

Water System Evaluation New Castle, New Hampshire

Final
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Prepared by:



EXECUTIVE SUMMARY

The Town of New Castle, with the assistance of the City of Portsmouth, has requested an evaluation of their municipal water distribution system in order to identify appropriate capital improvement projects. The water distribution system within the Town is fed by the City of Portsmouth. It is generally divided into two systems: the Village system, which is owned and operated by the Town of New Castle and the City system, which is owned and operated by the City of Portsmouth. In addition to the two municipal systems, privately owned mains exist within the southern portion of the island. Underwood Engineers was tasked with evaluating the following:

- Existing conditions of the Town's system.
- Available fire flows throughout the Island.
- Future capital improvements projects.

Water System Inventory

Underwood Engineers evaluated the existing conditions of the Town's system (Village) and compiled an inventory of the system as follows:

- The Town's system contains approximately 18,500' of water mains
 - Mostly 4", 6", and 8" pipe
 - Primarily cast iron and ductile iron pipe
 - Age ranges from the 1960's, 70's, unknown, and portions that may date back to the military installations on the island.
- 30 fire hydrants
- Approximately 80 valves
- Approximately 365 accounts with meters

Water Balance

Water is supplied to the island by the City of Portsmouth from three different connections:

- An 8" connection from Peirce Island on Shapleigh Island
- A 12" connection from Little Harbor Road to Campbell Island
- An 8" connection from Odiorne Point on the southern point of the island.

Two master meters owned by the City bookend the Village system and measure the volume of supplied water entering the Village. Over the past three years the City has supplied an average of 54,000 gpd to the Village system. The Town maintains meters for its individual users for billing and an estimated 3-year average of 43,000 gpd of water is consumed. The difference between the supplied water from the City and the consumed water by the Town (21%) can be attributed to discrepancies in metering, leaks within the system, flushing or other factors.

Water Quality

The Town was recently issued a violation for Total Trihalomethanes (TTHMs) exceeding maximum contaminant levels in the second quarter of 2016. The City is currently in the process of addressing TTHMs and other disinfectant by-products (DBPs) at the Madbury WTP and distribution system.



Leak Detection Survey

During the evaluation, a leak detection survey was performed on the Village portion of the water system, and 2 leaks were discovered. The first was located on Walton and Locke Road and estimated to be approximately 50 gpm. This estimate appears to be high in comparison to the recorded non-revenue water calculations reported in Section 2.2. The leak was repaired by the Town Staff in June, 2016. The second leak (1-3gpm) was reported on a service line on Mainmast Circle, and its exact location is currently being investigated.

Flow Testing

Underwood Engineers worked with Town and City staff to conduct flow testing at specific locations around the island. These tests were used to evaluate the static pressures within the system as well as to determine the friction C values within the evaluated pipe segments. The observed static pressure (45-64psi) was well within the nominal desirable static pressures of a municipal water system (35-80psi). The calculated friction C values are described below:

Table EX-1. Flow Testing

Flow Test	Location	Pipe Material	Flow (gpm)	Calculated C Value
1	KPYC to Goat Island	CI	570	122
2A	Goat Island to Oliver Street	CI	570	142
2B	Oliver Street to Colonial Lane	CI	570	141
3	Main Street to Piscataqua	DI	570	200*
4	Cranfield and Portsmouth to Quarterdeck	CI	450	48
5	Wentworth Road	CI	450	42
6	Little Harbor to Campbell Island	DI	890	143
7	Odiorne Point to Crosby	CI	220	78

*C value is assumed to be high likely due to limited pressure gauge precision and was not used in the model.

Existing Fire Flows

In order to determine what the existing available fire flows are within the system, Underwood Engineers worked with the City's consultant to evaluate the system using the City's existing hydraulic model. Using the C values calculated from the flow tests, the model was calibrated in the New Castle area and examined at six locations determined by the Insurance Services Office (ISO).

