



## Department of Environmental Protection

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*SENT VIA ELECTRONIC MAIL*

Mr. James Mercer, Treasurer  
Housatonic Water Works  
80 Maple Ave Ste 1  
Great Barrington, MA 01230

August 1, 2022

Housatonic Water Works  
PWS ID#: 1113003  
BRP WS 21B Pilot Study  
Mn Treatment, Transmittal # X289054  
Conditional Approval

Dear Mr. Mercer,

The Massachusetts Department of Environmental Protection (MassDEP) received the above referenced permit application dated May 20 on May 26, 2022. The permit application was prepared and submitted by Northeast Water Solutions, Inc. (NWSI) on behalf of the Housatonic Water Works Company (HWWC). Subsequently following the application, NWSI's Robert F. Ferrari PE, provided critical supplemental information required for this pilot study to MassDEP on June 24, 2022, June 27, 2022 and July 12, 2022.

The above referenced permit application is conditionally approved for manganese (Mn) treatment pilot study. MassDEP understands from some statements by the applicant that it hopes to understand and address Disinfection Byproduct issues through selective monitoring during the pilot. **This conditional approval is based on a pilot for Mn treatment only**, with appropriate consideration of simultaneous compliance with the Surface Water Treatment rule, Lead and Copper Rule and Disinfection Byproducts Rule. The piloted treatment does not have state-wide new technology approval for Mn treatment of surface water. **Please read the conditions cited carefully.** The conditions cited in the attached document must be met or the permit is void. **MassDEP must conduct a final inspection of the pilot study setup prior to running the Pilot test at HWWC.** MassDEP also requires HWWC to fully isolate and dispose of the piloted water safely and not mix pilot study water with the HWWC drinking water.

Note that the signature on this cover letter indicates formal issuance of the attached document. If you have any questions regarding this matter, please contact Hem Pokharel at 617-455-7957 or [Hem.Pokharel@Mass.Gov](mailto:Hem.Pokharel@Mass.Gov).

Respectfully,

Deirdre Doherty  
Drinking Water/Municipal Services Chief  
Western Regional Office

Attachments: Conditional Approval, permit application pilot test schematic, pilot test sampling schedule  
cc: DWP, Boston, Great Barrington Board of Health (eCopy), Hem Pokharel (eCopy); Doug Paine (eCopy)  
DEP WERO\BWR\WS\Permits\Treatment\1113003 -HWW Mn Pilot\1113003-2022-08-01-PER-MnPilot-ConApvl-HousatonicWW

**Manganese Treatment Pilot Study– Housatonic Water Works Company**  
**Conditional Permit Approval**  
**BRP WS-21 B Pilot Study**

**Background:**

The Housatonic Water Works Company (HWWC) water treatment, storage and distribution facility produces an average demand of approximately 100,000 gpd (0.1 million gallons per day (MGD)), operating with a flowrate range of 50 to 150 gallons per minute (GPM). The permit application states that during 2020/2021, the system demonstrated an average daily use of approximately 104,000 gallons per day (GPD) to 111,000 GPD. 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. The permit application states that the majority of each operating year the manganese concentration demonstrates consistent compliance with water quality requirements. The permit application also states during the "summer season June 1 to September 30", the manganese will sometimes seasonally increase to levels that cause problems with discoloration of the treated water. Additionally, the system has recently experienced exceedances of the Disinfection-by-Products (DBP) HAA<sub>5</sub> LRAA (60 ug/l).

HWWC draws surface water supply from one (1) intake structure installed in Long Pond. The raw water enters the treatment building, where it undergoes slow sand filtration, chlorination (sodium hypochlorite) disinfection and clearwell mixing, prior to discharge to the nearby 1.1 MG water storage tank. 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 the above reference objective, HWWC submitted the above reference permit application to MassDEP to conduct a pilot study using Greensand Filtration, which has been demonstrated to be an effective treatment process for removal of manganese from raw ground water supplies, according to the vendor's brochure and specification. Based on the permit application, 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.

**Pilot Testing Objectives and Goals (Based on the permit application):**

The following language is from the permit application materials:

"The intent of the pilot plant shall be to evaluate the greensand (GreensandPlus) filtration process, installed following the existing chlorination process, for consistent removal of manganese to  $\leq 0.015$  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 (Mn) 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 greensandplus filtered water based upon hydraulic retention time in the water storage tank and distribution system."

**Water Characterization-Inorganic & Physical Parameters provided in the permit application:**

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.

