BOSCAWEN, NH

Water Asset Management Plan **SEP 2025**

Pennacook/Boscawen Water Precinct Water System Asset Management Plan

WRIGHT-PIERCE
Engineering a Better Environment

Pennacook/Boscawen Water Precinct Water System Asset Management Plan

Boscawen, NH

September 2025

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First Last, PE
Date: ______________________________

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Section 1 Introduction

1.1 Historical Background

Portions of the Town of Boscawen and the Penacook section of Concord have operated as a Village District since 1891. Under the direction of an elected board of commissioners, the Penacook-Boscawen Water Precinct (PBWP) has been providing water service to the Village Precinct's citizens and businesses for the last 130 years. The PBWP provides water for approximately 1,200 accounts currently. The original water source was likely to be surface water drawn from Walker Pond located in western Boscawen. Walker Pond was the sole water source for the Village Precinct until its use was discontinued in 1996 in favor of a pair of groundwater wells near the Merrimack River. Since then, PBWP has installed additional wells to meet the growing water system demand.

The first two water storage tanks, located on Queen Street, were constructed in 1954 and 1974 with capacities of 0.265 and 1.0 million gallons (MG) respectively. Two additional water storage tanks were constructed in 1995; One is located on Fairbanks Street with a 0.75 MG capacity and the other is near the Merrimack County Nursing Home with a capacity of 0.26 MG. Currently the total combined storage capacity of PBWP is 2.28 MG. PBWP added a booster pump station and corrosion control facility located off of Water Street in 1995 to supply water to the newer storage tanks.

The PBWP last completed a system evaluation in 2020 with the assistance of Underwood Engineers. In early 2023, the PBWP contracted with Wright-Pierce to prepare their first official Asset Management Plan. The intent of this Asset Management Plan is to develop strategies, goals, and targeted improvements which prepare the water system for the future so it may meet projected needs, population growth and corresponding demands.

1.2 Study Goals and Objectives

The purpose of this study is to conduct a condition assessment of the water system infrastructure, including the storage tanks, pump stations, water sources, treatment, and distribution piping network, affirm the hydraulic strengths and limitations of the distribution system under existing and future conditions, and develop a Capital Improvement Plan (CIP) which incorporates recommendations generated during the evaluation. The objectives for the study are as follows:

- Update inventory of water assets. Conduct condition analysis of all water assets and estimate remaining useful life. Update existing water system map.
- Develop level of service plan and conduct management workshop. Conduct a criticality analysis of assets and rank according to priority.
- Evaluate the physical/mechanical condition and hydraulic capacity of the existing storage tanks.
- Update and calibrate the distribution system hydraulic model to be used to evaluate the system under a variety of hydraulic conditions.
- Identify hydraulic deficiencies under existing and projected conditions and develop recommendations for improvements to meet current and future demand conditions.
- Develop a CIP for the recommendations developed from the study.
- Develop a Financial Implementation Plan to allow for the CIP recommendations to be appropriately funded during the short term (0-5 years), intermediate term (5-10 years), and long term (10-50 years) periods.
- Prepare asset management plan. Present asset management plan and provide training in asset management principles to the Board of Commissioners.

1.3 Basis for Estimates of Probable Costs

Planning-level costs have been estimated for recommended water system improvements. These planning-level costs were estimated using standard cost estimating procedures consistent with industry standards utilizing unit cost information. Total capital cost estimates include an allowance of the estimated construction costs to account for construction contingency, design and construction phase, engineering, permitting, materials testing, as well as financing, administrative and legal expenses. The planning cost information presented herein is in current dollars and is based on an ENR Index of 13632 (9/15/2024).

These estimates were primarily developed for planning level budgeting and are generally reliable for determining the relative costs associated with equipment replacement. To group proposed improvements into biddable projects, additional factors not easily defined for this planning level report would need to be considered during preliminary and final design (e.g., foundation conditions, owner selected features and amenities, building code issues, bypass pumping, etc.). Contingency was included in the estimates to account for unknown design conditions. However, this contingency allowance may not be adequate in all circumstances.

1.4 Review of Prior Studies, Reports and Documentation

A variety of documents were collected, cataloged, and reviewed in conjunction with this study. The documentation included information such as record drawings, operational records, reports and studies and other pertinent information. These documents were considered in the context of the evaluation and final recommendations. Specific documentation collected and referenced during the study includes:

- Water System Evaluation Technical Memo, 2020, Underwood Engineers
- Water Quality Report, 2023, Penacook Boscawen Water Precinct
- Public Water System Emergency Plan Guide, 2023, NHDES
- AWWA Water Audit, 2022
- Water Rates and Fees, 2022, PBWP
- ISO Fire Flow Hydrant Summary, 2016
- Existing GIS data for all water assets
- Record Drawings
- Water main break history
- PBWP Budget, 2023
- PBWP Billing Records

1.5 Organization of Report

The report is organized into seven sections as follows:

- Section 1 – Introduction
- Section 2 – Existing Water System Review
- Section 3 – Regulatory Review
- Section 4 – Distribution System Evaluation
- Section 5 – Facility Evaluation and Risk Analysis
- Section 6 – Level of Service
- Section 7 – Capital Improvement Plan

Section 2 Existing Water System Review

2.1 General

The purpose of this section is to provide a general overview of the Penacook Boscawen Water Precinct's (PBWP) existing water distribution system and infrastructure. This includes distribution piping, groundwater supplies, and storage facilities. Recommendations for distribution system improvements are included in the Capital Improvement Program (CIP) presented in **Section 6**.

2.2 Water System History

The PBWP was originally developed in 1891 to provide water to a portion of Boscawen and the Penacook portion of Concord, NH. It is categorized as a "Village District" per NH RSA 52: Village Districts. The original water source, Walker Pond, was used until 1996 when the Precinct transitioned to two groundwater wells. A third well was completed in 2004 to provide additional water.

The first water storage tank (Queen Street Tank) was constructed in 1954 and can store up to 256,000 gallons. At the same location, a 1.0 MG (million gallons) storage tank was constructed in 1974. In the early 1990s two additional water storage tanks were constructed with a combined storage capacity of 1.015 MG. The Precinct's corrosion control facility and water booster pump station were also added to the system in the early 1990s.

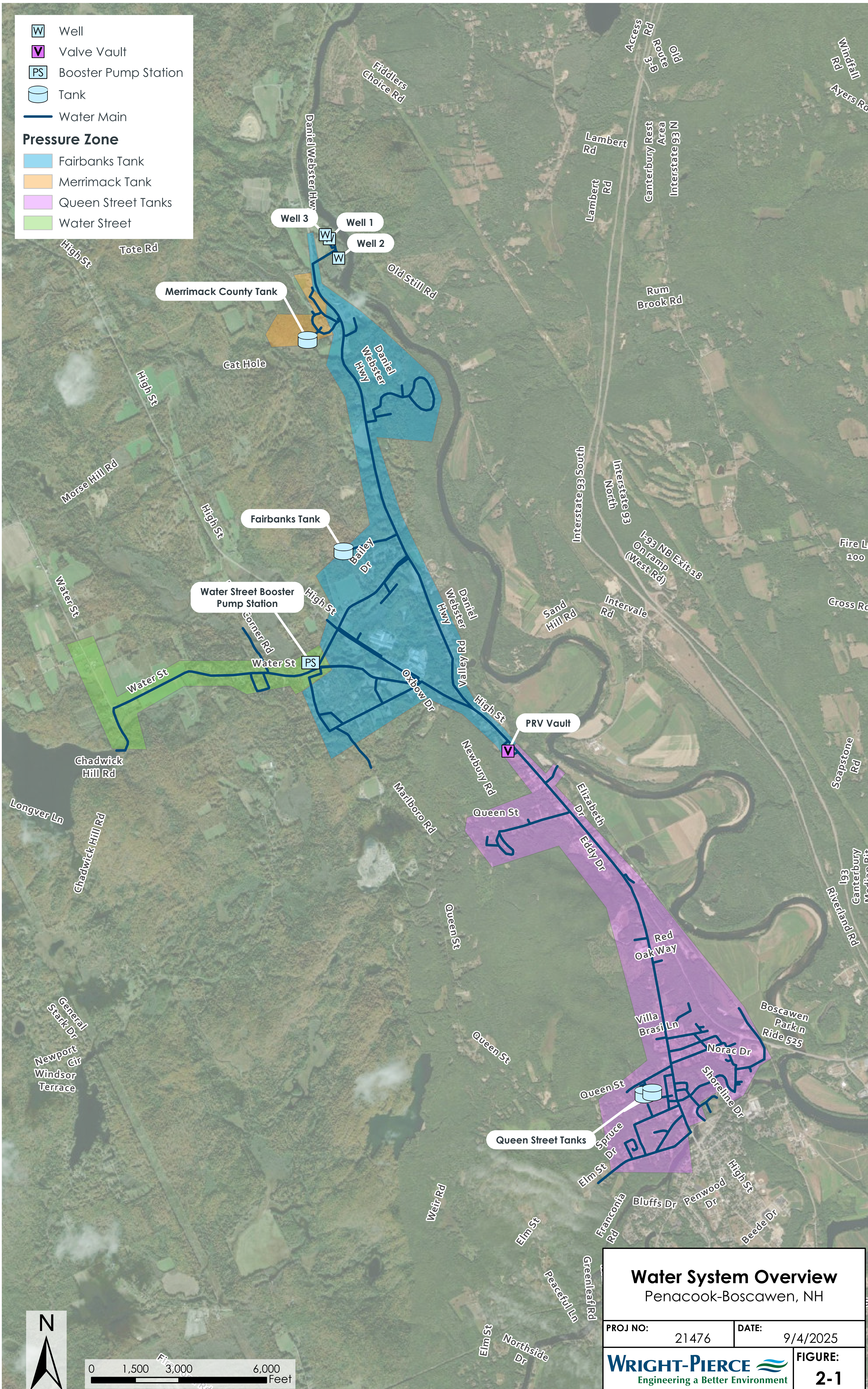
2.3 Distribution System Overview

The distribution system is split into four pressure zones (**Figure 2-1**). The corrosion control building and the three water source wells are located in the most northern portion of the Fairbanks Zone, which is supplied by the Fairbanks Tank and operates at a hydraulic gradeline (HGL) of 532 feet. The Fairbanks Zone supplies the majority of the system north of the Route 3/4 split. There is a Pressure Relief Valve (PRV) vault located in the vicinity of this intersection that separates the Fairbanks Zone and Queen Street Zone. The Queen Street Zone is supplied by both Queen Street, operates at an HGL of 508 feet, and supplies the portion of the distribution system south of the Route 3/4 PRV Vault. The Merrimack County Zone is supplied by the Merrimack County Tank, operates at an HGL of 500 feet and is privately owned.

The fourth pressure zone is the Water Street zone which is based on the discharge pressure of the Water Street pump station. This zone does not have gravity storage so fire flows are limited by the capacity of the pumps. All hydrants located within this zone are either inoperable or do not provide sufficient fire flow flows. The Water Streer Zone operates at an HGL of approximately 680 feet. Please see **Table 2-1** for a summary of the pressure zones and their HGLs, highest service elevation, and lowest service elevation.

Table 2-1 Water Supply Sources

Service Zone	HGL (feet)	Lowest Service Elevation (feet)	Highest Service Elevation (feet)
Queen Street Zone	508	252	450
Merrimack County Zone	500	362	390
Fairbanks Zone	532	285	465
Water Street Zone	680	400	570



Water System Overview

Penacook-Boscawen, NH

PROJ NO: 21476

DATE: 9/4/2025

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FIGURE: 2-1

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2.3.1 Groundwater Supplies & Distribution System Facilities

The PBWP water distribution system includes three wells, one pump station, one corrosion control building and one pressure reducing valve vault. Properties for each groundwater supply source are listed in Table 2-2. Each well station and distribution system facility has a generator on site.

Table 2-2 Water Supply Sources

Name/ Location	DES Data Base 0251010-	Year Installed	Well Depth (ft)	Currently Estimated Well Capacity (gpm)
Well #1	002-G	1994	51	450
Well #2	003-G	1994	52.1	450
Well #3	004-G	2004	39.7	250
			Total	**1,150**

All three water supply sources owned and operated by the PBWP are shallow gravel-packed wells which draw water from a large aquifer below the Merrimack River. The three wells are permitted to pump 1.54 million gallons per day (MGD).

Wells #1 and #2, installed in October 1994, are equipped with a submersible pump rated for 425 and 445 gallons per minute (gpm), respectively, at 680 TDH and are read through a 6" Venturi meter. Well #3, installed in April 2004, is equipped with a 25 HP submersible pump rated for 200 gallons per minute (gpm) at 680 TDH and is read through a 4" Neptune meter. Wells #1 and #2 were last cleaned in 2016 and Well #3 has yet to be cleaned since installation.

Well #1 experiences continuous clogging due to biofouling as discovered by EGGI during a 2011 investigation. EGGI recommended an in-well treatment system to prevent biofouling as a possible long-term solution. Well #2 consistently has a high concentration of iron in the raw water which is currently reduced via blending of water with the other two source wells. Well #3 typically has raw water iron concentrations very close to the USEPA secondary drinking water standard of 0.3 mg/L. All three source water wells have a typical pH below 6.25 hence the corrosion control treatment facility. Under typical operations, Wells #1 and #3 are run together.

In 1995, a booster pump station (BPS) was installed on Water Street and is used to pressurize the High Service Area. This Water Street BPS is equipped with three 7.5 HP, 65 gpm nominal pumps operating individually providing, on average, 20 gpm at 115 psi resulting in 50 psi at the high point of the service area.

2.3.2 Corrosion Control Facility

The corrosion control facility, constructed in 1995, is located off the Daniel Webster Highway and downstream of the PBWP's three production wells prior to the distribution system piping. The corrosion control facility utilizes corrosion control, iron sequestering, and disinfection as treatment methods.

Originally, the facility used polyphosphate for iron sequestering, sodium hydroxide (25%) for pH balance and alkalinity of raw water, sodium hypochlorite (4%) for disinfection, and zinc orthophosphate for pipe coating. In 2014, the facility transitioned from polyphosphate to Aqua-mag for iron sequestering, raised sodium hypochlorite from 4% to 12.5%, and removed zinc orthophosphate. Currently, the facility uses sodium hydroxide (25%) for pH balance and alkalinity of raw water, sodium hypochlorite (12.5%) for disinfection, and orthophosphate for iron sequestering.

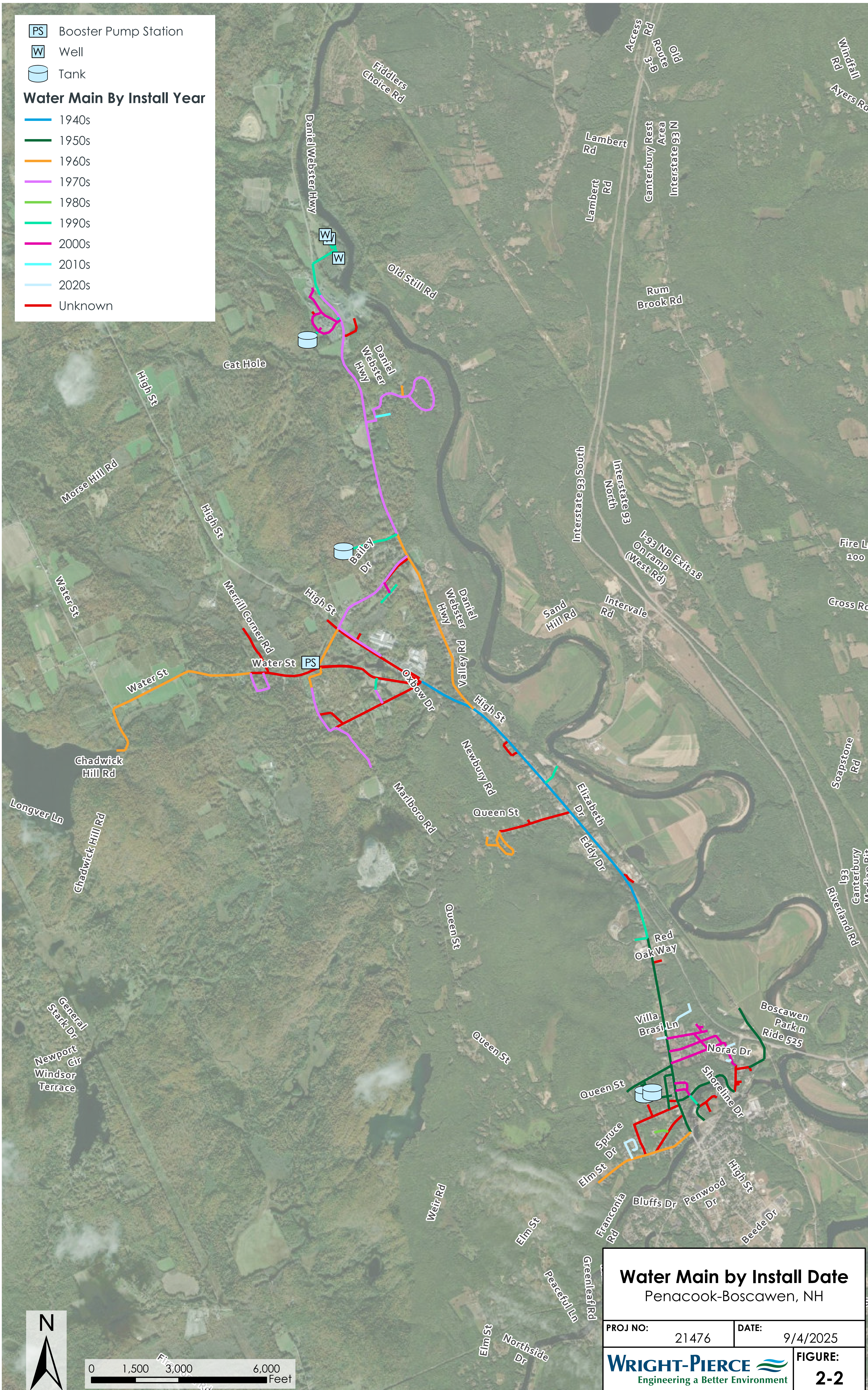
2.3.3 Distribution System Piping

The water distribution system consists of approximately 26 miles of water main piping ranging in size from 4-inch to 12-inch in diameter. In addition, there are approximately 130 hydrants, 190 gate valves, one pressure reducing valve, and approximately 1,200 metered service connections. A breakdown of piping by material type and diameter are presented in Table 2-3.

Table 2-3 Distribution System Piping

Pipe Material	Diameter (inches)	Length (feet)	% Total System
Asbestos Cement	4	395	0.28%
	6	33,979	24.53%
	8	20,849	15.05%
	10	4,134	2.98%
	12	9,950	7.18%
	Subtotal	69,307	50.04%
Cast Iron	6	8,344	6.02%
	8	1,882	1.36%
	10	17,423	12.58%
	12	1,285	0.93%
	Subtotal	28,934	20.89%
PVC	2	2,323	1.68%
	4	537	0.39%
	6	1,402	1.01%
	8	1,433	1.03%
	Subtotal	5,695	4.11%
Ductile Iron	6	2,190	1.58%
	8	14,149	10.22%
	10	795	0.57%
	12	8,814	6.36%
	Subtotal	25,948	18.73%
Unknown	4	1,366	0.99%
	6	903	0.65%
	8	3,207	2.32%
	10	924	0.67%
	12	2,216	1.60%
	Subtotal	8,616	6.22%
	Total	138,501	100.00%

A breakdown of piping by year, diameter, and material type are summarized from the updated mapping database developed for this study and presented in Figures 2-2, 2-3, and 2-4, respectively.



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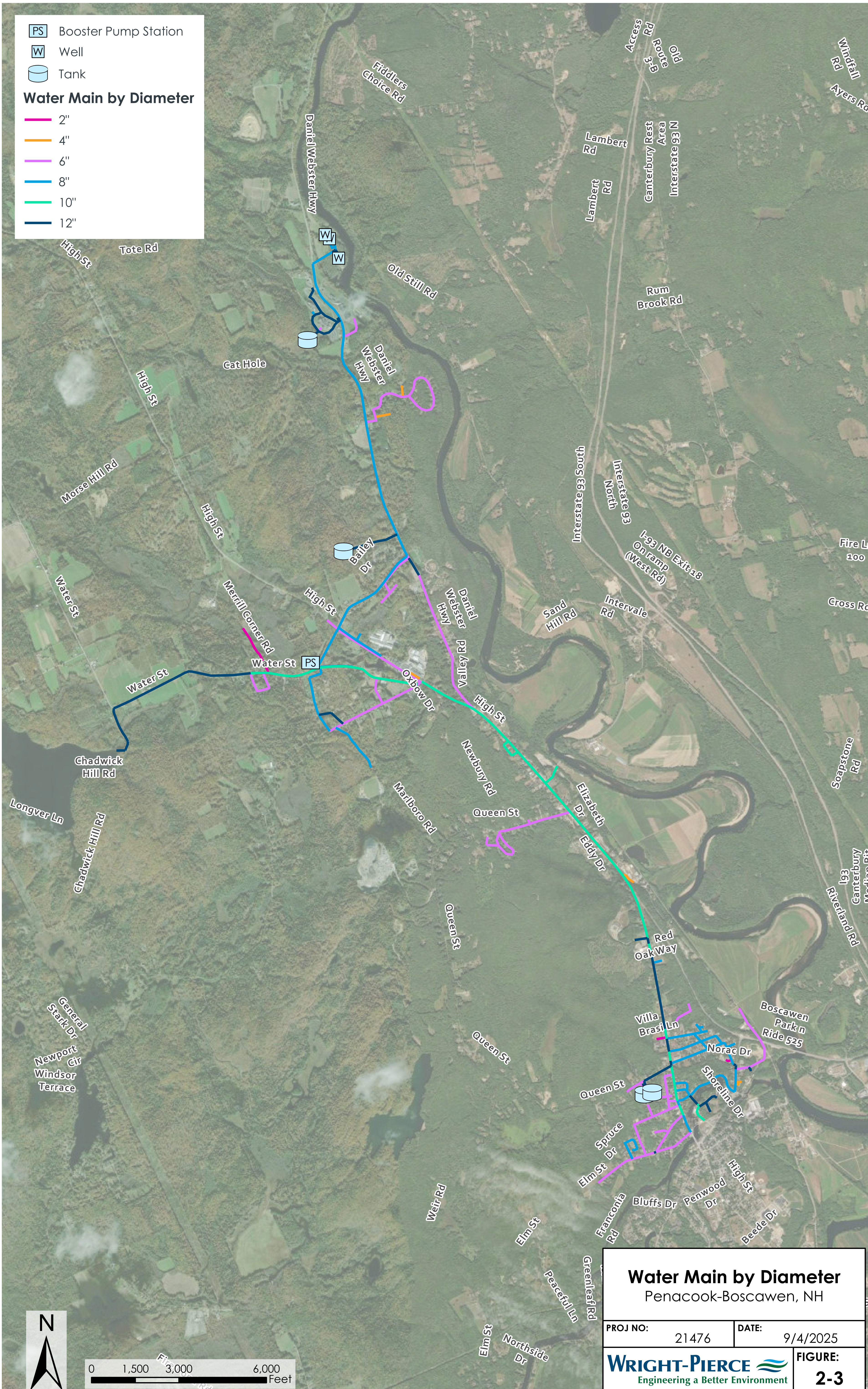

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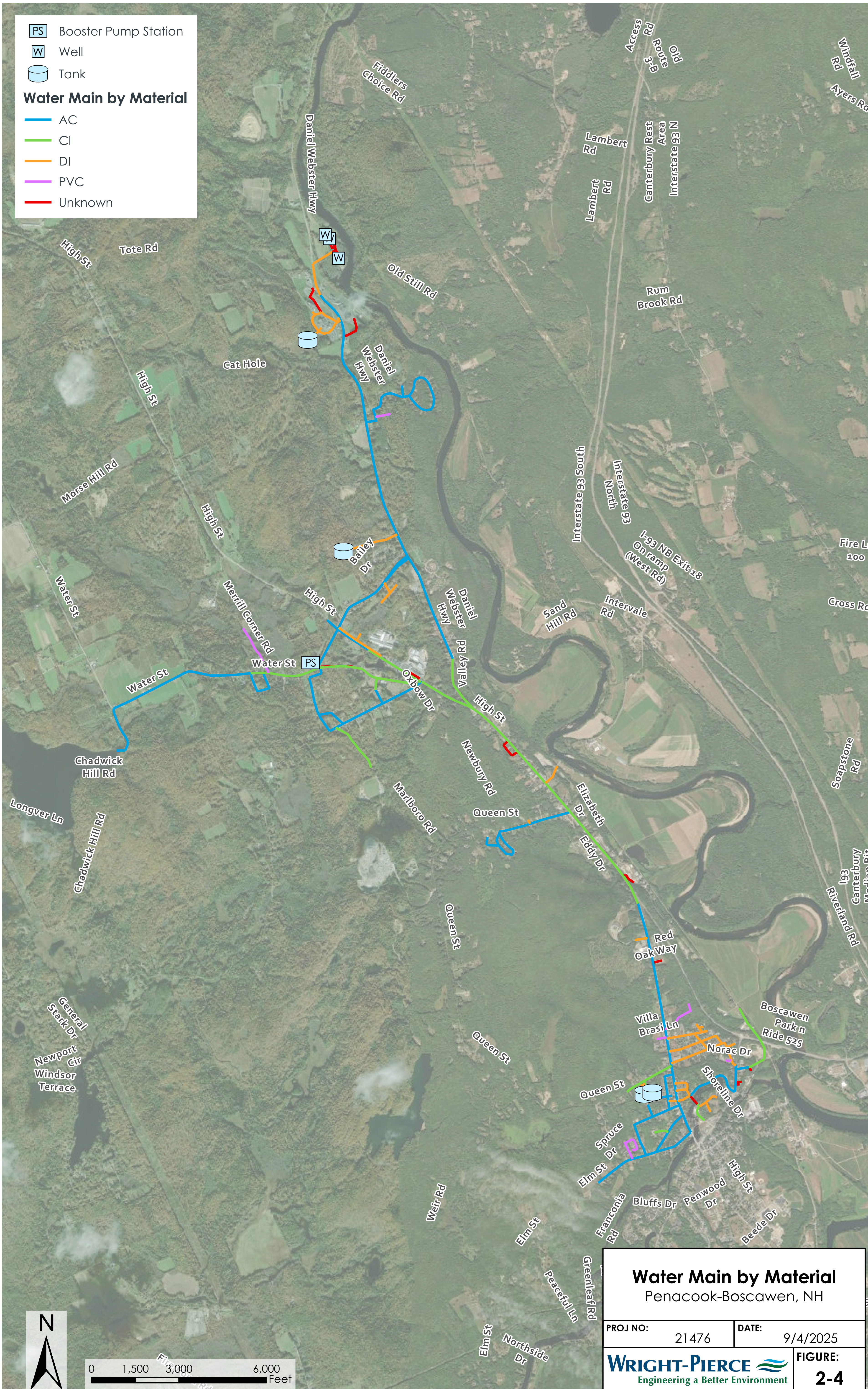

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In general, the majority of the distribution system piping is considered to be in poor physical condition. The oldest pipes in the system are cast iron that were installed in the 1940s. The majority of the system consists of asbestos cement, cast iron, and ductile iron with a small amount of PVC.

The PBWP currently inspects 20% of gate valves per year. PBWP conducts system flushing once a year. These activities maintain water quality in the distribution system by flushing out stagnant water and sediment build up, thus keeping the distribution system in operation longer and ensuring hydrants and valves are operational when needed for emergencies or construction projects.

2.3.4 Storage

Storage of water within the distribution system is typically used to provide for peak hourly demands, firefighting needs, and emergencies. Adequate storage allows transmission and treatment systems to be sized for no more than the maximum daily flows. Storage volume is replenished daily during periods of low demand. A diurnal 24-hour water use pattern typical of residential communities would allow for peak day-time water use periods to be replenished at night-time when demands are low. The PBWP distribution system includes four water storage tanks. None of the storage tanks include mixing systems. All four water storage tanks were cleaned and inspected by Underwater Solutions in 2021. A summary of storage facilities is presented in Table 2-5.

Table 2-4 Water Storage Facilities

Storage Facility	Material	Installation Year	Inside Diameter (feet)	Base Elevation (feet)*	Overflow Elevation (feet)*	Service Zone	Total Capacity (MG)
Queen Street Tank #1	Welded Steel	1954	25	434	508	Queen	0.30
Queen Street Tank #2	Welded Steel	1974	50	434	508	Queen	1.00
Fairbanks Street Tank	Pre-cast Concrete	1995	56	492	532	Fairbanks	0.75
Merrimack County Nursing Home Tank	Bolted Steel	1995	27	430	500	County	0.26
						Total Volume	2.31

2.3.5 System Controls

The gravel packed well pumps start and stop on a 4-foot operating band at the Fairbanks Tank. The Merrimack County Tank, which is at a lower elevation than the Fairbanks Tank, is fed through a solenoid-assisted control valve located near the complex main entrance, which opens and closes to maintain a 4-foot operating band in the Merrimack County Tank. Water levels at the Queen Street Tanks are telemetered to the electronic controls at the corrosion control facility, which in turn controls a solenoid-assisted pressure reducing valve located between the upper and lower zones near the intersection of Routes 3 and 4. The Queen Street Tanks have a 5.5-foot operating band, an as the tank levels drop, the PRV opens to increase flow to the lower zone. The Water Street Zone is pressurized by the Water Street booster station, which serves 60-70 customers. The Water Street Zone does not have gravity storage. The system operators indicated that only one pump operates at a time and delivers about 20 gpm on average at a discharge pressure of 115 psi, which provides 50 psi at the top of the hill. A 40-kW diesel generator provides backup power for the booster station. There are no high-capacity pumps provided in the Water Street Zone. There is also an emergency valved connection to the Concord Water Works that flows towards Concord due to the PBWP's higher hydraulic grade line.

2.4 Water Demands, Trends, and Projections

To plan for future needs of the water system facilities and infrastructure, it is important to understand future growth within the service area. An important aspect of the planning process is to plan for upgrades and/or infrastructure replacements in advance of the impending increases in demand.

Future water demands were projected as a part of this study and used to evaluate the PBWP water distribution system over the 20-year planning period. Demands were projected using historical meter readings and U.S. Census Bureau population trends for Boscawen, NH. The projections presented herein will serve as the framework for the distribution system analyses in Section 4.

2.4.1 Population Trends & Projections

The first step in estimating future service populations is understanding the existing service population. The PBWP serves approximately 94% of the residents of the Town of Boscawen (which was reported to have a population of 3,998 in 2020) and approximately 50 residents in the Penacook section of the City of Concord. This comes to a current population served of 3,808 which includes residential, commercial, industrial, agricultural, and municipal services. Historical population data serves as the basis for projecting demands.

According to the U.S. Census Bureau, the Town of Boscawen has experienced varied population growth in recent decades. Annual growth has ranged between -0.8% and 8.6% since 1970. Table 2-6 contains historical population trends for the Town of Boscawen.

Table 2-5 Boscawen Population Trends

Year	Population	% Increase
1970	3,162	---
1980	3,435	8.6%
1990	3,407	-0.8
2000	3,668	7.7%
2010	3,966	7.5%
2020	3,998	0.8%

*U.S. Census Bureau Data

The NH DBEA prepared population projections for all towns and counties in the state up to 2050 based on 2020 US Census Data. Table 2-7 contains the projected population for the Town of Boscawen and population served by PBWP, assuming this number stays at approximately 94% of Boscawen's population.

Table 2-6 Boscawen Population Projections

Year	Boscawen Population	Population Served	% Increase
2020	3,998	3,808	---
2025	4,143	3,945	3.6%
2030	4,265	4,059	2.9%
2035	4,346	4,136	1.9%
2040	4,383	4,173	0.9%
2045	4,387	4,177	0.1%

2.4.2 Historical Demand Trends

Historical water demand was evaluated and used as a baseline for demand projections throughout the system. Pumping data was provided by the PBWP for the years 2019-2024 and is presented in Table 2-8.

Table 2-7 Historical Demand Trends

Year	Average-Day Demand (GPD)	Maximum-Day Demand (GPD)	Ratio of Maximum/ Average
2019	338,421	521,656	1.54
2020	342,481	729,122	2.13
2021	294,560	546,487	1.86
2022	304,559	710,714	2.33
2023	281,403	525,400	1.87
2024	298,038	516,280	1.73
Average	**309,910**	**591,610**	**1.91**

Knowledge of water system ADDs and MDDs is required to evaluate the adequacy of the existing system. The ADD is useful in estimating total water demand, chemical needs associated with treatment, and electric power consumption required for pumping. ADD is defined as the total water-use in a year divided by 365 days. The MDD is defined as the maximum day of water-use that occurs during a given year. The maximum daily demand is generally used to size pumping units, water mains, treatment processes, and storage facilities. The ratio of the maximum to average-day demand provides a general indication of the demand fluctuation over a typical day. The average MDD/ADD ratio was used for projecting future MDDs.

Future ADDs were projected by using the average ADD over the past 6 years and multiplying by the population percentage increase until 2045. This ADD was multiplied by the average MDD/ADD ratio (1.91) to obtain future MDD projections. The future ADDs, MDDs, and annual demands are presented in Table 2-8.

Table 2-8 Projected Water Use Demand Summary

Year	Average-Day Demand (GPD)	Maximum-Day Demand (GPD)
2025 (current)	309,910	591,610
2030	318,897	609,093
2035	324,956	620,666
2040	327,881	626,253
2045	328,209	626,879

The demand projections will be used to assess the hydraulic adequacy of the distribution piping and storage facilities, the results of which are presented in Section 4 of this report.

2.5 Water Audit

A water audit is a formal procedure to define sources of non-revenue water within the distribution system and determine if the sources can be remedied in a cost-effective manner. The audit should be developed in accordance with the guidelines of the American Water Works Association (AWWA) Manual of Water Supply Practices entitled "Water Audits and Leak Detection, AWWA M36". A water audit characterizes a variety of sources of lost water and includes a plan to address and account for sources of non-revenue water.

In general, revenue water is water-use that has been metered and billed to customers while non-revenue water is water-use that is not metered or results from inaccuracies of metering and other sources. Table 2-10 presents a breakdown of typical revenue and non-revenue sources in a system. The following is a list of definitions for the various terms used therein:

- Total Production Volume - The annual volume input to the water supply system.
- Authorized Consumption - The annual volume of metered and/or unmetered water taken by any user authorized to do so.
- Water Losses - The difference between Total Production Volume and Authorized Consumption, consisting of Apparent Losses plus Real Losses.
- Apparent Losses - Unauthorized Consumption, all types of metering inaccuracies and data handling errors.
- Real Losses - The annual volumes lost through all types of leaks, breaks and overflows on mains, service reservoirs and service connections, up to the point of customer metering. Commonly referred to as lost water.
- Revenue Water - Those components of Total Production Volume which are billed and produce revenue.
- Non-Revenue Water - The difference between Total Production Volume and Billed Authorized Consumption.

Some non-revenue water-uses can be confidently estimated and are therefore considered “authorized consumption” of water. The remaining volume is considered “water losses”. Industry standards suggest that total water loss volume should be no higher than 20% of the total production volume while real losses, by definition, true unaccounted for water (UAW), should be 10-15% of the total production volume. The State of New Hampshire has adopted rules under Env-Ws 2101, which require applicants for development of new sources to demonstrate that UAW is less than 15%.

Leaks are often the largest contributor to UAW and can originate from anywhere in the system. Leaks most commonly occur on main lines or valves but also can be found in service-lines, residential meter boxes, on the customer side of the service, and other miscellaneous sources.

The Precinct maintains a list of metered (non-billed) services across the distribution system. NCWP also estimates water used for hydrant flushing, service leaks, tank discharges, construction projects, and water main breaks. Water used for firefighting purposes is estimated as there are seven Fire Departments in the greater North Conway area. Sometimes trucks are filled via system hydrants and usage is not reported to the NCWP. We recommend NCWP coordinate with local fire departments to come up with a plan to improve communications and reporting of this estimated use.

The AWWA offers a free software (Microsoft Excel format) which water utilities can utilize to complete water audits for their system. The software estimates non-revenue water by comparing water entering the system (purchased, produced, etc.) to water exiting the system (sold, lost, etc.). Additionally, the software includes an interactive data grading tool which accounts for utility operational practices such as source meter calibration, system flushing, data retention, and customer meter location and calibration amongst other criteria. The software produces a Data Validity score which utilities can use to better manage their system and reduce non-revenue water use and associated expenses.

Table 2-9 Revenue and Non-Revenue Water Use Categories*

<table>
<tr><td rowspan="10">Total Production Volume (corrected for known errors)</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption (including water exported)</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="8">Non-Revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

*From AWWA M36.

We entered 2023 production and billed water data into the AWWA Water Audit Software along with BPWP operational practices. We used 2023 data in this evaluation as it was the last full year of data available at the time of the evaluation. Table 2-11 below contains the results of the water audit. In is estimated that BPWP had 11.2 MG of non-revenue water in 2023, representing approximately 15% of the total produced volume. BPWP is within industry standards for non-revenue water and should continue to execute sound operational practices to maintain this standing.

