COMMITTEE OF THE WHOLE MEETING
APRIL 29, 2019

REPORT #ENG-2019-11

MILL STREET RESERVOIR
AERATION SYSTEM

RECOMMENDATION

That Report #ENG-2019-11 be received;

And further that Engineering Services pertaining to the Mill Street Reservoir Aeration System be awarded to RV Anderson Associates Ltd., in accordance with the amended Town Procurement of Goods and Services (Purchasing) Policy (Bylaw 2014-100) as a single source procurement, for the upset fee of $93,000.00 plus HST;

And further that Construction Services pertaining to the Mill Street Reservoir Aeration System be awarded to Greatario, in accordance with the amended Town Procurement of Goods and Services (Purchasing) Policy (Bylaw 2014-100) as a sole source procurement, for the upset fee of $625,000.00 plus HST;

And further that a project contingency allowance in the amount of $72,000.00 be approved for the project within which the General Manager, Infrastructure & Development, or his designate, is authorized to approve amendments to the scope of work;

And further that the project be funded from the Asset Replacement - Water Reserve.

And further that the necessary by-law be enacted authorizing the Mayor and Clerk to sign the appropriate documents respecting the above award of contracts.

OBJECTIVE

The purpose of this report is to provide Council with a recommendation to retain RV Anderson Associates Ltd. (RVA) and Greatario to undertake detail design, tender documents, and construction service in support of a water aeration system for the Community of Tottenham to improve water quality.

BACKGROUND

The existing Tottenham water system is provided by four groundwater wells which have challenging natural water quality. There is presence of methane, elevated natural ammonia leading to a need for high chlorine dosages for disinfection, presence of natural bromide, and elevated natural iron resulting in aesthetic complaints. The dosage and treatment with chlorine contributes to elevated levels of trihalomethanes (THMs).

As detailed in ENG-2019-05 Report to Council dated March 18, 2019, a meeting was held between Town Staff, Ministry of Health (MOH) and Ministry of Environment, Conservation and Parks (MECP) on January 10, 2019, where it was suggested that the Town consider investigating the possibility of additional operational improvements that could be undertaken to potentially further reduce THM levels in the Tottenham water system. The suggestion included the investigation of aeration of the treated water in the reservoir as a possible method of reducing THM levels. Aeration systems can be used to increase the exposure of treated water to air, by way of spray nozzles, which will encourage THMs to volatize and reduce their concentration in the treated water. As a result of the meeting, RVA was retained to investigate short term THM reduction strategies to the Tottenham water system.

On March 26, 2019, the MECP issued a letter, appended to this Report as Attachment No. 1, strongly recommending that the Town pursue additional treatment/operation measures to control and reduce the formation of THMs.

On April 2, 2019, the Town, in conjunction with the Simcoe Muskoka District Health Unit and RVA, hosted a public open house to discuss the Tottenham Water System and present information to the public to address water quality concerns raised by residents.

On April 11, 2019, the Simcoe Muskoka District Health Unit provided a letter of support, appended to this Report as Attachment No. 2, to the Town for the implementation of improvements on reducing THM levels in the water supply in advance of the completion of the Tottenham Transmission Main, which is anticipated to be commissioned in 2022.

COMMENTS AND CONSIDERATIONS

RVA's Short Term THM Reduction Strategies Technical Memorandum (the Study) dated April 16, 2019 has been appended to this report as Attachment No. 3. Appendices contained within the Report have not been provided herein but are available for review at the Engineering Department and on the Town's website.

The following are the list of alternative solutions that were evaluated as part of the Study to reduce THMs in the water system. A detailed description of each alternative can be found in Section 3 of the Study.

1. pH Depression
2. Reducing chlorine dose through disinfection and process optimization
    a. Increasing chlorine contact time by moving chlorine feed point
    b. Reservoir baffling
3. Aeration
    a. Aeration at the Mill Street Reservoir
    b. Aeration at the Elevated Tank
4. Water Age
    a. System flushing

b. Minimize stored water volume

The Study investigated various strategies to assist in improving THMs in the Tottenham water system. The complete list of recommended works can be found in Section 5.

The most significant strategy recommended was to install an aeration system in the Mill Street Reservoir (MSR). This system would have the biggest impact on THMs and could reduce the levels leaving the Mill St Reservoir by approximately as much as 40% under ideal conditions. However, as noted in section 3.3.1 in the Study, reformation of THMs will continue to occur in the distribution system.

The aeration system in the MSR will be activated if any of the 4 wells in Tottenham are used. The Tottenham wells are part of the overall water supply system in the Town. With the construction of the Tottenham-Beeton pipeline, this supply will be connected to the overall distribution system. The aeration system will be used as the Town continues to use wells to keep the wells active, as well as during high demands or if the pipeline water supply to Tottenham was ever disrupted. If the water supply to Beeton was ever disrupted, the MSR could be designed to pump the Tottenham well water up to Beeton. This would be part of the scope of a future project.

For the fastest implementation of an Aeration system, Staff recommend that a purchase order be issued for the preferred aeration equipment to initiate fabrication as the typical delivery times for this equipment is 8 to 14 weeks. As this is a packaged system, this will reduce the detailed design efforts and costs associated with RVA.

Staff, as per RVA, recommend sole sourcing the work, per Section 4 of the Town's Procurement of Goods and Services (Purchasing) Policy (Bylaw 2014-100), as only one supplier is able to provide the requirements of a turn-key type solution for the aeration system. RVA has previous experience working with the company's design engineers which would help expedite the design process and implementation. The overall schedule could allow the equipment design, installation and commissioning in approximately 12 to 18 weeks.

FINANCIAL CONSIDERATIONS

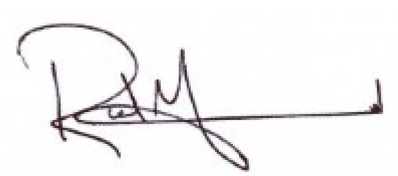
There is no approved capital budget sheet for this project. The Water Rates Reserves Fund could be utilized to fund the project.

Based on the Study, the estimated high level cost of completing the detail design, contract administration/inspection and construction of the improvements recommended above is as follows:

Short Term THM Reduction	
Description	**Cost**
RVA - Detail Design, CA/Inspection	$93,000.00

Greatario (Gridbee) - Construction	$625,000.00
Sub-Total	**$718,000.00**
Project Contingency (10% rounded up)	$72,000.00
Sub-Total Cost of Project	**$790,000.00**
HST (13%)	$102,700.00
Less Applicable Tax Rebate (86.461538%)	($88,796.00)
Total Net Cost of Project	**$803,904.00**

Respectfully submitted:



Rob Greenwood
Engineering Coordinator

Attachments:

□ Attachment No. 1 - MECP Letter
□ Attachment No. 2 - SMDHU Letter
□ Attachment No. 3 - Short Term THM Reduction RVA - No Appendices

Approved By:	**Department:**	**Status:**
Rick Vatri, C.E.T., Director of Engineering	Engineering	Approved - 25 Apr 2019
John Henry CPA, CMA, Director, Financial Services / Treasurer	Finance	Approved - 25 Apr 2019
Khurram Tunio, M. Eng., P. Eng, GM of Infrastructure and Development	Development and Infrastructure Division	Approved - 25 Apr 2019
Blaine Parkin, P. Eng., CAO	CAO	Approved - 25 Apr 2019

Ministry of the Environment, Conservation and Parks
1201-54 Cedar Pointe Drive
Barrie ON L4N 5R7
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Ontario

March 26, 2019

Khurram Tunio, M.Eng., P.Eng.
General Manager, Infrastructure & Development
Town of New Tecumseth
10 Wellington Street, Alliston, ON L9R 1A1

Dear Mr. Tunio:

Further to our telephone discussion of March 13, 2019, we wish to reiterate the ministry's position with respect to the potential for Trihalomethane (THM) control and reduction in Tottenham Drinking Water system (Tottenham DWS), through the implementation of additional treatment measures and operational practices by the Town.

The ministry first raised the idea of additional treatment measures and operational practices with the Town in a January 31, 2017 e-mail correspondence In response, the Town indicated that suggested treatment measures such as venting of wellheads and aeration and/or baffling in the contact reservoir "were considered and were eliminated for various reasons, primarily based on achieving the required quality parameters."

In the Tottenham DWS inspection report dated March 17, 2017, the ministry recommended that the Town undertake a comprehensive THM sampling survey in the distribution system to provide more representative THM data, as the current Licence for the Tottenham Drinking Water System requires monthly sampling at a single location (Nolan Road Pumping Station). The ministry suspected that much of the THM formation was occurring during treatment, at the point of chlorine addition, due to the high concentration of naturally occurring precursor organic compounds in the source water. This raised concerns regarding elevated THM concentrations in other parts of the distribution system which would not be detected by the Nolan Road sampling efforts.

On December 8, 2017, the Simcoe Muskoka District Health Unit (SMDHU), ministry staff and Town Public Works staff met to discuss the Tottenham THM issue. Although the running annual average (RAA) for THMs at that time (92.77 ug/L) for the Tottenham DWS was currently meeting the Ontario Drinking Water Quality Standard (ODWQS) for THM, the Medical Officer of Health (MOH) also urged the Town to follow the MECP recommendation for a more comprehensive THM sample survey.

The Town conducted the requested THM sample survey on May 14, 2018. The sample survey results showed elevated THM concentrations following chlorine addition at the treated water point of entry and single sample results from locations in the distribution system that exceeded 100 ug/L. It should be noted that calculated RAA for THMs, which considered these results, met the ODWQS for THMs. In response to a ministry request, the Town conducted a second comprehensive survey of THM sampling on September 17, 2018, which again yielded single sample results which exceeded the ODWQS while the RAA, although high (94.25 ug/L), met the ODWQS. The ministry conducted a third round of THM sampling during the December 4, 2018 inspection of the Tottenham DWS which produced results similar to the first two rounds while the calculated RAA continued to meet the ODWQS.

The ministry most recently met with the Town and the SMDHU on January 10, 2019 to discuss the Tottenham THM issue. During this meeting, the ministry restated the recommendation that the Town investigate additional treatment options (aeration and/or baffling) in the contact reservoir and the storage tower in an effort to reduce THM formation without compromising water disinfection. Both the Ontario MOH and Health Canada recommend that "THM concentrations be kept as low as achievable without compromising water disinfection." You indicated that the Town would investigate these treatment options as well as other operational measures such as the installation of auto-flushers at end-off-line locations in the distribution system. Our recommendation is documented in the most recent Tottenham DWS inspection report dated February 20, 2019.

The Town is currently operating the Tottenham DWS in compliance with their Drinking Water Licence and Permit and producing drinking water which currently meets Ontario Drinking Water Quality Standards. The Tottenham DWS licence will soon be amended to require monthly THM sampling to be undertaken by the Town at locations recommended by the ministry, rather than being limited to a single sampling location at the Nolan Road pumping station.

