OWNER REVIEW (4/07/2022)

Report for

City of Richwood, Texas

Engineering Report for the Elevated Storage Tank

This document is released for the purpose of review under the authority of Morgan Ruiz on April 7, 2022.
It is not to be used for construction, bidding, or permit purposes.

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PURPOSE

The purpose of this Engineering Report (Report) is to evaluate alternatives for the construction of a new elevated storage tank (EST) in the City of Richwood, Texas (City). The evaluation will include hydraulic modeling to review the size, location, and potential modifications to the existing water storage infrastructure. Hydraulic modeling will be used by Strand Associates, Inc.® (Strand) to evaluate how EST placement and elevation might affect static pressures and fire flow availability. Results of the evaluation are documented in the following.

EXISTING WATER DISTRIBUTION SYSTEM

Table 1 summarizes the major supply and storage facilities in the City's water distribution system based on information provided by the City. This Table includes the North Water Plant (NWP), which is currently under construction.

Street Address	Storage	High Service Pumps	Well (State Well No.)	Well Capacity
720 North Mahan Street	75,000-gallon EST	-	Well No. 1 (G0200035A)	Inactive
966 Brazosport Boulevard	330,000-gallon GST	Three 500-gpm pumps at 150 feet of TDH	Well No. 2 (G0200035B)	Plugged
			Well No. 3 (G0200035C)	440 gpm
			Well No. 4 (G0200035D)	
1051 FM 2004	250,000-gallon EST	-	-	-
1003 1/2 Oyster Creek Drive	-	-	Well No. 5 (G0200035E)	450 gpm
614 Audubon Woods Drive	-	-	Well No. 6 (G0200035F)	400 gpm
3019 FM 2004 (not yet in service)	350,000-gallon GST	Three 450-gpm pumps at 121 feet of TDH	Well No. 7 (not yet given)	600 gpm

FM = Farm-to-Market
GST = ground storage tank
gpm = gallons per minute
TDH = total dynamic head

Table 1 Major Water Distribution System Infrastructure

The City's water distribution system is located within a single-pressure plane with two ESTs maintaining the hydraulic grade line within the system. The overflow elevation of the two ESTs is approximately 137 feet based on information provided by the City. The City had 2,480 active connections as of January 2022, also based on information provided by the City.

Table 2 summarizes the Texas Commission on Environmental Quality (TCEQ) Texas Administrative Code (TAC) §290.45 Minimum Water System Capacity Requirements for community groundwater

systems with greater than 250 connections and the City's capacity ratings based on the information in Table 1. Although the NWP is not actively in service, it has been added in the tables and calculations for the purposes of this Report. As shown in Table 2, City infrastructure currently meets all capacity requirements once the NWP is in service.

The City has a purchase point (located on the south side of the City) with Brazosport Water Authority. The City is allowed to use up do 235,000 gallons per day. This allowance was distributed throughout the day to be approximately 163 gpm per day. This amount is calculated into the Well Infrastructure Capacity in Table 2.

For the pumping capacity TAC requirement, the lesser of two considerations must be used. The first is the total capacity of 2.0 gallons per minute per connection (gpm/conn). The second is a minimum of 1,000 gpm and the ability to meet peak hourly demands with the largest pump out of service. The peak-hour demand for the City is 0.5 gpm; therefore, the second consideration was used for Table 2.

30 TAC §290.45	Description	TCEQ Requirement		Infrastructure Capacity		Connections as of January 2022	City Capacity		Satisfies TCEQ Requirement
(b)(1)(D)(i)	Well Capacity	0.6	gpm/conn	2,053	gpm	2,480	0.8278	gpm/conn	Yes
(b)(1)(D)(ii)	Total Storage Capacity	200	gal/conn	1.005	MG	2,480	405.24	gal/conn	Yes
(b)(1)(D)(iii)	Pumping Capacity	0.5	gpm/conn	1,900	gpm	2,480	0.7661	gpm/conn	Yes
(b)(1)(D)(iv)	Elevated Storage Capacity	100	gal/conn	0.325	MG	2,480	131.05	gal/conn	Yes
(b)(1)(D)(v)	Emergency Power	0.35	gpm/conn	Not applicable; elevated storage criteria met.					

MG = million gallons
gal/conn = gallons per connection

Table 2 City System Capacity Requirements

DEMAND PROJECTIONS

Based on historic growth and information provided by the City, Table 3 summarizes the anticipated growth in connections for the City over the next ten years. This growth includes the complete build out for Oakwood Shores (OS) subdivision, where the NWP is located.

Date	Increase	Connections
January 2022	-	**2,480**
January 2023	+97 conn	2,577
January 2024	+97 conn	2,674
January 2025	+97 conn	2,771
January 2026	+97 conn	2,868
January 2027	+97 conn	2,965
January 2028 through 2032	+50 conn per year Total = +250 conn	3,215
Total	**+785 conn**	-

conn = connections

Table 3 Connection Projections

REVIEW OF HYDRAULIC WATER MODEL

The model includes all known water mains and all infrastructure noted in Table 1. The model simulates well pumps as fixed inputs into the model and does not use pump curves. This is a simplification and common practice in hydraulic modeling. The input matches the reported capacity of the wells.

C factors for all pipes within the model are set at 120, indicating the water model is likely not calibrated. Pipe materials are only listed for approximately 10 percent of water mains in the water model, all of which are listed as polyvinyl chloride. New water mains installed as part of the NWP project have been added to the model. Pipe age is unknown for all other existing pipes in the water model and have an existing year of installation defaulted to 1999. All existing pipes do have data sources listed, which is a good indicator that the location, diameter, and connectivity of water mains in the distribution system are accurate.

Demand estimates were increased in the OS subdivision to project complete buildout of the subdivision. No changes to demand were made to the water model in other locations for the review of the system improvements.

When reviewing the Appendices, consideration should be taken that these pressures are at ground elevation. For areas that have multi-story buildings, these pressures will be lower than the range shown. For approximation purposes only, these higher stories can be reduced one pressure range, or approximately 5 pounds per square inch (psi) per story.

The hydraulic model was reviewed for both existing conditions and when OS is completely built out. As shown in Appendix A, pressures in the northern portion of the City will continue to decrease as development of OS increases. In Appendix B, available fire flows will decrease even in the central area of the City, as OS development increases. It should also be noted in the model that fire flows less than 500 gpm occur at several locations where areas are served by water mains with pipe diameters equal to or lesser than 4 inches.

REVIEW OF ALTERNATIVES

The following alternatives were simulated to review proposed EST improvements. In all alternative options, the City's current 75,000-gallon EST is taken out of service. These alternatives are also calibrated to show pressure demands based on OS being completely built out. The model reviewed how the system would be affected constructing an EST at the current overflow elevation of 137 feet and increasing the hydraulic gradient line (HGL) by 10 psi; therefore, raising the overflow elevation to 160 feet for all ESTs in the system. The proposed EST locations are at the NWP site, in the northeast quadrant of the FM 2004 and Highway 288B intersection (Intersection), and across Highway 288B at City Hall (City Hall).

1. NWP Site

The results of the modeling for a new EST at the NWP can be found in Figures 1A and 1B of the appendices. Figure 1A of Appendices A and B presents the modeling results with the EST constructed at the existing overflow elevation and Figure 1B of Appendices A and B presents the results at an overflow elevation of 160 feet.

Figure 1A of Appendices A and B shows that by constructing an EST at the NWP, pressures increase within OS and the remainder of the City north of FM 2004. Pressures would also increase in areas north of the 75,000-gallon EST to be taken out of service. The majority of the City would have average pressures of 50 to 55 psi. Available fire flow increases from less than 1,000 gpm to more than 1,500 gpm in the majority of OS. Flows northeast of the Intersection increase from 1,000 gpm being the maximum to 1,000 gpm being the minimum.

Figure 1B of Appendices A and B shows the HGL being increased by constructing an EST at the NWP with an overflow elevation of 160 feet as well as raising the existing 250,000-gallon EST to an overflow elevation of 160 feet. If this is done, the entire City would have pressures of more than 60 psi. By constructing an EST at the NWP at the raised overflow elevation, available fire flows continue to increase. Much of the City would be able to have a minimum of 1,500 gpm available with this option.

2. Intersection

The results of the modeling at the Intersection can be found in Figures 2A and 2B of the appendices. Figure 2A of Appendices A and B presents the modeling results with the EST constructed at the existing overflow elevation and Figure 2B of Appendices A and B presents the results at an overflow elevation of 160 feet.

Figure 2A of Appendices A and B shows pressures would have a similar effect on the system in this location as with the NWP location. Overall pressures would increase, and the City's lowest pressure, at ground level, would be 50 psi. Fire flow availability would increase throughout the northwestern and central portions of the City better than at the NWP site. Fire flow would increase in OS, but not as significantly as at the NWP site.

