Final Draft Water Supply Master Plan Update

City of Guelph

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Executive Summary

ES-1 Background

In 2007, the City of Guelph (City) completed the Water Supply Master Plan (WSMP) project to ensure that the City's water supply continues to meet current and future demands. The 2014 WSMP Update covered a 25-year period from 2013 to 2038 to make it consistent with the current needs of the City. The purpose of the current WSMP Update is to review and revise the 2014 WSMP covering a 30-year period from 2021 to 2051 to align with the Provincial Growth Plan, **A Place to Grow: Growth Plan for the Greater Golden Horseshoe** (amended in August 2020), and the update to the City's Official Plan (in progress). This update will build upon the previous work, review the 2014 WSMP recommendations as well as examine new water supply alternatives in accordance with the Class Environmental Assessment (EA) process for Municipal Water projects, resulting in the listing of recommended water supply projects, including phased implementation schedules and recommended Class EA schedules. Class EA approvals for Schedule "B" and "C" projects can then be conducted by using the Master Plan as a starting point.

ES-2 Challenge and Opportunity Statement

Phase 1 of the Class EA planning process requires the proponent of an undertaking to first document factors leading to the conclusion that the improvement or change is needed, and ultimately, develop a clear statement of the identified problems, deficiencies or opportunities to be investigated. The Challenge and Opportunity Statement for the 2021 WSMP Update was developed through engagement and consultation with the public and stakeholders in the first round of consultation.

> *The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.*
>
> *The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands and set out a strategy for*

meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.

The proposed implementation strategy must deliver, through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

ES-3 Population and Water Demand Projections

ES-3.1 Population Projections

Population projections are required to determine future water supply requirements. The projections developed for the WSMP Update include the serviced population and employment population within the City. This later category includes the population representative of industrial, commercial and institutional (ICI) land use. The combined total population forms the basis for developing existing and future water demands. Two future population and employment growth scenarios were considered when developing the demand forecasts for the WSMP Update, including the "reference" and "low" growth scenarios from the Province of Ontario's August 28th, 2020 report **A Place to Grow: Growth Plan for the Greater Golden Horseshoe** (P2G). The "reference" growth rate represents the expected rate and was ultimately used to identify the 2051 water supply demand projections. The population projections from 2021 to 2051, in five-year increments are presented in **Table ES-1**.

Table ES-1: Projected "Reference" Growth Population and Employment Rates

Year	Population	Employment
2021	145,777	84,359
2026	155,314	89,633
2031	164,852	94,906
2036	174,389	100,180
2041	183,926	105,453
2046	193,463	110,727
2051	203,000	116,000

ES-4 Water Demand Projections

Design Basis for Average Day Demands

The basis for projecting demands from the residential and ICI sectors, as well as non-revenue water[1] (NRW), was to apply historical per capita demands to population projections, i.e., representative of per capita demands without the influence of future conservation, efficiency and demand management efforts. This baseline was used to measure the effect of potential future programs and their associated costs against the costs and efforts to provide new water supply.

The baseline demand for the residential and ICI sectors considered historical customer demand and analysis of recent trends from the 2010-2019 period. It was evaluated that, while per capita water production and demand rates in litres per capita per day[2] (Lcd) have declined since 2010, the rate of decline was lower between 2015 to 2019 than it was from 2010 to 2015. The per capita NRW rates fluctuated through the review period; however, the 2019 rates are very similar to the rates in 2010. This observation suggests that future per capita customer water demand declines associated with conservation, efficiency and demand management programming and natural water savings may be more difficult to achieve moving forward.

To be conservative when projecting water demand rates to 2051, the average per capita residential, employment, and NRW demand rates between 2015 and 2019 were applied to the years 2020 to 2051. This means that the projected demands assume that further reductions in Lcd customer demands will not occur. The values used in the projection analysis are as follows:

- Average per capita residential demand rate: 167 Lcd
- Average per capita employment demand rate: 191 Lcd
- Average per capita NRW demand rate: 61 Lcd

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1. Non-Revenue Water - The difference in water consumed by customers as measured directly through utility billings and that which is pumped at water facilities to the water distribution system. This includes water that is lost from the distribution system through leakage, flows used in fire fighting, watermain flushing and other losses.
2. Litres per capita per day – the amount of water each person in the City uses on a daily basis.

Design Basis for Maximum Day Demand

The Maximum Day Factor (MDF) for a water system is generally defined as the ratio between the water production rate on the highest single production day each year (maximum day) and the average day production rate for the entire year, after removing extreme anomalous events. The average MDF in Guelph between 2010 and 2019 was 1.24 and the highest ratio of 1.34 occurred in 2011. To be conservative, a MDF of 1.34 was used when projecting future maximum day water demands in Guelph.

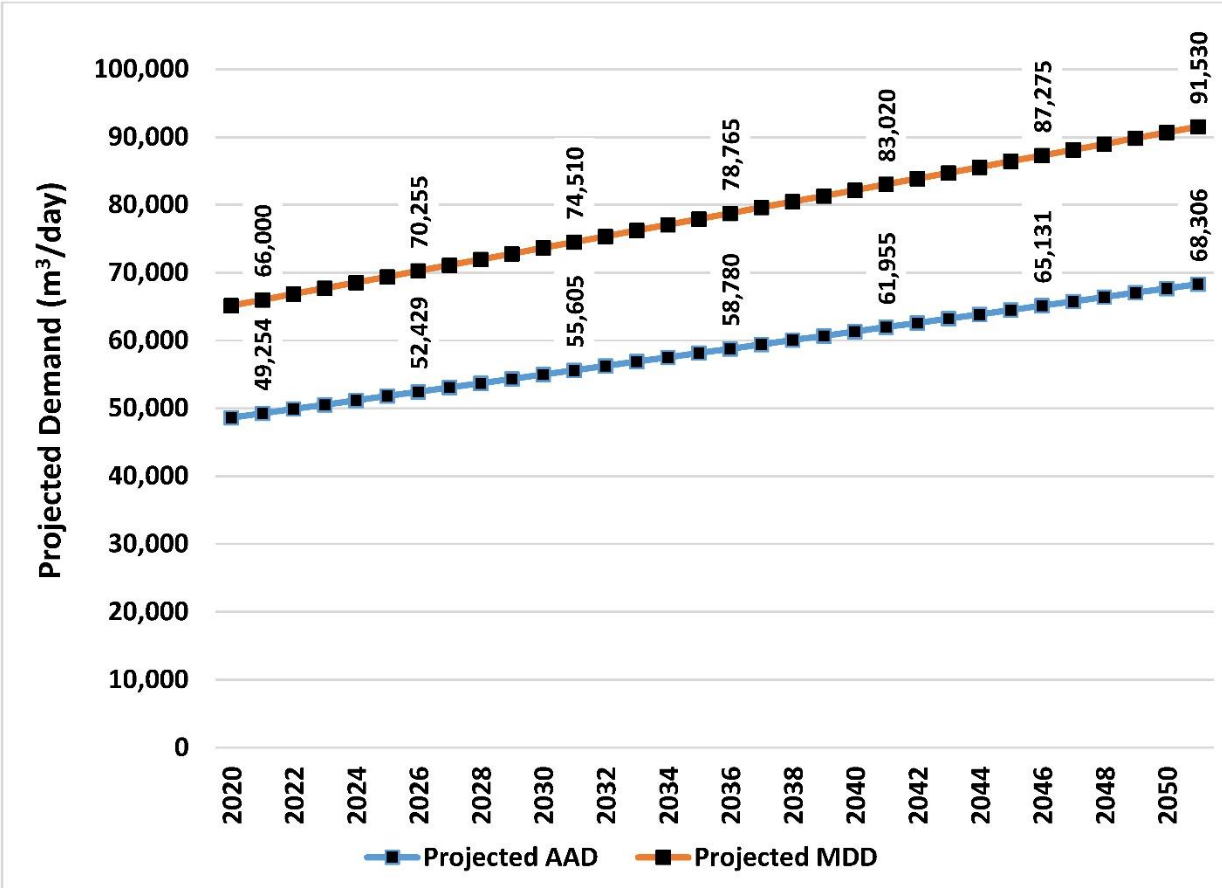
Projected 2051 Water Supply Requirements

Table ES-2 and **Figure ES-1** present the projected average annual day and maximum day water demand from 2021 to 2051, based on the design per capita demands. These estimates represent the projected total demand rates on an average annual and maximum day for each year in the planning period (i.e., combined residential, ICI and NRW demands).

Table ES-2: Total Projected Average Annual Day and Maximum Day Water Demands – Reference Growth Scenario

Demand	2021	2026	2031	2036	2041	2046	2051
Average Annual Day Demand (AAD) (m^3/day)	49,254	52,429	55,605	58,780	61,955	65,131	68,306
Maximum Day Demand (MDD) using MDF of 1.34 (m^3/day)	66,000	70,255	74,510	78,765	83,020	87,275	91,530

Figure ES-1: Total Projected Average Annual Day and Maximum Day Water Demands – Reference Growth Scenario



ES-5 Existing Water Supply System Capacity Assessment

The City relies almost exclusively on groundwater to meet customer water demands. The groundwater supply system comprises 25 drilled wells screened within overburden and shallow and deep bedrock aquifers, as well as one groundwater collection system.

A detailed assessment of the capacity of the existing water supply system was completed to determine: the current maximum capacity for each individual groundwater supply source; any constraints to operating at the maximum; the total sustainable capacity of the groundwater supply system; and, an evaluation of potential risks to system operation and the vulnerability of the identified sustainable capacity from a hydrogeological and operational perspective (i.e., the Security of Supply).

Evaluation of the system was completed with reference to the four quadrants of the City for the purposes of assessment: Southeast, Southwest, Northeast and Northwest. Historical records (from 1997 through 2019) for each groundwater supply source and quadrant provided the daily pumping total, the monthly average of the daily pumping total, observed groundwater elevation, the Ministry of the Environment, Conservation and Parks (MECP) permitted rate and maximum pumping elevations. Based on a review of these data, the capacity of each supply well and the collector system was re-evaluated relative to the 2014 WSMP.

The identified maximum capacity of the existing system is interpreted to be approximately 79,422 m^3/day. This estimate reflects normal operating conditions (i.e., non-drought conditions), and recognizes interference effects amongst the groundwater supply sources, as well as other interferences such as that from dewatering of the Dolime Quarry. This represents a decrease of 4,414 m^3/day, relative to the maximum system capacity reported within the 2014 WSMP. The results are presented in **Table ES-3**, along with an explanation of the capacity values that have changed from the 2014 assessment.

Table ES-3: Updated Capacity Assessment Summary – City of Guelph Groundwater Supply Active Sources

City Quadrant	Groundwater Supply Source	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Comments on Updated Capacity
Southeast	Arkell Well 1	2,000	2,000	Unchanged
Southeast	Arkell Well 6	28,800	28,800	Unchanged
Southeast	Arkell Well 7	-[b]	-[b]	Unchanged
Southeast	Arkell Well 8	-	-	Unchanged
Southeast	Arkell Well 14	-	-	Unchanged
Southeast	Arkell Well 15	-	-	Unchanged
Southeast	Glen Collector	6,900	5,100	Decreased to reflect available capacity with artificial recharge system inactive
Southeast	Burke Well	6,500	6,500	Unchanged
Southeast	Carter Well 1	5,500[c]	5,184[c]	Decreased by 316 m^3/day based on uncertainty of potential effects on Torrance Creek
Southeast	Carter Well 2	-[c]	-[c]	-

City Quadrant	Groundwater Supply Source	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Comments on Updated Capacity
Southwest	Membro/Rocco	6,000	5,200	Decreased by 800 m^3/day based on preliminary OTP results
Southwest	Water Street Well	2,700	1,901	Decreased by 799 m^3/day based on well field testing that evaluated mutual interference with Membro site
Southwest	Dean Well	1,500	1,500	Unchanged
Southwest	University Well	2,500	2,500	Unchanged
Southwest	Downey Well	5,236	5,237	Unchanged
Northeast	Park Well 1	8,000[d]	8,000[d]	Unchanged
Northeast	Park Well 2	-[d]	-[d]	
Northeast	Emma Well	2,800	2,800	Unchanged
Northeast	Helmar Well	1,500	800	Decreased by 700 m^3/day based on performance record, rehabilitation results and interference drawdown.
Northwest	Paisley Well	1,400	1,400	Unchanged
Northwest	Calico Well	1,400	1,400	Unchanged[a]
Northwest	Queensdale Well	1,100	1,100	Unchanged
Total	**-**	**83,836**	**79,422**	**-**

Notes:
a) Capacity is total for site (Membro Well and Membro Replacement Well)
b) 28,800 m^3/day is the total daily capacity of the Arkell bedrock wells (Wells 6,7, 8, 14, and 15).
c) Total daily capacity of Carter Well 1 and 3.
d) 8,000 m^3/day is the total daily capacity of Park Well 1 and 2.
e) Capacity increased by 1 m^3/day to match PTTW No. 8468-BCVQAN
f) Well is currently off-line due to casing failure, assigned value represents capacity for the site.

The security of supply assessment considered a series of potential risks to the system including drought conditions, loss of a well (i.e., a contamination event, equipment failure, structural failure, etc.), regulatory permitting changes, and risks to the well facilities and distribution system. These results indicate that that City should continue on-going monitoring of available system capacity, with the objective of maintaining a system redundancy of 15%. With respect to the existing system, 15% of the existing available water supply system capacity should continue to be reserved for servicing of existing customers (i.e., not available for future growth).

ES-6 Water Supply Alternatives

The 2014 WSMP implementation plan set out a strategy for the City to investigate and execute the necessary steps to optimize existing and develop new water supplies, with a focus on local sustainability. As part of the initial WSMP, City Council provided direction in 2003 "That the focus of the WSMP establish a sustainable water supply to regulate future growth". Public response to the 2007 WSMP helped shape the definition of local sustainability to refer to available local water supplies, which included local groundwater and surface water sources.

The utmost importance was placed on water conservation and as a result, the City has become a renowned leader in water conservation, efficiency and demand management in Canada. The City's Official Plan calls for the WSMP to "develop programs and policies to conserve water and to reduce requirements for additional water supply and treatment, including the implementation of the Water Conservation Efficiency Strategy". It is the aim of this update to document demand reductions achieved to date, and to determine feasible reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 and 2014 indicated that the City first examine groundwater supply opportunities within the City's boundaries in order to minimize potential effects on its neighbours. As a result, the City has since implemented a number of programs and studies to maintain and optimize existing supply facilities within the City and in areas of existing municipal well supply infrastructure, including (since 2014):

- Completed construction of new well facilities (Arkell 14 and 15) and completed the Arkell Adaptive Management Plan and Operational Testing Program;
- Upgrades to the Arkell artificial groundwater recharge system;
- Completed upgrades to the existing Burke Well facility, including iron and manganese treatment;
- Class EA for a Clythe Well water treatment facility (existing, off-line well);
- Replacement well on the Membro site, referred to as the Membro Replacement Well or the Rocco Well; and

- Through mediation with the Dolime Quarry owner, identified a potential solution to address the City's concerns about how operations at the quarry could affect local groundwater.

Also included in the short- to mid-term implementation strategy was the initiation of various hydrogeological investigations inside the City and just outside the City's boundaries to explore the potential for new water supplies in these areas. These include the Guelph South Groundwater Supply Investigation (on-going) and the Southwest Guelph Water Supply Class EA to evaluate additional water supply sources within southwest Guelph, including a long-term Operational Testing Program at the Dolime Quarry and surrounding existing municipal wells (on-going).

In addition to the above initiatives, the City has completed the following regional studies and plans to ensure the protection and long-term sustainability of the existing water supply system:

- The Guelph and Guelph/Eramosa Township Tier Three Water Budget and Local Area Risk Assessment (Tier Three Study) was completed to evaluate the sustainability of the City's water supply system from a quantity perspective and to identify potential threats to that sustainability (Matrix Solutions Inc., 2017). This study and the Tier Three Groundwater Flow model (Tier Three Model) of Guelph's municipal aquifer system (in and outside the City) provide invaluable insights into reviewing the current water supply system and its reliability now and into the future. It is also referenced herein in determining the feasibility of new water supplies from both a potential capacity and environmental effect perspective.
- A Threats Management Strategy was developed to address the results of the Tier Three Study and guide the development of associated water quantity policies.
- The Grand River Source Protection Plan was developed within a watershed context to identify and evaluate potential water quality threats to the municipal supply system. This process also included the development of policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants. At this time, the City is currently working on updates to the plan

and development of policies to address the potential water quantity impacts.

The objective of the WSMP Update is to continue to ensure that the City can provide an adequate, safe and sustainable supply of water to meet the current and future needs of all customers over the next 30 years (i.e., to 2051). The water supply demand forecast, and the existing water supply system capacity assessment concluded that under a "do nothing" scenario with continued growth, in 2051, the City would require an additional water supply capacity of approximately 26,000 m^3/day to satisfy maximum day demand with an additional 15% allowance for security of supply.

The following alternatives are evaluated with respect to their capability to contribute to the total water supply solution. It is acknowledged that each does not address the challenge and opportunity statement as a stand-alone alternative. Therefore, each alternative is discussed and evaluated on its own merit as part of the total solution.

ES-6.1 Water Conservation, Efficiency and Demand Management

Based on past success and public support, it is anticipated that water conservation, efficiency and demand management will continue to form part of the preferred sustainable water supply solution (via reductions in water demand) in the future. Four scenarios are developed to consider the potential reductions associated with various combinations of initiatives in order to set a reasonable and publicly supported reduction target, as follows:

Scenario 1: No further reductions - ceasing non-provincially mandated water efficiency measures (baseline scenario)

Scenario 2: Potential reduction through maintaining a level of programming similar to the current water conservation, efficiency and demand management program

Scenario 3: Potential reduction through a focus on high water use customers

Scenario 4: Potential reduction through a focus on the current level of programming *and* water reuse initiatives

A summary of potential reclaimed water supply capacity and costs associated with each scenario is included in **Table ES-4**. Also included in this table is a blended scenario that was recommended through the assessment of alternatives step. This scenario considers the modification of programming through the planning period (2021 to 2051) in response to successfully achieving demand reductions under Scenario 2 in the short-term and subsequently shifting the focus of programming as described in Scenarios 3 and 4 in the mid- and long-term, respectively.

Table ES-4: Summary of Potential Savings and Program Cost Estimates for Each Scenario

Scenario	Projected Reduction in Average Annual Day Demand (m^3/day)	Estimated Program Cost (million $)	Estimated Average Annual Cost ($)	Capital Cost per m^3/day ($)	Life Cycle Cost* – Cost per m^3 avoided ($)
1	-	-	-	-	-
2	4,424	11.41	380,000	2,600	0.53
3	2,220	4.73	157,670	2,100	0.44
4	4,952	15.04	501,333	3,000	0.62
5^	3,683	8.99	299,792	2,400	0.50

Notes: * Life cycle cost is the cost per m^3 of avoided capacity over a 20-year period.
^Blended scenario.

The above water conservation, efficiency and demand management scenarios were developed and reviewed to demonstrate the range of potential savings and associated costs of various combinations of programs, for discussion through public consultation. Implementation of the scenarios would be further developed through future updates to the City's Water Efficiency Strategy.

ES-6.2 Expand Existing Groundwater Supply System

The approach undertaken in investigating opportunities for optimizing the City's existing groundwater supplies and developing new sources followed direction provided through the previous WSMP consultation processes (2007 and 2014 update). Public response clearly indicated that the City should consider groundwater opportunities within its municipal boundaries prior to exploring beyond. As noted in the 2014 WSMP, the development of new water supply sources in the surrounding Townships (Guelph/Eramosa and Puslinch) would require concurrence of both the respective Township and the

County of Wellington. In this update, consistent with previous plans, potential groundwater sources outside of the City boundaries are limited to a distance of approximately 5 km. This parameter was initially determined with consideration to limiting potential effects on surrounding municipalities, as well as the practicality of connecting to the City's existing water distribution system.

The first step in the evaluation of groundwater sources was to review the potential sources on a City quadrant basis and identify those that could potentially provide additional capacity. The potential groundwater opportunities for expansion of the existing supply system are grouped into the alternatives below, following the order established in the 2014 WSMP:

- Alternative 2A - Optimize existing municipal sources
- Alternative 2B - Restore off-line municipal sources
- Alternative 2C/D - Develop municipal test wells (includes Dolime Quarry)
- Alternative 2E - Develop new sources inside City
- Alternative 2F - Install new Aquifer Storage and Recovery wells inside City to optimize excess Arkell Collector system volumes
- Alternative 2G - Develop new wells outside City

A summary of potential new water supplies within each Alternative is provided below.

Optimize Existing Municipal Sources

An extensive assessment of existing municipal production wells was undertaken to determine sustainable concurrent water takings from all supplies, and to identify wells where upgrades and/or modifications could be considered to improve the well performance, water quality and general security of the source. The only well identified as possibly having more capacity available as compared to its current Permit to Take Water (PTTW) is the Downey Well which could potentially pump at a rate 5,700 m^3/day. The potential for increasing the capacity of the Downey Well will be reviewed within the ongoing Southwest Guelph Water Supply Class EA.

Restore Off-line Municipal Sources

This alternative includes wells that are permitted by MECP but where the City has discontinued their use due to concerns regarding existing water quality issues. In general, these wells require upgrades for water quality treatment and to provide the required disinfection contact time. The primary method for evaluating the potential sustainable capacity associated with each source was use of the Tier Three Model. The following sections outline the potential additional capacity available from off-line sources within each City quadrant.

