FINAL
REPORT

# WATER SYSTEM MASTER PLAN
# 2019 Update of the 2008 Plan

Town of Salem, New Hampshire


*August 2019*
*(Finalized December 2019)*

CDM Smith

CDM Smith
670 North Commercial Street
Manchester, New Hampshire 03101
tel: 603 222-8300
fax: 603 628-7675

December 23, 2019

Mr. Roy Sorenson
Director of Municipal Services
Town Hall
33 Geremonty Drive
Salem, New Hampshire 03079

Subject: 2019 Update of the Water System Master Plan

Dear Mr. Sorenson:

CDM Smith is pleased to submit this 2019 Update of the Water System Master Plan.

This Update Report supersedes the 2013 Update report, and functions as a companion volume to the original 2008 Water System Master Plan.

## Executive Summary

This Update Report follows the same 11-section structure as the original 2008 Master Plan, and retains the same section titles. In some cases, a section in this report supersedes that of the 2008 Plan; in other cases, this report's section supplements that of the 2008 Plan; in still other cases, the Town requested no updates to sections in the original 2008 Plan.

After the introductory Section 1, each section of this Update Report starts with a brief explanation of its relationship to the 2008 Plan, to guide the reader.

The primary discussion items in this Update Report are listed below, for ease of reference.

- **Section 2, Description of Existing System –** An updated water system map is included. The major improvements to the Manor Parkway high service area, which were completed after the 2013 Update, are described.
- **Section 3, Population and Water Consumption –** Updated data and projections for population and water consumption are presented. The Town's recent efforts in water conservation and demand management are discussed, and recommendation for future efforts are presented.

- **Section 4, Water Quality and Treatment Review –** A proposed treatment process and operations review is described. The intent of this proposed project is to assist the Town in optimizing its operations of the Canobie Lake Water Treatment Plant.
- **Section 5, Analysis of Existing Water Distribution System –** As has been true in the past, this section and Section 11, Capital Improvement Planning, will likely be the most-frequently referenced portions of this Update Report, particularly during Salem's annual budgeting cycle. This section updates the list of future piping projects (see Figure 5-1 and Table 5-1), summarizes the many piping projects completed by Salem since the original 2008 Plan (see Table 5-2), discusses the system's overall ability to provide satisfactory fire flows, and describes the condition of the three water storage tanks. Future projects are described here and are prioritized in Section 11.
- **Section 7, Operation and Maintenance Practices –** A proposed maintenance building at the Canobie Lake Water Treatment Plant is described.
- **Section 8, Supply Source Issues –** The abandonment of the Town's former groundwater supply sources, past and proposed future efforts regarding the Salem/Methuen water system interconnection, and Salem's participation in NHDES's Regional Water Project, are discussed.
- **Section 9, Organizational Evaluation –** A current organizational chart of the Utilities Division is presented. Staffing levels for operating and maintaining Salem's water system are compared to those at similar communities in New Hampshire.
- **Section 11, Capital Improvement Planning –** The CIP section prioritizes the proposed piping improvements after considering Salem's ten-year roadway plan (see Table 11-1 and Figure 11-1). This section then presents all projects on an overall schedule chart (see Figure 11-2) which also references the section in the Master Plan in which more details about each project can be found.

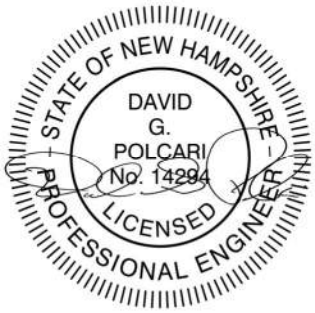
We are grateful for the opportunity to work with you on this project. We also thank Dan Hudson (former Director of Engineering), Fred Wallace (Utilities Manager), Jim Brown (Engineering Division) and Glenn Burton (former Distribution/Construction Foreman), for their assistance throughout this assignment.

This report was prepared under the general supervision of David G. Polcari, client service leader, by Jeffrey E. Diercks, project manager and by Steven L. Carey, project engineer.

Sincerely,

Jeffrey E. Diercks, P.E.
Associate
CDM Smith Inc.

David G. Polcari, P.E.
Vice President
CDM Smith Inc.




cc: Dan Hudson, P.E., former Director of Engineering
Fred Wallace, Utilities Manager
Jim Brown, Engineering Division
Glenn Burton, Distribution/Construction Foreman (retired)
Steve Carey, CDM Smith

# Table of Contents

# List of Figures

# List of Tables

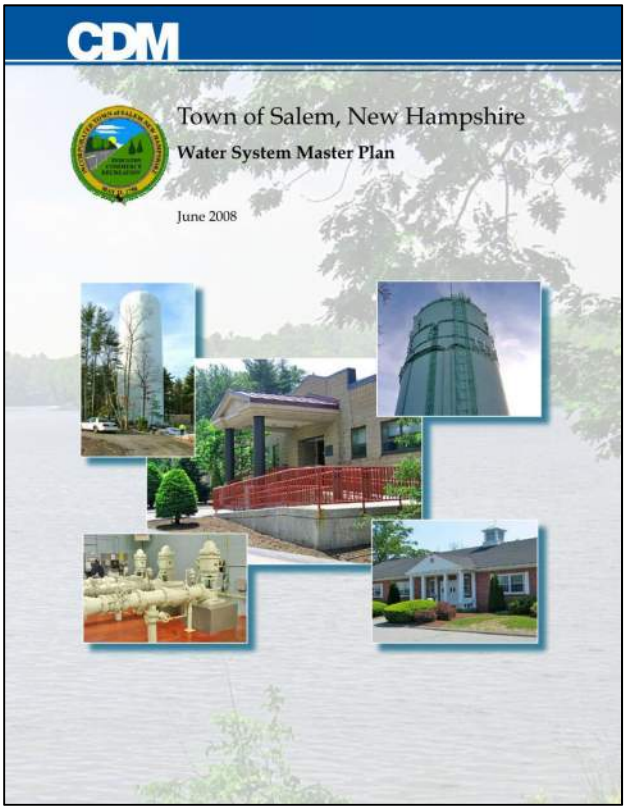


# Appendices

# Section 1
# Introduction

## 1.1 Salem's 2008 Water System Master Plan

In 2007 and 2008, the Town of Salem and CDM Smith developed the Town's Water System Master Plan. Prior planning efforts in the early 1990s had focused on water supply and treatment alternatives. The 2008 Plan, while addressing those issues, emphasized the integration of the water distribution system into the planning process.



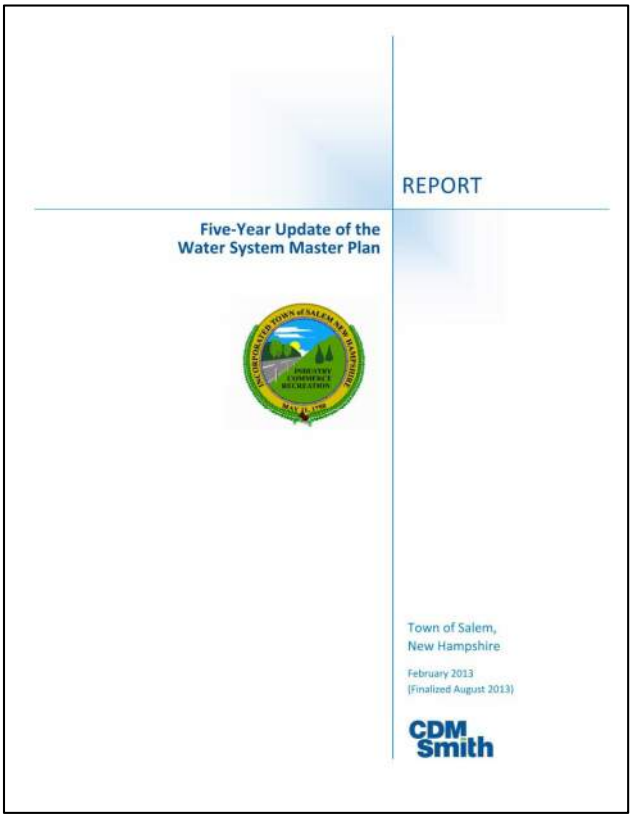

To address all the issues desired by the Town, the Master Plan was divided into eleven basic sections. Following an introductory section, those sections were as follows:

- ***Section 2, Description of Existing System.*** Overview of Salem's water system and its major components.
- ***Section 3, Population and Water Consumption***. Discussed population and water consumption projections, and the Town's water conservation efforts.
- ***Section 4, Water Quality and Treatment Review.*** Summarized the current and pending water treatment regulations, actions taken or planned by the Town, and potential future impacts to the Town.
- ***Section 5, Analysis of Existing Facilities***. Presented the evaluation of the distribution system and identified existing and future deficiencies.
- ***Section 6, Alternatives for System Expansion.*** Presented two alternatives for expansion of the existing distribution system for future supply of the currently unserved portions of the Town, primarily located in North Salem and southwestern Salem.
- ***Section 7, Operation and Maintenance Practices.*** Provided a review of current O&M practices and recommendations for improvement to the existing programs.
- ***Section 8, Supply Source Issues.*** Commented on the status of Salem's existing and future potential supply sources.
- ***Section 9, Organization Evaluation.*** Commented on the department's management structure and presented recommendations for improvement.

- ***Section 10, Financial Evaluation.*** Provided an assessment of the financial management of the department.
- ***Section 11, Recommended Capital Improvements***. Presented recommendations and a prioritized program for system capital improvements.

## 1.2 Update Report in 2013

The Town initiated an Update to the 2008 Master Plan in 2012, which was completed in 2013.




The major topics addressed in this Update were as follows:

- Updating the water distribution system map.
- Preparing a new Section 3, Population and Water Consumption, superseding that in the 2008 Plan.
- Making major revisions to Section 5, Analysis of Distribution System, to reflect the work completed since 2008 and reprioritize the work yet to be done.
- Preparing a new Section 11, Capital Improvement Planning, superseding that in the 2008 Plan.

The prioritized program of capital improvements presented in each of these two reports formed the basis of financial and scheduling decisions during the Town's annual budgeting cycle each year.

## 1.3 Purposes of the 2019 Update

The primary purposes of this 2019 Update include the following:

- To prepare a new Section 3, Population and Water Consumption, which now includes the effect of the Tuscan Village development.
- To provide again a new version of Section 5, discussing the past and future work on the water distribution system.
- To document the Town's participation in the Southern New Hampshire Regional Water Project, which has superseded other alternatives the Town once considered for increasing its supply source capacity.
- To supplement the original Plan's discussion in Section 9, Utilities Division, addressing several specific requests including an organizational chart, a review of staffing at similar communities, and consideration of a new maintenance building.

- To prepare a new Section 11, Capital Improvement Planning, superseding that in the 2013 Update.

For this 2019 Update, CDM Smith decided to retain the 11-section format of the original 2008 Plan. After this introductory section, each section begins by citing the relationship of this report's work to the prior versions of the Water System Master Plan. In some cases, the work in this report supplements that in the original, in some cases the new work fully supersedes the prior versions of that section, and in a few cases the section was not updated. In each case, the reader is informed immediately, in the opening sentences.

## 1.4 Suggestion Regarding Future Updates

During the development of the original 2008 plan, CDM Smith described to the Town how some water purveyors set a goal of conducting water system planning on a 5-year & 15-year cycle. In this philosophy, the original Water System Master Plan is updated after five years, and updated again after another five years. Fifteen years after the original plan, a new Plan is prepared, rather than continuing to update the original one. The Town may wish to consider this approach in 2024, the suggested year for the next planning effort.

# Section 2

# Description of Existing System

## 2.1 Relationship to Prior Versions of the Master Plan

In the 2008 Water System Master Plan, Section 2 presented a detailed description of the major components of the Salem water system. The Town did not request updates to this section, beyond the brief notes below which supplement the 2008 Plan and supersede the 2013 Update report.

## 2.2 Updated Water Distribution System Map

An updated water distribution system map, **Figure 2-1**, is provided in the map pocket at the end of this section.

## 2.3 Improvements to Manor Parkway Booster Pumping Station and New Commercial Drive Pumping Station

At the time of the 2013 Update report, the Town was planning improvements to the Manor Parkway high service area whose boundaries are shown on the water distribution system map. These improvements included upgrades to the Manor Parkway Booster Pumping Station, and construction of a new Commercial Drive Pumping Station.

**Manor Parkway Booster Pumping Station**

The upgrades were completed to accomplish a number of objectives. Between the upgrades and construction of the new station, fire flows were increased to an available 3,500 gallons per minute (gpm) at 20 psi residual in all Town-owned mains in the Manor Parkway high service zone. Over-pressurization caused by the prior fire pump was reduced. Fire pump controls were improved and the new fire pump is now able to start independently of alarm transmission from private sprinkler systems. The Manor Parkway booster pumping system was replaced and upsized to meet peak hour demand with the largest pump out of service. The prior pumping system was demolished since it had reached the end of its useful life.

The new pumping system installed at the Manor Parkway Booster Pumping Station includes two vertical multistage jockey pumps, both for low flow service demand and each with a capacity of 44 gpm. It also includes two end suction centrifugal booster pumps, one duty, one standby, and each rated for a capacity of 383 gpm. In addition to those 4 pumps, the horizontal diesel-driven fire pump is rated for 1,750 gpm.

The new Commercial Drive Pumping Station was constructed to house a single horizontal diesel-driven fire pump identical to the one installed as part of the Manor Parkway upgrades.

Operating simultaneously, the fire pumps in the two stations meet the Manor Parkway high service zone's needed fire flow of 3,500 gpm.

**Table 2-1** below summarizes all of the water pumping stations operated by the Town of Salem.

**Commercial Drive Pumping Station**

**Table 2-1 Salem Pumping Stations**

| Pump Station | Installed Pumps | Firm Pumping Capacity[1] |
|---|---|---|
| Arlington Pond Raw Water Transfer Station | 3 X 1,400 gpm @ 142 ft | 2,800 gpm (4 mgd) |
| Canobie Lake Raw Water Transfer Station | 3 X 1,400 gpm @ 70 ft | 2,800 gpm (4 mgd) |
| Canobie Lake Water Treatment Plant | 3 X 1,400 gpm @ 165 ft | 2,800 gpm (4 mgd) |
| Commercial Drive Pumping Station | 1 X 1,750 gpm fire pump | Station only intended for fire demands |
| Manor Parkway Booster Station | 2 X 44 gpm<br>2 X 383 gpm (4-pump skid)<br>1 X 1,750 gpm fire pump | 471 gpm (0.7 mgd)<br>For non-fire demands |
| Nirvana Road Booster Station | 3 X 84 gpm @ 112 ft<br>1 X 1,500 gpm fire pump | 84 gpm (0.1 mgd)<br>For non-fire demands |

[1]Firm pumping capacity is considered to be the capacity with largest non-fire pump out of service

Windham,NH

Pelham,NH

Derry,NH

Atkinson,NH

Methuen,MA

Haverhill,MA

Donigian Wells (Abandoned)

Commercial Drive Booster Station

Manor Parkway Booster Station

Canobie Lake Water Treatment Plant

Turner Well (Abandoned)

Howard Street Standpipe

Arlington Mill Pond Raw Water Pumping Station

Salem Street Methuen Interconnection

Lawrence Road Standpipe

Spicket Hill Tank

Nirvana Drive Booster Station

Hitching Post Lane Methuen Interconnection

Main Street Methuen Interconnection

PORCUPINE BROOK

CANOBIE LAKE

SHADOW LAKE

POLICY BROOK

HITTY TITY BROOK

TAYLOR RESERVOIR

HEDGEHOG POND

MILLVILLE POND

ARLINGTON MILL POND

WILSONS POND

PROVIDENCE HILL BROOK

HAWKINS POND

WIDOW HARRIS BROOK

SPICKET RIVER

BODWELL POND

S BROADWAY BRIDGE

CAPTAINS POND BROOK

WORLD END BROOK

CAPTAINS POND

WORLD END POND

STILLWATER POND

38

111

28

97

93

## Legend

- Water Distribution Mains
- High Service Zone Boundary
- Town Boundary
- Former Well, Abandoned
- Pump Station
- Water Storage Tank

Note: Raw water transfer main from Arlington Mill Pond to Water Treatment Plant not shown.

N W E S

0 0.25 0.5 0.75 1 Miles

**Notes:**
**Existing pipe information based on GIS data provided by the Town of Salem in May 2019**

CDM Smith

Figure 2-1
Town of Salem, New Hampshire
Existing Water Supply and Distribution System
December 2019

# Section 3

# Population and Water Consumption

## 3.1 Relationship to Prior Versions of the Master Plan

This section supersedes the versions of Section 3 in the 2008 Water System Master Plan and the 2013 Update report.

## 3.2 Recent Population Data

The two previous editions of the Water System Master Plan used population data from the 2000 and 2010 U.S. Census, along with estimates provided by the New Hampshire Office of Energy and Planning (NHOEP). The 2010 U.S. Census reported Salem's population to be 28,776. The U.S. Census Bureau provides population estimates in additional to the decadal census. Their most recent estimate is for July 1, 2018, when they estimated Salem's population to be 29,554.

As stated in the 2013 Update, NHOEP no longer produces population estimates. They do, however, post population estimates prepared by the New Hampshire Office of Strategic Initiatives (NHOSI). NHOSI estimated in their 2017 report (published August 2018) that the Town of Salem had a population of 28,914.

Given that the two agencies utilized a different year as the basis of their estimates, these two estimates are not in conflict. For the purpose of this 2019 Update, we have elected to use the more-recent (2018) population estimate of 29,554.

