

2018 WATER MASTER PLAN

Prepared for:

City of Tomball

October 2018



Prepared by:

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FNI Project No.
TMB16575

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

Freese and Nichols, Inc. (FNI) was retained in 2017 by the City of Tomball to prepare a Water Master Plan. The City provides water to a service area of approximately 19 square miles. The existing water service area population is 12,401 and is projected to grow to 29,361 by 2042. The goals of the 2018 Water Master Plan were to evaluate the integrity of the existing water system and to recommend a phased Capital Improvements Plan (CIP) through 2042. The major elements of the scope of this project included:

- Population and Water Demand Projections
- Water Model Development
- Field Testing and Model Calibration
- Existing and Future Water System Hydraulic Analysis
- Water System Capital Improvements Plan
- Water Master Plan Report

2.0 POPULATION AND LAND USE

Population and land use are important elements in the analysis of a water system. Water demands depend on the residential population and commercial development served by the system and determine the sizing and location of system infrastructure. A thorough analysis of historical and projected populations, along with land use, provides the basis for projecting future water demands. The projected service population and non-residential acreage for each planning period is shown in **Table ES-1**.

Table ES-1: Projected Service Population and Non-Residential Acreage

Year	Service Population	Non-Residential Acreage
2017	12,401	746
2022	16,276	754
2027	21,594	1,359
2042	29,361	1,495

3.0 WATER DEMANDS

Reviewing historical water demands provides insight into selecting design criteria for projecting future water demands. Annual average day demand, maximum day to average day peaking factors, and per-

capita consumption were reviewed and provided a basis for determining the design criteria used to project water demands. **Table ES-2** presents the projected water demands for each planning year.

Table ES-2 Projected Water Demands

Year	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Peak Hour Demand (MGD)
2017	2.12	4.76	8.09
2022	2.99	6.72	11.42
2027	4.64	10.44	17.75
2042	6.16	13.87	23.58

4.0 EXISTING WATER SYSTEM

The City of Tomball’s water distribution system currently consists of approximately 215 miles of water lines, two elevated storage tanks, the Pine Street Water Plant, and the FM 2920 Water Plant. Water is supplied by the City’s five groundwater wells. The water distribution system operates on a single pressure plane.

5.0 HYDRAULIC FIELD TESTING AND MODEL CALIBRATION

A hydraulic model was developed as a tool in the evaluation of the City of Tomball’s water distribution system. The hydraulic model was developed in the InfoWater software by *Innovyze*®. The model network was developed from the City’s Geographic Information System (GIS) and design plans. The calibration process involved adjusting system operation, C-values, demand allocation, and diurnal patterns to match a known condition. The 24-hour period occurring on July 26, 2017, from midnight to midnight was selected for calibration. A close correlation between modeled and observed values was achieved, creating a high degree of confidence in the accuracy of the model.

6.0 WATER SYSTEM ANALYSIS AND HYDRAULIC MODELING

Hydraulic analyses were conducted to identify deficiencies in the City of Tomball’s existing water distribution system and to establish a CIP to reinforce the existing system and meet projected water demands through 2042. The existing system was evaluated to analyze pressure, velocity, headloss, and fire flow.

Water system improvements were developed to accommodate the anticipated residential and non-residential growth through 2042. Challenges facing the water system include providing additional supply, pumping and storage capacity, and improving available fire flow. FNI worked with City staff to develop

and identify water system improvements to accommodate future growth while optimizing the existing system operations and infrastructure. Some of the recommended improvements to the distribution system include:

- Proposed East Water Plant
- New 1.25 MG elevated storage tank
- New water lines to improve connectivity and reduce dead-end water lines
- Expanding existing water plant facilities

8.0 CAPITAL IMPROVEMENTS PLAN

A CIP was developed for the City of Tomball to maintain high quality water service that promotes and sustains residential and commercial development. The recommended improvements will provide the required capacity and reliability to meet projected water demands through 2042. Capital costs were calculated for recommended CIP projects. The costs are in 2018 dollars and include an allowance for engineering, surveying, and contingencies. **Table ES-3** summarizes the cost of the water system CIP by planning period.

Table ES-3: Capacity Capital Improvements Plan Cost Summary

Phase	Project Number	Project Name	Cost
By 2022	1	12-inch Water Line along Hufsmith Road	\$ 1,477,900
	2	New 3,000 gpm East Water Plant with 1.0 MG GST	\$ 14,882,400
	Total 2017 - 2022		\$ 16,360,300
By 2027	3	12/16-inch Water Line along Main Street	\$ 2,229,900
	4	12-inch Water Line along Medical Complex Drive	\$ 1,045,100
	5	16-inch Water Line along SH 249	\$ 1,566,800
	6	1.25 MG EST and 16-inch Water Line ⁽¹⁾	\$ 6,851,600
	7	2,000 gpm FM 2920 Pump Station Expansion with 1.5 MG GSTs	\$ 4,442,900
	8	1,500 gpm East Water Plant Expansion with 1.0 MG GST	\$ 5,602,000
	Total 2023 - 2027		\$ 21,738,300
By 2042	9	0.4 MG Pine Street Water Plant GST and Pine Street Pump Station Condition Assessment	\$ 836,200
	10	12-inch Water Lines along Snook Lane, Lovett Street, and Zion Road	\$ 952,100
	11	12-inch Water Line along Agg Road	\$ 621,300
	12	16-inch Water Line along Ulrich Road	\$ 333,400
	Total 2028 - 2042		\$ 2,743,000
Total 25-year Water CIP Cost			\$ 40,841,600
Timeline Pending	A	SCADA System	\$ 650,000
	B	12-inch Water Line along Oak Street	\$ 112,200
	C	8-inch Water Line in Corral RV Park	\$ 58,400
	D	8-inch Water Line along Liberty Lane	\$ 71,100
	E	12-inch Water Line along SH 249	\$ 226,600
	F	8-inch Water Line along Stella Lane	\$ 225,800
	G	8-inch Water Line along Julia Lane	\$ 306,500
	H	8-inch Water Line along Persimmon Road	\$ 201,900
	Total Timeline Pending Projects Cost		\$ 1,852,500
Total 25-year Water CIP Cost with Timeline Pending Projects			\$ 42,694,100

(1) This project may be constructed sooner to meet commercial fire flow requirements.

1.0 INTRODUCTION

The City of Tomball (City) is a growing community located in Northwest Harris County, Texas. The City currently provides water service to approximately 12,401 people. The population within the service area is projected to grow to 29,361 by 2042. Accommodating this growth in an efficient and cost-effective manner is the focus of this 2018 Water Master Plan. This report has been prepared by Freese and Nichols, Inc. (FNI) to provide the City of Tomball with a planning tool to serve as a guide for 5-year, 10-year, and 25-year improvements to the infrastructure within the water system.

1.1 SCOPE OF WORK

Freese and Nichols, Inc. (FNI) was retained in 2017 by the City of Tomball to prepare a Water Master Plan. The goals of the 2018 Water Master Plan were to evaluate the integrity of the existing water system and to recommend a phased Capital Improvements Plan (CIP) through 2042. The recommended improvements will serve as a basis for the design, construction, and financing of facilities required to meet Tomball's water capacity and system renewal needs. The major elements of the scope of this project included:

- Population and Water Demand Projections
- Water Model Update
- Field Testing and Model Calibration
- Existing and Future Water System Hydraulic Analysis
- Water System Capital Improvements Plan
- Water Master Plan Report

1.2 LIST OF ABBREVIATIONS

A list of abbreviations used throughout the report is included in **Table 1-1**.

Table 1-1: List of Abbreviations

Abbreviation	Actual
AD	Average Day
CCN	Certificate of Convenience and Necessity
CIP	Capital Improvement Program
EPS	Extended Period Simulation
EST	Elevated Storage Tank
FNI	Freese and Nichols, Inc.
ft	Feet
GIS	Geographic Information Systems
gpad	Gallons per acre per Day
gpcd	Gallons per Capita per Day
gpm	Gallons per Minute
GPTC	Grand Parkway Town Center
GST	Ground Storage Tank
HCID	Harris County Improvement District
HGAC	Houston Galveston Area Council
MD	Maximum Day
MG	Million Gallons
MGD	Million Gallons per Day
NHCRWA	North Harris County Regional Water Authority
PH	Peak Hour
psi	Pounds per Square Inch
SCADA	Supervisory Control and Data Acquisition
SH	State Highway
SUD	Special Utility District
TCEQ	Texas Commission on Environmental Quality

2.0 POPULATION AND LAND USE

Population and land use are important elements in the analysis of water distribution systems. Water demands depend on the residential population and commercial development served by the system and determine the sizing and location of system infrastructure. A thorough analysis of historical and projected populations, along with land use, provides the basis for projecting future water demands.

2.1 WATER SERVICE AREA

The existing service area for Tomball's water system is defined by the City's water Certificate of Convenience and Necessity (CCN) located inside the City limits and a portion of the City's Extra-Territorial Jurisdiction (ETJ). The City's existing water service area encompasses an area of approximately 19 square miles and is illustrated on **Figure 2-1**. This study accounts for all growth projected to occur within the City of Tomball water service area in addition to potential water service areas outside the existing water CCN. Growth within the service area will occur through the development of vacant land or through redevelopment. Developments outside the City's water CCN include the Grand Parkway Town Center (GPTC), Harris County Improvement District (HCID) 17, and developments along Telge Road.

2.2 HISTORICAL POPULATION

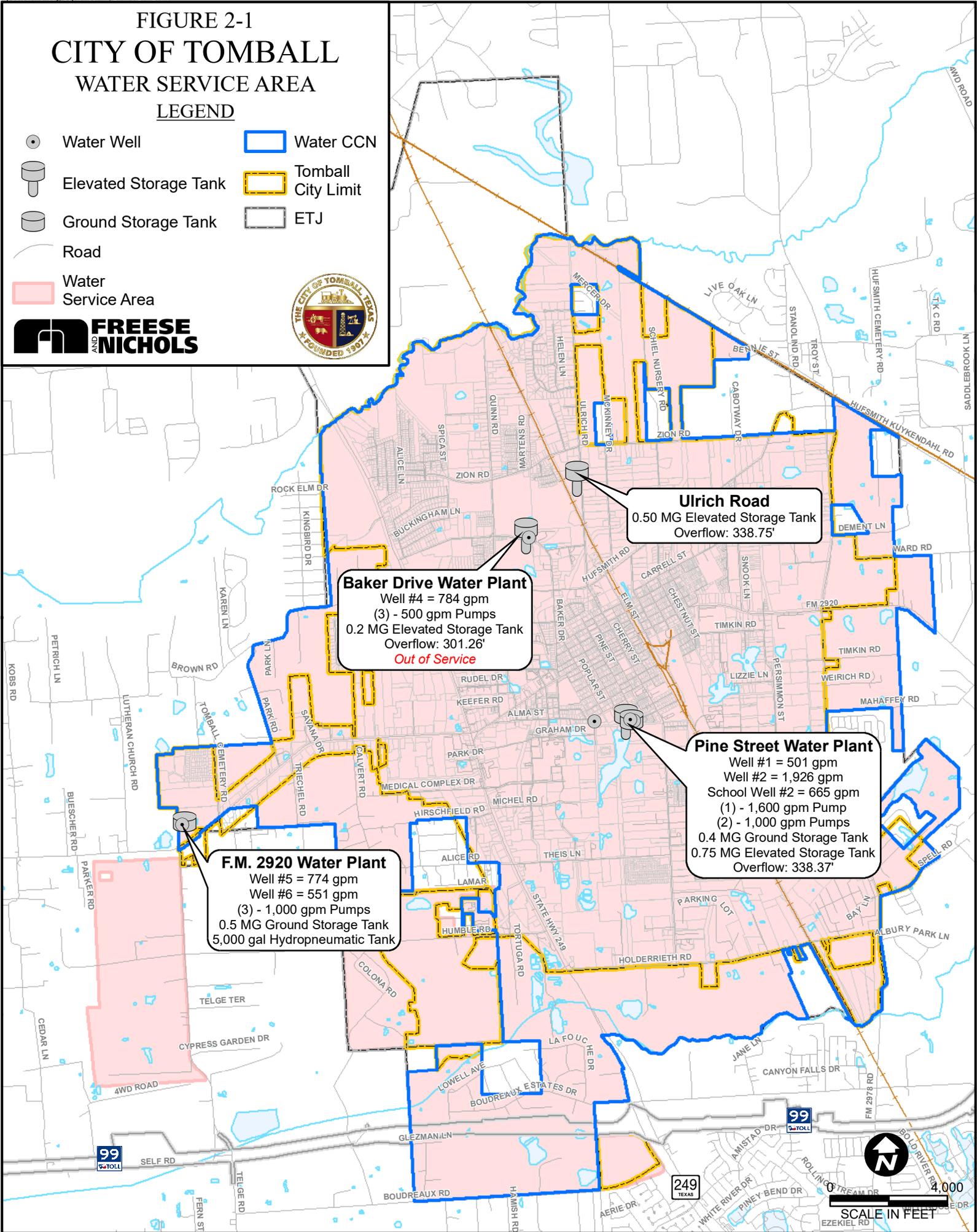
According to the US Census, the City's population increased from 9,089 in 2000 to 10,753 in 2010. The historical City population from 2000 through 2017 is shown in **Table 2-1**. Population estimates for 2001-2009, and 2011-2014 are from the Houston Galveston Area Council (HGAC). The average annual growth rate from 2000 through 2014 ranges from 0.6% to 3.3%, with an average of 1.6%. The populations for 2015, 2016, and 2017 are estimated using the 1.64% growth rate observed in 2014.

The City's water service area population is larger than the City population due to Boudreaux Estates, which is not served wastewater by the City. Based on the water meter connection information, the estimated 2017 population of Boudreaux Estates is approximately 538 people, making the existing Tomball Water Service Area population 12,401.

FIGURE 2-1 CITY OF TOMBALL WATER SERVICE AREA

LEGEND

-  Water Well
-  Elevated Storage Tank
-  Ground Storage Tank
-  Road
-  Water Service Area
-  Water CCN
-  Tomball City Limit
-  ETJ



Baker Drive Water Plant
 Well #4 = 784 gpm
 (3) - 500 gpm Pumps
 0.2 MG Elevated Storage Tank
 Overflow: 301.26'
Out of Service

Ulrich Road
 0.50 MG Elevated Storage Tank
 Overflow: 338.75'

Pine Street Water Plant
 Well #1 = 501 gpm
 Well #2 = 1,926 gpm
 School Well #2 = 665 gpm
 (1) - 1,600 gpm Pump
 (2) - 1,000 gpm Pumps
 0.4 MG Ground Storage Tank
 0.75 MG Elevated Storage Tank
 Overflow: 338.37'

F.M. 2920 Water Plant
 Well #5 = 774 gpm
 Well #6 = 551 gpm
 (3) - 1,000 gpm Pumps
 0.5 MG Ground Storage Tank
 5,000 gal Hydropneumatic Tank





Table 2-1: City of Tomball Historical Population

Year	Population ⁽²⁾	Annual Growth Rate (%)
2000 ⁽¹⁾	9,089	-
2001	9,389	3.3%
2002	9,537	1.6%
2003	9,641	1.1%
2004	9,726	0.9%
2005	9,839	1.2%
2006	10,133	3.0%
2007	10,243	1.1%
2008	10,403	1.6%
2009	10,628	2.2%
2010 ⁽¹⁾	10,753	1.2%
2011	10,935	1.7%
2012	11,047	1.0%
2013	11,117	0.6%
2014	11,299	1.6%
2015 ⁽³⁾	11,484	1.6%
2016 ⁽³⁾	11,672	1.6%
2017 ⁽³⁾	11,863	1.6%
Average		1.6%

(1) U.S. Census data for Tomball city limits.

(2) 2001 – 2009, and 2011 – 2014 population estimates from Houston-Galveston Area Council.

(3) 2015, 2016, 2017 population estimates based on 1.6% growth rate from 2014.

2.3 PROJECTED POPULATION AND DEVELOPMENTS

Growth projections are an important component of the water master planning process. The magnitude and distribution of growth in population and non-residential development will dictate where future water infrastructure is required. It is important to note that projecting the future population is challenging, especially for relatively small geographic areas because it can be difficult to predict how fast or slow development will occur when there are a variety of circumstances that can have an impact.

Future population projections and commercial acreage for each planning year were developed based on input from the City’s Planning, Community Development, and Engineering staff regarding proposed developments and developable acreage, as well as FNI’s analysis. Based on the projected developments and historical trends, an average annual growth rate of 6.2% was used to project the 2022 water service area population, 6.5% to project the 2027 population and 2.4% to project the 2042 population. This is equivalent to an average annual growth rate of 5.5% over the next 25 years. **Table 3-2** presents the water service area projected population for each planning period. The projected growth in commercial acreage is also included.

Table 2-2: Water Service Area Projected Population

Year	Population	Annual Growth Rate	Commercial Acreage
2017	12,401	-	746
2022	16,276	6.2%	754
2027	21,594	6.5%	1,359
2042	29,361	2.4%	1,495
Average Annual Growth Rate		5.5%	-

The total population and commercial acreage for each planning year was distributed throughout the City using the future developments as identified by the City’s Planning, Community Development, and Engineering staff. **Figure 2-2** shows the location of anticipated developments.

The *2009 Tomball Comprehensive Plan* provided assumptions for anticipated residential and commercial land use, and the City directed that the ‘Low’ and ‘Medium’ Density classifications be utilized for the majority of the residential developments, except where indicated on Figure 2-2. These classifications are defined as 2.0 units per acre and 4.5 units per acre, respectively. The comprehensive plan specified a density of 2.6 people per unit. This density was used to determine the population resulting from anticipated developments. The Grand Parkway Town Center provided detailed development information, show in **Table 2-3**.

Table 2-3: Grand Parkway Town Center Projections

Tract	Building Area (acres)	Type	Equivalent Single Family Connection
1	2.64	Grocery	104
2	0.94	Retail	12
3	0.10	Rest. (Sit)	15
4	0.07	Rest.	7
5	3.13	Retail w/Grocery	45
6	0.11	Rest.	10
7	0.08	Rest.	8
8	0.14	Rest. (Sit)	20
9	0.21	Rest. (Sit)	30
10	0.85	Retail	10
11	1.15	Retail	14
12	0.06	Rest.	6
13	0.09	Rest. (Sit)	13
14	0.21	Retail	3
15	0.18	Retail	2
Northside	-	-	100
Total Equivalent Single Family Connections			400

FIGURE 2-2
CITY OF TOMBALL
ANTICIPATED FUTURE DEVELOPMENTS
LEGEND

FUTURE DEVELOPMENTS

- General Development
- Commercial

Residential

- Medium Density* (4.5 Units/Acre)
- Combined Low and Medium Density* (2.0 - 4.5 Units/Acre)

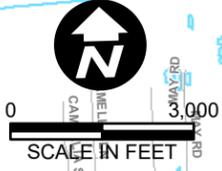
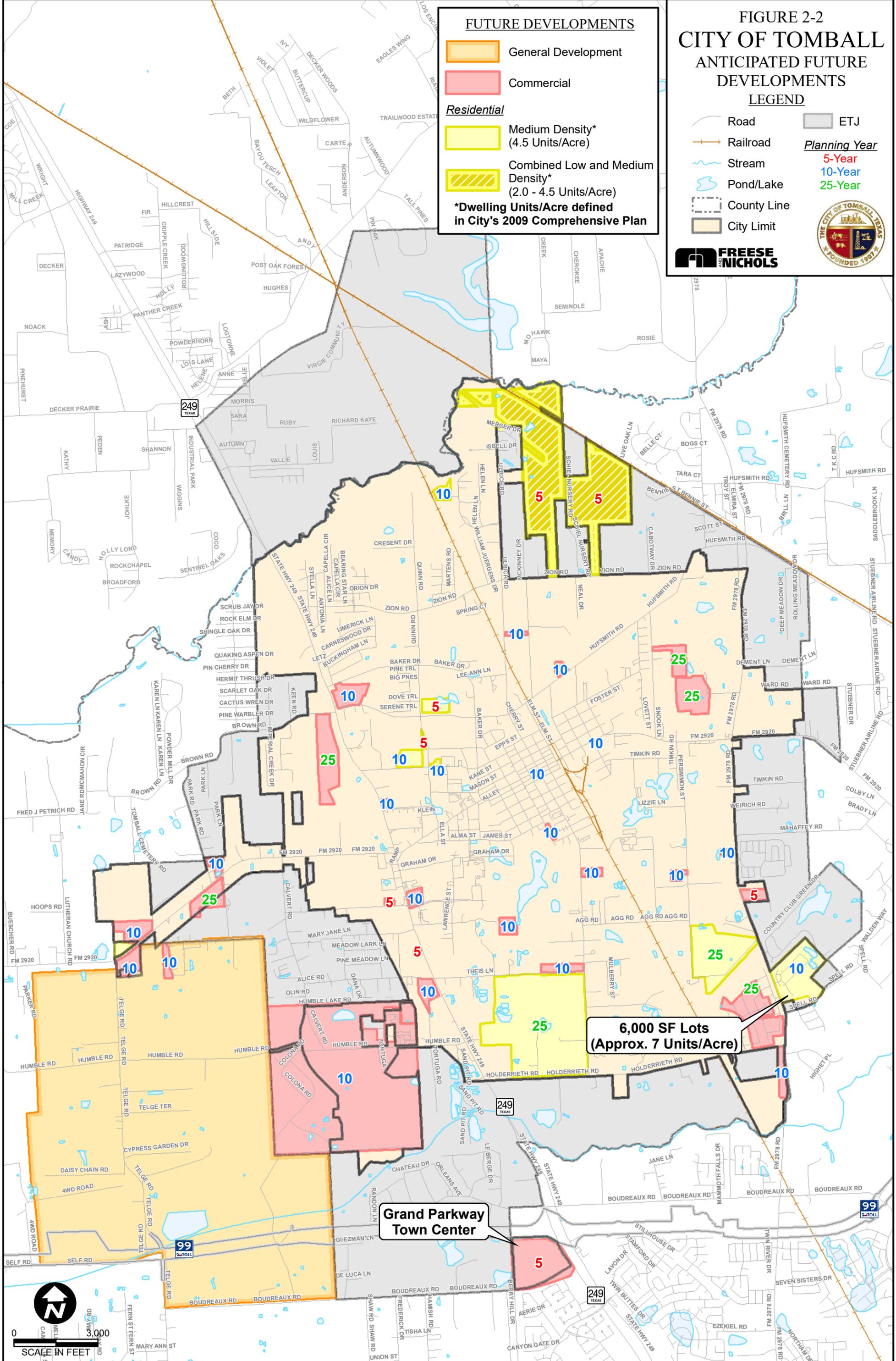
***Dwelling Units/Acre defined in City's 2009 Comprehensive Plan**

- Road
- Railroad
- Stream
- Pond/Lake
- County Line
- City Limit
- ETJ

Planning Year

- 5-Year
- 10-Year
- 25-Year





3.0 WATER DEMANDS

A water utility must be able to supply water at rates that fluctuate over time. Yearly, monthly, daily, and hourly variations in water use occur, with higher use during dry years and in hot months. Also, water use typically follows a diurnal pattern, being low at night and peaking in the early morning and evening. Flow rates most important to the hydraulic design and operation of a pump station and distribution system are average day (AD), maximum day (MD), and peak hour (PH) demands. Average day use is the total annual water use divided by the number of days in the year. The average day demand rate is used as a basis for estimating maximum day and peak hour demands. Maximum day demand is the maximum quantity of water used on any one day of the year. Water supply facilities are typically designed based on the maximum day demand. Peak hour use is the peak rate at which water is required during any one hour of the year. Since minimum distribution pressures are usually experienced during peak hour, the sizes and locations of distribution facilities are generally determined based on this condition.

3.1 HISTORICAL WATER DEMANDS

Reviewing historical water demands provides insight into selecting design criteria used to project future water demands. Historical water production and consumption data was analyzed from 2012 through 2016. FNI obtained recent water production data from the City that consisted of daily production of water facilities in the City. Historical annual average day production in million gallons per day (MGD), peaking factors, and per-capita consumption in gallons per capita day (gpcd) are summarized in **Table 3-1**. Historical average day consumption in MGD, gpcd and gallons per acre per day (gpac) are based on meter billing data and are summarized in **Table 3-2**.

Table 3-1: Historical Water Production

Year	Population ⁽¹⁾	Average Day Demand (MGD)	Average Day Demand (gpcd)	Maximum Day Demand (MGD)	MD:AD Peaking Factor
2012	11,548	2.25	195	4.64	2.06
2013	11,621	2.18	188	4.69	2.15
2014	11,812	2.13	180	4.80	2.25
2015	12,005	2.07	173	4.26	2.06
2016	12,202	2.15	176	4.64	2.16
Average		2.16	182	4.61	2.14
Maximum		2.25	195	4.80	2.25
Minimum		2.07	173	4.26	2.06

(1) Population includes Boudreaux Estates, estimated to be 538 people.

Table 3-2: Historical Water Consumption by Usage Type

Year	Population	Non-Residential Acreage	Average Day Demand (MGD)	Residential		Commercial		Other ⁽¹⁾ Demand (MGD)
				Average Day Demand (MGD)	Average Day Demand (gpad)	Average Day Demand (MGD)	Average Day Demand (gpad)	
2012	11,548	746	1.90	0.98	85	0.80	1,074	0.12
2013	11,621	746	1.91	0.94	81	0.86	1,155	0.10
2014	11,812	746	1.89	0.96	81	0.85	1,136	0.08
2015	12,005	746	1.73	0.88	73	0.77	1,027	0.08
2016	12,202	746	1.79	0.90	74	0.84	1,122	0.05
Average			1.84	0.93	79	0.82	1,103	0.09
Maximum			1.91	0.98	85	0.86	1,155	0.12

(1) Public/municipal and flushed, pumped and emergency water demand.

Since the historical average day residential consumption represents the entire City, the City asked FNI to consider the historical water demand of a recent development, Pine Country, in determining future water demands since future residential development will likely use water in a similar manner. **Table 3-3** presents the historical water consumption for Pine Country using meter billing data for the development and the estimated population to determine the per capita demand.

Table 3-3: Historical Pine Country Water Demand

Month	Number of Meters	Average Day Consumption (gallons per day)	Average Day Consumption ⁽¹⁾ (gpcd)
Aug-15	70	67,390	370
Sep-15	70	45,778	252
Oct-15	69	43,939	245
Nov-15	68	23,291	132
Dec-15	70	14,194	78
Jan-16	69	14,033	78
Feb-16	69	20,325	113
Mar-16	69	21,066	117
Apr-16	70	28,002	154
May-16	71	20,356	110
Jun-16	72	25,228	135
Jul-16	72	47,262	252
Aug-16	72	51,132	273
Sep-16	72	30,325	162
Oct-16	72	34,550	185
Nov-16	72	33,034	176
Dec-16	70	16,002	88
Average			172

(1) Assuming 2.6 people per meter.

3.2 WATER DEMAND PROJECTIONS

Water demands were projected for 2017, 2022, 2027 and 2042 planning periods. The evaluation of historical data in **Table 3-1**, **Table 3-2**, and **Table 3-3** provided a basis for determining the design criteria used to project water demands. Based on the review of this data, FNI recommends using a future average day demand of 175 gpcd for residential growth and 1200 gpad for non-residential acreage growth.

Maximum Day Demand

In selecting a peaking factor to project maximum day demands, FNI reviewed historical peaking factors and the years in which those peaking factors occurred. Historical water usage data indicated the maximum day to average day peaking factor ranged from 2.06 to 2.25 over the last five years; therefore, a peaking factor of 2.25 was selected for future demands.

Peak Hour Demand

After reviewing data recorded during pressure testing, FNI recommends using a peaking factor of 1.7 to project the peak hour demand. Pressure testing and diurnal pattern development is discussed further in **Section 5.0**.

Wholesale Water Customers

The City currently provides wholesale water to HMW Special Utility District (SUD), serving 94 connections or the equivalent of 245 people using a density of 2.6 people per meter. The previously mentioned per capita demand and peaking factors were used to determine HMW SUD water demand.

Figure 3-1 provides a graphical illustration of the historical and projected water demands for the City of Tomball through 2042. **Table 3-4** summarizes the projected water demands

Figure 3-1: Historical and Projected Water Demands

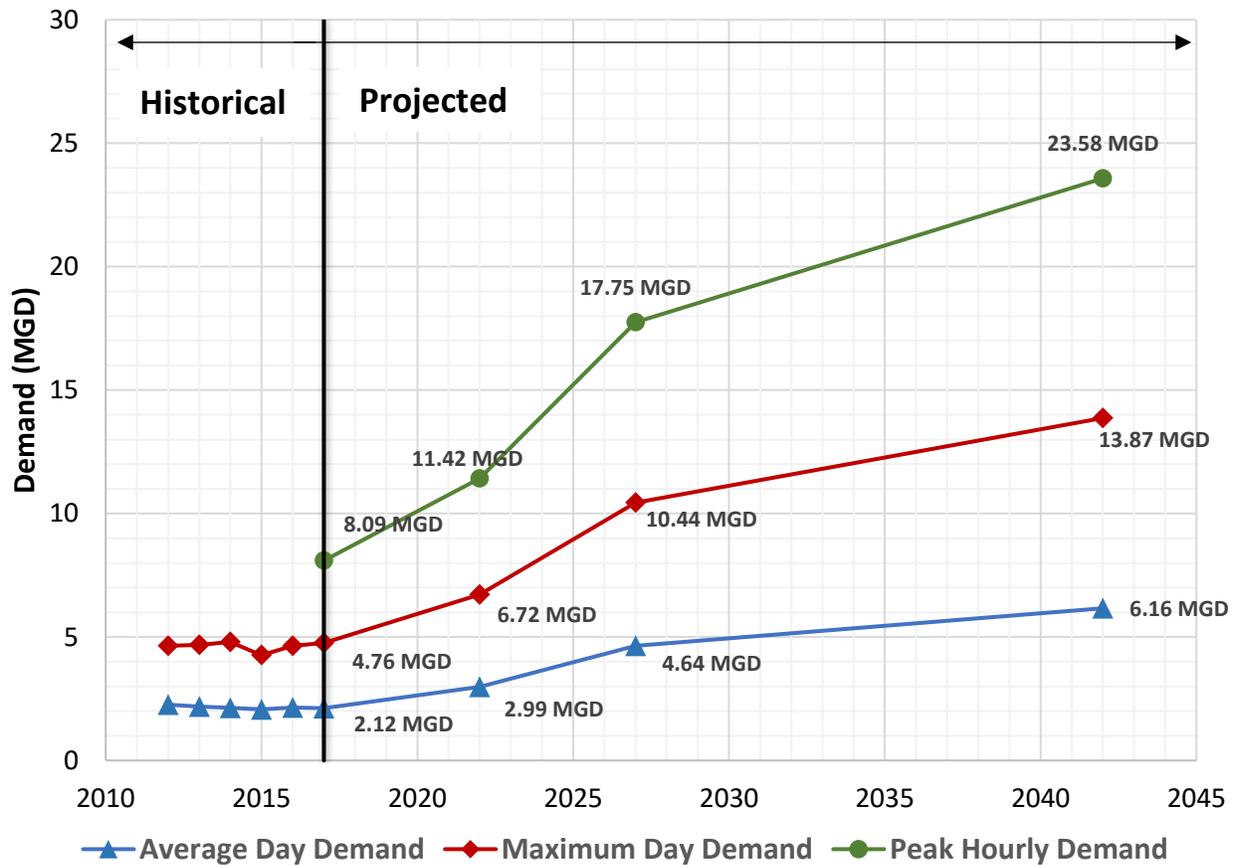


Table 3-4: Projected Water Demands

Year	Population ⁽¹⁾	Number of Connections	People per Connection	Average GPCD ⁽²⁾	AD Demand (MGD)	MD:AD Peaking Factor ⁽³⁾	MD Demand (MGD)	PH:MD Peaking Factor ⁽⁴⁾	Peak Hour (MGD)
2017	12,401	7,029	1.76	171	2.12	2.25	4.76	1.70	8.09
2022	16,276	9,367	1.74	183	2.99	2.25	6.72	1.70	11.42
2027	21,594	11,910	1.81	215	4.64	2.25	10.44	1.70	17.75
2042	29,361	15,459	1.90	210	6.16	2.25	13.87	1.70	23.58

(1) Population and commercial acreage based on Wastewater Master Plan with recent developments added.