<b>Table 2-1: HWWC Water Characterization</b>			
<b>Sample Date/Parameter</b>	<b>03/22/22</b>	<b>03/22/22</b>	<b>Cornwall Report 2018 - 2020</b>
<b>Location</b>	<b>Raw Water</b>	<b>Finished Water</b>	<b>POE</b>
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 <sub>3</sub> )	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 <sub>3</sub> )	-----	86.6 mg/l	-----
<b>Corrosion/Scale Indices:</b>			
Langelier Saturation Index	-----	-1.42	-----
Larson Skold Index	-----	0.25	-----
CSMR	-----	2.63	-----
Alkalinity-to-Chloride Ratio	-----	7.16	-----

Table 2.2 presents a summary of the analytical characterization of both the source water and POE finished water from August 3, 2020, through March 21, 2022. This table includes a breakout of the "summer seasonal monitoring during 2020/2021 from June 1<sup>st</sup> to September 30<sup>th</sup>, each year.

Total Manganese: Permit application states that 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/. 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 application continues by stating the seasonal variability is further demonstrated by the “non-summer” (October 1<sup>st</sup> to May 31<sup>st</sup>) monitoring indicating an average concentration of 0.0202 mg/l and a range of 0.0128 to 0.0411 mg/l. Based on the permit application, the seasonally increased manganese content contributes to the seasonal increase in both turbidity and color.

<b>Table 2-2</b>									
<b>HWWC Source &amp; Point-of-Entry Water Quality Monitoring (08/03/2020 – 03/21/2022)<sup>1</sup></b>									
<b>Parameter</b>	<b>Units</b>	<b>Long Pond Source Monitoring</b>				<b>Point-of-Entry Finished Water</b>			
		<b># Samples</b>	<b>Avg.</b>	<b>Min.</b>	<b>Max.</b>	<b># Samples</b>	<b>Avg.</b>	<b>Min.</b>	<b>Max.</b>
<b>Temperature:</b>									
All Samples	°C	21	14.1	0.7	27.2	43	13.0	2.0	25.7
Summer	°C	9	21.4	18.0	27.2	14	19.2	10.6	25.7
<b>pH:</b>									
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
<b>Tot. Dis. Solids</b>									
All Samples	mg/l	24	122	74	325	44	121	54	436
Summer	mg/l	10	129	74	325	15	118	98	168
<b>Alkalinity (CaCO<sub>3</sub>)</b>									
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
<b>Total Iron</b>									
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
<b>Total Mn</b>									
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
<b>Color</b>									
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
<b>Turbidity</b>									
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
<b>Cl<sub>2</sub> Residual</b>									
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 1<sup>st</sup> to September 30<sup>th</sup>, each year.**

The permit application included the following assertions: 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/, with only 3 of 28 samples having detectable manganese (0.0061 to 0.0141 mg/). 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 permit application concludes that the key to treatment to remove manganese must consistently achieve oxidation and precipitation of soluble manganese, that is passing through the slow sand filters.

#### **Pilot Testing Proposed in the Permit Application:**

Regarding the pilot plant, Table 3-1, provided in the permit application, presents a summation of the proposed pilot plant equipment including operating process & configuration, vessel size, hydraulic loading, oxidant and oxidant feed control, backwash specifications, etc. The table is presented again, herein.

<b>Table 3-1</b> <b>Greensand Filter Pilot Plant</b> <b>Design &amp; Operating Criteria</b>	
Process Type	Catalytic Oxidation
Operating Configuration	Parallel, Continuous
Vessel Dimensions	13" $\phi$ x 54" Ht.
X-Section Surface Area	0.92 ft <sup>2</sup>
Design Flowrate per Vessel	1.8 to 7.5 gpm
Hydraulic Loading	2 to 8 gpm/ft <sup>2</sup>
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 <sup>2</sup>
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

As presented in the permit application, the pilot plant will consist of 3 greensand filter vessels installed in parallel, to allow concurrent testing of the system operation and performance under different operating conditions (hydraulic loading, media configuration, etc.). Figure PF-1 presents the location of the pilot plant within the HWWC water treatment facility. As noted in the Proposal:

- The pilot plant will be integrated into the existing water treatment plant and therefore will require no side stream pumping, no separate chlorine feed system, etc.
- A side stream flow of filtered/chlorinated water will be drawn from the pumped transmission main from the water plant to the water storage tank. This position is optimal according to the applicant, because it is in the exact position it would be in the full-scale operation.

- “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 factoring for scale-up to the full-scale treatment system operation.”
- The position of the pilot plant provides the significant additional benefit of utilizing the existing chlorine residual, turbidity, and pH monitoring, immediately upstream of the pilot plant. This will provide a continuous, logged database of these critical water quality parameters, which can then be compared to the subsequent greensand filter effluent monitoring values, to assess system performance.

