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Memorandum

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Subject	**Needs Assessment and Justification Study - Final Draft**	**Project Name**	Mount Albert Water Supply System Upgrades
Attention	Region of York	**Project No.**	CE731500
From	Jacobs		
Date	April 30, 2020		
Copies to			

1. Introduction

Drinking water for the Mount Albert community (located within the Town of East Gwillimbury) is supplied by wells owned and operated by the Regional Municipality of York (Region). The Mount Albert Water Supply System has historically experienced aesthetic water quality issues related to iron and manganese as a result of the presence of these constituents in the source water. The Region has engaged Jacobs to undertake a Schedule 'B' Class Environmental Assessment (EA) to identify the best approach for resolving customer complaints with current water quality, meeting anticipated changes in manganese regulations and providing sufficient capacity for future demands while improving system redundancy and reliability.

The purpose of this technical memorandum (TM) is to is consolidate the assessment of background data, document the population, storage requirement, supply capacity and demand projections for a planning horizon of 2041, in alignment with the Region's master planning, to support the development of the problem and opportunity statement for this Class EA.

2. Overview of the Mount Albert Water Supply System Study Area

The Community of Mount Albert is located in the Town of East Gwillimbury, in the northeast of York Region, to the east of the intersection of Highway 48 and Mount Albert Road. It is primarily a residential community with a supporting commercial and retail area. The population of Mount Albert was reported as approximately 4,925 in 2016.

The community of Mount Albert is provided with drinking water from the Mount Albert Water Supply System, owned and operated by York Region. The system consists of three wells located at two well treatment facilities and two distribution system elevated storage tanks, as shown in Figure 2-1. The local distribution system of watermains, services and hydrants are owned and operated by the Town of East Gwillimbury.

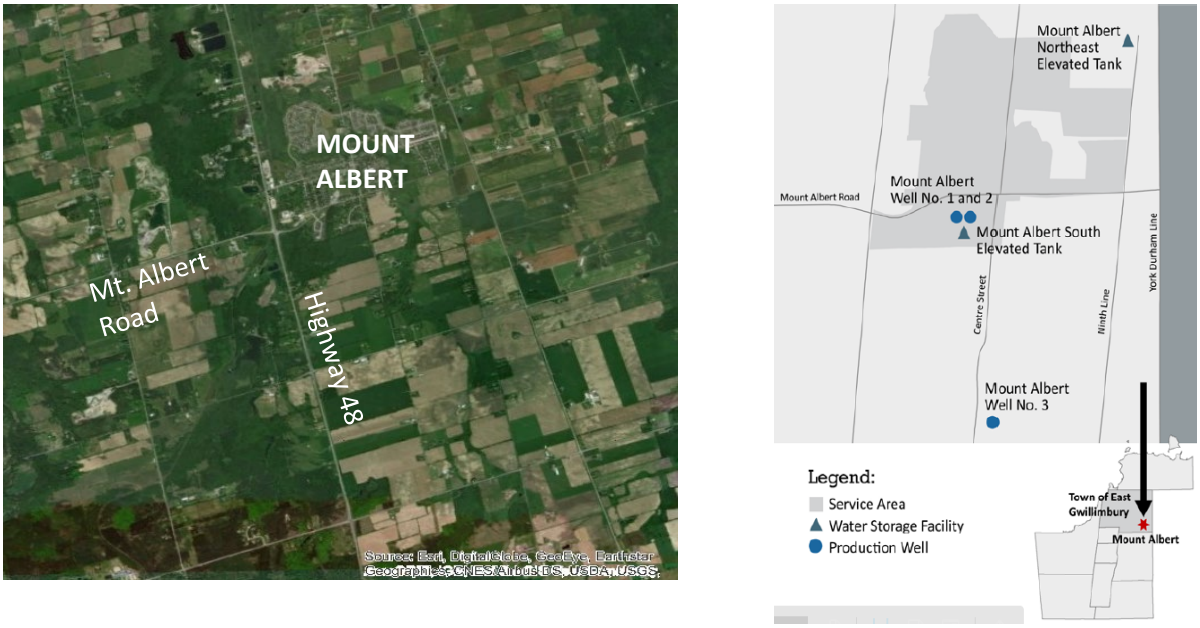

Figure 2-1 Mount Albert Water Supply System Location Plan

The system is supplied solely by groundwater from three wells that are treated at the two well facilities. The existing permit to take water (PTTW) No. 1312-AVKKZM defines the maximum water taking allowed from the three wells in this system, as a combined daily taking from any combination of Wells 1 to 3 of 4,990 m^3/day (57.8 L/s) with a maximum taking per minute per well of 2,273 L/min (37.88 L/s). The groundwater from these wells contains elevated levels of iron and manganese, which is treated using sodium silicate for sequestration to minimize deposition in the distribution system and discoloured water issues. Chlorine is added to support sequestration, as well as to provide primary and secondary disinfection.