(2) Resulting gpcd after using 95 gpcd for existing population, 175 gpcd for future residential population, and 1200 gpcd for commercial.

(3) Based on historical water demand data.

(4) Based diurnal pattern from calibration process.

4.0 EXISTING WATER SYSTEM

The City of Tomball’s water system consists of a network of water lines, the Pine Street Water Plant, the FM 2920 Water Plant and two elevated storage tanks. **Figure 4-1** shows the existing water distribution system for the City of Tomball.

4.1 PRESSURE PLANES

The City’s water distribution system currently has one pressure plane. Ground elevations range between 153 feet and 226 feet. The pressure plane operates at a static hydraulic gradient of 338 feet established by the Pine Street and Ulrich Road elevated storage tanks (ESTs).

4.2 WATER LINES

The City of Tomball’s water system consists of 215 miles of water lines, ranging in size from 1-inch to 18-inches. **Figure 4-2** illustrates the percentage of water line length by diameter.

4.3 WATER SUPPLY

4.3.1 Groundwater

The City relies on five groundwater wells to provide water to its residents. A summary of existing groundwater supply capacity in gallons per minute (gpm) and MGD is shown in **Table 4-1**.

Table 4-1: Existing Groundwater Wells

Well Name	Tested Capacity	
	gpm	MGD
Pine Street #1	501	0.72
Pine Street #2	1,926	2.77
School #2	665	0.96
Well #5	774	1.11
Well #6	551	0.79
TOTAL	4,417	6.36

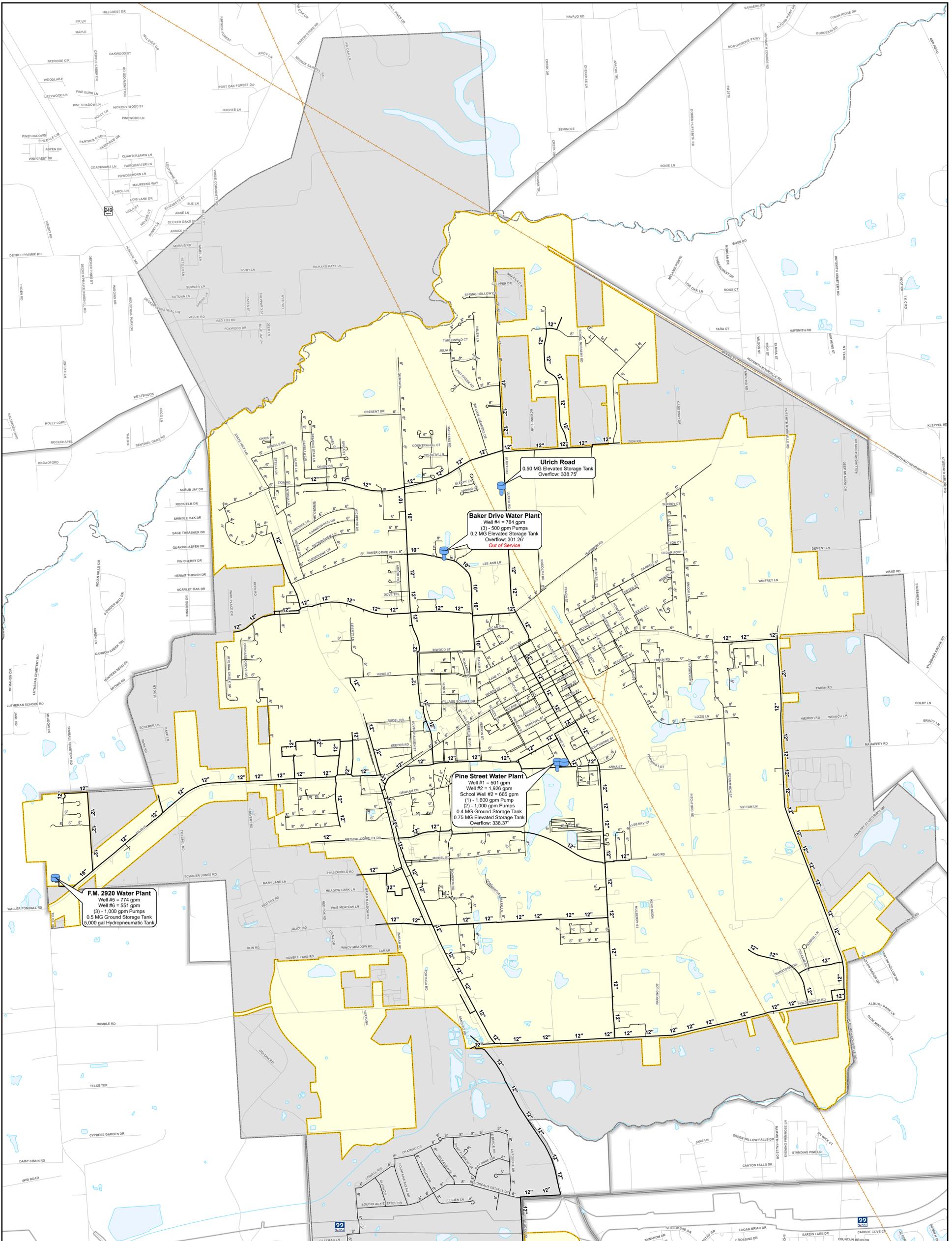


FIGURE 4-1
CITY OF TOMBALL
EXISTING WATER SYSTEM

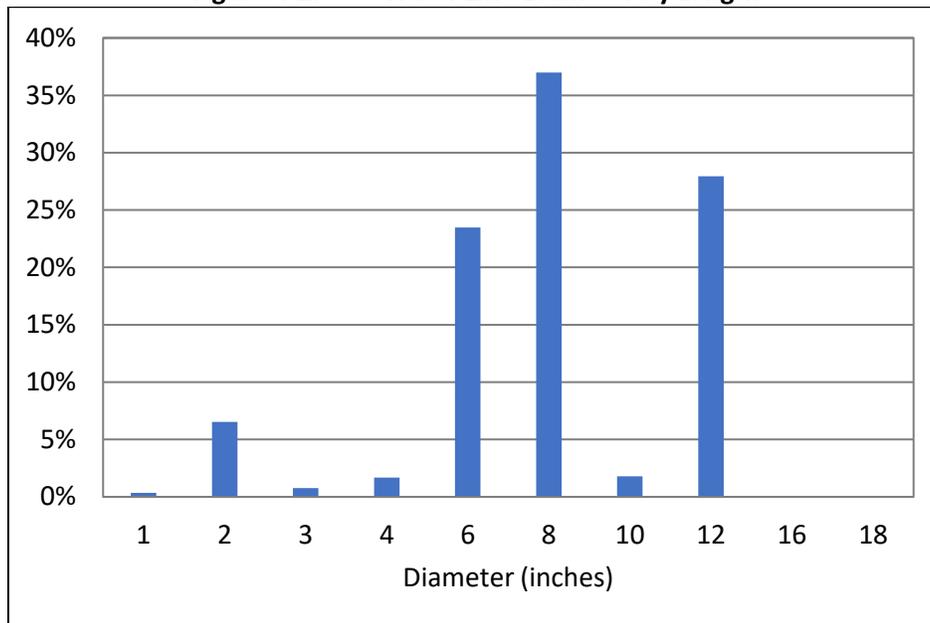
LEGEND

- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ



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 PROJECT: 1710_WW_PLANNING_CDD_FINAL_0807_FINAL_REPORT_VAMP/figm_4-1-Existing_Water_System.mxd
 Update: Monday, September 10, 2018 7:28:48 AM

Figure 4-2: Water Line Diameter by Length



4.3.2 Surface Water

The City of Tomball falls under the North Harris County Regional Water Authority (NHCRWA), which was established to help water providers comply with groundwater reduction plans set forth by the Harris-Galveston Subsidence District. NHCRWA maintains infrastructure to convey treated surface water from the City of Houston Northeast Water Purification Plant to customers in north Harris County. NHCRWA is currently developing infrastructure to provide surface water to the City of Tomball after 2025. The City is actively discussing future surface water requirements with NHCRWA.

4.4 STORAGE FACILITIES

The City currently utilizes two ground storage tanks (GSTs): a 0.4 million gallon (MG) tank at the Pine Street Water Plant and a 0.5 MG tank at the FM 2920 Water Plant. There are two ESTs in the water distribution system: Pine Street (0.75 MG) and Ulrich Road (0.5 MG).

4.5 PUMP STATIONS

The City has two pump stations: Pine Street and FM 2920. The City has a total system pumping capacity of 10.37 MGD and a firm system pumping capacity of 8.06 MGD, which is the capacity with the largest pump out of service. **Table 4-2** provides a summary of pumping facilities.



Table 4-2: Existing Pumping Facilities

Facility Name	Pump Number	Rated Capacity (gpm)	Rated Capacity (MGD)	Rated Head (feet)
Pine Street Pump Station	1	1,000	1.44	110
	2	1,000	1.44	110
	3	1,600	2.30	110
FM 2920 Pump Station	1	1,000	1.44	150
	2	1,000	1.44	150
	3	1,000	1.44	150
TOTAL		7,200	10.37	-
FIRM		5,600	8.06	-

5.0 HYDRAULIC FIELD TESTING AND MODEL CALIBRATION

The hydraulic model is one of the most critical elements in the analysis of water distribution systems. A calibrated water model serves as a key decision making tool to help determine the sizing and location of system infrastructure in both the present and future planning periods.

5.1 FIELD PRESSURE TESTING

To assist with model calibration and supplement available operational data, field pressure testing was conducted October 25 – November 22, 2016, and July 19 – August 4, 2017. A total of eight pressure recorders were installed throughout the distribution system. Locations of the pressure recorders are illustrated on **Figure B-1** in **Appendix B**. Minimum, maximum, and average pressures were recorded every fifteen minutes at each location. Complete data from most recorders was collected from October 25th at 12:00 AM through November 21st at 12:00 AM and from July 20th at 12:00 AM through August 3rd at 12:00 AM. During the Fall 2016 pressure testing, the hydrant at PR-07 was accidentally closed during testing. During the Summer 2017 pressure testing, the hydrant at PR-01 was accidentally closed during testing. **Appendix B** includes the pressure recorder data from the field testing period.

5.2 MODEL DEVELOPMENT

5.2.1 Physical Network

The water model was updated using the InfoWater software by *Innovyze*[®]. City staff provided the GIS shapefiles of water lines that were imported into the model. The model contains 1,308 links with diameters ranging in size from 1-inch to 18-inches. FNI added links to connect pumps to the distribution system. Initial Hazen-Williams roughness coefficients for water lines were assigned based on the installation year, as listed in **Table 5-1**.

Table 5-1: Initial Hazen-Williams C-Value Assignments

Year	C-Value
1991 – Present	130
1980 – 1990	120
Before 1980	100

All pumping and storage facilities, including pump curves, were manually added to the model based on as-built drawings and information provided by the City. Variable area tank curves were developed to accurately model changes in tank volume. There are 1,067 junctions, six pumps, four storage tanks, and two reservoirs in the model, representing groundwater wells. Model nodes in the distribution system

were assigned an elevation based on the two-foot ground contour data provided by the City. Elevations for facilities (tanks and pumps) were assigned using as-built drawings and two-foot contour elevations.

5.2.2 Demand Allocation

FNI allocated demands to the model using water customer billing accounts. The active water meters were spatially located, and the associated consumption was assigned to the nearest model node. The water demands were divided into two categories: residential and non-residential usage. The information from the customer billing database was joined to the parcel shapefile by the unique customer address. FNI used the spatial join function in GIS to distribute August 2016 demands to the model nodes. Once demands were allocated to the model nodes, they were scaled to match the demands of the selected calibration day.

5.2.3 Extended Period Simulation Calibration

In order to verify that the hydraulic model accurately represents actual distribution system operation, an extended period simulation (EPS) model calibration analysis was performed. The calibration process involves adjusting system operational parameters, roughness values, demand allocation, and diurnal patterns to match a known system condition. The 24-hour period occurring on July 26, 2017, was selected for calibration. This day was selected because there were no irregularities in system operations. Data for PR-01, which was closed during pressure testing, was substituted with data from November 2, 2016. This section provides a summary of the calibration process, the adjustments made during calibration and the modeled results versus the actual recorded values.

5.2.4 Calibration Process

The City provided typical pump controls for both water plants based on the Ulrich EST level, included in **Table 5-2**. Data from pressure recorders near the Pine Street and Ulrich Road ESTs were used to estimate elevated storage tank levels. The flow from each pump station was estimated based on the pressure data at the ESTs. Estimated flows and tank levels were utilized to calculate an overall diurnal curve by examining water going into (supply) and out of (demand) the distribution system. The City provided water production data for July 26th indicating an average demand of 2.86 MGD.

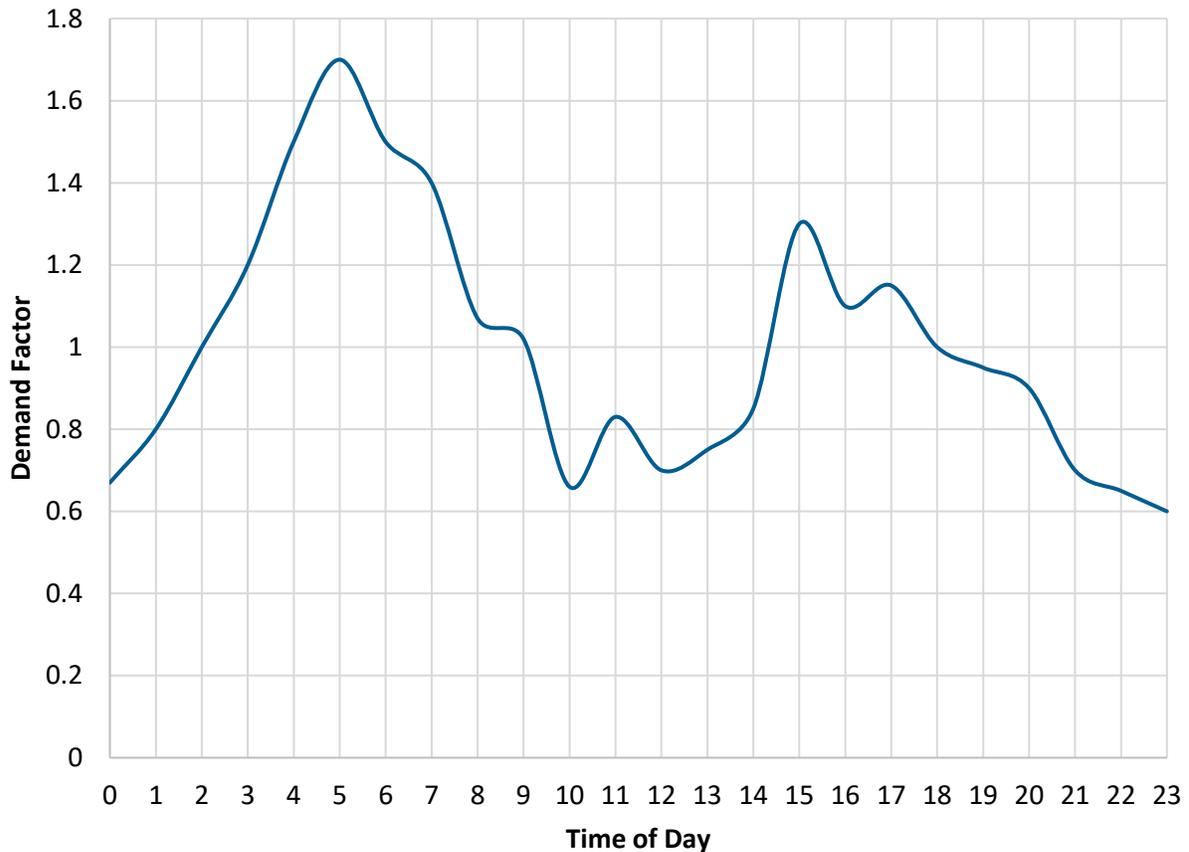
Table 5-2: Existing Pump Controls

Facility Name	Pump Number	Control	Pump On	Pump Off
Pine Street Pump Station	1	Ulrich EST Level (feet)	33	37
	2		30	37
	3		25	37
FM 2920 Pump Station	1	Pressure at Ulrich EST (psi)	60	65
	2		48	65
	3		45	65

5.2.5 Calibration Controls and Adjustments

During the EPS calibration, adjustments were made to the model in order to match the known conditions of July 26, 2017. The calculated diurnal pattern factors and pump settings were adjusted such that the resulting pressure values better matched the recorded data. **Figure 5-1** shows the diurnal pattern for July 26, 2017.

Figure 5-1: Water System Diurnal Pattern for July 26, 2017



5.2.6 Calibration Results

The results of the EPS calibration are summarized on the graphs included in **Appendix C**. The graphs show modeled pressures versus recorded data at pressure recorder locations. Calibration statistics are presented in **Table 5-3**. Each monitored location includes 24 data points (one for each hour of the calibration) where the recorded and modeled pressures were compared. The percentages presented in the tables were determined by the number of points that fell within the given measurement range. The results suggest a good correlation between recorded and modeled values and provide a high level of confidence in the accuracy of the model. The model is calibrated well within the industry standards.

Table 5-3: Pressure Calibration Statistical Summary

Pressure Recorder	Within 5 psi	Within 3 psi
PR-1 ⁽¹⁾	100%	96%
PR-2	100%	100%
PR-3	100%	100%
PR-4	100%	100%
PR-5	100%	100%
PR-6	100%	100%
PR-7	100%	100%
PR-8	100%	100%
Average	100%	99%

(1) Data from November 2, 2016.



6.0 WATER SYSTEM ANALYSIS AND HYDRAULIC MODELING

As a public water utility, the City of Tomball must comply with the rules and regulations for public water systems set forth by the Texas Commission on Environmental Quality (TCEQ) in Chapter 290. Hydraulic analyses were conducted to identify deficiencies in the City of Tomball’s existing water distribution system and to establish a CIP to reinforce the existing system and meet projected water demands through 2042. Various combinations of improvements and modifications were investigated to determine the most appropriate approach for meeting projected demands. Considerations used in developing the improvements plan included evaluating supply, storage and pumping, meeting required fire flows, and maintaining proper residual pressures.

6.1 EXISTING WATER SYSTEM ANALYSIS

6.1.1 Existing Water Supply Capacity

The City is required to meet the TCEQ water supply requirement of two or more wells having a total capacity of 0.6 gpm per connection. The City’s tested water supply capacity was provided by the City and used for this analysis. The estimated existing number of connections was used to calculate the minimum required water supply capacity. **Table 6-1** presents the TCEQ water supply requirements for the existing water system.

Table 6-1: 2017 TCEQ Water Supply Capacity Requirements

Population	Number of Connections	Existing Tested Water Supply Capacity (MGD)	TCEQ Requirement ⁽¹⁾ 0.6 gpm/con (MGD)
12,401	7,029	6.36	6.07

(1) According to 290.45(b)(1)(D)(i).

Based on the regulations, the City is currently in compliance with the minimum water supply capacity requirement.

6.1.2 Existing Storage Capacity

The City is required to meet the TCEQ total storage capacity requirement of 200 gallons per connection and elevated storage capacity requirement of 100 gallons per connection. The estimated existing number of connections was used to calculate the TCEQ minimum required storage. **Table 6-2** presents the TCEQ storage requirements for the existing water system.

Table 6-2: 2017 TCEQ Storage Capacity Requirements

Population	Number of Connections	Total Storage (MG)		Elevated Storage (MG)		200 gal/con
		Existing	Required (200 gal/con)	Existing	Required (100 gal/con)	
12,401	7,029	2.15	1.41	1.25	0.7	1.41

Based on the regulations, the City is in compliance with the minimum amount of total and elevated storage capacity requirement.

6.1.3 Existing Pumping Capacity

In addition to storage and water supply requirements, the City is also required to meet the service pumping capacity requirements presented in **Table 6-3**. **Table 6-4** presents the TCEQ service pumping requirements for the existing water system.

Table 6-3: TCEQ Service Pumping Requirements

Condition	Service Pumping Capacity Requirement ⁽¹⁾
1. If providing at least 200 gallons per connection of elevated storage	Two service pumps with a minimum combined capacity of 0.6 gpm per connection at each pressure plane
2. If providing less than 200 gallons per connection of elevated storage	The lesser of (a) or (b):
	(a) Total pumping capacity of 2.0 gpm per connection
	(b) Total capacity of at least 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service

(1) According to 290.45(b)(1)(D)(iii).

From **Table 6-2**, Tomball does not have greater than 200 gallons per connection of elevated storage; therefore, Condition 1 from **Table 6-3** is not satisfied. Based on the City’s elevated storage capacity, Condition 2b is the lesser of Condition 2 and governs the City’s service pumping capacity, which requires that the City be able to meet peak hourly demands with firm pumping capacity. Model results included in **Section 6.1.4** show that the City is not able to meet peak hourly demands with the largest pump out of service and maintain a minimum pressure of at least 35 psi throughout the water system. However, this is due to high elevations and small water lines resulting in headloss and is not due to a lack of firm pumping capacity. **Section 6.1.4** outlines recommendations to reduce headloss and increase the City’s water system pressure by constructing new water lines and improving connectivity.

Table 6-4: 2017 TCEQ Pumping Capacity Requirements

Population	Number of Connections	Peak Hour Demand (MGD)	Existing Firm Pumping Capacity (MGD)	TCEQ Requirement 0.6 gpm/con (MGD)	TCEQ Requirement 2.0 gpm/con (MGD)
12,401	7,029	8.09	8.06	6.08	20.25

6.1.4 Hydraulic Analysis

A 24-hour EPS hydraulic model analysis were performed on the distribution system under maximum day demand conditions. By examining the distribution system under these various operating conditions, it is possible to determine where issues with pressures occur, if tanks are filling or draining properly, and if the service pumping facilities are adequate to meet the required demand at acceptable pressures.

A maximum day EPS model run evaluates the ability of the system to provide adequate supply to meet demands while maintaining levels in storage facilities. During a maximum day EPS analysis, the peak hour demand is also simulated through the use of the diurnal patterns developed in **Section 5.2.5**. Peak hour demand represents the single hour of the year with the highest system demand. Peak hour simulations are used to assess the ability of the distribution system to maintain minimum residual pressures. Lower demand periods throughout the day are simulated in EPS modeling as well. This is when the system’s ability to replenish storage tanks is evaluated.

Color-coded pressure maps were prepared to illustrate the residual pressure calculated at model junctions. The maps helped identify potential problem areas in the system and were used as a tool to check that reasonable pressure ranges were maintained throughout the system. Maps showing the minimum pressures under maximum day demands can be found in **Appendix D**. Minimum pressures shown on the maps represent the lowest value of the pressures experienced during the 24-hour simulation, usually occurring during the peak hour demand.

High elevation areas near the northwest area of the City are shown to experience low water system pressure. Water lines throughout the downtown area are shown to experience excessive headloss due to undersized water lines, which contribute to low water system pressure. It is recommended that the City increase the size of the distribution lines along Main Street as well as connecting larger water lines in the northeast area of the City.

6.1.5 Fire Flow Analysis

To evaluate the fire suppression capabilities of the system, a fire flow model analysis was conducted under maximum day demand conditions. TCEQ requires a minimum residual pressure of 20 psi be maintained while delivering the fire flow demand. For this analysis, a steady-state model run was utilized to calculate the available fire flow at each fire hydrant node in the system with a pressure of 20 psi and maintaining velocity of less than 10 feet per second in nearby water lines. A fire flow contour map was also prepared to show the available fire flow throughout the distribution system. Areas shown to have an available fire flow less than 1,000 gpm include small lines (less than 6-inches) and dead-end lines in the north, northeast, and west areas of Tomball. The majority of the City has an available fire flow greater than 1,500 gpm. The fire flow maps for existing system conditions can be found in **Appendix D**.

6.2 FUTURE WATER SYSTEM ANALYSIS

6.2.1 Future Required Water Supply Capacity

Table 6-5 shows the City’s water supply capacity versus TCEQ water supply requirements for future planning periods. The future number of connections is based on the existing people per connection of 1.79 for regular City growth and adding the anticipated number of connections for HWM SUD wholesale, GPTC and developments along Telge Road.

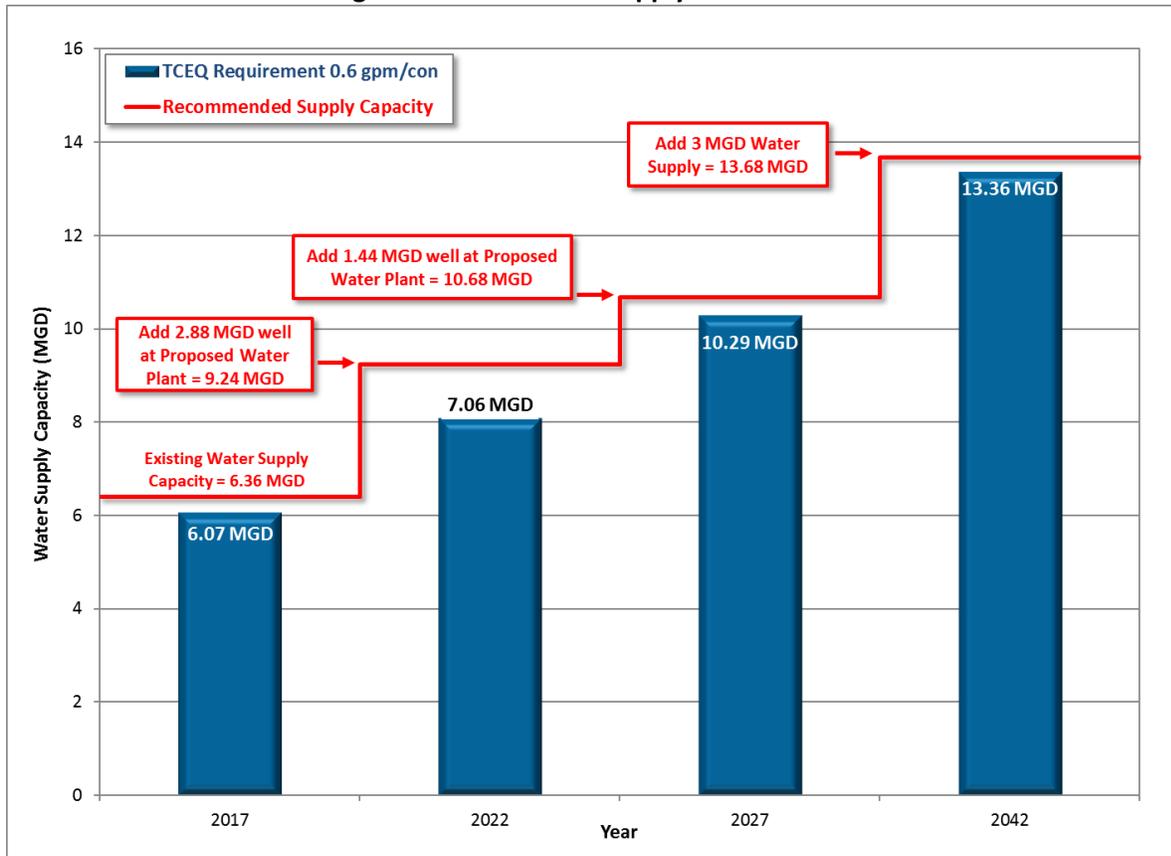
Table 6-5: Projected Water Supply Capacity Requirements

Year	Population	Number of Connections	Existing Water Supply Capacity (MGD)	TCEQ Requirement 0.6 gpm/con (MGD)	Recommended Capacity ⁽¹⁾ (MGD)
2022	16,276	9,367	6.36	8.09	9.24
2027	21,594	11,910	6.36	10.29	10.68
2042	29,361	15,459	6.36	13.36	13.68

(1) It is recommended that the City add 2.88 MGD groundwater supply by 2022, 1.44 MGD groundwater supply by 2027, and 3 MGD of water supply by 2042.

It is recommended that the City add 2.88 MGD of groundwater supply by 2022, 1.44 MGD of groundwater supply by 2027, and 3 MGD of water supply (groundwater or surface water) by 2042 to meet future water demand, shown on **Figure 6-1**.

Figure 6-1: Water Supply Recommendations



6.2.2 Future Required Storage Capacity

Table 6-6 shows the City’s total and elevated storage capacity versus TCEQ storage requirements for future planning periods. It is recommended that the City maintain enough ground storage to store 8 hours of maximum day demand and be able to meet 70% of peak hour demand with service pumping and 30% with elevated storage.

