A Scientific Evaluation of the Occurrence of Haloacetic Acids and Manganese in the Housatonic Water Works Company's Drinking Water

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1. Introduction

There appear to be many misconceptions in the Great Barrington area about the quality of drinking water supplied by the Housatonic Water Works Company (HWWC). This report focuses on the two primary yet separate areas of controversy – periodic discolored water caused by manganese, and the exceedances of regulatory limits for disinfection byproducts known as haloacetic acids – and provides an evaluation of the available data for both.

In response to those issues, HWWC modified the chlorination procedure in 2023 to reduce formation of the disinfection byproducts, and a new treatment system for manganese removal is currently being designed with installation expected in 2025.

HWWC's treated water currently meets all of the state and federal regulatory requirements for drinking water, including for the following important water quality parameters:

- ✓ Bacteria and other microorganisms
- ✓ Total trihalomethanes (TTHMs)
- ✓ Haloacetic acids (HAA5)
- ✓ Lead and copper
- ✓ Synthetic organic chemicals (SOCs)
- ✓ Volatile organic chemicals (VOCs)
- ✓ Heavy metals (e.g., mercury, arsenic)
- ✓ Iron and manganese
- ✓ Per- and polyfluoroalkyl substances (PFAS)
- ✓ Radiological substances
- ✓ Nitrate and nitrite
- ✓ Pesticides (insecticides, herbicides)
- ✓ Algae and algal toxins
- ✓ Taste and odor

HWWC's water has many desirable characteristics, include the following:

- The Long Pond source water is an oligotrophic reservoir located in a small, mostly undeveloped watershed with minimal human activity near the pond.
- The water is crystal clear throughout the reservoir, has a low nutrient loading that does not support algal blooms, and is low in hardness and iron.
- There are no synthetic organic chemicals (SOCs), volatile organic chemicals (VOCs), toxic metals (e.g., arsenic, cadmium, chromium, mercury, etc.), or the newly regulated PFAS.
- The water is naturally corrosion resistant because of its relatively high pH (~7.7 average in the distribution system), and there are no known lead service lines in the community, so adding chemicals for controlling lead corrosion is not necessary
- No lead was detected in 18 of the 20 samples (90%) collected during the most recent round of monitoring, and the highest result was only 1.6 ppb, well below the Action Level of 15 ppb.
- HWWC reports there has never been a detection of either total coliform bacteria or *E. coli* in the finished water or anywhere in the HWWC distribution system.

The remainder of this report focuses on haloacetic acids and manganese.

2.0 Haloacetic Acids

Water systems add chlorine to drinking water as a disinfection process to kill or inactivate harmful organisms. During this process chlorine also reacts with naturally occurring organic matter that may be present in the source water. As a result, disinfection byproducts (DBPs) such as haloacetic acids (HAAs) can form during the chlorination process.

There are a total of nine haloacetic acids containing chlorine and/or bromine, five of which are regulated as “HAA5” by the U.S. Environmental Protection Agency (USEPA) and the Massachusetts Department of Environmental Protection (MassDEP).

2.1 Water quality standard for HAA5

USEPA and MassDEP have established a Maximum Contaminant Level (MCL) of 60 ppb (µg/L) for HAA5. Compliance with the MCL is based on the calculated Locational Running Annual Average (LRAA) at each individual monitoring location. MCL compliance *IS NOT* based on individual test results, only on the running annual average at each location.

HWWC has two required monitoring locations within the distribution system, and each is sampled once per quarter in February, May, August, and November. The Depot Street location has been sampled since 1st quarter 2004, with LRAA results available starting 4th quarter 2004. The N. Plain Rd. location was added by MassDEP in 1st quarter 2022, and for that site the LRAAs started in 4th quarter 2022.

2.2 Potential health impacts from HAA5

It is important to recognize that the benefits of chlorination far outweigh the health risks from disinfection byproducts such as HAA5. Adding chlorine to drinking water sources with bacteria and other harmful organisms makes the water safer to drink. When used correctly, chlorine kills harmful microorganisms that cause human diseases such as *E. coli* infection, typhoid fever, cholera, dysentery, giardiasis, and Legionnaire’s disease.

