HOUSATONIC WATER WORKS COMPANY

SINCE 1897

Mr. Mark Pruhenski
Town of Great Barrington
334 Main Street
Great Barrington, MA 01230

May 27, 2022

Dear Mr. Pruhenski:

We are in receipt of your letter of May 3, 2022, requesting bottled water and financial reimbursements for concerned residents.

As a regulated utility we are bound to rules, regulations and tariffs approved by the Mass Department of Public Utilities, and there are no provisions in those filings for the accommodations sought.

As you know, our water is frequently tested by both company personnel and an independent certified laboratory. The results, summarized in our annual Consumer Confidence Report, demonstrate compliance with the state and federal water quality regulatory standards. The one exception is for haloacetic acids (HAA5), which temporarily increased following the historical rainfall in July 2021. HAAs can potentially cause health effects after decades of excessive exposure. However, that is not the case here, as HWWCO's water had never exceeded the HAA5 maximum contaminant level (MCL) prior to August 2021 and no health impact is expected from this short-term exceedance of the MCL. Also, the occasional seasonal spikes in manganese present in our source water are the cause of the colored-water episodes. While the levels of manganese detected are at times high enough to cause color in the water, they are not high enough to be considered a health hazard. So while HWWCO's water may have color at times due to the manganese, at no time has the water been considered unsafe for customer consumption by either HWWCO or the Massachusetts Department of Environmental Protection (MassDEP). Enclosed is a copy of our most recent Consumer Confidence Report that will be mailed to all customer of record with our June 1st billing. It is currently available on our website, housatonicwater.com.

Also enclosed are copies of our most recent testing report for haloacetic acids indicating levels are returning to historic concentrations (e.g., the May 2022 concentration was below the result from May 2021), along with related submittals to the MassDEP. A pilot study will be conducted this summer to evaluate the removal of manganese using an oxidation/greensand filtration system and assess formation of disinfection byproducts. We will be holding an informational meeting regarding the pilot study on June 16, 2022 and encourage community participation.

We share our customer's frustration with the colored water situation and have been diligently working with our water chemists and engineers to develop long-term solutions. As we move forward and finalize these plans we look forward to regularly sharing progress updates with our customers and the Town.

Sincerely,

James J. Mercer
Treasurer

Enclosures

80 Maple Avenue, Suite 1, Great Barrington, MA 01230

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Fax: 413.528.3024
E-mail: housatonicwater@gmail.com
www.housatonicwater.com

2021 Consumer Confidence Report

Your Annual Drinking Water Quality Information

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Housatonic Water Works
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Great Barrington, MA 01230
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Massachusetts Department of Environmental Protection
Public Water Supply ID #1113003

This report provides a snapshot of the drinking water quality that was achieved last year. Included are details about where your water comes from, what it contains and how its quality compares to state and federal standards. We are committed to providing you with information because informed customers are our best allies.

PUBLIC WATER SYSTEM INFORMATION

Our water system is routinely inspected by the Massachusetts Department of Environmental Protection (MA DEP). MA DEP inspects our system for its technical, financial, and managerial capacity to provide safe drinking water to you. To ensure that we provide the highest quality of water available, your water system is operated by a Massachusetts certified operator who oversees the routine operations of our system. A treatment process that includes filtration and disinfection is also provided. Reservoir water is directed through slow sand filters and then a controlled amount of sodium hypochlorite is added and mixed in a contact time basin. This maze-like structure mixes the chlorinated water and provides treatment over time that helps ensure complete disinfection of the drinking water. The water is monitored by us and MassDEP to determine the effectiveness of existing water treatment and to check if any additional treatment is warranted. MassDEP conducts regular Sanitary Survey inspections on our water system every 3 years to assess and inspect our water system. Our last Sanitary Survey was conducted in September of 2020. As part of our ongoing commitment to you we make regular repairs to the system and address concerns of our customers and regulators.

YOUR DRINKING WATER SOURCE

Where Does My Drinking Water Come From?

Housatonic Water Works water comes from the surface water source, Long Pond Reservoir and is located southwest of the Village of Housatonic. Long Pond has a surface area of 115 acres and storage capacity of 263 million gallons. The source is designated by MA DEP Source Name and ID Source Number as: Long Pond [1113003-01S]. The water system supplies approximately 824 service connections and serves a population of approximately 1300 people. Great Barrington Fire District's Water system can be used in emergencies. The last Sanitary Survey was conducted in 2020.

How are These Sources Protected?

MassDEP has prepared a Source Water Assessment Program (SWAP) Report for the water supply sources serving this water system. The SWAP Report assesses the susceptibility of public water supplies. A susceptibility ranking of "moderate" was assigned to this system using the information collected during the assessment by MassDEP, which included the absence of hydrogeological barriers that can prevent potential contaminant migration from the surface. Typical agricultural, commercial, industrial, and residential land uses can contribute to contamination. The complete SWAP report is available by contacting the Water Department, or online at https://www.mass.gov/service-details/the-source-water-assessment-protection-swap-program. For more information you may also contact the MassDEP Western Region Office at (413) 755-2215.

Residents can help protect sources by:

- *practicing good septic system maintenance,*
- *supporting water supply protection initiatives at the next town meeting*
- *taking hazardous household chemicals to hazardous materials collection days,*
- *contacting the water department or Board of Health to volunteer for monitoring or education outreach to schools,*
- *Limiting pesticide and fertilizer use, etc.*

SUBSTANCES FOUND IN TAP WATER

Sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals, and in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity. Contaminants that may be present in source water include.

Microbial contaminants - such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
Inorganic contaminants - such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial, or domestic wastewater discharges, oil and gas production, mining, and farming.
Pesticides and herbicides - which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
Organic chemical contaminants - Including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.
Radioactive contaminants - which can be naturally occurring or be the result of oil and gas production and mining activities.

COMPLIANCE WITH REGULATIONS

Does Drinking Water Meet Current Health Standards?

We are committed to providing you with the best water quality available. Last year we conducted hundreds of water tests for over 80 contaminants. While nearly all of these tests showed that our water quality meets or exceeds MassDEP and EPA standards, there were two instances of violations which are described below.

During our third quarterly test for Haloacetic Acids (HAA5) and Total Trihalomethanes (TTHM) taken on 8/9/21, it was determined that our levels were above the maximum contaminant level (MCL). MassDEP has set the MCL for HAA5 at 60ppb and the MCL for TTHM at 80ppb. Our results from the August 9, 2021 samples showed our HAA5 level at 103.1ppb and TTHM level at 97.9ppb.

During our fourth quarterly test for Haloacetic Acids (HAA5) taken on 11/10/21, it was determined that our level was again above the MCL, with a result of 77.3ppb. While this was an improvement on the previous result from the third quarter, it was still above the MassDEP maximum contaminant level of 60ppb.

The Company's engineers are preparing a report to address the HAA5 issue. Additional information will be posted on our website as it becomes available.

IMPORTANT DEFINITIONS

Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCL's are set as close to the MCLG's as feasible using the best available treatment technology.

Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known expected risk to health. MCLG's allow for a margin of safety.

Action Level (AL) - The concentration of a contaminant which, if exceeded triggers treatment or other requirements that a water system must follow.

90th Percentile - Out of every 10 homes sampled, 9 were at or below this level.

Treatment Technique (TT) - A required process intended to reduce the level of a contaminant in drinking water.

Secondary Maximum Contaminant Level (SMCL) – These standards are developed to protect aesthetic qualities of drinking water and are not health based.

Unregulated Contaminants – Contaminants for which EPA has not established drinking water standards. The purpose is to assist EPA in determining their occurrence in drinking water and whether future regulation is warranted.

Maximum Residual Disinfectant Level (MRDL) - The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Maximum Residual Disinfectant Level Goal (MRDLG) - The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.

Massachusetts Office of Research and Standards Guidelines (ORSG) - This is the concentration of a chemical in drinking water, at or below which, adverse health effects are unlikely to occur after chronic (lifetime) exposure.

WATER QUALITY TESTING RESULTS

The water quality tables show the most recent water quality testing results where levels were detected and compares those levels to standards set by the Environmental Protection Agency and Massachusetts Environmental Protection Agency.

MassDEP has reduced the monitoring requirements for Perchlorate, Inorganic Contaminants (IOCs), and Synthetic Organic Contaminants (SOCs), because the source is not at risk of contamination. The last sample was collected In 7/14/2021 for Perchlorate, 7/14/2021 for Inorganic Contaminants, and 6/1/2021 for SOCs, and all were found to meet all applicable US EPA and MassDEP standards. The water quality information presented in the table is from the most recent round of testing done in accordance with the regulations. All data shown was collected during the last calendar year unless otherwise noted in the table. With the exception of those compounds noted on the tables below, all other compounds reported undetectable levels. "Quarterly" samples were collected on the following dates: 2/9/2021, 5/10/2021, 8/9/2021 & 11/10/2021

Regulated Contaminant	Date(s) Collected	Highest Result or Running Annual Average[2]	Range Detected	MCL	MCLG	Violation (Yes/No)	Possible Source(s) of Contamination
INORGANIC CONTAMINANTS							
Perchlorate (ppb)	*7/14/2021*	*0.1*	*N/A*	*2*	*N/A*	*No*	*Rocket propellants, fireworks, munitions, flares, blasting agents.*
DISINFECTANTS AND DISINFECTION BY-PRODUCTS							
Chlorine Residual (ppm)	*Daily*	*1.44*[2]	*0.96-1.90*	*4*	*4*	*No*	*Byproduct of drinking water chlorination*
Total Trihalomethanes (TTHMs) (ppb)	*Quarterly*	*66.5*[2]	*39.3-97.9*	*80*	*N/A*	*Yes**	*Byproduct of drinking water chlorination*
**While the average for the year did not exceed the MCL there was an individual MCL violation that was determined during August sampling. Some people who drink water containing trihalomethanes in excess of the MCL over many years may experience problems with their liver, kidneys, or central nervous systems, and may have an increased risk of getting cancer.*							
Haloacetic Acids (HAA5) (ppb)	*Quarterly*	*73.5*[2]	*55.5-103.1*	*60*	*N/A*	*Yes*	*Byproduct of drinking water disinfection*
Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer.							

Contaminant (units)	Dates Collected	Result or Range Detected	Average Detected	SMCL	ORSG	Possible Source(s) of Contamination
UNREGULATED AND SECONDARY CONTAMINANTS						
Sodium (ppm)	*7/14/2021*	*8.85*	*N/A*	*N/A*	*20*	*Natural Sources, runoff from use of salt on roadways, byproduct of water treatment process.*
Chloroform (ppb)	*Quarterly*	*36-91*	*61.4*	*N/A*	*70*	*Trihalomethane; by-product of drinking water chlorination*
Some people who drink water containing chloroform at high concentrations for many years could experience liver and kidney problems and may have an increased risk of cancer.						
Bromodichloro-methane (ppb)	*Quarterly*	*3.3-6.9*	*5.125*	*N/A*	*N/A*	*Trihalomethane; by-product of drinking water chlorination*
Some people who drink water containing bromodichloromethane at high concentrations for many years could experience liver and kidney problems.						