Mount Albert Well 1 is currently not being used as the manganese concentration in the raw water from this well has exceeded a maximum acceptable concentration (MAC) for manganese of 0.12 mg/L identified by Health Canada. Under normal operation, Mount Albert Wells 1 and 2 operated in a duty/standby scenario (alternated on a weekly basis) in conjunction with Mount Albert Well 3 (continuous operation) and the Mount Albert North Elevated Tank). The North Elevated Tank (North ET) has a design storage volume of 2,727 m^3. The Mount Albert South Elevated Tank (South ET) has a storage volume of 910 m^3 but is not currently in service. The operation of the Mount Albert Water Supply System is monitored, controlled, and recorded through the Region's central SCADA control system.

Recent condition assessments completed at each of the treatment facilities and the towers indicate that the system components, with the exception of the South ET, can be considered to be in fair to good condition. The North ET was identified as requiring minor repairs and cleaning at present, in order to extend the useful life, with more significant rehabilitation recommended within the next 20 years. At the treatment facilities, the majority of assets were identified as requiring no intervention or routine

maintenance only. An upgrade contract is underway at the Wells 1 and 2 Treatment Facility, scheduled for completion in March 2020, to replace chemical feed systems, install a standby generator and provide additional monitoring. There has been minimal decline in the performance of the three wells over time; however, it was noted that Well 3 appears to have declined more significantly than the other two wells. While issues during the performance testing created some questions in the confidence of the results, the Well 3 screen was found to have heavy iron precipitate plugging and biofouling during an inspection in 2017. Well 3 had been rehabilitated as recently as 2012 and although cleaned in 2012, it was noted that more thorough rehabilitation may be required at the next service interval to restore well performance.

3. Population

The town of Mount Albert was first settled in the early 1800's as a farming community. In the 1850's, it was known as Birchardtown. At the turn of the century, the town was a major railway junction of three lines. It was renamed Mount Albert after the visit of Prince Albert to Ontario.

The Town of East Gwillimbury reported a population of Mount Albert as 4,925 residents in 2016, with an expected overall residential population of approximately 6,000 people, at community build-out, as shown in Table 3-1. Figure 3-1 provides an overview of the current community boundary and proposed development areas in Mount Albert.

Table 3-1. Mount Albert Population Forecast to 2041 (number of persons)

2016	2021	2026	2031	2036	2041
5,434 [1]	5,904	5,927	5,953	5,968	5,975

Note:

[1] Forecasted population per 2016 Water and Wastewater Master Plan Upgrade, it may differ from the 2016 census.

