



TOWN OF SOUTHERN PINES WATER ASSET MANAGEMENT PLAN

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APPENDICES

- Appendix I – GIS Maps
- Appendix II – Storage Tank Inspection Reports
- Appendix III – Water Treatment Plant Condition Assessment Report
- Appendix IV - Hydraulic Modeling Report
- Appendix V – References

LIST OF ABBREVIATIONS

AC	-	Asbestos Cement
ADD	-	Average Daily Demand
AMP	-	Asset Management Plan
CI	-	Cast Iron Pipe
CIP	-	Capital Improvement Plan
DIP	-	Ductile Iron Pipe
FY	-	Fiscal Year
GALV	-	Galvanized Pipe
GIS	-	Geographic Information System
GPM	-	Gallons per Minute
HDPE	-	High Density Polyethylene Pipe
LF	-	Linear Feet
LOS	-	Level of Service
MG	-	Million Gallons
NCAC	-	North Carolina Administrative Code
NCDEQ	-	North Carolina Department of Environmental Quality
O&M	-	Operation and Maintenance
PSI	-	Pounds per Square Inch
PVC	-	Polyvinyl Chloride Pipe
RCP	-	Reinforced Concrete Pipe
TDH	-	Total Dynamic Head
WTP	-	Water Treatment Plant

1 Executive Summary

1.1 Introduction

The Town of Southern Pines, with the assistance of WithersRavenel, developed an Asset Management Plan (AMP) for its water distribution system. The AMP is funded through the North Carolina Division of Environmental Quality (NCDEQ) Asset Inventory and Assessment (AIA) Grant program.

The scope of the Asset Management Plan is shown in Table 1 below which outlines the Town's water system infrastructure assets assessed and included in this AMP.

Table 1 - Town's Core Water Infrastructure Assets

Asset Category	Asset Type
Water System	Water Mains, Valves, Fire Hydrants, Storage Tanks, Wells, Booster Pump Stations, and Water Treatment Plant

1.2 Project Purpose

The purpose of this AMP is to deliver a near- and long-term roadmap for proactive management of the Town's water assets. The AMP will also provide data-driven insights for the Town to make informed decisions for capital planning while maximizing value of existing infrastructure in the most cost-effective manner, all while ensuring enhanced levels of service for its residents.

The AMP is a compilation of four (4) key components:

1. Inventory of Assets
2. Condition of Assets
3. Capital Improvements Plan (CIP) with projected cost estimates
4. Operation and Maintenance (O&M) Plan

1.3 Key Components

1.3.1 Inventory of Assets

Table 2 below summarizes inventory of the Town’s water system assets and their replacement values.

Table 2 - Water System Inventory

Water System Inventory		
Asset Type	Quantity	Replacement Value
Water Mains	1,338,404 LF	\$191,221,001
Valves	5,051	\$ 28,233,250
Fire Hydrants	1,628	\$13,024,000
Storage Tanks ¹	4	-
Wells ¹	4	-
Booster Pump Stations ¹	2	-
Water Treatment Plant ¹	1	-

¹ Storage Tanks, Wells, Booster Pump Stations, and Water Treatment Plant were not assessed for their replacement values.

1.3.2 Risk Assessment Summary

Figure 1 below illustrates the summary of risk scores across each asset type.

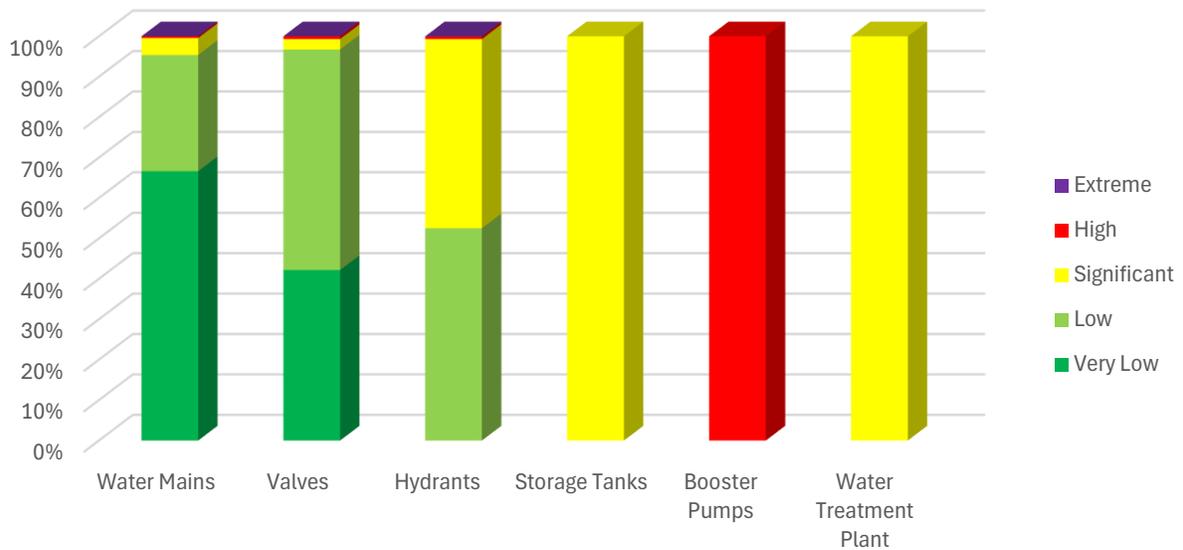


Figure 1 - Summary of Water System by Risk

1.3.3 10-Year Capital Improvement Plan

The list below represents the CIP by year over a 10-year span as found in Section 7.

- Midland Road Water Line Replacement (Water Project #2)
- North Pressure Zone (Water Project #4)
- Pinebluff Parallel Transmission Main (Water Project #8)
- US-1 Booster Pump Station Addition (Water Project #5)
- US-1 Parallel Transmission Main (Water Project #6)
- US-1 Waterline Relocation and Upsize (Water Project #3)
- US-15-501 Waterline Replacement and Upsize (Water Project #7)
- Water Treatment Plant Capacity Expansion Study (WTP Project #6)
- Water Treatment Plant Raw Water Main Replacement (WTP Project #5)
- Water Treatment Plant Modifications (WTP Projects #1-4)
- Annual Waterline Replacement

1.3.4 Operation and Maintenance (O&M) Plan

Table 3 provides an O&M recommended list prepared as a part of the project.

Table 3 - Operations and Maintenance Schedule

Operation and Maintenance Schedule		
Asset	Recommendation	Frequency
Water Mains	Break Evaluation Log	As Needed
	Inspection – High Priority Lines	Semi-annual
Customer Meters	Record Non-Revenue Water	Semi-annual
	Accuracy Testing	Semi-annual
Storage Tanks	Maintenance, Safety, Structural, and Security Inspection	Annual
Booster Pump Station	Maintenance, Safety, Structural, Operational, and Security Inspection	Annual
Valves	Inspection and Exercise	Annual
Hydrants	Inspection	Annual
	Flushing	Annual
Wells	Inspection	Semi-annual
	Performance Testing	Semi-annual
Water Treatment Plant	Maintenance, Safety, Structural, Operational, and Security Inspection	Per Permit Requirement
Emergency Plan	Review System Operations Plan	Annual

2 Background and System Overview

2.1 Background

The Town of Southern Pines is in eastern North Carolina in Moore County, approximately 30 miles west of Fayetteville. The population of the Town is approximately 16,052 and accounts for approximately 15% of the total population in Moore County.

In the Fall 2022 funding cycle, the Town was awarded an AIA grant of \$200,000 to conduct a comprehensive study of its water system. In partnership with WithersRavenel, the Town evaluated its water system assets by analyzing existing Geographic Information System (GIS) data, identifying data gaps, conducting field data collection, and updating the GIS mapping system. The collected data supported detailed risk assessments, enabling the classification of critical assets essential to the long-term performance of the water system.

A hydraulic model developed as part of the project provided valuable insight into the behavior of the water system and its components. As a result, the Town was able to identify and prioritize projects for inclusion in the Capital Improvements Plan (CIP). The study and modeling effort also produced operation and maintenance recommendations aimed at extending asset life and reducing the risk of future failures.

This study culminated in the development of the Asset Management Plan (AMP), which includes the following key elements:

- Level of Service (LOS) Statement
- Asset Inventory
- Risk Analysis using Likelihood of Failure (LoF) and Consequence of Failure (CoF)
- Operation and Maintenance (O&M) Plan
- 10-Year Capital Improvements Plan (CIP)
- Hydraulic Model Findings

This AMP is intended to be a living document that is updated regularly. It is recommended that the data stored within the Town's GIS database be continually validated and updated to ensure that the most relevant and accurate representations of the current system are captured.

2.2 System Overview

The Town owns their distribution system and provides water services to the Town's 15,500 (Source: 2024 Local Water Supply Plan) customers. The water system assets include:

- Approximately 253 miles of Water Mains
- 5,051 Valves
- 1,628 Fire Hydrants
- 4 Storage Tanks
- 4 Wells
- 2 Booster Pump Stations
- 1 Water Treatment Plant

The water distribution system inventories are stored and maintained in the Town's GIS database. The following sections break down the current state of the inventory. Maps of water system assets can be found in Appendix I.

3 Level of Service

Level of Service (LOS) criteria define the goals and standards the Town will strive to attain. LOS criteria reflect the mission of the Town and are expressed in terms of quality, quantity, reliability, responsiveness, cost, and environmental impact. Taking all these considerations into account, the Town is adopting the following LOS criteria listed in Table 4 below.

Table 4 - Southern Pines, NC Level of Service Criteria

Category	Level of Service	Performance Measure	Target
Health and Safety	1. Water Quality Compliance with Safe Drinking Water Act (SDWA) primary and secondary standards and Ground Water Rule (GWR)	Number of violations per year	0 violations/year
	2. Fire Protection and Water Pressure Compliance with North Carolina Administrative Code (NCAC) and Insurance Services Office (ISO)	Number of violations per year	0 violations/year
	3. Water Availability No adverse event will cause the customer to be without water	Time without water	< 8 hours
	4. Water System Performance	Main break frequency per year Full leak detection survey	≤ 15/100 miles Every 5 years
Customer Service	5. Response Time Respond to customer complaints/requests in a timely manner	Emergency (breaks)	1-2 hours
		Leaks	1-2 hours
		Meter Repair	1-5 days
	6. Complaints Number of complaints due to unplanned or unanticipated events	Water outage	≤ 2/month
		Colored water	< 3/month
		Water with bad taste, odor	< 5/month
		Pressure	< 5/month
	7. Education and Outreach	Water conservation information included with water bill and on website	Yearly
8. Communication Notification of planned shutdown will be provided	Number of days	≥ 72 Hours	
9. Customer Readings Ensure meters communicate information	Number of non-communicating meters	< 75 meters/month	
Source Water Protection	10. Outreach Outreach to property owners within the protection area	Outreach frequency	Once/year
Financial	11. Financial Capability Rates are reviewed on an annual basis and revised as needed to ensure full cost recovery	Revise, review rates	Once/year

With the LOS criteria developed, the Town must establish sustainable business processes to ensure information required for measuring LOS is readily available and cost effective. The processes for collecting the information will be integrated with existing workflows. For example, the hydrant fire flow pressures are located in a digital format kept by the fire department.

Fire Protection and Water Pressure were designated as important metrics for the water system analysis, and Table 5 summarizes the water system design standards per NCAC and ISO. These standards were used to identify assets within the distribution system that require updates to become compliant.

Table 5 - Water System Design Standards Per NCAC and ISO

System Parameter	Evaluation Criterion	Value	Design Standard/Guideline
Valves	Number at Crosses	3	NCAC T15A:18C.0907(a)
	Number at Tees	2	
	Number on Hydrant Branch	1	
System Pressure	Minimum, during Peak Hourly Demand (PHD)	30 psi	NCAC T15A:18C.0405(b)
	Minimum, during Max Daily Demand (MDD) + Fire Flow	20 psi	
Water Storage	Minimum Combined Elevated and Ground Storage Capacity	1/2 Average Daily Demand (ADD)	NCAC T15A:18C.0805
	Fire Flow Volume	Min 75,000 gal	
Minimum Residential Fire Flow, by Distance Between Buildings	> 30 ft	500 gpm	ISO Guide for Needed Fire Flow (2014)
	21 - 30 ft	750 gpm	
	11 - 20 ft	1,000 gpm	
	< 10 ft	1,500 gpm	
Minimum Nominal Diameter	Hydrant Branches	6-inch	NCAC T15A:18C.0901
	Non-Fire Protection Mains ¹	2-inch	

1. Contingent on residence restrictions per NCAC T15A:18C.0002

4 Water System Inventory

4.1 Water Mains

The Town's distribution system consists of approximately 253 miles of water mains to convey water from the Southern Pines water treatment plant to their 11,600 customers. Pipe diameters range from 3/4 inches to 30 inches, and pipe materials include asbestos cement (AC), cast iron (CI), ductile iron (DIP), galvanized iron (GALV), high density polyethylene (HDPE), polyvinyl chloride (PVC), and reinforced concrete (RCP). Table 6 below provides a summary of the diameter and materials of the water main pipes contained in the distribution system.

Table 6 - Water System by Diameter and Material (Summarized by Length in Feet)

Materials / Diameter	AC	CI	DIP	GALV	HDPE	PVC	RCP	Unknown	Total	Percent of Total
3/4 Inch	-	-	-	-	-	-	-	239	239	0.02%
1 Inch	-	-	-	-	-	479	-	-	479	0.04%
2 Inch	-	-	258	7,232	-	70,271	-	11,509	89,271	6.67%
3 Inch	-	602	590	-	-	418	-	-	1,610	0.12%
4 Inch	-	2,946	1,036	-	-	2,897	-	211	7,089	0.53%
6 Inch	92,597	129,589	20,690	-	-	296,056	-	67,627	606,558	45.32%
8 Inch	11,795	34,614	17,419	930	321	279,042	-	42,777	386,898	28.91%
10 Inch	-	6,864	1,422	-	-	4,101	-	905	13,292	0.99%
12 Inch	12,208	27,402	7,421	-	921	60,165	-	16,544	124,663	9.31%
16 Inch	-	-	2,746	-	-	25,834	-	6,490	35,069	2.62%
18 Inch	-	-	5,688	-	-	50,218	-	2,192	58,099	4.34%
20 Inch	-	-	4,702	-	-	-	-	-	4,702	0.35%
24 Inch	-	-	9,830	-	-	-	-	-	9,830	0.73%
30 Inch	-	-	-	-	-	-	341	-	341	0.03%
Unknown	-	-	-	-	-	-	-	263	263	0.02%
Total	116,600	202,017	71,803	8,162	1,243	789,480	341	148,758	1,338,404	
Percent of Total	8.71%	15.09%	5.36%	0.61%	0.09%	58.99%	0.03%	11.11%		

Over 88% of the system has known material and over 99% has known diameters. The most common material in the system is PVC, with approximately 59%, followed by CI, with approximately 15%. The most common diameter across the system is 6 inches, representing approximately 45%, followed by 8 inches, representing 29%. Approximately 7% of the system is comprised of lines smaller than 6 inches which is no longer allowed in new water construction designed to carry fire protection flows.

DIP and PVC represent approximately 64% of the system and are materials commonly used in new water construction projects. GALV represent approximately 0.6% of the system and are typically the oldest and potentially most deteriorated pipe materials. CI was first used in the 1930s, reaching peak popularity in the 1950s and discontinued in the 1980s. GALV was a popular construction material prior to the 1960s.

Figure 2 illustrates water mains by sizes and materials summarized by length in feet.

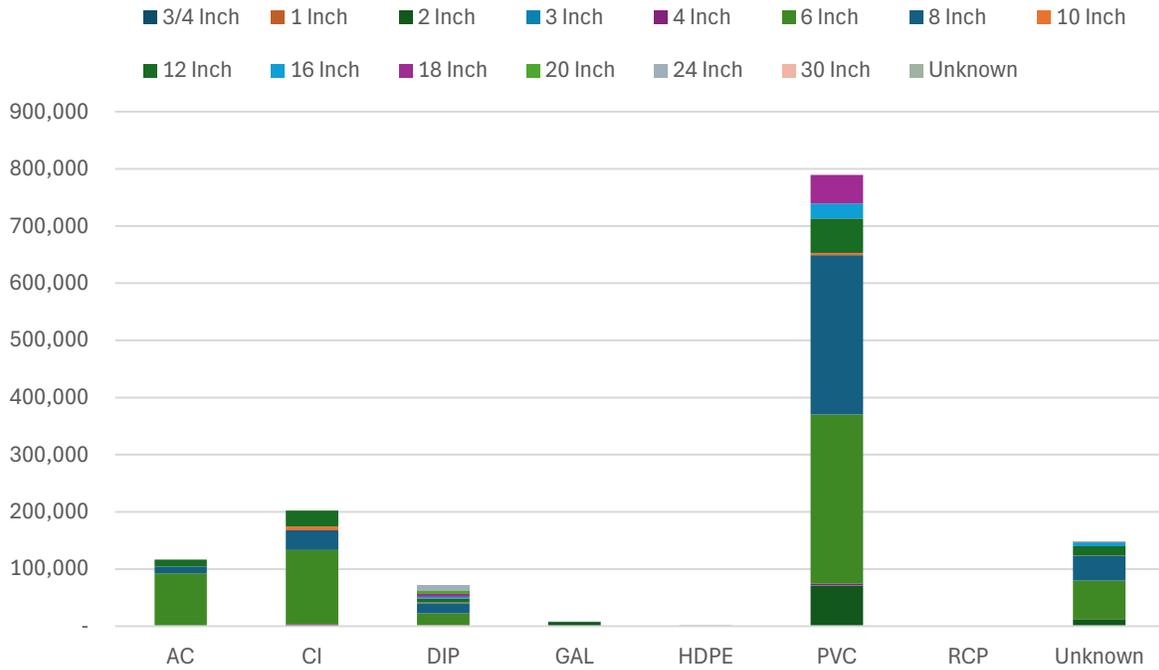


Figure 2 - Distribution of Water Mains by Diameter and Material (summarized by length in feet)

4.2 Valves

The distribution system in Southern Pines consists of 5,051 water valves, which control the conveyance of water throughout the Town, ranging in diameter from 1 inch to 24 inches. Table 7 provides a summary of the valve diameters contained in the distribution system.

Table 7 - Valves by Diameter

Diameter	Count
1 inch	11
1.5 inch	1
2 inch	423
3 inch	21
4 inch	64
6 inch	2,915
8 inch	1,058
10 inch	32
12 inch	256
16 inch	41
18 inch	25
20 inch	5
24 inch	9
Unknown	190
Total	5,051

4.3 Fire Hydrants

The distribution system contains approximately 1,628 fire hydrants to provide fire flow and flushing throughout the Town. Fire hydrant construction dates range from 1924 to 2024, as shown below in Figure 3.

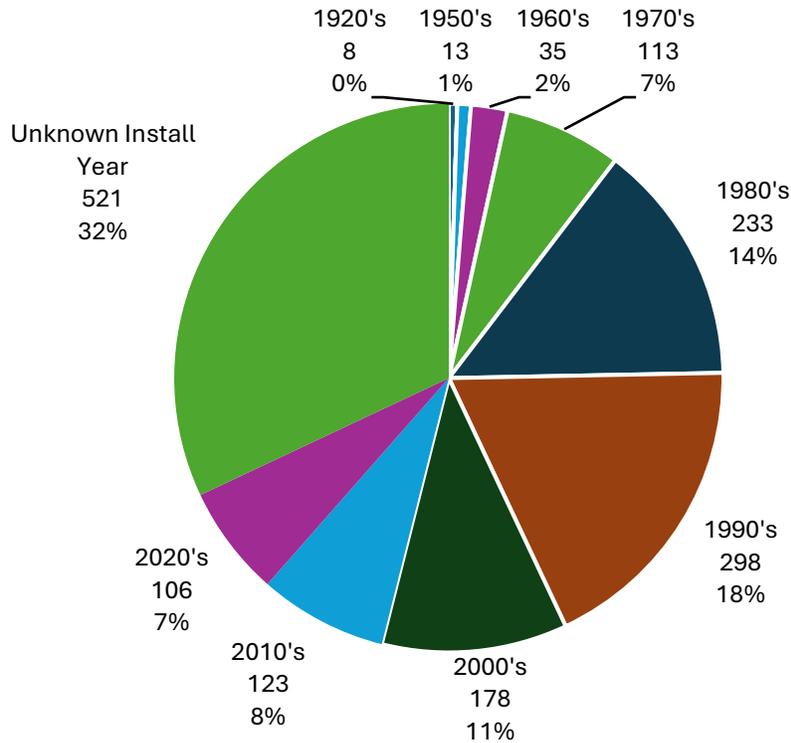


Figure 3 - Fire Hydrants by Construction Period

4.4 Storage Tanks

The distribution system contains four (4) water storage tanks. Information about the storage tank is listed in Table 8 below.

Table 8 - Summary of Storage Tank Information

Tank Name	Type	Install Date	Capacity (MG)
Eastman Tank	Elevated	1984	1
Henly Tank	Elevated	Unknown	0.5
Hwy 1 Ground Storage Tank	Ground	2002	2
Weymouth Tank	Standpipe	1990	2

4.5 Booster Pump Station

The distribution system contains two (2) booster pump station owned by the Town. Information about the booster pump station can be found in Table 9 below.

Table 9 - Summary of Booster Pump Station

Name	Install Date	Capacity (MG)
US1 Booster Station	2002	2
Weymouth Pressure Zone Booster Station	2019	2

4.6 Wells

The distribution system contains (4) wells owned by the Town that are for emergency use only. Information about the wells can be found in Table 10 below.

Table 10 - Summary of Well Information

Name	Well Depth (Feet)	Casing Depth (Feet)	Top Screen Depth (Feet)	Bottom Screen Depth (Feet)	Well Diameter (Inches)	Pump Intake Depth (Feet)
No. 1 - Weymouth	250	180	180	220	10	231
No. 2 - Henley	250	180	180	220	10	231
No. 4 - Douglas Center	180	120	120	160	10	150
Water Plant / 5	122	80	80	112	10	117

4.7 Water Treatment Plant

The distribution system contains a water treatment plant with a permitted capacity of 8 MGD. The inventory of treatment plant assets is shown in Table 11 and a schematic is shown in Figure 4.

Table 11 - Water Treatment Plant Inventory Summary

Asset Name	Quantity of Assets
Raw Pump Station	1
Raw Water Impoundment	1
Low Service Pumps	1
Flash Mixer	2
Super Pulsator Clarifier	2
Filter Building	2
Clearwell	1
High Service Pump Station	1
Finished Water Storage	1
Distribution Pump Station	1

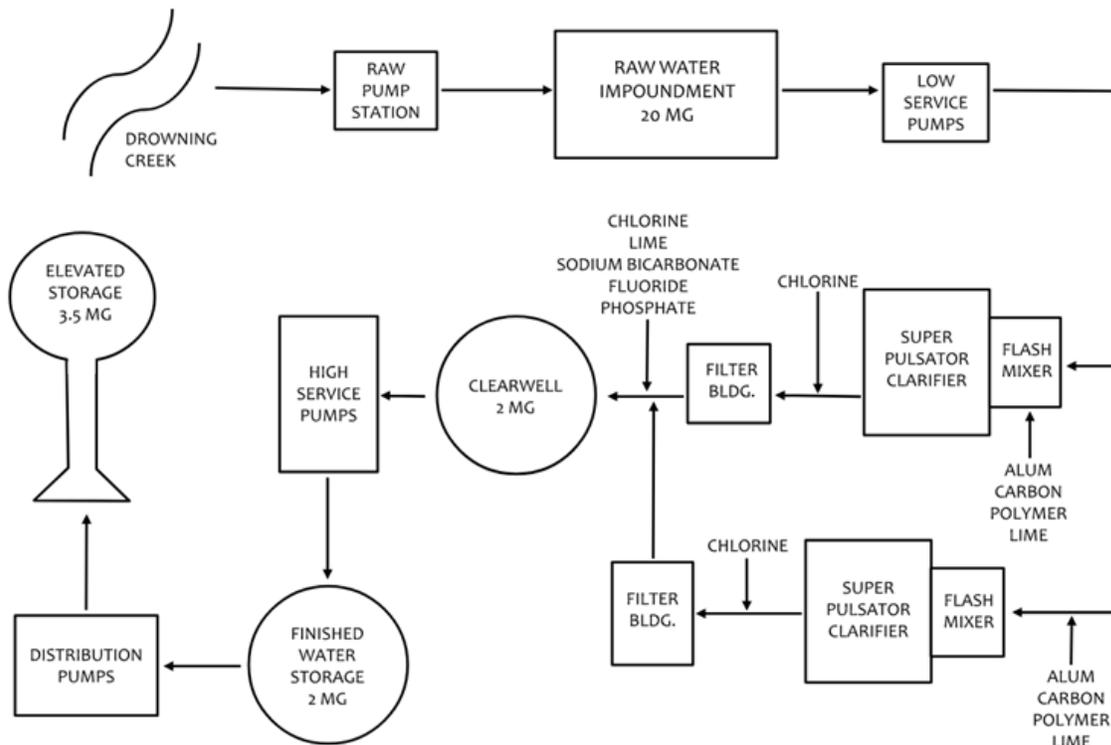


Figure 4 - Water Treatment Plant Schematic

5 Risk Assessment

As infrastructure ages, it becomes increasingly more challenging to assign limited capital expenditures to the repair, rehabilitation, or replacement of the assets. This section describes how the Town’s risk model was used in decision making and in preparing the Town’s capital improvements program for the prioritization of water infrastructure.

The intent of the risk model is to answer questions such as “which water mains will have the greatest impact if a failure is to occur?” This allows staff to focus resources and effort on these assets before they fail.

The risk associated with a given asset failing can be determined by multiplying Likelihood of Failure (LoF), based on asset’s condition, and the Consequence of Failure (CoF), based on its criticality.

$$\text{Risk} = \text{LoF} \times \text{CoF}$$

The following summarizes the LoF and CoF criteria and methodologies used to calculate risk for prioritization of projects for capital planning. The results of the risk analysis can be found in the GIS database created as a part of this asset inventory assessment.

5.1 Likelihood of Failure (LoF)

LoF is a numerical representation that denotes the probability of an asset’s failure based on its condition from known metrics such as asset age, condition inspections, historical breaks, staff input, etc.

Each of the water main lines and water valves inventoried were assessed using their age. The age of an asset is calculated using NCDEQ recommended lifespans for various material types as listed in Table 12 below. Based on these lifespans and the asset’s age, the estimated remaining useful life was calculated. Condition ratings were assigned to each water main asset based on its remaining useful life. Water valves were assigned condition ratings based on the condition estimates of the water mains at their location.

Table 12 - Pipe Life Expectancy by Material Type

Material	Life Expectancy (Years)
PVC	80
CI	90
AC	60
DIP	90
GALV	50
RCP	100
HDPE	80
Unknown	60

Reference: Recommended Life Spans, sourced from 2022 AMP DWI Guidance Document

Fire hydrants were assigned condition ratings based on visual condition assessment results (stored in GIS). The storage tanks were assigned condition based on their most recent inspection reports (included in Appendix II). Booster pump station was assigned condition rating based on Town staff input. For the purposes of the condition assessment, the water treatment plant was assigned one comprehensive condition rating, based on the most recent condition assessment report (located in Appendix III).

Condition scores were assigned to each water main asset using the criteria shown in Table 13, each hydrant as shown in Table 14, and to each storage tank and booster pump station using criteria listed in Table 15. Scores were on a scale of 1 through 5, with 1 being the lowest LoF and 5 being the highest.

Table 13 - Condition Criteria for Water Mains and Valves

Condition Rating	Condition	
	Age	Work Order
	80%	20%
5	<5% Remaining Useful Life. Very poor. Requires complete rehabilitation	>=5 work orders containing the keywords "Main", "Break", "Replace", "Leaking", "6 inch"
4	>=5 and <15% Remaining Useful Life. Poor, Unable to meet level of service	-
3	>=15 and <50% Remaining Useful Life. Fair, Major wear, impacting level of service	>=3 work orders containing the keywords "Main", "Break", "Replace", "Leaking", "6 inch"
2	>=50 and <95% Remaining Useful Life, Good, Minor wear	-
1	>=95%, Very Good, New or nearly new	>=1 work orders containing the keywords "Main", "Break", "Replace", "Leaking", "6 inch"

Table 14 - Condition Criteria for Hydrants

Rating	Age	Fire Flow	Work Order
Weights	33%	33%	33%
5	<5% Remaining Useful Life. Very poor. Requires complete rehabilitation	> 0 <= 500	>=5 work orders containing the keywords "Hydrant Meter Work Orders"
4	>=5 and <15% Remaining Useful Life. Poor, Unable to meet level of service	> 500 <= 1000	
3	>=15 and <50% Remaining Useful Life. Fair, Major wear, impacting level of service	> 1000 <= 1500	>=3 work orders containing keywords "Hydrant Replacement Work Orders"
2	>=50 and <95% Remaining Useful Life, Good, Minor wear	> 1500 <= 2000	
1	>=95%, Very Good, New or nearly new	> 2000 <= 5000	>=1 work orders containing keywords "Hydrant Repair Work Orders"

Table 15 - Condition Criteria for Storage Tanks and Booster Pump Stations

Condition Rating	Description
5	Poor condition determined via visual assessment or inspection report or Town Staff Input
3	Fair condition determined via visual assessment or inspection report or Town Staff Input
1	Good condition determined via visual assessment or inspection report or Town Staff Input

Using the above criteria, each asset in the distribution system was placed in a condition category. These condition categories have been summarized in

Table 16 and recorded in the GIS database. These categories were summarized by linear foot for water mains and were summarized by asset count for the storage tanks, booster pump station, valves, fire hydrants, and the water treatment plant.

Table 16 - Summary of Condition Ratings for Water System Assets

Asset / Condition	5 - Very Poor	4 - Poor	3 - Fair	2 - Good	1 - Very Good
Water Mains	-	238 (0.02%)	319,644 (23.88%)	723,614 (54.07%)	294,908 (22.03%)
Valves	-	1 (0.02%)	1451 (28.73%)	2879 (57.00%)	720 (14.25%)
Fire Hydrant	-	1 (0.06%)	10 (0.61%)	762 (46.81%)	855 (52.52%)
Storage Tanks	-	-	-	-	4 (100%)
Booster Pump Station	-	-	2 (100%)	-	-
Water Treatment Plant	-	-	-	1 (100%)	-

Table **16** shows that approximately 76% of water distribution system mains were determined to be in good condition or better.

While determining condition based upon material and diameter is not the most conclusive condition assessment, it can be used as an alternate method to prioritize areas where additional analysis may be necessary to determine replacement needs. The additional recommended assessments section below provides condition assessment criteria that can increase the accuracy of the condition assessment.

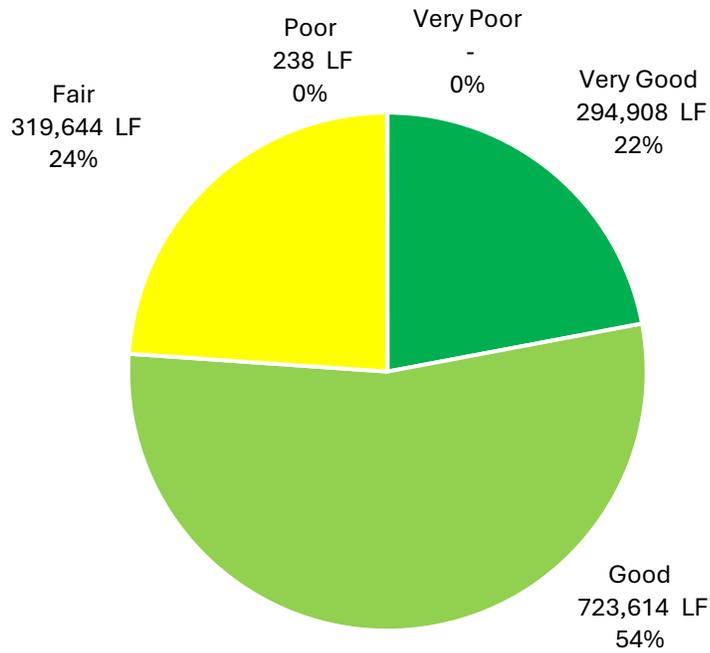


Figure 5 - Summary of Water Mains by Condition (summarized by length in feet)

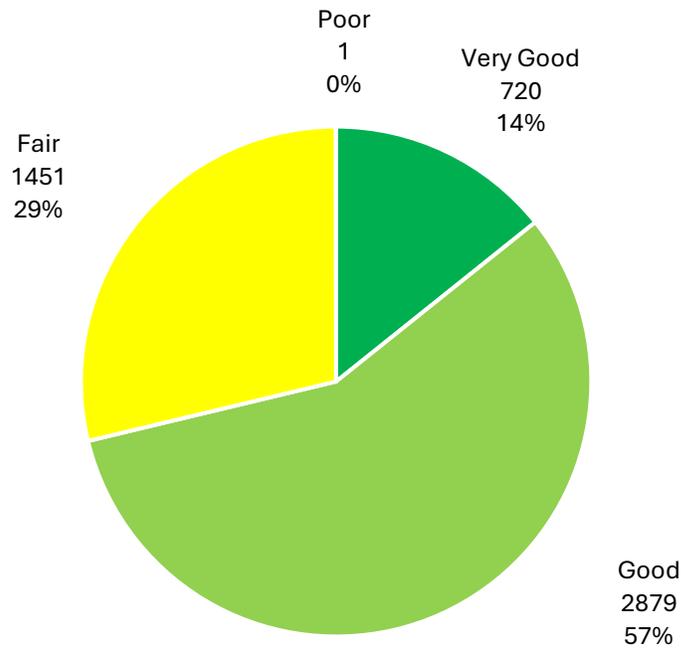


Figure 6 - Summary of Valves by Condition (summarized by count)

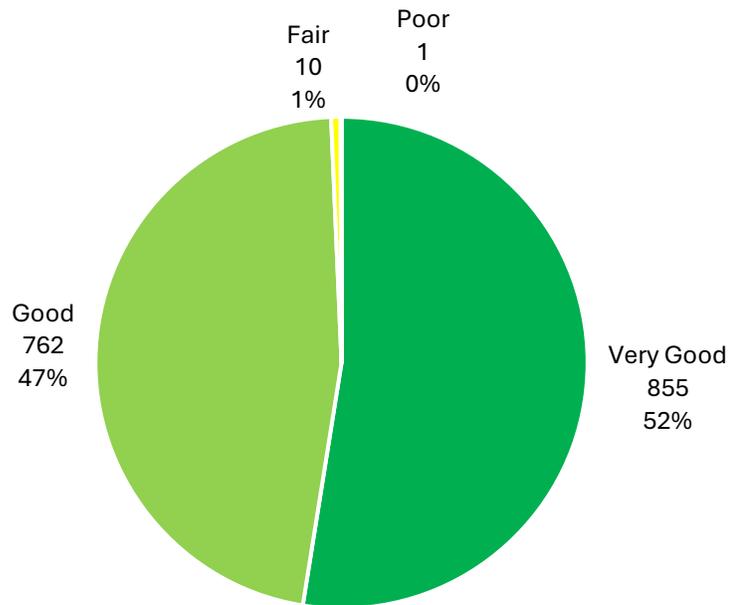


Figure 7 - Summary of Hydrants by Condition (summarized by count)

5.1.1 Asset Performance Assessment

Asset performance was also evaluated for water mains. Each inventoried water main was assigned a performance rating operating pressure criteria, as summarized in Table 17 below.