As a result, the ministry strongly recommends that the Town pursue additional treatment/operational measures to control and reduce the formation of THMs in the contact reservoir and water tower.

Yours truly,

Cindy K. Hood
District Manager
Barrie District

cc: Craig Seabrook
Sheri Broeckel
Dr. Charles Gardner, MOH, SMDHU

simcoe muskoka
DISTRICT HEALTH UNIT

April 11, 2019

Khurram Tunio
General Manager of Infrastructure and Development
Town of New Tecumseth
10 Wellington Street East
Alliston, Ontario L9R 1A1

Dear Khurram Tunio:

I am writing in support of your recommendation to the council for New Tecumseth for the installation of the technical means to reduce the levels of Trihalomethanes (THMs) in the municipal water supply for Tottenham in the very near future, well in advance of the additional water to be supplied with the upcoming pipeline. This would be to address the finding of THMs to be associated with certain cancers (of the colon, rectum, kidney, bladder and liver) in some studies, as I indicated at the public open house on April 2nd, 2019. Although the level of risk is quantified by Health Canada to be low (1 additional cancer case per 100,000 people exposed at 100 ug / L concentration over a 70 year period), it is important that all municipal water supplied in Ontario be in compliance with all health standards including for THMs. It should be noted that Health Canada's safe drinking water guidelines indicate that the annual running average for THMs be no greater than 100 ug / L, and also that measures should be put in place to maintain them as low as reasonably possible to achieve.

It should also be noted that although some studies have found an association between THMs and adverse birth outcomes (stillbirths, miscarriages and reduced birth weights), these findings have not been consistently demonstrated in research.

Attached you will find the slides on display at the open house provided by the Simcoe Muskoka District Health Unit, as well as a review on the health effects of THMs provided at our request by Public Health Ontario.

Given the purpose of my letter, I would certainly support it being included with your report to the council Committee of the Whole on this matter on April 29th, 2019. If I can be of any further assistance to you or to council please let me know.

Sincerely,

ORIGINAL Signed By:

Charles Gardner, MD, CCFP, MHSc, FRCPC
Medical Officer of Health

CG:cm

Att. (1)

❑ Barrie: 15 Sperling Drive, Barrie, ON L4M 6K9, 705-721-7520, FAX: 705-721-1495
❑ Collingwood: 280 Pretty River Pkwy., Collingwood, ON L9Y 4J5, 705-445-0804, FAX: 705-445-6498
❑ Cookstown: 2-25 King Street S., Cookstown, ON L0L 1L0, 705-458-1103, FAX: 705-458-0105
❑ Gravenhurst: 2-5 Pineridge Gate, Gravenhurst, ON P1P 1Z3, 705-684-9090, FAX: 705-684-9887
❑ Huntsville: 34 Chaffey St., Huntsville, ON P1H 1K1, 705-789-8813, FAX: 705-789-7245
❑ Midland: B-865 Hugel Ave., Midland, ON L4R 1X8, 705-526-9324, FAX: 705-526-1513
❑ Orillia: 120-169 Front St. S., Orillia, ON L3V 4S8, 705-325-9565, FAX: 705-325-2091

TRIHALOMETHANES

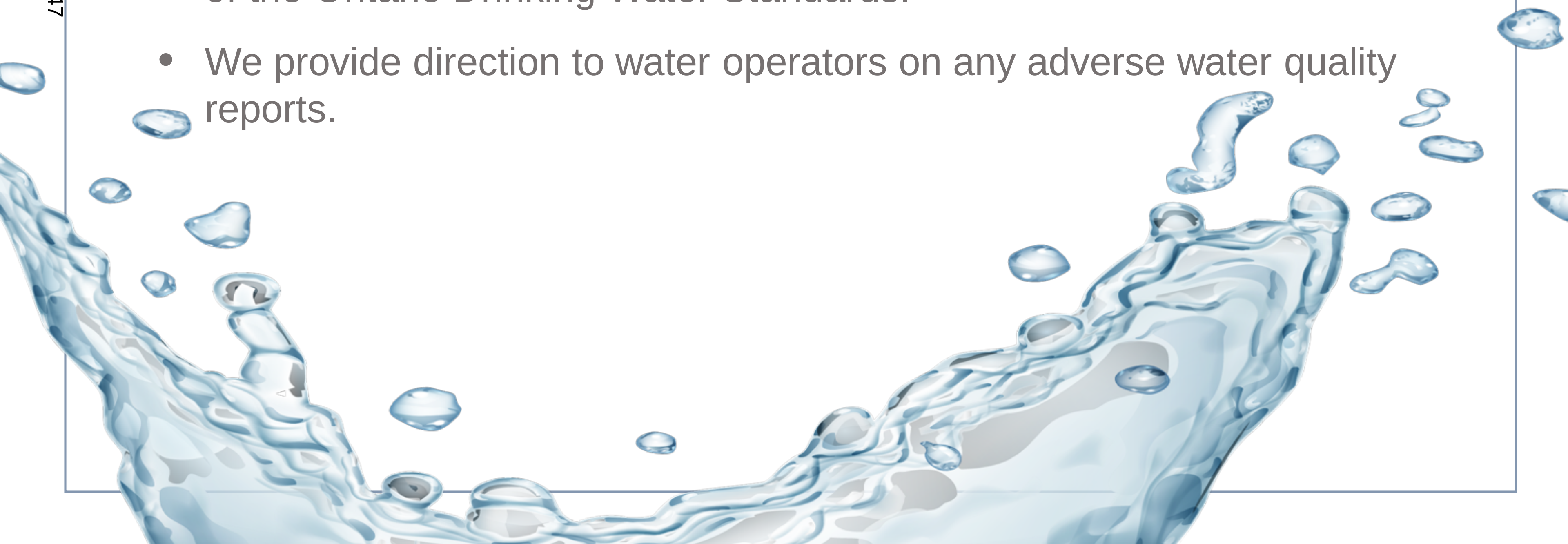
Subtitle

SAFE WATER

simcoe muskoka DISTRICT HEALTH UNIT

It's the health unit's responsibility

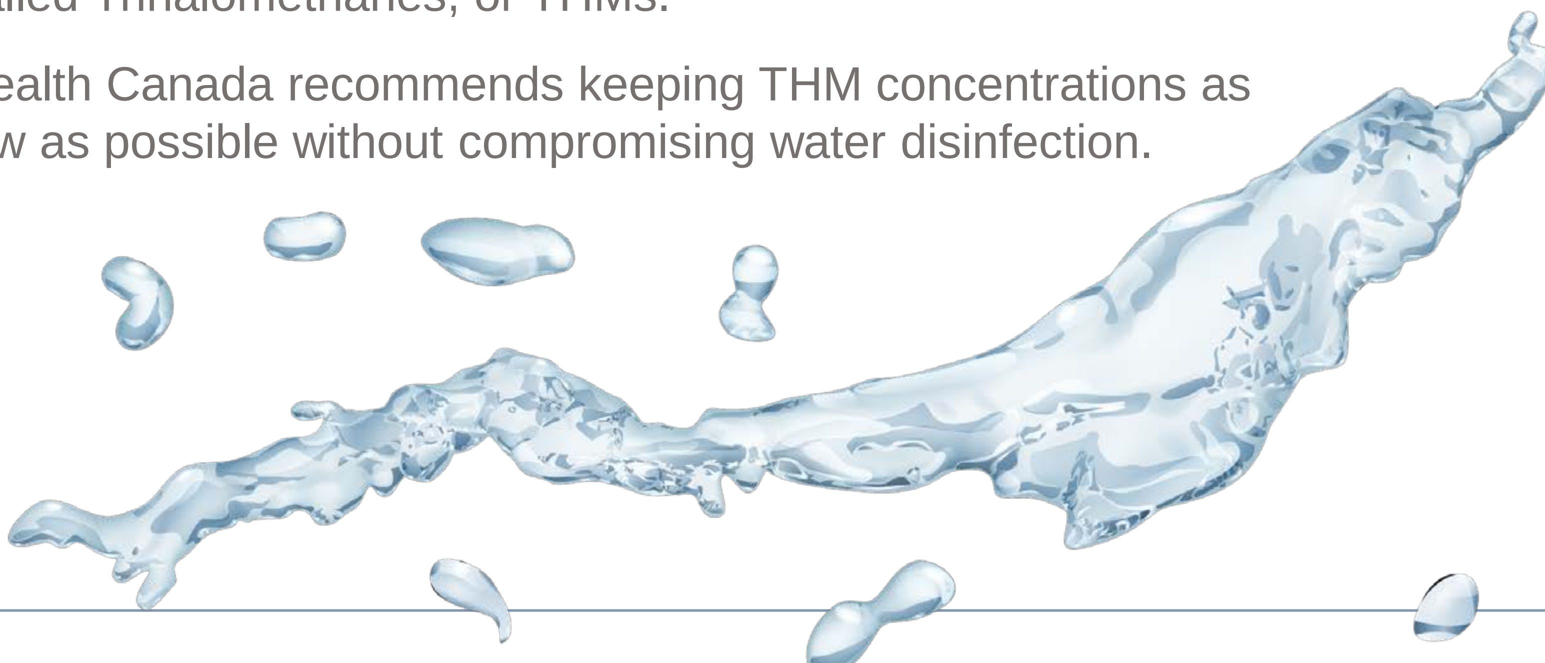
- Our goal is to prevent or reduce water-borne illnesses related to drinking water.
- We work with the Ministry of Environment, Conservation and Parks and drinking water operators
- We respond to adverse water quality reports including exceedances of the Ontario Drinking Water Standards.
- We provide direction to water operators on any adverse water quality reports.



CHLORINE

Why do we use Chlorine in drinking water?

- Chlorination of drinking water has virtually eliminated typhoid fever, cholera and many other diseases in Canada
- Chlorine is one of the greatest achievements of public health protection.
- Chlorine reacts with organic material in water, creating byproducts called Trihalomethanes, or THMs.
- Health Canada recommends keeping THM concentrations as low as possible without compromising water disinfection.



THMs

simcoe muskoka
DISTRICT HEALTH UNIT

What are Trihalomethanes (THMs)?

- THMs are a colourless, tasteless, and odourless by-product. They include: Chroloform, bromoform, dibromochloromethane, bromodicholomethane.
- Concentrations of THMs within a drinking water system may vary significantly over time.
- The drinking water standard for THMs, is 0.100 mg/L (reported as a running annual average).
- Without adequate disinfection of our water supplies, the health risks from bacteria and viruses would far outweigh the risks from THMs

THE EVIDENCE

THMs and health

- Some research shows elevated THMs may cause cancer in colon, rectum, kidney, bladder, liver.
- A slight increase in risk may exist with a lifelong exposure at high levels.
- Risk elevation of 1 cancer case per 100,000 people exposed over 70 years at 0.100 mg/L.
- Low birth weight, miscarriages, stillbirths are not consistently found in research associated with THMs.
- No adverse health effects linked with short-term spikes in THM levels.