Per the MassDEP, people who drink water containing HAA5 in excess of the MCL over many years (decades) may have an increased risk of developing cancer. MassDEP (2022) also states that:

- *“HAA5 are possibly carcinogenic to humans based on evidence of carcinogenicity in laboratory animals and limited evidence in people.*
- *Other effects have been reported in experimental animals exposed to high levels of HAA5 and other disinfection byproducts. These include effects on the liver, kidneys, and reproductive system and on development.*
- *The significance of these effects is uncertain as some studies of people have reported similar effects while others have not. Scientists are working to address these differences.”*

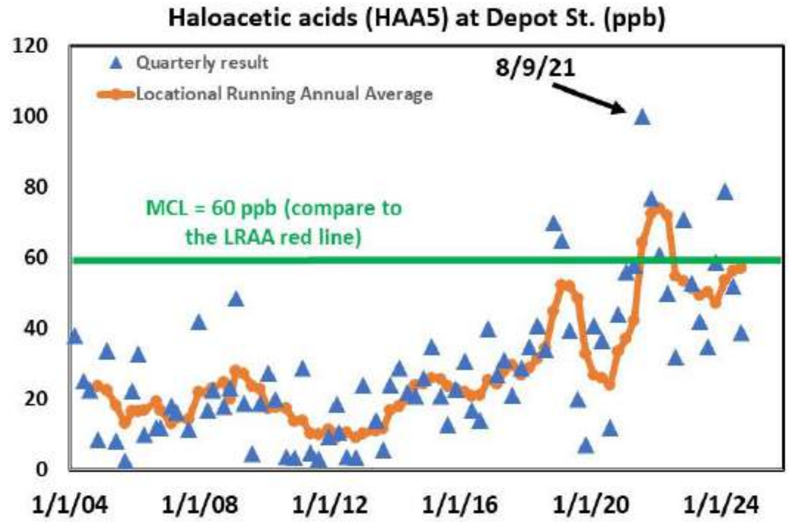
The City of Springfield, Massachusetts has been exceeding the HAA5 MCL for some time. Their July 7, 2023 MassDEP-approved Public Notice for an HAA5 violation noted that “*The HAA5 water quality violation is not a public health emergency. Customers may continue to use and consume the water as normal. The health risks of disinfection byproducts are associated with consumption at elevated levels for many years (i.e. decades or a lifetime).”*

And the State of Washington Department of Health (2024) determined that *“At present, however, there is no conclusive evidence linking DBPs in water with cancer or other health effects”.*

Exceedance of the Maximum Contaminant Level for HAA5 should be considered a cause for action, not a cause for fear.

2.3 Occurrence of HAA5 in HWWC water

The HAA5 quarterly data and resulting LRAAs for the Depot St. monitoring location are shown in the figure below. A total of 83 samples have been collected there over the >20-year period from 2004 to 2024 (one per quarter), with an average result of 29 µg/L (ppb). Of the 83 samples, only 7 (8%) had results above 60 µg/L, all within the past six years. The maximum result was 103 µg/L in August 2021.



In terms of regulatory compliance, the MCL for HAA5 was met 95% of the time over the past 21 years at the Depot St. location. The LRAA exceeded the MCL during only four (4) of the 80 quarters (5% of the time). That was the period from 3rd quarter 2021 to 2nd quarter 2022.

Recently, HWWC's water at the Depot St. location has been in compliance with the HAA5 MCL for the last nine (9) quarters, since 3rd quarter 2022. Compliance has been met for the past five (5) quarters at the N. Plain Rd. monitoring site (since 3rd quarter 2023).

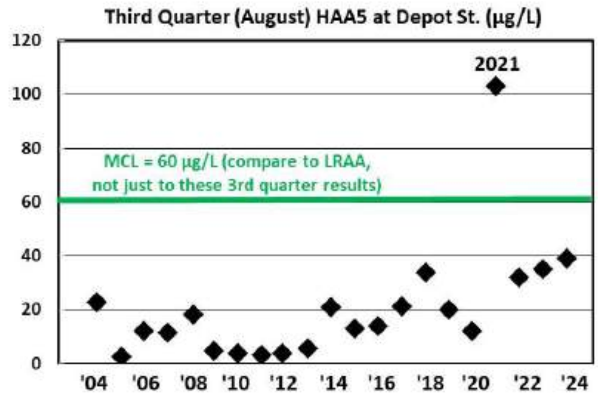
HAA5 levels vary seasonally, with HWWC's higher levels generally being in February (1st quarter) and lower levels in August (3rd quarter).