Table 17 - Performance Based Criteria for Water Mains

Performance Rating	Pressure
Weights	100%
5	0-30 psi or > 150 psi
4	-
3	>100 - 150 psi or 30 - 40 psi
2	-
1	40 - 100 psi

As described above, Table 17 summarizes the performance criteria for each asset category on a scale of 1 through 5 with 1 representing very good performance and 5 representing very poor performance.

Using these categories, each water main in the system was assigned a performance score based on modeled system pressures. A summary of the performance scores is listed in Table 18 below and stored in the Town's GIS database.

Table 18 - Summary of Performance Ratings for Water Main Assets

Asset / Performance	5 - Very Poor	4 - Poor	3 - Fair	2 - Good	1 - Very Good	Unknown
Water Main	6,900 (0.53%)	-	595,115 (43.34%)	-	710,586 (54.14%)	25,803 (1.93%)

As indicated in the table above, majority of the system performs within acceptable pressure ranges, with approximately 54% rated excellent and 43% rated Fair. A small portion of the system (less than 1%) was identified as operating under very poor pressure conditions.

This performance information was used to help identify operational deficiencies and to support CIP prioritization particularly in areas where pressure conditions may affect system reliability or service levels.

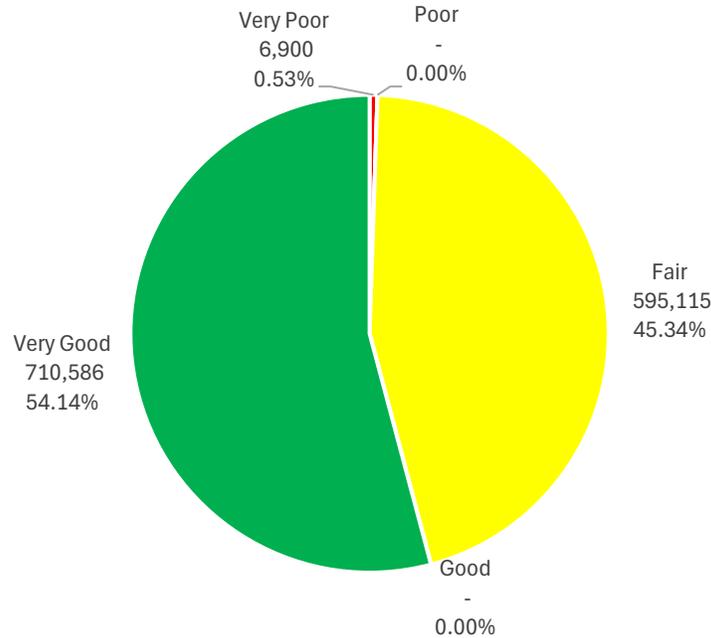


Figure 8 - Summary of Water Mains by Performance (summarized by length in feet)

5.1.2 Additional Recommended Assessments

The forecasted state of the water asset condition assessment is focused on increasing the known condition information of the distribution system.

Leak Detection

As stated above, the condition was determined based on the material and diameter of the water main asset. Leak detection and water audit initiatives provide information about unreported water leaks or breaks, and locations contributing to water loss. Water main leaks, breaks, and other factors contributing to water loss would provide additional condition information.

Valve Exercising

Additional valve field location and valve exercising would increase the accuracy of the GIS database as well as provide performance indicators to help the Town prioritize rehabilitation / replacement needs.

Water Coupon Program

Consider implementing a water coupon program. Make it a requirement of any new water tap to turn in the coupon from the tap. This will help collect information about the water system’s condition, material, and performance.

5.2 Consequence of Failure (CoF)

CoF is a numerical representation of the impact of an asset’s failure to the community. Assets with higher CoF scores are considered to be the most critical components of the Town’s water system in terms of maintaining the performance and integrity of the entire system.

The CoF scores were determined using economic and social impacts as described in Table 19 below. Various CoF criteria were presented to the Town, and the selected ones are listed below based on their applicability to the Town’s system. The weighting for each category was equally distributed among the three (3) criteria selected.

Table 19 - Consequence of Failure Criteria for Water Mains and Valves

Consequence of Failure		
Criteria	Condition Rating	Description
Service Impacts	5	Complete or >30 disruptions impacted, no redundancy, emergency backup needed
	4	-
	3	Partial or <30 connections impacted, no redundancy, emergency backup needed, short term service impact
	2	-
	1	No or minimal service disruption in service, redundancy available, no emergency backup needed
Proximity to Critical Infrastructure ¹	5	<50 ft of railroad or NCDOT state road, significant impact on traffic flow and access issue
	4	>=50, <100 ft railroad or NCDOT state road, major impact on traffic flow and access issue
	3	>=100, <150 ft railroad or NCDOT state road, moderate impact on traffic flow, some access issue
	2	>=150, <200 ft railroad or NCDOT state road, minimal impact on traffic flow, easy access for repair
	1	>=200 ft railroad or NCDOT state road, no/minimal impact on traffic flow, easy access for repair
Critical Users ²	5	Health and Safety, Public Utilities (Hospitals, Schools, Treatment Plant, etc.)
	4	Public Services/ Administration (Town Office)
	3	Industrial/commercial
	2	Businesses
	1	Residential

Notes:

- 1 Critical Infrastructure selected for analysis includes: US HWY 64, NC HWY 16, HWY 90 (W Main Ave/E Main Ave), Liledoun Rd
- 2 Critical Users selected for analysis include: Urgent Care of Mountain View, Alexander County Sheriff’s Office/Law Enforcement Center, Waste Water Treatment Plant, Alexander Co Emergency Communications, Interconnection with Energy United, Interconnection with Hickory, Alexander County Juvenile Detention Center, Valley Nursing Home, Southern Pines House, Alexander Central High School, Southern Pines Elementary School, Alexander County Head Start, CVCC Tech School, Town Hall, First Baptist Daycare, 16th St Car Wash, Happy Our

Laundromat, Washroom Laundromat, Mays Meats, S&S Family Restaurant, Hollars backstreet Grill, Brushy Mountain Brews Liledoun Rd Restaurants, Koto's, 16/90 T'Ville Scoops, Mexico Viejo, Bojangles, Wendys, Food Lion, Walmart & Shopping Center

Using the above criteria, each water asset was assigned a CoF rating, which is stored in the GIS geodatabase. The results were summarized in linear foot for water mains and by asset count for valves. Hydrant, wells, storage tank, booster pump, and water treatment plant assets were all determined to be a criticality rating of 5.

Table 20 - Summary of Criticality Ratings for Water System Assets

Asset / Criticality	5 - Very High	4 - High	3 - Medium	2 - Low	1 - Very Low
Water Mains	65,653 (5%)	21,575 (2%)	34,536 (3%)	543,637 (41%)	673,003 (50%)
Valves	64 (1%)	69 (1%)	329 (7%)	2,950 (58%)	1,639 (32%)
Hydrants	1,628 (100%)	-	-	-	-
Wells	4 (100%)	-	-	-	-
Storage Tanks	4 (100%)	-	-	-	-
Booster Pump Stations	2 (100%)	-	-	-	-
Water Treatment Plant	1 (100%)	-	-	-	-

As shown in Table 20, approximately 5% of the water mains and 100% of hydrants, storage tanks, and booster pumps in the system are highly critical to the system. If any of these assets fail, the Town can expect severe loss to their levels of service.

5.2.1 Additional Analysis Recommendations

Regulatory Considerations

In 2018, America’s Water Infrastructure Act (AWIA) was signed into law. This law requires drinking water systems serving more than 3,300 people to develop or update risk and resilience assessments and emergency response plans. The information gathered for the requirements of these assessments and plans will identify critical assets in respect to crucial locations within the Town, such as schools, industries, hospitals, etc.

In 1991, the Lead and Copper Rule was signed into law, with the most recent revision taking effect in June 2021. This law was implemented to minimize lead and copper levels in drinking water. It requires drinking water systems to monitor lead and copper concentrations in the drinking water at customer taps. Systems exceeding the action level require notification to the public and action taken to reduce the lead and copper concentrations in the water by implementing applicable corrosion control and treatment requirements. If the system continues to exceed the action level following these actions, lead and copper pipes shall be replaced.

There has recently been indication that galvanized iron pipes will be added to this list for monitoring or replacement requirements.

In 1974, the Safe Drinking Water Act was signed into law, with the most recent revision taking effect in 1996. This law created the National Primary and Secondary Drinking Water Regulations. These regulations, last updated in 2009, are standards and treatment techniques that public water systems must follow. These standards include microorganisms, disinfectants and disinfection byproducts, inorganic and organic chemicals, and radionuclides. These standards are measured at the Water Treatment Plant (WTP), and the disinfectants and disinfection byproducts are additionally measured throughout the distribution system.

5.3 Risk Score Analysis

The quantification of risk using LoF and CoF scores was used to identify priority projects for preparation of the Town’s Capital Improvements Plan (CIP).

$$\text{Risk} = \text{LoF} \times \text{CoF}$$

Multiplying the LoF and CoF scores for each asset were jointly analyzed on the risk matrix shown in Figure 9 below.

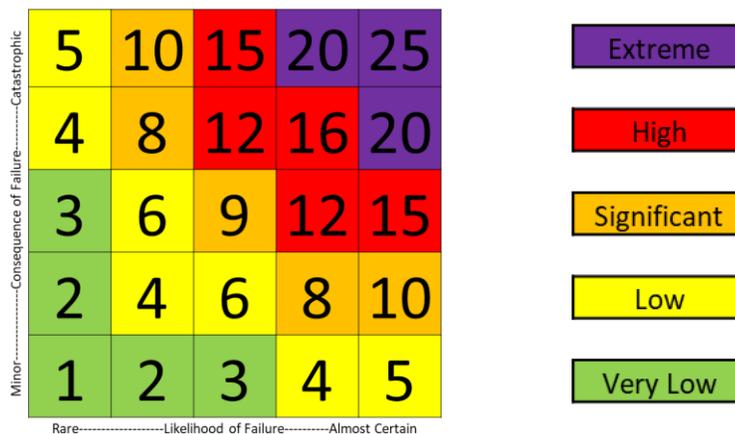


Figure 9 - Risk Score Matrix

Assets with a high likelihood of failure, as indicated by their poor condition, and high consequences of failure, as indicated by their criticality, score in the extreme risk category and have been prioritized for replacement in the Town’s CIP. Assets with very low to significant risk could be considered for replacement at a later year and/or for operation and maintenance activities, etc.

Performance ratings were evaluated separately and were not directly incorporated into the LoF × CoF risk calculation. Performance information was used as a supplemental planning tool to further inform capital improvement recommendations.

Appendix I includes a map with assets identified based on their risk scores.

Table 21 - Summary of Risk Scores for Water System Assets

Asset / Risk	Extreme	High	Significant	Low	Very Low
Water Mains	-	5,665 (0.42%)	56,077 (4.19%)	384,894 (28.76%)	891,768 (66.63%)
Valves	-	34 (0.67%)	131 (2.59%)	2,756 (54.56%)	2,130 (42.17%)
Hydrants	1 (0.06%)	10 (0.61%)	762 (46.81%)	855 (52.52%)	-
Storage Tanks	-	-	4 (100%)	-	-
Booster Pumps	-	2 (100%)	-	-	-
Water Treatment Plant	-	-	1 (100%)	-	-

Table 21 shows approximately 5% of water mains were given a significant risk value or higher, indicating that the consequence of the assets failing will be detrimental to the Town's service areas. These respective assets were used to prioritize replacement projects in the Town's CIP, as discussed in Section 7.

Risk was not calculated for wells as the wells do not have assigned condition ratings.

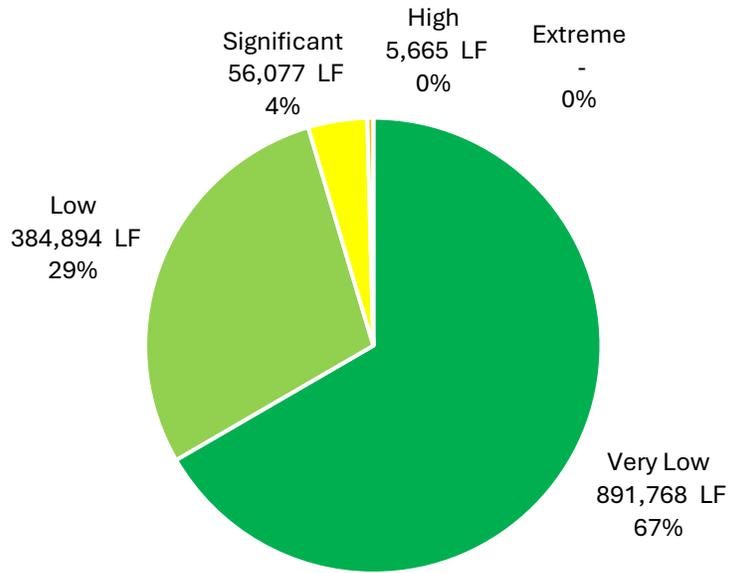


Figure 10 - Summary of Water Mains by Risk (summarized by length in feet)

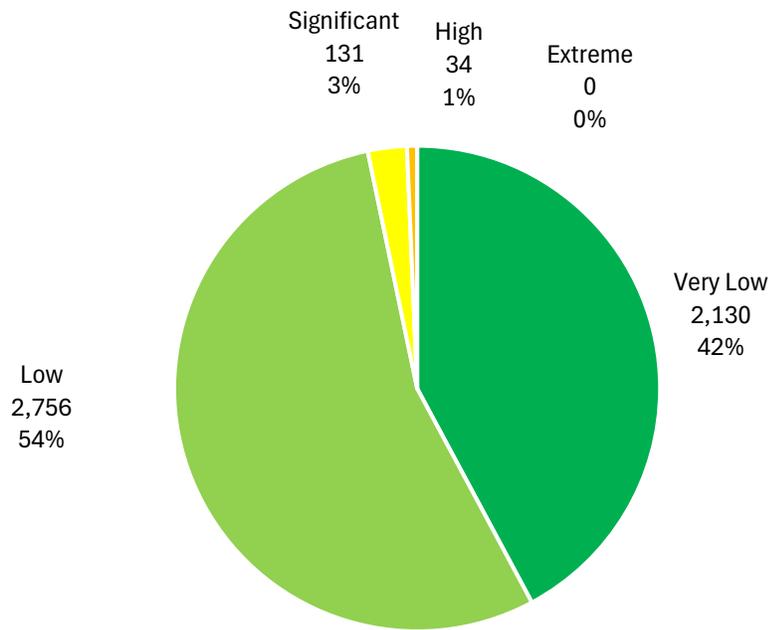


Figure 11 - Summary of Valves by Risk (summarized by count)

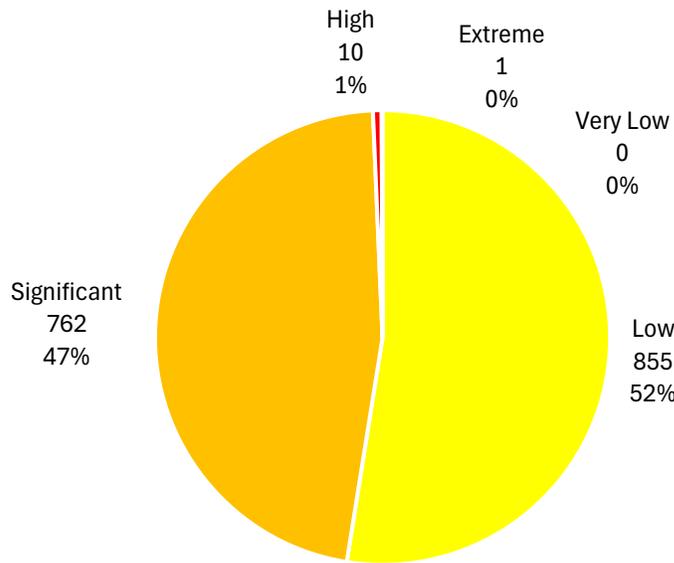


Figure 12 - Summary of Hydrants by Risk (summarized by count)

5.4 CIP Prioritization and Decision Making

To translate the results of the condition, risk, and performance assessments into actionable capital planning, the Town developed a tiered CIP Prioritization and Decision-Making Framework for the water system. This framework uses asset risk scores as the primary driver for prioritization and applies condition and performance information as supplemental criteria to refine capital improvement decisions.

Asset risk scores were calculated using a likelihood of failure (LoF) and consequence of failure (CoF) framework. Following risk evaluation, condition ratings and performance indicators—such as operating pressure—were used to further differentiate priority levels and to inform the appropriate timing and scope of capital improvements. Assets exhibiting poor condition and/or significant performance deficiencies were assigned higher priority, while assets with acceptable condition and performance were placed in lower tiers.

Town staff input was incorporated throughout the prioritization process to ensure that operational experience, maintenance history, and local system knowledge were reflected in final CIP recommendations.

The prioritization criteria and recommended actions associated with each tier are summarized in Table 22.

Table 22 - CIP Prioritization and Decision Making

Tier	Criteria	Description	Action
4	Condition > 4 and Performance > 4	Physically failing assets with significant pressure issues	Prioritized Rehabilitation ; perform additional hydraulic evaluation to address pressure issues.
3	4-5 in one category, 1-3 in other	High risk driven by either deterioration or hydraulic condition	Further assessment and prioritized rehab , note structural or hydraulic driver dominates.
2	Both Condition & Performance = 3-4	Moderate wear and moderate pressure issues	Plan for mid-term or long-term renewal (5-10 or 10+ yrs) ; continue pressure zone monitoring and trend analysis.
1	Both Condition & Performance = 1-3	New or well-performing mains with no significant issues	Routine inspection and monitoring ; maintain preventive maintenance schedule.

This integrated prioritization approach builds the CIP recommendations to address both asset condition and system performance, supporting long-term sustainability of the Town's water system.

The resulting priority projects are listed in Table 23 and recommended for funding within the Town's 10-year Capital Improvements Plan.

6 Operation and Maintenance (O&M) Plan

Operation and Maintenance (O&M) for the water distribution system focuses on upkeep of the water mains, treatment plant, storage tanks, booster pumps, valves, and fire hydrants. Maintenance consists of “Emergency Maintenance,” which is corrective action needed quickly to keep the system operational, and “Preventative Maintenance,” which is routine, scheduled tasks to prevent problems before they arise. The items below represent routine maintenance items performed throughout the distribution system.

6.1 Water Mains

Perform routine inspection or maintenance on the following items:

- Bi-annual inspection of all high priority lines. Maintain log of date, area inspected, method of inspection, and corrective action taken or initiated. High priority lines include the following:
 - Aerial and sub-waterway crossings.
 - Lines contacting surface waters and lines positioned parallel to stream banks and subject to eroding in such a manner that may threaten the line.
 - Any other segment of the system that is designated as high priority.

Utilize and maintain a Water Main Break Evaluation Log, including the following items:

- Suspected water main breaks or leaks due to unexplained wet areas on ground with the date, location, and pictures to document the unexpected wet area.
- Reported water main breaks or leaks, with the date, location of break, size, material, condition, asset identifier of water main, description of break (cause, estimated quantity of water lost, etc.), and summary of repair.

Incorporate information from new construction and rehabilitation projects, including line diameter, material, and condition, into the collection system GIS within one (1) year of construction completion.

6.2 Customer Meters

Routinely reconcile water production data against water sales records:

- Record non-revenue water and identify and repair leaking or under-recording customer meters.

Perform meter accuracy testing and flow meter maintenance:

- Check for appropriate meter sizing and meter type for customer usage, along with checking installation, to reduce reporting errors.

6.3 Storage Tanks

Perform routine inspections on the following items:

- Coating Type and Conditions
 - Note interior coating condition, exterior coating condition, and logo condition.
 - Take pictures to document condition of each.
- Safety
 - Note any safety climbing devices and if they are properly secured.
 - Note any deficiencies with access hatches.
- Security
 - Ensure fence around the site is secure, the ladder gate/access door is locked, and the access hatch is locked and secure.
 - Note any evidence of vandalism.
- Structural
 - Inspect the foundation, vertical supports (legs), access ladders and catwalks, column flanges, anchor bolts and other connections, riser pipe, riser rods, wind rods, balcony, interior ladders, roof, vents, overflow pipe, and welds, and note any deficiencies such as corrosion or rust.
 - Ensure connections are watertight and there are no visible leaks.
 - Take pictures to document condition of each.

Complete maintenance items on a rotating schedule:

- Recoating / repair interior and exterior.
- Disinfect according to an approved AWWA method.

6.4 Valves

Perform annual inspection and exercise of each valve. Maintain log of date, asset identifier, location of valve, and general condition of valve.

6.5 Hydrants

Perform routine inspections or maintenance items:

- Annual inspections of each hydrant. Maintain log of date, asset identifier, location of hydrant, and general condition of hydrant.
- Regular flushing of selected fire hydrants throughout the system, location and schedule determined by the flushing program. Maintain a log of date, hydrant location, duration of flushing, and approximate volume of water flushed.

6.6 Booster Pump Stations

Perform routine inspections on the following items:

- Inspecting, cleaning, and removing debris from the booster pump structure, and outside perimeter.
- Inspecting and exercising all valves.
- Inspecting and lubricating pumps and other mechanical equipment.
- Verifying the proper operation of the alarms, telemetry system, and auxiliary equipment.
- Other testing procedures as recommended by the manufacturer.

- Annual flow meter calibration (at a minimum).
- NOTE: Pump stations not connected to telemetry systems must be inspected at least daily. Pump stations with telemetry must be inspected at least once per week.

In addition, a Booster Pump Station Check List Form should be created and utilized for each inspection. The inspection form should cover the following items:

- Record hours of running time from elapsed time meters at least once per week and check for equal running times on each pump.
- Test alarms.
- Check valves for proper positioning (valves functioning, normally open valves are open, normally closed valves are closed).
- Confirm valve lever arms and weights are ok.
- Check for unusual pump noise or vibration.
- Check amp readings. Note discrepancies.
- Confirm pumps appear to be seated properly.
- Confirm that no leakage is observed.
- Confirm guide rails and brackets are aligned and fastened.
- Note any rust or loose parts.
- Confirm that piping and valves are not leaking and that bolts and nuts are properly torqued.
- Confirm that any corroded or worn parts have been replaced, cleaned, painted, or restored.
- Record flow rate observed during site visit.
- Check and record pressure gauge readings during observed flow rate. Note any changes from normal readings.
- At least once per week, manually pump down the wet well to check for and remove debris.
- Inspect floats, transducer, and cables and remove all debris to ensure proper operation.
- Ensure all automatic cycle operation cables and appurtenances are free and clear of debris or obstructions and functioning as designed.
- Check control settings.
- If a pump is removed, place the lead pump selector switch on the number of the pump remaining in operation.
- Inspect the pump hand/off/automatic selector switch. Turn to off. Fill up wet well with water until high water is activated. Turn to auto and check if both pumps operate automatically with slight delay between each. Pump until pump shuts off. Fill water until the lead pump starts. When the lead pump starts, shut off water. Allow pump to lower the wet well until the pump shuts off.
- Check pumps for blockage and any abnormalities in operation.
- Confirm generator is automatically exercising on schedule at start-up. Periodically, manually throw main disconnect to check the Automatic Transfer Switch (ATS) and generator operation.
- Cut grass, pick up trash, remove debris, walk around perimeter, inspect fencing, landscaping, look for vandalism or evidence of trespassing or other security concerns.
- Greasing valves and cycling valves to ensure free operation and functionality.

- Recording hour meter readings.
- Check by-pass operation (as applicable).
- Confirm emergency power is available.
- Inspect the Pump station security (fence locks, building locks, wet well/dry well secured).
- Untangle twisted cables that may affect the automatic cycle operation.
- Inspect lighting of station.
- Sweep and clean station interior and/or grounds as applicable.
- Check for unusual pump noise or vibration.
- Check amp readings. Note discrepancies.
- Confirm pumps appear to be seated properly.
- Confirm that no leakage is observed. This includes both water as well as lubricant oils.
- Confirm guide rails and brackets are aligned and fastened and are corrosion free or track rate of corrosion for possible maintenance action.
- Confirm that piping and valves are not leaking and that bolts and nuts are tight.
- Record findings and assessment on Monthly Utility maintenance form.

7 Capital Improvement Plan

7.1 Capital Costs

The capital improvement cost includes the material cost and labor cost for the rehabilitation, replacement, or installation of a new or existing water system asset. This cost can be determined for an asset with direct price quotes provided by a supplier or general cost estimates based on an evaluation of recent construction bids across North Carolina and the RSMeans Catalog. For the purposes of this project, a combination of direct price quotes and general cost estimates were used to determine unit costs for replacement or rehabilitation of water mains, valves, hydrants and ground storage tanks.

7.2 Capital Improvement Projects

Based on input from Town Staff and results of the risk analysis, the projects listed in Table 23 below are recommended for inclusion in the CIP budget for the water system over the next ten (10) years.

1. Midland Road Water Line Replacement (Water Project #2)
An existing 6-inch and 8-inch water line will be replaced with a 12-inch water line along Midland Road from Knoll Road to Pee Dee Road. This project is currently scheduled for possible implementation in FY2028 following the adoption of the 2024 SDF Report update. The original estimated cost upon which the SDF Fee is based is \$2,536,000. Based on this estimate, the project would be eligible for \$570,600 in SDF, based on 30% of project cost after 25% discount. The balance of upfront costs will be covered by water capital funds. The project will address future growth and pressures to anticipated further development in the Mid-South and Talamore areas.
2. North Pressure Zone (Water Project #4)
The Town plans to install a 184 ft. high 1.0 MG North Elevated Storage Tank and associated valves. Project design has been implemented and the original estimate updated to \$7,019,000. SDF in the amount \$3,158,550 or 60% of final costs after 25% discount, will ultimately be appropriated to the CRF for this purpose with the balance of upfront costs covered by water capital funds and installment loans. \$271,765 were appropriated in FY25. The project will successfully add a pressure zone in the northern portion of our service area to address potential low flow conditions which could impact future growth in this area.
3. Pinebluff Parallel Transmission Main (Water Project #8)
Install a 24" water line parallel to the existing 18" transmission main from the WTP to the US 1 Booster Pump Station. This project will add a redundant supply line from the WTP to the Booster Pump Station and provide additional transmission capacity necessary to supply future demands.

4. US-1 Booster Pump Station Addition (Water Project #5)
The Town plans to install infrastructure to provide for an additional 4,500 gpm Pumping Capacity to the US 1 Booster Pump Station. This project is currently scheduled for implementation in 2027 with an estimated cost of \$731,000. Based on original estimates, the Town would appropriate approximately \$301,537.50 based on 55% of project costs after 25% discount, of System Development Fee revenues to the CRF for this purpose with the balance of upfront costs covered by water capital funds and potentially loans. The additional flow will support ongoing development throughout our Water service area.

5. US-1 Parallel Transmission Main (Water Project #6)
This project was envisioned to install a 20" water line parallel to the existing 18" transmission main from the US1 Booster Pump Station to the intersection of US1 and Saunders in addition to replacing a 6" line along the west side of Old US1 from Murray Hill to Morganton. This project is scheduled for implementation in FY27. Projected at a cost of \$3,747,000, the project is 90% SDF eligible resulting in a planned SDF appropriation of \$2,529,225 after the 25% discount. The project improvements will provide increased transmission capacity into the system and reduce excessive head loss and velocity in the existing transmission main. These improvements are needed to meet future demands.

6. US-1 Waterline Relocation and Upsize (Water Project #3)
An existing waterline will be relocated along US-1 with the goal of improving transmission capacity in the system for this area. The project is scheduled for completion in FY 26 - 27 with a projected cost of \$500,000.

7. US-15-501 Waterline Replacement and Upsize (Water Project #7)
An existing 8-inch waterline will be replaced with a 12-inch waterline along US-15-501/Commerce Avenue from Murray Hill Road to Turner Street. This project will improve transmission capacity and eliminate an existing bottleneck in the system. The project had an estimated cost of \$1,511,000 and is eligible for \$226,650 in SDF Revenues based on 20% of estimated final costs after the 25% discount.

8. Water Treatment Plant Capacity Expansion Study (WTP Project #6)
The Town Water Plant operates off of a license to produce 8.0 MGD but has the ability to produce up to 11.0 MGD. It is anticipated based on current growth models that an application for expansion of Plant capacity will need to be developed and filed around the year 2028. Fees and adjustments associated with application are estimated to be \$150,000 and after 25% discount the Town intends to appropriate \$112,500 of System Development Fee revenues to the CRF for this purpose with the balance of upfront costs covered by water capital funds and Retained Earnings. The additional licensed capacity will support ongoing development throughout our Water service area.

9. Water Treatment Plant Raw Water Main Replacement (WTP Project #5)
Cost estimate features the installation of 12,500 ft of 30" pipe from the raw water pump station to the 140 MG reservoir, following the same route as the existing 18" pipe. Allowances are provided for connecting to the existing 18" feeding the 20 MG reservoir and connecting through the dam at the 140 MG reservoir.

10. Water Treatment Plant Modifications (WTP Projects #1-4)
 1. This project features chemical feed modification for the chlorine feed system, to convert from feeding gas chlorine to liquid sodium hypochlorite. The estimate includes the construction of a new hypochlorite building adjacent to the existing gas chlorine room as well as bulk tanks, feed/recirculation pumps, chemical feed piping, and modifications to the chemical pump room.

 2. This project features chemical feed modifications for the ammonia feed system, to convert from feeding anhydrous ammonia to liquid ammonia. The estimate includes a new bulk tank, concrete containment structure, feed pumps, feed piping, and electrical.

 3. This project features the conversion of the old side Greenleaf Filter backwash from surface sweeps to air scour. The estimate includes the demolition of the existing filter underdrains, installation of new AWI filter bottoms, installation of a new blower unit, piping and valves required to connect the blower to the air scour system, and electrical and controls for the proposed system.

 4. This project features the construction of a new mechanical dewatering facility adjacent to the existing drying beds, including belt press equipment, a new building, process piping, electrical/controls, modifications to Clarifier #1, and a sludge containment basin. Note that an alternative expansion of drying beds is also being considered.

11. Annual Waterline Replacement
This project is intended to replace all the waterlines and associated appurtenances within the High Risk and Tier 3 categories, as identified in the analysis sections above.

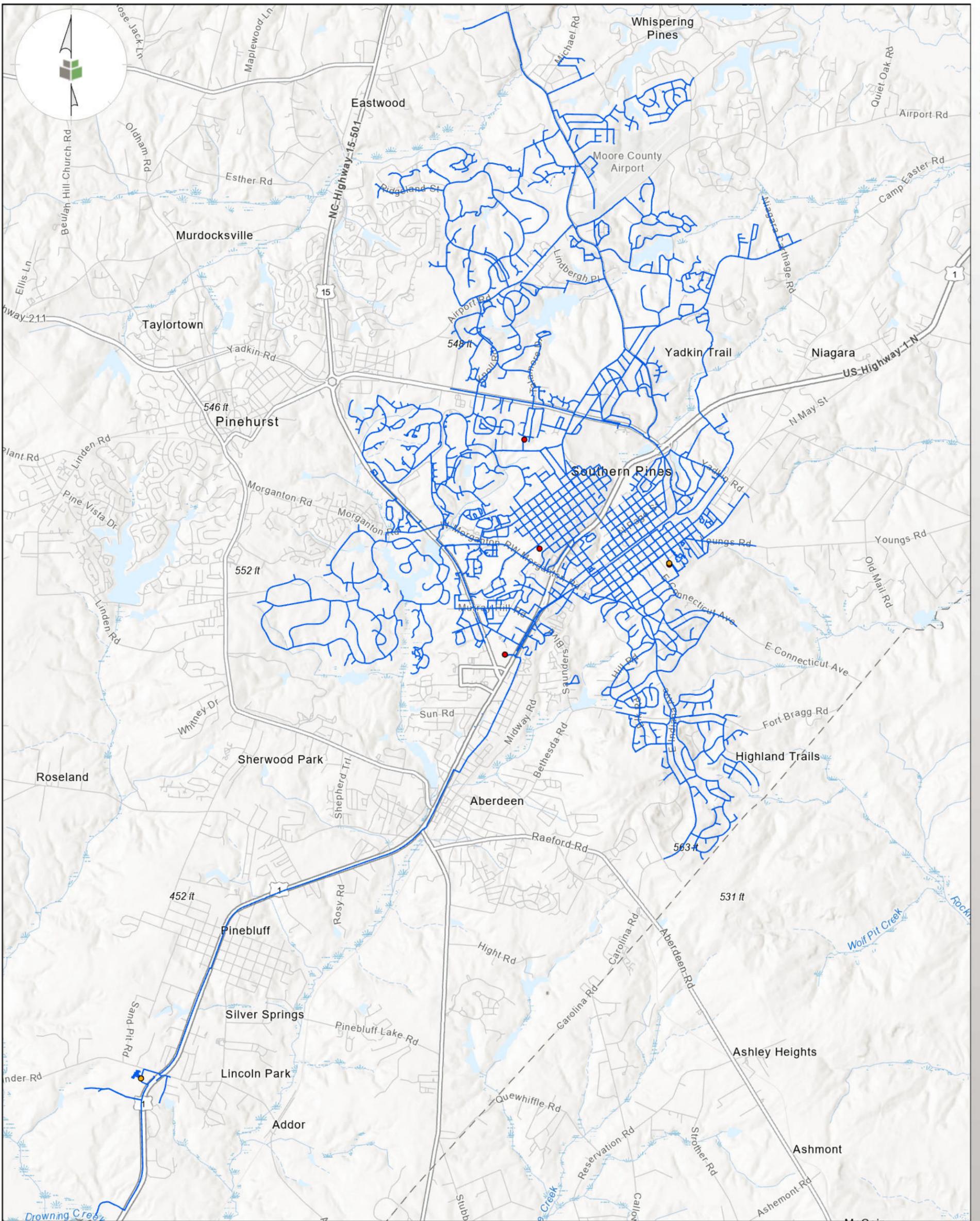
Table 23 - List of Proposed Capital Improvement Projects

Project Location	Year 1 FY 26 - 27	Year 2 FY 27 - 28	Year 3 FY 28 - 29	Year 4 FY 29 - 30	Year 5 FY 30 - 31	Future Years FY 31 - 36
Midland Road Water Line Replacement (Water Project #2)	\$331,000	\$2,205,000				
North Pressure Zone (Water Project #4)	\$7,019,000					
Pinebluff Parallel Transmission Main (Water Project #8)						\$30,123,000
US-1 Booster Pump Station Addition (Water Project #5)		\$731,000				
US-1 Parallel Transmission Main (Water Project #6)		\$448,000	\$3,299,000			
US-1 Waterline Relocation and Upsize (Water Project #3)	\$500,000					
US-15-501 Waterline Replacement and Upsize (Water Project #7)						\$1,511,000.00
Water Treatment Plant Capacity Expansion Study (WTP Project #6)		\$150,000				
Water Treatment Plant Raw Water Main Replacement (WTP Project #5)			\$500,000	\$2,625,000	\$2,625,000	
Water Treatment Plant Modifications (WTP Projects #1-4)	\$3,748,318					
Annual Waterline Replacement	\$158,267	\$163,015	\$167,905	\$172,943	\$178,131	\$890,655
TOTAL	\$11,756,585	\$3,694,015	\$3,966,905	\$2,797,943	\$2,803,131	\$32,524,655

8 Hydraulic Model Considerations

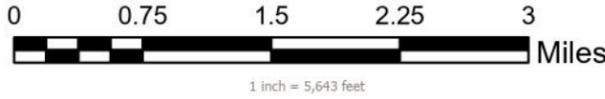
Throughout the course of this project, the GIS connectivity updates, hydraulic model development, and review of recent and future state standards have been used to identify additional criticality and risk parameters that are important to the distribution system. The hydraulic model report, located in Appendix IV, details the full data collection, calibration, and development process.

