%	100%
Wastewater Treatment	20-5275	Utility Specific	0%	100%
Water & Wastewater Other	20-5235	Revenue	49%	51%

Activities associated with capital funding, including impact fee revenues and bond proceeds, were further separated from daily operating and maintenance activities in each fund. For the purposes of this study, the consultant team developed two separate cash flows within each fund were developed for the rate analysis:

- Capital cash flow (includes restricted cash from impact fees and bond proceeds)
- Operating cash flow (unrestricted cash)

The operating cash flow is used for the basis of rate-setting. Tables for the water, wastewater, and surface water utility financial plans and rate analysis can be found in **Appendix D**.

7.2.4. Water Fund

Water Capital Cash Flow

Because of the restrictions on the uses of certain bond proceeds and impact fee revenues, this cash flow is tracked separately from operating activities.

Beginning Balance

The cash flow balance includes carryover impact fee revenues and bond proceeds from previous years. The fund balance was $2.6M at the beginning of FY 2019.

Sources of Funds

Sources include impact fee revenue, transfers from the operating cash flow, bond proceeds, and investment income. Impact fee revenue averages $0.8M annually beginning in FY 2019. Water impact fee revenue projections are based on the City's projections for FY 2019 and beginning in FY 2020 are calculated using preliminary updated water impact fees multiplied by projected growth in customer accounts. Proposed revenue bond issuances totaling $20.6M between FY 2022 and FY 2028 are anticipated for funding the projected 10-year CIP. Investment income is calculated using a 1.0 percent annual interest rate applied to each year's average fund balance.

Uses of Funds

The sum total of City's water capital projects for the study period is approximately $48.0M, inflated. An annual inflation factor of 3.0 percent is applied to the projected capital costs. Debt issuance costs are 1.5 percent of the total debt issue and debt reserve costs are equal to the average annual debt service (annual max debt service). Annual debt service costs on the existing and proposed bond issues are accounted for in the water operating fund. **Appendix D** contains details of the water capital improvement program.

Water Operating Cash Flow

Financial activities associated with funding annual operating revenues and revenue requirements are tracked separately from the activities associated with capital project funding. Revenue requirements include O&M expense, payments on existing and proposed debt, transfers to the capital fund to cash

finance projects, maintaining reserves, and debt service coverage.

Beginning Balance

The operating cash balance includes unrestricted net revenues carried over from previous years. Because the unrestricted reserves are reported on a combined water and wastewater basis by the City, the beginning balance was allocated 49% to water and 51% to wastewater based on historical revenue distribution. The allocated water fund balance is projected to be $1.8M at the beginning of FY 2019.

Revenues

Operating revenue is derived from water sales revenue, investment income, and other miscellaneous sources. Water sales revenue under existing rates is based on the projected number of water accounts and water usage amounts for each customer class. Revenue from existing rates and proposed increases averaged $5.6M, annually, during the study period. The rate revenue is generated by the minimum charge and volumetric rates assessed to water customers. The minimum charge is based on the meter size that each customer uses regardless of customer class. The volumetric rates vary based on whether a customer is categorized as residential, irrigation, school, government, cooling tower, commercial, or industrial. Each class pays a separate volumetric rate. When projecting rate increases, each rate, minimum charge, industrial, school, etc. is increased at the same percentage. For example, if the increase is three percent in a given year, then all the water rates will increase by three percent.

Miscellaneous revenues include water tap fees, service charge revenues from FBCMUD 140, and other miscellaneous sources. Miscellaneous revenues take into account the contractual obligations in place with MUDs. The miscellaneous revenue is projected to remain constant throughout the study period.

Revenue Requirements

Revenue requirements imposed on these operating revenues include O&M expense, debt service payments for existing and proposed debt issuances, transfers for cash financed capital projects, and transfers to the wastewater fund. O&M consists of personnel, materials, supplies, and water production and distribution, and transfers to the City general fund for shared services. O&M expense averaged $3.7M annually during the study period. Transfers for cash funded capital projects occur when impact fee revenues, reserves, or debt issuances are insufficient to meet the capital requirements. These transfers average $1.5M per year over the study period. Projected debt service on existing and proposed debt averaged $0.7M per year over the study period. A transfer of $1.4M in FY 2021 to the wastewater fund is projected to maintain the wastewater fund's solvency. The wastewater fund is projected to transition to self-sustainability over the study period, with the assistance of this water fund transfer.