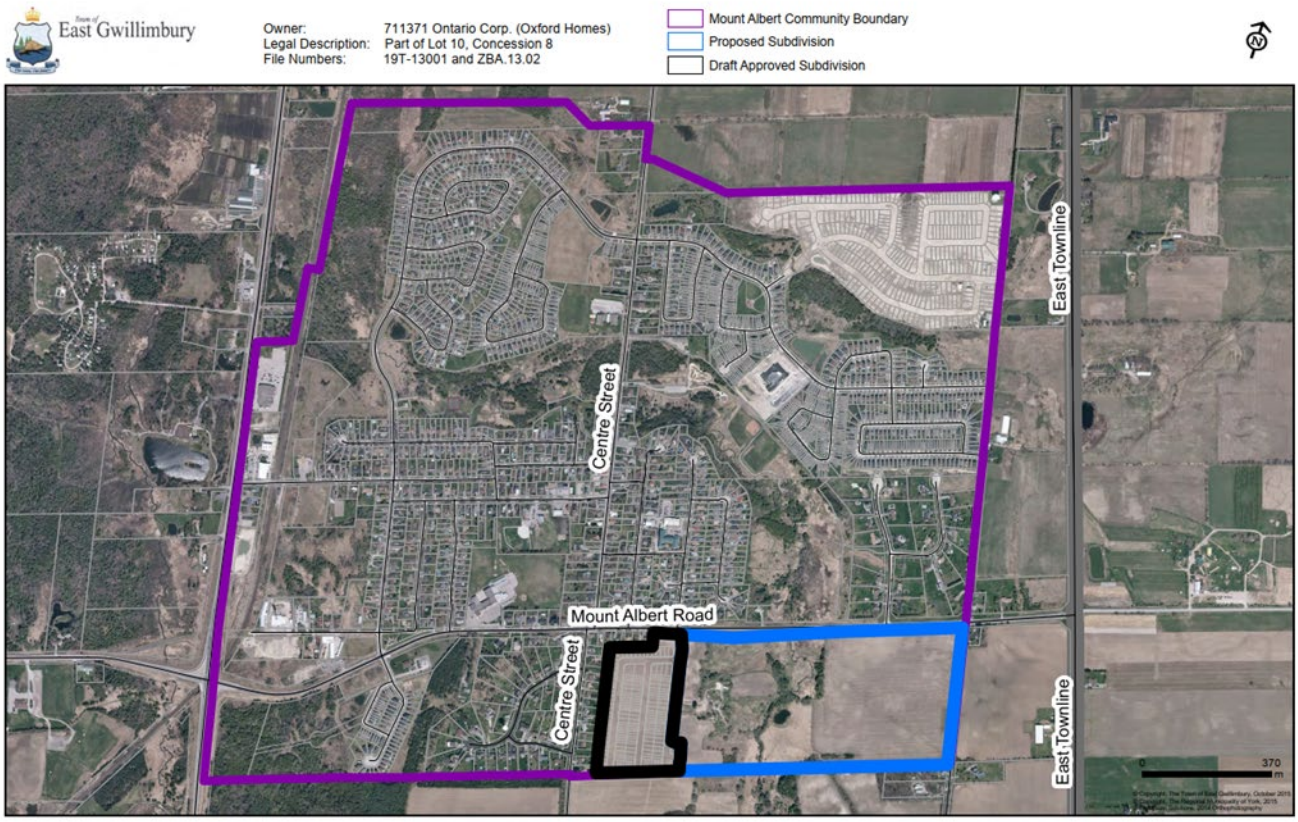

Figure 3-1. Mount Albert Development Plans – Current Community Boundary and Proposed Development

4. Water Supply and Storage Requirements

Recent water demand for the period of 2016-2018 identified that system demand can be met by any of the wells operating without exceeding the individual wells permitted capacity of 3,280 m^3/d with the exception of an isolated incident in late 2017. The reported well pump capacities are slightly less at 3,273 m^3/d, and while minor declines have been reported in well efficiencies, the firm capacity of the system supply remains more than sufficient to meet the current demands of the system.

Over this period of time, the system demand has been met through a combination of the wells, as duty has been rotated. As noted previously, Well 1 was removed from service in 2017 and demand was shifted to the other wells, with Well 3 operation continuing to increase, as demonstrated in Table 4-1 below.

Table 4-1. Percent Allocation of Mount Albert Well Operation from 2016-2018

	2016	2017	2018
Well 1	29.9%	7.2%	0.7%
Well 2	24.4%	41.8%	42.6%
Well 3	45.7%	51.0%	56.7%

The projected future water demand as identified in the Region's 2016 Master Plan Update and historical water demands are summarized in Table 4-2.

Table 4-2. Projected Average Day and Maximum Day Demand to 2041

Parameter		2016	2021	2026	2031	2036	2041
Residential Population	persons	5,434	5,904	5,927	5,953	5,968	5,975
Residential ADD (from MP)	L/cap/d	233	218	211	201	195	189
Residential Average Day Demand	MLD	1.27	1.29	1.25	1.20	1.16	1.13
Employment Population	persons	745	1,125	1,197	1270	1,328	1,337
Employment ADD (from MP)	L/cap/d	182	164	160	155	149	144
Employment Average Day Demand	MLD	0.14	0.18	0.19	0.20	0.20	0.19
Total Average Day Demand	MLD	1.4	1.5	1.4	1.4	1.4	1.3
	L/s	16.2	17.4	16.2	16.2	16.2	16.2
Total Maximum Day Demand (Max. Day Factor=2.3)	MLD	3.3	3.4	3.3	3.2	3.1	3.1
	L/s	38.2	39.4	38.2	37.0	35.9	35.9

The future projected needs of the system assume a decline in per capita water consumption and therefore continue to be met within the current firm capacity of the system (i.e. largest capacity well out of service), including some decline in well efficiency. This assessment assumes that Well 1 has been returned to service, which will require additional assessment in terms of treatment requirements. Projected system demands remain below the permitted maximum combined daily taking from wells of 4,990 m^3/day.