Table 6-6: Projected Storage Capacity Requirements

Year	Population	Number of Connections	Total Storage (MG)		Ground Storage (MG)	Elevated Storage (MG)	
			Reqd. (200 gal/con)	Recommended	Recommended ⁽¹⁾	Required (100 gal/con)	Recommended ⁽²⁾
2022	16,276	9,367	1.87	3.15	1.90	0.94	1.25
2027	21,594	11,910	2.38	6.90	4.40	1.19	2.50
2042	29,361	15,459	3.09	7.30	4.80	1.55	2.50

(1) Includes 1 MG GST at Proposed East Water Plant by 2022, three 0.5 MG GSTs at FM 2920 Water Plant by 2027, 1 MG GST at Proposed East Water Plant By 2027, 0.4 MG GST at Pine Street Water Plant by 2042.

(2) It is recommended that the City construct a 1.25 MG EST by 2027. The EST may be constructed sooner to meet commercial fire flow requirements.

The existing total storage capacity of 2.15 MG meets TCEQ minimum total storage requirements through 2022. It is recommended that 3.9 MG of ground storage capacity be added at the City’s existing water plants or at new water plants the City constructs to provide storage for 8 hours of maximum day demand. A new 1.25 MG EST is recommended to be constructed near the south area of the City by 2027 to meet 30% of peak hour demand and fire flow emergencies.

6.2.3 Future Required Service Pumping Capacity

Table 6-7 shows the City’s service pumping capacity versus TCEQ service pumping requirements and FNI’s recommended pumping capacity for future planning periods.

Table 6-7: Projected Service Pumping Capacity Requirements

Year	Population	Number of Connections	Existing Firm Pumping Capacity (MGD)	Design Criteria 70% of PH (MGD)	Recommended Capacity ⁽¹⁾ (MGD)
2022	16,276	9,367	8.06	7.99	11.52
2027	21,594	11,910	8.06	12.43	13.68
2042	29,361	15,459	8.06	16.50	16.56

(1) It is recommended that the City construct the Proposed East Water Plant with 4.32 MGD firm pumping capacity by 2022, expand the Proposed East Water Plant by 2.16 MGD firm pumping capacity by 2027, and expand the FM 2920 Water Plant by 2.88 MGD by 2042.

It is recommended to add 4.32 of service pumping capacity by 2022, 2.16 MGD by 2027 and 2.88 MGD of service pumping capacity by 2042. Model results included in **Section 6.2.4** show that the City will be able to meet peak hourly demands with the largest pump out of service and maintain a minimum pressure of at least 35 psi throughout the water system.

6.2.4 Water System Improvements

FNI worked with City staff to develop and identify water system improvements to accommodate future growth while optimizing the existing system operations and infrastructure. Some of the major operational changes and improvements to the distribution system include:

- Add water supply capacity through groundwater wells and surface water from NHCRWA
- Increase emergency water storage capacity by adding ground storage tanks
- Improve system pressure by adding booster pumping capacity, a new elevated storage tank and constructing larger water lines
- Increase available fire flow by adding a new elevated storage tank and looping dead-end water lines

Specific capital improvement projects to accomplish the above are discussed in detail in **Section 7.0**. Hydraulic analyses of the maximum day EPS and fire flow scenarios were evaluated to ensure CIP projects addressed existing and future water system problems. Maps showing model results are included in **Appendix E**. The results show improvement in system pressures as well as the available fire flow throughout the City.

7.0 CAPITAL IMPROVEMENTS PLAN

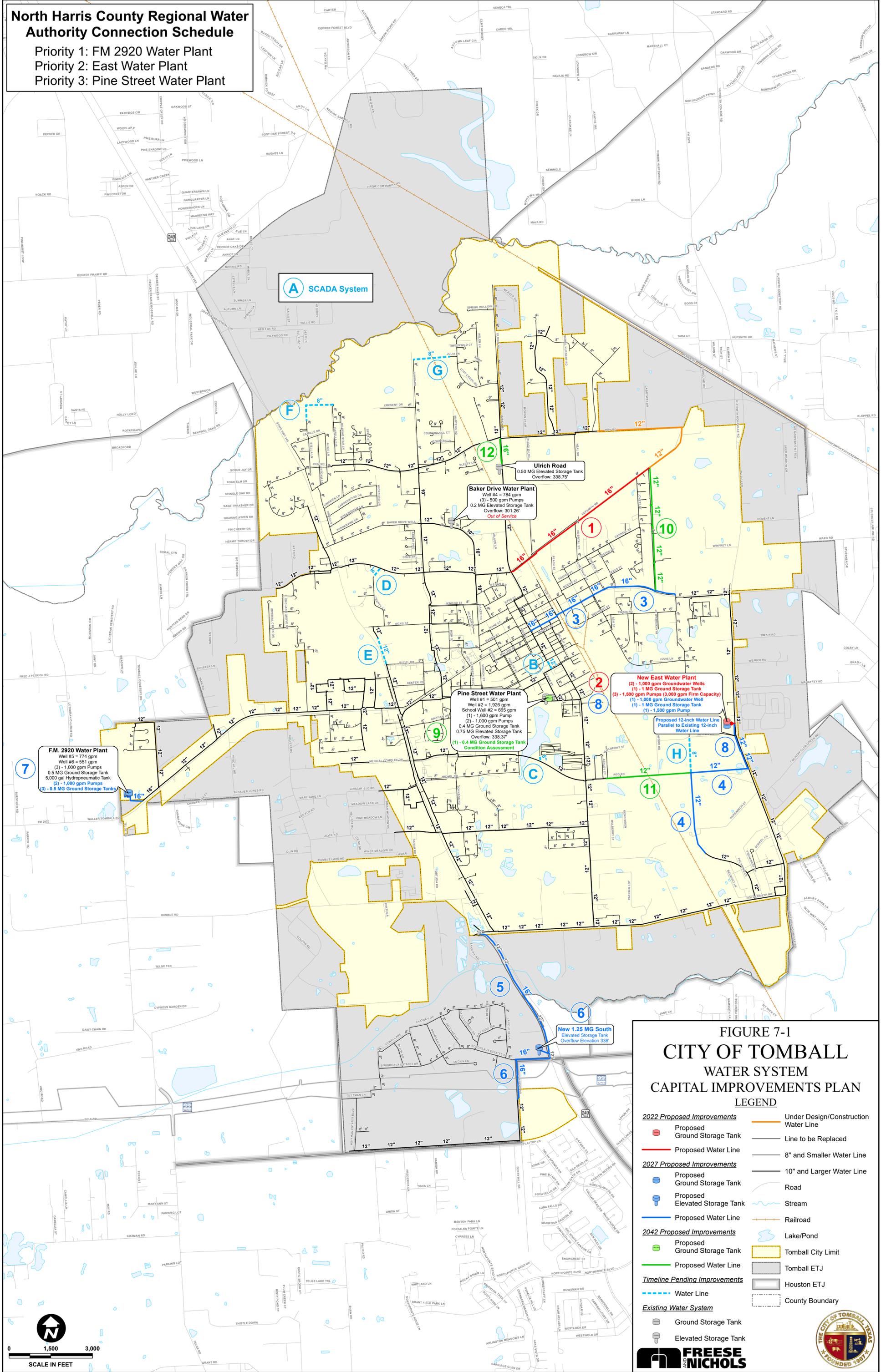
A capital improvements plan was developed for the City of Tomball to promote a high level of water service that promotes residential and commercial development. The recommended improvements will provide the required capacity and reliability to meet projected water demands through 2042 conditions. The recommended projects for the water system are presented on **Figure 7-1**.

Locations shown for new lines and other recommended improvements were generalized for hydraulic analyses. Specific alignments and sites will be determined as part of the design process. Water projects currently under design are shown in **orange** on **Figure 7-1**. Timeline pending water line projects are shown in **sky blue** on **Figure 7-1**. Water lines to be constructed as part of future development are shown in **purple** on **Figure 7-2** and were included and correctly sized for the hydraulic analysis. It is recommended that these projects be constructed generally in the order listed; however, development or renewal patterns may make it necessary to construct some projects sooner than anticipated.

Capital costs were calculated for the recommended improvements. The costs are in 2018 dollars and include an allowance for engineering, surveying, and contingencies. Costs do not include easements or land acquisition, except where specifically noted in detailed cost estimates. The following sections describe how the CIP projects contribute to major operational changes and water system improvements. **Table 7-1** summarizes the costs of the water system CIP for the City of Tomball. Detailed cost estimates are included in **Appendix A**.

North Harris County Regional Water Authority Connection Schedule

- Priority 1: FM 2920 Water Plant
- Priority 2: East Water Plant
- Priority 3: Pine Street Water Plant



A SCADA System

Ulrich Road
0.50 MG Elevated Storage Tank
Overflow: 338.75'

Baker Drive Water Plant
Well #4 = 784 gpm
(3) - 500 gpm Pumps
0.2 MG Elevated Storage Tank
Overflow: 301.26'
Out of Service

Pine Street Water Plant
Well #1 = 601 gpm
Well #2 = 1,926 gpm
School Well #2 = 665 gpm
(1) - 1,500 gpm Pump
(2) - 1,000 gpm Pumps
0.4 MG Ground Storage Tank
0.75 MG Elevated Storage Tank
Overflow: 338.37'
(1) - 0.4 MG Ground Storage Tank
Condition Assessment

New East Water Plant
(2) - 1,000 gpm Groundwater Wells
(1) - 1 MG Ground Storage Tank
(3) - 1,500 gpm Pumps (3,000 gpm Firm Capacity)
(1) - 1,000 gpm Groundwater Well
(1) - 1 MG Ground Storage Tank
(1) - 1,500 gpm Pump

Proposed 12-inch Water Line
Parallel to Existing 12-inch
Water Line

F.M. 2920 Water Plant
Well #5 = 774 gpm
Well #6 = 551 gpm
(3) - 1,000 gpm Pumps
0.5 MG Ground Storage Tank
5,000 gal Hydro-pneumatic Tank
(2) - 1,000 gpm Pumps
(3) - 0.5 MG Ground Storage Tank

New 1.25 MG South
Elevated Storage Tank
Overflow Elevation 338'

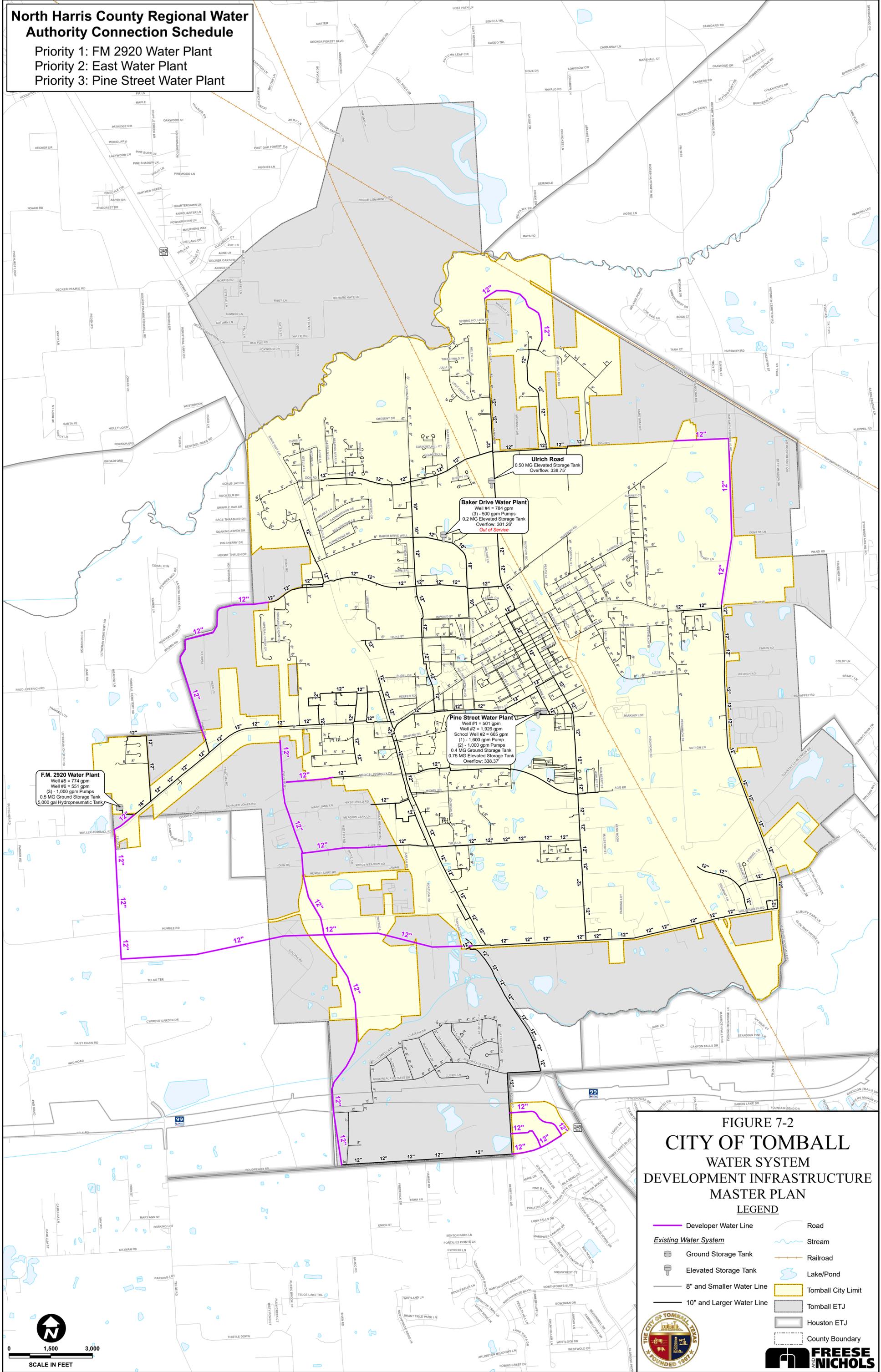
FIGURE 7-1 CITY OF TOMBALL WATER SYSTEM CAPITAL IMPROVEMENTS PLAN LEGEND

- | | | |
|--------------------------------------|------------------------------|--------------------------------------|
| 2022 Proposed Improvements | Proposed Ground Storage Tank | Under Design/Construction Water Line |
| Proposed Water Line | Line to be Replaced | 8" and Smaller Water Line |
| 2027 Proposed Improvements | Proposed Ground Storage Tank | 10" and Larger Water Line |
| Proposed Elevated Storage Tank | Proposed Water Line | Road |
| 2042 Proposed Improvements | Proposed Ground Storage Tank | Stream |
| Proposed Water Line | Railroad | Lake/Pond |
| Timeline Pending Improvements | Water Line | Tomball City Limit |
| Existing Water System | Ground Storage Tank | Tomball ETJ |
| Elevated Storage Tank | Houston ETJ | County Boundary |



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North Harris County Regional Water Authority Connection Schedule
 Priority 1: FM 2920 Water Plant
 Priority 2: East Water Plant
 Priority 3: Pine Street Water Plant



F.M. 2920 Water Plant
 Well #5 = 774 gpm
 Well #6 = 551 gpm
 (3) - 1,000 gpm Pumps
 0.5 MG Ground Storage Tank
 5,000 gal Hydropneumatic Tank

Baker Drive Water Plant
 Well #4 = 784 gpm
 (3) - 500 gpm Pumps
 0.2 MG Elevated Storage Tank
 Overflow: 301.28'
 Out of Service

Pine Street Water Plant
 Well #1 = 501 gpm
 Well #2 = 1,029 gpm
 School Well #2 = 665 gpm
 (1) - 1,600 gpm Pump
 (2) - 1,000 gpm Pumps
 0.4 MG Ground Storage Tank
 0.75 MG Elevated Storage Tank
 Overflow: 338.37'

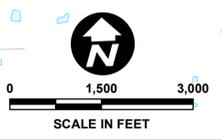
Ulrich Road
 0.50 MG Elevated Storage Tank
 Overflow: 338.75'

FIGURE 7-2
CITY OF TOMBALL
WATER SYSTEM
DEVELOPMENT INFRASTRUCTURE
MASTER PLAN
LEGEND

	Developer Water Line		Road
	Existing Water System		Stream
	Ground Storage Tank		Railroad
	Elevated Storage Tank		Lake/Pond
	8\"/>		Tomball City Limit
	10\"/>		Tomball ETJ
	County Boundary		Houston ETJ

THE CITY OF TOMBALL TEXAS
 FOUNDED 1907

FREES & NICHOLS



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Table 7-1: Capital Improvements Plan Cost Summary

Phase	Project Number	Project Name	Cost
By 2022	1	12-inch Water Line along Hufsmith Road	\$ 1,477,900
	2	New 3,000 gpm East Water Plant with 1.0 MG GST	\$ 14,882,400
	Total 2017 - 2022		\$ 16,360,300
By 2027	3	12/16-inch Water Line along Main Street	\$ 2,229,900
	4	12-inch Water Line along Medical Complex Drive	\$ 1,045,100
	5	16-inch Water Line along SH 249	\$ 1,566,800
	6	1.25 MG EST and 16-inch Water Line ⁽¹⁾	\$ 6,851,600
	7	2,000 gpm FM 2920 Pump Station Expansion with 1.5 MG GSTs	\$ 4,442,900
	8	1,500 gpm East Water Plant Expansion with 1.0 MG GST	\$ 5,602,000
	Total 2023 - 2027		\$ 21,738,300
By 2042	9	0.4 MG Pine Street Water Plant GST and Pine Street Pump Station Condition Assessment	\$ 836,200
	10	12-inch Water Lines along Snook Lane, Lovett Street, and Zion Road	\$ 952,100
	11	12-inch Water Line along Agg Road	\$ 621,300
	12	16-inch Water Line along Ulrich Road	\$ 333,400
	Total 2028 - 2042		\$ 2,743,000
Total 25-year Water CIP Cost			\$ 40,841,600
Timeline Pending	A	SCADA System	\$ 650,000
	B	12-inch Water Line along Oak Street	\$ 112,200
	C	8-inch Water Line in Corral RV Park	\$ 58,400
	D	8-inch Water Line along Liberty Lane	\$ 71,100
	E	12-inch Water Line along SH 249	\$ 226,600
	F	8-inch Water Line along Stella Lane	\$ 225,800
	G	8-inch Water Line along Julia Lane	\$ 306,500
	H	8-inch Water Line along Persimmon Road	\$ 201,900
	Total Timeline Pending Projects Cost		\$ 1,852,500
Total 25-year Water CIP Cost with Timeline Pending Projects			\$ 42,694,100

(1) This project may be constructed sooner to meet commercial fire flow requirements.

7.1 WATER PROJECTS FROM 2017 TO 2022

Project 1: 12-inch Water Line along Hufsmith Road

Description: This project includes the construction of a new 12-inch water line along Hufsmith Road from Ulrich Road to Lovett Street.

Project Drivers: The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing

available fire flow. This project will help alleviate areas of low water system pressure in the northwest area of the City.

Project 2: New 3,000 gpm East Water Plant 1.0 MG GST

Description: This project includes the construction of a new 3,000 gpm pump station, 1.0 MG ground storage tank and 2,000 gpm of groundwater well capacity along Hufsmith-Kohrville Road in between Mahaffey Road and Country Club Green Drive. Surface water from NHCRWA is anticipated to be delivered to this facility by 2027.

Project Drivers: The recommended pump station is sized to meet 70% of 2042 peak hourly demand. The recommended ground storage tank is sized to meet 8 hours of 2042 maximum day demand. The recommended groundwater supply capacity is sized to meet 75% of maximum day demand.

7.2 WATER PROJECTS FROM 2022 TO 2027

Project 3: 12/16-inch Water Line along Main Street

Description: This project includes the construction of a 12-inch water line to replace the existing 6-inch water line along Main Street from Persimmon Street to Snook Lane. This project also includes the construction of a 16-inch water line to replace the existing 6-inch water line along Main Street from Oak Street to Snook Lane. This project is recommended to coincide with the planned Main Street construction.

Project Drivers: The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Project 4: 12-inch Water Line along Medical Complex Drive

Description: This project includes the construction of a 12-inch water line along Medical Complex Drive from Hufsmith-Kohrville Road to Holderrieth Road to coincide with Medical Complex Drive expansion.

Project Drivers: The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow. This project will provide water for the upcoming Medical Complex development.



Project 5: 16-inch Water line along SH 249

Description: This project includes the construction of a 12-inch water line along future Holderrieth Road from Telge Road to SH 249. This project also includes the construction of a 16-inch water line to replace the existing 12-inch water line along SH 249 from Holderrieth Road to the proposed 1.25 MG elevated storage tank (**Project 6**).

Project Drivers: The recommended water lines are sized to serve 2042 peak hourly demand and provide water service to development along future Holderrieth Road.

Project 6: 1.25 MG EST and 16-inch Water Line

Description: This project includes the construction of a new 1.25 MG elevated storage tank and 16-inch water line near SH 249 and Boudreaux Estates Drive. The elevated storage tank may be constructed sooner to meet commercial fire flow requirements.

Project Drivers: The elevated storage tank and the 16-inch water line are sized to meet Grand Parkway Town Center fire flow requirements and meet 30% of 2042 projected peak hourly demand.

Project 7: 2,000 gpm FM 2920 Pump Station Expansion with 1.5 MG GSTs

Description: This project includes the expansion of the FM 2920 pump station from 3,000 gpm to 5,000 gpm. This project also includes the construction of three 0.5 MG ground storage tanks at the FM 2920 Water Plant. Surface water from NHCRWA is anticipated to be delivered to this facility by 2027.

Project Drivers: The recommended pump station is sized to meet 70% of 2042 peak hourly demand. The recommended ground storage tanks are sized to meet 8 hours of 2042 maximum day demand.

Project 8: 1,500 gpm East Water Plant Expansion with 1.0 MG GST

Description: This project includes the addition of a 1,500 gpm pump, a 1,000 gpm groundwater well and construction of a 1 MG ground storage tank at the East Water Plant (**Project 5**). This project also includes the construction of a parallel 12-inch water line along Hufsmith-Kohrville Road from the East Water Plant to future Medical Complex Drive.

Project Drivers: The recommended pump station is sized to meet 70% of 2042 peak hourly demand. The recommended ground storage tank is sized to meet 8 hours of 2042 maximum day demand. The recommended groundwater supply capacity is sized to meet 75% of maximum day demand.

7.3 WATER PROJECTS FROM 2027 TO 2042

Project 9: 0.4 MG Pine Street Water Plant GST and Pine Street Pump Station Condition Assessment

Description: This project includes the construction of a 0.4 MG ground storage tank at the Pine Street Water Plant. Surface water from NHCRWA is anticipated to be delivered to this facility by 2042. This project also includes the condition assessment of the Pine Street Water Plant.

Project Drivers: The recommended ground storage tank is sized to meet 8 hours of 2042 maximum day demand. The hydraulic model indicates that existing pumps at Pine Street will not be able to meet future water system demand and head conditions.

Project 10: 12-inch Water Lines along Snook Lane, Lovett Street, and Zion Road

Description: This project includes the construction of a 12-inch water line replacing the existing 6-inch water lines along Snook Lane and Hufsmith Road. This project also includes the construction of 12-inch water lines along future Lovett Street and Zion Road.

Project Drivers: The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Project 11: 12-inch Water Line along Agg Road

Description: This project includes the construction of a 12-inch water line along Agg Road from Mulberry Street to Persimmon Street.

Project Drivers: The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow.

Project 12: 16-inch Water Line along Ulrich Road

Description: This project includes the construction of a parallel 16-inch water line from the Ulrich Road elevated storage tank to Zion Road.

Project Drivers: The recommended water lines are sized to serve 2042 peak hourly demand and reduce excessive headloss in existing water lines.

7.4 TIMELINE PENDING WATER PROJECTS

Project A: SCADA System

Description: This project includes the selection and installation of a Supervisory Control and Data Acquisition (SCADA) system at the City's storage tanks and pump stations to monitor tank levels and pumped flow in addition to other system parameters the City elects to monitor.

Project Drivers: The new SCADA system will allow the City to monitor changing water system conditions in real time at major facilities.

Project B: 12-inch Water Line along Oak Street

Description: This project includes the construction of a new 12-inch water line to replace the existing 6-inch water line along Oak Street.

Project Drivers: The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow.

Project C: 8-inch Water Line in Corral RV Park

Description: This project includes the construction of a new 8-inch water line from the 8-inch Corral RV Park water line to the 12-inch water line along Medical Complex Drive.

Project Drivers: The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow.

Project D: 8-inch Water Line along Liberty Lane

Description: This project includes the construction of an 8-inch water line from the 6-inch water line along Liberty Lane to the 12-inch water line along Hufsmith Road.

Project Drivers: The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Project E: 12-inch Water Line along SH 249

Description: This project includes the construction of a 12-inch water line along SH 249 connecting 12-inch water lines along Hicks Street and Rudel Drive.

Project Drivers: The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Project F: 8-inch Water Line along Stella Lane

Description: This project includes the construction of 8-inch water lines along Stella Lane from Camille Drive to Capella Circle.

Project Drivers: The water lines are recommended to connect existing dead end water lines and increase available fire flow.

Project G: 8-inch Water Line along Julia Lane

Description: This project includes the construction of 8-inch water lines along Julia lane from Lost Creek Road to Quinn Road.

Project Drivers: The water lines are recommended to connect existing dead end water lines and increase available fire flow.

Project H: 8-inch Water Line along Persimmon Road

Description: This project includes construction of an 8-inch water line along Persimmon Road connecting the existing 6-inch water line to the proposed 12-inch water line (**Projects 4 and 11**).

Project Drivers: The water line is recommended to connect existing dead end water lines and increase available fire flow.

APPENDIX A

Water System Capital Improvements Plan

Cost Summary Sheets

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 1

Phase: By 2022

Project Name: 12-inch Water Line along Hufsmith Road

Project Description:

This project includes the construction of a new 12-inch water line along Hufsmith Road from Ulrich Road to Lovett Street.

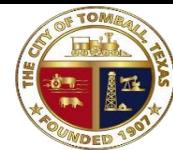
Project Drivers:

The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow. This project will help alleviate areas of low water system pressure in the northwest area of the City.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" WL & Appurtenances	6,300	LF	\$ 120	\$ 756,000
2	24" Boring and Casing	500	LF	\$ 420	\$ 210,000
3	Pavement Repair	300	LF	\$ 75	\$ 22,500
SUBTOTAL:					\$ 988,500
CONTINGENCY				30%	\$ 296,600
SUBTOTAL:					\$ 1,285,100
ENG/SURVEY				15%	\$ 192,800
SUBTOTAL:					\$ 1,477,900
Estimated Project Total:					\$ 1,477,900

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 2

Phase: By 2022

Project Name: New 3,000 gpm East Water Plant with 1.0 MG GST

Project Description:

This project includes the construction of a new 3,000 gpm pump station, 1.0 MG ground storage tank and 2,000 gpm of groundwater well capacity along Hufsmith-Kohrville Road in between Mahaffey Road and Country Club Green Drive. Surface water from NHCRWA is anticipated to be delivered to this facility by 2027.

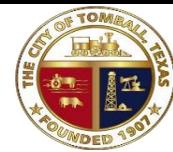
Project Drivers:

The recommended pump station is sized to meet 70% of 2042 peak hourly demand. The recommended ground storage tank is sized to meet 8 hours of 2042 maximum day demand. The recommended groundwater supply capacity is sized to meet 75% of maximum day demand.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Pump Station - New 4.32 MGD	1	LS	\$ 4,320,000	\$ 4,320,000
2	1.0 MG Ground Storage Tank	1	LS	\$ 1,000,000	\$ 1,000,000
3	Chemical Feed System	1	LS	\$ 300,000	\$ 300,000
4	2,000 gpm Groundwater Well Capacity	1	LS	\$ 3,000,000	\$ 3,000,000
				SUBTOTAL:	\$ 9,540,000
				CONTINGENCY	30%
					\$ 2,862,000
				SUBTOTAL:	\$ 12,402,000
				ENG/SURVEY	20%
					\$ 2,480,400
				SUBTOTAL:	\$ 14,882,400
Estimated Project Total:					\$ 14,882,400

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 3

Phase: By 2027

Project Name: 12/16-inch Water Line along Main Street

Project Description:

This project includes the construction of a 12-inch water line to replace the existing 6-inch water line along Main Street from Persimmon Street to Snook Lane. This project also includes the construction of a 16-inch water line to replace the existing 6-inch water line along Main Street from Oak Street to Snook Lane. This project is recommended to coincide with the planned Main Street construction.

Project Drivers:

The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" WL & Appurtenances	5,600	LF	\$ 160	\$ 896,000
2	12" WL & Appurtenances	900	LF	\$ 120	\$ 108,000
3	Pavement Repair	6,500	LF	\$ 75	\$ 487,500
				SUBTOTAL:	\$ 1,491,500
			CONTINGENCY	30%	\$ 447,500
				SUBTOTAL:	\$ 1,939,000
			ENG/SURVEY	15%	\$ 290,900
				SUBTOTAL:	\$ 2,229,900
Estimated Project Total:					\$ 2,229,900

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 4

Phase: By 2027

Project Name: 12-inch Water Line along Medical Complex Drive

Project Description:

This project includes the construction of a 12-inch water line along Medical Complex Drive from Hufsmith-Kohrville Road to Holderrieth Road to coincide with Medical Complex Drive expansion.

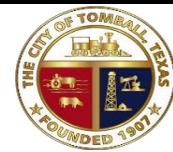
Project Drivers:

The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow. This project will provide water for the upcoming Medical Complex development.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" WL & Appurtenances	5,700	LF	\$ 120	\$ 684,000
2	Pavement Repair	200	LF	\$ 75	\$ 15,000
				SUBTOTAL:	\$ 699,000
			CONTINGENCY	30%	\$ 209,700
				SUBTOTAL:	\$ 908,700
			ENG/SURVEY	15%	\$ 136,400
				SUBTOTAL:	\$ 1,045,100
Estimated Project Total:					\$ 1,045,100

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 5

Phase: By 2027

Project Name: 16-inch Water Line along SH 249

Project Description:

This project includes the construction of a 16-inch water line to replace the existing 12-inch water line along SH 249 from Holderrieth Road to the proposed 1.25 MG elevated storage tank (Project 6).