For water system planning, the "serviced population" is of interest, in addition to the total population of Salem. Large areas of North Salem and the southwest portion of Town do not have municipal water. In the 2008 Master Plan, we estimated that the serviced population was 72% of the total population.

The 2008 Plan also provided buildout projections for the Town, and described options for how the water system could be expanded into the unserved areas. There has, however, been very little if any expansion of the water system into the unserved areas presented in the 2008 Plan. Therefore, we have retained the 2008 Plan's 72% figure for the estimate of the present-day serviced population.

## 3.3 Population Projections

The 2008 Plan used population projections provided by NHOEP. Since the actual 2010 U.S. Census fell short of those projections, the 2013 Update used the 2010 Census to reestablish the baseline and adjust the NHOEP projections.

NHOEP in partnership with NH Regional Planning Commissions (RPCs) developed updated population projections for New Hampshire municipalities in September 2016. These projections estimated a population as of 2015, and used that value as a baseline for projecting population growth through 2040. Today, however, we have more recent estimates which differ from that

used in this 2016 report. Similarly to the approach used in the 2013 Update, we have decided to reestablish the baseline for 2020 and use the year-by-year percentage increases in the NHOEP projection to update the projection forecast. To calculate the 2020 baseline, we elected to use the 2018 U.S. Census Bureau estimate, and apply the same annual growth rate since the 2010 U.S. Census. We then used the NHOEP percentage increases over the next 20 years to establish a population increase for each 5-year period.

One complicating factor that was separately accounted-for was adding in an expected population increase associated with the Tuscan Village development between the years 2020 and 2025. This development, the largest in the Town's history, was not factored into prior projections. We assumed all residential units will be completed and occupied during the 2020-to-2025 period. Information for the projected population of Tuscan Village was derived from the Tuscan Village Demand Benefit Assessment (DBA) dated January 19, 2019. Population was calculated based on residential units or bedrooms, as listed in the DBA. We assumed 1 person per Assisted Care Living unit, and 1.5 persons per bedroom for all other residential unit types. This equates to a total residential population of 1,530 in the Tuscan Village development, which was added to population projection for 2025 and afterwards.

**Table 3-1** below presents the updated population projection through the year 2040.

**Table 3-1 Populations Projections**

| Year | Population |
|---|---|
| 2018* | 29,554 |
| 2020 | 29,752 |
| 2025 | 31,345 |
| 2030 | 32,011 |
| 2035 | 32,393 |
| 2040 | 32,466 |

*U.S. Census Bureau estimate.

The serviced population is being taken as 72% through 2020, then increasing to 73% from 2025 on due to the effect of the Tuscan Village development.

## 3.4 Recent Water Demands

**Table 3-2** displays water production and consumption data from 1999 through 2018. The Town has indicated that enhanced metering installed in 2010 and more detailed recordkeeping has significantly improved the records in the last decade.

The "total pumped" column reflects Salem's Water Treatment Plant (WTP) production, and the remaining columns track the usage. Residential use has historically been Salem's largest consumption category averaging 46% of total water produced from 1999-2018. Salem's commercial water usage averaged 34% of the total water produced during the same time period. Looking only at the last six-year period (from 2013 to 2018), residential average water use was 45% and commercial average water use was 35% of total water produced.

The remaining water is categorized as "unmetered water". Unmetered water includes water used in such events as hydrant testing, fire department training, firefighting, main breaks, leaks, underregistration of customer meters, and more. In the most recent year, 2018, the unmetered water was 16%.

Some of this unmetered water can actually be estimated and accounted-for. Examples include water used during hydrant flushing, firefighting, and main breaks. As of 2010, the Town estimates and subtracts such water usage from the unmetered water, to estimate the "unaccounted-for water". The unaccounted-for water for 2018 was 16% (slightly lower than the unmetered water for that year, though that is not apparent when rounding to the nearest integer).

**Table 3-2** also lists the maximum day demand, which is of significant interest in water system planning. The Town started tracking reliable data for this in 2003. The average maximum day demand from 2003 to 2018 was 4.14 MGD, which is down from 4.23 MGD between 2003 to 2012. This can be attributed to the recent period having the two lowest maximum day demand values since recordkeeping began in 2003 and 5 out of 6 years being below the average value.

Another parameter closely related to the maximum day demand is the "peaking factor", which is the ratio of maximum day demand to average day demand. The average value of this parameter over the 2003-2018 period of record is 1.796, which is virtually identical to the average value in the 2013-2018 period, namely 1.790.

There can, however, be significant variations in the peaking factor year-to-year, because the parameter is sensitive to summer climatic conditions. In the past decade, there were three years with peaking factors above 1.9. The year 2011 had the highest value (2.09), and the most recent year was 1.91. In the same decade, there were four years with peaking factors under 1.75, the lowest being 2017 at 1.61. Suburban communities often have peaking factor values approaching and occasionally exceeding 2.0.

**Table 3-2 Water Demand Data (continues onto next page)**

| Year | Total Pumped (MGD) | Residential Metered (MGD) | Commercial Metered (MGD) | Unmetered Water* (MGD) | Unmetered Water* (%) | Un-accounted For Water* (%) | Max. Day Pumped (MGD) |
|---|---|---|---|---|---|---|---|
| 1999 | 2.38 | 1.14 | 0.93 | 0.30 | 13% | N/A | N/A |
| 2000 | 2.23 | 1.05 | 0.84 | 0.34 | 15% | N/A | N/A |
| 2001 | 2.39 | 1.15 | 0.85 | 0.38 | 16% | N/A | N/A |
| 2002 | 2.24 | 1.09 | 0.82 | 0.32 | 14% | N/A | N/A |
| 2003 | 2.26 | 1.08 | 0.77 | 0.42 | 18% | N/A | 3.96 |
| 2004 | 2.40 | 1.08 | 0.79 | 0.53 | 22% | N/A | 3.93 |
| 2005 | 2.40 | 1.13 | 0.82 | 0.46 | 19% | N/A | 4.07 |
| 2006 | 2.49 | 1.07 | 0.79 | 0.63 | 25% | N/A | 4.47 |
| 2007 | 2.50 | 1.15 | 0.78 | 0.56 | 22% | N/A | 4.61 |

| Year | Total Pumped (MGD) | Residential Metered (MGD) | Commercial Metered (MGD) | Unmetered Water* (MGD) | Unmetered Water* (%) | Un-accounted For Water* (%) | Max. Day Pumped (MGD) |
|---|---|---|---|---|---|---|---|
| 2008 | 2.40 | 1.02 | 0.74 | 0.64 | 27% | N/A | 4.18 |
| 2009 | 2.28 | 0.96 | 0.71 | 0.62 | 27% | N/A | 3.82 |
| 2010 | 2.42 | 1.15 | 0.76 | 0.51 | 21% | 20% | 4.65 |
| 2011 | 2.18 | 0.98 | 0.76 | 0.43 | 20% | 18% | 4.56 |
| 2012 | 2.20 | 1.01 | 0.81 | 0.38 | 17% | 16% | 4.05 |
| 2013 | 2.11 | 0.95 | 0.72 | 0.44 | 21% | 21% | 3.66 |
| 2014 | 2.21 | 0.98 | 0.83 | 0.40 | 18% | N/A | 4.26 |
| 2015 | 2.38 | 1.04 | 0.83 | 0.51 | 21% | 21% | 4.06 |
| 2016 | 2.42 | 1.05 | 0.79 | 0.58 | 24% | 23% | 4.48 |
| 2017 | 2.13 | 0.96 | 0.77 | 0.39 | 18% | 17% | 3.43 |
| 2018 | 2.13 | 1.01 | 0.78 | 0.34 | 16% | 16% | 4.07 |

* See text for definitions

## 3.5 Water Demand Projections

CDM Smith prepared revised demand projections using the following assumptions:

- The serviced population will be as stated in Section 3.3 above. Should Salem eventually undertake significant expansion of its water distribution system into currently-unserved areas, the serviced population may be greater than indicated here, and these projections should be reconsidered.
- The residential per-capita consumption of 52.5 gallons per person per day used in previous versions of the Water System Master Plan will remain constant through 2040.
- Commercial water use will increase proportionally to residential water use.
- The peaking factor will be 2.0.
- The future unmetered water will be 15% of total water production.

The water demand projections based on the above assumptions are shown on Table 3-3. The average day demand is projected to increase to approximately 2.61 MGD in 2040. The maximum day demand is projected to increase to approximately 5.21 MGD in 2040.

**Table 3-3 Population and Water Demand Projections**

| Year | Total Population | Percent Served | Service Population | Average Day Demand (MGD) | Maximum Day Demand (MGD) |
|---|---|---|---|---|---|
| 2018 | 29,554 | 72% | 21,279 | 2.13 | 4.07 |
| 2020 | 29,752 | 72% | 21,421 | 2.34 | 4.69 |
| 2025 | 31,345 | 73% | 22,997 | 2.52 | 5.03 |
| 2030 | 32,011 | 73% | 23,485 | 2.57 | 5.14 |
| 2035 | 32,393 | 73% | 23,766 | 2.60 | 5.20 |
| 2040 | 32,466 | 73% | 23,819 | 2.61 | 5.21 |

# 3.6 Water Conservation and Demand Management

## 3.6.1 Water Audit

The most-recent comprehensive water audit was completed by Wright-Pierce in their "2012 Water Audit Report". The report quantified water production, consumption, and losses in the water system at that time. The report also offered various recommendations on water conservation and demand management. These recommendations, and their page numbers in the 2012 report, were as follows:

- *Meter System Upgrade.* "It is recommended that the Town replace meters with new, accurate meters using current AMR devices and flow measurement technology." (page 14) See Section 3.6.3 below, regarding this program.
- *Leak Detection.* "Contract with an experienced leak survey consultant on a yearly basis until meters are sufficiently upgraded, and then bi-annually after that. Keep detailed records of distribution system leak repairs and estimated flow rate of repaired leaks." (page 2) See Section 3.6.2 below regarding this program.
- *Unmetered Consumption Tracking.* "In order to accurately track the effectiveness of measures implemented by the Town to reduce non-revenue water it is important the unmetered consumption estimates are carefully tracked using consistent methodology." (page 14)
- *Capital Improvement: Distribution System.* "The Town should keep records of water main leaks and breaks as a way to track problem areas." (page 14) The report also stated that such areas should be prioritized for upgrades, and that any bleeds and blowoffs should be eliminated.
- *Future Water Audits.* "Water audits should be conducted every five years in order to track water accountability and provide measurements of effectiveness for loss prevention activities undertaken by the Town." (page 15) This refers to the rigorous, comprehensive type of audit such as in the 2012 report; DPW calculates its unmetered water on an annual

basis also, which provides additional information on effectiveness of its water conservation and demand management measures. See Section 3.6.7 below.

- *Water Treatment Plant (WTP) Flow Meters*. "Hire a qualified instrumentation technician to volumetrically calibrate the raw, finished and carbon dioxide motive water flow meters each year." (page 2) See Section 3.6.7 below.
- *WTP Water Audit.* "Perform a usage audit on the water treatment plant to assess production water efficiency internal to the facility operations." (page 2) See Section 3.6.7 below.

## 3.6.2 Leak Detection

The Town has conducted whole-system or partial-system leak detection surveys for some years. The most recent such survey was a whole-system review performed in 2018 by Arthur Pyburn & Sons Inc. of Lynnfield, Massachusetts. Pyburn detected seven leaks. Their estimated loss rate from these leaks was a range of 23 to 41 gpm, which is 33,000 to 59,000 gpd. Although this number of leaks is not large, the loss rate justifies the continuance of this program from purely an economic point of view.

## 3.6.3 Meter Replacement Program

In the 2008 Water System Master Plan, CDM Smith recommended a consumer meter replacement program, given the age of the meters and the documented problems at the time with meter reading inaccuracy.

**Figure 3-1**
**Salem's residential customers are now equipped with Neptune T-10 meters with electronic registers**

In October 2011, the Town received proposals from vendors for an Advanced Metering Infrastructure (AMI) system, including meters, meter reading devices, a communications network, and a central server to receive and process meter reading data. After review of the five proposals, the Town selected the system offered by Neptune.

In February 2012, the Town received bids for the installation of meters and meter reading devices. The Town awarded the installation contract to Bridgewater WinWater Services.

Installation of the communications network was completed in 2012, and meters were replaced through an annual installation program until completion in 2015. Each installation included a new meter and a new meter reading device, called a Meter Interface Unit (MIU). The MIU is a battery-powered radio transmitter which sends the meter reading and other data to the nearest of several Data Collector Units (DCUs), which in turn transmits the data to the central computer. Most of these MIUs are mounted on the outside of the residences and businesses, to improve radio transmission and also to facilitate replacement of the MIU.

### 3.6.4 Rain Barrel Program and Water Conservation Committee

In 2018, Salem started a rain barrel program to encourage water conservation. The program partners with The Great American Rain Barrel Company of Hyde Park, Massachusetts, to provide discounted rain barrels to residents of Salem. Great American Rain Barrel Company offers rain barrels which are re-purposed food shipping drums at a cost of up to 54% of the full retail price. Once these are installed, they can be used to store roof runoff from downspouts in one or multiple barrels to then be used for watering lawns, gardens, plants and any other non-potable functions. Benefits of this program include reduced water bills for the customer, reduced stormwater runoff and reduced water demand. In its inaugural year of 2018, 85 rain barrels were purchased. Salem is offering the purchasing program again in 2019.

In addition to the rain barrel program, the Town of Salem also has an informal water conservation committee which includes a member of the Board of Selectmen, Town staff (including Roy Sorenson, Director of Municipal Services), and Salem residents. The committee occasionally makes presentations to the Board of Selectmen, and recently helped establish a sustainability club at Salem High School. Some of the key areas the committee focuses on are public awareness of water conservation, lawn and landscape watering, and water supply and treatment processes. Future projects the committee has planned are a social media campaign to educate residents of water conservation issues, and a committee review of irrigation permit and site plan requirements.

### 3.6.5 Customer Meter Testing Ordinance

In 2013, the Town of Salem approved a new article in the municipal code, called Customer Water Meter Testing. The ordinance addresses procedures for two situations:

1. Meter testing requests made by customers
2. Mandatory testing of large commercial meters by customers

The mandatory testing applies only to customers which have meters of 4-inch size or greater. Such customers are to conduct a test on their meter and report the results to the Utilities Manager. If customers do not do so, the Town has the right to engage a meter testing firm and charge the cost to the customer. The first such test by the customer is to take place within four years of either (1) the Town's installation of a new meter through its 2012-2015 meter replacement program, or (2) installation of a meter on a new service, or (3) the prior meter test conducted under this ordinance.

The purpose of this ordinance is to limit the negative effects of customer meter underregistration upon water system operation. Most meters lose accuracy with time and tend to underregister, thereby costing the utility revenue and increasing the utility's unaccounted-for water. This effect can be significant especially on larger meters, which is why regulatory agencies such as the New Hampshire Public Utilities Commission (NHPUC) require utilities under their jurisdiction to test meters at a certain frequency. Salem's water system, like other municipally-owned systems in the state, is not under NHPUC's jurisdiction, but the NHPUC procedures nevertheless provided a framework for the new ordinance. We note that the required testing frequency in the NHPUC

regulations is annually for large meters; during the preparation of the ordinance, Town officials elected to implement a frequency of every four years.

We understand that the ordinance has not yet been enforced. Given that it has now been over four years since the ordinance's adoption, we recommend that the Town proceed with the first round of notices to owners of large commercial meters to proceed with meter testing. This will help control unaccounted-for water over time.

### 3.6.6 Water Rates

The Town's current water rate is $3.55 per hundred cubic feet. The current rate was set in September 2017 and took effect on July 1, 2019, replacing the prior rate of $3.45 per hundred cubic feet.

This flat rate has no minimum amount or service charge. If the Town were interested in considering a more conservation-friendly rate structure, several possibilities have been noted in the past:

- NHDES has previously suggested that Salem consider an inclining-block rate structure, in which the unit cost would increase as water use exceeds certain thresholds.
- Though not in common use in New England, Salem could consider a seasonal-rate structure. This rate structure increases the cost of water during the high-demand season, with the goal of reducing the peak water demand. This rate structure could not formerly have been considered by Salem, but the upgraded water metering system would facilitate its implementation now, if desired.
- Salem could also consider implementing a minimum-bill amount. This rate structure assigns a minimum service charge for each billing period. Some utilities which implement this structure offer a discount for senior citizens. A usage charge is added to the service charge, based on either a flat rate or an inclining-block rate.

### 3.6.7 Future Efforts

Figure 11-2 in Section 11 of this report presents recommended projects for 2020 and beyond. The water conservation and demand management projects listed therein are described below.

#### Water Audit and Master Meter Testing

As it has been more than five years since the last comprehensive water audit, CDM Smith recommends that the Town conduct another. This should follow the procedures outlined in AWWA Manual M-36. During years when no comprehensive water audit is being performed, the Town should continue to perform an annual review of unaccounted-for water to determine changes from prior years.

If the Town wishes to perform a WTP water use audit as part of this effort, then the scope of services for the comprehensive water audit can include the various other raw water and process water meters, to determine the overall plant water use, and compare it to a performance benchmark of 4-5% of the finished water for efficiently-operating surface water treatment plants.

The Town has targeted 2021 for the next water audit, as shown in the CIP chart in Section 11. Depending upon the desired scope of work, the budget for the comprehensive water audit may be $35-45,000.