APPENDIX I – GIS Maps



Overall System Map

Town of Southern Pines, NC

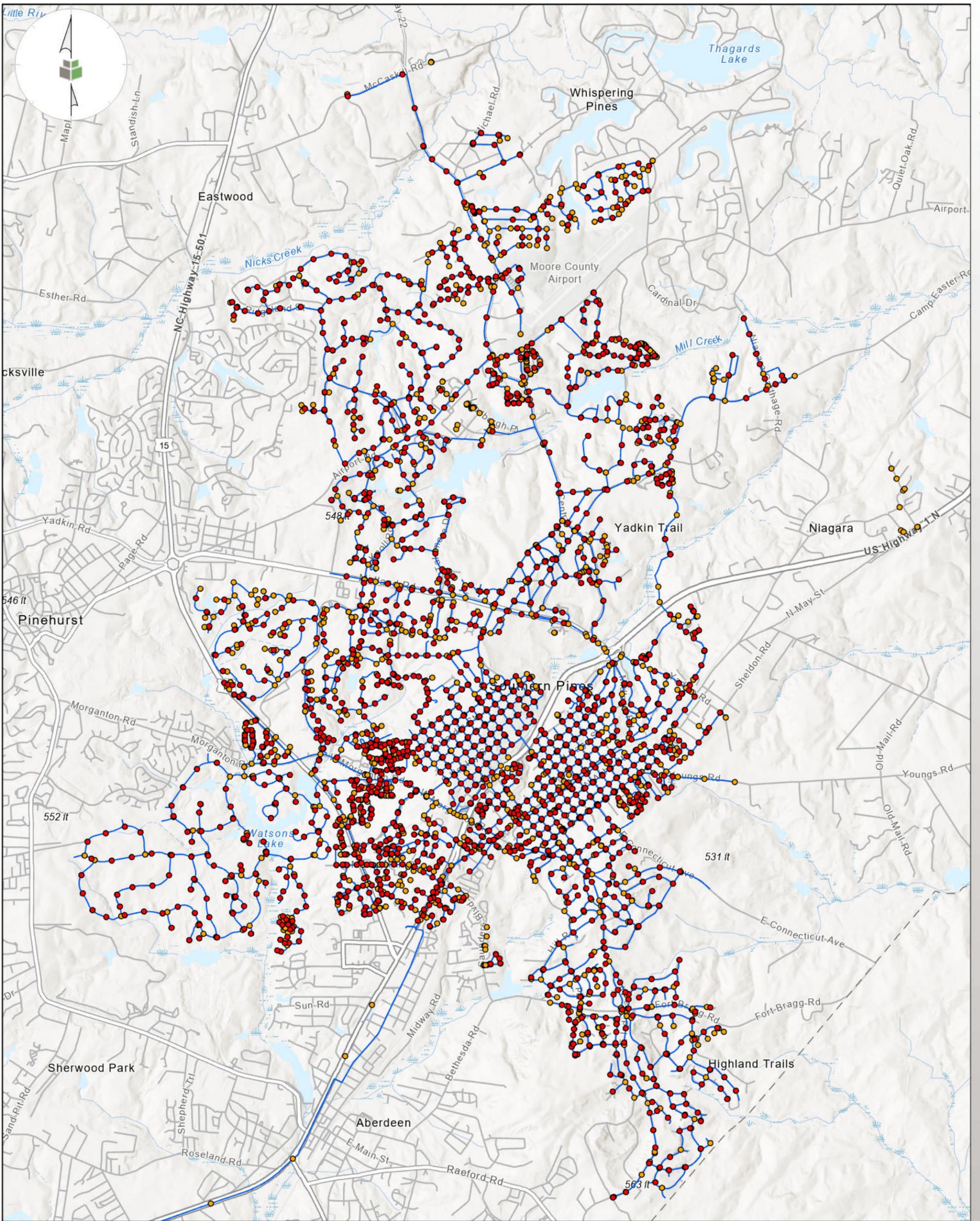


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- Legend**
- Water Well
 - Water Storage Tank
 - Water Mains

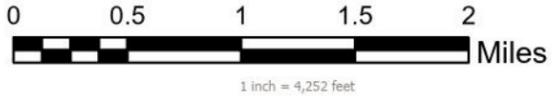
This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.



Overall System Map

Town of Southern Pines, NC

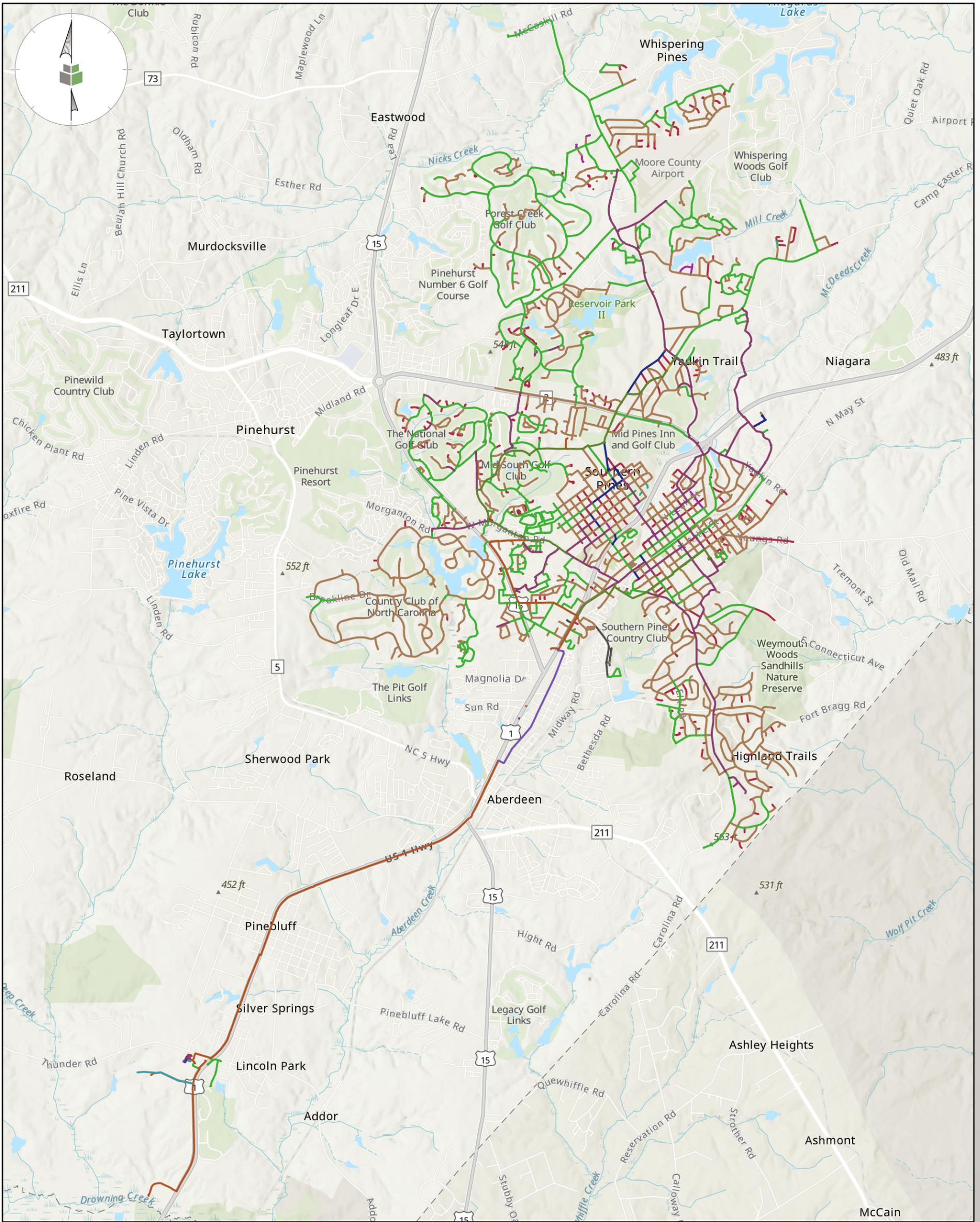


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- Legend**
- Hydrants
 - Water Service Valves
 - Water Mains

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Data features are not based on professional field survey unless stated otherwise.



Water Mains by Diameter

Town of Southern Pines, NC

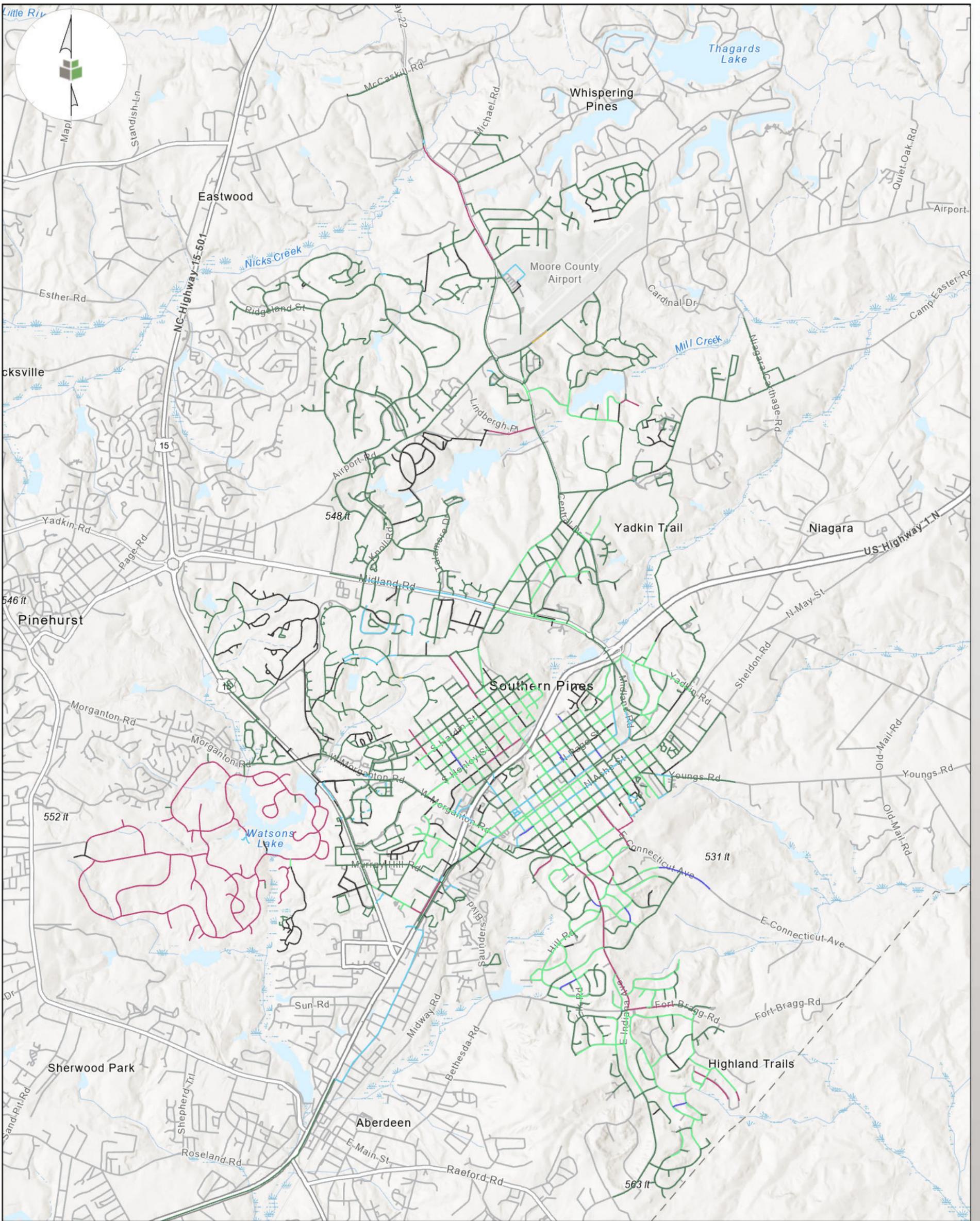


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Legend	
Water Main Diameter	
	0.75
	1
	2
	3
	4
	6
	8
	10
	12
	16
	18
	20
	24
	30
	Unknown
	Non-Town Owned Water Mains

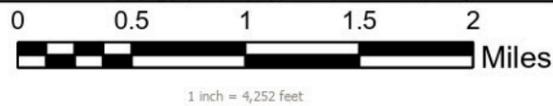
This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.



Water Mains by Material

Town of Southern Pines, NC

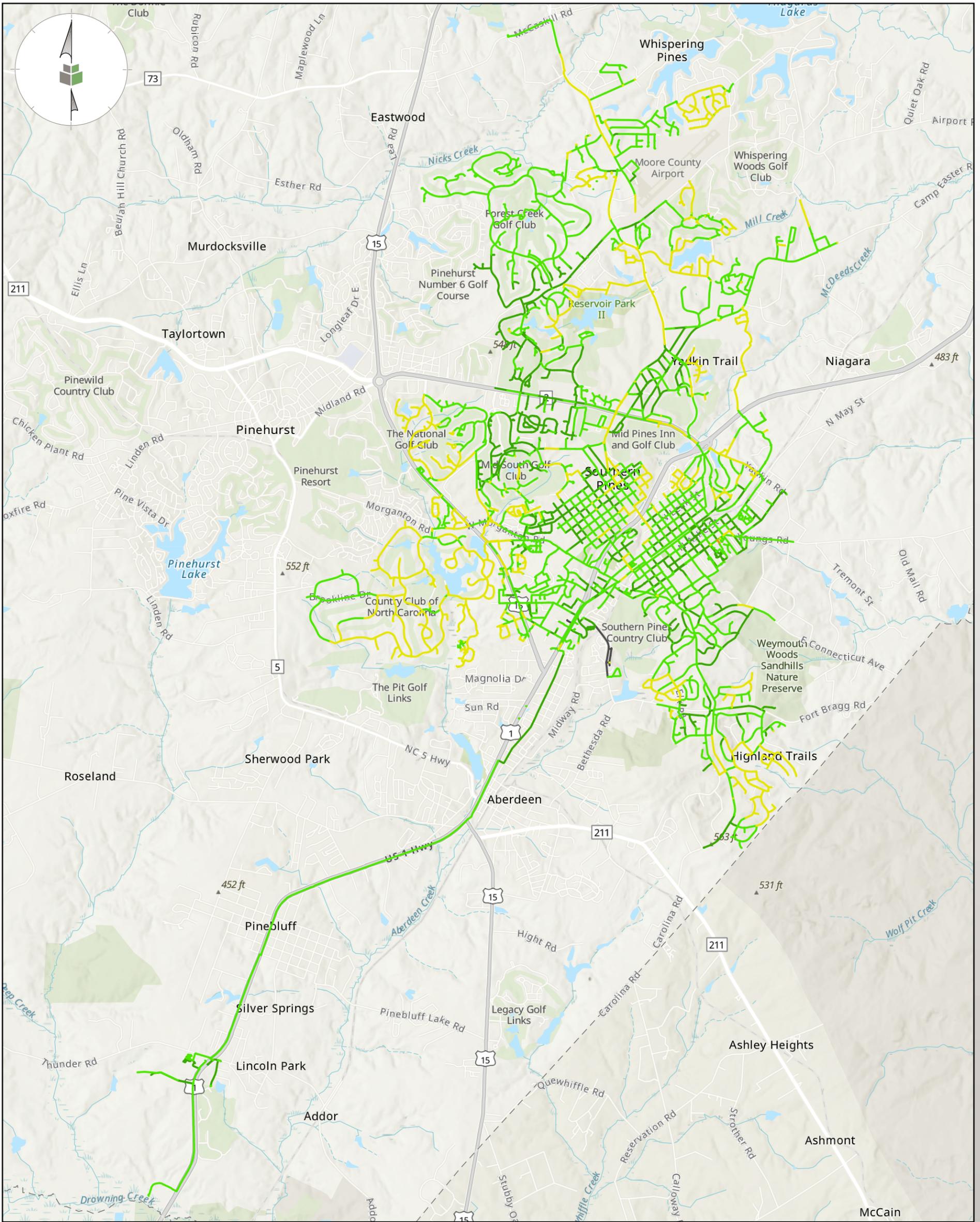


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 t: 919.469.3340
 license #: F-1479
 www.withersravenel.com

- Material**
- AC
 - CI
 - DIP
 - GAL
 - HDPE
 - PVC
 - RCP
 - Unknown

This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.



Water Mains by LoF

Town of Southern Pines, NC

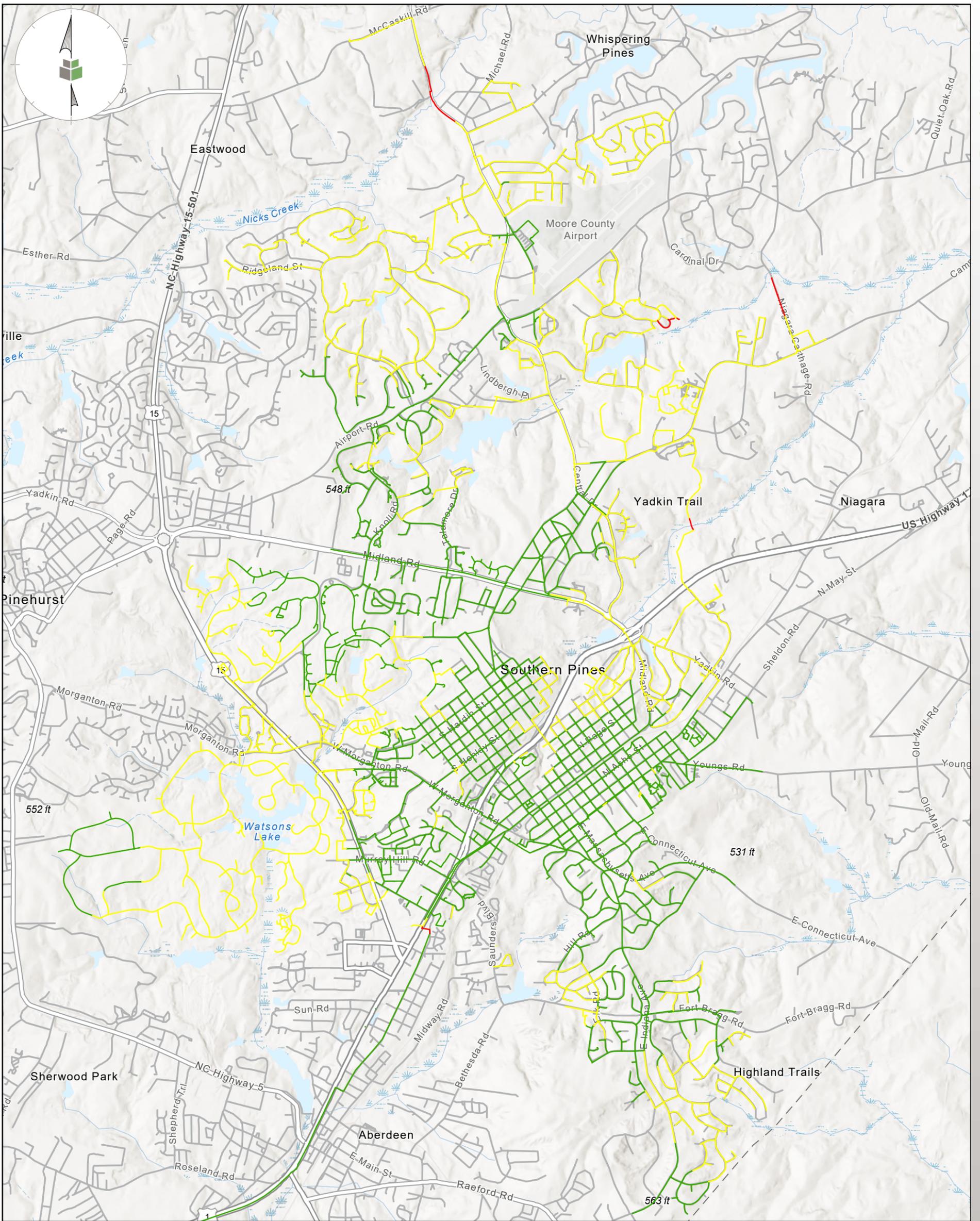


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 license #: F-1479
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- Legend**
- Water Main**
- LoF**
- Very Good (294,908 LF)
 - Good (723,614 LF)
 - Fair (319,644 LF)
 - Poor (238 LF)
 - Very Poor (0 LF)
 - Non-Town Owned Water Mains

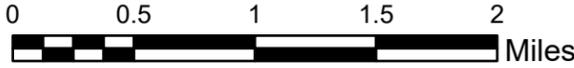
This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.



System Performance Map

Town of Southern Pines, NC



1 inch = 3,994 feet

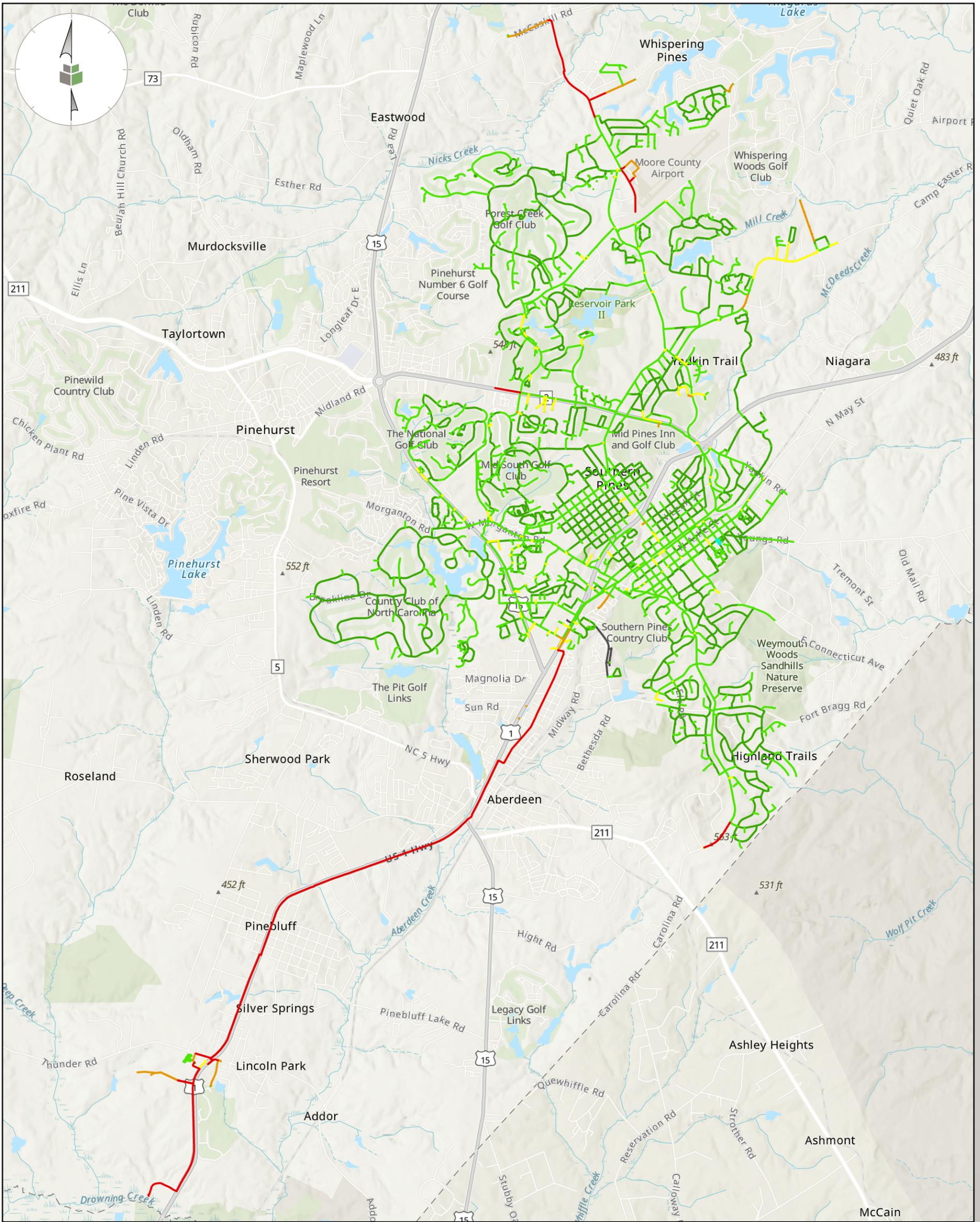


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 t: 919.469.3340
 license #: F-1479
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- Water Main Pressure**
- Excellent
 - Fair
 - Very Poor

This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.



Water Mains by CoF

Town of Southern Pines, NC

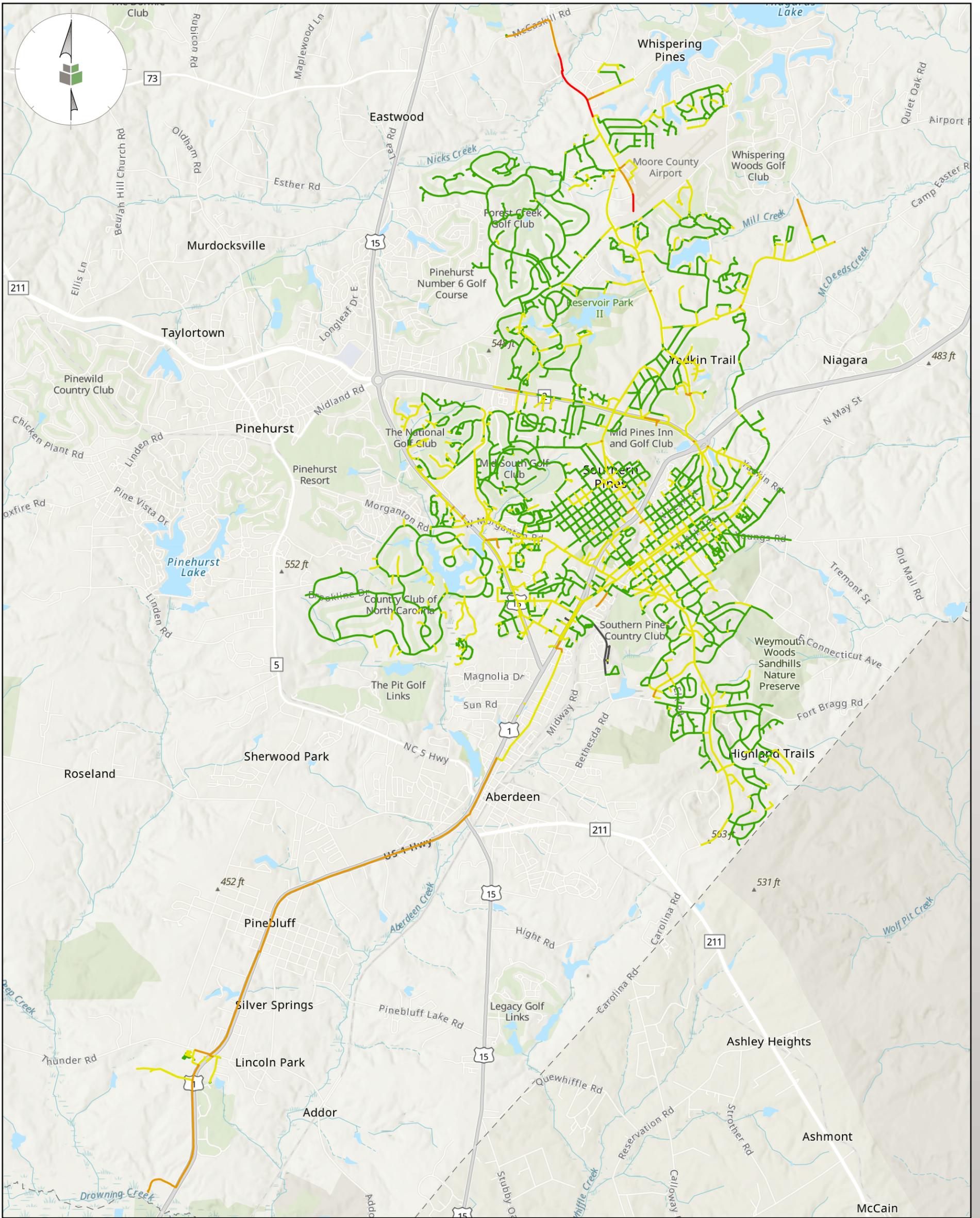


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 license #: F-1479
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This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.

- Legend**
- Water Main**
- CoF**
- Very Low (673,003 LF)
 - Low (543,637 LF)
 - Fair (34,536 LF)
 - High (21,575 LF)
 - Very High (65,653 LF)
 - Non-Town Owned Water Mains



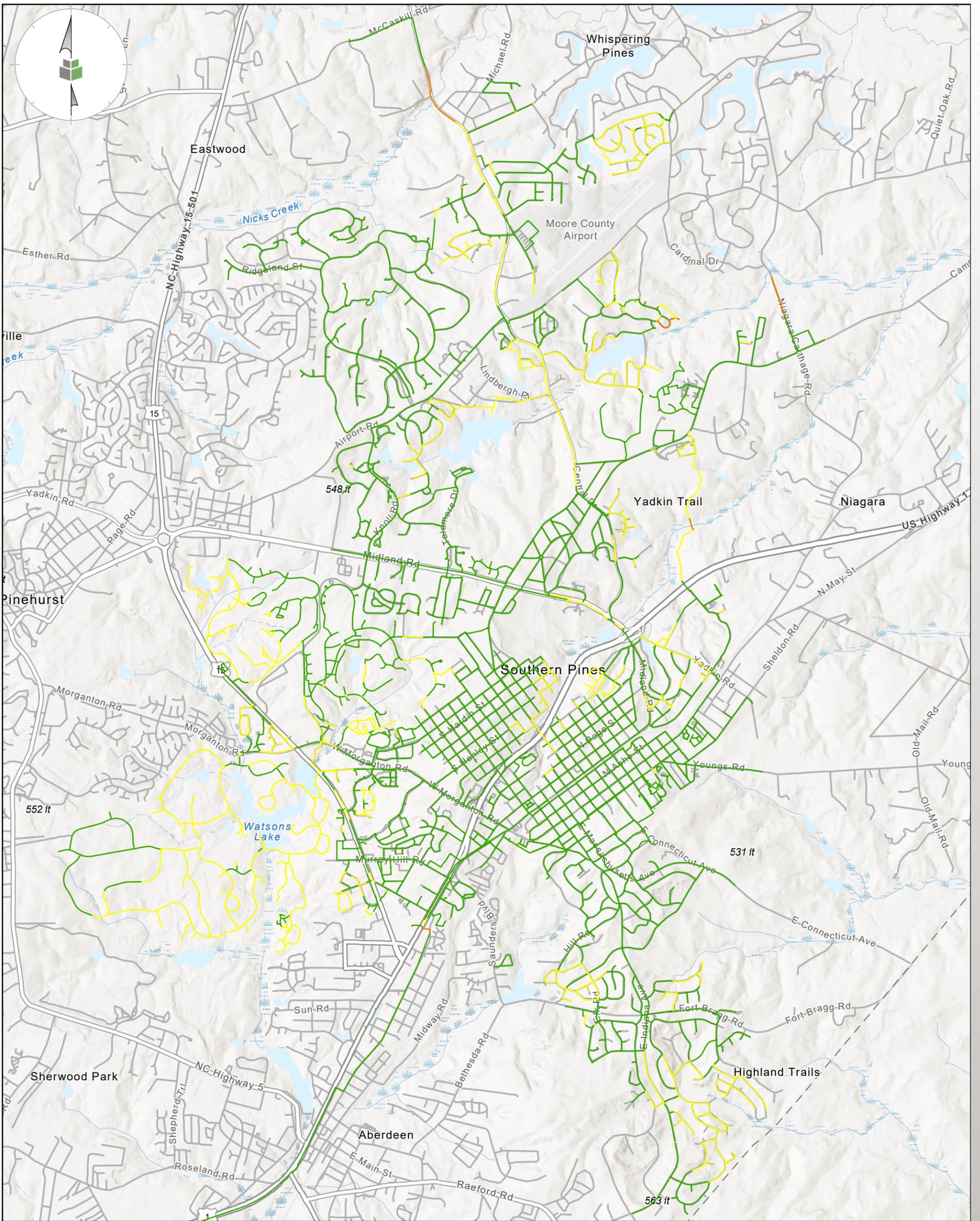
Water Mains by Risk

Town of Southern Pines, NC

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 license #: F-1479
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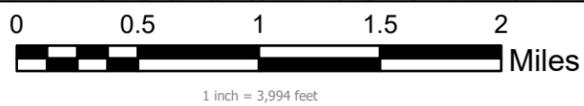
This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.
 Data features are not based on professional field survey unless stated otherwise.

- Legend**
- Water Main**
- Risk**
- Very Low (891,767 LF)
 - Low (384,894 LF)
 - Significant (56,077 LF)
 - High (5,665 LF)
 - Extreme (0 LF)
 - Non-Town Owned Water Mains



CIP Tiers Map

Town of Southern Pines, NC



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 115 MacKenan Dr | Cary NC, 27511
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 license #: F-1479
 www.withersravenel.com

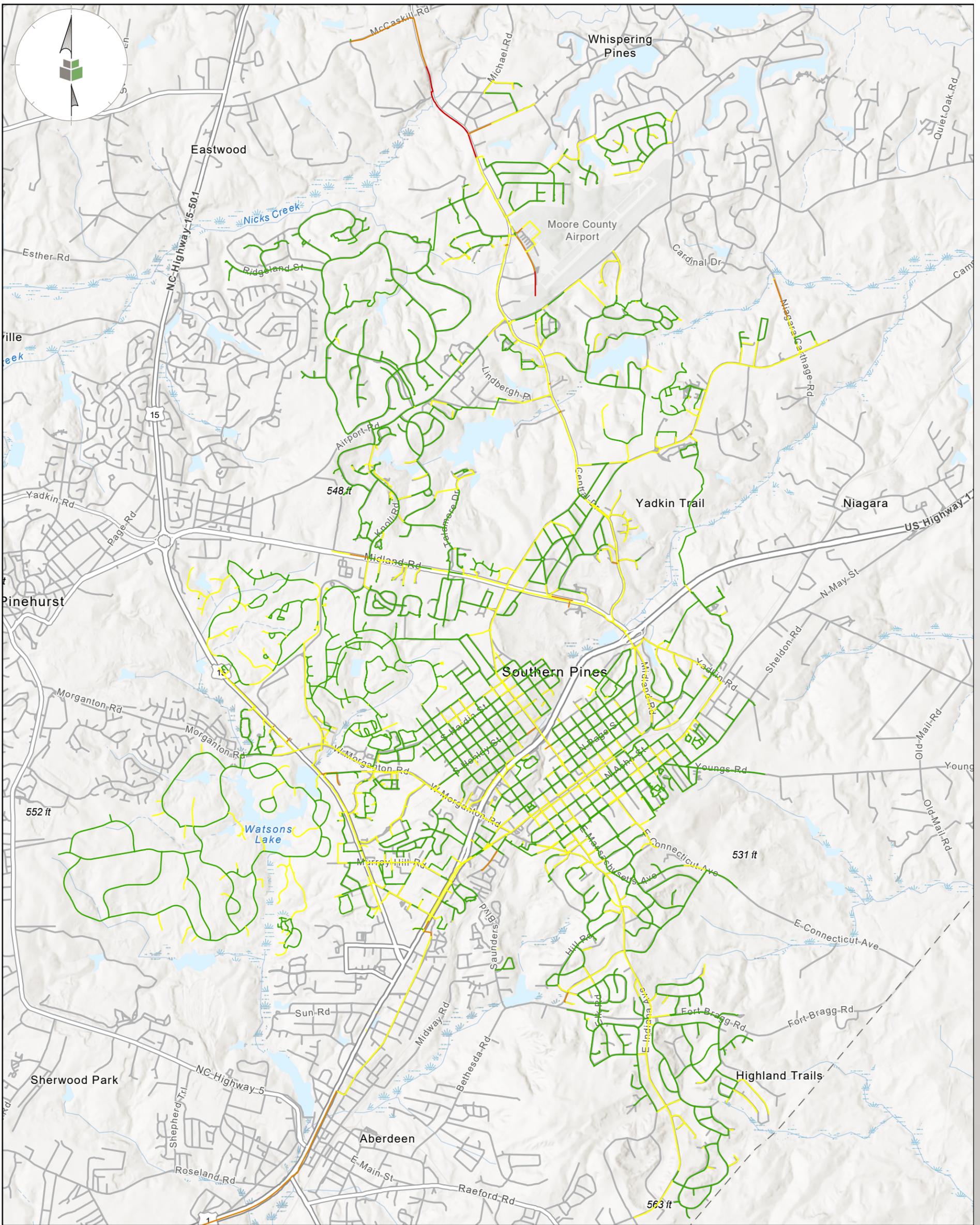
Water Main

CIP Tier / Cost Estimate

- 1 / \$197,930,194
- 2 / \$52,834,682
- 3 / \$1,582,665
- 4 / \$0

This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.