The evaluation placed BPWP in the Tier III group. AWWA recommends that Tier III water systems focus water loss control planning around the following areas:

Audit Data Collection	Establish/revise policies and procedures for data collection
Short-term loss control	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring
Long-term loss control	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process
Target-setting	Establish long-term apparent and real loss reduction goals (+10-year horizon)
Benchmarking	Preliminary Comparisons - can begin to rely upon with PIs for performance comparisons for real losses

Table 2-10 AWWA Water Audit Report

AWWA Free Water Audit Software
Water Balance

FWAS v6.0

American Water Works Association.
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Water Audit Report for: Penacook Boscawen Water Precinct
Audit Year: 2023 | Jan 01 2023 - Dec 31 2023
Data Validity Tier: TBD

Volume from Own Sources (VOS) (corrected for known errors) 75.573	System Input Volume 75.573	Water Exported (WE) (corrected for known errors) 0.000	Billed Water Exported			Revenue Water (Exported) 0.000
		Water Supplied 75.573	Authorized Consumption 70.176	Billed Authorized Consumption 64.335	Billed Metered Consumption (BMAC) (water exported is removed) 64.335	Revenue Water 64.335
					Billed Unmetered Consumption (BUAC) 0.000	
				Unbilled Authorized Consumption 5.841	Unbilled Metered Consumption (UMAC) 4.805	Non-Revenue Water (NRW) 11.238
					Unbilled Unmetered Consumption (UUAC) 1.036	
			Water Losses 5.397	Apparent Losses 0.495	Systematic Data Handling Errors (SDHE) 0.161	
					Customer Metering Inaccuracies (CMI) 0.173	
					Unauthorized Consumption (UC) 0.161	
Water Imported (WI) (corrected for known errors) 0.000				Real Losses 4.902	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

2.6 Water Quality Evaluation

The PBWP is considered a small community water system (<10,000 people) that serves approximately 3,808 customers. The PBWP supplies drinking water to the customers from three groundwater sources with varied water quality parameters. Over the past few years, the United States Environmental Protection Agency (EPA) has undertaken significant rule making activity which affects the operation of the PBWP System, including the Groundwater Rule and updates to the Lead and Copper Rule. Furthermore, the State of New Hampshire has lowered the MCL for detectable arsenic and PFAS.

Currently PBWP is a chlorinated system capable of treating up to 1.4 million gallons per day (MGD) utilizing sodium hypochlorite for disinfection and sodium hydroxide as pH adjustment for corrosion control purposes.

The purpose of the Safe Drinking Water Act (SDWA) of 1974 (amended in 1984 and 1996) is to ensure that public water systems meet national standards that protect consumers from the harm of contaminants in drinking water, by requiring EPA to regulate contaminants that present health risks, and which are known to, or are likely to, occur in public drinking water supplies. For each regulated contaminant, the EPA sets a legal limit on the amount allowed in drinking water. Limits set by States must be at least as strict as those established by the EPA.

Existing and future regulations identified as impacting PBWP include:

- Arsenic Rule
- Ground Water Rule (GWR)
- Total Coliform Rule (TCR)
- Lead and Copper Rule (LCR)
- PFAS/PFOA Regulation
- Radon Rule
- Unregulated Contaminant Monitoring Rule (UCMR IV)

The PBWP conducts a regular program of source and distribution water quality sampling and testing. Table 2-12 lists composite results of untreated water quality for the three wells. A compilation and summary of sampling results from both sources and distribution system are published in the yearly Consumer Confidence Report (CCR), which is distributed to all customers, as required by the United States Environmental Protection Agency (EPA).

Currently, the PBWP does not meet all USEPA Primary Drinking Water Standards. The source wells all have pH levels that are below the EPA MCL. The corrosion control facility uses sodium hydroxide to raise the pH of the water to a compliant level. Well #2's iron levels are above the MCL. To combat this, the wells' water is blended to keep iron levels below 0.3 mg/L.

Table 2-11 2024 Source Water Sample Results

Parameters	Units	MCL	Well #1	Well #2	Well #3
Alkalinity	mg/L as $CaCO_3$	NA	12	13	16*
Arsenic	mg/L	0.005	ND**	ND	ND
Calcium	mg/L	500	5.2	7.6	8.1*
Chloride	mg/L	250	16	23	30*
Hardness	mg/L	500	13.0	25.2	26.8*
Iron	mg/L	0.3	0.200	0.213	0.025*
Manganese	mg/L	0.050	0.0373	0.0091	0.0012*
Nitrate	mg/L	0.2	0.31	0.35	0.33
pH		6.5 - 8.5	5.75	5.63	6.01*
PFOA	ppt	4.0	ND	ND	ND
PFOS	ppt	4.0	ND	ND	ND
PFHxS	ppt	10.0	ND	ND	ND
PFNA	ppt	10.0	ND	ND	ND
Sodium	mg/L	100	11.7	11.6	18.5*
Sulfate	mg/L	250	9	7	9*

*Sampled in 2022

**ND indicates Non-Detect

2.6.1 National Primary Drinking Water Regulations

National Primary Drinking Water Regulations (or primary standards) are legally enforceable standards that apply to public water systems for primary contaminants. Primary standards limit the levels of contaminants in drinking water that adversely affect the public's health. Currently, the primary contaminant standards are divided into the following six categories:

- Microorganisms;
- Disinfectants;
- Disinfection Byproducts;
- Inorganic Chemicals;
- Organic Chemicals; and
- Radionuclides.

The concentrations allowed for the primary contaminants are quantified with a maximum contaminant level (MCL) as each can compromise public health through chronic or acute exposure.

The EPA is currently considering regulations for a group of compounds designated as Carcinogenic Volatile Organic Compounds (cVOCs) which include eight currently regulated Volatile Organic Compounds (VOCs) and eight unregulated VOCs. The EPA is also considering lowering the MCL for Trichloroethylene (TCE) and Tetrachloroethylene (PCE). These potential changes are not expected to impact PBWP.

2.6.2 National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as color, taste, or odor) in drinking water. The EPA recommends secondary contaminant standards to water systems but does not require systems to comply. However, individual states may choose to adopt them as enforceable standards.

Well #2 and Well #3 meet or exceed the SMCL for Iron. Well #2 is currently on a reduced pumping schedule based on Precinct's ability to blend water sources to maintain sufficiently low Iron levels. This has become challenging due to the decreasing productivity of Well #1 and the near SMCL Iron concentrations of Well #3, noted in the 2017 NHDES sanitary survey. These factors are one of the drivers in the Precinct's current investigations to develop a 4th well.

2.6.3 Arsenic Rule

Arsenic is common to New England states as it is an element that naturally occurs in bedrock. Ingesting water with elevated levels of arsenic for prolonged periods of time can increase the risk of cancer (bladder, lung, and skin) and cardiovascular disease. Studies have also shown arsenic in drinking water can increase the risk birth defects and reduced IQ in children.

In 2018, New Hampshire State Legislature directed NHDES to review the EPA's recommended MCL of 0.010 mg/L for arsenic in drinking water and groundwater. The NHDES evaluation considered, "the prevalence of arsenic in New Hampshire water supplies, the adverse health impacts that could be avoided by lowering the limit, the cost of water treatment to remove arsenic, and other factors all of which are explained in the report" (NHDES). Based on the findings of their evaluation, NHDES recommended that the MCL for arsenic in drinking water be reduced from 0.010 mg/L to 0.005 mg/L, effective July 1, 2021.

Compliance with the current and proposed Arsenic Rule is anticipated to continue. Table 2-13 contains the most recent arsenic sampling results.

Table 2-12 Arsenic Sampling Compliance

Year	Current Arsenic Limit (mg/L)	Well #1	Well #2	Well #3
2022	0.005	0.0015	0.0015	0.0015

2.6.4 Ground Water Rule

The Ground Water Rule (GWR), which pertains to groundwater sources not under the influence of surface water, was finalized on November 8, 2006. Compliance requirements of the GWR began in 2010. The purpose of the GWR is to better identify systems at risk for fecal contamination, and to provide the primacy agency a flexible range of tools to better protect the public health.

The GWR has the following four major components:

1. Periodic sanitary surveys of ground water systems that require the evaluation of eight critical elements and the identification of significant deficiencies (e.g., a well located near a leaking septic system). States had to complete the initial survey by December 31, 2012, for most community water systems (CWSs) and by December 31, 2014, for CWSs with outstanding performance and for all non-community water systems.
2. Source water monitoring to test for the presence of E. coli, enterococci, or coliphage in the sample. There are two monitoring provisions:

   a. Triggered monitoring for systems that do not already provide treatment that achieves at least 99.99 percent (4-log) inactivation or removal of viruses and that have a total coliform-positive routine sample under Total Coliform Rule (TCR) sampling in the distribution system.
   b. Assessment monitoring - As a complement to triggered monitoring, a State has the option to require systems with sources that seem susceptible to fecal contamination, to conduct source water assessment monitoring to help identify high risk systems.

3. Corrective actions required for any system with a significant deficiency or source water fecal contamination. The system must implement one or more of the following correction action options:

   a. correct all significant deficiencies,
   b. eliminate the source of contamination,
   c. provide an alternate source of water, or
   d. provide treatment which reliably achieves 99.99 percent (4-log) inactivation or removal of viruses.

4. Compliance monitoring to ensure that treatment technology installed to treat drinking water reliably achieves at least 99.99 percent (4-log) inactivation or removal of viruses.

A sanitary survey by the State primacy agency would be required every 3 years, and would review eight critical components to the extent that they apply to the individual water system being surveyed:

- Source
- Treatment
- Distribution System
- Finished Water Storage
- Pumps, Pump Facilities and Controls
- Monitoring, Reporting, and Data Verification
- System Management and Operation
- Operator Compliance with State Requirements

Survey frequency may be reduced to five years if the system either treats to 4-log inactivation of viruses or has an outstanding performance record in the eight performance elements documented in previous inspections and has no history of TCR, MCL or monitoring violations since the last sanitary survey.

Significant deficiencies in groundwater systems include, but are not limited to, the following types:

- Unsafe source (e.g., septic systems, sewer lines, feed lots nearby),
- Improper well construction,
- Fecal indicators present,
- Lack of proper cross-connection control for treatment chemicals,
- Lack of redundant mechanical components where chlorination is required for disinfection,
- Improper venting of chemical storage tanks,
- Overflow and drainpipes not properly screened,
- Holes in storage tank roof, improper hatch construction, improper clearwell hatch construction,
- Inadequate internal cleaning and maintenance of storage tank,
- Unprotected cross connection (e.g., hose bib without vacuum breaker),
- System leakage that could result in the introduction of contaminants,
- Inadequate monitoring of disinfectant residuals and TCR, MCL or monitoring violations.

The GWR uses the existing TCR monitoring as one trigger for identifying whether a system should be defined as high risk and requiring source monitoring. A groundwater system that does not disinfect to 4-log virus inactivation and has a distribution system TCR sample that tests positive for total coliform is required to conduct "triggered source water monitoring" to evaluate whether the total coliform presence in the distribution system is due to fecal contamination in the groundwater source. Within 24-hours of receiving the total coliform positive notice, the system must collect at least one groundwater sample from each groundwater source and test it for fecal indicators.

If any monitoring sample is fecal indicator-positive, the system must notify the State immediately, and then take corrective action. Corrective action is required to correct the significant deficiency, provide an alternate source of water, or provide treatment which reliably achieves at least 99.99 percent (4-log) inactivation or removal of viruses before or at the first customer. The 4-log virus inactivation can be achieved through treatment technique. One available treatment technique is to maintain a disinfectant residual for a prescribed length of contact time. The required contact time is dependent upon the type of disinfectant used and the water pH and temperature.

When a system continuously monitors chemical disinfection, the system must notify the State any time the residual disinfectant concentration falls below the state-determined residual disinfectant concentration and is not restored within four hours. If any sample does not contain the required residual concentration, the system must take follow-up samples every four hours until the required residual disinfectant concentration is restored.

2.6.5 Total Coliform Rule

2.6.5.1 Current Requirements

The existing Total Coliform Rule (TCR) applies to all public water systems regardless of their size or water source and requires monitoring the distribution system for total coliforms. If a total coliform (TC) test is positive, the rule prescribes follow up sampling within 24 hours at the sample tap that failed and at two additional taps, one within 5 services downstream, and one within 5 services upstream.

The Maximum Contaminant Levels (MCLs) for microbiological contaminants is based on the presence or absence of total coliform in routine samples, rather than coliform density. A system the size of the PBWP would take 4 samples per month and a violation is triggered when more than one routine/repeat sample per month is total coliform positive.

Any fecal coliform-positive repeat sample or E. coli-positive repeat sample, or any total coliform-positive repeat sample following a fecal coliform-positive or E. coli-positive routine sample constitutes a violation of the MCL for total coliform. For purposes of the public notification requirements in 310 CMR 22.16, this is a violation that may pose an acute risk to health. The PBWP has not been in violation of the TCR.

The following have been determined to provide best available technology (BAT), be defined as treatment technique, or other means available for achieving compliance with the maximum contaminant level for total coliform:

- Wells are protected from coliform contamination by appropriate placement and construction;
- Proper maintenance of the distribution system including appropriate pipe replacement and repair procedures, main flushing programs, proper operation and maintenance of storage tanks and reservoirs, and continual maintenance of positive water pressure in all parts of the distribution system;
- The development and implementation of a NHDES approved wellhead protection program.

2.6.6 Lead & Copper Rule

The Lead and Copper Rule (LCR) was promulgated in June 1991 and has been revised several times including in 1998, 2000, 2004, 2007, and 2021 with plans for further improvements in 2024. The purpose of the LCR is to protect public health by minimizing lead and copper levels in drinking water, primarily by reducing water corrosivity. The LCR requires that 90% (P90) of lead and copper samples tested fall below the respective action levels (AL) of 0.015 mg/L for lead and 1.3 mg/L for copper. Recent revisions require all water systems to develop a publicly available Lead Service Line (LSL) Inventory (LSLI) and LSL Replacement Plan (LSLR Plan) by October 2024 with annual updates. Any changes to source water or treatment techniques must be accompanied by primacy agency approval and followed by biannual monitoring.

PBWP began sampling for lead and copper in 1992 on a semi-annual basis. Based on a successful history of meeting LCR requirements, PBWP sampling was reduced to an annual basis in 2000 and further reduced to once every three years in 2003. The PBWP is currently required to sample 20 sites throughout the distribution system every three years. **Table 2-14** contains sampling results for the last five sampling cycles.

Table 2-13 Lead and Copper Sampling Compliance

Year	Lead MCL (mg/L)	Lead Result (mg/L)	Copper MCL (mg/L)	Copper Result (mg/L)
2012	0.015	0.002	1.3	0.260
2015	0.015	0.001	1.3	0.240
2018	0.015	0.002	1.3	0.264
2021	0.015	0.0	1.3	0.158

Year	Lead MCL (mg/L)	Lead Result (mg/L)	Copper MCL (mg/L)	Copper Result (mg/L)
2024	0.015	0.0	1.3	0.148

Sampling and Monitoring: Lead and copper sampling must be conducted in wide-mouthed bottles of the first liter of at least 6-hour-old stagnant water (fifth liter for homes with lead service lines). Aerator cleaning or removal and pre-stagnation flushing prior to sample collection is prohibited. Sampling occurs every 6-months at a number of sites dependent on system size.

- Systems serving ≤ 3,000 people may apply for a water quality monitoring waiver to sample every 9 years.
- Systems serving ≤ 50,000 people that test below the AL for both lead and copper for two consecutive 6-month monitoring periods may begin sampling annually. After three years of annual sampling the system qualifies for triennial sampling. Water quality monitoring must be conducted for systems with 6-month sampling intervals
- Systems serving > 50,000 people must meet above requirements and have optimal source water quality parameters to qualify for annual or triennial sampling. Regular water quality monitoring must be conducted.
- Systems with lead ≤ 0.005 mg/L and copper ≤ 0.65 mg/L for two consecutive 6-month periods may qualify for accelerated reduced monitoring and triennial sampling.
- Lead sampling may be required more frequently in systems with higher lead concentrations, but this does not impact copper sampling frequency.
- 20% of elementary schools and childcare facilities must be sampled for lead annually. Secondary school sampling should be conducted upon request. All applicable lead sampling results must be shared with the respective schools, health departments, and primacy agencies. Facilities constructed or have had a complete plumbing renovation after January 2014 are exempt from lead sampling requirements.
- Source water monitoring is required in all systems with source water treatment and/or lead levels exceeding the AL. Primacy agencies may waive continued source water monitoring requirements for untreated systems if no new water sources are added and previous continuous monitoring has been conducted.
- New lead sample location tiering criteria was introduced in 2021 which requires all samples to be taken from locations with known LSLs when possible.

Trigger Level (TL) Requirements: Defined a lead TL of P90 > 0.010 mg/L and introduced requirements based on water system size. When the TL is exceeded, annual lead sampling is the new minimum frequency and systems must conduct testing to develop or re-optimize corrosion control plans.

- Systems serving > 3,300 people must implement their LSLR program in consultation with their primacy agency for at least 2 consecutive years.
- Systems serving > 10,000 people must address the implementation or effectiveness of corrosion control treatment within the system. The first TL exceedance requires the system to develop a treatment plan which would be installed upon the second TL exceedance.
  Systems serving ≤ 10,000 people may choose to reduce lead levels below the TL from four options: corrosion control treatment, LSL replacement, replacement of all lead-bearing plumbing materials, or providing and maintaining point-of-use treatment devices (such as pitcher filters) to customers. All options are subject to primacy agency approval.

Action Level (AL) Requirements: Strengthened requirements for systems exceeding the lead AL of P90 ≥ 0.015 mg/L now mandate several actions dependent on system size. When the TL is exceeded, 6-month lead sampling is the new minimum frequency. Systems must install or re-optimize corrosion control treatment (CCT) immediately.

- Systems serving > 3,300 people must begin replacing ≥ 3% of LSLs within their system annually based on a two-year rolling average.
- Systems serving > 10,000 people must immediately implement corrosion control treatment regardless of historical lead levels.
- Systems serving ≤ 10,000 people must reduce lead levels by CCT or LSL replacement within 15 years.
- All systems must notify customers within 24 hours of receiving test results and provide public education materials discussing lead sources, health effects, measures to reduce lead exposure, and sources for additional information. All public education materials must be available in multiple languages upon request.
- All systems without source water treatment and exceed the AL must undergo continued source water monitoring.

Individual Samples Exceeding AL: All customers with individual samples exceeding the AL must be provided with a lead notice within 3 days and effected sample locations must be re-sampled within 30 days. Systems with corrosion control treatment must conduct water quality parameter monitoring at or near the site and perform corrective actions. If the customer does not respond or refuses contact after two attempts, the water system must document interactions and inform local public health officials.

LSL Replacement Program: The annual LSL replacement rate is dependent on the number of unknown material, galvanized, and lead service lines present at the time of AL exceedance. Both private and public sides of the service line must be replaced to count towards the completion of annual rates and qualify for some funding programs. If a customer decides to replace their private side LSL, the system must replace the public side within 45 days of notification. The state may authorize a replacement period extension for up to 180 days from the date of notification. Within 24 hours of LSLR completion, systems must provide consumers with a 6-month supply of pitcher filters and replacement cartridges and a new lead test must be conducted in 3 to 6 months.

Public Education and Outreach: Updated consumer confidence report (CRR) lead health effect language. Requires the CCR to include access information for the system's LSLI and tap sampling results. Annual notice to customers supplied by LSLs or service lines of unknown material is now required and any water-related work that may disturb LSLs must be accompanied by prior notice and educational materials. Targeted outreach to LSL customers encouraging LSLR must be completed in systems utilizing a goal based LSLR program, otherwise additional outreach actives may be required. The system must provide educational materials to local health authorities and healthcare providers.

Lead Service Line Inventory: A fully developed LSLI is required by October 2024. The LSLI must include information on both the public and private sides of each service line that is connected to the public water system. The LSLI requires that each service line be classified as one of four options: lead, galvanized requiring replacement (GRR), non-lead (or the actual material), or lead status unknown. It is recommended that each service line also includes other details of the service line such as street address (for the locational identifier), pipe diameter, and installation date.

Currently, PBWP is on a reduced monitoring schedule and complies with all the provisions of the lead and copper rule.

2.6.7 Radon Rule

Radon-222 is a naturally occurring volatile gas which forms from the radioactive decay of uranium-238 in the ground. Radon is colorless, odorless, tasteless, chemically inert, and radioactive. Radon can move through air or dissolve into water occurring in soil pores. Radon commonly enters homes through soil gas entering basement and crawl spaces, or when water containing radon is used for cooking or washing, releasing it Into the air of the house where it can be inhaled.

The Radon Rule was proposed on November 2, 1999, but has not yet been finalized. It was re-scheduled to be promulgated in late 2004, but remains delayed. The rule is unique in that for the first time, the EPA seeks to address a health risk caused by an air and water-borne contaminant with one rulemaking.

Section 3 Regulatory Review

3.1 Introduction

The Safe Drinking Water Act (SDWA) of 1974 (amended in 1986 and 1996) is the legal foundation of most United States Environmental Protection Agency (EPA) water regulations. The purpose of the SDWA is to ensure that customers of public water systems are protected from contaminants that have been known to or have the potential to cause adverse health effects to the consumer by regulating contaminant concentrations that may be distributed to the general public. For each regulated contaminant, EPA sets a legal limit on the amount allowed in drinking water. Limits set by States must be at least as strict as those established by the EPA.

In recent years, the EPA has continued to progress regulations that affect the operation of water systems. Notable regulatory changes include the update to the Lead and Copper Rule (LCR) and PFAS regulation development. These two regulatory changes have had a large impact on the water industry and public water suppliers have had to pivot and re-think priorities. Additionally, new contaminants are routinely under review or in the planning stages for future regulation by the EPA.

In New Hampshire, the Department of Environmental Services (NHDES) are responsible for enforcing National Primary Drinking Water Regulations along with state-based treatment initiatives that are more stringent than the national standard. This report section will review water quality regulations (current and future) which have the potential to impact the Penacook-Boscawen Water Precinct (PBWP). Regulations that pertain to the PBWP or have the potential to impact the PBWP in the future include:

- National Primary Drinking Water Regulations:
  - Ground Water Rule
  - Revised Total Coliform Rule
  - Stage 1 & 2 Disinfectants and Disinfection Byproducts Rule
  - Chemical Contaminant Rules
  - Arsenic Rule
  - Lead and Copper Rule
  - PFAS Rule
  - Radionuclides Rule
- Unregulated Contaminant Monitoring Rule:
  - Contaminant Candidate Lists
  - Unregulated Contaminant Monitoring Rules (1-5)
  - Regulatory Determination
- National Secondary Drinking Water Regulations
- Regulatory Assessments
  - Source Water Protection
- Horizon Issues
  - Radon Rule
  - Manganese Rule
  - Other horizon issues

3.2 Classification of a Water System

The classification of a water system is typically based upon the population served and the characteristics of the water source (e.g., surface water vs. groundwater), the volume of water furnished, and complexity of treatment provided. A water system's classification is used to establish which state and federal rules apply to the water system and the requirements for compliance.

The PBWP system is classified as a non-transient community water system because it is a public water system (PWS) that supplies water to a population year-round. PBWP serves approximately 1,200 residential customer accounts. For regulatory purposes, the Precinct serves a population of approximately 3,800 (NHDES) which categorizes it as a major community water system. The distribution system is operated by Pennichuck Water, headquartered in Nashua, NH, and is classified as a groundwater system and is subject to the requirements of the Groundwater Rule (GWR). The treatment facilities require an operator to maintain a Grade 1 License to operate the systems.

3.3 New Hampshire Drinking Water Standards

In accordance with the SDWA, a State may be granted primacy for implementing the provisions of the SDWA provided that the regulations are as stringent as the EPA regulations, at a minimum. The NHDES is the primacy agency which regulates water systems under the New Hampshire Code of Administrative Rules, Env-Dw. Applicable rules include:

- Env-Dw 100 – Public Water Systems: Purpose and Applicability; Use Of Federal Terms; Special Provisions for Political Subdivisions; Definitions.
- Env-Dw 200 – Rule Waivers; Confidential Business Information; Hearing Procedures.
- Env-Dw 300 – Sources of Water.
- Env-Dw 400 – Public Water System Classification and Design.
- Env-Dw 500 – Operation and Maintenance.
- Env-Dw 600 – Capacity Assurance.
- Env-Dw 700 – Water Quality: Standards, Monitoring, Treatment, Compliance, and Reporting.
- Env-Dw 800 – Public Notification by Public Water Systems.
- Env-Dw 900 – Protection of Water Sources.
- Env-Dw 1000 – Grants for Public Water System.
- Env-Dw 1100 – Drinking Water State Revolving Loan Fund Program.
- Env-Dw 1300 – Administrative Procedures for Grants and Loans from the Drinking Water and Groundwater Trust Fund.
- Env-Dw 1400 – Per And Polyfluoroalkyl Substances (PFAS) Remediation Grant and Loan Fund Programs for Certain Public Water Systems

3.4 National Primary Drinking Water Regulations

National Primary Drinking Water Regulations (NPDWR, or primary standards) are legally enforceable contaminant concentration limits and treatment techniques that apply to a PWS. The concentration limits for primary contaminants are quantified with a Maximum Contaminant Level (MCL) because either chronic or acute exposure to these can compromise public health. The EPA is required to review, and if appropriate, revise existing National Primary Drinking Water Rules every six years with the last review occurring in 2022 with expected completion in 2023. A complete listing of the national primary drinking water standards may be found on the EPA website at http://water.epa.gov/drink/contaminants.

Currently, the NPDWRs are divided into the following six categories. Each category is comprised of a specific group of contaminants, each regulated by rules developed to effectively control their concentrations in drinking water. The rules associated with the six NPDWR categories are outlined below:

- Microorganisms:
  - Ground Water Rule
  - Revised Total Coliform Rule
- Disinfectants:
  - Stage 1 Disinfectants and Disinfection Byproducts Rule
  - Stage 2 Disinfectants and Disinfection Byproducts Rule
- Disinfection Byproducts:
  - Same as under *Disinfectants*
- Inorganic Chemicals:
  - Chemical Contaminant Rules
  - Arsenic Rule
  - Lead & Copper Rule
  - PFAS Rule
- Organic Chemicals:
  - Chemical Contaminant Rules
- Radionuclides:
  - Radionuclides Rule

Of the NPDWRs outlined above, the Surface Water Treatment Rule and Stage 1/2 Disinfection Byproduct Rules dodoes not apply to PBWP. The following subsections detail the rules applicable to PBWP and outline the treatment and sampling requirements of the Precinct.

3.4.1 Ground Water Rule

The Ground Water Rule (GWR) which pertains to groundwater sources not under the influence of surface water was finalized on November 8, 2006. Compliance requirements of the GWR began in 2010. The purpose of the GWR is to better identify systems at risk for fecal contamination, and to provide the primacy agency with a flexible range of tools to better protect public health. The GWR has the following four major components:

1. Periodic sanitary surveys of ground water systems that require the evaluation of eight critical elements and the identification of significant deficiencies (e.g., a well located near a leaking septic system). States had to complete the initial survey by December 31, 2012, for most community water systems (CWSs) and by December 31, 2014, for CWSs with outstanding performance and for all non-community water systems.
2. Source water monitoring to test for the presence of E. coli, enterococci, or coliphage in the sample. There are two monitoring provisions:
   a. Triggered monitoring for systems that do not already provide treatment that achieves at least 99.99 percent (4-log) inactivation or removal of viruses and that have a total coliform-positive routine sample under Total Coliform Rule (TCR) sampling in the distribution system.
   b. Assessment monitoring - As a complement to triggered monitoring, a State has the option to require systems with sources that seem susceptible to fecal contamination, to conduct source water assessment monitoring to help identify high risk systems.

3. Corrective actions required for any system with a significant deficiency or source water fecal contamination. The system must implement one or more of the following correction action options:
    a. correct all significant deficiencies,
    b. eliminate the source of contamination,
    c. provide an alternate source of water, or
    d. provide treatment which reliably achieves 99.99 percent (4-log) inactivation or removal of viruses.
4. Compliance monitoring to ensure that treatment technology installed to treat drinking water reliably achieves at least 99.99 percent (4-log) inactivation or removal of viruses. A sanitary survey by the State primacy agency would be required every 3 years, and would review eight critical components to the extent that they apply to the individual water system being surveyed:
    a. Source
    b. Treatment
    c. Distribution System
    d. Finished Water Storage
    e. Pumps, Pump Facilities and Controls
    f. Monitoring, Reporting, and Data Verification
    g. System Management and Operation
    h. Operator Compliance with State Requirements

The survey frequency may be reduced to five years if the system either treats to 4-log inactivation of viruses or has an outstanding performance record in the eight performance elements documented in previous inspections and has no history of TCR, MCL or monitoring violations since the last sanitary survey. Significant deficiencies in groundwater systems include, but are not limited to, the following types:

- Unsafe source (e.g., septic systems, sewer lines, feed lots nearby),
- Improper well construction,
- Fecal indicators present,
- Lack of proper cross-connection control for treatment chemicals,
- Lack of redundant mechanical components where chlorination is required for disinfection,
- Improper venting of chemical storage tanks,
- Overflow and drainpipes not properly screened,
- Holes in storage tank roof, improper hatch construction, improper clearwell hatch construction,
- Inadequate internal cleaning and maintenance of storage tank,
- Unprotected cross connection (e.g., hose bib without vacuum breaker),
- System leakage that could result in the introduction of contaminants,
- Inadequate monitoring of disinfectant residuals and TCR, MCL or monitoring violations.

The GWR uses the existing TCR monitoring as one trigger for identifying whether a system should be defined as high risk and requiring source monitoring. A groundwater system that does not disinfect to 4-log virus inactivation and has a distribution system TCR sample that tests positive for total coliform is required to conduct "triggered source water monitoring" to evaluate whether the total coliform presence in the distribution system is due to fecal contamination in the groundwater source. Within 24-hours of receiving the total coliform positive notice, the system must collect at least one groundwater sample from each groundwater source and test it for fecal indicators.

If any monitoring sample is fecal indicator-positive, the system must notify the State immediately, and then take corrective action. Corrective action is required to correct the significant deficiency, provide an alternate source of water, or provide treatment which reliably achieves at least 99.99 percent (4-log) inactivation or removal of viruses before or at the first customer. The 4-log virus inactivation can be achieved through treatment technique. One available treatment technique is to maintain a disinfectant residual for a prescribed length of contact time. The required contact time is dependent upon the type of disinfectant used and the water pH and temperature.

3.4.2 The Revised Total Coliform Rule

The Revised Total Coliform Rule (RTCR) was promulgated in 2013 and requires PWS to comply with the requirements of the RTCR by April 1, 2016. The RTCR was intended to reduce the implementation burden of the original Total Coliform Rule (TCR) while, at the same time, better ensuring the integrity of the distribution system.

The objectives of the RTCR are as follows: (1) to evaluate the effectiveness of treatment, (2) to determine the integrity of the distribution system, and (3) to signal the possible presence of fecal contamination. It did not change the monitoring required, but it did change the actions a PWS must take for compliance.

The RTCR set a MCLG and MCL for E. coli and Total Coliforms to protect water supplies against possible fecal contamination. A PWS that exceeds a specified frequency of total coliform occurrence must conduct either a Level 1 or Level 2 Assessment to determine if any sanitary defects exist. Sanitary defects are defined by the RTCR as a “defect that could provide a pathway of entry for microbial contamination into the distribution system or that is indicative of a failure or imminent failure of a barrier that is already in place”. If any sanitary defects are found, the system must correct them.

- Level 1 Assessment – Is triggered when a system that collects less than 40 samples per month has two or more total coliform positive samples in the same month (5%), or if a PWS fails to take all required repeat samples after any total coliform positive sample. The Level 1 Assessment is performed by the PWS. The Level 1 Assessment form must be submitted to the state within 30 days of the infraction.
- Level 2 Assessment – Is triggered if a PWS sample exceeds the E. Coli MCL, there is the need for a second Level 1 Assessment within a year of the first assessment, or if a PWS has a Level 1 Assessment triggered in two consecutive years. The Level 2 Assessment is performed by the state or state-approved entity. The Level 2 Assessment form must be submitted to the state within 30 days of the infraction.

For every regulation, the EPA is required to identify a Best Available Technology (BAT), which is defined as treatment technique, or other means available for achieving compliance with the rule’s requirements. In the case of the RTCR, the following BAT are recommended to ensure levels below the MCL for total coliform:

1. Disinfectant residual is maintained throughout the distribution system,
2. Proper maintenance of the distribution system including appropriate pipe replacement and repair procedures, main flushing programs, proper operation, and maintenance (O&M) of storage tanks and reservoirs, and continual maintenance of positive water pressure in all parts of the distribution system,
3. Filtration and/or disinfection of surface water using strong oxidants such as chlorine, chlorine dioxide, or ozone.

NHDES published guidance on addressing bacterial contamination in small transient water systems in 2020 “DWGB-7-8” which is intended to assist small water systems in the evaluation and correction of bacterial contamination for compliance with the RTCR.

PBWP is required to take four routine samples per month. If a sample is positive for total coliform, the rule prescribes that three repeat samples be taken within 24 hours for each positive sample to ensure a false positive sample did not occur. Any positive repeat sample constitutes a violation of the MCL for total coliform. PBWP would also be required to take two routine samples the month following a positive routine sample. For purposes of the public notification requirements in 310 CMR 22.16, this is a violation that may pose an acute risk to health. PBWP has not had a violation since the inception of the RTCR in 2013.

3.4.3 Stage 1 & 2 Disinfectants and Disinfection Byproduct Rules

The Stage 1 & 2 Disinfectants and Disinfection Byproduct Rules (DDBR) regulate all community water systems that deliver water disinfected by any means other than UV light. While non-UV disinfectants are important and effective for controlling microorganisms, they react with naturally occurring organic matter (NOM) in the finished water to form potentially dangerous by-products. The DDBR protects the public against the excessive presence of ozone or chlorine-based disinfectants and disinfection byproducts (DBPs) such as Trihalomethanes (TTHM), Five Haloacetic Acids (HAA5), Bromate, and Chlorite in drinking water by introducing an MCL on the running annual average concentration of each group of compounds. The MCLs established under the DDBR are as follows: TTHM < 80ppb, HAA5 < 60ppb, Chlorate < 1.0 mg/L, Bromate < 0.010 mg/L, and the maximum residual disinfectant level must be less than 4.0 mg/L for chlorine or chloramines as Cl_2.

Stage 1 DDBR required disinfection byproduct sampling to occur at the location of maximum residence time during the month of the warmest weather and the entire system is averaged for compliance purposes. These sampling requirements were soon increased by the Stage 2 DDBR. The Stage 2 DDBR requires a distribution system evaluation to be completed in order to determine the sampling locations in the system which are most likely to form DBPs. Each Stage 2 DDBR sampling location is assessed separately with its own running annual average which must meet the MCLs. If the running annual average for an individual sampling location exceeds the MCLs for one or more DBP compound, then the system must increase monitoring to a quarterly frequency until the system returns to compliance.

Water systems at higher risk of DBP formation typically have areas in the water distribution system with high residence times, tanks with low turnover or mixing, high dosage and residual concentrations of disinfectant, and increased presence of organic matter. Reducing the formation of DBPs within the treatment plant can be achieved by one of three primary practices: Reducing the concentration of natural organic matter (NOM) precursor (measured as total organic carbon (TOC) and color) before the addition of disinfectant, reducing the concentration of disinfectant used to achieve the required contact time with the disinfectant during the primary disinfection process, and switching to a disinfectant that forms lower levels of regulated DBPs.

NHDES requires PBWP to complete annual sampling of TTHM and HAA5 at two locations within the distribution system in accordance with the Stage 1 DDBR. PBWP is in good standing with the Stage 1/2 DDBR.

3.4.4 Chemical Contaminant Rules

The Phase I, II, IIA, and V Chemical Contaminant Rules were promulgated between 1987 and 1992 and apply to all PWS. The Rules regulate over 65 contaminants to reduce the risk associated with developing cancer, organ damage, and circulatory/nervous/reproductive system disorders in public water system customers. The Rules have also reduced the risk of "Blue Baby Syndrome" which occurs when high levels of nitrate/nitrite are ingested by infants. Each contaminant can be categorized into one of the following three groups:

- Inorganic Contaminants (IOCs)
- Volatile Organic Contaminants (VOCs)
- Synthetic Organic Contaminants (SOCs)

The majority of the regulated contaminants are organic, but some are inorganic. Organic contaminants require quarterly analysis for the first few years of treatment plant operation while inorganic contaminants require annual analysis. For groundwater systems with contaminant concentration levels below the MCL, the system may request a waiver to reduce sampling to once every 3, 6 or 9 years for synthetic organic compounds, volatile organic compounds, and inorganic compounds (respectively). Waivers associated with synthetic and volatile organic contaminants require a vulnerability assessment be renewed every 3 years. Vulnerability assessments require a PWS to prove that the contaminants have not been used in the area and that the source water is not susceptible to contamination from the contaminants of interest. Waiver renewals associated with inorganic contaminants depend on the results of previous sampling events.

The EPA is currently considering additional regulations under this ruling for a group of compounds designated as Carcinogenic Volatile Organic Compounds (cVOCs) which include eight currently regulated Volatile Organic Compounds (VOCs) and eight unregulated VOCs. The EPA is also considering lowering the MCL for Trichloroethylene (TCE) and Tetrachloroethylene (PCE). These potential changes are not expected to impact PBWP.

PBWP samples for SOCs and VOCs annually. PBWP used to operate under an SOC and VOC waiver until 2019. WP recommends PBWP applies to renew the expired waivers.