## Leak Detection and Repair Program

The 2013 Update report and prior documentation recommended that leak detection and repair programs be conducted on an every-other-year cycle. The Town has targeted 2021 for the next survey, as shown in the CIP chart in Section 11. Pyburn's quote for the 2018 survey of the entire water distribution system was $13,200. For the 2021 program, we suggest a planning budget of $15,000.

Following the conclusion of the next leak detection survey, the Town should examine the surveyor's estimated water loss rate and the cost of lost water, to determine whether an annual leak detection and repair program is justified. Several of the New England cities and towns that have examined this issue have determined that annual programs are in their economic interest, while others have not.

## AMI Equipment Replacement Program

Initially during the 2012-2015 meter replacement program, the Meter Interface Units (MIUs) installed in Salem had replaceable batteries. Later in the program, Neptune modified its equipment such that the MIUs did not have replaceable batteries, meaning the entire MIU would need to be replaced when meter reading signals are no longer being transmitted.

**Figure 3-2**
**Eight Neptune Data Collector Units (DCUs) receive meter reading data and transmit the information to Town Hall**

Salem's model R450 MIUs came with a 20-year warranty, which covers the cost of replacement equipment for the first decade. A sliding scale is then utilized for the replacement equipment cost during the second decade. The Town's labor cost for replacements is not covered by the warranty. The model R450 Data Collection Units (DCUs), which receive meter readings and other data from the MIUs and transmit the data to the central computer, were covered by a one-year warranty. Salem has purchased an extended maintenance contract for the DCUs.

We contacted the Neptune representative in May 2019 to inquire about future availability of the model R450 DCUs and MIUs. They indicated the following:

> "Neptune announced the R450 Rack Mount collector last June and will continue to support existing DCUs through June 30, 2023 or as parts are depleted. Salem will also be

> able to obtain replacement R450 MIUs for the foreseeable future as there have not been any announcements to the contrary. R450 batteries are no longer replaceable, however battery packs are still available for the older units that have replaceable batteries."

Salem will need to make arrangements in 2022 and 2023 for continuation of the communications network, due to the conclusion of vendor support in 2023. The CIP chart in Section 11 indicates a potential project involving communications network equipment replacement in those years. Further, as the batteries and MIUs age, their replacement will be a growing need. It is not possible to estimate with any certainty when the frequency of battery/MIU replacement will become a major annual cost, but Neptune's comments above indicate that replacement battery packs and MIUs are expected to continue to be available. For battery/MIU replacement, the CIP chart in Section 11 indicates equipment replacement continuing into 2024 and Phase 2 (2025-2029).

## Meter/AMI System Replacement

The Capital Improvements Plan presented in Section 11 includes four 5-year phases. The replacement of the current meter/AMI system is listed as a Phase 3 project (2030-2034). This corresponds to the period in which most of the MIU warranties expire. Further, many utilities consider residential meter changeout programs on approximately a 20-year frequency, to maintain accuracy of the overall metering system.

Metering and AMI technology has continued to develop in the years since Salem purchased its current system, and will no doubt continue to develop for years to come. As one example, cellular-based AMI systems are now on the market and are being considered with increasing frequency. As the time for system replacement approaches, Salem will need to survey the then-current technologies available on the market to determine what meets the Town's needs best.

# Section 4

# Water Quality and Treatment Review

## 4.1 Relationship to Prior Versions of the Master Plan

In the 2008 Water System Master Plan, Section 4 presented the then-current drinking water regulations, discussed expected upcoming regulations, provided an overview of the Water Treatment Plant's treatment processes, assessed the Town's compliance with the regulations, and offered remarks on various water quality challenges the Town was then facing.

The 2013 update included a series of potential projects that had been developed by Wright-Pierce of Portsmouth, New Hampshire, during their work on the WTP. The two largest projects discussed were: (1) improvements to the WTP waste discharge system (including clarifier flushing and filter wash/rinse cycles) to reduce the waste volume and associated costs of disposal to the Greater Lawrence Sanitary District (GLSD), and (2) an expansion of the WTP clearwell to increase chlorine contact time and improve process control. Several smaller projects were aimed at monitoring and treatment strategies for use of the Arlington Mill Pond supply source.

The Town proceeded with improvements to the waste discharge system, doubling the waste tank holding capacity and increasing the amount of washwater that can be recycled rather than being disposed. The other suggestions were deferred.

The Section 4 discussions in the 2008 and 2013 reports are now outdated, but it was not in the scope of this 2019 review to address those issues. The one item of this nature in the scope of this 2019 update is presented below.

## 4.2 WTP Visit and Proposed Treatment Process and Operations Review

On August 27, 2018, three CDM Smith staff visited the WTP for a meeting and plant walk-through with Town operators. The CDM Smith staff included a senior treatment design engineer, senior operations and maintenance specialist, and the project engineer for this update report as well as other recent assignments with Salem. Town operators reviewed their current concerns about staffing and operation of the WTP.

One concern that was repeatedly raised by Salem during the discussion was the need for optimization of the treatment process. This is especially challenging because of the wide range of influent water quality and the twice-annual switchover between the two surface water supply sources (Canobie Lake and Arlington Mill Pond).

The following is a draft scope of services for the proposed Treatment Process and Operations Review, based on the discussions during the August 2018 visit and also on discussions in subsequent meetings. The primary purpose of this effort would be to conduct an independent review of treatment process operations to develop comments and recommendations on current system operation, treatment practices, clarifier backflushing operations, chemical dosing

strategies, spent filter backwash handling, and plant staffing. The 2013 suggestion of increasing the clearwell volume can be considered during this review.

1. Engineer will provide a senior treatment design engineer and senior O&M specialist to spent two consecutive calendar days to shadow operations staff through daily operations in winter 2020 when Arlington Mill Pond provides the source water, then again in spring/summer 2020 when Canobie Lake provides the source water.

2. Engineer will conduct jar testing of up to two coagulants and one polymer during the second day of each 2-day visit, with the goal of optimizing pretreatment of each water source. Engineer will furnish jar testing equipment and labor, while the Town will provide all chemicals to be tested. Most laboratory analyses will be done by plant staff; Engineer will carry an allowance for analyses that must be done by an offsite laboratory.

3. Engineer will develop recommendations following each on-site deployment. These will include remarks on source water transition, staffing recommendations, and any obvious capital improvements that may be identified during each 2-day onsite review. After the first two-day deployment, a memorandum will be submitted by Engineer to the Town. After the second 2-day deployment, a draft letter report will be submitted by Engineer to the Town.

4. Engineer and the Town will then meet to discuss the draft letter report. Within two weeks of receipt of Town comments, Engineer will submit the final letter report to the Town.


Based on our discussions, this scope does not include an evaluation of the current condition and/or code compliance of the WTP's physical facilities. The Town does not believe this is necessary at this time, indicating that a leaky roof is the only such issue needing attention.

In this report's Capital Improvements Plan (CIP), which is presented in Section 11, the foregoing project is listed as having a 2020 completion date and a planning budget of $55,000.

## 4.3 PFAS Sampling Program

Recently, national attention has been focused on the frequent occurrence of per- and polyfluoroalkyl substances (PFAS) in drinking water supplies. The United States Environmental Protection Agency (EPA) and many state agencies have released Health Advisories for these compounds in drinking water, and some states including New Hampshire are in the process of

developing Maximum Contaminant Levels (MCLs). These MCLs, unlike Health Advisories, are enforceable standards.

On June 28, 2019, the New Hampshire Department of Environmental Services (NHDES) released its proposal to establish MCLs for four specific PFAS compounds as follows:

- Perfluorooctanoic acid (PFOA), 12 parts per trillion (ppt)
- Perfluorooctanesulfonic acid (PFOS), 15 ppt
- Perfluorohexanesulfonic acid (PFHxS), 18 ppt
- Perfluorononanoic acid (PFNA), 11 ppt

At the time of this writing, the new MCLs and sampling requirements have taken effect, but are being challenged in court.

The sampling frequency at public water supply sources is quarterly. Salem has begun its sampling program, and also has received approval from NHDES to test Canobie Lake water and Arlington Mill Pond water only in the periods when those sources are being utilized.

# Section 5

# Analysis of Existing Water Distribution System

## 5.1 Relationship to Prior Versions of the Master Plan

Section 5 of the 2008 Water System Master Plan presented a detailed analysis of the existing water distribution system, including water mains, pumping stations, and storage tanks.

The 2013 Update report revised the 2008 recommendations on the piping system, storage tanks, and cost estimates, based on work that had been accomplished since the 2008 Plan. It was not intended in 2013 (or in 2019) to repeat the 2008 Plan's detailed hydraulics studies of the water system nor its assessment of storage tank volume.

This 2019 report supersedes the discussions about the piping system, storage tanks, and cost estimates, that were presented in the 2008 Plan and 2013 Update.

## 5.2 Piping System Issues

### 5.2.1 Development of Piping System Projects in 2008 Plan and Updates

The 2008 Water Master Plan included lists of known distribution system problems that the Town maintained, and the 2013 Update provided a revision to that list. The Town prioritized those projects into tiers based on project need. Projects were originally identified and evaluated based on the following considerations and criteria:

- **Abandoning old parallel mains**
  Salem has a number of instances where old unlined cast iron pipe was kept in service, even after a newer, larger-diameter main was placed in the same street. In many cases, there are still service connections, hydrants, and/or side street mains connected to the old main instead of the newer one. Unlined cast iron mains can be sources of leakage, breakage, and impaired water quality. Their internal diameter is typically reduced by tuberculation (formation of iron hydroxide deposits), such that their hydraulic capacity may be very limited. In one case, at the Pine Grove Cemetery, Salem operates a bleeder (a continuous flow of water) to control the water quality in a cast iron main. Such mains are candidates to be abandoned, with their service connections, hydrants, and side-street connections switched over to newer mains.

- **Replacing other old mains**
  Salem has other old unlined cast iron pipe which is still in service, but for which there is no parallel newer main. These can be replaced with new mains to eliminate the issues described above that are associated with unlined cast iron mains.

- **Eliminating undersized mains**
  Salem has several 4-inch mains in small residential areas. Mains of this size cannot provide any significant fire flows. Improved service results from replacing these undersized mains.

Typically this is done with an 8-inch main to assure proper residential fire protection, although in some cases a 6-inch main may suffice.

- **Accessibility**
  Some old Salem mains are located in easements and/or at depths that make them almost inaccessible. Water mains should be in public rights-of-way or in dedicated and accessible easements, and should be buried at proper depths, to allow for long-term maintenance. Old mains in this situation can be abandoned and replaced with new mains in proper locations at conventional depths.

- **Looping projects**
  All water systems have some dead-end mains. It is desirable, however, to minimize dead-end mains where possible. Dead-end mains can be associated with water quality deterioration. Looped mains generally improve water quality by providing better circulation, which also boosts available fire flows. Several locations in Salem are candidates for looping projects which would eliminate dead-end mains.

As part of this update, CDM Smith met with the Town of Salem to identify which previously-recommended projects have been completed. The list of piping system improvement projects completed since 2008 is presented in **Table 5-1.** Bearing in mind the criteria listed above and the forthcoming Regional Water Initiative projects in the region, the Town of Salem and CDM Smith identified ten additional projects to be added to the list of piping system improvements. The Town also re-organized projects into three tiers based on current priority. This list is included as **Table 5-2**, which shows the Regional Water Initiative projects separately at the bottom. The locations of the projects are shown on **Figure 5-1**.

In a few cases where projects have been called out to eliminate undersized 4-inch mains, the Town is uncertain about the presence and/or extent of the 4-inch main. Test pit programs are recommended to verify the presence and extent of 4-inch mains in such cases, which are noted in Table 5-2.

### 5.2.2 Updated Costs

Project costs presented in the 2013 Update report used the assumptions and unit cost prices originally presented in the 2008 report, adjusted for inflation to calculate a percentage for adjusting costs to the year 2014. Given the time which has elapsed and the changes in market value of construction and materials, it was determined that CDM Smith would not adjust unit costs presented in previous years and instead re-evaluate the base unit costs for 2020. These unit costs are presented in **Table 5-3** below. The assumptions made when developing these costs are as follows:

- Projects will be contracted out rather than constructed by Town staff.
- 5-foot of cover in paved roadways, with trench paving included.

## Table 5-1
## Piping System Improvements, Completed 2008 - 2019

| Project No.[1] | Street | Location | Problem | Completed Action | Year Completed |
|---|---|---|---|---|---|
| 1-2 | Main St | School St to N Main St | Unlined, redundant, blow off running | Connected 15 services to 16" main, abandon 6" | 2009 |
| 1-3 | North Policy St | Pump Station Rd to St. Mary's Ln | Poor condition, undersized | Replaced with est. 300' of 16" main | 2011 |
| 1-4 | North Policy St | WTP to North Policy St. | Inadequate discharge connections | Installed new 16" WTP discharge to improve reliability in emergency situations | 2015 |
| 1-5 | Hampshire Rd | RR Xing to 300' into Methuen | Unlined, blow off running | Connected customers to Methuen Water Dept, abandoned 6", as part of development | 2014 |
| 1-6 | St. Mary's Ln | N Policy Rd to Old Rockingham Rd | Redundant, 4 mains connected to 1890 12", 9' deep. | Connected 12 services to new mains. Connected new 12" directly to new 16" | 2011 |
| 2-1 | Spencer Ave | at Joyce Heard Ave | No interconnection, poor flow, stagnation | Installed <100' of 6" to connect dead ends | 2010 |
| 2-2 | Haigh Ave | at Streeter Ave | No interconnection, poor flow, stagnation | Installed <100' of 6" to connect dead ends | 2016 |
| 2-3 | Pond St | Lawrence Rd to Sand Hill Rd | Unlined, poor condition, undersized | Replaced existing 6" with 1,600' of new 8" | 2012 |
| 2-6 | Willow St | All | Unlined, poor condition, undersized | Removed and replaced existing 6" with est 350' of 8" | 2012 |
| 3-1 | Main St | N Policy St to Sullivan Ave | Unlined, redundant | Connected 8 services to 12" main, abandoned 6" | 2015 |
| 3-2 | North Policy St | St. Mary's Ln to Veronica Ave. | Poor condition, undersized | Installed 4,400' of 16" main | 2014 |
| 3-3 | Old Rockingham Rd | 12" through back yards | Stagnation, no access to piping through back yards, under decks, etc. | Installed 5 services to main on Old Rockingham Rd | 2015 |
| 3-4 | Old Rockingham Rd | At Therese, at Helen, at Joseph | No interconnection, poor flow, stagnation | Phone duct conflict, needed complicated plan | 2015 |
| 3-5 | Howard St | Charles St to Franklin St | Unlined, poor condition, undersized, needed to replace 1922 cross-country line | Replaced existing lines with est. 675' of 12" main | 2017 |
| 3-6 | Taylor St | Lee Joy Ln to Howard St | Needed to replace 1922 cross-country line, dead ends, improve flow, bypass Depot piping | Installed est. 400' of 12" main | 2012 |
| 3-7 | Cluff Crossing Rd | S Broadway to Lancelot Ct | Unlined, redundant | Connected existing services over to 16" main | 2010 |
| 3-8 | MacLaughlin Ave | North Main St to Oak Ave | Unlined, poor condition, undersized | Removed and replaced existing 6" with est 750 of 8" | 2017 |
| 3-9 | Point A Rd | South Policy St to Fairmont Rd | Unlined, redundant | Connected 2 services to 16" main on S Main St and removed 6" from service | 2016 |
| 4-2 | Old Rockingham Rd | St. Mary's Ln to Range Rd | Poor condition, undersized | Replaced existing main with approx. 3000' of 12" main | 2015 |
| 4-3 | Franklin St | Howard St to Millville St | Unlined, poor condition | Removed and replaced est. 1100' of existing 6" with new 8" | 2010 |
| 4-4 | Pond St | Sand Hill Rd to Copper Beech | Unlined, poor condition, undersized | Removed and replaced existing 4" with est. 1800' of new 8" | 2012 |
| 4-5 | Lawrence Rd | Senter St to S Broadway | Unlined, redundant | Connected 21 3/4" services and 1 4" service to 12" main, abandoned existing 6" | 2012 |
| 4-6 | South Broadway | Lawrence Rd to Mass. Line | Unlined, poor condition, undersized | Removed and replaced existing 6" with est. 700' of new 8" (6, 3/4" services,1, 8" service) | 2010 |
| 4-10 | Geremonty Dr | Main St to Meisner Dr | Dead ends, service interruptions, flows | Installed est 500' of 8" main to connect dead ends | 2011 |
| 4-13 | Fairmont Rd | S Policy St to end | Unlined, poor condition, undersized | Removed and replaced existing 6" with approx. 250' of new 8" | 2017 |
| U-3 | Clifton Ave | Millville St to Dyer Ave | Undersized 4" | Town of Salem investigated and determined size of main is actually 6", no work needed | (2019) |
| U-4 | Crestwood Cir | Green Acre Dr to Marie Ave | Undersized 4" | Replaced 4" main with new 8" | 2017 |
| U-6 | Hampshire Rd | State Border Into Methuen | Undersized 4" | Replaced 4" main with new 8" | 2014 |
| Other-3 | North Policy St | WTP to Old Rockingham Rd | Install redundant line | Installed new 16" main | 2015 |

1. Project numbers are consistent with the 2008 Water Master Plan report and 2013 Five Year Update of the Water System Master Plan .