CIP Risk Map

Town of Southern Pines, NC



Our People. Your Success.
 115 MacKenan Dr | Cary NC, 27511
 t: 919.469.3340
 license #: F-1479
 www.withersravenel.com

Water Main Risk / Cost Estimate

- 1 - 3 / \$155,787,223
- 4 - 7 / \$85,318,118
- 8 - 11 / \$20,827,074
- 12 - 19 / \$1,132,995
- 20 - 25 / \$0

This map is for informational purposes only. All feature locations displayed are approximate based on available data sources.

Data features are not based on professional field survey unless stated otherwise.

APPENDIX II – Storage Tank Inspection Reports

Town Of Southern Pines

CONDITION ASSESSMENT REPORT



Tank Name:

Weymouth Tank

Location:

475 North Ridge Road

Tank Size and Style:

2,000,000 Standpipe

Project Number:

156675

Inspection Date:

January 23, 2024

Inspected By:

Taylor Jennings

Town Of Southern Pines Contact Information:

Administrative:

Gary Stainback

Address:

125 Se Broad Street
Southern Pines, NC 28387

Phone/Email:

336-766-0270

Job:

David Mckew

Utility Service Co., Inc.

Address

535 Courtney Hodges Blvd
PO Box 1350
Perry, GA 31069

Email and Website

Website: www.usgwater.com
Email: customerservice@usgwater.com

Customer Service Information

Sue Roach
866-919-3471

Summary

A visual inspection was performed on the exterior condition. The exterior continues to be in good condition with no nonconforming items to report. The interior coating was not fully inspected but will be at the next scheduled washout when the interior will be cleaned, inspected and disinfected. Interior roof and structure was partially inspected from hatch. Personnel are not allowed to enter the structure (i.e. "break the plane") when filled with water in order to maintain compliance with the OSHA 1926.1201 Confined Space for Construction Standard. However, based on this limited view no deficiencies were noted with roof structure.

The tank will be scheduled for a Washout Inspection in 2025.

Coating Type & Conditions

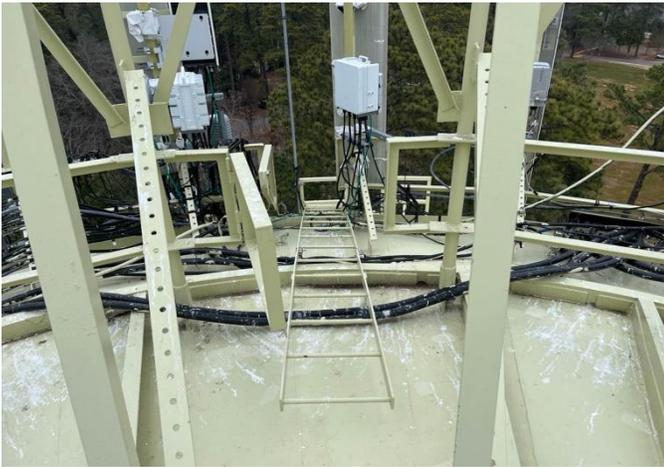
- **Interior Coating Condition:** Visible areas of the Interior lining are in good condition and continues to protect the substrate.
- **Exterior Coating Condition:** No deficiencies noted in the exterior coating.



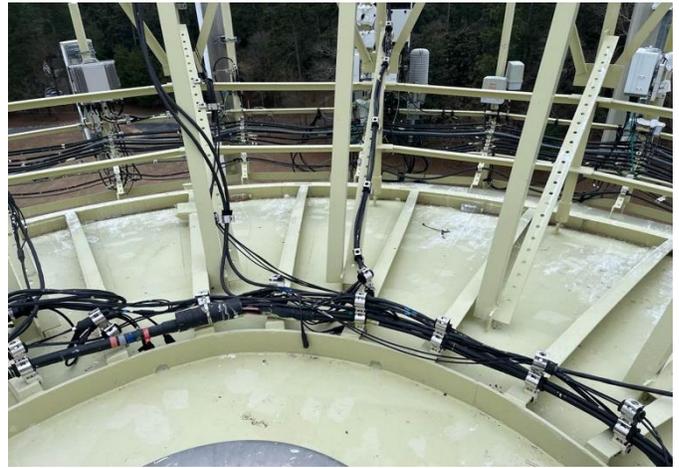
Interior Sidewall Coating



Interior Sidewall Coating



Exterior Roof Coating



Exterior Roof Coating



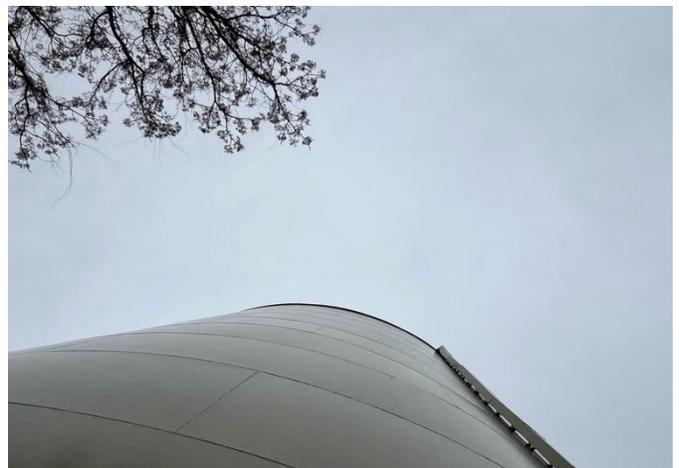
Exterior Sidewall Coating



Exterior Sidewall Coating



Exterior Sidewall Coating



Exterior Sidewall Coating



Exterior Base Coating



Exterior Base Coating

Safety

- **Safety Climbing Devices:** Ladders are equipped with secured safety climb devices.
- **Access Hatch1:** No deficiencies noted.



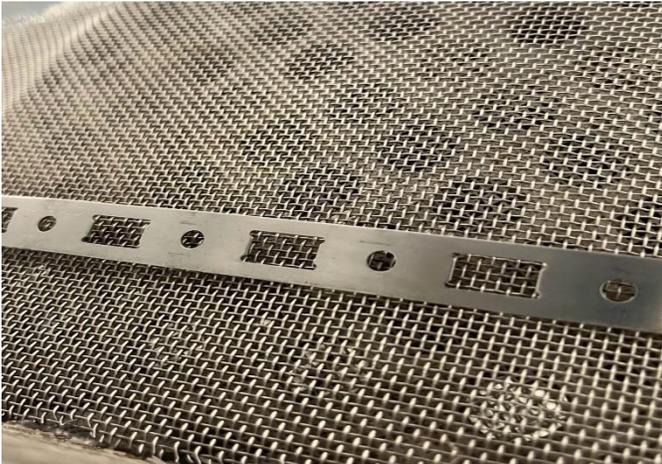
Safety Climb on Access Ladder



Wet Interior Access Hatch Open

Sanitary

- **Vent Screen:** Vent screen was replaced during the inspection.
- **Evidence Of Foreign Matter:** No evidence of foreign matter observed.
- **Sediments:** Sediment was present in the bottom of the tank and will be cleaned out at the next scheduled washout.



Vent Screen

Security

- **Fence Around Site:** Tank is located inside a fenced-in area that is secure.
- **Access Hatch Locked:** Access hatch is locked and secured.
- **Evidence Of Vandalism:** No evidence of vandalism was found.



Ladder Gate Locked



Wet Interior Access Hatch Locked

Structural

- **Foundation:** Foundation appears in good condition. No deficiencies noted.
- **Access Ladders:** No deficiencies noted for dry-side access ladder stiles, rungs and connections.
- **Watertight Conditions:** There are no visible leaks at manway, riser or legs.
- **Interior Ladders:** Interior ladder partially inspected from hatch. No deficiencies noted with visible portion of ladder.
- **Roof:** The interior roof does not have roof beams. No deficiencies noted.
- **Vents:** No deficiencies noted with vent.
- **Overflow Pipe:** No deficiencies noted. Overflow pipe extends to ground level.
- **Welds:** No deficiencies noted with weld seams.
- **Float System:** Float system is in working condition. No deficiencies noted.
- **Level Indicator:** Level indicator is in working condition with no deficiencies noted.



Foundation



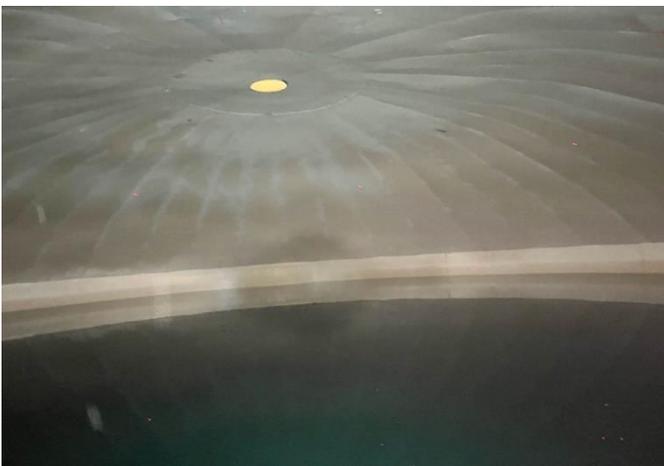
Sidewall Manway 1



Sidewall Manway 1



Interior Ladder Structure



Interior Roof Structure



Vent Structure

Steel Tanks

The determinations and recommendations made within this report with respect to the condition of the steel structure, integrity, or other surface defects are based upon visual observations made during the inspection. Extensive testing or investigation of the steel to determine the extent of the metal loss or capacity of the structure was not completed.



**Town Of Southern Pines
ATTN: David Mckew
125 Se Broad Street
Southern Pines, NC 28387**

Town of Southern Pines

CONDITION ASSESSMENT REPORT



Tank Name:
Eastman Tank

Location:
240 Eastman Rd

Tank Size and Style:
1,000,000 Fluted Column

Project Number:
156673

Inspection Date:
January 23, 2024

Inspected By:
Taylor Jennings

Town of Southern Pines Contact Information:

Administrative:
Gary Stainback

Address:
125 Se Broad Street
Southern Pines, NC 28387

Phone/Email:
336-766-0270

Job:
David Mckew

Utility Service Co., Inc.

Address
535 Courtney Hodges Blvd
PO Box 1350
Perry, GA 31069

Email and Website
Website: www.usgwater.com
Email: customerservice@usgwater.com

Customer Service Information
Sue Roach
866-919-3471

Summary

A visual inspection was performed on the exterior condition. The interior coating was not fully inspected but will be at the next scheduled washout when the interior will be cleaned, inspected and disinfected. Interior roof and structure was partially inspected from hatch. Personnel are not allowed to enter the structure (i.e. "break the plane") when filled with water in order to maintain compliance with the OSHA 1926.1201 Confined Space for Construction Standard. However, based on this limited view no major deficiencies were noted with the interior roof structure.

The tank is scheduled for a washout inspection in 2025.

Coating Type & Conditions

- **Interior Coating Condition:** Visible areas of the interior coating are in good condition and continues to protect the substrate.
- **Exterior Coating Condition:** No deficiencies noted in the exterior coating.
- **Dry Interior Condition:** No deficiencies noted in the dry interior coating.



Interior Roof and Sidewall Coating



Interior Roof and Sidewall Coating



Exterior Roof Coating



Exterior Roof Coating



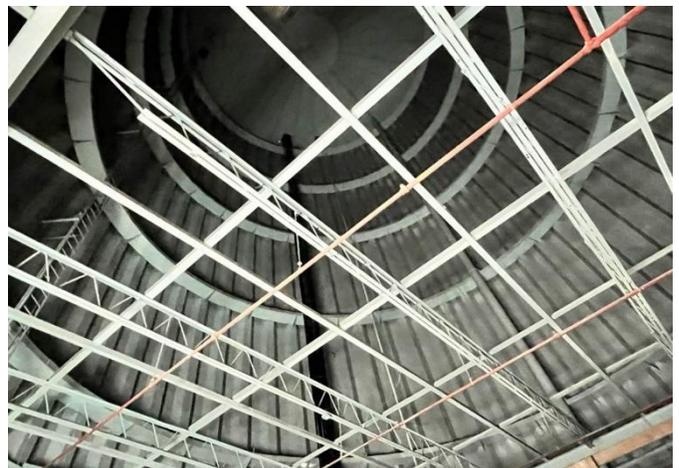
Exterior Roof Coating



Exterior Roof Coating



Exterior Column Coating



Dry Interior Column Coating



Dry Interior Catwalk and Bowl Coating



Dry Interior Dry Riser Coating

Safety

- **Safety Climbing Devices:** Ladders are equipped with secured safety climb devices.
- **Access Hatch1:** No deficiencies noted with the dry interior roof access hatch.
- **Access Hatch2:** Minor deficiencies noted with the wet interior roof access hatch. We will continue to monitor these areas.



Safety Climb on Access Ladder



Wet and Dry Interior Roof Access Hatches

Sanitary

- **Vent Screen:** No deficiencies noted with vent screen.
- **Overflow Pipe Screen Flapper:** Overflow pipe is equipped with flap gate. No deficiencies noted with flapper.
- **Evidence Of Foreign Matter:** No evidence of foreign matter observed.
- **Sediments:** Sediment is present in the bottom of the tank and will be cleaned out at the next washout.



Roof Vent Screen



Overflow Flap Gate

Security

- **Fence Around Site:** Tank is located inside a fenced-in area that is secure.
- **Ladder Gate/Access Door:** Tank has a door access to the interior dry ladder and the door was locked.
- **Access Hatch Locked:** Access hatch is locked and secured.
- **Evidence Of Vandalism:** No evidence of vandalism was found.



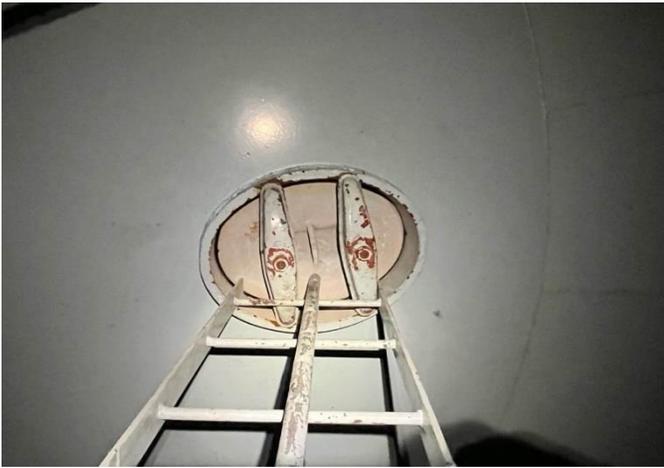
Locked Tank Access Door



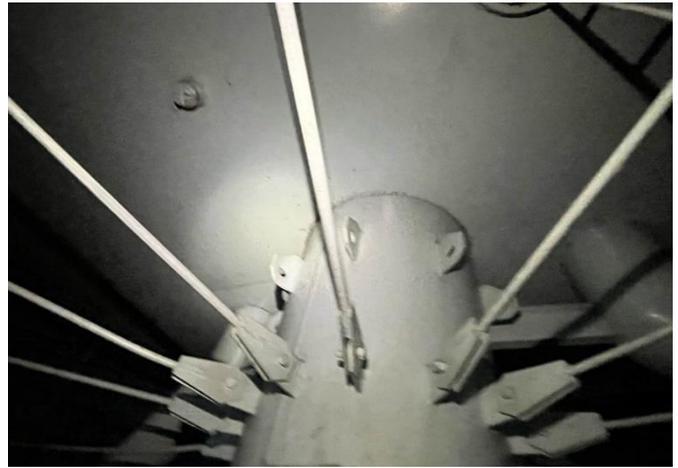
Locked Roof Access Hatch

Structural

- **Foundation:** Foundation appears in good condition.
- **Access Ladders:** No deficiencies noted for dry-side access ladder stiles, rungs and connections.
- **Watertight Conditions:** There are no visible leaks at manway, riser or legs.
- **Interior Ladders:** Interior ladder partially inspected from hatch. No deficiencies noted with visible portion of ladder.
- **Roof:** Interior roof structure partially inspected from hatch. Very minor spot corrosion deficiencies noted with the interior roof structure. We will continue to monitor these areas.
- **Vents:** No deficiencies noted with the roof vent structure.
- **Overflow Pipe:** Tank is equipped with an internal overflow.
- **Welds:** No deficiencies noted with weld seams.



Boiler Wet Interior Manway



Rod Connections



Interior Access Ladder



Interior Roof Structure



Roof Vent Structure



Overflow Pipe Termination

Steel Tanks

The determinations and recommendations made within this report with respect to the condition of the steel structure, integrity, or other surface defects are based upon visual observations made during the inspection. Extensive testing or investigation of the steel to determine the extent of the metal loss or capacity of the structure was not completed.



**Town of Southern Pines
ATTN: David Mckew
125 SE Broad Street
Southern Pines, NC 28387**

Town of Southern Pines

CONDITION ASSESSMENT REPORT



Tank Name:
Henley Street Tank

Location:
890 Henley St

Tank Size and Style:
500,000 Elevated

Project Number:
125701

Inspection Date:
February 3, 2023

Inspected By:
Felipe Torres

Town of Southern Pines Contact Information:

Administrative:
Gary Stainback

Address:
125 SE Broad Street
Southern Pines, NC 28387

Phone/Email:
336-766-0270

Job:
David McKew

Utility Service Co., Inc.

Address
535 Courtney Hodges Blvd
PO Box 1350
Perry, GA 31069

Email and Website
Website: www.veolianorthamerica.com
Email: us.vna.customerserviceadvancedsolutions
.all.mailbox@veolia.com

Customer Service Information
Sue Roach
866-919-3471

Summary

A visual inspection was performed on the exterior condition. The interior coating was not fully inspected but will be at the next scheduled washout when the interior will be cleaned, inspected and disinfected. Interior roof and structure was partially inspected from hatch. Personnel are not allowed to enter the structure (i.e. "break the plane") when filled with water in order to maintain compliance with the OSHA 1926.1201 Confined Space for Construction Standard. However, based on this limited view no major deficiencies were noted with roof structure.

The tank will be scheduled for a Visual Inspection in 2024.

Coating Type & Conditions

- **Interior Coating Condition:** Interior coating is in overall good condition and continues to protect the substrate. Corrosion and rust deficiencies noted with the roof. Due to the contract schedule, an interior renovation is tentatively scheduled.
- **Exterior Coating Condition:** No deficiencies noted in the exterior coating.



Interior Roof and Sidewall Coating



Interior Roof and Sidewall Coating



Exterior Roof Coating



Exterior Roof Coating



Exterior Sidewall Coating



Exterior Sidewall Coating



Exterior Bowl Coating



Exterior Bowl Coating



Exterior Leg Coating



Exterior Riser Coating

Safety

- **Safety Climbing Devices:** Ladders are equipped with secured safety climb devices.
- **Access Hatch:** Corrosion deficiencies noted on the interior portion of the access hatch. Areas will be addressed at the tentatively scheduled interior renovation.



Ladder with Safety Climb Device



Roof Access Hatch Open

Sanitary

- **Vent Screen:** No deficiencies noted with vent screen.
- **Evidence of Foreign Matter:** No evidence of foreign matter observed.
- **Sediments:** Sediment was present in the bottom of the tank and will be cleaned at the next scheduled washout.



Roof Vent Screen

Security

- **Fence Around Site:** Tank is located inside a fenced-in area that is secure.
- **Ladder Gate/Access Door:** Exterior ladder has a ladder gate installed and is locked.
- **Access Hatch Locked:** Access hatch is locked and secured.
- **Evidence of Vandalism:** No evidence of vandalism was found.



Locked Ladder Gate



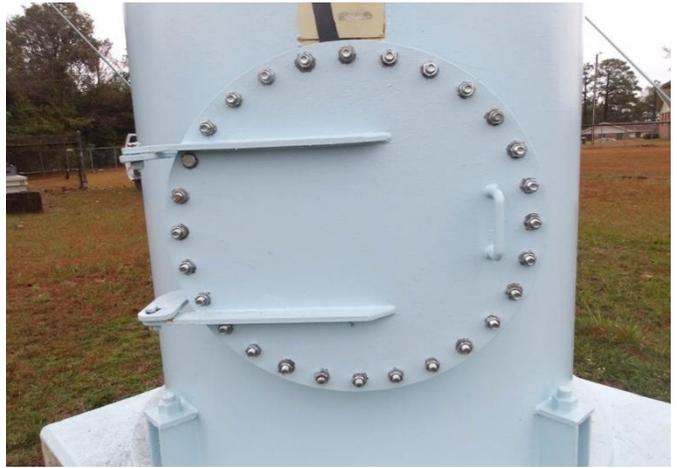
Locked Roof Access Hatch

Structural

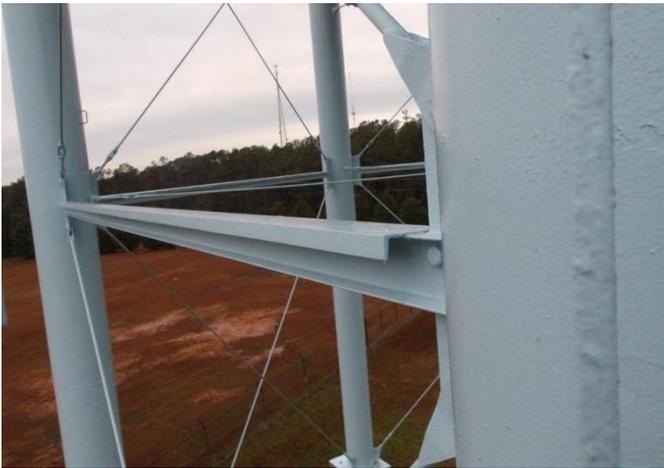
- **Foundation:** Foundation appears in good condition. No deficiencies noted.
- **Legs:** No deficiencies noted with tank legs. Paint coating continues to protect the substrate.
- **Access Ladders:** No deficiencies noted for dry-side access ladder stiles, rungs and connections.
- **Column Flanges:** Column flanges are painted and no corrosion is present.
- **Anchor Bolts:** Anchor bolts are protected and show no rust or corrosion.
- **Riser Pipe:** No deficiencies noted with riser. Paint coating continues to protect the substrate.
- **Riser Rods:** No deficiencies noted with riser rods.
- **Wind Rods:** No deficiencies noted with wind rods.
- **Watertight Conditions:** There are no visible leaks at manway, riser or legs.
- **Balcony:** No deficiencies or corrosion damage noted for balcony railings and landings.
- **Interior Ladders:** Interior ladder partially inspected from hatch. No deficiencies noted with visible portion of ladder.
- **Roof:** Corrosion deficiencies noted on the interior roof structure. Areas will be addressed at the tentatively scheduled interior renovation.
- **Vents:** No deficiencies noted with vent.
- **Overflow Pipe:** No deficiencies noted. Overflow pipe extends to ground level.
- **Welds:** No deficiencies noted with weld seams.



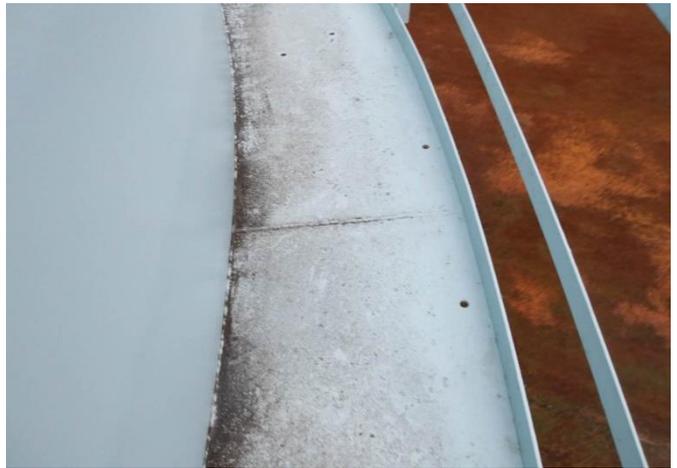
Leg Structure



Multi-Bolt Riser Manway



Strut Connections



Balcony Landing with Handrail



Interior Ladder



Interior Roof Structure



Roof Vent Structure



Tank Identification Plate

Steel Tanks

The determinations and recommendations made within this report with respect to the condition of the steel structure, integrity, or other surface defects are based upon visual observations made during the inspection. Extensive testing or investigation of the steel to determine the extent of the metal loss or capacity of the structure was not completed.

**Town of Southern Pines
ATTN: David McKew
125 SE Broad Street
Southern Pines, NC 28387**

Town Of Southern Pines

CONDITION ASSESSMENT REPORT



Tank Name:

Hwy 1 Tank

Location:

1800 Hwy Us 1

Tank Size and Style:

2,000,000 Concrete

Project Number:

156830

Inspection Date:

January 23, 2024

Inspected By:

Taylor Jennings

Town Of Southern Pines Contact Information:

Administrative:

Gary Stainback

Address:

125 Se Broad Street
Southern Pines, NC 28387

Phone/Email:

336-766-0270

Job:

David Mckew

Utility Service Co., Inc.

Address

535 Courtney Hodges Blvd
PO Box 1350
Perry, GA 31069

Email and Website

Website: www.usgwater.com
Email: customerservice@usgwater.com

Customer Service Information

Sue Roach
866-919-3471

Summary

A visual inspection was performed on the exterior condition. The interior coating was not fully inspected but will be at the next scheduled washout when the interior will be cleaned, inspected and disinfected. Interior roof and structure was partially inspected from hatch. Personnel are not allowed to enter the structure (i.e. "break the plane") when filled with water in order to maintain compliance with the OSHA 1926.1201 Confined Space for Construction Standard. However, based on this limited view no deficiencies were noted with roof structure.

The tank will be scheduled for a Washout Inspection in 2025.

Coating Type & Conditions

- **Interior Coating Condition:** No interior coating present.
- **Exterior Coating Condition:** No deficiencies noted in the exterior coating.



Interior Condition



Interior Condition



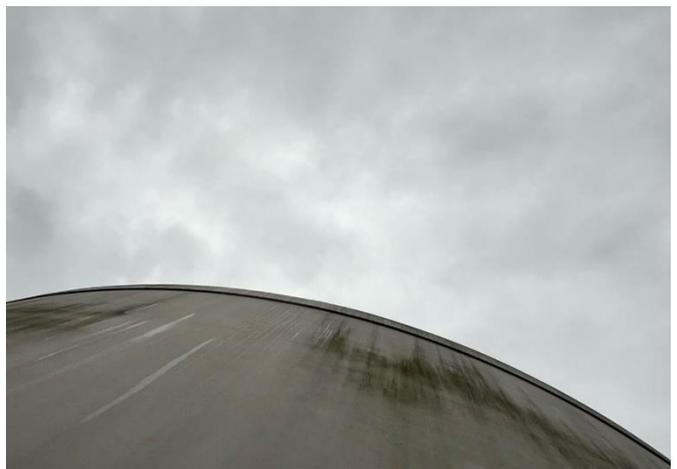
Exterior Roof Coating



Exterior Roof Coating



Exterior Sidewall Coating



Exterior Sidewall Coating



Exterior Sidewall Coating



Exterior Sidewall Coating



Exterior Base Coating



Exterior Base Coating

Safety

- **Access Hatch1:** No deficiencies noted.



Wet Interior Access Hatch

Sanitary

- **Vent Screen:** No deficiencies noted with vent screen.
- **Overflow Pipe Screen Flapper:** Overflow pipe is equipped with screen. No deficiencies noted with screen.
- **Evidence Of Foreign Matter:** No evidence of foreign matter observed.
- **Sediments:** Sediment was present in the bottom of the tank and will be cleaned out at the next scheduled washout.



Vent Screen 1



Vent Screen 2

Security

- **Fence Around Site:** Tank is not located inside a fenced-in area.
- **Ladder Gate/Access Door:** Exterior ladder has a ladder gate installed and is locked.
- **Access Hatch Locked:** Access hatch is locked and secured.
- **Evidence Of Vandalism:** No evidence of vandalism was found.



Ladder Gate Locked



Wet Interior Access Hatch Locked

Structural

- **Foundation:** Foundation appears in good condition. No deficiencies noted
- **Access Ladders:** No deficiencies noted for dry-side access ladder stiles, rungs and connections.
- **Watertight Conditions:** There are no visible leaks at manway, riser or legs.
- **Interior Ladders:** Interior ladder partially inspected from hatch. No deficiencies noted with visible portion of ladder.
- **Roof:** Interior roof structure partially inspected from hatch. No deficiencies noted with roof structure.
- **Vents:** No deficiencies noted with vent.
- **Overflow Pipe:** No deficiencies noted. Overflow pipe extends to ground level.
- **Float System:** Float system is not working and will be scheduled for repair.
- **Level Indicator:** Level indicator is not working and will be scheduled for repair.



Foundation



Sidewall Manway



Interior Ladder Structure



Vent Structure

Concrete Tanks

The determinations and recommendations made within this report with respect to the condition of concrete, cracking, or other surface defects are based upon visual observations made during the inspection. Extensive testing or investigation of the concrete was not completed.

**Town Of Southern Pines
ATTN: David Mckew
125 Se Broad Street
Southern Pines, NC 28387**

APPENDIX III – Water Treatment Plant Condition Assessment Report



Southern Pines

Water Treatment Facility

Pinebluff, North Carolina

Condition Assessment Report

May 15, 2023





May 15, 2023

Southern Pines Water Treatment Facility

RE: Condition Assessment Report

The following document is an accumulative report of the Condition Assessment Evaluation performed at Southern Pines Water Treatment Facility the week of March 14, 2023. The overall results were satisfactory and all discrepancies will be indicated for each individual machine with a recommended repair.

Some assets in the Inspection Scoring section, scoring a 4 or higher are recommended further inspection by staff or a specialist to determine repair or replacement, Maintenance or Capital expense.

Work orders will be created for assets recommended for repair on page six (6), and work order numbers submitted to the asset management team for tracking repairs.

Table of Contents

1. Condition Assessment Process Overview	Page 4
2. Summary/ Recommendations	Page 6
3. Vibration Scoring Report	Page 8
4. Ultrasound Scoring Report	Page 12
5. Inspection & Weighted Average Scoring Report	Page 13

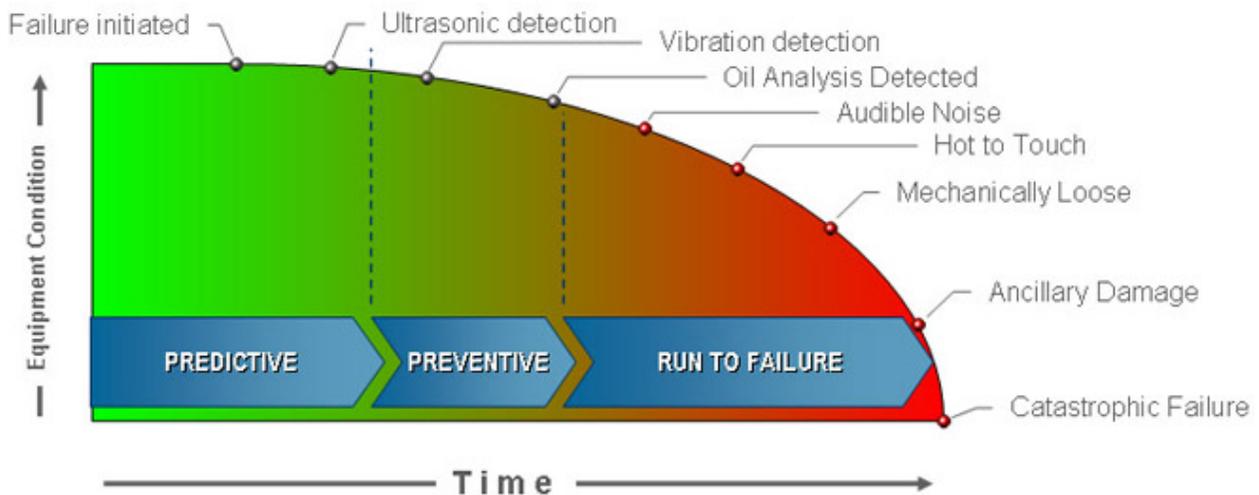
1. Condition Assessment Process Overview

A systematic asset condition assessment review was completed for Southern Pines Water Treatment Facility in Pinebluff, North Carolina. A condition assessment process allows identification, warranty repairs and maintenance/replacement prioritization of facility assets based on condition. The assessment provides a condition rating from advanced detection techniques by comparing detected values to standardized rating criteria adapted through a combination of industry best practices and Veolia operating experience. The end ratings are highly useful in a number of areas associated with the operation of the plant and maintenance planning, these include;

- Prioritize Corrective Work Orders to reduce Operation and/ or Compliance Risks
- Long Range Planning
- Capital and Maintenance Budget Planning, Scoring 4 – 5
- Contract Renewal

A condition assessment was completed for all major plant assets. The condition assessment is intended to be a “snap shot” of the condition of an asset and give it a ranking number based on deficiency scoring where 1 is new and 5 is failed. Higher numerical values represent worse condition. In other words, evidence of defects, wear, or aging is necessary to give a higher value score. The purpose of developing a ranking number is to prioritize where maintenance and capital should be focused to increase reliability of system functions. Each asset was ranked in multiple areas such as performance, appearance, vibration levels, ultrasonic emission, infrared thermography readings, metal thickness testing, reliability, safety, etc. Appendix A defines the criteria and the ratings for each of these key criterions. Using a VWNA developed software tool, the selected assets were analyzed and rated according to these criteria.

If an asset is in a state of wear or aging, oftentimes an end-of-life can be predicted based on the principal of the potential for failure versus actual failure event curve (P-F curve). This phenomenon is commonly described in maintenance and condition assessment literature as the ability to detect issues with equipment in advance of a complete failure occurring by performing advanced condition assessment. With this advanced knowledge of issues being present and predictions of future deterioration and end-of-life, it becomes possible to make strategic refurbishment or replacement decisions. Below graph depicts the theoretical Statistical P-F curve.





Benefits of Proactive Maintenance:

- Predictability: Gives maintenance staff time to schedule required repair and acquire needed spare parts
- Safety: Takes faulty equipment offline before a hazardous condition occurs
- Increased Maintenance Intervals: Life of equipment can be extended and maintenance can be scheduled by need
- Reliability: Fewer unexpected or catastrophic failures, problem areas can be anticipated before failure
- Peace of Mind: Builds confidence in maintenance schedules, budgeting and productivity estimates

Tools used to complete the Assessment:

- Fluke 810 & Examiner 1000 Vibration Testers



- SDT270 Ultrasound Meter - Ultraprobe 100 Ultrasound Meter





2. Summary of Assessment:

Work orders will be created in the CMMS for assets in need of maintenance work identified from the condition assessment process.