Southeast Quadrant – Lower Road Collector

A review of historical collector production indicates that the Lower Road Collector produced between 600 and 6,000 m^3/day. The collector has been off-line for two decades and would require a full re-build to return to service. The Tier Three Model assessment indicated that a re-built collector could add 4,000 m^3/day to the current minimum collector output.

Coordination with the on-going Water and Wastewater Servicing Master Plan indicates that the City's F.M. Woods Ultraviolet (UV) system has sufficient capacity for the total flows from Arkell. Limitations, that may be partially addressed through infrastructure upgrades, have been identified for flow rates associated with the combined maximum capacity of the Arkell wells and collector PTTW maximum flows (C3, 2018).

The Arkell Collectors are located near the Eramosa River and Eramosa River Blue Springs Creek Provincially Significant Wetland complex. As this is a previously permitted water source and an increase to the PTTW maximum[3] for the system is not being proposed, it is not anticipated that future operation of the Lower Road Collector would cause an impact to the natural environment. As the system has been offline since 2000, a review of existing conditions would be required to confirm this interpretation.

Northeast Quadrant - Clythe Well

The modelling assessment estimated a sustainable capacity for the Clythe Well with consideration of potential effects on the natural environment. The

3. The Glen and Lower Road Collectors are included on a single PTTW with a maximum permitted flow rate of 25,000 m3/day.

well is located near Clythe Creek and the Clythe Creek Provincially Significant Wetland (PSW) and under long-term pumping conditions the modelling assessment indicated the potential for a greater than 10% baseflow reduction to Clythe Creek. Although the creek has historically been identified as a coldwater feature, current temperature monitoring suggests that the middle and lower reaches of the creek, in the vicinity of this well, are no longer coldwater. With respect to the modelling results, the Tier Three Study (Matrix, 2017) noted that insufficient data were available to calibrate the model to shallow conditions locally. As such, the results presented herein should be considered preliminary and further evaluated along with future field data. Evaluation of the Clythe Well alternative cost is based on the upper range of the steady-state modelled capacity of 1,180 m^3/day and the field-tested rate of 3,370 m^3/day (**Table ES-5**).

Northwest Quadrant - Sacco and Smallfield Wells

The modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from Sacco, Smallfield and Hauser. Testing completed by the City in 2009 (Stantec, 2009) has demonstrated a capacity of 1,150 m^3/day for the Sacco Well and 1,408 m^3/day for the Smallfield Well. Additional capacity developed from these wells would contribute to system redundancy. Evaluation of the costs associated with re-instating these wells is based on the full potential capacity of 2,560 m^3/day (**Table ES-5**).

The Smallfield Well and to a lesser extent, the Sacco Well are impacted by Volatile Organic Contaminants (VOCs) within the aquifer. There has been a lack of action remediating these sources, going back to 1994 when the issue first affected the wells. As such, there remains great uncertainty and risk for the City in the design of a treatment system with respect to the maximum raw water contaminant concentrations, the concentration trend with time, the duration of treatment, and the potential liability of pulling contaminated groundwater across areas which are not yet impacted. To that end, the City is proposing to defer re-instating these already permitted water supply sources through the update of the WSMP until such time as the sources of groundwater contamination in the area have been remediated. However, these wells should remain as part of the WSMP as future drinking water sources (i.e., post-2051, or until source remediation occurs).

Develop Existing Municipal Test Wells

An extensive review and assessment of existing municipal test wells was undertaken to determine potential well yields and water quality treatment requirements. The following sections outline the potential additional capacity available from test wells within each City quadrant.

Southwest Quadrant - Steffler, Ironwood, and Guelph South

The Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,500 m^3/day to the overall system capacity under current quarry dewatering conditions. These wells have demonstrated individual well capacities above this combined capacity of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively. Therefore, additional capacity developed from these wells would contribute to system redundancy. Baseflow reduction of >10% was simulated using the Tier Three Model for Hanlon and Irish Creeks, although there is uncertainty with the results for Irish Creek due to its proximity to the model boundary. These test wells will be further assessed through a detailed Operational Testing Program being completed for the Southwest Guelph Water Supply Class EA, including monitoring of surface water features for baseflow reductions. The cost estimates for these test wells are presented in and are based on the noted individual well capacities of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively (**Table ES-5**).

Dolime Quarry

Significant dewatering occurs within the Dolime Quarry on an on-going basis to maintain the water level within the quarry pond (i.e., to prevent flooding of the quarry). Recent dewatering rates, as reported by the quarry owners (River Valley Developments Inc.), have typically ranged from 8,000 to 11,000 m^3/day. The agreement in place between the City and RVD includes, in part, the City assuming control of water management, thereby controlling the groundwater elevation within the quarry at a level below the surrounding area, resulting in groundwater inflow to the quarry pond (via a hydraulic gradient). This strategy will be evaluated as a potential alternative within the on-going Southwest Guelph Water Supply Class EA. Through this process, the City will determine the pumped flow from the quarry necessary to protect the water supply and, subject to the technical assessment process, the Class EA may consider the feasibility of an additional alternative of capturing groundwater directly from the quarry as a potential future source. The groundwater modelling assessment reported daily groundwater discharge to the quarry that ranged from approximately 3,400 to 6,100 m^3/day. Acknowledging the uncertainty in assigning a potential volume that could be available from the quarry under Pond Level Management, a conservative range of 1,000 to 3,000 m^3/day was carried forward for costing and evaluation purposes. The cost estimate for the Dolime Quarry water treatment facility, provided in **Table ES-5**, is based on a capacity of 3,000 m^3/day. The cost for a full-scale water treatment facility is high and will be refined through the Southwest Guelph Water Supply Class EA and associated Operational Testing Program.

Northeast Quadrant - Logan and Fleming

The Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,180 m^3/day, similar to the 2014 WSMP result of 4,700 m^3/day. The City has initiated a project to reconstruct the Logan Test Well to target the Gasport aquifer by drilling out the existing borehole to below the Vinemount Member (regional aquitard) and installing a new casing. This project will include an assessment of potential effects on surrounding private wells and the natural environment. Consultation with Guelph/Eramosa Township will be required to develop the Logan supply. The cost estimate presented in **Table ES-5** is based on a capacity of 4,700 m^3/day.

Northwest Quadrant - Hauser

The modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from Sacco, Smallfield and Hauser. The estimated capacity of a well at this site is approximately 900 m^3/day; however, this requires significant study for verification. Additional studies would be required to determine if water quality impacts would occur from long-term pumping due to known contaminated sites in the Smallfield Well area located 2.2 km to the northeast. Future work should also focus on potential effects on the local natural environment, which includes Ellis/ Chilligo Creek and the Ellis Creek PSW Complex. The cost estimate is presented in **Table ES-5** and reflects a capacity of 900 m^3/day.

Develop New Sources Inside City

Two locations in the SEQ and one location in the NWQ for potential new wells were evaluated on a preliminary basis but were not carried forward to the detailed evaluation of alternatives. The modelling output suggested that any new wells would reduce the capacity of existing municipal wells, resulting in little to no net capacity increase.

Install new ASR wells inside City for Excess Arkell Flows

This alternative consists of capturing and treating a portion of the excess flow available from the Arkell collector systems, when it is not required to meet customer demands, and storing it underground in aquifers for recovery when demands are higher. This option is referred to as an aquifer storage recovery (ASR) system. Based on the completed modelling assessment, the estimated excess flow available from the collectors for ASR, on a monthly basis, was 451,000 m^3. The aquifer injection and recovery system was simulated with six ASR wells located within the Guelph Innovation District Lands. The modelling output suggests that the ASR wells should be operated at 60% of the target withdrawal rates tested in the model, while the existing municipal wells are operated at baseline rates (i.e., system total of 53,551 m^3/day). These were the rates identified to accomplish withdrawal at the ASR wells, while allowing the existing municipal wells to continue operating sustainably.

The modelling output further indicated that with optimization of ASR well locations, higher volumes could be extracted. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option. It is recommended that additional work focus on the potential to site ASR wells that maximize the ability for existing municipal wells to form part of this alternative, thereby greatly reducing the associated cost.

With an optimized strategy, a net zero injection/ withdrawal water balance would be achieved and significant interference effects on existing groundwater dependent natural features or users are not anticipated.

The total potential additional system capacity from the Arkell ASR is 1,170 m^3/day (in consideration of the 60% withdrawal constraint). With optimization of both the artificial recharge system and the injection/

withdrawal strategy, it is anticipated that additional capacity is possible. The cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells, dechlorination and rechlorination systems, and approvals is provided in **Table ES-5**. The total cost presented is very high in comparison to other water supply alternatives and illustrates the need to further develop this alternative through an optimization strategy that maximizes the capacity available through ASR, minimizes the number of new ASR wells required for the system and utilizes existing municipal supply wells as part of the injection/withdrawal process.

Develop New Sources Outside City

Guelph Southeast

A potential test well area, located southeast of the City (east of Victoria Road, on Maltby Road) within the Mill Creek catchment area was modelled in the completed assessment. The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 1,600 m^3/day on an average basis with a low potential for effects on baseflow within Mill Creek. The cost estimate for the Guelph Southeast Well is included in **Table ES-5** and is based on the modelled capacity value of 1,600 m^3/day.

Guelph North

A second potential test well area, located north of the City (the western limit of Conservation Road) within the Marden Creek catchment area was modelled in the completed assessment. The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 2,935 m^3/day on an average basis. A baseflow reduction greater than 10% was modelled for Marden Creek.

Future work associated with the Guelph Southeast and North locations would require a detailed assessment of potential effects on surrounding private wells and the natural environment after specific potential well locations are identified. As these well areas are located outside of the City, there is a higher density of active private wells. New property would be required for test wells and future well facilities. Consultation and collaboration with Puslinch Township (Southeast) and Guelph/Eramosa Township (North) would be required in advance of initiating these projects.

The cost estimate for this alternative is included in **Table ES-5** and is based on a capacity of 2,935 m^3/day.

Summary

Table ES-5 summarizes, for all groundwater alternatives, the cost estimate for capital works for preliminary investigations, design, land acquisition (where required), construction of new wells and treatment systems, and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour and energy costs.

Table ES-5: Summary of Potential Capacity and Cost Estimates for Each Groundwater Alternative

Alternative Name	Alternative Category	Potential Capacity Range (m^3/day)	Estimated Cost	Cost per m^3/day
Clythe Well	Off-line source	1,180 – 3,370	$6,781,000	$2,012
Smallfield/Sacco Wells	Off-line source	850 – 2,560	$13,116,000	$5,127
Lower Road Collector	Off-line source	4,000	$13,874,000	$3,469
Fleming/ Logan Well	Test well	4,180 – 4,700	$10,103,000	$2,150
Guelph South Well	Test well	2,250 – 4,320	$4,800,000	$1,111
Steffler Well	Test well	2,250 – 3,600	$6,194,000	$1,721
Ironwood Well	Test well	2,250 – 8,000	$5,125,000	$640
Hauser Well	Test well	425 - 900	$5,832,000	$6,480
Dolime	Test well	1,000 - 3,000	$18,976,440	$6,325
Arkell ASR	ASR	1,170	$25,284,000	$21,610
Guelph SE	Well outside City	1,600	$6,862,000	$4,289
Guelph N	Well outside City	2,935	$12,841,000	$4,375

ES-6.3 Establish New Local Surface Water Supply

Two local surface water sources were assessed as potential supply on a continuous or seasonal basis, including the Speed River (at Guelph Lake) and the Eramosa River (at the Arkell Spring Grounds). Surface water must either be treated to provide a continuous flow into the distribution system, or alternatively, volumes of water can be used within an ASR system, as described for the Arkell site. The supply capacity available from this source on a continuous basis is equal to the volume taken from surface water when available and treated and injected, and then removed over the period of a full year.

For both continuous flow and ASR approaches, construction of a water treatment plant (WTP) is required to fully treat the surface water to meet Ontario Drinking Water Quality Standards. In the first option, the WTP is sized to treat a continuous input to the plant with direct discharge to the City's distribution system. In the second option, the WTP would be required to treat varying flows ranging from the continuous flow requirement to the maximum design capacity based on high seasonal river flows.

To evaluate potential quantity available through this alternative, the Grand River Conservation Authority (GRCA) provided their expert opinion on this managed watershed. It was determined that only the Guelph Lake option provided a reasonable surface water alternative for continuous and seasonal flows. Through this evaluation, a base level water taking was established which would be available year-round, while maintaining minimum river flows and minimizing potential environmental effects associated with reducing total river flows. The GRCA also reviewed historical records to establish reliability of taking additional volumes during times of higher river flows.

Historical water quality information for the Speed River was referenced to determine treatment processes required to achieve drinking water quality. Conventional treatment is proposed with treatment for taste and odour on a seasonal basis, as necessary. The proposed WTP has been sized to accommodate the following alternatives at Guelph Lake:

- continuous taking of 150 L/s (12,960 m^3/day) – Municipal Base Taking
- maximum taking of 300 L/s (25,920 m^3/day) – ASR option

The total increase in potential quantity available from surface water treatment and ASR systems based on after treatment flows is 25,825 m^3/day (i.e., a continuous taking from Guelph Lake of 150 L/s and a step taking of 300 L/s with a 5% loss at the WTP). This can be viewed as two alternatives, the first being a continuous surface WTP, and the second an expansion to the WTP and development of the ASR well system. Similar to the Arkell ASR evaluation, the modelling output suggests that the ASR wells should be operated at 60% of the target withdrawal rates tested in the model. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option.

Table ES-6 summarizes the cost estimate for implementation of the two surface water alternatives.

Table ES-6: Cost Estimate for Guelph Lake Surface Water Alternatives

Item Description	WTP	WTP + ASR
Potential Capacity (m^3/day)*	**12,312**	**25,825**
Estimated Cost	**$51,322,000**	**$57,283,000**
Cost per m^3/day	**$4,168**	**$4,239^**

Notes: * Values assume that 5% of raw water is lost during treatment process.
^ Cost to increase WTP capacity from 12,312 to 25,825

ES-7 Environmental Assessment Process

Evaluation criteria were developed based on the environmental components that address the broad definition of the environment described in the Environmental Assessment Act, as summarized in **Table ES-7**. The criteria were refined through the project consultation and engagement process.

Table ES-7: Evaluation Criteria Components Summary

Component	Criteria
Effect on Indigenous values, culture, and Traditional use	■ An evaluation of the effect on Indigenous values, culture, and Traditional use. Key themes shared with the Project Team that help guide the evaluation include: – valuing and respecting the agency of water – understanding the spirit and personhood of water, – good stewardship of the connected ecosystem including protection of water’s pureness, – consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation.
Technical Considerations	■ Constructability ■ Potential productivity and reliability ■ Water treatment requirements ■ Approval requirements
Natural Environmental	■ Effect of construction and operation on aquatic and terrestrial species and habitat ■ Effect on surface water quantity and quality
Built Environment	■ Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities ■ Effect on private and municipal wells

Component	Criteria
Social/Cultural Environment	■ Ability to meet municipal and provincial growth targets ■ Public acceptance ■ Effect of noise/vibration on sensitive receptors ■ Effect on cultural heritage landscapes and built heritage resources ■ Effect on potential archaeological resources
Legal/Jurisdictional Considerations	■ Location inside versus outside of City boundaries
Financial Considerations	■ Estimated capital costs; capital cost per capacity ■ Estimated operation and maintenance costs ■ Life cycle cost (per volume produced)

Each potential alternative was assessed using a consistent approach and evaluation criteria along with specific indicators for each. The evaluation was qualitative – not a numerical ranking system – and considered the suitability of the identified alternative solutions and strategies based on significant advantages and disadvantages. The summary evaluation tables (included within the report) provide an overall recommendation for each of the alternatives which can be compared to the other alternatives. This provides a means to rank the alternatives to allow for incorporation into an implementation plan to meet the water supply requirement to 2051. The alternatives are listed in **Table ES-8** in order of the priority as determined by the summary outputs:

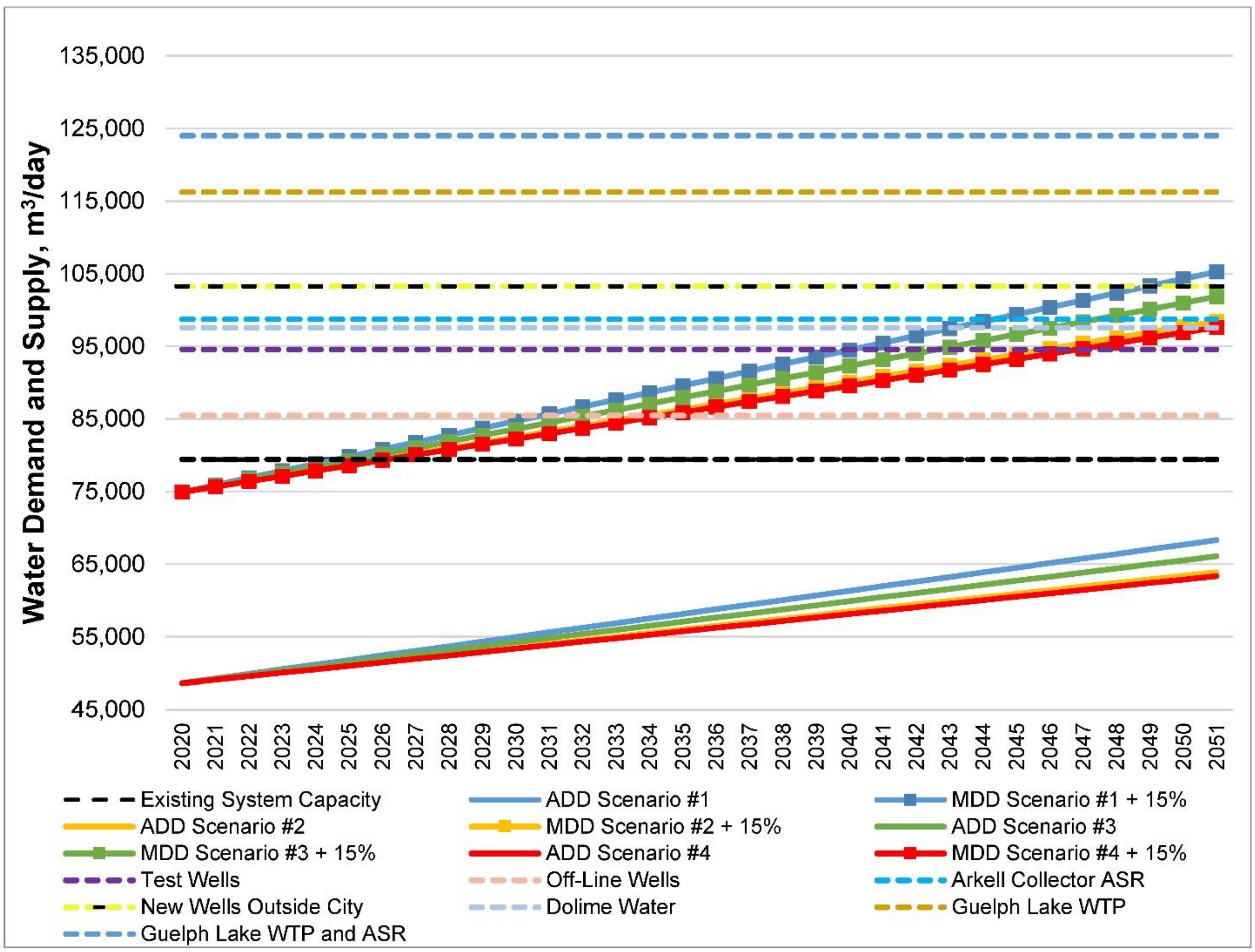
Table ES-8: Summary of Evaluation Outputs

Alternative	Result	Comments
1A – Conservation, Efficiency & Demand Management	Part of preferred solution – high priority	Strong public support for continued programming; strategy must be adjusted through planning period in response to performance; target reduction explored further through financial analysis
2B – Groundwater: Restore Off-line Municipal Wells	Part of preferred solution – high priority	Support for restoring capacity within the City; order of implementation to be determined by the City with consideration for regulatory, treatment, financial constraints. Timeline for Smallfield/Sacco wells uncertain, not currently feasible.
2C/D – Groundwater:	Part of preferred solution – high priority	Support for pursuing test wells within City/on City property; order of implementation to be determined by the

Alternative	Result	Comments
Develop Municipal Test Wells		City with consideration for regulatory, treatment, financial constraints. Assessment of groundwater quality within NWQ required prior to pursuing Hauser site.
2F – Groundwater: Arkell Collectors & ASR Wells	Part of preferred solution – medium priority	ASR alternative requires additional feasibility investigation with respect to Eramosa River PTTW optimization; water volumes available via collector systems; optimization of ASR configuration; option of changing existing well permits to allow for flexible takings
2G – Groundwater: Develop New Wells Outside City	Part of preferred solution – low priority	Incorporates Townships' staff and public response to maximize water takings inside the City before pursuing wells in the Townships
3A – Surface water: Guelph Lake Water Treatment Plant	Part of preferred solution – low priority	While this alternative is not required to provide water supply within the study period (with continued conservation, efficiency and demand management programming) the City will track timeline to determine 10-year lead-in required prior to implementation; Speed River/Guelph Lake water taking requires GRCA policy approvals
3B – Surface water: Guelph Lake Water Treatment Plant & ASR Wells	Part of preferred solution – low priority	While this alternative is not required to provide water supply within the study period (with continued conservation, efficiency and demand management programming) the City will track timeline to determine 10-year lead-in required prior to implementation; Speed River/Guelph Lake water taking requires GRCA policy approvals
Limit Growth	Not preferred	This alternative does not meet the Study Challenge and Opportunity Statement and contravenes the Provincial growth targets
Do Nothing	Not preferred	This alternative does not meet the Study Challenge and Opportunity Statement and contravenes the Provincial growth targets

Figure ES-2 compares the implementation of all of the water supply alternatives to the water demand curve with and without conservation programming to 2051. It can be seen that with conservation programming, new wells outside of the City and the Guelph Lake surface water alternative may not be required prior to 2051. As there is uncertainty about the water supply capacity that each potential source will yield, as the City progresses with implementation of the projects, the water supply deficit will subsequently be evaluated, and the implementation plan will be revised as necessary. This process may result in additional projects falling outside of the planning period.