## Table 5-2
## List of Piping System Improvements

| Project No.[1] | Status | Street | Location | Problem | Required action | Budget[2] |
|---|---|---|---|---|---|---|
| **First Tier - Highest Priority** | | | | | | |
| 1-1[3] | Recommended | North Main St | Main St to Bluff St | Unlined, redundant, blow off running | Connect 40 services to 16" main, abandon 6" | $314,000 |
| 2-4 | Recommended | Spicket Hill Tank | Cross-country | Flow restrictions to storage tank | Install 1,800' of 12" main from tank to Nirvana Dr (needs hydraulic evaluation) | $632,000 |
| 2-5[4] | In Design | South Broadway | 469 S B'way to 300 Lawrence Rd | Unlined, poor condition, cross country | Connect 5- 3/4", 1- 1 1/2", 1- 2" and 1- 8" services over to existing 12" mains | $253,000 |
| Proposed-3[5] | Recommended | Main St | Between Millville St and Lawrence Rd | Lined 1940's or 1950's | Replace lined 10" Main with new 12"; Abandon old 10" pipe between Lawrence Rd and School St and tie over services and hydrants to 16" main | $4,050,000 |
| Proposed-1a[5] | Recommended | N Broadway, Main Street and Cross Country | Broadway between 29 N Broadway and Willow St; Main St from Depot to Pleasant St; and cross-country from N Broadway to Howard St | Replace Lined 1890's pipe and abandon cross country pipe | Replace 12" main with new 12" and abandon 12" Main | Change Order |
| Proposed-1b[5] | Recommended | N Broadway/Old Rockingham Rd | Between Willow St and Catherine Rd | Lined 1890's pipe | Replace 12" main with new 12" | $2,000,000 |
| Proposed-2[5] | Recommended | S Broadway | Between Kelley Rd and south of Cluff Rd Intersection | Unlined 1920's pipe | Replace 12" main with new 12" | $1,728,000 |
| **Second Tier** | | | | | | |
| 4-1 | Recommended | Brady Ave | Cortland to 71 Brady Ave | Unlined, undersized | Replace with est. 3000' of 12" main | $1,053,000 |
| 4-7 | Recommended | Lake St | Millville St to Easy St | Poor condition, undersized | Remove and replace existing 6" with est 2200' of new 12" main | $772,000 |
| 4-8 | Recommended | Veterans Parkway | Senior Center to Freedom Dr (small segment already built) | Dead ends, service interruptions, flows | Install est 1750' of 12" main to connect dead ends | $614,000 |
| 4-9 | Recommended | Geremonty Dr | Court House to Veterans Pkwy | Dead ends, service interruptions, flows | Install est 1000' of 12" main to connect dead ends | $351,000 |
| 4-11 | Recommended | Azarian Rd | to future road connection | Single feed to area, dead end, flow | Require connection as part of subdivision approval of lot 135-8944 as part of future development | Privately Funded |
| 4-12 | Recommended | Stone Post Rd | Jana Rd Connection | Cross country feed | Install est 500' of 8" to connect to Jana, remove cross-country feed from service | $153,000 |
| **Third Tier** | | | | | | |
| U-2 | Recommended | Alexander Ave and Beverly Ave | Beverly Ave to 14 Alexander Ave | Undersized | Replace 4" main with new 8" | $294,000 |
| U-5[7] | Recommended | Green Ave | Haigh Ave to Baron Ave | Undersized | Replace 4" main with new 8" | $187,000 |
| U-7[7] | Recommended | Jennings Rd | N Main St to end | Undersized | Replace 4" main with new 8" as part of future development | $187,000 |
| U-8[7] | Recommended | Linwood Ave | Lawrence Rd to Eleanor St | Undersized | Replace 4" main with new 8" (GIS shows 6") | $670,000 |
| U-9 | Recommended | Ansel St, Messer Ave, and Otis Ave | Baldwin St to Ansel St | Undersized | Replace 4" main with new 8" | $301,000 |
| U-10 | Recommended | Robert Ave | Dawson Ave to Highland Ave | Undersized | Replace 4" main with new 8" | $286,000 |
| U-11 | Recommended | Summer St | Millville St to Morrison Ave | Undersized | Replace 4" main with new 8" | $312,000 |
| Other-1[8] | Recommended | Brookdale Rd/ Cross-Country | Northeastern Blvd to Industrial Way | Connect Manor Parkway high service zone to N Policy St | Install new 12" main | $1,500,000 |
| Proposed-4 | Recommended | Church St | Between Main St and new stub on South Broadway | Dead end on Church St | Replace existing 6" CI on Church St and complete "loop" to S Broadway | $275,000 |
| Proposed-5 | Recommended | Duston Rd | Between Timberwood Rd and Whiteneck Way | Close loop of 12" water main | Install 1200' of 12" water main | $421,000 |
| Proposed-6 | Recommended | Millville St | Between Car Mar Ln and Bluff St | Connect 12" main on Millville St to main on Bluff St (proposed as part of RWI-2) | Install 2000' of 12" water main | $702,000 |
| Proposed-7 | Recommended | Willow St | From Willow St to Main St | Close loop between Willow St to Main St | Install 700' of 8" water main | $214,000 |
| Proposed-8[9] | In Design | West Duston Rd Neighborhood | West of North Policy St | No water service | Install water main, booster station and services | By Others |
| **Regional Water Project (partial NHDES funding to be sought for RWI-1 and RWI-2)** | | | | | | |
| RWI-1[6] | Recommended | Shannon Rd | Colleen Dr to Atkinson, NH | Regional Water Initiative Project Phase I | Install 8" water main | $2,210,000 |
| RWI-2[6] | Recommended | Lake St and Bluff St | Two segments between end of Regional Main and N Main St | Regional Water Initiative Project Phase II | Install 12" water main | $3,980,000 |
| RWI-3 | Recommended | Atkinson Rd | Extend water main to Town Line | Regional Water Initiative Project Phase III | Install 16" water main | $515,000 |

1. Project numbers are consistent with the 2008 Water Master Plan report. Priorities were determined by DPW using the following factors weighted in order:

   1: effect on operating cost
   2: risk of failure and severity of impact on operations
   3: fire flows
   4: water quality
   5: overall customer benefit

2. Budget estimates provided by CDM Smith and in 2020 dollars, unless otherwise noted.
3. Project budget previously provided.
4. Project budget based on bid results from Bid Alternate A from Miscellaneous Water Main Replacements Project. Project changes still being considered.
5. Project budget based on bid results from the South Broadway Sewer, Water & Bridge Improvements Project.
6. Project budget based on budget numbers submitted in 2018 SRF Pre-Application, adjusted for inflation to 2020.
7. Test pit program recommended prior to design (see text).
8. Alternatives analysis recommended prior to design (see text). Budget shown includes placeholder for I-93 bridge crossing.
9. Project is currently pending a feasibility study and final design. Final budget to be determined upon completion of study.

Windham,NH

Pelham,NH

Derry,NH

Atkinson, NH

Haverhill,MA

Methuen,MA

PORCUPINE BROOK

CANOBIE LAKE

SHADOW LAKE

POLICY BROOK

HITTY TITY BROOK

TAYLOR RESERVOIR

HEDGEHOG POND

MILLVILLE POND

ARLINGTON MILL POND

HAWKINS POND

WILSONS POND

PROVIDENCE HILL BROOK

SPICKET RIVER

BODWELL POND

BRIDGE ST BRIDGE

CAPTAINS POND BROOK

CAPTAINS POND

WORLD END BROOK

WORLD END POND

STILLWATER POND

Donigian Well (Abandoned)

Commercial Drive Booster Station

Other-1 New 12" main

Manor Parkway Booster Station

Proposed - 8 New Water Main

Canobie Lake Water Treatment Plant

Other-3

Turner Well (Abandoned)

Proposed - 1b Replace 12"

Proposed - 7 New 8"

Proposed - 1a Replace 12"

Howard Street Standpipe

4-1 Upsize to 12"

Proposed - 4 New 8"

Proposed - 3 Upsize to 12"

Proposed - 6 New 12"

4-12 New 8"

Arlington Mill Pond Raw Water Pumping Station

Proposed - 5 New 12"

RWI - 3 New 16"

RWI - 2 New 12"

4-7 Upsize to 12"

1-1 Abandon 6"

RWI - 1 New 8"

HYD-1 Hydrant Repair in Various Locations

Salem Street Methuen Interconnection

Parallel Main Abandoned

South Broadway Project Complete

4-9 New 12"

4-8 New 12"

4-11 New Connection

Proposed - 2 Replace 12"

Lawrence Road Standpipe

Spicket Hill Tank

Nirvana Drive Booster Station

2-4 New 12"

Hitching Post Lane Methuen Interconnection

Main Street Methuen Interconnection

2-5 Connect services to 12"

3-2 1-4 1-3 3-4 1-6 4-2 3-1 4-13 3-9 3-3 2-6 3-6 U-2 U-11 3-5 4-3 3-7 4-10 U-10 U-7 1-2 3-8 U-4 U-5 U-9 U-8 2-2 2-1 U-6 1-5 4-5 4-6 2-3 4-4

## Legend

- Water Distribution Mains
- Town Boundary
- High Service Zone Boundary
- P — Well (Out of Service)
- PS — Pump Station
- Water Storage Tank
- X-X — Completed Project
- Recommended Upgrade
- 4" Pipe To Be Upsized

Note: Raw water transfer main from Arlington Mill Pond to Water Treatment Plant not shown.

N W E S

0 0.25 0.5 0.75 1 Miles

**Notes:**
1. Existing pipe information based on GIS data provided by the Town of Salem in May 2019
2. The diameters of the 4" pipes recommended to be upsized should be confirmed prior to design.

CDM Smith

# Figure 5-1
## Town of Salem, New Hampshire
## Water Supply and Distribution System
## Recommended Piping System Improvements
## December 2019

- No rock or unsuitable materials.
- Restrained-joint, ductile-iron pipe to be utilized.
- New Hampshire labor rates.
- Hydrant assemblies every 500 feet, mainline or same-size sideline valves every 1,000 feet, and 15 services per 1,000 feet.
- Costs originally based on December 2018 prices and then inflated to estimated 2020 prices (inflation rate of 4%/year), unless otherwise noted.
- Prices include all contractor indirect costs, and a 25% construction contingency.
- Engineering assumed to be by Town staff, thus costs not included.

**Table 5-3 Updated Unit Pipe Costs**

| Pipe Diameter | Unit Cost |
|---|---|
| 8” | $306/ft |
| 10” | $328/ft |
| 12” | $351/ft |
| 16” | $429/ft |

Although the majority of the project budgets were evaluated based on these unit prices, a few alternative methods were used to assign a budget to certain projects:

1. Some projects have been bid under bid alternatives by the Town and never constructed. For those projects an average of the low three bid prices was taken and adjusted for estimated iron tariffs, and escalated to 2020 dollars.
2. There are also projects for which CDM Smith had previously provided budgetary estimates. These were retained and escalated to the year 2020.
3. There are some projects which include significant work on major roads in Salem including Broadway and Main Street. These require scope and construction challenges beyond the assumptions accounted for in the unit cost evaluation above. For developing a budget for those projects, bid results from the South Broadway Sewer, Water and Bridge Improvements Project (bid in February 2018) were used to estimate a unit cost per foot.

Project budgets are included in Table 5-2. Cases where one of these alternative methods was used for developing a budget have been noted in the table.

### 5.2.3 ISO’s 2013-14 Hydrant Testing Program

The most-recent review of Salem’s fire protection capabilities by the Insurance Services Office (ISO) occurred in 2013-14. A copy of ISO’s “Hydrant Flow Test Report” is included in Appendix A.

During this program, ISO established Needed Fire Flow rates for selected buildings at 21 locations in Salem. In a few cases, they considered more than one building at a given location. Working with the Town, they conducted fire flow tests to determine the available hydrant flow, at a residual pressure of 20 psi at the hydrant location. ISO conducts these tests for the purpose of guiding property insurance rates, but the data are also useful to water system operators and planners.

Out of the 21 locations, there were only three where the available fire flow was less than the Needed Fire Flow. Each of these three is discussed below:

- Test No. 5 (Industrial Way at Commercial Drive). The fire flow deficiency in this area was addressed by the upgrade of the Manor Parkway Booster Pumping Station and the construction of the new Commercial Drive Booster Pumping Station. These projects were cited in Section 2 of this report.

- Test No. 11 (Sand Hill Road at Pond Street). The need for a project to address the fire flow deficiency at this location was identified in the original 2008 Water System Master Plan and again in the 2013 Update report. The project was Project 2-3, located in Pond Street. This work, and also the adjacent Project 4-4 in Pond Street, are now complete, addressing the deficiency.

- Test No. 14 (Geremonty Drive at the High School). The need for work to remedy this deficiency was identified in the original 2008 Water System Master Plan and again in the 2013 Update report. The project numbers were Projects 4-8 and 4-9. This work continues to be carried in this 2019 Update report as a future project.

Therefore, out of the 21 locations tested by ISO in 2013, the current status is that only one location (the High School) has available fire flow that is less than the Needed Fire Flow.

### 5.2.4 Low-Pressure Area Near Canobie Lake

The 2008 Plan indicated that the Salem water system can generally provide adequate pressures to consumers located in areas up to 235 feet elevation above mean sea level. One area of Salem which is at a higher elevation than that is near Canobie Lake, as was shown in the 2008 Plan's Figure 6-1 (copy included in Appendix B herein). It includes portions of Brookdale Road, Northeastern Boulevard, Canobie Avenue, North Policy Street, and several smaller adjacent roads. Low-pressure complaints are received from customers in this area periodically. ISO has not included this area in their hydrant flow test surveys but, if they did, it may be shown that the water system could not supply the Needed Fire Flow with adequate pressures at all locations.

The 2008 Plan envisioned that part of a solution to this issue would be to extend the existing Manor Parkway high service zone to the area of concern. The concept was to construct a new 12-inch main in an easement on private property from Industrial Way north to Brookdale Road, then northeast in Brookdale Road to its intersection with Northeastern Boulevard. This route includes a crossing of Interstate 93 on an existing bridge. Brookdale Road, its side streets, and part of Northeastern Boulevard would then become part of the high service area. This project continues to be carried in this 2019 Update.

The existing 16-inch main in North Policy Street must, however, remain part of the main service zone. Therefore, a full solution to the low-pressure concerns would also need to include a parallel main in North Policy Street's high-elevation area, assuming enough space exists in the street for this. A plan would need to be developed for closing existing valves and possibly installing new valves, to convert parts of the North Policy Street area to the extended high service zone.

Other alternative approaches could be investigated prior to final selection of an approach to implementation:

- The existing dead-end 12-inch main at the Manor Parkway cul-de-sac could be extended through private property to Brookdale Road, instead of the route cited above which begins on Industrial Way.
- The feasibility and cost of a trenchless crossing under Interstate 93 could be evaluated. This would allow a connection of the existing main at the Manor Parkway cul-de-sac to the existing main in Northeastern Boulevard.
- Construction of a new booster pumping station and high service zone, or multiple such facilities, could be considered instead of extending the existing high service zone. Any such station(s) and service zone(s) would be located east of Interstate 93, eliminating the need of a bridge crossing or trenchless crossing.
- The benefits of a new storage tank for the high service zone could also be considered.

An alternatives assessment, including modeling of fire flows and pressures in the area of concern, would determine the advantages, disadvantages and costs of the various alternatives. The Town could then select and implement the preferred alternative. This alternatives assessment would need to be scoped, budgeted, and added to the CIP in Section 11 should the Town wish to consider this.

As a step toward solving this area's issues, the Town is proceeding with the concept of designing and constructing a new water main and booster pumping station on West Duston Road to increase pressures to customers located on that and adjacent streets. As of this writing, a feasibility study is being performed and the water main is being designed. Booster station design, and facilities construction, will follow.

## 5.3 Condition of Water Tanks

### 5.3.1 Lawrence Road Tank

The Lawrence Road Tank, a welded steel standpipe, was inspected most recently by Utility Service Company Inc. (USCI) on August 6, 2018. Their report's recommendations were as follows:

- "The protective coatings along both the exterior and interior surfaces of the tank are in generally very good condition with at least 95% of the respective surfaces still being afforded sound protection… It is anticipated, however that currently active corrosion particularly along the shell interior surfaces may progress to an actionable level over the next 3-4 years. Therefore, in order to prevent any significant furtherance in metal loss of

already exposed substrate surfaces, it is recommended that the subject tank be re-inspected in 2020 in order to reassess prevailing conditions at that time for possible scheduling of at least spot maintenance to the interior surfaces currently exhibiting active corrosion, particularly along the shell interior surfaces and the mixing system support brackets."

**Figure 5-2**
**Finial vent atop the Lawrence Road Tank (photo by USCI)**

- "The roof of the tank is equipped with a finial vent assembly comprised of a 24" stub with (4) vertical standoffs which support a raised, slightly domed cap which allows for a large open venting area susceptible to wind driven rain. The venting area between the stub and cap is screened with a ¼" mesh galvanized screen which is not tightly fitted and is bent and torn at the base of the stub. As a minimum, consideration should be given to replacing the existing screening with a stainless-steel screen properly fitted and banded into place. Consideration should also be given to possibly welding a vertical leg to the outer perimeter of the finial cap so as to properly shroud the venting area against wind driven raid or replacing the entire vent assembly with a new freeze/vacuum resistant vent assembly to ensure full compliance with current standards."

- "There is no longer a functional fall prevention device on the exterior access ladder. Consideration should be given to re-installing a new flexible cable fall prevention device at least up the vertical leg of the access ladder to the top of the shell."