3.4.5 Arsenic Rule

Arsenic is common to New England states as it is an element that naturally occurs in bedrock. Ingesting water with elevated levels of arsenic for prolonged periods of time can increase the risk of cancer (bladder, lung, and skin) and cardiovascular disease. Studies have also shown arsenic in drinking water can increase the risk of birth defects and reduced IQ in children.

In January 2001, the EPA lowered the previous MCL for arsenic from 50 ppb to 10 ppb. Arsenic was added to the Phase II/V Chemical Contaminant Rules described above and public water systems were required to comply with the revised concentration limit by February 2006.

In 2018, New Hampshire State Legislature directed NHDES to review the EPA's recommended MCL of 0.010 mg/L for arsenic in drinking water and groundwater. The NHDES evaluation considered, "the prevalence of arsenic in New Hampshire water supplies, the adverse health impacts that could be avoided by lowering the limit, the cost of water treatment to remove arsenic, and other factors all of which are explained in the report" (NHDES). Based on the findings of their evaluation, NHDES recommended that the MCL for arsenic in drinking water be reduced from 0.010 mg/L to 0.005 mg/L, effective July 1, 2021.

PBWP last tested for arsenic in 2021, which resulted in a highest detect of 0.0015 mg/L. PBWP is in compliance with the current arsenic MCL of 0.005 mg/L.

3.4.6 Lead and Copper Rule Improvements

The Lead and Copper Rule was promulgated in June 1991 and has been revised several times including in 1998, 2000, 2004, 2007, 2021, and 2023 when the Lead and Copper Rule Improvements (LCRI) was proposed. The LCRI is anticipated to be finalized in October 2024, until then the (Lead and Copper Rule Revisions) LCRR is the current rule that must be followed. The purpose of the LCRI is to protect public health by minimizing lead and copper levels in drinking water, primarily by reducing water corrosivity. The LCRI proposes that 90% (P90) of lead and copper samples tested fall below the respective action levels (AL) of 0.010 mg/L for lead and 1.3 mg/L for copper. The lead AL is to be reduced from the 0.015 mg/L that is currently in place. Recent revisions require all water systems to develop a publicly available Lead Service Line Inventory (LSLI) and LSL Replacement Plan (LSLR Plan) by October 2024 with annual updates beyond the initial deadline. Any changes to source water or treatment techniques must be accompanied by primacy agency approval and followed by biannual monitoring.

Sampling and Monitoring

Lead and copper sampling must be conducted in wide-mouthed bottles of the first liter of at least 6-hour-old stagnant water (fifth liter for homes with lead service lines). Aerator cleaning or removal and pre-stagnation flushing prior to sample collection is prohibited. Sampling occurs every six months at a number of sites depending on system size.

- Systems serving ≤ 3,000 people may apply for a water quality monitoring waiver to sample every 9 years.
- Systems serving ≤ 50,000 people that test below the AL for both lead and copper for two consecutive 6-month monitoring periods may begin sampling annually. After three years of annual sampling the system qualifies for triennial sampling. Water quality monitoring must be conducted for systems with 6-month sampling intervals.
- Systems serving > 50,000 people must meet above requirements and have optimal source water quality parameters to qualify for annual or triennial sampling. Regular water quality monitoring must be conducted.
- Systems with lead ≤ 0.005 mg/L and copper ≤ 0.65 mg/L for two consecutive 6-month periods may qualify for accelerated reduced monitoring and triennial sampling.
- Lead sampling may be required more frequently in systems with higher lead concentrations, but this does not impact copper sampling frequency.
- 20% of elementary schools and childcare facilities must be sampled for lead annually on a rotating basis so that all facilities are sampled in a five-year period. Secondary school sampling should be conducted upon request. All applicable lead sampling results must be shared with the respective schools, health departments, and primacy agencies. Facilities constructed or have had a complete plumbing renovation after January 2014 are exempt from lead sampling requirements. Under the proposed LCRI, site specific waivers may be obtained which relieve the school or childcare from the first five-year testing cycle given lead samples were collected between January 2021 and the LCRI compliance date.
- Source water monitoring is required in all systems with source water treatment and/or lead levels exceeding the AL. Primacy agencies may waive continued source water monitoring requirements for untreated systems if no new water sources are added and previous continuous monitoring has been conducted.
- New lead sample location tiering criteria was introduced in 2021 under the LCRR which requires all samples to be taken from locations with known LSLs when possible. The proposed LSRI revises this location tiering criteria to include galvanized services and lead connectors. The EPA website should be consulted when determining sample site selection.

Trigger Level (TL) Requirements

The LCRR introduced the concept of "Trigger Levels" to aid systems in strengthening their corrosion control plans. The LCRR defined a lead TL of P90 > 0.010 mg/L and introduced requirements based the water system size. When the TL is exceeded, annual lead sampling is the new minimum frequency and systems must conduct testing to develop or re-optimize corrosion control plans.

- Systems serving > 3,300 people must implement their LSLR program in consultation with their primacy agency for at least 2 consecutive years.
- Systems serving > 10,000 people must address the implementation or effectiveness of corrosion control treatment within the system. The first TL exceedance requires the system to develop a treatment plan which would be installed upon the second TL exceedance.
- Systems serving ≤ 10,000 people may choose to reduce lead levels below the TL from four options: corrosion control treatment, LSL replacement, replacement of all lead-bearing plumbing materials, or providing and maintaining point-of-use treatment devices (such as pitcher filters) to customers. All options are subject to primacy agency approval.

The EPA is proposing to eliminate lead TL requirements with the upcoming LCRI to simplify the rule and require water systems to act sooner. As a result, the Action Level, described below, would be lowered to P90 ≥ 0.010 mg/L to cover the full range of what is currently the TL.

Action Level (AL) Requirements

The LCRR strengthened requirements for systems exceeding the lead AL of P90 ≥ 0.015 mg/L and now mandates several actions dependent on system size. Upon exceeding the lead AL, systems must install or re-optimize corrosion control treatment (CCT) immediately, begin acting on their lead service line replacement plan, and increase lead sampling frequency to 6-month intervals.

- Systems serving > 3,300 people must begin replacing ≥ 3% of LSLs within their system annually based on a two-year rolling average.
- Systems serving > 10,000 people must immediately implement corrosion control treatment regardless of historical lead levels.
- Systems serving ≤ 10,000 people must reduce lead levels by CCT or LSL replacement within 15 years.
- All systems must notify customers within 24 hours of receiving test results and provide public education materials discussing lead sources, health effects, measures to reduce lead exposure, and sources for additional information. All public education materials must be available in multiple languages upon request.
- All systems without source water treatment that exceed the AL must undergo continued source water monitoring.

The proposed LCRI lowers the lead action level further P90 ≥ 0.010 mg/L to encompass the removal of the lead TL. Upon exceeding the reduced AL under the proposed LCRI systems would be required to provide public notification within 24-hours and public education opportunities. Systems with P90 > 0.010 mg/L must implement CCT regardless of historical lead levels, systems with CCT must re-optimize, and systems with optimal CCT (OCCT) meeting optimal water quality parameters (OWQPs) need only re-optimize OCCT once, unless otherwise required by the State.

Individual Samples Exceeding AL

All customers with individual samples exceeding the AL must be provided with a lead notice within 3 days and effected sample locations must be re-sampled within 30 days. Systems with corrosion control treatment must conduct water quality parameter monitoring at or near the site and perform corrective actions. If the customer does not respond or refuses contact after two attempts the water system must document interactions and inform local public health officials. The proposed LCRI would increase the number of required customer contact attempts from two to four.

Public Education and Outreach

The LCRR updated consumer confidence report (CCR) lead health effect language and requires the CCR to include access information for the system's LSLI and tap sampling results. Annual notice to customers supplied by LSLs or service lines of unknown material is now required and any water-related work that may disturb LSLs must be accompanied by prior notice and educational materials. Targeted outreach to LSL customers encouraging LSLR must be completed in systems utilizing a goal based LSLR program, otherwise additional outreach actives may be required. The system must provide educational materials to local health authorities and healthcare providers. Educational materials must also be included with advanced notices of water-related work that could disturb LSLs.

The proposed LSRI eliminates the goal-based public outreach activities and requires systems failing to meet the mandatory service line replacement rate to conduct targeted outreach to LSL customers encouraging LSLR. Large systems with a significant population of consumers with limited written English proficiency must provide a translated statement with all educational materials describing the importance of the materials and instructions on how to contact the system to get the materials translated into other languages.

In the event that a water system has multiple lead AL exceedances, under the LCRI the system would be required to conduct additional public outreach activities and make filters available. The LCRI also requires that all water systems offer lead tap sampling be available upon request for customers with lead, galvanized, and unknown service lines.

Lead Service Line Inventory

A fully developed LSLI is required by October 2024. The LSLI must include information on both the public and private sides of each service line that is connected to the public water system, including street address with each service line and connector. The LSLI requires that each service line be classified as one of four options: lead, galvanized requiring replacement (GRR), non-lead (or the actual material), or lead status unknown. It is recommended that each service line also includes other details of the service line such as pipe diameter, and installation date. All systems serving > 50,000 people must make the LSLI publicly accessible and available online.

The proposed LSRI introduces requirements that water systems must respond to customer inquiries about incorrectly identified service line materials within 60 days. Existing LSLIs must be updated annually and systems must validate the accuracy of non-lead services lines in their inventory within seven years of the October 2024 compliance date unless subject to shortened or deferred deadlines. Furthermore, all unknown service lines must be identified by the mandatory lead and GRR service line replacement deadline.

LSL Replacement Program

Under the current LCRR all water systems with at least one lead or GRR service line must develop LSLR plan that includes: strategies for identifying unknown service line materials, procedures for a full-service line replacement, a customer communication strategy, service line flushing instructions, and a service line replacement prioritization strategy. In addition to the requirements of the LCRR, the proposed LCRI requires LSL replacement plans to include strategies to inform customers of proposed service line replacements and to identify any legal requirements such as water tariffs that may affect the system's ability to complete a service line replacement.

Currently, the annual LSL replacement rate is dependent on the number of service pipes that have unknown, galvanized, or lead material present at the time of AL exceedance. See the AL and TL sections for required replacement rates. Both private and public sides of the service line must be replaced to count towards the completion of annual rates and qualify for some funding programs. If a customer decides to replace their private side lead or GRR service line, the system must replace the public side within 45 days of notification. The state may authorize a replacement period extension for up to 180 days from the date of notification. Within 24 hours of LSLR completion, systems must provide consumers with a 6-month supply of pitcher filters and replacement cartridges and a new lead test must be conducted in 3 to 6 months. All lead connectors must be replaced when encountered.

The proposed LCRI mandates the complete replacement of all lead and GRR service lines within 10 years with late 2034 being the earliest likely deadline. The majority of water systems will be required to replace at least 10% of lead and GRR service lines annually. The number of service lines requiring replacement will be calculated on a rolling 3-year period. Very large systems with over 10,000 lead or GRR service lines may be granted extended deadlines. Systems with a high percentage of lead or GRR service lines may also be granted extended deadlines. The LSL replacement plan does not need to be made publicly available unless the water system serves >50,000 people in which case the replacement plan must be made available online.

NHDES currently requires PBWP to have a minimum of 40 sample sites and collect 20 samples across the distribution system triennially. PBWP complies with all the provisions of the LCR and are in the process of completing the LSLI to be in compliance with the October 2024 deadline.

3.4.7 PFAS Rule

Per- and polyfluoralkyl substances (PFAS) are a group of man-made chemicals that are resistant to heat, water, and oil, and have been used in a wide range of consumer products and industrial applications such as food packaging, clothing, fire-fighting foams, and upholstery since the 1940s. Often referred to as "forever chemicals", PFAS are resistant to typical degradation processes due to their highly stable chemical structure, and thus persist in the environment and have been found in surface and ground water as well as finished drinking water across the country.

Because of their widespread use and endurance in the environment, most people have been exposed to some level of PFAS. It has been reported that exposure to certain PFAS can be linked to health problems in the liver, kidneys, immune system, and nervous system and may also cause developmental and reproductive issues such as low birth weight, accelerated puberty, and skeletal changes. Research has also suggested links to cancer, thyroid disease, and endocrine disruption. Due to these impacts, both state and federal agencies have begun taking action to protect public health and the environment.

In June 2016, the EPA issued a non-enforceable interim health advisory level for the sum of PFOS and PFOA of 70 ppt, which was revised in June 2022, based on best available science and occurrence data, to 0.004 ppt and 0.02 ppt for PFOS and PFOA, respectively. Along with this revision, the EPA also issued final health advisories for hexafluoropropylene oxide dimer acid (HPFO-DA, commonly referred to as GenX Chemicals) of 10 ppt and for perfluorobutane sulfonic acid (PFBS) of 2,000 ppt. These interim health advisory levels were intended to remain in place until the EPA established a NPDWR. A draft NPDWR was issued in March 2023, and finalized by the EPA on April 10, 2024, establishing the first enforceable federal regulatory limits for PFAS. The NPDWR establishes the MCLs shown in **Table 3-1**:

Table 3-1 PFAS MCLs

Chemical	Maximum Contaminant Level Goal (MCLG)*	Maximum Contaminant Level (MCL)
PFOA	0	4.0 ppt
PFOS	0	4.0 ppt
PFNA	10 ppt	10 ppt
PFHxS	10 ppt	10 ppt
HFPO-DA (GenX chemicals)	10 ppt	10 ppt
Mixture of two or more: PFNA, PFHxS, HFPO-DA, and PFBS	Hazard Index of 1	Hazard Index of 1

***Maximum Contaminant Level Goal (MCLG)**: The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

The NPDWR establishes an individual MCL of 4.0 ppt for both PFOA and PFOS and an individual MCL of 10 ppt for PFNA, PFHxS, and HFPO-DA. Additionally, PFNA, PFHxS, HFPO-DA, and PFBS will be regulated as a mixture, with an MCL established at a Hazard Index of 1. The Hazard Index is a calculated value based on a combination of health-based ratios developed for each of the four PFAS, as follows:

$$\text{Hazard Index (HI) Value} = \frac{\text{PFNA}}{10} + \frac{\text{PFHxS}}{10} + \frac{\text{PFBS}}{2{,}000} + \frac{\text{HFPO-DA}}{10}$$

Public water systems will be required to monitor for these PFAS and notify the public and take action to reduce PFAS concentrations if they exceed the proposed MCLs. Initial monitoring is required to be completed within three years following rule promulgation (between 2024 – 2027), and results will determine a system's required initial compliance monitoring schedule for each individual entry point within the system. Depending on the size and type of water system, two or four samples collected at each entry point to the system over a one-year period is required for initial monitoring data.

As discussed, public water systems are required to collect sampling data for 29 PFAS (and lithium) under UCMR 5. Consistent with the goals of the PFAS Strategic Roadmap published by the EPA in 2021, which outlines their whole-of-agency approach to addressing PFAS, this monitoring data is used in conjunction with best available science as the EPA makes determinations regarding future PFAS regulatory actions. monitoring requirements. As part of the final NPDWR, UCMR 5 or state-level drinking water occurrence data can be used to satisfy initial monitoring requirements.

Beginning three years following rule promulgation (2027 – 2029), initial monitoring results are required to be included in a system's Consumer Confidence Reports (CCRs), and regular compliance monitoring begins. Compliance monitoring data will be required to be included in CCRs moving forward, and public notification for monitoring and testing violations will also be required. Beginning five years following rule promulgation (2029), systems will be required to comply with all MCLs and notify the public of any MCL violations.

In May 2025, the EPA announced its intent to rescind the regulatory determinations for PFNA, PFHxS, and HFPO-DA, as well as the Hazard Index for these three PFAS along with PFBS, and extend the compliance deadlines, with more information to follow. The EPA announced its intent to keep the regulatory determinations for PFOA and PFOS intact.

Currently, the State of New Hampshire regulates four PFAS, with enforceable MCLs, as established by House Bill-1264 in July 2020:

- PFOA – 12 ppt
- PFOS – 15 ppt
- PFHxS – 18 ppt
- PFNA – 11 ppt

Now that the new federal NPDWR has been established, state-level regulations will be required to be at least as stringent as the federal MCLs moving forward. PBWP collected PFAS samples in 2023 which resulted in non-detects at each of the wells for the four contaminants. PBWP is due to collect their next round of PFAS Sampling in 2026.

Treatment

PWSs may be able to reduce PFAS concentrations by discontinuing the use of contaminated wells or by blending water sources, if allowed. Conventional water treatment technologies are typically ineffective for removing PFAS. To date, the most common treatment methods for PFAS have been granular activated carbon (GAC) and ion exchange (IX). The EPA has also identified high-pressure membranes such as nanofiltration (NF) and reverse osmosis (RO) as effective technologies. Novel adsorbents, such as surface-modified clays, are another group of emerging technologies that are being piloted and considered for PFAS removal. When selecting a PFAS treatment option, is important for PWSs to understand the type of PFAS requiring removal (e.g., short-chain, long-chain, carboxylate, sulfonate), compatibility with any existing treatment processes, resulting waste stream characteristics, as well as more typical design considerations such as footprint and energy requirements.

3.4.8 Radionuclides Rule

The Radionuclides Final Rule was published on December 7, 2000, by the EPA, revising the existing regulation that was introduced in 1977. This revision of the rule introduced the regulation of uranium and maintained the existing MCLs for combined radium-226 and radium-228, gross alpha particle activity, man-made beta particles and photon emitters. In 2004, minor corrections were issued by the EPA identifying the detection limit for uranium.

Community water systems of all sizes were expected to meet these MCLs. Initial monitoring consisted of four consecutive quarters of monitoring for gross alpha activity, combined radium-226/228, and uranium, with samples collected from the entry point to the distribution system. Initial monitoring for beta particle and photon radioactivity was not required of most PWS, only those that were considered vulnerable such as waters contaminated by effluents from nuclear facilities. All systems were required to complete initial monitoring of these contaminants by December 31, 2007 using EPA approved methods, which are specified in 40 CFR 141.25.

PWS are eligible for reduced monitoring if the initial monitoring results for each contaminant were below the detection limit, below half of the MCL, or greater than one-half the MCL but less than or equal to the MCL. The reduced sampling rates are one sample every nine years, one sample every six years, or one sample every three years respectively.

The PBWP are currently operating under three year reduced sampling regimen for each of their supply sources. Should the MCL be exceeded in any future sampling events, PBWP would be required to return to quarterly sampling until four consecutive samples contained concentrations below the MCL. Table 3-2 describes the MCLs and best available treatment techniques for radionuclides in drinking water.

Table 3-2 MCLs for Radionuclides in Drinking Water (Other Than Radon)

Parameter	MCL and BAT
Gross Alpha (excluding radon and uranium)	15 pCi/L; Reverse Osmosis
Beta Particle and Photon Emitters	4 mrem/year, Ion Exchange, and Reverse Osmosis
Uranium	30 ug/L; Ion Exchange, Lime Softening, Reverse Osmosis, Enhanced Coagulation/Filtration
Combined Radium-226 and Radium-228	5 pCi/L; Ion Exchange, Lime Softening, Reverse Osmosis

3.5 Unregulated Contaminant Monitoring Rule

The 1996 SDWA Amendments created a new method of prioritizing new contaminants to be regulated. As a result, EPA promulgated the Unregulated Contaminant Monitoring Rule (UCMR) and Contaminant Candidate List (CCL), which were developed as coordinating processes. The UCMR process is used to generate occurrence data of selected contaminants from the CCL.

The regulatory determinations (RDs) are made based on the results of CCL/UCMR and the EPA's 6-year reviews. This section describes the regulatory process followed by the EPA and provides a view of the regulatory horizon.

3.5.1 Contaminant Candidate Lists

The CCL is used to define unregulated contaminants for which EPA needs to obtain occurrence data, develop analytical methods, ascertain potential health effects, and evaluate treatment techniques. Every five years the EPA is required to publish a CCL of currently unregulated contaminants in drinking water that may pose risks, and to make determinations on whether or not to regulate at least five contaminants on a five-year cycle, or 3½ years after each CCL is published, if EPA finds that such regulation would present a meaningful opportunity for health risk reduction. The CCL includes contaminants that are (1) not currently regulated by the National Primary Drinking Water Regulations, (2) are known or anticipated to occur at PWS, and (3) that may warrant regulation under the SDWA. The number of contaminants on the CCL lists are therefore much greater than those monitored under each UCMR.

The CCL process builds on evaluations used for previous CCLs and is based on substantial expert input and recommendations from the National Academy of Science's National Research Council (NRC) and the National Drinking Water Advisory Council (NDWAC). EPA re-issues the CCL based on reviewed contaminants that had been targeted through existing prioritization processes, including previous UCMR contaminants and previous CCLs. Many contaminants may be carried over into succeeding CCLs. Additional contaminants are identified based on current research on occurrence and health effect risk factors. Contaminants are prioritized on the CCL according to whether they have analytical methods that are ready for use, have an analytical reference standard, or whether they are registered for use and are likely to be found in the United States (in the case of certain pesticides). EPA further prioritizes contaminants based on more extensive health effects evaluations by the Office of Water's Office of Science and Technology.

The previous CCL, CCL5, was finalized in November 2022, and contained 69 chemicals or chemical groups and 12 microbiological contaminants which are known or anticipated to occur in PWS. The list included chemicals used in commerce, pesticides, biological toxins, DBPs, cyanotoxins, and waterborne pathogens. Cyanotoxins are naturally produced or released from naturally occurring cyanobacteria, a type of blue-green algae, which have been identified in some lakes and surface water bodies in New England. Contaminants from CCL5 were included in UCMR 5.

CCL 6 is currently under development. On February 17, 2023, the EPA requested nominations of chemicals, microbes, and other contaminants to be nominated by April 2023. The EPA will then review those nominations and will issue a draft CCL 6 for public comment.

3.5.2 Unregulated Contaminant Monitoring Rules (1-5) Summary

The UCMR process is used to generate occurrence data required by selected contaminants on the CCL. Once every five years the EPA issues a list of no more than 30 unregulated contaminants selected from the CCL for monitoring by PWS under the UCMR. There have been five UCMR rounds to date:

- UCMR 1 – published on September 17, 1999,
- UCMR 2 – published on January 4, 2007,
- UCMR 3 – published on May 2, 2012,
- UCMR 4 – published on December 20, 2016,
- UCMR 5 – published on December 27, 2021.

Data collected through the UCMR process is stored in the National Contaminant Occurrence Database (NCOD) and may be viewed by the public. The data is used to support analysis and review of contaminant occurrence, to guide the CCL selection process, and to support the Administrator's determination of whether to regulate a contaminant in the interest of protecting public health.

The SDWA was amended in 2018 with Section 2021 of America's Water Infrastructure Act (AWIA). All community water systems and non-transient non-community water systems serving more than 3,300 persons (small/large systems) that use surface water, ground water under the direct influence of surface water or ground water systems are required to monitor for the full 30 contaminants. A representative sample of 800 randomly selected small SW and GWUDI systems (serving < 3,300 persons) must monitor for all 30 contaminants.

PWS are required to report contact information to the EPAs Safe Drinking Water Accession and Review System (SDWARS) and review or revise their sampling locations and monitoring schedule in SDWARS. Laboratory results must be posted to SDWARS withing 90 days of the sample collection date.

The SDWA was also amended by Section 7311 of the National Defense Authorization Act (NDAA) in 2020. The amendment specified that, *"EPA shall include all PFAS in UCMR 5 for which a drinking water method has been validated, and that are not subject to a national primary drinking water regulation." (EPA).*

UCMR 5 consists of 29 PFAS substances (within the scope of EPA Methods 533 and 537.1) and lithium. PWS are to monitor all 30 contaminants during a 12-consecutive month period from January 2023 through December 2025. The UCMR 5 contaminants are presented in Table 3-3.

Because the ELVD is estimated to serve more than 3,300 persons, ELVD is required to participate in UCMR 5 and sample for all 30 contaminants.

Table 3-3 Contaminants for UCMR 5

Contaminant	Minimum Reporting Level	Analytical Methods
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)	0.005 µg/L	EPA Method 533
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)	0.002 µg/L	EPA Method 533
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	0.003 µg/L	EPA Method 533
hexafluoropropylene oxide dimer acid (HFPO-DA)	0.005 µg/L	EPA Method 533
nonafluoro-3,6-dioxaheptanoic acid (NFDHA)	0.02 µg/L	EPA Method 533
perfluorobutanoic acid (PFBA)	0.005 µg/L	EPA Method 533
perfluorobutanesulfonic acid (PFBS)	0.003 µg/L	EPA Method 533
1H,1H, 2H, 2H-perfluorodecane sulfonic acid (8:2FTS)	0.005 µg/L	EPA Method 533
perfluorodecanoic acid (PFDA)	0.003 µg/L	EPA Method 533
perfluorododecanoic acid (PFDoA)	0.003 µg/L	EPA Method 533
perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	0.003 µg/L	EPA Method 533
perfluoroheptanesulfonic acid (PFHpS)	0.003 µg/L	EPA Method 533
perfluoroheptanoic acid (PFHpA)	0.003 µg/L	EPA Method 533
1H,1H, 2H, 2H-perfluorohexane sulfonic acid (4:2FTS)	0.003 µg/L	EPA Method 533
perfluorohexanesulfonic acid (PFHxS)	0.003 µg/L	EPA Method 533
perfluorohexanoic acid (PFHxA)	0.003 µg/L	EPA Method 533
perfluoro-3-methoxypropanoic acid (PFMPA)	0.004 µg/L	EPA Method 533
perfluoro-4-methoxybutanoic acid (PFMBA)	0.003 µg/L	EPA Method 533
perfluorononanoic acid (PFNA)	0.004 µg/L	EPA Method 533
1H,1H, 2H, 2H-perfluorooctane sulfonic acid (6:2FTS)	0.005 µg/L	EPA Method 533
perfluorooctanesulfonic acid (PFOS)	0.004 µg/L	EPA Method 533

Contaminant	Minimum Reporting Level	Analytical Methods
perfluorooctanoic acid (PFOA)	0.004 µg/L	EPA Method 533
perfluoropentanoic acid (PFPeA)	0.003 µg/L	EPA Method 533
perfluoropentanesulfonic acid (PFPeS)	0.004 µg/L	EPA Method 533
Perfluoroundecanoic acid (PFUnA)	0.002 µg/L	EPA Method 533
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	0.005 µg/L	EPA Method 537.1
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	0.006 µg/L	EPA Method 537.1
perfluorotetradecanoic acid (PFTA)	0.008 µg/L	EPA Method 537.1
perfluorotridecanoic acid (PFTrDA)	0.007 µg/L	EPA Method 537.1
Lithium	9 µg/L	EPA Method 200.7; SM 3120 B (2017); SM 3120 B-99 (1999); ASTM D1976-20

3.5.3 Regulatory Determination

The EPA evaluates the UCMR sampling results and compiles a "short list" of those contaminants with sufficient data to make a regulatory determination. A preliminary "determination" is published in the Federal Register for public comment. The EPA considers the following criteria when making a Regulatory Determination for a particular contaminant:

1. The contaminant may have adverse health effects,
2. The contaminant is known to occur or there is a substantial likelihood that the contaminant will occur in PWS with a frequency and at levels of concern,
3. In the sole judgment of the Administrator, regulation of such contaminant presents a meaningful opportunity for health risk reduction through a national drinking water regulation.

3.5.3.1 Regulatory Determination 1

In June 2002, the EPA published preliminary determinations associated with nine contaminants from CCL 1 to the Federal Register. Based on comments received during the public comment period, the EPA announced (July 2003) that no regulatory action was appropriate for the following contaminants: acanthamoeba, aldrin, dieldrin, hexachlorobutadiene, manganese, metribuzin, naphthalene, sodium, and sulfate.

3.5.3.2 Regulatory Determination 2

In May 2007, the EPA published preliminary determinations associated with 11 contaminants from CCL 2 to the Federal Register. Based on comments received during the public comment period, the EPA announced (July 2008) that no regulatory action was appropriate for the following contaminants: boron, dacthal mono-acid (MTP) degradate, dacthal di-acid (TPA) degradate, 1,1-Dichloro-2,2-bis(p-chlorophenyl)ethylene (DDE), 1,3-Dichloropropene (Telone), 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, s-Ethyl propylthiocarbamate (EPTC), fonofos, terbacil, and 1,1,2,2-Tetrachloroethane.

Methyl-tertiary dibromoethylene (MTBE) and perchlorate were included on CCL 2, but regulatory determinations were not made for these contaminants in 2008. However, on February 11, 2011, an off-cycle Final RD was published in the Federal Register for perchlorate. This means that the EPA intended to propose a national primary drinking water regulation for perchlorate, but more research was required. However, in July 2020 the EPA made a determination not to regulate perchlorate in drinking water citing "best available peer reviewed science" for their decision. Subsequently, EPA published a plan to address perchlorate contamination in March 2022. The plan includes the following items:

1. Continue ongoing cleanup activities at perchlorate contaminated sites.
2. Propose revisions to Resource Conservation and Recovery Act (RCRA) standards for the open burning and open detonation of waste explosives and bulk propellants to reduce impacts of perchlorate to human health and the environment.
3. Strengthening labeling requirements for hypochlorite solutions that include storage and handling information to minimize perchlorate formation.
4. Providing resources and recommendations for water systems to address perchlorate contamination.
5. Conduct Studies to Characterize Perchlorate Occurrence in Ambient Waters.
6. Develop a Web-Based Toolkit about Perchlorate.

MTBE was not regulated in 2008 because EPA's health risk assessment had not been finalized. To date, EPA has not regulated MTBE but EPA Archives note that “there is little likelihood that MTBE in drinking water will cause adverse health effects at concentrations between 20 and 40 ppb or below.”

3.5.3.3 Regulatory Determination 3

In October 2014, the EPA published preliminary determinations associated with five contaminants from CCL 3 to the Federal Register. Based on comments received during the public comment period, the EPA announced (January 2016) that no regulatory action was appropriate for the following contaminants: dimethoate, 1,3-dinitrobenzene, terbufos, and terbufos sulfone. At that time, the EPA chose to delay the final determination for strontium to “consider additional data and decide whether there is meaningful opportunity for health risk reduction by regulating strontium in drinking water.”

3.5.3.4 Regulatory Determination 4

In February 2020, the EPA published preliminary determinations associated with eight contaminants from CCL 4 to the Federal Register. Based on comments received during the public comment period, the EPA announced (February 2021) that regulation is appropriate for PFOS and PFOA and no regulatory action was appropriate for the following contaminants: 1,1-dichloroethane, acetochlor, methyl bromide (bromomethane), metolachlor, nitrobenzene, and RDX).

3.6 National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as color, taste, or odor) or even technical effects (such as corrosivity, scale, or sedimentation) in drinking water. The EPA recommends secondary contaminant standards to water systems but does not require systems to comply. However, individual states may choose to adopt them as enforceable standards.

Although secondary standards are considered as aesthetic issues that are non-compulsory to water systems, they can nevertheless be problematic. Some secondary contaminants are also regulated as MCLs when they occur at higher concentrations. For example, fluoride is listed with an MCL of 4.0 milligrams per liter (mg/L) and a Secondary Maximum Contaminant Level (SMCL) of 2.0 mg/L. Copper is regulated under the LCR to an Action Level (AL) of 1.3 mg/L for health reasons, yet it is also included as an SMCL for aesthetic reasons. Table 3-4 lists the EPA SMCLs.

A complete listing of the national secondary drinking water standards is published by the EPA on its website: https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals.

Table 3-4 Secondary Drinking Water Regulations

Contaminant	GPW1 (mg/L)	GPW2 (mg/L)	GPW3 (mg/L)	Secondary MCL (SMCL) (mg/L)	Noticeable Effects above the SMCL
Aluminum				0.05 to 0.2 mg/L	Colored Water
Chloride	16	23	30	250 mg/L	Salty Taste
Color				15 (color units)	Visible Tint
Copper	0.0049	0.0029	0.0036	1.0 mg/L	Metallic Taste, Blue-Green Staining
Corrosivity				Non-corrosive	Metallic Taste, Corroded Pipes, Fixtures Staining
Fluoride	ND	ND	ND	2.0 mg/L	Tooth Discoloration
Foaming Agents				0.5 mg/L	Frothy, Cloudy, Bitter Taste, Odor
Iron	0.200	0.213	0.025	0.3 mg/L	Rusty Color, Sediment, Metallic Taste, Reddish/Orange Staining
Manganese	0.0373	0.0091	0.0012	0.05 mg/L	Black/Brown Color, Black Staining, Bitter Metallic Taste
Odor				3 threshold odor number (TON)	"Rotten-Egg", Musty/Chemical Smell
pH	5.75	5.63	6.01	6.5-8.5	Low Ph: Bitter Metallic Taste, Corrosion
Silver				0.10 mg/L	Skin Discoloration, Graying of the White Part of the Eye
Sulfate	9	7	9	250 mg/L	Salty Taste
Total Dissolved Solids (TDS)				500 mg/L	Hardness, Deposits, Colored Water, Staining, Salty Taste
Zinc	0.0257	0.0342	0.0162	5 mg/L	Metallic Taste

3.7 Regulatory Assessments

This section of the report aims to describe policies associated with preparedness and protection of Precinct assets.

3.7.1 Source Water Protection

Section 1453 of the 1996 amendments to the SDWA mandated that States develop and implement source water assessment programs (SWAP). The purpose of SWAP is to provide a basis for developing, implementing, and improving a state's Source Water Protection Plan by:

- Delineating and mapping protection areas for drinking water intakes,
- Identifying and inventorying potential sources of contamination in the protection areas,
- Determining the susceptibility of public water supply systems to the entrance of contaminants released within the protection areas, and
- A release of the results of the plan to the public.

The assessment serves to elevate the status of a hydrogeologically-defined geographic area for special consideration in the land use decision-making by federal, state, and local governments, as well as efforts of local land-use stakeholders. The assessment reviews and recommends protection options for each source. Source protection and control is a requirement for reduced monitoring (waivers) from the Phase II and V Chemical Contaminant Rules (discussed previously in this Section) for systems that can show that the threat of contamination from these chemicals is minimal and that a source water protection plan is in place.

In 2000 and 2004, NHDES completed a Source Water Assessment for the PBWP supply sources. The assessment indicated that PBWP's sources scored low-risk for following contamination sources: Detects, Well/Intakes, KCSs, Pesticides, Urban Land Cover, Animals, Lagoons, and Sanitary Radius. Their sources scored a medium risk for PCSs contamination. All three sources scored a high risk for following contamination sources: Highways/Railroads, Septics, and Agricultural Land Cover. The results of the Source Water Assessment can be seen below in **Figure 3-1**.

Figure 3-1 Assessment of Public Water Supply Sources

Assessments of Public Water Supply Sources - BOSCAWEN

This report is a summary of NH Department of Environmental Services' assessments of the vulnerability of each source used by the public water system(s) located in this municipality. The sources listed here are grouped first by the type of public water system and then by the system itself. Each source was ranked according to a number of criteria; a vulnerability ranking is given for each criterion that applies to the source. *An explanation of each column in the report can be found on the last page.*

System Type C **C=Community; P=Non-Transient, Non-Community; N=Transient**

EPAID 0251010 **System Name:** PENACOOK BOSCAWEN WATER PRCT

Source Number	Source Description	Source Type	Date Assessment Completed	Number of Vulnerability Rankings: Highs	Mediums	Lows	Susceptibility Ranking Criteria: Detects	Well/Intake	KCSs	PCSs	Highways/RRs	Pesticides	Septics	Urban Land Cover	Ag Land Cover	Animals	Lagoons	Dry discharges	Sanitary radius	Trophic status
002	GPW	G	8/4/2000	3	1	7	L	L	L	M	H	L	H	L	H		L		L	
003	GPW	G	8/4/2000	3	1	7	L	L	L	M	H	L	H	L	H		L		L	
004	GPW	G	9/30/2005	3	1	8	L	L	L	M	H	L	H	L	H	L	L		L	

3.8 The Regulatory Horizon

This section of the report serves to provide updates to policies and rules currently in development or that have the potential for development in the future by regulatory agencies such as EPA and NHDES.

3.8.1 Radon Rule

Radon-222 is a naturally occurring volatile gas which forms from the radioactive decay of uranium-238 in the ground. Radon is colorless, odorless, tasteless, chemically inert, and radioactive. Radon can move through air or dissolve into water. It commonly enters homes through basements and crawl spaces when gases escape the soil, or when water containing radon is used for cooking or cleaning and is released into the air of the house where it can be inhaled.

The Radon Rule was proposed on November 2, 1999, but never reached regulation. The rule was unique in that for the first time, the EPA sought to address a health risk caused by an air and water-borne contaminant with one rulemaking. The EPA originally proposed an MCL of 300 picocuries per liter (pCi/L) and an alternative MCL (AMCL) of 4,000 pCi/L for governments or utilities that have implemented a "multi-media mitigation (MMM) program" to lower indoor air radon from all sources. This means that treatment would not be required for supplies with radon levels between 300 and 4,000 pCi/L if the State were to develop and implement a MMM program. With or without a MMM program, sources with radon levels above 4,000 pCi/L would be required to provide treatment. The volatile nature of radon makes it easy to remove with exposure to the atmosphere, usually during aeration, which EPA has designated as the Best Available Technology (BAT) for radon removal.

Despite the Radon Rule never reaching regulatory status, NHDES issued recommended health advisories for radon concentrations in private wells as follows:

- > 10,000 pCi/L – water treatment recommended along with indoor air mitigation.
- 2,000 – 10,000 pCi/L – water treatment recommended if indoor air concentrations exceed 4 pCi/L.
- < 4,000 pCi/L – no water treatment, retest air and water every 3-5 years.