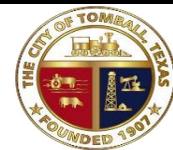
Project Drivers:

The recommended water lines are sized to serve 2042 peak hourly demand.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	16" WL & Appurtenances	5,800	LF	\$ 160	\$ 928,000
2	30" Boring and Casing	200	LF	\$ 525	\$ 105,000
3	Pavement Repair	200	LF	\$ 75	\$ 15,000
SUBTOTAL:					\$ 1,048,000
CONTINGENCY				30%	\$ 314,400
SUBTOTAL:					\$ 1,362,400
ENG/SURVEY				15%	\$ 204,400
SUBTOTAL:					\$ 1,566,800
Estimated Project Total:					\$ 1,566,800

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 7

Phase: By 2027

Project Name: 2,000 gpm FM 2920 Pump Station Expansion with 1.5 MG GSTs

Project Description:

This project includes the expansion of the FM 2920 pump station from 3,000 gpm to 5,000 gpm. This project also includes the construction of three 0.5 MG ground storage tanks at the FM 2920 Water Plant. Surface water from NHCRWA is anticipated to be delivered to this facility by 2027.

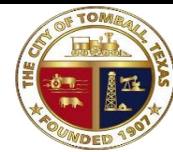
Project Drivers:

The recommended pump station is sized to meet 70% of 2042 peak hourly demand. The recommended ground storage tanks are sized to meet 8 hours of 2042 maximum day demand.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Pump Station - Expans 2.88 MGD	1	LS	\$ 864,000	\$ 864,000
2	0.5 MG Ground Storage Tank	3	LS	\$ 500,000	\$ 1,500,000
3	24" WL & Appurtenances	1,300	LF	\$ 240	\$ 312,000
4	16" WL & Appurtenances	1,000	LF	\$ 160	\$ 160,000
				SUBTOTAL:	\$ 2,848,000
				CONTINGENCY	30%
					\$ 854,400
				SUBTOTAL:	\$ 3,702,400
				ENG/SURVEY	20%
					\$ 740,500
				SUBTOTAL:	\$ 4,442,900
Estimated Project Total:					\$ 4,442,900

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 8

Phase: By 2027

Project Name: 1,500 gpm East Water Plant Expansion with 1.0 MG GST

Project Description:

This project includes the addition of a 1,500 gpm pump, a 1,000 gpm groundwater well and construction of a 1 MG ground storage tank at the East Water Plant (Project 5). This project also includes the construction of a parallel 12-inch water line along Hufsmith-Kohrville Road from the East Water Plant to future Medical Complex Drive.

Project Drivers:

The recommended pump station is sized to meet 70% of 2042 peak hourly demand. The recommended ground storage tank is sized to meet 8 hours of 2042 maximum day demand. The recommended groundwater supply capacity is sized to meet 75% of maximum day demand.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	1.0 MG Ground Storage Tank	1	LS	\$ 1,000,000	\$ 1,000,000
2	1,500 gpm Pump	1	LS	\$ 150,000	\$ 150,000
3	1,000 gpm Groundwater Well Capacity	1	LS	\$ 1,500,000	\$ 1,500,000
4	12" WL & Appurtenances	7,300	LF	\$ 120	\$ 876,000
5	Pavement Repair	200	LF	\$ 75	\$ 15,000
6	Land Acquisition	1	Ac	\$ 50,000	\$ 50,000
				SUBTOTAL:	\$ 3,591,000
				CONTINGENCY	30%
				SUBTOTAL:	\$ 4,668,300
				ENG/SURVEY	20%
				SUBTOTAL:	\$ 5,602,000
Estimated Project Total:					\$ 5,602,000

Project Name: 0.4 MG Pine Street Water Plant GST and Pine Street Pump Station Condition Assessment

Project Description:

This project includes the construction of a 0.4 MG ground storage tank at the Pine Street Water Plant. Surface water from NHCRWA is anticipated to be delivered to this facility by 2042. This project also includes the condition assessment of the Pine Street Water Plant.

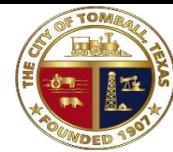
Project Drivers:

The recommended ground storage tank is sized to meet 8 hours of 2042 maximum day demand. The hydraulic model indicates that existing pumps at Pine Street will not be able to meet future water system demand and head conditions.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	0.4 MG Ground Storage Tank	1	LS	\$ 400,000	\$ 400,000
2	24" WL & Appurtenances	200	LF	\$ 240	\$ 48,000
3	18" WL & Appurtenances	100	LF	\$ 180	\$ 18,000
4	Water Plant Condition Assessment	1	LS	\$ 70,000	\$ 70,000
				SUBTOTAL:	\$ 536,000
				CONTINGENCY	30%
				SUBTOTAL:	\$ 696,800
				ENG/SURVEY	20%
				SUBTOTAL:	\$ 836,200
Estimated Project Total:					\$ 836,200

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 10

Phase: By 2042

Project Name: 12-inch Water Lines along Snook Lane, Lovett Street and Zion Road

Project Description:

This project includes the construction of a 12-inch water line replacing the existing 6-inch water lines along Snook Lane and Hufsmith Road. This project also includes the construction of 12-inch water lines along future Lovett Street and Zion Road.

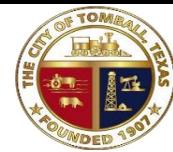
Project Drivers:

The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" WL & Appurtenances	4,900	LF	\$ 120	\$ 588,000
2	Pavement Repair	650	LF	\$ 75	\$ 48,750
				SUBTOTAL:	\$ 636,800
				CONTINGENCY	30%
				SUBTOTAL:	\$ 827,900
				ENG/SURVEY	15%
				SUBTOTAL:	\$ 952,100
Estimated Project Total:					\$ 952,100

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: 11

Phase: By 2042

Project Name: 12-inch Water Line along Agg Road

Project Description:

This project includes the construction of a 12-inch water line along Agg Road from Mulberry Street to Persimmon Street.

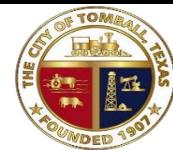
Project Drivers:

The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" WL & Appurtenances	3,400	LF	\$ 120	\$ 408,000
2	Pavement Repair	100	LF	\$ 75	\$ 7,500
				SUBTOTAL:	\$ 415,500
				CONTINGENCY	30%
				SUBTOTAL:	\$ 540,200
				ENG/SURVEY	15%
				SUBTOTAL:	\$ 621,300
Estimated Project Total:					\$ 621,300

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: A

Phase: Timeline Pending

Project Name: SCADA System

Project Description:

This project includes the selection and installation of a Supervisory Control and Data Acquisition (SCADA) system at the City's storage tanks and pump stations to monitor tank levels and pumped flow in addition to other system parameters the City elects to monitor.

Project Drivers:

The new SCADA system will allow the City to monitor changing water system conditions in real time at major facilities.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	SCADA System	1	LS	\$ 500,000	\$ 500,000
				SUBTOTAL:	\$ 500,000
			CONTINGENCY	30%	\$ 150,000
				SUBTOTAL:	\$ 650,000
			ENG/SURVEY	0%	\$ -
				SUBTOTAL:	\$ 650,000
Estimated Project Total:					\$ 650,000

City of Tomball



Water Master Plan Capital Improvements Plan September 10, 2018
 Construction Project Number: B Phase: Timeline Pending

Project Name: **12-inch Water Line along Oak Street**

Project Description:

This project includes the construction of a new 12-inch water line to replace the existing 6-inch water line along Oak Street.

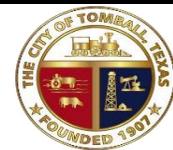
Project Drivers:

The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" WL & Appurtenances	500	LF	\$ 120	\$ 60,000
2	Pavement Repair	200	LF	\$ 75	\$ 15,000
SUBTOTAL:					\$ 75,000
CONTINGENCY				30%	\$ 22,500
SUBTOTAL:					\$ 97,500
ENG/SURVEY				15%	\$ 14,700
SUBTOTAL:					\$ 112,200
Estimated Project Total:					\$ 112,200

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: C

Phase: Timeline Pending

Project Name: 8-inch Water Line in Corral RV Park

Project Description:

This project includes the construction of a new 8-inch water line from the 8-inch Corral RV Park water line to the 12-inch water line along Medical Complex Drive.

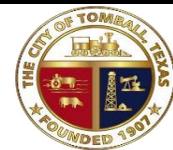
Project Drivers:

The recommended water lines are sized to serve 2042 peak hourly demand and increase available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" WL & Appurtenances	300	LF	\$ 80	\$ 24,000
2	Pavement Repair	200	LF	\$ 75	\$ 15,000
				SUBTOTAL:	\$ 39,000
				CONTINGENCY 30%	\$ 11,700
				SUBTOTAL:	\$ 50,700
				ENG/SURVEY 15%	\$ 7,700
				SUBTOTAL:	\$ 58,400
Estimated Project Total:					\$ 58,400

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: D

Phase: Timeline Pending

Project Name: 8-inch Water Line along Liberty Lane

Project Description:

This project includes the construction of an 8-inch water line from the 6-inch water line along Liberty Lane to the 12-inch water line along Hufsmith Road.

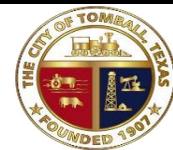
Project Drivers:

The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" WL & Appurtenances	500	LF	\$ 80	\$ 40,000
2	Pavement Repair	100	LF	\$ 75	\$ 7,500
SUBTOTAL:					\$ 47,500
CONTINGENCY				30%	\$ 14,300
SUBTOTAL:					\$ 61,800
ENG/SURVEY				15%	\$ 9,300
SUBTOTAL:					\$ 71,100
Estimated Project Total:					\$ 71,100

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: E

Phase: Timeline Pending

Project Name: 12-inch Water Line along SH 249

Project Description:

This project includes the construction of a 12-inch water line along SH 249 connecting 12-inch water lines along Hicks Street and Rudel Drive.

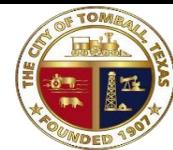
Project Drivers:

The recommended water line is sized to serve 2042 peak hourly demand and provide distribution system capacity for maintaining the Ulrich Elevated Storage Tank water level and increasing available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	12" WL & Appurtenances	1,200	LF	\$ 120	\$ 144,000
2	Pavement Repair	100	LF	\$ 75	\$ 7,500
SUBTOTAL:					\$ 151,500
				CONTINGENCY	30%
					\$ 45,500
SUBTOTAL:					\$ 197,000
				ENG/SURVEY	15%
					\$ 29,600
SUBTOTAL:					\$ 226,600
Estimated Project Total:					\$ 226,600

City of Tomball



Water Master Plan Capital Improvements Plan September 10, 2018
 Construction Project Number: F Phase: Timeline Pending

Project Name: **8-inch Water Line along Stella Lane**

Project Description:

This project includes the construction of 8-inch water lines along Stella Lane from Camille Drive to Capella Circle.

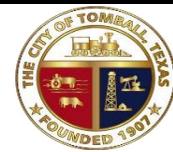
Project Drivers:

The water lines are recommended to connect existing dead end water lines and increase available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" WL & Appurtenances	1,700	LF	\$ 80	\$ 136,000
2	Pavement Repair	200	LF	\$ 75	\$ 15,000
SUBTOTAL:					\$ 151,000
CONTINGENCY				30%	\$ 45,300
SUBTOTAL:					\$ 196,300
ENG/SURVEY				15%	\$ 29,500
SUBTOTAL:					\$ 225,800
Estimated Project Total:					\$ 225,800

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: G

Phase: Timeline Pending

Project Name: 8-inch Water Line along Julia Lane

Project Description:

This project includes the construction of 8-inch water lines along Julia lane from Lost Creek Road to Quinn Road.

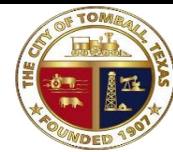
Project Drivers:

The water lines are recommended to connect existing dead end water lines and increase available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" WL & Appurtenances	1,500	LF	\$ 80	\$ 120,000
2	20" Boring and Casing	200	LF	\$ 350	\$ 70,000
3	Pavement Repair	200	LF	\$ 75	\$ 15,000
				SUBTOTAL:	\$ 205,000
				CONTINGENCY	30%
					\$ 61,500
				SUBTOTAL:	\$ 266,500
				ENG/SURVEY	15%
					\$ 40,000
				SUBTOTAL:	\$ 306,500
Estimated Project Total:					\$ 306,500

City of Tomball



Water Master Plan Capital Improvements Plan

September 10, 2018

Construction Project Number: H

Phase: Timeline Pending

Project Name: 8-inch Water Line along Persimmon Road

Project Description:

This project includes construction of an 8-inch water line along Persimmon Road connecting the existing 6-inch water line to the proposed 12-inch water line (Projects 5 and 13).

Project Drivers:

The water line is recommended to connect existing dead end water lines and increase available fire flow.

Opinion of Probable Construction Cost

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	8" WL & Appurtenances	1,500	LF	\$ 80	\$ 120,000
2	Pavement Repair	200	LF	\$ 75	\$ 15,000
SUBTOTAL:					\$ 135,000
	CONTINGENCY			30%	\$ 40,500
SUBTOTAL:					\$ 175,500
	ENG/SURVEY			15%	\$ 26,400
SUBTOTAL:					\$ 201,900
Estimated Project Total:					\$ 201,900

APPENDIX B

Pressure Recorder Data and Map

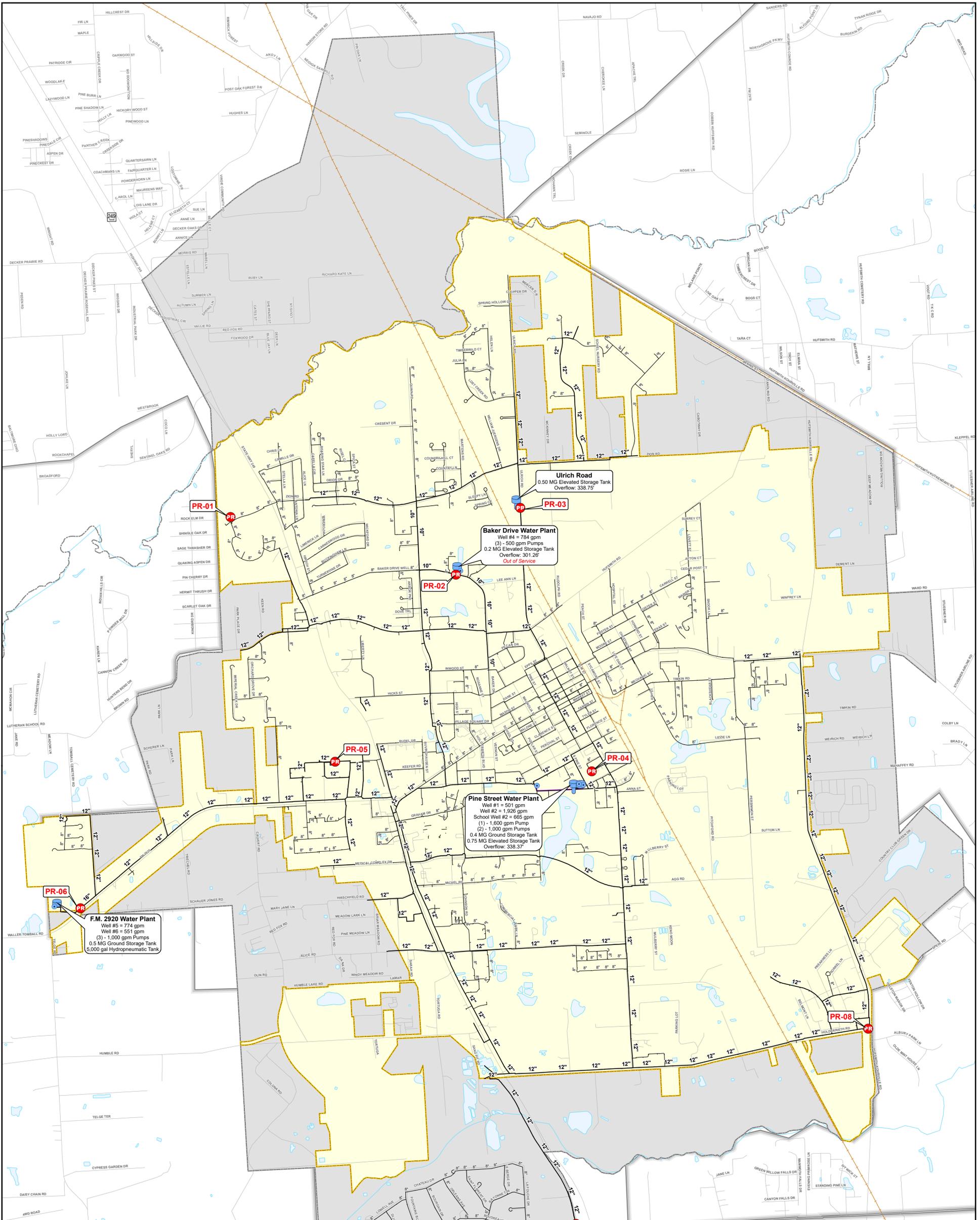


FIGURE B-1
CITY OF TOMBALL
EXISTING WATER SYSTEM
PRESSURE RECORDER LOCATIONS

LEGEND

- Pressure Recorder
- Water Well
- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Raw Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ



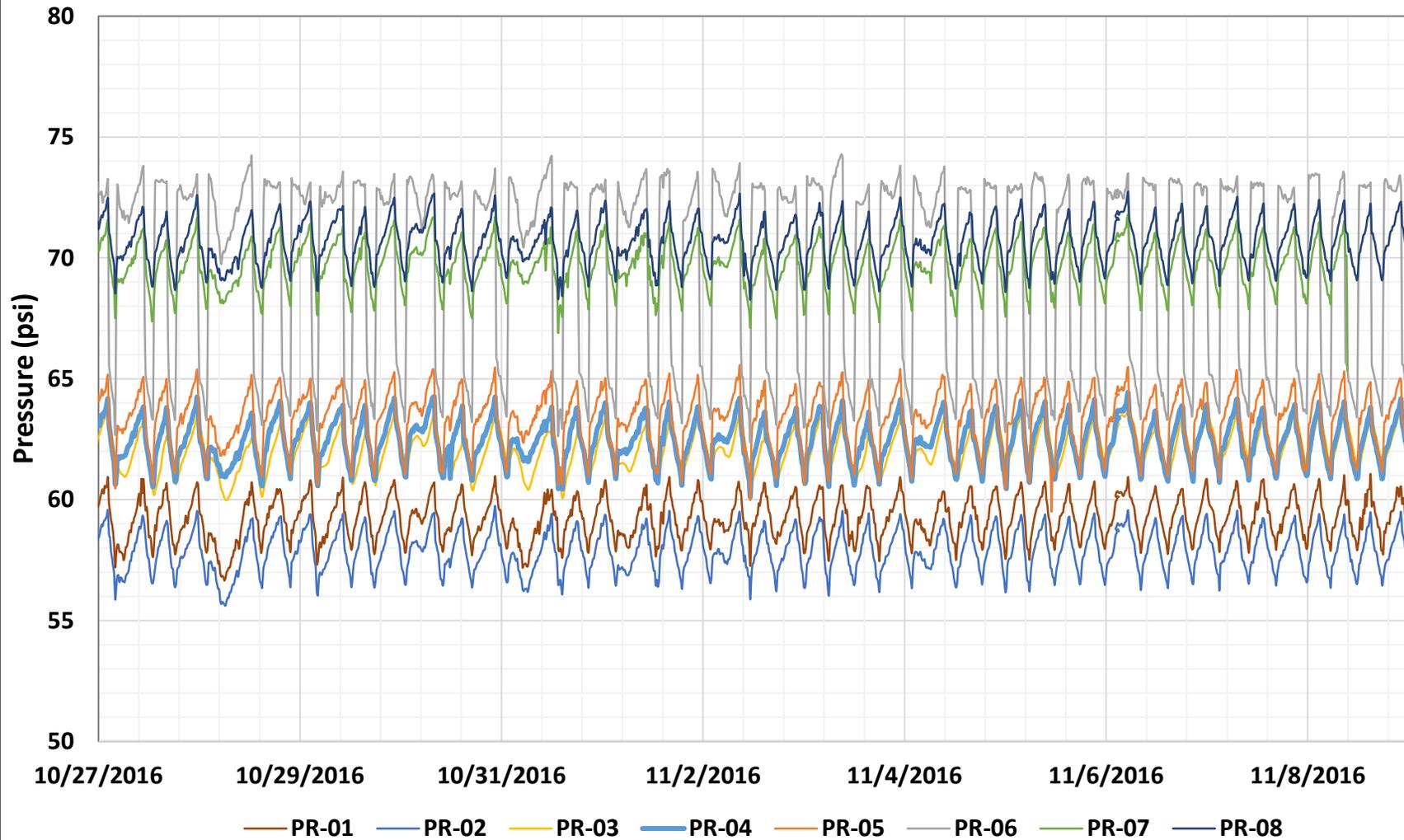


City of Tomball

Water Master Plan

Pressure Recorder Testing

October 27 - November 9, 2016



*Tomball Fire Department accidentally closed the hydrant at Location 7 on November 8, 2016.