Indicated Water Sales Revenue Adjustments

Water rate revenue should be sufficient to meet revenue requirements, finance the CIP, maintain adequate reserves, and comply with bond covenants and targets. A minimum operating reserve equal to 90 days of operating expenses is recommended, which is typical in the industry and for a utility of this

size. DSC target was set at 1.25 times net revenue to ensure that the City had sufficient coverage capacity to issue debt in the future. Equal annual revenue adjustments of 3.0% in FY 2019 – FY 2023 are projected to meet the requirements and maintain the financial health of the utility. It is recommended that the financial plan be updated annually to determine whether the projected increases are appropriate.

Table 7-7 below summarizes the indicated water rate revenue adjustments and target versus projected reserve and DSC values by fiscal year.

Table 7-7. Water Fund Projections

Water							
Fiscal Year	**Rate Revenue Adjustment**	**Projected Ending Balance *($M)***	**Target Ending Balance *($M)***	**Projected Debt Issuance *($M)***	**Projected DSC**	**Target DSC**	**Recommended Rate Increase without Subsidy to Wastewater**
2019	3%	$2.3	$0.8		0.60	1.25	3%
2020	3%	$3.2	$0.8		2.05	1.25	3%
2021	3%	$1.5	$0.9		3.27	1.25	3%
2022	3%	$.9	$0.9	$1.7	3.08	1.25	0%
2023	3%	$.8	$0.9		4.24	1.25	0%
2024	0%	$1.3	$0.9	$3.9	2.83	1.25	0%
2025	0%	$2.0	$1.0	$2.1	3.23	1.25	0%
2026	0%	$2.5	$1.0	$1.6	3.23	1.25	0%
2027	0%	$4.2	$1.0	$4.7	2.61	1.25	0%
2028	0%	$2.5	$1.1	$6.6	1.75	1.25	0%
Total	16%			$20.6			

7.2.5. Wastewater Fund

Wastewater Capital Cash Flow

Because of the restrictions on the uses of certain bond proceeds and impact fee revenues, this cash flow is tracked separately.

Beginning Balance

The cash flow balance includes carryover impact fee revenues and bond proceeds from previous years. The fund balance was $4.2M at the beginning of FY 2019.

Sources of Funds

Sources of funds include impact fee revenue, transfers from the operating cash flow, bond proceeds, investment income, and transfers from the water fund. Impact fee revenue averages $1.1M annually beginning in FY 2019. Wastewater impact fee revenue projections are based on the City's projections for

FY 2019 and beginning in FY 2020 are calculated using half of the preliminary updated wastewater impact fees multiplied by projected growth in customer accounts. Proposed revenue bond issuances totaling $81.8M between FY 2021 and FY 2028 are anticipated for funding the projected 10-year CIP. Investment income is calculated using a 1.0 percent annual interest rate applied to each year's average fund balance. A transfer of $1.4M in FY 2021 from the water operating fund is assumed to maintain the wastewater fund's solvency. The wastewater fund is projected to transition to self-sustainability over the study period, with the assistance of this water fund transfer.

Uses of Funds

The City's wastewater capital projects for the study period totaled approximately $101.7M, inflated. An annual inflation factor of 3.0 percent is applied to the projected capital costs. Debt issuance costs are 1.5 percent of the total debt issue and debt reserve costs are set to the average annual debt service. Annual debt service costs on the existing and proposed bond issues are accounted for in the wastewater operating fund. **Appendix D** summarizes the wastewater CIP.

Wastewater Operating Cash Flow

Financial activities associated with funding annual operating revenues and revenue requirements are tracked separately from the activities associated with capital project funding. Revenue requirements include O&M expense, payments on existing and proposed debt, transfers to the capital fund to cash finance projects, maintaining reserves, and debt service coverage.

Beginning Balance

The operating cash balance includes unrestricted net revenues carried over from previous years. Because the unrestricted reserves are reported on a combined water and wastewater basis by the City, the beginning balance was allocated 49% to wastewater and 51% to water based on historical utility revenue distribution. The allocated wastewater fund balance is projected to be $0.4M at the beginning of FY 2019.