Historical average of HAA5 at Depot St. (2004 – 2024)

Month	Historical average (µg/L)	# of quarterly samples
February	38	21
May	27	21
August	20	21
November	31	20
Total	**29**	**83**

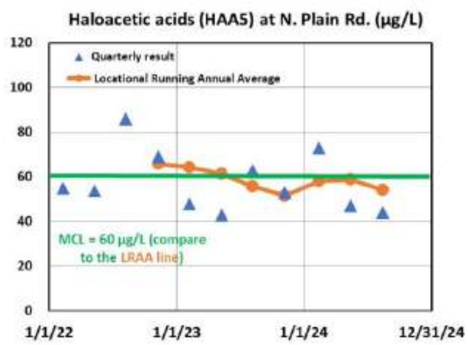
One single high sample result can cause a full year of violations (one each quarter) due to the use of a running annual average for MCL compliance. That is what happened in this case with the August 2021 result of 103 µg/L, as that single sample result effectively caused all four quarters of MCL exceedance.

The August 2021 test result was a surprisingly high anomaly (see plot), as the previous 17 other August HAA5 results had averaged only 13 µg/L. Historically heavy rainfall in July 2021 appears to have been the cause of a temporary change in the quality of the Long Pond source water that caused an increase in HAA5. Other utilities in western Massachusetts also experienced elevated DBPs during that time, and they too presumed the historically wet weather was the cause in their cases.



Hypothetically (and mathematically), if the August 2021 HAA5 result had been ≤ 45 µg/L instead of 103 µg/L, then there would have been no MCL exceedances at all. And that 45 µg/L is over three times higher than the 13 µg/L historical average for August results up to that date. In that case there would have been no MCL violations, no scarily-worded required Public Notices, and no resulting controversy. And HWWC would still have had a perfect record of HAA5 compliance. That is, if that one sample had been only three times higher than the long-term historical average…

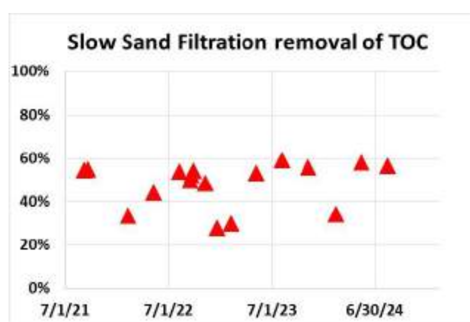
For the N. Plain Rd. location, 11 samples have been collected since 2021, with an average result of 58 µg/L, just below the MCL of 60 µg/L. Results have ranged from 43 to 86 µg/L, with four of the 11 sample results above 60 µg/L. The LRAA exceeded the MCL for the first three quarters of compliance calculations, and since then has been below the MCL for the most recent five quarters.



2.4 Control of HAA5

HWWC employs two methods for controlling the formation of HAA5, focusing on both of the primary causative factors by reducing the amount of natural organic matter present in the water and reducing the chlorine dose applied.

HWWC's current slow sand filtration plant already does an excellent job at removing natural organic matter, and averages 52 percent reduction of total organic carbon (TOC) during spring through fall and 33 percent removal during the cold winter months. Both are very impressive for slow sand filters, which typically are expected to remove only ~15 to 20 percent of the TOC.



Raw water TOC has averaged 3.2 mg/L, while the treated water has averaged only 1.7 mg/L. This success in TOC removal is attributed largely to the well-established age of the microbial population and HWWC's custom hydraulic rake filter cleaning system. Periodically cleaning the sand surface with water instead of physically removing the top layer of sand has allowed the sand to not be replaced in many years, providing better treatment while also saving money.

In response to the higher levels of HAA5 experienced in recent years and the corresponding MCL exceedances, HWWC prepared and submitted to MassDEP an evaluation of alternative methods for reducing these compounds in the future. On March 1, 2023 MassDEP approved HWWC's proposed concept for revising the chlorine disinfection procedure by reducing the amount of chlorine applied in the treatment plant and installing a second chlorine feed to boost the chlorine residual just before the entry to the distribution system. This two-stage chlorination system was started in October 2023, and allows HWWC to reduce the amount of chlorine added while still providing ample disinfection.