#### Filter Pilot Sampling and Analysis Protocol:

At the minimum, all pilot plant sampling would be done according to MassDEP policy 90-04, which was provided to HWWC. Greensand filtration system pilot plant operational water characterization monitoring schedule and filter backwash monitoring is provided below,

<b>TABLE 1 - HWWC  GREENSAND FILTRATION SYSTEM PILOT PLANT  OPERATIONAL WATER CHARACTERIZATION MONITORING SCHEDULE</b>						
Parameter/Composite Sample Date	Units	Continuous <sup>1</sup>	Hourly	Daily	Weekly	Other
<b>FIELD MONITORING:</b>						
Temperature – GSF Influent	°C		X			
Temperature – GSF Effluent	°C		X			
Turbidity – GSF Influent	NTU	X				
Dissolved Oxygen – GSF Influent	mg/L					4X/Day
Dissolved Oxygen – GSF Effluent	mg/L					4X/Day
pH – GSF Influent	SU	X				
pH – GSF Effluent	SU		X			
TDS – GSF Influent	mg/L					4X/Day
TDS – GSF Effluent	mg/L					4X/Day
Sp. Cond. – GSF Influent	umhos/cm		X			
Sp. Cond. – GSF Effluent	umhos/cm		X			
Cl Residual – GSF Influent	mg/L	X				
Cl Residual – GSF Effluent	mg/L					4X/Day
Manganese – GSF Influent	mg/L					4X/Day
Manganese – GSF Effluent	mg/L					4X/Day
<b>LABORATORY ANALYSIS:</b>						
Turbidity – GSF Effluent	NTU			X		
True Color – GSF Influent	Color Units				X	
Apparent Color – GSF Influent	Color Units				X	
True Color – GSF Effluent	Color Units				X	
Apparent Color – GSF Effluent	Color Units				X	
Carbon Dioxide – GSF Influent	mg/L				X	
Carbon Dioxide – GSF Effluent	mg/L				X	
TSS – GSF Influent	mg/L			X		
TSS – GSF Effluent	mg/L			X		
TDS – GSF Influent	mg/L				X	
TDS – GSF Effluent	mg/L				X	
Sp. Cond. – GSF Influent	umhos/cm				X	
Sp. Cond. – GSF Effluent	umhos/cm				X	
Alkalinity (CaCO <sub>3</sub> ) – GSF Influent	mg/L				X	
Alkalinity (CaCO <sub>3</sub> ) – GSF Effluent	mg/L				X	
Chloride – GSF Influent	mg/L				X	
Chloride – GSF Effluent	mg/L				X	
Sulfate – GSF Influent	mg/L				X	
Sulfate – GSF Effluent	mg/L				X	
Nitrate-N – GSF Influent	mg/L				X	
Nitrate-N – GSF Effluent	mg/L				X	
Calcium – GSF Influent	mg/L				X	
Calcium – GSF Effluent	mg/L				X	
Iron – GSF Influent	mg/L			X		
Iron – GSF Effluent	mg/L			X		
Total Manganese – GSF Influent	mg/L			X		
Total Manganese – GSF Effluent	mg/L			X		
Soluble Manganese – GSF Influent	mg/L			X		
Soluble Manganese – GSF Effluent	mg/L			X		

<b>TABLE 1 - HWWC  GREENSAND FILTRATION SYSTEM PILOT PLANT OPERATIONAL  WATER CHARACTERIZATION MONITORING SCHEDULE (Continued)</b>						
Parameter/Composite Sample Date	Units	Continuous	Hourly	Daily	Weekly	Other
<b>LABORATORY ANALYSIS:</b>						
Calcium – GSF Influent	mg/L				X	
Calcium – GSF Effluent	mg/L				X	
Magnesium – GSF Influent	mg/L				X	
Magnesium – GSF Effluent	mg/L				X	
Potassium – GSF Influent	mg/L				X	
Potassium – GSF Effluent	mg/L				X	
Sodium – GSF Influent	mg/L				X	
Sodium – GSF Effluent	mg/L				X	
Aluminum – GSF Influent	mg/L				X	
Aluminum – GSF Effluent	mg/L				X	
Heavy Metals – GSF Influent	mg/L					2X During Test
Heavy Metals – GSF Effluent	mg/L					2X During Test
VOCs – GSF Influent	ug/L					2X During Test
VOCs – GSF Effluent	ug/L					2X During Test
DBPs – GSF Influent	ug/L				X	
DBPs – GSF Effluent + Extended Study	ug/L				X	Water Age Study

Note 1: Existing on-line, real-time monitoring instrumentation.