Sources: 1. Public Health Ontario (2017). Trihalomethanes in drinking water 2. Health Canada, 2006 (with 2009 addendum). Guidelines for Canadian Drinking Water Quality: Guideline Technical Document: Trihalomethanes

New Tecumseh
Alliston · Beeton · Tottenham

Short Term THM Reduction Strategies

Technical Memorandum

Final

Prepared for:
Town of New Tecumseh

arva

RVA 184167.03

April 25, 2019

R.V. Anderson Associates Limited
2001 Sheppard Avenue East Suite 300
Toronto Ontario M2J 4Z8 Canada
Tel 416 497 8600 Fax 855 833 4022
www.rvanderson.com

April 25, 2019

RVA 142999.15

Engineering Department
Town of New Tecumseth
10 Wellington Street East
Alliston, ON L9R 1A1

Attention: Mr. Doug Austin

Dear Mr. Austin:

Re: Short Term THM Reduction Strategies
Tottenham Water System, Town of New Tecumseth

We are pleased to provide the Town of New Tecumseth with the enclosed Final Draft Technical Memorandum.

We appreciate the opportunity to work with the Town on this important project and look forward to continuing our work together.

Should you have any questions or require additional information, please contact the undersigned at 416-497-8600.

Yours very truly,

R.V. ANDERSON ASSOCIATES LIMITED

Kimberly Sayers, P.Eng., PMP
Project Manager

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1.0 INTRODUCTION AND BACKGROUND

The existing Tottenham water system is fed by four groundwater wells which have challenging water quality. Some of the challenges include elevated natural iron resulting in aesthetic complaints, the presence of methane, and elevated natural ammonia leading to a need for high chlorine dosages for disinfection. The treatment with chlorine and the presence of natural bromide contributes to elevated levels trihalomethanes (THMs), especially brominated species of THMs.

This Technical Memorandum is provided to summarize the existing issues in Tottenham and to identify and evaluate possible short-term treatment strategies to reduce THMs.

1.1 2016 Water Supply Distribution and Storage Master Plan

The feasibility of interim treatment alternatives to improve water quality in Tottenham was evaluated as part of the Water Supply Distribution and Storage Master Plan (2016). The resulting study concluded that the water quality in Tottenham is problematic, with no simple means to achieve treatment to reduce ammonia, iron, methane and bromide. The preferred treatment process included Reverse Osmosis, which is an energy and operationally intensive process.

The other alternative evaluated in the Master Plan was to connect the Tottenham water system with the Alliston/Beeton water system through the Tottenham Transmission main.

At the time of the study, the time required to procure a full temporary treatment system was anticipated to be similar to the timeframe of the design and construction of the proposed Tottenham Transmission Main. Since Town Operations staff had successfully been able to improve the THMs so that the existing Tottenham water supply met the health-related Ontario water quality parameters, the recommended course of action was to move forward immediately with the long-term pipeline solution.

After the Master Plan was issued, a Part II Order was filed with the Ministry of Environment, Conservation and Parks (MECP). The MECP reviewed the project file, and after giving careful consideration to the issues raised in the Part II Order request, ruled in April 2018 that an individual environmental assessment was not required, allowing the Tottenham Transmission Main project to proceed.

1.2 Tottenham Transmission Main

The Town is currently in the process of designing a Transmission Main to bring water from Beeton to replace the Tottenham groundwater supply and the expansion of the Mill Street Reservoir. It is anticipated that the transmission main will be commissioned in 2022.

In order to address the delays in the implementation of the preferred solution, the Town is currently looking for other short-term measures that could help to reduce THMs while the transmission main is being designed and constructed.

2.0 EXISTING SYSTEM

2.1 Existing Groundwater Supply

The Tottenham ground water supply consists of four wells, located at two well sites:

- Walkem Drive Wells - Well 4 (18.9 L/s) and 5 (18.9 L/s). The well operation is limited to one well at a time.
- Coventry Park Wells - Wells 6a (20 L/s) and 7 (30.3 L/s). Both wells can be operated concurrently.

2.2 Groundwater Quality

The existing groundwater quality is summarized in **Table 2.1**.

Table 2.1 – Tottenham Groundwater Quality

Parameter	Ontario Drinking Water Quality Standard / Objective	Well 4 (1970)	Well 5 (1977)	Well 5 (2010)	Well 7 (1997)	Well 7 (2010)	Well 6A (2009)	Mill Street Reservoir (2009)
pH	*6.5-8.5*	8.2	7.9		8		8.22	8.09
Total Dissolved Solids (mg/L)	*500*	-	-		309		306	
Total Hardness (as CaCO3) (mg/L)[2]	*80-100*	195	198		188		180	176
Chloride (mg/L)	*250*	50	23		56		44.7	
Nitrate as N (mg/L)	*10*	-	0.1		0.05		0.05	0.033
Nitrite as N (mg/L)	*1*	-	-		0.01		0.05	0.005

Parameter	Ontario Drinking Water Quality Standard / Objective	Well 4 (1970)	Well 5 (1977)	Well 5 (2010)	Well 7 (1997)	Well 7 (2010)	Well 6A (2009)	Mill Street Reservoir (2009)
Sulphate (mg/L)	*500*	-	2		2		0.1	
Ammonia as N (mg/L)	-	-	-	0.71	0.37	1.28	0.53	0.2
Organic N (mg/L)	*0.15*	-	-		0.6		0.43	
Total Organic Carbon (mg/L)	-	-	-		1.4		1.9	
Reactive Silica (mg/L)	-	-	-		16.8		16.2	
Colour (TCU)	*5*	3	-		8		20	5
Turbidity (NTU)	*5*	-	-		1.3		3.2	
Calcium (mg/L)	-	-	48		39.4		38	38.4
Magnesium (mg/L)	-	-	19		21.6		20.7	
Sodium (mg/L)	*20(200)*	-	25		42.1		32.9	
Potassium (mg/L)	-	-	1.5		2		1.98	
Aluminum (mg/L)	*0.1*	-	-		0.01		0.087	
Arsenic (mg/L)	*0.025*	-	-		0.002		0.003	
Barium (mg/L)	*1*	-	-		0.142		0.112	
Boron (mg/L)	*5*	-	-		0.078		0.059	
Cadmium (mg/L)	*0.005*	-	-		0.0005		0.002	
Chromium (mg/L)	*0.05*	-	-		0.002		0.003	
Copper (mg/L) [3]	*1*	-	-		0.002		0.003	
Iron (mg/L) [3]	*0.3*	0.85	0.59		0.52		0.613	0.717
Lead (mg/L)	*0.01*	-	-		0.0001		0.002	
Manganese (mg/L) [3]	*0.05*	-	0.029		0.024		0.028	
Methane (L/m^3) [3]	*3*	-	-	4.6	10.73	16	14	
Bromide (mg/L)	-	-	-	0.25	-	0.62	0.48	

Notes:

[1](Genivar, 2011)

[2] Operational Objective

[3]Aesthetic Objective

2.3 Mill Street Reservoir and Pumping Station

The water from the wells is pumped to the Mill Street Reservoir, where chlorine is added for primary disinfection and sodium silicate is added immediately after to sequester both iron and manganese. A summary of the system is shown in

Table 2.

Table 2.2 – Mill Street Reservoir

Condition	Mill St Reservoir	Notes
Typical Chlorine Primary Disinfection Dose	5-7 mg/L	During site visit of January 18, 2019, the primary disinfection chlorine residual was approximately 1.28 mg/L
Typical Sodium Silicate Dose	7-14 mg/L	During site visit of January 18, 2019, the sodium silicate dose was reported to be 4.75 mg/L
Target Chlorine Residual on HLP Discharge for Secondary Disinfection	1.30 to 1.45 mg/L	During site visit of January 18, 2019, the secondary disinfection chlorine residual was approximately 1.32 mg/L
Volume	890 m^3	
Dimensions (L X W)	17.7m x 17.7m	
Minimum level for primary disinfection	2.35 m	Reservoir lockout SCADA Setpoint during site visit of January 18, 2019
Low Operating Level (Well start operating)	2.40 m	SCADA Setpoints during site visit of January 18, 2019
Upper Operating Level (Well stop operating)	2.67 m	SCADA Setpoints during site visit of January 18, 2019
Overflow Level	2.78 m	
Underside of Roof	3.50m	
Baffling Factor	±0.024	Back calculated from tracer test

The Mill Street Reservoir is used both for providing contact time for primary disinfection and for water storage. Water enters the reservoir through an upturned pipe onto a splash plate to encourage aeration of the water supply and off-gassing of the methane. Water exits the reservoir through the suction bells of three high lift pumps at the north wall. There is no baffling of the reservoir, and tracer study tests completed by the Town and R.G. Robinson & Associates Ltd in 2005 - 2008 indicate that the baffling factor is very poor and short circuiting is prevalent. **Table 2.3** shows the contact time (T_{10}) values used for primary disinfection calculations that were generated from the tracer test study. This table also lists the minimum chlorine residual required to achieve primary disinfection under various flow conditions. However, it is noted that the operational targeted chlorine residual is typically higher than the minimum residual noted in **Table 2.3** for process control and secondary disinfection.

Table 2.3 – Hydraulic and Primary Disinfection Parameters

Flow	Hydraulic retention time (mins)	Tracer based T_{10} (mins) [1,2]	Minimum Required Cl_2 residual (mg/L)[1,2]	Operational Minimum Chlorine Residual (mg/L)[3]
40 L/s	371	15	0.27	0.50 mg/L
50 L/s	297	10	0.40	0.50 mg/L
60 L/s	247	9	0.44	0.50 mg/L
70 L/s	212	5	0.80	1.0 mg/L

NOTES:
[1] R.G. Robinson & Associates Ltd, Mill Street Reservoir Tracer Study January 04, 2004
[2] Town of New Tecumseth, Mill Street Reservoir Tracer Study February 22, 2008
[3] Mill Street Reservoir, Primary Disinfection SOP, April 16, 2015

Water is then drawn from the reservoir using the three high lift pumps and delivered to the distribution system and elevated tank. Additional chlorine is dosed at the high lift pump discharge to ensure that adequate residuals are maintained in the distribution system for secondary disinfection. Typically, only one high lift is used at a time which has a flowrate of 40 L/s and additional pumps are only required during periods of elevated demand (fires, flow testing, hydrant flushing, etc).

The Town currently has an application with the MECP to relocate the chlorine systems from the Mill St. Reservoir to the two well houses. The timing of approval is currently unknown. The wells were operated this way for a brief period of time in 2014 when the reservoir was isolated for maintenance.

The Town noted that the reservoir was taken offline in 2014 for cleaning, and not much sediment was observed. The Town has scheduled a robotic clean of the reservoir for 2019.

In 2014, the Town installed an active ventilation system (3,400 m^3/hr) to vent methane gas from the headspace of the reservoir due to safety concerns regarding the explosion risk.