Table EX-2 shows that the "Needed Fire Flow" (NFF) recommended by the ISO are not met at every location. The NFF is not met due to the headloss in smaller mains on the island and mains supplying the island.



Table EX-2. ISO “Needed Fire Flow” vs. Existing

ISO Location	Description	ISO “Needed Fire Flows” (gpm)	ISO Observed Flows (gpm)	Modeled Existing Fire Flows (gpm)
1	Oliver St. and Cape Rd	1,250	750	690
2	Cranfield St. and Colonial Ln	750	700	657
3	Main St. and Atkinson St	2,250	750	666
4	Wentworth Rd. and Memorial Way	2,000	550	669
5	Wentworth Rd. and Shaw Cir.	750	600	753
6	Wentworth Rd. and Morgans Way	1,750	1,300	1,235

Fire Flow Evaluations

Underwood Engineers evaluated multiple alternatives to increase the available fire flows on the island. These alternatives were grouped into three different scenarios:

- Scenario 1: Water main improvements only (no tank)
- Scenario 2: Install a new water storage tank located within the Village.
- Scenario 3: Install a new water storage tank located on the City’s portion of the system.

Underwood Engineers used the ISO locations described in Table EX-2 as the basis of comparison for each alternative. The ISO “Needed Fire Flows” were used as a target, but they should not be considered a requirement per AWWA standards.

Of all the alternatives evaluated under each scenario, three stood out as viable options for significantly increasing the available fire flows of the system.

- **Alternative 1D** – The replacement/installation of water mains along Route 1B with 12” pipe, a new 12” connection to Rye and replacing the 8” line from Shapleigh Island across Peirce Island to Marcy Street with 12”.
 - Provides a significant increase to the available fire flow in the system without the addition of a water storage tank.
 - Opinion of probable cost: \$8.3M
 - Note: Alternative 1D was further modeled with 16” pipe (Alt 1E and Alt. 1F) on Route 1B in place of 12” DI pipe. In Underwood Engineers opinion, the increase in available fire flow provided by the larger diameter pipe does not justify the higher costs of the 16” pipe because available fire flows are close to meeting ISO needed fire flows with a 12” pipe under conservative conditions modeled (system demands, tank levels, etc.).
- **Alternative 2B** - The installation of a new storage tank located at the school with water main enhancements along the length of Route 1B on the island.
 - Meets every ISO “Needed Fire Flows”.



- Opinion of probable cost: \$8.9M
- **Alternative 3C** – The installation of a storage tank at Shaw Circle with water main enhancements along the length of Route 1B on the island.
 - Meets all of the ISO “Needed Fire Flows” at each location
 - Opinion of probable cost: \$8.9M

Conclusions

- **Flow Testing**
 - Hydrant flow testing and modeling of existing conditions indicate that available fire flows within the system are below the recommended ISO needed fire flows.
 - Of the seven (7) flow tests, all were below 900 gpm
 - Observed static pressures throughout the system (45psi-64psi) are within the normal municipal static pressure range (35psi-80psi).
 - Low fire flow issues appear to be due to the high headloss in smaller mains reducing the volume of water available in New Castle.
- **Fire Flow Evaluations**
 - Alternatives 1D, 2B, and 3C were viable options to increase the available fire flows within the system.
 - Scenarios that include a storage tank (Scenarios 2 and 3) present the following disadvantages
 - Long-term maintenance costs
 - Increased water age and potential for water quality degradation including loss of chlorine residual and increased formation of regulated disinfection byproducts.
 - Per City officials, additional water storage volume is not required.
 - Aesthetic impacts

For these reasons, Underwood Engineers does not recommend construction of a water storage tank in New Castle

- Alternative 1D presents the following advantages in addition to increased fire flow:
 - Replaces existing aging infrastructure.
 - Improves redundancy of supply to New Castle by adding a connection from Rye.

In summary, Alteration 1D is the preferred alternative to provide a significant improvement in available fire flow without the disadvantages of a water storage tank.