The modification allows for a substantial reduction in the dose of the initial chlorine feed, reducing the "*CT*" attained in both the chlorine contact basin and the 1.1-million gallon storage tank while still easily achieving the required *CT* level (*CT* = chlorine concentration x contact time). This will substantially reduce the exposure of natural organic matter to chlorine during the long contact times of the HWWC contact basin and storage tank. The plan takes advantage of relatively inexpensive operational flexibility without exposing customers to the costs of an expensive capital project.

2.5 Conclusions about HAA5

In summary, HWWC's water has complied with the MCL for HAA5 at the Depot St. monitoring location for 19 of the past 20 years (95 percent of the time). Overall, HAA5 has averaged only 29 µg/L, well below the MCL of 60 µg/L. The one year of noncompliance was apparently caused by an unexpected short-term change in the source water resulting from historical rainfall levels in July 2021, and the single sampling result in August 2021 caused the LRAA to exceed the MCL for four quarters.

It is also noted that the relatively short-term MCL exceedances were not by very large concentrations, with the highest LRAA being 74 µg/L. That level of HAA5 is expected to only have a potential health impact after decades of consumption, and that's just not the case here.

The incidences of exceeding the HAA5 MCL had adverse impacts on regulatory compliance and public perception, but should not be expected to have had any impact on public health.

HWWC recently improved the chlorination system to reduce formation of HAA5, and the upcoming greensand filters to be installed (after the chlorine contact basin for manganese removal) should consume about 0.5 mg/L of the initial chlorine feed applied, further reducing formation of HAA5 during the relatively long residence time of the 1.1-MG storage tank.

3.0 Manganese and Color

There are two primary reasons why HWWC's water may be turbid or discolored. First, turbid water will result from an unusual or sudden acceleration of the flow of water through the pipes such as from a main break, when a hydrant is opened, or if the water changes flow direction. Sediment that has settled in pipes may be stirred up and material bound to pipe surfaces may detach and be transported with the water flow, resulting in particles and/or color. Significant disturbances create more discoloration. Corrosion of galvanized service lines and household plumbing systems can also discolor water.

Secondly, HWWC's water has experienced episodes of yellow or brownish color as a result of seasonal spikes in manganese present in the Long Pond source water. This has happened in warmer weather during five of the past seven years. This report focuses on the Long Pond source of manganese.

The colored water episodes ARE NOT caused by iron coming from rusting pipes, which is a theory espoused by other entities in recent years, including MassDEP and a Town of Great Barrington engineering consultant, who then advocated for unnecessary and expensive replacement of numerous iron water mains. Of 394 distribution system samples collected since 2018, only one was above the 0.3 mg/L Secondary MCL for iron (at 0.48 mg/L, and apparently a flushing sample).

HWWC's pipes actually appear to be in relatively good condition, regardless of their age. Examination of pipe interiors (samples from breaks) has shown relatively clean pipes mostly free of tuberculation. The rate of main breaks is very low, and the amount of unaccounted for (non-billed) water is also quite low. All of these characteristics suggest a relatively sound piping infrastructure.

Extensive analytical data are available that show little or no iron in the colored water. The measured iron concentrations are consistently well below the Secondary MCL, and iron is often not even detected in HWWC's samples having the most color.

3.1 Water quality standard for manganese

The USEPA and MassDEP have not established a health-based standard for manganese in drinking water. They have, however, established a voluntary Secondary Maximum Contaminant Level (SMCL) for manganese of 0.05 mg/L (ppm) to address aesthetic concerns regarding staining and taste considerations (USEPA 2004).

It should be noted that the SMCL level of 0.05 mg/L is known in the drinking water industry to be too high to prevent manganese coloring in water systems. Per Water Research Foundation guidance (Brandhuber et al., 2013), manganese levels of less than about 0.015 mg/L should be targeted to avoid customer complaints about color. That is the goal applied to HWWC's upcoming manganese removal treatment system.

3.2 Manganese as an essential human nutrient

Manganese is an essential nutrient for normal human growth and health, and helps the body break down fats, carbohydrates, and proteins as a part of several enzymes (USEPA, 2004).