LEAD AND COPPER – Q2 () and Q4 ()

Contaminant (units)	Action Level	90th Percentile	Number of Sites Sampled	Number of sites above the Action Level	Possible Sources of Contamination	Violation (Yes/No)
Lead (ppb)	*15*	*Q2 – 2.3* *Q4 - <1*	*Q2 -20* *Q4 - 20*	*Q2 – 1* *Q4 - 0*	*Corrosion of household plumbing*	*No*
Copper (ppm)	*1.3*	*Q2 – 1.1* *Q4 – 0.1*	*Q2 -20* *Q4 - 20*	*Q2 – 1* *Q4 - 0*	*Corrosion of household plumbing*	*No*

Turbidity	TT	Lowest monthly % of Samples	Highest Detected Daily Value	Violation	Possible Sources of Contamination
Daily Compliance (NTU)	*5*	*N/A*	*0.086*	*No*	*Soil Runoff*
Monthly Compliance*	*At least 95%*	*100%*	*N/A*	*No*	
Turbidity is a measure of the cloudiness of the water. We monitor it because it is a good indicator of water quality.					
**Monthly turbidity compliance is related to a specific treatment technique (TT). Our system filters the water so at least 95% of our samples each month must be below the turbidity limits specified in the regulations.*					

ppm = parts per million, or milligrams per liter (mg/l)
ppb = parts per billion, or micrograms per liter (ug/l)

N/A = Not Applicable
NTU = Nephelometric Turbidity Unit

HEALTH NOTES

In order to ensure that **tap water is safe to drink**, the Department of Environmental Protection (MassDEP) and U.S. Environmental Protection Agency (EPA) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. The Food and Drug Administration (FDA) and Massachusetts Department of Public Health (DPH) regulations establish limits for contaminants in bottled water that must provide the same protection for public health. All drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the Environmental Protection Agency Safe Drinking Water Hotline (800-426-4791).

Some people may be more vulnerable to contaminants in drinking water than the general population. **Immuno-compromised persons** such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and some infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/Centers for Disease Control and Prevention (CDC) guidelines on lowering the risk of infection by cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800)-426-4791.

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. Housatonic Water is responsible for providing high quality drinking water but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at hrtp://www.epa.gov/safewater/lead.

Cross connections are potentially hazardous situations for public or private potable water supply and a source of potable water contamination. A cross connection is any potential or actual physical connection between potable water supply and any source through which it is possible to introduce any substance other than potable water into the water supply. Common cross connection scenarios are a garden hose whose spout is submerged in a bucket of soapy water or connected to a spray bottle of weed killer.

Cross connections between a potable water line and a non-potable water system or equipment have long been a concern of the Department of Environmental Protection (MA DEP). MA DEP established regulations to protect the public health of water consumers from contaminants due to back-flow events. The installation of back-flow prevention devices, such as a low-cost hose bib vacuum breaker, for all inside and outside hose connections is recommended. You can purchase this at a hardware store or plumbing supply store. This is a great way for you to help protect the water in your home as well as the drinking water system in your community. For additional information on cross connections and on the status of your water system's cross connection program, please contact Jim Mercer.

OPPORTUNITIES FOR PUBLIC PARTICIPATION

Housatonic Water Works sponsors bi-annual public information meetings and we encourage dialogue on water quality issues on an on-going basis. If you have any questions about the water you drink, please contact, Jim Mercer. For more information regarding our system, you may also visit the EPA website at: http://www.epa.qov/enviro/facts/sdwis/search.htm

This report is a compilation of best available data sources including: licensed operators' reports, water supply owner's coordination. MassDEP public records and EPA online records. The report represents an accurate account of your water quality to the best of our knowledge. Prepared by Housatonic Basin Sampling & Testing on behalf of your water supplier.

Massachusetts Department of Environmental Protection - Drinking Water Program **HAA5**

Haloacetic Acids Report doc rev 12/2020

I. PWS INFORMATION: Please refer to your DEP Water Quality Sampling Schedule (WQSS) to help complete this form

PWS ID #: 1113003 **City / Town:** Great Barrington

PWS Name: Housatonic Water Works **PWS Class:** COM ☑ NTNC ☐

	DEP LOCATION (LOC) ID#	DEP Location Name	Date Collected	Collected By
A	10003	10 Depot Rd	05/11/2022	Tim Vreeland
B	10004	314 N Plain Rd	05/11/2022	Tim Vreeland
C				
D				

	Routine or Special Sample	Original, Resubmitted or Confirmation Report	If Resubmitted Report, list below: (1) Reason for Resubmission	(2) Collection Date of Original Sample
A	☑ RS ☐ SS	☑ Original ☐ Resubmitted ☐ Confirmation	☐ Resample ☐ Reanalysis ☐ Report Correction	
B	☐ RS ☑ SS	☑ Original ☐ Resubmitted ☐ Confirmation	☐ Resample ☐ Reanalysis ☐ Report Correction	
C	☐ RS ☐ SS	☐ Original ☐ Resubmitted ☐ Confirmation	☐ Resample ☐ Reanalysis ☐ Report Correction	
D	☐ RS ☐ SS	☐ Original ☐ Resubmitted ☐ Confirmation	☐ Resample ☐ Reanalysis ☐ Report Correction	

	SAMPLE COMMENTS
A	
B	
C	
D	

II. ANALYTICAL LABORATORY INFORMATION: Attach copy of subcontracted analysis report (as applicable)

Primary Lab MA Cert. #: M-IN035 **Primary Lab Name:** Eurofins Eaton South Bend **Subcontracted? (Y/N)** N

Analysis Lab MA Cert. #: M-IN035 **Analysis Lab Name:** Eurofins Eaton South Bend

Contaminant	MCL µg/L	MDL µg/L	MRL µg/L	Dilution Factor	A µg/L	Result Qualifier	B µg/L	Result Qualifier	C µg/L	Result Qualifier	D µg/L	Result Qualifier
TOTAL HAA5	**60**	-----	-----	-----	50.00		54.20					
MONOCHLOROACETIC ACID		1.5	**2.0**	**1**	ND		2.2					
DICHLOROACETIC ACID		0.60	**1.0**	**1**	18		20					
TRICHLOROACETIC ACID		0.70	**1.0**	**1**	32		32					
MONOBROMOACETIC ACID		0.50	**1.0**	**1**	ND		ND					
DIBROMOACETIC ACID		0.50	**1.0**	**1**	ND		ND					
Lab Method					552.2		552.2					
Date Extracted					05/24/2022		05/24/2022					
Date Analyzed					05/25/2022		05/25/2022					
Primary Lab Sample ID#					810-24464-1		810-24464-2					
Analysis Lab Sample ID#					810-24464-1		810-24464-2					
Surrogate: 2-Bromopropionic acid					106 %		103 %					

[1] Report Total HAA5s result as a number greater than 0 or ND (not a < MDL value) to 2 significant figures.

	LAB ANALYSIS COMMENTS
A	
B	
C	
D	

Result Qualifiers and Descriptions

I certify under penalties of law that I am the person authorized to fill out this form and the information contained herein is true, accurate and complete to the best extent of my knowledge.

Authorized Signature: [signature] Amanda Scott, Project Manager

Date: 05/26/2022

In accordance with 310 CMR 22.15(2), if mailing paper reports, TWO copies of this report must be received by your MassDEP Regional Office no later than 10 days after the end of the month in which the results are received or no later than 10 days after the end of the monitoring period, whichever is sooner. Please note: Electronic reporting (eDEP) deadline is the same as above.

DEP REVIEW STATUS (Initial and Date) ☐ Accepted ____ ☐ Disapproved ____	Review Comments		☐ WQTS Data Entered

Northeast Water Solutions, Inc.

PROPOSAL FOR PILOT PLANT TEST PROGRAM

GREENSAND FILTRATION TREATMENT
REMOVAL OF MANGANESE
&
ASSESSMENT OF DBP
FORMATION & CONTROL

FOR

HOUSATONIC WATER WORKS CO.
80 MAPLE AVENUE
GREAT BARRINGTON, MA 02130
PWS # 1113003

COMMONWEALTH OF MASSACHUSETTS
ROBERT F FERRARI
CIVIL
No. 31932
REGISTERED PROFESSIONAL ENGINEER

MAY 20, 2022

567 South County Trail, Suite 116, Exeter RI 02822. Tel: 401-667-7463. Fax: 401-667-7465 www.nwsi.net

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1.0 PURPOSE OF PILOT PLANT TEST PROGRAM

The Housatonic Water Works Company (HWWC) draws surface supply from one(1) intake structure installed in Long Pond. The raw water enters the Treatment Building where it undergoes slow rate media filtration, chlorination (sodium hypochlorite) disinfection and clearwell mixing, prior to discharge to the nearby 1.1 MG water storage standpipe tank. The finished water is pumped continuously (24 hrs./day) to the water storage tank at flowrates ranging from approximately 50 to 100 gpm (150 gpm during hydrant flushing exercises) , with gravity discharge to the water distribution system. During 2020/2021 the system demonstrated an average daily use of approximately 104,000 to 111,000 gpd.

The finished water pH averages 7.5 su with the chlorine residual ranging from 1.0 – 1.5 mg/l. The water suffers seasonal manganese contamination, typically from late June to September, demonstrating manganese concentrations on the order of 0.05 – 0.34 mg/l. It should be noted that iron typically demonstrates non-detectable to trace (0.1 mg/l) concentrations in the water. The water also contains moderately elevated alkalinity (≈ 80 mg/l, as $CaCO_3$), moderate calcium hardness (≈ 47.5 mg/l, as $CaCO_3$) and low sodium (<10 mg/l).

HWWC is proposing to conduct a pilot plant study and implement manganese treatment to meet a goal of ≤ 0.015 mg/l, which is below the USEPA/MassDEP Secondary Water Quality Limit (0.05 mg/l). The pilot plant will be performed during the summer when manganese is typically experienced in the water supply. Additionally, the pilot plant program will assess the impact of the manganese treatment upon disinfection by-products (DBP) formation and viability.