Assets listed below have Category Score and Overall Score to identify the alarm(s) that triggered the recommendation(s).

Asset ID	Asset Description	Recommendations	Category - Score	Overall Score
1054-900007	VALVE, LOWER SERVICE PUMP 1 AIR RELIEF ISO,	Schedule repair or replacement	Inspection – 5	5.0
1054-900138	FILTER LEVEL TRANSMITTER	Display blank, schedule an inspection repair or replace as needed	Inspection – 5	5.0
1054-900160	FILTER LEVEL TRANSMITTER	Display blank, schedule an inspection repair or replace as needed	Inspection – 5	5.0
1054-899999	WATER TREATMENT FACILITY	Schedule repair or replace of entry doors around the facility	Inspection – 4	4.0
1054-900228	MIXER MOTOR	Schedule motor bearing inspection, repair or replace as needed	Inspection – 4 Ultrasound – 4	4.0
1054-900393	AIR RELIEF VALVE NO1 RAW WATER PUMP	Schedule inspection, repair or replace as needed	Inspection – 4	4.0

Out of Service or Unable to operate assets during site visit are listed below. Recommended inspection by staff or a specialist to determine repair or replacement, Maintenance or Capital expense

Asset ID	Asset Description	Recommendations	Category - Score	Overall Score
1054-900029	FLASH MIXER #1	Off line	Inspection – 5	5.0
1054-900030	DISCONNECT, FLASH MIXER CTC-4	Off line	Inspection – 5	5.0
1054-900031	MIXER, FLASH MIXER #1	Off line	Inspection – 5	5.0
1054-900032	MOTOR, FLASH MIXER #1	Off line	Inspection – 5	5.0
1054-900044	FLOCCULATOR AIR BLOWER #3	Off line	Inspection – 5	5.0
1054-900130	LASER TRAC PARTICLE COUNTER	Off line	Inspection – 5	5.0
1054-900077	GEAR, MCC PANEL 4 - HS 3 PUMP	Normal wear	Inspection – 4	4.0
1054-900078	GEAR, MCC PANEL 5 - GEAR	Normal wear	Inspection – 4	4.0
1054-900220	PUMP FOR AIR COMPRESSOR	Normal wear	Inspection – 4	4.0
1054-900221	MOTOR FOR AIR COMPRESSOR PUMP	Normal wear	Inspection – 4	4.0
1054-	CHEMICAL FEED ROOM	Environment wear	Inspection – 4	4.0

900224				
1054-900225	HOPPER FEED MOTOR	Environment wear	Inspection – 4	4.0
1054-900226	AUGER FOR HOPPER FEED MOTOR	Environment wear	Inspection – 4	4.0



Vibration Analysis Report

Vibration Analysis Definition: The analysis of vibration monitoring data to monitor the characteristic changes in rotating equipment caused by imbalance, misalignment, bent shaft, mechanical looseness, faults in gear drive and defects in rolling - element bearings.

This report will contain vibration data and diagnostic information for all assets tested, defects, repairs and recommendations are included in comments.

The following two pages will display ISO standards for vibration alarm levels.

ISO Overall Alarm Values

ISO 10816 was released in August 2000, establishes the general conditions and procedures for measurement and evaluation of vibration using measurements made on the non-rotating parts of machines. It also provides general evaluation criteria related to both operation monitoring and acceptance testing established primarily with regard to securing reliable long term operation of the machine.

ISO 10816-3 separates the working conditions into four zones:

- Zone A Green: Vibration values from machines just put into operation
- Zone B Yellow: Continuous operation without any restrictions
- Zone C Orange: Condition is Acceptable only for a limited period of time
- Zone D Red: Dangerous vibration values – damage could occur at any time

It also defines four groups of machines, according to their size, base and purpose.

This part of ISO 10816 gives criteria for assessing vibration levels when measurements are made in situ. The criteria specified apply to machine sets having a power above 15kW (20 HP) and operating at speeds between 120 and 15,000 RPM.

Centrifugal pumps with integrated drive are not covered by this section. (See ISO 10816-7)

The criteria of this part of ISO 10816 apply to in situ broad band vibration measurements taken on the bearings, bearing pedestals or housing of a machine under steady state operating conditions within the nominal speed range. They relate to both acceptance and operational monitoring.

This part encompasses machines that may have gears or rolling element bearings, but does not address the diagnostic evaluation of the condition of said gears or bearings.

This part is only applicable to vibration created by the machine set itself and not for vibration transmitted to the machine from external sources.

ISO 10816-3

Industrial machines with nominal power above 15kw (20 HP) and normal speeds between 120 – 15,000 RPM

								VELOCITY
								inches/sec rms
								10-1000Hz > 600RPM
								2-1000Hz > 120RPM
D								.43
C								.28
B								.18
B								.14
B								.11
B								.09
A								.06
A								.03
RIGID	FLEXIBLE	RIGID	FLEXIBLE	RIGID	FLEXIBLE	RIGID	FLEXIBLE	FOUNDATION
pumps >15kw (20HP) radial, axial, mixed flow				medium sized machines 15kw (20HP) - 300kW (402HP)		large machines >300kW (402HP)		MACHINE TYPE
integrated driver		external driver		GROUP 2		GROUP 1		GROUP
GROUP 4		GROUP 3						

ISO Overall Alarm Values

This part of ISO 10816 gives instructions for evaluation of vibration on centrifugal pumps for industrial application with nominal power above 1kW. It defines the requirements for evaluation of vibration when measurements are taken on non-rotating parts (bearing housing)

For pumps with integrated motors (impeller directly mounted to motor shaft or rigidly connected to motor shaft) this part of ISO 10816 applies to the whole coupled unit.

For flexible coupled motors this part of ISO 10816 is applicable to the pump only. Refer to ISO 10816-3 for separated mounted drives.

ISO 10816-7

Centrifugal Pumps for Industrial Application

ISO 10816-7		Category 1		Category 2				
Pump Type		Centrifugal Pumps with high reliability, availability or security requirements		Centrifugal Pumps for general or less critical applications			< 600 RPM Journal Bearing Machines	
Power		< 200kW (268HP)	>200kW (268HP)	< 200kW (268HP)	>200kW (268HP)			
Velocity inches/sec rms	292	D		.374	D	Displacement mils p-peak	D	
	.255			.334				
	.196	C		.240	C			
	10-1000Hz >600rpm 2-1000Hz <600rpm			.200			5.11	
	.157	B		.165	B		3.14	C
	.137			.125			1.96	B
	.098	A			A	1.96	A	
	in/sec rms					mils p-p		
A	New or Rebuilt Machine Condition							
B	Unlimited Long Term Operation Allowed							
C	Short Term Operation Allowable							
D	Vibration Causing Damage							

Note: Overall alarm values for machines tested at this facility are based on the above ISO vibration charts. These charts are used for reference. Any machine that has an overall vibration value that exceeds the limits listed, shall be diagnosed using spectral analysis.



Vibration Analysis Report

Vibration testing scores:

Score - 1= Measurements below 0.10

Score - 2 = Measurements between 0.11 – 0.25

Score - 3 = Measurements between 0.26 – 0.40

Score - 4 = Measurements between 0.41 – 0.70

Score – 5 = Measurements above 0.70

Asset ID	Asset Description	Vibration Score	Comments
1054-900005	MOTOR, LOW SERVICE PUMP 1	2	
1054-900021	MOTOR, LOW SERVICE PUMP 3	1	
1054-900042	FLOCCULATOR AIR BLOWER #1	2	
1054-900043	FLOCCULATOR AIR BLOWER #2	3	
1054-900050	MOTOR, HIGH SERVICE PUMP 1	1	
1054-900066	MOTOR, HIGH SERVICE PUMP 3	2	
1054-900274	MOTOR, RAW WATER PUMP 1	3	Air release valve issue
1054-900279	MOTOR, RAW WATER PUMP 2	1	
1054-900284	MOTOR, RAW WATER PUMP 3	2	
1054-900295	MOTOR, RAW WATER PUMP 1	1	
1054-900319	MOTOR, BOOSTER PUMP 1	1	
1054-900324	MOTOR, BOOSTER PUMP 2	1	



Ultrasound Analysis Report

STD 270 Ultrasound meter testing scores

Score – 1 = Runs quiet and smooth, meter dBuV level below 24

Score – 2 = Runs fairly quiet, meter levels between 25 - 33

Score – 3 = Bit of discernable noise, considered normal and meter levels between 34 – 48

Score – 4 = Concerning noise, meter levels between 49 – 59

Score – 5 = Sounds bad, meter level is great than 60

Asset ID	Asset Description	Ultrasound Score	Comments
1054-900005	MOTOR, LOW SERVICE PUMP 1	3	
1054-900021	MOTOR, LOW SERVICE PUMP 3	1	
1054-900042	FLOCCULATOR AIR BLOWER #1	3	
1054-900043	FLOCCULATOR AIR BLOWER #2	3	
1054-900050	MOTOR, HIGH SERVICE PUMP 1	1	
1054-900066	MOTOR, HIGH SERVICE PUMP 3	3	
1054-900274	MOTOR, RAW WATER PUMP 1	2	Air release valve issue
1054-900279	MOTOR, RAW WATER PUMP 2	1	
1054-900284	MOTOR, RAW WATER PUMP 3	1	
1054-900295	MOTOR, RAW WATER PUMP 1	1	
1054-900319	MOTOR, BOOSTER PUMP 1	3	
1054-900324	MOTOR, BOOSTER PUMP 2	3	
1054-900228	MIXER MOTOR	4	
1054-900255	MOTOR, MIXER MOTOR FOR LIME TANK	3	
1054-900256	MIXER GEARBOX	3	



Inspection Report

Staff actively participated in the Inspection scoring portion of the condition assessment process. Inspection process included observing the asset, conduit, process tie-points, corrosion issues, base and grout condition, coating, piping, etc. Evaluate oil level and lubrication condition where possible.

Inspection scores:

Score – 1, New or in excellent shape

Score – 2, Approximately 20% Life used, some wear, meeting designed functionality

Score – 3, Approximately 40% Life used, some wear, still meeting designed functionality

Score – 4, Approximately 60% Life used, worn, operating but no longer fully meeting designed functionality

Score – 5, Very worn, not meeting design functionality or equipment in failed condition

Asset ID	Asset Description	Inspection Score	Average Score	Comments
1054-900005	MOTOR, LOW SERVICE PUMP 1	2	2.0	
1054-900021	MOTOR, LOW SERVICE PUMP 3	2	1.3	
1054-900042	FLOCCULATOR AIR BLOWER #1	2	2.0	
1054-900043	FLOCCULATOR AIR BLOWER #2	3	2.5	
1054-900050	MOTOR, HIGH SERVICE PUMP 1	2	1.3	
1054-900066	MOTOR, HIGH SERVICE PUMP 3	2	2.0	
1054-900274	MOTOR, RAW WATER PUMP 1	3	2.7	Air release valve issue
1054-900279	MOTOR, RAW WATER PUMP 2	3	1.7	
1054-900284	MOTOR, RAW WATER PUMP 3	3	2.0	
1054-900295	MOTOR, RAW WATER PUMP 1	2	1.3	
1054-900319	MOTOR, BOOSTER PUMP 1	2	2.0	
1054-900324	MOTOR, BOOSTER PUMP 2	2	1.8	
1054-900228	MIXER MOTOR	4	4.0	
1054-900255	MOTOR, MIXER MOTOR FOR LIME TANK	3	3.0	
1054-900256	MIXER GEARBOX	3	3.0	
1054-899999	WATER TREATMENT FACILITY	4	4.0	Several doors around facility need repaired or replaced
1054-900000	BUILDING, LOW SERVICE PUMP STATION	3	3.0	
1054-900002	DISTRIBUTION PANEL, LOW SERVICE PS	3	3.0	
1054-900003	LOW SERVICE PUMP 1	2	2.0	
1054-900004	PUMP, LOW SERVICE PUMP 1	2	1.5	
1054-900006	VALVE, LOW SERVICE PUMP 1 CHECK	2	2.0	
1054-900007	VALVE, LOWER SERVICE PUMP 1 AIR RELIEF ISO,	5	5.0	
1054-900011	LOW SERVICE PUMP 2	2	2.0	
1054-900012	PUMP, LOW SERVICE PUMP 2	2	2.0	
1054-900013	MOTOR, LOW SERVICE PUMP 2	2	2.0	
1054-900014	VALVE, LOW SERVICE PUMP 2 CHECK	2	2.0	
1054-900015	VALVE, LOWER SERVICE PUMP 2 AIR RELIEF ISO,	2	2.0	

1054-900019	LOW SERVICE PUMP 3	2	2.5	
1054-900020	PUMP, LOW SERVICE PUMP 3	2	2.0	
1054-900022	VALVE, LOW SERVICE PUMP 3 CHECK	2	2.0	
1054-900023	VALVE, LOWER SERVICE PUMP 3 AIR RELIEF ISO,	2	2.0	
1054-900027	LOW SERVICE AIR COMPRESSOR	3	3.0	
1054-900028	MOTOR, LS AIR COMPRESSOR	3	3.0	
1054-900029	FLASH MIXER #1	5	5.0	Off line
1054-900030	DISCONNECT, FLASH MIXER CTC-4	5	5.0	Off line
1054-900031	MIXER, FLASH MIXER #1	5	5.0	Off line
1054-900032	MOTOR, FLASH MIXER #1	5	5.0	Off line
1054-900038	SUPER PULSATOR BASINS	2	2.0	
1054-900041	SUPER PULSATOR BASIN #1	2	2.0	
1054-900044	FLOCCULATOR AIR BLOWER #3	5	5.0	Off line
1054-900047	BUILDING, HIGH SERVICE PUMP STATION	3	3.0	
1054-900048	HIGH SERVICE PUMP 1	2	2.0	
1054-900049	PUMP, HIGH SERVICE PUMP 1	2	2.5	
1054-900051	VALVE, HIGH SERVICE PUMP 1 AIR RELIEF ISO,	2	2.0	
1054-900056	HIGH SERVICE PUMP 2	2	2.0	
1054-900057	PUMP, HIGH SERVICE PUMP 2	3	3.0	
1054-900058	MOTOR, HIGH SERVICE PUMP 2	2	2.0	
1054-900059	VALVE, HIGH SERVICE PUMP 2 AIR RELIEF ISO,	2	2.0	
1054-900064	HIGH SERVICE PUMP 3	2	2.0	
1054-900065	PUMP, HIGH SERVICE PUMP 3	3	3.0	
1054-900067	VALVE, HIGH SERVICE PUMP 3 AIR RELIEF ISO,	3	3.5	
1054-900072	H/S DISCHARGE PRESSURE TRANSMITTER	2	2.0	
1054-900073	HIGH SERVICE GENERATOR ROOM	3	3.0	
1054-900074	GEAR, MCC PANEL 1 TRANSFER SWITCH	3	3.0	
1054-900075	GEAR, MCC PANEL 2 GEAR	3	3.0	
1054-900076	GEAR, MCC PANEL 3	3	3.0	
1054-900077	GEAR, MCC PANEL 4 - HS 3 PUMP	4	4.0	
1054-900078	GEAR, MCC PANEL 5 - GEAR	4	4.0	
1054-900081	GEAR, MCC1 PANEL	3	3.0	
1054-900082	GEAR, HS1 MAIN DISCONNECT	3	3.0	
1054-900083	GEAR, MTS-2	3	3.0	
1054-900084	GEAR, MTS-3 TRANSFER SWITCH	3	3.0	
1054-900085	GEAR, 2 MAIN DISCONNECT BREAKERS	3	3.0	
1054-900086	HIGH SERVICE GENERATOR 1	3	3.0	Schedule oil change, filter dated 2-22-21
1054-900087	HIGH SERVICE GENERATOR 2	3	3.0	Schedule oil change, filter dated 2-22-21
1054-900088	HIGH SERVICE BACKWASH PUMP	1	1.0	Off line
1054-900089	PUMP, BACKWASH PUMP	1	1.0	Off line
1054-900090	MOTOR, BACKWASH PUMP	1	1.0	Off line
1054-900091	VALVE, BACKWASH PUMP AIR RELIEF ISO,	1	1.0	Off line
1054-900096	EXHAUST FAN 1	3	3.0	
1054-900097	EXHAUST FAN 2	3	3.0	
1054-900101	FILTER BUILDING FILTERS 1 THRU 4	3	3.0	Schedule door repair or replacement
1054-900106	FILTER LEVEL TRANSMITTER	2	2.0	
1054-900107	TURBIDITY ANALYZER	2	2.0	
1054-900112	TURBIDITY ANALYZER	2	2.0	
1054-900113	FILTER LEVEL TRANSMITTER	2	2.0	
1054-900118	TURBIDITY ANALYZER	2	2.0	
1054-900119	FILTER LEVEL TRANSMITTER	2	2.0	
1054-900124	TURBIDITY ANALYZER	2	2.0	
1054-900125	FILTER LEVEL TRANSMITTER	2	2.0	
1054-900126	SCADA CONTROL PANEL	3	3.0	
1054-900129	SETTLED WATER TURBIDITY	3	3.0	
1054-900130	LASER TRAC PARTICLE COUNTER	5	5.0	Off line
1054-900132	HYDRO RANGER LEVEL DETECTOR	2	2.0	

1054-900133	FILTER BUILDING 5 THRU 8	3	3.0	Schedule door repair or replacement
1054-900138	FILTER LEVEL TRANSMITTER	5	5.0	Display blank, schedule inspection repair or replace as needed
1054-900140	FILTER FLOW METER	2	2.0	
1054-900146	FILTER LEVEL TRANSMITTER	2	2.0	
1054-900147	FILTER FLOW METER	2	2.0	
1054-900153	FILTER LEVEL TRANSMITTER	2	2.0	
1054-900154	FILTER FLOW METER	2	2.0	
1054-900160	FILTER LEVEL TRANSMITTER	5	5.0	Display blank, schedule inspection repair or replace as needed
1054-900161	FILTER FLOW METER	2	2.0	
1054-900162	SCADA CONTROL PANEL	3	3.0	
1054-900163	HVAC HEATER EAST	3	3.0	Unit has been repaired since visit
1054-900164	HVAC HEATER WEST	3	3.0	
1054-900167	AIR BLOWER 1	3	3.0	
1054-900168	AIR BLOWER 1 MOTOR	2	2.0	
1054-900168	AIR BLOWER 1 FILTER	2	2.0	
1054-900170	AIR BLOWER 2	3	3.0	
1054-900171	AIR BLOWER 2 MOTOR	2	2.0	
1054-900172	AIR BLOWER 2 FILTER	2	2.0	
1054-900173	HVAC HEATER	3	3.0	
1054-900174	DUAL AIR COMPRESSOR 1	3	3.0	
1054-900175	DUAL AIR COMPRESSOR 2	3	3.0	
1054-900176	AIR COMPRESSOR DRYER	3	3.0	
1054-900177	VACUUM PUMP 1	3	3.0	Schedule repair or replace, fan cover corrosion
1054-900178	VACUUM PUMP 2	3	3.0	Schedule repair or replace, fan cover corrosion
1054-900182	FLASH MIX PH	3	3.0	
1054-900185	EXHAUST FAN 5	3	3.0	Off line
1054-900186	EXHAUST FAN 6	2	2.0	Off line
1054-900187	HEATER	2	2.0	
1054-900191	FILTER SAMPLE PUMP 1	2	2.0	
1054-900192	FILTER SAMPLE PUMP 2	2	2.0	
1054-900192-1	Clearwell sample pump	2	2.0	
1054-900193	BLOWER MOTOR 1	2	2.0	
1054-900194	BLOWER MOTOR 2	2	2.0	
1054-900201	SLUDGE DRYING BEDS	2	2.0	
1054-900202	SLUDGE BED 1	2	2.0	
1054-900203	SLUDGE BED 2	2	2.0	
1054-900204	SLUDGE BED 3	2	2.0	
1054-900205	SLUDGE BED 4	2	2.0	
1054-900206	SLUDGE BED 5	2	2.0	
1054-900207	SLUDGE BED 6	2	2.0	
1054-900208	2 MG GROUND STORAGE TANK	2	2.0	
1054-900209	LEVEL DETECTOR	2	2.0	
1054-900211	BASIN 1	2	2.0	
1054-900212	BASIN 2	2	2.0	
1054-900213	DISCHARGE PUMP 1	2	2.0	
1054-900214	DISCHARGE PUMP 2	2	2.0	
1054-900215	SLUDGE PUMP 1	2	2.0	
1054-900216	SLUDGE PUMP 2	2	2.0	
1054-900217	TRANSFER PUMP 1	3	3.0	
1054-900218	TRANSFER PUMP 2	3	3.0	
1054-900219	MOTOR CONTROL CENTER MCC-2	3	3.0	
1054-900220	PUMP FOR AIR COMPRESSOR	4	4.0	
1054-900221	MOTOR FOR AIR COMPRESSOR PUMP	4	4.0	
1054-900222	RADIATOR AFTER-COOLER FOR COMPRESSOR	3	3.0	
1054-900223	MOTOR FOR AFTER COOLER FAN	3	3.0	

1054-900224	CHEMICAL FEED ROOM	4	4.0	
1054-900225	HOPPER FEED MOTOR	4	4.0	
1054-900226	AUGER FOR HOPPER FEED MOTOR	4	4.0	
1054-900227	ELECTRIC ACTUATOR	3	3.0	
1054-900229	POLYMER FEED PUMP 1	3	3.0	
1054-900230	MOTOR FOR POLY FEED PUMP 1	3	3.0	
1054-900231	POLYMER FEED PUMP 2	3	3.0	
1054-900232	MOTOR FOR POLY FEED PUMP 2	3	3.0	
1054-900233	POLYMER FEED PUMP 3	3	3.0	
1054-900234	MOTOR FOR POLY FEED PUMP 3	3	3.0	
1054-900235	CHEMICAL HOLDING TANK, SODIUM BICARBONATE	2	2.0	
1054-900236	MIXER MOTOR FOR BICARBONATE HOLDING TANK	2	2.0	
1054-900237	CHEMICAL FEED PUMP 1A	3	3.0	
1054-900238	CHEMICAL FEED PUMP 1B	3	3.0	
1054-900239	MOTOR, FOR CHEMICAL FEED PUMPS 1A & 1B	3	3.0	
1054-900240	CHEMICAL FEED PUMP 2B & 2B(?)	3	3.0	
1054-900241	ALUM STORAGE TANK #1	2	2.0	
1054-900242	ALUM STORAGE TANK #2	2	2.0	
1054-900243	ALUM FEED PUMP #1	2	2.0	
1054-900244	ALUM FEED PUMP #2	3	3.0	
1054-900245	ALUM FEED PUMP #3	2	2.0	
1054-900246	ALUM FEED PUMP #4	2	2.0	
1054-900247	CAUSTIC STORAGE TANK	2	2.0	
1054-900254	LIME TANK	3	3.0	
1054-900257	LIME PUMP #1	3	3.0	
1054-900258	MOTOR, FOR LIME PUMP 1	2	2.0	
1054-900259	LIME PUMP #2	3	3.0	
1054-900260	MOTOR, FOR LIME PUMP 2	2	2.0	
1054-900261	LIME PUMP #3	3	3.0	
1054-900262	MOTOR, FOR LIME PUMP 3	2	2.0	
1054-900264	ANHYDROUS AMMONIA TANK	2	2.0	
1054-900265	CL17 CHLORINE ANALYZER	2	2.0	
1054-900270	SLUDGE CLARIFIER	2	2.0	
1054-900271	SLUDGE HOLDING BASIN	3	3.0	
1054-900272	RAW WATER PUMPING STATION	3	3.0	
1054-900273	PUMP, RAW WATER PUMP 1	3	3.0	
1054-900275	VALVE, RAW WATER PUMP 1 CHECK	3	3.0	
1054-900276	VALVE, RAW WATER PUMP 1 ISOLATION VALVE	3	3.0	
1054-900277	R/W PUMP 1 DISCHARGE PRESSURE TRANSMITTER	3	3.0	
1054-900278	PUMP, RAW WATER PUMP 2	3	3.0	
1054-900280	VALVE, RAW WATER PUMP 2 CHECK	3	3.0	
1054-900281	VALVE, RAW WATER PUMP 2 ISOLATION VALVE	3	3.0	
1054-900282	R/W PUMP 2 DISCHARGE PRESSURE TRANSMITTER	3	3.0	
1054-900283	PUMP, RAW WATER PUMP 3	3	3.0	
1054-900285	VALVE, RAW WATER PUMP 3 CHECK	3	3.0	
1054-900286	VALVE, RAW WATER PUMP 3 ISOLATION VALVE	3	3.0	
1054-900287	R/W PUMP 3 DISCHARGE PRESSURE TRANSMITTER	3	3.0	
1054-900288	RAW WATER LEVEL TRANSMITTER	2	2.0	
1054-900289	RAW WATER PUMPING STATION	3	3.0	
1054-900290	AIR-COMPRESSOR	2	2.0	
1054-900291	PUMP, AIR COMPRESSOR	2	2.0	
1054-900292	MOTOR, AIR-COMPRESSOR	2	2.0	

1054-900294	PUMP, RAW WATER PUMP 1	2	2.0	
1054-900296	VALVE, RAW WATER PUMP 1 ISOLATION VALVE	3	3.0	
1054-900297	ISOLATION VALVE ACTUATOR, RAW PUMP 1	2	2.0	
1054-900298	R/W PUMP 1 PRESSURE TRANSMITTER	3	3.0	
1054-900299	RAW WATER PUMP 2	1	1.0	Replace with rebuilt pump after site visit
1054-900300	MOTOR, RAW WATER PUMP 2	1	1.0	Replace with rebuilt pump after site visit
1054-900301	ISOLATION VALVE ACTUATOR, RAW PUMP 2	2	2.0	
1054-900308	PRESSURE REGULATOR PRV 1	3	3.0	
1054-900309	PRESSURE REGULATOR PRV 2	3	3.0	
1054-900313	OVERHEAD HOIST SYSTEM	3	3.0	
1054-900314	DISTRIBUTION BOOSTER PUMP STATION	3	3.0	
1054-900315	CLEAR WELL STORAGE TANK	2	2.0	
1054-900316	LEVEL TRANSMITTER	2	2.0	
1054-900317	MCC ELECTRICAL PANEL, DISTRIBUTION P/S	3	3.0	
1054-900318	PUMP, BOOSTER PUMP 1	3	3.0	
1054-900320	AIR RELIEF VALVE	3	3.0	
1054-900321	CHECK VALVE, BOOSTER PUMP 1	3	3.0	
1054-900322	MAGNETIC FLOW METER	3	3.0	
1054-900323	PUMP, BOOSTER PUMP 2	3	3.0	
1054-900378	FILTER 1	2	2.0	
1054-900379	FILTER 2	2	2.0	
1054-900380	FILTER 3	2	2.0	
1054-900381	FILTER 4	2	2.0	
1054-900382	FILTER 5	2	2.0	
1054-900383	FILTER 6	2	2.0	
1054-900384	FILTER 7	2	2.0	
1054-900385	FILTER 8	2	2.0	
1054-900387	LEVEL SENSOR	2	2.0	
1054-900393	AIR RELIEF VALVE NO1 RAW WATER PUMP	4	4.0	Schedule inspection repair or replace as needed
1054-900394	AIR RELIEF VALVE NO2 RAW WATER PUMP	3	3.0	
1054-900395	AIR RELIEF VALVE NO3 RAW WATER PUMP	3	3.0	
1054-900411	CHLORINE ROOM	3	3.0	

APPENDIX IV – Hydraulic Modeling Report

TO:	James Michel, P.E.
FROM:	Brian White, P.E.
SUBJECT:	Water Model AIA Update and Calibration
PROJECT:	Southern Pines AIA Hydraulic Model Update
DATE:	July 14, 2025
CC:	Ashley Castillo, P.E. Nina Caraway, P.E. Maggie Clutter, EI

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FREESE AND NICHOLS, INC.
NORTH CAROLINA REGISTERED
ENGINEERING FIRM C-3916

1.00 INTRODUCTION AND BACKGROUND

The Town of Southern Pines, North Carolina received an Asset Inventory and Assessment (AIA) grant for the Spring 2022 Funding Cycle. Freeze and Nichols, Inc. (FNI) was retained in 2023 by the Town of Southern Pines, North Carolina to update the

Table of Contents	
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3.00	Water Production 8
4.00	Pressure Testing..... 8
5.00	Hydraulic Model Update And Calibration..... 10
6.00	Next steps 14

Town’s water distribution system hydraulic model. The hydraulic model update supports the completion of an Asset Management Plan (AMP) that is being overseen by Withers Ravenel (Withers). The goals of this study were to update the Town's existing water distribution system model that was developed during the *2020 Water Master Plan* and calibrate the model to observed field conditions. The major elements of the scope of this project included:

- Historical water production data
- Customer demand data collection and review
- Field pressure testing
- SCADA data collection and review for pressure testing period
- Update of the distribution system hydraulic model to reflect GIS database updates provided by Withers

- Extended Period Simulation (EPS) hydraulic model calibration
- Gap analysis of available data
- Documentation of model update and calibration in the form of Hydraulic Characterization Report

Abbreviations found in this report are defined in **Table 1-1**.

Table 1-1: Abbreviations

Abbreviation	Full Nomenclature
AIA	Asset Inventory and Assessment
ADD	Average Day Demand
AMI	Advanced Metering Infrastructure
AMP	Asset Management Plan
BPS	Booster Pump Station
CIP	Capital Improvement Plan
EPS	Extended Period Simulation
EST	Elevated Storage Tank
FNI	Freese and Nichols, Inc.
GIS	Geographic Information System
GST	Ground Storage Tank
MG	Millions of Gallons
MGD	Millions of Gallons per Day
MSL	Mean Sea Level
NCDEQ	North Carolina Department of Environmental Quality
PBI	PowerBI
PR	Pressure Recorder
psi	Pounds per square inch
SCADA	Supervisory Control and Data Acquisition
Withers	Withers Ravenel
WTP	Water Treatment Plant

2.00 EXISTING WATER DISTRIBUTION SYSTEM

The Town of Southern Pines' water distribution system consists of one water treatment plant (WTP) with two raw water reservoirs and one ground storage tank, approximately 257 miles of water lines, three pump stations, two elevated storage tanks (EST), and one standpipe.

shows the Town's existing water distribution system which is discussed further in the following sections.

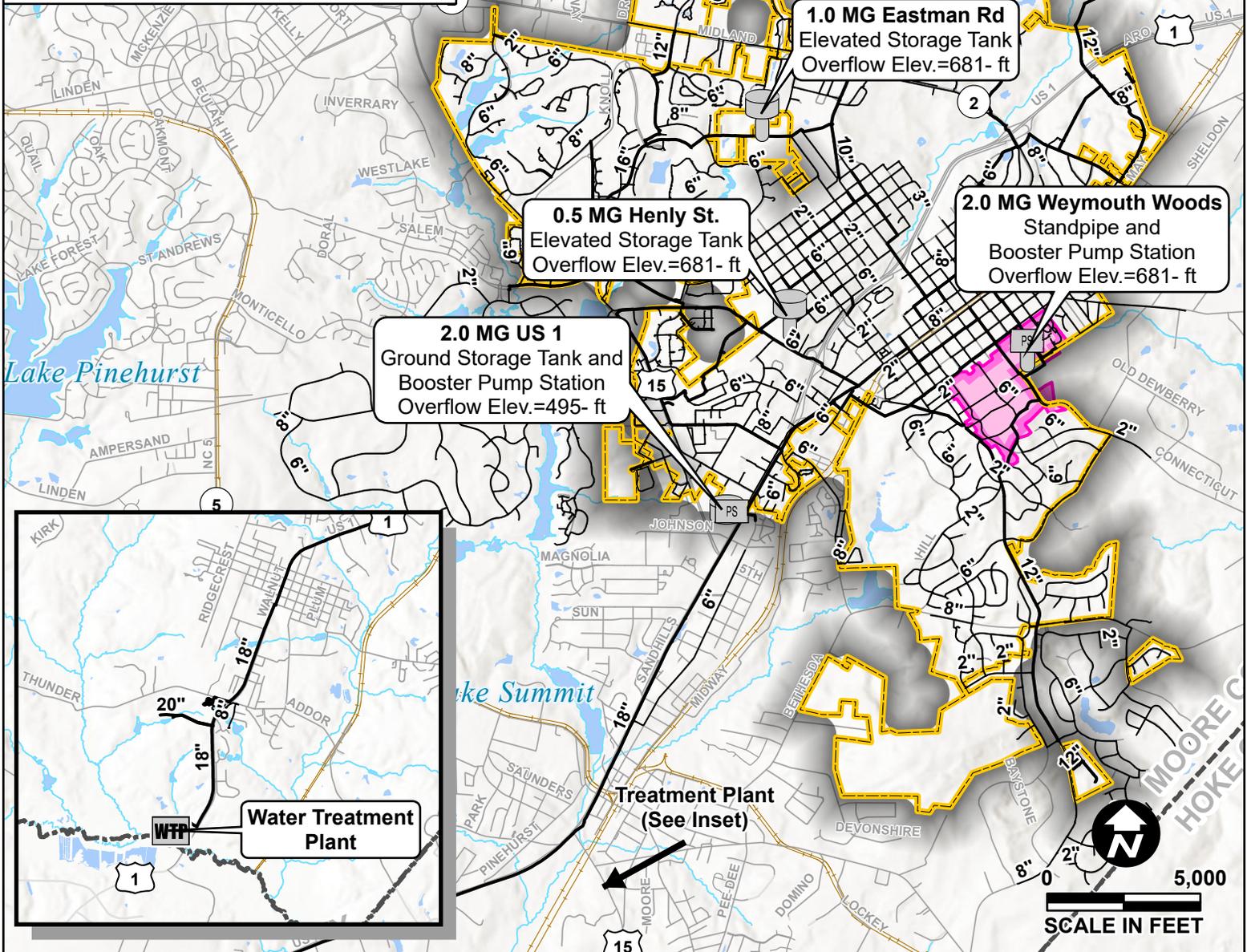
FIGURE 2-1 TOWN OF SOUTHERN PINES EXISTING WATER SYSTEM

LEGEND

-  Pump Station
-  Water Treatment Plant
-  Standpipe
-  Ground Storage Tank
-  Elevated Storage Tank
-  8" and Smaller Water Line
-  10" and Larger Water Line
-  Road
-  Railroad
-  Stream
-  Pond/Lake
-  Weymouth Woods Pressure Zone
-  City Limit
-  County Boundary



SOUTHERN PINES
 North Carolina



2.01 PRESSURE PLANES

The Town's water distribution system currently has two pressure planes- the Main Zone and the Weymouth Zone. The Main Zone has ground elevations ranging between 295 feet and 600 feet above mean sea level (MSL). The Weymouth Zone has ground elevations ranging between 545 feet and 611 feet. The main pressure plane operates at a static hydraulic gradient of 681 feet MSL established by the Henley and Eastman Elevated Tanks. The Weymouth pressure plan operates at a static hydraulic grade line of 780 feet MSL established by the Weymouth Woods Booster Pump Station.

2.02 PUMPING AND STORAGE FACILITIES

The Town of Southern Pines has three pump stations: Southern Pines Water Treatment Plant, US HWY 1 Booster Pump Station (BPS), and Weymouth Woods Booster Pump Station. Water is conveyed into the system from the Water Treatment Plant to the US HWY 1 GST and BPS where it is pumped into the main distribution system. The Town has a firm system pumping capacity of 15.80 MGD. Firm capacity is defined as the capacity with the largest pump out of service at each respective facility. **Table 2-1** provides a summary of pumping facilities.