Manganese is naturally present in many foods and is also available as a dietary supplement. The top sources in diets of U.S. adults are grain products, tea, and vegetables. Various other foods contain manganese including coffee and many spices such as black pepper (NIH 2021).

Normally the manganese intake from food is substantially higher than that from drinking water (USEPA, 2004). Drinking water may contain small amounts of manganese, and manganese is absorbed by the body more readily from drinking water than from food (ORS, 2013).

Given the basic need for consumption of manganese, the National Institutes of Health (NIH) has established what they consider to be daily "Adequate Intakes" (AIs) for the nutrient. Intake at this level is assumed to ensure nutritional adequacy. Adequate Intake levels are established when evidence is insufficient to develop a Recommended Dietary Allowance (RDA). The RDA is the average daily level of intake sufficient to meet the nutrient requirements of nearly all (97% – 98%) healthy individuals; often used to plan nutritionally adequate diets for individuals (NIH 2021).

Adequate Intakes (AIs) for Manganese (NIH 2021)

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months*	0.003 mg	0.003 mg		
7–12 months	0.6 mg	0.6 mg		
1–3 years	1.2 mg	1.2 mg		
4–8 years	1.5 mg	1.5 mg		
9–13 years	1.9 mg	1.6 mg		
14–18 years	2.2 mg	1.6 mg	2.0 mg	2.6 mg
19–50 years	2.3 mg	1.8 mg	2.0 mg	2.6 mg
51+ years	2.3 mg	1.8 mg		

* *For infants from birth to age 6 months, the AI is based on mean manganese intakes of infants fed primarily human milk.*

For perspective, it is informative to compare these dietary requirements to the levels of manganese found in drinking water. For example, to provide the recommended daily intake of 0.6 mg for children ages 7-12 months via drinking water, it would take 3.2 gallons (or 12 liters) of water with manganese at the SMCL concentration of 0.05 mg/L. For adult males, it would take over 12 gallons (46 liters) to provide the recommended 2.3 mg of manganese daily. Those calculations emphasize that the recmmended daily intake amounts cannot easily be supplied by drinking water even if it is discolored.

A typical daily multivitamin has 1.0 to 4.5 mg of manganese (NIH 2021), and supplemental pills available in pharmacies and grocery stores typically contain 50 mg each. It would take 5.3 gallons (20 liters) of drinking water containing the SMCL of 0.05 mg/L to provide 1.0 mg of manganese. The 50-mg supplemental pills would correspond to 264 gallons (1,000 liters) of water containing 0.05 mg/L Mn.

3.3 Sources of Manganese for HWWC's water

Manganese naturally occurs in HWWC's Long Pond source water throughout the year, though the concentrations may vary widely depending on the season and the year. Low levels are detected during the winter months and higher levels during warmer months, with problematic levels occasionally at times between June and September. The highest concentration detected in Long Pond to date was 0.34 mg/L (out of 82 samples since 2020).

Sediments at the bottom of lakes and reservoirs are typically the main source of manganese. Its release from sediments is primarily controlled by dissolved oxygen levels in the water. Temperature will affect dissolved oxygen levels, but is not the primary determinant in the fate of manganese (as evidenced by some summers without manganese spikes). Anoxic conditions (no oxygen) cause particulate manganese to dissolve and be released from sediments into the water column, where it can then enter the intake and treatment plant.

Manganese can also potentially come from residual manganese (legacy manganese) that has collected on distribution system pipe walls over the years. But in HWWC's case, the customer complaints about color and the corresponding monitoring data in the distribution system correspond to the spikes of manganese in the source water, so legacy manganese is apparently not a substantial issue in this system.

3.4 Aesthetic impacts of manganese

Dissolved manganese is largely colorless, but once it is oxidized by chlorine (used as a microbial disinfectant) it forms a precipitate that causes color in the water. The color ranges with increasing manganese concentration from light yellow to dark brown to grey or black, and the manganese leaves a black or grey residue on plumbing surfaces. The water may still be transparent, especially at lower manganese concentrations.