The intent of the pilot plant shall be to evaluate the greensand (Greensand Plus) filtration process, installed following the existing chlorination process, for consistent removal of manganese to ≤0.015 mg/l. The pilot plant program will evaluate the impact of critical operational variables (hydraulic loading, manganese loading, pre-oxidation chlorine dosage, pH, backwash flowrates, differential pressure, etc.) upon finished water quality and will define the operating criteria for a full-scale system. The pilot plant is proposed to operate at a flowrate of 5 – 15 gpm, over a period of 2 – 4 weeks, to provide a rigorous evaluation of the process and application to this water source.

The pilot plant program will evaluate the impact of critical operational variables (manganese and TOC loading, differential pressure, pH, oxidant dosage, etc.) upon finished water quality and will define the operating criteria for a full-scale system. The pilot plant evaluation will further include an assessment DBP formation in the greensand filtered water based upon hydraulic retention time in the water storage tank and distribution system.

2.0 SOURCE & FINISHED WATER CHARACTERIZATION

2.1 Water Characterization – Inorganic & Physical Parameters

Table 2-1 presents a summary of the analytical characterization of the HWWC point-of-entry (POE) finished water from previous evaluations by Lenard Engineering and Cornwell Engineering (July – September, 2020), augmented with raw source water and finished water samples obtained on March 22, 2022. Table 2-2 presents a summary of the analytical characterization of both the source water and POE finished water from August 5, 2020 through March 21, 2022. This table includes a breakout of the "summer" seasonal monitoring during 2020/2021 from June 1st to September 30th, each year.

Total Manganese: The source water demonstrates elevated total manganese with an annual average concentration of 0.0530 mg/l, with a range of 0.0128 to 0.343 mg/l. The manganese concentration increases during the summer season, demonstrating an average of 0.095 mg/l, with a range of 0.033 to 0.343 mg/l. The seasonal variability is further demonstrated by the "non-summer" (October 1st to May 31st) monitoring indicating an average concentration of 0.0202 mg/l and a range of 0.0128 to 0.0411 mg/l. It is believed the seasonally increased manganese content contributes to the seasonal increase in both turbidity and color.

The finished water (POE) demonstrates an annual average total manganese concentration of 0.0028 mg/l. However, the "non-summer" monitoring demonstrates an average concentration <0.0006 mg/l, with only 3 of 28 samples having detectable manganese (0.0061 to 0.0141 mg/l). The "summer season" monitoring demonstrates an average total manganese concentration of 0.082 mg/l, with a range of <0.002 to 0.282 mg/l. This indicates the manganese is seasonally generated in Long Pond. Additionally, a comparison of the summer season average total manganese in the source (0.095 mg/l) and POE (0.082 mg/l) samples indicates that **an average of only 14% of the manganese is being removed through the treatment facility**, during the summer season. This is due to manganese being much more difficult to oxidize and precipitate, compared to iron. As a result, the key to treatment to remove manganese must **consistently achieve oxidation and precipitation of soluble manganese, that is passing through the slow sand filters.**

Table 2-1: HWWC Water Characterization			
Sample Date/Parameter	**03/22/22**	**03/22/22**	**Cornwall Report 2018 - 2020**
Location	**Raw Water**	**Finished Water**	**POE**
Temperature – Field	5.0°C	14.6°C	-----
pH – Laboratory	7.3 su	7.4 su	7.3
Turbidity	0.75 NTU	0.15 NTU	-----
Apparent Color	8 C.U.	2 C.U.	20
UV 254	0.055	-----	-----
Total Organic Carbon	2.86 mg/l	1.66 mg/l	-----
Total Solids	-----	105 mg/l	-----
Total Dissolved Solids	-----	99 mg/l	107 mg/l
Conductivity (umhos/cm)	191	206	-----
Alkalinity ($CaCO_3$)	80 mg/l	83 mg/l	80 mg/l
Chloride	9.2 mg/l	11.6 mg/l	14.2 mg/l
Sulfate	-----	4.4 mg/l	<5 mg/l
Fluoride	<0.02 mg/l	<0.02 mg/l	-----
Nitrate – N	<0.002 mg/l	0.047 mg/l	-----
Nitrite-N	<0.002 mg/l	<0.002 mg/l	-----
Silica	-----	1.6 mg/l	-----
Arsenic	<0.0005 mg/l	<0.0005 mg/l	-----
Barium	0.005 mg/l	0.005 mg/l	-----
Beryllium	-----	<0.003 mg/l	-----
Calcium	-----	21.7 mg/l	19.2 mg/l
Copper	<0.01 mg/l	<0.01 mg/l	
Iron	0.03 mg/l	<0.01 mg/l	<0.05 mg/l
Lead	<0.001 mg/l	<0.001 mg/l	
Magnesium	-----	7.90 mg/l	0.086 mg/l
Manganese	0.02 mg/l	<0.01 mg/l	-----
Potassium	-----	0.79 mg/l	-----
T. Phosphate	ND	<0.007 mg/l	-----
Selenium	<0.001 mg/l	<0.001 mg/l	-----
Sodium	5.0 mg/l	6.8 mg/l	-----
Zinc	<0.01 mg/l	,0.01 mg/l	-----
Total Hardness ($CaCO_3$)	-----	86.6 mg/l	-----
Corrosion/Scale Indices:			
Langelier Saturation Index	-----	-1.42	-----
Larson Skold Index	-----	0.25	-----
CSMR	-----	2.63	-----
Alkalinity-to-Chloride Ratio	-----	7.16	-----

Table 2-2 HWWC Source & Point-of-Entry Water Quality Monitoring (08/03/2020 – 03/21/2022)[1]									
Parameter	**Units**	**Long Pond Source Monitoring**				**Point-of-Entry Finished Water**			
		# Samples	**Avg.**	**Min.**	**Max.**	**# Samples**	**Avg.**	**Min.**	**Max.**
Temperature:									
All Samples	^0C	21	14.1	0.7	27.2	43	13.0	2.0	25.7
Summer	^0C	9	21.4	18.0	27.2	14	19.2	10.6	25.7
pH:									
All Samples	SU	22	7.5	7.09	8.5	43	7.50	7.2	7.90
Summer	SU	10	7.46	7.09	8.5	15	7.42	7.21	7.71
Tot. Dis. Solids									
All Samples	mg/l	24	122	74	325	44	121	54	436
Summer	mg/l	10	129	74	325	15	118	98	168
Alkalinity ($CaCO_3$)									
All Samples	mg/l	20	83.5	75.0	95.0	44	83.2	67.5	95.0
Summer	mg/l	10	80.8	75.0	87.5	15	82.0	75.0	87.5
Total Iron									
All Samples	mg/l	21	0.074	<0.050	0.333	40	<0.0500	<0.0500	<0.0500
Summer	mg/l	11	0.114	<0.050	0.333	15	<0.0500	<0.0500	<0.0500
Total Mn									
All Samples	mg/l	25	0.0530	0.0128	0.343	43	0.0028	<0.020	0.282
Summer	mg/l	11	0.095	0.033	0.343	15	0.082	<0.002	0.282
Non-Summer	mg/l	14	0.0202	0.0128	0.0411	28	<0.0006	<0.002	0.0072
Color									
All Samples	C.U.	18	23.3	<1	45	43	10.8	<1	50
Summer	C.U.	10	25.5	10	45	15	26	<1	50
Turbidity									
All Samples	NTU	22	0.88	0.04	3.7	41	0.22	0.02	0.90
Summer	NTU	10	1.32	0.04	3.7	15	0.41	0.02	0.90
Cl_2 Residual									
All Samples	mg/l	-----	-----	-----	-----	43	1.58	0.56	2.80
Summer	mg/l	-----	-----	-----	-----	15	1.37	0.56	1.74

Note 1: Summer Samples are from June 1st to September 30th, each year.

2.2 Water Characterization – Disinfection-by-Products

Organic oxidation reactions with humic and fulvic acids can produce Trihalomethane (THM) by-products including chloroform, bromodichloromethane, dibromocloromethane and bromoform, and haloacetic acids (HAA5). The current maximum contaminant level (annual average) in drinking water for THM is 0.08 mg/l (80 ug/l) and for HAA5 is 0.06 mg/l (60 ug/l). Factors that impact the formation of disinfection by-products include; (a) the type and concentration of the precursor materials, (b) disinfectant type and concentration, (c) ratio of oxidant to precursor, contact time, pH and temperature.

The HWWC system has historically demonstrated compliance with the USEPA/MassDEP requirements for control of Disinfection-by-Products (DBPs). However, the system experienced an exceedance of the Locational Running Annual Average (LRAA) MCL (60 ug/l) for Haloacetic Acids (HAA5), initially in August 2021 and subsequent quarters during 2021 and

2022. The exceedances were due to significantly elevated HAA5 concentrations during 2021 Q3 (101 ug/l) and Q4 (77 ug/l) that have skewed the LRAA.

Studies of the HWWC source and finished water, regarding Disinfection-by-Products (DBP) formation have been performed by others (R. Gullick). A review of this work, and related historical water quality monitoring results in the following general findings:

- Source water Natural Organic Matter, proxy identified by Total Organic Carbon (TOC) analysis, may have been elevated during 2021 Q3 and Q4 due to excessively elevated precipitation conditions that increased solids and organic loading into Long Pond.

- The slow sand filtration process demonstrates removal of 34% to 55% of influent TOC, which indicates a significant fraction of the TOC is associated with particulate solids that are filterable. This performance exceeds typical expectations for filtration plants.

- The monitoring on March 22, 2022 (Table 1) demonstrates source water TOC at 2.86 mg/l, compared to finished water TOC at 1.66 mg/l, a nominal 42% removal across the treatment system. Additional TOC monitoring data demonstrates a range of 2.94 mg/l to 4.24 mg/l in the raw source water and 1.72 mg/l to 2.22 mg/l in the finished water.

The need for disinfection chlorination in conjunction with the extended hydraulic retention time in the HWWC storage and distribution system, mandates the need for consistent, effective control of DBPs. Based upon a review of the available data and information, it is concluded that while the severe increase in HAA5 during 2021 may have been due, in part, to short-term environmental conditions beyond the control of HWWC, the inherent, extended storage duration in the system creates a risk factor indicating a need for enhanced control of DBP precursor materials.

2.3 Alternatives for Manganese Treatment

There are a number of alternative processes used for removal of manganese that Lenard Engineering previously reviewed. Lenard submitted a feasibility pilot study to the Department on September 20, 2021 that was approved (by the Department) on November 5, 2021. NWSI suggests the following:

Greensand Media Filtration: A widely used and effective means to remove manganese (and iron) is chemical oxidation followed by media filtration. This is typically accomplished by either of two (2) methods; (a) chemical oxidation followed by conventional multi-media filtration, or (b) chemical oxidation followed by manganese greensand filtration or other manganese dioxide oxidative filtration. Iron, and to a lesser extent manganese, is readily oxidized by chlorine (sodium hypochlorite, etc.), after which it can be effectively removed by multi-media filtration. However, un-reacted (soluble) manganese would pass through a conventional media depth filter, thus compromising water quality.