Figure 2B of Appendices A and B also has a similar effect on the system as with the NWP location. The City would have pressures more than 60 psi for the whole system. Fire flow availability in OS would overall increase to more than 1,000 gpm, with an even greater increase in the southern portion of OS of more than 1,500 gpm.

3. City Hall

The results of the modeling at the Intersection can be found in Figures 3A and 3B of Appendix A. Figure 3A presents the modeling results with the EST constructed at the existing overflow elevation and Figure 3B presents the results at an overflow elevation of 160 feet. As indicated in Figures 3A and 3B, the City Hall alternatives did not show significant system pressure improvements when compared to the other two alternatives. For this reason, available fire flow was not reviewed for this study.

Figure 3A shows that building an EST on the outskirts of the central area of the City would increase poor pressures around Audubon Woods Drive and along the northern areas of Highway 288B. Pressures in OS and on the western side of the City would not be affected.

Figure 3B shows, as with the previous two locations, pressures would significantly increase if the overflow elevation was raised. However, only pressures south of FM 2004 would increase to more than 60 psi. The pressures north of FM 2004 would still be less than 60 psi.

REVIEW OF FIVE- AND TEN-YEAR SYSTEM IMPROVEMENTS

Table 4 shows the TCEQ TAC §290.45(b)(1)(D)(iv) Minimum Elevated Storage Capacity Requirements with and without the additional EST for the five- and ten-year growth projections, respectively.

Description	TCEQ Requirement		Infrastructure Capacity		Connections	City Rating		Satisfies TCEQ Requirement
Five-Year Projected Requirements (January 2027)								
Without Additional EST	100	gal/conn	0.325	MG	2,965	109.6	gal/conn	Yes
With Additional 150,000-gal EST			0.475	MG		160.2	gal/conn	Yes
With Additional 200,000-gal EST			0.525	MG		177.1	gal/conn	Yes
Ten-Year Projected Requirements (January 2032)								
Without Additional EST	100	gal/conn	0.325	MG	3,215	101.1	gal/conn	Yes
With Additional 150,000-gal EST			0.475	MG		147.7	gal/conn	Yes
With Additional 200,000-gal EST			0.525	MG		163.3	gal/conn	Yes

Table 4 Projected Elevated Storage Capacity Requirements

As shown in Table 4, without a proposed EST, the City is barely capable of meeting elevated storage capacity requirements in ten years, indicating improvements are required to maintain compliance with TCEQ requirements if growth continues as anticipated. Even in the five-year requirements, the elevated storage capacity surpasses the 85-percent rule, as outlined in the TAC §291.93(3) and will require a planning report submitted to the TCEQ executive director clearly explaining how the City will provide the expected service demands to the remaining areas within its boundaries. Table 5 shows other TCEQ TAC §290.45 Minimum Water System Capacity Requirements for other infrastructure in the City, based on no improvements being made in those areas.

30 TAC §290.45	Description	TCEQ Requirement		Infrastructure Capacity		Connections	City Capacity		Satisfies TCEQ Requirement
Five-Year Projected Requirements (January 2027)									
(b)(1)(D)(i)	Well Capacity	0.6	gpm/conn	2,053	gpm	2,965	0.69	gpm/conn	Yes
(b)(1)(D)(ii)	Total Storage Capacity	200	gal/conn	1.005	MG		338.95	gal/conn	Yes
(b)(1)(D)(iii)	Pumping Capacity	0.5	gpm/conn	1,900	gpm		0.64	gpm/conn	Yes
(b)(1)(D)(v)	Emergency Power	0.35	gpm/conn	Not applicable; elevated storage criteria met.					
Ten-Year Projected Requirements (January 2032)									
(b)(1)(D)(i)	Well Capacity	0.6	gpm/conn	2,053	gpm	3,215	0.64	gpm/conn	Yes
(b)(1)(D)(ii)	Total Storage Capacity	200	gal/conn	1.005	MG		312.60	gal/conn	Yes
(b)(1)(D)(iii)	Pumping Capacity	0.5	gpm/conn	1,900	gpm		0.59	gpm/conn	Yes
(b)(1)(D)(v)	Emergency Power	0.35	gpm/conn	Not applicable; elevated storage criteria met.					

Table 5 Projected City System Capacity Requirements

Although all requirements are satisfied in Table 5, well capacity for the five- and ten-year projected requirements surpasses the 85-percent rule. Pumping capacity for the ten-year projected requirements is at the 85-percent threshold. Therefore, continued planning would still be required to address system supply and demand.

It should also be noted that well pumps that pump directly into the system will be affected by increasing the HGL. These pumps may need to be reviewed and modified to meet the new design point.

OPINION OF PROBABLE PROJECT COST (OPPC)

Tables 6 and 7 summarize the OPPCs for a 150,000-gallon and 200,000-gallon EST, respectively. Table 8 summarizes the OPPC designed to elevate the existing 250,000-gallon EST.

Description	Estimated Quantity		Unit Cost	Total Cost
Foundation.	1	LS	$250,000.00	$250,000.00
150,000-gallon welded steel, multi-leg EST with wet riser.	1	LS	$775,000.00	$775,000.00
Electrical controls and SCADA integration.	1	LS	$125,000.00	$125,000.00
Sitework, grading, and seeding.	1	LS	$5,000.00	$5,000.00
			Subtotal	$1,155,000.00
			Contingency	$231,000.00
			Engineering–15%	$208,000.00
			Total	**$1,594,000.00**

LS = lump sum
SCADA = supervisory control and data acquisition

Table 6 OPPC for 150,000-Gallon EST

Description	Estimated Quantity		Unit Cost	Total Cost
Foundation.	1	LS	$300,000.00	$300,000.00
200,000-gallon welded steel, multi-leg EST with wet riser.	1	LS	$850,000.00	$850,000.00
Electrical controls and SCADA integration.	1	LS	$125,000.00	$125,000.00
Sitework, grading, and seeding.	1	LS	$5,000.00	$5,000.00
			Subtotal	$1,280,000.00
			Contingency	$256,000.00
			Engineering–15%	$30,000.00
			Total	**$1,766,000.00**

Table 7 OPPC for 200,000-Gallon EST

Description	Estimated Quantity		Unit Cost	Total Cost
Increase tank elevation a maximum of 23 feet by a jack system with minor foundation modifications.	1	LS	$525,000.00	$525,000.00
Traffic control.	1	LS	$5,000.00	$5,000.00
Electrical modifications.	1	LS	$30,000.00	$30,000.00
Sitework, grading, and seeding.	1	LS	$5,000.00	$5,000.00
			Subtotal	$565,000.00
			Contingency	$113,000.00
			Engineering–15%	$100,000.00
			Total	**$778,000.00**

Table 8 OPPC to Elevate the Existing 250,000-Gallon EST

Total OPPC for the proposed EST is approximately $1,594,000 for a 150,000-gallon EST and $1,766,000 for a 200,000-gallon EST. The total cost to elevate the existing 250,000-gallon EST is approximately $778,000.00. These OPPCs do not include any acquisition costs that may be necessary.

The OPPCs are presenting in spring 2022 dollars. Construction and steel costs in particular have been very volatile, with significant rates of inflation over the last year. Before proceeding with obtaining funding with any approach, Strand highly recommends that current budgetary costs be obtained to reflect the current economic conditions.

CONCLUSION

Based upon the projected growth, a new EST is required to meet TCEQ code requirements. Either a 150,000- or 200,000-gallon tank would satisfy these requirements. Given the relatively small increase in cost, strong consideration should be given toward the larger tank, as it provides greater operation capability when a tank is down for recoating and provides for greater future growth at a relatively low cost per addition gallon.