CDM Smith spoke with Scott Kelley, who authored the inspection report, to obtain a budget for the recommended work. For the upcoming inspection, he provided the following three options:

- Visual inspection -- $1,000
- ROV inspection -- $3,700
- Washout inspection with cleaning & disinfection (drained tank, no chemical added) -- $4,500

The Town could perform the two recommended repairs at the time of the inspection, or instead could plan to do them the year after the inspection at which time any needed maintenance noted during the inspection could also be addressed. The Town decided to schedule the inspection for 2021 and the repairs for 2022. The budget figure for a new vent and fall protection device is $10,900 in 2019 dollars. The 2021 inspection and 2022 repair of currently-known items appear in the Capital Improvement Plan (CIP) in Section 11 – see Figure 11-2. These two repair items can be addressed while the tank remains in service.

### 5.3.2 Howard Road Tank

Rehabilitation of the steel standpipe on Howard Road was completed in late 2016. Comprehensive inspections are recommended in AWWA Standard G200 to be conducted every 3-to-5 years. For the purpose of this Master Plan, and considering all the system needs, the Town assigned this tank's next inspection to the year 2022. As shown on the CIP schedule chart later in this report (Figure 11-2), this inspection could be coordinated with the work on the Lawrence Road Tank.

### 5.3.3 Spicket Hill Tank

The Spicket Hill Tank, a concrete reservoir constructed in 1998, was inspected most recently by USCI on August 7, 2018.

Their report's recommendations were as follows:

- The exterior and interior surfaces were in good condition. The tank should be re-inspected after 5 years, in 2023. USCI noted that the tank floor "could not be thoroughly inspected due to a uniform layer of sediment covering the entire floor". For the 2023 inspection, they suggested that "consideration should be given to draining the tank in order to remove all existing sediment and possibly chemically cleaning the shell walls in order to perform a thorough inspection of all surfaces".

- USCI found that the vent screen had become partially detached. They secured it temporarily with wire and duct tape. They recommended that the "screening should be replaced with a new stainless-steel screen permanently attached to the stub of the vent utilizing stainless-steel banding clamps. The retention bolts which secure the vent in place should also be sealed with an elastomeric caulking to prevent any further corrosion of the bolts." USCI later took care of this repair.

- "There is no safety rail enclosing the roof hatch. Consideration should be given to installing at least a section of OSHA approved guardrail along the outer edge of the roof hatch to allow for a secure point to tie off a temporary access ladder and ensure safe utilization of the roof hatch."

- "There is also an antenna tower located within close proximity to the tank shell which could allow for easy access to the tank roof by unauthorized personnel. Consideration should be given to enclosing the lower section of antenna within a secure secondary fenced enclosure or installing anti-climb plates along the tower itself."

**Figure 5-3**
**Roof hatch atop the Spicket Hill Tank**
**(photo by USCI)**

For roof-related repairs including not only the safety rail but also some additional fall prevention improvements, USCI provided a budgetary figure of $20,000 in 2019 dollars. They recommended working with the antenna owner and/or cellular

carrier to address the security of the access to the tank roof, which they felt should be paid for by the carrier, not the Town. If the Town concurs that there is a significant security risk here, this work can be considered.

CDM Smith suggests that any desired repairs be performed in the same timeframe as the repairs for the Lawrence Road Tank. As shown on the CIP schedule chart later in this report (Figure 11-2), this work is therefore slotted for performance in 2022. These repair items can be addressed while the tank remains in service.

## 5.4 Note on WTP Pumping Capacity

The 2008 and 2013 reports carried a recommendation for augmenting the raw water and finished water pumping capacities for the Canobie Lake WTP. The reason for this was as follows. The raw and finished water pumping stations each have three 2-mgd pumps. Ideally, with redundancy needs in mind, it should be assumed that one of the three pumps is out of service on the day of the water system's maximum demand. Thus, the WTP would be able to produce 4 mgd in this situation. That is not enough to meet the current maximum day demand, hence the prior recommendation to augment raw and finished water pumping capacity.

This work was not pursued by the Town. The need for such work has been reconsidered herein, and the Town and CDM Smith have decided not to carry this recommendation forward. The Regional Water Project (see Section 8.4 of this report) will represent an independent source of water supply to the Salem water system. The eventual capacity of this source for Salem will be 1.5 mgd. With that and the existing pumping capacities for the Canobie Lake WTP, Salem will be able to meet its maximum day demand throughout the planning period of this report.

# Section 6

# Alternatives for System Expansion

## Relationship to Prior Versions of the Master Plan

In the 2008 Water System Master Plan, Section 6 discussed two different alternatives for future expansion of the water system into currently-unserved areas of North Salem and the southwestern portion of town. Figures 6-2 and 6-3 in that report presented water system layout and pipe sizing information for those two alternatives. Reduced-size copies of those figures are included in Appendix B herein for reference.

The Town did not request updates to Section 6 in the 2013 or 2019 Water System Master Plan update reports.

Nevertheless, we note here that the Regional Water Project will include new mains near the Atkinson line, some with diameters differing from those shown in the 2008 Plan. The Regional Water Project is discussed later herein – see Section 8.4 and also Appendix B, which includes mapping showing the locations and sizing of Regional Water Project mains near the Atkinson line.

# Section 7

# Operation and Maintenance Practices

## 7.1 Relationship to Prior Versions of the Master Plan

In the 2008 Water System Master Plan, Section 7 described the Town's operations and maintenance practices for the water distribution system. These maintenance practices included water main flushing, valve exercising, hydrant replacement, storage tank inspection, and more.

The Town did not request updates to this section in either the 2013 or 2019 Water System Master Plan Update reports, except for the following description of a proposed maintenance building which supplements the 2008 Plan.

## 7.2 Maintenance Building at the Water Treatment Plant

As part of the Town's plan for the next five years, the need for a maintenance building at the Canobie Lake Water Treatment Plant (WTP) has been identified.

In the past, the Utilities Division had used the DPW site and building on Cross Street for vehicle and equipment storage. In recent years, however, those assets have been moved to the Water Treatment Plant. Vehicles, and materials such as hydrants, are stored outside at the plant. Portions of the existing treatment plant complex including the boiler room and the raw water pumping station are currently used for tool storage and for Utilities Division workspaces such as a meter workshop.

The proposed maintenance building will provide space to park three Utilities Division vehicles, storage racking, and workbenches, to house equipment and tools and provide a workspace for staff. This will remove Utilities Division storage from the WTP itself and improve overall housekeeping at the treatment plant site.

The proposed building would be constructed on the property of the Water Treatment Plant at 161 North Policy Street, and be located west of the existing building and driveway as shown on **Figure 7-1**. The proposed slab-on-grade building would have approximate dimensions of 60-feet by 50-feet. It would be constructed of steel framing and aluminum siding with three motorized overhead garage doors. The building's electrical system would be tied into that of the WTP, to take advantage of the plant's standby power system.

We estimate a planning-level total project cost of $3 million for the design and construction of this building in the years 2022 and 2023. In addition to the construction cost, this figure includes an allowance for engineering and a 25% contingency. We suggest that the first step should be a preliminary design report. This would include site survey, geotechnical borings, permitting, a workshop to develop consensus among all stakeholders regarding the programming of the space in the proposed building, a building footprint and site plan, and a cost estimate based on the foregoing information.


CDM Smith

**Legend**

Proposed Building

Parcels

W N S E

0 25 50 100 Feet

Salem, New Hampshire
Water System Master Plan Update
Proposed Maintenance Building
Figure 7-1
July 2019

# Section 8

# Supply Source Issues

## 8.1 Relationship to Prior Versions of the Master Plan

This section of the 2019 Update supersedes that in the 2013 Update. It supplements the version in the 2008 Water System Master Plan.

## 8.2 Abandonment of Former Municipal Wells

Salem formerly operated the Donigian and Turner Wells as municipal water supply sources. Due primarily to the poor groundwater quality and the high anticipated cost of treatment, the Town determined to abandon both supply sources.

**Figure 8-1 The Turner Well Station in 2012.**

Both supply sources were located on privately-owned property. The water rights and the Turner Well Station facilities (Figure 8-1) were transferred to the landowner in late 2012. Similarly, the Donigian Wells and Station were turned over to their landowner in 2014-15. The landowner intended to utilize the Donigian Wells as supply sources for a nearby age-restricted residential housing subdivision.

## 8.3 Salem/Methuen Interconnection Review

In 2017, CDM Smith performed a Phase 1 Evaluation of the Salem/Methuen water system interconnections. A Technical Memorandum presenting the evaluation was submitted in October 2017, and the final version was issued on March 26, 2018. This work was fully funded by the New Hampshire Department of Environmental Services (NHDES).

These interconnections are for emergency use only. Use of the interconnections has been governed by documents developed by the two municipalities in 1985. These documents were included in Appendices D and E of the 2008 Water System Master Plan. Before the 2017 study, however, no hydraulic evaluation of the interconnections had ever been performed.

Available hydraulic models for the two water systems were combined into a single, comprehensive model of the Salem/Methuen system. Simulations of interconnection performance were prepared and discussed in the Technical Memorandum. Three interconnection locations, and three different interconnection flow rates selected by Salem, were utilized for the evaluation. For all three flow rates, the intent was to isolate a portion of the Salem system such that those customers would receive Methuen water, rather than a mix of Salem and Methuen water which could be problematic because of the differences in water quality and treatment procedures. This evaluation served as a screening tool. Several alternatives were

determined to be infeasible or undesirable, while others were determined to be more promising. Specific issues to be evaluated in a Phase 2 project were identified.

CDM Smith prepared a detailed proposal for a Phase 2 evaluation, which was intended to address the remaining hydraulic issues, determine the conceptual design of a booster pumping station, prepare cost estimates, and determine a recommended project to facilitate emergency use. The proposal was dated August 15, 2018, and was accepted by both municipalities. The anticipated NHDES funding for Phase 2 was, however, withdrawn; Town funding would be necessary for this project to proceed.

Salem and CDM Smith both believe there is value in pursuing the proposed Phase 2 work. Should there be a major problem at the Canobie Lake WTP which would require its shutdown for a period of more than a few hours, Salem would likely need to purchase Methuen water during the emergency, even after the Regional Water Initiative (see below) is fully operating. Therefore, the Phase 2 evaluation project is being carried in the Capital Improvement Plan presented in Section 11 of this 2019 Update.

**Figure 8-2 The underground Salem Street booster station is one of the Salem/Methuen interconnections evaluated.**

## 8.4 NHDES Regional Water Project

### 8.4.1 Phase 1 and Phase 2 of the Project

On March 12, 2019, the voters of Salem overwhelmingly approved an appropriation of $5,355,000 to purchase drinking water rights of 1.5 MGD from Manchester Water Works (MWW) through the upcoming Southern New Hampshire Regional Water Project. Of the 4,030 votes cast on this warrant article, 76.6% were in favor, readily surpassing the 60% required for passage. Salem will thus become a party to the Joint Public Works Agreement (JPWA) which will govern this project.

The planned facilities for Phase 1 of this project are shown on a map in Appendix B. The map was prepared by Weston & Sampson for NHDES in January 2018. The centerpiece of the plan is a new 20-inch water main extending south on Route 28 through Derry and Windham to the Salem town line. Water would then be wheeled through the existing Salem water distribution system to the Atkinson town line, where a pumping station and additional water mains would facilitate delivery of water to the Hampstead Area Water Company (HAWC). HAWC in turn would wheel some of the received water to Plaistow.

The Phase 1 improvements are planned to be completed in mid-2020. NHDES is funding the $27,000,000 cost from the Drinking Water and Groundwater Trust Fund (DWGTF). The project will deliver up to 0.8 MGD to the Salem line, of which 0.3 MGD would be utilized in Salem and the rest be conveyed to the downstream water systems (HAWC and Plaistow) participating in the JPWA.

Additional water will be available to Salem when Phase 2 of the project is completed. The centerpiece of Phase 2 will be a new MWW Water Treatment Plant with a capacity of

approximately 7 MGD, located in Hooksett on the west side of the Merrimack River. The WTP is scheduled to be completed in fall 2022. At that time, the Regional Water Project will deliver up to 2.82 MGD to the Salem town line. Of that amount, 1.5 MGD is designated to Salem and 1.32 MGD to the downstream water systems.

### 8.4.2 Potential Improvements in Reliability and Redundancy of Salem System

The successful and continuous wheeling of water through the Salem system to HAWC will be dependent upon the integrity of that portion of the Salem water system. There are places where the water being wheeled must pass through a single water main rather than a looped system. This means that Salem's delivery of water to the downstream systems is more vulnerable to disruption than it would be with a looped system. To improve the reliability and redundancy of the water distribution system to meet customer needs in the HAWC and Plaistow service areas, as well as Salem's own customers along the route, Salem and CDM Smith developed two alternative projects for submission to NHDES in June 2018 for consideration for DWGTF funding participation. The two projects were:

1. Approximately 7,000 feet of 8-inch main in Shannon Road.
2. Approximately 10,300 feet of 12-inch main in Lake Street and Bluff Street.

Appendix B includes the following maps which were included in the Town's DWGTF submission:

- A map of the Salem water system showing the proposed routes for the two redundancy-related improvements. The base map was the 2013 Update's version of the overall Salem water system map. It is readily apparent from inspecting this map how the cited improvements would provide looping for more-reliable service, and would eliminate a number of dead-end water main situations.
- Two maps that were developed in the 2008 Water System Master Plan, wherein we presented two alternative means of planning for large-scale expansion of the Salem water system in future decades, into currently-unserved areas. Those figures (Nos. 6-2 and 6-3) show which size mains would have been considered along the routes, absent the Regional Water Project.

These two projects were not selected by the DWGTF for implementation in 2018-19. NHDES stated that the projects had merit, but that they would not provide sufficient immediate benefit to be considered. NHDES recommended that Salem consider resubmitting these projects in a future year when the projects would provide immediate benefit to the goals of the Regional Water Project, possibly coordinating the Salem projects with the timing of Phase 2 of the Regional Water Project. We recommend contacting DWGTF personnel in midsummer 2019 to discuss the potential timing of an application, because the next application deadline for DWGTF funding is September 13, 2019.

These projects are included in the Capital Improvement Plan presented in Section 11 of this 2019 Update.

### 8.4.3 Superseded Projects

The Regional Water Project has superseded a number of other alternatives Salem considered in past years for increasing its available water supply capacity. Among those former alternatives were the following:

- Treatment of the two prior groundwater sources mentioned above (now abandoned).
- Development of one or more new groundwater sources.
- Pumping Arlington Mill Pond water into Canobie Lake for storage for later use, instead of the current practice of pumping Arlington Mill Pond water directly to the Canobie Lake WTP.
- Seeking the purchase of Methuen water on a permanent, non-emergency basis.

There appears to be no need for Salem to consider these or any other capacity increase alternatives at this time.

# Section 9
# Organizational Evaluation

## 9.1 Relationship to Prior Versions of the Master Plan

In the 2008 Water System Master Plan, Section 9 presented an evaluation of the Salem Utilities Division organization, including its structure, management systems and overall work environment. The Town did not request updates to this section in either the 2013 or 2019 Water System Master Plan Update reports, except for the following discussion of water utility staffing levels, which supplements the 2008 Plan.

## 9.2 Staffing Levels for Water System Operations

The Utilities Division requested a brief review of Salem's water system operations staffing level. The purpose was to better understand whether Salem's water system staffing level is or is not generally comparable to that of other public water systems in New Hampshire. One way to do this is to obtain information on the population served per staff person for each system, and compare these values.

### 9.2.1 Salem Utilities Division

The current organizational chart of the Salem Utilities Division is presented in Figure 9-1. As shown, the Division has a Utilities Director in charge of twelve other staff. There are four staffing categories: Distribution (Foreman plus three staff), Treatment (Foreman plus two staff), Meters (Foreman plus three staff), and a Chemist, giving a total roster of 13.

Four of the 13 persons, however, have responsibility for the wastewater collection system in addition to their water system duties. The Utilities Director and the three Treatment personnel are approximately 70% dedicated to the water system and 30% to the wastewater collection system. Therefore, the total number of full-time equivalent (FTE) staff for the water system is 11.8.

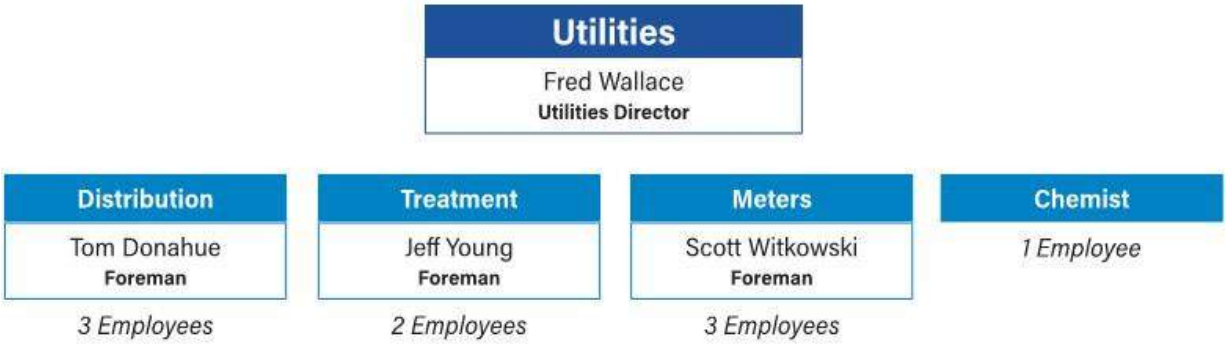



**Figure 9.1**
**Staffing Chart for Salem Water Department Operations**

## 9.2.2 Comparable New Hampshire Municipal Water Systems

Information on the serviced population of New Hampshire water systems is available on the NHDES One-Stop Database. In the specific case of Salem, however, the serviced population was taken as 21,350, which is the average of the 2018 and 2020 values given in Section 3, Table 3-3, rather than using the NHDES figure.