Figure ES-2: Water Demand Projection with All Water Supply Alternatives



ES-8 Engagement and Consultation

Community input is an essential part of the WSMP Update process. People care about where their water comes from, and they want to see a safe and sustainable supply maintained for present and future generations, and Guelph residents, agencies, stakeholders and Indigenous Peoples were engaged throughout the project. The following provides an overview of the main consultation and engagement activities completed for the project:

- newspaper advertising and electronic mailing to inform people about the start of the WSMP Update;
- a project website to provide useful information, including links to the previous 2014 WSMP Update, contact information and invitations to online and in-person engagement opportunities;
- Online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- One meeting with Mississaugas of the Credit First Nation to provide an overview of the on-going water-related City Master Plans;
- One meeting with Six Nations of the Grand River to provide an overview of the on-going water-related City Master Plans;
- An inclusive and diverse **Community Liaison Group** (CLG) was established to advise and provide feedback to the project team throughout the process. The group met formally on three occasions;
- Two **Municipal / Agency Workshops** provided crucial inputs from a government and approval agency perspective;
- Two public **Open Houses** were held during the course of the study (one in-person and one virtual), giving community members an opportunity to discuss the project with the Study Team and provide comments;
- Presentations and discussion related to the WSMP Update were included at two meetings of the Water Conservation and Efficiency Public Advisory Committee;

- Presentations were made at Puslinch Township and Guelph/Eramosa Township Council meetings at their request; and
- Co-ordination other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

The feedback received through the various engagement tools and activities indicates that there is a continued interest from community members and stakeholders about water supply in Guelph. Several themes emerged related to the key engagement topics of this phase, including:

- prioritizing conservation;
- protecting the natural environment;
- managing growth and development;
- controlling groundwater impacts from large water users;
- concerns about source protection areas and land use constraints particularly with respect to impacts on the Townships;
- concerns about potential well interference effects with existing wells particularly with respect to impacts on the Townships;
- prioritizing supply within the City before considering sources within Township(s);
- considering potential climate change impacts on water supply;
- questions about the Dolime Revitalization Plan and how it fits into the WSMP
- monitoring emerging contaminants;
- limiting impacts to aquatic and terrestrial wildlife; and
- valuing the agency of water.

There are Indigenous Peoples—First Nations, Métis and Inuit Peoples–living in Guelph who have worked with the City and contributed to the development of the WSMP Update. Specifically, through the Community Liaison Group, Indigenous Peoples shared their perspectives on the spirit of water and the importance of respecting the agency of water.

Overall, the community has played an important role in providing feedback to the project team and contributing various perspectives on water supply planning. The main points of discussion at the Community Open Houses were water conservation programming, the impact of major water users on the water system, protecting the natural environment, source water protection (including revitalization of the Dolime Quarry), climate change and water quality. The quality of questions and the engagement of those present at the Community Open Houses was a positive indicator of the interest in water supply issues within the City and the surrounding area.

The additional consultation offered and provided to the Townships at their request resulted in additional feedback that focused on the alternatives outside of the City. Township representatives raised concerns regarding source protection issues and potential constraints on land uses resulting from new water supplies. These meetings provide a good starting point for future discussions around the potential for new wells to be located just outside the City's boundaries in the neighbouring Townships.

ES-9 Implementation Recommendations

ES-9.1 Financial Evaluation Approach

Based on the evaluation outputs for each of the alternatives, a priority was established for the proposed water supply projects that determines how the City will proceed to develop its water supply over time to meet future needs. This implementation strategy is to ensure that there will always be sufficient supply including an additional allowance for security of supply in place prior to approving growth.

The timeline for this plan is dependent on the water conservation scenarios. A financial evaluation was carried out to determine the optimal water conservation scenario when viewed in the context of cost, impact on demand and the resulting timeline and costs for all of the water supply projects.

The financial evaluation takes into consideration the following:

- Timeline and costs associated with each alternative – including technical investigations, water quality analysis, environmental impact studies, land acquisition, preliminary and detailed design, and construction and commissioning. The timeline allowed in advance of water supply availability is as follows:

- Groundwater – 5 year timeline
- Arkell Collector ASR wells – 8 year timeline
- Surface Water – 10 year timeline

- The exception to the above is that the investigative phase for the test wells and inside-City groundwater options is scheduled to occur early in the implementation timeline so that the City has sufficient information to determine whether the alternative is feasible, to identify any constraints, and to confirm capacity and treatment requirements prior to the next WSMP Update. For the proposed wells outside the City, budget is allocated in the short- to mid-term for additional modeling work to update and substantiate the estimated capacities and potential effects related to the Guelph North and Guelph Southeast alternatives for use in future WSMP Updates.
- An assumed order of groundwater projects is based on the prioritization of alternatives identified in the alternatives evaluation. It is important to note that the assumptions made in the prioritization of projects were for the purpose of determining the requirement for new supplies against the demand curve in comparison to varying conservation scenarios. Most of these projects would be in investigation and design phases concurrently and the schedule for each would be a function of constraints and ease of implementation.
- The schedule for implementation is such that new water supply projects will be brought online when required capacity reaches 90% of system capacity to ensure sufficient capacity for proposed development commitments, and industrial/ commercial applications, as well as to respond to large increases in demand by current customers, in particular major industries or ICI consumers. This flexibility is important to address growth needs or demands that do not follow the planned demand projection.

ES-9.2 Recommended Water Conservation Strategy

Five water conservation, efficiency and demand management scenarios were developed to represent a range of possible target reductions and associated costs. These programs are forecasted to range in cost from $0/year to approximately $501,333/year, and reduce average day water demand by 0 m^3/day to 4,952 m^3/day (Table ES-9). This includes a blended scenario that envisions implementing the current level of programming in the short-term (approximately years 0-10), adjusting the focus to high demand and/or inefficient customers in the mid-term (approximately years 11-20) and incorporating water reuse in the long-term (approximately years 21-30). Each of the water conservation scenarios explored (except Scenario 1) will delay the need to implement proposed projects for increasing the water supply, assuming that conservation is successfully implemented to achieve the desired targets.

Table ES-9: Water Conservation Scenarios

Scenario	Reduction in Average Day Demand (m^3/day)	Est. Total Program Cost (Non-Discounted; million $)
1	-	-
2	4,424	11.41
3	2,220	4.73
4	4,952	15.04
5	3,683	8.99

The analysis compares the forecasted impacts of the five scenarios on: the demand for potable water, the timing of the City's proposed water supply projects, and the City's capital spending and operating expenditure on water supply projects and water conservation.

The forecasted timing of proposed water supply projects under the different scenarios is presented in **Table ES-10**. Included in each project expenditure is the preceding timeline for work and associated costs outlined in the assumptions.

Table ES-10: Timing of Proposed Water Supply Projects Under Different Conservation Scenarios

Order of Implementation	Project Name	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Project 1	Clythe Well	2023	2023	2023	2023	2023
Project 2*	Ironwood/ Steffler Well	2027	2027	2027	2027	2027
Project 3*	Guelph South Well	2028	2030	2028	2030	2030
Project 4*	Dolime Quarry	2031	2032	2031	2032	2032
Project 5	Fleming/ Logan	2033	2036	2034	2037	2036
Project 6	Lower Road Collector	2037	2042	2038	2042	2040
Project 7	Arkell Collector ASR Wells	2041	2047	2044	2047	2045
Project 8	Hauser test well	2042	2049	2045	2049	2047
Project 9	Guelph North	2043	2049	2046	2050	2048
Project 10	Guelph Southeast	2046	Post-2051	2048	Post-2051	Post-2051
Project 11	Guelph Lake WTP	2048	Post-2051	2051	Post-2051	Post-2051
Project 12	Smallfield/ Sacco Wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051
Project 13	Guelph Lake WTP and ASR wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051

Notes: *Project implementation subject to outcome of on-going Southwest Guelph Water Supply EA

The timing of the water supply projects is dependent on the City's overall demand for water and is different under each scenario.

ES-9.3 Preferred Water Supply Alternative

The preferred water supply alternative consists of the blended conservation scenario as well as Projects 1 through 9 listed in **Table ES-11**. These are all groundwater projects included in the preferred alternatives in the evaluation process, consisting of existing municipal off-line wells, existing municipal test wells, Dolime Pond Level Management, Arkell ASR, and a new well

(Guelph North) outside of the City. A recommended implementation strategy for all required projects is provided in detail in the full report.

Table ES-11: Preferred Water Supply Alternatives

Alternative	Timeline	Projects
1A – Conservation, Efficiency & Demand Management	Throughout	■ Blended Conservation Scenario
2B – Groundwater: Restore Off-line Municipal Wells	Short-term	■ Clythe Well (completion in 2023)
2B – Groundwater: Restore Off-line Municipal Wells	Mid-term	■ Lower Road Collector (completion in 2037)
2C/D – Groundwater: Develop Municipal Test Wells	Short-term	■ Ironwood/Steffler (completion in 2027) ■ Guelph South (completion in 2028) ■ Dolime Quarry (pumping station component completed to align with Ironwood/ Steffler) ■ Logan/ Fleming (completion in 2030)
2C/D – Groundwater: Develop Municipal Test Wells	Long-term	■ Hauser (completion in 2047)
2F – Groundwater: Arkell Collectors & ASR Wells	Long-term	■ Arkell ASR (completion in 2045)
2G – Groundwater: Develop New Wells Outside City	Long-term	■ Guelph North (completion in 2048)

It will be important for the City to closely track the success of the water conservation and efficiency program to ensure that the predicted reductions are being achieved, and to be able to trigger the initial phases of supply projects noting the lengthy lead-in time to complete all of the necessary investigations, approvals and design such that the water is available when needed. This is particularly important for the mid- and long-term projects as there are five supply facilities scheduled to come online in the 2022 to 2031 portion of the timeline. The City may decide to take a more conservative approach to complete more of the preliminary steps in advance to allow for a shorter final implementation time required for final construction and commissioning once triggered. This would also assist in identifying project issues early, and also securing land requirements.

ES-9.4 Recommendations

A series of recommendations are provided in the full report and a subset are provided here as an overview.

General Program Recommendations

- As each new supply source is developed, it is recommended that the total water budget be re-evaluated as compared to the conditions at the time of assessment to ensure that additional groundwater extraction does not result in adverse environmental or well interference effects.
- As each new water supply project is developed, it is recommended that additional surface water and groundwater monitoring programs be put in place to monitor for potential environmental effects to adapt the water takings to mitigate impacts, if necessary. Since water taking effects may extend outside of the City, collaboration with the GRCA and the Townships may be required to implement programs outside of the City.
- Groundwater modelling is recommended as an important tool to assess potential cumulative effects and environmental effects. It is recommended that the City's groundwater flow model be continuously updated and maintained for application in the various WSMP projects.
- A basic premise of the WSMP Update is that the existing supply system is protected, and the City does not lose supply through contamination events or as a result of other non-municipal water takings. Therefore, it is important that the City enhance/maintain its source protection programs, particularly with respect to contaminated sites and to support, and in some cases, sponsor source protection programs outside of the City to provide equal protections. In addition, it is recommended that the preferred solution (i.e., future drinking water sources) in this WSMP Update be incorporated into the City's Source Protection Program for protection of water quantity of future drinking sources as required by the purpose of the Clean Water Act and the objective of the Source Protection Plan.
- In comparison to the 2014 WSMP Update, capital and unit costs for the development of new groundwater supplies have increased, for a variety of reasons. Pandemic-related, supply-chain issues have been identified in developing cost estimates but there is uncertainty if some of the

increased material and service costs will persist into the future. With Guelph City Council's direction of growth paying for the cost of growth, it is recommended that cost estimates in the WSMP Update be updated as part of Class EA projects once additional design details are available and with each subsequent WSMP Update (approximate frequency of five years).

- It is recommended, as part of feasibility studies or the Class EA process, that each potential new source of water supply require additional field work and environmental impact assessments, particularly with respect to water budget and sustainability issues.
- Through the WSMP Community Engagement Plan, the Project Team heard concerns from adjacent municipalities on source protection and land use constraints as well as potential impacts to domestic wells from well interference. It is recommended that future programs have a focus on enhanced engagement and development of intergovernmental relations with the goal to promote more regional water resources management, to support water supply needs for all affected municipalities and to address attendant environmental effects with the support of provincial agencies (i.e., Ministry of the Environment, Conservation and Parks) to meet provincial growth targets.
- It is recommended that the City build on the existing Drinking Water Quality Management System process by developing a risk management plan that includes mitigation and response strategies. This will include current risks to the existing groundwater-based system and may be expanded upon to include additional risks relevant to future water supplies, whether groundwater or surface water based.
- The feasibility of both the Arkell and Guelph Lake ASR alternatives should be further developed, and this process should include an optimization study to evaluate the placement of ASR wells that best utilize the existing municipal supply wells to efficiently recover injected water.

Water Supply Planning Recommendations

- Build on the current process and guidelines for review of applications from new large volume users (e.g., industry), which considers a balance of employment and water use. Future projections are based on allocated amounts dedicated to the residential and ICI sectors, where the volume for ICI relates to a specified employment number. If high volume water users are not coupled with high employment, water demand projections will need to be revisited to establish a revised schedule for new water supply without jeopardizing the needs of planned growth.

- Investigate more robust policies for supply capacity allocation for both new and existing customers that take into account the relatively large capital expenses and lengthy timelines required to fully commission new water supply facilities. These policies would ensure maximum value to the City for supply capacity allocated to both new and existing customers.
- Complete an update of the 2016 Water Efficiency Strategy, commencing as early as 2022, based on the blended water conservation (Scenario 5), efficiency and demand management scenarios presented through the WSMP. This will include evaluation of non-potable reuse options in alignment with the City’s other water-related Master Plans.
- Continue, and refine as necessary, the tracking system that closely monitors sectoral demand management (i.e., conservation and efficiency programs) and optimization successes and review whether results are in-line with the forecasted demand for the preferred scenario and are achieving the goals of the Water Efficiency Strategy. Trends must be monitored with a long-term view recognizing that the effect of some direct programs may be more immediate, resulting in short-term deviations from the forecast.
- Consider time limits on development commitments such that water capacity is not ‘held’ for long periods of time. Review possible mechanisms to synchronize approvals of significant capacity increases with the proposed timing of new supplies in accordance with the master planning schedule.
- Assess the Development Charges planning process for the ability to provide flexibility in funding in relation to COVID cost increases.
- Review land acquisition requirements for all projects, both short- and long-term, to ensure future flexibility when implementing alternatives. Consider delegation of authority to staff to execute strategic land procurement requirements for future water supply provided property

values fall within 20% of study estimates, subject to the approval of the DCAO and City solicitor.

Supply Capacity Management Recommendations

- Water Services should conduct annual reviews of each component of the water supply system to determine the supply capacity and to identify any changes in the capacity from previous years or any constraints in delivering the optimal supply capacity.

- Based on the annual reviews of water supply capacity, Water Services should develop programs and implement maintenance and upgrades to the water supply system so that the system can deliver its optimal supply capacity.

- To protect water quantity and to mitigate potential impacts on quantity from other water takings, the City should consider implementing a municipal by-law to prohibit new private groundwater supply wells in the City as well as other areas where municipal water services are present.

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Appendices

1. Introduction

In 2007, the City of Guelph (City) completed the Water Supply Master Plan (WSMP) project to ensure that the City's water supply continues to meet current and future demands. As part of the initial WSMP, City Council provided direction in 2003 "That the focus of the WSMP establish a sustainable water supply to regulate future growth". The WSMP provided recommendations for the planning of development of future water supply capacity for the City through to 2054 (50-year planning horizon). This included recommendations for short-term, mid-term and long-term water supply options to meet the predicted demand. The short-term recommendations included water conservation and demand management programs and expansion of the existing groundwater supply system. Mid- and long-term recommendations included continuation of groundwater development within the City along with consideration of groundwater sources outside of the City in consultation with the neighbouring Townships. All options were prefaced with the need to consider the investigation and feasibility of options prior to implementation. In 2007, City Council approved the WSMP and directed staff to implement all components of the WSMP including the water conservation and efficiency strategy with the exception of the Great Lakes Water Supply alternative. One of the recommendations was that the WSMP be updated every five years, and the City moved forward with the first update in 2014. The 2014 WSMP Update covered a 25-year period from 2013 to 2038 to make it consistent with the needs of the City at that time.

The purpose of the current WSMP Update is to review and revise the 2014 WSMP covering a 30 year period from 2021 to 2051 to align with the Provincial Growth Plan: A Place to Grow: Growth Plan for the Greater Golden Horseshoe (amended in August 2020), and the Municipal Comprehensive Review of the City's Official Plan (in progress). The WSMP Update applies to water supply only; however, references to other City studies including the Wastewater Treatment and Biosolids Master Plan (WWTBMP) and Water and Wastewater Servicing Master Plan (WWSMP) are relevant in terms of infrastructure planning co-ordination. The distribution and servicing of the municipal potable water system including watermains, pumping stations and reservoirs are addressed in the WWSMP.

The WSMP Update builds upon the work previously completed taking into account more recent studies and the work activities completed since 2014. This update will review the 2014 WSMP recommendations as well as examine new water supply alternatives in accordance with the Class Environmental Assessment (EA) process for Municipal Water projects. This project provides an update to the following components of the 2014 WSMP:

- Community engagement and consultation and engagement of Indigenous communities – complete the required consultation to collect and incorporate public and agency input into the update; contact and engage with First Nations, Métis and Inuit Peoples living in Guelph and Indigenous communities identified by the Ministry of the Environment, Conservation and Parks (MECP);
- Population and water demand projections – review potential population and industrial/ commercial/ institutional (ICI) growth and historical water demands to establish future water supply demand projections;
- Water supply capacity – review and assess the current water supply system and establish a range of system capacities under several scenarios;
- Water supply alternatives – review existing hydrogeological information and recent water supply projects to identify potential areas of additional groundwater supply capacity; and develop and evaluate feasible concepts for alternative municipal water supplies;
- Implementation recommendations – develop an implementation plan for new water supply capacity to satisfy future demand forecasts; and
- WSMP Update report – document all findings and recommendations.

The update will provide a listing of the recommended water supply projects, including phased implementation schedules and recommended Class EA Schedules. Class EA approvals for Schedule “B” and “C” projects can then be conducted by using the Master Plan as a starting point.

1.1 Background

The City relies almost exclusively on groundwater to meet the municipality's residential, industrial, commercial and institutional water demands. It is one of the largest cities in Canada relying on groundwater.

In 1990, the City initiated a multi-phase study of its water system. The water system was broadly defined to include not only groundwater and its protection but also the supply, distribution and conservation of water. The study area encompassed the City of Guelph and included the southern portion of Wellington County. The Phase 1 report was completed in April 1991. As part of this project, it was recognized that, for the City to continue to utilize their groundwater resources while sustaining the quality of these resources, it was necessary to pursue multiple initiatives. The four major areas of sustainable water resources, supply and/or management were identified as follows:

- Water Conservation and Efficiency – public education and awareness programs, and conservation initiatives to promote the conservation of water by all (residential, ICI), in the City.
- Water Supply/Distribution – optimization of the City's water supply and distribution system and expansion to meet growth requirements to ensure capital works meet supply and demand needs.
- Water Resource Evaluations – investigations to characterize the City's groundwater resources and its general relationship within the natural environment.
- Water Resource Protection – the development of strategies and implementation measures to ensure the protection of ground and surface water quantity and quality.

Since the completion of this first phase, various investigations and studies were completed pertaining to all four areas, with a primary focus on the evaluation of the water resource. This effort involved the collection of a substantial volume of information on the physical setting, the evaluation of water supply aquifers through extensive testing of existing municipal wells and the development of a groundwater flow model. The evaluation of this information led to a more comprehensive understanding of the City's water resources.

In 1999, the City of Guelph initiated the Water Supply Strategy (WSS) project to address the supply of water to meet future projected demands. Climatic conditions, well interference and water quality degradation had reduced the yield of the existing system. The WSS examined alternatives in accordance with the Class EA process for Municipal Water projects. The first phases of the EA were conducted in 2000 and included a review of the following:

- Current system capacity and long-term water supply system capacity;
- Water demand, average day water demand and maximum day water demand;
- Population projections;
- Water demand projections; and
- Alternatives to meet projected water demands.

Based on comparisons of demand to capacity, the WSS concluded that there was a need to supplement the existing water supply system, both immediately and in the long term. The alternatives to meet the projected water demands included the following:

- Do nothing;
- Reduce water demand through conservation and unaccounted for water (UFW);
- Limit community growth;
- Increase takings from established sources;
- Develop additional groundwater supplies; and
- Develop alternative municipal supplies.

The Class EA concluded that the City should implement immediately the alternatives to reduce water demand through conservation, to identify unaccounted for water use; and to increase taking from established sources (Arkell Spring Grounds). In the longer term, it was recommended that the

City should pursue the alternatives of developing additional groundwater supplies and alternative municipal supplies.