Example color from low levels of manganese

Typical drinking water conditions (pH and reduction/oxidation potential) are in the range in which manganese can readily cycle between soluble and insoluble forms (Brandhuber et al., 2013), which can explain in part why water colored by manganese can seem to appear and disappear in HWWC's distribution system. Also, more color can appear as dissolved manganese reacts with chlorine over time in the distribution system. Distribution system samples with the same total manganese concentration may have very different color depending on the form of manganese (i.e., relative extent of reduced/dissolved versus oxidized/precipitated),

3.5 Potential adverse health impacts from manganese

Adverse health effects can be caused by either inadequate intake of manganese or overexposure to it. While manganese is essential for human health at appropriate levels of consumption, it may cause certain health problems if levels are too high. Individual requirements for manganese, as well as adverse effects from manganese, can be highly variable (ORS 2013).

In 2004 the USEPA set a non-enforceable lifetime health advisory (HA) level of 0.3 mg/L for chronic exposure to manganese and a 1-day and 10-day health advisory of 1 mg/L for acute exposure. USEPA also suggests 0.3 mg/L be used for both chronic and acute exposure for infants less than 6 months old.

USEPA/MassDEP Advisory for Mn	**mg/L**
Secondary MCL (aesthetics)	0.05
Lifetime health advisory level	< 0.3
Short-term health advisory level (possible neurological effects)	< 1
NIH (2004) Adequate Intake (AI) for Mn	**mg/day**
Elementary school age	1.2 – 1.5
Adults	1.8 – 2.3

It is important to recognize that these are not "typical" health advisory levels, as the guidance is not intending to claim that higher levels will necessarily cause any problems. Instead these limits were generated through correlation with daily dietary intake requirements.

Specifically, MassDEP reports that "***The general population water concentration exposure limits of 0.3 and 1 mg/L have been set based upon typical daily dietary manganese intake levels not known to be associated with adverse health effects. This does not imply that intakes above these levels will necessarily cause health problems***. *As a precaution, the general population should consider limiting their consumption of drinking water with high levels of manganese to decrease their exposures and to decrease the possibility of adverse neurological effects*." (MassDEP 2024)

So effectively USEPA and MassDEP aligned these recommended "exposure limits" with the actual dietary intake requirements. Comparing the Health Advisory levels with the dietary Adequate Intakes for perspective, if water were consumed containing the lifetime health advisory level of 0.3 mg/L manganese, it would take four liters (over a gallon) to provide an elementary school age girl's recommended daily intake of 1.2 mg manganese.

Recall that food is the primary source of manganese intake for people. Large volumes of water containing manganese would need to be consumed just to reach the recommended daily intake of the nutrient. And that's just not likely to happen with discolored water. Color appears at manganese concentrations well below that required to cause adverse health impacts, and the color understandably decreases people's consumption of the water.

To further clarify the health advisory levels for manganese, the Massachusetts Office of Research and Standards Guideline (ORSG) included the following evaluation (ORS 2013):

> *"The Massachusetts ORSG for manganese closely follows the United States Environmental Protection Agency's (US EPA) Health Advisory (HA) for manganese. The basis for the US EPA manganese HA is explained in US EPA (2004). The lifetime HA value is 0.3 mg/L. For shorter term exposures, US EPA established a ten-day HA of 1 mg/L for the general population (based on Mn intake data for children from 7 months to 3 years of age, which was conservatively applied to older individuals).*
>
> *Because no suitable data were available in the literature to determine a one-day HA, USEPA used the ten-day value for the one day HA as a default. For infants younger than 6 months, USEPA stated that these individuals should not be given water containing more than 0.3 mg Mn/L for longer than ten days. USEPA did not establish a one-day HA for infants in this age range. Together these HAs help to limit the potential for excess intake of manganese, which has been associated with adverse neurological effects in several studies of children.*
>
> *The lifetime USEPA Health Advisory value of 0.3 mg/L represents a reasonable value for consumption of water from public drinking water supplies and is adopted as part of the ORSG for manganese.*
>
> *Data on the duration of Mn exposure that is of concern is limited. In addition, Mn intakes from other sources, such as from food, are variable over time and Mn in drinking water is more easily absorbed into the body than from food. These factors preclude the establishment of a precise bright line for health-protective short-term guidelines for Mn in drinking water* ***. Instead, US EPA established short-term HAs based on upper-end manganese intake estimates (not adverse health effects)****, yielding a ten-day HA of 1 mg/L.* ***The 10 day limit is not a bright line, but is used to minimize Mn exposures****. ORS has adopted it as part of its ORSG for manganese."*