Table 2-1: Summary of Pumping Facilities

Facility Name	Firm Capacity (MGD)
Water Treatment Plant	8.00
US HWY 1 Booster Station	6.50
Weymouth Woods Booster Station	1.30
Total (MGD)	15.80

In addition to booster pumping, the Town also utilizes storage tanks to maintain system pressures. **Table 2-2** provides a summary of storage capacities. It should be noted that the Water Treatment Plant has two raw water reservoirs that are 20 MG and 140 MG respectively.

Table 2-2: Summary of Storage Facilities

Storage Type	Facility Name	Storage Volume (MG)	Tank Dimensions			
			Bottom of Bowl Elevation (feet)	Overflow Elevation (feet)	Head Range (feet)	Diameter (feet)
Ground	US HWY 1 GST	2.0	445.0	475.9	30.9	105.0
Elevated	Eastman Rd. EST	1.0	641.0	681.0	40.0	65.0
Elevated	Henley St. EST	0.50	651.0	681.0	30.0	50.0
Standpipe	Weymouth Woods	2.0	601.5	681.0	80.5	65.5
Total Storage Volume		5.50				

2.03 INTERCONNECTIONS

Southern Pines provides water for multiple other utilities through interconnections. A summary of the wholesale agreements Southern Pines has with each interconnection is outlined in **Table 2-3**.

Table 2-3: Summary of Interconnections

Customer	Location(s)	Contracted Amount (MGD)
Carolina Water	Niagara-Carthage	0.25 – 0.60
	Hardee Ln	
	Rays Bridge Rd	
Moore County	Midland Rd	0.30 – 1.00
	Addor Rd	
Department of Defense	Camp Mackall	0.50
Town of Carthage	Carthage Emergency Connection	Emergency
Town of Aberdeen	Aberdeen Emergency Connection	0.00 - 0.03
	Shaw's Landing	
Town of Pinebluff	Town of Pinebluff	0.00 - 0.01

Figure 2-2 shows a map of the above interconnections. These interconnections were considered for model calibration and analyzed where appropriate. Southern Pines additionally provided Bulk User Advanced Metering Infrastructure (AMI) data for some wholesale customers. This AMI data was used to create unique model diurnal patterns. This is further discussed in **Section 5.02**.

2.04 WATER LINES

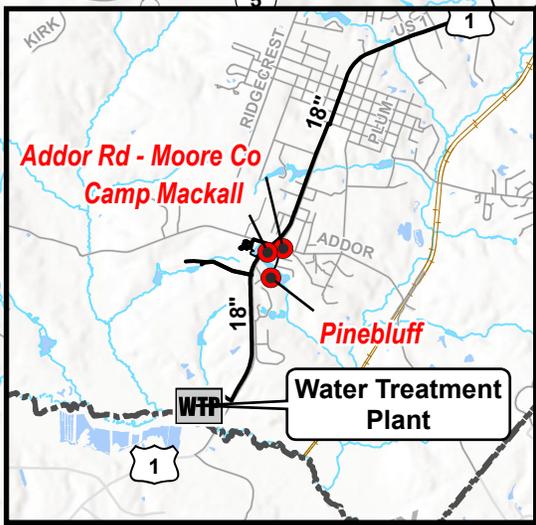
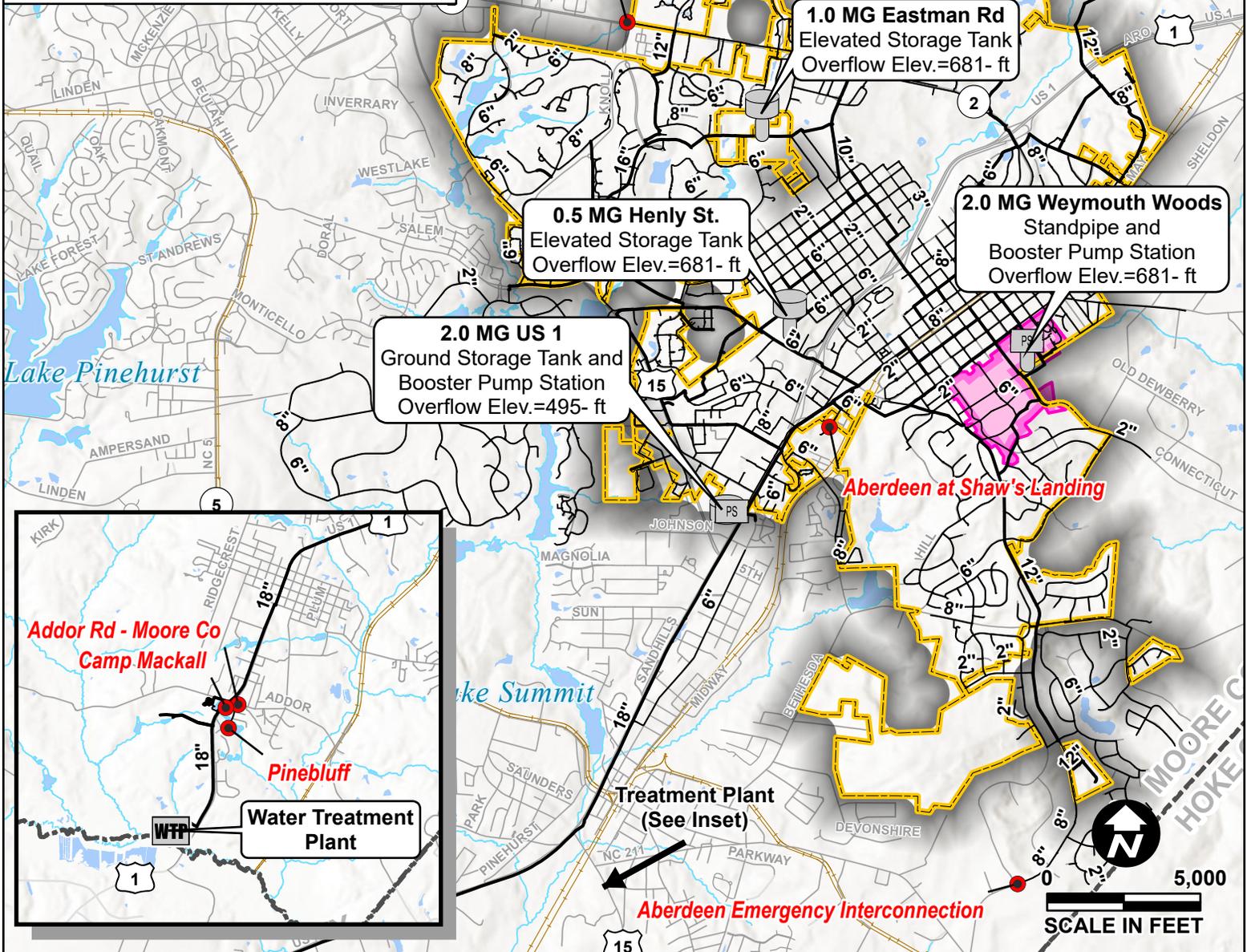
FNI received updated water system Geographic Information System (GIS) from Withers as part of the AIA project. Water line diameters range from 1" – 24" in Southern Pine's system. The Town of Southern Pine's water system consists of approximately 257 miles of water distribution lines in total.

FIGURE 2-2 TOWN OF SOUTHERN PINES EXISTING WATER SYSTEM LEGEND

- Interconnections
- PS Pump Station
- WTP Water Treatment Plant
- Standpipe
- Ground Storage Tank
- Elevated Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Railroad
- Stream
- Pond/Lake
- Weymouth Woods Pressure Zone
- City Limit
- County Boundary



SOUTHERN PINES
 North Carolina



3.00 WATER PRODUCTION

3.01 HISTORICAL WATER DEMAND DATA

The Town of Southern Pines provided water meter billing information from January 2021 – May 2024. FNI conducted a monthly and customer class–based analysis (e.g., commercial, residential, governmental) of this dataset. Consumption and production data from April 2024 were used to calculate the system’s average daily demand (ADD) on a per-meter basis. In April 2024, the ADD was 3.87 million gallons per day (MGD). The water system includes approximately 12,300 active meters serving an estimated 16,700 customers. **Table 3-1** presents the distribution of total water usage by customer class.

Table 3-1: Distribution of Customer Classes

Customer Class	Distribution of Customers
Residential	73.4%
Commercial	22.5%
Institutional	0.2%

4.00 PRESSURE TESTING

Pressure testing was conducted between April 15th and 25th, 2024 in Southern Pine’s distribution system. Eleven pressure recorders were placed throughout the distribution system to capture system pressures and operational conditions during spring demand conditions. Minimum, maximum, and average pressures were recorded every five (5) minutes at each location. Detailed mapping for each pressure recorder location is found in **Appendix A**. Pressure recorder location details with a summary of observed pressure ranges during the pressure recording period are provided in **Table 4-1**.

Table 4-1: Pressure Recorder Locations and Observed Pressure Ranges

Pressure Recorder ID	Hydrant ID	Location	Observed Pressure Range (psi)
PR-1A	02-D021	Fire station at Highway 22/ Waynor Rd	97-112
PR-2A	03-C005	Myers Farm Dr/ Forest Creek Dr	89-105
PR-3B	04-G007	Niagara Carthage Rd. near Cardinal Drive	145-161
PR-4A	4F-23	Pine Barrens Ct	104-110
PR-5A	05-C030	Triple Crown Circle	71-86
PR-6B	07-D013	Eastman Road adjacent to Eastman Rd EST	80-84
PR-7A	07-E007	Skye Dr near Sandavis Rd	108-111
PR-8C	08-C022	Brucewood Road	91-95
PR-9B	09-F001	Corner of North Weymouth Rd and Connecticut Ave	78-79
PR-10A	09-F028	Corner of E Indiana Ave and Maples Rd	49-52
PR-11A	06-17	Corner of Bel Air Dr and Brookline Dr	104-111

5.00 HYDRAULIC MODEL UPDATE AND CALIBRATION

The Town of Southern Pines developed a hydraulic water model of the distribution system during the *2020 Water Master Plan*. This model is in the WaterGems software by Bentley. FNI started with this WaterGems model and updated it with the Town's latest GIS provided by Withers. The model was then calibrated to 2024 field pressure testing data and operational information provided by the Town. The resulting water model is a tool that can be utilized for future system analyses.

5.01 MODEL UPDATE

A. Physical Network

1. Modeled Lines and Junctions

As part of this project, FNI updated the Town's existing water distribution system model using the GIS data provided by Withers, as detailed in **Section 2.04**. The updated model includes a total of 11,561 pipes and 11,193 junctions. Internal piping within pump stations and certain private lines were excluded from the model, as they do not impact the overall hydraulic performance. Elevation data was derived from two-foot ground contour information, with junction elevations assumed to be three feet below ground surface in accordance with NCDEQ standards.

2. Modeled Facilities

The model includes nine (9) distribution pumps, one (1) ground storage tank, two (2) elevated storage tanks, one (1) standpipe, and one (1) reservoir. Since the development of the 2020 hydraulic water model, the Town has not constructed any new pumping or storage facilities, and the capacities of the existing facilities have not changed.

The Town has completed waterline replacements at East Morganton Road and Pennsylvania Ave/Pee Dee Rd in accordance with the previous water plan's Capital Improvement Plan (CIP).

3. Demand Allocation

The average daily demand information for each active water account in the system (discussed in **Section 3.01**) was spatially located using water meter GIS provided by the Town of Southern Pines. Consumption data was imported into the model on a water meter level basis using the 'Customer Meter' feature in WaterGems. Customer meters allow for individual customer demands to be maintained and accurately spatially distributed through the system. Each customer meter and its associated demands are then assigned to the nearest model junction.

5.02 MODEL CALIBRATION

A 24-hour extended period simulation (EPS) model calibration was performed to verify that the hydraulic model accurately represents actual distribution system operations. The calibration process involved adjusting system operational parameters, demand allocation, and diurnal patterns to match known or observed system conditions. The following sections provide a description of the model calibration and EPS calibration results.

A. Calibration Day System Operations

April 24, 2024 was selected as the calibration day as there was no rainfall on this day and system operations were typical with no major changes in pressure due to line breaks or other incidents visible in the pressure recorder data. The geocoded meter billing demand in the model was scaled to match the Water Treatment Plant Discharge flow data for the calibration day, 3.87 MGD. This scaling reflects the system non-revenue water. It should be noted that water level data was not available for the Eastman Rd EST. Pressure recorder 6B was placed on an adjacent water line to the Eastman Rd EST to account for this missing data.

B. US HWY 1 Booster Station

Discharge flow data for the US HWY 1 Booster Station was not available. FNI discussed booster pump station operations with the Town of Southern Pines staff. Based on discussion, time controls were implemented for the booster station pumps. Controls were also based on water level SCADA for the system tanks and pressure recording data. The BPS was set to maintain a target discharge pressure of 122 psi based on available discharge pressure data at the US HWY 1 Booster Station. The time controls are summarized below in **Table 5-1**:

Table 5-1: US HWY 1 Booster Pump Calibrated Controls

Facility	Calibration Day Clock Time	Operation
US HWY 1 BPS	0	On
	1:30	Off
	2:15	On
	3:30	Off
	4:30	On

C. Diurnal Pattern

The M32 Standard Diurnal pattern was used as the starting point for all system diurnals. Discharge flow data for the US HWY 1 Booster Station was not available. Therefore, a unique system diurnal pattern

could not be created for the distribution system. The M32 Diurnal was adjusted based on SCADA data, System EST water levels, and pressure recording data. Two customer diurnal patterns were created based on these criteria. Additional diurnal patterns were created for bulk users using hourly AMI data where available. All diurnal patterns can be found in **Appendix B**.

D. EPS Calibration Results

The calibration scenario representing the day of April 25, 2024 was run for a 24-hour period with outputs in 15-minute increments. The modeled pressures at each time step were compared to the field recorded pressures at each location. The modeled water levels for the Henley and Weymouth Tanks were compared to the SCADA data provided. Calibration results were visualized in Power Bi (PBI). An example calibration graph for PR-7A is seen below in **Figure 5-1**. The additional calibration graphs for all PRs, Eastman EST, Henley EST, and Weymouth Woods Standpipe are located in **Appendix C**.

This same calibration information is computed within given tolerances and shown in **Table 5-2**. The percentages shown represent the number of occurrences where the modeled pressures and observed data were within given tolerances of 10 psi, 5 psi, and 3 psi. The calibration graphs demonstrate a good correlation between recorded data and the calibrated model. A well-calibrated model adds confidence in the validity of the model as a tool for system hydraulic analyses.

Pressure Recorder 3B was located near the Niagara-Carthage interconnection. Pressure data collected on the calibration day indicated pumped flow at the interconnection, which has been represented accordingly in the model. Due to the large range in psi of observed pressures of pumped flows, calibration within 10 psi of the EPS model output was achievable for only 90% of the timesteps.

Figure 5-1: Calibration Graph for PR-7A

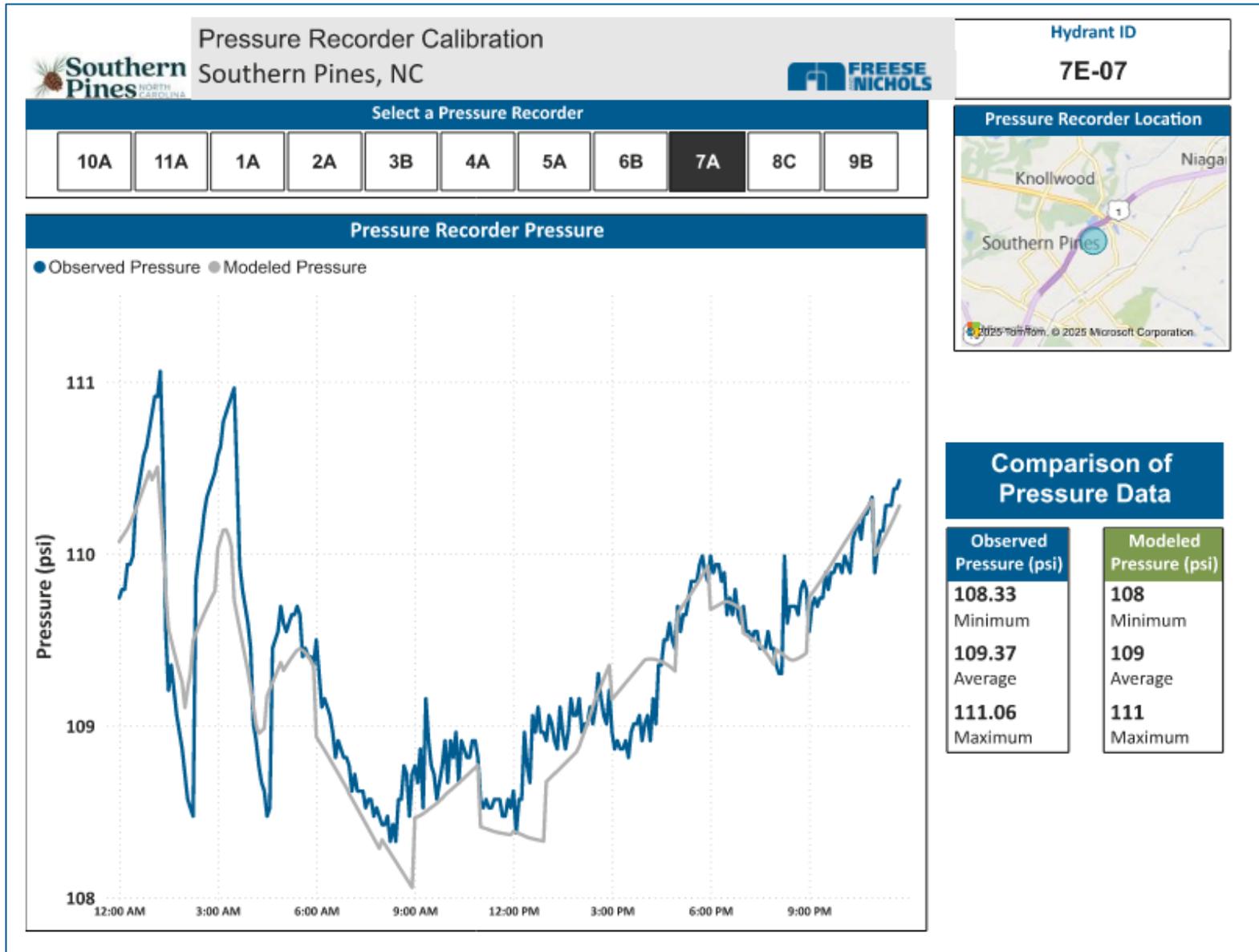


Table 5-2: Summary of Calibration Pressures for April 25, 2024

Pressure Recorder	Within 10 psi	Within 5 psi	Within 3 psi
PR-1A	100%	99%	83%
PR-2A	100%	98%	83%
PR-3B	90%	83%	80%
PR-4A	100%	100%	100%
PR-5A	100%	96%	71%
PR-6B	100%	100%	100%
PR-7A	100%	100%	100%
PR-8C	100%	100%	100%
PR-9B	100%	100%	100%
PR-10A	100%	100%	100%
PR-11A	100%	100%	97%
Average	99%	98%	92%

E. Model Assumptions

Based on a review of the SCADA for the calibration period, FNI noted an imbalance in the HGL between the Henley EST and the Weymouth Woods Standpipe. FNI adjusted the following in the calibration process to account for the varying HGL:

- Closed Model Pipe ID WM-838-107
- Adjusted the diameter of Model Pipe ID WM-2369 to 3" to simulate potential pinched valve

FNI recommends additional field verification along the water transmission corridor between the Weymouth Woods Standpipe and the Henley EST.

5.03 FIRE FLOW

A fire flow analysis evaluates the fire suppression capabilities of the existing system. The Town requires a minimum residual pressure of 20 psi be maintained at neighboring hydrants while delivering a fire flow demand of 1,000 gpm. The maximum velocity allowed was 20 feet/second. For this analysis, a steady-state model run during high-demand morning hours of the calibration day demands was utilized to calculate the available fire flow at each fire hydrant node. All tanks were 50 percent full at the beginning of the model run to simulate realistic summer conditions, and pump suction nodes were excluded. Available fire flow was evaluated at hydrants.

Over 92 percent of the Town's service area demonstrated available flows greater than 1,000 gpm, meeting the Town's standards. Available fire flows range from 100-3,133 gpm. Locations that exhibited lower fire flow values were primarily in areas with small diameter pipelines and dead-end lines. The locations of modeled fire flow availability are shown in **Figure 5-2**.

FIGURE 5-2 TOWN OF SOUTHERN PINES EXISTING WATER SYSTEM FIRE FLOW

LEGEND

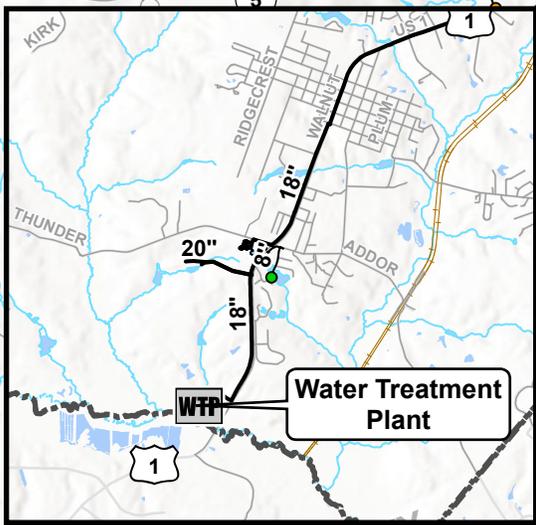
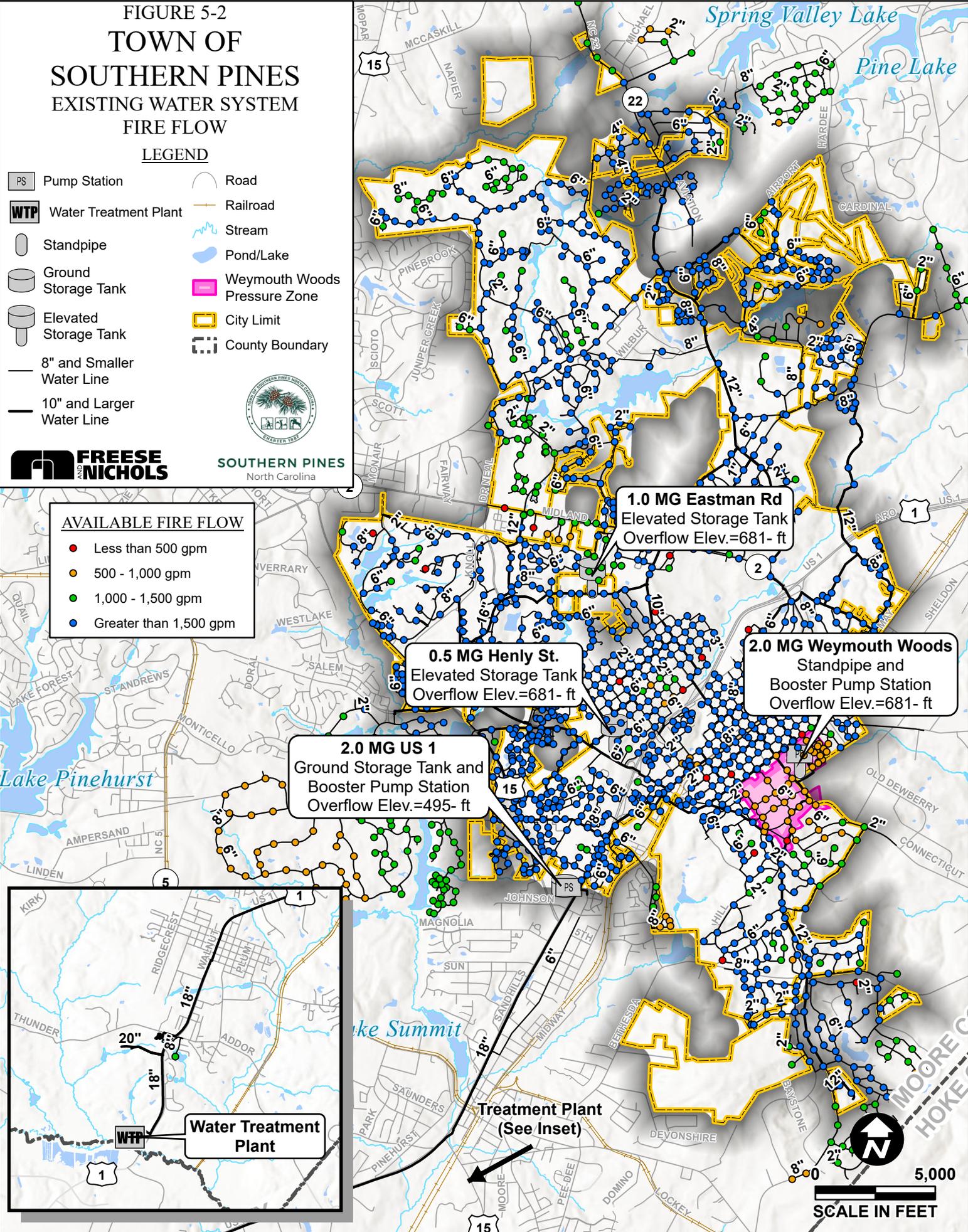
- Pump Station
- Water Treatment Plant
- Standpipe
- Ground Storage Tank
- Elevated Storage Tank
- 8" and Smaller Water Line
- 10" and Larger Water Line
- Road
- Railroad
- Stream
- Pond/Lake
- Weymouth Woods Pressure Zone
- City Limit
- County Boundary



SOUTHERN PINES
 North Carolina

AVAILABLE FIRE FLOW

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



5,000
 SCALE IN FEET

6.00 NEXT STEPS

The updated hydraulic water model will be utilized to conduct system analyses and evaluate future demand conditions. The hydraulic water model will also be used by Withers for risk modeling.

APPENDIX A
PRESSURE RECORDER MAPPING



Pressure Records

- Primary (Red circle)
- Alternate 1 (Green circle)
- Alternate 2 (Purple circle)

Hydrant

- Elevated Storage Tank
- Ground Storage Tank
- Standpipe
- Pump Station

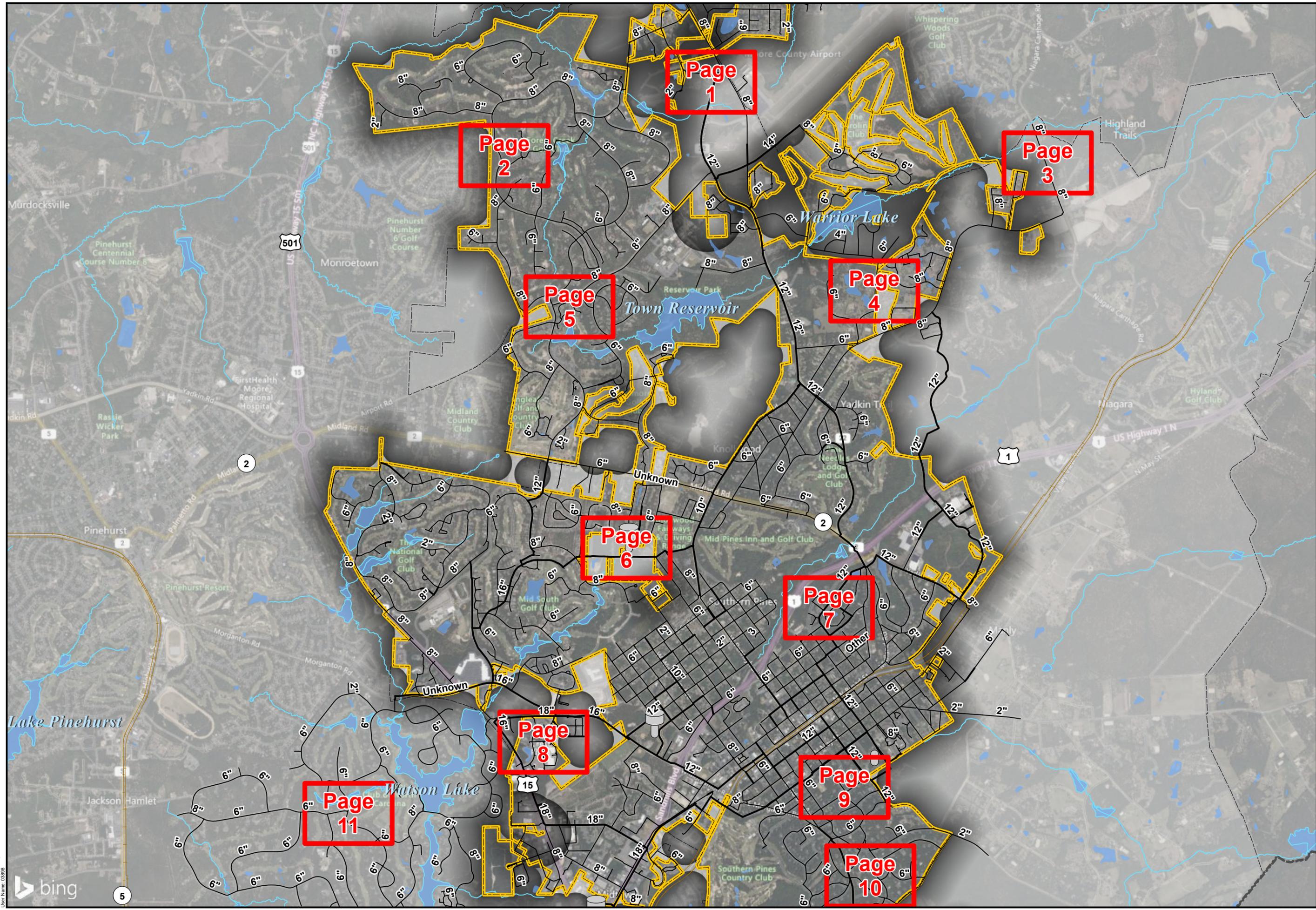
8" and Smaller Water Line

- 8" and Smaller Water Line
- 10" and Larger Water Line
- Stream
- Pond/Lake

Parcel

- City Limit
- Southern Pines ETJ
- Weymouth Pressure Zone

FIGURE A-1
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
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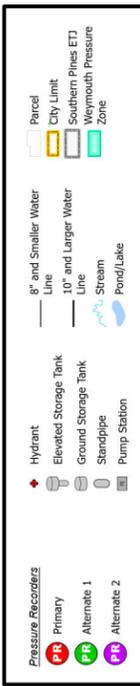


FIGURE A-2
 SOUTHERN PINES
 DEPLOYED PRESSURE
 RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
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 User Name: 03888





Pressure Recorders

- PR Primary
- PR Alternate 1
- PR Alternate 2

Hydrant

- Elevated Storage Tank
- Ground Storage Tank
- Standpipe
- Pump Station

8" and Smaller Water Line

- 8" and Smaller Water Line
- 10" and Larger Water Line
- Stream
- Pond/Lake

Parcel

- City Limit
- Southern Pines ETJ
- Weymouth Pressure Zone

FIGURE A-3
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
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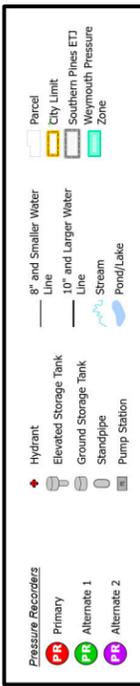


FIGURE A-4
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



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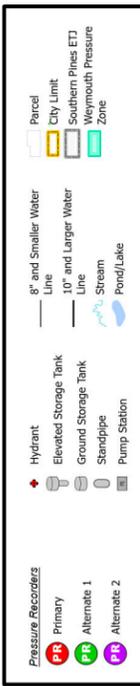


FIGURE A-5
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
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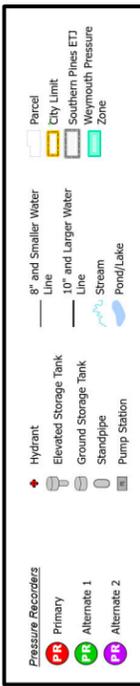
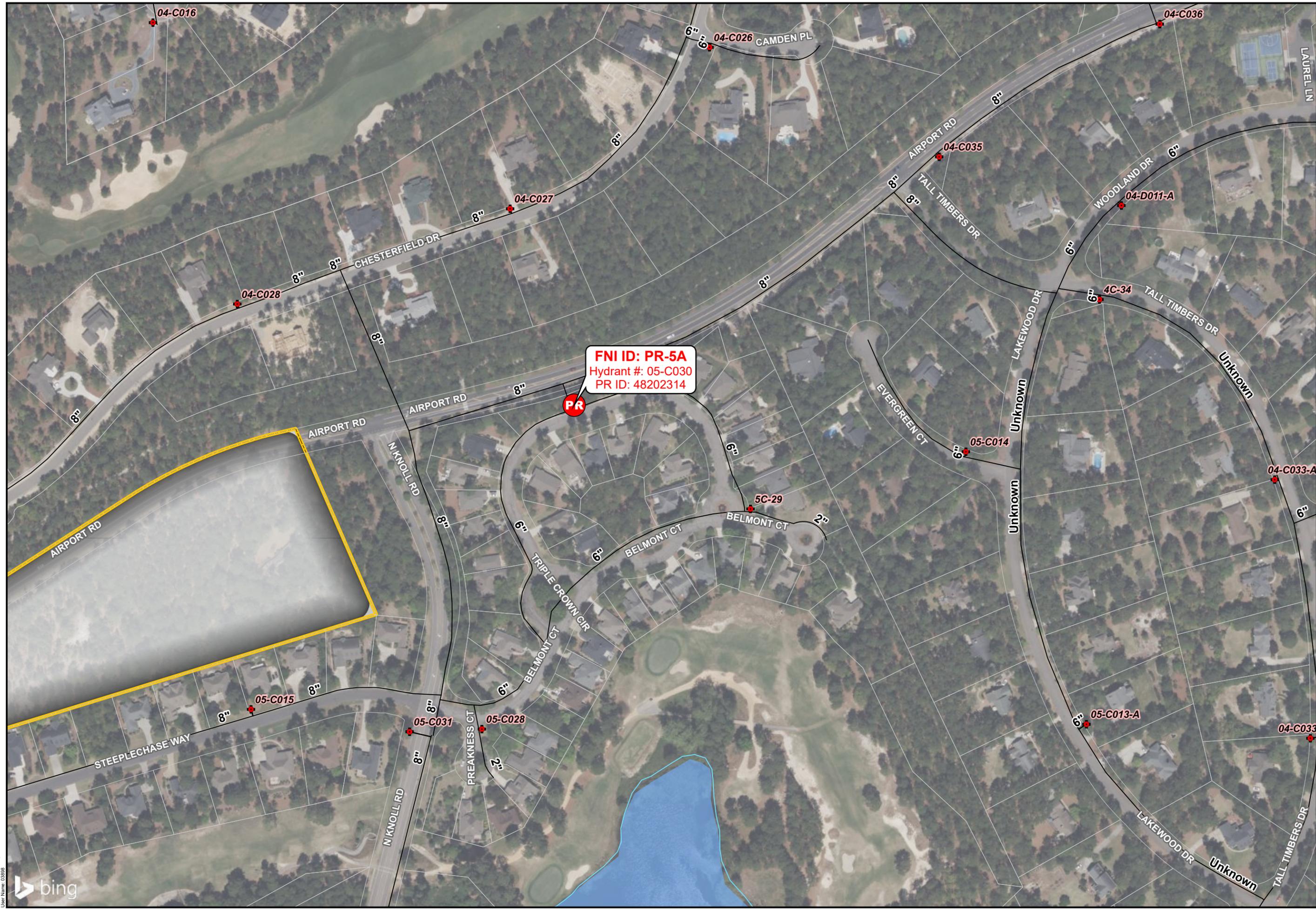


FIGURE A-6
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



FNI ID: PR-5A
Hydrant #: 05-C030
PR ID: 48202314



Created by Freese and Nichols, Inc.
Location: HWY_WW_PLANNING01_DELIVERABLES01_Pressure_Records/PRESSURE_RECORDERS_PRO.aprx
Updated: Thursday, May 2, 2024 9:26 PM
User Name: 03888