PBWP currently recommends following NHDES recommendations if customers are concerned with radon concentrations in their homes. The PBWP has no treatment obligations regarding radon as there are no Federal or State regulatory standards in place at this time. However, since this contaminant is common across New England, PBWP should continue to be aware for future regulatory developments as it may impact the Precinct treatment requirements.

3.8.2 The Manganese Rule

In July 2021, NHDES announced that they were in the process of developing a rule to enforce a maximum manganese concentration of 0.3 mg/L in drinking water. The proposed rule was based on, “the adoption of a 0.3 mg/L ambient groundwater quality standard (AGQS) pursuant to Env-Or 603.03(c), Table 600-1, that took effect on January 1, 2021.” The rule was anticipated to take effect by July 2022 and would include mandatory notification for any manganese concentrations above 0.1 mg/L as studies have shown developmental impacts for infants exposed to concentrations exceeding this value.

However, in January 2023 NHDES announced that the development of the Manganese Rule has been suspended indefinitely due to several policy and legal issues that arose following the adoption of the AGQS described above. Despite this announcement, NHDES encouraged water systems to “install and maintain treatment when manganese exceeds 0.3 mg/L and to notify the public of the health risks when manganese exceeds 0.1 mg/L.” NHDES also noted that funding opportunities will be available through the EPA over the next few years for the installation and treatment of manganese.

In 2023, PBWP reported a manganese concentration of 0.00406 mg/L which is below NHDES recommended action levels. We recommend that PBWP continue to monitor developments on this rule in the future.

3.8.3 Other Horizon Issues

Below is a summary of the research that is continuing on other aspects of water treatment and may become the foundation upon which future regulation is based:

- In 2015, the CDC published the results of their most recent surveillance of waterborne disease outbreaks associated with drinking water. The report shows that in the 2013-2014 surveillance period, Legionella was responsible for 78% of the 23 outbreaks associated with drinking water and was responsible for 100% of the 25 resulting deaths. Legionella is currently regulated under the Surface Water Treatment Rule and GWR. However, the EPA has included Legionella on CCL 5 citing that "these contaminants have limitations as a class under these rules, and therefore lack contaminant-specific monitoring and filtration or treatment requirements." It is possible new Legionella regulations will be introduced to drinking water legislation in the future.
- In April 2015, the US Department of Health and Human Services (DHHS) changed its recommended level of fluoride in drinking water for the prevention of dental cavities to be set at 0.7 mg/L, at the lower end of the optimal range of 0.7-1.0 mg/L. In 2016, the EPA reviewed the current Fluoride MCL (4.0 mg/L) during the third 6-year NPDWR review and determined that a revision was not a priority at that time due to other higher priority rulemakings being pursued by the agency. The EPA noted that they would continue to monitor studies and new information as they are developed to determine if a revision to the current fluoride MCL is warranted in the future.
- Endocrine disruptors are a new family of contaminants under consideration for regulation in drinking water. These are man-made chemicals that act like hormones in the bodies of people, animals, and fish, which interfere with the natural development of fetuses, causing birth defects and health issues. The problem is caused by many classes of chemicals including pesticides, herbicides, pharmaceuticals, and personal health care products (PPCPs), and other compounds that find their way into both groundwater and surface water. These substances enter the water supply through human activity such as swimming, and through groundwater from disposal of these products in landfills, septic systems, and through waste discharges. PPCPSs are any product used by individuals for personal health or cosmetic purposes or used by agribusiness to enhance growth or health of livestock. PPCPs include thousands of substances including prescription drugs, cosmetics, fragrances, lotions, and veterinary drugs.

Section 4 Distribution System Hydraulic Evaluation

The purpose of the distribution system evaluation is to assess the hydraulic adequacy of the Penacook Boscawen Water Precinct (PBWP) water system and infrastructure and its ability to satisfy both existing and projected demand conditions.

4.1 General

The purpose of the distribution system evaluation is to assess the hydraulic adequacy of the PBWP's water system and its ability to satisfy both the existing and projected demand conditions developed in Section 2. The scope of the evaluation will be focused on the following:

- Maximum and minimum system pressures
- Adequate fire flows
- Reliable pipe looping
- Reliability, redundancy, and criticality
- Pipe velocities
- Interconnections to adjacent utilities
- Business Risk Exposure (BRE) Assessment

Water systems are analyzed, planned and designed primarily through the application of basic hydraulic principles. A computer hydraulic model was updated, calibrated, and used as the hydraulic tool to assess the condition and hydraulics of current infrastructure under existing and projected demands and to guide future improvement recommendations. The evaluation was based on compliance with State of New Hampshire code requirements and standard water works engineering practice. Alternatives and recommendations are presented at the end of this Section.

4.2 Distribution System Hydraulic Model Update

One of the primary goals of this study was to update the existing hydraulic computer model of the PBWP water distribution system. InfoWater hydraulic modeling software developed by Innovyze was used for the analysis. Existing water system data incorporated into the model includes pipe diameter, pipe geometry, and pipe roughness as C-value, ground elevation at pipe intersections, hydraulic gradeline elevations, pump data, and total system demand.

The calibrated model was used to evaluate the adequacy of the system under existing and future demands and various stress conditions by assessing a variety of operating criteria such as pressures, hydraulic gradeline, available fire flows, and velocities and head losses within each pipe. Where deficiencies were identified, improvements were simulated to assess the benefit of the proposed improvement.

The following details the procedures and methodologies used to update the hydraulic model for this study.

4.2.1 Distribution System Mapping

A detailed base-map of the existing piping network was obtained from the PBWP Geographical Information System (GIS). The PBWP staff reviewed the existing mapping to verify and validate pipe diameters, material and year of installation. It is critical that actual details of the subsurface piping network be clearly understood in order to validate the necessity of improvements. As more accurate data is identified, and when updates to the system are made, the hydraulic model network and GIS system database should both be updated.

The hydraulic model represents pipes as lines and pipe intersections as nodes. Each pipe is assigned specific physical information including diameter, length between nodes, material of construction and C-value. Nodes are assigned elevation and demands. Supply sources and storage facilities are represented as pipes connected to a single node which are assigned hydraulically-relevant information associated with the type of asset it is representing.

4.2.2 Water Demand Apportionment

Both existing and projected future water demands, developed in **Section 2**, were distributed among the nodes throughout the service area. Current demands were initially assigned to nodes from actual customer billing records by geocoding the customer data to the network.

Geocoding involves the conversion of a physical address and billing data associated with the address to an x and y coordinate system which can then be linked to the distribution network through GIS. This method of demand apportionment more closely replicates actual demand locations, as opposed to a traditional method of equal distribution across all nodes. Because demand apportionment is typically the largest source of modeling error, demand apportionment by geocoding provides a more accurate model.

The majority of the demands in the PBWP system were able to be geocoded. Customer demands, which were not assigned through the geocoding effort, were added to the model manually. In addition, the largest water-use customers were identified, and their demands were assigned directly to the model nodes to their physical location in the system. The following are PBWP's highest usage customers based on 2024 billing information:

- 325 Daniel Webster Highway – Merrimack County Nursing Home
- 314 Daniel Webster Highway – Merrimack County Jail
- 121 King Street – Concord Village Apartments
- 326 Daniel Webster Highway – Edna McKenna Community Corrections Center
- 100 Elm Street – Woody Hollow Co-Op
- 126 High Street – Elektrisola
- 0 Corn Hill Road – Oxbow Drive Trailer Park
- 0 Elizabeth Drive – Trailer Park
- 133 North Main Street – Alan's of Boscawen Restaurant
- Rosue Drive – Bailey's Trailer Park

Once the average-day demands have been apportioned to each of the nodes and calibration is complete, the model can be used to evaluate the performance of the system under varying demand conditions.

4.2.3 Fire Flow Field Testing Program

Fire flow testing was performed to gather actual system data used to calibrate the hydraulic computer model. In addition, the fire flow testing provides both an estimate of the flow rate available for fire protection at specific locations within the system and a direct indication of the relative strengths and weaknesses of the system in the vicinity of the test.

Fire flow tests were performed by Wright-Pierce and PBWP personnel on August 6 and 7, 2025. The results of these tests and associated boundary conditions are summarized in **Table 4-1**. Boundary conditions of the system during the fire flow tests include tank levels, pump status and flows. The locations of the tests are presented in **Figure 4-1**.

Test locations were selected based on system hydraulics, zoning, and prior locations tested by the Insurance Service Office (ISO), an insurance organization responsible for evaluating and classifying communities for insurance rating purposes. The specific hydrants used by ISO were not known and, therefore, the resulting data collected as part of this study may not coincide exactly with the prior ISO data. The remaining fire flow test locations were selected to provide data in order to calibrate the hydraulic model, fill in data gaps or to test known weak points in the distribution system. Further details on the role of the ISO as it pertains to a community's water system are discussed later in this Section.

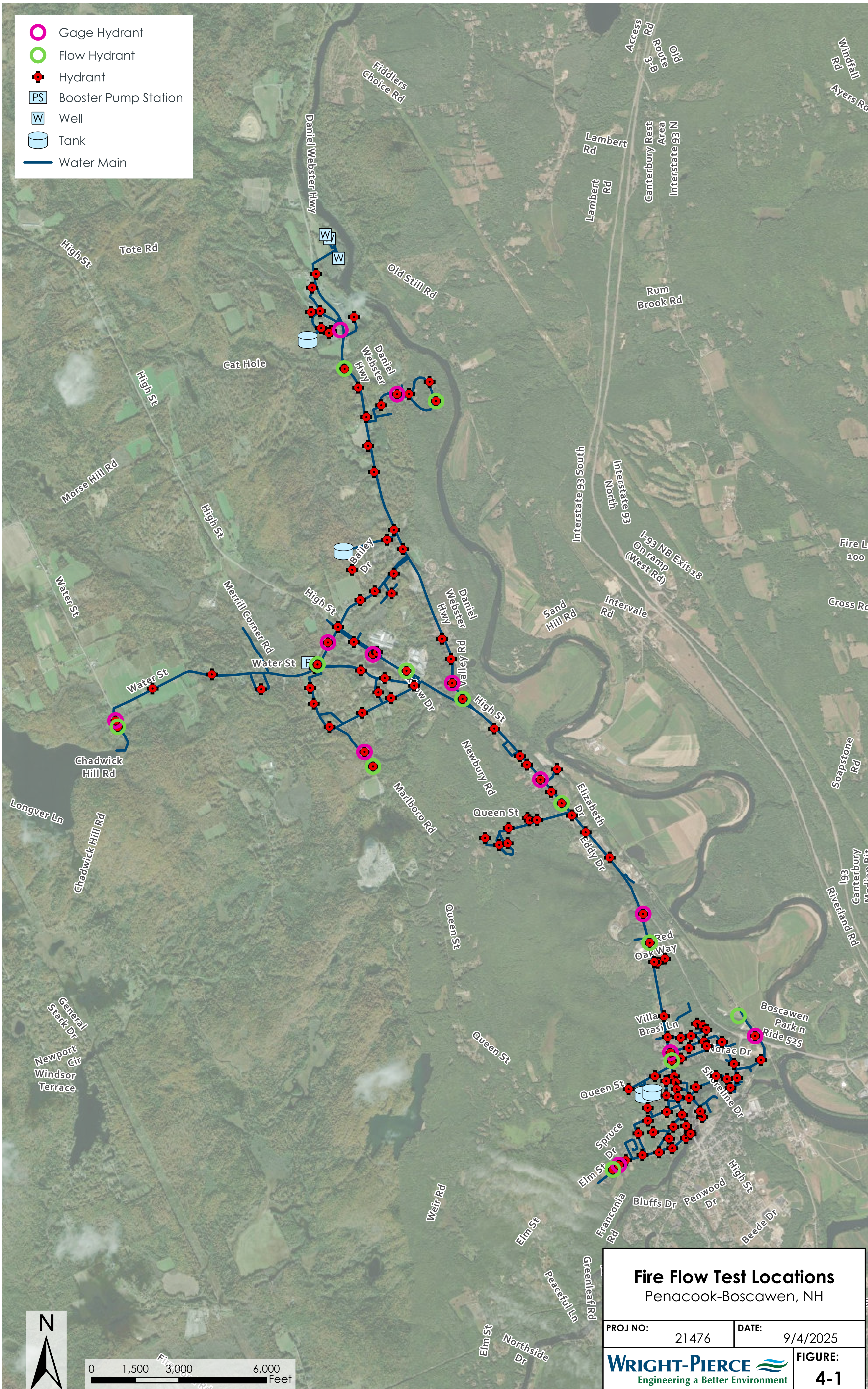
A typical fire flow test utilizes a minimum of two, and in some cases three or more, hydrants. One hydrant is used to monitor pressure while one or more hydrants are used and monitored for flow. The purpose of the test is to stress the system by simulating an actual fire flow condition in order to measure the drop in pressure at a specific hydrant flow rate.

Static pressure is measured prior to conducting the test and represents the system pressure at the test location. Once a hydrant is opened, residual pressure is measured at a gauge hydrant and flow is measured from the flowing hydrant. The result represents the system pressure at a measured discharge rate. The goal is to obtain a pressure drop of at least 10 psi (the greater the pressure drop, the higher the level of the accuracy). Where a 10-psi drop cannot be attained through one hydrant, two or more may be flowed.

Table 4-1 Fire Flow Field Test Location and Boundary Conditions

Field Test Operation Data				Boundary Conditions		
Test Information				Merrimack Tank	Queen Street Tank	Fairbanks Tank
Test No.	Date	Time	Location	ft	ft	ft
1	8/7/25	3:47 AM	Route 3/Daniel Webster Highway	62.05	75.74	34.37
2	8/7/25	3:35 AM	Forest Lane	62.07	75.72	34.50
3	8/7/25	3:13 AM	Valley of Industry Road, near DW Highway @ High Street	62.07	75.75	34.75
4	-	-	Route 4/High Street	-	-	-
5	8/7/25	3:22 AM	Raymond Road	62.07	75.72	24.68
6	8/7/25	12:48 AM	Chadwick Hill Road @ Water Street	62.32	75.49	36.57
7	8/7/25	1:18 AM	Marlboro Road (Transfer Station)	62.28	75.61	36.26
8	8/7/25	3:03 AM	Route 3/King Street, South of Depot Street	62.07	75.78	34.85
9	8/7/25	1:58 AM	North Main Street	62.22	75.72	35.74
10	8/7/25	2:51 AM	River Road, North of Route 4	62.07	75.72	34.97
11	8/7/25	2:18 AM	N Main Street, between Jackson and Academy	62.22	75.72	35.51
12	8/7/25	2:33 AM	End of Elm Street	62.09	75.68	35.28

*Please note the wells were not running and the valve at the Route 3/Route 4 intersection was closed for the duration of all tests



JA W:\GIS_Development\Projects\NH\Penacook-Boscawen WD\21476_Boscawen2023AM\MXDs\AMPFigures.aprx - Fig4_1_FireFlow_11x17

The test results were used to calculate the available flow rate at the test location while maintaining a residual system pressure of 20 psi. The "Recommended Standards for Water Works", also known as the "Ten States Standards", specifies that water systems should be "designed to maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow". Maintaining a minimum residual pressure assures uninterrupted service to customers, protects the system from possible vacuum conditions which could damage infrastructure or contaminate the system water, and provides adequate suction pressure for firefighting pump equipment.

The fire flow testing program results are difficult to compare to the ISO test results since boundary conditions were not recorded during the ISO testing program. In addition, modeling allows a specific available flow at a given location to be limited by low pressures elsewhere in the distribution system, not just at the residual hydrant where pressure is measured during a test.

4.2.4 C-Value Determination

The Hazen-Williams C-value is a relative measure of the hydraulic capacity of a water main. New pipe C-values are established by the piping and engineering industry. However, the C-value of existing pipe must be estimated (see below for discussion of field testing for C-value). Pipes having a C-value less than that for new pipe of the same diameter have less carrying capacity than the new pipe. For example, a 12-inch pipe having a C-value of 50 will transmit half the water, with the same pressure drop, as a 12-inch pipe of the same length with a C-value of 100.

The C-values of some pipe materials such as cement and bituminous lined ductile iron (DI) pipes and asbestos cement (AC) pipe generally change very little from when they were originally placed into service. Other materials such as unlined cast iron (CI), however, may change significantly over time. The piping materials in the PBWP distribution system include unlined CI, AC, PVC, and cement-lined DI.

Typically, unlined cast iron water mains are the most problematic for water utilities because cast iron is relatively brittle and, being an unprotected ferrous metal, tends to develop corrosion deposits on the interior surface of the pipe after years of service. These deposits are called tubercles. Tubercles have two detrimental effects on flow carrying capacity: (1) they reduce the inside diameter of the pipe and, (2) they result in increased frictional head losses. For that matter, any obstruction, such as a partially closed valve will reduce the carrying capacity of the pipe. Corrosion tubercles are more prevalent in unlined mains with low flow velocities. This explains why older unlined piping has relatively low C-values. Typical C-values for new pipes are 120 for cement-lined ductile iron pipe (CLDI) and 140 for PVC or HDPE pipe.

C-values for existing pipe can be estimated in the field by selecting a straight section of pipe that contains a minimum of at least three fire hydrants in series (one flow and two residual hydrants). Once the test location has been selected, the test pipe segment is isolated by closing branch lines, and the flow and differential pressure are measured and recorded at the hydrants. Additional information, such as the diameter and length of the test pipe segment between the gauge hydrants, is determined from existing records and mapping.

Pipe roughness is then calculated by using the Hazen-Williams equation:

$$C = \frac{3.54Q}{D^{2.63}(\frac{h}{L})^{0.54}}$$ where,

C = Hazen-Williams C-factor
Q = Flow in gallons per minute
D = Pipe diameter in inches
h = Head loss in feet
L = Length of test section in feet

C-values testing was not conducted as part of this effort.

4.2.5 Model Calibration

Calibration involves simulating each field fire flow test and making adjustments or corrections to the C-values of pipes, so that the model closely approximates the data collected in the field. The interior roughness of pipes can and does change over time and, therefore, the C-value is the primary variable which is adjusted during calibration. Physical characteristics such as pipe diameter, length, age, and material type are fixed and, therefore, cannot be manipulated.

Initially, average-day demand was simulated to validate static pressures against those measured during the fire flow test program. This is done to calibrate the ground surface elevations at the test locations. Next, each fire flow was simulated, and C-values were adjusted until the model results replicated the field results within 10% or less.

The accuracy of the estimates of total system demand and the apportionment to the nodes is not critical during calibration because demands are distributed so widely throughout the system. The low system demands result in minimal pipe flow velocities and virtually static conditions. For this reason, fire flow, which stresses the system at a single location, tends to govern the hydraulic requirements of the system.

Several iterations of calibration were attempted during the model development. Typical causes of discrepancies between model results and those observed in the field include closed/partially closed valves, larger or smaller pipes or incorrect configurations in the model. For all of the field fire flow test simulations, the model did not closely replicate actual field conditions. It was determined that the pressure gauge used to record the field static and residual pressures was faulty. For this reason, the ISO test results were used for the model calibration. It should be noted that multiple locations on the ISO tests were not made abundantly clear, therefore not every ISO test was able to be included in the model calibration. Please see Table 4-2 for hydraulic calibration information.

Table 4-2 Hydraulic Model Calibration Information

Field Test Operation Data		Field Results				Calculated	Model Results					
Test Information		Static Gage Hyd.	Residual Gage Hyd.	Pitot Flow Hyd.	Observed Flow	Flow at 20 psi	Static Gage Hyd.	Static Flow Hyd.	Residual Gage Hyd.	Static Difference (Model-Field)	Residual Difference (Model-Field)	
Test No.	Location	P_r (psi)	P_r (psi)	P_f (psi)	(gpm)	(gpm)	P_r (psi)	P_f (psi)	P_r (psi)	psi	psi	%
1	Route 3/Daniel Webster Highway	66	32	15	650	764	66.00	-	31.49	0	0.51	1.6%
2	Forest Lane	88	28	10	530	567	88.00	-	32.29	0	-4.29	15.3%
3	Valley of Industry Road, near DW Highway @ High Street	94	70	15	650	1,192	93.99	-	72.10	0.01	-2.10	3.0%
4	Route 4/High Street	-	-	-	-	-	-	-	-	-	-	-
5	Raymond Road	60	40	20	750	1,090	59.98	-	42.26	0.02	-1.26	3.1%
6	Chadwick Hill Road @ Water Street	44	42	-	-	-	-	-	-	-	-	-
7	Marlboro Road (Transfer Station)	63	24	15	630	684	62.96	-	24.82	0.04	-0.82	3.4%
8	Route 3/King Street, South of Depot Street	80	62	28	880	1,684	80.00	-	59.96	0	2.04	3.3%
9	North Main Street	71	62	35	1000	2,530	71.00	-	61.32	0	0.68	1.1%
10	River Road, North of Route 4	105	38	-	-	-	105.00	-	-	-	-	-
11	N Main Street, between Jackson and Academy	58	50	25	840	1,944	58.00	-	53.68	0	-3.68	7.4%
12	End of Elm Street	48	20	10	530	530	47.99	-	20.98	0.01	-0.98	4.9%

4.3 Water System Evaluation

The approach used to evaluate the distribution system was first, to establish the existing and projected hydraulic requirements of the system and, second, to evaluate the adequacy and limitations of the system under the existing and projected demand conditions. The system was evaluated against a number of key operating and engineering principles and industry standards. These include:

- System pressure
- Velocity of water in the pipelines
- Headloss
- Pipe looping
- Piping redundancy, reliability and adequacy
- Fire flow

Several stress conditions were simulated using the hydraulic model, to evaluate the adequacy of the system under existing and projected demand conditions. Stress conditions used for this analysis include:

Peak Hour on Maximum Day in the Year 2044

Under peak-hour conditions, a water system is considered adequate if a minimum pressure of 35 psi can be provided at ground level to the entire service area. Where it can be provided, it is recommended that systems be designed to provide 35 psi to the second story of a building (i.e., 15 feet above ground elevation). It is recognized that this is not always practical or possible. For purposes of this study, the evaluation will consider pressure at ground level.

Maximum Day in the Year 2044 Plus Fire Flow Requirements

Under maximum-day plus fire flow demand conditions, a system must be capable of providing the needed fire flow during maximum-day demands while coincidentally maintaining a minimum residual pressure of 20 psi throughout the distribution system.

Each of these conditions are evaluated under varying demands and where the system does not meet the criteria set forth, alternative improvements are modeled, and recommendations are made based on the hydraulic and cost-effectiveness of the improvements.

4.3.1 Water System Pressure

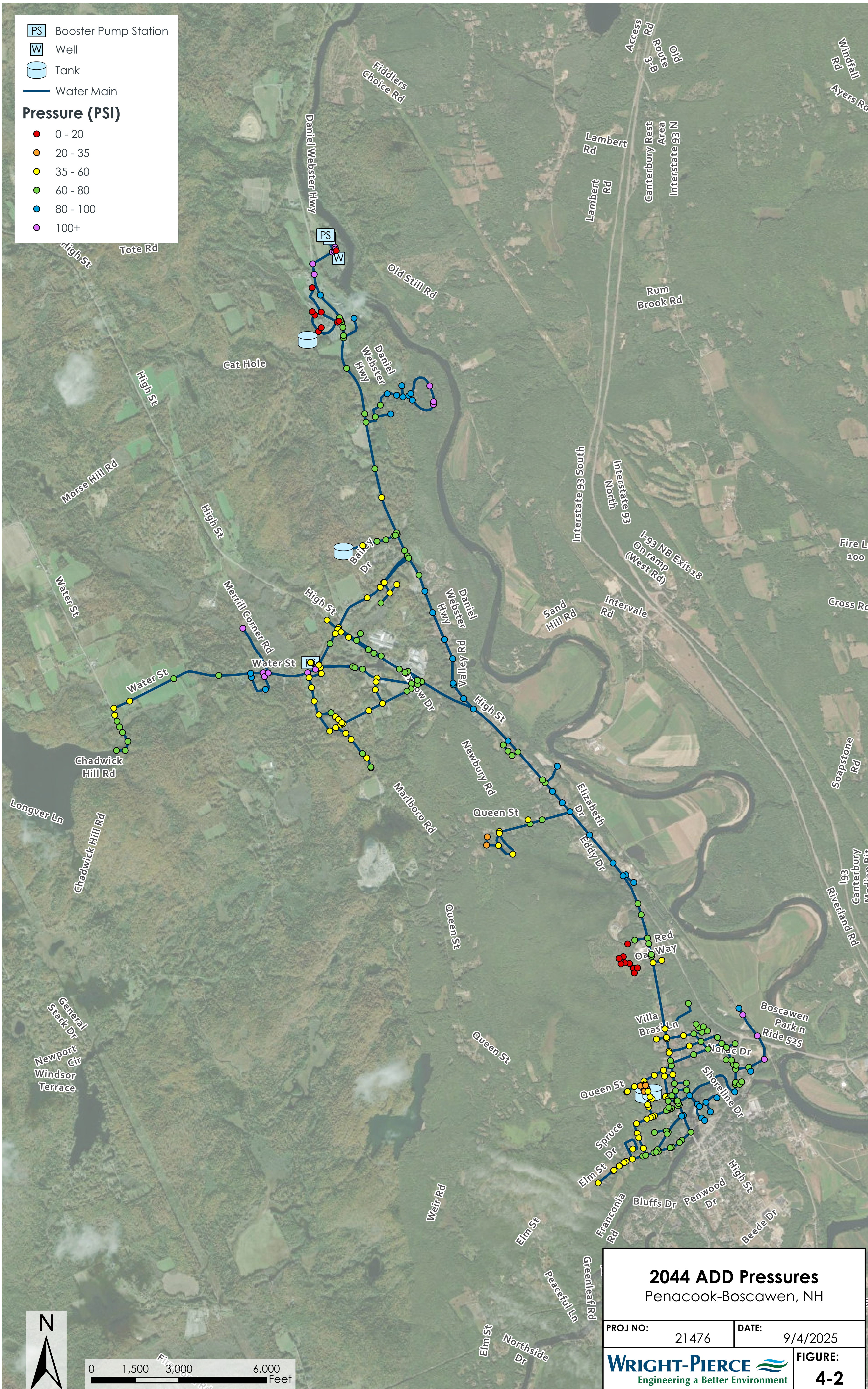
A water system should be designed to accommodate a range of pressures within minimum and maximum guidelines. Low system pressures result in customer complaints, may affect the accuracy of meters, and restrict available flows for firefighting. Higher pressures can contribute to increased water loss from leakage, increase maintenance on equipment, lead to higher energy costs, and tend to increase consumption.

Variations in customer demand, changes in elevation, and proximity to pumping facilities and sources of supply will affect water pressure. In general, when customer demands increase, pressure will decrease. Areas with higher elevations typically have lower pressures.

Standard water works practice and State Plumbing Code requires that municipal water systems be designed with a normal operating pressure range of 60-80 psi and no less than 35 psi at all locations in the distribution system.

Pressures throughout the system during fire flow events should be maintained above 20 psi at all locations. Where pressures exceed 80 psi, pressure reducing valves should be considered on service connections at the service meter connection. Table 4-3 presents an overview of areas where pressures were found to be below 35 psi, between 35 - 50 psi and greater than 80 psi. Figure 4-2 presents normal pressures across the system under 2044 ADD.

Pressures throughout the system are generally adequate. As is typical of most systems, isolated areas of low pressure exist in the immediate vicinity of storage tanks and in the highest elevations of the system. Bluebird Lane was the only area, other than at the Queen Street Tanks, to have pressures below 35 psi under Average Day or Maximum Day Demand in the year 2044 within the Main, County, and Water Zones supplied by the PBWP. Areas of low pressure were found in the Queen Street Zone at the south end of the system and around the BPS. There were areas in all zones, except for the County zone, that had pressures above 80 psi under ADD or MDD in the year 2044.



2044 ADD Pressures
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FIGURE: 4-2

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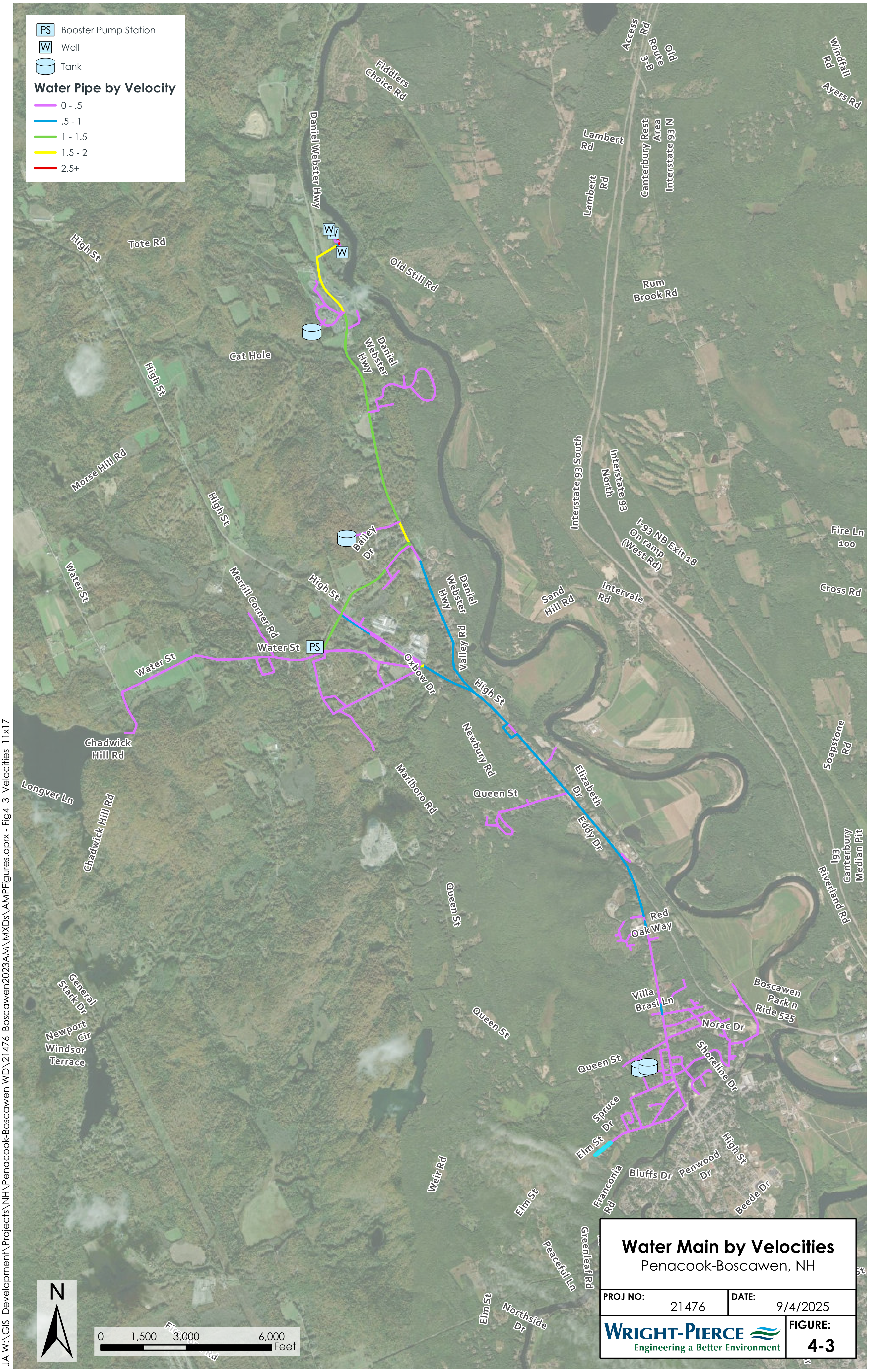
Table 4-3 Low and High Pressure Areas of Distribution System

	Service Zone	(< 35 psi)	(35 - 50 psi)	(> 80 psi)
AVERAGE DAY 2044	Main	None	Marlboro Rd/Corn Hill Rd Intersection, Raymond Rd/High St Intersection, Near BPS, Knowlton Rd	Forest Ln, Valley of Industry, Near County Complex, DW Highway Near Valley of Industry
	Queen Street	Bluebird Ln, Vicinity of Queen St Tank	Robin St, Prospect St, End of Elm St, Chandler St, Queen St, Oak St	Crescent St, River Rd, King St, Depot St, Eel St, Sweatt St
	County	None	Nursing Home	None
	Water Street	None	None	Merrill Corner Rd, Terrace Hill Rd, Water St, BPS
MAXIMUM DAY 2044	Main	None	Marlboro Rd/Corn Hill Rd Intersection, Knowlton Rd, Raymond Rd/High St Intersection, Goodhue Rd	Forest Ln, Valley of Industry, Near County Complex, DW Highway Near Valley of Industry
	Queen Street	Bluebird Ln, Vicinity of Queen St Tank	Robin St, Prospect St, End of Elm St, Chandler St, Queen St, Robin St, Oak St	Crescent St, River Rd, King St, Sweatt St, Eel St, Depot St
	County	None	Nursing Home	None
	Water Street	None	None	Merrill Corner Rd, Terrace Hill Rd, Water St, BPS

4.3.2 Pipe Velocities and Head Loss

Optimally, pipe velocities should be maintained below 2 feet per second (fps) to prevent resuspension of accumulated sediments in the pipeline which can cause aesthetic problems. Velocities of 2 - 5 feet per second (fps) are accepted during stressed circumstances such as a fire condition. Velocities greater than 5 fps contribute to increased headloss, which in turn requires pumps to work harder and results in higher energy costs. Higher velocities can also scour the interior of the pipe, reducing its useful life.

Pipe velocities were evaluated under year 2044 MDD conditions, as presented in **Figure 4-3**. There were no areas found to have velocities greater than 5 fps in the system under these conditions. All pipes were found to have velocities under 2 fps besides three pipes located at the wells.



PS Booster Pump Station
W Well
Tank
Water Pipe by Velocity
0 - .5
.5 - 1
1 - 1.5
1.5 - 2
2.5+
Water Main by Velocities
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0 1,500 3,000 6,000 Feet
N
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4.3.3 Dead-End Mains and Pipe Looping

Dead-end mains in a water system present a number of operational issues because water velocities in these pipes tend to be very low. This condition can cause sediment build-up and contribute to poor water quality. In winter months, pipes having low velocities can be prone to freezing. Generally, the only way to improve this condition is to regularly flush the ends of these pipes, add bleeders or loop the pipe into another location in the distribution system.

Flushing can be labor intensive and if not done on a regular basis, will have little effect in improving conditions. Bleeders can be effective in improving water quality and help prevent freezing. But this method increases unbilled water and electrical pumping costs. The PBWP system currently has four active bleeds in the system, all of which are equipped with meters and dual checks. Looping requires capital investment in new piping and in some cases it may not be practical to loop pipes because of physical or environmental impediments or simply the cost of investment exceeds the benefit.

The PBWP distribution system is generally well looped, although there are a few dead-end mains spread throughout the system. The PBWP should take advantage of future opportunities to eliminate dead-end mains. Future looping opportunities may occur as a result of new residential or commercial development.

4.3.4 Piping Reliability and Redundancy

Piping reliability is defined as the ability of the piping network to supply service to an area of the system in the event of isolated or catastrophic disruptions. Isolated disruptions include shutdowns required to repair main breaks, replace valves or services, flush hydrants, etc. In some cases, the measure of reliability is a function of the redundancy of piping. Adequacy relates to the ability of the network piping to convey the required demands under all conditions.

In general, ferrous metal water main, such as cast iron or ductile iron, has a useful life of approximately 75-100 years. The useful life of an unlined metal pipe can be extended by cement lining the pipe, a practice commonly employed by many municipalities, and by adding polyethylene encasement to the exterior on the pipe during installation. This assumes that the materials of construction were proper for the application, that the size is adequate for the flows, that the pipes were properly installed and protected, and that water quality and pipe bedding materials are not aggressive to the interior and exterior of the pipe, respectively.

The majority of the mains in the distribution system are either AC, cast iron, or ductile iron with a limited amount of PVC.

In most cases, older pipe 6-inch in diameter and less should be replaced with a minimum of 8 inch diameter piping as opportunities arise (i.e. local road projects, new developments etc.). However, it may be acceptable to maintain a limited network of 2- to 6-inch pipe, depending on the number of services on each segment and the proximity of fire hydrants to the homes. The water distribution system hydraulic model should be used to verify the pipe size required.

General water works practice is to maintain an on-going replacement program where 1-2% of the total system pipe length is replaced each year. This assures that the distribution system is fully replaced every 50-100 years. The oldest known pipe in the PBWP distribution system is approximately 85 years old and approximately 21% of the distribution system is over 60 years old. Approximately 38% of the piping within the distribution system does not have a known installation date. A sustainable replacement rate of 1-2% per year would allow the PBWP to catch up with upgrading and maintaining its distribution system.

Many communities, including Pennacook-Boscawen, are limited in the amount of investment that can be made in a rehabilitation and replacement program. However, even in the face of limited funding resources, establishment of a routine replacement/rehabilitation program will pay dividends in the long-term.

- Replacement of approximately 3,400 feet of 6-inch asbestos cement main on High Street with new 8-inch ductile iron main.
- Replacement of approximately 1,500 feet of 6-inch asbestos cement main on Corn Hill Road from High Street to Pine Street.

4.3.5 Fire Flow

The ability to provide fire protection is a valuable asset for a community. Guidelines for fire flow requirements are provided by the Insurance Services Office (ISO). ISO is an organization responsible for evaluating and classifying communities for insurance rating purposes. Periodically, the ISO will visit a community, perform fire flow tests and develop a fire insurance rate for that community. The rate assigned ranges from 1 to 10 with 1 being the best rating. The rating is based on the total firefighting capability of the community including such factors as water supply, fire department structure and available communication systems.