CDM Smith pared down the NHDES list by considering only the following water systems:

1. Those systems which have a serviced population in the 8,000 to 50,000 range.
2. Those systems which are municipally-owned and operated, as opposed to privately-owned or operated.
3. Those water systems in municipalities that also have wastewater collection systems, as does Salem.

Water systems which met all three criteria were considered to be "comparable" to Salem, for the purpose of this review. **Table 9-1** presents the comparable systems. As shown, there are 15 such systems including Salem, which ranks as the sixth largest system on the list.

**Table 9-1 Water Systems Comparable to Salem's**

| Rank | City/Town | Population Served by Water System | Population 2010 US Census |
|---|---|---|---|
| 1 | Concord | 44,000 | 43,019 |
| 2 | Portsmouth | 33,000 | 21,796 |
| 3 | Dover | 28,000 | 31,398 |
| 4 | Rochester | 25,000 | 30,797 |
| 5 | Keene | 25,000 | 22,949 |
| 6 | **Salem** | **21,350** | **29,046** |
| 7 | Laconia | 20,500 | 16,464 |
| 8 | Durham | 16,000 | 16,523 |
| 9 | Exeter | 12,000 | 15,082 |
| 10 | Somersworth | 12,000 | 11,900 |
| 11 | Lebanon | 10,050 | 13,522 |
| 12 | Milford | 9,500 | 15,449 |
| 13 | Berlin | 9,500 | 10,225 |
| 14 | Claremont | 9,000 | 12,982 |
| 15 | Hanover | 8,500 | 11,485 |

## 9.2.3 Comparison of Staffing Levels

Department of Municipal Services personnel then attempted to contact representatives of the other 14 water systems on the list. The purpose of the contacts was to obtain, if possible, the following:

1. An organizational chart which included water system personnel.

2. Whether or not the water/sewer staff include a billing department.

3. If the municipality has a wastewater treatment plant, the number of staff dedicated to that operation. (The intent would be to subtract such staff from the total, to compare to Salem.)

4. Typical operational hours the system's water treatment plant runs, and whether some shifts are unmanned.

One way to compare staff size across a wide variety of system sizes is to normalize the data by creating a "population served per water employee" parameter. Systems which have low values of this parameter have proportionally larger staff sizes than comparable systems. Systems which have high values of this parameter have proportionally smaller staff sizes and thus, it could be argued, are being expected "to do more with fewer resources".

Most of the municipalities contacted have not yet responded as of the time of this writing, and some which did respond did not provide all of the key information. For those municipalities providing usable information, Table 9-2 shows the serviced population, the total number of water department staff, and the serviced population per staff member.

**Table 9-2 Serviced Population per Water Department Staff**

| City/Town | Population Served by Water System | Water Dept. Staff | Serviced Population per Water Dept. Staff | Notes |
|---|---|---|---|---|
| Concord | 44,000 | | | Information not yet received |
| Portsmouth | 33,000 | 29.25 | 1,128 | |
| Dover | 28,000 | 15 | >1,866 | Need more info to assign split between water and sewer |
| Rochester | 25,000 | | | Information not yet received |
| Keene | 25,000 | | | Information not yet received |
| **Salem** | **21,350** | 11.8 | 1,809 | |
| Laconia | 20,500 | 17 | 1,206 | |
| Durham | 16,000 | | | Information not yet received |
| Exeter | 12,000 | | | Information not yet received |
| Somersworth | 12,000 | | | Information not yet received |
| Milford | 9,500 | | | Information not yet received |
| Berlin | 9,500 | | | Information not yet received |
| Claremont | 9,000 | | | Information not yet received |
| Hanover | 8,500 | 4 | >2,125 | Need more info to assign split between water and sewer |

An estimate of the "serviced population per staff member" parameter can be made for Portsmouth, Salem, and Laconia. As shown, Portsmouth and Laconia are both in the 1,100-1,200 persons per staff member range, while Salem has about 1,800 persons per staff member, indicating that Salem has proportionally the smallest staff of the three.

Some information, however, was also available from Dover and Hanover. Though there was not enough information to separate out the wastewater responsibilities from the water system responsibilities, we can nevertheless state that the parameter value is higher than the values shown in the table for those two systems. Both values are higher than Salem's.

Thus, Salem is the median of the five systems which have provided information. With such a limited data set, however, it is difficult to draw conclusions. If more data could be obtained from some of the other systems in the table, a clearer comparison of Salem's staffing level compared to other New Hampshire municipalities may emerge.

# Section 10

# Financial Management Evaluation

## Relationship to Prior Versions of the Master Plan

In the 2008 Water System Master Plan, Section 10 discussed various aspects of financial management of the water system. The Town did not request updates to this section in the 2013 or 2019 Water System Master Plan update reports.

# Section 11

# Capital Improvement Planning

## 11.1 Relationship to Prior Versions of the Master Plan

This section supersedes the versions of Section 11 in the 2008 Water System Master Plan and the 2013 Update report.

## 11.2 Introduction

This Water System Master Plan update has re-evaluated many of the recommendations from the prior reports, as discussed in the previous sections. The primary purpose of this section is to collect and summarize recommendations regarding facilities and infrastructure and include them in a single section for the Town's future reference.

This section reviews issues related to the integration of water system work with other Town efforts, such as the roadway improvements program. We offer suggestions on the prioritization of the various improvements to the existing water system that were presented in Section 5 and group the projects in 5-year phases.

## 11.3 Integration of Water System Work with Other Town Projects


Salem provided CDM Smith with the most recent five-year Capital Improvements Plan (2019 to 2024) and the ten-year road plan (2020 to 2029). The annual budgeting cycle and these planning documents provide opportunities for integration of the needed water system work into the Town's overall financial planning. We offer the following remarks on this process:

- The Town's 2019-2024 Capital Improvement Plan (CIP) was issued in September 2018. Several water-related projects appear in the town-wide CIP. These include: (1) the Regional Water Project, (2) water mains in Duston Road, Shannon Road, Lake Street, and Bluff Street, (3) a new maintenance building at the WTP, and (4) placeholders for other Water Master Plan projects.
- The ten-year road plan includes numerous roadway projects which will be constructed in areas that also have water system needs. Combining utility projects into a single coordinated program typically results in cost savings for the community, and should be done whenever possible. The Town has expressed a preference for constructing water system projects the year before any scheduled roadway improvements. This schedule allows time for any issues, such as settling, to be resolved prior to paving.

- As demonstrated in this update, any utility plan needs to be re-evaluated after some time. Some projects will have been completed, others deferred, and issues will arise that could not have been anticipated in the prior plan. In the short term, this can be done fairly simply. Issues and ideas can be noted throughout the year on hard copies or e-copies of the key maps and tables in this document, and then reviewed as part of the annual coordination process. In the long term, Town officials may opt for formal updates. Some utilities follow a 15-year cycle for major updates of utility master plans. This cycle includes updates at 5-year intervals, such as this update. If Salem wishes to continue to follow this philosophy, then the Town should prepare a major update or new Master Plan in five years.

To facilitate the coordination process, CDM Smith has reviewed the current town-wide CIP and roadway improvement plan and created **Figure 11-1**, which overlays the recommended water system improvements from Section 5 with the Town's ten-year road plan.

## 11.4 Prioritizing Improvements to the Existing Distribution System

Table 5-2 presented DPW's prioritized list of improvements to the existing distribution system. As in the 2008 and 2013 reports, this Section 11 reprioritizes Table 5-2 based on other work scheduled in the Town.

In developing the reprioritization, we considered the following factors:

- As in the prior versions of the Master Plan, four phases are considered, as follows:

  Phase 1 – 2020 through 2024
  Phase 2 – 2025 through 2029
  Phase 3 – 2030 through 2034
  Phase 4 – 2035 through 2039

- As shown on Figure 11-1, a number of projects on the DPW list correspond to roadway projects that are included in the Town's ten-year road plan. The roadway projects already have an assigned date, and where possible that date was held for the purpose of this Water System Master Plan update. Such water projects were slotted into the appropriate phase based on the road project's date, commonly for the year before the scheduled road work.

- Similarly, the timing of water projects carried in the Town's current CIP were adjusted in some cases based on information that became available after its September 2018 issuance.

- As was the case with the 2013 Update report, no specific projects have been assigned to Phase 4. All of the specific, already-identified projects are grouped into Phases 1 through 3.

The resulting reprioritization of Table 5-2 is shown on **Table 11-1**.

**Notes:**
1. Existing pipe information based on GIS data provided by the Town of Salem in May 2019
2. The diameters of the 4" pipes recommended to be upsized should be confirmed prior to design.
3. Paving based on Town's 10-year road plan (2020 through 2029) submitted November 2019
4. Other projects besides piping improvements are also planned, and are listed in Figure 11-2.

Pelham,NH

Windham,NH

Derry,NH

Atkinson, NH

Haverhill,MA

Methuen,MA

PORCUPINE BROOK

CANOBIE LAKE

SHADOW LAKE

POLICY BROOK

HITTY TITY BROOK

TAYLOR RESERVOIR

HEDGEHOG POND

MILLVILLE POND

ARLINGTON MILL POND

WILSONS POND

HAWKINS POND

PROVIDENCE HILL BROOK

WIDOW HARRIS BROOK

SPICKET RIVER

BODWELL POND

BRIDGE ST BRIDGE

CAPTAINS POND BROOK

CAPTAINS POND

WORLD END BROOK

WORLD END POND

STILLWATER POND

Donigian Well (Abandoned)

Commercial Drive Booster Station

Other-1 New 12" main

Proposed - 8 New Water Main

Canobie Lake Water Treatment Plant

Manor Parkway Booster Station

Turner Well (Abandoned)

4-1 Upsize to 12"

Proposed - 1b Replace 12"

Proposed - 7 New 8"

Proposed - 1a Replace 12"

Howard Street Standpipe

U-2

U-11

Proposed - 4 New 8"

RWI - 2 New 12"

4-7 Upsize to 12"

Proposed - 6 New 12"

4-12 New 8"

Proposed - 3 Upsize to 12"

Arlington Mill Pond Raw Water Pumping Station

Proposed - 5 New 12"

RWI - 3 New 16"

U-7

U-10

4-9 New 12"

1-1 Abandon 6"

Salem Street Methuen Interconnection

4-8 New 12"

4-11 New Connection

U-5

Proposed - 2 Replace 12"

Lawrence Road Standpipe

U-9

U-8

RWI - 1 New 8"

Spicket Hill Tank

HYD-1 Hydrant Repair in Various Locations

2-5 Connect services to 12"

Nirvana Drive Booster Station

2-4 New 12"

Hitching Post Lane Methuen Interconnection

Main Street Methuen Interconnection

## Legend

- Water Distribution Mains
- Town Boundary
- High Service Zone Boundary
- Well (Out of Service)
- Pump Station
- Water Storage Tank
- Recommended Upgrade
- 4" Pipe To Be Upsized

Note: Raw water transfer main from Arlington Mill Pond to Water Treatment Plant not shown.

## Paving Year

| ProgramYear | |
|---|---|
| 2020 | 2026 |
| 2021 | 2027 |
| 2022 | 2028 |
| 2023 | 2029 |
| 2024 | 2025 |

N W E S

0 0.25 0.5 0.75 1 Miles

CDM Smith

Figure 11-1
Town of Salem, New Hampshire
Recommended Piping System Improvements and Paving Plan
December 2019

## Table 11-1
## Reprioritized List of Water System Improvements

| | Year | Project | Street | Location | Required Action | Project Cost |
|---|---|---|---|---|---|---|
| Phase 1 (2020-2024) | 2020 | 2-5 | South Broadway | 469 S B'way to 300 Lawrence Rd | Connect services over to existing 12" mains | $253,000 |
| | 2020 | Proposed-1a | N Broadway, Main Street and Cross Country | Broadway between 29 N Broadway and Willow St; Main St from Depot to Pleasant St; and cross-country from N Broadway to Howard St | Replace 12" main with new 12" and abandon 12" cross country main | Change Order |
| | 2020 | Proposed-8 | West Duston Rd Neighborhood | West of North Policy St | Install water main, booster station and services | By Others |
| | 2021 | U-2 | Alexander Ave and Beverly Ave | Beverly Ave to 14 Alexander Ave | Replace 4" main with new 8" | $294,000 |
| | 2021 | RWI-3 | Atkinson Rd | Extend water main to Town Line | Install 16" water main | $515,000 |
| | 2021 | Proposed-5 | Duston Rd | Timberwoods Dr to Whiteneck Way | Install 12" water main | $421,000 |
| | 2022 | 1-1 | North Main St | Main St to Bluff St | Connect 40 services to 16" main, abandon 6" | $314,000 |
| | 2022/ 2023 | Proposed-3 (2022 design, 2023 const.) | Main St | Between Millville St and Lawrence Rd | Replace lined 10" main with new 12"; Abandon old 10" pipe between Lawrence Rd and School St and tie over hydrants to 16" main | $4,050,000 |
| | 2023 | RWI-1 | Shannon Rd | Colleen Dr to Atkinson, NH | Install 8" water main | $2,210,000 |
| | 2023 | Proposed-4 | Church St | Between Main St and new stub on South Broadway | Replace existing 6" CI on Church Street and complete "loop" to S Broadway | $275,000 |
| | 2023 | Proposed-7 | Willow St | From Willow St to Main St | Install 700' of 8" water main | $214,000 |
| | 2024 | RWI-2 | Lake St and Bluff St | Two segments between end of Regional Main and N Main St | Install 12" water main | $3,980,000 |
| | | | | | **Phase 1 Subtotal:** | **$12,526,000** |
| Phase 2 (2025-2029) | 2025 | Proposed-6 | Millville St | Near Car Mar Ln to Bluff St | Install 12" water main | $702,000 |
| | 2026 | Proposed-1b | N Broadway/Old Rockingham Rd | Between Willow St and Catherine Rd | Replace 12" main with new 12" | $2,000,000 |
| | 2026 | Proposed-2 | S Broadway | Between Kelley Rd and south of Cluff Rd Intersection | Replace 12" main with new 12" | $1,728,000 |
| | 2027 | 4-11 | Azarian Rd | to future road connection | Require connection as part of subdivision approval of lot 135-8944 as part of future development | Privately Funded |
| | 2027 | U-11 | Summer St | Millville St to Morrison Ave | Replace 4" main with new 8" | $312,000 |
| | 2028 | U-10 | Robert Ave | Dawson Ave to Highland Ave | Replace 4" main with new 8" | $286,000 |
| | 2029 | 2-4 | Spicket Hill Tank | Cross-country | Install 1,800' of 12" main from tank to Nirvana Dr. (needs hydraulic evaluation) | $632,000 |
| | 2029 | 4-1 | Brady Ave | Cortland Dr to 71 Brady Ave | Replace with est. 3000' of 12" main | $1,053,000 |
| | | | | | **Phase 2 Subtotal:** | **$6,713,000** |
| Phase 3 (2030-2034) | 2030 | 4-7 | Lake St | Millville St to Easy St | Remove and replace existing 6" with est 2200' of new 12" main | $772,000 |
| | 2030 | 4-8 | Veterans Parkway | Senior Center to Freedom Dr (small segment already built) | Install est 1750' of 12" main to connect dead ends | $614,000 |
| | 2030 | 4-9 | Geremonty Dr | Court House to Veterans Pkwy | Install est 1000' of 12" main to connect dead ends | $351,000 |
| | 2031 | 4-12 | Stone Post Rd | Jana Rd Connection | Install est 500' of 8" to connect to Jana, remove cross-country feed from service | $153,000 |
| | 2031 | Other-1 | Brookdale Rd/Cross-Country | Northeastern Blvd to Industrial Way | Install new 12" main (see text, section 5.2.4) | $1,500,000 |
| | 2032 | U-5* | Green Ave | Haigh Ave to Baron Ave | Replace 4" main with new 8" | $187,000 |
| | 2032 | U-7* | Jennings Rd | N Main St to end | Replace 4" main with new 8" as part of future development | $187,000 |
| | 2033 | U-8* | Linwood Ave | Lawrence Rd to Eleanor St | Replace 4" main with new 8" | $670,000 |
| | 2033 | U-9 | Ansel St, Messer Ave, and Otis Ave | Baldwin St to Ansel St | Replace 4" main with new 8" | $301,000 |
| | | | | | **Phase 3 Subtotal:** | **$4,735,000** |

* Test pit program recommended prior to design (see text, Section 5.2.1)

# 11.5 Water System Capital Improvement Program

**Figure 11-2** presents a one-page summary of the overall water system capital improvement program. All facility-related recommendations are listed on this summary figure, and the report section in which they are discussed is identified on the figure. The program elements are grouped into six major categories, as shown on the left-hand side of Figure 11-2.