Subsequently the City completed the WSMP study in 2007 and an update in 2014. The WSMP implementation plan set out a strategy for the City to investigate and execute the necessary steps to optimize existing and develop new water supplies, with a focus on local sustainability. Public response to the 2007 WSMP helped shape that definition of sustainable to refer to available local water supplies, which included local groundwater and surface water sources. A Great Lakes pipeline alternative was considered in the long list of alternatives within the 2007 Plan but was determined to be unsustainable in the local context and City Council removed discussion of the pipeline alternative from the Plan. Consistent with this direction of Council, a Great Lakes pipeline alternative has not been included in subsequent updates.

The utmost importance was placed on water conservation and as a result, the City has become a renowned leader in water conservation and demand management in Canada. The City's Official Plan calls for the WSMP to "develop programs and policies to conserve water and to reduce requirements for additional water supply and treatment, including the implementation of the Water Conservation Efficiency Strategy". It is the aim of this update to document demand reductions achieved to date, and to determine feasible reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 and 2014 indicated that the City first examine groundwater supply opportunities within the City's boundaries in order to minimize potential impacts on its neighbours. Although groundwater flow does not respect geographic borders, effects from pumping from aquifers may result in potential local effects on the natural environment and also on private and municipal wells in close proximity as well as potential land use constraints from source water protection requirements. As a result, the City has since implemented a number of programs and studies to maintain and optimize existing supply facilities within the City and in areas of existing municipal well supply infrastructure, including (since 2014):

- Completed construction of new well facilities (Arkell 14 and 15) and completed the Arkell Adaptive Management Plan and Operational Testing Program;

- Upgrades to the Arkell artificial groundwater recharge system;
- Completed upgrades to the existing Burke Well facility, including iron and manganese treatment;
- Class EA for a Clythe Well water treatment facility (existing, off-line well);
- Replacement well on the Membro site, referred to as the Membro Replacement Well or the Rocco Well; and
- Through mediation with the Dolime Quarry owner, identified a potential solution to address the City's concerns about how operations at the quarry could affect local groundwater.

Also included in the short- to mid-term implementation strategy was the initiation of various hydrogeological investigations inside the City and just outside the City's boundaries to explore the potential for new water supplies in these areas. These include the Guelph South Groundwater Supply Investigation (on-going) and the Southwest Guelph Water Supply Class EA to evaluate additional water supply sources within southwest Guelph, including a long-term Operational Testing Program at the Dolime Quarry and surrounding existing municipal wells (on-going).

In addition to the above initiatives, the City has completed the following regional studies and plans to ensure the protection and long term sustainability of the existing water supply system:

- The Guelph and Guelph/Eramosa Township Tier Three Water Budget and Local Area Risk Assessment (Tier Three Study) was completed to evaluate the sustainability of the City's water supply system from a quantity perspective and to identify potential threats to that sustainability (Matrix Solutions Inc., 2017). This study concluded that the Queensdale Well had a significant risk of not meeting future pumping requirements under drought conditions and that all other City wells are expected to meet future needs. However, a high level of uncertainty was also associated with the results for the Arkell 1 Well. As a result of this assessment, and since the City's drinking water system is dependent on the contribution of water from the Eramosa River intake, a Well Head Protection Area for water quantity (WHPA-Q) was developed for the water supply aquifer and an Intake Protection Zone for water quantity (IPZ-Q) was established for the Eramosa River. This study and the Tier Three Groundwater Flow model (Tier Three Model) of Guelph's municipal aquifer system (in and outside the City) provide invaluable insights into reviewing the current water supply system and its reliability now and into the future. It is also referenced herein in determining the feasibility of new water supplies from both a potential capacity and environmental effects perspective.

- A Threats Management Strategy was developed to address the results of the Tier Three Study and guide the development of associated water quantity policies.
- The Guelph Drinking Water Source Protection Plan was developed within a watershed context to identify and evaluate potential water quality threats to the municipal supply system. The City and other municipalities within the Grand River Watershed, through the Lake Erie Source Protection Authority, have developed policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants. At this time, the City is currently working on updates to the plan and development of policies to address the potential water quantity impacts.

1.1.1 Water Resource Protection

Recognizing the importance of protecting the City's water resources, groundwater and water resources protection policies have been incorporated into the City's Official Plan. The June 2021 consolidation provides the rationale for protection policies and describes these as follows:

> ***"4.3 Watershed Planning and Water Resources***
>
> *Protection, conservation and enhancement of the City's water resources are integral to sustaining the environmental, social and economic well-being of the community. The City employs a watershed/subwatershed based planning approach to inform broader scale natural heritage, land use and infrastructure planning policy. The City emphasizes water resource protection and conservation, ensuring long term safety and security through the identification of potential quality and quantity threats to surface water and groundwater resources. Additional measures*

to protect the City's existing and future sources of water supply are anticipated through the development and implementation of a Source Protection Plan.

Objectives

a) To use a watershed/subwatershed planning systems approach to inform the identification, evaluation and protection of the natural environment.

b) To protect, improve or restore the quality and quantity of the City's surface water and groundwater resources through municipal initiatives and community stewardship.

c) To practice and encourage effective management of stormwater drainage in order to maintain or enhance the water resources of the City.

d) To use stormwater management to assist in regulating the quantity and quality of stormwater run-off to receiving natural watercourses, wetlands and recharge facilities.

e) To work with the Grand River Conservation Authority and Lake Erie Source Protection Committee to develop a Source Protection Plan.

4.3.2 Water Resource Protection and Conservation

1. The City will protect, improve or restore the quality and quantity of water by:

i) minimizing potential negative impacts, including cross jurisdictional and cross-watershed impacts;

ii) implementing necessary restrictions on development and site alteration to protect all municipal drinking water supplies and designated vulnerable areas;

iii) promoting efficient and sustainable use of water resources, including practices for water conservation and sustaining water quality; and

iv) ensuring stormwater management practices minimize stormwater volumes and contaminant loads.

2. Reduction in water consumption will be encouraged through upgrading/retrofitting of existing buildings and facilities. The City may require a Water Conservation Efficiency Study in conjunction with new development.

3. Landscaping and maintenance practices that minimize water consumption and reduce the use of potable water for irrigation associated with development are encouraged.

4. The use of potable water for outdoor watering is discouraged.

5. The City will increase the use of low maintenance and drought tolerant landscaping at municipal facilities.

6. The City will encourage and implement Low Impact Development (LID) where appropriate.

7. Alternative water supply and demand management systems such as rain water harvesting and grey water reuse is encouraged throughout the city and in all new development.

8. The City will ensure, through consultation with the Province and the Grand River Conservation Authority, that all development meets provincial water quality and quantity objectives for surface water and groundwater.

9. The City will ensure that development activities do not impair the future ability of the area's groundwater and surface water resources to provide a quality water supply to satisfy the residential and business needs of the city and to sustain the area's natural ecosystem.

10. Development shall be restricted in or near sensitive surface water features and sensitive groundwater features and tributaries such that these features and their related hydrologic functions and water quality functions shall be protected, improved or restored. Mitigative measures and/or alternative development approaches may be required to protect, improve or restore sensitive surface water features, sensitive groundwater features and their hydrologic functions.

11. The City will implement the recommendations of the Water Conservation and Efficiency Strategy Update (2009) or successor thereto.

4.3.3 Source Protection

Source protection planning is designed to protect existing and future sources of municipal drinking water thereby safeguarding human health and the environment. A Source Protection Plan is being developed by the Lake Erie Source Protection Committee. The Source Protection Plan will place restrictions on land use activities within Wellhead Protection Areas, Intake Protection Zones and Issues Contributing Areas. Once approved by the Ministry of the Environment, the Source Protection Plan policies will be incorporated into this Plan through amendment. In the interim, the City will continue to place restrictions on land use activities that have the potential to impact the City's water supply and may implement risk management measures required by the Clean Water Act.

1. The entire City area is considered to be a recharge area for municipal drinking water supply. To protect this valuable water resource, the City will introduce conditions of development approval that:

> *i) protect wetlands and other areas that make significant contributions to groundwater recharge;*
>
> *ii) ensure that stormwater management systems protect water quality and quantity;*
>
> *iii) require all storage of liquid waste, petroleum, fuels, solvents, fertilizers and related chemicals be provided for in properly designed and engineered containment areas in accordance with all applicable policies, guidelines, technical standards and legislation;*
>
> *iv) restrict the placement of underground chemical/fuel storage tanks;*
>
> *v) require impact studies and risk management plans where proposed development has the potential to affect the quantity or quality of groundwater resources;*

vi) require that contaminated properties be restored to the appropriate condition in compliance with applicable Provincial legislation and regulations; vii) place restrictions on land use in areas of greatest risk to contamination of groundwater resources. Uses that may be restricted include, but are not limited to: industrial landfills, lagoons, waste disposal facilities, asphalt and concrete batching plants not associated with mineral aggregate operations, the storage or processing of chemical products, gasoline or oil depots and service stations, and vehicle salvage, maintenance, service yards and other activities identified as significant drinking water threats; and

viii) may require risk management measures for specific land uses and prescribed drinking water threat activities, in Wellhead Protection Areas A, B and C identified on Schedule 7.

2. The City's Wellhead Protection Areas, Intake Protection Zones and Issues Contributing Areas extend into the County of Wellington and the Region of Halton. The City will work co-operatively with the upper and lower tier municipalities within Wellington County and Halton Region to develop source protection policies to ensure the long-term protection of the water resources of all these municipalities.

3. The City may require that technical studies be prepared by a qualified professional to assess and mitigate the potential impacts of a proposed development application within the City's wellhead protection areas as part of a complete application. These studies may include but are not limited to a Disclosure Report, detailed Hydrogeological Study and a Spill Prevention and Contingency Plan.

4. Interim Risk Management Plans may be required to reduce the risk of significant drinking water threat activities identified through the Assessment Reports or by other means."

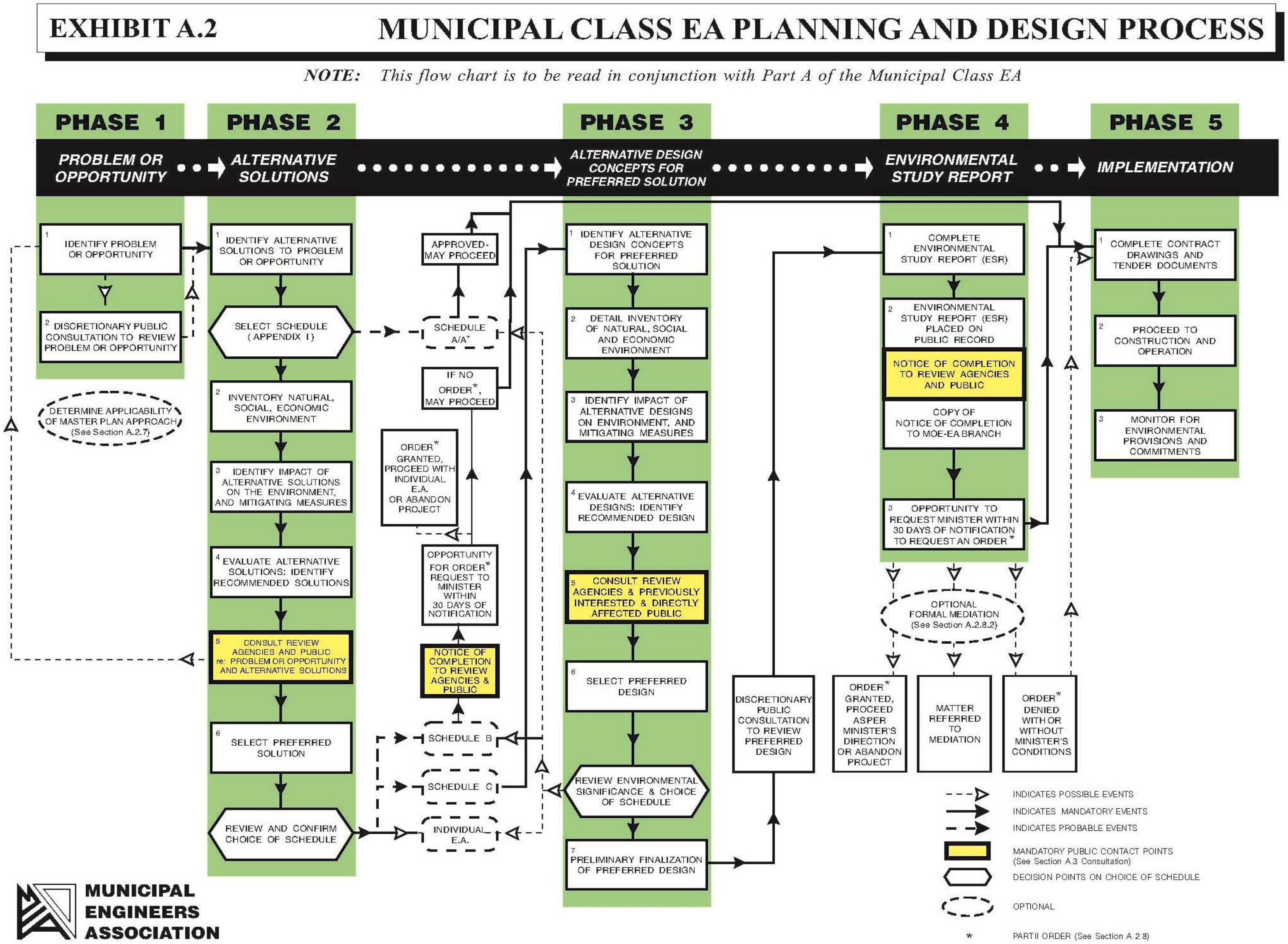
As defined by the Source Protection Program based on the location of the Wellhead Protection Areas (WHPA), Wellington County has responsibilities under Ontario's Clean Water Act to protect drinking water sources in the County. In addition to the City's policies, the Wellington County Official Plan contains some protection measures for the City's wells located in Puslinch and Guelph/Eramosa Townships. The Arkell Spring Grounds is designated as a protection area with specific development constraints. The City is circulated by the County on all development proposals that are in close proximity to the Arkell Spring Grounds. Each application is reviewed for any potential risk posed to the City's water resource.

1.2 Environmental Assessment Master Planning Process

Master Plans are long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. These plans examine an infrastructure system, or group of related projects, to outline a framework for planning for subsequent projects and/or developments. As a minimum, Master Plans should address Phases 1 and 2 of the Municipal Class EA process to the extent possible (**Figure 1-1**). Master planning provides a municipality with a broad framework through which the need and justification for specific projects can be established such that the environmental assessment process can be satisfied. Key features of a Master Plan include:

- Addressing the key principles of successful environmental planning.
- Addressing at least the first two phases of the Municipal Class EA to the extent possible.
- Allowing for an integrated process with other planning initiatives.
- Providing a strategic level assessment of various options to better address overall system needs and potential impacts and mitigation.
- Long term planning.
- Taking a system-wide approach to planning which relates infrastructure either geographically, or by function.
- Recommending an infrastructure master plan which can be implemented through separate projects.
- A description of specific projects.

Figure 1-1: Planning and Design Process for Municipal Class EA Projects



Source: (Municipal Engineers Association, 2011)

Examples of Master Plans include: wastewater and water servicing plans for entire or major portions of a municipality; wastewater treatment plans and water supply plans for a community or municipality; watershed plans; transportation master plans; stormwater management master plans and infrastructure master plans.

This Guelph WSMP Update document was prepared at the conclusion of Phases 1 and 2 of the Municipal Class EA process. The draft Master Plan document will be made available for public comment pending approval by City Council. The WSMP has been completed at a broad level of assessment, requiring more detailed investigations at the project-specific level to fulfill Municipal Class EA documentation requirements for any specific Schedule B or C projects, as applicable, identified within the Master Plan. The Master Plan will therefore become the basis for, and be used in support of, future investigations for any specific Schedule B and C projects identified within it. Schedule B projects will require filing of the Project file for public review while Schedule C projects will have to fulfill Phases 3 and 4 of the process prior to filing an Environmental Study Report (ESR) for public review.

The WSMP will continue to be reviewed approximately every five years to determine the need for a detailed formal review and/or updating. In general, potential changes which may trigger the need for a detailed review include:

- Major changes to original assumptions;
- Major changes to components of the Master Plan;
- Significant new environmental effects;
- Major changes in the proposed timing and/or scope of projects recommended within the Master Plan.

Specific to this update, it is critical to track the progress and success of the recommended projects identified herein, as changes to scope or timing has the potential to impact the City’s ability to provide water supply to meet projected demand.

1.2.1 Master Plan Approach

Key aspects of the WSMP Update approach are provided in **Table 1-1**.

Table 1-1: Master Plan Update Approach Overview

Task No.	Task Description
Task 1 – Public Consultation	■ WSMP Community Liaison Group (CLG) meetings (3) ■ Municipality / Agency workshops (2) ■ Community Open Houses (2) ■ Water Conservation and Efficiency Public Advisory Committee meetings (2) ■ Master Plan briefings for First Nation Communities (2) ■ Presentations to Township Councils (2)
Task 2 – Population and Water Demand Forecasts	■ Develop population projections – residential and Industrial/Commercial/Institutional (included 2020 Places to Grow amendment to 2051) ■ Develop water demand projections
Task 3 – Existing Water Supply Capacity Assessment	■ Update the assessment of existing well/supply system performance, maximum system capacity and minimize potential constraints for each supply source ■ Compare existing capacity with demand forecast to identify future supply needs
Task 4 – Water Supply Alternatives	Review potential alternatives including: ■ Conservation, Efficiency and Demand Management programs (including water reuse) ■ Groundwater sources inside city ■ Groundwater sources outside city ■ Local surface water supply ■ Limit growth/Do nothing
Task 5 – WSMP Update	■ Evaluate alternatives ■ Develop Implementation Strategy ■ Complete WSMP Update report

This report documents outcomes of each of the above tasks, commencing with development of the Master Plan Challenge and Opportunity Statement.

1.2.2 Challenge and Opportunity Statement

Phase 1 of the Class EA planning process requires the proponent of an undertaking to first document factors leading to the conclusion that the improvement or change is needed, and ultimately, develop a clear statement of the identified problems, deficiencies, or opportunities to be investigated. As such, the Challenge and Opportunity Statement is the principle starting point in the undertaking of a Class EA study and becomes the central theme and integrating element of the project. It also assists in setting the scope of the project. A draft Challenge and Opportunity Statement for the City of Guelph WSMP Update was provided to the public for comment at the Community Liaison Group, Municipality and Agency workshop, and Community Open House in the winter of 2020. Suggestions provided by the public, agencies and municipalities were reviewed and incorporated in developing the final statement:

> *The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.*
>
> *The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.*
>
> *The proposed implementation strategy must deliver, through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.*

It is, therefore, necessary to carry out the WSMP Update to identify a strategy that will increase the capacity of the City's existing water system and provide additional security of supply. The strategy will ensure that an adequate amount of water can be provided in a safe, reliable and cost-effective manner to satisfy current and long-term municipal demand requirements. The study will have regard to innovative technologies, and established sustainability and environmental planning principles that properly consider potential impacts to sensitive land uses such as the natural environment and agriculture, both inside and outside of the current City municipal boundaries. Furthermore, the update will define and factor in the role of water conservation, efficiency and demand management measures which can extend the life of existing supply capacity and defer the need for future water supply capacity.

2. Study Area Profile

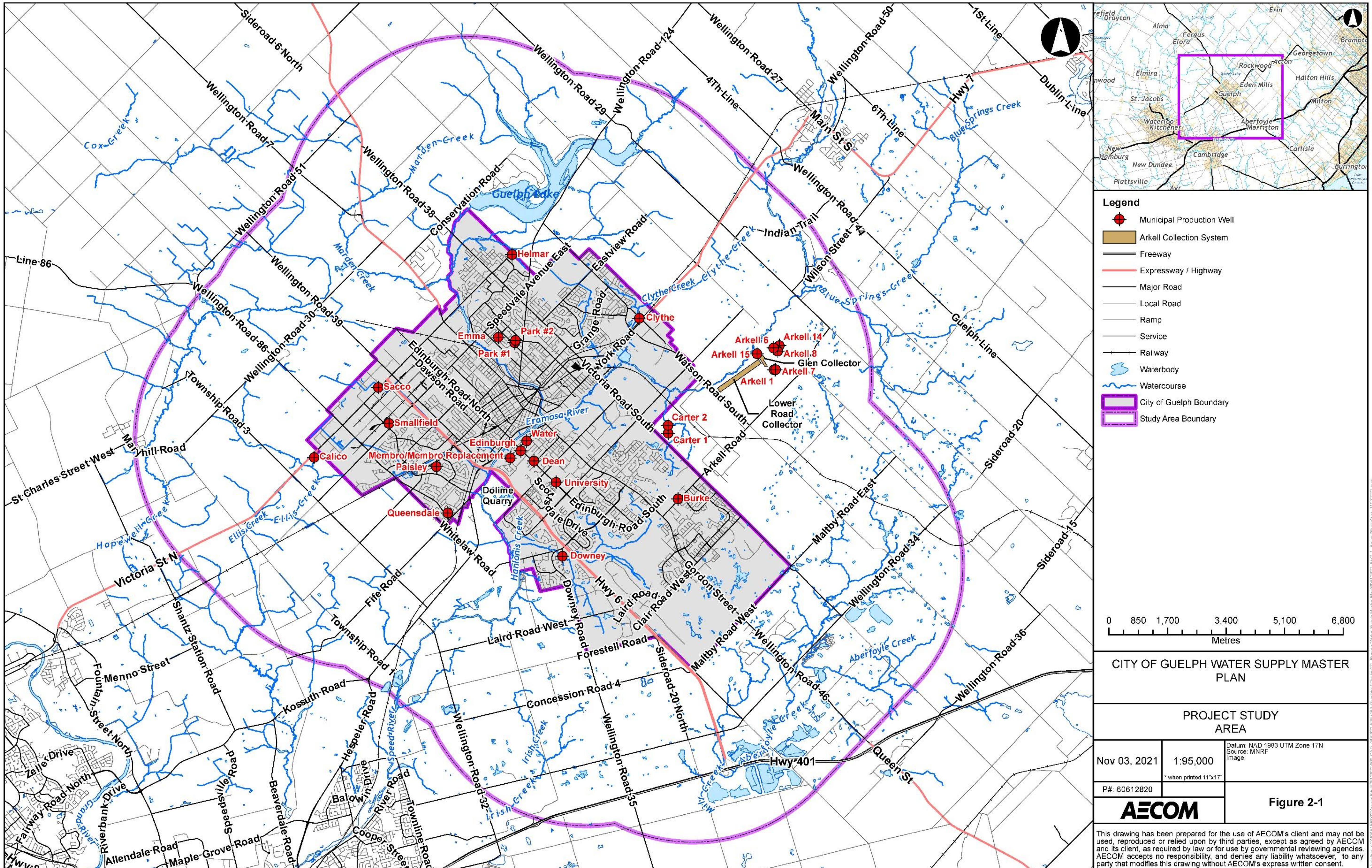
The source of Guelph's drinking water is a series of 21 operational groundwater wells and a shallow groundwater collector system located within the City and the surrounding Townships (Puslinch and Guelph/Eramosa). The water system is operated to meet daily, seasonal, and other operational demands with various combinations of supply sources in operation at any given time. The distribution system (including storage, watermains, valves, fire hydrants, water services, and meters) serves a population of approximately 131,794[4] within the City. The groundwater that supplies water to the City system is a shared resource that is utilized by the residents of Guelph, the surrounding County and Townships and the natural environment. Additional information about the existing water supply sources is provided in Section 4.