The fire storage, equalization storage and emergency storage requirements, based on the population forecasts and a fire with a water demand of 10,000 L/min for a duration of 2 hours, as per Region's Design Guidelines are summarized in Table 4-3.

Table 4-3. Projected Storage Requirements for Mt. Albert Water Distribution System

Year	Projected Maximum Day Demand (MLD)	Projected Average Day Demand (MLD)	Fire Storage (A) (m^3)	Equalization Storage (B) (m^3)	Emergency Storage (C) (m^3)	Total Storage Required (S) (m^3) [(a)]	Total Storage Provided (m^3) [(b)]
2021	3.4	1.5	1,200	850	513	**2,563**	**2,727**
2041	3.1	1.4	1,200	775	494	**2,469**	**2,727**

Notes:

(a) Total Treated Water Storage (S) = Fire Storage (A) + Equalization Storage (B) + Emergency Storage (C)

(b) Excluding Mount Albert South Elevated Tank which is out of service

The design storage volume of 2,727 m^3 available in the existing North ET is sufficient to meet the identified needs, with a theoretical excess storage capacity of 258 m^3 available beyond 2041. As noted in the System Capacity Optimization Study (February 2020), with the South ET out-of-service, there is little redundancy available in the system to accommodate maintenance of the North ET.

Consideration is being given to returning the South ET to service for a limited basis to permit maintenance; however, if this is not feasible, Pressure Mode operation of the system will be required.

A Hydraulic Analysis Study (November 2019) was undertaken to update and calibrate a draft hydraulic model of the Mount Albert water distribution system. Field monitoring was completed in order to calibrate the model and verify the results. It was noted that pressures in the system ranged between 328 and 742 kPa (47.6 and 107.6 psi) under ADD and under MDD conditions. The water pressure can drop as low as 242 kPa (35.1 psi). York Region Design Guidelines recommend an operating range of 276-689 kPa (40-100 psi) and both ends of the range are exceeded in areas throughout the system.

Most areas in the distribution system were identified to meet fire flow targets. The hydraulic modelling exercise identified that approximately 73% of the junctions meet their fire flow target (i.e. available fire flow is greater or equal to the target (10,000 L/min) and a residual pressure of 138 kPa (20 psi) is maintained). The areas that failed to meet the fire flow target are typically located at dead ends, and in some commercial areas, school areas and higher density townhouses with a higher fire flow target.

5. Treated Water Quality

The treated water quality for the well facilities is summarized in Table 5-1, based on five (5) years of historical data (2014-2018, unless otherwise noted). The applicable limits as identified in O. Reg. 169/03: Ontario Drinking Water Quality Standards and the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines are presented for comparison purposes.

Table 5-1. Mt. Albert Wells – Treated Water Quality

Parameter	Drinking Water Standards or Guideline [1]	Wells 1 and 2			Well 3		
		Minimum	Average[2]	Maximum	Minimum	Average[2]	Maximum
Dissolved Organic Carbon, mg/L	5 (AO)	0.5	0.9	1.3	0.34	0.71	1.06
pH	6.5-8.5 (OG)	7.9	8.1	8.3	7.65	7.84	8.10
Alkalinity, mg/L as $CaCO_3$	30-500 (OG)	233	244	253	214	235	248
Hardness, mg/L as $CaCO_3$	80-100 (OG)	180	265	309	324	338	355
Ammonium and Ammonia, mg/L as N[3, 4]	0.1[5]	<0.005	<0.10	0.04	<0.005	<0.1	0.017
Nitrate, mg/L as N[4,6]	10 (MAC)	<0.001	0.098	<0.5	4.31	4.78	6.06
Nitrite, mg/L as N[4]	1 (MAC)	<0.003	0.019	<0.25	<0.008	0.0195	<0.25
Methane, L/m^3	3 (AO)	0.028	0.050	0.084	0.016	0.048	0.071
Iron, total, mg/L	0.3 (AO)	0.411	0.610	0.924	0.066	0.103	0.160
Manganese, total, mg/L	0.05 (AO) HC: 0.12 (MAC)[7], 0.02 (AO)[8]	0.049	0.066	0.089	0.038	0.044	0.051
Sodium, mg/L	200[9] (AO)	8.5	11.4	16.0	6.3	8.9	11.1
Calcium, mg/L		52.8	76.3	90.6	91.8	96.0	101.0
Magnesium, mg/L		11.6	18.2	20.0	23.1	23.9	25.3
Chloride, mg/L	250 (AO)	16.0	26.7	42.0	24.60	28.63	32.30
Sulfate, mg/L	500 (AO)	22.5	35.3	41.5	46.20	57.22	64.20
Phosphate, mg/L[10]		<0.01	0.03	0.05	<0.005	<0.02	<0.02
Chlorine Residual, mg/L[11]	0.05 (minimum)[12] 4.0 mg/L (maximum)[12]	0.50	1.51	3.63	0.76	1.62	4.3
N-Nitrosodimethylamine, ng/L[13]	9.0 (MAC)	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9