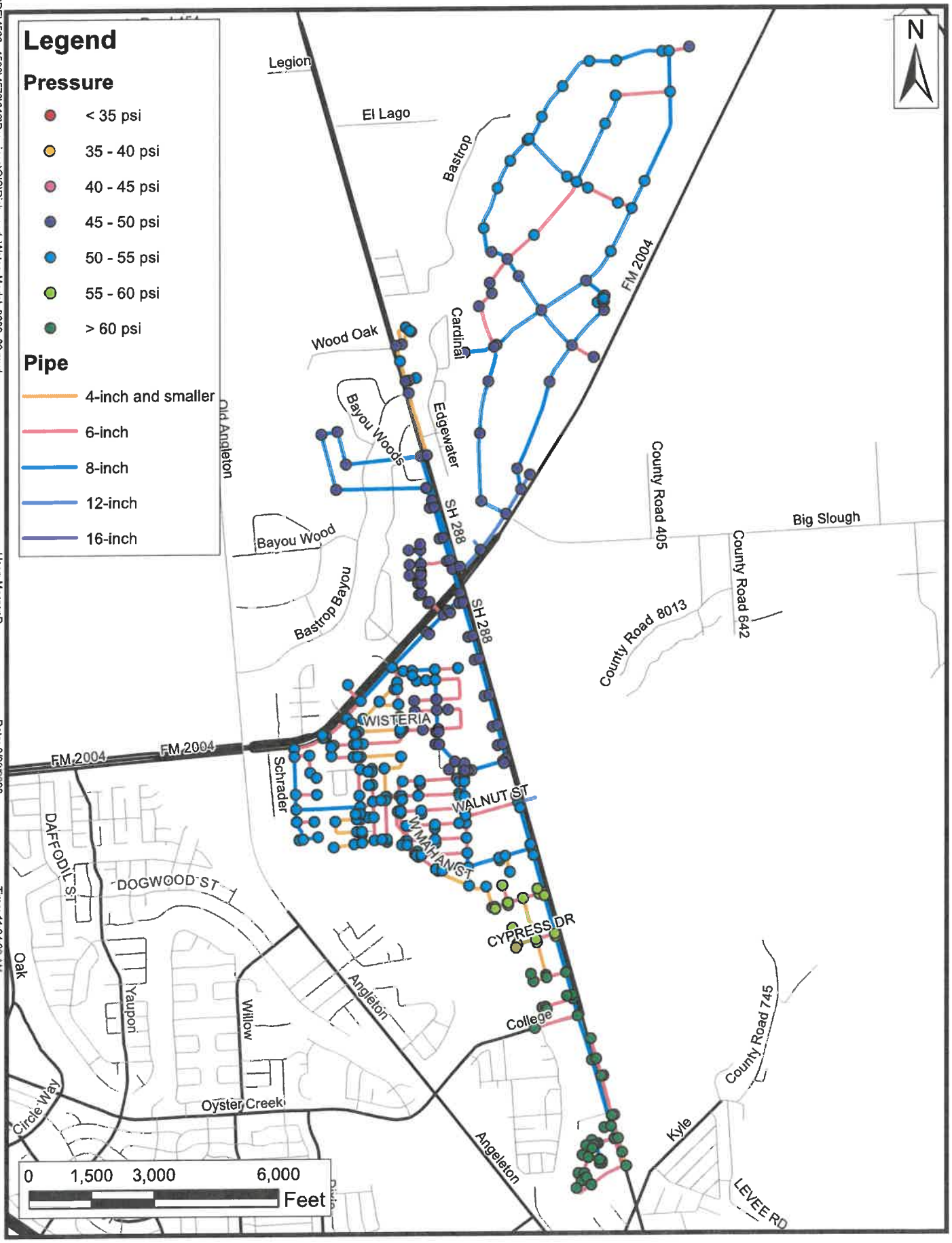
Based on Strand analysis, the location of the new EST north of FM 2004 appears to be most effective. The actual location at either the NWP or Intersection is dependent upon where the anticipated growth will occur. Either location is suitable.

Increasing the existing tank elevation and increasing the overflow elevation of the new EST can provide additional system pressure and improve fire flows. Fire flows less than 500 gpm still exist but appear to be more a function of the local pipe size than the HGL of the tank. Raising the EST is a significant effort and may require modifications to all existing pumping equipment, in addition to raising the overflow of the EST. Based upon the modeling, the existing EST and proposed EST should typically provide adequate pressure, with all pressures generally staying above the minimum TCEQ code requirements.

APPENDIX A
SYSTEM PRESSURES

OWNER REVIEW (4/07/2022)

EXISTING CONDITIONS



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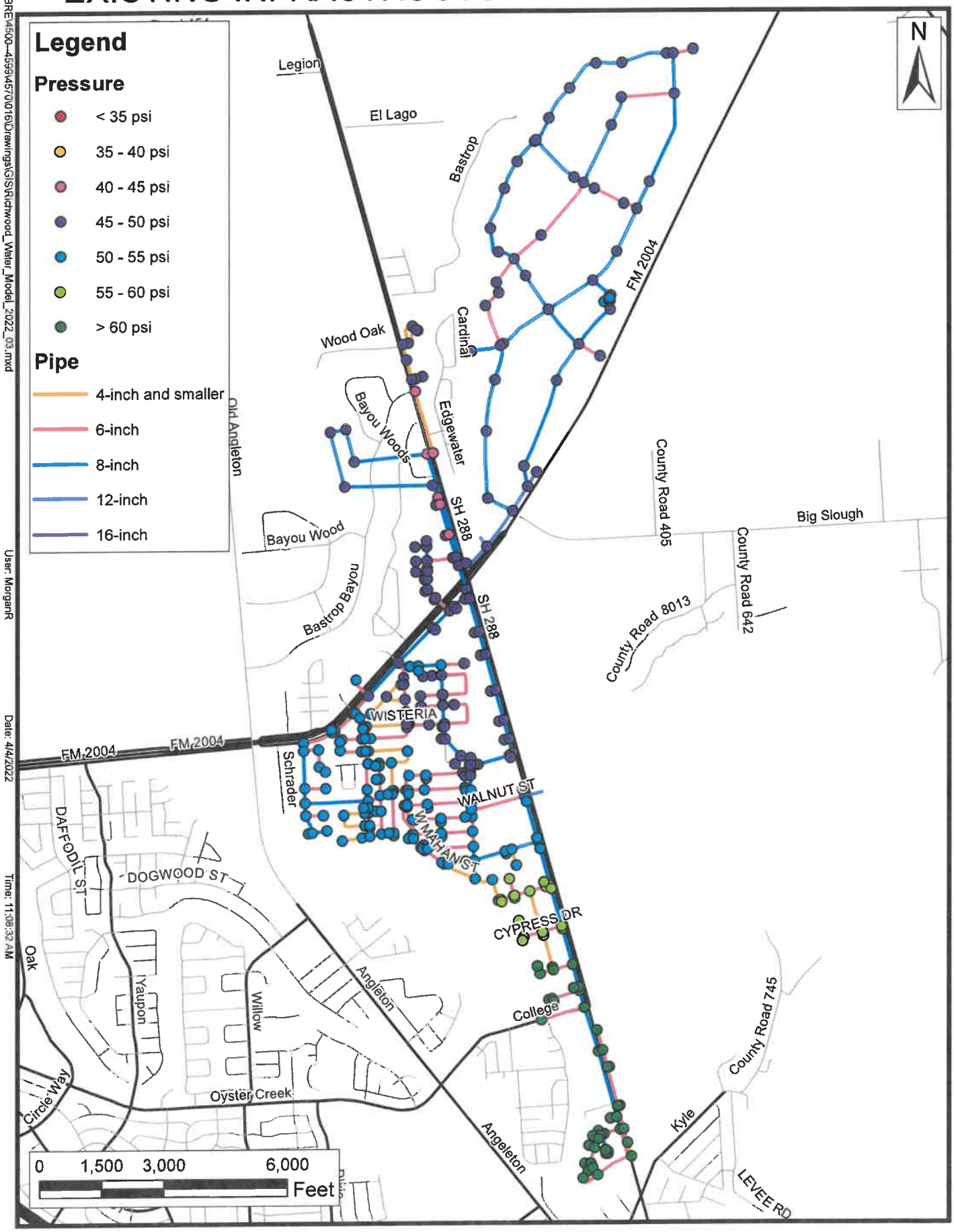
OWNER REVIEW (4/07/2022)