Specific fire protection requirements at a given locale vary with the physical characteristics of a building. ISO assigns a required fire flow based on the worst case premise in a general location using the following factors: (1) materials of construction, (2) occupancy use, (3) proximity to other structures, (4) height and size of building, (5) the existence of fire walls, (6) presence or absence of sprinklers, as well as other factors. Some special use buildings may have required fire flow as high as 12,000 gallons per minute (gpm). **Table 4-4** presents typical fire flow requirements for various building types and uses.

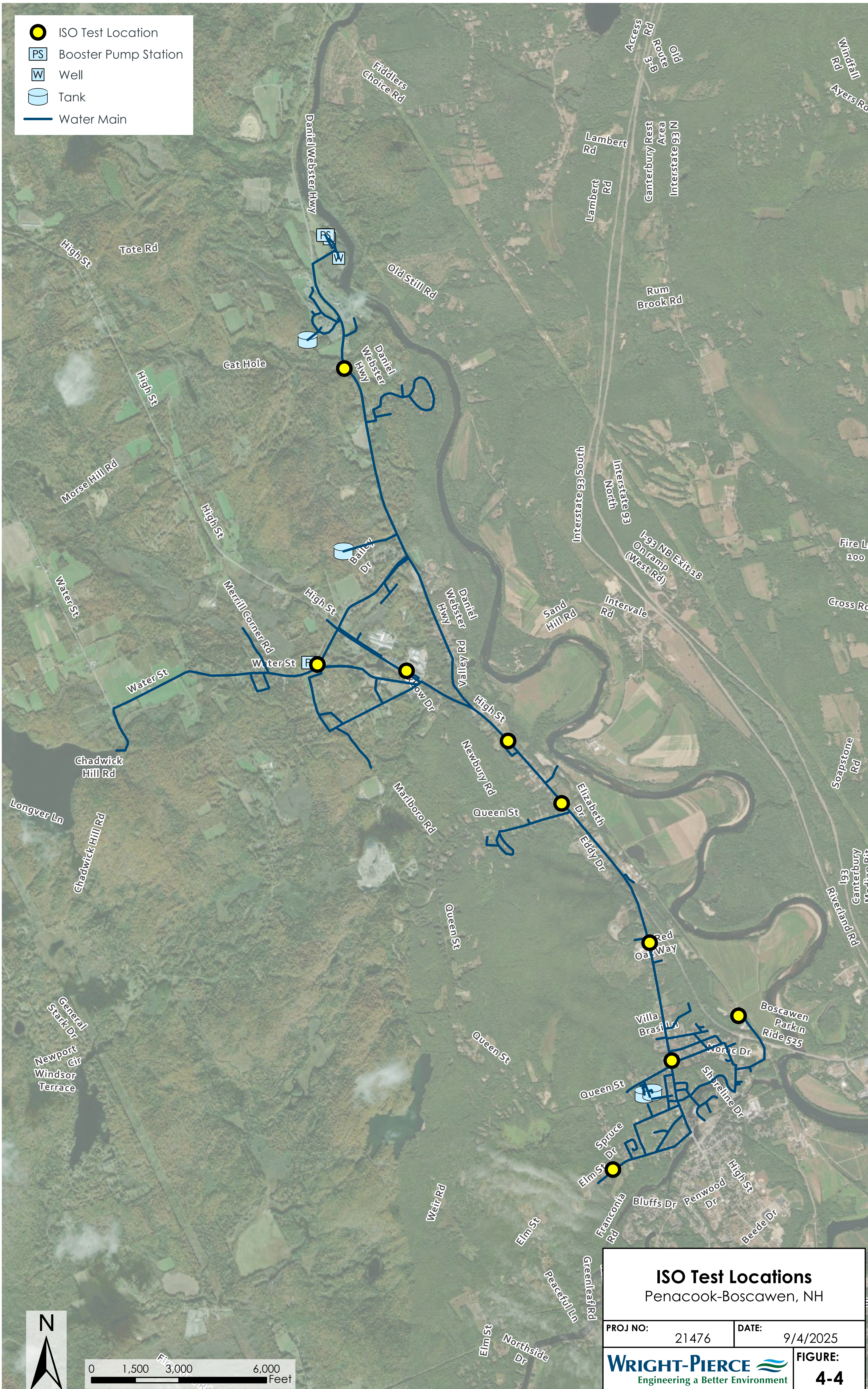
Table 4-4 Typical Fire Flow Requirements

Land-Use or Building Type	Range of Required Fire Flows and Flow Duration
Single and Two Family Dwellings	
Over 100 feet Building Separation	500 gpm for 2 hours
31 - 100 feet Building Separation	700 gpm for 2 hours
11 - 30 feet Building Separation	1,000 gpm for 2 hours
10 feet or less Building Separation	1,500 gpm for 2 hours
Multiple Family Residential Complexes	2,000 to 3,000 gpm for 2-3 hours
Average Density Commercial	1,500 to 2,500 gpm for 2-3 hours
High Value Commercial	2,500 to 3,500 gpm for 2-3 hours
Light Industrial	2,000 to 3,500 gpm for 2-3 hours
Heavy Industrial	2,500 to 3,500 gpm for 2-3 hours

Municipal fire insurance ratings are partially based on a water utility's ability to provide needed fire flows up to a maximum flow of 3,500 gpm for all non-residential land uses. This is the largest fire flow that the ISO recognizes as necessary for a system to provide even if a specific building within the community requires a greater fire flow.

ISO last surveyed PBWP's distribution system in 2016. A copy of their hydrant testing report is included in **Appendix A**. ISO ratings for PBWP ranged from a low of 750 gpm for residential areas to a high of 4,500 gpm. Recommended fire flows greater than 3,500 gpm are generally located in the vicinity of dense commercial and large populated establishments (i.e., schools, hospitals, commercial and industrial centers). **Figure 4-4** delineates the approximate ISO test locations in the PBWP system.

Table 4-5 presents the results of the model simulations of the available fire flows coincident with the projected year 2034 maximum-day demand for representative locations throughout the service area. The simulated available flows were compared to the required flows developed by the ISO.



ISO Test Locations

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FIGURE: 4-4

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The modeled available fire flows shown in **Table 4-5** differ from the ISO test results and from field testing results completed for this study because of varying pumping rates, system demands, infrastructure improvements and water level elevations in the storage tanks during the testing periods. In addition, the modeled available fire flows presented are based on maintaining a minimum 20 psi residual in all areas of the distribution system. Normal field flow test and ISO testing procedures do not take into account pressures in the distribution system other than at the test hydrant. Of the ISO fire flow locations that were evaluated as part of this report, 89% of the locations are deficient (assuming a maximum flow requirement of 3,500 gpm). The recommendations that follow address fire flow deficiencies listed in **Table 4-5**:

- Replacement of approximately 3,400 linear feet of existing 6-inch asbestos cement main on High Street with new 8-inch ductile iron main.
- Replacement of approximately 3,900 linear feet of existing 6-inch asbestos cement main on Elm Street with new 8-inch ductile iron main.
- Replacement of approximately 2,100 linear feet of existing 8-inch ductile iron main on Daniel Webster Highway from approximately 325 Daniel Webster Highway (Nursing Home) to the Corrosion Control Facility with new 12-inch ductile iron main.

Table 4-5 Available Fire Flows at ISO Test Locations Under Projected Year 2044 Maximum-Day Demands

Test No.	Land-Use Description	Test Location	ISO Required Fire Flow (gpm)	(1) Minimum 20 psi under Existing Conditions		(2) Minimum 20 psi assuming Improvements to Select Areas of System	
				Available Fire Flow[1] (GPM)	Adequate[2] (Yes/No)	Available Fire Flow[1] (GPM)	Adequate[2] (Yes/No)
1	Commercial	Daniel Webster @ County Complex	3500	650	No	2,750	No
2	Residential	Daniel Webster Hwy @ North of Complex	750	800	Yes	1,770	Yes
3	Residential	Raymond @ Woodberry	750	900	Yes	1,210	Yes
4	Commercial	High St @ North of Corn Hill	3500	675	No	1,460	No
5	Commercial	King St @ North of Queen	2500	1,500	No	2,800	Yes
6	Commercial	King @ Crete Barn	2250	1,950	No	3,075	Yes
7	Commercial	N. Main St @ Jackson	2500	2,100	No	2,525	Yes
7-A	Residential	N. Main St @ Jackson	750	2,100	No	2,525	Yes
8	Residential	Elm St @ End	750	500	No	875	Yes
9	Commercial	N. Main St @ River*	4500	-	N/A	-	N/A
9-A	Commercial	N. Main St @ River*	3500	-	N/A	-	N/A

*Exact location was unable to be determined from ISO Report.

4.4 Opportunities for Interconnection with Adjacent Water Systems

Interconnections with surrounding communities can be valuable from an emergency response perspective. Generally, benefit will be gained by both PBWP and the adjacent community should they interconnect. All interconnection locations should be metered to account for water transferred between water systems. Agreements pertaining to construction cost sharing, amount of water and the conditions under which water could be transferred will need to be negotiated between the individual communities.

4.4.1 Interconnection with Concord

There is currently an emergency interconnection between PBWP and Concord that is in Penacook. Notification to the City of Concord is required for activation of the emergency interconnection. During the loss of one well, the Precinct can request activation to cover long term needs in a limited area. The Precinct could obtain water from Concord in the case of a complete loss of water supply. A pump would need to be placed between two hydrants on Route 3 to supply water to the Fairbanks Tank. As the City of Concord uses chloramines for ion disinfection and high pH adjustment, the PBWP's corrosion control facility would need to be turned off when the emergency interconnection is activated.

4.5 Distribution System Business Risk Exposure Assessment

Not all assets are equally important to a water system's operation; some assets are highly critical to operations and others are much less so. Furthermore, the definition of a critical asset is completely system specific. A water system must examine its own assets very carefully to determine which current assets are critical and why.

Analyzing the existing distribution system to determine the likelihood of failure (LoF), and the consequence of failure (CoF), provides valuable information about locations in the distribution system that have the greatest business risk exposure (BRE). This evaluation methodology is additionally beneficial to the development of cost-effective CIP planning allowing the BPWP to add business risk exposure to the process.

4.5.1 Likelihood of Failure

As a first step in determining risk, a system needs to look at what it knows about the likelihood that a given asset is going to fail. The four general models of asset failure are:

- Mortality - physical failure of the asset. This is the most common mode of failure.
- Inefficiency - the asset costs too much maintain operability and keep in service.
- Capacity – the asset is operational, but is unable to deliver the required capacity
- Level of Service – the asset is operational, but is unable to meet the required level of service

An asset may be highly likely to fail if it is old, has a long history of failure, has a known failure record in other locations, or has a poor condition rating. An asset may be much less likely to fail if it is newer, is highly reliable, has little to no history of failure and has a good to excellent condition assessment rating.

4.5.2 Consequence of Failure

In terms of the CoF, it is important to consider various possible costs of failure. The costs potentially include loss of fire protection, public health impact, social cost associated with the loss of the asset, repair/replacement costs related to collateral damage, legal costs related to additional damage, environmental costs, and any other associated costs or asset losses. The CoF can be high if any of these costs are significant or if there are several of these costs that will occur with a failure.

4.5.3 Business Risk Exposure

Assessing risk requires an examination of the LoF and CoF as discussed above. The BRE score combines the two measures of failure into one number that can be used to sort and rank assets for further analysis.

BRE = LoF x CoF

Using this methodology, the BPWP's exposure to the risk of failure for a given asset can be evaluated. Risk can be reduced by decreasing either the LoF through replacement or refurbishment or decreasing the CoF through redundancy or relocation. In most cases it is not cost effective to install redundant infrastructure and sometimes, in the case of distribution systems and storage tanks, too much redundancy can often be detrimental to water quality in the system.

Normally, the most cost-effective means of reducing BRE on aging assets is to reduce the LoF through infrastructure replacement projects. The assets that have the greatest LoF and the greatest CoF will be the assets that have the greatest BRE and should be further evaluated to determine ways to reduce the BRE through replacement, refurbishment, redundancy or relocation.

In most cases a significant amount of risk can be mitigated through replacement. For example, BRE for an existing 8-inch CI pipe on Elm Street, installed in 1940, with a static pressure of 60 psi, and a break history, will go from a BRE score of 24.1 to a BRE score of 6.5 after replacement with 12-inch HDPE pipe (Table 4-6). The replacement of an existing pipe with a new pipe reduces the LoF thus reducing the BRE score.

Table 4-6 Impact of Replacement on BRE Scores

Description	Existing 8" CI Pipe Score	Proposed 12" HDPE Pipe Score
LoF Score	*6.9*	*0.4*
CoF Score	*3.5*	*5.5*
BRE Score	24.1	6.5

The distribution system BRE assessment was developed to utilize specific available GIS attributes to assign risk for each pipe segment in the water system network.

Table 4-7 BRE Categories for Distribution System Analysis

Likelihood of Failure	Consequence of Failure
Asset Life Consumed	Business Interruption
Material	Traffic Interruption
Repair History	Fire Flow Reduction
Static Pressure	

4.5.4 LoF Development

The LoF score is a sum of the factors listed below normalized to a 1-10 scale by weighting the factors per Table 4-8. These weighting factors have been selected by the PBWP to appropriately reflect the potential risk for each factor in.

Table 4-8 Likelihood of Failure Factor Weighting

Factor	Weighting
Asset Life Consumed	0.55
Material	0.15
Repair History	0.20
Static Pressure	0.10

Asset Life Consumed – This factor gives weight to the age of a pipe. This factor assumes a conservative useful lifespan of 60 years asbestos cement (AC) and steel pipes, 70 years for cast iron (CI), HDPE, and unknown pipe materials, and 100 years for ductile iron (DI) distribution system pipes. The scoring is a ratio of current time in service for each pipe by the expected lifespan. This ratio is multiplied by 10 to adjust the ration to the 1-10 scoring mechanism as shown below. All pipes with unknown ages were assigned a score of 5. Figure 2-2 presents the distribution system by installation year.

Score = (Current Year - Installation Year)/Useful Lifespan *10)

*It should be noted that pipes with unknown installation years were assumed to be halfway through their useful lifespan to be conservative.

Material Type – This factor gives weight to the different types of pipe material. Some types of pipe are more susceptible to failure than others. Weighting factors are presented in Table 4-9. Figure 2-4 shows the distribution system by material type.

Table 4-9 Pipe Material Scoring

Material	Score
Asbestos Cement	7
CI	7
CLDI	1
DI	1
HDPE	1
Steel	8
Unknown	5

Static Pressure – This factor gives weight to areas where higher static pressures are present. High pressure adds additional stress on a pipe and can lead to failure. Weighting factors are presented in **Table 4-10**. Refer to **Figure 4-2** for the normal distribution system pressure.

Table 4-10 Static Pressure Scoring

Static Pressure (psi)	Score
0-25	1
25-50	3
50-75	7
75+	10

4.5.5 CoF Development

The CoF score is a sum of the factors listed below normalized to a 1-10 scale. These weighting factors have been selected by the PBWP to appropriately reflect the potential risk for each factor in Pennacook.

Table 4-11 Consequence of Failure Factor Weighting

Factor	Weighting
Business Interruption	0.25
Traffic Disruption	0.25
Fire Flow Reduction	0.5

Business Interruption – This factor gives weight to sections of the distribution system that are necessary to supply water to facilities where water is of high importance such as school buildings and medical facilities. Weighting factors are presented in **Table 4-12**. Refer to **Figure 4-5** for critical facility and pipe locations.

Table 4-12 Business Interruption Scoring

Business Interruption (Y/N)	Score
No	1
Yes	10

Traffic Disruption – This factor gives weight to the impact to traffic if a given piper were to fail. Disruptions were divided into three types (Major, Moderate and Minor). Weighting factors are presented in Table 4-13. Figure 4-6 delineates the three traffic disruption classifications.

Table 4-13 Traffic Disruption Scoring

Traffic Disruption	Score
Major	10
Moderate	5
Minor	1
Cross-Country	1

Fire Flow Reduction – Larger diameter water mains provide the backbone of the fire protection and water transmission for the system. Larger diameter pipes are also more difficult to repair in the event of a main break. This factor provides weight to the importance of these mains. Figure 2-3 shows the distribution system by pipe diameter.

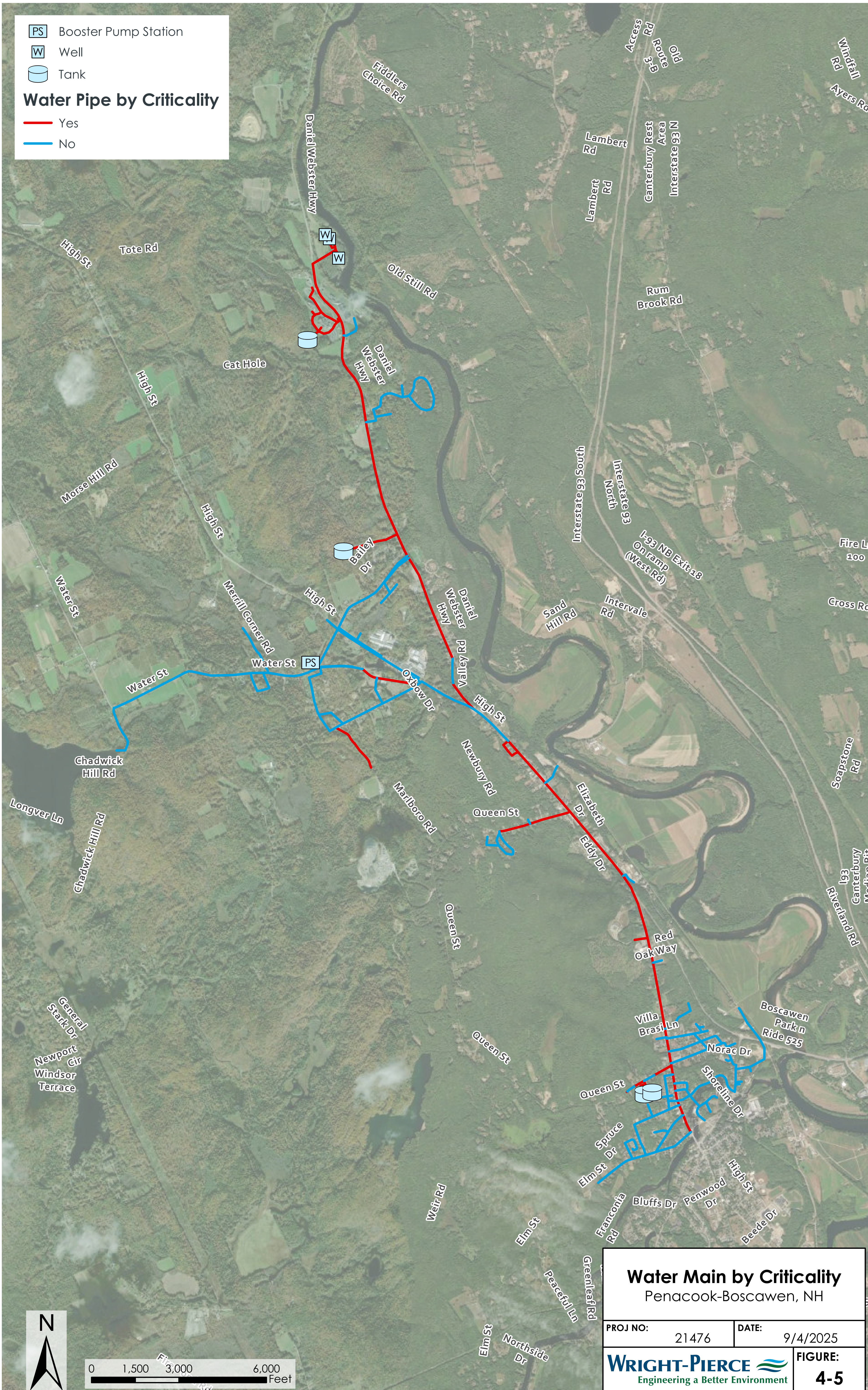
Table 4-14 Fire Flow Reduction Scoring

Diameter (inch)	Score
2	1
4	2
6	4
8	6
10	8
12	10

4.5.6 Distribution System Business Risk Exposure (BRE)

Figure 4-7 shows the BRE scores across the PBWP water distribution system. As shown in the figure, the majority of the highest risk water mains are located on Daniel Webster Highway, King Street, and North Main Street. Plotting the LoF scores against the CoF scores for all pipes in the system on a graph provides another visual means of reviewing this information (**Figure 4-8**). Generally, the water mains in PBWP have a high LoF score as the majority of the pipes in the system were installed before 1970 and this is the LoF factor with the most weight. This will continue to rise as the pipes age and will be the driver for water main replacement in the next 20-year planning cycle. The majority of the water mains have a high CoF as the majority of the pipes are essential to the water system and/or are located on state highways.

As shown on the graph it is evident that some assets in the distribution system fall into the “high risk” category of the graph. Most of the risk associated with these “high risk” assets is associated with the CoF factors where risk is not mitigated through replacement. Most of the larger water mains in Precinct are located in the areas where failure of the water mains is of the most consequence. Close monitoring of these higher risk assets is recommended. If the maintenance frequency of these assets starts to increase, replacement or relocation is recommended. As older water main is replaced, the BRE score is reduced. A copy of the BRE water main spreadsheet is included in **Appendix B**.



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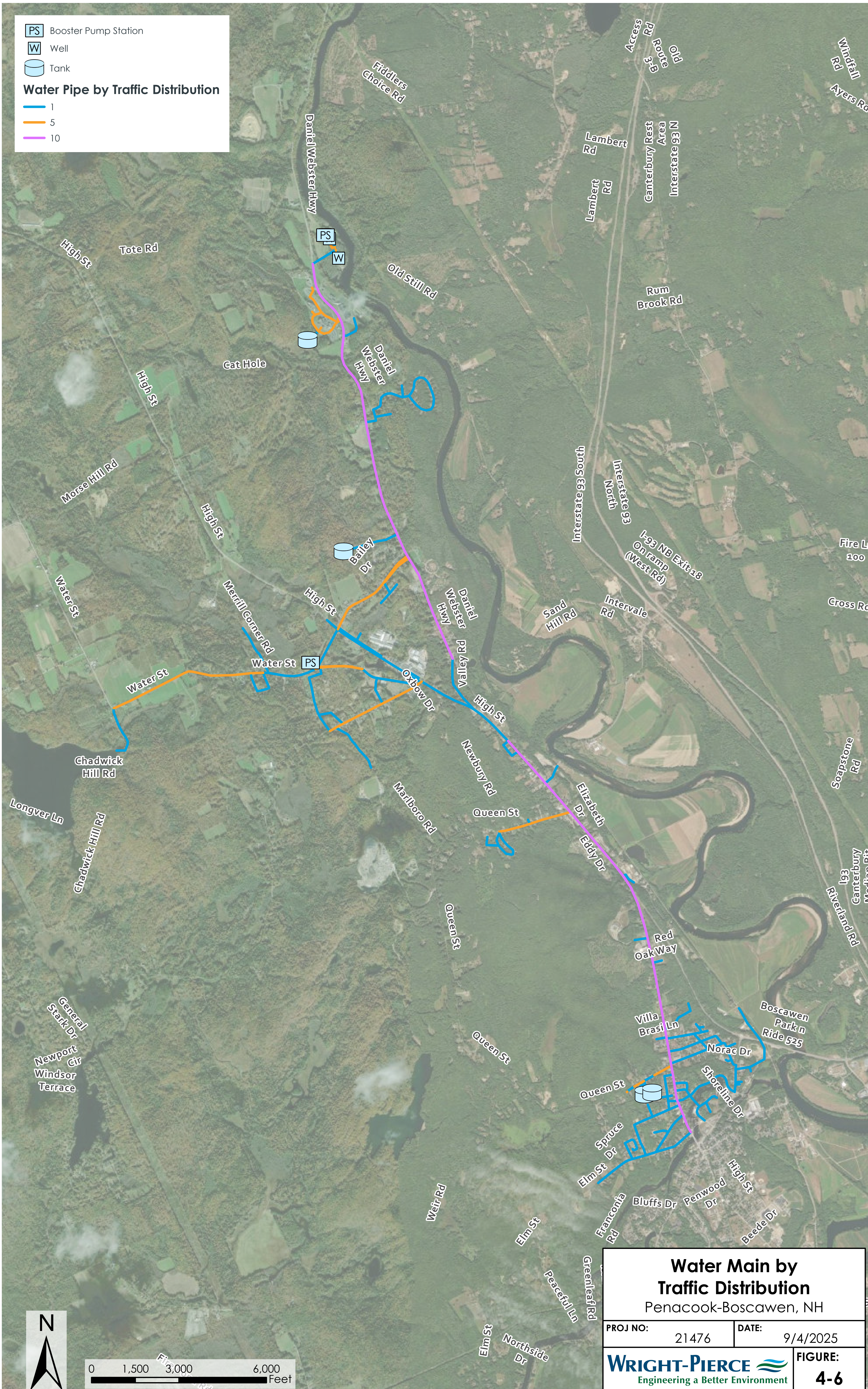

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Water Main by Traffic Distribution

Penacook-Boscawen, NH

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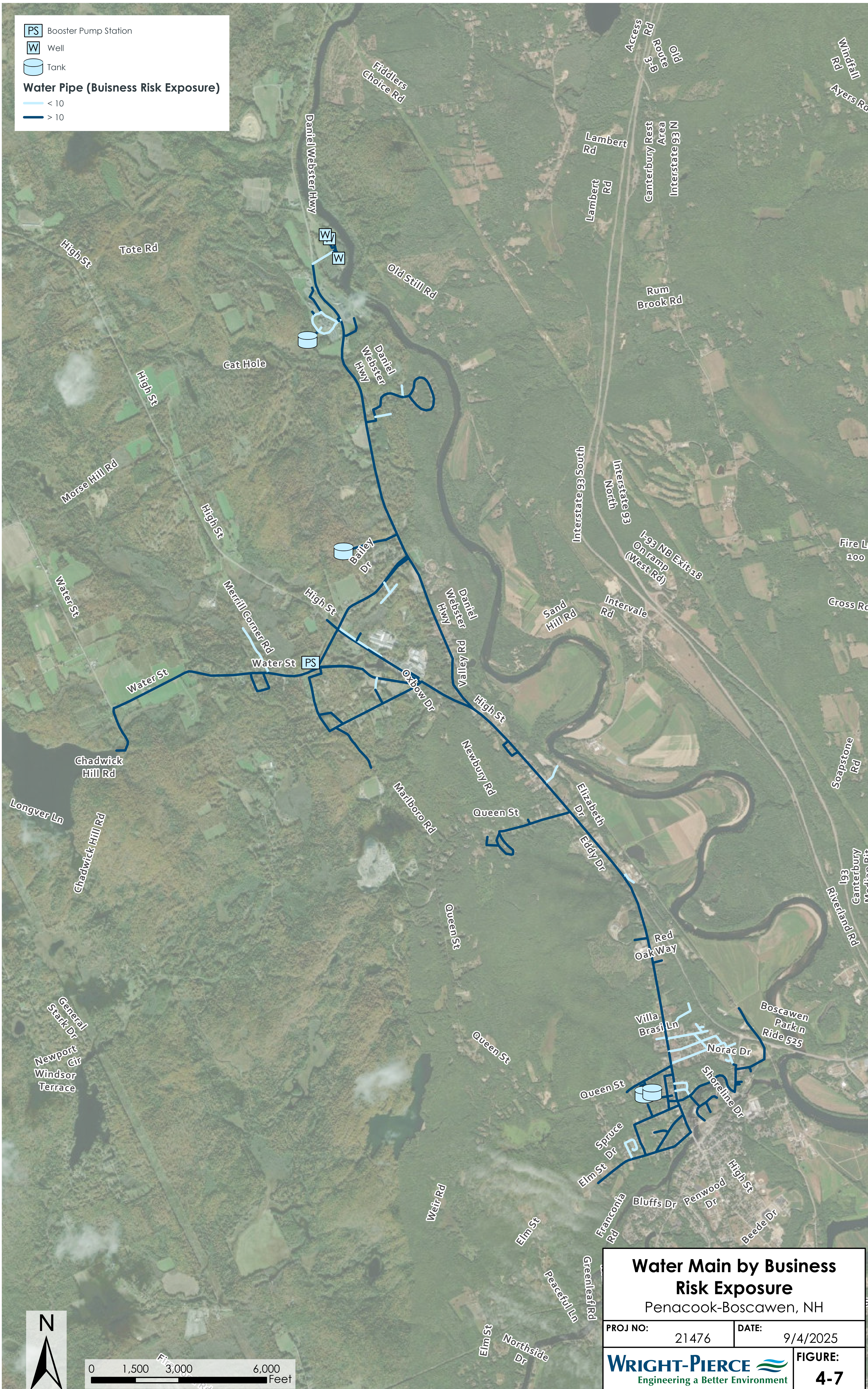
FIGURE: 4-6



Water Main by Business Risk Exposure

Penacook-Boscawen, NH

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FIGURE: 4-7

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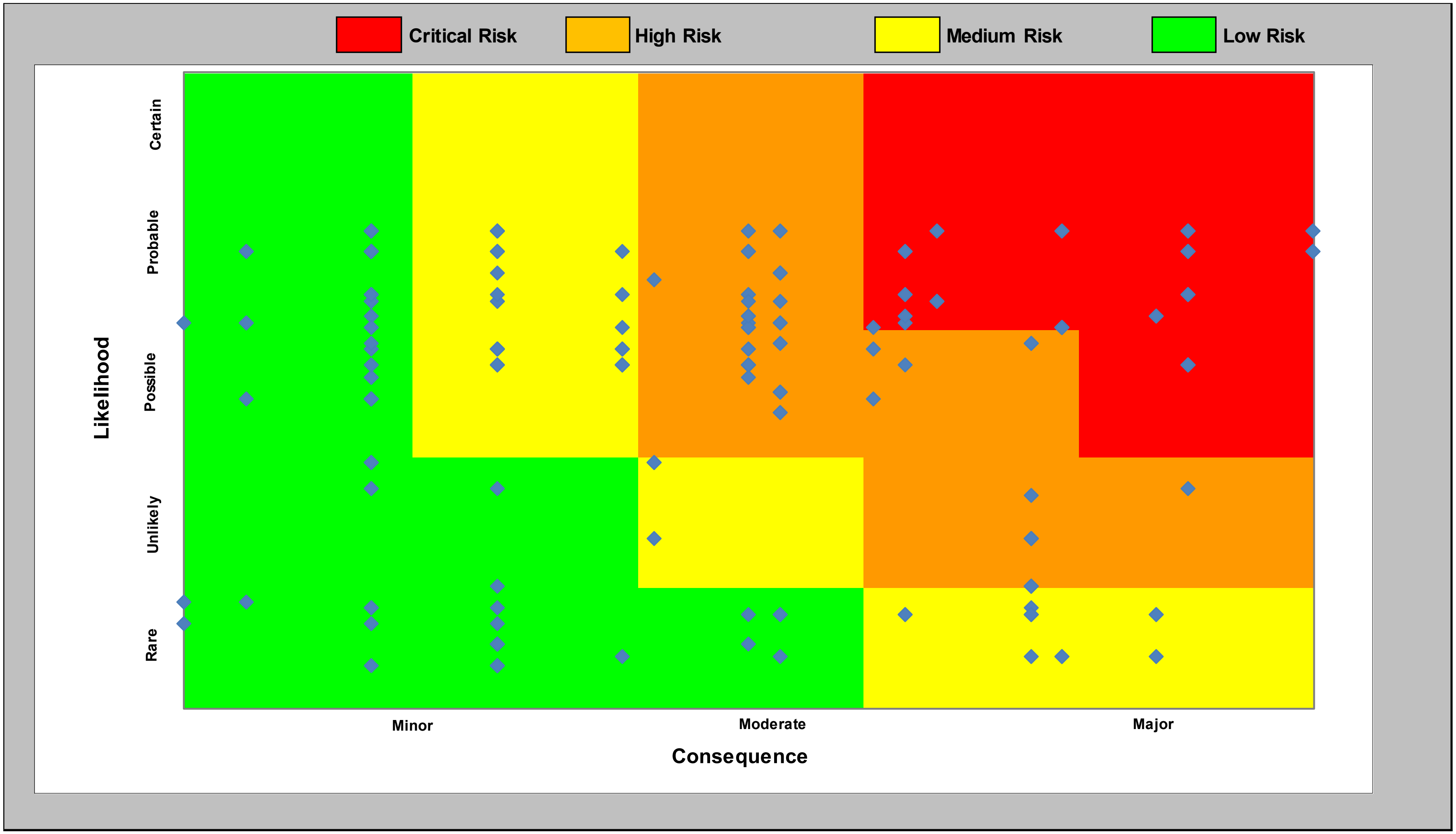
Figure 4-8 Distribution System Business Risk Exposure: All Pipes



4.6 Conclusions and Recommendations

As stated at the beginning of this section, the purpose of this evaluation was to assess the strengths and weakness of the distribution system under existing and projected future demand conditions and determine the risk associated with the existing distribution system. Based on the evaluations presented, the following conclusions and recommendations are offered.

Cost estimates for piping recommendations have been based upon an average unit price for similar publicly bid and constructed projects (unless otherwise noted) inclusive of the installation of water mains and appurtenances, services, ledge, paving and restoration. All of the project costs listed include an additional 20% construction contingency and 20% for engineering unless otherwise noted.

4.6.1 Operations and Maintenance Recommendations

Valve Exercise Program

A routine valve exercise program is recommended. Main transmission valves should be exercised yearly. Smaller distribution valves should be operated at a minimum every three (3) years.

Hydrant and Valve Replacement Program

We recommend the PBWP begin a hydrant and valve replacement program. Initially this should consist of budgeting to replace a small number of known problem valves and hydrants each year. Additional location and condition assessment data can be collected during the flushing and exercise programs on the hydrants and valves to target replacements of assets that are most critical or not functional.

Unidirectional Flushing

Pipe velocities were evaluated under year 2044 MDD conditions. The analysis found that a majority of the mains throughout the system have velocities below 1 fps. Low velocities are generally desired in distribution piping to reduce headloss and to avoid the possibility of re-suspending sediment in pipes during typical operations. The collection of deposits can become problematic if not flushed on a regular basis. BPWP currently flushes the distribution system on a biannual basis in the spring and fall using modified unidirectional flushing (UDF). We recommend that BPWP continue this practice. UDF is designed to routinely and systematically flush water from the supplies and storage to remove sediments and should be combined with hydrant and pipe maintenance.

4.6.2 Distribution System Improvements

In general, the majority of the distribution system (piping, pumping and storage) is hydraulically strong yet there are deficiencies of varying degree which should be addressed. A number of potential improvements were modeled to resolve the deficiencies identified from the analysis. In many cases, an improvement was found to resolve more than one deficiency. For this reason, the improvements were considered from a holistic perspective to maximize the benefit while minimizing the amount of infrastructure investment needed. Recommended improvements are prioritized in the Capital improvement Plan section (Section 5).

System Pressure Improvements

- Low pressures are present at Bluebird Lane, Robin Street, and Dove Street. A private booster station for this area would result in static pressures over the recommended 40 psi. There are also low pressures at Prospect Street, which is located in the vicinity of the Queen Street Tanks. Individual boosters for residences on this street is also recommended to increase static pressures to over 40 psi.

High Velocity, Excessive Headloss Improvements

- No significant recommended improvements.

Pipe Looping Recommendations

- No significant recommended improvements.

Piping Redundancy, Reliability and Adequacy Recommendations

- Replacement of approximately 1,500 linear feet of 6-inch asbestos cement main on Corn Hill Road from High Street to Pine Street with 8-inch ductile iron main.

Fire Flow Improvements

- Replacement of approximately 3,400 linear feet of existing 6-inch asbestos cement main on High Street with new 8-inch ductile iron main.
- Replacement of approximately 3,900 linear feet of existing 6-inch asbestos cement main on Elm Street with new 8-inch ductile iron main.
- Replacement of approximately 2,100 linear feet of existing 8-inch ductile iron main on Daniel Webster Highway from approximately 325 Daniel Webster Highway (Nursing Home) to the Corrosion Control Facility with new 12-inch ductile iron main.

Business Risk Improvements

- Replace approximately 7,700 linear feet of 10-inch and 12-inch asbestos cement and 10-inch cast iron pipe on North Main Street from River Road to Elm Street with 12-inch ductile iron pipe.
- Replace approximately 13,500 linear feet of 6-inch and 8-inch asbestos cement pipe on Daniel Webster Highway from approximately 325 Daniel Webster Highway (Nursing Home) to Valley of Industry Road with 12-inch ductile pipe.
- Replace approximately 8,800 linear feet of 10-inch cast iron pipe on King Street with 12-inch ductile iron pipe.
- Replace approximately 2,000 linear feet of 10-inch asbestos cement pipe on Woodbury Avenue with 12-inch ductile iron pipe.
- Replace approximately 5,100 linear feet of 12-inch asbestos cement pipe on Water Street with 12-inch ductile iron pipe.

4.6.3 Interconnections with Adjacent Water System

In general, interconnections with water systems are advantageous to both systems involved decreasing the amount of risk associated with the loss of source water and in the increased amount of potentially available emergency storage. As the PBWP already has an interconnection with the Concord water system, we recommend rehabilitating the existing interconnection point.