Parameter	Drinking Water Standards or Guideline [1]	Wells 1 and 2			Well 3		
		Minimum	Average[2]	Maximum	Minimum	Average[2]	Maximum
Nitrilotriacetic Acid (NTA), mg/L[14]	0.4 (MAC)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

1. Ontario Drinking Water Standards (ODWS) O.Reg. 169/03 – Maximum Acceptable Concentration (MAC); Aesthetic Objectives (AO) and Operational Guidelines (OG) as presented in the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (MOE, 2006)
2. Where some of the measured values were reported as less than the Method Detection Limit (MDL), the average was calculated by assigning half the MDL to those values. If all measured values were less than MDL or the calculated average was less than the MDL, the average is indicated as being less than the MDL.
3. The data reported for ammonia for 2016 to 2018 for Wells 1 and 2 ranged from a MDL of <0.1 mg/L to a Reported Detection Limit (RDL) of <1.25 mg/L. This unusually high RDL of <1.25 mg/L would skew the results if used as described in Note 2, and therefore, the historical values for 2010 to 2015 are presented for this parameter.
4. Different MDLs or RDLs reported for different sampling dates. The minimum is reported as the minimum measured value or as the lowest MDL/RDL noted, whichever was lower. The calculated average as described in Note 2 was compared to the highest MDL/RDL and, where it was lower than this value, is reported as such here. The maximum is reported as the maximum measured value or, where all values were lower than MDL/RDL, as the highest MDL/RDL noted.
5. Health Canada's Drinking Water Guidelines recommend limiting excess free ammonia to below 0.1 mg/L-N to help prevent nitrification; however, there is no aesthetic objective or maximum acceptable concentration noted.
6. Nitrate data for April 13, 2017 For Wells 1 and 2 Facility, reported as a RDL of <2.5 mg/L was excluded from the analysis as half the MDL was higher than historical values and would have significantly skewed the results.
7. Maximum Acceptable Concentration [MAC] under Health Canada's Drinking Water Guidelines.
8. Aesthetic Objective under Health Canada's Drinking Water Guidelines.
9. MOE (2006) notes that "The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L, so that this information may be passed on to local physicians" Ontario Drinking Water Standard under O.Reg. 169/03.
10. The values presented are for the period from 2010 to 2015. The data from 2016 to 2018 for Wells 1 and 2 Facility, 3 of the 12 data points were actual reported values ranging from 0.03 to 0.05 mg/L, while the remaining values were reported as either less than the MDL of <0.01 or <0.05 mg/L or less than the RDL of <2.5 mg/L. For Well 3 Facility, all values reported were less than the MDL or RDL. Using the values reported for 2016 to 2018 in the manner described in Note 2 would skew the results, and therefore, the data from 2010 to 2015 are used.
11. Data presented is for January 2016 through to December 2018, excluding March and April 2016 for Well 3 Facility as data was missing for this time period.
12. Procedure for Disinfection of Drinking water in Ontario (MECP, 2018). Minimum and maximum free chlorine residuals when using chlorine as a secondary disinfectant at a pH of 8.5 or lower. Data shown is from 2012 to 2016.
13. No values were reported for 2014 or 2015. The three values reported from 2016 to 2018 were the MDL of <0.9 ng/L.
14. The values presented are for the period from 2010 to 2013, as there was no data available for NTA from 2014 to 2018. The values reported from 2010 to 2013 were all lower than the MDL.

Iron and manganese represent the most significant water quality issues in the Mount Albert Water Supply System. Iron exceeds the Aesthetic Objective of 0.3 mg/L regularly at Well 1 and Well 2 with some exceedances at Well 3. Hardness levels in both wells are high, reaching the upper limit of the Operational Guideline and Nitrates are higher in Well 3 than Wells 1 and 2, perhaps reflecting its location in an agricultural setting.