EXISTING INFRASTRUCTURE - OS FULL BUILD OUT



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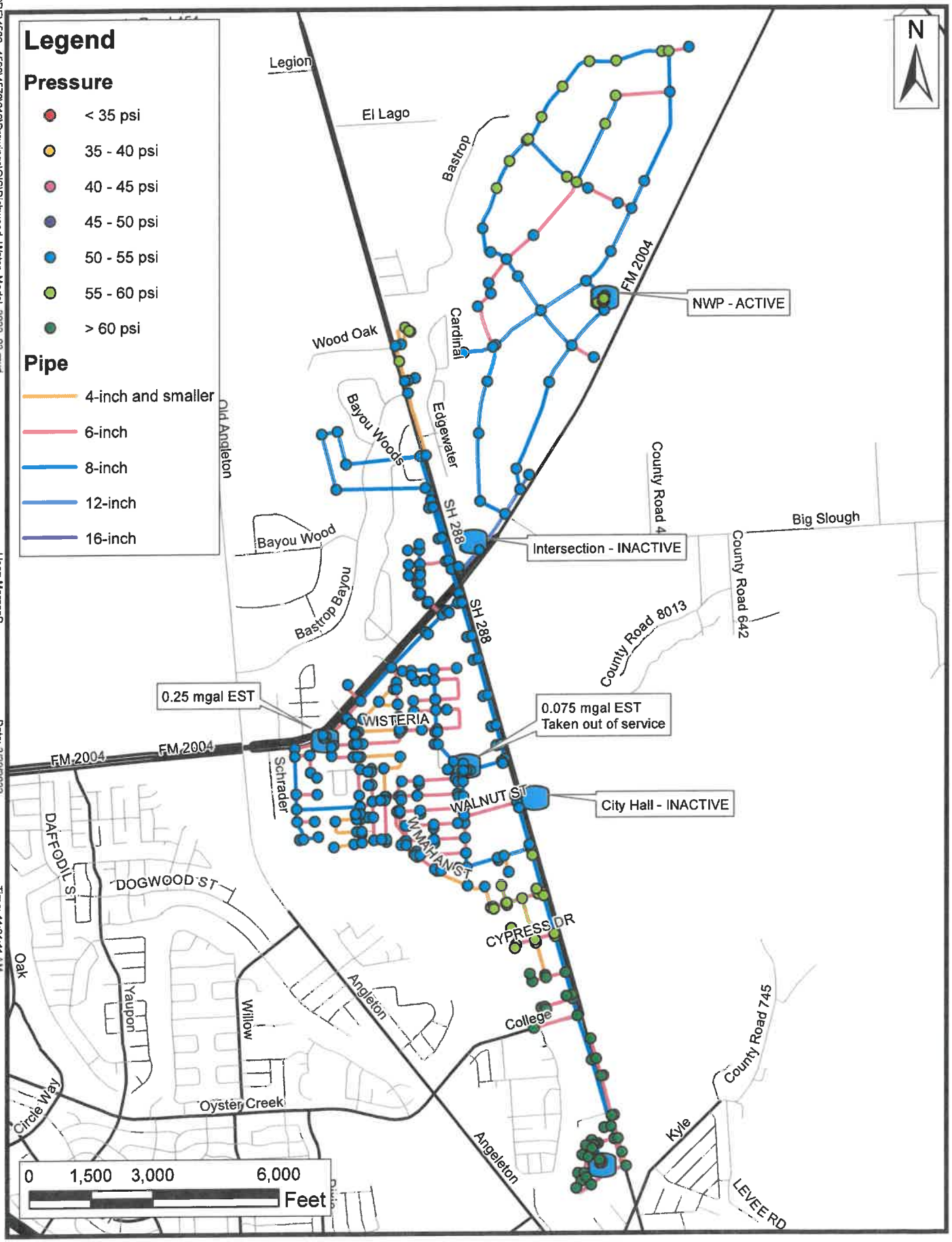
OWNER REVIEW (4/07/2022)

1A - NWP- CURRENT OVERFLOW



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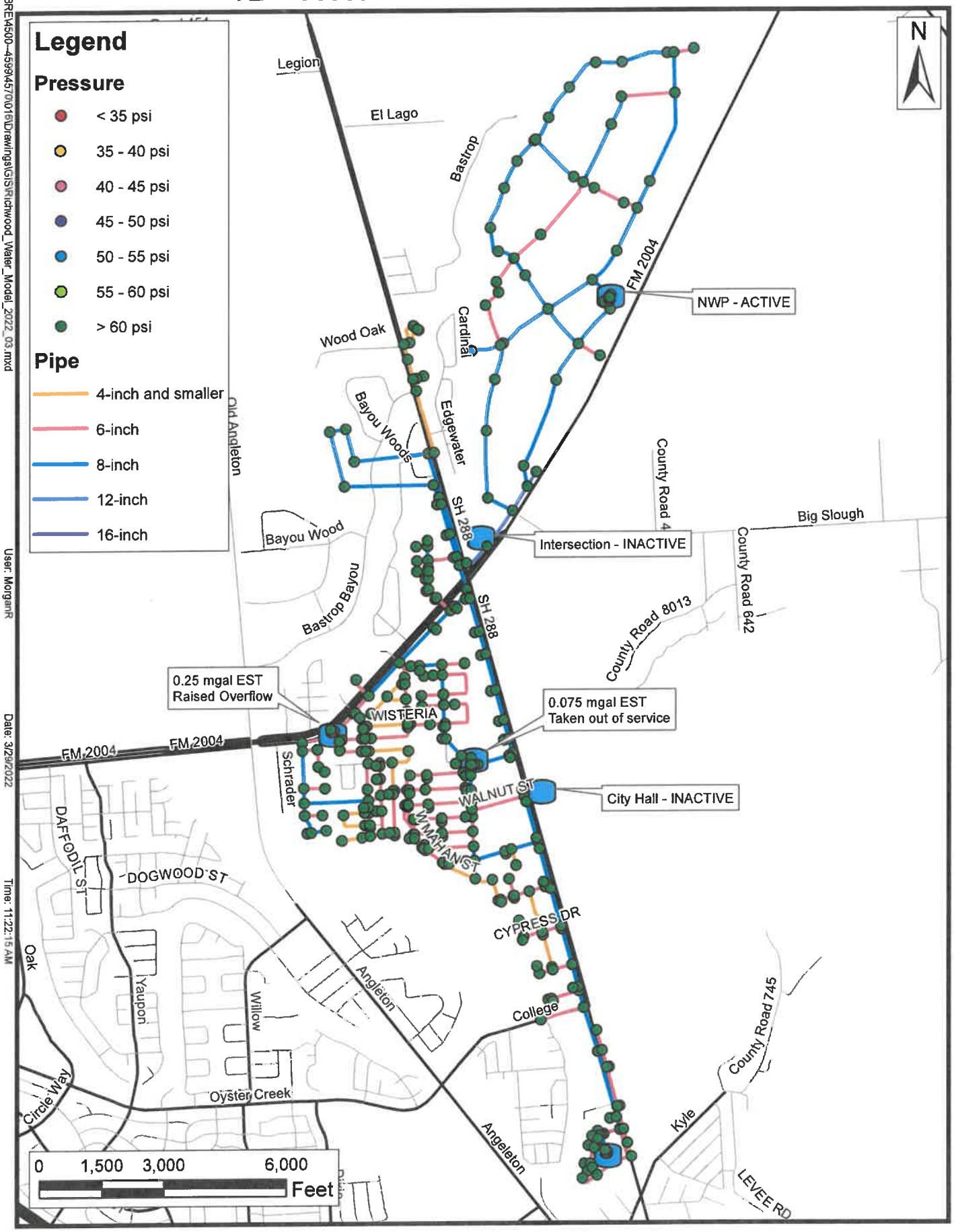
OWNER REVIEW (4/07/2022)

1B - NWP- RAISED OVERFLOW



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OWNER REVIEW (4/07/2022)

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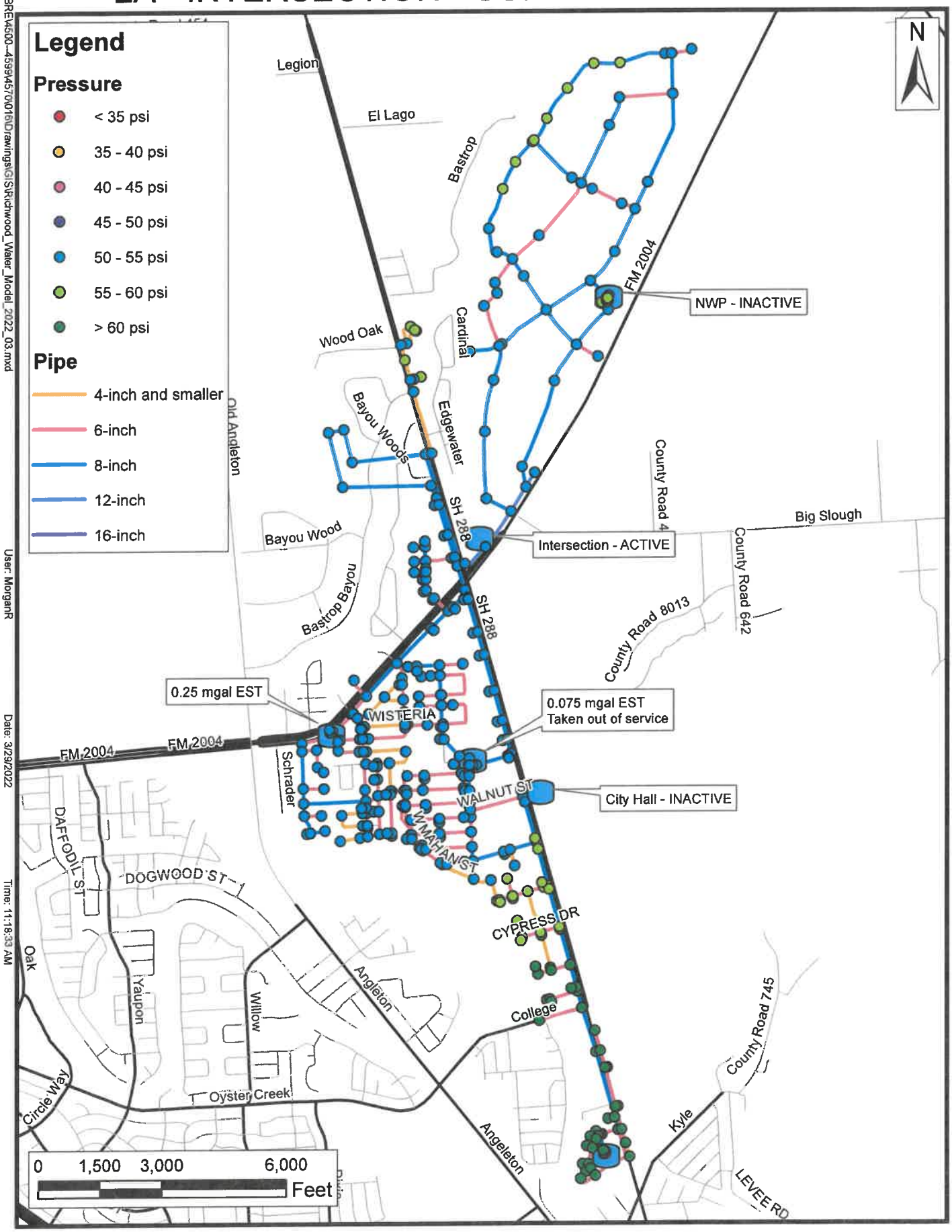