2.4 Tottenham Elevated Tank

The Tottenham Elevated Tank is located near the wastewater treatment plant, on the west side of Tottenham. **Table 2.4** lists some of the parameters associated with the Elevated Tank.

The tank has one common inlet/outlet pipe located at the bottom of the tank. Operations staff noted that the minimum level in the elevated tank had recently been lowered from approximately 9 m to 7.5 m improve turn over and reduce water age in the tank.

The Town also recently added a solar bee system to the elevated tank to mix the tank and prevent stratification. The solar bee system has been reported to have operational difficulties due to a failed battery system and with mixing intensities lower than anticipated.

Table 2.4 – Tottenham Elevated Tank

Condition	Elevated Tank	Notes
Volume	4,540 m^3	
Diameter	22.86 m	
Low Low Water Level	299.80 masl	
Low Water Level Setpoint	5.5 m / 45 %	Current setting to reduce water age
High Water Level Setpoint	7.5 m / 61 %	Current setting to reduce water age
High High Water Level Setpoint	312.0 masl	
Overflow Setpoint	312.5 masl	

2.5 Current THM Levels

2.5.1 Distribution System

The current running annual average THM levels are below the Ontario Drinking Water Quality Standard for THMs of 100 micrograms/L, as shown in **Figure 2.1** (orange boxes), however, individual readings (blue line) have exceeded the standard.

The methodology for calculating regulatory THMs in Ontario utilizes a Running Annual Average (RAA) approach, with quarterly (4-months) divisions throughout a 12-month period. This provides a composite measurement that is more reflective of yearly THMs levels and is described in detail in the following MECP document “ Trihalomethane and haloacetic acid sampling and reporting requirements technical bulletin” that can be accessed at https://www.ontario.ca/page/total-trihalomethane-thm-reporting-requirements-technical-bulletin.

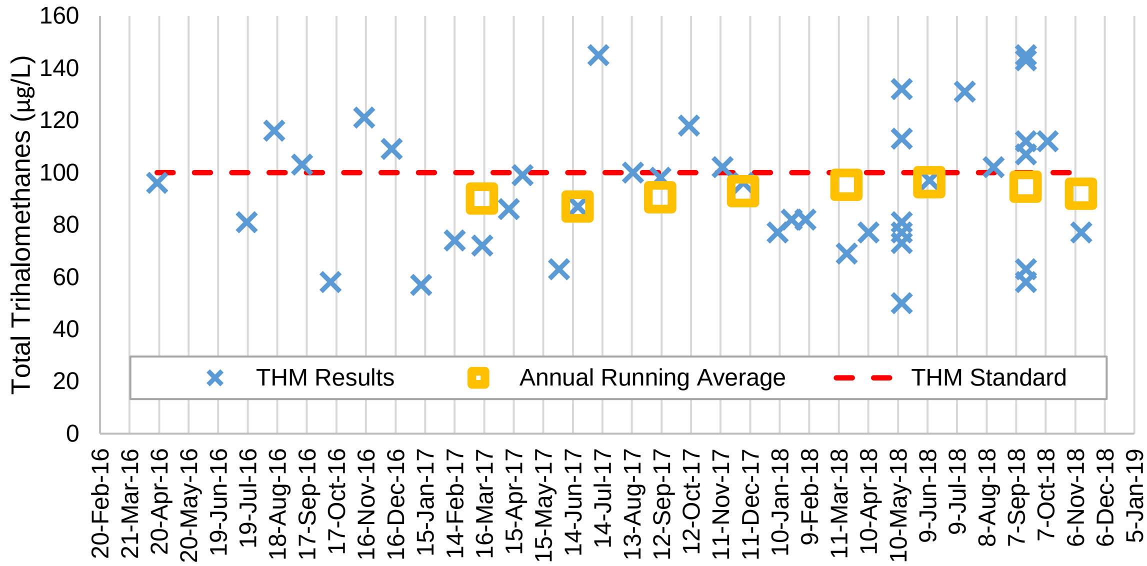


Figure 2.1: Tottenham Distribution System THM Concentrations (2016 – 2018)

2.5.2 Mill Street Reservoir

The Tottenham Disinfection and Treatability Study (Genivar, 2011) found that THM formation rates are relatively rapid with the majority forming in under 12 hours. The study also found that water age at the compliance point (Nolan Road) was also found to be in excess of 22 hours. **Figure 2.2** shows the THM formation rates and **Figure 2.3** shows the estimated water age as reported in the Treatability Study report. At the time of the 2011 Treatability Study, chlorine doses used for primary disinfection were 10-12 mg/L; however, the Town has since optimized disinfection doses which has resulted in decreased chlorine doses in the range of 5 - 7 mg/L.

The most recent THM sampling by the Town confirms that THM concentrations leaving the Mill Street reservoir averaged 60 µg/L in 2018 (see **Figure 2.4**); however, spikes as high as 119 µg/L have been measured in the past. The spikes in THM concentrations appear to slightly corelate with water usage and temperature. There could be multiple explanations why this correlation exists, such as the system drawing older water from the corners of the reservoir, changes in source water quality due to pumping stress and the impact of temperature on THM formation kinetics.

What is evident from these studies is that THM formation is fairy rapid, with the majority occurring within the Mill Street Reservoir.

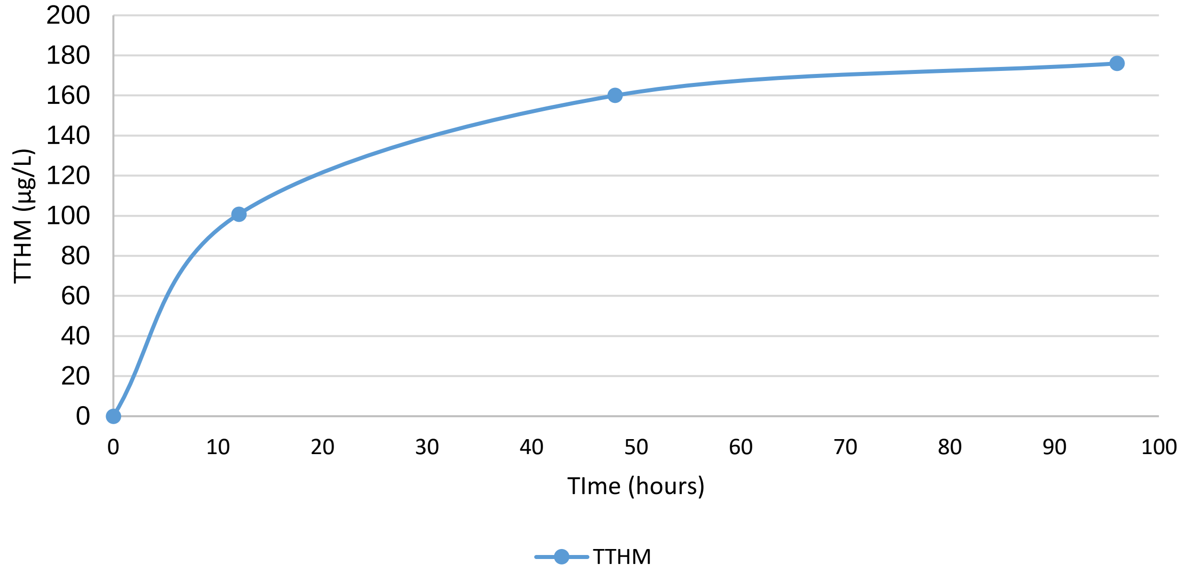


Figure 2.2: Total Trihalomethane formation rates for Tottenham Water (Genivar, 2011)

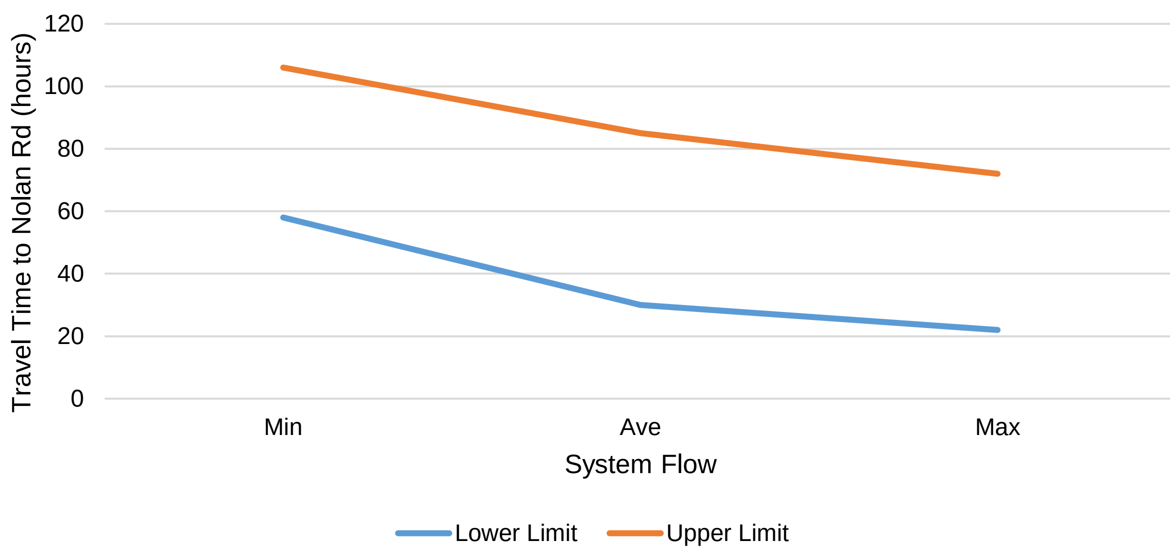


Figure 2.3: Water age at Nolan Road (Genivar, 2011)