Background data were collected on existing regulatory, environmental, social and economic conditions in the study area[5] (**Figure 2-1**). These existing conditions were used to characterize the study area and provide a basis for assessment and evaluation purposes for future water supply alternatives. Reference is made to some of the evaluation criteria utilized in the assessment of alternatives, and a full description of the criteria is provided in Section 6. The conditions are described as follows:

- Consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation. The intent is to assess the potential effect of each alternative on Indigenous values, culture, and Traditional use.
- Current status of the regulatory environment in which alternatives must be developed to meet current and future water quality, Source Protection, and environmental requirements.
- The natural environments in those areas impacted by any or all of the water supply alternatives to be developed and evaluated.
- The current and proposed built environment recognizing potential impacts to land uses and landowners.
- The social/cultural issues to be taken into account based on those policies and/or that information available from the various areas impacted by any proposed water supply alternatives.

4. Statistics Canada, 2016 Census of Population.
5. The project study area includes the City of Guelph and the area within 5 kilometres of the City limits.

Figure 2-1: Project Study Area



- The economic and financial measures to be utilized for alternative assessment and evaluation purposes.
- The legal/jurisdictional issues to be addressed, specifically issues that are a result of a proposed alternative being located in a separate jurisdiction.
- The technical considerations to be taken into account for implementation and operation of water supply alternatives.

Details are outlined in the following sections.

2.1 Indigenous Peoples

At the outset of the project, MECP notified the Project Team of the Indigenous communities to contact regarding the WSMP Update and included Six Nations of the Grand River, Haudenosaunee Confederacy Chiefs Council and Mississaugas of the Credit First Nation. These contacts were provided with a formal letter, the Notice of Commencement and invitation to the first workshop with agencies and other municipalities, and the notice and invitation to the first community open house. Follow-up with the communities was conducted by the City in June 2020 to determine if there is any specific consultation format that is preferred in addition to the tools and activities utilized to date. In addition, the City conducted general communication and engagement with the Indigenous communities identified above with the intent to improve relationships with the communities and to share information with respect to the City's Municipal Comprehensive Review and updating of a number of the City Master Plans. These contacts resulted in meetings to discuss the City's general master planning processes and the WSMP Update in particular. To date, specific feedback on the water supply alternatives has not been received.

There are Indigenous Peoples — First Nations, Métis and Inuit Peoples living in Guelph who are working with the City and contributing to the development of the WSMP Update. These individuals do not formally represent a specific community in the WSMP process, rather, they contributed ideas and information to the Project Team that represents their culture and worldview with respect to water and its use.

Key themes shared with the Project Team that help guide the evaluation include:

- valuing and respecting the agency of water,
- understanding the spirit and personhood of water,
- good stewardship of the connected ecosystem including protection of water's pureness, and
- consideration of First Nations', Métis' and Inuit Peoples' culture and worldview in all aspects of the evaluation.

2.2 Regulatory Environment

The City of Guelph, like all municipalities in Ontario, must operate within the administrative, legislative and financial framework established by senior levels of government. The key provincial and federal initiatives that provide directives, and are considered under the master planning process, are provided below.

The ***Environmental Assessment Act (EAA),1990***, generally requires an environmental assessment of any major public or designated private undertaking in order to determine the ecological, cultural, economic and social impacts of the project. The Act established a "Class Environmental Assessment" (Class EA) process for planning certain municipal projects. Municipal projects that may be affected include municipal road, water, sewage and stormwater projects. For water projects, the purpose of the municipal class environmental assessment is to ensure that projects will be "undertaken to address problems affecting the operation and efficiency of existing water systems, to accommodate future growth of communities, or to address water source contamination problems".

The ***Environmental Bill of Rights (EBR), 1993***, led to the establishment of an Environmental Registry to notify the public of important environmental decisions and to solicit public comment. The EBR also established an independent Environmental Commissioner who oversees the province's environmental practices and consideration. Through the EBR, the public has the right to request reviews of inadequate laws, regulations, policies or instruments, and to comment on proposed legislation and regulations.

The ***Ontario Water Resources Act (OWRA), 1990***, is the statutory foundation of Ontario's water policy. It assigns to the Minister of the Environment and his or her delegates broad oversight of Ontario's waters, including powers to approve works and facilities, enter property and carry out inspections, make orders and enforce them. Regulations under the Act provide drinking water quality requirements, licensing of well drillers, Permits to Take Water (PTTW), sewage treatment plant obligations, duties to collect and report information, and a range of other matters. To protect sustainable water supplies, the Province of Ontario has a program to manage water takings through the OWRA and the Water Taking and Transfer Regulation (Ontario Regulation 387/04). Through the regulation, the MECP permits water taking and establishes limits on the total quantity of water for each permit, along with the duration of the permit. Water taking permits are issued for a maximum of up to 10 years. Under Section 34 of the OWRA, anyone taking more than 50,000 L of water in a day from a lake, stream, river or groundwater source, with some exceptions, must obtain a PTTW.

The ***Environmental Protection Act (EPA)***, ***1990,*** is the primary pollution control legislation in Ontario and can be used somewhat interchangeably with the Ontario Water Resources Act. The legislation prohibits discharge of any contaminants into the environment that cause or are likely to cause adverse effects. Amounts of approved contaminants must not exceed limits prescribed by the regulations.

The ***Lakes and Rivers Improvement Act (LRIA), 1990*** was introduced to protect the province's surface water resources. The Act regulates the public and private use of Ontario's lakes and rivers, including the construction, repair and use of dams.

A number of other important policies and pieces of legislation have also had an impact on water systems and their owners and operators since the Walkerton tragedy. These include:

- The ***Safe Drinking Water Act (SWDA), 2002,*** and its regulations impose a licensing/certification regime for drinking water providers. Through SDWA changes, water taking rules have been redrafted to protect water supplies. Reviews of PTTWs now have a greater emphasis on environmental considerations such as the potential for proposed taking to impact natural water flows, fish habitats, water levels and water budgets and on the inter-relation between groundwater and surface water. This is in addition to ensuring that conservation programs have been applied in the existing water taking and future water supply planning.

- The ***Sustainable Water and Sewage Systems Act (SWSSA), 2002,*** and its associated regulations require municipalities to develop full-cost recovery plans and set their water and wastewater rates accordingly. The cost recovery plans are to be based on asset management plans, as required by the SDWA and must be certified by a professional engineer.
- The ***Nutrient Management Act (NMA), 2002*** and its regulations require farm operators to develop nutrient management strategies as part of source water protection. The legislation, and source protection in general, has an impact on the quality of source water for municipal drinking water, and therefore on their costs to treat it. As part of Ontario's Clean Water Strategy, this Act was designed to reduce the potential for water and environmental contamination from some agricultural practices. The Nutrient Management Act also provides standards for nutrient storage and how nutrients are applied to farmland, in order to reduce the likelihood of ground or surface water contamination.
- The ***Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement (December 2005).*** The Great Lakes Charter Annex agreements are intended to implement the 2001 Great Lakes Charter Annex, in which Ontario, Quebec and the eight Great Lakes States (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin) committed to protect and manage the waters of the Great Lakes and the St. Lawrence River Basin through agreements that set a common standard decision basis for proposed water uses. Ontario has already passed strict laws banning water diversions. The province has also introduced tough rules for water taking and stronger conservation measures. Through the Charter Annex agreements, the province will continue its ban of water diversions and will further advance its programs to protect Ontario water resources. The Great Lakes Agreement will restrict the development of Great Lake water supply systems and imposes conditions on how and when the Great Lakes may be used as a source.

- The ***Safeguarding and Sustaining Ontario's Water Act, 2007*** is intended to amend the Ontario Water Resources Act to safeguard and sustain Ontario's water, to make related amendments to the Safe Drinking Water Act, 2002 and to repeal the Water Transfer Control Act.
- The ***Clean Water Act (CWA), 2007*** is intended to ensure communities are able to protect their municipal drinking water supplies, as well as non-municipal supplies where added by municipalities or the Minister, now and in the future from overuse and contamination, through locally developed science-based source protection plans. The Act substantially implements the drinking water source protection recommendations made by Justice Dennis O'Connor in Part II of the Walkerton Inquiry Report. Municipalities are primarily responsible for the implementation and enforcement of the Source Protection Plan using existing powers, including those under the Planning Act and Municipal Act, as well as the CWA.

  The Source Protection Plan is a document that sets out the policies to protect sources of drinking water against threats identified in an Assessment Report. The Plan sets out how drinking water threats will be reduced, eliminated or monitored, who is responsible for taking action, timelines, and how progress will be measured. Implementation of the Source Protection Plan, once it has been approved by the Minister of the Environment, will be led by municipalities in most cases. In some cases, conservation authorities, public health units, or other organizations may be involved in implementing Source Protection Plans. The implementers will be able to use a range of programs and tools, including instruments or mechanisms such as zoning by-laws, and amendments to the Official Plans, or voluntary initiatives, if appropriate. Actions will be mandatory for significant risks. Risk management plans may be required for some activities and land uses within designated municipal wellhead protection areas deemed to be significant threats, in order to reduce their risk to the municipal drinking water source.

  The Source Protection Committee will identify the potential risks to local water sources to reduce or eliminate these risks. The overall objective of the Lake Erie Region Source Protection Committee, in partnership with local communities and the Ontario government, is to protect the quality and quantity of present and future sources of municipal drinking water in the Lake Erie Source Protection Region. The City of Guelph together with surrounding municipalities and the Grand River Conservation Authority participated on this committee in development of the Source Protection Plan in order to:

- propose policies that are environmentally protective, effective, economical, and fair to local communities;
- develop policies that are practical and implementable, and that focus limited resources on areas that net the greatest benefit, while recognizing that the plan must address significant threats so that they cease to exist;
- develop policies and programs that provide a benefit to broader protection of water quality and quantity; and
- assess drinking water threats and issues based on the best available science, and where there is uncertainty, to follow a precautionary approach.

Guelph-specific Source Water Protection policies for water quality were presented and endorsed by the City Council on February 4, 2013. These policies were rolled up into the Grand River Source Protection Plan which forms part of the Lake Erie Region Source Protection Plan. The Lake Erie Region Source Protection Plan has been approved and the most recent update came into effect February 3, 2021. The MECP developed a list of prescribed drinking water threats. A significant drinking water threat requires action to reduce the risk of impact to drinking water sources. Significant drinking water quality threats were identified in the Grand River Assessment Report, and the Grand River Source Protection Plan was then prepared to address those threats through a variety of municipal policies. The Guelph-specific policies in the submitted Plan address 19 of the 21 prescribed drinking water threats, specifically those related to water quality threats. The two remaining threats are water quantity threats and the City is currently working on updates to the plan to address the potential water quantity impacts identified through the Tier Three Water Budget Study.

- The ***Water Opportunities and Conservation Act, 2010*** is to foster innovative water, wastewater and stormwater technologies, services and practices in the private and public sectors; to create opportunities for economic development and clean-technology jobs in Ontario; and to conserve and sustain water resources for present and future generations.
- The ***Canadian Environmental Assessment Act, 2012*** requires municipal groundwater takings that qualify as a "designated project" based on the project descriptions listed in the Regulations Designating Physical Activities to undergo a federal environmental assessment process if the Canadian Environmental Assessment Agency (CEAA) determines that a federal environmental assessment (EA) is required. There are limited circumstances that would trigger such a requirement. The City could be subject to the Act and required to undertake a federal environmental assessment for new groundwater wells that would result in a taking in excess of 200,000 m^3/year or an expansion of a groundwater extraction well/facility that would increase production capacity by more than 35% (groundwater taking). There is a decision making step that requires the further review of a project by CEAA to determine if it will be required to undergo a federal EA. A proponent is required to submit a project description for a designated project to CEAA that includes mandatory information about the project and potential environmental impacts as set out under the Prescribed Information for the Description of a Designated Project Regulations. This consists of a general description of the project and a description of the potential environmental effects relating only to areas of federal jurisdiction: With this information, CEAA will then conduct a screening to determine whether an environmental assessment of the designated project will be required. If a federal EA is required, the process would require similar scope, time and resources to complete to a provincial individual environmental assessment under Part II of the Environmental Assessment Act (Ontario).
- The Province of Ontario ***A Place to Grow: Growth Plan for the Greater Golden* Horseshoe, 2020*;*** places priority on intensification of existing developed areas over greenfield development. The City of Guelph is located within the jurisdiction of

the Growth Plan in the "Outer Ring" of the western region of the Greater Golden Horseshoe (G.G.H.). The Growth Plan is intended to "support economic prosperity, protect the environment, and help communities achieve a high quality of life." The August 2020 office consolidation extends and updates population and employment projections to 2051. All municipalities within the Growth Plan area were required to bring their official plans in conformity with the amendment by July 1, 2022. Schedule 3 of the August 2020 Growth Plan forecasts Guelph's population and employment base to reach 203,000 and 116,000, respectively by 2051.

2.3 Natural Environment

2.3.1 Natural Heritage Systems

This section presents the natural heritage features such as wetlands, watercourses, fisheries, Species at Risk, and Areas of Natural and Scientific Interest within the study area. Due the conceptual nature of this WSMP Update, existing information was referenced to determine the location of natural heritage areas generally present within the study area rather than associated with a specific site. The following documents were reviewed:

Official Plans

- City of Guelph Official Plan
- Wellington County Official Plan

Other Documents

- City of Guelph Natural Heritage Strategy
- Grand River Conservation Authority website
- Soil Survey of Wellington County
- Ontario Reptile and Amphibian Atlas
- Ontario Butterfly Atlas
- Department of Fisheries and Oceans Species at Risk Mapping
- Ministry of Natural Resources and Forestry, Natural Heritage Information Centre website

- Wellington County website Interactive Mapping Tool
- Atlas of the Breeding Birds of Ontario
- Mammals of Ontario
- iNaturalist Online

The study area (**Figure 2-1**) consists of the City of Guelph and its immediate neighbouring municipalities within Wellington County (Puslinch Township, and Guelph/Eramosa Township) in which existing and proposed water supply alternatives may be considered.

The following provides a general description of the natural environment within the study area. Each individual Class EA for the identified water supply alternatives will include a more detailed review utilizing Wetland Evaluations, Environmental Significant Area Reports and Fisheries Information. Further details along with the referenced extracts from Official Plan documents can be found in **Appendix A**.

City of Guelph

As noted in the Natural Heritage Strategy, with a total coverage of approximately 22%, the City of Guelph contains a fairly diverse natural heritage system comprised primarily of wetland complexes, woodlands and ravines associated with the City's river systems (City of Guelph, 2018). The City of Guelph includes the following natural heritage features:

- Five Subwatershed/Watershed Areas:
    1. Schneider Creek-Grand River;
    2. Ellis Creek-Speed River;
    3. Eramosa River;
    4. Guelph Line-Speed River; and
    5. Mill Creek-Grand River.
- Three Areas of Natural and Scientific Interest (ANSIs):
    1. Paris Moraine Provincial Earth Science;
    2. Guelph Correctional Centre Quarry Provincial Earth Science; and
    3. Guelph Interstadial Site Regional Earth Science.

- Ten Provincially Significant Wetlands (PSWs) Complexes (partially or entirely within the Study Area):
  1. Clythe Creek Wetland Complex;
  2. Ellis Creek Wetland Complex;
  3. Eramosa River Blue Springs Creek Wetland Complex;
  4. Guelph Northeast Wetland Complex;
  5. Halls Pond Wetland Complex;
  6. Hanlon Creek Swamp;
  7. Marden South Wetland Complex;
  8. Mill Creek Puslinch Wetland Complex
  9. Speed River Wetland Complex; and
  10. Torrance Creek Swamp.
- One Locally Significant Wetland (LSW):
  1. Guelph Southwest Wetland Complex.
- The Speed, Eramosa, Hanlon, Torrance, Clythe and Ellis River Systems;
- Several Locally Significant Woodland Areas (i.e., of 1 hectare or greater); and
- Large areas of what are currently identified as ecological corridors, buffers and linkages (i.e., 'Other Natural Heritage Features' in the Official Plan, March 2018 consolidation).

Within and surrounding the City, a total of 46 species listed as Endangered, Threatened or Special Concern (referred to as Species at Risk [SAR]) under the Endangered Species Act, 2007 (ESA) have been recorded. Species that have been observed more recently in the last 20 years within the City of Guelph include: Least Bittern (*Ixobrychus exilis*), Prothonotary Warbler (*Protonotaria* citrea), Butternut (*Juglans cinera*), Blanding's Turtle (*Emydoidea blandingii*) and Redside Dace (*Clinostomus elongatus*).

As stated in the City of Guelph's Official Plan, the protection and enhancement (where appropriate) of natural heritage features and their associated ecological functions is required. Natural heritage features are defined as areas containing significant wetlands and other wetlands, significant habitats of endangered and threatened species, significant ANSIs, surface water features and fish habitat, significant woodlands, significant landform, significant valleylands, ecological linkages and significant wildlife habitat, restoration areas, habitat of significant species and cultural woodlands.

A copy of Schedule 4 "Natural Heritage Features and Development Constraints", from the City Guelph's Official Plan as well a copy of Schedule 2 "Land Use Plan" is provided in **Appendix A**.

Wellington County

The topography and geology of Wellington County on a whole is made up of elongated hills, known as drumlins. These occupy much of the southern and northern parts of Wellington County, while the central part consists of undulating moraine. In general, the land slopes from east to west and from north to south. Some of the drainage features include the Grand, Speed and Eramosa Rivers, the Grand being the most prominent. Guelph Lake, a result of the construction of Guelph Lake Dam in 1974, is located north of the City.

Loam textured till materials predominate in the northern and southern ends of the County. The till plains in these areas are drumlinized and contain many low broad oval hills with smooth slopes that are characteristic of drumlins.

A total of 46 SAR are known to occur within Wellington County. In addition to this, one species that has been designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada but has no status in Ontario is also known to occur within Wellington County.

Natural heritage features are located throughout the County and include PSWs, LSWs, unevaluated wetlands, ANSIs and woodlands.

A copy of Appendix 1 "South Wellington Watershed Study Areas" and Appendix 3 "Provincially Significant Wetlands" is provided in **Appendix A**.

2.4 Social/Cultural and Built Environment

The Social/Cultural and Built environments are considered in the evaluation of water supply alternatives referencing the following considerations.

2.4.1 Municipal Growth Targets

The City of Guelph forms part of one of the fastest growing regions in the Province of Ontario, and has experienced considerable growth during the last decade. Defining growth, where it will occur and to what extent, will have a significant impact on the WSMP.

The Province's Places to Grow Plan designated Guelph as an Urban Growth Centre, and prescribed population and employment projections, and intensification and Greenfield density targets for Guelph/ Wellington County and 24 other Greater Golden Horseshoe municipalities (see Section 2.3 and Province of Ontario ***A Place to Grow: Growth Plan for the Greater Golden*** **Horseshoe, 2020)**. The Guelph Growth Management Strategy was a detailed strategy to implement the City's vision to encompass Growth Management Policies consistent with the Provincial Places to Grow requirements to be incorporated into the City's Official Plan. This strategy included completing background research, including several significant studies examining environmental, social/cultural and economic parameters of growth. The City has also completed several public engagement sessions with the Guelph community and on-going discussions with government partners, the surrounding municipalities around Guelph and the Provincial Government. The City Council received the final phase of the strategy, the implications of the growth plan, in 2009. The growth plan is being implemented through the recent City's Official Plan update, which includes a municipal comprehensive review. The update process must consider the growth plan targets to 2051 and be completed by July 1, 2022.

For the evaluation of alternative solutions, the ability to meet municipal growth management targets was considered in a broad sense (i.e., ability to supply water to meet planned growth).