4.7 General

Distribution storage provides a number of important functions to a water system. This includes establishing and sustaining adequate pressure throughout the system, water for firefighting capabilities, and storage during short-term emergency purposes. Storage also provides a "cushion" to equalize peak demand fluctuations, improves service reliability, provides operational flexibility, and allows intermittent operation of pumping and treatment systems. The Precinct owns and operates four distribution storage facilities located within the Upper and Queen Street pressure zones.

As part of the asset management plan, a conditional assessment of the existing water storage tanks and a storage analysis was conducted for the system. Where required, recommendations for improvements to the existing water storage tanks, storage volume and operation are provided.

4.8 Existing Storage Tank Evaluation

4.8.1 Queen Street Tank #1

The 1.0 MG welded steel water storage tank was constructed in 1974. The tank was last inspected in August 2021 by Underwater Solutions, Inc., along with sediment removal services. The inspection found the tank to have declining/thinning protective coating throughout the exterior of the tank and less than 5-percent of the south and east walls of tank to have exposed steel. Both exterior manways of the tank have peeling on their coatings and there are signs of metal exposure. The roof was found to have declining/peeling protective coating throughout the roof. The exterior of the tank also does not have a catwalk nor safety railings present.

The interior of the tank was found to have mild biofilm/staining throughout and less than 5-percent exposed steel on its walls. There was 1.5-inches of iron magnesium mineral sediment removed from the interior of the tank. The interior pipe was found to have a blistering coating. The interior overhead was found to have declining/thinning or peeling protective coating and less than 5-percent exposed steel throughout. The interior of the tank does not have cathodic protection nor an interior ladder currently.

4.8.2 Queen Street Tank #2

The 0.265 MG welded steel water storage tank was constructed in 1954. The tank was last inspected in August 2021 by Underwater Solutions, Inc., along with sediment removal services. The inspection found the tank to have declining/thinning protective coating throughout the exterior of the tank and less than 5-percent of the north and east walls of tank to have exposed steel. The exterior manway's coating was found to be declining, thinning, and peeling. There were also signs of metal exposure on the exterior manway. The exterior ladder was found to have a declining/thinning coating. The roof was found to have a declining/thinning coating and greater than 20-percent exposed steel throughout. The exterior of the tank also does not have a catwalk nor safety railings present.

The interior of the tank was found to have mild biofilm/staining through and less than 5-percent exposed steel on its wall and the east floor. There was 2-inches of iron magnesium mineral sediment removed from the interior of the tank. The interior manway was found to have a declining/thinning/peeling coating and there were signs of metal exposure and corrosion. The interior pipe was found to have a blistering coating. The interior overhead was found to have declining/thinning coating and less than 5-percent exposed steel. The interior of the tank does not have cathodic protection nor an interior ladder currently.

4.8.3 Fairbanks Street Tank

The 0.75 MG precast, prestressed concrete water storage tank was constructed in 1995. The tank was inspected in August 2021 by Underwater Solutions, Inc., along with sediment removal services. The inspection found that the protective coating of the exterior walls was declining/thinning throughout. The exterior walls were also found to have greater than 20-percent of tanks with those cracks having greater than 20-percent efflorescence. The exterior manway was found uncoated. The roof had a declining/thinning coating throughout. Portions of the roof had cracks up to 10-percent and some cracking had greater than 20-percent efflorescence. The exterior of the tank does not have a rooftop aerator nor safety railings present.

The interior walls of the tank had heavy biofilm/staining, and the interior floor had mild biofilm/staining. There was 2-inches of iron magnesium mineral sediment removed from the interior of the tank. The interior manway was found to be uncoated and did not have a fall prevention device nor safety cage. Interior Pipe #1 was found to have a blistering coating while Interior Pipe #2 was found to be uncoated. Both the interior overflow and overhead were found to be uncoated.

4.8.4 Merrimack County Nursing Home Tank

The 0.25 MG bolted steel water storage tank was constructed in 1995. The tank was inspected in August 2021 by Underwater Solutions, Inc, along with sediment removal services and a sacrificial anode replacement. The exterior of the tank was found to be in overall good condition. Both exterior manways were found to be uncoated and there was graffiti on the north/south quadrants of the roof.

The interior walls of the tank were found to have heavy biofilm. There was 3-inches of iron magnesium mineral sediment removed from the interior of the tank. The interior pipe was found to have a blistering coating. The existing sacrificial anodes were found to have 0-percebt lifetime remaining at the time of inspection and were replaced. The overhead was found to have a peeling protective coating throughout and there was les than 5-percent of exposed steel at the north and east quadrants of the overhead.

4.9 Storage Volume Analysis

In general, distribution system storage is necessary to satisfy the following conditions:

- To satisfy all demands which exceed the maximum day pumping capacity from the wells. The storage volume, which is depleted during the daytime, peak flow periods is refilled during the lower demand, nighttime hours.
- For fire protection. If a fire occurred during the maximum day demand, all of the water used to fight the fire would be drawn from storage volume.
- To meet emergency conditions such as power failures, transmission main breaks, treatment/pumping equipment failure and other unanticipated supply interruptions.
- For cycling pumps during normal daily operation.

The primary criteria used to evaluate storage requirements include; average and peak water usage, water supply capabilities, as well as fire protection and reserve or emergency needs. Each of these criteria is used to establish three components of storage; equalizing volume, emergency volume, and fire volume. The total of these three components is referred to as the active or required storage volume. All of these storage components should be available while still providing, at a minimum, pressure of 20 psi at ground level (recommend 35 psi) throughout the distribution system under all conditions, as a requirement of NHDES/Ten States Standards. Assuring a minimum pressure prevents backflows from plumbing fixtures into the distribution system. When possible, storage should be located throughout the distribution system to deliver flows from multiple locations to reduce pipe velocities, maintain pressures, and provide appropriate flows to a fire location.

Equalizing storage is the volume of water required during the daily demand fluctuations to meet the peak usage periods that exceed the maximum available pumping capacity. This volume should be provided independent of the required fire volume in order to assure sufficient reserve volume in the event of a fire during the peak demand period. Using the maximum day demand figures from Section 2, the equalizing storage volume for the entire system was estimated to be approximately 25% of the maximum daily demand (MDD) to estimate peak hour conditions.

Fire storage is the volume of water needed for firefighting and should include a sufficient volume of water for fire protection on days of maximum demand. In most cases, the fire volume is the largest component of storage. The storage evaluation will include an analysis under a fire flow of 3,500 gpm for three hours as ISO recognizes this flow as the largest that is required to be provided.

Emergency storage is recommended when an additional factor of safety is desired for emergencies or where demands are unpredictable and fluctuate widely. Emergency storage may also be included when a utility desires to take advantage of off-peak electrical charges for pumping. Determining the emergency storage generally depends on the adequacy of the supply sources, redundancy and the level of safety a utility desires. Emergency storage is often simply calculated as the volume necessary to supply the system during repair or maintenance work, or in the event that the pumping facilities do not have emergency back-up power equipment. In most cases, this is calculated as a specified number of hours of the average-day demands. The Precinct currently has an emergency interconnection with the City of Concord. For the purposes of this study, an assumption was made that no emergency storage will be required.

4.9.1 Active Storage Volume Analysis

The existing storage facilities were evaluated on the three storage criteria identified above. Storage was considered for the entire distribution system. It is important to point out that in most cases, not all of the storage volume within a tank is useable and is dependent upon the highest service elevations in the system, operational set points, and minimum operating pressures that are to be maintained under all conditions. The useable storage volume is known as the "active" volume and is the amount that will be considered in the storage analysis. Based on the tank dimensions, highest served elevations and the water system hydraulics, the total available active volume available during normal operating conditions is presented in Table 4-16. The volumes calculated will be used in the analysis of required storage which follows. Operational recommendations are presented at the end of this section.

Table 4-15 Active Storage Volume by Service Zone

Criteria	Fairbanks Zone	Queen Street Zone		County Zone
	Fairbanks Tank	Queen Street Tank #1	Queen Street Tank #2	Merrimack County Tank
Total Capacity (gallons)	750,000	265,000	1,000,000	261,000
Overflow Elevation (feet - USGS)	532.0	508.0	503.2	500.0
Base Elevation (feet - USGS)	492.0	426.0	426.3	430.0
High Water Elevation (feet – USGS)	530.0	501.5	501.8	492.0
Low Water Elevation (feet – USGS)	526.0	496.0	496.3	499.0
Inside Diameter (feet)	56.0	25.0	47.0	27.0
Unit Volume (gallons/foot)	18,423	3,672	12,977	4,283
Highest Elevation Served (feet - USGS)	465.0	450.0	450.0	390.0
Minimum Elevation to Maintain 20 psi (feet-USGS)	511.2	496.2	496.2	436.2
Available Active Volume Depth (feet)	20.8	11.8	7	63.8
Available Active Storage Volume (gallons)	383,205	43,326	90,842	273,237
Total Available Active Storage Volume	**383,200**	**134,200**		**273,300**
	790,700			

4.9.2 Current System Storage Capacity Analysis

Three primary criteria were used to develop a relationship between the supply capacity and recommended storage volumes for the PBWP distribution system.

- The reliable supply capacity should equal or exceed the MDD requirements.
- Total storage should be capable of meeting fire protection needs throughout the system.
- The reliable supply capacity plus the available storage volume should equal or exceed fire flow requirements plus the maximum-day volume requirements.

4.9.2.1 Fairbanks Zone

Storage in the Fairbanks Zone is provided by the Fairbanks Tank at HGL of 532 feet. The highest known service in the Fairbanks Zone is at 465 feet.

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the current MDD of the Fairbanks Zone. Twenty-five percent of the 2024 MDD of 83,000 gpd is approximately 20,750 gallons.
- Fire Protection – The maximum fire flow required to be provided by the PBWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.

- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 650,750 gallons. The existing active storage volume in the Fairbanks Zone service area is approximately 383,200 gallons. The analysis is summarized on Table 4-17.

4.9.2.2 Queen Street Zone

Storage in the Queen Street Zone is provided by both Queen Street Tanks at a HGL of 508 feet. The highest known service in the Queen Street Zone is at 450.0 feet USGS.

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the current MDD of the Queen Street Zone. Twenty-five percent of the 2024 MDD of 208,400 gpd is approximately 52,100 gallons.
- Fire Protection – The maximum fire flow required to be provided by the PBWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.
- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 651,775 gallons. The existing active storage volume in the Queen Street Zone service area is approximately 134,200 gallons. The analysis is summarized on Table 4-17.

4.9.2.3 County Zone

Storage in the County Zone is provided by the Merrimack County Tank at HGL of 500 feet. The highest known service in the County Zone is at 390 feet.

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the current MDD of the County Zone. Twenty-five percent of the 2024 MDD of 87,100 gpd is approximately 21,775 gallons.
- Fire Protection – The maximum fire flow required to be provided by the PBWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.
- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 651,775 gallons. The existing active storage volume in the County Zone service area is approximately 273,300 gallons. The analysis is summarized on Table 4-17.

4.9.2.4 Water Street Zone

Storage in the Water Street Zone is based on the discharge pressure of the Water Street Pump Station at HGL of 680 feet. The highest known service in the Water Street Zone is at 570 feet.

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the current MDD of the Water Street Zone. Twenty-five percent of the 2024 MDD of 10,300 gpd is approximately 2,575 gallons.
- Fire Protection – The maximum fire flow required to be provided by the PBWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.
- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 632,575 gallons. The existing active storage volume in the Water Street Zone service area is approximately 383,200 gallons. The analysis is summarized on **Table 4-17**.

Table 4-16 Current Storage Needs Analysis

Scenario	Storage Requirements	Fairbanks Zone Active Storage Needs (Gallons)	Queen Street Zone Active Storage Needs (Gallons)	County Zone Active Storage Needs (Gallons)	Water Street Zone Active Storage Needs (Gallons)
1	25% of MDD	20,750	52,100	21,775	2,575
2	3-hour fire @ 3,500 gpm	630,000	630,000	630,000	630,000
3	Emergency Storage	0	0	0	0
Total Required Storage		650,750	682,100	651,775	632,575
Active Storage Available		383,200	134,200	273,300	383,200
Total Surplus/(Deficit)		**(267,550)**	**(547,900)**	**(378,475)**	**(249,375)**

As shown in the table above, the PBWP currently has a storage surplus when reviewing maximum day demand and emergency storage. The PBWP has a deficit when reviewing ISO's maximum requirement for fire flow (3,500 gpm for 3-hours).

4.9.3 Projected System Storage Capacity Analysis

All storage tank components and operating parameters remained unchanged for the projected system storage capacity analysis. The analysis below uses projected demands from Section 2 of this report.

4.9.3.1 Fairbanks Zone

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the projected 2044 MDD of the Fairbanks Zone. Twenty-five percent of the 2044 MDD of 87,800 gpd is approximately 21,950 gallons.
- Fire Protection – The maximum fire flow required to be provided by the BPWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.
- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 651,950 gallons. The projected active storage volume in the Main Zone service area is approximately 383,200 gallons. The analysis is summarized on **Table 4-18**.

4.9.3.2 Queen Street Zone

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the projected MDD of the Queen Street Zone. Twenty-five percent of the 2044 MDD of 220,900 gpd is approximately 55,200 gallons.
- Fire Protection – The maximum fire flow required to be provided by the BPWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.
- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 685.200 gallons. The projected active storage volume in the Queen Street Zone service area is approximately 134,200 gallons. The analysis is summarized on **Table 4-18**.

4.9.3.3 County Zone

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the projected MDD of the County Zone. Twenty-five percent of the 2044 MDD of 92,300 gpd is approximately 23,100 gallons.
- Fire Protection – The maximum fire flow required to be provided by the BPWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.
- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 653,100 gallons. The projected active storage volume in the County Zone service area is approximately 273,300 gallons. The analysis is summarized on **Table 4-18**.

4.9.3.4 Water Street Zone

The needed storage volume required is outlined as follows:

- Equalization Storage for Peak-Hour Fluctuation – The storage volume necessary to provide the system hourly fluctuation demands was estimated to be 25% of the projected MDD of the Water Street Zone. Twenty-five percent of the 2044 MDD of 10,900 gpd is approximately 2,700 gallons.
- Fire Protection – The maximum fire flow required to be provided by the BPWP is 3,500 gpm for 3 hours equal to 630,000 gallons, which is the ISO recommended maximum necessary for a public water system to supply.
- Emergency Storage – No provisions for emergency storage are recommended as the PBWP currently has an interconnection with the City of Concord and a generator at each the corrosion control facility and BPS.

The total active storage volume requirement for the components described above is approximately 632,700 gallons. The projected active storage volume in the Water Street Zone service area is approximately 383,200 gallons. The analysis is summarized on **Table 4-18**.

Table 4-17 Projected Storage Needs Analysis

Scenario	Storage Requirements	Fairbanks Zone Active Storage Needs (Gallons)	Queen Street Zone Active Storage Needs (Gallons)	County Zone Active Storage Needs (Gallons)	Water Street Zone Active Storage Needs (Gallons)
1	25% of MDD	21,950	55,200	23,100	2,700
2	3-hour fire @ 3,500 gpm	630,000	630,000	630,000	630,000
3	Emergency Storage	0	0	0	0
	Total Required Storage	651,950	685,200	653,100	632,700
	Active Storage Available	383,200	134,200	273,300	383,200
	Total Surplus/(Deficit)	**(268,750)**	**(551,000)**	**(379,800)**	**(250,500)**

As shown in the table above, the PBWP has a storage surplus when reviewing future maximum day demand and emergency storage. The PBWP has a deficit when reviewing ISO's maximum requirement for fire flow (3,500 gpm for 3-hours).

4.9.4 Storage Tank Water Quality

Storage facilities can contribute to poor distribution water quality from lack of adequate circulation and turnover. Unchlorinated systems, like PBWPs, are susceptible to potential bacterial growth in storage tanks if water is not well circulated. There is not a mechanical mixer installed in any of the four storage tanks.

It is typically recommended to fluctuate 25% of the tank volume daily to maintain water quality. However, with an internal tank mixer the recommended turnover can be less than 25%. If needed in the future, an operational modification which could help improve turnover in the tanks would be to vary the tank operating level over a greater range. However, any change in operating level must be balanced with the ability to maintain adequate pressure and available storage volume. A better approach, that would improve water quality in all of the system tanks, would be to consider an internal tank mixing system to promote internal water exchange within the tank.

There are generally two distinct approaches to improving mixing within storage tanks: passive or mechanical methods.

Passive mixing systems simply consist of piping placed within the tank, which includes separate inlets and outlets located on opposite sides of the tank. A typical passive system consists of piping run along the floor of the tank with "duck bill" style check valves located on the inlet and outlet. In some cases, the piping and valves can be extended above the tank floor in a vertical orientation. These applications must take into account winter conditions where an ice lens can form and potentially damage the system. Passive systems are generally more difficult to maintain and service because it requires dewatering the tank or the use of divers.

Mechanical mixing systems consist of one or more electrical mixing devices which are designed to create a current and move water through the tank. Several types are available which include submersible type systems, which simply rest on the tank floor, or floating units.

4.9.5 Storage Considerations During Tank Maintenance

To maintain fire protection during a planned maintenance event at any of the Precinct's storage tanks (i.e. coating replacement and tank repairs) the interconnections with the Portsmouth water systems may be used as an additional source of storage in the event of an emergency. The Washington Road site has two tanks so maintenance should be staggered so that one tank can be kept online while maintenance is completed on the other. The Washington Road booster pump station has a VFD available offline and can maintain a constant pressure system for the Breakfast Hill Zone when maintenance is required for the Breakfast Hill tank.

4.10 Conclusions and Recommendations

As stated at the beginning of this section, the purpose of this evaluation was to assess the strengths and weakness of the storage tanks under existing and future demand conditions. Based on the evaluations presented, the following conclusions and recommendations are offered.

4.10.1 Storage Tank Repairs and Replacements

We do not recommend any specific repairs to the tanks. We recommend continued periodic tank inspections at a maximum interval of five years to evaluate coating conditions. Normal coating replacement cycles run approximately 15 to 20 years between coating replacement projects subject to satisfactory inspection. Routine inspections and surveillance of the storage tanks is recommended to track performance and to identify if any unanticipated or any unusual circumstances that might occur.

4.10.2 Water Turnover and Exchange

PBWP does not have mixers in any of their four water storage tanks. Installation of mixing systems could be considered during future tank maintenance projects, if water quality concerns arise. As part of any design for mixing systems, a hydraulic study and modeling of tank fill and drain cycles combined with a Computational Fluid Dynamic (CFD) analysis should be conducted to determine the most appropriate mixing strategy.

Section 5 Facility Evaluation and Risk Analysis

5.1 General

The Penacook Boscawen Water Precinct (PBWP) owns and operates one booster pump station (BPS), one pressure reducing valve (PRV), one corrosion control facility, three groundwater wells, four water storage tanks, and 26 miles of distribution piping.

The purpose of this section is to provide a condition assessment of the assets within the existing PBWP facilities. The evaluation was completed using observations from Wright-Pierce (WP) inspections of each facility and conversations with the Precinct and system operators.

5.2 Facility Risk Analysis Concept

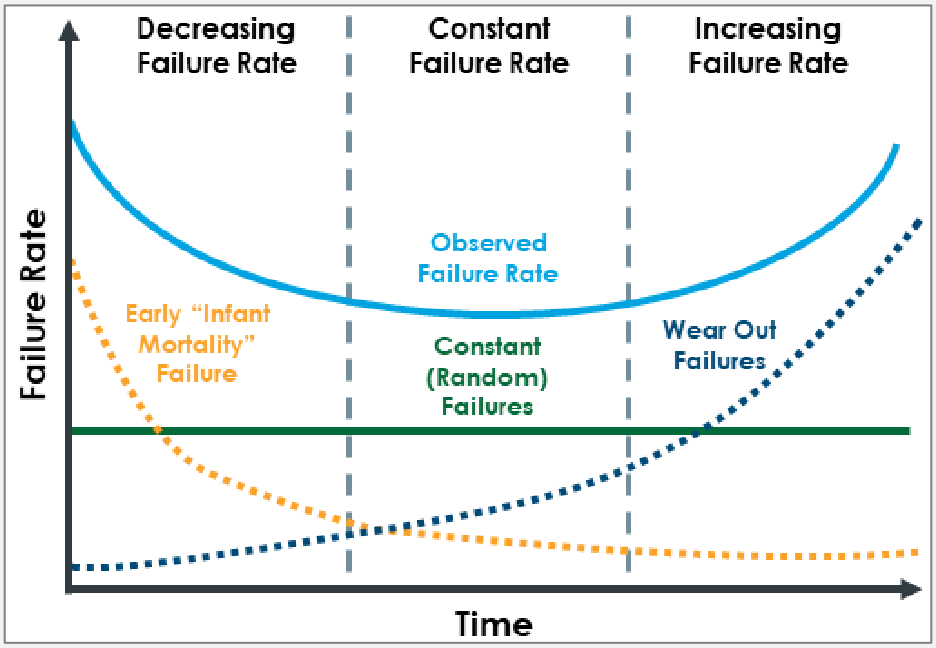
Not all assets are equally important to a water system's operation; some assets are highly critical to operations and others are much less so. Furthermore, the definition of a critical asset is completely system specific. A water system must examine its own assets very carefully to determine which current assets are critical and why.

Analyzing the existing water system assets to determine the probability of failure (PoF), and the consequence of failure (CoF), provides valuable information about assets in the system. The scope of this risk analysis is limited to the pump stations and vaults within the distribution system. This risk analysis evaluation provides the foundation for the development of the most cost-effective asset management planning allowing the PBWP to add risk modeling to the process and ensure money is allocated where risk can best be mitigated within the distribution system.

5.2.1 Condition Assessment

The first step to determine risk is to complete a condition assessment on each asset to determine its functionality within the system and its remaining life. This information is used in a Weibull analysis which determines the asset's failure rate and plots where the asset falls on the bathtub curve (**Figure 5-1**) below.

Figure 5-1 Bathtub Curve



The Bathtub Curve has three distinct zones:

- Decreasing Failure Rate – When an asset first starts, early Infant Mortality (defective equipment, poor installation, for example) is the primary mode of failure.
- Constant Failure Rate – Over time, random failures are the primary mode of failure.
- Increasing Failure Rate – As an asset ages and parts wears out, the failure rate increases.

The failure rate from the Weibull analysis is adjusted based on the asset's performance and maintainability ratings to determine the final PoF score of the asset.

5.2.2 Probability of Failure

As a first step in determining risk, a system needs to look at what it knows about the PoF of a given asset. There are four primary failure models of which an asset can fail. The primary failure modes are:

- Capacity – the asset is operational, but growth or expansion is making it unable to deliver the required capacity.
- Level of Service – the asset is operational but is causing violations of the level of service (LOS) agreement, codes, permits, or safety.
- Mortality – physical deterioration of the asset, it is no longer operational. This is the most common mode of failure.
- Efficiency – the asset is operational but costs more to maintain and operate than alternatives.

An asset may be highly likely to fail if it is old, has a long history of failure, has a known failure record in other locations, or has a poor condition rating. An asset may be much less likely to fail if it is new, has little to no history of failure and has a good to excellent condition assessment rating.

5.2.3 Consequence of Failure

In terms of the CoF, it is important to consider various possible costs of failure. The costs potentially include public health impact, social cost associated with the loss of the asset, repair/replacement costs related to collateral damage caused by the failure, legal costs related to additional damage caused by the failure, environmental costs created by the failure, and any other associated costs or asset losses. The CoF can be high if any of these costs are significant or if there are several of these costs that occur with a failure.

5.2.4 Risk Analysis

Assessing risk requires an examination of the PoF and the CoF as discussed above. To assess the risk for each particular asset, the two measures of failure are combined into a risk matrix.

Using this methodology, the PBWP's risk of failure for a given asset is evaluated and the most cost-effective management strategy is determined in order to minimize that risk. Risk can be reduced by decreasing the PoF through augmentation, repair, replacement, or refurbishment. Also, by decreasing the CoF through redundancy, relocation, insurance, or alarms. In most cases, reducing the CoF is not cost-effective, so it has to be evaluated on a case-by-case basis

Normally, the most cost-effective means of reducing risk for aging assets is to reduce the PoF through infrastructure replacement projects. The assets that have the greatest PoF and the greatest consequences associated with the failure will be the assets that have the greatest risk and should be further evaluated to determine ways to reduce the risk.

5.3 Facility Risk Analysis Scoring

Due to the variety of components within each pump station, the categories used in analyzing facility assets need to be broad enough to assess the performance of many different types of assets. **Table 5-1** summarizes the categories used to determine risk for facility assets.

Table 5-1 Risk Categories for Facilities Analysis

Probability of Failure	Consequence of Failure
Physical Condition	Social/Community
Reliability	Economic/Financial
Performance	Environmental
Maintainability	Replacement Time
	Redundancy

5.3.1 Probability of Failure Analysis and Scoring

Physical Condition Rating – The condition is based off several factors including vibration, noise, temperature, coating condition, wear or corrosion, and leakage. The following are the possible condition ratings:

1. New or Excellent Condition
2. Very Good Condition
3. Minor Defects Only
4. Some Defects and Deterioration
5. Moderate Deterioration
6. Moderate to Significant Deterioration
7. Significant Deterioration
8. Significant Deterioration w/ Major Repairs Performed on Equipment
9. Virtually Unserviceable
10. Unserviceable

Reliability Rating – The condition is based on the history of the asset and relates the number of reported breakdowns or unplanned maintenance calls and potential downtime related to the availability of parts and service for the asset. The following are the possible reliability ratings:

1. Exceptional (No Problems)
2. Random Breakdown (Every 5 Years)
3. Occasional Breakdown (Every 2 Years)
4. Periodic Breakdown (Once per Year)
5. Continuous Breakdown (Multiple Times per Year)

Current Performance Rating – The condition is based on efficiency, attention required, and the asset's ability to meet required demands. The following are the possible performance ratings:

1. Meets or Exceeds all Performance Targets
2. Minor Performance Deficiencies
3. Considerable Performance Deficiencies
4. Major Performance Deficiencies
5. Does not meet any Performance Targets

Maintainability Rating – The condition is based on the level and frequency of maintenance and monitoring required to keep the asset operational. The following are the possible maintainability ratings:

1. Easily Maintained
2. Largely Preventative Maintenance
3. Periodic Corrective Maintenance
4. More Frequent Corrective Maintenance
5. Work Orders Well Above Average
6. Corrective Maintenance has become Routine

5.3.2 Consequence of Failure Analysis and Scoring

Social/Community – This factor gives weight to the social/community consequences that would occur if a given asset were to fail. Potential consequences included in this factor are of three types: Loss of Service, Safety, and the Municipality's Image.

Economic/Financial – This factor gives weight to the economic and financial consequences that would occur if a given asset were to fail. Potential consequences included in this factor are of two types: Economic and Financial.

Environmental Impact – This factor gives weight to the environmental consequences that would occur if a given asset were to fail. Potential consequences included in this factor are of two types: Spill/Flood Potential and Permit Compliance.

Scoring for the above weighting factors is summarized in **Table 5-2**.

Table 5-2 Consequence of Failure Factors – Analysis and Scoring

Potential Consequences		Score 1	3	5	7	9	10
Social and Community	**Loss of Service**	Can be out of service indefinitely	Cannot be down a month	Cannot be down a week	Cannot be down a day	Cannot be down 8 hours	Cannot be down one hour
	Safety	No impact	Minimal Impact	Minor injury	Moderate Impact on Public Safety	Significant Impact to Public Safety	Significant and Immediate Impact to Public Safety
	Agency's Image	No media or no consequence	Neutral coverage	Adverse media	Widely adverse media	Continual; political opposition	Nationally adverse media
Economic Financial	**Economic Impact**	Low cost	Moderate cost	High cost	High cost; diverts $	Painful change of priorities	Likely to trigger rate increase, staff changes
	Financial Impact	Insignificant	<$10k	<$50k	<$100K	<$1 million	>$1 million
Environmental Impacts	**Spill/ Flood**	No Impact	Short duration, small quantity	Moderate flooding, some offsite spillage	Many inconvenienced; moderate health and habitat issues	Severe health and habitat issues; some mandatory vacation of premises	Large areas vacated and closed to public access; extensive specialized containment cleanup required
	Permit Compliance	No consequence	Minor violation - reporting only	Regulatory sanction possible	Regulatory sanction likely; Damage reversible less than one year	Extensive regulatory sanction virtually assured; damage reversible in one to five years	Severe sanctions; damage reversible in five years or more

After the CoF is determined, replacement time and redundancy factors are incorporated into the calculation. These two factors increase or decrease the score based on the replacement time and level of redundancy for each asset.

5.4 Facility Risk Final Score Calculations

The below figures provide visual depictions which describe how the above discussed input factors contribute to PoF (**Figure 5-2**) and CoF (**Figure 5-3**) final score calculations.

Figure 5-2 Probability of Failure Score Calculation

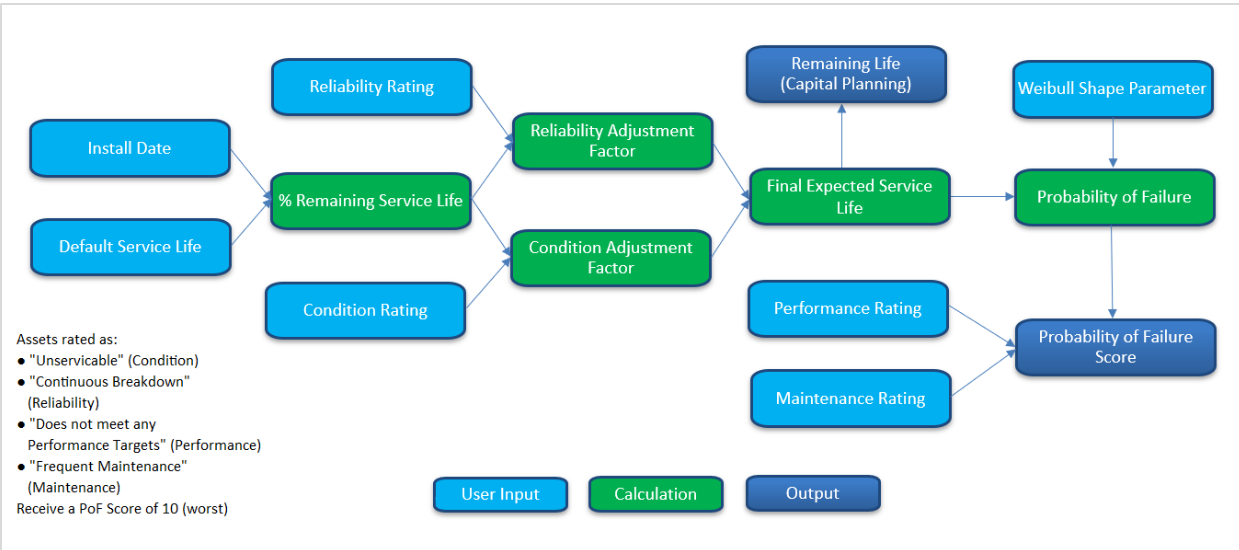
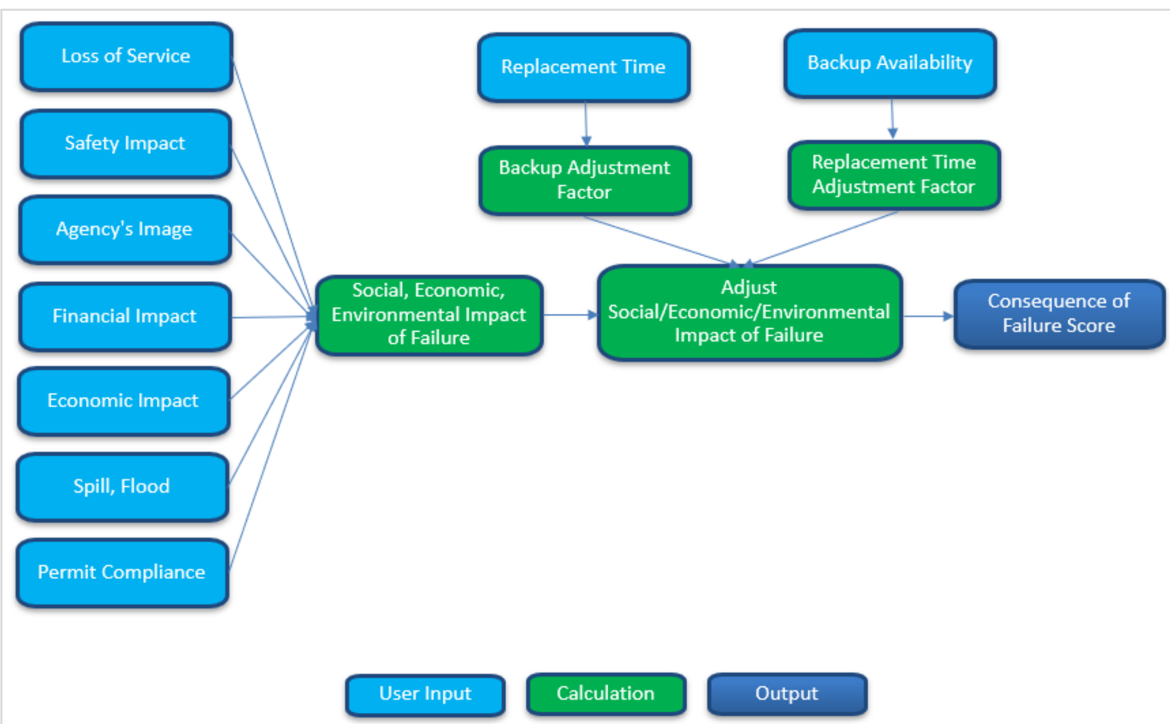


Figure 5-3 Consequence of Failure Score Calculation



5.5 Facility Risk Management Stratigies

Once the final scores for PoF and CoF are determined they are put into the risk matrix shown in **Figure 5-4** below. Based on the group (A, B, C, D, E, or F) the asset falls into, it is assigned a management strategy to maximize cost-effective maintenance practices and reduce the risk associated with the asset. Management strategies for groups A through F are described below.

Figure 5-4 Risk Matrix

	Consequence of Failure										
Probability of Failure		1	2	3	4	5	6	7	8	9	10
	10	D	D	B	B	A	A	A	A	A	A
	9	D	D	B	B	A	A	A	A	A	A
	8	D	D	C	B	B	B	A	A	A	A
	7	D	D	C	B	B	B	B	B	A	A
	6	F	F	C	C	C	B	B	B	B	B
	5	F	F	F	C	C	C	C	C	C	C
	4	F	F	F	E	C	C	C	C	C	C
	3	F	F	F	E	E	E	E	C	C	C
	2	F	F	F	E	E	E	E	E	E	E
	1	F	F	F	E	E	E	E	E	E	E

A. Critical Repair & Replacement

Critical repair and replacement are the highest priority asset management strategy. We recommend that the NCWP repair or replace assets in this category within the year or appropriate funds and replace these assets as soon as possible.

B. Priority Repair & Replacement

Priority repair and replacement assets are recommended to be repaired or replaced within the next 5 years.

C. Predictive Maintenance

Predictive maintenance involves measuring performance standards such as vibration, temperature, and thermography to assess the current condition of the asset. For each asset, there is a defined set of performance standards that represent ideal performance. Comparisons of actual readings to the ideal performance standards are made to determine if the asset is operating within an accepted range. As an asset operates and parts wear-out, readings will change. By monitoring the change in readings, the failure of the parts can be predicted prior to actual failure, so preventive measures can be completed. The predictive maintenance provides:

- Early problem warnings
- Fewer catastrophic failures
- Increased productivity
- More effective maintenance scheduling
- Reduced spare parts inventory
- Improved energy efficiency
- Reduced maintenance costs
- Extend equipment life
- Reduced long-term capital replacement costs

D. Opportunistic Repair & Replacement

Opportunistic repair and replacement assets are recommended to be if the NCWP has funds available or when convenient. These assets are past their expected useful life but are not critical enough to operation to warrant immediate replacement.

E. Routine or Preventative Maintenance

Preventative maintenance consists of, but is not limited to, routine scheduled tasks such as lubrication, oil changes, changing filters, mechanical adjustments, scheduled tank cleanings, and general house cleaning items. These tasks should be scheduled based on the manufacturers' recommendations, actual conditions, and the results of predictive maintenance measurements.

Also, observations of the equipment by skilled mechanics and operators are required to notice changes in operation such as noise, vibration, temperature, leaking fluid, and grease. Preventive maintenance is performed to enable equipment to continue to operate with minimum downtime and minimal expense. Filters and grease are much cheaper than new motors and pumps.

F. Run to Fail

Some assets have low CoF and if they fail it would not greatly disrupt operations. These assets could theoretically be taken out of operation for extended periods of time with little to no consequence. These specific assets fall in the "run to fail" management category. That means that it is not cost-effective for preventative maintenance to be completed. They are run with no maintenance until it is opportunistic to conduct the renewal decision. This strategy saves the NCWP money by reallocating funds towards assets whose failure would be greatly disruptive to operations.

5.6 Facility Risk Analysis

Each facility's assets were evaluated using Fulcrum, a cloud-based data collection software. WP staff toured each facility with Operations staff and entered pertinent condition and operational performance information for each asset into Fulcrum using a tablet. Ratings were assigned to each asset based on industry standards for asset management, including physical condition, reliability, current performance, and maintainability in order to categorize risk.