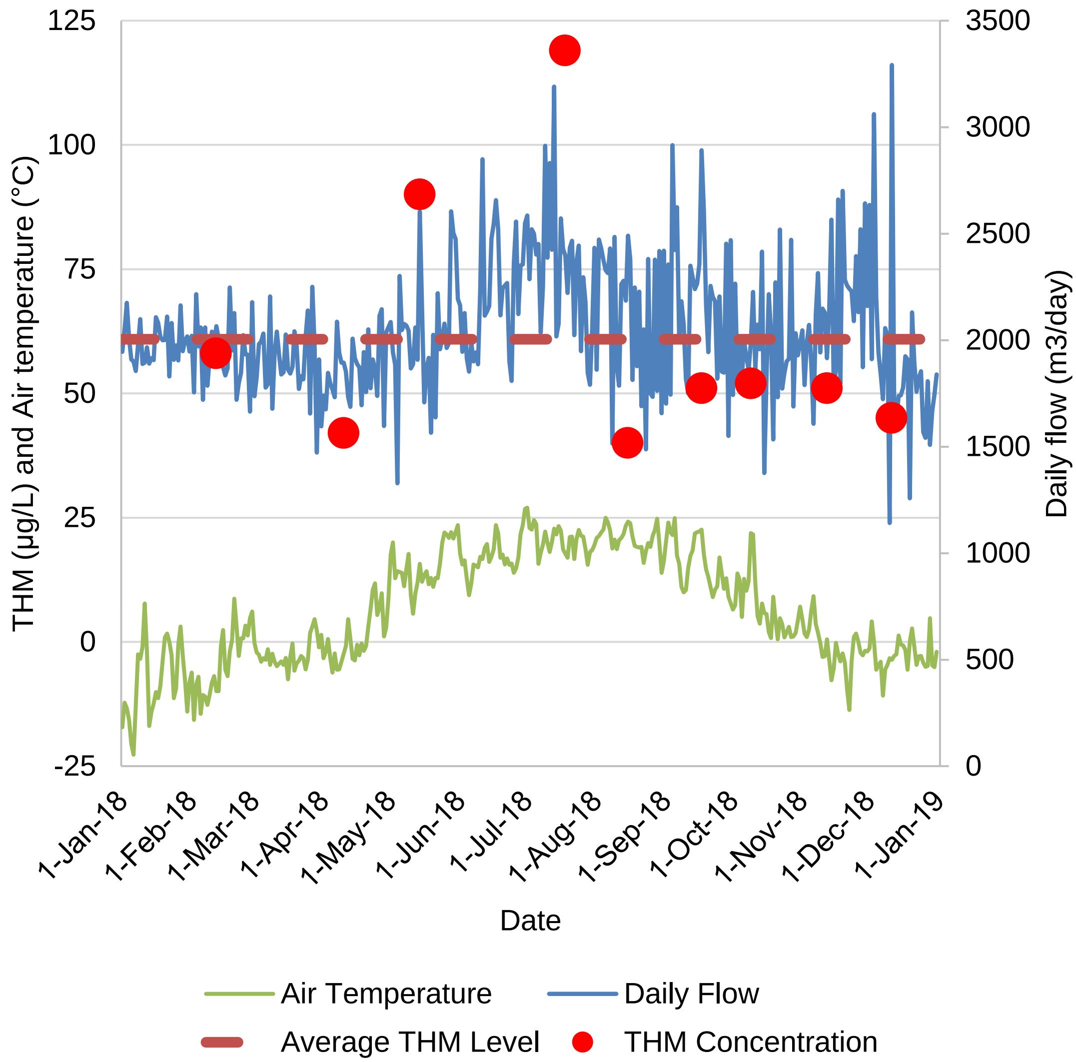


Figure 2.4: THM Concentrations at the Mill Street Reservoir

2.6 Current Distribution System Operations and Maintenance Practices

The Town currently employs additional operational activities to help reduce THMs in the distribution system. The activities include:

- A directional flushing program is completed three times per year.
- A swabbing program is conducted every two years.
- Additionally, the Town is planning on working with developers to continuously run the tap at the end of new developments during construction to reduce the water age in dead end mains of new developments that have not reached full occupancy yet.

3.0 ALTERNATIVE SOLUTIONS

THMs are formed when chlorine used for primary disinfection reacts with organic matter naturally present in the source water. The formation of THMs generally increases with total organic carbon and bromide concentration in the raw water, as well as chlorine dose, pH and temperature. Some THMs will form immediately when chlorine is added to the water, and the THM levels will typically increase over time as the water ages.

The traditional and most effective approach to control THMs is to remove the organic precursor material before it can react with chlorine to from the DBPs. However, this was previously evaluated and determined not to be the preferred solution.

The following section discusses alternative solutions that were evaluated as part of this study to reduce THMs in the Tottenham water system.

3.1 pH Depression

The formation of THMs is known to be impacted by pH, with higher THM formation occurring at higher pH values. The pH of the existing Tottenham water is approximately 7.9 to 8.2. The pH of the water could be reduced through the addition of an acid (sulphuric acid, carbon dioxide, etc.) to a range of 7.0 to 7.5, which could result in THM reductions of 5% - 10% in the distribution system.

However, this alternative could result in other downstream implications, such as increased corrosion in the distribution system, which could impact water quality. Additionally, acid addition is an added operation and maintenance concern, as the chemical is highly corrosive and would present additional operational challenges. Due to these challenges and disadvantages, this alternative is not recommended.

3.2 Reducing Chlorine Dose Through Disinfection and Process Optimization

Although the minimum chlorine residual in the Mill St reservoir required for disinfection is only 0.5 mg/L, the operational target is approximately 1.2 to 1.35 mg/L. This higher residual is desired for proper control of the process, as the chemical reactions between chlorine, ammonia and the other water parameters is not instantaneous and takes time to reach breakpoint chlorination and for the chlorine residual to stabilize.

If a solution could be found to reduce the chlorine doses (and associated residual) in the reservoir while maintain adequate process control, then the THMs formed at the primary disinfection stage of treatment could also be potentially reduced. However, it is recognized that operating the reservoir at a lower chlorine residual, close to the minimum required for disinfection, would leave little room for error and is operationally challenging.

Chlorine doses could be reduced by removing ammonia before adding chlorine, however, ammonia is relatively difficult to remove, requiring involved and complicated treatments such as air stripping, biological filters, reverse osmosis, or Ion exchange.

Alternative oxidants such as potassium permanganate or hydrogen peroxide could be considered for disinfection; however, these alternatives could potentially result in increased complaints regarding aesthetic issues due to pink water (potassium permanganate), an increase in metal precipitates in the finished water and difficult process control related to the use of hydrogen peroxide. Therefore, these alternatives were not evaluated further.

Two alternatives to improve the primary disinfection process and provide more time for the chemical reactions to complete in order to reduce the chlorine residual in the reservoir were identified and evaluated for this study.

3.2.1 Increasing Chlorine Contact Time by Moving Chlorine Feed Point

Increasing the time that chlorine is in contact with the water can reduce the concentration of chlorine that is required for primary disinfection, as well as providing additional time for the chemical reactions to reach completion. In order to increase chlorine contact time and potentially reduce the chlorine residual required for disinfection, the chlorine application point could be relocated to the Well houses. As shown in **Table 3.1**, the contact time achieved in the watermains from each well to the Mill St Reservoir could provide all of the required contact time to achieve 2-log virus removal for primary disinfection at a chlorine residual of 0.5 mg/L.

Table 3.1 – Impact of Moving Primary Disinfection Point on Contact Time

Condition	Walkem Drive Wells	Coventry Wells
Pipe length to Mill St (m)[1]	491 m	1,175 m
Pipe diameter (mm)	200 mm	300 mm
Contact Volume	15.4 m^3	83.0 m^3
Baffle Factor	0.9	0.9
Maximum Well Flow	18.9 L/s	50.3 L/s
Maximum Well Flow	1.13 m^3/min	3.02 m^3/min
Contact Time at Max Well Flow	13.6 min	24.75 min
CT achieved with 0.5 mg/L Chlorine	6.1 mg/L.min	12.4 mg/L.min
CT required for primary disinfection (2-log virus removal at 5°C)	4 mg/L.min	4 mg/L.min

Note: [1]Pipe length from wellhouse to reservoir

If the chlorination point were relocated to the wells, all of the CT for primary disinfection could be achieved in the well transmission mains at low chlorine residuals (approx. 0.5 mg/L). The reservoir would then be used primarily for equalization, and the chlorine residual could then be topped up on the HLP discharge to reach the secondary disinfection target of 1.35 mg/L.

However, lowering the chlorine residual to the minimum required for disinfection in the well transmission mains and reservoir may not be desired from an operational perspective, as the system would rely heavily on the top-up chlorination system to achieve desired secondary chlorine residuals. The current system uses the contact time in the Mill Street Reservoir to stabilize the chlorine residual and the top-up chlorine feed point would have less margin for error. However, the primary chlorine residual could be lowered slightly from the current setpoint. Additionally, a phased approach could be used, with the addition of an intermediate chlorine application at the entry to the reservoir.

Further optimization could be achieved by reducing the secondary disinfection targets as much as possible, to reduce further THM formation within the distribution system.

If the chlorination point is relocated to the well houses, the sodium silicate should also be relocated. For effective sequestration, sodium silicate should be added nearly simultaneously or just prior to chlorination to properly control the process and prevent oxidation and sedimentation of the iron and manganese by chlorine. Poor results are typically expected if the chlorine is added first by several seconds or if the sequestering chemical is added first by more than 30 seconds (AWWARF, 1990).

The advantages and disadvantages of this alternative to relocate the chlorine application point to the well houses are as follows:

Advantages:

- Chlorine residual in reservoir could be reduced, thereby reducing THM levels formed in the Mill St Reservoir,
- Plug flow conditions in the well discharge watermains would result in a more homogenous chlorine residual and provide longer contact time for disinfection and to achieve a stable chlorine residual for better process control, allowing the secondary chlorine residual target to be lowered
- Reservoir could be modified or altered by adding mixing and aerations systems, without compromising primary disinfection,
- Relatively low cost. The Town already has the majority of the equipment required to relocate the chlorination systems to the wells.

Disadvantages:

- The reduction of chlorine residual in the reservoir to the absolute minimum levels required for disinfection may not be operationally preferred, as it relies heavily on the top-up chlorination system to increase the chlorine residual from 0.5 mg/L to 1.35 mg/L. This could be addressed by making minor reductions to the chlorine residual, or with an intermediate chlorine application point as it enters the reservoir.

3.2.2 Reservoir Baffling

The present design of the Mill Street Reservoir has been shown using tracer studies to have extreme short circuiting, which results in a relatively short contact time for primary disinfection.

The arrangement of the reservoir also results in a variable water age in different sections of the reservoir, which allows greater time for THM formation in the areas with low turnover. During periods of high demand, water from these older sections with elevated THMs would be fed into the distribution system.

The addition of baffles to the reservoir would help to improve disinfection performance by reducing short circuiting, providing a more consistent water age in the reservoir and increasing the effective contact time. This would allow a lower chlorine dose to be used; and THM concentration leaving the reservoir.

The existing reservoir could be retrofitted with baffle curtains, as shown in **Figure 3.1**. These are comprised of a polyethene assembly anchored to the roof of the reservoir, with a ballasted bottom.