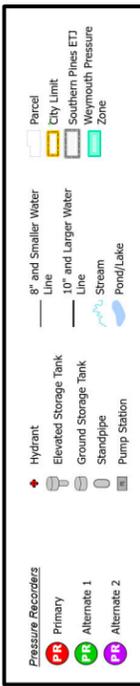
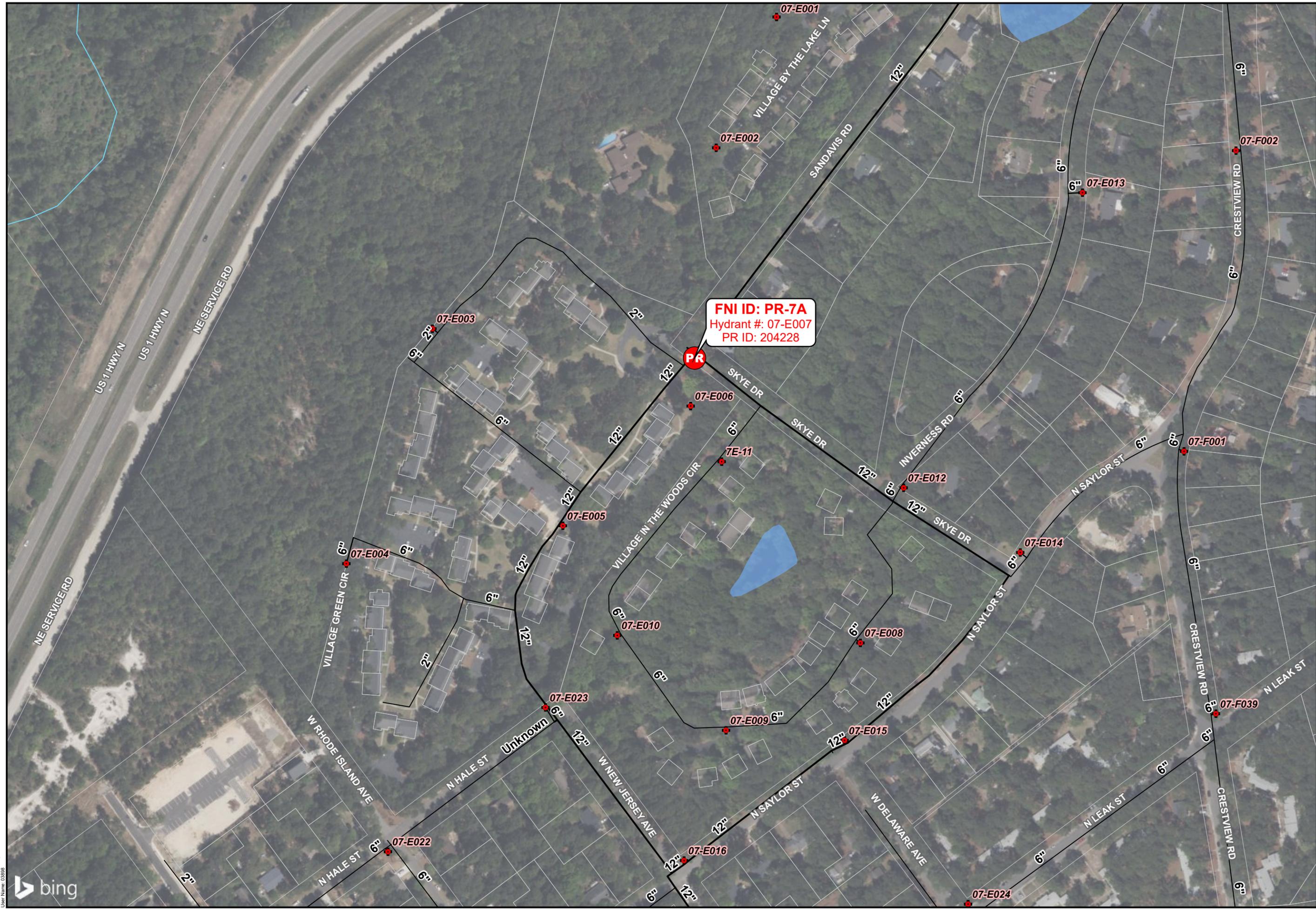


FIGURE A-8
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
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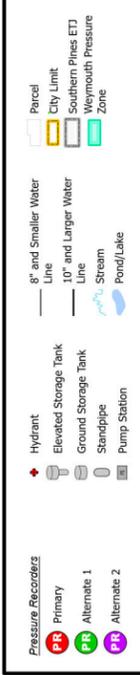


FIGURE A-9
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
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Updated: Thursday, May 2, 2024 9:28 PM
User Name: 03888



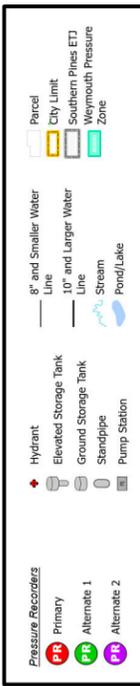
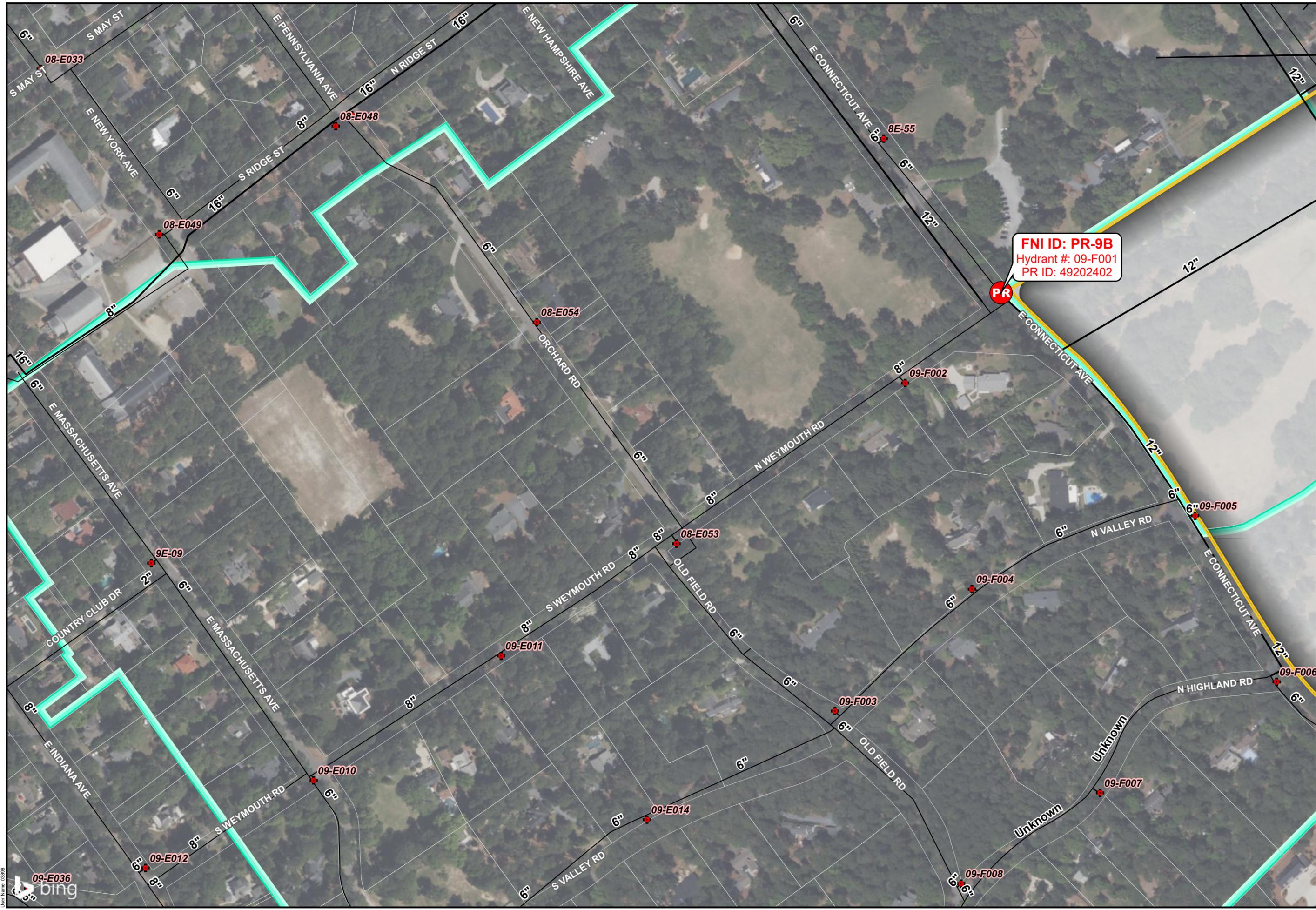


FIGURE A-10
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
Location: HWY_WW_PLANNING01_DELIVERABLES01_Pressure_Recorders/PRESSURE_RECORDER_RECORDERS_PRO.aprx
Updated: Thursday, May 2, 2024 9:28 PM
User Name: 0388B

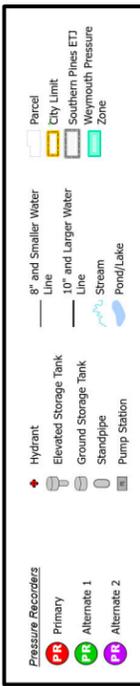
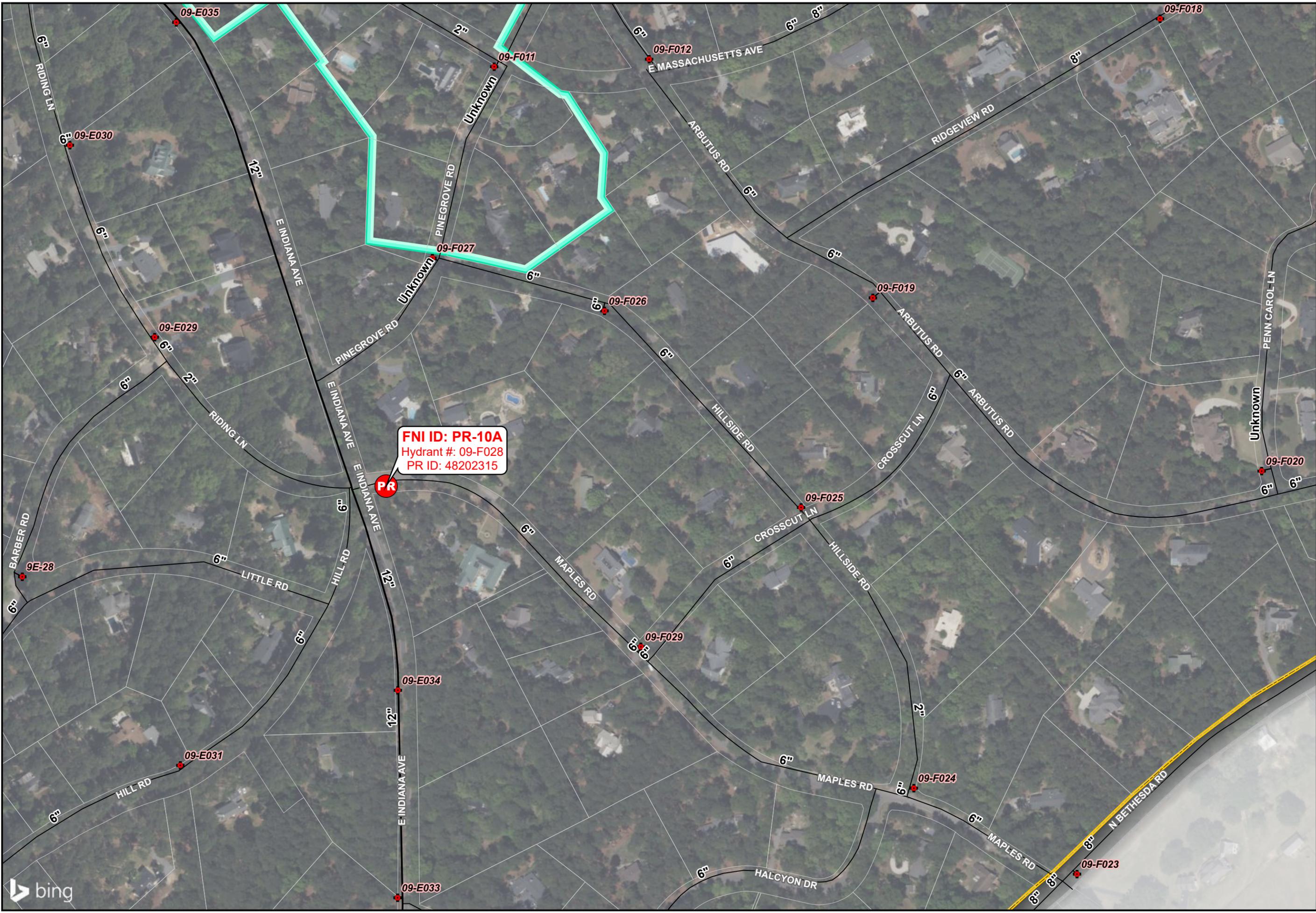


FIGURE A-11
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS



Created by Freese and Nichols, Inc.
Location: HWY_WW_PLANNING01_DELIVERABLES01_Pressure_Recorders/PRESSURE_RECORDER_RECORDERS_PRO.aprx
Updated: Thursday, May 2, 2024 9:28 PM
User Name: 03888



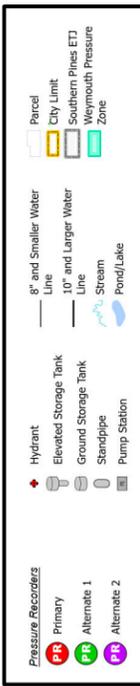


FIGURE A-12
SOUTHERN PINES
DEPLOYED PRESSURE
RECORDER LOCATIONS

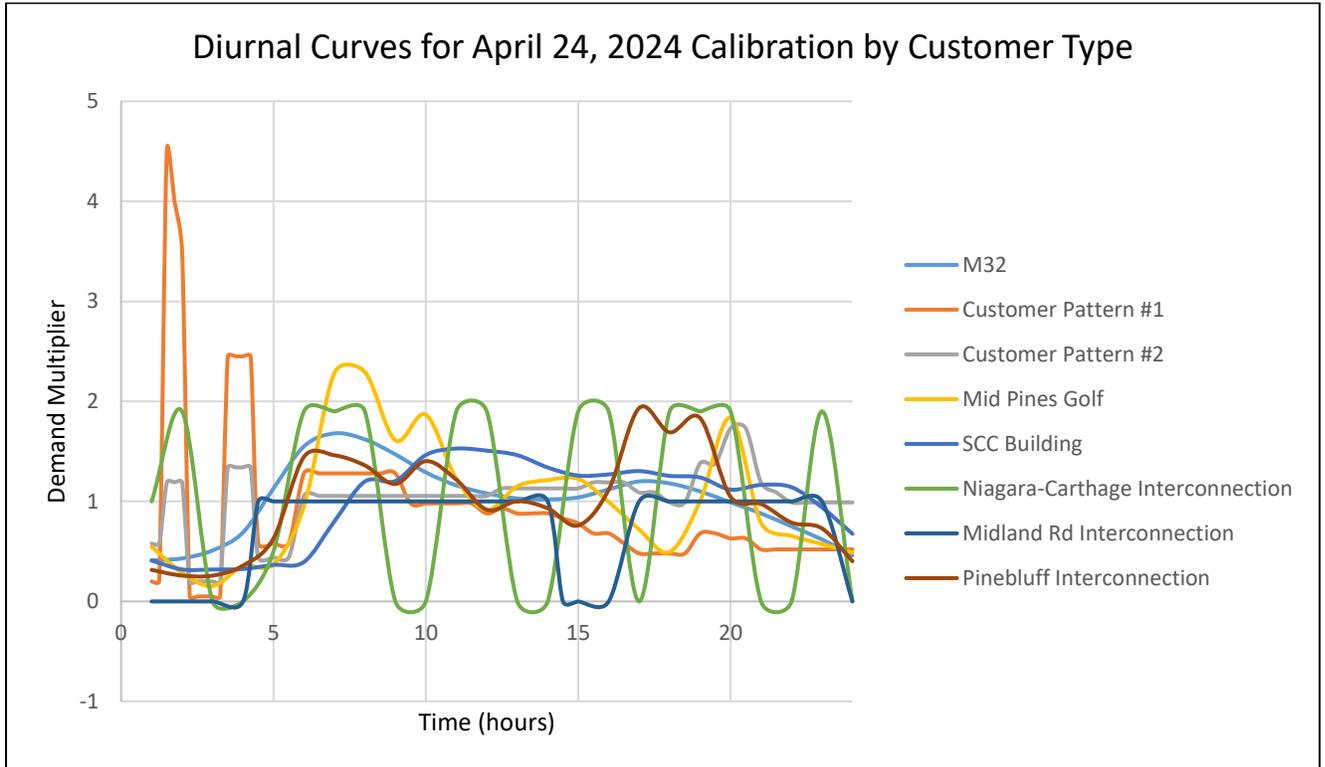


Created by Freese and Nichols, Inc.
Location: HWY_WW_PLANNING01_DELIVERABLES01_Pressure_Recorders/PRESSURE_RECORDERS_PRO.aprx
Updated: Thursday, May 2, 2024 9:29 PM
User Name: 03888



APPENDIX B
DIURNAL PATTERNS

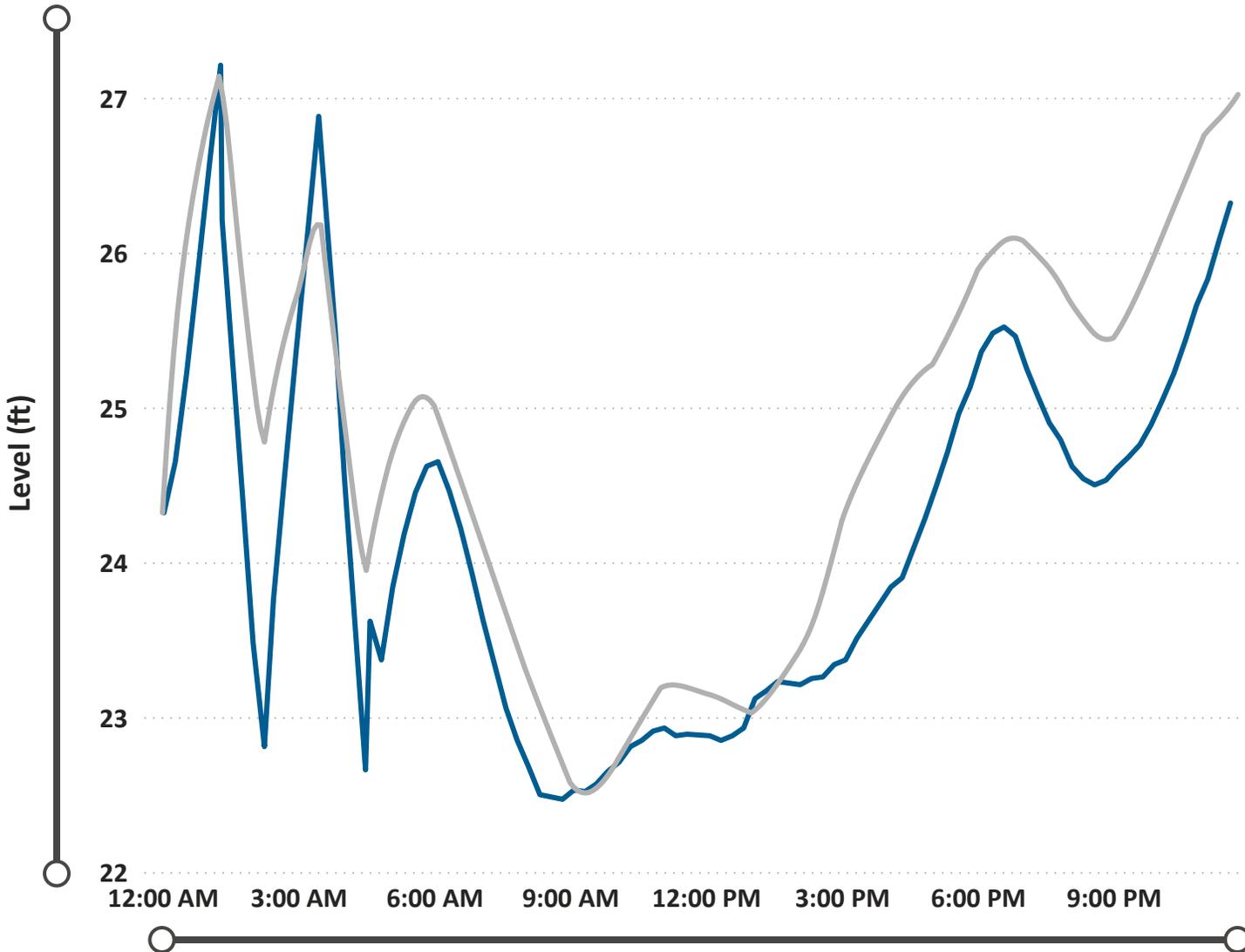
Figure B-1: Diurnal Patterns by Customer Type



APPENDIX C
CALIBRATION RESULTS

Elevated Storage Tank Level (ft)

● SCADA Level (ft) ● Model Level (ft)



Maximum Level (ft)

27.21
SCADA Level (ft)

27.14
Model Level (ft)

Average Level (ft)

24.19
SCADA Level (ft)

24.75
Model Level (ft)

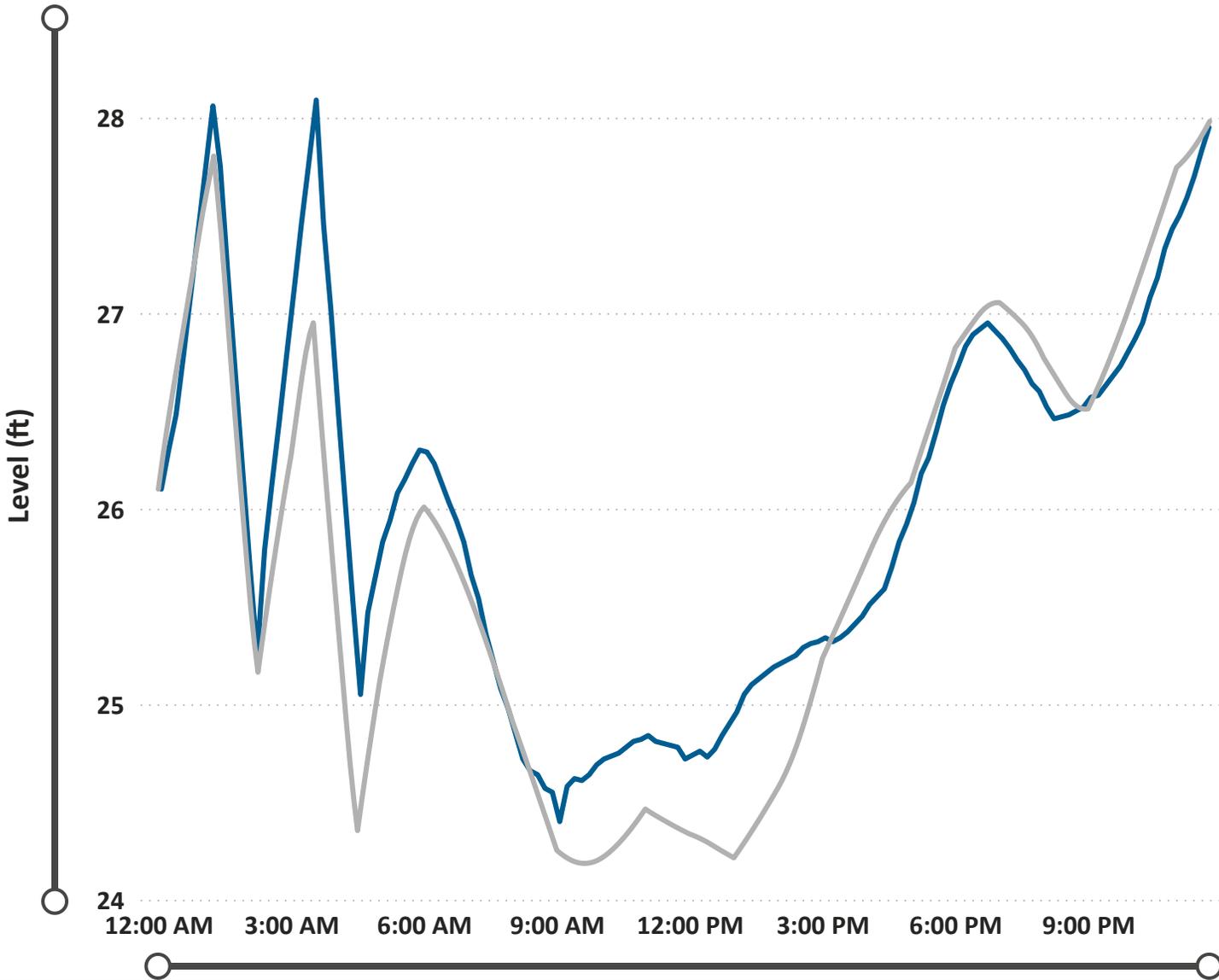
Minimum Level (ft)

22.47
SCADA Level (ft)

22.51
Model Level (ft)

Elevated Storage Tank Level (ft)

● SCADA Level (ft) ● Modeled Level (ft)



Maximum Level (ft)

28.09
SCADA Level (ft)
77.48
Model Level (ft)

Average Level (ft)

25.99
SCADA Level (ft)
75.27
Model Level (ft)

Minimum Level (ft)

24.40
SCADA Level (ft)
73.69
Model Level (ft)



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

9F-28

Select a Pressure Recorder

10A

11A

1A

2A

3B

4A

5A

6B

7A

8C

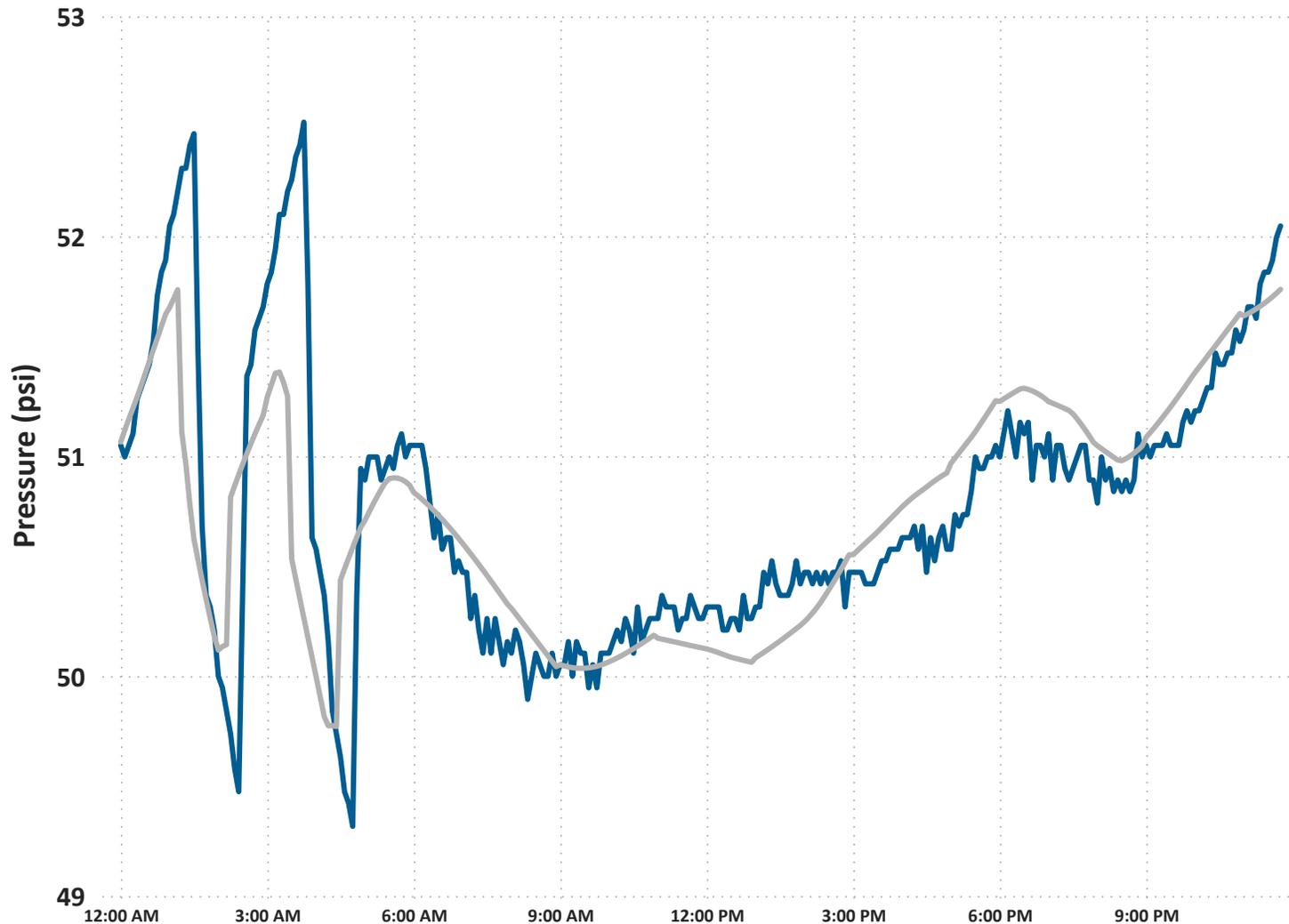
9B

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)
49.32
Minimum
50.76
Average
52.52
Maximum

Modeled Pressure (psi)
50
Minimum
51
Average
52
Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

6-17

Select a Pressure Recorder

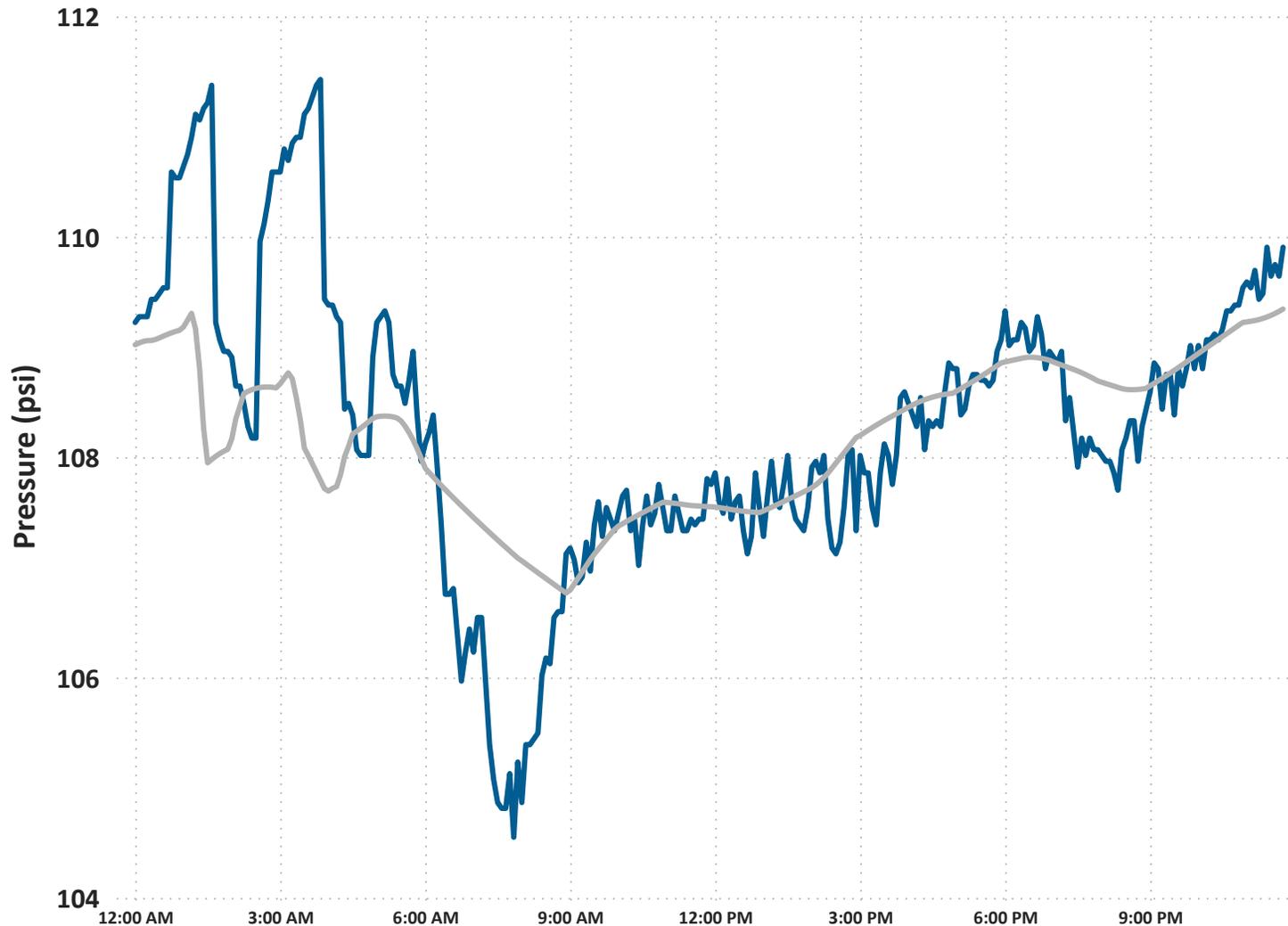
- 10A
- 11A**
- 1A
- 2A
- 3B
- 4A
- 5A
- 6B
- 7A
- 8C
- 9B

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)

104.55
Minimum

108.29
Average

111.43
Maximum

Modeled Pressure (psi)