The condition assessments of the vault assets are primarily based on visual and auditory observations and were limited to accessible areas. Permit-required confined space entry was not performed during the evaluations, nor was destructive testing of construction materials (concrete, paint, metal, insulation, etc.) to determine the condition of assets. While some non-destructive testing (auditory, vibration, thermal) was performed during the evaluation, the results of those observations were limited to the timeframe allowed for each site inspection and using commonly available tools. The tools used during the evaluations were not specifically calibrated for each use but rather the results were used as an indicator to identify assets that are performing outside their expected performance range. It is recommended that all assets be re-evaluated every five years.

Assets from each facility were evaluated using the methods and scoring strategies outlined above on July 25, 2024. **Figure 5-5** and **Figure 5-6** depict the resulting asset management strategies for the PBWP vertical assets.

Figure 5-5 PBWP Management Strategy Outputs

	Consequence of Failure									
Probability of Failure	1	2	3	4	5	6	7	8	9	10
10	-	2	-	3	1	-	-	-	-	-
9	-	-	3	10	-	-	4	-	-	-
8	-	-	4	3	5	-	-	-	-	-
7	-	-	-	3	1	-	-	-	-	-
6	-	7	2	2	13	2	-	1	-	-
5	-	1	-	4	-	-	2	-	-	-
4	-	1	2	1	5	5	-	1	-	-
3	-	-	1	2	-	-	-	-	-	-
2	-	1	2	4	4	-	-	-	-	4
1	-	-	13	17	5	2	4	-	-	-

Figure 5-6 Summary of PBWP Assets by Strategy

Group	Strategy	Count	% Assets
A	Critical R&R	5	3%
B	Priority R&R	31	21%
C	Add PdM Schedule	38	26%
D	Opportunistic R&R	2	1%
E	Rt or PM Schedule	43	29%
F	Run to Fail	28	19%
G	(undefined)	0	0%
	TOTAL	**147**	

5.7 Vertical Asset Management

The following sections describe a brief overview of what information is important to keep track of for asset management and how PBWP's assets were categorized by Wright-Pierce.

5.7.1 Asset Registry

The asset registry is the backbone of an effective Computer-based Maintenance Management System (CMMS) program. If an asset is not in the asset registry, it cannot be managed or tracked very easily. The asset registry lists assets and important asset information. A well-developed asset registry will include the following (if applicable):

- Asset ID number
- Asset description
- Serial number
- Model number
- Equipment class
- Manufacturer
- Material
- Size and Capacity
- Installation Date
- Service life
- Replacement cost
- Criticality ranking
- Warranty begin and end date
- Equipment condition rating

The asset registry should be organized in a hierarchy that allows staff to report on the performance and cost impacts of assets quickly and effectively.

5.7.2 Asset Hierarchy

An asset hierarchy is the logical organization and grouping of assets based on asset location and asset type. The purpose of the asset hierarchy is to assign definitive titles to each asset and differentiate one asset from another. Wright-Pierce has developed an asset hierarchy based on a numbering convention that encompasses all of PBWP's facilities.

The asset numbering convention uses a series of codes that provide useful information about the asset. The asset number structure includes a facility number, a location number, a room number, an asset classification, and an identifying asset number. An example asset ID is 200-201-001-PP-01:

200 = Facility Number (Wells)
201 = Location Number (Well No. 1)
001 = Room Number (Valve Vault)
PP = Asset Classification (Pump)
01 = Asset Number (Pump)

This example (200-201-001-PP-01) is the asset ID for the pump located in the valve vault at the Well No. 1 site.

This naming convention supports effective analyses for both individual and groups of assets within CMMS programs and provides the flexibility to easily assign ID's to future assets. The complete asset hierarchy and evaluation for PBWP is in **Appendix C** The following sections will consist of a summary assessment and discussion for each of PBWP's facilities.

5.7.3 Maintenance Facility/Administration Building

The Maintenance Facility/Administration Building is PBWP's office, garage, and storage building. WP evaluated 16 assets at the Maintenance Facility/Administration Building. **Table 5-3** contains a summary of asset replacement costs within each of the planning periods. Assets with replacement dates beyond 2073 are not included in the tables for any facilities within this section.

Table 5-3 Maintenance Facility/Administrative Building Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	9	$12,500
Intermediate Term Improvements	5 to 10 years	1	$1,000
Long Term Improvements	10 to 50 years	5	$1,183,300
		Total:	$1,196,800

5.7.4 Corrosion Control Facility

The Corrosion Control Facility is an aboveground building equipped with various treatment technologies, including chlorine, sodium hypochlorite, orthophosphate, caustic soda, and sodium hydroxide. The facility also includes electrical, HVAC, SCADA elements, lab equipment, and an underground chemical injection vault. WP evaluated 47 assets at the Corrosion Control Facility. **Table 5-4** contains a summary of asset replacement costs within each of the planning periods.

Table 5-4 Corrosion Control Facility Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	25	$110,370
Intermediate Term Improvements	5 to 10 years	6	$26,110
Long Term Improvements	10 to 50 years	15	$1,493,990
			Total: $1,630,470

5.7.5 Well No. 1

The Well No. 1 site consists of Well No. 1, a pump, and an underground valve vault. Well No. 1 is permitted for a daily discharge of 612,000 gpd (425 gpm). WP evaluated 5 assets at the Well No. 1 site. **Table 5-5** contains a summary of asset replacement costs within each of the planning periods.

Table 5-5 Well No. 1 Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	2	$
Intermediate Term Improvements	5 to 10 years	0	$
Long Term Improvements	10 to 50 years	3	$
			Total: $

5.7.6 Well No. 2

The Well No. 2 site consists of Well No. 2, a pump, and an underground valve vault. Well No. 2 is permitted for a daily discharge of 640,800 gpd (445 gpm). WP evaluated 5 assets at the Well No. 2 site. **Table 5-6** contains a summary of asset replacement costs within each of the planning periods.

Table 5-6 Well No. 2 Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	2	$
Intermediate Term Improvements	5 to 10 years	0	$
Long Term Improvements	10 to 50 years	3	$
		Total:	$

5.7.7 Well No. 3

The Well No. 3 site consists of Well No. 3, a pump, an underground meter vault, and a well control building. Well No. 3 is permitted for a daily discharge of 288,000 gpd (200 gpm). The well control building houses electrical elements, HVAC, and a VFD. WP evaluated 14 assets at the Well No. 3 site. **Table 5-7** contains a summary of asset replacement costs within each of the planning periods.

Table 5-7 Well No. 3 Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	5	$
Intermediate Term Improvements	5 to 10 years	2	$10,930
Long Term Improvements	10 to 50 years	6	$
		Total:	$

5.7.8 Water Street Booster Station

The Water Street Booster Station is an aboveground building equipped with three pumps, electrical, HVAC, and SCADA elements. This station provides pressure to the Water Street Pressure Zone. WP evaluated 31 assets at the Water Street Booster Station. **Table 5-8** contains a summary of asset replacement costs within each of the planning periods.

Table 5-8 Water Street Booster Station Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	13	$65,100
Intermediate Term Improvements	5 to 10 years	2	$25,600
Long Term Improvements	10 to 50 years	14	$142,600
			Total: $233,300

5.7.9 Fairbanks Tank Site

The Fairbanks Tank Site consists of a 750,000-gallon water storage tank and an underground vault. This tank provides water to the Upper Pressure Zone. WP evaluated 6 assets at the Fairbanks Tank Site. Table 5-9 contains a summary of asset replacement costs within each of the planning periods.

Table 5-9 Fairbanks Tank Site Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	3	$8,990
Intermediate Term Improvements	5 to 10 years	0	$0
Long Term Improvements	10 to 50 years	2	$7,422,760
			Total: $8,605,000

5.7.10 Merrimack Tank Site

The Merrimack Tank Site consists of a 261,000-gallon water storage tank. This tank provides water to the Upper Pressure Zone. WP evaluated 5 assets at the Merrimack Tank Site. Table 5-10 contains a summary of asset replacement costs within each of the planning periods.

Table 5-10 Merrimack Tank Site Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	3	$4,500
Intermediate Term Improvements	5 to 10 years	0	$0
Long Term Improvements	10 to 50 years	0	$0
			Total: $4,500

5.7.11 Queen Street Tank Site

The Queen Street Tank Site consists of two water storage tanks (265,000-gallon and 1,000,000-gallon), an underground vault, and a control building. These tanks provide water to the Lower Pressure Zone. WP evaluated 9 assets at the Queen Street Tank Site. Table 5-11 contains a summary of asset replacement costs within each of the planning periods.

Table 5-11 Queen Street Tank Site Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	1	$3,300
Intermediate Term Improvements	5 to 10 years	0	$0
Long Term Improvements	10 to 50 years	5	$446,600
		Total:	$449,900

5.7.12 Route 3/4 Pressure Reducing Valve Vault

The Route 3/4 Pressure Reducing Valve Vault is an underground concrete vault equipped with a pressure reducing valve, dehumidifier, and two sump pumps. This station separates the Main Pressure Zone from the High Pressure Zone and maintains the water level of the Pine Hill Tank. WP evaluated 10 assets at the Route 3/4 Pressure Reducing Valve Vault. Table 5-12 contains a summary of asset replacement costs withing each of the planning periods.

Table 5-12 Route 3/4 Pressure Reducing Valve Vault Upcoming Asset Replacements

Planning Period	Estimated Renewal Date	Effected Asset Count	Replacement Cost in 2024 dollars
Short Term Improvements	0 to 5 years	4	$15,300
Intermediate Term Improvements	5 to 10 years	0	$0
Long Term Improvements	10 to 50 years	3	$89,100
		Total:	$104,400

Section 6 Level of Service

6.1 Introduction

A Level of Service Agreement (LOS) defines the way in which the utility owners, managers, and operators want the system to perform over the long term. Establishing the level of service in a utility is a critical first step in creating an asset management plan. The LOS can include any technical, managerial, or financial components the Precinct wishes, if all regulatory requirements are met. The LOS will become a fundamental part of how the system is operated and how assets are replaced and renewed. The LOS is intended not only to be a tool for measuring the success and deficiencies of the system for individuals working for the utility, but also for conveying these metrics to customers.

For the Penacook Boscawen water system, a workshop was conducted to refine the existing level of service plan previously developed for the 2025 Asset Management Plan. A Precinct Commissioner and water operators were involved with the creation of the LOS. Once the LOS goals and objectives were defined, an asset management plan described later in this document was developed to meet this vision for the water system.

6.2 Level of Service Development

6.2.1 Overview

There are two key facets to asset management; defining the LOS the system will strive to provide its customers over the long term and determining the most efficient and economical way to deliver that service. Therefore, determining and detailing the LOS that the system is going to provide is a key step in the overall process.

Recent updates to the NHDES Asset Management Handbook & Toolkit provide important building blocks to creating and maintaining a sustainable LOS. NHDES suggests using the acronym SMART(ER) when defining LOS goals.

- Specific – Definitive and capable of being understood.
- Measurable – Will the Precinct be able to track progress towards the goal?
- Attainable – Is the Precinct able to achieve the goals being set?
- Relevant – Are specific goals in line with the vision of the Precinct?
- Time Bound – Time frame for achieving goals
- Evaluate – Continually assess the reality of goals
- Re-Do – update or re-do goals in need of adjustment based on evaluation

The LOS Agreement, the document that will spell out the services the Precinct wishes to provide, is a multi-faceted tool that can be used to:

- Improve Customer Communication
- Determine critical assets
- Provide a means of assessing overall system performance
- Provide a direct link between costs and service
- Serve as an internal guide for system management and operations staff
- Provide information for system annual report or annual meeting presentation

6.2.1.1 Customer Communication

It is important for a water utility to communicate with its customers to avoid confusion, bad feelings, accusations of improper operation, and to make clear what the customer's expectations should be. Effective communication aligns the utilities and customers' expectations on issues such as water quality, water rates, service responses and other issues related to how a water utility operates and is managed.

6.2.1.2 Determine Critical Assets

The LOS can be one factor in determining critical assets. An example of how the LOS can impact criticality is where a system's LOS includes the factor "water will be delivered to customers 99% of the time." If the system has only one water source, the source will be a critical asset for the system. It must keep the source operational at all times in order to meet this criteria.

6.2.1.3 Provide a Means for Assessing Overall System Performance

If at least some of the LOS factors include measurable items, the system can keep information regarding how well they are meeting these criteria and use the criteria as a benchmark in assessing the overall operation. For example, consider a system that includes the following measures in its LOS:

- Breaks will be repaired within 6 hours of initiation of repair 95% of the time.
- Customer complaints will be responded to within 24 hours, Monday through Friday.
- Losses will be kept to less than 15% as measured by gallons pumped each month – gallons sold each month.
- System will meet all state and federal regulations.

All of these items in this example are measurable if the system collects the appropriate data. Assume the system has the following data from its first year of operation.

- 250 breaks occurred, 230 were fixed in less than 6 hours
- 30 complaints were received, all 30 responded to within 24 hours
- Losses over the year as follows: January - 12%, February - 10%, March - 19%, April - 14%, May - 9%, June - 13%, July - 9%, August - 10%, September - 12%, October - 9%, November - 10%, December - 12%
- System met all regulations, no violations

Based on this data, the system met some, but not all of its LOS factors. The following items were met: The customer complaints were responded to on time and the system met all the state and federal regulations. The following items were not met: breaks were not repaired within 6 hours and the losses were not kept to less than 15% in all months. The system can look at these results and determine the items that it needs to work harder on in order to meet the LOS requirements.

It is important to note that data collected on LOS items must be consistently collected and recorded at given intervals (daily, weekly, monthly, or quarterly) to be able to assess and make changes in the system as necessary.

6.2.1.4 Provide a Direct Link between Costs and Service

There is a direct link between the LOS provided and the cost to the customer. When a higher LOS is provided, the costs to the customers will likely increase. This relationship provides an opportunity for the water system to have an open dialogue with its customers regarding the LOS desired and the amount the customers are willing to pay for this LOS or increased services.

For example, customers may complain about the aesthetic condition of the water citing concerns such as taste, odor, or color. While such conditions do not pose a direct health concern, the customers may still request to have the contaminants removed. The water system can install treatment to remove these contaminants, but it will cost each customer more for their water each month. The water system can have a dialogue with the customers to explain what the treatment would entail, what the finished water quality would be, and how much it would cost the customers. Following the discussions, the customers could decide whether or not they were willing to pay for the additional treatment. In this way, the LOS sets desired services and provides information to the customers regarding what the costs of their LOS will be.

6.2.1.5 Serve as an Internal Guide to System Operation and Management

It is much easier to operate or manage a system when the operations and maintenance staff as well as the management staff understand the goals of the operation. Defining the LOS sets these goals for the system. These goals ensure the operations staff has a better understanding of what is desired from them and the management has a better understanding of how to use staff and other resources more efficiently and effectively. Checking how well the system is meeting LOS also allows the management to shift resources, if need be, from one task to another to meet all the goals more effectively.

6.2.1.6 Provide Information for Annual Report or Meeting

If the system tracks information regarding how well it is meeting the LOS criteria on a weekly or monthly basis, it can use this information to prepare an annual report regarding how well the system met these criteria over the course of a year. This information can be presented to the Board of Selectmen or customers at an annual meeting so that customers are aware of how well the system met the overall goals for the operations of the system.

This meeting would also be an opportunity to discuss any changes needed in the LOS, based on the operations data. Perhaps some of the LOS conditions are not possible to be met given the current staff or resources. If that is the case, the system will either have to reduce the LOS provided or increase staff or other resources in order to meet the current LOS. The decision to increase staff or other resources or decrease LOS will directly impact customers, so it is important to use the opportunity of the annual meeting to discuss the potential options with them.

Alternatively, the system may decide that some criteria are very easily met and may not be stringent enough. The system may find that it can increase the LOS for particular criteria without impacting costs and may wish to discuss the changes with the customers at the annual meeting.

6.3 Level of Service Goals for NCWP

LOS goals are a combination of both external and internal set goals. Goals have been separated into these categories to be easily communicated to the public.

External Goals:

Generally external goals relate to keeping the public informed. These goals are easy for the public to understand and encourage conversation between the precinct and its customers. When setting external goals, it is recommended to involve customers in the decision-making process.

Internal Goals:

Internal LOS goals relate to defining the operations of a utility that are not easily understood by the public. These goals generally involve key performance indicators that are more granular and process specific. Created from professional standards, and technical experience.

The proposed Precinct water system external and internal LOS goals can be organized into the following subcategories:

A. Operations & Maintenance
B. Business
C. Workplace Environment

6.3.1 Customer Service Goals

Customer service goals are considered external goals.

External Goals:

1. *Respond to customer calls or complaints within 24 business hours* – The Precinct has set a goal of 95% compliance. This goal will be measured annually by reviewing Precinct records and call logs.
2. *Provide notification at least 48 hours in advance of scheduled water main shutdown* – The Precinct has set a goal of 95% compliance. This goal will be measured annually by reviewing work records and public notice postings.
3. *Notify customers within 2 hours in the event of an emergency water main shutdown* – The Precinct has set a goal of 95% compliance. This goal will be measured annually through work records.
4. *Minimize the time customers can expect to be without water* – The Precinct has set a goal of returning water service to customers within 8 hours of official shut off. This goal will be measured annually through work records.

6.3.2 Operations & Maintenance Goals

Operations goals are a combination of internal and external objectives.

External Goals:

1. *Repair water main and service breaks/leaks in a timely manner after detection* – This goal is driven by customer service expectations and the Precinct has set a goal of less than 6-hour response time for breaks and less than 24-hour response time for leaks. This goal is measured annually through work records.
2. *Maintain a normal working system pressure of 35 pounds per square inch (psi), and a minimum pressure of 20 psi under all flows* - This goal is driven by NHDES and is set at a target goal of a normal working system pressure of 35 psi, and a minimum pressure of 20 psi under all flows. It will be measured annually through field pressure measurements.

Internal Goals:

1. *Inspect and exercise distribution system hydrants* – This goal is driven by AWWA G200/M-17 and is set to a target goal of annual inspection of 130 hydrants per year. This goal will be measured annually using work order records. Compliance with this goal helps to improve hydrant life and distribution system function as well as contribute to a high Insurance Service Office (ISO) rating in the Precinct.
2. *Inspect and exercise distribution system valves* – This goal is driven by AWWA G200/M-17 and is set to a target goal of one fifth of the system's valves per year. This goal will be measured annually using work order records. Compliance with this goal helps to improve valve life and distribution system function.
3. *Maintain regular distribution system flushing* – This goal is driven by AWWA G200/M-17 and is set to a target goal of 100% compliance. This goal will be measured annually using work order records. Compliance with this goal helps to improve hydrant life and distribution system function as well as contribute to a high ISO rating in the Precinct.
4. *Maintain an UAW value of less than 15%* - This goal is driven by NHDES and industry standards. This goal will help the water system appropriately account for water used and ensure revenue is not lost through leakage, overflow, or underreporting meters. It will be measured annually using an internal water audit spreadsheet.
5. *Maintain and update GIS database* – The Precinct has set a goal of 100% compliance. This goal will be measured via project record document review and comparison with the GIS database.
6. *Reduce the number of water main breaks on an annual basis* – This goal is self-imposed and set to less than 6 breaks per year. This goal will be measured annually using work order records. This goal is important because excessive breaks may indicate an area of the distribution system where an underlying problem is present. Breaks in distribution mains are also costly to repair in terms of time, labor, parts, and an inconvenience to customers.
7. *Maintain a full inventory of distribution system parts required for emergency repair* – This goal is self-imposed and set to 100%. This goal will be measured annually using review of work records.
8. *Eliminate unprotected cross connections* – This goal is driven by NHDES and has been set for a target goal of 0 cross connections. This goal will be measured annually using work order records. Compliance with this goal will avoid intervention by the NHDES as well as ensure the quality and safety of the potable water supply.

6.3.3 Regulatory Compliance Goals

Regulatory Compliance goals are typically external objectives and include compliance with drinking water standards that are easily comprehended by Precinct customers.

External Goals:

1. *Maintain compliance with SDWA rules and regulations* – Set to a target goal of zero violations. This goal is driven by the (EPA) SDWA and will be measured using annual compliance reports. This goal is important because its compliance is federally mandated to ensure safe public drinking water supplies nationwide.
2. *Maintain compliance with EPA secondary drinking water standards* – Set to a target goal of zero violations. The goal is driven by the EPA SDWA and will be measured using samples taken annually. This goal is important because, although compliance is not mandatory due to secondary drinking water standards being comprised of non-life-threatening water qualities, it does measure aesthetic qualities such as taste and odor. Customers value such aesthetic qualities and compliance.
3. *Maintain compliance with NH specific water standards* – Set to a target goal of zero violations. This goal is driven by NHDES policy and will be measured in NHDES sanitary surveys.

4. *Update lead service line inventory annually, set to a goal of annually* – This goal is driven by NHDES which requires an annual update to lead service line inventories. NHDES also requires distribution systems to identify 20% of their service lines that have unknown materials annually.

6.3.4 Business Goals

Business goals are a combination of internal and external goals.

Internal Goals:

1. *Rates will be reviewed on an annual basis and raised as needed to ensure full cost recovery* - This is a self-imposed goal which ensures the viability of the water system infrastructure and water rates. This goal will be measured annually by way of a budget review. Meeting this goal avoids complaints from customers due to sharp, unexpected rate increases some years and relatively low rate increases other years.
2. *Operating expenses budget will be reviewed on an annual basis* – This is a self-imposed goal which ensures the viability of the water system operations under the current budget. This goal will be measured annually by way of a budget review. Meeting this goal will ensure the Precinct is able to continue operations.

6.3.5 Workplace Environment Goals

Workplace environment goals are internal goals.

Internal Goals:

1. *Deliver service in the safest possible manner* – This goal is driven by Department of Labor and OSHA regulations. The target for this goal has been set at 0 accidents per year as measured by accident reports. Compliance with this goal not only helps meet DOL and OSHA standards but should also always be the number one priority of any workplace.
2. *Treatment system operator training level* – This goal is driven by State Regulations and has been set at all treatment system operators being Grade 2 or better. This goal will be measured annually using certification records. Compliance with this goal is required by the state and helps increase the depth of knowledge among treatment operators.
3. *Distribution system operator training level* – This goal is driven by State Regulations and has been set at all distribution system operators being Grade 2 or better. This goal will be measured annually using certification records. Compliance with this goal is required by the state and helps increase the depth of knowledge among distribution operators.

6.4 Level of Service Agreement

The LOS goals described above provides the basis for the proposed Precinct water system LOS Agreement. This agreement defines the way in which the water commissioners, managers, operators, and customers want the system to perform over the long term and by what means this performance is measured. The LOS Agreement is consolidated in Table 6-1 and Table 6-2 which can be used for tracking goal attainment.

6.5 Recommendations

The Precinct should review and report on the LOS Agreement annually to evaluate its effectiveness for delineating the necessary effort required by the Precinct to provide clean, safe drinking water to the public in the most efficient, economical, and sustainable way. The LOS Agreement in its entirety, or in excerpts, is an excellent tool to communicate how the system is operating and how well the community is being served. External goals should be available for the public to review and provide feedback. Transparency is critical for the growth of the Precinct. Customers that are informed and engaged about the water service they are being provided are critical to the longevity and growth of the Precinct.

Table 6-1 Internal Level of Service Agreement

Asset Category	Specific	Measurable	Achievable	Realistic	Evaluation	Responsibility	Reassess
	Objective	Measure Units	2024 Benchmark	2025 Target	2024 Attainment	PBWP or Pennichuck	Corrective Measures/Comments
Operation & Maintenance	Inspect and exercise all distribution system hydrants on an annual basis.	Number of hydrants inspected each year.		130		Pennichuck	
	Inspect and exercise all system valves on an annual basis.	Number of valves inspected each year.		1/5 of System Valves		Pennichuck	
	Maintain regular distribution system flushing	Annual distribution system flushing		Annually		Pennichuck	
	Unaccounted for water losses shall be less than 15% on an annual basis	Compare master meter with billing record annually.		15%		PBWP	
	Maintain and update GIS database	Review project record documents and GIS database for compliance biannually.		100%		PBWP	
	Reduce the number of water main breaks on an annual basis.	Annual number of breaks. Review work records annually against previous year's records to determine a realistic target.		6		PBWP	
	Maintain a full inventory of distribution system parts required for emergency repair.	Review work order records and purchase order invoices annually.		100%		PBWP	
	Eliminate unprotected cross connections	Annual review of work order records.		100%		PBWP	
Business	Review water rates annually and revise as needed to ensure full cost recovery	Annual budget review		Yes		PBWP	
	Review budget for operating expenses	Annual budget review		Yes		PBWP	
Workplace Environment	Deliver service in the safest possible manner	Accidents per year		0		Pennichuck	
	Treatment system operator training level	Annual review of certification records		Grade II or better		Both	
	Distribution system operator training level	Annual review of certification records		Grade II or better		Both	

Table 6-2 External Level of Service Agreement

Asset Category	Specific	Measurable	Achievable	Realistic	Evaluation	Responsibility	Reassess
	Objective	Measure/Units	2024 Benchmark	2025 Target	2024 Attainment	PBWP or Pennichuck?	Corrective Measures/Comments
Customer Service	Respond to all customer complaints/calls within 24hours	Review Precinct records and call logs for compliance.		95%		Pennichuck	
	Provide notification at least 48 hours in advance of scheduled water main shutdown	Review Precinct work logs and public notice postings for compliance.		95%		Pennichuck	
	Notify customers via social media post within 2 hours in the event of an emergency water main shutdown	Review Precinct work logs and public notice postings for compliance.		95%		PBWP	
	Minimize the time customers can expect to be without water.	Review work records for average response time to a water main/service break/leak and duration of shutdown.		< 8 hours		PBWP	
Operation and Maintenance	Repair water main and service breaks/leaks in a timely manner after detection	Review work records and determine if the time it took after detection to repair the issue was generally more/less than the goal.		< 6 hours for breaks, <24 hours for leaks		PBWP	
	Maintain a minimum system operating pressure of 35 psi, 20 psi minimum under all flows	Review operating records and customer water pressure complaints to determine areas of the system that have insufficient water pressure.		35 (20) PSI		Pennichuck	
Regulatory Compliance	Maintain compliance with Safe Drinking Water Rules and regulations	Number of violations		0		Both	
	Maintain compliance with EPA Secondary Drinking Water Standards	Number of violations		0		Both	
	Maintain compliance with NH specific water standards	Number of violations		0		Both	
	Updated lead service line inventory annually.	Review LSL and update. Identify material of 20% of service lines with unknown material.		Annually		PBWP	

Section 7 Capital Improvement Program

7.1 Objective

This Section summarizes recommendations made throughout the report and presents the projects in a sequenced and summarized CIP. The goal of the CIP is to offer a comprehensive approach to addressing the immediate and future needs to assure that PBWP can offer reliable water service to their customers throughout and beyond the planning period of this study.

7.2 Overview of Findings

In general, the system was found to be in fair to good condition. Improvements to the source water facilities and distribution system are warranted to address current and projected deficiencies. Improvements to Wells 1-3 are recommended to improve the reliability and water quality of these important water resources. Continued investment in source water and distribution will continue to be an important priority for PBWP in the short, medium and long term.

7.2.1 Basis of Cost Estimates

The cost estimates for recommended projects are based on recent similar publicly bid construction projects and pricing is referenced to the February 2025 Engineering News Record (ENR) 20 City average construction cost index of 13793.

Cost estimates for recommended water main projects are based upon an average unit price for similar publicly bid and constructed projects (unless otherwise noted) which included the installation of water mains and appurtenances, services, trench paving and typical site restoration. All project costs include an additional 40% construction and engineering contingency which is intended to account for engineering design services, permitting efforts, and unanticipated changes which arise during construction.

Vertical construction projects such as pump stations, storage tanks, treatment facilities, PRVs, etc. were assigned a budgetary cost estimate that is intended to act as a placeholder for planning purposes. If PBWP has interest in pursuing these projects, detailed cost estimates would be developed during the design phase of planning.

7.2.2 Capital Improvement Program

The purpose of the CIP is the following:

- To prioritize and schedule recommended improvements identified as part of this study.
- To position the Precinct to meet the needs of the community.
- To sustain the viability of the water system infrastructure through routine maintenance and replacement programs.
- To meet current, pending, and future federal and state regulatory requirements.

The CIP is intended to be flexible and subject to adjustment as required to respond to changes in demands and as water regulations are promulgated. Medium and long-term recommendations should be reviewed and re-evaluated periodically to assure that initial assumptions used to generate specific recommended projects remain relevant and accurate. The priority of improvements within each priority category should also be periodically reassessed with the Precinct's budget to assure the highest priorities in the system are being addressed in any given year.

The PBWP may need to shift the priority of projects in order to respond to the needs of the community and/or to take advantage of opportunities such as roadway reconstruction projects, which were either not known or could not be predicted within this study. It is important that the NCWP revisit the recommendations yearly to re-prioritize, schedule, and budget projects as priorities change. All improvements have been assigned to one of the following three categories:

7.3 Evaluation Recommendations

The following recommendations are divided into three categories for each facility: Priority Improvements, Predictive Improvements, and Prospective Improvements.

Priority Improvements generally aim to improve system safety and reliability in the short term. Projects typically include resolving safety or code issues that should be fixed right away, replacing equipment that has reached the end of its useful life, and anticipating required equipment repairs within the next five years (2025 to 2029).

Predictive Improvements typically include projects that do not have an immediate impact on system performance, but completion in the near future has some level of priority. Projects typically include improvements to the hydraulic and fire flow capabilities of the distribution system and the replacement of equipment anticipated to reach the end of their useful life within five to 10 years (2030 to 2034).

Prospective Improvements are generally low-priority long-term investment projects that are not critical to system operations and are expected to be completed within the next fifty years (2035 to 2074).

Based upon the field evaluation, the following Priority Improvements (short term 0-5 years), Predictive Improvements (intermediate term 5–10 years), and Prospective Improvements (long term 10-50 years) are recommended to correct the deficiencies identified.

7.3.1 Maintenance Facility/Administrative Building

Table 7-1 Observations and Recommended Improvements to Maintenance Facility/Administrative Building

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Compressor	Garage	Minimal corrosion, end of useful life	Replace in kind	2025
Exhaust Fan	Garage	Rust, rashing, or spotting, apparent corrosion, end of useful life	Replace in kind	2025
Panel – Power No. 1	Garage	End of useful life	Replace in kind	2025
Panel – Power No. 2	Garage	End of useful life	Replace in kind	2025
Welder No. 1	Garage	End of useful life	Replace in kind	2025
Computer	Office	End of useful life	Replace in kind	2025
Printer	Office	End of useful life	Replace in kind	2025
Computer	Side Office	Moderate to significant deterioration, periodic breakdown, end of useful life	Replace in kind	2025
Maintenance Facility	-	Vegetation overgrowth on backside of building	Cut vegetation 5 feet away from building	2025
Predictive Asset Improvements				
Welder No. 2	Garage	End of useful life	Replace in kind	2029
Air Conditioner	Office	End of useful life	Replace in kind	2032
Prospective Asset Improvements				
Furnace	Garage	End of useful life	Replace in kind	2035
Tank - Propane	Exterior	Poor coating, rust, rashing, or spotting, apparent corrosion, end of useful life	Replace in kind	2036
Trash Pump	Garage	End of useful life	Replace in kind	2040
Building	-	Poor edge trim, doors are past useful life, some defects/deterioration on structure, end of useful life	Replace in kind	2061
Meter Test Bench	Garage	Rust, rashing, or spotting, minimal corrosion, end of useful life	Replace in kind	2063
			Total Estimated Cost:	$1,197,600

7.3.2 Corrosion Control Facility

Table 7-2 Observations and Recommended Improvements to Corrosion Control Facility

Description	Location	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Flowmeter	Chemical Injection Vault	Rust, rashing, or spotting, uniform corrosion, end of useful life	Replace in kind	2025
Autodialer	Chemical Room	End of useful life	Replace in kind	2025
Control Panel	Chemical Room	End of useful life	Replace in kind	2025
Control Panel – Hypochlorite and Orthophosphate Chemical Feed	Chemical Room	End of useful life	Replace in kind	2025
Control Panel – Sodium Hydroxide Chemical Feed	Chemical Room	Rust, rashing, or spotting, end of useful life	Replace in kind	2025
Control Panel – Well Pump No. 2	Chemical Room	Missing high voltage label, end of useful life	Replace in kind, install high voltage label on panel dead front	2025
Exhaust Fan	Chemical Room	Moderate deterioration, end of useful life	Replace in kind	2025
Panel – Distribution PDP/CCP	Chemical Room	End of useful life	Replace in kind	2025
Emergency Eyewash/Shower - Caustic	Chemical Room	Rust, rashing, or spotting, end of useful life	Replace in kind	2025
Emergency Eyewash/Shower – Hypo	Chemical Room	Apparent corrosion, end of useful life	Replace in kind	2025
Chart Recorder – Merrimack and Fairbank Tanks	Chemical Room	End of useful life	Replace in kind	2025
Chart Recorder – Well Pump Flow	Chemical Room	End of useful life	Replace in kind	2025
Chart Recorder – Queens Street Tank	Chemical Room	End of useful life	Replace in kind	2025
Panel – Lighting LP-1	Chemical Room	End of useful life	Replace in kind	2025
Water Meter	Chemical Room	End of useful life	Replace in kind	2025
Pump – Sodium Hydroxide No. 1 Metering	Chemical Room	End of useful life	Replace in kind	2025
Pump – Sodium Hydroxide No. 2 Metering	Chemical Room	End of useful life	Replace in kind	2025
Pump – Sodium Hydroxide Transfer	Chemical Room	End of useful life	Replace in kind	2025
Pump – Orthophosphate Metering	Chemical Room	End of useful life	Replace in kind	2025
Pump – Orthophosphate Transfer	Chemical Room	End of useful life	Replace in kind	2025
Tank – Sodium Hydroxide Bulk	Chemical Room	No flexible connections, end of useful life	Replace in kind, install bellows on tank pipe outlet	2025
Tank – Sodium Hydroxide Day	Chemical Room	No flexible connections, end of useful life	Replace in kind, install bellows on tank pipe outlet	2025
Tank – Sodium Hypochlorite Day	Chemical Room	No flexible connections, end of useful life	Replace in kind, install bellows on tank pipe outlet	2025
Tank - Orthophosphate	Chemical Room	No flexible connections, end of useful life	Replace in kind, install bellows on tank pipe outlet	2025

Description	Location	Observation	Recommendation	Plan Year
Pump – Hypochlorite Metering	Chemical Room	Apparent leakage, discharge fitting has constant drip	Tighten discharge fitting	2025
Tank – Sodium Hypochlorite Bulk	Chemical Room	No flexible connections	Install bellows on tank pipe outlet	2025
Building – Corrosion Control Facility	Chemical Room	Poor floors, floor coating failure, heavy corrosion on frame base, poor exterior doors, couple of holes in the siding, edge trim needs to be repainted	Clean, prep, and recoat floor. Repair damaged holes in siding. Paint edge trim.	2025
Corrosion Control Facility	Chemical Room	Grass needs to be mowed	Mow grass biweekly	2025
Pump – Hypochlorite Metering	Chemical Room	End of useful life	Replace in kind	2025
Predictive Asset Improvements				
Transfer Switch – Automatic	Chemical Room	End of useful life	Replace in kind	2031
Transformer	Chemical Room	Rust, rashing, or spotting, end of useful life	Replace in kind	2031
Transformer	Chemical Room	End of useful life	Replace in kind	2031
Analyzer – Chlorine	Chemical Room	End of useful life	Replace in kind	2032
pH Probe	Chemical Room	End of useful life	Replace in kind	2032
Transmitter - Flowmeter	Chemical Room	End of useful life	Replace in kind	2032
Prospective Asset Improvements				
Generator	Exterior	Rust, rashing, or spotting, apparent atmospheric corrosion, end of useful life	Replace in kind	2035
Tank – Sodium Hypochlorite Bulk	Chemical Room	End of useful life	Replace in kind	2036
Unit Heater - Gas	Chemical Room	End of useful life	Replace in kind	2036
Transmitter – pH Probe & Chlorine Analyzer	Chemical Room	End of useful life	Replace in kind	2037
Backflow Preventer	Chemical Room	End of useful life	Replace in kind	2039
Damper	Chemical Room	End of useful life	Replace in kind	2039
Disconnect – Main	Chemical Room	End of useful life	Replace in kind	2039
Disconnect – Well Pump No. 1	Chemical Room	End of useful life	Replace in kind	2039
Disconnect – Well Pump No. 2	Chemical Room	End of useful life	Replace in kind	2039
Air Conditioner	Chemical Room	End of useful life	Replace in kind	2039
Pump – Sodium Hypochlorite Transfer	Chemical Room	End of useful life	Replace in kind	2040
Building – Corrosion Control Facility	-	End of useful life	Replace in kind	2061
Chemical Injection Quills	Chemical Injection Vault	End of useful life	Replace in kind	2063
Piping, Valves, and Appurtenances - Chemical	Chemical Room	End of useful life	Replace in kind	2063

Description	Location	Observation	Recommendation	Plan Year
Chemical Injection Vault	-	End of useful life	Replace in kind	2070
			Total Estimated Cost:	$1,765,400

7.3.3 Well No. 1

Table 7-3 Observations and Recommended Improvements to Well No. 1

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Pump – Sump	Valve Vault	Pump not plugged in, end of useful life	Replace in kind, power should be supplied to valve vault to run sump pump	2025
Pump – Well No. 1	-	End of useful life	Replace in kind	2025
Predictive Asset Improvements				
None				
Prospective Asset Improvements				
Disconnect – Well Pump No. 1	-	Delamination, rusting, rashing, or spotting, moderate deterioration, end of useful life	Replace in kind	2036
			Total Estimated Cost:	$16,400