Figure 3.1: Example of baffle curtain installation

The advantages and disadvantages of this alternative are as follows:

Advantages

- Baffling would increase effective contact time for primary disinfection and allow for a reduction of required chlorine residual, which could reduce THM levels
- Baffling would reduce dead zones in the reservoir, and result in a more consistent water age entering the distribution system

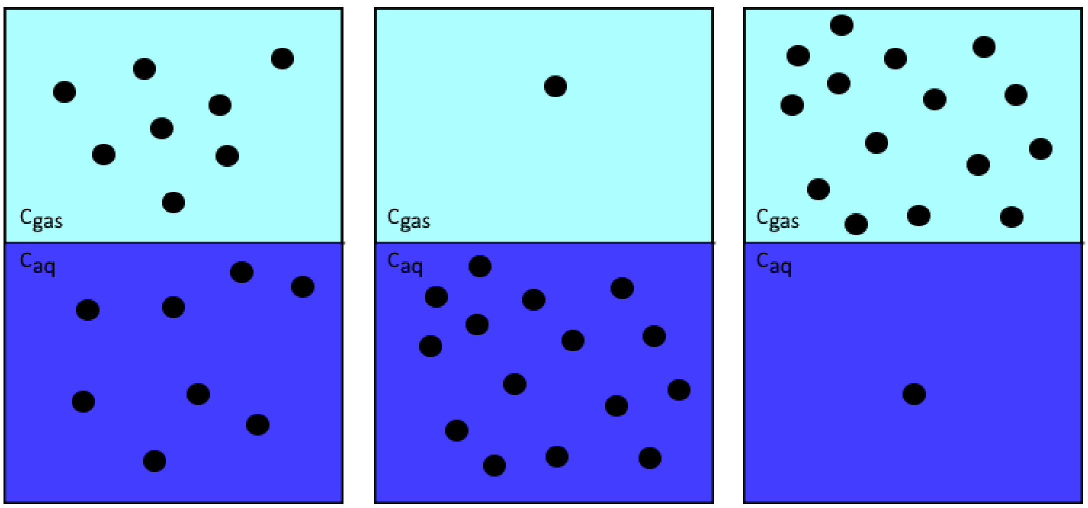
Disadvantages:

- The reservoir only has a single access hatch to enter the cell, making construction more challenging.
- Reservoir would need to be taken offline for at least 1 week.
- The retrofit of baffles is a costly alternative with approximate construction costs in the range of $100,000 – 150,000.
- The addition of baffles could reduce the effectiveness of aeration, as the proposed aeration systems discussed below rely on mixing and turn over of the reservoir.

3.3 Aeration

Aeration has been identified as an alternative method of THM control that would remove THMs after they have been formed. Trihalomethanes are volatile substances and they have the ability to partition from a dissolved aqueous phase to a gas phase under the right conditions. Aeration can be used to increase the exposure of treated water to air, which will encourage the THMs to volatize and reduce their concentration in the treated water.

This partition is governed by a compounds Henry's Constant (KH), which is a ratio of the gas and aqueous phases at equilibrium. Compounds with higher values of KH are more easily transferred from the aqueous phase to the gaseous phase, as illustrated in **Figure 3.2**.



K_H=1
Compound equally divided between gas and liquid phase

K_H<<1
Compound prefers liquid phase

K_H>>1
Compound prefers gas phase

Figure 3.1: Impact of K_H Values on Partitioning of a Compound between the Gas and Aqueous phases

Regulated trihalomethanes are composed of four different compounds (Chloroform, Bromoform, Bromodichloromethane (BDCM), and Dibromochloromethane (DBCM)). Each compound has a different K_H value which impacts its relative ease of removal using aeration. As shown in **Figure 3.3,** brominated compounds have lower K_H values, and are therefore more difficult to remove using aeration. Due to the presence of bromide in the groundwater, Tottenham THMs primarily consist of brominated species (**Figure 3.4**), and will be more challenging to remove.

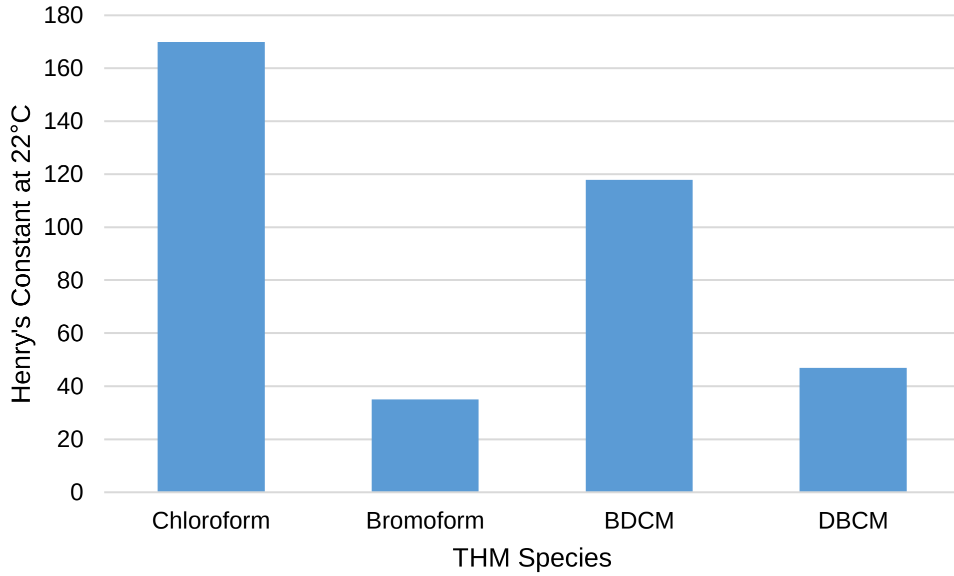


Figure 3.3: Henry's constant for regulated THM species

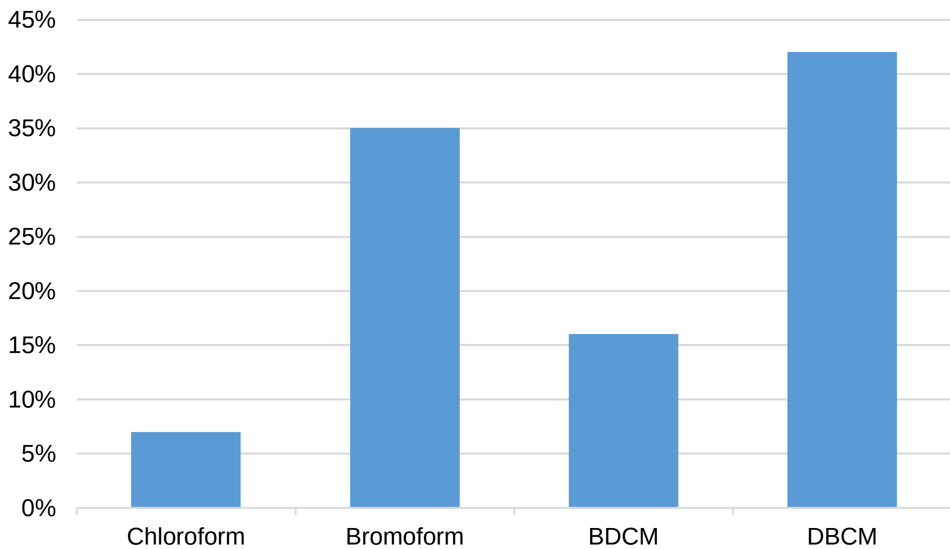


Figure 3.4: Fractions of THM species formed in Tottenham water

THM removal can be achieved by increasing the surface area of the water to air transfer zone, by:

- Ventilation (air changes) of headspace above water - Air can become saturated with THMs, stopping THMs from transferring to a gaseous state. By ventilating the reservoir headspace, the THMs can be removed.

- Intensive mixing of the water to maintain uniform THM concentrations at surface. The topmost layer of the water can become depleted of THMs, slowing the transfer rate of THMs from water to the air
- Increase surface area ratios between water and air via spraying - small water droplets have a much larger combined surface area being exposed to the air instead of just the top layer of the water being exposed, increasing the transfer rate
- Bubbling air up through the water – small air bubbles travel up the water column and THMs partition into the bubbles. When then bubbles reach the surface the THMs are then transferred into the air.

A number of commercially available products are marketed to aid in THM removals that harness these factors and include bubble aerators, intensive mixers and droplet spray systems. These are often coupled with active ventilation systems.

Spray systems are preferable, as they have relatively high removals of all THM species due to high rate of mass transfer from the small water droplets to the surrounding air. A typical spray aeration installation is shown in **Figure 3.5** with a floating surface aerator with an onboard pump. THM removals via spray aeration are shown in **Figure 3.6,** which can approach 50% - 70% per unit of water passed through the spray system, with higher removal rates seen in the chlorinated THM species. The most significant factor in achieving THM removals is the rate of recycle that can be achieved within the system.

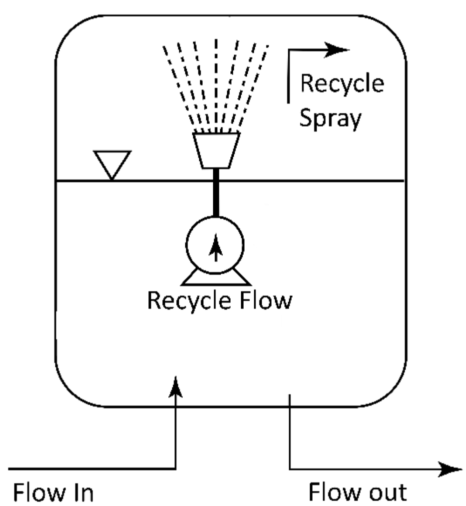


Figure 3.5: Simplified diagrams of spray aeration system

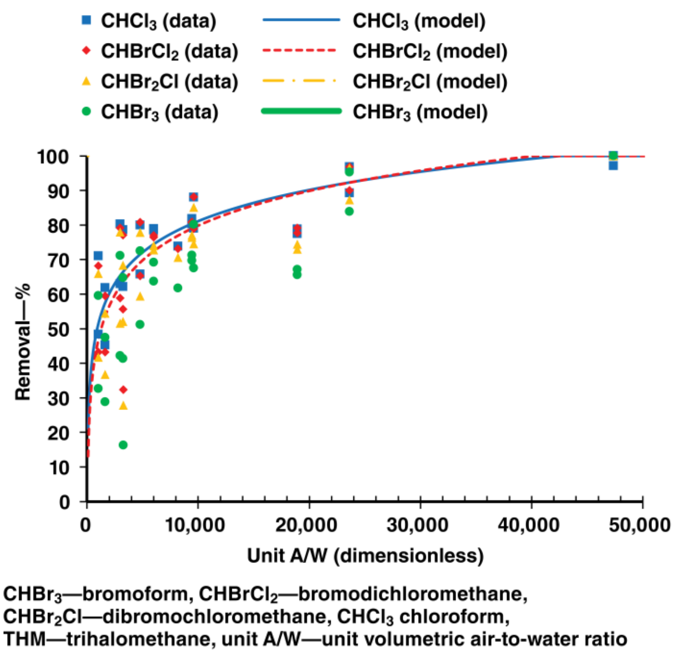


Figure 3.6: THM removals via spray aeration. Note that typical A/W ratios range between 3,000 - 5,000 (Cecchetti et al, 2014)

The aeration process will also strip carbon dioxide from the water and will result in some chemistry changes that could impact the Tottenham Water Quality:

- pH increases of 0.2 - 0.4 pH units. Large increases in pH (ie. 1 – 2 pH units) are generally associated with 5 – 10% increases in THM formation, however the anticipated increase in pH resulting from aeration would be minor (0.2 - 0.4) and would not be expected to have a significant impact.