Revenues

Operating revenue is derived from wastewater rates and investment income. Wastewater sales revenue under existing rates is based on the projected number of wastewater accounts and wastewater usage amounts for each customer class. Revenue from existing rates and proposed increases averaged $8.0M, annually, during the study period. The wastewater monthly minimum charge varies by customer class – residential, residential senior, or commercial. For residential customers, the wastewater volumetric rates multiplied by the average monthly winter water consumption for the three months from January to March. Commercial customers are assessed wastewater volume rates based on actual monthly water consumption. The volumetric rates per thousand gallons are the same for all customer classes. This is a common industry-wide practice due to the inability to measure wastewater flows.

Revenue Requirements

Revenue requirements imposed on these operating revenues include O&M expenses, debt service payments for existing and proposed debt issuances, and transfers for cash financed capital projects. O&M expenses consists of personnel, materials, supplies, and wastewater treatment and collection, and transfers to the City general fund for shared services. O&M averaged $4.5M annually during the study period. Transfers for cash funded capital projects occur when impact fee revenues, reserves, or debt issuances are insufficient to meet the capital requirements. These transfers average $0.3M per year over the study period. Projected debt service on existing and proposed debt averaged $3.2M per year over the study period.

Indicated Wastewater Sales Revenue Adjustments

Wastewater rate revenue should be sufficient to meet revenue requirements, finance the CIP, maintain adequate reserves, and comply with bond covenants and targets. A minimum operating reserve equal to 90 days of operating expenses is recommended, which is typical in the industry and for a utility of this size. DSC target of 1.25 times net revenue was set to ensure that the City had sufficient coverage capacity to issue debt in the future. Equal annual rate revenue adjustments of 10.0% in FY 2019 – FY 2022, followed by 3.0% annual adjustments in FY 2023 – FY 2026 are projected to meet the requirements and maintain the financial health of the utility. It is recommended that the financial plan be updated annually to determine whether the projected increases are appropriate.

Table 7-8 below summarizes the indicated wastewater rate revenue adjustments and target versus projected reserve and DSC values by fiscal year.

Table 7-8. Wastewater Fund Projections

Wastewater							
Fiscal Year	**Rate Revenue Adjustment**	**Projected Ending Balance *($M)***	**Target Ending Balance *($M)***	**Projected Debt Issuance *($M)***	**Projected DSC**	**Target DSC**	**Recommended Revenue Adjustment without Water Subsidy**
2019	10%	$(.1)	$1.0		-0.13	1.25	20%
2020	10%	$(.3)	$1.0	$.5	1.40	1.25	15%
2021	10%	$.4	$1.0	$10.0	1.85	1.25	10%
2022	10%	$.5	$1.1	$14.2	1.32	1.25	10%
2023	3%	$.5	$1.1	$16.8	.99	1.25	3%
2024	3%	$.3	$1.1	$6.5	1.07	1.25	3%
2025	3%	$.4	$1.2	$4.9	1.19	1.25	2%
2026	3%	$.4	$1.2	$20.9	1.03	1.25	0%
2027	0%	$.3	$1.2	$8.0	1.06	1.25	0%
2028	0%	$.5	$1.3		1.03	1.25	0%
Total	65%			$81.8			

As displayed in the **Table 7-8**, the wastewater fund does not meet financial targets every year of the study period. This was a deliberate decision made in the financial planning process. Based on the feedback from City stakeholders, annual rate revenue adjustments were capped at 10.0%. Given this rate revenue cap, the following parameters for the wastewater funds were set to develop the financial plan scenario.

- Reach target operating reserve of 90 days of O&M by FY 2022.
- Transition to and maintain at least 1.00x debt service coverage by FY 2020.

7.2.6. Combined Water and Wastewater Fund

The water and wastewater funds are accounted for on a combined basis by the City for legal and reporting purposes. A goal of the City was to minimize customer rate impacts and achieve a phased-in rate increase approach. Therefore, while the water and wastewater funds were separated out for planning purposes, the combined water and wastewater fund is still a key driver in rate increases for each utility. The following combined water and wastewater financial targets are met, the individual water or wastewater funds can fall below target levels as rate increases are phased in:

Combined Water and Wastewater Fund

- Meet annual operating reserve target of 90 days O&M each year of the study period.
- If DSC falls below 1.25x target in a given fiscal year, the following fiscal year must rebound and meet the 1.25x target.