3.6 Occurrence of manganese in HWWC water

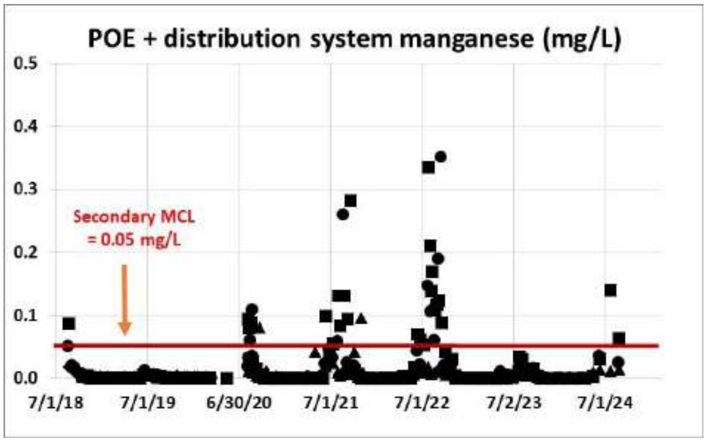
As required by MassDEP, HWWC has conducted a very extensive special monitoring program for manganese since 2018 (along with several other parameters), which is now over six years and counting. For most of that period samples were collected biweekly from different locations in the distribution system, and also the finished water (at the point of entry (POE) to the distribution system) and the Long Pond source water. Starting in 2024 the samples have been collected monthly.

Throughout this monitoring program all of the samples were collected by independent, trained samplers from *Housatonic Basin Sampling & Testing* (Lee, MA). Their independent, state-certified laboratory has also been responsible for the water quality analyses. In addition, HWWC contracts with an independent expert consultant who compiles and interprets the resulting data (*Water Compliance Solutions, LLC*; Leominster, MA). This report is a product of that work.

The number of HWWC water samples collected and analyzed for manganese from August 2018 through August 2024 are at minimum as follows:

Location	# samples
Distribution system	344
Point of Entry	+ 104
Total special monitoring program	448
Additional customer-requested samples	+ 44
Total treated water samples	492
Long Pond source water	+ 82
Grand Total	574

The manganese data from the biweekly monitoring program are provided in the below plot for the treated water. The current treatment plant removes low levels of manganese, and it has basically not been detected in the treated water during November through April. However, slow sand filtration is not capable of removing larger quantities of manganese over time as the season progresses, and specialized treatment systems would be required for that (e.g., greensand filtration).



The seasonal nature of the manganese occurrences is readily apparent in the data. But it doesn't happen every year – two of the past seven years did not have appreciable levels of manganese or color (2019 and 2023). Unfortunately, the other five years (2018, 2020, 2021, 2022, and 2024) did have seasonal episodes of excessive manganese and the resulting undesirable color.

Regarding the 448 samples of treated water analyzed for manganese since 2018:

- None (0) of the 448 manganese samples were above 1 mg/L (the short-term health advisory level)
- Only 1 of the 448 samples (0.22%) was above 0.35 mg/L. That was 0.74 mg/L for an extremely colored sample on 7/24/24 (an outlier not plotted above), and the source water concentration has never measured nearly that high.
- Only 3 samples (0.67%) were above 0.3 mg/L, the long-term health advisory level.
- Only 6 samples (1.3%) were above 0.2 mg/L manganese
- 37 of the 448 results (8.3%) were above the SMCL of 0.05 mg/L
- 237 samples (53%) were non-detect for manganese (< 0.0020 mg/L)

Almost all of the samples (> 99%) were below the applicable Health Advisory levels. Furthermore, the Health Advisory levels are based on dietary intake requirements and not on adverse health effects. So despite the unfortunate color, the manganese concentrations encountered in HWWC's water do not pose a public health risk. The few times a monitoring test result did exceed the long-term health advisory level the water was so colored it's likely no one would consider drinking much of it (if any…).