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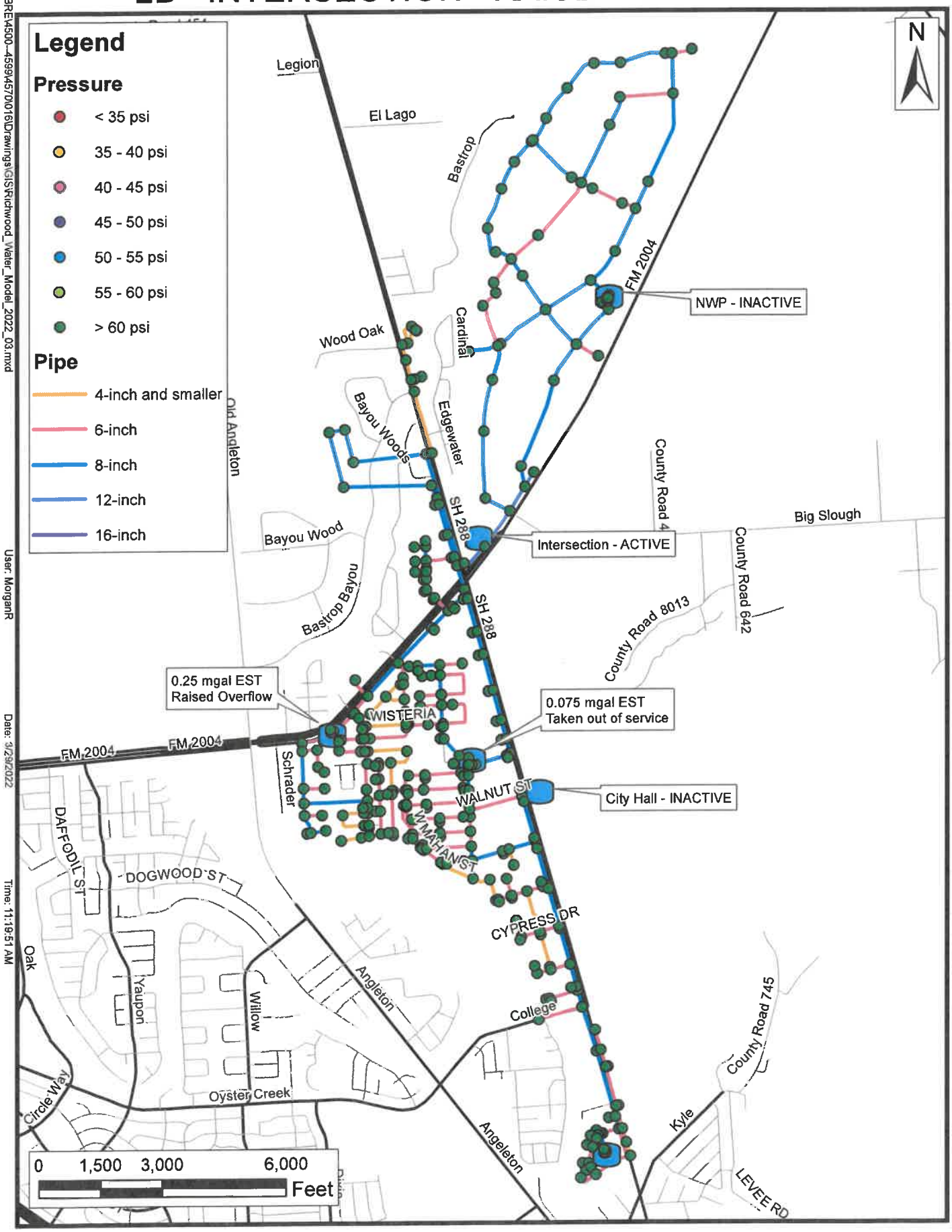

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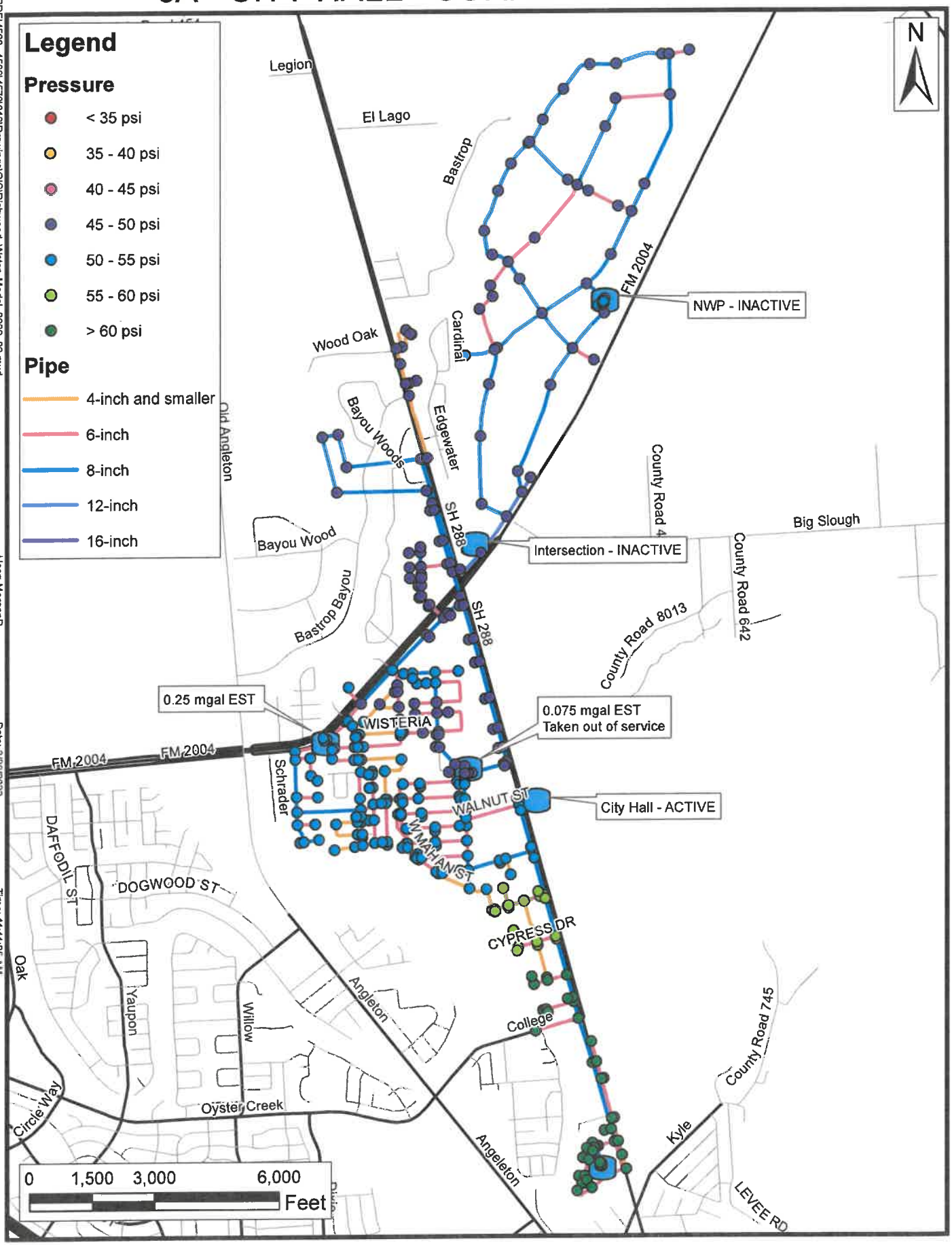
OWNER REVIEW (4/07/2022)