The existing slow sand filtration system provides excellent, consistent filtration. With manganese present in a comparatively significant concentration with minimal to non-detectable iron in the raw water, the manganese greensand filtration process, with continuous regeneration, is recommended as the optimum means to achieve the desired reduction of manganese. This process would be installed downstream of the existing slow sand filters, following the addition of sodium hypochlorite for disinfection.

Manganese greensand is a granular filter media produced from a natural zeolite (glauconite) with catalytic oxidative properties to facilitate the oxidation-reduction reaction of iron and manganese. The original mineral media has been supplanted by a manganese dioxide coated silica sand media (Greensand Plus) that provides performance that is equal or superior to the original natural media. Operating in the "continuous regeneration" mode, soluble manganese (and iron) in the raw water will be oxidized and precipitated, and then filtered from the water as it passes through the media bed. Soluble iron and manganese remaining in the water following pre-oxidation are readily oxidized within the filter bed by the catalytic oxidative properties of the Greensand Plus.

Greensand filtration operates optimally when the water pH is in the range of 6.2 to 8.5 su. Because this application principally involves removal of manganese, the "Continuous Regeneration" mode of operation is recommended, using the addition of sodium hypochlorite (NaOCl) upstream of the greensand filter system. The residual chlorine remaining after oxidation of the soluble iron and manganese will maintain the filtration media in a continuously regenerated, oxidative condition. Installed downstream of the existing chlorine contact chamber to accept the pumped discharge to the water storage tank will optimize utilization of the existing system equipment and processes.

The greensand filter typically uses a dual media configuration including anthracite and greensand, with periodic backwash to flush accumulated particulate iron and manganese from the filter bed, to restore the filter to full service. Due to the minimal iron content, it may be possible to eliminate the anthracite and utilize a single greensand media bed configuration. The filters are provided with automated operating cycle control and the full backwash duration is approximately 20 minutes with an anticipated frequency of 1X per week. A conceptual design analysis was performed, summarized in Table 2-3. Evaluating the findings results in a determination that a triplex or quadriplex greensand filtration system (depending upon pilot plant results) utilizing 36" Ø filter vessels operating in parallel, provides the optimum system design treating the filtered source water prior to discharge to the water storage standpipe tank and distribution system. Benefits of this system design, configuration and operation include the following:

- The use of 36" Ø vessels operating in parallel, each designed for a maximum 50 gpm flowrate, allows the system to handle the full range of discharge flowrates under consistent hydraulic load conditions. The Greensand Plus media has a hydraulic loading range of 2 to 12 gpm/ft^2 of media bed therefore the design results in a moderately conservative hydraulic design, based upon the very moderate manganese load, which assumes no removal credit for the upstream slow sand filters.
  - ➢ Based upon the sustained average daily summer demand (110,749 gpd = 77 gpm) the hydraulic loading with 2 vessels on-line is 5.5 gpm/ft^2.

- At the peak pumping rate of 150 gpm, with three (3) filter vessels on-line, the hydraulic loading rate is 7.1 gpm/ft^2.

- The filter vessels can operate on the basis of gallons treated, differential pressure and/or effluent turbidity, depending upon the findings of the pilot test program to optimize the control metric. The filter vessels operate in a staggered sequence such that only one vessel would backwash at any given time. Based upon 100% maximum manganese load, each vessel has a nominal volumetric capacity of 155,000 gallons (21,930 gallons per ft^2). The anticipated operating cycle for each vessel ranges from 1.4 days at maximum manganese loading, to 7 days under average load conditions.

- Greensand filtration operates optimally when the water pH is in the range of 6.2 to 8.5 su and therefore no pH adjustment is necessary upstream of the filtration process.

- This system utilizes "Continuous Regeneration" using sodium hypochlorite with flow proportional feed control to maintain the correct feed dosage. Under average load conditions, using 12% sodium hypochlorite increases the existing chemical demand by approximately 0.20 gallons per day (<6 gallons per month). This will not require any modification to the existing chlorination system.

- The only wastewater normally generated by the Greensand Filter system will be the periodic backwash to flush accumulated solids from the media bed. Assuming a conservative 10-minute, air scour-assisted backwash duration (plus valve positioning time) the backwash water volume is ≈320 gallons per vessel backwash event. Based upon a nominal treated water capacity of 155,000 gallons per operating cycle, this equates to a "parasitic" equivalent of 0.2%, which is extremely efficient. Furthermore, this water can be discharged into the existing lagoon.

- The triplex or quadriplex filter system is a standard commercial design that can be provided with an integral PLC-based control system, monitoring the flowrate and water volume to each filter vessel, and automatically controlling the filter backwash and sequencing of the filters on/off line. The controller is provided an operator interface and manual override is provided for all controls and functions;

- The greensand filters operate under pressure and can directly accept the discharge from the transfer pumps to the water storage standpipe tank.

- The system operating labor will be 4-6 hours per week to perform inspection, chemical replenishment, field iron & manganese tests, oversee backwash events, data logging, etc. Annual maintenance includes inspection of the filter beds and replenishing media (typically 3% per year) and maintenance of the chemical feed metering pump;

- Assuming installation along an interior wall, the footprint for the Greensand Filtration system is approximately 100 ft^2. This would be incorporated into a new treatment building to include an operator office, monitoring panel, storage and room for the potential addition of other treatment equipment.

- The system will likely require a treatment operator with a Class 2T certification;

Table 2-3
Greensand Filter Concept Design & Operating Criteria

Design Flowrate – Total	50 gpm	100 gpm	150 gpm
Number of Vessels	4	4	4
Number of Vessels On-Line	2	3	3
Process Type	Catalytic Oxidation	Catalytic Oxidation	Catalytic Oxidation
Operating Configuration	Parallel, Continuous	Continuous	Continuous
Design Flowrate per Vessel	25 gpm	33.3 gpm	50
Vessel Dimensions	36" ϕ x 72" Ht.	36" ϕ x 72" Ht.	36" ϕ x 72" Ht.
X-Section Surface Area	7.06 ft^2	7.06 ft^2	7.06 ft^2
Hydraulic Loading	1.8 gpm/ft^2	2.2 gpm/ft^2	7.1 gpm/ft^2
Pre-Oxidation Chemistry	Sodium Hypochlorite	Sodium Hypochlorite	Sodium Hypochlorite
Avg. Oxidant Dosage (additional)	0.21 mg/l	0.21 mg/l	0.21 mg/l
Oxidant Feed Control	Flow Proportional	Flow Proportional	Flow Proportional
Minimum Chlorine Residual	0.5 mg/l	0.5 mg/l	0.5 mg/l
Media Configuration:	Dual Bed	Dual Bed	Dual Bed
Anthracite – Bed Depth	15"	15"	15"
Anthracite – Vol/Vessel	9.0 ft^3	9.0 ft^3	9.0 ft^3
Greensand Plus – Bed Depth	24"	24"	24"
Greensand Plus – Vol/Vessel	14.1 ft^3	14.1 ft^3	14.1 ft^3
Bedding Quartz	Bottom Head	Bottom Head	Bottom Head
Total S/S Filter Media Depth	39"	39"	39"
Freeboard	21"	21"	21"
Backwash Flowrate	32 gpm	32 gpm	32 gpm
Backwash Hydraulic Loading	4.5 gpm/ft^2	4.5 gpm/ft^2	4.5 gpm/ft^2
Air Scour Loading	2 cfm/ft^2	2 cfm/ft^2	2 cfm/ft^2
Backwash Bed Expansion	40%	40%	40%
Backwash Duration	10 minutes	10 minutes	10 minutes
Backwash Volume	320 gallons	320 gallons	320 gallons
Final Rinse Flowrate	50 gpm	50 gpm	50 gpm
Final Rinse Duration	3 minutes	3 minutes	3 minutes
Final Rinse Volume	150 gallons	150 gallons	150 gallons
Operating Cycle Capacity/Vessel	155000 gallons	155,000 gallons	155,000 gallons

Table 2-4 Greensand Filter System Media Specification		
	Anthracite	**Greensand Plum**
Acid Solubility (AWWA B100-89)	<1%	NA
Caustic Solubility (1% @ 190°F)	<1%	NA
Specific Gravity	1.65	2.40
Effective Size	0.65 to 0.90 mm	0.30 to 0.35 mm
Screen Grading	NA	18 x 60 Mesh
Sphericity (Loose)	0.61	NA
Sphericity (Packed)	0.60	NA
Hardness (Mohs Scale)	3.0 to 3.8	NA
Ignition Point	950°F	NA
Porosity	NA	0.45
Uniformity Coefficient	NA	<1.60
pH Range	NA	6.2 to 8.5

3.0 GREENSAND FILTRATION PILOT PLANT SYSTEM & TEST PROGRAM

The Greensand Filtration Process is recommended for application treating the pre-filtered, pre-oxidized source water. The concept design for the full-scale greensand filtration system is presented in Table 2-3, integrated into the existing water treatment processes. The pilot plant would consist of a series of greensand filter vessels installed within the existing Treatment Building, treating a side stream of the pre-treated water.

3.1 Design of Pilot Plant System

The pilot plant will operate under the same hydraulic and loading conditions, chemical pre-treatment and pressure, as the full-scale treatment system, therefore the pilot plant operating data and findings require no adjustment or scale-up for the full-scale treatment system operation. The greensand filter pilot plant will utilize 13" Ø x 54" Ht. vessels, installed in parallel, to evaluate a range of hydraulic loading from 2 to 8 gpm/ft^2. The specifications for the pilot plant system are summarized in Table 3-1, and the installation is presented in the attached Process Flow Diagram figures.