Because the water and wastewater funds are accounted for and reported on a combined basis, the consultant team deemed this approach as being reasonable, provided the long-term goal of achieving utility self-sufficiency was maintained.

Table 7-9 below summarizes the projected combined water and wastewater operating reserves and DSC at fiscal year-end for each year of the study period.

Table 7-9. Water and Wastewater Combined Financial Projections

Water and Wastewater Combined					
Fiscal Year	**Projected Ending Balance *($M)***	**Target Ending Balance *($M)***	**Projected Debt Issuance *($M)***	**Projected DSC**	**Target DSC**
2019	$2.2	$1.8		0.1	1.25
2020	$2.9	$1.8	$.5	1.57	1.25
2021	$1.9	$1.9	$10.0	2.17	1.25
2022	$1.4	$1.9	$15.9	1.61	1.25
2023	$1.2	$2.0	$16.8	1.34	1.25
2024	$1.7	$2.1	$10.4	1.35	1.25
2025	$2.5	$2.1	$7.0	1.50	1.25
2026	$2.9	$2.2	$22.5	1.32	1.25
2027	$4.6	$2.3	$12.7	1.31	1.25
2028	$3.0	$2.3	$6.6	1.19	1.25
Total			$102.4		

7.2.7. Surface Water Fund

Surface Water Capital Cash Flow

Because of the restrictions on the uses of certain bond proceeds, this cash flow is tracked separately.

Beginning Balance

The assumed surface water beginning FY 2019 capital balance is $0. All existing surface water reserves are allocated to the operating reserve.

Sources of Funds

Sources of funds include transfers from the operating cash flow to cash finance capital projects, bond proceeds, and investment income. Proposed bond issuances totaling $51.5M between FY 2020 and FY 2027 are anticipated for funding the projected 10-year CIP. Investment income is calculated using a 1.0 percent annual interest rate applied to each year's average fund balance. The surface water fund is projected to remain self-sufficient throughout the study period.

Uses of Funds

The City's surface water capital projects for the study period total $64M, inflated. An annual inflation factor of 3.0 percent is applied to the projected capital costs. Debt issuance costs are 1.5 percent of the total debt issue and debt reserve costs are equal to average annual debt service. Annual debt service costs on the existing and proposed bond issues are accounted for in the surface water operating fund. **Appendix D** summarizes the surface water CIP.

Surface Water Operating Cash Flow

Financial activities associated with funding annual operating revenues and revenue requirements are tracked separately from the activities associated with capital project funding. Revenue requirements include O&M expense, payments on existing and proposed debt, transfers to the capital fund to cash finance projects, maintaining reserves, and debt service coverage.

Beginning Balance

The assumed surface water operating fund cash balance at the beginning of FY 2019 is $2.8M.

Revenues

Operating revenue is derived from surface water rates and investment income. The surface water rates are paid by all participants in the GRP. The City of Richmond and partner MUDs participate in this program. Each customer pays a volumetric rate on every 1,000 gallons that is used. Revenue from existing surface water rates and proposed increases averaged $5.8M, annually, during the study period.

Along with the water, wastewater, and surface water operations the City provides reclaimed water to certain customers. Currently, these customers receive the water at no cost, although providing the reclaimed water comes at a cost to the City. The utility must pay for operating costs such as power, labor, and cloth filter replacements and capital related costs related to reclaimed water lines. It is therefore recommended that the City implement a charge for this service to recover costs. Revenue from proposed reclaimed water rates averaged $0.2M, annually, during the study period.

Revenue Requirements

Revenue requirements imposed on these operating revenues include O&M expenses, debt service payments for existing and proposed debt issuances, and transfers for cash financed capital projects. O&M expenses consists of personnel, materials, supplies, and surface water production and distribution. O&M averaged $1.4M annually during the study period. Transfers for cash funded capital projects occur when reserves or debt issuances are insufficient to meet the capital requirements. These transfers average $1.3M per year over the study period. Projected debt service on existing and proposed debt averaged $3.2M per year over the study period.