2.4.2 Land Use

Land use impacts relate to potential positive and negative impacts as part of the implementation of alternative solutions. These impacts include consideration of potential effects from construction and operations on residents, businesses, agricultural, cultural/heritage (i.e., archaeological) and/or tourist and recreational resources. The evaluation in turn may also include short- and long-term impacts to groundwater and surface water users as well as individual residents and surrounding communities.

The Source Protection Plan is a document that sets out the policies to protect sources of drinking water against threats identified in the Assessment Report. The Plan includes how drinking water threats will be reduced, eliminated or monitored, who is responsible for taking action, timelines, and how progress will be measured. Implementation of the policies includes a range of programs and tools, including instruments or mechanisms such as zoning by-laws, and amendments to the Official Plans, or voluntary initiatives, if appropriate. Actions will be mandatory for significant risks. Risk management plans are required for some activities and land uses within designated municipal wellhead protection areas deemed to be significant threats, in order to reduce their risk to the municipal drinking water source. The potential land use constraints associated with the expansion of existing and/or delineation of new WHPA/WHPA-Q for the water supply alternatives were included in the evaluation of these alternatives.

The Planning Act requires municipalities to prepare an Official Plan which defines local land use. An Official Plan is a document, adopted by the Council of the municipality and approved by the Ministry of Municipal Affairs and Housing (MMAH) or their delegate under Section 17 of the Planning Act. As such, an Official Plan, once approved by the Minister, is a legal document that requires compliance for municipal land use activities and initiatives. Municipalities use Official Plans to guide land use decisions based on land use designations and policies. The Planning Act also requires that each municipality periodically (every five years) review its Official Plan to ensure that it is up to date, reflects community needs and values, and conforms to the current legislative environment and policies.

2.4.3 Education Programs

Various alternative solutions can provide the opportunity to be combined with water conservation, efficiency and management initiatives that have a positive impact on servicing approved growth and managing natural resources. The nature of (e.g., partnerships) and the degree to which an alternative provides educational opportunities were considered.

2.5 Economic/Financial Considerations

Economic/financial impacts are also a consideration to be taken into account when evaluating various water supply alternatives. Estimated capital costs were determined based on current tender and/or material cost information for relative comparison amongst the various water supply alternatives. The cost comparisons were done on a total estimated capital cost and cost per cubic-metre-per-day capacity basis.

Operating and maintenance costs were also estimated to develop life cycle costs for each proposed water supply alternative, for relative comparison between alternatives. Overall, economic/financial considerations were just one of a number of criteria that were assessed for overall preferred alternative identification purposes.

2.6 Legal Jurisdiction

Legal jurisdictional issues were also considered given the potential effects that groundwater taking or other water alternatives may have on areas outside the current City boundaries. As such, alternatives were assessed with respect to implementation outside the City boundary, and the added complexity and approvals that may be required, and the potential to share control and resources if implemented. In this context each alternative was assessed in terms of location inside or outside of City boundaries, relative land and/or easement requirements, right-of-way needs, etc. and related costs, where possible. With respect to Source Water Protection implications, potential effects on agricultural operations and other land uses were also considered for water supply alternatives outside of the City.

2.7 Technical

Technical considerations included the capability of each alternative to meet the water supply requirements from a technical feasibility perspective. These factors range from the reliability and history of a specific technology, to constructability, (e.g., ease of implementation, capability of expansion, flexibility in operation, etc.). Therefore, the criteria included within this category include:

- The ability to implement an alternative. This criterion could be impacted by ease of approvals, and the need to satisfy regulatory requirements, and the need for modifications to existing facilities to accommodate the alternative;
- Maintaining operation during construction and considering impacts to existing infrastructure (e.g., existing wells, the aqueduct, etc.), and maintaining service to City residents and businesses;
- Minimizing disruptions/downtime by taking into consideration required changes to existing infrastructure to implement;
- Constructability to reflect ease of construction, and impacts to operations;
- Scheduling and timing to confirm whether an alternative can be brought online in a timely manner to meet possible demand;
- Water quality and related requirements for treatment. The treatment requirement for each alternative varies depending on the source. Within the groundwater sources, there are some wells with better water quality than others. Surface water generally requires the greatest degree of treatment;
- Allowances for future treatment needs. With increasingly stringent drinking water standards, any treatment process implemented will need to be flexible to accommodate future processes;
- Expandability and ability to increase the capacity of an alternative solution if additional source water is available; and
- The ability of an alternative to use existing infrastructure. This criterion reflects the opportunity to reuse existing buildings, distribution systems and storage. It also infers how well an alternative could be integrated to complement other alternatives.

3. Population and Water Supply Demand Projections

This section presents the population projection and future water supply requirements (demand projections or an estimate of the volume of water that the City will need to provide customers in the future) used for this Water Supply Master Plan Update.

3.1 Population Projections

3.1.1 Historical Population Data

Historical serviced population and employment (job) rates within the City between 2010 and 2019 (inclusive), are presented in **Table 3-1**. The serviced population consists of households to which the City's Water Services Department provides treated water (i.e., connected to the municipal distribution system).

Table 3-1: Historical Population and Employment Rates

Year	Population	Employment
2010	125,332	74,200
2011	127,305	75,000
2012	128,599	76,000
2013	130,669	77,000
2014	133,231	78,000
2015	134,654	79,000
2016	136,325	79,600
2017	138,375	80,500
2018	140,015	81,150
2019	141,963	82,250

3.1.2 Population Growth Targets

Two future population and employment growth scenarios were considered when developing the demand forecasts for the WSMP Update, including:

1. The "reference" growth scenario, which reflects *expected* population and employment growth rates based on the Province of Ontario's August 28th, 2020 report **A Place to Grow Growth**

Plan for the Greater Golden Horseshoe (P2G), Schedule 3, Distribution of Population and Employment for the Greater Golden Horseshoe, i.e., a 2051 residential population and employment population in the City of 203,000 and 116,000, respectively.

2. The "low" growth scenario, which reflects slightly lower population and employment growth rates based on Hemson Consulting Ltd.'s August 26th, 2020 technical report **Greater Golden Horseshoe: Growth Forecasts to 2051**, i.e., a 2051 residential population and employment population of 198,000 and 115,000, respectively.

Ultimately the province limited the growth targets in the final P2G report to the "reference" growth scenario. In addition, the initial analysis of potential additional water supplies indicated that the availability of sufficient water supply was not anticipated to limit the "reference" growth scenario. As such, the "low" target is not discussed further herein.

3.1.2.1 Reference Population Growth Scenario

Table 3-2 presents projected "reference" residential population and employment population rates between 2020 and 2051, based on the 2051 P2G values of 203,000 and 116,000, respectively and an assumed linear growth rate between 2019 and 2051.

The COVID-19 pandemic occurred during the WSMP Update project and has introduced uncertainty in terms of anticipated growth rates from year to year within the planning period. The necessary data required to assess the impact, if any, was not available during the project but will be incorporated into subsequent master plan updates.

Table 3-2: Projected "Reference" Growth Population and Employment Rates

Year	Population	Employment
2020	143,870	83,305
2021	145,777	84,359
2022	147,685	85,414
2023	149,592	86,469
2024	151,500	87,523
2025	153,407	88,578
2026	155,314	89,633

Year	Population	Employment
2027	157,222	90,688
2028	159,129	91,742
2029	161,037	92,797
2030	162,944	93,852
2031	164,852	94,906
2032	166,759	95,961
2033	168,666	97,016
2034	170,574	98,070
2035	172,481	99,125
2036	174,389	100,180
2037	176,296	101,234
2038	178,204	102,289
2049	180,111	103,344
2040	182,018	104,398
2041	183,926	105,453
2042	185,833	106,508
2043	187,741	107,563
2044	189,648	108,617
2045	191,555	109,672
2046	193,463	110,727
2047	195,370	111,781
2048	197,278	112,836
2049	199,185	113,891
2050	201,093	114,945
2051	203,000	116,000

3.2 Water Production Rates and Demand Projections

3.2.1 Basis for Projections

The projections for future water supply requirements were developed by evaluating recent customer water demands within the City, evaluating how these demands may change in the future, and applying the resulting daily demand estimates to the population forecast discussed in the previous section.

3.2.1.1 Historical Water Production Rates and Demand Data

Table 3-3 presents average annual day (AAD) water production rates in the City for the years 2010 to 2019 inclusive. AAD water production is the total volume of water produced by the City each year divided by 365 days. This represents the average daily volume of water produced by the City for each year in this period of time.

Table 3-3: Historical AAD Water Production Rates, m^3/day

Water Production	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
m^3/day	48,519	47,627	45,267	44,443	45,742	46,873	46,285	46,360	47,449	47,015

Table 3-4 presents the AAD water demand of residential and industrial/ commercial/ institutional (ICI) customers in the City for the years 2010 to 2019 inclusive. AAD water demand is the total volume of water distributed to the noted customers divided by 365 days. These values are determined through a review of City billing records and represent a lower volume of water than the total amount produced or pumped (**Table 3-3**). This occurs because the City does not bill for certain types of water use, some water may not pass through a water meter (water used for fire fighting, watermain flushing, etc.), some unauthorized water use may occur, and some water is lost through system leakage. The water within this category is called non-revenue water[6] (NRW).

Table 3-4: Historical AAD Water Demands Based on Customer Type, m^3/day

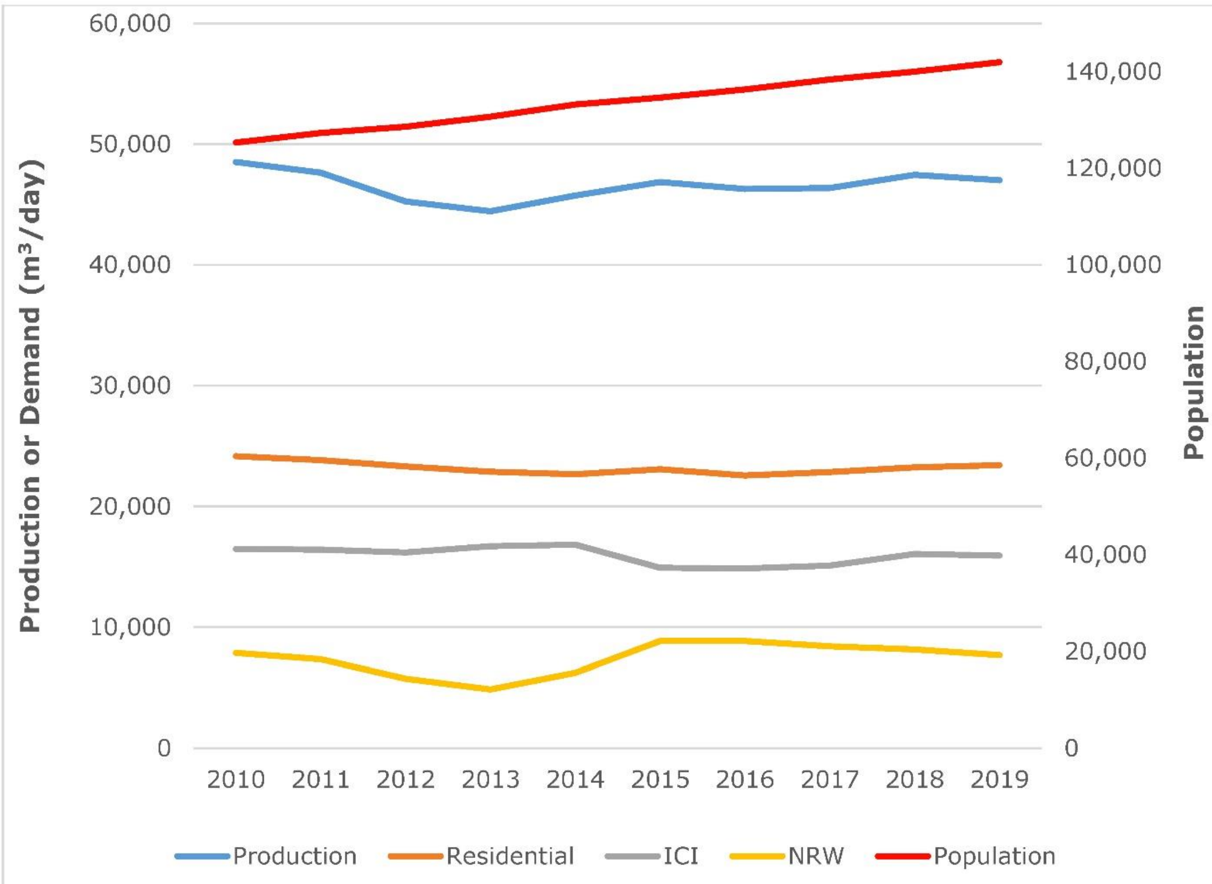
Customer Type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Residential	24,160	23,843	23,324	22,875	22,655	23,084	22,564	22,843	23,233	23,408
ICI	16,482	16,425	16,186	16,700	16,835	14,930	14,862	15,104	16,069	15,924
Total	**40,642**	**40,267**	**39,510**	**39,575**	**39,489**	**38,014**	**37,426**	**37,947**	**39,302**	**39,333**

Figure 3-1 illustrates historical AAD water production rates, AAD water demand rates (by customer type), NRW rates (i.e., total production (**Table 3-3**) minus total demand (**Table 3-4**)), and population values for the City between 2010-2019 inclusive. In this figure, the population values are displayed on the right-hand y-axis and the water production rates on displayed on the left-hand axis. The residential, ICI and NRW demands sum to the total production value, plotted using a blue line.

6. Non-revenue water is water produced by the City that does not generate revenue.

An assessment of this figure indicates that the water production, demand, and NRW rates in **Figure 3-1** remained relatively flat during this period even though the City's population increased from 125,332 to 141,963 (an increase of 13.3%).

Figure 3-1: AAD Production, Demand, NRW & Population



The annual changes in production and demand rates between 2010 and 2019 can be further assessed by converting the AAD water production and demand rates into average daily volume per capita[7] and per employee rates. In **Figure 3-2**, daily water production rates, residential demand rates, and NRW rates have been divided by the City's residential population identified in **Table 3-1**, while the ICI demand rates have been divided by the City's employment population identified in **Table 3-1**. This results in a measurement called litres

7. Per capita is the volume of water used by each person or employee in the City.

per capita per day (Lcd), or the average number of litres of water used per day by each person or employee in the City for each year shown.

Figure 3-2: AAD Per Capita Water Production, Demand and NRW Rates

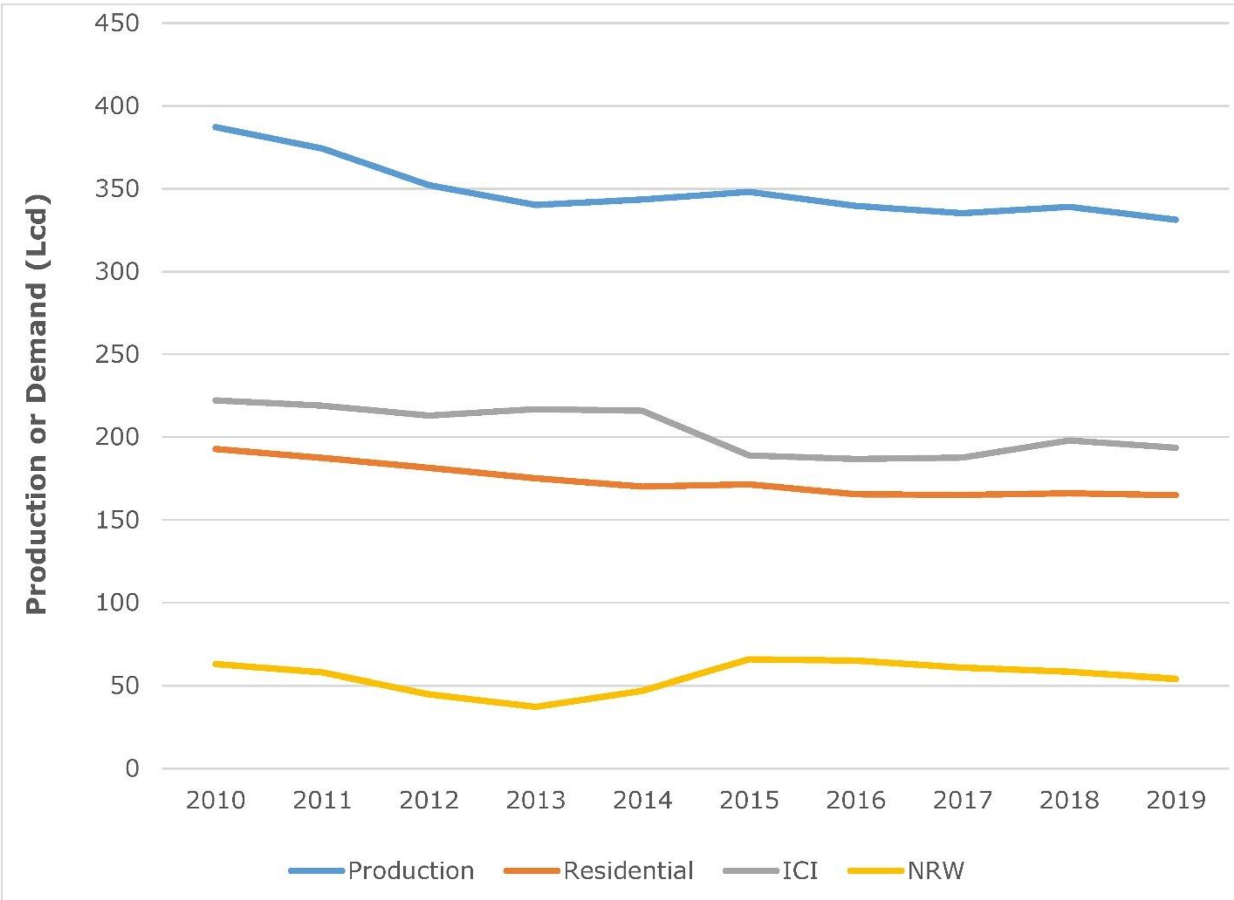
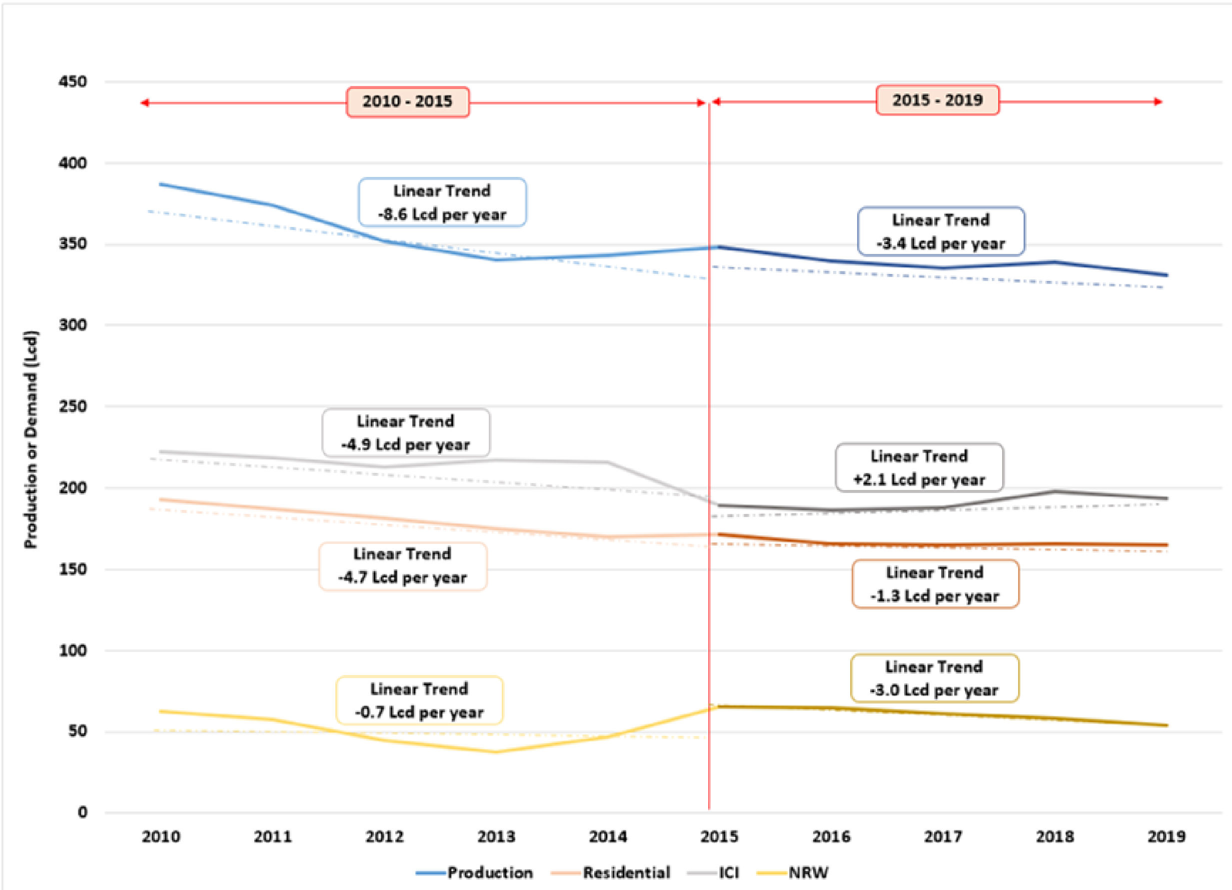


Figure 3-2 illustrates that there has been a decline in per capita water production and demand rates since 2010. **Figure 3-2** also illustrates that, while NRW rates have fluctuated between 2010 and 2019, the per capita NRW rates in 2019 are very similar to the rates in 2010.