3A - CITY HALL - CURRENT OVERFLOW



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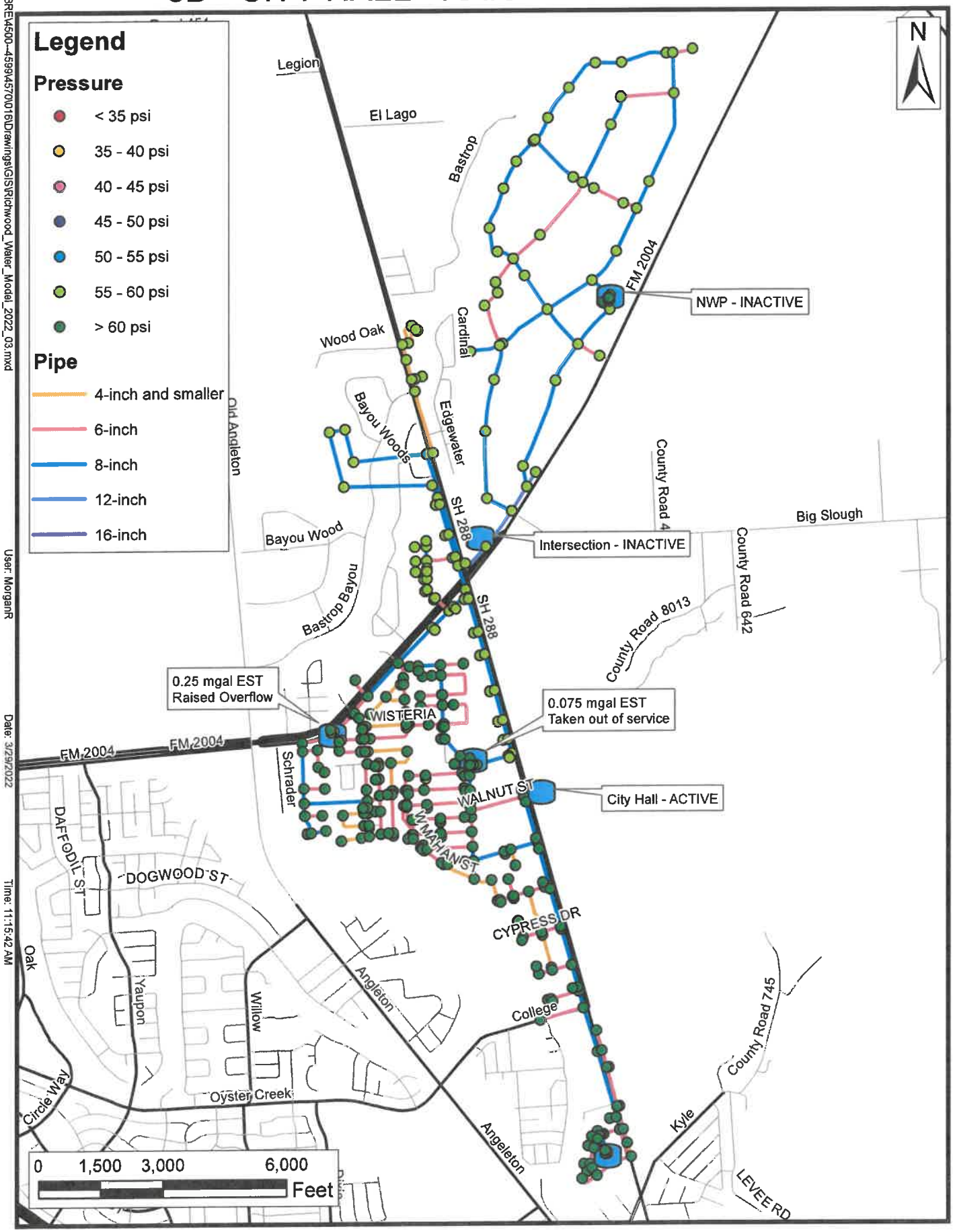
OWNER REVIEW (4/07/2022)

3B - CITY HALL - RAISED OVERFLOW



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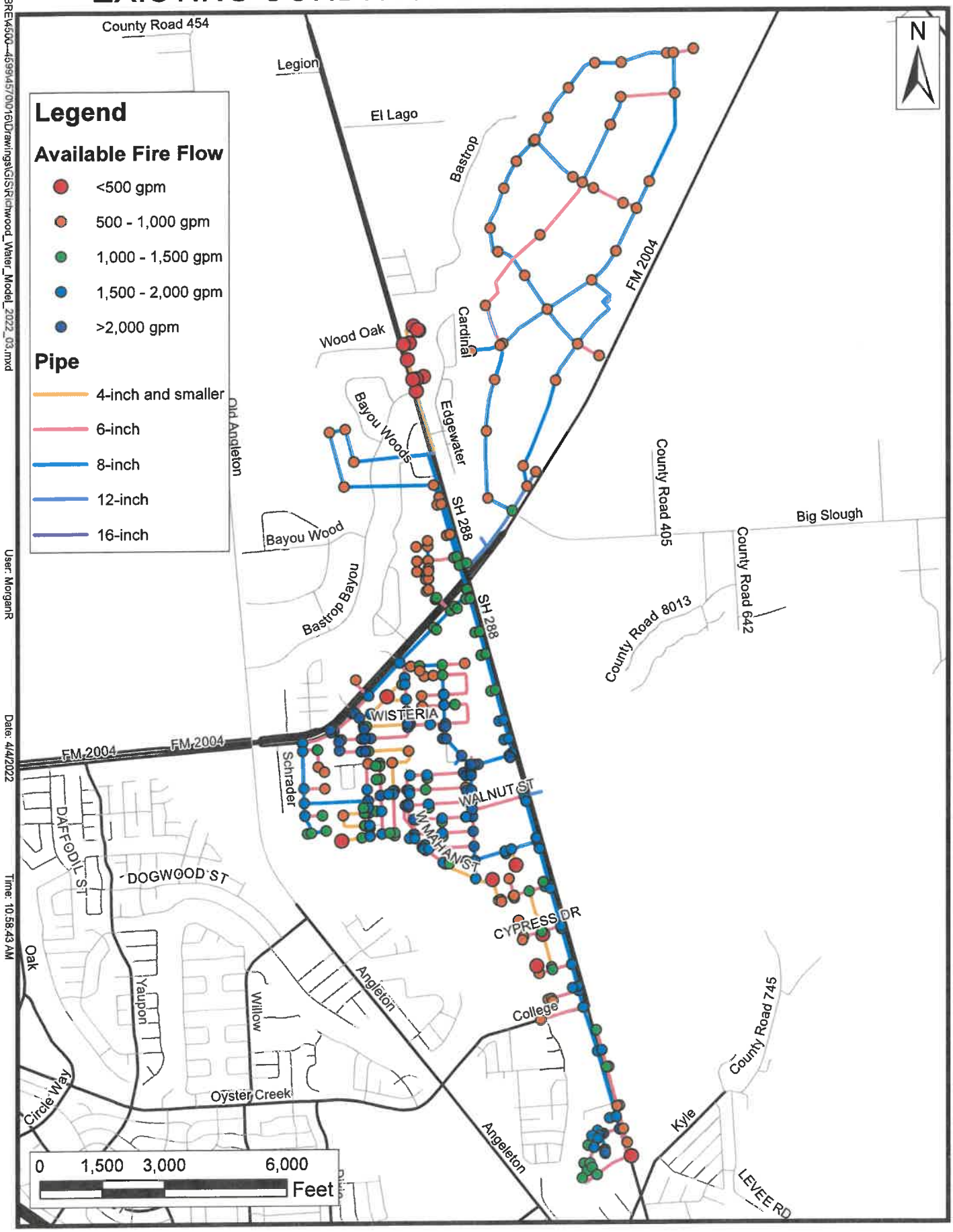
APPENDIX B
AVAILABLE FIRE FLOW

OWNER REVIEW (4/07/2022)