Table 3-1
Greensand Filter Pilot Plant
Design & Operating Criteria

Process Type	Catalytic Oxidation
Operating Configuration	Parallel, Continuous
Vessel Dimensions	13" ϕ x 54" Ht.
X-Section Surface Area	0.92 ft^2
Design Flowrate per Vessel	1.8 to 7.5 gpm
Hydraulic Loading	2 to 8 gpm/ft^2
Pre-Oxidation Chemistry	Sodium Hypochlorite
Avg. Oxidant Dosage (additional)	0.21 mg/l
Oxidant Feed Control	Flow Proportional
Minimum Chlorine Residual	0.5 mg/l
Media Configuration:	Dual Bed
Anthracite – Bed Depth	Variable
Greensand Plus – Bed Depth	Variable
Freeboard	15"
Backwash Flowrate	4 to 11 gpm
Backwash Hydraulic Loading	12 gpm/ft^2
Backwash Bed Expansion	40%
Backwash Duration	10 minutes
Backwash Volume	110 gallons
Final Rinse Flowrate	5 gpm
Final Rinse Duration	3 minutes
Final Rinse Volume	15 gallons
Operating Cycle Capacity/Vessel	50,000 to 102,000 gallons
Operating Cycle Duration	5 - 10 days

3.2 Greensand Filter Pilot Plant Test Protocols

3.2.1 Installation and Preparation of Pilot Plant Filter Vessel: Upon completion of the installation of the pilot plant filter vessels, the system will be inspected to assure compliance with the design documents. The (Inversand) Greensand Plus media will be installed into the vessel in accordance with the specifications and the written protocol provided by Inversand. The Greensand Plus media will then undergo oxidative preconditioning in accordance with the specifications and Inversand approved protocol. Upon completion of the greensand media preconditioning, the anthracite media will be installed and then the vessel will undergo a full backwash and rinse, to prepare the vessel for operation

3.2.2 Pilot Plant Operating Plan: To assess and validate the performance of the Greensand Filtration process in this application, the Pilot Plant vessels will be operated through multiple operating cycles, under the range of load conditions. The pilot plant operating duration may be extended with additional cycles if determined to be needed to fully assess and validate performance. Assuming continuous operation the Pilot Plant is anticipated to be operated for a minimum of 10 to 20 consecutive days. During the pilot plant operation critical operating variables and performance to be assessed shall include, but not be limited to, the following:

- Hydraulic Loading;
- Chlorine Pre-Oxidant Dosage and Oxidation Efficiency;
- Raw Water pH;
- Manganese Loading and Removal Efficiency;
- Effective System Capacity – gallons;
- Effective System Capacity – manganese mass load;
- Backwash Flowrate, Volume, and Manganese Concentration;
- Evaluation of Field Monitoring (Mn) v Laboratory Monitoring Results

Pilot Plant monitoring will include flowrate; volume treated; influent and effluent chlorine, iron, manganese concentrations, pH, conductivity and turbidity and inlet/outlet pressure. The chlorine residual analyzer shall provide automatic monitoring of the filter effluent chlorine residual.

3.2.3 Hydraulic Loading: The feedwater flowrate will be monitored at each filter control head, and will be throttled to the specified operating flowrate (2 to 8 gpm). The greensand filter control head water meter will provide indication of the water flowrate continuously during operation, and also indication of the gallons of raw water treated on each filter operating cycle. The operating cycle volume will be specified and programmed into the control head. Manual logging of the pilot plant pressure, flowrate, treated water volume and water quality parameters will augment the electronic monitoring and logging to assess the following, for each operating cycle:

- Instantaneous Filter Bed Hydraulic Loading (gpm/ft^2);
- Filter Bed Total Volumetric Loading (gallons/ft^2);

- Filter Bed Mn Mass Load (Grains/ft^2);
- Filter operating pressures and differential pressure;
- Turbidity leakage vs effluent manganese;

3.2.4 Chlorine Pre-Oxidant Load and Oxidation Efficiency: Field monitoring of filter influent/effluent total and free chlorine will be used to quantify the pre-oxidation chlorine mass load, the filter effluent chlorine residual and the oxidant demand per mass of manganese removed. The pre-oxidant dosage will be evaluated relative to the influent total manganese and iron concentrations and the dosage may be adjusted as needed to optimize the efficiency of the treatment process. Additionally, the filter effluent chlorine residual will be automatically monitored and data logged, providing extensive data to assess the optimum concentration to use for process control and as an indicator of performance.

3.2.5 Raw Water pH: The pre-treated water average pH 7.5 su, indicating that pH adjustment upstream of the greensand filtration system is not needed. The influent water to the Pilot Plant will undergo pH monitoring to assess the consistency of the pH and if there is any adverse impact upon manganese oxidation and treatment performance.

3.2.6 Manganese Loading and Removal Efficiency: The filter influent and effluent manganese and iron concentrations will be monitored using a combination of field and laboratory analyses. The monitoring data will be accumulated over each operating cycle and be used to assess the total and unit mass load of total manganese and total Mn/Fe the filter bed. This data is critical to the overall pilot plant performance evaluation and will be used to assess the effective filter cycle time/volume relative to Mn mass loading and chlorine residual. Ultimately, this data will be used to develop baseline performance curves to be incorporated into the system O&M Manual and be used as a diagnostic tool for system operational monitoring.

3.2.7 Backwash Water Flowrate, Volume, and Manganese Concentration: Upon completion of each operating cycle the Pilot Plant filter vessel shall undergo a proscribed backwash protocol that is programmed into the filter control head. The backwash flowrate, hydraulic loading rate (gpm/ft^2), duration and volume will be monitored. During backwash events the backwash discharge will be sampled at 2-minute intervals for analysis. Field testing shall include turbidity and manganese content and laboratory analyses shall include TSS and total manganese content. The intent of the backwash water monitoring shall be to assess the repeatability of the system performance and also develop a profile of the backwash water characterization over time. This in turn will be used to develop a baseline "bell curve" of volume v [TSS] and volume v [Mn] that will be used to assess the effectiveness of the backwashing, and determine if the backwash flowrate and duration is acceptable or must be modified to optimize the system performance. The backwash curves will be incorporated into the system O&M Manual and be used as a diagnostic tool for operational monitoring, in conjunction with other critical parameters including chlorine residual, manganese concentrations, pH and hydraulic loading.

3.2.8 Evaluation of Field Monitoring (Mn) v Laboratory Monitoring Results: A comparison of the results of field and laboratory analysis of iron and manganese will be conducted to assess the accuracy and correlation of the field test kit results to laboratory wet chemistry results. This is critical to assess because the field test kits will be used for routine, daily operational monitoring of the full-scale system, augmented by periodic laboratory wet chemistry analysis.

3.2.9 Disinfection-by-Products Evaluation: An evaluation of effluent DBP formation will be performed using samples of the greensand filter effluent. This test program shall include the following:

Discrete samples of greensand filter and slow sand filter effluent shall be drawn and analyzed for Mn and Chlorine Residual;

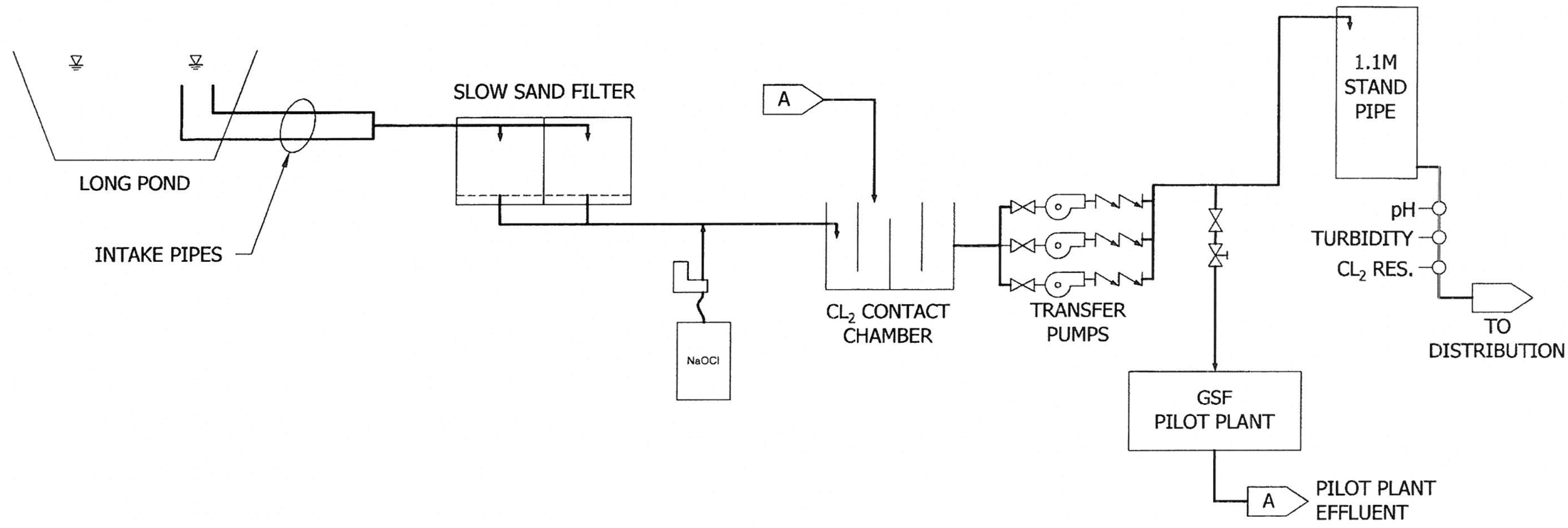
Sample splits will be obtained at intervals of: 0 to 240-hours for DBP (HAA5 & TTHM) analysis, to assess the impact of hydraulic retention time upon DBP formation.

The Pilot Plant test data will be compiled into spreadsheets for tabulation and evaluation. A sample spreadsheet is presented with this Pilot Plant Proposal.

3.3 Greensand Filtration Pilot Plant Documentation & Report

Upon completion of the Pilot Plant program a comprehensive Pilot Plant Summary Report shall be prepared and submitted to MassDEP. The report shall present the following information, summary evaluations and recommendations, including, but not limited to, the following:

- Description of the Pilot Plant system equipment and installation including documentation drawings and photographs;
- Summary of Pilot Plant test protocols, operating/performance and backwash data, in tabular format;
- Pilot plant performance evaluation and summary, including tabular and graphic outputs of hydraulic loading; manganese removal efficiency, mass loading and maximum load capacity; effluent quality; optimum effluent chlorine residual; pH; backwash loading and efficiency, DBP evaluation, etc.
- Recommendations for full-scale operation;
- Complete set of all laboratory certificates of analysis, meter outputs, chlorine residual analyzer data log, etc.