## Water Conservation and Demand Management

Four items discussed in Section 3 are placed on the CIP chart, Figure 11-2, in the timeframes cited in Section 3. They are as follows:

- The water audit report. As noted in Section 3, we recommend that a detailed water audit be performed on a 5-year cycle, with annual tracking during the other years. The Town determined to slot the next detailed audit as a 2021 project on Figure 11-2.
- Leak detection surveys. The timing of the next such survey is to be coordinated with the 2021 water audit, as discussed in Section 3. In Figure 11-2, we show these surveys taking place every other year. The Town can adjust this frequency either up or down over time, based on a review of the amount of leakage discovered, the cost of the lost water, and the cost of the survey.
- The need for replacement of batteries for the water metering system's Meter Interface Units (MIUs), or of the MIUs themselves, will become more frequent as the equipment ages, as described in Section 3. We expect that some time in Phase 2, as shown on Figure 11-2, battery-related failures will grow enough in frequency to become a line item in the Utilities Division budget.
- During Phase 3 (2030-2034), the entire water metering system will have passed its warrantee period and design life. Therefore, a major upgrade or entirely-new water metering system should be anticipated.

## Supply Sources

These projects include the following:

- The water treatment plant process review was discussed in Section 4. As stated there, this is a 2020 project.
- The redundancy improvements related to the Regional Water Plan discussed in Section 8.4 are slotted for 2022-2023.
- The new maintenance building at the WTP discussed in Section 7 is slotted for 2022-2023.
- The next phase of the evaluation of an upgrade to the Salem/Methuen emergency interconnection discussed in Section 8.4 is slotted for 2024. Construction would occur in Phase 2 (2025-2029).

## Storage Tanks

As discussed in Section 5.3, comprehensive storage tank inspections should be performed every 5 years, or more often if either preferred by the Town or recommended by the inspector. The next inspections of each of the three tanks, and the planned repairs to the Lawrence Road tank, have been assigned on Figure 11-2 to the years cited in Section 5.3.

## Improvements to Existing Distribution System

Routine valve and hydrant maintenance programs are listed first, and should be performed on an annual basis. The distribution system improvements from Section 11.4 above are grouped in Figure 11-2 by Phase; the specific projects and budgets were listed on Table 11-1.

## Expansion of the Distribution System

The degree, nature, and timing of system expansion into North Salem or southwest Salem as described in Section 6 of the 2008 report is subject to future policy decisions by the Town. Since the direction and schedule of such efforts over the next 20 years cannot be detailed at this time, Figure 11-2 simply displays the possibility that such efforts could occur in any or all of the four phases. However, the Town should consider system expansion as it pursues its road program. Before constructing any work on roads near the distribution system that do not have water service, the Town should consider whether to coordinate the work with water system expansion.

## Water System Master Plan

As mentioned in Section 1.4, we recommend that a major update or new Water System Master Plan be prepared in five years, completing the previously-discussed 15-year planning cycle. Figure 11-2 shows this work in 2024 as a "New Plan", followed in later Phases by 5-year updates.

We note that there are several model-related issues that could be addressed in the 2024 Plan, if they are not addressed earlier. These include the following:

- The Town has several versions of its water distribution system model that remain in use after being created for past programs. We suggest the Town designate a single version as the "official" version, and also designate a Town employee as the "keeper of the model". The official version, and no other, would then be utilized in future projects.
- The keeper of the model would also be responsible for periodic updates to the model. We suggest a brief annual review to keep the official version up to date with respect to new or replacement water system facilities.
- Section 5.2.4 of this report discussed the potential use of the model to develop a comprehensive solution to the low-pressure problems near Canobie Lake.

| | Report Section Reference[1] | Phase 1 | | | | | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|---|---|---|---|---|
| | | 2020 | 2021 | 2022 | 2023 | 2024 | 2025-2029 | 2030-2034 | 2034-2039 |
| **WATER CONSERVATION/DEMAND MANAGEMENT** | | | | | | | | | |
| • Water Audit Report per AWWA Procedures | 3.6 | | (Detailed) | | | | (Annual tracking with a detailed water audit report every 5 years) | | |
| • Leak Detection and Repair | 3.6 | | | | | | (Leak detection program every two years) | | |
| • AMI Equipment Replacement | 3.6 | | | | | | | | |
| • Meter/AMI System Replacement | 3.6 | | | | | | | | |
| **SUPPLY SOURCES** | | | | | | | | | |
| • Water Treatment Process Review | 4.2 | | | | | | | | |
| • Phase 1 of the Regional Water Plan (Rt. 28 Water Main) | 8.4 | | | | | | | | |
| • Phase 2 of the Regional Water Plan (MWW WTP) | 8.4 | | | | | | | | |
| • New Maintenance Building at WTP, Design and Construction | 7.2 | | | | | | | | |
| • Salem/Methuen Emergency Interconnection, Phase 2 Evaluation | 8.3 | | | | | | | | |
| • Salem/Methuen Emergency Interconnection, Design and Construction | 8.3 | | | | | | | | |
| **STORAGE TANKS** | | | | | | | | | |
| • Howard Street Standpipe, Comprehensive Exterior and Interior Inspection | 5.3 | | | Inspect | | | (Consider needs based on inspections) | | |
| • Lawrence Road Standpipe, Comprehensive Exterior and Interior Inspection | 5.3 | | Inspect | Repair | | | (Consider needs based on inspections) | | |
| • Spicket Hill Tank, Comprehensive Exterior and Interior Inspection | 5.3 | | | Repair | | Inspect | (Consider needs based on inspections) | | |
| **DISTRIBUTION SYSTEM -- EXISTING** | | | | | | | | | |
| • Valve Maintenance | 7.3* | | | | | | (Annually) | (Annually) | (Annually) |
| • Hydrant Maintenance | 7.4* | | | | | | (Annually) | (Annually) | (Annually) |
| • Phase 1 Improvements (see Table 11-1) | 5.2/11.4 | | | | | | | | |
| • Phase 2 Improvements (see Table 11-1) | 5.2/11.4 | | | | | | | | |
| • Phase 3 Improvements (see Table 11-1) | 5.2/11.4 | | | | | | | | |
| **DISTRIBUTION SYSTEM -- EXPANSION[2]** | | | | | | | | | |
| • Phase 1 Expansion | 6.4* | | | | | | | | |
| • Phase 2 Expansion | 6.4* | | | | | | | | |
| • Phase 3 Expansion | 6.4* | | | | | | | | |
| • Phase 4 Expansion | 6.4* | | | | | | | | |
| **WATER SYSTEM MASTER PLAN** | 1.4 | | | | | New Plan | 5-Year Update | 5-Year Update | New Plan |

* An asterisk designates a report section in the original 2008 Master Plan.

**Notes:**

1. See Section 11.5 of text for discussion of the overall program.
2. See Figures 6-2 and 6-3 of 2008 report for maps showing improvements. Reduced-size copies are in Appendix B of this Update report.

**Figure 11-2**
**Summary of Capital Improvements Program Planning**

# Appendices

## Appendix A – 2013-14 ISO Hydrant Flow Test Report

## Appendix B – Miscellaneous Maps

- Proposed Regional Water System Improvements Phase I, prepared by Weston & Sampson, January 2018.
- Salem Reliability Improvements for the Southern New Hampshire Regional Water Initiative, DWSRF/DWGTF Pre-Applications, June 2018.
- Figure 6-1 from the 2008 Water System Master Plan, Areas of High Elevation/Low Water Pressure, June 2008.
- Figure 6-2 from the 2008 Water System Master Plan, Areas of Recommended System Improvements using Multiple North High Service Zones, June 2008.
- Figure 6-3 from the 2008 Water System Master Plan, Areas of Recommended System Improvements using Consolidated North High Service Zone, June 2008.

# Appendix A

# 2013-14 ISO Hydrant Flow Test Report

Note: This excerpt of the overall ISO report includes the cover letter (dated February 24, 2014) and the 2013 hydrant flow test data.

4 B Eves Drive, Suite 200
P.O. Box 961
Marlton, NJ 08053-3112

t 856.985.5600
f 856.810.9065

February 24, 2014

Mr. Keith Hickey, Manager
Salem
33 Geremonty Drvie
Salem, NH 03079

RE: Salem, Rockingham County, NH
Public Protection Classification 3/9
Effective Date: June 1, 2014

Dear Mr. Keith Hickey:

We wish to thank you, Mr. Kevin Breen, and Mr. Frank Giordano for your cooperation during our recent Public Protection Classification (PPC) survey. ISO has completed its analysis of the structural fire suppression delivery system provided in your community. The resulting classification is indicated above.

Enclosed is a summary of the ISO analysis of your fire suppression services. If you would like to know more about your community's PPC classification, or if you would like to learn about the potential effect of proposed changes to your fire suppression delivery system, please call us at the phone number listed below.

ISO's Public Protection Classification Program (PPC) plays an important role in the underwriting process at insurance companies. In fact, most U.S. insurers – including the largest ones – use PPC information as part of their decision- making when deciding what business to write, coverage's to offer or prices to charge for personal or commercial property insurance.

Each insurance company independently determines the premiums it charges its policyholders. The way an insurer uses ISO's information on public fire protection may depend on several things – the company's fire-loss experience, ratemaking methodology, underwriting guidelines, and its marketing strategy.

PPC is important to communities and fire departments as well. Communities whose PPC improves may get lower insurance prices. PPC also provides fire departments with a valuable benchmark, and is used by many departments as a valuable tool when planning, budgeting and justifying fire protection improvements.

ISO appreciates the high level of cooperation extended by local officials during the entire PPC survey process. The community protection baseline information gathered by ISO is an essential

foundation upon which determination of the relative level of fire protection is made using the Fire Suppression Rating Schedule.

The classification is a direct result of the information gathered, and is dependent on the resource levels devoted to fire protection in existence at the time of survey. Material changes in those resources that occur after the survey is completed may affect the classification. Although ISO maintains a pro-active process to keep baseline information as current as possible, in the event of changes please call us at 1-800-444-4554, option 2 to expedite the update activity.

ISO is the leading supplier of data and analytics for the property/casualty insurance industry. Most insurers use PPC classifications for underwriting and calculating premiums for residential, commercial and industrial properties. The PPC program is not intended to analyze all aspects of a comprehensive structural fire suppression delivery system program. It is not for purposes of determining compliance with any state or local law, nor is it for making loss prevention or life safety recommendations.

If you have any questions about your classification, please let us know.

Sincerely,

*Dominic Santanna*

Dominic Santanna
(800) 444-4554 Option 2

CM

Encl.

cc: Mr. Kevin Breen, Chief, Salem Fire Department
Mr. Frank Giordano, Water Superintendent, Salem Water Dept
Mr. Ernest Petrin, Director, Concord Fire Alarm

INSURANCE SERVICES OFFICE, INC.

# HYDRANT FLOW DATA SUMMARY

City Salem

County Rockingham State NEW HAMPSHIRE (28) Witnessed by: Insurance Services Office

Date: Oct 30, 2013

| TEST NO. | 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 | | Main St @ Broadway | Salem Water Dept, Main | 2780 | 0 | 0 | 2780 | 92 | 86 | 6000 | 10600 | | |
| 1-A | | Main St @ Broadway | Salem Water Dept, Main | 2780 | 0 | 0 | 2780 | 92 | 86 | 2500 | 10600 | | |
| 10 | | Cross Street | Salem Water Dept, Main | 1450 | 0 | 0 | 1450 | 95 | 84 | 2000 | 4100 | | |
| 11 | | Sand Hill Rd @! Pond St | Salem Water Dept, Main | 920 | 0 | 0 | 920 | 76 | 54 | 3000 | 1500 | | |
| 12 | | School St @ Stone Pond Rd | Salem Water Dept, Main | 1380 | 0 | 0 | 1380 | 90 | 84 | 3000 | 5200 | | |
| 13 | | Main St @ Henderson Cir. | Salem Water Dept, Main | 1300 | 0 | 0 | 1300 | 80 | 76 | 4000 | 5600 | | |
| 13-A | | Main St @ Henderson Cir. | Salem Water Dept, Main | 1300 | 0 | 0 | 1300 | 80 | 76 | 2000 | 5600 | | |
| 14 | | Geremonty Dr @ High School | Salem Water Dept, Main | 1350 | 0 | 0 | 1350 | 80 | 73 | 5000 | 4300 | | |
| 14-A | | Geremonty Dr @ High School | Salem Water Dept, Main | 1350 | 0 | 0 | 1350 | 80 | 73 | 2250 | 4300 | | |
| 15 | | S.Policy St @ Raymond St | Salem Water Dept, Main | 1520 | 0 | 0 | 1520 | 85 | 78 | 2000 | 5100 | | |
| 16 | | Main St @ Hampstead Rd | Salem Water Dept, Main | 1190 | 0 | 0 | 1190 | 66 | 65 | 2250 | 9400 | | |

THE 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 CONDITION.

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

*Comm = Commercial; Res = Residential.

**Needed 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 Suppression Rating Schedule.

*** (A)-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.

INSURANCE SERVICES OFFICE, INC.

# HYDRANT FLOW DATA SUMMARY

City Salem

County Rockingham State NEW HAMPSHIRE (28) Witnessed by: Insurance Services Office Date: Oct 30, 2013

| TEST NO. | TYPE DIST.* | TEST LOCATION | SERVICE | FLOW - GPM | | | | PRESSURE PSI | | FLOW -AT 20 PSI | | REMARKS*** | MODEL TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | INDIVIDUAL HYDRANTS | | | TOTAL | STATIC | RESID. | NEEDED ** | AVAIL. | | |
| 17 | | Wells Ave @ McLanghlin Ave | Salem Water Dept, Main | 1190 | 0 | 0 | 1190 | 89 | 38 | 750 | 1400 | | |
| 18 | | Dustin Rd @ Atkison Rd | Salem Water Dept, Main | 1470 | 0 | 0 | 1470 | 81 | 77 | 750 | 6400 | | |
| 19 | | Cole St @ Shepard Ave | Salem Water Dept, Main | 1140 | 0 | 0 | 1140 | 90 | 71 | 750 | 2300 | | |
| 2 | | Old Rockingham Rd @ Joseph Rd | Salem Water Dept, Main | 1060 | 0 | 0 | 1060 | 74 | 72 | 5500 | 6300 | | |
| 2-A | | Old Rockingham Rd @ Joseph Rd | Salem Water Dept, Main | 1060 | 0 | 0 | 1060 | 74 | 72 | 3500 | 6300 | | |
| 20 | | Lawrence Rd @ Linwood Ave | Salem Water Dept, Main | 920 | 0 | 0 | 920 | 100 | 48 | 750 | 1200 | | |
| 21 | | Northeastern Blvd. @ N.Policy | Salem Water Dept, Main | 1260 | 0 | 0 | 1260 | 73 | 70 | 4000 | 5900 | | |
| 21-A | | Northeastern Blvd. @ N.Policy | Salem Water Dept, Main | 1260 | 0 | 0 | 1260 | 73 | 70 | 2250 | 5900 | | |
| 3 | | N.Policy St @ Webster St | Salem Water Dept, Main | 1690 | 0 | 0 | 1690 | 50 | 48 | 4500 | 7300 | | |
| 3-A | | N.Policy St @ Webster St | Salem Water Dept, Main | 1690 | 0 | 0 | 1690 | 50 | 48 | 3000 | 7300 | | |
| 4 | | Pelham Rd @ Stiles Rd | Salem Water Dept, Main | 1300 | 0 | 0 | 1300 | 79 | 70 | 3500 | 3600 | | |
| 5 | | Industial Way @ Commercial Dr | Salem Water Dept, Main | 1300 | 0 | 0 | 1300 | 70 | 50 | 3500 | 2100 | | |
| 6 | | Lowell Rd @ Delaware Dr | Salem Water Dept, Main | 1400 | 0 | 0 | 1400 | 88 | 86 | 2250 | 9400 | | |
| 7 | | S.Broadway @ Cliffs Crossing | Salem Water Dept, Main | 2780 | 0 | 0 | 2780 | 95 | 91 | 5500 | 13500 | | |

THE 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 CONDITION.

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

*Comm = Commercial; Res = Residential.

**Needed 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 Suppression Rating Schedule.

*** (A)-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.

INSURANCE SERVICES OFFICE, INC.

# HYDRANT FLOW DATA SUMMARY

City Salem

County Rockingham State NEW HAMPSHIRE (28) Witnessed by: Insurance Services Office

Date: Oct 30, 2013

| TEST NO. | TYPE DIST.* | TEST LOCATION | SERVICE | FLOW - GPM | | | | PRESSURE PSI | | FLOW -AT 20 PSI | | REMARKS*** | MODEL TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | INDIVIDUAL HYDRANTS | | | TOTAL | STATIC | RESID. | NEEDED ** | AVAIL. | | |
| 7-A | | S. Broadway @ Cliffs Crossing | Salem Water Dept, Main | 2780 | 0 | 0 | 2780 | 95 | 91 | 3500 | 13500 | | |
| 8 | | Pleasant St @ Rock. Park Mall | Salem Water Dept, Main | 1400 | 0 | 0 | 1400 | 87 | 84 | 6000 | 7500 | | |
| 8-A | | Pleasant St @ Rock. Park Mall | Salem Water Dept, Main | 1400 | 0 | 0 | 1400 | 87 | 84 | 3500 | 7500 | | |
| 9 | | S.Broadway @ Cumo Dr | Salem Water Dept, Main | 1440 | 0 | 0 | 1440 | 92 | 86 | 4000 | 5500 | | |
| 9-A | | S.Broadway @ Cumo Dr | Salem Water Dept, Main | 1440 | 0 | 0 | 1440 | 92 | 86 | 3500 | 5500 | | |

THE 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 CONDITION.

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

*Comm = Commercial; Res = Residential.