While per capita water production and demand rates have declined since 2010, the rate of decline was lower between 2015 to 2019 than it was from 2010 to 2015. **Figure 3-3** illustrates the average annual decline in per capita demands (based on linear trends) for the periods 2010-2015 and 2015-2019.

Figure 3-3: Average Annual Per Capita Demand Rates: 2010 to 2015 vs. 2015 to 2019



The relative 'flatness' of the per capita water production rate and both the residential and employment water demand rates from 2015 to 2019 indicates that customer water demands may be beginning to stabilize after approximately two decades of significant decline. This observation suggests that future per capita customer water demand declines associated with conservation, efficiency and demand management programming and natural water savings may be more difficult to achieve moving forward. This trend is considered in the projection of future water supply demands and when setting targets for future conservation, efficiency and demand management programming.

3.2.2 Water Supply Projections to 2051

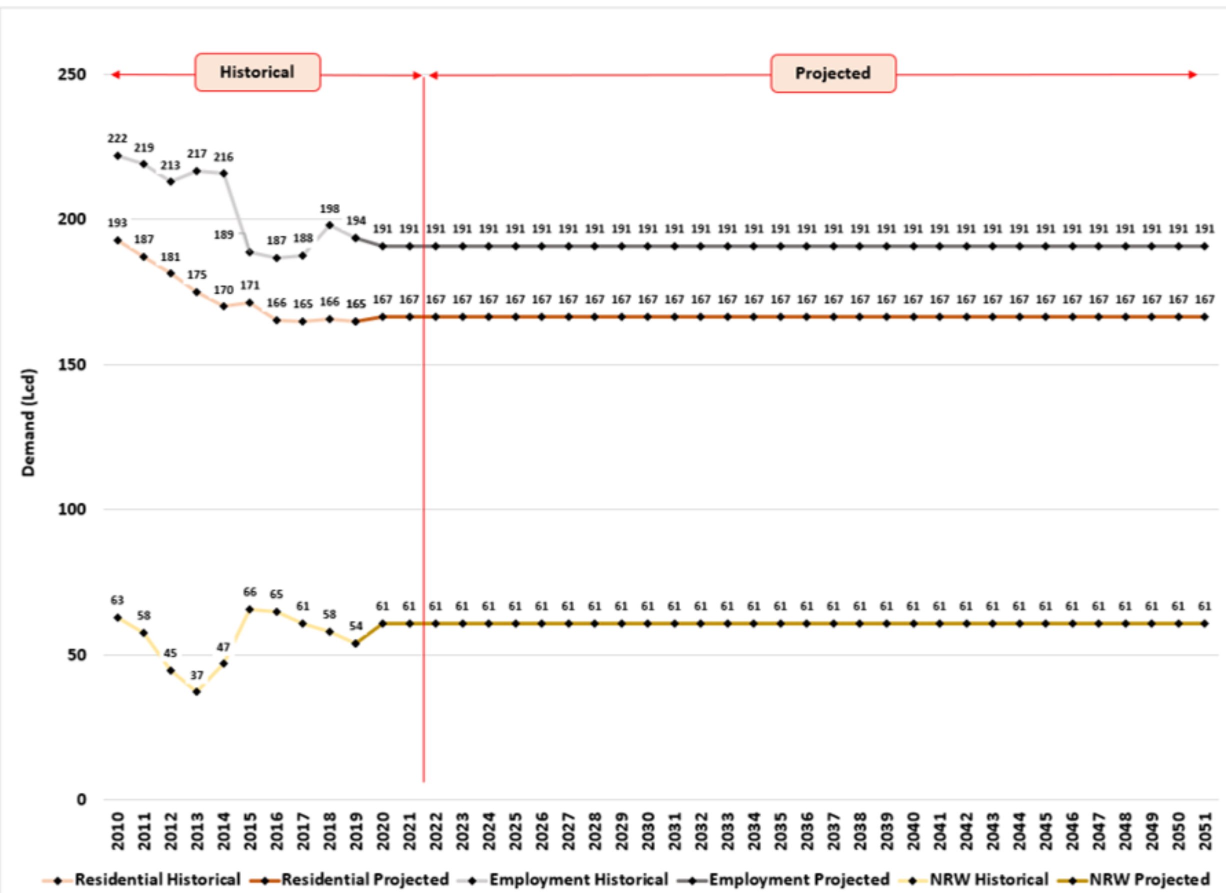
3.2.2.1 Per Capita Projections

To be conservative when projecting water demand rates to 2051, the average per capita residential, employment, and NRW demand rates between 2015 and 2019 have been applied to the years 2020 to 2051 as follows and as illustrated in **Figure 3-4**:

- Average per capita residential demand rate 2015-2019: 167 Lcd
- Average per capita employment demand rate 2015-2019: 191 Lcd
- Average per capita NRW demand rate 2015-2019: 61 Lcd

These projected demands assume that further reductions in Lcd customer demands will not occur.

Figure 3-4: Historical and Projected Per Capita Water Demand Rates



3.2.2.2 Reference Growth Water Demand Projections

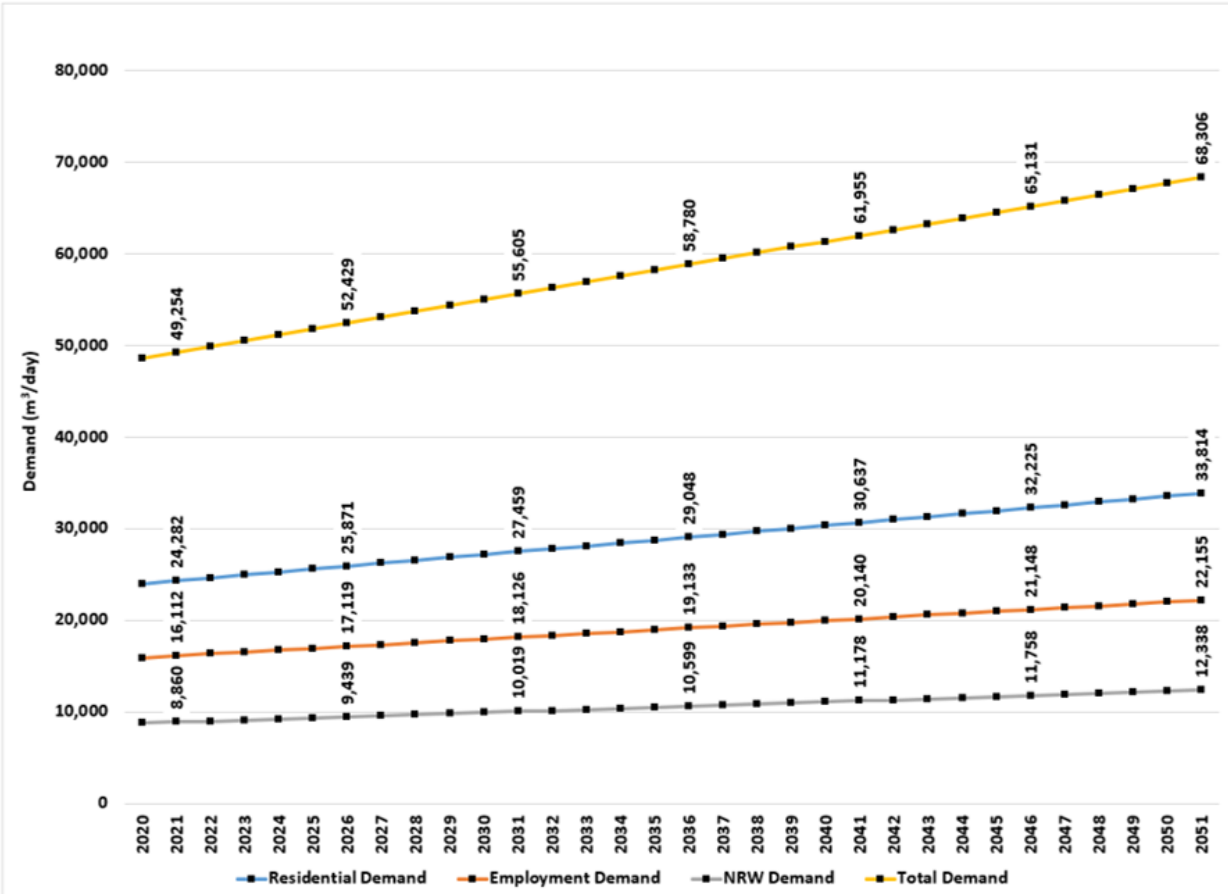
<u>Average Annual Day Projections</u>

The 2020 to 2051 per capita water demand values illustrated in **Figure 3-4**, along with the “reference” growth rate population and employment values in **Table 3-2**, were used to project AAD residential, employment, and NRW water demands until 2051 (**Table 3-5** and **Figure 3-5**). For clarity, the term production is used in this report to refer to historical records of City water supply production based on pumping records (i.e., total daily volume of water pumped by the City). The total demand projections presented here represent the estimated future total daily volume of water required on an average day and this total is comprised of the Residential, ICI and NRW demands.

Table 3-5: Projected Average Annual Day Water Demand – “Reference” Growth Scenario, m^3/day

Demand Type	2021	2026	2031	2036	2041	2046	2051
Residential	24,282	25,871	27,459	29,048	30,637	32,225	33,814
ICI	16,112	17,119	18,126	119,133	20,140	21,148	22,155
NRW	8,860	9,439	10,019	10,559	11,178	11,758	12,338
Total Demand	**49,254**	**52,429**	**55,605**	**58,780**	**61,955**	**65,131**	**68,306**

Figure 3-5: Projected Average Annual Day Water Demand – "Reference" Growth Scenario



Maximum Day Projections

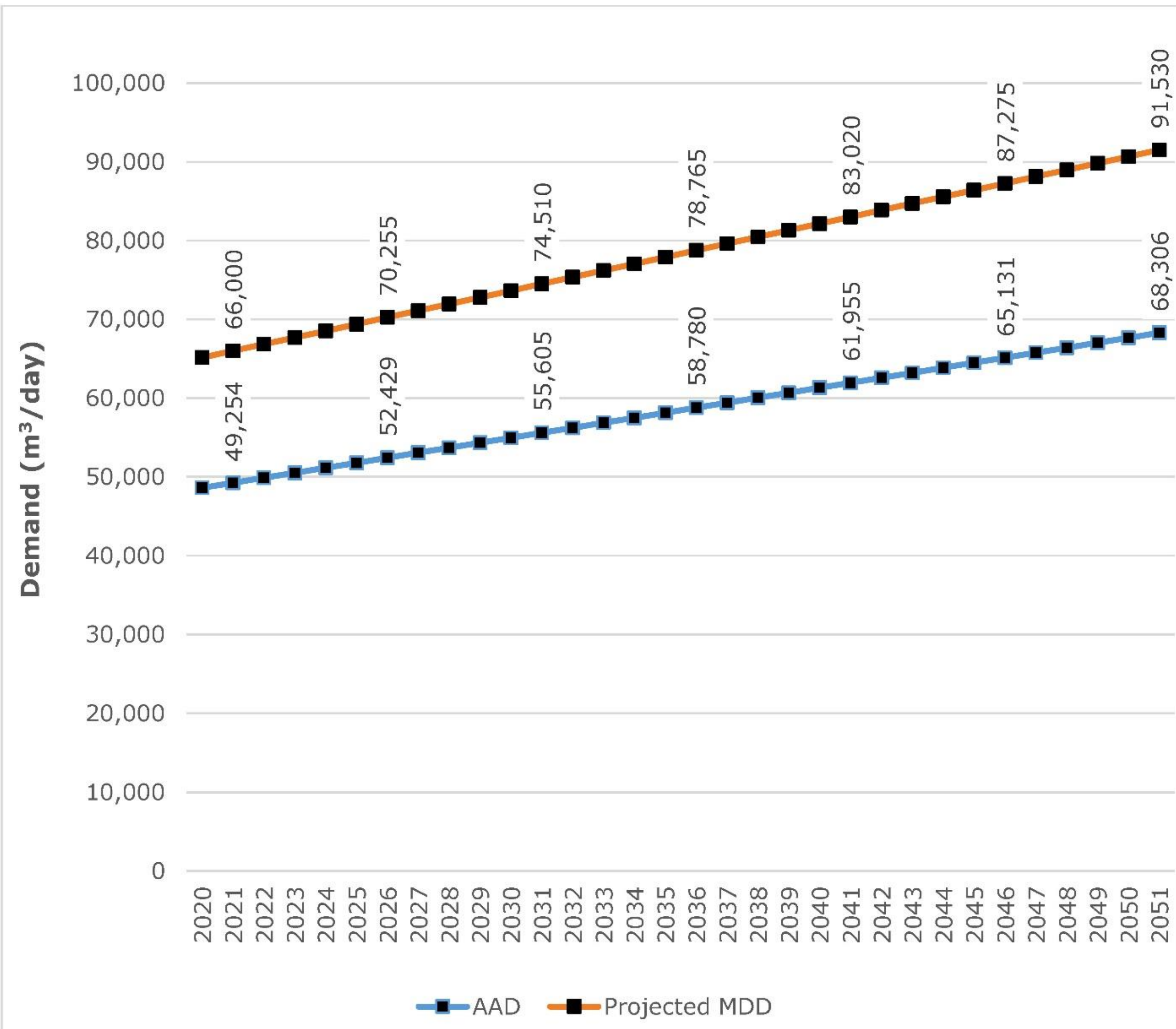
The Maximum Day Factor (MDF) for a water system is generally defined as the ratio between the water production rate on the highest single production day each year (maximum day) and the AAD production rate for the entire year, after removing extreme anomalous events. The average MDF in Guelph between 2010 and 2019 was 1.24 (i.e., the average maximum day production rate was 24% higher than the AAD production rate) and the highest ratio of 1.34 occurred in 2011.

To be conservative, a Maximum Day Factor of 1.34 was used when projecting future maximum day water demands in Guelph, i.e., the projected Average Annual Day demands identified in **Table 3-6** were multiplied by 1.34 (see **Table 3-6** and **Figure 3-6**).

Table 3-6: Total Projected Average Annual Day and Maximum Day Water Demands – Reference Growth Scenario

Parameter	2021	2026	2031	2036	2041	2046	2051
Average Annual Day Demand (m^3/day)	49,254	52,429	55,605	58,780	61,955	65,131	68,306
Maximum Day Demand using Maximum Day Factor of 1.34 (m^3/day)	66,000	70,255	74,510	78,765	83,020	87,275	91,530

Figure 3-6: Projected "Reference" Growth Average Annual Day and Maximum Day Demands



3.3 Water Demand Forecasts vs. Required Water Supply Capacity

In previous versions of the WSMP, the projected maximum day demand included the estimated residential and employment consumption and NRW, as well as a 'safety factor' to address risks to the water supply sources (i.e., groundwater aquifer, surface water lake or river), City facilities and/or distribution system. A similar assessment was completed for this WSMP Update and is presented in Section 4.2. Because the projected water demands provided in Section 3.2 do not include this safety factor, it is noted that the total future values will appear 10 to 15% lower than previous master plan projections. However, the additional facility capacity needed to address potential risks and to provide system redundancy is included in the study and is presented in Section 4.2.

For the purpose of evaluating the water supply deficit and planning for future water supply sources, the "reference" growth scenario presented above was utilized. Determination of the supply deficit is based on the projected maximum day demands as the system must be designed to meet this demand. Therefore, implementation of projects to develop the required water supply and construct the required infrastructure is planned to meet the maximum day requirements.

4. Existing Water Supply System Capacity Assessment

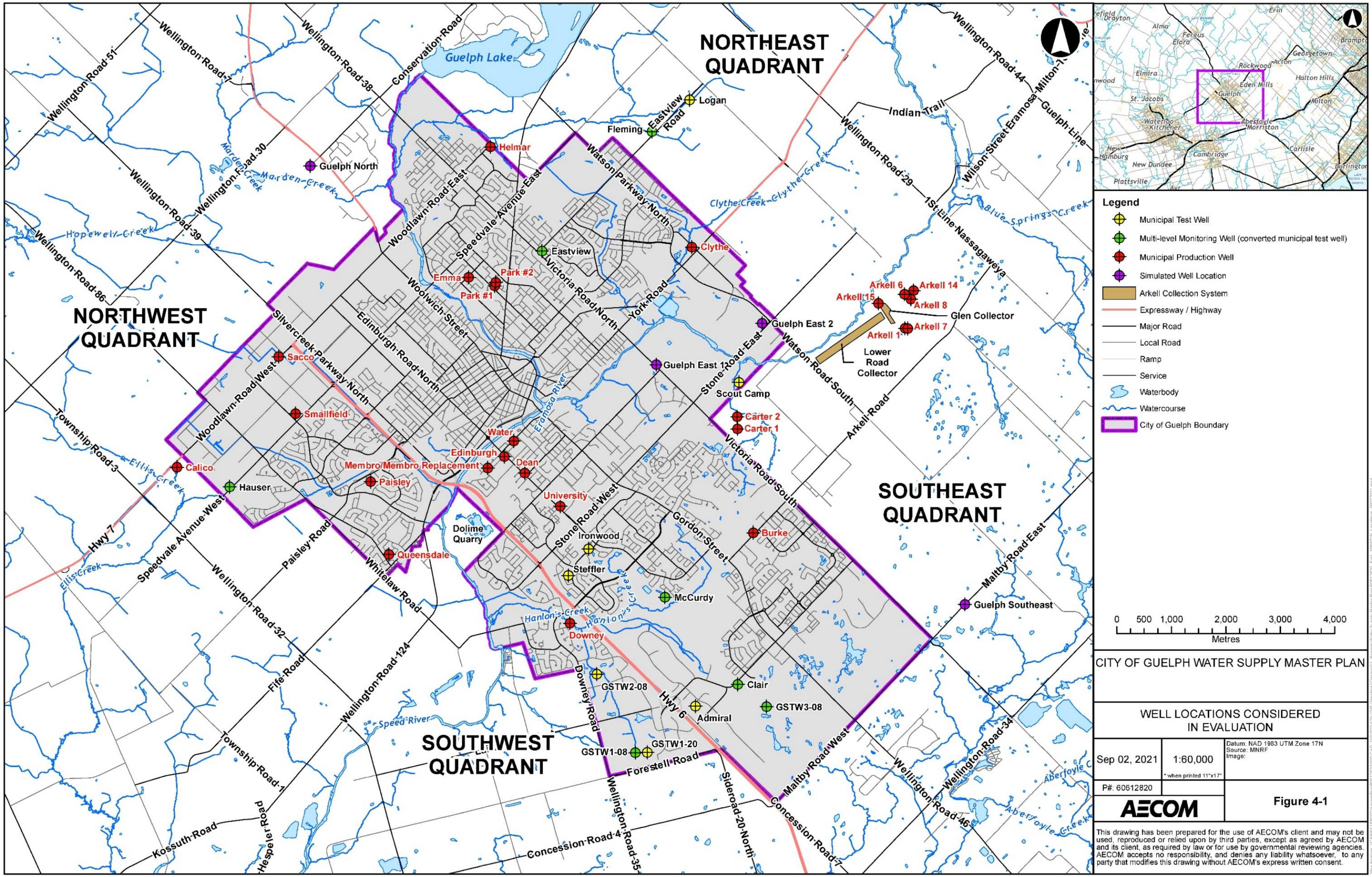
The City relies almost exclusively on groundwater to meet the residential and ICI water demands and has done so since 1908. The groundwater supply system, which comprises 25 drilled wells screened within overburden and shallow and deep bedrock aquifers, as well as one groundwater collection system located within the City and the surrounding Townships (Puslinch and Guelph/Eramosa) (**Figure 4-1**). The groundwater that supplies water to the City system is a shared resource that is utilized by the residents of Guelph, the surrounding County and Townships and the natural environment.

A detailed assessment of the capacity of the City's existing groundwater supply system was completed in 2021, which included the following components:

- Current maximum capacity of each individual groundwater supply source; including any constraints to operating at their maximum rate/volume;
- Sustainable capacity of the overall groundwater supply system; and
- Evaluation of potential risks to system operation (i.e., the Security of Supply); including the vulnerability of identified sustainable capacity from both a hydrogeological and operational perspective.

In conjunction with the above, the average (steady-state) capacity of the existing groundwater supply system was also evaluated using the Tier Three Model in an exercise referred to as a Sustainability Assessment (**Appendix B**). This evaluation considered long-term sustainable pumping rates that could be achieved at each well location, assuming that the wells are operated in parallel continuously (i.e., 24 hours per day). The model simulated interference between pumping locations and interaction with surface water features, with the objective of minimizing reductions in surface water baseflows. Results of the Sustainability Assessment are discussed in Sections 4.1.5 and 4.2.

Figure 4-1: Well Locations Considered in Evaluation



4.1 Assessment of Existing Well Capacities

Consistent with previous WSMPs, the City's groundwater supply system has been organized into the following four (4) quadrants for the purposes of this assessment: Southeast, Southwest, Northeast and Northwest. Details of the existing wells are provided in **Table 4-1**. Maximum pumping levels[8] were developed for each well through discussion with City staff, based on a number of considerations, including: well screen elevation, pump intake elevation, depth of water bearing zones, and operational considerations, where applicable.

Historical City records extending from 1997 through to 2019 for each groundwater supply source and quadrant provided daily pumping totals, monthly average of the daily pumping totals, observed groundwater elevations, MECP permitted rates, and maximum pumping elevations. Based on a review of pumping volume and groundwater elevation data, the capacity of each groundwater supply well and the collector system was re-evaluated relative to the 2014 WSMP. This re-evaluation considered:

- Long-term performance history;
- Recently demonstrated specific capacity;
- Response to previous maintenance efforts;
- Input provided by City Water Services staff;
- Review of available groundwater quality data; and
- Results of the Tier Three Study.