- Alkalinity increase of 2 - 5 mg/L. Increase in alkalinity can add buffering potential and results in the potential for more scale formation in the distribution system. However, it is not expected that a change in this magnitude would have a significant impact.

- Langelier Saturation Index (LSI) increase of 0.2 - 0.4, increasing the potential for scale formation.

Although THMs can be removed with aeration, aeration does not remove the pre-cursor material that reacts with chlorine to form THMs, and therefore THM formation will continue to occur over time when the water is in the distribution system.

The magnitude of THM reduction will be greatest at the point of aeration, and it is possible that the reduction achieved at the point of aeration may not be equivalent to the reduction at the extents of the distribution system. This reaction will be highly dependent on the water matrix.

Additionally, one supplier noted that the mixing provided by their system in the reservoir could accelerate THM formation in the reservoir and potentially result in increased THM levels leaving the Mill St Reservoir. However, the accelerated initial formation in the reservoir could reduce the rate of THM formation after aeration, leading to overall lower THM levels in the distribution system.

The advantages and disadvantages of aeration are as follows:

Advantages

- THMs can be removed after they have been formed. Removal rates will be dictated by the system recycle rate, and the speciation of THMs, temperature, with increased removals found in chlorinated species.
- Aeration will also improve removal of methane gas
- Aeration will also remove any other volatile compounds

Disadvantages

- Minor increase in pH (0.2 to 0.4 units). Higher pH has been suggested to increase deposition rates of metal precipitates.
- It is possible that the change in pH could impact the oxidation state iron, resulting in precipitation of iron more rapidly and earlier than un-aerated water, hence inhibiting the sequestration of iron in the treated water. This is being further evaluated using bench scale testing and is discussed further below. If the pH change is found to be a significant concern, a pH adjustment system could be used to maintain the reservoir pH to pre-aeration levels, though this would add additional cost and complexity.
- Aeration does not remove THM precursors and THMs will continue to form in the distribution system.

Aeration is a promising alternative that could be applied at the Mill St reservoir, and at the Tottenham Elevated Tank.

3.3.1 Aeration at the Mill Street Reservoir

THM results from Mill St Reservoir show that a significant portion of THMs are forming in the reservoir, prior to entering the distribution system. Therefore, aeration at this location has the potential to reduce THM levels entering the distribution system; however, reformation of THMs in the distribution system would still occur. With the composition of THMs being primarily brominated, a spray aeration system would be required to ensure that these fractions are properly removed.

A properly sized system aeration system can result in THM removals of up to 10% - 50% for each unit of water passed through this system, depending on recirculation rates, temperature, spray efficiency and ventilation rates.

An aeration system at the Mill St Reservoir would generally consist of a floating assembly with either a pump and spray nozzle arrangement, or a surface aerator with mixer. A mechanical ventilation system would then remove THMs from the reservoir headspace.

One disadvantage to this system is that it could impact disinfection performance of the reservoir. Typically, mixed systems with an agitated basin can be considered to have a baffle factor of 0.1 (Procedure for Disinfection of Drinking Water, MECP 2008). As the current Mill St reservoir has a baffle factor of less than 0.1, it is unknown if the mixing system would improve or worsen the short circuiting inside the reservoir. Therefore, it would be recommended that the chlorination point be moved upstream to the wells to avoid relying on the reservoir to achieve CT for primary disinfection.

3.3.2 Aeration at the Elevated Tank

After water is pumped from the HLP to the distribution system, it enters the distribution system where it proceeds either east to the main area of Tottenham, or west to the elevated tank. The location of the elevated tank is somewhat isolated from the remainder of the distribution system, and therefore, it is anticipated that water age and THMs would be high.

Additionally, the elevated tank serves to provide fire and emergency storage to the community, therefore the tank level can not be significantly exercised over the course of a normal day. During a fire or emergency event, the contribution of the elevated tank to the system would be significant, however, during a normal day, the contribution of flow from the elevated tank would be much lower.

A small aeration system could be installed in the elevated tank. However, due to the low turnover rate, the addition of an aeration system may not result in significant reductions in overall THM levels in the distribution system. Therefore, it would be recommended to first install an aeration system in the Mill St reservoir, and then if additional THM reductions are required, a system in the elevated tank could be considered.

3.4 Water Age

3.4.1 System Flushing

A simple approach for reducing THMs is to reduce the relative water age in the distribution system. This could be achieved by flushing the system, or through the installation of automated hydrant flushing devices.

The Town currently employs a flushing program three times per year to flush out dead ends or low use mains. Additional measures could be considered, including the installation of automated hydrant flushing devices on long single dead end watermains. The system could be intensively flushed during the night to reduce any disernable disturbances to the water system. Portable automatic flushing systems could only be utilized when temperatures are above freezing, and they may require dechlorination of their discharge.

Additionally, the Town is planning on working with developers to continuously run taps at the end of new developments during construction. This would control water age locally around the dead-end or low use watermains and could reduce the THMs in these areas.

3.4.2 Minimize Stored Water Volume

This approach would attempt to reduce water age by operating the Mill Street Reservoir and the Elevated Tank at their lowest possible levels, as dictated by demand and fire flow requirements. This would require ongoing optimization by plant staff to ensure that the system has an adequate reserve to meet system demands. This may be too onerous for plant staff to implement year-round and it could be feasible to only target certain times of the year when THM levels are highest.

4.0 BENCH SCALE TESTING

One important consideration for the implementation of any new THM reduction treatment process will be the impact on the precipitation of iron in the distribution system. Although iron is not a health concern, it is an aesthetic concern that is highly visible and any increase in iron precipitation will be quickly noticed by the public.

Aeration is a process that can be used to oxidize and precipitate iron. It is not known how aeration of the water treated with sodium silicate sequestering agent will impact the performance of the sequestration process. It is possible that the change in pH could impact the oxidation state iron, resulting in precipitation of iron more rapidly and earlier than un-aerated water, hence inhibiting the sequestration of iron in the treated water.

Little information is available in the literature that evaluates the impact on aeration after sodium silicate addition. However, discussions with sodium silicate chemical suppliers indicated that they are of the opinion that sequestration efficacy would not be impacted by aeration.

Bench scale testing was performed to compare the filterable iron content of aerated water samples against non-aerated water samples over the course of 7 days.

The results of the bench scale testing were documented in the Impacts of Aeration on Metal Sequestration Efficacy Technical Memorandum (**Appendix A**)

The bench scale testing found that the application of aeration to the water samples in the test resulted in minor increases (less than 10%) in measured iron and manganese precipitation. However, the qualitative experiments indicated that there was a small perceptible difference between the filters of the aerated and non-aerated samples within the first two days.

However, the slight increase in precipitated iron and manganese observed in the aerated water was minimal compared with the performance of the sequestration process in general. The majority of the iron and manganese were observed and measured to precipitate out of the water early in the process in both aerated and non-aerated samples. Overall, it would appear that the current sequestration process is performing poorly at the Mill Street reservoir, as at Day 0 and 1, iron precipitate was observed on the filter paper and only 35% of the metals were found to be in a dissolved state.

It is recommended that the Town consider a review of their sequestration process, as at present it appears not to be performing optimally. This could be as a result of the following:

- Sodium silicate dose may need to be increased, and the dose be flow paced to match well output flowrates
- Point of application and timing - Sodium silicate should be added upstream (ideally 15 seconds) of chlorination
- Review pump stroke and speed settings to provide a more constant feed or consider adding a pulsation dampener, which would provide a more constant feed rate

- Sodium silicate should be thoroughly mixed prior to chlorination, and consideration could be given to using a static mixer after chemical injection.

It is recommended to optimize the sequestration process first, prior to installing an aeration system, as aeration was observed to slightly decrease the efficacy of the sequestration process (under 10%); which could lead to an increase in aesthetic complaints. Optimization of the existing sequestration process would likely counteract and possibly negate any slight negative impact of aeration.

5.0 RECOMMENDED SOLUTION

Based on the above analysis, the following improvements are recommended to reduce THMs in the Tottenham system.

1. The Town should continue their efforts to reduce water age through ongoing flushing and swabbing programs. Additionally, the Town should continue to work with developers to maintain flow through dead end watermains. The Town should also investigate the installation of automatic flushing stations at far ends of the distribution system. If the Town has concerns regarding freezing in the winter, the systems can be removed during the winter and reinstalled in the spring, summer and fall when THMs tend to be higher.

2. Move the chlorine and sodium silicate chemical feed systems to the well houses. The Town already has the chlorination equipment installed and an application with the Ministry of Environment, Conservation and Parks to allow this operational change. It is recommended that once approved, the Town proceed with this change as it is a low-cost option and would improve control over the chlorination process.

   Additionally, the Town will need to relocate the sodium silicate system to the well houses for best performance of the sequestering system.

   Relocating the chlorination system to the well houses will allow the reservoir to be de-coupled from the disinfection process. The watermain lengths should be confirmed and disinfection CT calculations reviewed and updated to confirm the minimum chlorine dose.

3. If possible, chlorine levels for secondary disinfection should be decreased as much as possible to reduce THM reformation within the distribution system. This should be approached gradually with extensive monitoring within the distribution system to ensure that adequate residuals are maintained.

4. Install an aeration system in the Mill Street Reservoir. This system would have the biggest impact on THMs and could reduce the levels leaving the Mill St reservoir. However, as noted above, reformation of THMs will continue to occur in the distribution system.

5.1 Conceptual Design of Aeration System

The following section discusses the conceptual design and costing for the recommended aeration system in the Mill St Reservoir

The Mill St Reservoir aeration system could be installed first and if additional THM removals are required a second system could be installed at the elevated tank.

Two suppliers, PSI Water Systems (as supplied by Indachem), and GridBee (as supplied by Greatario) were contacted to determine equipment sizing and costing for an aeration system at the Mill Street reservoir. Copies of the proposals are included in **Appendix B**. The equipment options are summarized in **Table 5.1**.

Both systems will cause the reservoir to be mixed, and therefore require that the chlorination point be moved upstream to the wells to avoid relying on the reservoir to achieve CT for primary disinfection.

The two systems are similar with each relying on spray and ventilation systems however; the PSI system maximizes air exchanges to increase THM removals, while the Gridbee system maximizes the volume of water sprayed. Both suppliers have suggested that removal rates could be as high as 45 to 50% under ideal conditions. There are many variables that determine the final removal rates, including starting THM levels, temperature and formation potential. However, they have also advised that under non-ideal conditions, removal rates could be as low as 5 to 10% at low temperatures.

The PSI Water Technologies system is conceptually shown in **Figure 5.1** and consists of the following equipment:

- <u>Floating surface aerator</u> which floats on top of the reservoir and is anchored via cables to the reservoir floor. The aerator generates high flow rates to generate a jet action to throw water into the air by pushing water from underneath the aerator into the air to increase the surface area of the water exposed to air. This system requires a minimum headspace in the reservoir of 1.2 m. This would require the high-water level in the reservoir to be lowered from 2.67 m down to 2.3 m. This is equivalent to a 116 m^3, or 13%, reduction in storage volume.