The current practice of sequestration with sodium silicate to mitigate deposition in the distribution system is not providing complete control. Evidence to support this arise from increasing customer complaints, results from July sampling that indicate iron deposition in the distribution system and silicate release, and observations of significant volumes of discoloured water discharged during recent fire flow testing.

During sampling, distribution iron concentrations averaged 0.142 mg/L (Figure 5-1). Results of the sampling showed that overall total iron concentrations tended to decrease with time, indicating that deposition was also occurring in the distribution system.

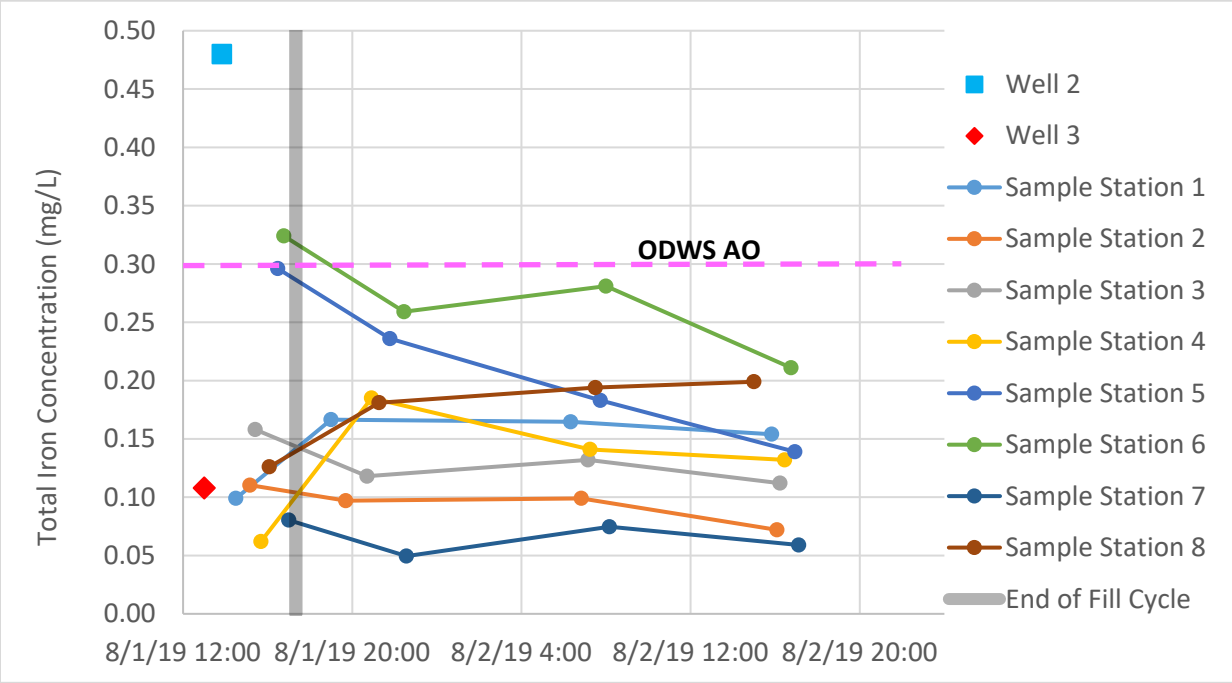

Figure 5-1. Total Iron Concentration from Mount Albert Wells and Sampling Stations

Sequestration of manganese can be less successful than iron due to the relatively slower oxidation rate of manganese by chlorine and the different mechanism of interaction. Average manganese concentrations at Well 1 are higher than the Aesthetic Objective of 0.05 mg/L, while at Well 2 and 3, results are in close proximity to the objective with the maximum value just slightly exceeding the AO. The average manganese concentration for the distribution system during the sampling period was 0.024 mg/L (Figure 5-2). It is noted that no values reported between 2014 and 2019 exceed the Health Canada proposed MAC of 0.12 mg/L, but manganese results from all wells consistently exceed Health Canada's lowered AO of 0.02 mg/L.

Total manganese concentrations followed a similar pattern to iron concentrations, with a general decrease in total manganese concentrations with time.