ISSUE	DATE	REVISION	BY	CHK

Water Solutions

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HOUSATONIC WATER WORKS COMPANY

GREAT BARRINGTON, MASSACHUSETTS

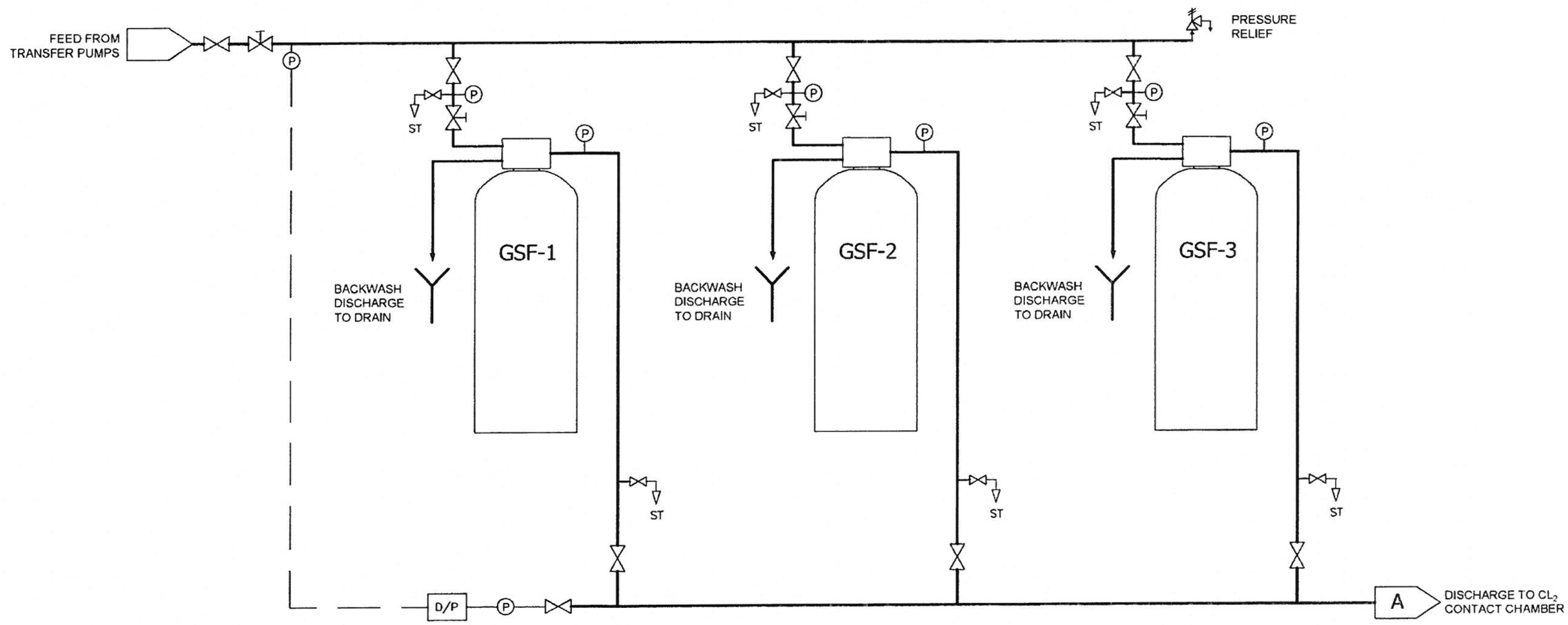
PILOT PLANT

PROCESS FLOW DIAGRAM

SHEET 1

DRAWN BY: SS
DESIGNED: RFF
CHECKED: RFF
APPROVED: RFF
SCALE: NTS
DRAWING NUMBER: PF-1

FILE NUMBER:
DATE: 5/23/2022
PROJECT NUMBER:



ISSUE	DATE	REVISION	BY	CHK

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HOUSATONIC WATER WORKS COMPANY

GREAT BARRINGTON, MASSACHUSETTS

PILOT PLANT

GREENSAND FILTER PILOT PLANT

SHEET 2

DRAWN BY	SS
DESIGNED	RFF
CHECKED	RFF
APPROVED	RFF
SCALE	NTS
DRAWING NUMBER	P-1
FILE NUMBER	
DATE	5/23/2022
PROJECT NUMBER	

Northeast Water Solutions, Inc.

May 20, 2022

MassDEP Western Regional Office - Springfield
Division of Drinking Water
436 Dwight Street
Springfield, MA 01103

Attn: Dierdre Doherty – Drinking Water/Municipal Services Chief

RE: Housatonic Water Works Company, PWS ID#1113003
BRP WS 21B Application for Approval

To Whom It May Concern:

Enclosed with this letter is MassDEP Transmittal Form X289054 and BRP WS 21B Application to Conduct a Pilot Study >40,000 gpd and <200,000 gpd, and the requisite supporting technical documentation. The purpose of this letter is to provide a comprehensive explanation of this request, and the subject Applications to conduct a pilot plant at the existing treatment facility.

The Housatonic Water Works Company (HWWC) water treatment, storage and distribution facility produces an average demand of approximately 100,000 gpd (0.1 MGD), operating with a flowrate range of 50 to 150 gpm. The finished water produced by the system contains variable amounts of manganese at levels from non-detectable (<0.020 mg/l) to 0.282 mg/l. During the majority of each operating year the manganese concentration demonstrates consistent compliance with water quality requirements. However, during the "summer season", June 1 to September 30, the manganese will sometimes seasonally increase to levels that cause problems with water color. Additionally, the system has recently experienced quarterly exceedances of the Disinfection-by-Products (DBP) HAA5 LRAA (60 ug/l).

The water produced by facility presently undergoes treatment including slow sand filtration and chlorination prior to discharge to the 1.1M gallon standpipe tank and the distribution system. HWWC desires to implement a manganese treatment system to produce water consistently in compliance with the MassDEP Secondary Limit (0.05 mg/l), using a target water quality goal of 0.015 mg/l.

To facilitate this objective, HWWC proposes to conduct a pilot plant program using Greensand Filtration, which has been demonstrated to be an effective treatment process for removal of manganese from raw water supplies. The intent of the pilot plant shall be to test and evaluate a pilot greensand filtration system, installed into the existing water treatment facility. The pilot plant program will evaluate the impact of critical operational variables (hydraulic loading, manganese loading, pre-oxidation chlorine dosage, turbidity, differential pressure, pH etc.) upon finished water quality and will define the operating criteria for a full-scale system. The pilot plant is proposed to operate at 5-15% of the full-scale capacity, for up to 4 weeks, to provide a rigorous evaluation of the process.

567 South County Trail, Suite 116, Exeter RI 02822. Tel: 401-667-7463. Fax: 401-667-7465 www.nwsi.net

The pilot plant test program will also include a rigorous evaluation of DBP formation in the system. This program will evaluate critical variables including precursor TOC loading, effectiveness of the slow sand filtration system, chlorine dosage, oxidative impact of the greensand filter system, and post-treatment hydraulic retention time in the water storage standpipe tank. The intent of this program will be to refine the analysis of DBP causal factors and determine alternatives for corrective action.

The attached Proposal for the Pilot Plant Test Program provides the complete design, installation and operating criteria for the Greensand Pilot Test and the DBP evaluation program.

I trust these applications and supporting documents will fulfill the requirements for review and approval of the proposed system construction/modifications. Please contact this office with any questions or comments.

Sincerely,

Robert F. Ferrari, PE
Northeast Water Solutions, Inc.

cc: James J. Mercer - HWWC

Water Distribution System Modeling Report

Housatonic Water Works Company

April 2022

Prepared for:

Housatonic Water Works Company
Great Barrington, Massachusetts

LENARD ENGINEERING INC.
CIVIL, ENVIRONMENTAL AND HYDROGEOLOGICAL CONSULTANTS
www.lenard-eng.com

LIST OF ATTACHMENTS

LIST OF MAPS AND FIGURES

LIST OF TABLES

HOUSATONIC WATER WORKS
WATER SYSTEM MODELING REPORT

EXECUTIVE SUMMARY

Lenard Engineering, Inc. (LEI) constructed a water distribution system model of the Housatonic Water Works (HWW) system, and evaluated the impact of various water main and water storage tank improvement options on available fireflows.

The primary focus of this report was to identify options that would increase available fireflows to the main core (Housatonic Village) of the water distribution system. Secondarily, the report evaluated the impacts of other distribution system improvements on locations throughout the distribution system.

As discussed in this report, LEI recommends HWW construct a new 200,000 gallon minimum volume elevated water storage tank on High Street, which would improve fireflows from the current 650 gpm to over 1,000 gpm, while at the same time stabilizing pressures at the system's higher elevations in the system during fireflow events.

I. INTRODUCTION

Maintaining adequate pressure and fire hydrant flows is important for water distribution systems. Lenard Engineering, Inc. (LEI) conducted a modeling study of the Housatonic Water Works Company (HWW) water distribution system to help identify any potential issues with low pressure or low fire-fighting flows, and to propose appropriate solutions as needed.

The HWW system operates as a single pressure zone, with system pressures regulated by the water level in the 1.0 MG concrete water storage tank located at the Long Pond treatment plant. This tank has an overflow elevation of 960 feet above sea level.

The existing HWW water distribution system consists of approximately 103,000 feet of water mains ranging from 2" to 12" in diameter. Piping materials consist of ductile iron, cast iron, asbestos cement, and PVC piping.

Water service elevations within the HWW system range from approximately 700 – 865 feet, a difference of 165 feet. This corresponds to a static pressure range during average daily demand conditions of between ~40 and ~110 psi. The highest location within the HWW system and thus lowest static pressure is located on Prospect Street at approximately 865 feet elevation.

II. GOALS

Pressure: Massachusetts drinking water regulations require a minimum of 35 psi water pressure at all locations during normal conditions, which is met in the HWWC system with a minimum pressure of 40 psi. The regulations also require a minimum 20 psi pressure during all conditions including fire flow. That is expected to be maintained at most locations within the HWW system during fire flow except for the most elevated locations such as Prospect Street.

Available fire flows: The Insurance Service Office (ISO) provides recommendations for needed fire flow for various types of structures and uses. For single-family residential areas, the typical needed fire flow is between 500 – 750 gpm, while maintaining 20 psi at all system locations. For commercial and industrial zoned areas, needed fire flows of 1,000 gpm or more are generally recommended, which varies by building use, construction materials, and proximity to adjacent structures.

III. MODEL DATA INPUT

A) <u>Mapping</u>- LEI utilized the June 2017 Tighe & Bond map to generate a hydraulic model using the WaterCAD software program. This map was reviewed for accuracy by HWW, and several more recent pipe improvements were added.

B) <u>Water Demands</u> - HWW provided updated water production records from the Long Pond slow sand filtration plant, which provided an average daily demand value of **0.11 MGD**, and a maximum daily demand value of **0.23 MGD**, which occurred during hydrant flushing.

LEI utilized a value of **0.15 MGD**, approximately 140 % of the average daily demand, to simulate peak daily demand conditions in our model, during non-flushing periods.

IV.. HYDRANT FLOW TESTING AND MODEL CALIBRATION

HWW conducted ten fireflow tests within the distribution system, to provide updated pressures and flows for model calibration purposes. **Figure 1** shows the flow test locations, taken throughout the system. Copies of the flow test results are provided in **Attachment A**.

Table A compares field flow and pressure results to those predicted by the model. The model was calibrated under both static conditions (no hydrants flowing), as well as dynamic conditions (with hydrants flowing). Good calibration is typically defined as the majority of the model predicted values being within 10 psi of observed field conditions. These are shown highlighted in yellow. The model had good calibration for 9 out of 10 locations for static conditions, and 7 out of 10 locations during dynamic conditions.