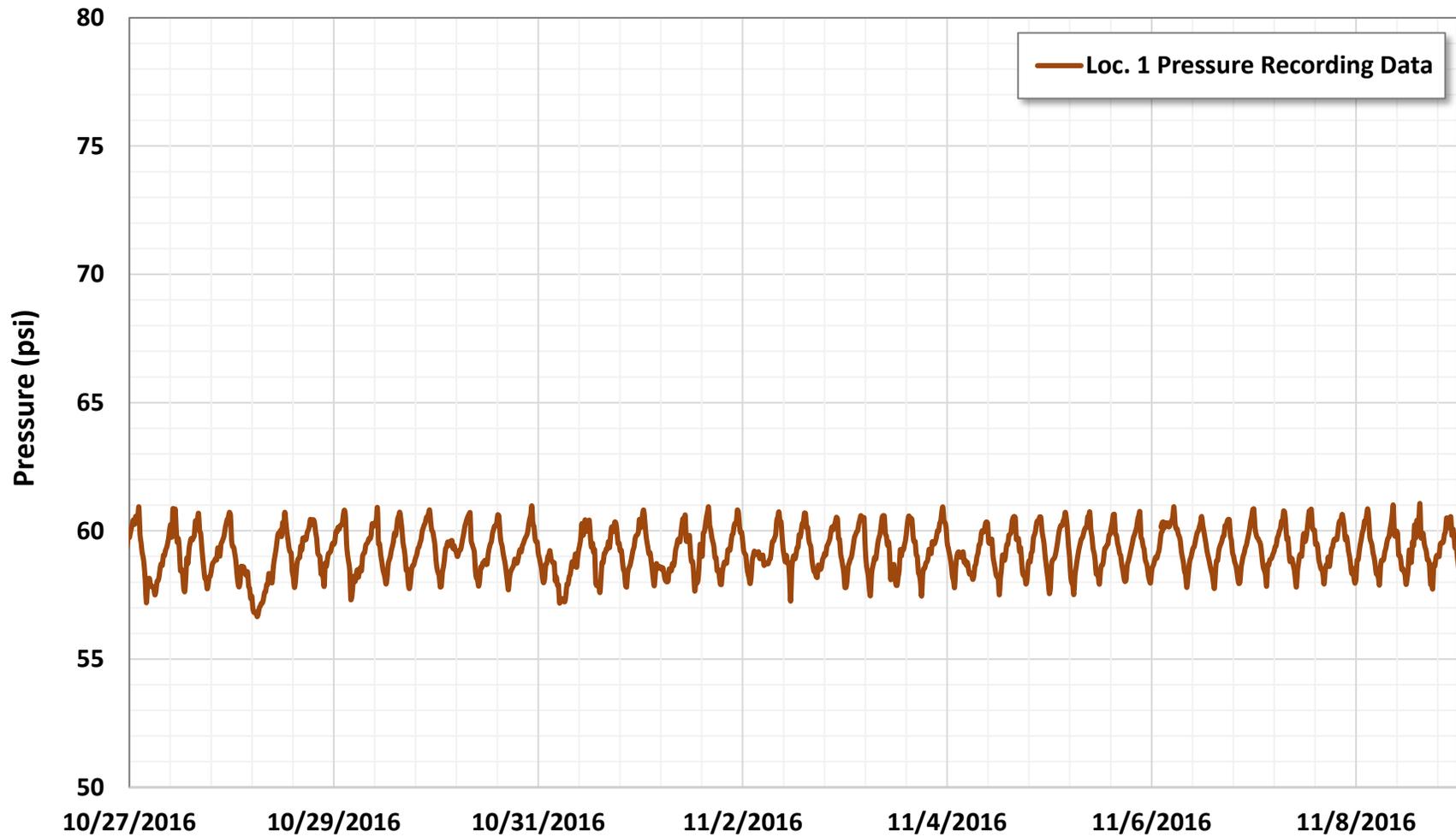


City of Tomball

Location 1: Lone Star College

Pressure Recorder ID: 1666 - **Ground Elevation 186'**

October 27 - November 9, 2016



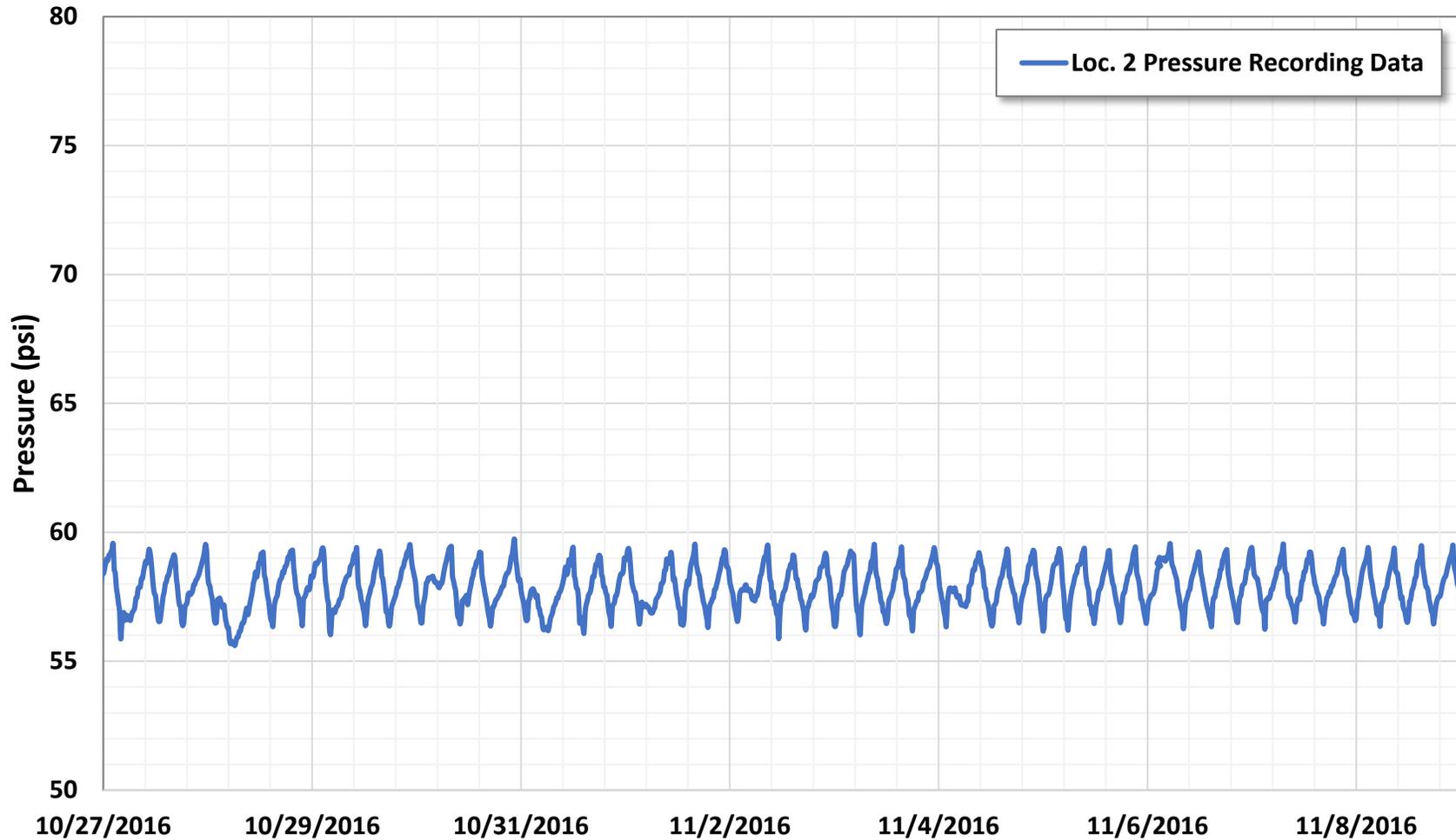


City of Tomball

Location 2: Baker Drive Well

Pressure Recorder ID: 205938 - **Ground Elevation 192'**

October 27 - November 9, 2016



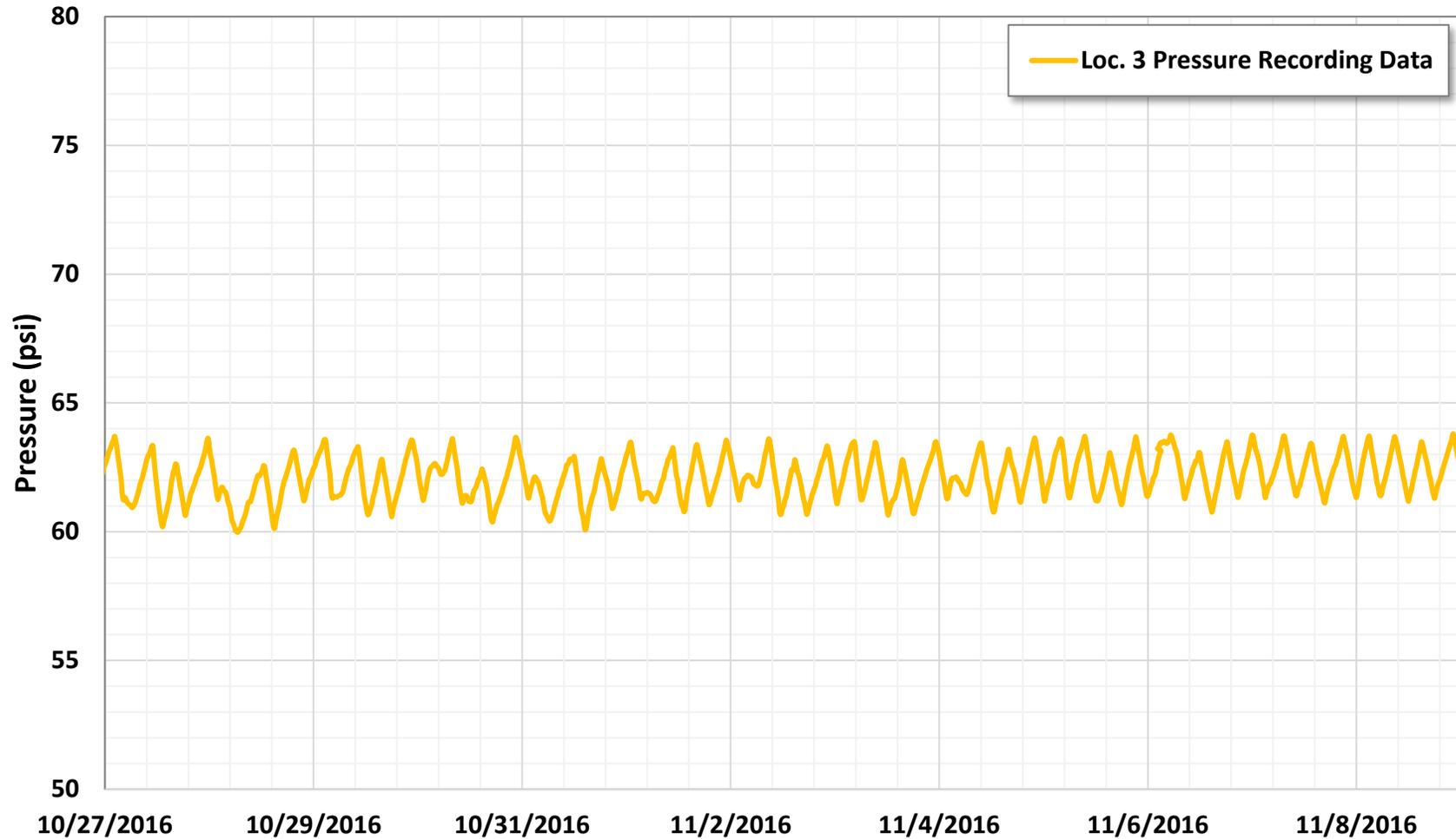


City of Tomball

Location 3: Ulrich Water Tower

Pressure Recorder ID: 204229 - **Ground Elevation 180'**

October 27 - November 9, 2016



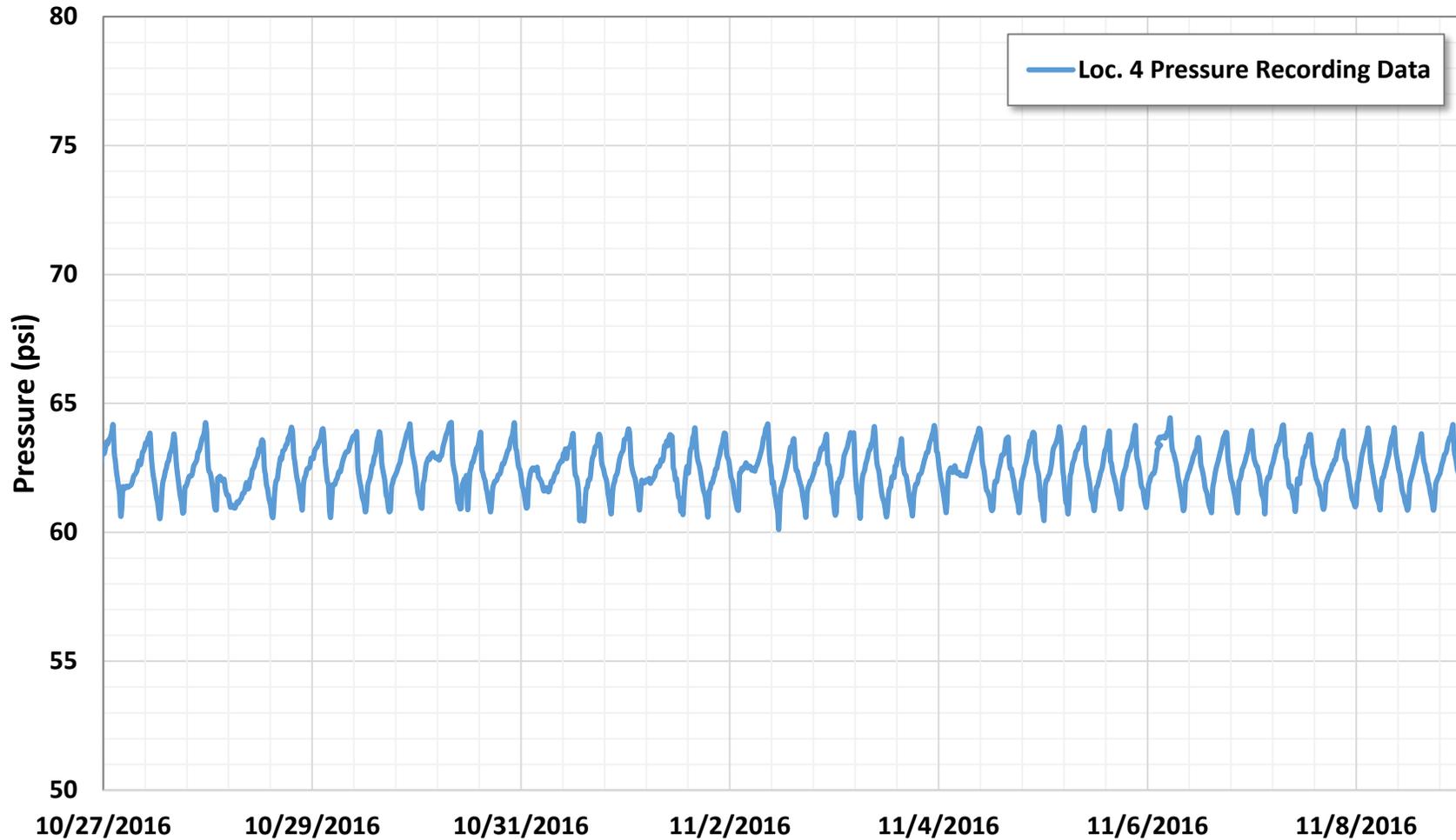


City of Tomball

Location 4: Pine Street and Florence Street Intersection

Pressure Recorder ID: 203436 - **Ground Elevation 180'**

October 27 - November 9, 2016



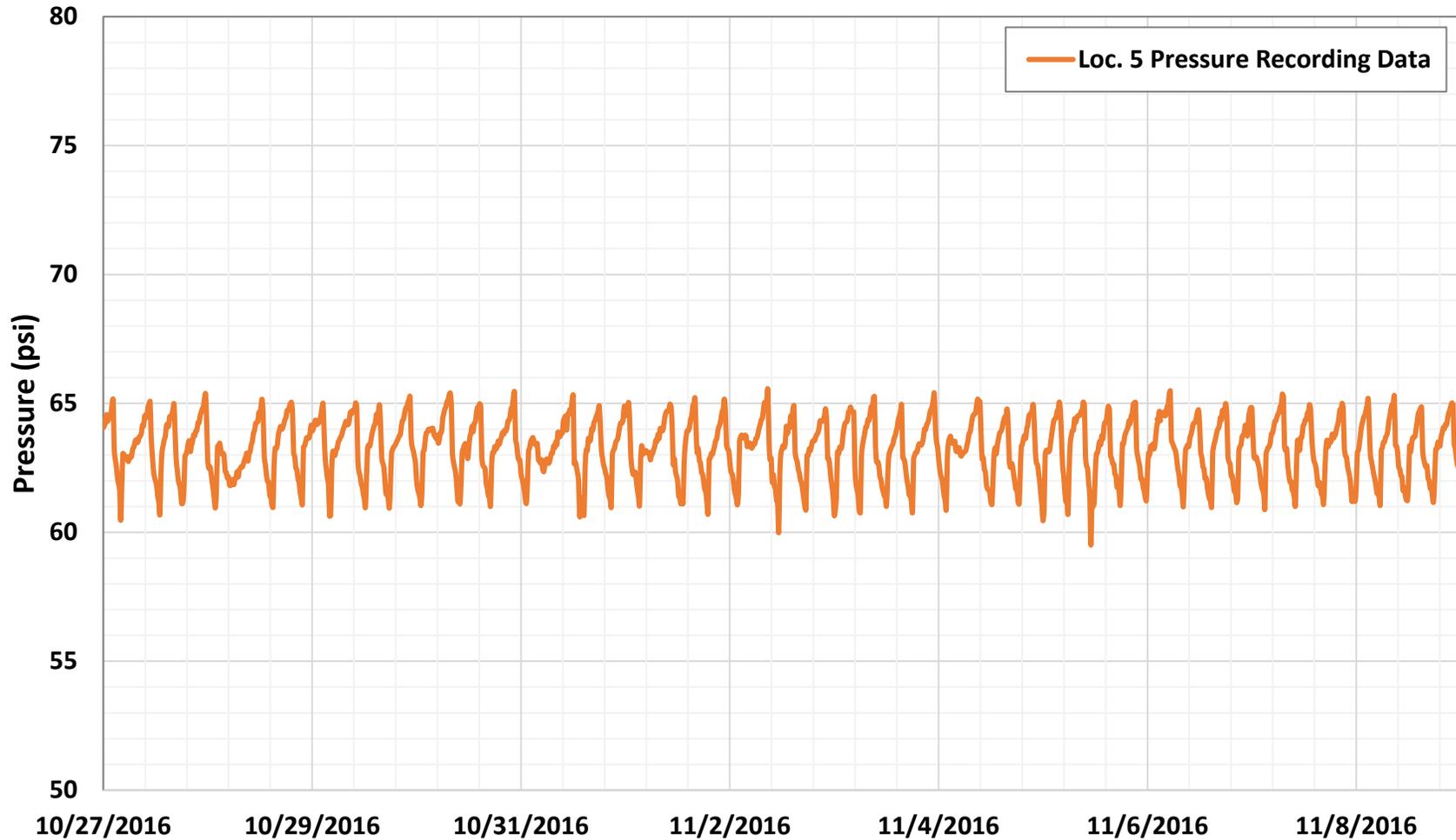
*Tomball Fire Department addicentally closed the hydrant at Location 7 on November 8, 2016.



City of Tomball



Location 5: Lowe's Hydro-pneumatic Tank
Pressure Recorder ID: 205929 - **Ground Elevation 178'**
October 27 - November 9, 2016



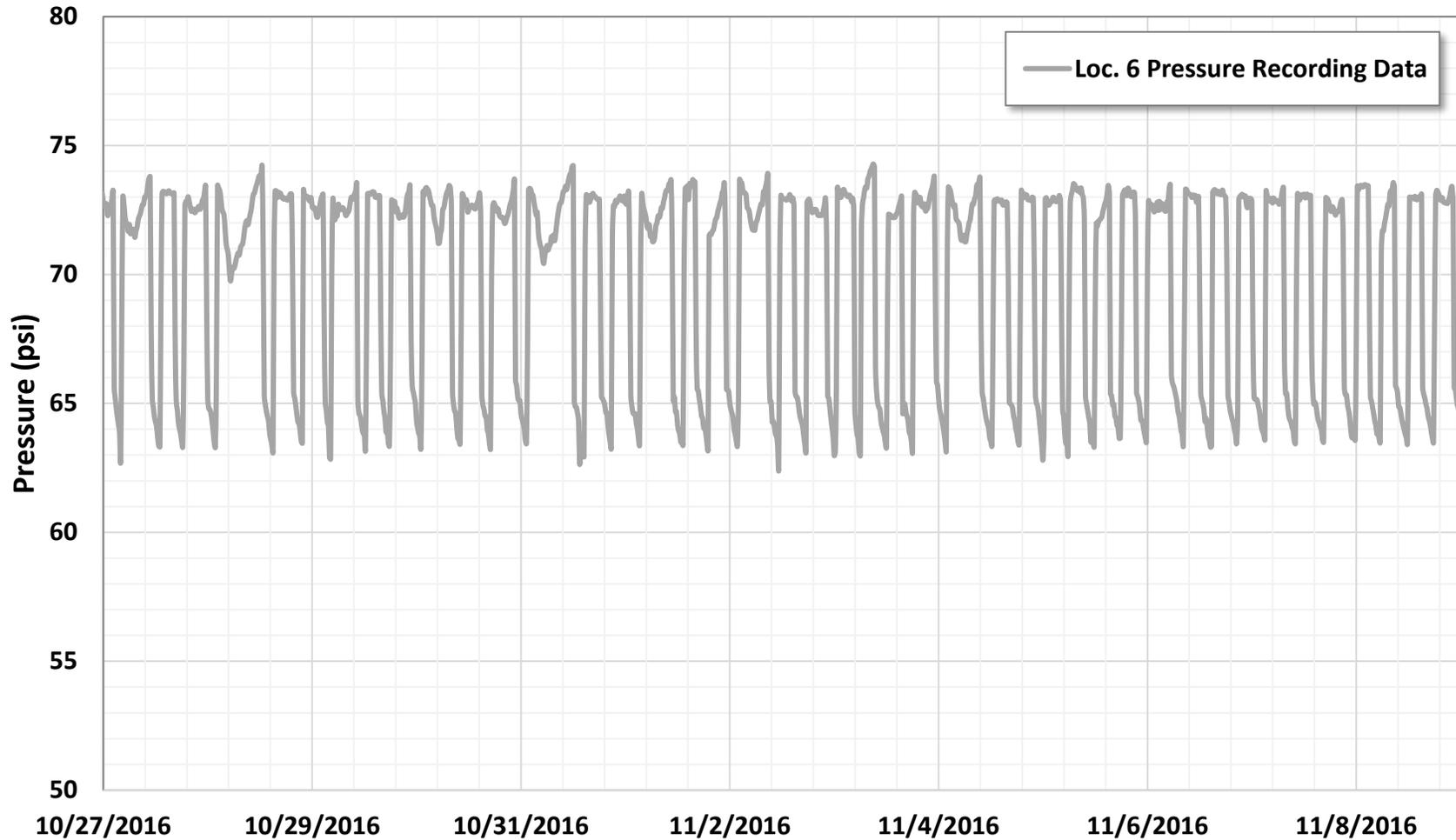


City of Tomball

Location 6: Water Plant on FM 2920

Pressure Recorder ID: 205930 - **Ground Elevation 174'**

October 27 - November 9, 2016





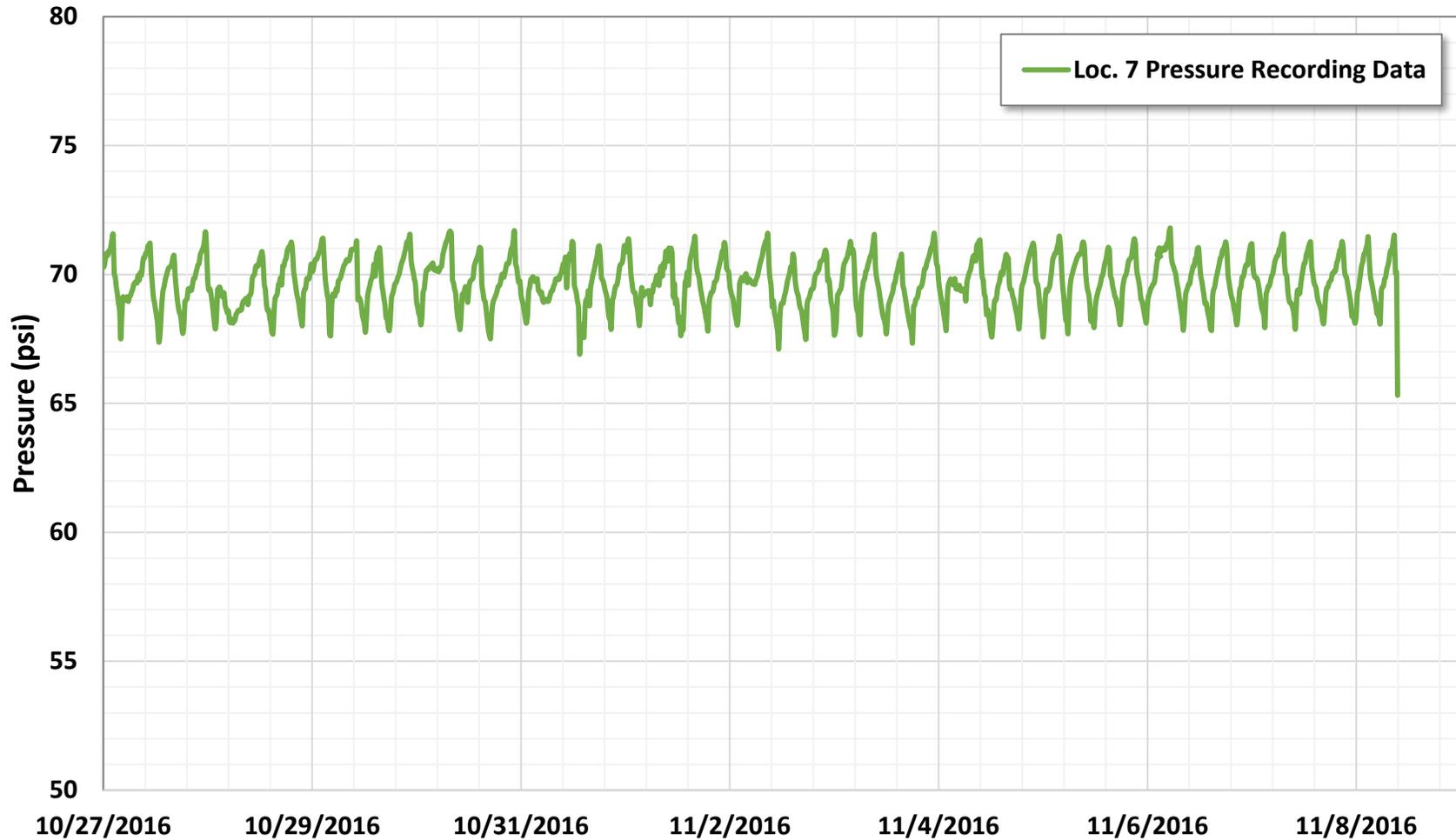
City of Tomball



Location 7: Rocky Road and Boudreaux Estates Drive Intersection

Pressure Recorder ID: 341253 - **Ground Elevation 166'**

October 27 - November 9, 2016



*Tomball Fire Department addicentally closed the hydrant at Location 7 on November 8, 2016.



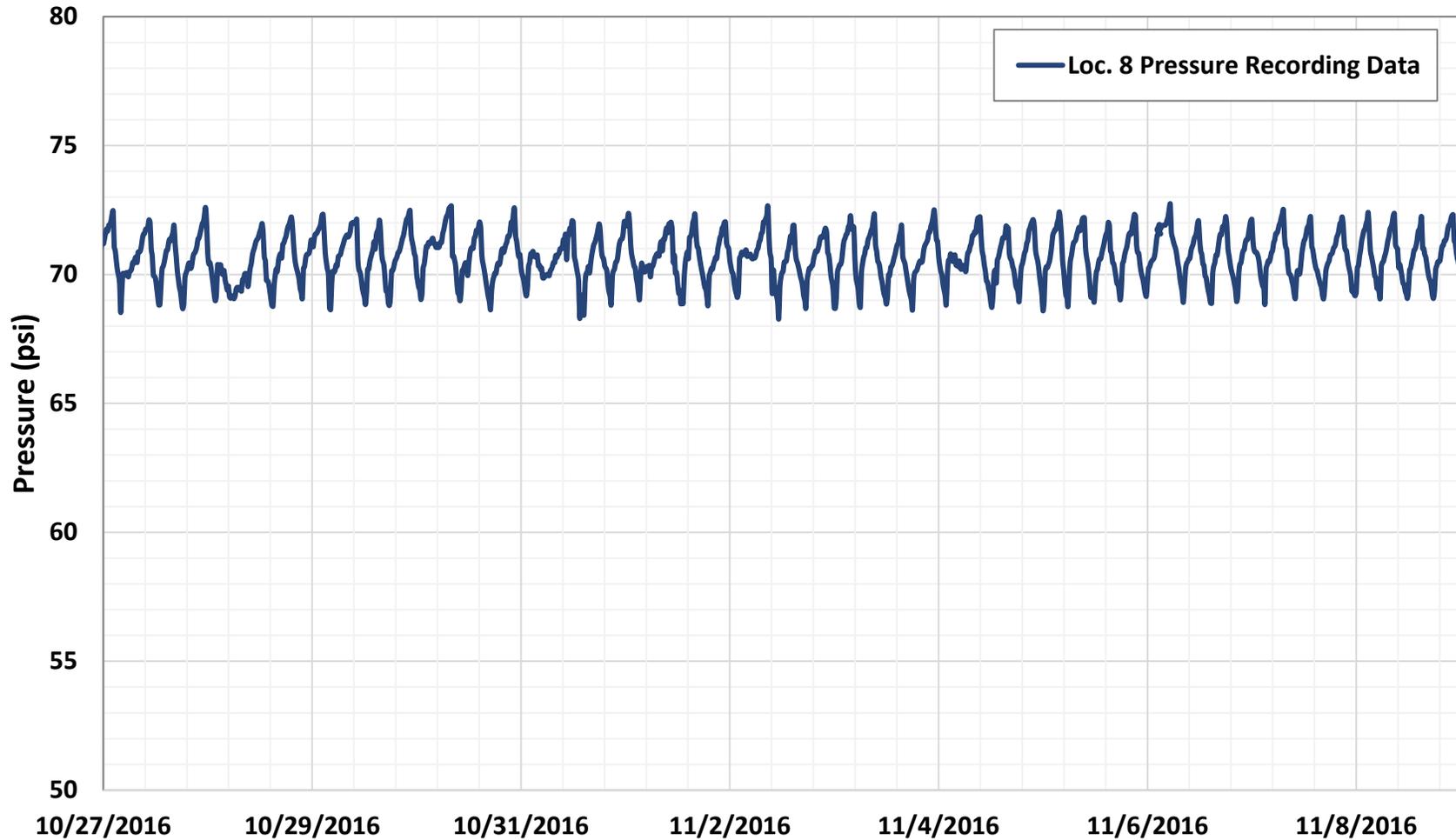
City of Tomball



Location 8: Hederrich Road and Huntsmith Kohrville Road Intersection

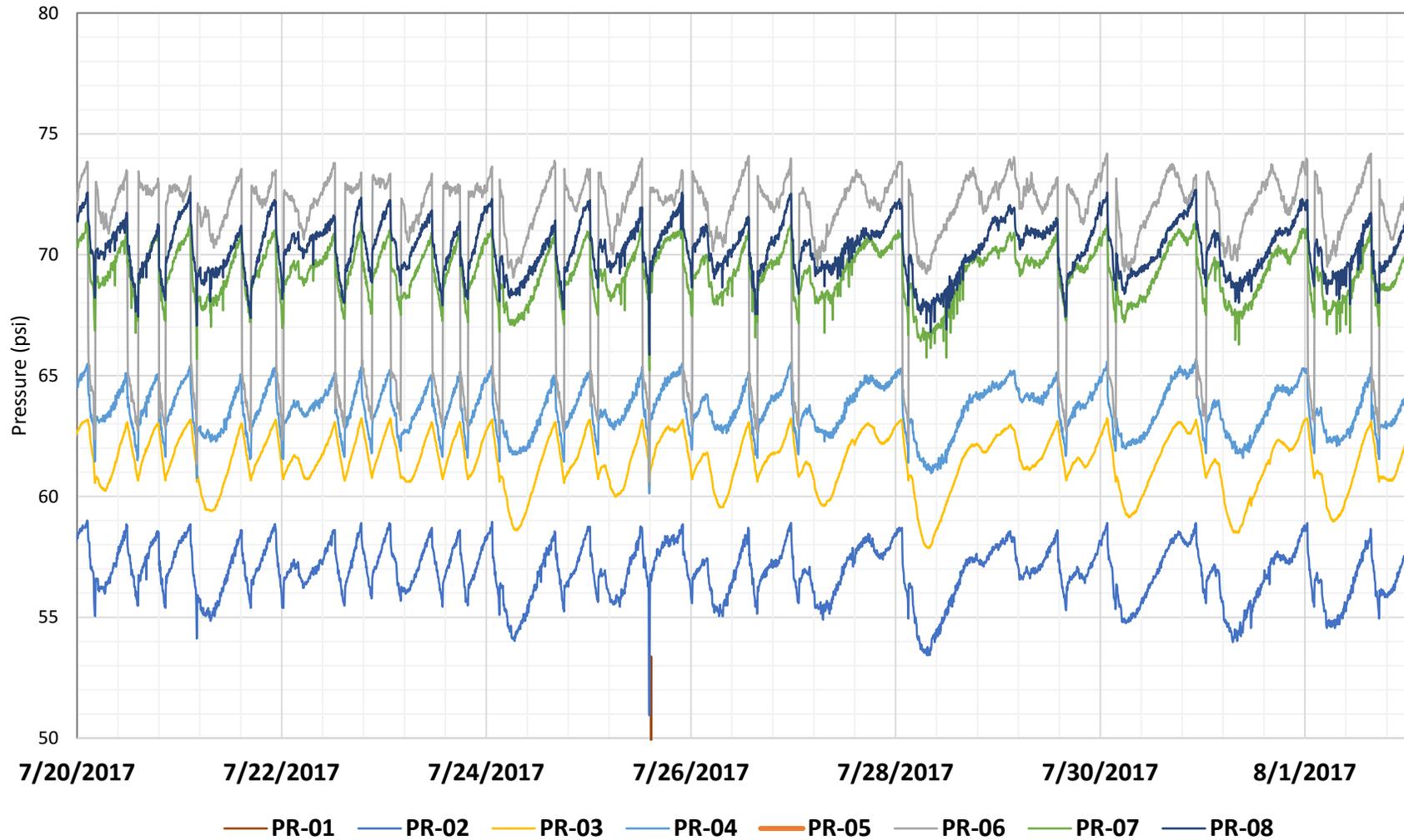
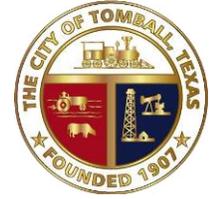
Pressure Recorder ID: 205935 - **Ground Elevation 160'**

October 27 - November 9, 2016





City of Tomball Water Master Plan Pressure Recorder Testing July 20 - August 2, 2017



*Hydrant at Location 1 closed 4 hours after installation.

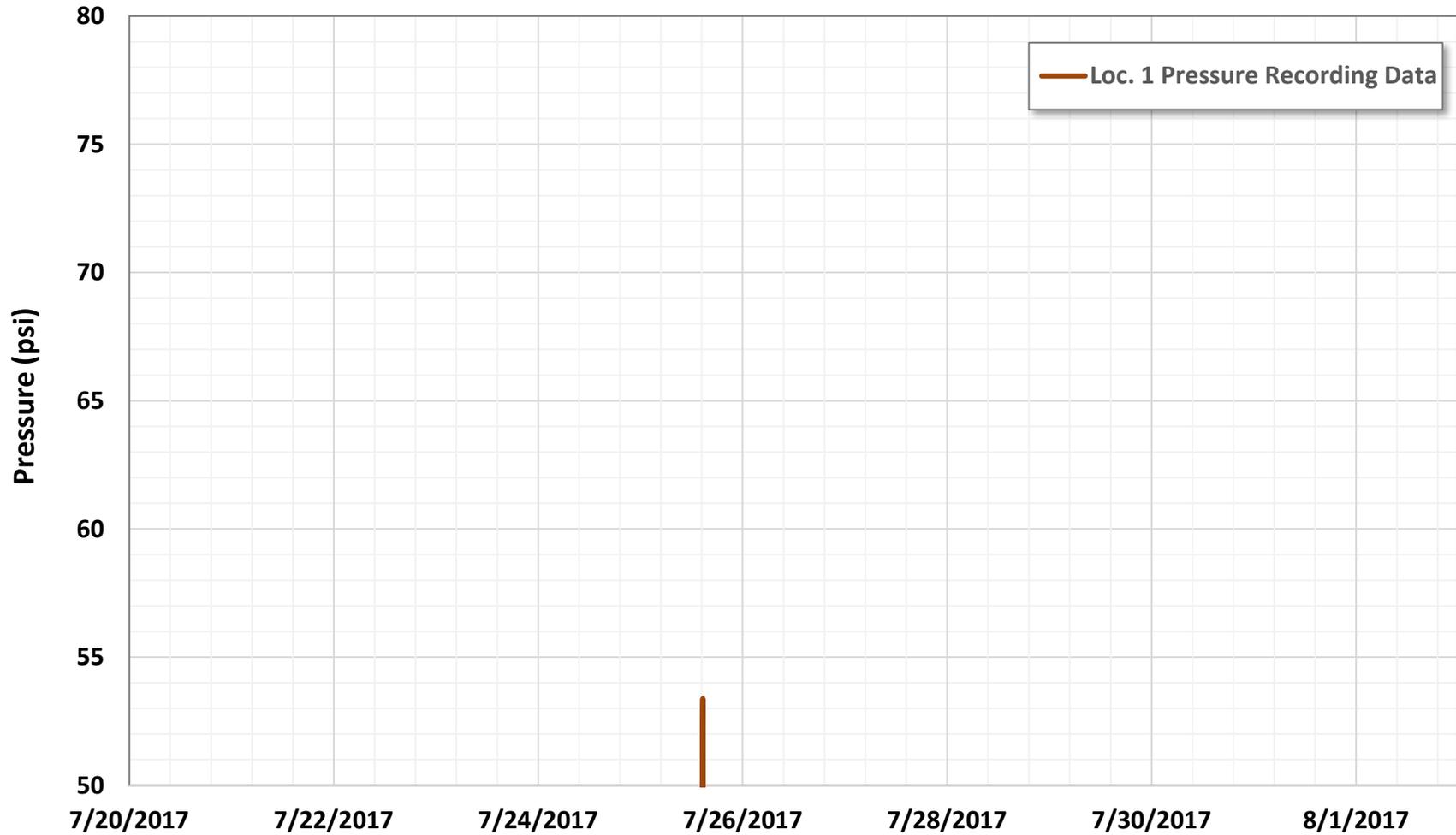


City of Tomball

Location 1: Lone Star College

Pressure Recorder ID: 204229 - **Ground Elevation 186'**

July 20 - August 2, 2017



*Hydrant at Location 1 closed four hours after installation.