- Active mixing system to continuously circulate water high in THMs to the top of the tank where they are volatized and removed. Mixers also eliminate short circuiting and dead zones.

- Ventilation system to blow fresh air into the tank to remove volatized THMs from the headspace of the tank. The rapid exchange rates recommended by PSI Water Technologies are designed to maintain the concentration of THMs in the gas phase close to zero in order to maximize the difference in concentrations between the liquid and the gas phase to improve overall removal efficiency. However, during the winter, these high ventilation rates will increase the potential for freezing and a duct heater would be required. Alternatively, the aeration system could be shut down during the winter.

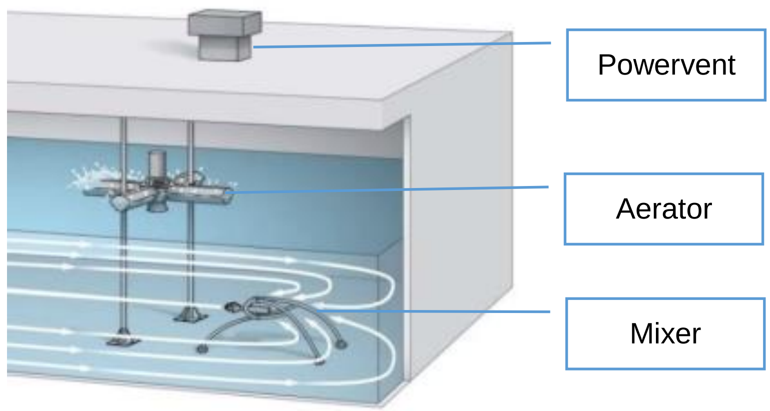


Figure 5.1 – PSI Water System THM Removal Solution

The GridBee system is conceptually shown in **Figure 5.2** and consists of the following equipment:

- Two floating spray nozzle units which consist of a self-contained pump and nozzle/jet system that is tethered via cables weighted on the reservoir floor. Both units would be installed near the outlet of the tank. The GridBee unit would not impact the high-water level in the reservoir, as it only requires 0.75 m of headspace.

- Ventilation system to remove volatized THMs from the headspace of the tank and reintroduce fresh air. The supplier requires lower air to water ratios than the other system, and therefore much lower ventilation rates are required for the GridBee system. However, a duct heater would still be recommended, as a precaution to minimize issues with freezing during winter months. Alternatively, the aeration system could be shut down during the winter.

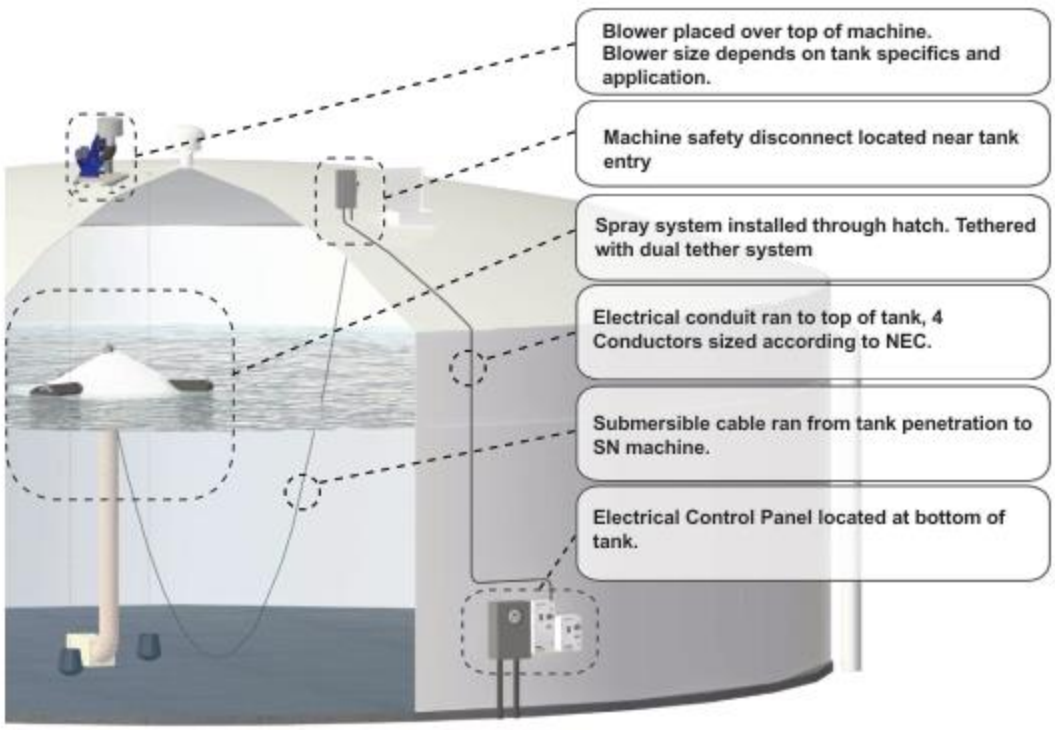


Figure 5.2 – GridBee Aeration System

Table 5.1 – Comparison of Reservoir Aeration System Alternatives

Parameter	PSI Water Technologies	GridBee
Maximum reported THM removal rate under ideal conditions	45%	45 – 55%
Surface Aerator / Sprayer	Yes	Yes
• Volumetric Tank Turnover Rate	2 times per day	4 times per day
• Aerator / Sprayer Flowrate	386 L/s	40 L/s each
• Motor HP	15	2 x 10
Active mixing system	0.5 HP	Not required
Active ventilation system	Yes	Yes

Parameter	PSI Water Technologies	GridBee
• Ventilation rate	12,000 cfm 20,388 m^3/hr 6 X current ventilation rate	3,000 cfm 5,097 m^3/hr 1.5 X current ventilation rate
• motor HP	10	5 – 7.5
• Duct heater	Sizing to be confirmed	Sizing to be confirmed
Control Panel	Basic	Basic
Minimum headspace requirements	1.2 m	0.75 m

The installation of both systems can be accomplished without draining down the reservoir by using divers (PAX System) or a crew in an inflatable raft (GridBee system) to minimize the downtime of the Mill St reservoir and HLPs. New penetrations into the reservoir roof would be required for the power cabling to the units and for the blower/ventilation system, and could be constructed without draining the reservoir, similar to what was done for the construction of the methane ventilation system.

5.2 Explosion Proof Requirements

The presence of methane in the Tottenham groundwater complicates the installation of equipment in the Mill St reservoir. All electrical equipment in the reservoir should be explosion proof rated.

- The PAX system supplier has been unable to confirm if an explosion proof motor is available for the aerator. Therefore, this system may not be a viable alternative for this application
- The pumps associated with the Gridbee system are submerged, and do not pose an explosion risk. No electrical equipment is located above the water line for this system, therefore, it is a viable alternative for this application.
- The blower and duct heater used for ventilation of the reservoir headspace would also need to be explosion proof.

It is recommended that a dedicated methane detector, with integrated alarms are installed in the Mill Street reservoir to provide warning of an explosion hazard. Additionally, a methane detector is recommended to be installed on the exhaust of the ventilation system.

Additionally, any openings in between the reservoir headspace and adjacent rooms (HLP room, and Mill St Reservoir operations building) should be reviewed to ensure they are properly sealed.

5.3 Mill St Reservoir Electrical System

As part of the design, the electrical system was investigated to determine if there is sufficient spare capacity to support the installation of a new system.

The power supply appears to be via a 300 kVa pole mounted transformer (to be confirmed with Alectra during design) which would be sufficient for an additional load up to 75 hP.

The diesel generator has been sized for the existing electrical load of the station. Under emergency power supply, the aeration system could run as long as only one HLP was running. If two HLPs were needed, the aeration system would need to be shut down.

A spare bucket is available in the existing MCC that can be used to power a distribution panel to power the new aeration and methane detection equipment. There is insufficient space within the electrical room to house additional panels, therefore the distribution panel, and control panel for the aeration system would be installed in the storage room.

5.4 Recommendation

Based on the advantages of the GridBee system (no impact on operating water level, lower ventilation rate, and submerged equipment not requiring explosion proof rating), it is recommended to be carried forward into design. Additionally, the local supplier of the GridBee system, Greatario, has in place construction relationships that would allow them to provide a turn-key type solution (final design and construction) for the aeration system.

5.5 Construction Cost

The estimated construction cost is shown in **Table 5.2**; however, there are presently a few outstanding items that require pricing confirmation.

Table 5.2 – Construction Cost

Item	Updated Cost
Aeration system equipment package	$303,000
Duct heater	$10,000
Start up costs	included
Freight	$7,000
Installation	$30,000
Electrical modifications and power wiring	$35,000
Vent opening, ductwork, etc.	$25,000
New duty/standby sodium silicate feed pumps (one per well house)	$60,000
Methane gas detection system	$25,000
General Contractor O/H and profit	$30,000
Sub-Total	**$525,000**
Class 'D' Estimate Construction Contingency	$100,000
Total Construction Cost	$625,000
Engineering Services	
•Design	$57,000
•Construction administration	$20,000
•Sequestration optimization study	$16,000
Total Cost	**$718,000**

6.0 SCHEDULE AND APPROVALS

For the fastest implementation of the aeration system, the following approach is recommended:

- Tender documents be prepared for the aeration system that would require a supplier to bid on completion of a detailed design, supply, installation and commissioning of the aeration system. This would include a performance guarantee. Greatario has confirmed that they are capable of providing this turn-key approach to support the design and construction of the GridBee system.
- The scope of work to relocate chemical feed systems to the well houses would be reviewed with the Town to determine the best approach to implement the changes. The changes could be completed by Town staff, local mechanical contractors, or be included in the Aeration system contract.

- RVA would work with Town operations staff to work towards optimization of the sequestering system, which we expect could also be optimized to some extent, through relocation of the injection point, and possibly dosage modifications.

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Table 6.0 outlines the proposed schedule for implementation.

Table 6.0 – Schedule

Parameter	Design
Prepare Tender Documents	3 weeks
Quotation period	2 weeks
Review and award contract	2 weeks
Shop Drawing Preparation	2-3 weeks
Shop Drawing Review	2 weeks
Equipment Manufacturing and Delivery	7-8 weeks
Equipment Installation and Commissioning	2 weeks
Total	20 – 22 weeks

The MECP would be consulted at the beginning of design to confirm if the proposed changes would require an amendment to the Drinking Water Works Permit, or if the changes could be considered minor and documented in a Form 2.

7.0 REFERENCES

American Water Works Association Research Foundation (AWWARF), Sequestering Methods of Iron and Manganese Treatment, 1990.

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R.G. Robinson & Associates Ltd, “CT Tracer Study”, ON, 2004

Town of New Tecumseth, “CT Compliance Study and SOP”, Alliston, ON, 2008

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APPENDIX A

Bench Scale Testing

APPENDIX B

Supplier Proposals and Correspondence