Several key observations during model calibration:

- 1) The Hazen-Williams "C" factor for water mains measures the relative roughness of the piping. The "C" factors throughout the HWW system were surprisingly higher (smoother) than expected for pipes approaching 100 years in age. Whereas older piping C values typically range from C=30 to C= 60, the model calibrated reasonably well assigning a C = 100 to the majority of the pipes. Note that brand new ductile iron piping is assigned a C factor of C = 140.

  A "C" factor of 100 is indicative of pipes with little or no buildup, which confirms HWW observations of smooth piping in good condition made during main tapping and repairs.

2) The model calibrates very well for Flow Test # 1 on North Plain Road. This location is critical, as this is reflective of the long 7,300 feet of 10" and 12" water main between the plant and the first customer. As all the water passes through this piping, getting this pipe accurately modeled is critical.

3) Flow tests # 5 and # 6, Front Street and Pleasant Street- also had good calibrations. This area – Front Street and Pleasant Street (Node J-50), will be used to compare the impacts of various system improvements on available fireflow in Housatonic Village.

4) The calibrated model predicted that negative pressures are occurring during fire flow conditions at local high point on Prospect Street (Node J-73). Maintaining positive pressures at all system locations, especially at the systems high points, is critical. Predictions of pressures at this high point during various system improvement options are shown in the tables.

High point pressures on Prospect Street should be monitored during future hydrant flow testing, to help confirm residual pressures at this critical location.

5) The three locations that fell outside the 10 psi calibration threshold are at system dead ends, which do not impact the calibration of the remainder of the modeling.

IV. POTENTIAL SYSTEM IMPROVEMENTS

LEI evaluated the impact of eliminating several smaller water mains, which could increase available flows and fireflows to the system. These potential improvements are shown on **Figure 2**, and included:

- Improvement # 1- Replacing 2,700 feet of 6" asbestos cement (AC) main on Van Deusenville Road with new 12" ductile iron (DI) piping. 12" piping was chosen, as it will connect a 10" main coming from the Water Treatment Plant, to a 12" main to the north which extends towards Housatonic Village.

- Improvement # 2- Replacing 5,600 feet of 6" CI main on North Plain Road with new 8" DI piping. An 8" main was chosen, as it continues an 8" main coming from the plant and connects at Crimson Lane.

- Improvement # 3- Replacing 2,400 feet of 4" and 6" CI main on Main Street North with new 8" DI piping.

- Improvement # 4- Replacing 2,100 feet of 6" CI main on Park Street with new 8" DI piping.

- Improvement # 5- Installing 7300 LF of parallel 12" piping between the treatment plant and North Plain Road.

- Improvement # 6- Constructing a 200,000 gallon elevated water storage tank on High Street.

V. WATER MODELING RESULTS

LEI used our model to evaluate alternative solutions to improve available fireflows within the HWW system.

LEI used the recent hydrant flow testing to create a baseline existing condition run, which was used for comparisons with other runs. Then LEI modeled fireflows at five different locations in the system, as shown in **Tables 1-5**. For each option, we simulated peak daily demands of 0.15 MGD, coincident with fire flow conditions, and evaluated residual pressures at the highest elevation in the system on Prospect Street (Node J-73).

LEI simulated fireflows of 750 gpm in residential areas, as this is the typical available fireflow required by the Insurance Service Office (ISO) to be provided in residentially zoned areas, while maintaining 20 psi residual pressure in all remaining locations.

ISO recommends higher available flows in commercial and industrial locations, and LEI plugged in flows as high as 1,500 gpm to evaluate their impacts.

A) IMPACTS OF PIPELINE IMPROVEMENTS ON FIRE FLOWS AT FRONT ST. (Node J-50)

Table 1 provides a summary of our modeling results of the existing conditions, and various pipe upgrades to improve fire flows on Front Street near the intersection of Pleasant Street.

Current Conditions: The model indicates that during a fire flow of 750 gpm the upstream node would drop in pressure from 91 psi to 49 psi and the pressure on Prospect St. would drop from 40 psi to -3 psi.

With Improvement Options 1, 2 and 3 In Place: LEI evaluated each of the piping improvements on Van Deusenville Road, North Plain Road, and on Main Street North, to see what impacts they have by themselves and in combination, on increasing available fireflows. As shown in **Table 1**, fireflows can be increased marginally, from 750 to 1000 gpm, but negative pressures will still occur at the system high point on Prospect Street.

B) IMPACTS OF PIPELINE IMPROVEMENTS ON FIRE FLOWS AT SPRUCE ST. (Node J-34)

Table 2 provides a summary of our modeling results of the existing conditions, and pipe upgrades to improve fire flows on Park Street, near the intersection of Spruce Street (Node J-34). .

Current Conditions: The model indicates that during a fire flow of 440 gpm the upstream node would drop in pressure from 93 psi to 63 psi and the pressure on Prospect Street would drop from 40 psi to 29 psi.

The model predicts that during a fire flow of 750 gpm the upstream node would drop in pressure from 93 psi to 13 psi and the pressure on Prospect Street would drop from 40 psi to 14 psi.

- **With Option 4 Improvements In Place:** Option 4 includes replacing approximately **2,100 feet** of undersized existing 6" water main with new 8" water main on Park Street. At a simulated fire flow of 750 gpm, with this improvement in place, residual pressures increase from 13 psi to 58 psi. The residual pressure at the Prospect Street high point would remain at 14 psi.

C. IMPACTS OF PIPELINE IMPROVEMENTS ON FIRE FLOWS AT NORTH PLAIN ROAD (Node J-124)

Table 3 provides a summary of our modeling results of the existing conditions, and pipe upgrades to improve fire flows on North Plain Road near Linda Street.

Current Conditions: The model indicates that during a fire flow of 380 gpm the upstream node would drop in pressure from 82 psi to 59 psi and the pressure on Prospect Street. would drop from 40 psi to 25 psi.

The model predicts that during a fire flow of 750 gpm the upstream node would drop in pressure from 82 psi to 7 psi and the pressure on Prospect Street. would drop from 40 psi to -5 psi.

With Option 2 Improvements In Place: Option 2 replaces approximately **5,600 feet** of undersized existing 6" water main with new 8" water main on North Plain Rd. With Option 2 improvements in place, at 750 gpm the residual pressure increases significantly, from **7 psi** to **43 psi.**

With this improvement in place, the pressure on the end of the line on Great Barrington Rd. is predicted to drop from 68 psi to 7 psi.

D. IMPACTS OF 7,300 LF OF PARALLEL 12" WATER MAIN FROM WATER TREATMENT PLANT TO NORTH PLAIN ROAD

Table 4 evaluates the impacts of installing a parallel 12" water main from the treatment plant to North Plain Road, in combination with the existing 10" and 12" main. The impacts generally improve pressures systemwide by approximately 16 psi, as this parallel pipe eliminates that amount of head loss, prior to branching off into the system.

Note that in the Housatonic Village area, residual pressures during fireflows at Front Street (Node J-50) are better, but slightly sub-standard pressures at the Pleasant Street high point (Node J- 73) still exist (13 psi at 750 gpm, and -4 psi at 1000 gpm).

E. IMPACTS OF PROPOSED 200,000 GALLON ELEVATED STORAGE TANK AND PIPELINE IMPROVEMENTS ON FIRE FLOWS AT FRONT STREET (Node J-50)

Table 5 provides a summary of our modeling results of the existing conditions, adding a 200,000 gallon water tank to improve fireflows in the core of the water distribution system. LEI chose 200,000 gallon sizing initially to provide two hours of fireflow storage at a rate of 1000 gpm (totaling 120,000 gallons), along with an additional 80,000 gallons reserved to meet typical peak domestic demands.

Current Conditions: The model indicates that during a fire flow of 750 gpm on Front Street the upstream node would drop in pressure from 91 psi to 49 psi, and the pressure on Prospect Street would drop from 40 psi to -2 psi.

Adding New Tank Only: Adding a new 200,000 gallon elevated water storage tank only and using the existing piping will allow full use of the 750 gpm fireflow, while drastically improving the water pressure at the high point in the system (41 psi).

Increased flow to 1,500 gpm would be available at Front Street, but predicted pressures at the high point are 9 psi, below the recommended 20 psi. Conservatively, we estimate an increased fireflow of **1,000 gpm** can be provided, while maintaining greater than 20 psi at all point in the system.

VI. CONCLUSIONS

1) LEI evaluated the impacts of both water distribution piping replacements, as well as adding a new water storage tank on the HWW system. Although pipeline replacement in the system has some positive results, the optimum improvement to enhance fireflows in the core of the system would be to construct a 200,000 gallon elevated water storage tank on High Street.

   This improvement would increase available fireflows to over 1,000 gpm, while maintaining adequate pressures at the systems high point on Prospect Street.

2) The added benefit to providing a tank within the distribution system is that HWW could potentially reduce the amount of water storage required at the Long Pond treatment plant.

   A smaller tank would still meet the chlorine contact time requirements of the Surface Water Treatment Rule, but also reduce water age which could potentially also reduce the concentrations of disinfection by-products (TTHM's and HAA5).