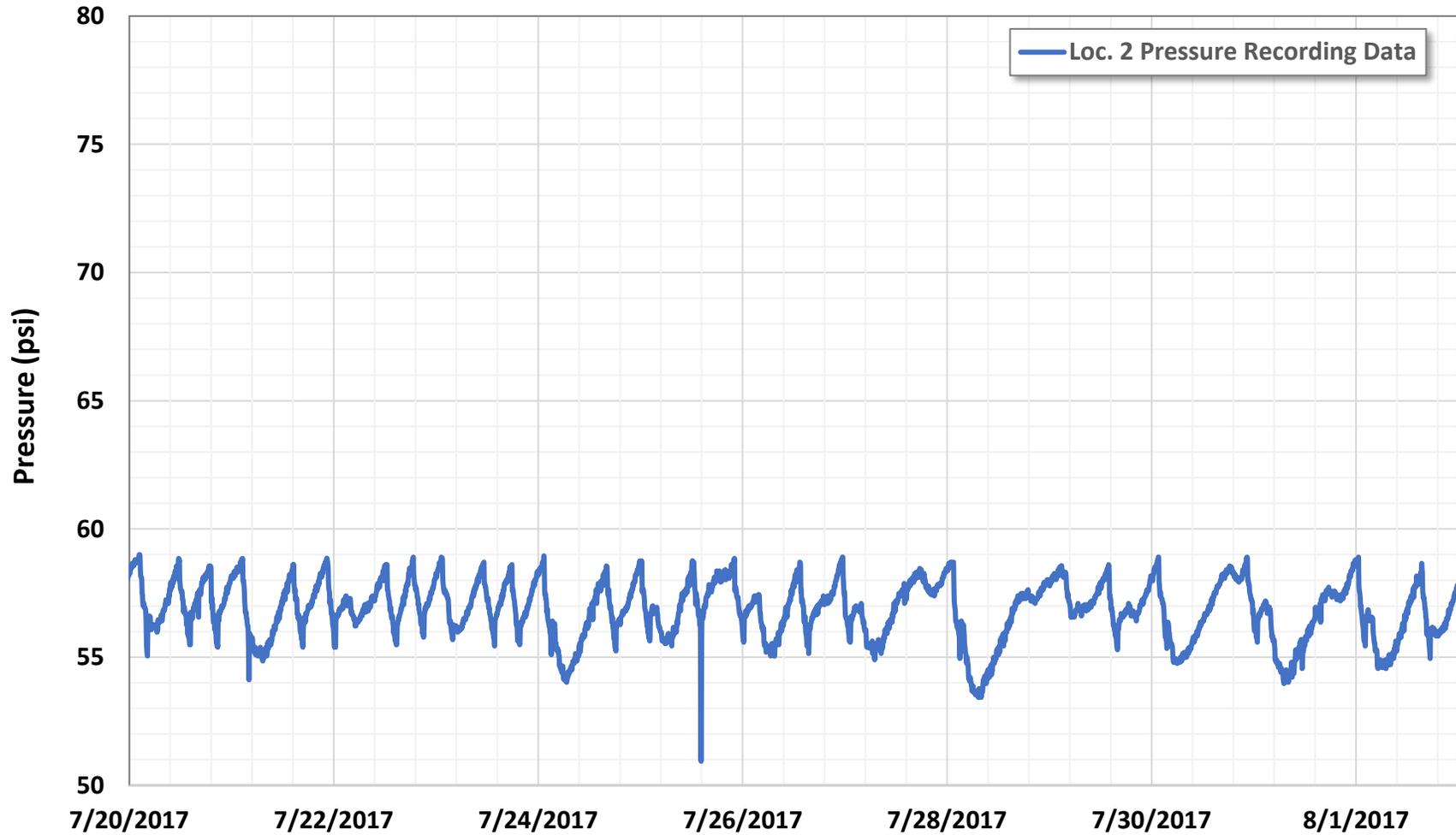


City of Tomball

Location 2: Baker Drive Well

Pressure Recorder ID: 205545 - **Ground Elevation 192'**

July 20 - August 2, 2017



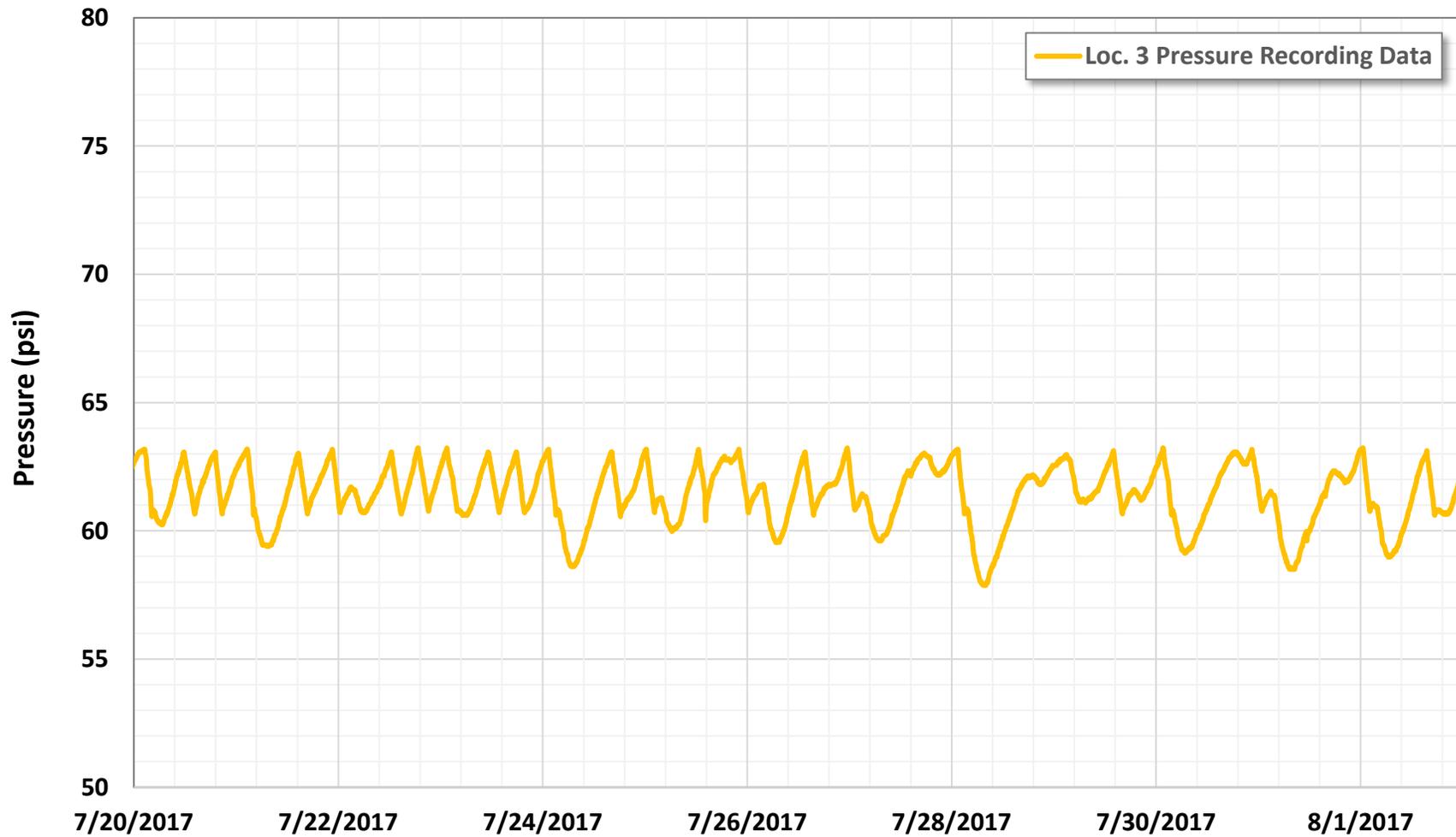


City of Tomball

Location 3: Ulrich Water Tower

Pressure Recorder ID: 341252 - **Ground Elevation 180'**

July 20 - August 2, 2017



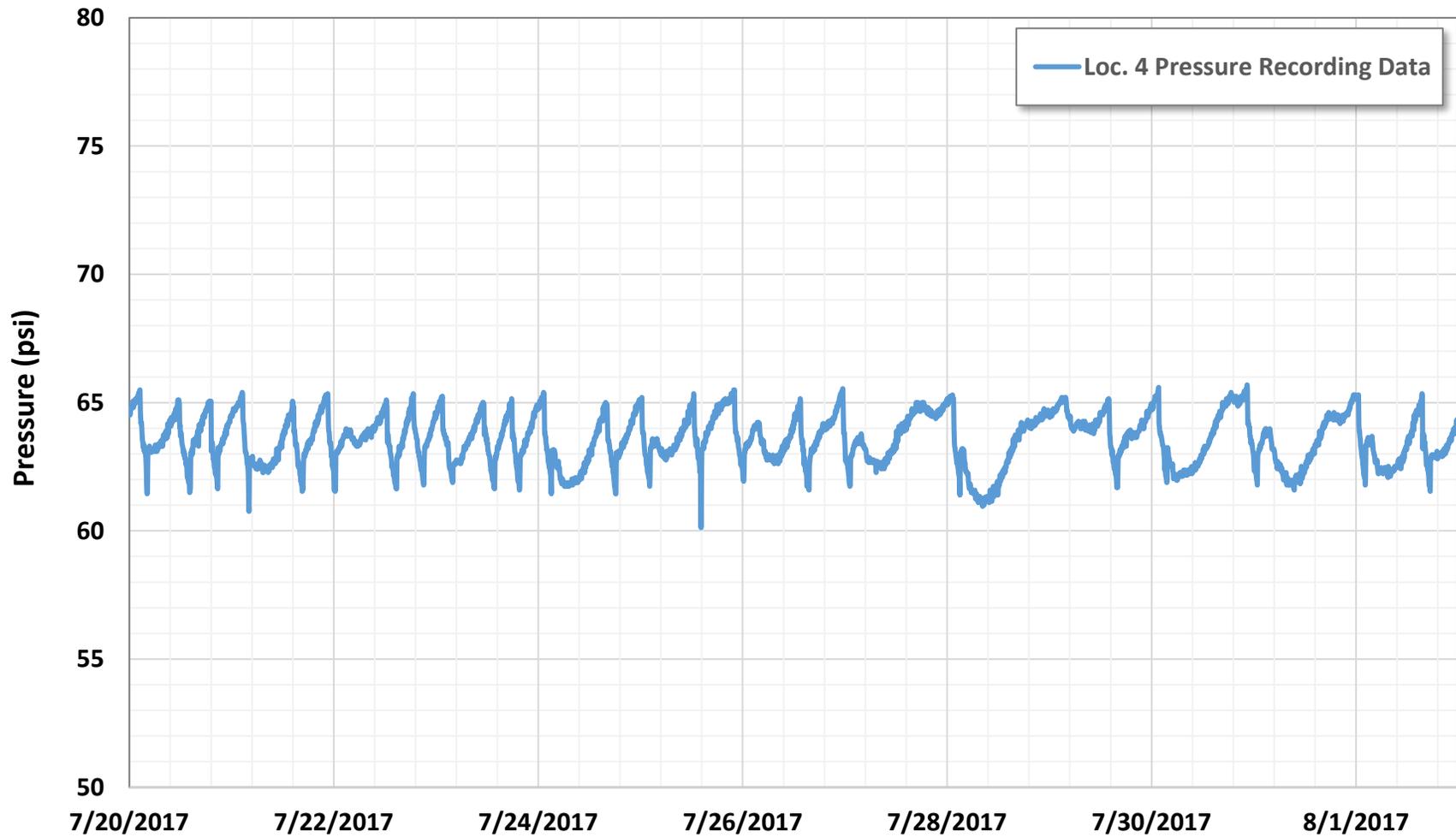


City of Tomball

Location 4: Pine Street and Florence Street Intersection

Pressure Recorder ID: 205929 - **Ground Elevation 180'**

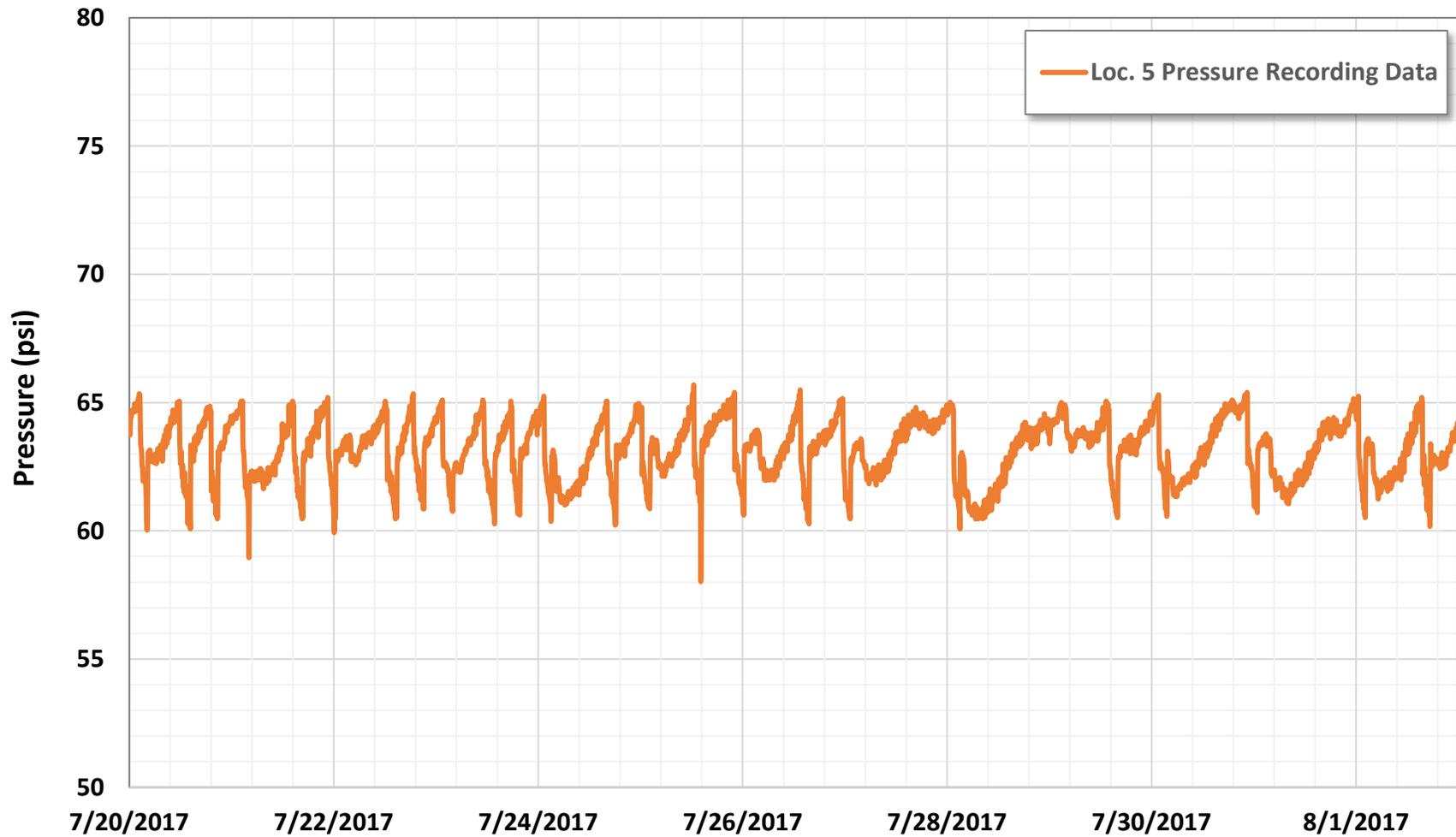
July 20 - August 2, 2017





City of Tomball

Location 5: Lowe's Hydropneumatic Tank
Pressure Recorder ID: 205934 - **Ground Elevation 178'**
July 20 - August 2, 2017



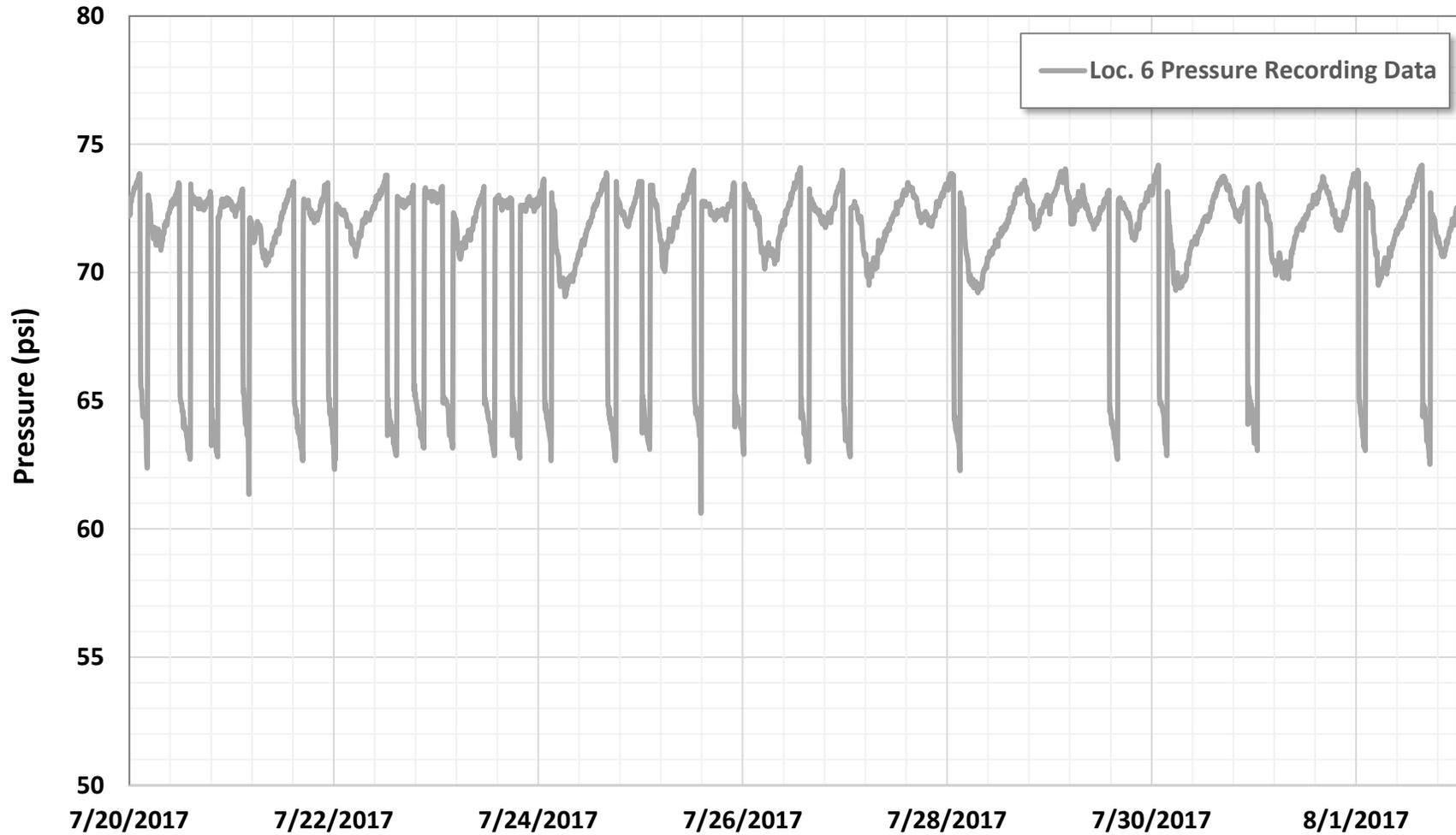


City of Tomball

Location 6: Water Plant on FM 2920

Pressure Recorder ID: 205931 - **Ground Elevation 174'**

July 20 - August 2, 2017



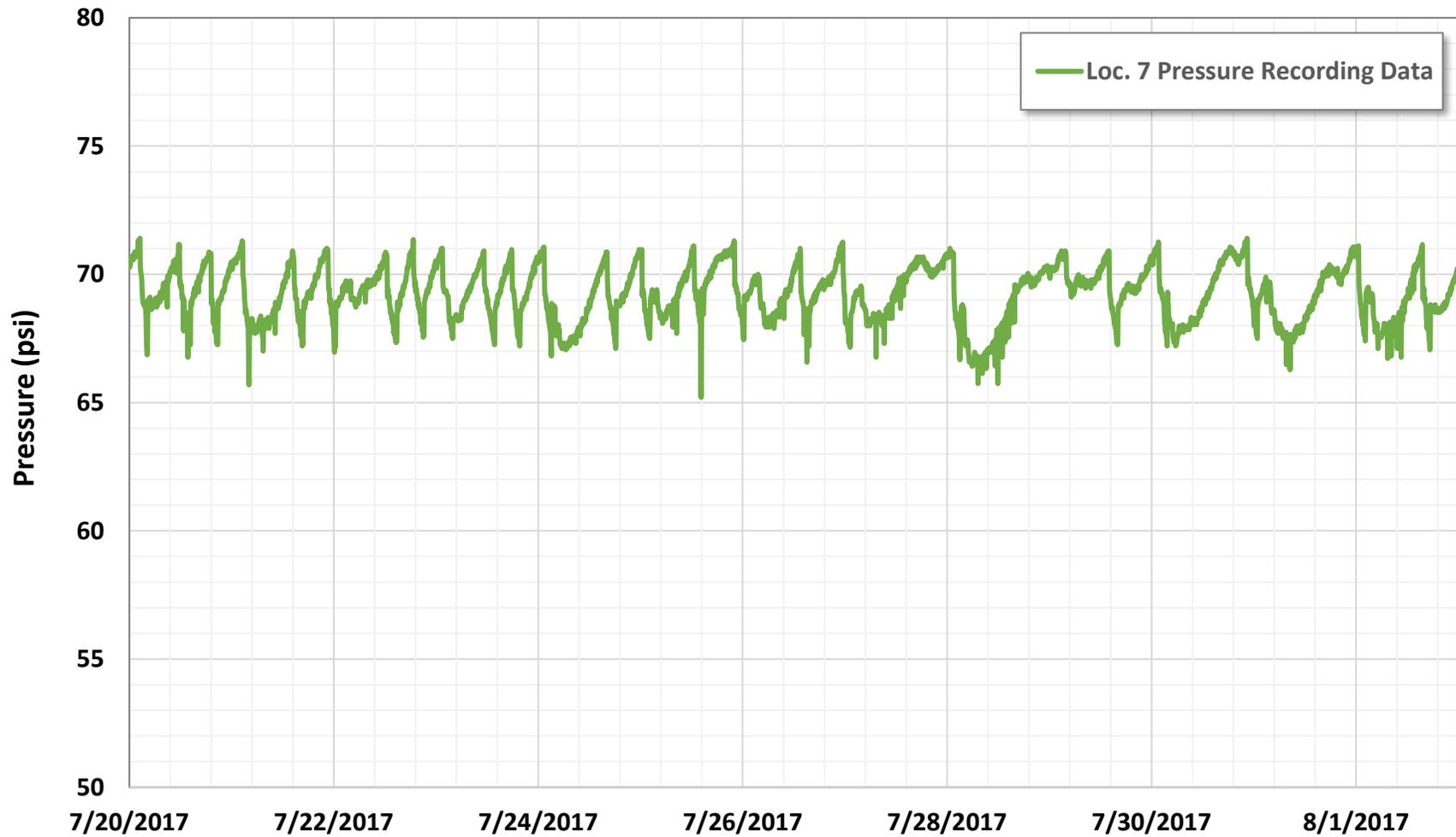


City of Tomball

Location 7: Rocky Road and Boudreaux Estates Drive Intersection

Pressure Recorder ID: 205933 - **Ground Elevation 166'**

July 20 - August 2, 2017



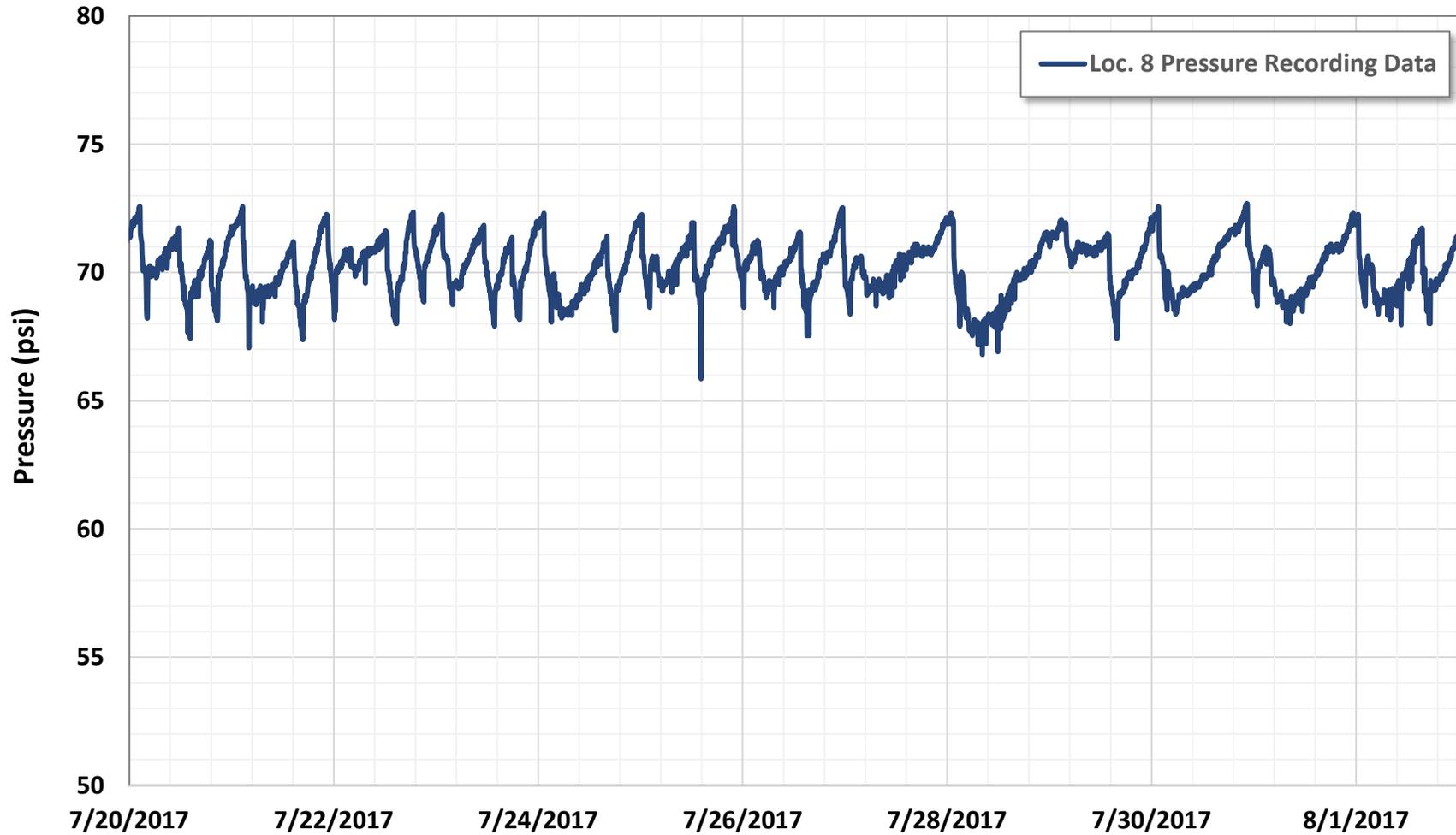


City of Tomball

Location 8: Hederrich Road and Hunsmith Kohrville Road Intersection

Pressure Recorder ID: 341253 - **Ground Elevation 160'**

July 20 - August 2, 2017



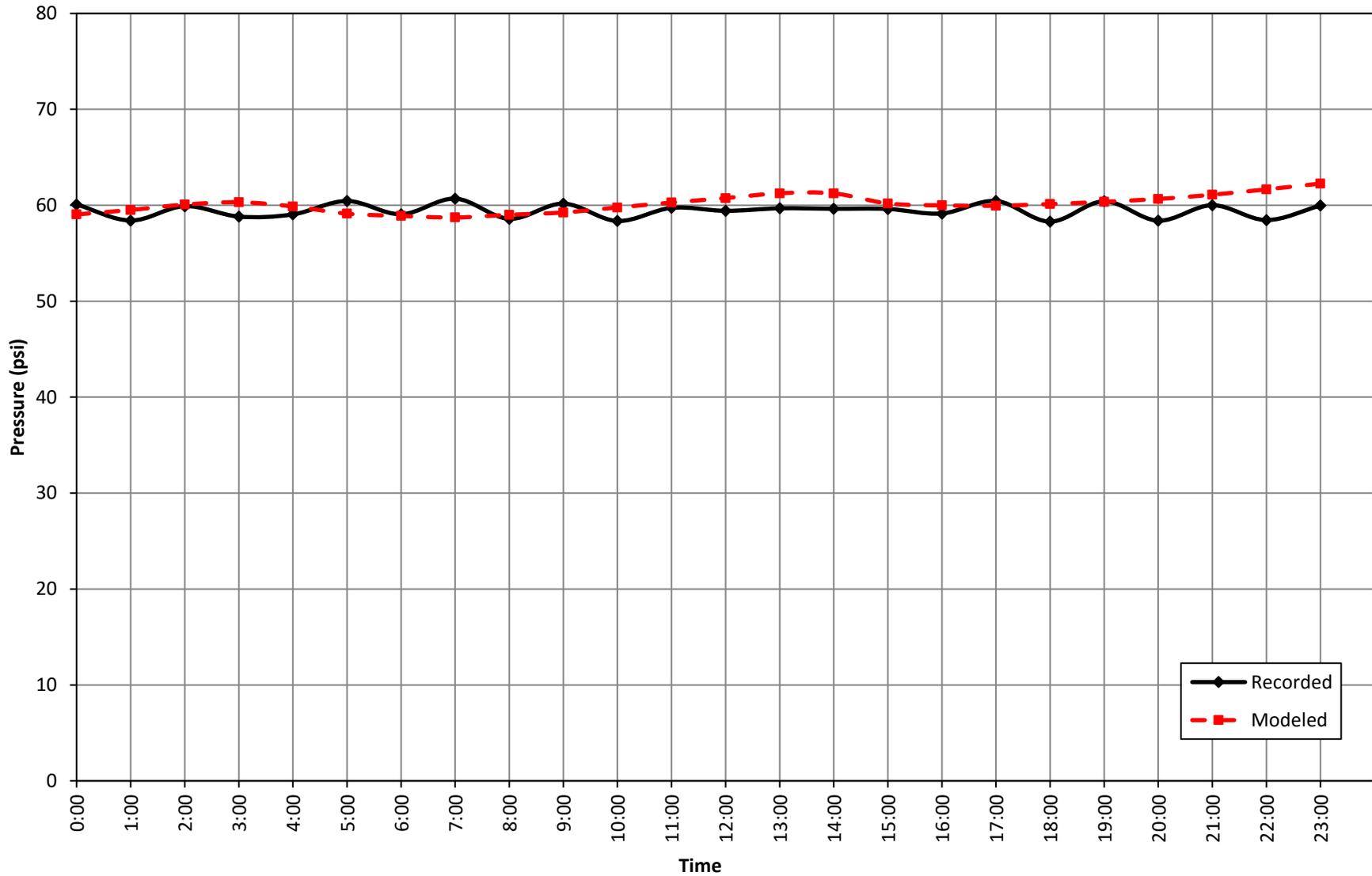
APPENDIX C

Hydraulic Model Calibration Charts

City of Tomball

Pressure Recorder #1 (Lone Star College) - 204229 - Ground Elevation 186'