7.3.4 Well No. 2

Table 7-4 Observations and Recommended Improvements to Well No. 2

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Pump – Sump	Valve Vault	Pump not plugged in, end of useful life	Replace in kind, power should be supplied to valve vault to run sump pump	2025
Pump – Well No. 2	-	End of useful life	Replace in kind	2025
Predictive Asset Improvements				
None				
Prospective Asset Improvements				
Disconnect – Well Pump No. 2	-	End of useful life	Replace in kind	2039
			Total Estimated Cost:	$16,400

7.3.5 Well No. 3

Table 7-5 Observations and Recommended Improvements to Well No. 3

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Flow Meter	Meter Vault	End of useful life	Replace in kind	2025
Pump - Sump	Meter Vault	End of useful life	Replace in kind	2025
Exhaust Fan	Well Control Building	End of useful life	Replace in kind	2025
Unit Heater - Gas	Well Control Building	End of useful life	Replace in kind	2025
Pump – Well No. 3	Exterior	End of useful life	Replace in kind	2025
Building – Well Control	-	Minor corrosion on exterior door frame	Clean, prep, and repaint door and frame	2025
Air Conditioner	Well Control Building	Rust, rashing, or spotting, end of useful life	Replace in kind	2029
Predictive Asset Improvements				
VFD – Well Pump No. 3	Well Control Building	End of useful life	Replace in kind	2035
Prospective Asset Improvements				
Main - Disconnect	Well Control Building	End of useful life	Replace in kind	2039
Disconnect – Well Pump No. 3	Exterior	End of useful life	Replace in kind	2039
Control Panel	Well Control Building	End of useful life	Replace in kind	2040
			Total Estimated Cost:	$46,300

7.3.6 Water Street Booster Pump Station

Table 7-6 Observations and Recommended Improvements to Water Street Booster Pump Station

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Control Panel	Pump Room	End of useful life	Replace in kind	2025
Control Panel – Pump No. 3	Pump Room	End of useful life	Replace in kind	2025
Exhaust Fan	Pump Room	Moderate deterioration, end of useful life	Replace in kind	2025
Panel – Distribution DBP-2	Pump Room	End of useful life	Replace in kind	2025
Chart Recorder – Pressure	Pump Room	End of useful life	Replace in kind	2025
Chart Recorder – Flow	Pump Room	End of useful life	Replace in kind	2025
Panel – Lighting LP-2	Pump Room	End of useful life	Replace in kind	2025
Pressure Element – Suction	Pump Room	Apparent corrosion, end of useful life	Replace in kind	2025
Pressure Element – Discharge No. 1	Pump Room	Rust, rashing, or spotting, end of useful life	Replace in kind	2025
Pressure Element – Discharge No. 2	Pump Room	Moderate deterioration, end of useful life	Replace in kind	2025
VFD – Pump No. 1	Pump Room	End of useful life	Replace in kind	2025
VFD – Pump No. 2	Pump Room	End of useful life	Replace in kind	2025
VFD – Pump No. 3	Pump Room	End of useful life	Replace in kind	2025
Building – Water Street Booster Station	-	Door frame is heavily corroded at the bottom, one loose section of siding, pine needles built up on roofing, edge trim needs to be repainted	Repair loose section of siding. Clean pine needles off roof. Paint edge trim.	2025
Predictive Asset Improvements				
Transfer Switch - Automatic	Pump Room	End of useful life	Replace in kind	2031
Transformer	Pump Room	Some defect and deterioration, end of useful life	Replace in kind	2031
Prospective Asset Improvements				
Unit Heater – Gas	Pump Room	End of useful life	Replace in kind	2036
Valve – Flow Control	Pump Room	Poor coating, flaking, rusting, rashing, or spotting, moderate deterioration, end of useful life	Replace in kind	2036
Disconnect – Main	Pump Room	End of useful life	Replace in kind	2039
Air Conditioner	Pump Room	End of useful life	Replace in kind	2039
Water Meter	Pump Room	End of useful life	Replace in kind	2040
Pressure Transmitter	Pump Room	End of useful life	Replace in kind	2041
Motor – Pump No. 1	Pump Room	End of useful life	Replace in kind	2042

Description	Room Area	Observation	Recommendation	Plan Year
Motor – Pump No. 2	Pump Room	End of useful life	Replace in kind	2042
Pump No. 1	Pump Room	End of useful life	Replace in kind	2042
Generator	Exterior	Apparent corrosion, some defects and deterioration, end of useful life	Replace in kind	2042
Pump No. 2	Pump Room	End of useful life	Replace in kind	2043
Motor – Pump No. 3	Pump Room	End of useful life	Replace in kind	2044
Pump No. 3	Pump Room	End of useful life	Replace in kind	2044
Building – Water Street Booster Station	-	End of useful life	Replace in kind	2061
Piping, Valves, & Appurtenances	Pump Room	Apparent atmospheric corrosion, end of useful life	Replace in kind	2063
				Total Estimated Cost: $234,800

7.3.7 Fairbanks Tank Site

Table 7-7 Observations and Recommended Improvements to Fairbanks Tank Site

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Pressure Element	Vault	End of useful life	Replace in kind	2025
Control Panel	-	End of useful life	Replace in kind	2025
Panel - Distribution	-	End of useful life	Replace in kind	2025
Tank Site	-	Tree growing close to fence	Cut tree before it damages the fence	2025
Predictive Asset Improvements				
None				
Prospective Asset Improvements				
Vault	Vault	Poor flooring, poor wall finish, moderate to significant deterioration, end of useful life	Replace in kind	2052
Tank – Water Storage	-	Efflorescence and spider web cracking in concrete, end of useful life	Replace in kind	2061
				Total Estimated Cost: $8,616,000

7.3.8 Merrimack Tank Site

Table 7-8 Observations and Recommended Improvements to Merrimack Tank Site

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Panel – Distribution	-	Poor coatings, peeling, cracking, rust, rashing, or spotting, significant deterioration, end of useful life	Replace in kind	2025
Pressure Element	-	Rust, rashing, or spotting, some defects and deterioration, end of useful life	Replace in kind	2025
Unit Heater - Electric	-	End of useful life	Replace in kind	2025
Tank Site	-	One section of damaged barbed wire	Repair damaged section of barbed wire	2025
Predictive Asset Improvements				
None				
Prospective Asset Improvements				
None				
			Total Estimated Cost:	$5,500

7.3.9 Queens Street Tank Site

Table 7-9 Observations and Recommended Improvements to Queens Street Tank Site

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Pump - Sump	Vault	End of useful life	Replace in kind	2025
Tank Site	-	Poor fence and gate, many damaged sections of fence from fallen trees, barbed wire needs to be replaced in many sections, lots of vegetation on fence, some defects and deterioration	Repair damaged sections of fence, replaced damaged sections of barbed wire, cut back all vegetation at least three feet from fence to avoid future damage	2025
Predictive Asset Improvements				
None				
Prospective Asset Improvements				
Unit Heater - Electric	Vault	End of useful life	Replace in kind	2037
Control Panel	Control Building	End of useful life	Replace in kind	2043
Panel - Distribution	Control Building	End of useful life	Replace in kind	2043
Main - Disconnect	Control Building	End of useful life	Replace in kind	2053
Building – Queen Street Tank	-	Building is being rebuilt, the original structure had a tree fall on it, some defects and deterioration, end of useful life	Replace in kind	2067
			Total Estimated Cost:	$459,800

7.3.10 Route 3 & 4 PRV

Table 7-10 Observations and Recommended Improvements to Route 3 & 4 PRV

Description	Room Area	Observation	Recommendation	Plan Year
Priority Asset Improvements				
Control Panel	-	End of useful life	Replace in kind	2025
Panel – Distribution	-	End of useful life	Replace in kind	2025
Pump – Sump	--	End of useful life	Replace in kind	2025
Unit Heater – Electric	-	Some defects and deterioration, end of useful life	Replace in kind	2025
Route 3 & 4 PRV Site	-	Overgrown vegetation	Trim overgrowth	2025
Predictive Asset Improvements				
None				
Prospective Asset Improvements				
Pressure Relief Valve	-	Apparent atmospheric corrosion, end of useful life	Replace in kind	2039
Main – Disconnect	-	End of useful life	Replace in kind	2054
Piping, Valves, & Appurtenances	-	Peeling, some defects and deterioration, end of useful life	Replace in kind	2055
			Total Estimated Cost:	$105,200

7.4 Capital Improvement Plan

Specific recommendations for each facility were summarized in this section. Estimated costs are provided, on a short-term (0-5 years, priority), intermediate-term (5-10 years, predictive), and long-term (10-50 years, prospective) basis.

The total estimated vertical project cost for the Recommended Capital Improvement Plan (CIP) over the 50-year planning period is approximately $12.5 million. The total estimated horizontal project cost for the Recommended Water Main Replacements over the 50-year planning period is approximately $26.8 million. The total estimated CIP cost is approximately $39.23 million. This is a planning level budgetary cost estimate and will need to be reviewed and updated annually or as needed by PBWP over the course of the upgrade program. It is recommended that each proposed improvement project be reevaluated before beginning the design, as changes in scope can occur over the course of the 50-year plan.

The timing of the improvements in the CIP is based on our review of the probability of failure, consequence of failure, and the risk matrix developed. This represents an appropriate process to prioritize the projects in the Plan. This CIP should be coordinated with other ongoing work. The proposed 50-Year Capital Improvement Plan is shown in **Table 7-11**.

This report provides planning level budgets for proposed improvements to help PBWP plan future capital improvements. The prioritized asset improvement list presented in this report is based on Wright-Pierce's engineering expertise and experience and should not be considered financial advice.

Table 7-11 Fifty-Year Capital Improvement Plan

General OH&P	20%
Bond and Insurance	3%
Ancillary Equipment/Material Adder	25%
Project Contingency	50%
Engineering Design and Bidding Services	20%
Engineering Construction Services	15%
Material Testing	1%
Legal/Admin and Easements	0%
Wetlands & Con.Com	0%

Table 7-11: Penacook Boscawen Water Precinct System 50-Year Capital Improvement Plan

Location	Priority Costs (Yr 1-5)	Predictive Costs (Yr 6-10)	Prospective Costs (Yr 11-50)	Plan Year										Total
				2025	2026	2027	2028	2029	2030-2034	2035-2044	2044-2054	2055-2064	2065-2074	
Maintenace Facility/Administration Building	$ 13,110	$ 1,000	$ 1,183,510	$ 11,830	$ -	$ -	$ -	$ 1,280	$ 1,000	$ 8,030	$ -	$ 7,500	$ 1,167,980	$ 1,198,000
Corrosion Control Facility	$ 129,920	$ 25,670	$ 1,609,980	$ 126,540	$ -	$ -	$ -	$ 3,380	$ 25,670	$ 97,870	$ -	$ -	$ 1,512,110	$ 1,766,000
Well No. 1	$ 12,480	$ -	$ 3,940	$ 12,480	$ -	$ -	$ -	$ -	$ -	$ 3,940	$ -	$ -	$ -	$ 17,000
Well No. 2	$ 8,750	$ -	$ 3,940	$ 8,750	$ -	$ -	$ -	$ -	$ -	$ 3,940	$ -	$ -	$ -	$ 13,000
Well No. 3	$ 24,580	$ -	$ 21,680	$ 24,260	$ -	$ -	$ -	$ 320	$ -	$ 21,680	$ -	$ -	$ -	$ 47,000
Water Street Booster Pump Station	$ 66,610	$ 25,620	$ 157,420	$ 66,610	$ -	$ -	$ -	$ -	$ 25,620	$ 104,830	$ 15,110	$ 37,480	$ -	$ 250,000
Fairbanks Tank Site	$ 11,090	$ -	$ 8,605,010	$ 11,090	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 39,780	$ 8,565,230	$ 8,617,000
Merrimack Tank Site	$ 5,510	$ -	$ -	$ 5,510	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,000
Queens Street Tank Site	$ 13,250	$ -	$ 446,560	$ 13,250	$ -	$ -	$ -	$ -	$ -	$ 5,790	$ 2,780	$ -	$ 437,990	$ 460,000
Route 3 & 4 PRV	$ 16,160	$ 36,870	$ 52,180	$ 16,160	$ -	$ -	$ -	$ -	$ 36,870	$ -	$ 2,870	$ 49,310	$ -	$ 106,000
Water Mains	$ 6,710,000	$ 6,710,000	$ 13,420,000	$ 1,342,000	$ 1,342,000	$ 1,342,000	$ 1,342,000	$ 1,342,000	$ 6,710,000	$ 13,420,000	$ -	$ -	$ -	$ 26,840,000
GRAND TOTAL	$ 7,012,000	$ 6,800,000	$ 25,505,000	$ 1,639,000	$ 1,342,000	$ 1,342,000	$ 1,342,000	$ 1,347,000	$ 6,800,000	$ 13,667,000	$ 21,000	$ 135,000	$ 11,684,000	$ 39,319,000

Note: All budgetary costs include a 3% per year escalation.

Appendix A
ISO Testing Report

Sprinkled Buildings NFPA
Unsprinkled Buildings ISO

500 GPM for 30 min

Reviewed every 10 years

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

Info Fr. Before tanks

City Boscawen

unty New Hampshire(Merrimack), State NEW HAMPSHIRE (28) Witnessed by: Insurance Services Office

Date: Nov 30, 2016

EST IO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM $Q=(29.83(C(d^2)p^{0.5}))$ INDIVIDUAL HYDRANTS			TOTAL	PRESSURE PSI STATIC	RESID.	FLOW -AT 20 PSI NEEDED **	AVAIL.	REMARKS***	MODEL TYPE
1		Daniel Webster @ County Complex	Boscawen Water Precinct, RHS	670	0	0	670	820	16	3500	650	(C)-(3351 gpm)	
2		Daniel Webster Hwy @ North of Complex	Boscawen Water Precinct, RHS	750	0	0	750	85	20	750	750		
3		Raymond @ Woodberry	Boscawen Water Precinct, HS	1010	0	0	1010	88	36	750	1200		
4		High St @ North of Corn Hill	Boscawen Water Precinct, LS	820	0	0	820	66	24	3500	850		
5		King St @ North of Queen	Boscawen Water Precinct, LS	1010	0	0	1010	87	36	2500	1200		
6		King @ Crete Barn	Boscawen Water Precinct, LS	1020	0	0	1020	73	37	2250	1300		
7		N.Main St @ Jackson	Boscawen Water Precinct, LS	1090	0	0	1090	60	42	2500	1700		
-A		N.Main St @ Jackson	Boscawen Water Precinct, LS	1090	0	0	1090	60	42	750	1700		
8		Elm St @ End	Boscawen Water Precinct, LS	630	0	0	630	46	14	750	550		
9		N.Main St @ River	Boscawen Water Precinct, LS	1140	0	0	1140	82	47	4500	1600	(D)-(3757 gpm)	
-A		N.Main St @ River	Boscawen Water Precinct, LS	1140	0	0	1140	82	47	3500	1600		

ABOVE LISTED NEEDED FIRE FLOWS ARE FOR PROPERTY INSURANCE PREMIUM CALCULATIONS ONLY AND ARE *NOT* INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE DITION.

AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

m = Commercial; Res = Residential.

eded is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire ression Rating Schedule.

)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

Appendix B
BRE Matrix

Penacook Boscawen Water Precinct Business Risk Exposure Matrix

Street Name	Remaining Asset Life	Pipe Material	Repair History	Static Pressure	Probability of Failure	Fire Flow Reduction	Business Interruption	Traffic Issues	Consequence of Failure	Business Risk Exposure
	0.55	0.15	0.2	0.1	1-10	0.5	0.25	0.25	1-10	PoF*CoF
N Main St	10	7	1	7	7.5	8	10	10	9.0	67.1
King St	10	1	1	10	6.9	8	10	10	9.0	61.7
Oak St	10	7	1	10	7.8	4	1	1	2.5	19.4
N Main St	10	7	1	7	7.5	10	10	10	10.0	74.5
N Main St	10	7	1	7	7.5	8	10	10	9.0	67.1
N Main St	10	7	1	7	7.5	10	10	10	10.0	74.5
Queen St	10	1	1	7	6.6	10	10	5	8.8	57.3
Elm St	10	7	1	10	7.8	4	1	1	2.5	19.4
Queen St Tank	10	7	1	3	7.1	4	10	1	4.8	33.5
Queen St Tank	5	1	1	3	3.4	10	10	1	7.8	26.4
Queen St Tank	5	1	1	3	3.4	10	10	1	7.8	26.4
Queen St Tank	5	1	1	3	3.4	10	10	1	7.8	26.4
Park St	10	7	1	7	7.5	4	1	1	2.5	18.6
N Main St	10	7	1	7	7.5	8	10	10	9.0	67.1
N Main St	10	7	1	10	7.8	8	10	10	9.0	69.8
N Main St	10	7	1	10	7.8	8	10	10	9.0	69.8
N Main St	10	7	1	10	7.8	8	10	10	9.0	69.8
Elm St	10	7	1	10	7.8	4	1	1	2.5	19.4
School St	1	1	1	10	1.9	6	1	1	3.5	6.7
Cottage St	1	1	1	10	1.9	6	1	1	3.5	6.7
Cross Country	1	1	1	10	1.9	6	1	1	3.5	6.7
Eel St	5	1	1	10	4.1	6	1	1	3.5	14.4
Cross Country	1	1	1	10	1.9	6	1	1	3.5	6.7
Eel St	10	7	1	0	6.8	6	1	1	3.5	23.6
Tremont St	10	7	1	0	6.8	6	1	1	3.5	23.6
Tremont St	10	7	1	10	7.8	6	1	1	3.5	27.1
Cross Country	10	5	1	10	7.5	2	1	1	1.5	11.2
Cross Country	10	5	1	10	7.5	2	1	1	1.5	11.2
Elm St	10	7	1	10	7.8	4	1	1	2.5	19.4
Tremont St	10	7	1	10	7.8	6	1	1	3.5	27.1
Fisher Ave	10	7	1	10	7.8	4	1	1	2.5	19.4
Cross Country	10	5	1	0	6.5	10	1	1	5.5	35.5
River Road	7.5	1	1	0	4.5	4	1	1	2.5	11.2
Gage St	1	1	1	7	1.6	6	1	1	3.5	5.6
Academy St	1	1	1	7	1.6	6	1	1	3.5	5.6
Jackson St	1	1	1	7	1.6	6	1	1	3.5	5.6
April Ave	1	1	1	7	1.6	6	1	1	3.5	5.6
Gage St	1	1	1	7	1.6	6	1	1	3.5	5.6
Elm St	10	7	1	10	7.8	4	1	1	2.5	19.4
Gage St	1	1	1	10	1.9	6	1	1	3.5	6.7
Baker St	1	1	1	7	1.6	6	1	1	3.5	5.6
Birch St	1	1	1	7	1.6	6	1	1	3.5	5.6
Baker St	1	1	1	10	1.9	6	1	1	3.5	6.7
Academy St	1	1	1	10	1.9	6	1	1	3.5	6.7
Martin Ave	1	1	1	10	1.9	6	1	1	3.5	6.7
April Ave	1	1	1	10	1.9	6	1	1	3.5	6.7
Jackson St	1	1	1	10	1.9	6	1	1	3.5	6.7
Tremont St	1	1	1	10	1.9	6	1	1	3.5	6.7
Tremont St	1	1	1	10	1.9	6	1	1	3.5	6.7
Tremont St	1	1	1	10	1.9	10	1	1	5.5	10.5
Tremont St	10	7	1	10	7.8	10	1	1	5.5	42.6
Barrett Ave	1	1	1	10	1.9	6	1	1	3.5	6.7
Dove St	10	7	1	7	7.5	4	1	1	2.5	18.6
Dove St	10	7	1	7	7.5	4	1	1	2.5	18.6
Robin St	10	7	1	0	6.8	4	1	1	2.5	16.9
Robin St	10	7	1	7	7.5	4	1	1	2.5	18.6
Cross Country	7.5	7	1	3	5.7	4	1	1	2.5	14.2
Bluebird Ln	7.5	7	1	3	5.7	4	1	1	2.5	14.2
Queen St	10	7	1	10	7.8	4	10	5	5.8	44.6
Elm St	10	7	1	10	7.8	4	1	1	2.5	19.4
Queen St	10	7	1	10	7.8	4	10	5	5.8	44.6
Queen St	10	7	1	0	6.8	4	10	5	5.8	38.8
Cross Country	10	1	1	7	6.6	4	1	1	2.5	16.4
King St	10	1	1	0	5.9	8	10	10	9.0	52.7
King St	10	1	1	0	5.9	8	10	10	9.0	52.7
King St	10	1	1	0	5.9	8	10	10	9.0	52.7
N Main Street	10	7	1	10	7.8	8	10	10	9.0	69.8
Best Ave	2.5	1	1	10	2.7	10	10	1	7.8	21.1
N Main St	10	7	1	10	7.8	10	10	10	10.0	77.5
Red Oak Way	10	5	1	7	7.2	6	1	1	3.5	25.0
N Main St	10	7	1	7	7.5	4	1	1	2.5	18.6
Daniel Webster Hwy	10	7	1	7	7.5	10	10	10	10.0	74.5
Daniel Webster Hwy	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Daniel Webster Hwy	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Cross Country	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Forest Ln	7.5	7	1	10	6.4	4	1	1	2.5	15.9

Penacook Boscawen Water Precinct Business Risk Exposure Matrix

Street Name	Remaining Asset Life	Pipe Material	Repair History	Static Pressure	Probability of Failure	Fire Flow Reduction	Business Interruption	Traffic Issues	Consequence of Failure	Business Risk Exposure
Forest Ln	7.5	7	1	10	6.4	4	1	1	2.5	15.9
Forest Ln	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Forest Ln	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Forest Ln	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Elm St	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Forest Ln	10	7	1	7	7.5	4	1	1	2.5	18.6
Forest Ln	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Forest Ln	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Forest Ln	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Deer Run Rd	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Cross Country	7.5	7	1	0	5.4	2	1	1	1.5	8.1
Daniel Webster Hwy	1	5	1	10	2.5	2	1	1	1.5	3.8
Daniel Webster Hwy	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Fairbanks Tank	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Fairbanks Tank	2.5	1	1	7	2.4	10	10	1	7.8	18.8
Elm St	2.5	1	1	10	2.7	10	10	1	7.8	21.1
Fairbanks Tank	10	7	1	7	7.5	4	1	1	2.5	18.6
Fairbanks Dr	2.5	1	1	10	2.7	10	10	1	7.8	21.1
Fairbanks Dr	2.5	1	1	10	2.7	10	10	1	7.8	21.1
Daniel Webster Hwy	2.5	1	1	10	2.7	10	10	1	7.8	21.1
Daniel Webster Hwy	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Goodhue Rd	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Goodhue Rd	7.5	7	1	10	6.4	6	1	5	4.5	28.7
Goodhue Rd	7.5	7	1	7	6.1	6	1	5	4.5	27.3
Goodhue Rd	7.5	7	1	7	6.1	6	1	5	4.5	27.3
Goodhue Rd	7.5	7	1	7	6.1	6	1	5	4.5	27.3
Elm St	7.5	7	1	7	6.1	6	1	5	4.5	27.3
Raymond Rd	10	7	1	7	7.5	4	1	1	2.5	18.6
Raymond Rd	7.5	7	1	7	6.1	6	1	1	3.5	21.3
Water St	7.5	7	1	7	6.1	6	1	1	3.5	21.3
Water St	10	5	1	10	7.5	6	1	5	4.5	33.5
Merrill Corner Rd	10	1	1	7	6.6	8	1	5	5.5	36.0
Terrace Hill Rd	10	1	1	0	5.9	8	1	1	4.5	26.3
Terrace Hill Rd	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Terrace Hill Rd	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Terrace Hill Rd	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Water St	7.5	7	1	0	5.4	4	1	1	2.5	13.4
Chandler St	10	1	1	0	5.9	8	1	5	5.5	32.2
Water St	10	7	1	10	7.8	4	1	1	2.5	19.4
Water St	7.5	7	1	0	5.4	10	1	5	6.5	34.9
Water St	7.5	7	1	10	6.4	10	1	5	6.5	41.4
Water St	7.5	7	1	7	6.1	10	1	5	6.5	39.5
Chadwick Hill Rd	7.5	7	1	7	6.1	10	1	5	6.5	39.5
Chadwick Hill Rd	7.5	7	1	7	6.1	10	1	1	5.5	33.4
Chadwick Hill Rd	7.5	7	1	7	6.1	10	1	1	5.5	33.4
Chadwick Hill Rd	7.5	7	1	10	6.4	10	1	1	5.5	35.1
Daniel Webster Hwy	7.5	7	1	10	6.4	10	1	1	5.5	35.1
Chandler St	10	7	1	10	7.8	10	10	10	10.0	77.5
Daniel Webster Hwy	10	7	1	10	7.8	4	1	1	2.5	19.4
Daniel Webster Hwy	10	7	1	0	6.8	4	10	10	7.0	47.3
Daniel Webster Hwy	10	7	1	0	6.8	4	10	10	7.0	47.3
Valley Rd	10	7	1	0	6.8	4	10	10	7.0	47.3
Valley Of Industry Rd	7.5	1	1	0	4.5	4	1	1	2.5	11.2
Goodhue Rd	7.5	1	1	0	4.5	4	10	1	4.8	21.3
Lawrence St	10	7	1	10	7.8	4	1	5	3.5	27.1
Welcome Ave	1	1	1	7	1.6	4	1	1	2.5	4.0
Welcome Ave	2.5	1	1	7	2.4	4	1	1	2.5	6.1
High St	2.5	1	1	7	2.4	4	1	1	2.5	6.1
Chandler St	10	7	1	7	7.5	4	1	1	2.5	18.6
High St	10	7	1	10	7.8	4	1	1	2.5	19.4
High St	10	7	1	7	7.5	4	1	1	2.5	18.6
High St	10	7	1	7	7.5	4	1	1	2.5	18.6
High St	10	7	1	10	7.8	4	1	1	2.5	19.4
High St	10	1	1	10	6.9	4	1	1	2.5	17.1
High St	2.5	1	1	7	2.4	6	1	1	3.5	8.5
Cross Country	2.5	1	1	10	2.7	6	1	1	3.5	9.5
High St	10	1	1	10	6.9	6	1	1	3.5	24.0
High St	10	1	1	10	6.9	8	1	1	4.5	30.8
King St	10	1	1	0	5.9	8	1	1	4.5	26.3
Chandler St	10	1	1	0	5.9	8	10	10	9.0	52.7
King St	10	7	1	10	7.8	4	1	1	2.5	19.4
King St	10	1	1	10	6.9	8	10	10	9.0	61.7
PRV	10	1	1	10	6.9	8	10	10	9.0	61.7
PRV	10	5	1	0	6.5	8	10	1	6.8	43.5
PRV	10	5	1	10	7.5	8	10	1	6.8	50.3
Depot St	10	5	1	10	7.5	8	10	1	6.8	50.3
Water St	2.5	1	1	0	1.7	8	1	1	4.5	7.8

Penacook Boscawen Water Precinct Business Risk Exposure Matrix

Street Name	Remaining Asset Life	Pipe Material	Repair History	Static Pressure	Probability of Failure	Fire Flow Reduction	Business Interruption	Traffic Issues	Consequence of Failure	Business Risk Exposure
Water St	10	1	1	7	6.6	8	1	5	5.5	36.0
Water St	10	1	1	10	6.9	8	1	5	5.5	37.7
Chandler St	10	1	1	10	6.9	8	1	5	5.5	37.7
Woodbury Ln	10	7	1	10	7.8	4	1	1	2.5	19.4
Woodbury Ln	10	1	1	10	6.9	8	10	1	6.8	46.2
Woodbury Ln	10	1	1	7	6.6	8	10	1	6.8	44.2
Cross Country	10	1	1	10	6.9	8	10	1	6.8	46.2
Cross Country	7.5	7	1	7	6.1	6	1	1	3.5	21.3
Knowlton Rd	7.5	7	1	7	6.1	6	1	1	3.5	21.3
Knowlton Rd	7.5	7	1	7	6.1	6	1	1	3.5	21.3
Knowlton Rd	7.5	7	1	7	6.1	6	1	1	3.5	21.3
Marlboro Rd	7.5	7	1	7	6.1	6	1	1	3.5	21.3
Corn Hill Road	7.5	1	1	7	5.2	6	10	1	5.8	29.8
Chandler St	7.5	7	1	7	6.1	4	1	5	3.5	21.3
Marlboro Rd	10	7	1	7	7.5	4	1	1	2.5	18.6
Marlboro Rd	7.5	1	1	10	5.5	6	10	1	5.8	31.5
Cross Country	7.5	1	1	10	5.5	6	10	1	5.8	31.5
Cross Country	2.5	1	1	7	2.4	4	1	1	2.5	6.1
Pine St	2.5	1	1	7	2.4	4	1	1	2.5	6.1
Corn Hill Rd	7.5	7	1	7	6.1	4	1	1	2.5	15.2
Corn Hill Rd	10	7	1	10	7.8	4	1	5	3.5	27.1
Corn Hill Rd	10	7	1	10	7.8	4	1	5	3.5	27.1
Corn Hill Rd	10	7	1	10	7.8	4	1	5	3.5	27.1
Corn Hill Rd	10	7	1	7	7.5	4	1	5	3.5	26.1
Chandler St	10	7	1	7	7.5	4	1	5	3.5	26.1
Corn Hill Rd	10	7	1	7	7.5	4	1	1	2.5	18.6
River Crossing	10	7	1	7	7.5	4	1	5	3.5	26.1
River Crossing	2.5	5	1	0	2.3	10	1	1	5.5	12.8
Crescent St	10	1	1	0	5.9	8	1	1	4.5	26.3
Crescent St	10	1	1	0	5.9	8	1	1	4.5	26.3
Pump Station	10	1	1	0	5.9	8	1	1	4.5	26.3
Daniel Webster Hwy	10	5	1	7	7.2	6	10	1	5.8	41.1
Chandler St	10	7	1	10	7.8	4	10	10	7.0	54.3
Goodhue Rd	10	7	1	7	7.5	4	1	1	2.5	18.6
High St	7.5	7	1	7	6.1	6	1	5	4.5	27.3
Corn Hill Rd	10	5	1	10	7.5	2	1	1	1.5	11.2
Cross Country	10	7	1	10	7.8	4	1	5	3.5	27.1
Cross Country	10	7	1	0	6.8	10	1	1	5.5	37.1
River Rd	10	7	1	7	7.5	10	1	1	5.5	41.0
Chandler St	10	5	1	0	6.5	2	1	1	1.5	9.7
River Road	10	7	1	7	7.5	4	1	1	2.5	18.6
Queen St Tank	10	5	1	0	6.5	2	1	1	1.5	9.7
Daniel Webster Hwy	5	1	1	3	3.4	4	10	1	4.8	16.2
County Tank	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Nursing Home	2.5	1	1	0	1.7	10	10	1	7.8	13.4
Nursing Home	1	1	1	0	0.9	10	10	5	8.8	7.9
Wastewater Treatment Access	1	1	1	0	0.9	10	10	5	8.8	7.9
Nursing Home	10	5	1	10	7.5	4	1	1	2.5	18.6
Daniel Webster Hwy	2.5	5	1	0	2.3	10	10	5	8.8	20.3
Chandler St	2.5	1	1	0	1.7	6	10	10	8.0	13.8
Wells	10	7	1	7	7.5	4	1	1	2.5	18.6
Wells	2.5	5	1	0	2.3	10	10	1	7.8	18.0
Queen St Tank	2.5	5	1	0	2.3	6	10	1	5.8	13.4
Nursing Home	5	5	1	3	4.0	10	10	1	7.8	31.0
Nursing Home	1	1	1	0	0.9	4	10	5	5.8	5.2
Norac Dr	10	1	1	0	5.9	6	10	5	6.8	39.5
Eagle Perch Dr	1	5	1	10	2.5	1	1	1	1.0	2.5
Villa Brasi Way	1	5	1	7	2.2	4	1	1	2.5	5.5
Chandler St	1	5	1	7	2.2	1	1	1	1.0	2.2
Woody Hollow Coop	10	7	1	7	7.5	4	1	1	2.5	18.6
Merrill Corner Rd	1	5	1	7	2.2	6	1	1	3.5	7.7
Pump Station	10	5	1	0	6.5	1	1	1	1.0	6.5
N Main St	10	5	1	7	7.2	6	10	1	5.8	41.1
Corn Hill Rd	10	7	1	10	7.8	10	10	10	10.0	77.5
Merrill Corner Rd	10	7	1	7	7.5	4	1	5	3.5	26.1
N Main St	10	1	1	0	5.9	8	1	1	4.5	26.3
N Main St Development	5	1	1	10	4.1	8	10	10	9.0	36.9
N Main Street Development	10	1	1	0	5.9	10	1	1	5.5	32.2
Chandler St	10	1	1	0	5.9	6	1	1	3.5	20.5
N Main Street Development	10	7	1	7	7.5	4	1	1	2.5	18.6
N Main Street Development	10	1	1	0	5.9	6	1	1	3.5	20.5
N Main Street Development	10	1	1	0	5.9	4	1	1	2.5	14.6

Penacook Boscawen Water Precinct Business Risk Exposure Matrix

Street Name	Remaining Asset Life	Pipe Material	Repair History	Static Pressure	Probability of Failure	Fire Flow Reduction	Business Interruption	Traffic Issues	Consequence of Failure	Business Risk Exposure
N Main Street Devleopment	10	1	1	0	5.9	6	1	1	3.5	20.5
N Main St Development	10	1	1	0	5.9	4	1	1	2.5	14.6
N Main St Development	10	1	1	0	5.9	10	1	1	5.5	32.2
N Main St Development	10	1	1	0	5.9	6	1	1	3.5	20.5
Crescent St	10	1	1	0	5.9	6	1	1	3.5	20.5
Crescent St	10	1	1	0	5.9	10	1	1	5.5	32.2
Crescent St	10	1	1	0	5.9	10	1	1	5.5	32.2
Chandler St	10	1	1	0	5.9	10	1	1	5.5	32.2
Jackson St	10	7	1	7	7.5	4	1	1	2.5	18.6
Academy St	1	1	1	10	1.9	6	1	1	3.5	6.7
Gage St	1	1	1	7	1.6	6	1	1	3.5	5.6
Pump Station	1	1	1	7	1.6	6	1	1	3.5	5.6
Pump Station	10	5	1	7	7.2	6	10	1	5.8	41.1
Pump Station	10	5	1	0	6.5	6	10	1	5.8	37.1
Daniel Webster Hwy	10	5	1	7	7.2	6	10	1	5.8	41.1
Nursing Home	7.5	7	1	10	6.4	6	10	10	8.0	51.0
Chandler St	1	1	1	0	0.9	10	10	5	8.8	7.9
Nursing Home	10	7	1	10	7.8	4	1	1	2.5	19.4
Daniel Webster Hwy	1	1	1	0	0.9	10	10	5	8.8	7.9
King St	7.5	7	1	10	6.4	6	10	10	8.0	51.0
N Main St	10	1	1	0	5.9	8	10	10	9.0	52.7
N Main St	10	7	1	7	7.5	8	10	10	9.0	67.1
Elm St	10	7	1	7	7.5	8	10	10	9.0	67.1
Elm St	10	7	1	10	7.8	10	1	1	5.5	42.6
Elm St	10	7	1	10	7.8	4	1	1	2.5	19.4
Elm St	10	7	1	10	7.8	4	1	1	2.5	19.4
Buxton Pl	10	7	1	7	7.5	4	1	1	2.5	18.6
Park St	5	1	1	10	4.1	4	1	1	2.5	10.3
Tremont St	10	7	1	7	7.5	4	1	1	2.5	18.6
Queen St Tank	1	1	1	10	1.9	6	1	1	3.5	6.7
High St	5	1	1	3	3.4	10	10	1	7.8	26.4
Corn Hill Road	10	1	1	10	6.9	4	1	1	2.5	17.1
Marlboro Rd	10	7	1	7	7.5	4	1	5	3.5	26.1
Cross Country	7.5	1	1	7	5.2	6	10	1	5.8	29.8
Cross Country	10	7	1	7	7.5	10	1	1	5.5	41.0

Appendix C
Asset Hierarchy

Facility/Room Numbering Guide

Penacook Boscawen Water Precinct					
Location		Facility		Room	
No.	Description	No.	Description	No.	Description
100	**Facilities**				
		110	Maintenance Facility/Administrative Building		
				101	Bathroom
				102	Garage
				103	Office
				104	Side Office
				EXT	Exterior
		120	Corrosion Control Facility		
				001	Chemical Injection Vault
				101	Chemical Room
				EXT	Exterior
200	**Well Sites**				
		201	Well No. 1		
				001	Valve Vault
		202	Well No. 2		
				001	Valve Vault
		203	Well No. 3		
				001	Meter Vault
				101	Well Control Building
300	**Booster Stations**				
		301	Water Street Booster Station		
				101	Pump Room
				EXT	Exterior
400	**Tanks**				
		401	Fairbanks Tank Site		
				001	Vault
		402	Merrimack Tank Site		
		403	Queen Street Tank Site		
				001	Vault
				101	Control Building
500	**Distribution System**				
		501	Water Mains		
		502	Hydrants		
		503	Valves		
		504	Service Connections		
		505	Pressure Relief Valves		
				101	Route 3&4
600	**Vehicles**				
		601	Maintenance		
		602	Operations		

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