Indicated Surface Water Sales Revenue Adjustments

Surface water rate revenue should be sufficient to meet revenue requirements, finance the CIP, maintain adequate reserves, and comply with bond covenants and targets. A minimum operating reserve equal to 90 days of operating expenses is recommended, which is typical in the industry and for a utility of this size. The consultant team set a debt service coverage target of 1.25 times net revenue was set to ensure that the City had sufficient coverage capacity to issue debt in the future. Equal annual rate revenue adjustments of 10.0% in FY 2019 – FY 2021, a 6.0% adjustment in FY 2022, and annual adjustments of 3.0% in FY 2023 – FY 2026 are projected to meet the requirements and maintain the financial health of the utility. It is recommended that the financial plan be updated annually to determine whether the projected increases are appropriate. **Table 7-10** summarizes the projected revenue adjustments and DSC at the end of each fiscal year.

Table 7-10. Surface Water Summary

Surface Water						
Fiscal Year	**Rate Revenue Adjustment**	**Projected Ending Balance *($M)***	**Target Ending Balance *($M)***	**Projected Debt Issuance *($M)***	**Projected DSC**	**Target DSC**
2019	10%	$2.2	$0.3		1.08	1.25
2020	10%	$.1	$0.3	$2.8	1.28	1.25
2021	10%	$.2	$0.3	$5.7	1.31	1.25
2022	6%	$.3	$0.3	$3.8	1.39	1.25
2023	3%	$.5	$0.3	$.7	1.54	1.25
2024	3%	$1.0	$0.3	$4.8	1.90	1.25
2025	3%	$.8	$0.4	$14.8	1.45	1.25
2026	3%	$.6	$0.4	$9.2	1.35	1.25
2027	1%	$.4	$0.4	$9.7	1.25	1.25
2028	0%	$1.6	$0.4		1.24	1.25
Total	60%			$51.5		

7.3. Rate Recommendations

7.3.1. Water Rates

The City's current rate structure consists of a monthly minimum charge that varies by meter size and volumetric rates that vary by customer class. The recommended rates are based on the increases to the existing rates calculated in the financial plan. **Table 7-11** shows the current water rates and structures, compared to the proposed FY 2019 and FY 2020 rates.

Table 7-11. Existing and Proposed Water Rates

	Existing	Proposed		Dollar Increase	
	FY 2018	FY 2019	FY 2020	FY 2019	FY 2020
Minimum Bill					
Meter Size					
5/8 inch	$15.00	$15.45	$15.91	$0.45	$0.46
1 inch	21.00	21.63	22.28	0.63	0.65
1.5 inch	27.00	27.81	28.64	0.81	0.83
2 inch	43.50	44.81	46.15	1.31	1.34
3 inch	165.00	169.95	175.05	4.95	5.10
4 inch	210.00	216.30	222.79	6.30	6.49
6 inch	315.00	324.45	334.18	9.45	9.73
8 inch	435.00	448.05	461.49	13.05	13.44
10 inch	600.00	618.00	636.54	18.00	18.54
Volumetric Rates ($ / kgal)					
Residential					
0-2,000 gal	0.00	0.00	0.00	0.00	0.00
2,001-5,000 gal	2.62	2.70	2.78	0.08	0.08
5,001-10,000 gal	2.87	2.96	3.04	0.09	0.09
10,001-20,000 gal	3.12	3.21	3.31	0.09	0.10
20,001-50,000 gal	3.37	3.47	3.58	0.10	0.10
50,000-75,000 gal	3.62	3.73	3.84	0.11	0.11
75,000+ gal	3.87	3.99	4.11	0.12	0.12
Irrigation					
0-5,000 gal	3.46	3.56	3.67	0.10	0.11
5,001-10,000 gal	3.71	3.82	3.94	0.11	0.11
10,001-20,000 gal	3.96	4.08	4.20	0.12	0.12
20,001-50,000 gal	4.21	4.34	4.47	0.13	0.13
50,001-75,000 gal	4.46	4.59	4.73	0.13	0.14
75,000+ gal	4.71	4.85	5.00	0.14	0.15
Schools	1.57	1.62	1.67	0.05	0.05
Government	4.40	4.53	4.67	0.13	0.14
Cooling Towers	5.08	5.23	5.39	0.15	0.16
Commercial	2.34	2.41	2.48	0.07	0.07
Industrial	3.79	3.90	4.02	0.11	0.12
Outside City Limit Rates are 2.0 Times of Inside City Rates					

7.3.2. Wastewater Rates

The City's current rate structure consists of a monthly minimum charge and volumetric rates that vary by customer class. Billed volume for residential customers is based on average winter months consumption, whereas commercial billed volume is based on actual water consumption. The recommended rates are equal to the existing rates adjusted by the indicated annual percentage increase necessary as calculated in the financial plan. **Table 7-12** shows the current wastewater rates and structures, compared to the proposed FY 2019 and FY 2020 rates.