EXISTING CONDITIONS - AVAILABLE FIRE FLOW



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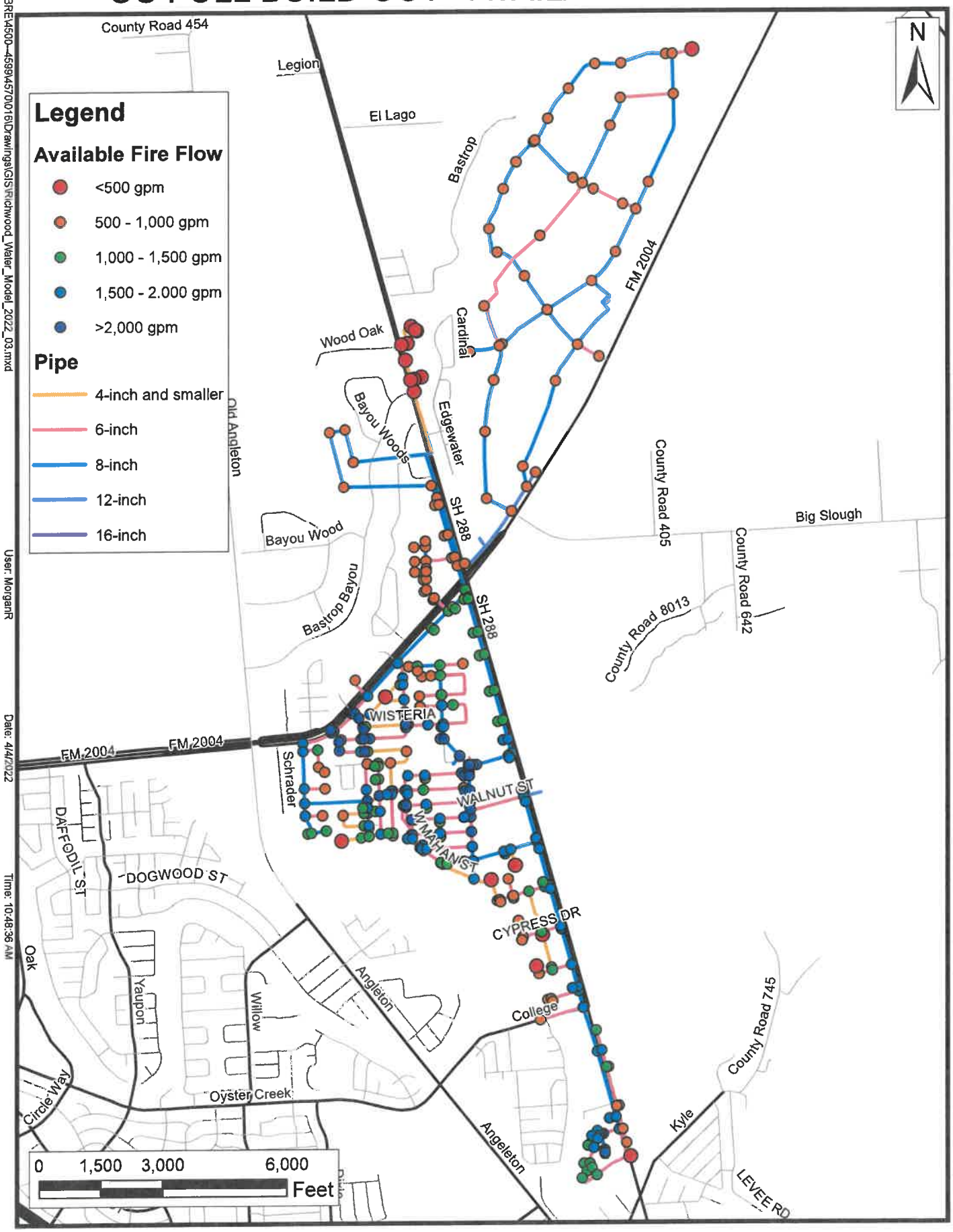
OWNER REVIEW (4/07/2022)

OS FULL BUILD OUT - AVAILABLE FIRE FLOW



OWNER REVIEW (4/07/2022)

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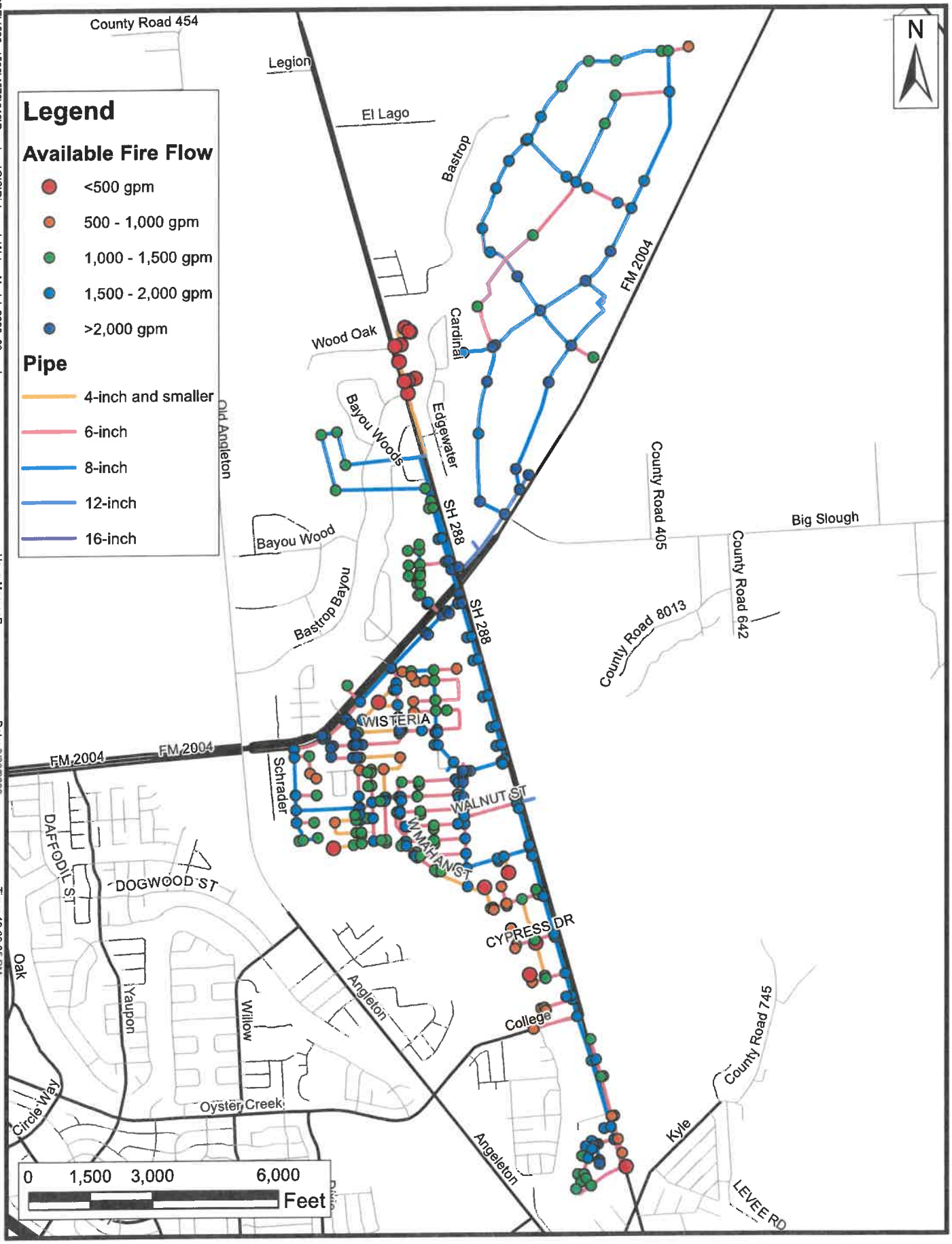

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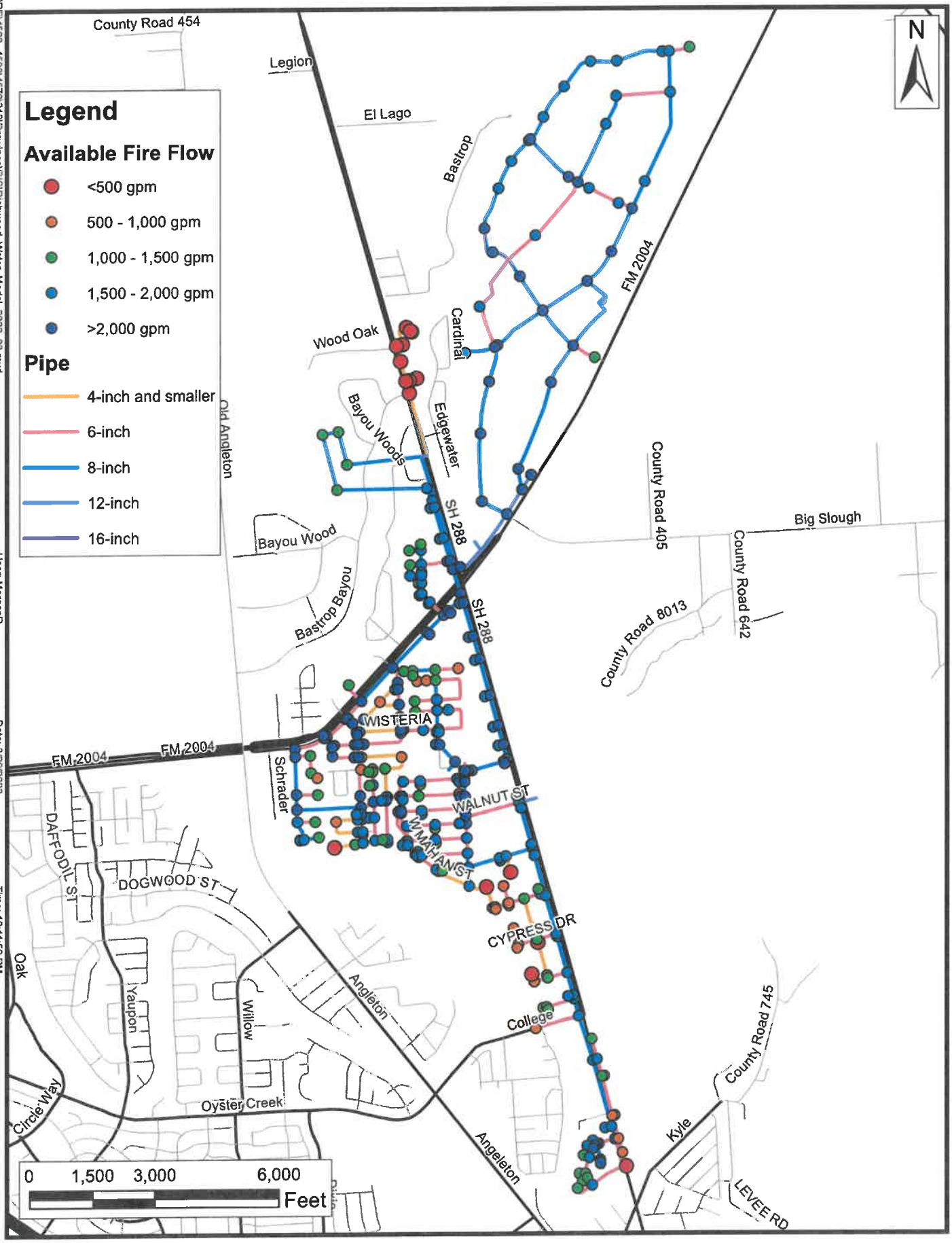
OWNER REVIEW (4/07/2022)