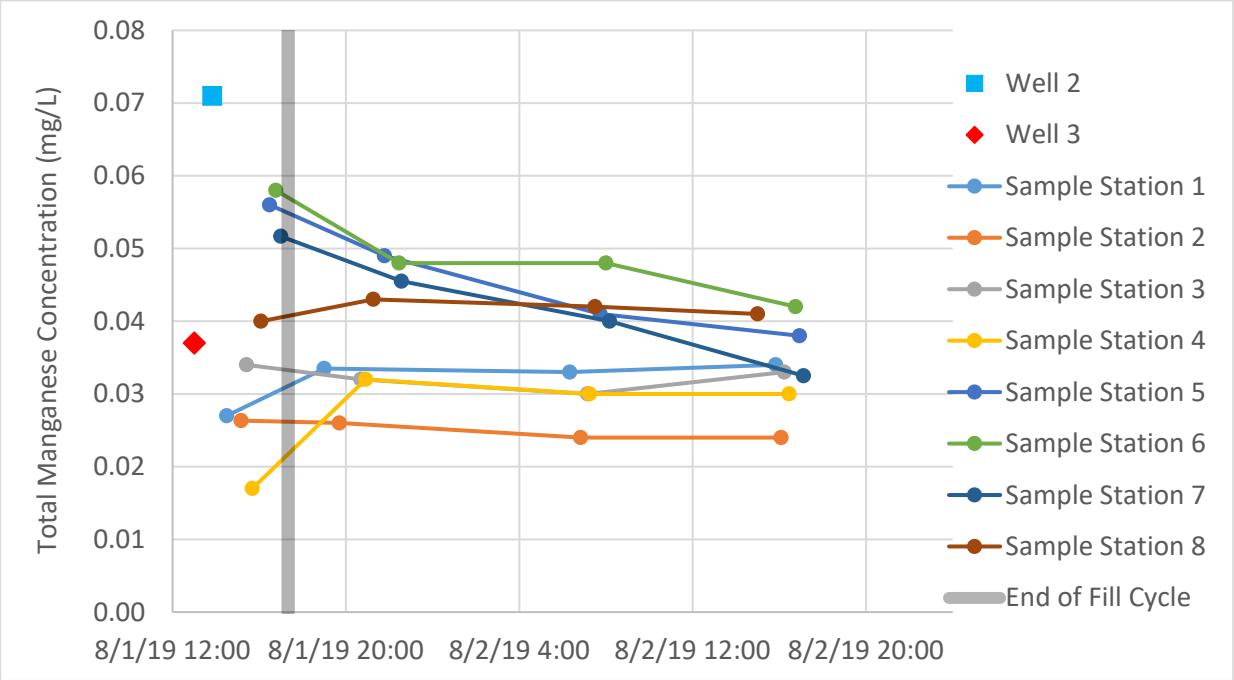

Figure 5-2. Total Manganese Concentration from Mount Albert Wells and Sampling Stations

The lower iron and manganese concentrations in the distribution system indicate that iron and manganese deposition is occurring in the distribution system and the analysis concluded that the occurrences appeared to be independent of water age, pipe material, pipe age or pipe diameter.

Deposition was observed regardless of the amount of iron and manganese in the dissolved form. Iron and manganese remained in the dissolved form until supply reached the elevated tank, at which point sodium silicate was no longer effective at sequestering the iron and manganese and it quickly converted to particulates.

The particulate formation may be related to water age in the tank, mixing with possible sediments in the elevated tank or perhaps some impact of the aeration that is provided by the arrangement of the tank inlet, as water from the elevated tank had much higher dissolved oxygen concentrations than measured at the wells.

Research to date has not identified a successful method to directly assess the effectiveness of sequestration; however, the Region has undertaken multiple investigations in well systems with iron and manganese through the ongoing Groundwater Treatment Strategy to identify means to address these water quality challenges. Through the study, raw water characteristics were considered to potentially impact on sequestration effectiveness amongst 33 groundwater wells used for water supply throughout the Region. Through on-site testing and review of the limited scientific research on the effectiveness of sequestration, the study notes upper targets of 0.6 mg/L for iron and 0.1 mg/L for manganese, and research suggests that calcium and potentially phosphate can interfere with the reaction.

It is recognized that there are likely many compounding influences on the effectiveness of sequestration, in addition to raw water characteristics; including sodium silicate dosage control, impacted by dosing accuracy, chemical quality and sediment accumulations within contact chamber and elevated tank condition.

The free chlorine residual leaving Mount Albert water treatment facilities is on average around 1.5 mg/L or higher. The associated CT calculated for each facility provides for 4-log virus inactivation. Historical distribution sampling results indicate that this residual has allowed levels to remain above both the regulatory minimum of 0.05 mg/L and the minimum operating target of 0.4 mg/L. Similar results were obtained from distribution sampling conducted in July and August 2019.