Recommendations

- **Implement Alternative 1D in a phased approach**
 - **Village System Improvements**
 - Replace the existing 8" pipe between the two master meters on Portsmouth Avenue, Cranfield Street, and Main Street with new 12" DI pipe.
 - **City System Improvements**
 - Replace the existing 8" pipe on Wentworth Road with 12" DI pipe.
 - Install a new 12" line in front of the Wentworth Hotel.
 - Provide a supply connection to the Town of Rye which also improves redundancy.
 - Replace the existing 8" pipe from the master meter on Shapleigh Island, across Peirce Island, to the 12" line on Marcy Street with a 12" DI pipe.
- **Considerations**
 - If the master meter pits remain, consider the installation of a meter bypass at Wentworth Road that would open automatically in the event of a hydrant flow on the City's side of the Meter
 - If the master meter pits remain, consider installing a smaller low flow meter at each meter vault to more accurately measure low flows especially at night.
 - Advance discussions with City regarding transferring ownership and operation of the village system to the City.
 - Perform extended period water modeling of any proposed improvements prior to final design to evaluate operations, turnover, water age, etc.
 - Conduct rate study to evaluate impact of recommendations.
 - Further evaluate water main improvements (looping and water main replacements) on all dead end mains to increase available fire flow and determine cost effective solutions to increasing available fire flows throughout the system.
 - It is recognized that the recommended option does not meet all ISO flows under the modeled conditions. If the Town desires to meet 100% of the ISO flows UE would recommend additional study and modeling to identify cost effective alternatives before pursuing higher cost options presented in this study (16" main). This would include looping and water main replacements on additional dead end mains to increase available fire flow. Modeling under different system conditions in Portsmouth (system demands, tank levels, etc.) may also be appropriate.

Funding

- Underwood Engineers has prepared a 5-year CIP identifying the projects needed for Alternative 1D as well as identifying future "radar" projects to replace aging system assets below:

Table EX-3. Recommended CIP

Year	Description	Cost
1	Replace the existing 8" line along the length of Wentworth Rd. on the City's Portion of the system with 12" DI, and install a new 12" line in front of the Hotel.	\$2.1M
2	Replace the existing 8" line on Portsmouth Ave, Cranfield St, and Main Street between the two master meters with a 12" DI pipe.	\$2.0M
3	Replace the existing 8" line on Portsmouth Ave, Cranfield St, and Main Street between the two master meters with a 12" DI pipe.	\$1.7M
4	Replace the existing 8" line from the master meter on Shapleigh Island, across Peirce Island to the 12" line on Marcy Street with a 12" Line.	\$2.1M
5	Install a new connection to the Town of Rye with a 12" pipe	\$0.43M

- Many of the capital recommendations above involve the City of Portsmouth and discussions over the system improvements would be needed.
- Underwood Engineers assisted the Town in preparing a pre-application in the amount of \$2M for the Drinking Water State Revolving Fund (DWSRF) administered by the New Hampshire Department of Environmental Services (NHDES). The SRF program offers low interest loans for municipalities to make improvements to their drinking water infrastructure. The pre-application is non-binding. New Castle is not currently in the funded portion of the draft priority list but may be funded if others drop out. If funding is offered to New Castle, the Town can choose to submit a full application or not. The deadline for a full application is June 30, 2017.
- For planning purposes, it is further recommended that annual funding levels for asset management replacement be budgeted at \$55,000 per year starting in year 6 assuming the above capital improvements are completed.
- Funding for additional loops should be considered as part of the Town's future radar projects for the CIP. Below are examples of possible system looping projects with estimated opinions of cost:
 - Cape Rd Loop - \$90,000
 - Salamander Lane Loop - \$54,000
 - Quarterdeck Lane Loop - \$123,000
 - Beach Hill Road Loop - \$165,000
 - Lavenger Lane Loop - \$250,000
 - Wild Rose Lane Loop – \$250,000

Note: The above projects are possible looping projects, and further cost/benefit evaluations are recommended to prioritize, confirm and/or identify alternative projects.

- A recommended CIP is provided in Appendix I.