1B - NWP - AVAILABLE FIRE FLOW



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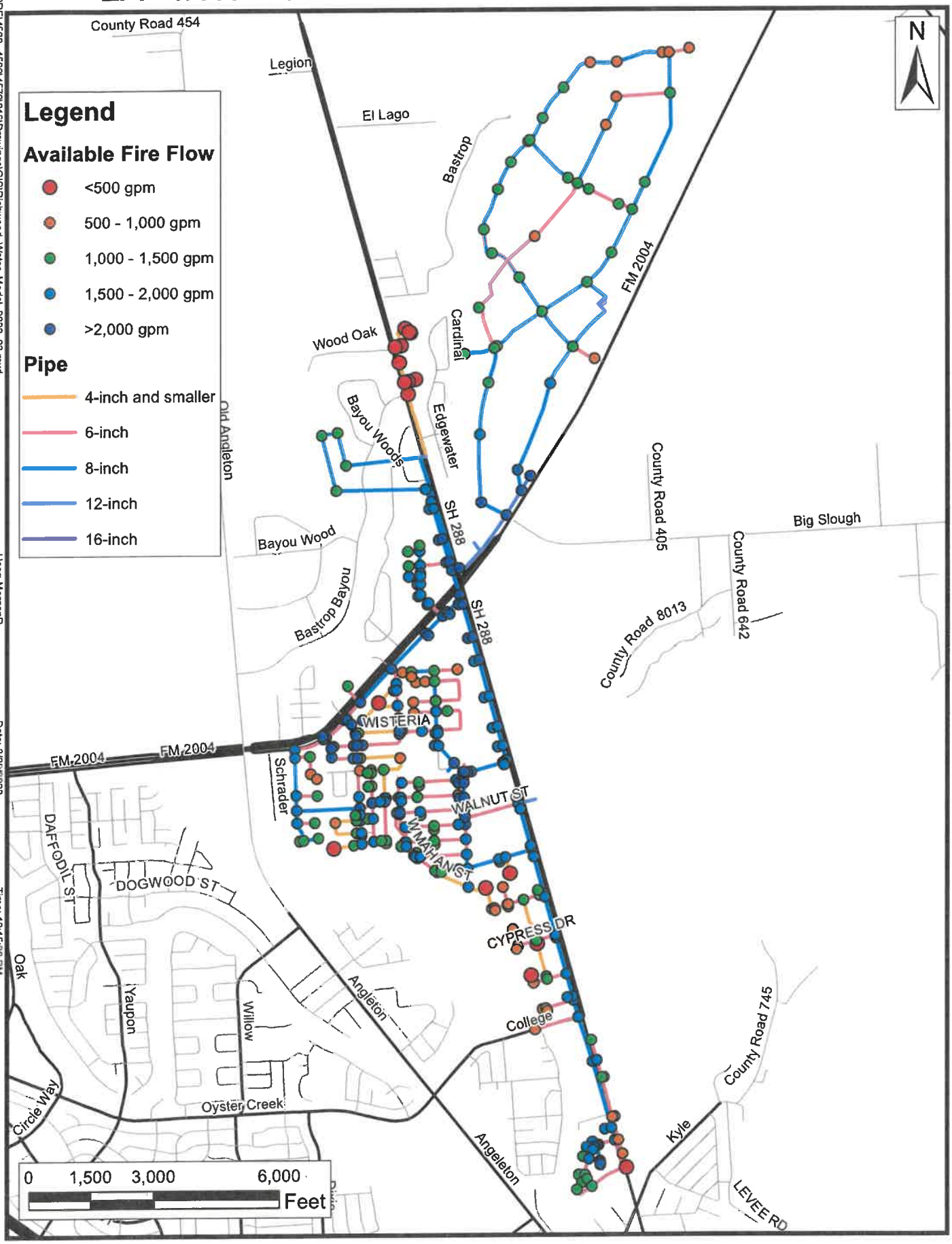
OWNER REVIEW (4/07/2022)

2A - INTERSECTION - AVAILABLE FIRE FLOW



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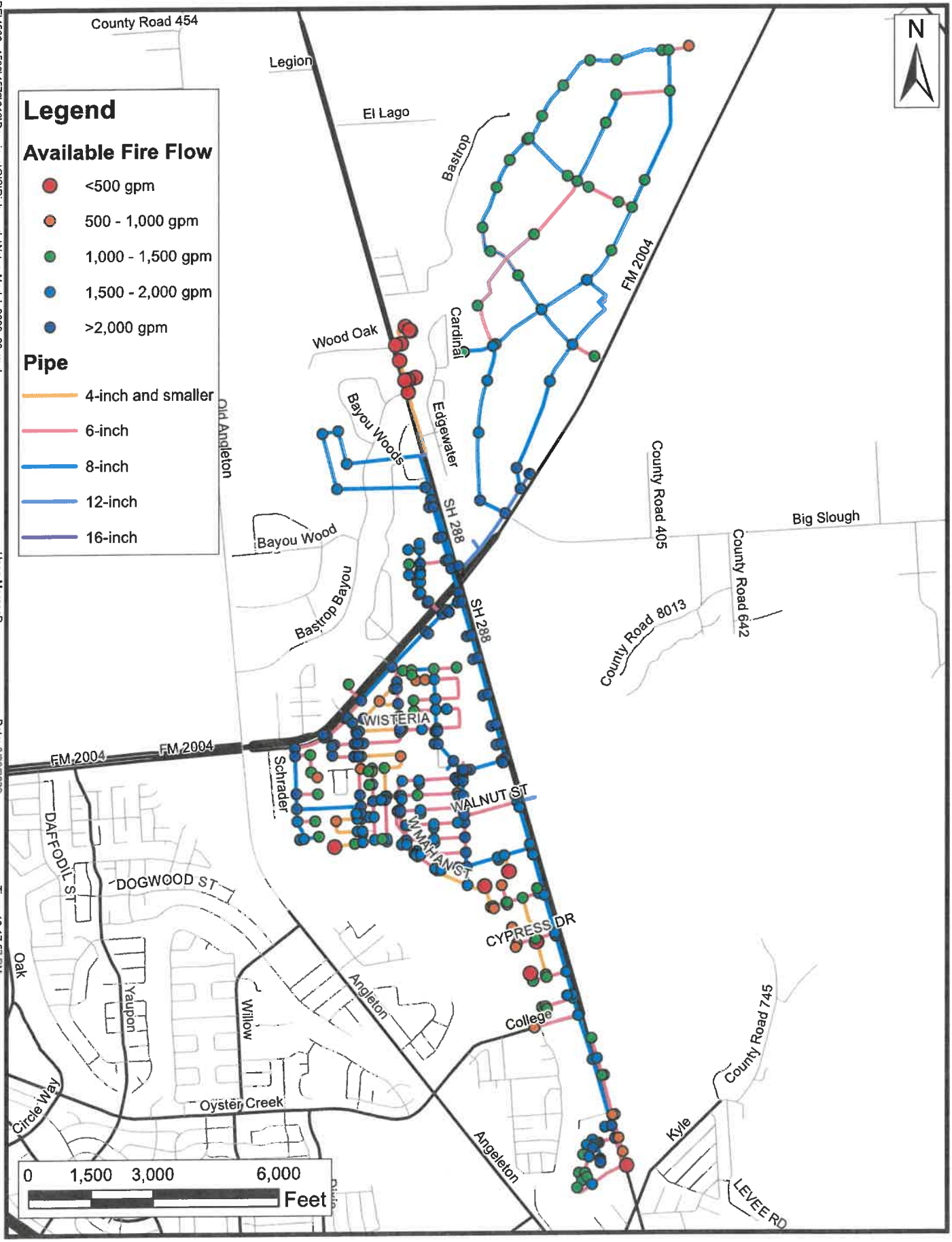

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