**Needed 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 Suppression Rating Schedule.

*** (A)-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

# Miscellaneous Maps

- Proposed Regional Water System Improvements Phase I, prepared by Weston & Sampson, January 2018.
- Salem Reliability Improvements for the Southern New Hampshire Regional Water Initiative, DWSRF/DWGTF Pre-Applications, June 2018.
- Figure 6-1 from the 2008 Water System Master Plan, Areas of High Elevation/Low Water Pressure, June 2008.
- Figure 6-2 from the 2008 Water System Master Plan, Areas of Recommended System Improvements using Multiple North High Service Zones, June 2008.
- Figure 6-3 from the 2008 Water System Master Plan, Areas of Recommended System Improvements using Consolidated North High Service Zone, June 2008.

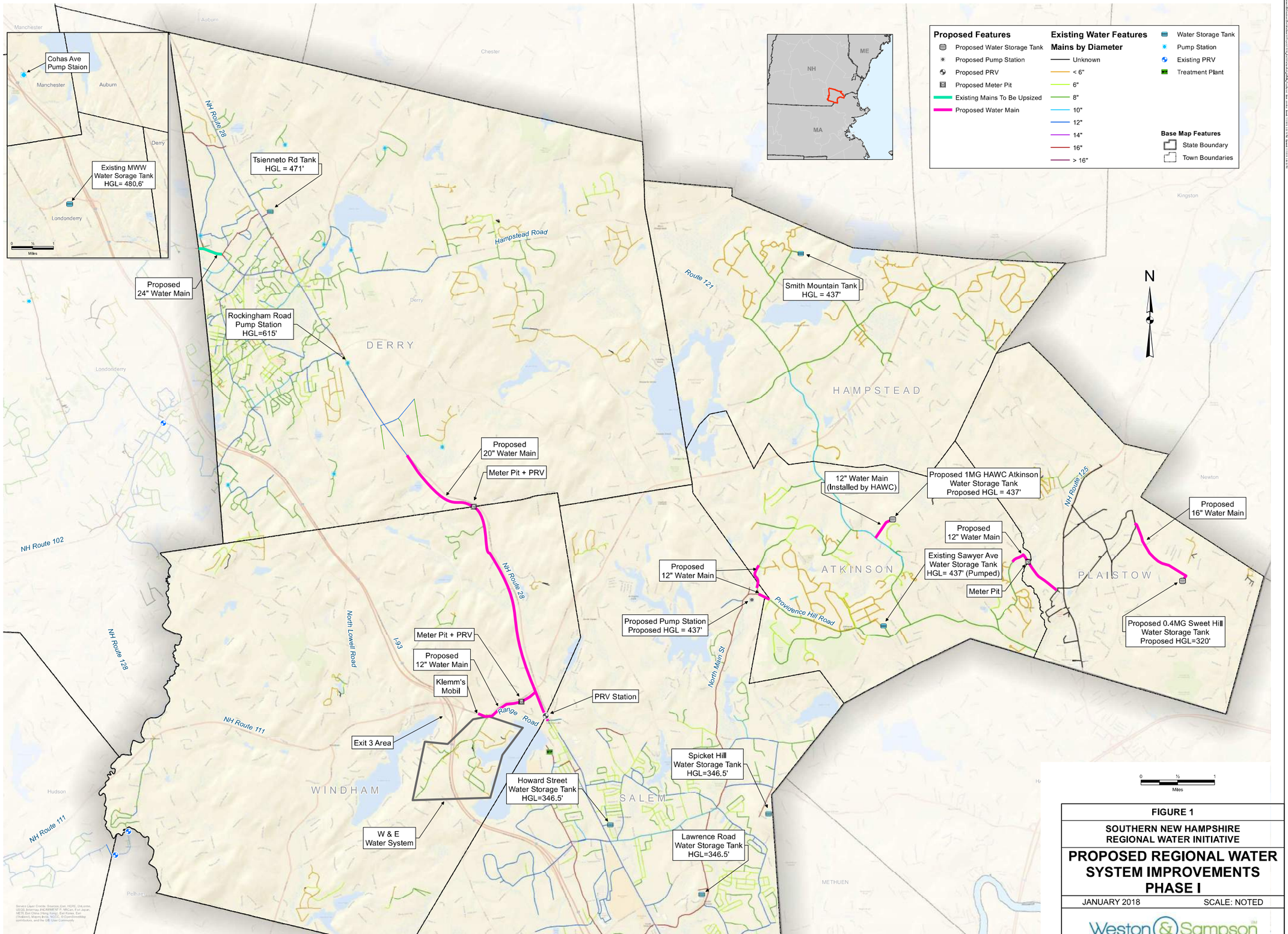


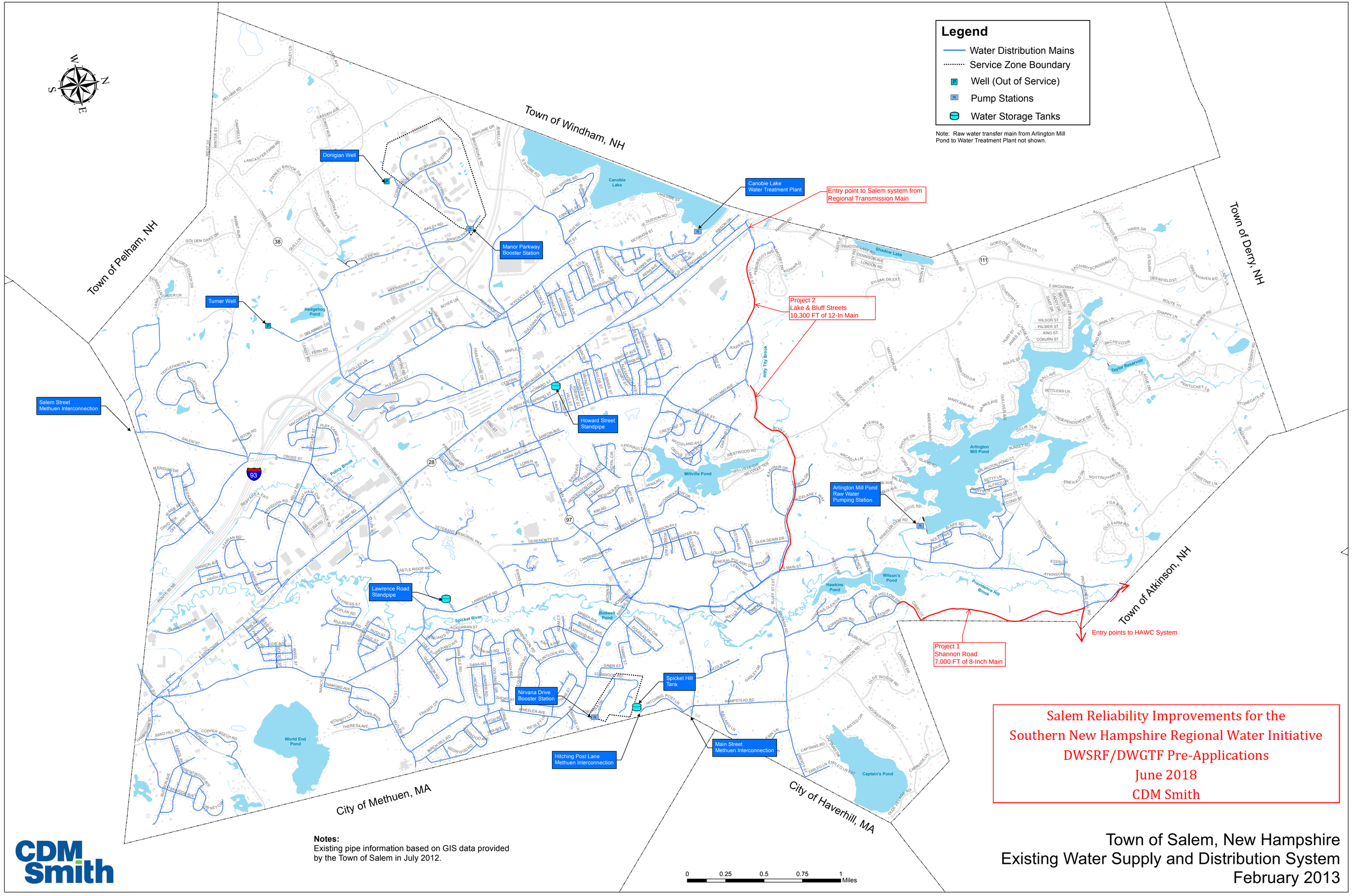

**FIGURE 1**

**SOUTHERN NEW HAMPSHIRE REGIONAL WATER INITIATIVE**

# PROPOSED REGIONAL WATER SYSTEM IMPROVEMENTS PHASE I

JANUARY 2018 SCALE: NOTED

Weston & Sampson

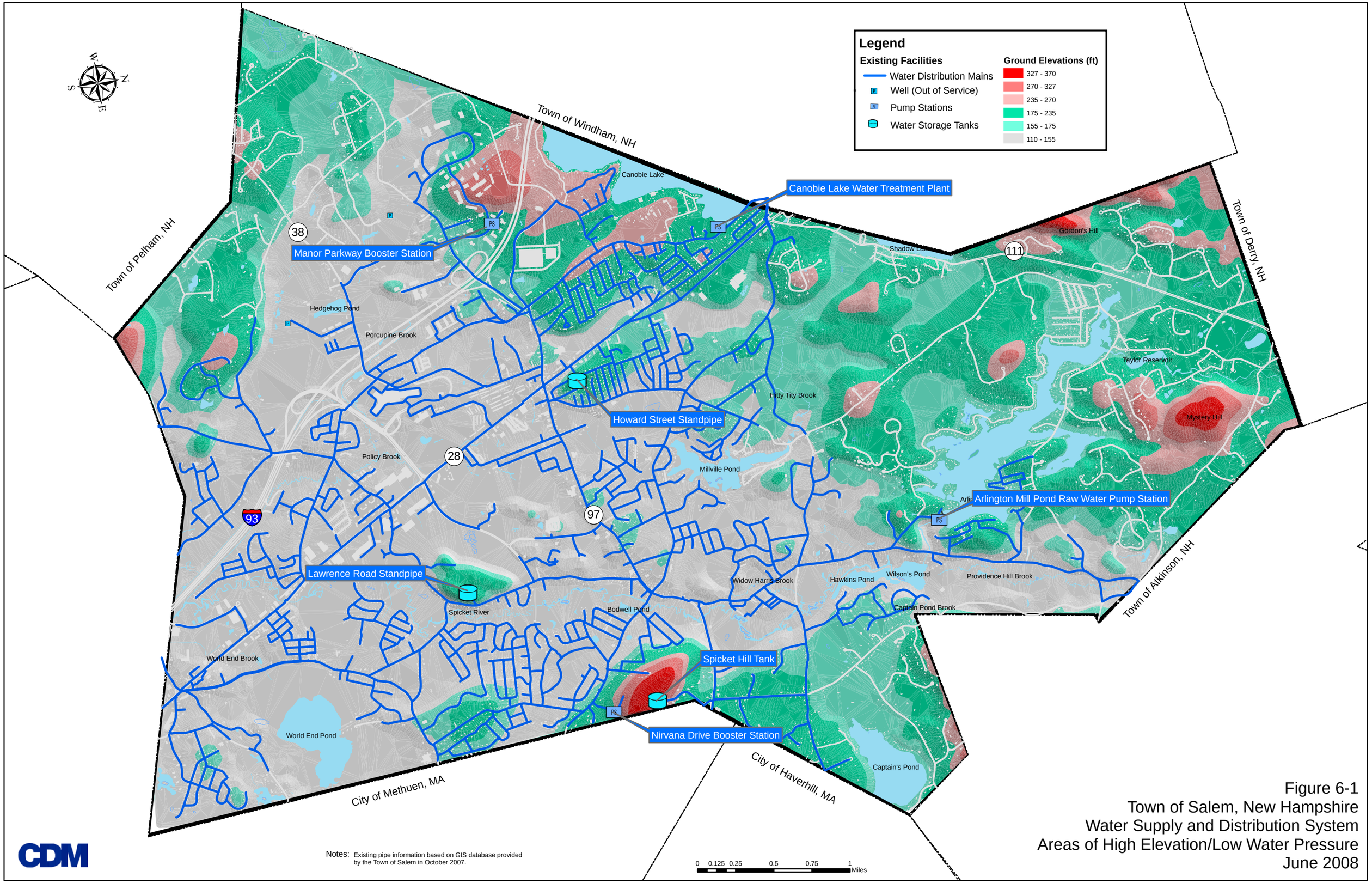



Salem Reliability Improvements for the
Southern New Hampshire Regional Water Initiative
DWSRF/DWGTF Pre-Applications
June 2018
CDM Smith

**Notes:**
Existing pipe information based on GIS data provided by the Town of Salem in July 2012.

CDM Smith

# Town of Salem, New Hampshire
# Existing Water Supply and Distribution System
# February 2013




Notes: Existing pipe information based on GIS database provided by the Town of Salem in October 2007.

Figure 6-1
Town of Salem, New Hampshire
Water Supply and Distribution System
Areas of High Elevation/Low Water Pressure
June 2008

## Legend

### Existing Facilities

- Water Distribution Mains
- Well (Out of Service)
- Pump Stations
- Water Storage Tanks
- ISO Test Location (2002)

### Proposed Facilities

- Upgrades to Existing System Piping
- Expansion of Distribution Network
- Pump Stations
- Water Storage Tanks
- Approximate Service Zone Boundary
- Additional Hydrants Required for ISO

Lowell Road Booster Station

Ticklefancy Lane Booster Station

Manor Parkway Booster Station

Upgrade Fire Pump System

Canobie Lake Water Treatment Plant

Finished Water Pump Capacity Upgrade

Howard Street Standpipe

Lawrence Road Standpipe

Samoset Drive Booster Station

Zachary's Crossing Road Booster Station

Briarwood Drive Booster Station

Zion Hill Road Booster Station

Independence Drive Booster Station

Spicket Hill Tank

Nirvana Drive Booster Station

Carriage Lane Booster Station

Town of Windham, NH

Town of Pelham, NH

Town of Derry, NH

Town of Atkinson, NH

City of Methuen, MA

City of Haverhill, MA

Canobie Lake

Shadow Lake

Gordon's Hill

Taylor Reservoir

Mystery Hill

Arlington Mill Pond

Millville Pond

Hitty Thy Brook

Hedgehog Pond

Porcupine Brook

Policy Brook

Spicket River

Bodwell Pond

Widow Harris Brook

Hawkins Pond

Wilson's Pond

Providence Hill Brook

Captain Pond Brook

Captain's Pond

World End Brook

World End Pond

ISO 2

ISO 3

ISO 4

ISO 5

ISO 6

ISO 7

ISO 8

ISO 9

ISO 10

ISO 11

ISO 12

ISO 13

ISO 14

ISO 15

ISO 16

ISO 17

ISO 18

ISO 19

ISO 20

ISO 21

0 0.125 0.25 0.5 0.75 1 Miles

Notes:
- Existing pipe information based on hydraulic model provided by the Town of Salem in October 2007.
- Proposed pipe diameters based on hydraulic simulations of full build-out conditions. Prior to implementation of individual improvements, separate evaluations should be made to determine adequacy of proposed improvements based on preexisting facilities.

CDM

# Figure 6-2
# Town of Salem, New Hampshire
# Water Supply and Distribution System
# Areas of Recommended System Improvements
# Using Multiple North High Service Zones
# June 2008

## Legend

### Existing Facilities

- Water Distribution Mains
- Well (Out of Service)
- Pump Stations
- Water Storage Tanks
- ISO Test Location (2002)

### Proposed Facilities

- Upgrades to Existing System Piping
- Expansion of Distribution Network
- Pump Stations
- Water Storage Tanks
- Approximate Service Zone Boundary
- Additional Hydrants Required for ISO

Lowell Road Booster Station

Ticklefancy Lane Booster Station

Canobie Lake Water Treatment Plant
Finished Water Pump Capacity Upgrade
New High Service Zone Pump System

Manor Parkway Booster Station
Upgrade Fire Pump System

Howard Street Standpipe

Lawrence Road Standpipe

Spicket Hill Tank

Nirvana Drive Booster Station

Gordon Avenue Tank

Carriage Lane Booster Station

Town of Windham, NH

Town of Pelham, NH

Town of Derry, NH

Town of Atkinson, NH

City of Methuen, MA

City of Haverhill, MA

Canobie Lake

Shadow Lake

Hedgehog Pond

Porcupine Brook

Policy Brook

Millville Pond

Hitty Tity Brook

Arlington Mill Pond

Taylor Reservoir

Hawkins Pond

Wilson's Pond

Providence Hill Brook

Captain Pond Brook

Willow Harris Brook

Bodwell Pond

Spicket River

World End Brook

World End Pond

Captain's Pond

ISO 3
ISO 4
ISO 5
ISO 6
ISO 7
ISO 8
ISO 9
ISO 10
ISO 11
ISO 12
ISO 13
ISO 14
ISO 15
ISO 16
ISO 18
ISO 19
ISO 20
ISO 21

Notes:
- Existing pipe information based on hydraulic model provided by the Town of Salem in October 2007.
- Proposed pipe diameters based on hydraulic simulations of full build-out conditions. Prior to implementation of individual improvements, separate evaluations should be made to determine adequacy of proposed improvements based on preexisting facilities.

0 0.125 0.25 0.5 0.75 1 Miles

# Figure 6-3
# Town of Salem, New Hampshire
# Water Supply and Distribution System
# Areas of Recommended System Improvements
# Using Consolidated North High Service Zone
# June 2008

CDM


CDM
Smith