<b>Table 2 – HWWC Greensand Filtration Pilot Plant  Filter Backwash Monitoring</b>					
Date					
Time					
Filter ID					
Cycle Vol.					
Backwash Duration	TSS	Turbidity	Total Mn	BW Flowrate	Cumulative BW Volume
	mg/L	NTU	mg/L	(gpm)	(gallons)
2-Min.					
4-Min.					
6-Min.					
8-Min.					
10-Min.					
12-Min.					
14-Min.					
16-Min.					
18-Min.					
20-Min.					
22-Min.					

## Conditional Approval

Based on the information submitted, MassDEP, acting under the authority of Chapter 111, Section 17 of the Massachusetts General Laws and 310 CMR 22.00 Massachusetts Drinking Water Regulations, hereby grants conditional approval of the pilot study proposal for treatment modifications for the Housatonic Water Works Company. Pursuant to MassDEP's authority under 310 CMR 22.04(7) to require that each supplier of water operate and maintain its system in a manner that ensures the delivery of safe drinking water to consumers, this permit is made subject to the following conditions:

1. MassDEP requires NWSI to submit a copy of the pilot study authorization letter from HWWC before the start date of the pilot study.

2. MassDEP requires NWSI to discharge the effluent water from the pilot unit safely to a HWWC's approved discharge location. This could include dechlorination of the piloted effluent water. **Do not mix** pilot study water with the HWWC's finished drinking water.
3. **The pilot study must be conducted for all four seasons.** Provide the schedule for the pilot study for all four seasons before the final inspection, as the GreensandPlus being used in the pilot study is not an approved technology for surface water in Massachusetts for Mn treatment. GreensandPlus is approved for Mn treatment in groundwater sources, but it is not approved in Massachusetts for surface water sources. Also, the vendor of the Greensand Plus, Inversand makes no reference to surface water treatment of Mn in its brochure and the application and the engineer for the applicant did not provide any surface water site examples for Mn treatment.
4. The final approval for this pilot study would be approved (for full-scale operation) only if the maximum (worst) influent tested water quality parameters like (turbidity, TOC, color etc.), treated through the pilot vessel occurs without an issue or interference in Mn reduction during the pilot study. For example, if the maximum of 0.5 NTU turbidity is treated during the pilot study without an issue, then the approval for the construction of the full-scale operation of the Mn treatment would be set for the maximum turbidity of 0.5 NTU.
5. This permit application is being approved as a Site-Specific New Technology Process (Type B) as the product and the process being used in the pilot study differ for different types of surface water treatment technologies. Therefore, for this pilot study, HWWC must submit the report at the end of the pilot study along with the permit application BRP WS 21.
6. MassDEP requires HWWC to calculate the Corrosion/Scale Indices daily for the influent and the effluent water for the pilot study, and provide the maximum corrosion recorded for the indices. The required four Corrosion/Scale Indices are, Langelier Saturation Index, Larson Skold Index, CSMR and Alkalinity-to-Chloride Ratio. This information is required to ensure that the treatment will not result in more corrosive water. Based on the historical data presented during the permit application, the CSMR index suggested corrosive water and this information will assist in assessing simultaneous compliance with the lead and copper rule and Safe Drinking Water Act standards.
7. The Safety Data Sheet (SDS) must be present at an accessible location at all times during the pilot study.
8. MassDEP requires NWSI to submit a copy of its Health & Safety Plan before the start of the Pilot Study and keep a copy at the study site at all times.
9. If the proposed monitoring in the permit application for the pilot study changes, HWWC must notify MassDEP and obtain MassDEP approval.
10. MassDEP requires that the pilot study report include an evaluation of final residuals handling and disposal options.



11. Once the pilot study treatment system is installed and ready for operation, MassDEP requires HWWC to schedule a final inspection with Hem Pokharel at [Hem.Pokharel@Mass.gov](mailto:Hem.Pokharel@Mass.gov) or another Drinking Water Program staff person to conduct a final inspection prior to placing the pilot study in service.
12. MassDEP reserves the right to require additional piloting or monitoring should any conditions or results warrant such a change.

Any deviation from approved plans or specifications affecting capacity, hydraulic conditions, operating units, or the quality of water to be delivered, must be approved by MassDEP.

If there are any questions regarding this permit review, please contact Hem Pokharel at 617-455-7957 or email at [hem.pokharel@mass.gov](mailto:hem.pokharel@mass.gov).

### Permit application pilot test schematic