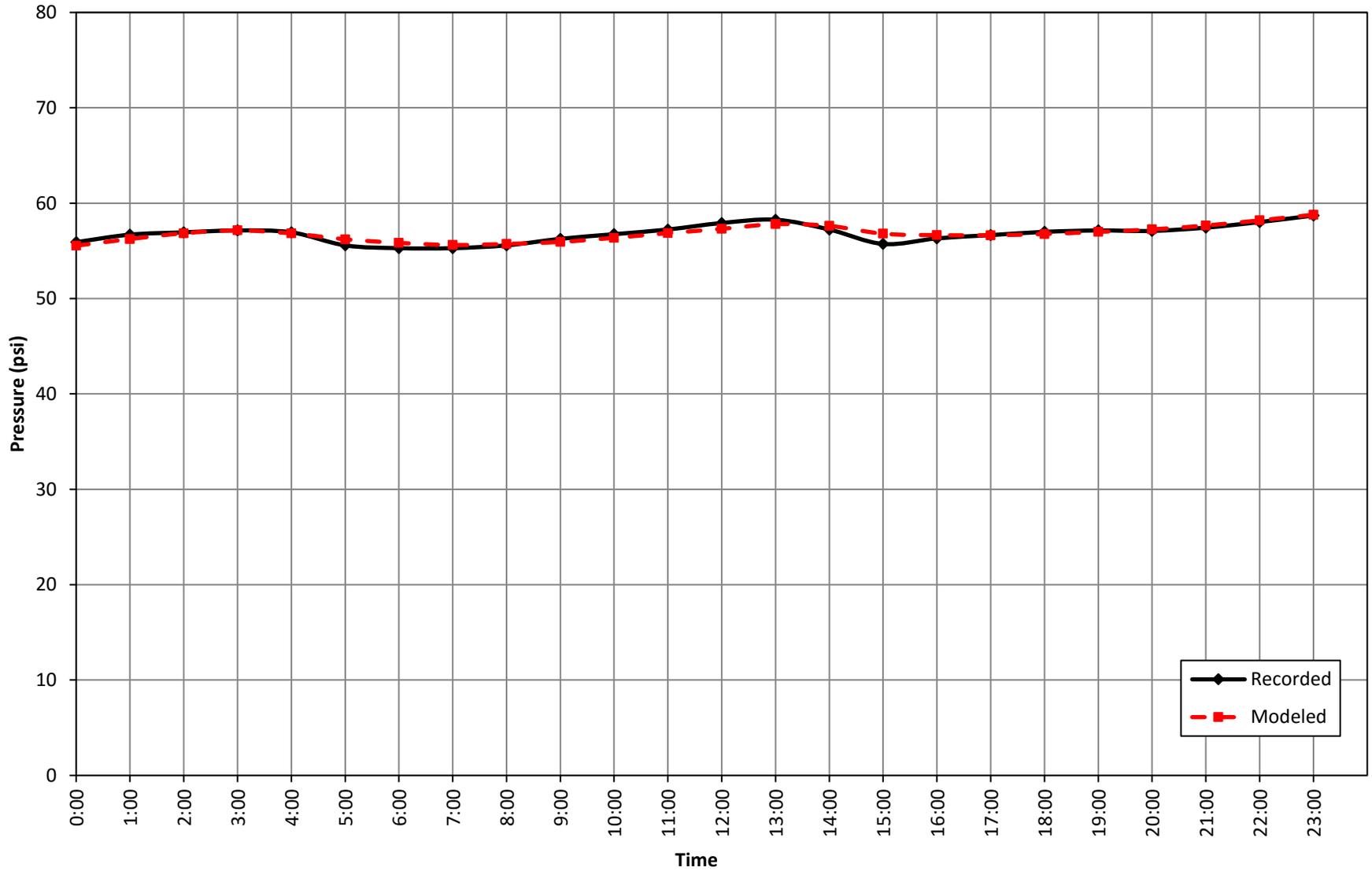
November 2, 2016



City of Tomball

Pressure Recorder #2 - 205545 - Ground Elevation 192'

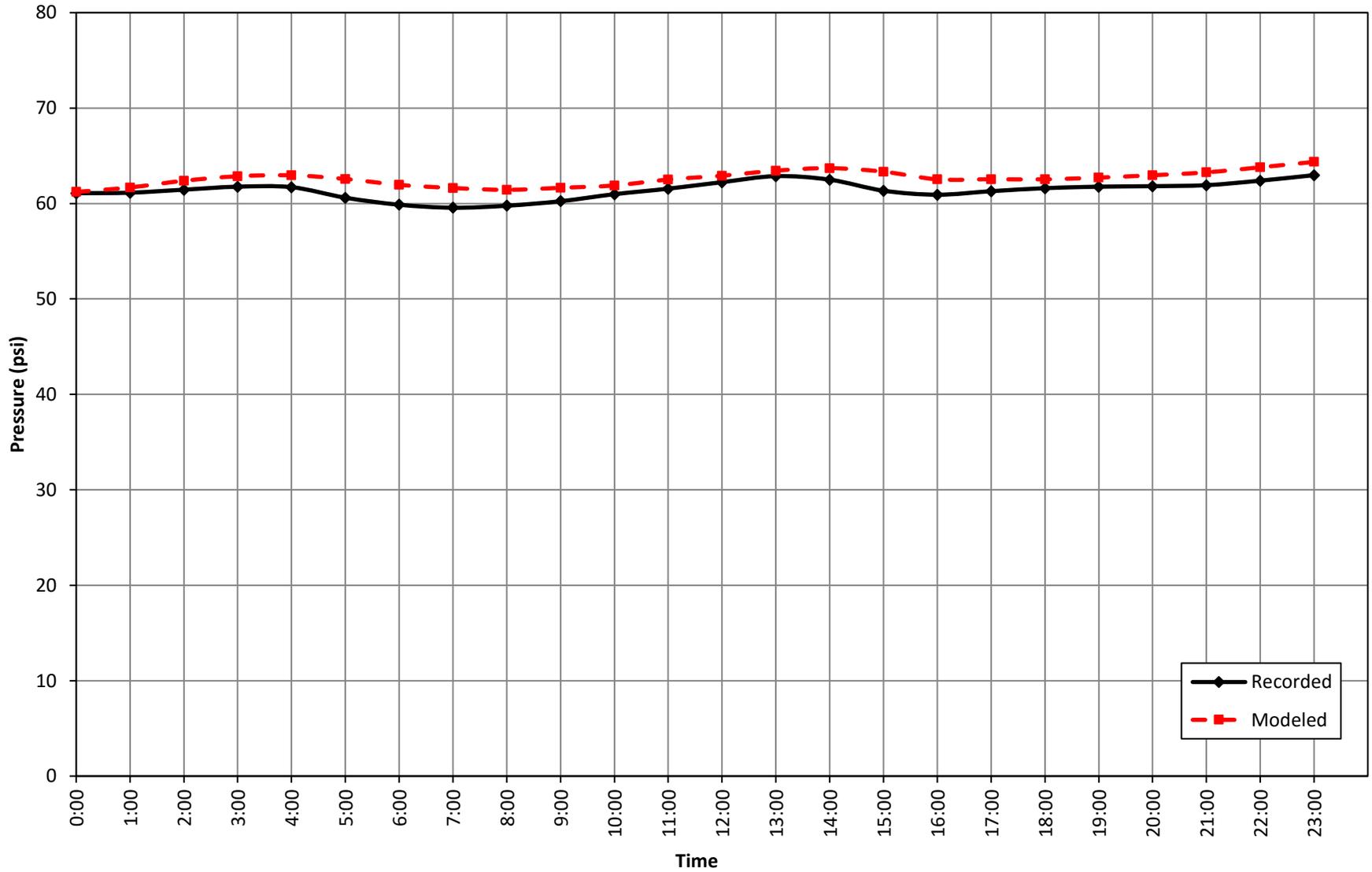
July 26, 2017



City of Tomball

Pressure Recorder #3 (Ulrich EST) - 341252 - Ground Elevation 180'

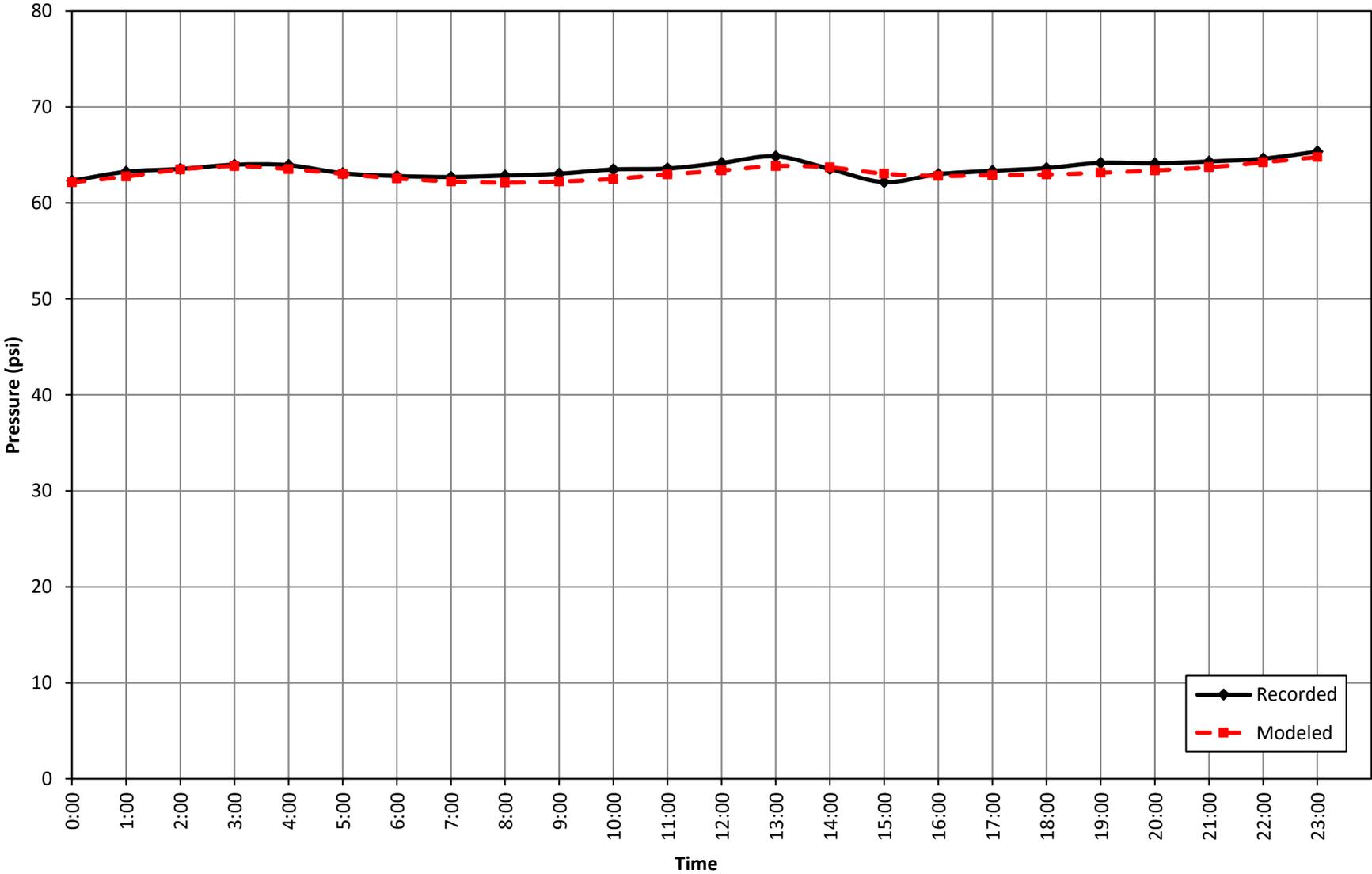
July 26, 2017



City of Tomball

Pressure Recorder #4 (Pine Street Water Plant) - 205929 - Ground Elevation 180'

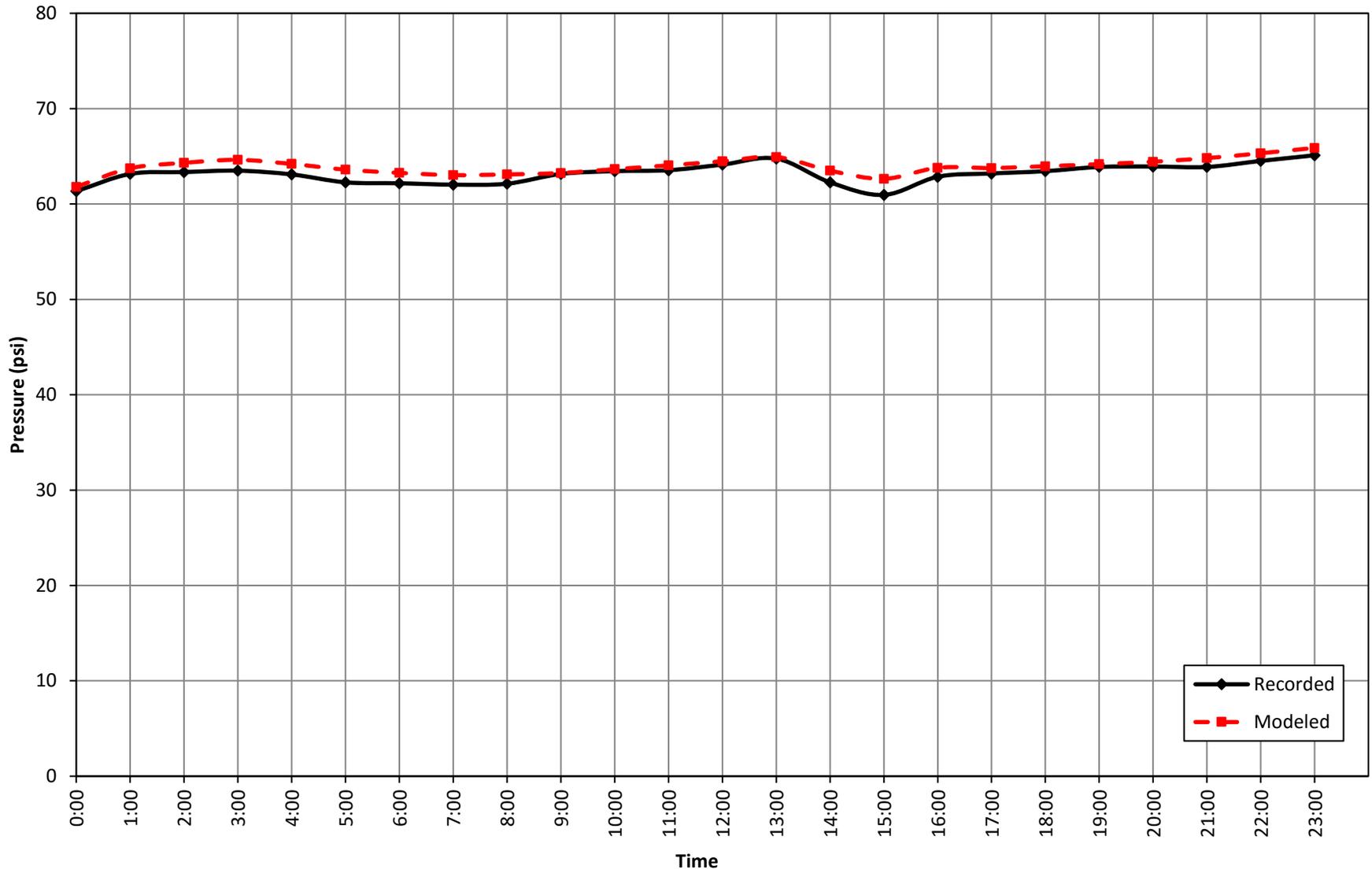
July 26, 2017



City of Tomball

Pressure Recorder #5 - 205934 - Ground Elevation 178'

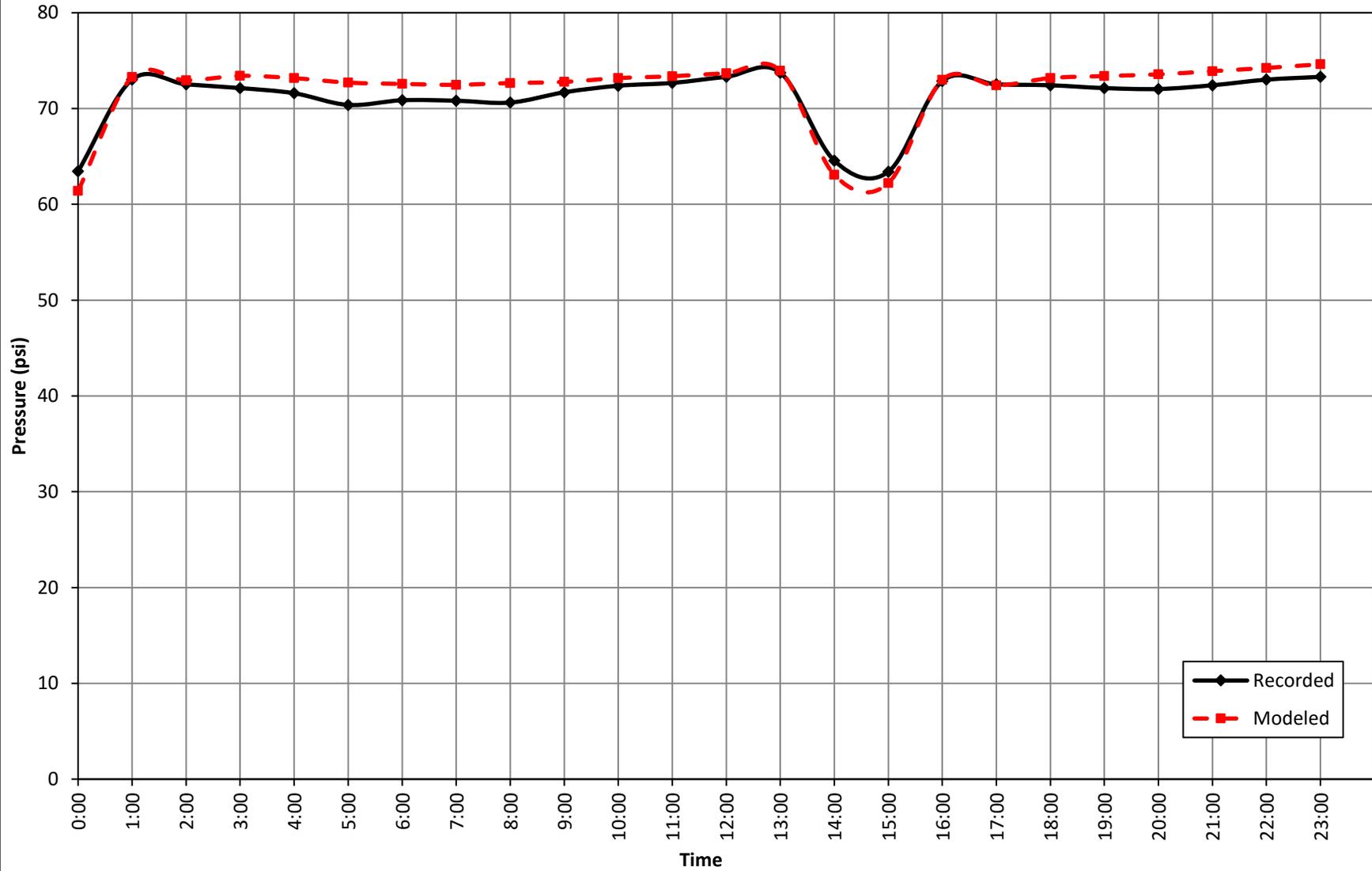
July 26, 2017



City of Tomball

Pressure Recorder #6 (FM 2920 Water Plant) - 205931 - Ground Elevation 174'

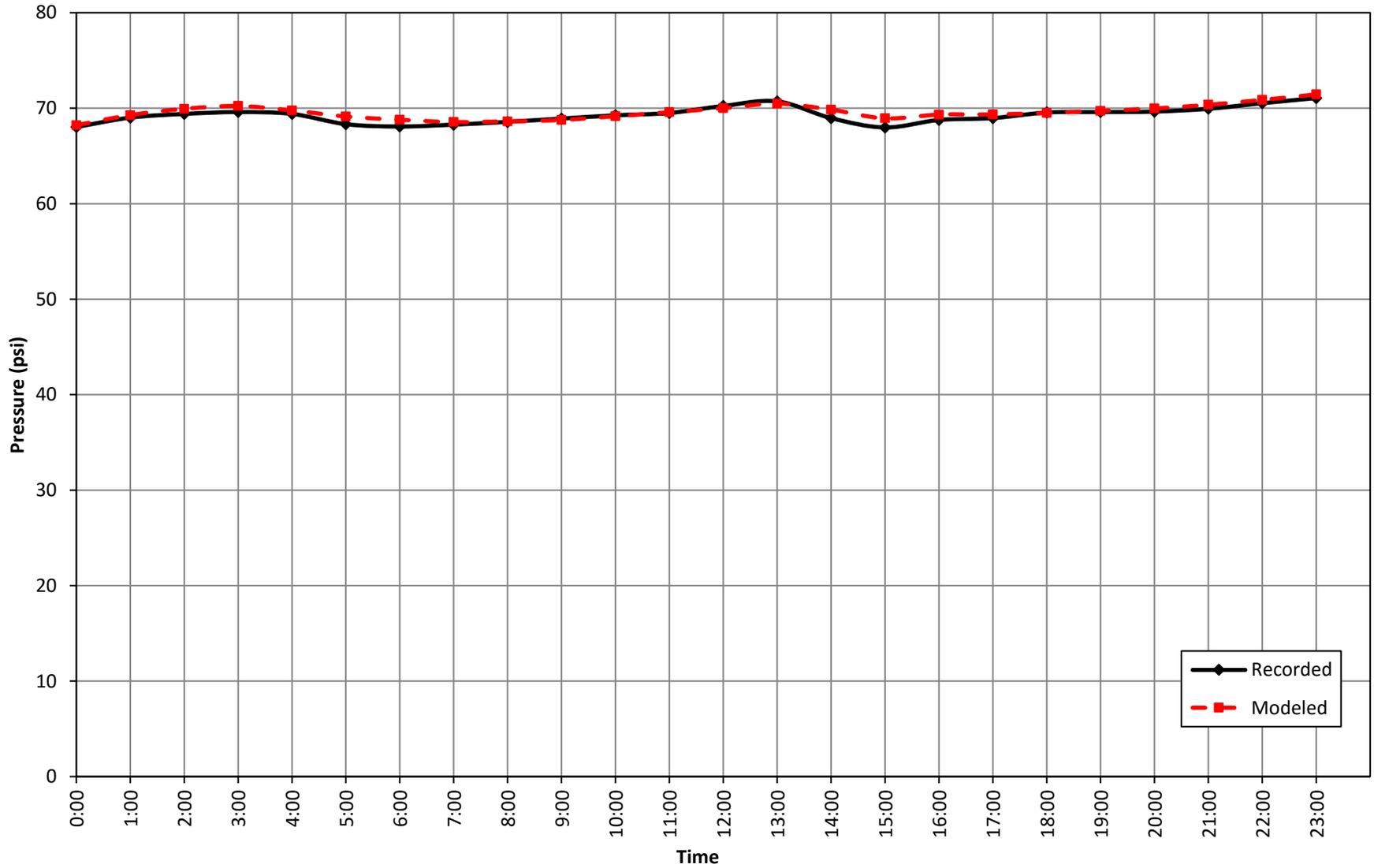
July 26, 2017



City of Tomball

Pressure Recorder #7 - 205933 - Ground Elevation 166'

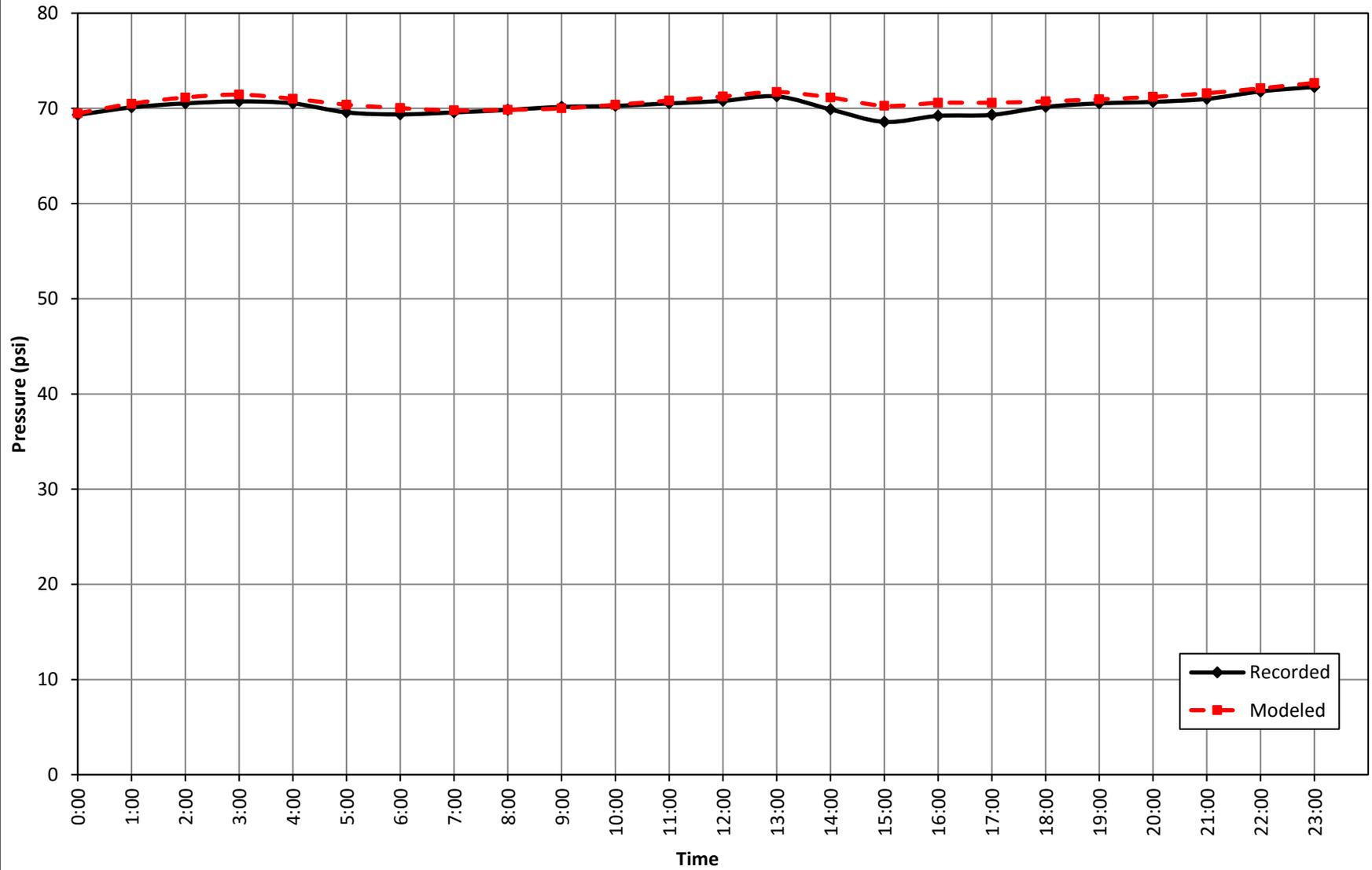
July 26, 2017



City of Tomball

Pressure Recorder #8 - 341253 - Ground Elevation 160'