Table 5-2. Summary of Free Chlorine from Distribution Sampling Stations, January 2015 to December 2016

Parameter	Free Chlorine (mg/L)	
	2015	2016
Minimum	0.62	0.52
Maximum	2.06	1.82
Average	1.21	1.21
No. of Data Points	359	486

Water quality modelling undertaken as a component of the Hydraulic Analysis Study matched well with these measurements, demonstrating that free chlorine residuals in the Mount Albert Water Supply System are stable and remain consistently above 0.4 mg/L. Further, there was little variation between the free chlorine residual and total chlorine residual measurements and no obvious trends, indicating a consistent biostability in the distribution system.

6. Summary of Existing Conditions

The baseline conditions and assessment of opportunities for performance enhancement and optimization of existing infrastructure are detailed in the System Capacity Optimization Study for the Mount Albert water supply system (February 2020). The study consolidated the findings of numerous completed and ongoing studies related to Mount Albert Water Supply System to identify the following areas of limited capital investment or operational improvements to be considered to address current challenges.

- Silicate dosing systems:
    - Implement improvements undertaken at Wells 1 and 2 at Well 3 to allow for tempered flushing and cleaning of the calibration columns and injection points
    - Supply a pressure or flow switch to provide a more positive indication of silicate application
    - Increase regular mixing and changeover in sodium silicate tanks to maintain silicate product quality
    - Continued monitoring and validation of dosage accuracy for continuous process improvements
    - Review of the impact of raw water chemistry on sequestration effectiveness, as infrastructure issues are addressed.
- Clean and inspect chlorine contact chambers
- Collaborate with Town of East Gwillimbury to develop and implement a tailored monitoring program for the distribution system to assess and track iron and manganese sequestration effectiveness
- Collaborate with Town of East Gwillimbury to refine a unidirectional flushing program to identify optimal flushing conditions and frequency and implement a swabbing program to address accumulated deposits
- Investigate and validate areas potentially operating outside system pressure guidelines
- Inspect and clean Mount Albert North elevated tank.Assess the ability of pressure-mode operation at all well facilities to meet system demands and develop detailed operational strategy and response procedures.

While dosage improvements at the wells may allow for more effective sequestration; it is noted that the raw water quality exceeds the recommended targets for effective treatment at Wells 1 and 2. As the raw water quality at Well 3 is comparatively better, dosage improvements may provide more satisfactory results. It is noted, though, that for all wells, the interference of the identified factors of hardness, alkalinity and potentially phosphate on the treatment process cannot be easily avoided and there remains the potential of water quality issues.

Even if water quality in Well 3 could be improved, the supply is insufficient on its own to meet the long-term needs of the community, and more extensive capital investments beyond the scope of system optimization would be required to provide redundancy.

It is therefore recommended that investigation of options be undertaken to identify preferred alternatives to resolve distribution system issues and associated discoloured water complaints from residents.

7. Problem and Opportunity Statement

The implementation of capital improvements is subject to the Municipal Class Environmental Assessment process with the first step being the development of a comprehensive problem or opportunity statement.

The Mount Albert water supply system has sufficient supply capacity and storage to service current and future water demands beyond 2041. Iron and manganese in the raw water from the existing wells regularly exceeds Aesthetic Objectives and current treatment does not provide consistent control, resulting in particulate deposition in the distribution system.

While there are opportunities to improve existing operation, it is noted that raw water chemistry may still preclude satisfactory operation. It is therefore recommended that investigation of alternatives, such as alternative treatment of Wells 1 and 2 or development of alternate sources be undertaken to identify a preferred alternative to resolve distribution system issues and associated discoloured water complaints from residents.

Through Phase II of the Class Environmental Assessment process, a series of alternatives will be identified to address these issues and screened for viability based on a series of defined criteria that incorporate the following key considerations.

- Maintain system supply & storage capacities to service current and future water demands.
- Comply with local and Regional planning policies (Official Plans, Green Belt Plan, Oak Ridges Moraine Conservation Plan).
- Optimize useful life of existing infrastructure .
- Maintain operability of existing system during construction
- Achieve reliable and sustained performance throughout full lifecycle.
- Provide means to improve flexibility and redundancy in the distribution system and supply & storage systems to permit maintenance.
- Mitigate impact on natural environment and community through construction and long-term operation of facilities.

Those identified for further consideration will be assessed through triple bottom line analysis that considers natural, socio-cultural and technical impacts of alternatives with relationship to long term capital and operating costs to identify the preferred alternative to be implemented in the Mount Albert Water Supply System.