Table 7-12. Existing and Proposed Wastewater Rates

	Existing	Proposed		Dollar Increase	
	FY 2018	FY 2019	FY 2020	FY 2019	FY 2020
Minimum Monthly Charge					
Customer Class					
Residential	$20.00	$22.00	$24.20	$2.00	$2.20
Residential Senior	15.00	17.00	19.20	2.00	2.20
Commercial	20.00	22.00	24.20	2.00	2.20
Volumetric Charge ($ / kgal)					
Residential (Based on Winter Average)					
0-2,000 Gallons	0.00	0.00	0.00	0.00	0.00
2,000+ Gallons	3.00	3.30	3.63	0.30	0.33
Commercial (Based on Water Consumption)					
0-2,000 Gallons	0.00	0.00	0.00	0.00	0.00
2,000+ Gallons	3.00	3.30	3.63	0.30	0.33
Outside City Limit Rates are 2.0 Times of Inside City Rates					

7.3.3. Surface Water Rates

The City's current rate structure consists of volumetric rates applied to billed water consumption. The recommended surface water rates are equal to the existing rates adjusted by the indicated annual increase calculated in the financial plan. **Table 7-13** shows the current surface water rates and structures, compared to the proposed FY 2019 and FY 2020 rates.

Table 7-13. Existing and Proposed Surface Water Rates

	Existing	Proposed		Dollar Increase	
	FY 2018	FY 2019	FY 2020	FY 2019	FY 2020
Groundwater Reduction Fee ($ / kgal)	2.20	2.42	2.66	0.22	0.24
Outside City Limit Rates are 2.0 times Inside City rates					

7.3.4. Reclaimed Water Rates

Along with the water, wastewater, and surface water operations the City provides reclaimed water to certain customers. Currently, these customers receive the water at no cost. Providing the reclaimed water comes at a cost to the City. The utility must pay for operating costs such as power, labor, and filter replacements and capital related costs related to reclaimed water lines. It is therefore recommended that the utility implement a charge for this service to recover costs.

To calculate the reclaimed water rate, the total annual reclaimed water revenue requirements are divided by the total projected consumption to get a cost per thousand gallons (kgal). Reclaimed water consumption is projected to increase over the study period as new reclaimed customers connect to the system. **Table 7-14** below summarizes total projected reclaimed water consumption, reclaimed water revenue requirements, and the two rate alternatives for the study period. The cost recovery rate is equal to the revenue requirements divided by the projected demand. A significant portion of the revenue requirements are related to capital project costs to improve facilities at the Regional WWTP and to construct reclaimed water pipelines to reach new customers that have not yet connected to the system. This results in a high dollar per thousand gallons rate of $13.37 in FY 2019. Therefore, the reclaimed water cost recovery rate in the latter part of the study period, for instance $2.90 per kgal in FY 2029, may be a more palatable reclaimed water rate to implement and would not require significant rate reductions in future years. It is also common for utilities to implement a policy to set reclaimed water rates as a percentage of potable water rates. The second-rate alternative set at 45% of the lowest irrigation tier rate. For cash flow projections, the consultant team assumed a conservative estimate of reclaimed water revenue assuming the 45% of irrigation rate is assessed to reclaimed water consumption, averaging $0.2M, annually, during the study period.

Table 7-14. Reclaimed Water Projections

Year	Projected Demand (kgal)	Revenue Requirements	Rate Alternatives	
			Cost Recovery Rate	45% of Irrigation Rate
FY 2019	38,900	$520,200	$13.37	$1.60
FY 2020	39,300	$521,500	$13.28	$1.65
FY 2021	77,300	$523,000	$6.76	$1.70
FY 2022	143,800	$524,400	$3.65	$1.75
FY 2023	182,300	$525,900	$2.88	$1.80
FY 2024	182,700	$527,400	$2.89	$1.80
FY 2025	183,100	$529,000	$2.89	$1.80
FY 2026	183,500	$530,700	$2.89	$1.80
FY 2027	183,900	$532,400	$2.90	$1.80
FY 2028	184,300	$534,100	$2.90	$1.80

7.3.5. Monthly Bill Forecasts

Figure 7-1 below compares a median residential monthly bill under existing FY 2018 rates through projected FY 2023 rates. Median monthly usage is 5,000 gallons.