107
Minimum

108
Average

109
Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

2D-21

Select a Pressure Recorder

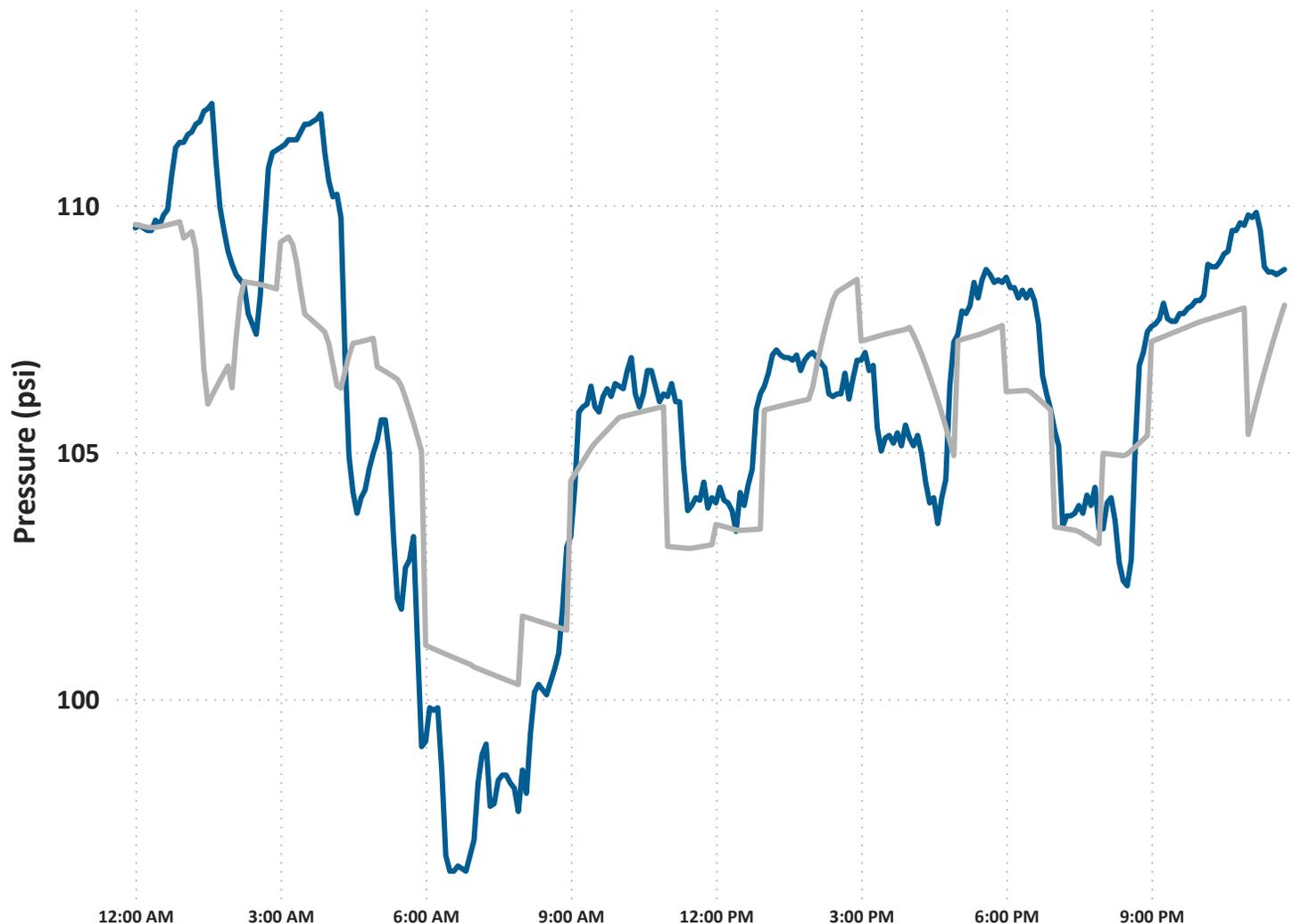
10A	11A	1A	2A	3B	4A	5A	6B	7A	8C	9B
-----	-----	-----------	----	----	----	----	----	----	----	----

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
96.52 Minimum	100 Minimum
105.93 Average	106 Average
112.06 Maximum	110 Maximum



Pressure Recorder Calibration

Southern Pines, NC



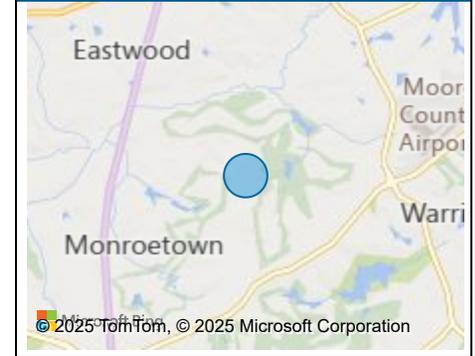
Hydrant ID

3C-05

Select a Pressure Recorder

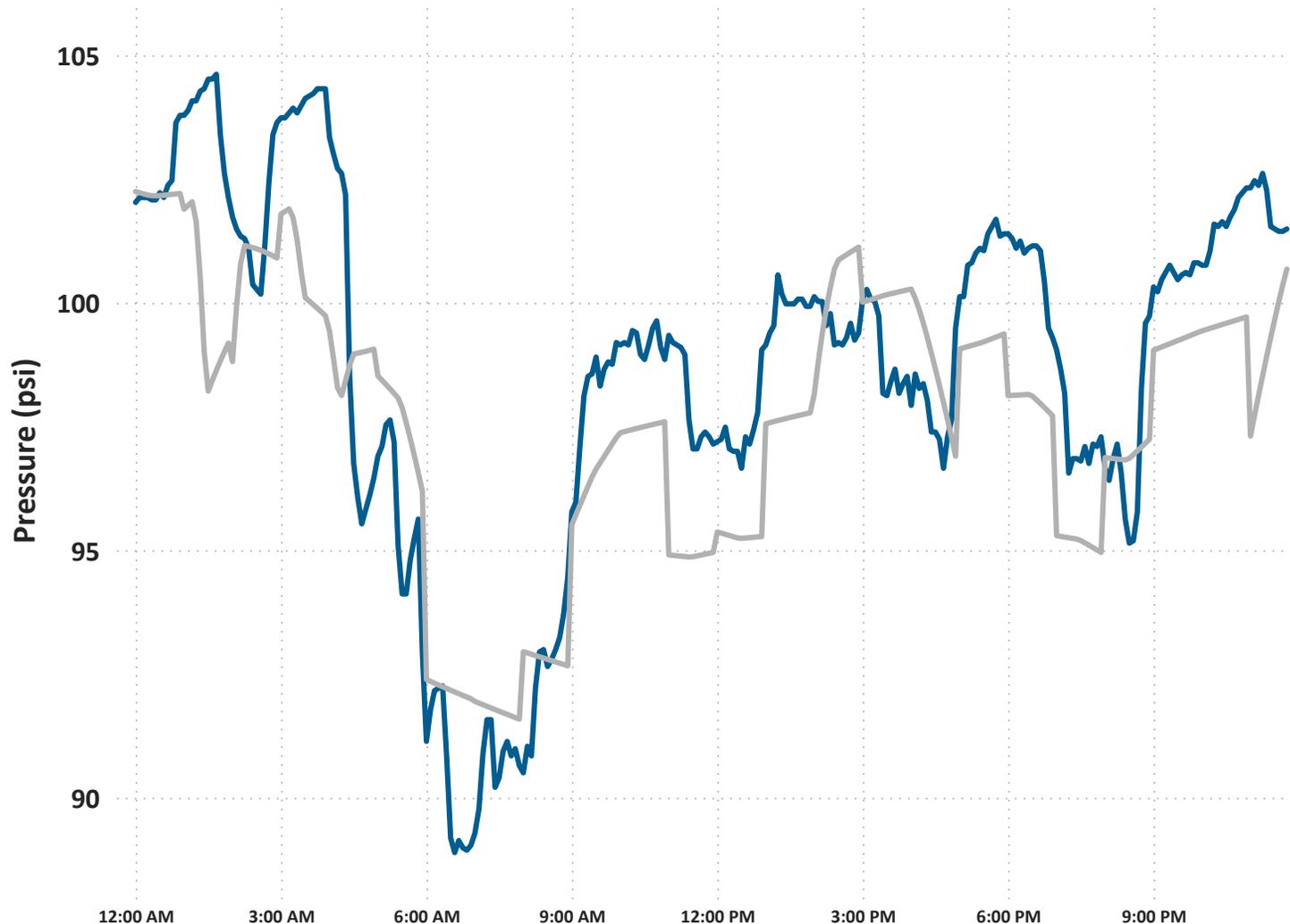
10A	11A	1A	2A	3B	4A	5A	6B	7A	8C	9B
-----	-----	----	----	----	----	----	----	----	----	----

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
88.89 Minimum	92 Minimum
98.70 Average	98 Average
104.62 Maximum	102 Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

4G-7

Select a Pressure Recorder

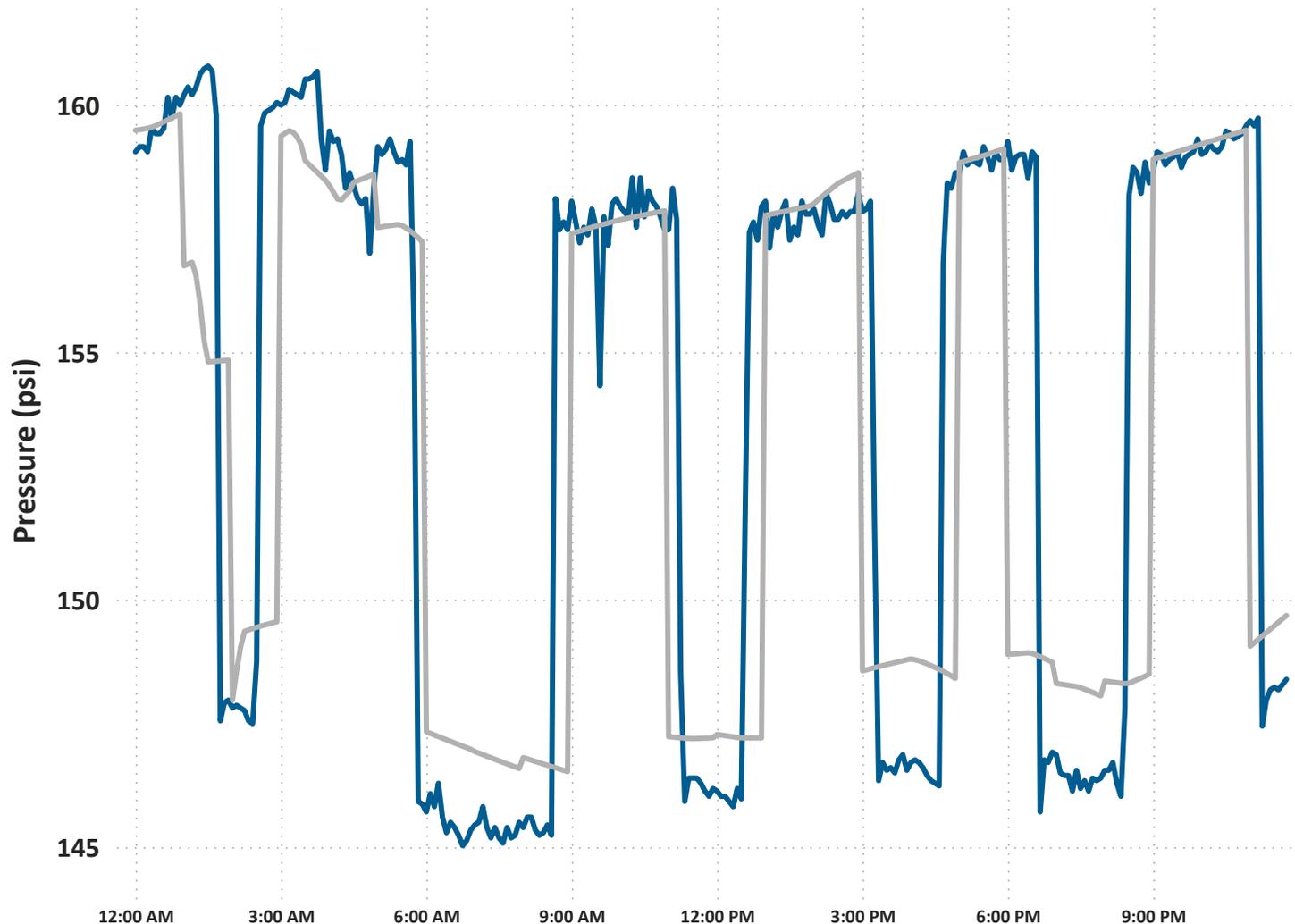
10A	11A	1A	2A	3B	4A	5A	6B	7A	8C	9B
-----	-----	----	----	-----------	----	----	----	----	----	----

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
145.03 Minimum	147 Minimum
154.11 Average	153 Average
160.78 Maximum	160 Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

4F-23

Select a Pressure Recorder

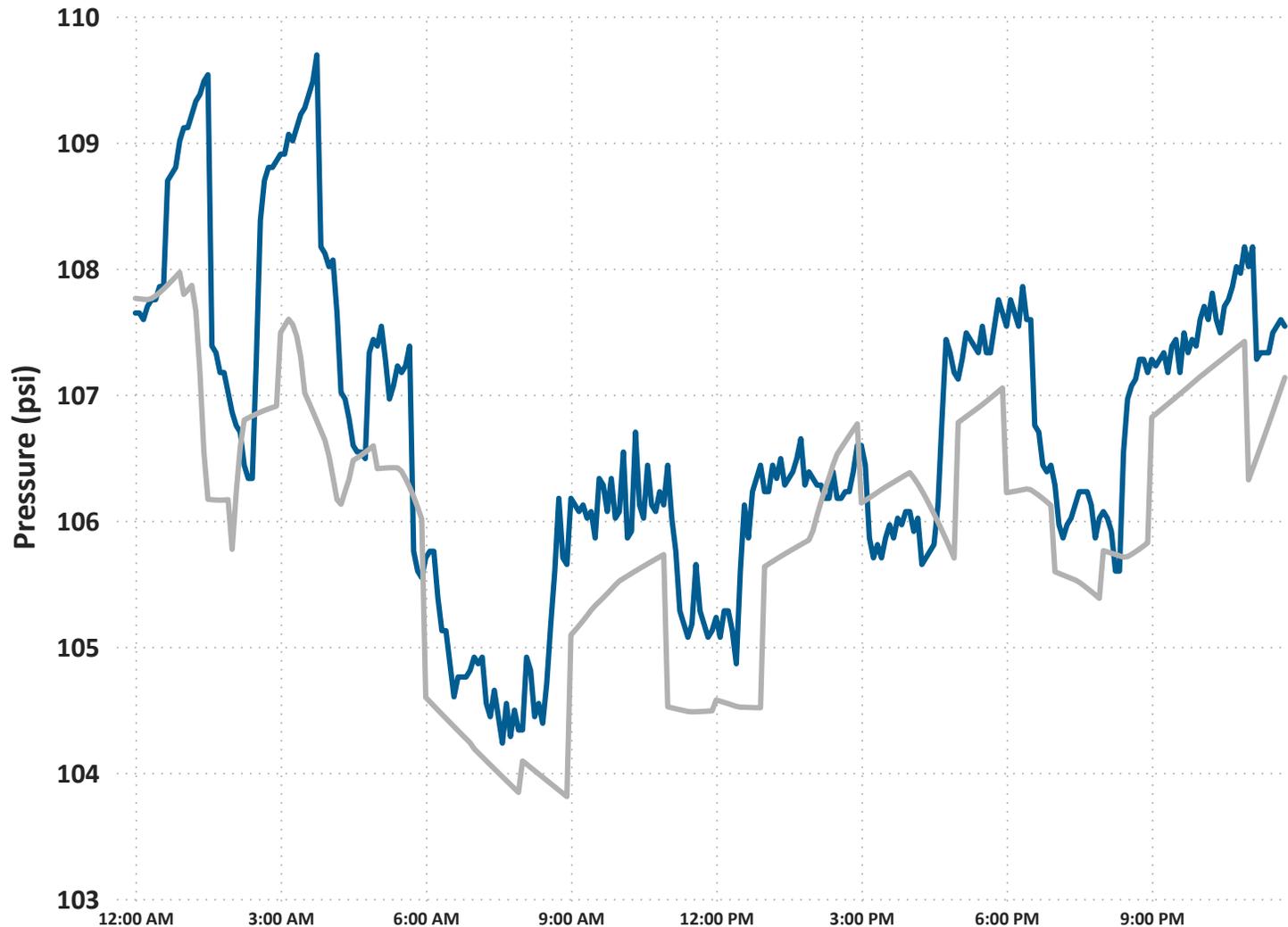
10A	11A	1A	2A	3B	4A	5A	6B	7A	8C	9B
-----	-----	----	----	----	----	----	----	----	----	----

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
104.23 Minimum	104 Minimum
106.66 Average	106 Average
109.69 Maximum	108 Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

5C-30

Select a Pressure Recorder

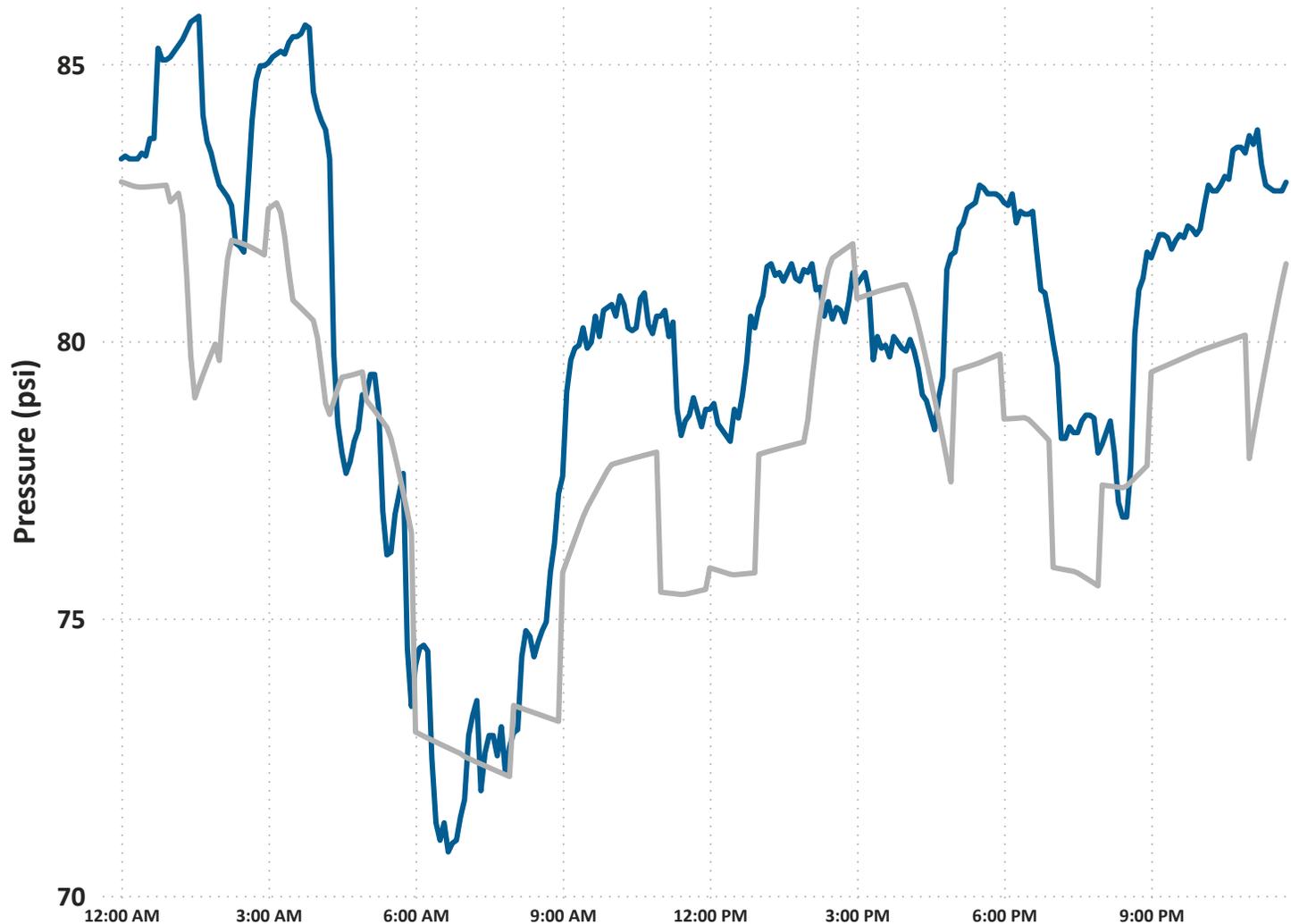
10A	11A	1A	2A	3B	4A	5A	6B	7A	8C	9B
-----	-----	----	----	----	----	-----------	----	----	----	----

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
70.79 Minimum	72 Minimum
80.15 Average	78 Average
85.86 Maximum	83 Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

7D-13

Select a Pressure Recorder

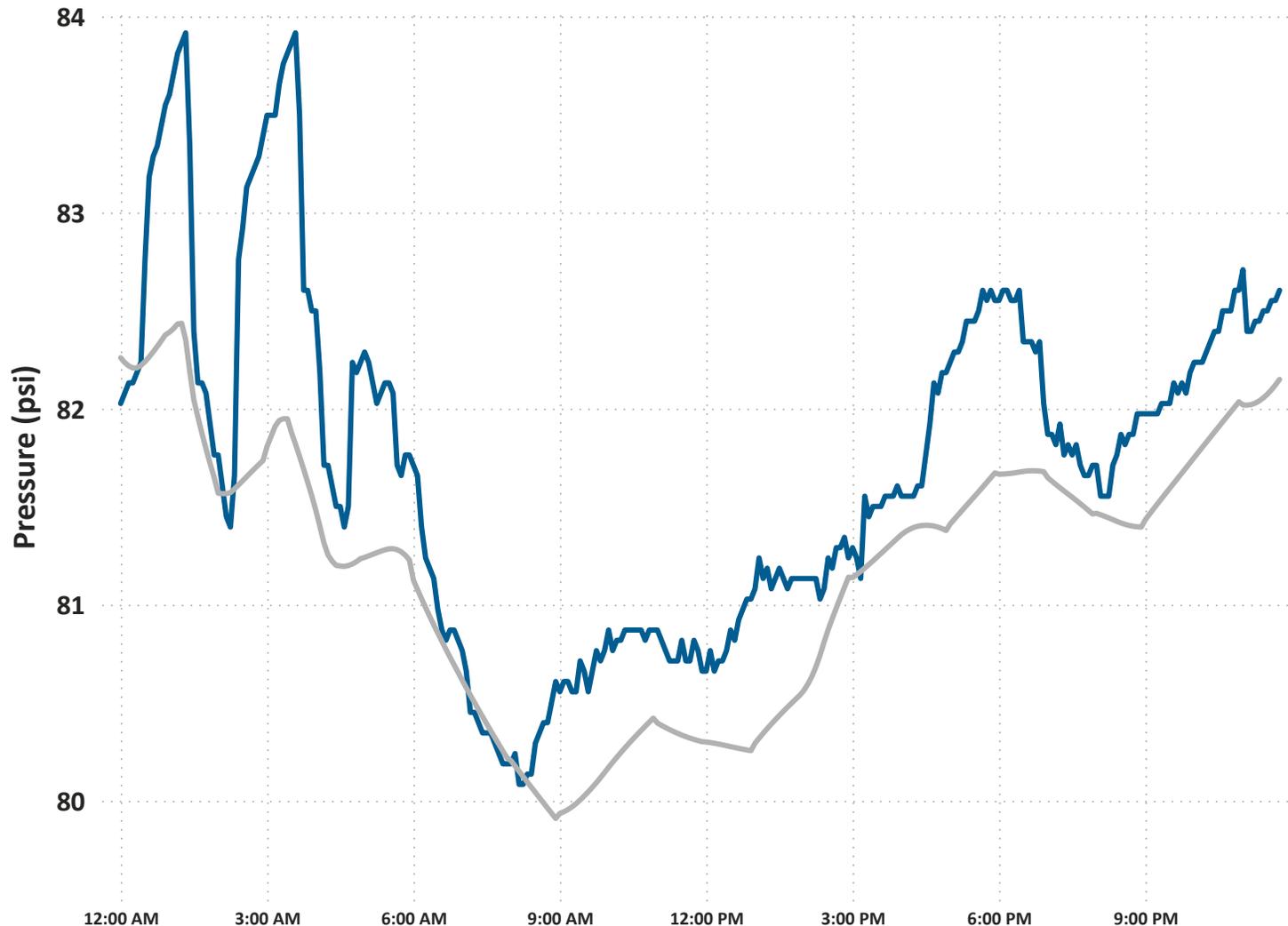
10A	11A	1A	2A	3B	4A	5A	6B	7A	8C	9B
-----	-----	----	----	----	----	----	----	----	----	----

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
80.08 Minimum	80 Minimum
81.71 Average	81 Average
83.92 Maximum	82 Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

7E-07

Select a Pressure Recorder

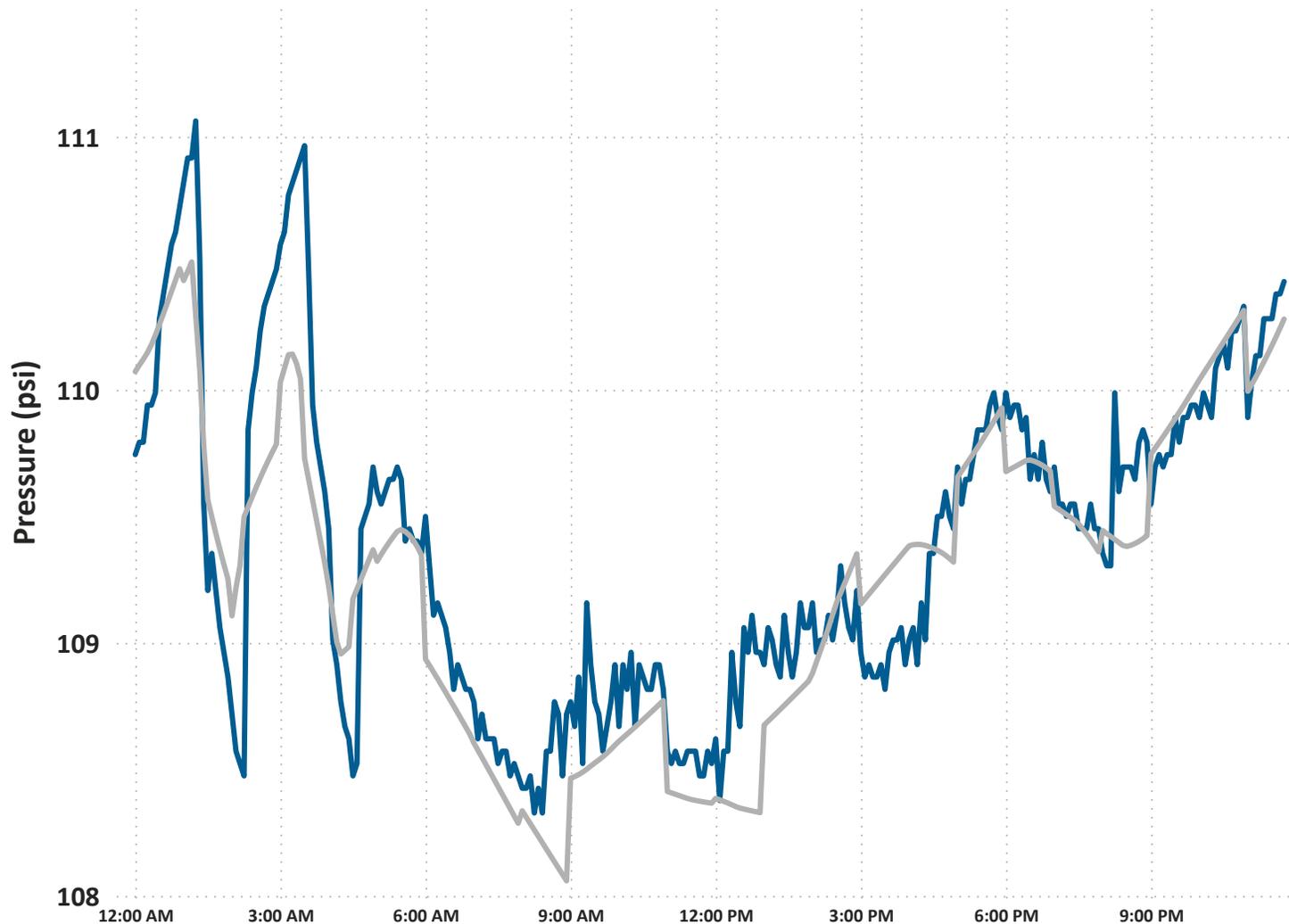
- 10A
- 11A
- 1A
- 2A
- 3B
- 4A
- 5A
- 6B
- 7A
- 8C
- 9B

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
108.33 Minimum	108 Minimum
109.37 Average	109 Average
111.06 Maximum	111 Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

8C-22

Select a Pressure Recorder

10A

11A

1A

2A

3B

4A

5A

6B

7A

8C

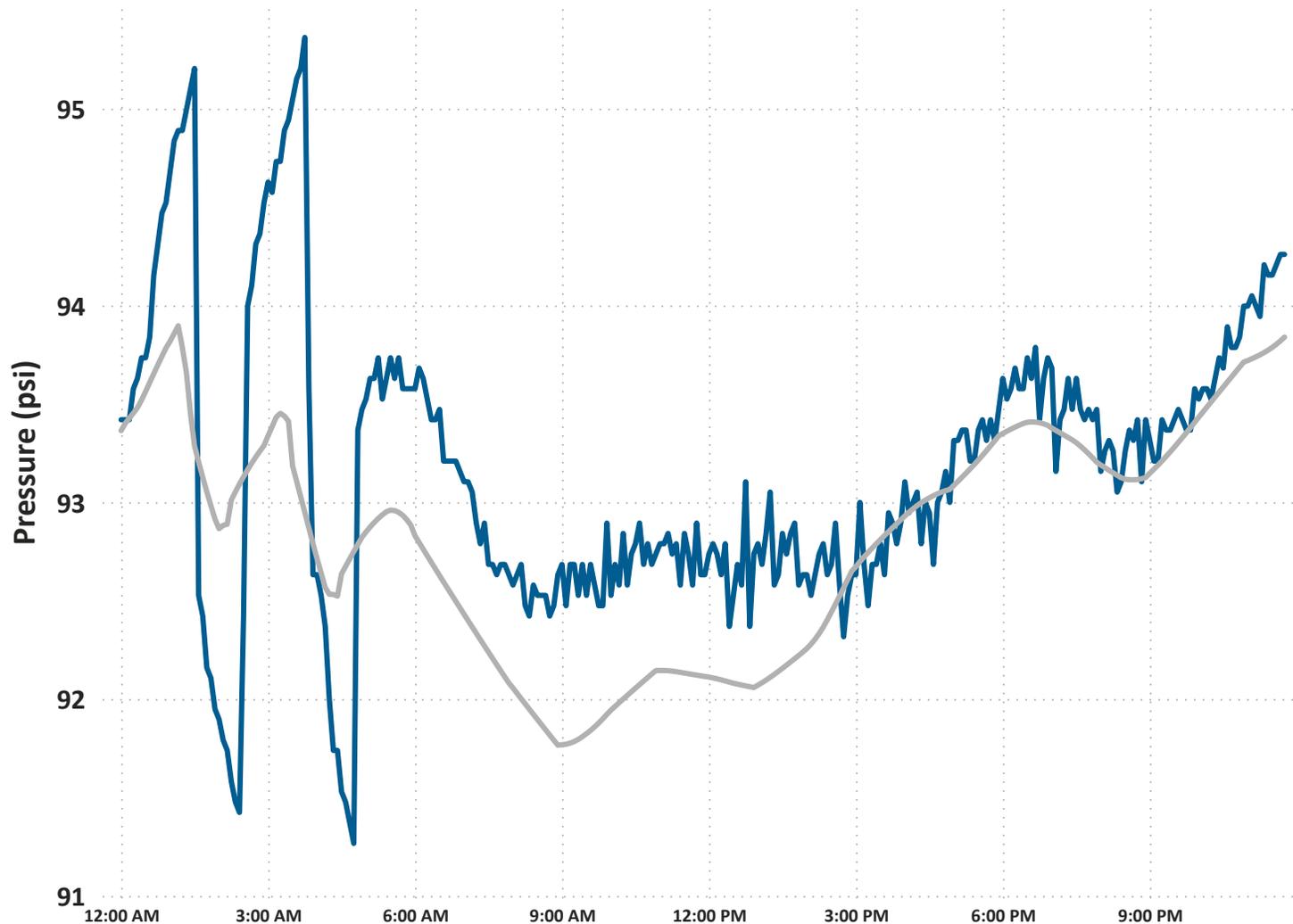
9B

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)

91.27

Minimum

93.17

Average

95.36

Maximum

Modeled Pressure (psi)

92

Minimum

93

Average

94

Maximum



Pressure Recorder Calibration

Southern Pines, NC



Hydrant ID

9F-01

Select a Pressure Recorder

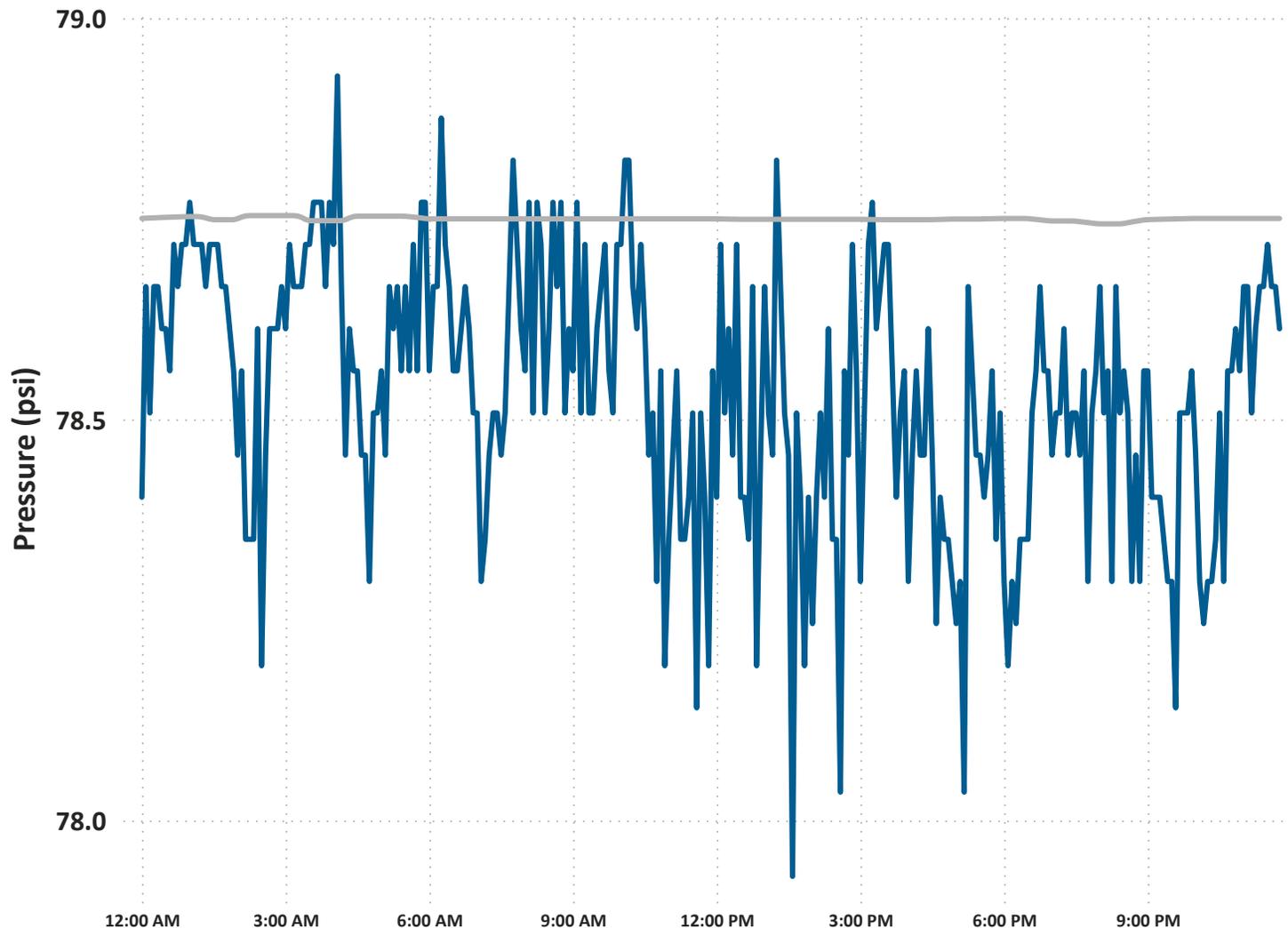
- 10A
- 11A
- 1A
- 2A
- 3B
- 4A
- 5A
- 6B
- 7A
- 8C
- 9B

Pressure Recorder Location



Pressure Recorder Pressure

● Observed Pressure ● Modeled Pressure



Comparison of Pressure Data

Observed Pressure (psi)	Modeled Pressure (psi)
77.93 Minimum	79 Minimum
78.53 Average	79 Average
78.93 Maximum	79 Maximum

APPENDIX V – References

1. NCDEQ Asset Assessment Guidance Document September 2020
2. NCDEQ DWR Southern Pines Local Water Supply Planning Document 2024