July 26, 2017



APPENDIX D

Existing Water System Analysis Maps

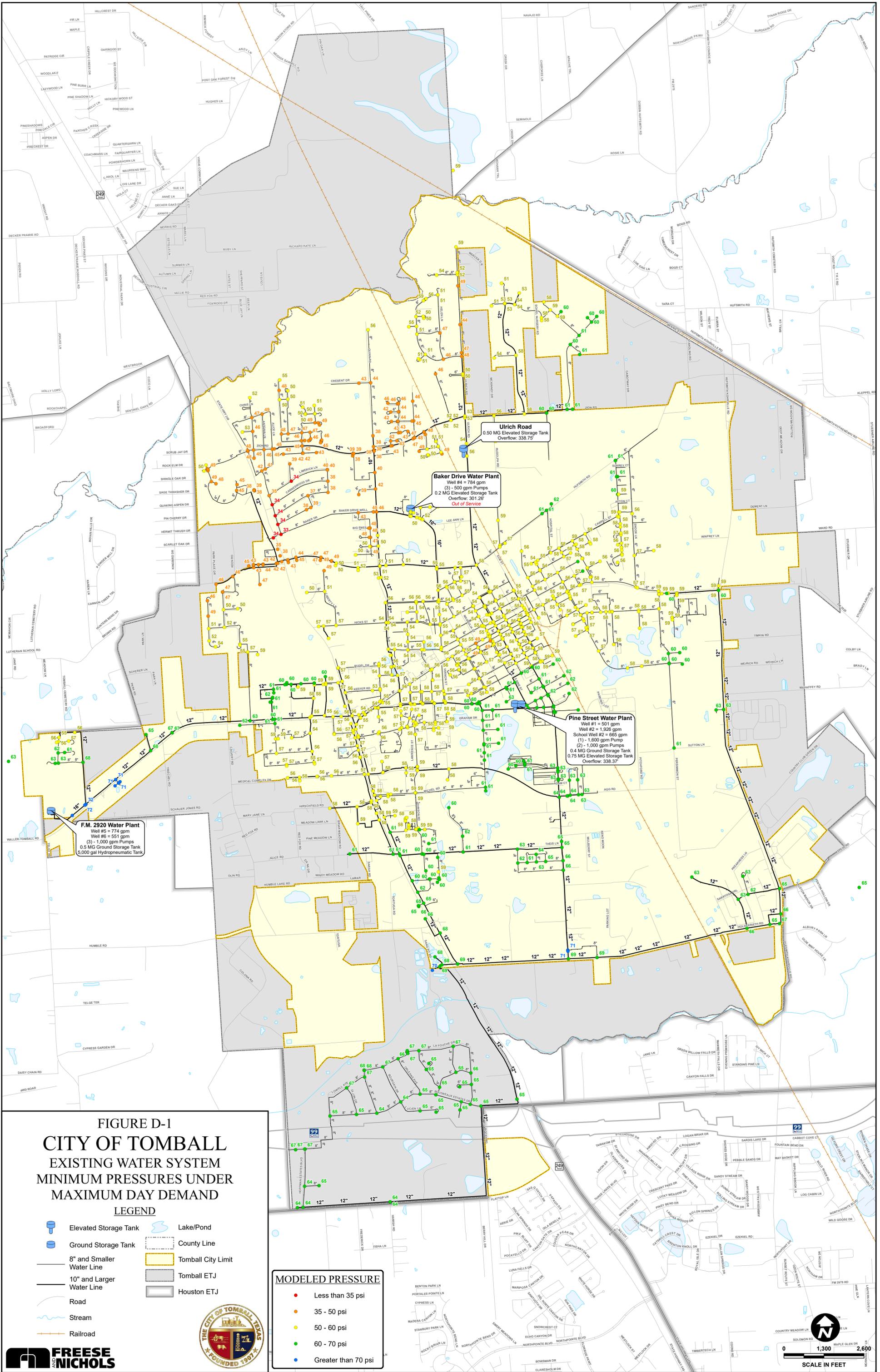


FIGURE D-1
CITY OF TOMBALL
EXISTING WATER SYSTEM
MINIMUM PRESSURES UNDER
MAXIMUM DAY DEMAND

LEGEND

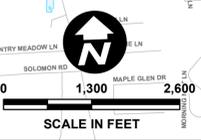
- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ

MODELED PRESSURE

- Less than 35 psi
- 35 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- Greater than 70 psi



DATE: 11/19/2019
PROJECT: 1910 - WATER PLANNING - CITY OF TOMBALL - 2019_FINAL_REPORT_VAMPAppendix_D(Figure_D-1) Existing_System_Minimum_Pressure.mxd
Updated: Monday, September 10, 2018 7:32:28 AM



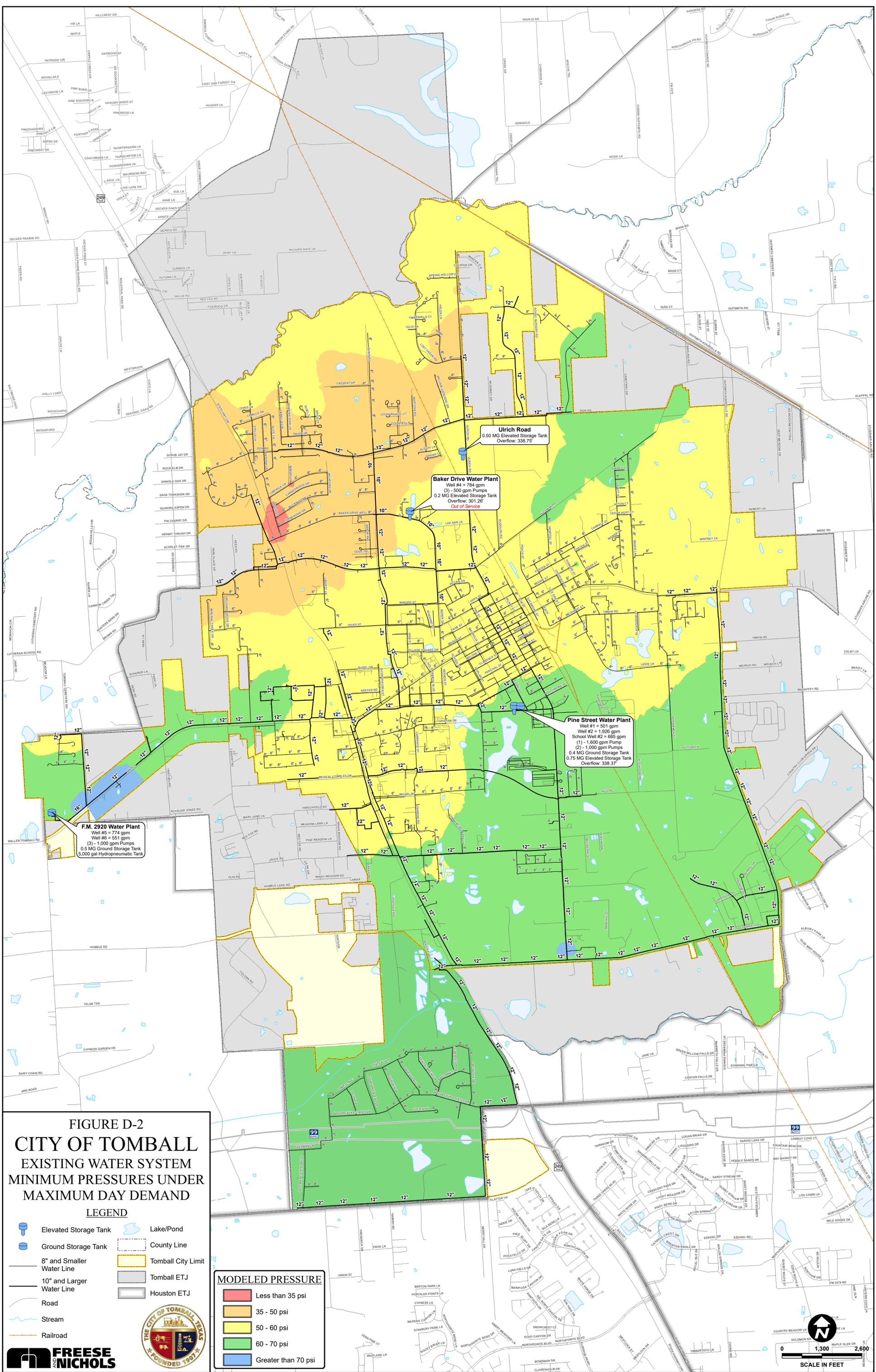


FIGURE D-2
CITY OF TOMBALL
EXISTING WATER SYSTEM
MINIMUM PRESSURES UNDER
MAXIMUM DAY DEMAND

LEGEND

- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ

MODELED PRESSURE

- Less than 35 psi
- 35 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- Greater than 70 psi

THE CITY OF TOMBALL, TEXAS
 FOUNDED 1907

FREES NICHOLS

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 FILE NO. 191670 - WWS_PLANNING - DELIVERABLE_007_FINAL_REPORT_VAMPAppendix_D(Figure_D-2) Existing_System_Minimum_Pressure_Map.mxd
 Updated: Monday, September 10, 2018 7:22:28 AM

0 1,300 2,600

SCALE IN FEET

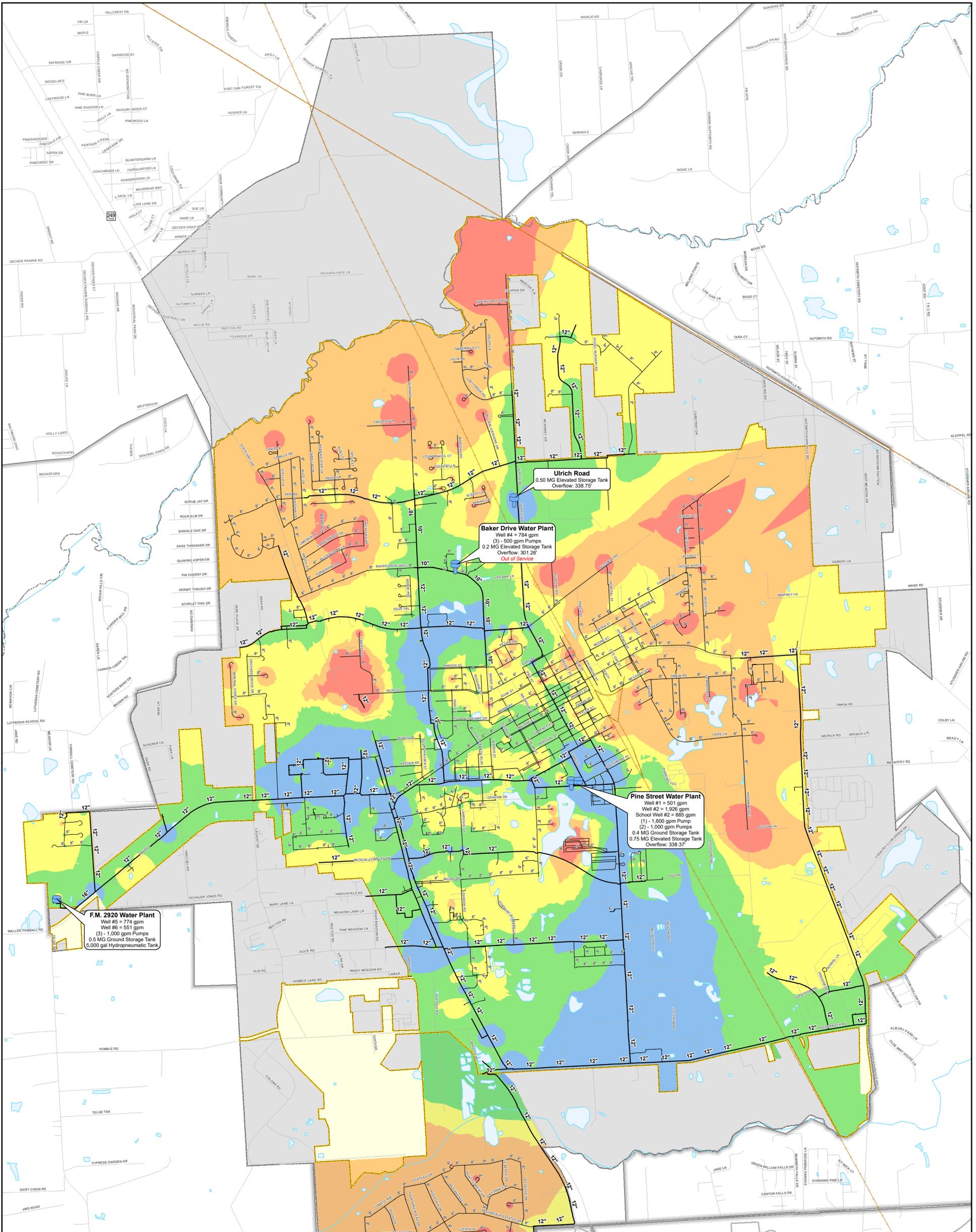


FIGURE D-3
CITY OF TOMBALL
EXISTING WATER SYSTEM
AVAILABLE FIRE FLOW AT 20 PSI
UNDER MAXIMUM DAY DEMAND

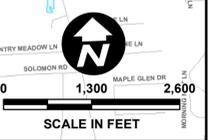
LEGEND

- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ

FIRE FLOW	
Velocity Constraint of 10 ft/s	
	Less than 1,000 gpm
	1,000 - 1,500 gpm
	1,500 - 2,500 gpm
	2,500 - 4,000 gpm
	Greater than 4,000 gpm



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 File No. 1718-Water_Planning_City_of_Tomball_2017_FINAL_REPORT_VAMP_Appendix_D\Figures\Figure_D-3_Existing_System_Fire_Flow.mxd
 Updated: Monday, September 10, 2018 7:33:44 AM



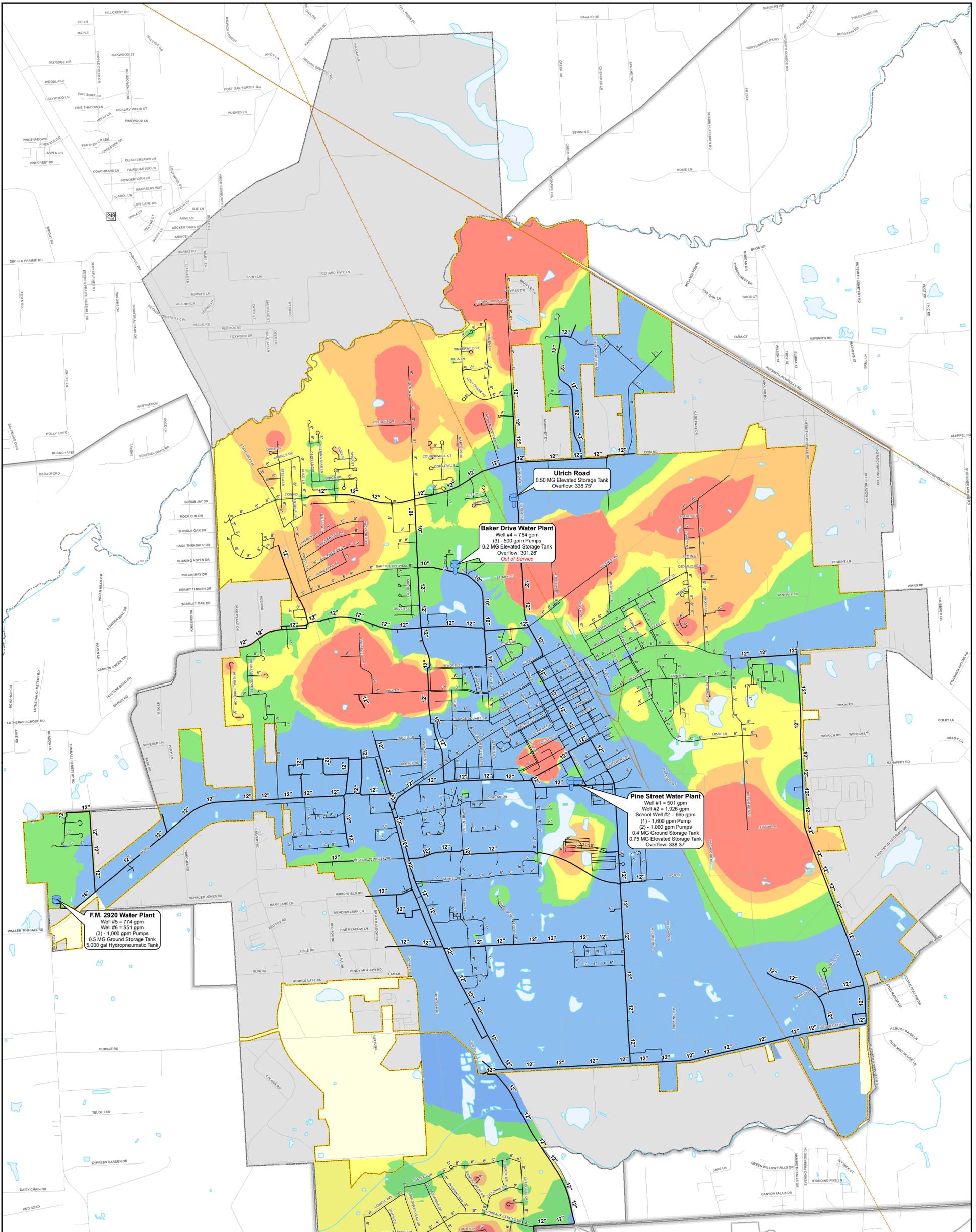


FIGURE D-4
CITY OF TOMBALL
EXISTING WATER SYSTEM
PRESSURE AT 1,000 GPM FIRE FLOW
UNDER MAXIMUM DAY DEMAND

LEGEND

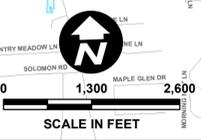
- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ

PRESSURE AT 1,000 GPM FIRE FLOW

- Less than 20 psi
- 20 - 30 psi
- 30 - 40 psi
- 40 - 50 psi
- Greater than 50 psi



Created by Freese and Nichols, Inc. on 11/16/2022
 Location: H:\WV_PLANS\GIS\DELIVERABLES\7_FINAL_REPORT\JMP\Appendix_D\Figure_D-4_Existing_System_Pressure_1000gpm_Fire_Flow.mxd
 Updated Monday, September 19, 2018 7:23:48 AM



APPENDIX E

2042 Water System Analysis Maps

FIGURE E-1 CITY OF TOMBALL 2042 FUTURE WATER SYSTEM MINIMUM PRESSURES UNDER MAXIMUM DAY DEMAND

LEGEND

- Proposed Ground Storage Tank
- Proposed Elevated Storage Tank
- Proposed Water Line
- Future Service Area
- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ



MODELED PRESSURE

- Less than 35 psi
- 35 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- Greater than 70 psi

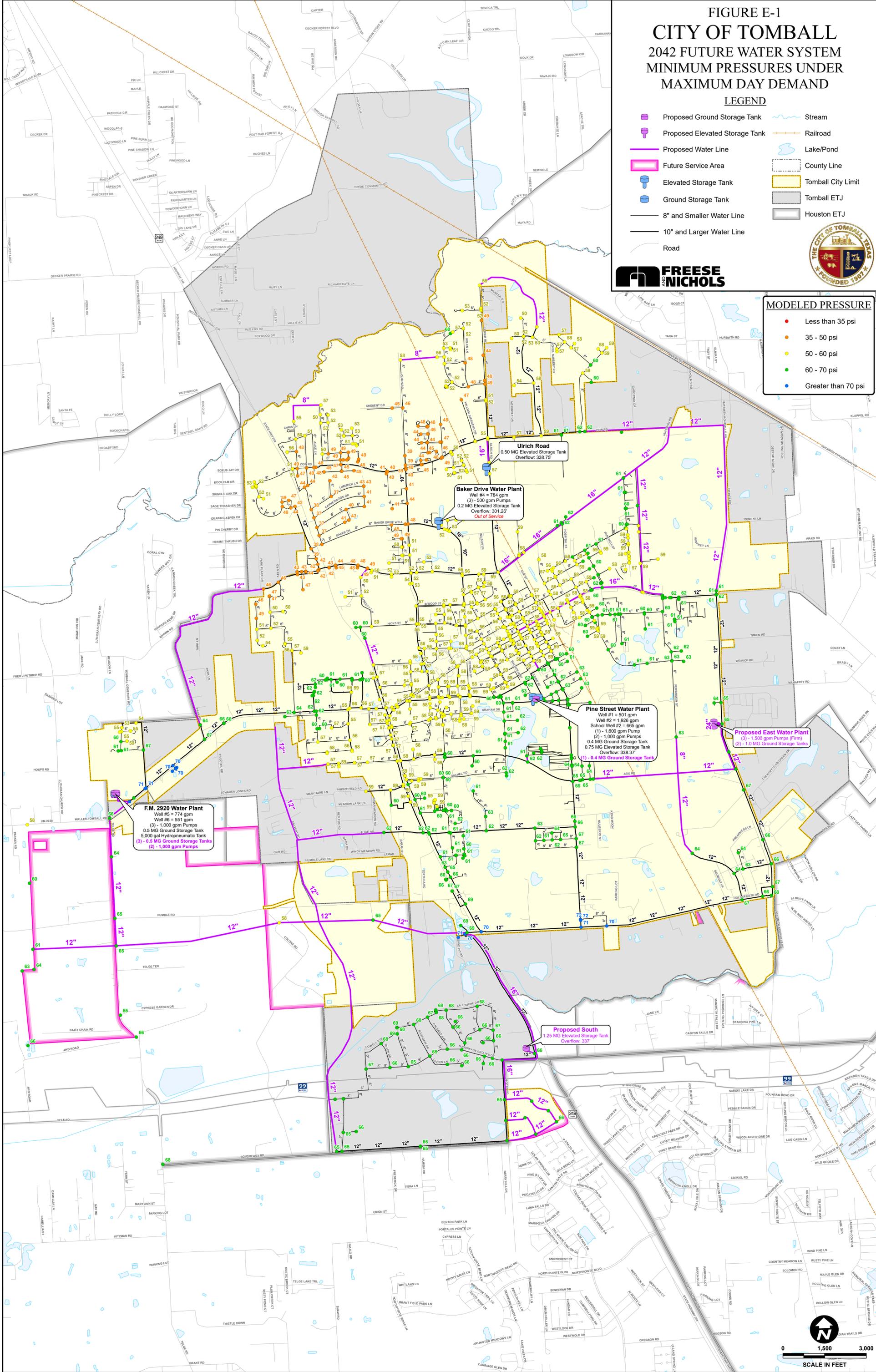


FIGURE E-2 CITY OF TOMBALL 2042 FUTURE WATER SYSTEM MINIMUM PRESSURES UNDER MAXIMUM DAY DEMAND

LEGEND

- Proposed Ground Storage Tank
- Proposed Elevated Storage Tank
- Proposed Water Line
- Future Service Area
- Elevated Storage Tank
- Ground Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Stream
- Railroad
- Lake/Pond
- County Line
- Tomball City Limit
- Tomball ETJ
- Houston ETJ



MODELED PRESSURE

- Less than 35 psi
- 35 - 50 psi
- 50 - 60 psi
- 60 - 70 psi
- Greater than 70 psi

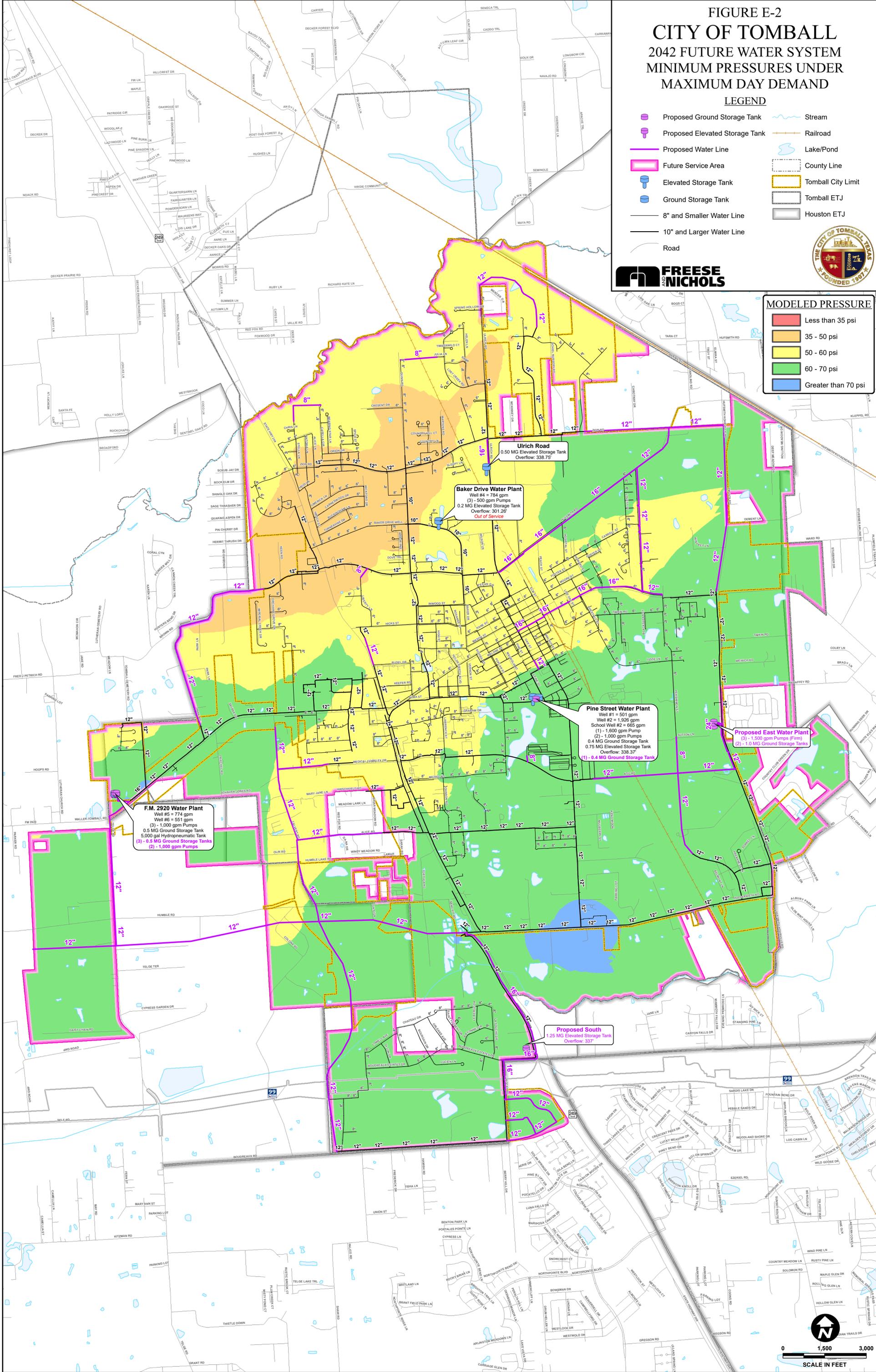


FIGURE E-3 CITY OF TOMBALL 2042 FUTURE WATER SYSTEM AVAILABLE FIRE FLOW

FIRE FLOW

Less than 1,000 gpm
1,000 - 1,500 gpm
1,500 - 2,500 gpm
2,500 - 4,000 gpm
Greater than 4,000 gpm

LEGEND

Proposed Ground Storage Tank	Stream
Proposed Elevated Storage Tank	Railroad
Proposed Water Line	Lake/Pond
Future Service Area	County Line
Elevated Storage Tank	Tomball City Limit
Ground Storage Tank	Tomball ETJ
8" and Smaller Water Line	Houston ETJ
10" and Larger Water Line	Road

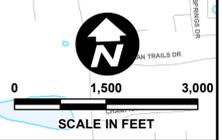
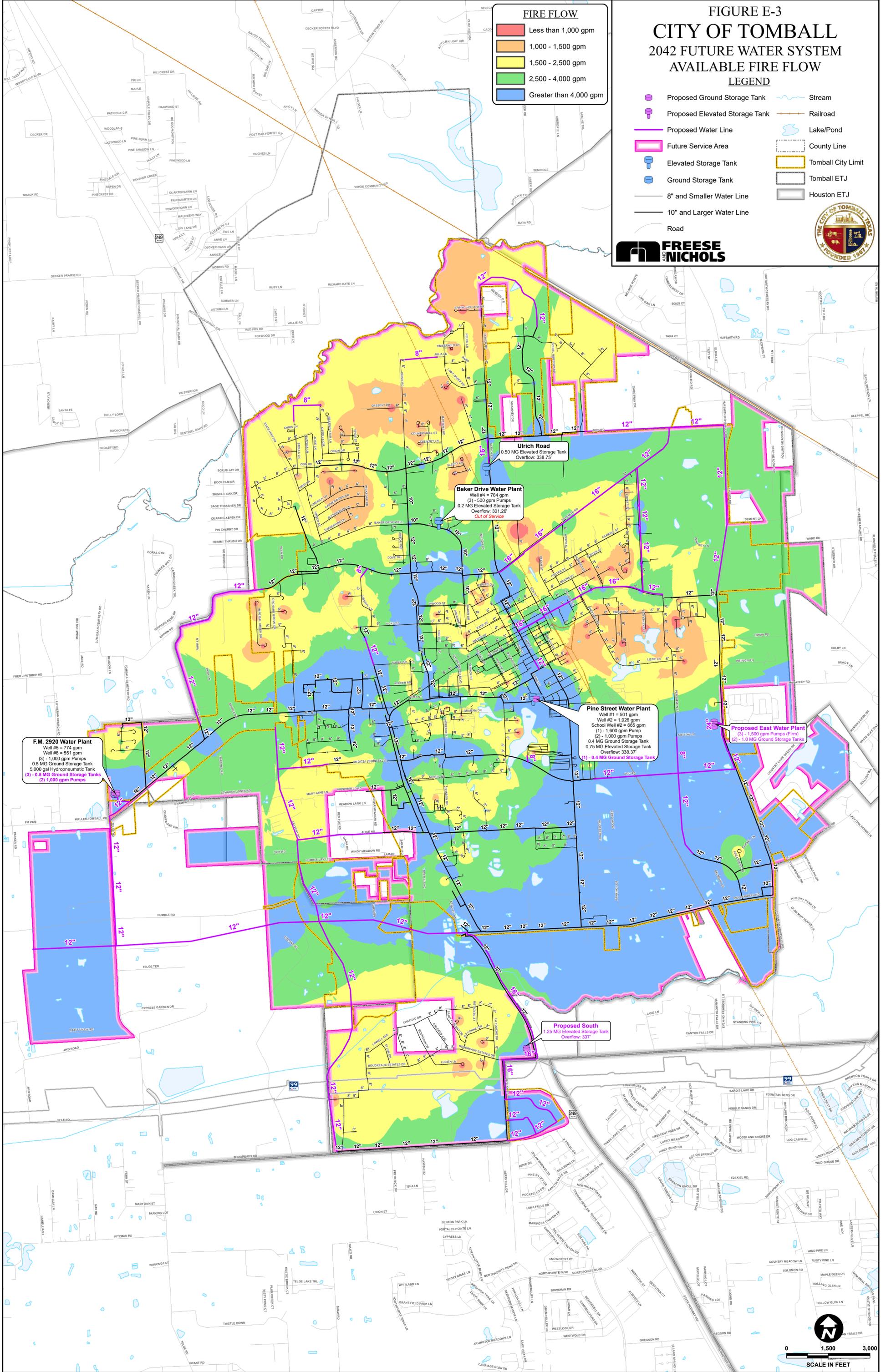


FIGURE E-4 CITY OF TOMBALL 2042 FUTURE WATER SYSTEM PRESSURE AT 1,000 GPM FIRE FLOW UNDER MAXIMUM DAY DEMAND