Regarding the 32 samples of water analyzed for customers complaining of colored water:

- None of the 32 samples were above 1 mg/L (the short-term health advisory level)
- Only 1 of the 32 samples (3.1%) was above 0.3 mg/L (that was 0.35 mg/L).
- Only 3 of the 32 samples (9.4%) were above 0.2 mg/L
- 14 of the 32 samples (44%) were above the SMCL of 0.05 mg/L

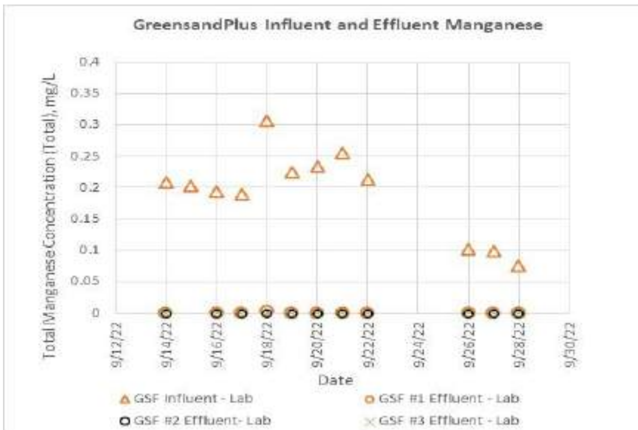
Importantly, it's not just a question of whether toxic or carcinogenic chemicals are in our water or air (they are, everywhere…), it's a question of what the concentrations are, the exposure time, and the route of exposure that determines whether there could be any real noticeable adverse health impact. The color resulting from the manganese understandably upsets customers, but it is not a health threat.

3.7 Future Control of Manganese

HWWC recognizes the objectionable burden of the colored water episodes on its customers, and has already taken action to soon resolve the issue permanently. HWWC's consulting engineer is currently designing a new GreensandPlus™ filtration treatment system for the removal of manganese. Removing the manganese from the source water should eliminate the colored-water episodes that some customers have experienced in recent summers.

GreensandPlus™ filtration is a well-established technology, and was proven highly effective using HWWC's Long Pond source water in an extensive pilot test program operating under worst-case manganese loading conditions. HWWC received MassDEP's approval for the completed pilot study report, and the new treatment system is currently under design. Installation is expected in 2025, assuming MassDEP provides timely review and approval.

Pilot testing of the proposed GreensandPlus™ filtration system was conducted for over 250 hours in September 2022 under a variety of flow conditions, and at a time when manganese in the Long Pond source water was at relatively high levels (about 0.1 to 0.3 mg/L).



September 2022 Pilot Study Results (NWSI 2023)

The GreensandPlus™ pilot study filters removed manganese to mostly non-detect levels, and always met the goal of ≤ 0.015 mg/L, well below the SMCL of 0.05 mg/L (see above plot). 93% of the filter effluent samples were non-detect for manganese, and the other 7% had just trace levels. The GreensandPlus™ filtration also had no observed adverse impact on other water quality parameters including disinfection byproducts and water corrosivity.

3.8 Conclusions regarding manganese

Like many chemicals, manganese not only is both harmless and an essential nutrient at low concentrations, but can potentially be toxic at high concentrations. While the periodic seasonal manganese in HWWC's water can cause unpleasant color in the water, it should not be considered a health risk at the manganese concentrations observed.

People consume much more manganese through food than they could via drinking HWWC's colored water. Furthermore, manganese causes objectionable color at concentrations that correspond to well below the recommended minimum daily dietary intake of this essential nutrient. And it would take drinking a large amount of HWWC's water to consume even the minimum dietary needs.

Regardless of the lack of adverse health impacts, the color caused manganese is not acceptable quality for any water utility. HWWC expects their new greensand filtration system for manganese removal will be installed in 2025, and will permanently resolve the seasonal color problem in Housatonic's water.

4.0 References

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About the author:

Dr. Rich Gullick has been tracking HWWC's water quality data since spring of 2019. He evaluates, plots, and interprets the data, and shares observations and recommendations with HWWC. It was Dr. Gullick who in 2019 first identified for HWWC that manganese was the cause of the color episodes in HWWC's water, and that it was not iron from allegedly rusting pipes.

Dr. Gullick earned an M.S. in Public Health degree from the University of North Carolina at Chapel Hill, and a PhD in Environmental Engineering from The University of Michigan. He holds drinking operator licenses in four states, including a Massachusetts Class 4T license. His full CV is available at https://watercompliancesolutions.com/qualifications.