FIGURES

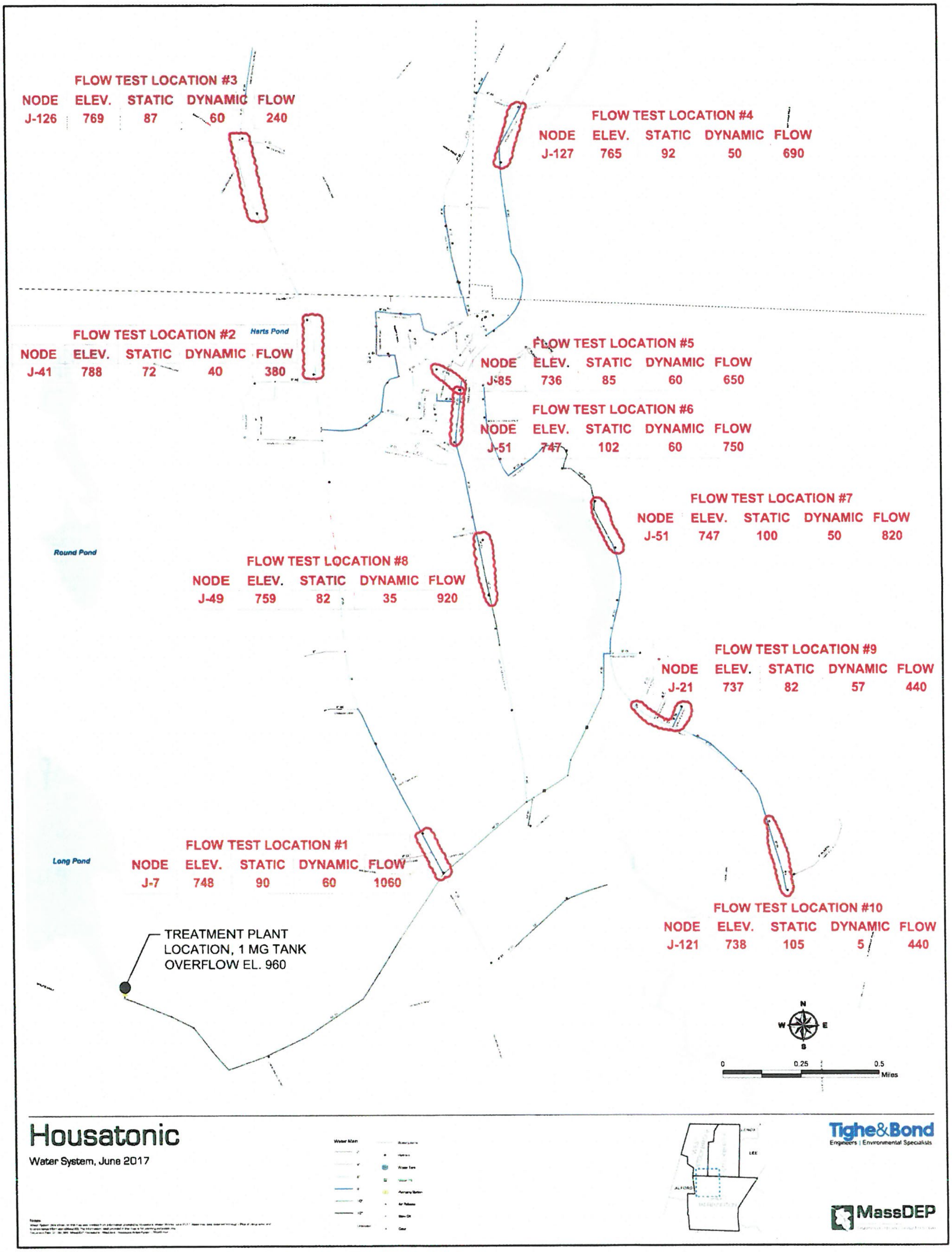


FIGURE 1 - FLOW TEST LOCATION MAP

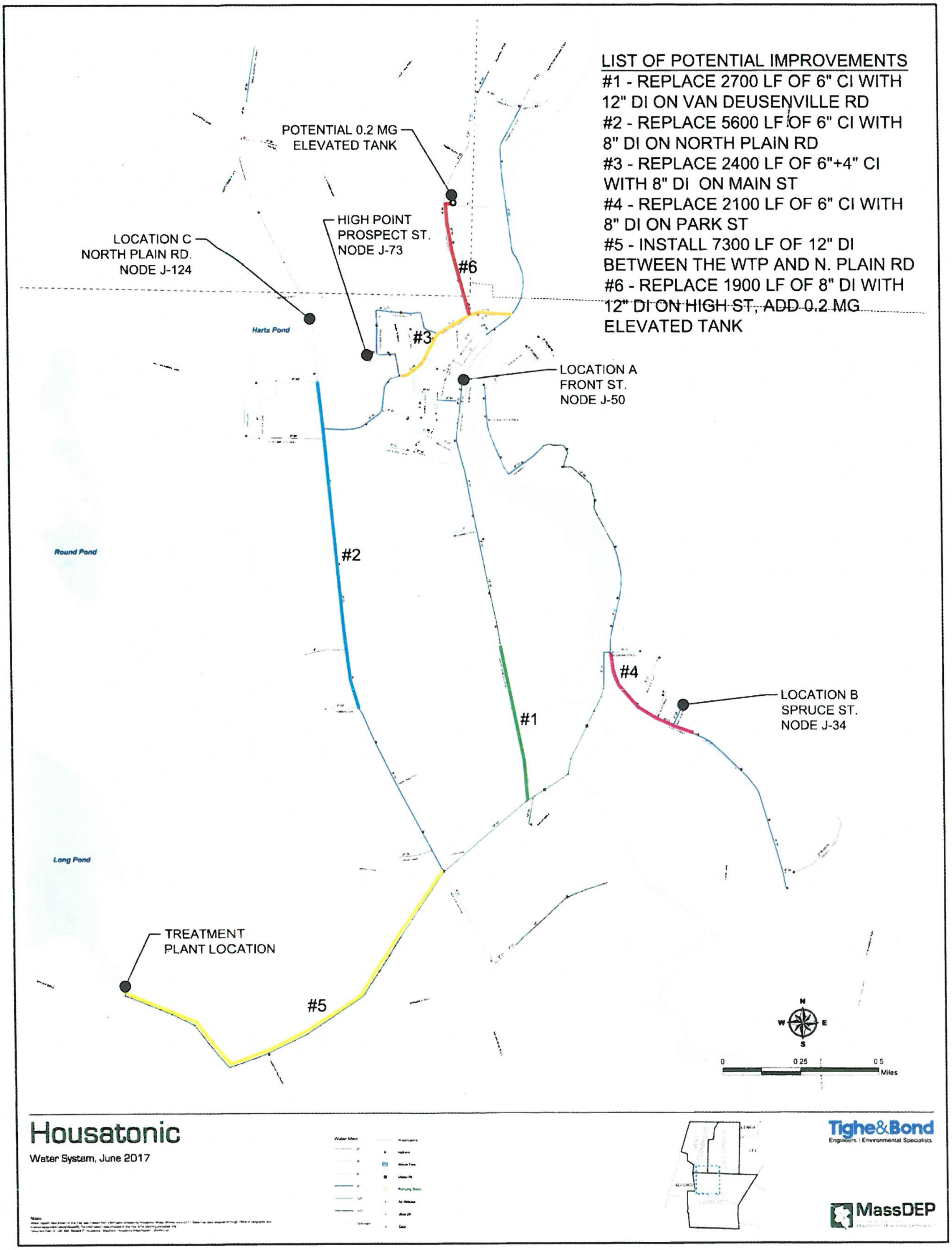
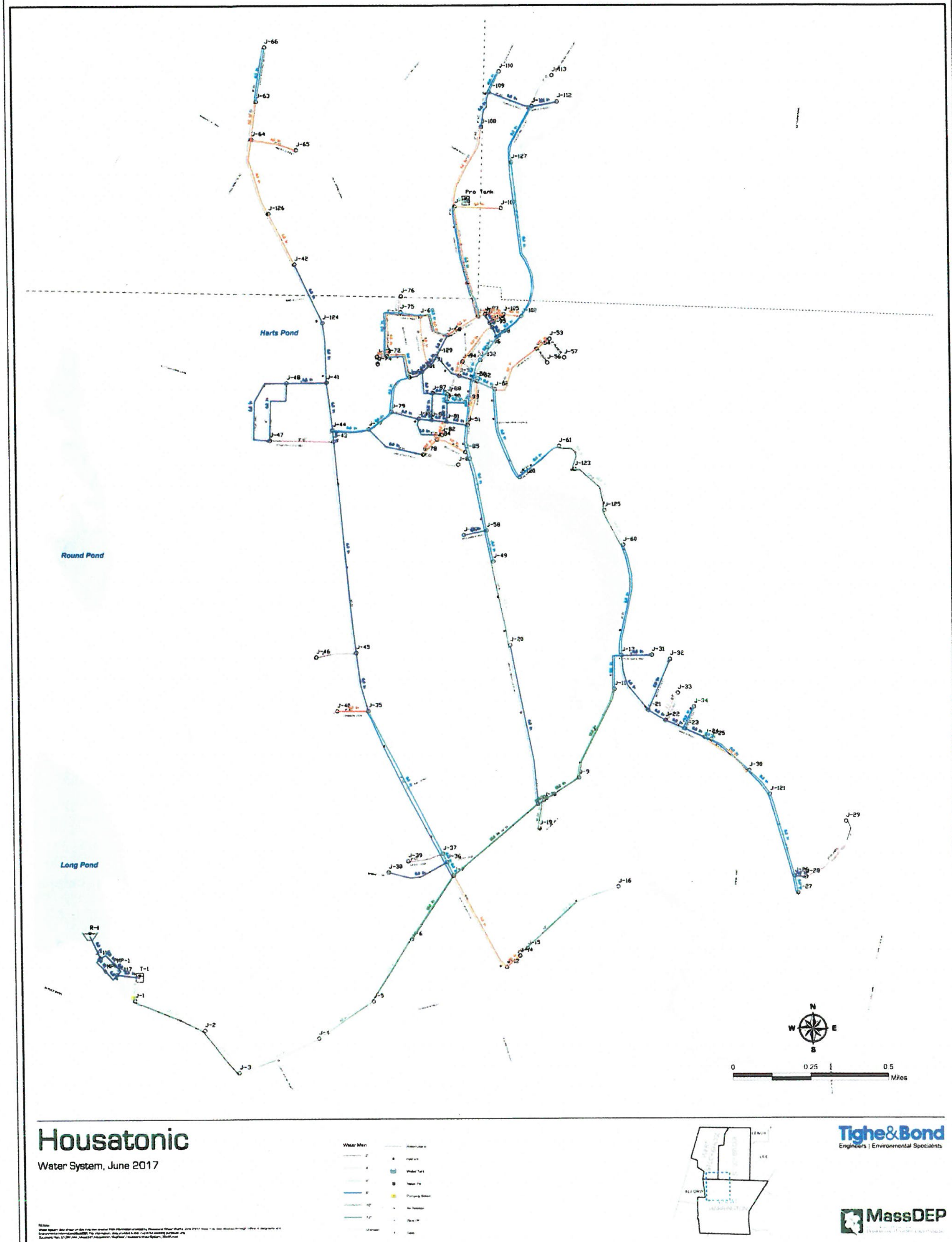


FIGURE 2 - POTENTIAL WATER SYSTEM IMPROVEMENTS

Attachment A - WaterCAD Node Map



Job #: 21-382	Drawing #: 1	**Lenard Engineering, Inc.** Civil, Environmental and Hydrogeological Consultants 2210 Main Street, GLASTONBURY, CT (860) 659-3100 140 Willow Street, WINSTED, CT (860) 379-6669 19 Midstate Drive, AUBURN, MA (508) 721-7600	WATERCAD NODE MAP *PREPARED FOR* *Housatonic Water Works* *Great Barrington, Massachusetts*	Drawing date: March 2, 2022 Drawing Scale: AS SHOWN Rev. / Date / Revision / By	Designed By: JED Drawn By: JED Checked By: JEE CAD File: BasePipes