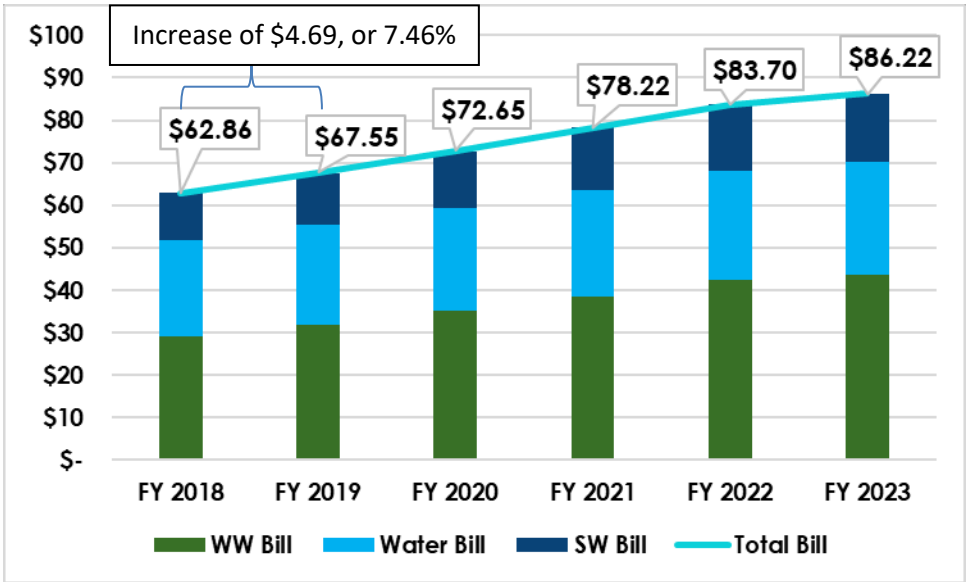

Figure 7-1. Median Customer Combined Monthly Bill Forecast

Figure 7-2 compares a higher usage, 75th percentile, residential monthly bill under existing FY 2018 rates through projected FY 2023 rates. The 75th percentile monthly usage is 8,000 gallons.

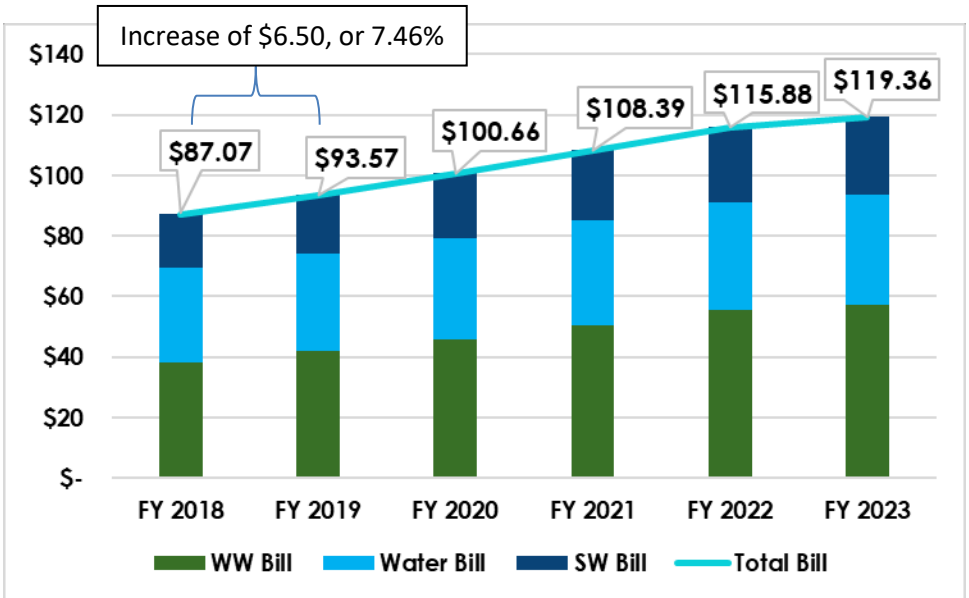

Figure 7-2. High User (75th Percentile Usage) Customer Combined Monthly Bill Forecast

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