The Guelph and Township of Guelph/Eramosa Tier Three Water Budget and Local Area Risk Assessment (Tier Three Study) was completed under the Clean Water Act, 2006, to evaluate sustainability of the City's groundwater supply system from a quantity perspective and to identify potential threats to that sustainability (Matrix Solutions Inc., 2017). The results of this assessment were utilized to evaluate how the system may respond to concurrent pumping at higher rates than the system is currently operated at, and how the system may respond under drought conditions.

8. This is the lowest water level elevation (i.e., the maximum water level depth below ground surface) within a well where the pumping rate is considered sustainable.

Table 4-1: City of Guelph Groundwater Supply Source Details

City Quadrant	Groundwater Supply Source	Year Constructed	Pump House Floor	Well Pump Base Plate	Casing Diameter	Bottom of Casing	Liner Diameter[a]	Bottom of Liner[b]	Pump Intake Elevation	Water Bearing Zone(s)[c]	Maximum Pumping Elevation[d]	Well Depth	Permitted Rate
			(masl)	(masl)	(mm)	(masl)	(mm)	(masl)	(masl)	(masl)	(masl)	(m)	(m^3/day)
Southeast	Arkell Well 1	1966	330.2	330.6	200	321.0	-	-	317.1	321.0	319.1	14.2	3,273
	Arkell Well 6	1963	330.3	330.8	305	320.2	-	-	299.6	298.5	301.6	42.6	28,800
	Arkell Well 7	1963	330.2	330.8	381	306.7	-	-	299.8	292.2 to 286.4	301.8	41.9	
	Arkell Well 8	1963	332.4	333.0	305	320.5	-	-	301.8	295.2 to 294.2 292.2 to 288.1	303.8	42.5	
	Arkell Well 14	2000	334.3	335.1	400	309.2	-	-	306.5	306.3 to 295.7[e]	308.5	40.5	
	Arkell Well 15	2000	319.8	320.6	400	306.7	356/324	297.2	305.3	297.4 to 291.7[f]	307.2	31.9	
	Glen Collector	1908	-	-	-		-	-	-	-	-	-	25,000
	Burke Well	1966	335.6	336.1	300	314.8	-	-	300.4	314.1 to 305.1	313.1	78.9	6,546
	Carter Well 1	1962	324.6	325.0	250	320.4	200	314.9	311.0	313.2	315.0	21.9	6,547
	Carter Well 2	1962	324.6	325.0	250	317.7	-	314.1	306.5	313.0	315.0	20.4	
Southwest	Membro Well	1953	315.6	316.0	254	309.0	200	275.0	277.5	273.3 262.3	275.3	64.6	6,050
	Membro Replacement Well	2016	-	315.7	356	275.4	-	-	-	269.0 to 266.0	272.9	76.2	
	Water Street Well	1953	314.5	315.3	300	308.9	250	283.2	273.9	275.3 to 270.3	275.9	60.1	3,400
	Dean Well	1958	323.3	323.8	330	310.5	250/220	293.3	271.7	276.8 to 269.8	277.8	57.0	2,300
	University Well	1965	329.5	329.9	254	303.1	200	272.8	272.8	274.5 to 265.2	282[g]	64.8	3,300
	Downey Well	1968	317.4	318.1	305	305.3	-	-	280.3	280.6	282.3	73.8	5,237
Northeast	Park Well 1	1937	328.6	329.0	508	319.8	350	285.1	281.8	282.4 to 272.4	286.9	54.7	10,300
	Park Well 2	1947	328.3	328.7	508	319.9	350	286.0	281.4	294.3 286.2 to 270.9	283.4	48.2	
	Emma Well	1931	329.3	329.9	300	325.0	200	286.6	288.9	284.5 to 281.5	291.9	47.3	3,100
	Helmar Well	1966	344.5	345.3	305	332.5	200	317.9	297.9	315.3 293.3 to 287.3	299.9	78.9	3,273
	Clythe Well [h]	1976	326.8	N/A	300	319.4	200	300.0	N/A	304.5 298.4 282.2 to 278.2	N/A	64.0	3,395
Northwest	Paisley Well	1952	322.2	322.6	300	311.1	250	289.4	288.4	288.6	290.4	68.5	3,200
	Calico Well	1976	324.1	324.8	305	306.8		-	288.2	303.7 to 299.7	290.2	64.0	5,237
	Queensdale Well	1970	317.4	317.9	300	307.1	N/A		265.4	269.5	269.9	61.7	5,237

Notes:
a) Multiple values denotes telescoping liner.
b) Elevation of deepest liner provided for telescoping liners.
c) Data sources are as follows: Arkell Well 1 (City of Guelph); Arkell Well 6, 7, 8, 14, 15 (Golder, 2011); Burke Well (LTS, 2018a); Carter Wells 1, 2 (Golder, 2011); Membro Production Well (LTS, 1998); Membro Replacement Well (Stantec, 2016); Water St. Well (LTS, 2017d); Dean Well (LTS, 2016); University Well (Golder, 2011); Downey Well (City of Guelph); Park Wells 1, 2 (Golder, 2011); Emma Well (Golder, 2011); Helmar Well (LTS, 2018d); Clythe Creek Well (Golder, 2011); Paisley Well (LTS, 2007); Calico Well (Golder, 2011); Queensdale Well (Golder, 2011)
d) Values provided by the City of Guelph, exceptions are as follows: Burke Well (LTS, 2018a; Matrix, 2017); Membro Replacement Well (Stantec, 2016); Dean Well (LTS, 2016)
e) Six (6) discrete fracture elevations reported within noted elevation range (Golder, 2011)
f) Five (5) discrete fracture elevations reported within noted elevation range (Golder, 2011)
g) Maximum pumping level is currently maintained at 282 masl to manage interference with University of Guelph Well No. 4
h) Pump not currently installed in the Clythe Creek Well

A discussion regarding the capacity assessment for each groundwater supply source is provided below, including: i) sources with a decreased maximum capacity relative to the 2014 WSMP; and, ii) recommendations for activities such as, performance testing, well rehabilitation, and/or mechanical / operational changes to confirm reported well capacity values. A discussion of groundwater quality trends for each groundwater supply source is also included within each quadrant section.

4.1.1 Southeast Quadrant Capacity Assessment

The Southeast Quadrant (SEQ) provides the bulk of the City's groundwater supply, from nine production wells and one groundwater collection system. Total daily production volumes have ranged historically between approximately 10,000 to 50,000 m^3/day. Production rates in 2019 followed this long-term trend, with a minimum daily production rate of approximately 15,400 m^3/day and a maximum of approximately 45,600 m^3/day. Active production wells/systems within the SEQ include:

- Arkell Wells 1, 6, 7, 8, 14 and 15
- Burke Well
- Carter Wells 1 and 2
- Arkell Spring Grounds Collection System (Glen Collector System)

An additional collector system on the Arkell Spring Grounds, known the Lower Road Collector, is currently off-line.

The City operates a seasonally active groundwater infiltration system that takes water from the Eramosa River and discharges it to a pond and trench system, where the water is permitted to infiltrate into the ground, thereby recharging the groundwater system. Upgrades to this system were completed in 2017, in an attempt to increase the volume of water infiltrating into the ground, so as to improve the capture efficiency of recharge water by the Glen Collector. Subsequent to these upgrades, the volume of recharge to the system and production from the Glen Collector has been relatively consistent. Overall, the average daily production rate from the Glen Collector has been nearly identical in the years 2017 to 2019 (approximately 10,500 m^3/day). These rates indicate that the upgrades have been successful when compared to the period of 2011 to 2016 where use of the recharge system and overall collector production were inconsistent.

An assessment was completed to determine the average flow rate from the Glen Collector during January and February – the two-month period with the lowest productivity on an annual basis. Available data for the years 2017, 2018 and 2019 were included in the assessment, as they represent three full years of data where the Glen Collector has operated in its current configuration. The average flow rate during these two months, over the three-year period was approximately 5,100 m^3/day. This value was carried forward within the WSMP Update as the capacity value that the system can reliably produce throughout the year under the operating conditions described above. This represents a decrease from the value of 6,900 m^3/day that was included in the 2014 WSMP.

The Carter Wells are classified as Groundwater Under Direct Influence of Surface Water With Effective In-Situ Filtration (GUDI-EF) and are permitted by MECP for a combined maximum pumping volume of approximately 6,547 m^3/day. Due to concerns related to GUDI water quality impacts, these wells have been used by the City sparingly since 2013. The groundwater quality issues identified in 2013 were attributed to influence from the adjacent Torrance Creek (Stantec, 2019). The results of testing at this site in 2018 indicated that the Carter Wells demonstrate a combined capacity of approximately 6,400 m^3/day with GUDI-EF according to the current MECP GUDI Terms of Reference (TOR). The testing program focused on raw water quality and did not assess fluctuations in water levels and flow conditions within Torrance Creek. There is uncertainty related to optimal operating conditions for the Carter wells while supporting natural creek function. This balance will be assessed by the City through an ongoing testing program that is planned to be completed in 2022. At this time, it is recommended that a conservative capacity value be assigned to the Carter wells of 5,184 m^3/day (60 L/s), representing a reduction to the value of 5,500 m^3/day, as presented in the 2014 WSMP.

Concentrations of key water quality parameters (i.e., chloride, sodium, iron, manganese and nitrate) generally have remained consistent or have decreased with time within the SEQ groundwater supply sources. The exception is the Burke Well, where concentrations of sodium and chloride have increased since 2008, likely as a result of winter road maintenance (salt application) activities in the area. Concentrations of certain metals (iron, manganese) have been variable in the Burke Well since 2017 and have generally returned to pre-2017 concentrations based on late 2019 and early 2020 sampling results. Higher concentrations may be related to facility upgrades and related well inactivity during the upgrades. Since 2004, the concentration of nitrate in the Carter Wells has gradually decreased from approximately 10 mg/L to less than 8 mg/L and below the Ontario Drinking Water Quality Standard (ODWQS) Maximum Acceptable Concentration (MAC) of 10 mg/L.

Recent detections of Volatile Organic Compounds (VOCs) have only occurred within Arkell Well 1 [Trichloroethylene (TCE), Tetrachloroethylene (PCE) and cis-1,2-Dichloroethlyene (DCE)]. The sporadic nature and low concentrations of VOC detections at Arkell 1 suggest that the groundwater samples may have been affected by a trace source contaminating the samples, rather than a reflection of aquifer water quality. Similar spurious detections of trihalomethanes (THMs) and bromodichloromethane are indicated in the water quality record. The absence of a trend in these detections, as well as those described for Arkell Well 1 suggests that an on-going presence of these parameters should not be expected; however, continued monitoring should be completed by the City to confirm.

4.1.2 Southwest Quadrant Well Capacity Assessment

A total of six production wells are located within the City's Southwest Quadrant (SWQ), including five active wells (Membro Well, Dean Well, Water Street Well, University Well, Downey Well), and one inactive well (Edinburgh Well), as shown in **Figure 4-1**. Mutual drawdown interference is experienced to occur between some of the production wells within SWQ and the nearby River Valley Developments Quarry Site (the Dolime Quarry). Operations at the quarry require pumping of up to approximately 13,750 m^3/day (current PTTW maximum rate). This rate is known to fluctuate in response to seasonal precipitation and operational changes at the City's production wells. The City has proposed a solution to address the groundwater quantity and quality risks related to the quarry that would include the City assuming operational control of groundwater management activities on-site and engineering a system to protect the groundwater supply aquifer from surface contamination. A portion of the groundwater currently removed from the quarry site may potentially be considered for use as a municipal supply. This evaluation of the existing capacity of the SWQ wells assumes continued operation of the Dolime Quarry water management system at current rates, as proposed future plans for the site are several years from being finalized. Depending on the final solution, well capacities in the SWQ may potentially be increased at some point in the future, and/or the capacity of municipal supply from the quadrant may be increased via direct water taking from the quarry site. Between 2001 and 2010, groundwater pumping from the SWQ wells averaged approximately 11,300 m^3/day. Pumping in the SWQ was reduced in 2011 in response to the commencement of the Arkell Operational Testing Program (OTP). Since 2012, total pumping in the SWQ has gradually increased from a low in 2011 to some of the highest values over the period occurring in 2019 (approximately 12,000 m^3/day).

A replacement well was drilled at the Membro site in 2016 and is referred to as the Membro Replacement Well (or the Rocco Well). This well was drilled to a larger diameter than the Membro Well, which has a liner that limits the size of pump that can be installed. The Replacement Well was constructed to increase the diameter of the well and to allow a pump size that would enable pumping of the well at its permitted rate. Both wells are permitted by MECP for operational use. Testing of the Membro Replacement Well at the time of construction indicated that it possessed a capacity of approximately 5,400 m^3/day, or about 20% higher than the evaluated capacity of the Membro Well (4,500 m^3/day) (Stantec, 2016). In 2020, the City completed long-term testing on the replacement well that demonstrated a sustainable pumping up to a rate of 5,275 m^3/day; however, a degree of drawdown interference within the well field was observed. Given the current maximum pumping level restrictions associated with operation of the quarry water management system and interference within the local well field, the Membro site has been assigned a capacity of 5,200 m^3/day, representing a reduction of 800 m^3/day, as presented in 2014 WSMP. Similarly, a reduced value of 1,901 m^3/day was evaluated for the Water Street Well due to local interference effects, as compared to the 2014 WSMP value of 2,700 m^3/day.

The University Well is located approximately 250 m northwest of the University of Guelph groundwater supply well UoG No. 4. In order to minimize potential interference effects with UoG No. 4, the City maintains a pumping level within the University Well above approximately 282 mASL. Per discussion with City staff, current use of UoG No. 4 by the University of Guelph is unknown. It is recommended that the City discuss the use of UoG

No. 4 with the University to determine if the maximum pumping level of the University Well can be optimized (i.e., lowered).

Groundwater quality monitoring data show increasing concentrations of sodium and chloride within the SWQ wells, with the Dean, University and Membro wells indicating concentrations that exceed the ODWQS Aesthetic Objective for Chloride of 250 mg/L in one or more groundwater samples. To address the rising concentrations of these constituents, the City utilizes best management source protection practices and actively educates residents and business owners about these practices. Other inorganic constituents (i.e., iron, nitrate, manganese) are stable and remain within ODWQS concentration limits.

Low concentrations of VOCs (TCE and DCE[9]) have been reported at the Membro Well, Edinburgh Well and Water Street Well. While the concentrations of these constituents have been decreasing at the Membro Well, observed concentrations in the Water Street Well do not show an apparent trend. Insufficient data are presently available for an Edinburgh Well VOC trend analysis. Although occasional low concentrations of THMs and bromodichloromethane were reported for certain wells, no increasing trends are interpreted in the data.

4.1.3 Northeast Quadrant Well Capacity Assessment

A total of five production wells are located within the City's NEQ, including four active wells (Park 1, Park 2, Emma, and Helmar), and one inactive well (Clythe), as shown in **Figure 4-1**. Since 2011, pumping in the NEQ has generally ranged from 2,000 to 12,000 m^3/day, with an overall average of approximately 6,600 m^3/day during this period.

In 2018, the Helmar well was rehabilitated and tested, as recommended within the 2014 WSMP. In 2019, the well operated at a typical monthly average production total of approximately 700 to 800 m^3/day. A maximum capacity of 800 m^3/day was identified for the Helmar well based on the reviewed response to rehabilitation and recent operational data. This represents a reduction of greater than 50%, as compared to a capacity of 1,500 m^3/day presented within the 2014 WSMP.

9. An ODWQS criteria limit has not been established for DCE.

Concentrations of sodium and chloride have increased to varying degreed within the active NEQ wells over the period of record. Reported concentrations have remained below the ODWQS Aesthetic Objectives, with the exception of chloride at the Park Wells. Similar to the SWQ Wells, the City addresses the rising concentrations of these parameters through best management source protection practices and actively educates residents and business owners about these practices. Other inorganic parameters are generally below ODWQS, with the exception of occasional detections of iron at the Helmar Well above the ODWQS Aesthetic Objective of 0.3 mg/L. It is understood that the City may implement treatment measures to address iron concentrations observed at the Helmar Well. Concentrations of manganese and nitrate (at the Park Wells) have been variable, but consistently remain below ODWQS criteria limits.

Occurrences of VOCs (TCE, PCE and DCE) have been reported at the Emma and Park Wells. At the Park Wells, trace VOC detections (i.e., less than 1 µg/L TCE and PCE) were first reported in 2012, and have remained relatively consistent through to 2019. Concentrations of DCE in these wells have remained consistently below 2 µg/L, with no trend apparent being observed through to 2019.

At the Emma Well, TCE, PCE and DCE detections have been observed since 2006. Since 2011, this well has operated at a relatively consistent rate and concentrations of TCE and PCE have decreased (below 1 µg/L for TCE and non-detect for PCE). Concentrations of DCE have increased over the same period to a maximum of 5 µg/L.

Concentrations of THMs and bromodichloromethane have only been detected in the Park Wells and remain below the ODWQS for THMs (an ODWQS criteria limit does not exist for bromodichloromethane).

4.1.4 Northwest Quadrant Well Capacity Assessment

There are five production wells located within the City's Northwest Quadrant (NWQ), including three active wells (Paisley, Queensdale, and Calico), and two inactive wells (Smallfield and Sacco), as shown in **Figure 4-1**. Since 2014, the combined pumping rate from the NWQ wells has ranged in monthly average production totals from approximately 400 to 3,400 m^3/day. Historically, the maximum pumping in the NWQ was approximately 5,000 m^3/day.

The Calico Well has been off-line since mid-2018 when a casing failure was discovered. The City is presently moving forward with a project to replace the Calico Well with a new well on site. For the purpose of evaluating the existing capacity, the 2014 WSMP capacity of 1,400 m^3/day is assigned to this well, or a subsequent replacement.

The Queensdale well was rehabilitated by the City in 2019, but did not show significant performance improvement in post-rehabilitation testing. The Tier Three Study (Matrix, 2017) predicted that the Queensdale Well would be unable to pump at its allocated rate of 2,000 m^3/day during average climate or drought conditions. A subsequent Threats Management Strategy (Matrix, 2018), completed to assess the options for mitigating the potential water quantity threats, including the Queensdale Well, concluded that this threat could be mitigated by optimizing pumping rates in the municipal production wells, including pumping of this well at a rate of up to 1,100 m^3/day under average and drought climate conditions. Based on these findings, the WSMP rate of 1,100 m^3/day is considered appropriate for the Queensdale Well.

Concentrations of sodium and chloride have increased in the active NWQ wells to varying degrees over the period of record (1991 to 2019). Reported concentrations of sodium and chloride have remained consistently below the ODWQS Aesthetic Objectives. Similar to the SWQ and NEQ wells, the City addresses the rising concentrations of these constituents through best management source protection practices and actively educates residents and business owners about these practices. Other inorganic parameters are generally below ODWQS criteria limits, with the exception of iron at the Queensdale Well, which is above the ODWQS Aesthetic Objective of 0.3 mg/L. Despite increasing concentrations of nitrate at the Paisley Well, it has occurred at a maximum value of 2.19 mg/L, as compared to an ODWQS MAC value of 10 mg/L.

VOCs (TCE, PCE and DCE) have not been detected in the active NWQ Wells. Occasional singular detections of THMs and bromodichloromethane are reported in the monitoring record; however, these detections not any apparent trends.

4.1.5 Summary of Existing Groundwater Supply Capacity

A summary of the individual well capacities evaluated in **Sections 4.1.1** to **4.1.4**, relative to the results for the same wells in the 2014 WSMP are presented in **Table 4-2**. The total capacity of the City's existing active groundwater sources is interpreted to be approximately 79,422 m^3/day. This represents a decrease in maximum system capacity of approximately 4,414 m^3/day, relative to that reported within the 2014 WSMP. This estimate reflects normal operating conditions (i.e., non-drought conditions), and recognizes interference effects amongst the various groundwater supply sources, as well as other interferences such as that from continued water management activities at the Dolime Quarry. The evaluation also considered other physical constraints, such as well diameter, well condition, etc. that may potentially limit long-term sustainable pumping rates within the groundwater well sources. Recommendations included in the existing capacity assessment section are summarized in **Table 4-3**.

It should be noted that, although the assessment of existing capacity is based on review of an extensive operational record, it is not feasible to field test the City's full groundwater supply system at the estimated maximum capacity due to limitations associated with current requirements for customer demand and available storage capacity within the system. The presented maximum capacity value should be considered achievable over a short-term, but not necessarily sustainable long-term.

Subsequent to the assessment of maximum capacity, an additional modelling analysis was completed to evaluate the long-term average capacity of the existing system (**Appendix B**). This assessment concluded that the average capacity of the system is approximately 67,000 m^3/day when all sources are pumped concurrently and continuously (i.e., 24 hours/day). This result does not directly address the capacity of the groundwater supply system to satisfy maximum day demands, and is considered conservative since experience indicates that modelling results are generally conservative in nature and field testing may not detect impacts to surface water features that are simulated in a model. This said, it does provide an estimate of how the full system may respond to continuous longer term pumping conditions. As additional groundwater sources are added to the City's supply network, detailed field work will be required to assess the sustainability of each new supply; including characterization of raw water quality, potential effects on the natural environment, and drawdown interference with other existing groundwater sources when operating concurrently.

Table 4-2: Updated Capacity Assessment Summary – City of Guelph Groundwater Supply Active Sources

City Quadrant	Groundwater Supply Source	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Comments on Updated Capacity
Southeast	Arkell Well 1	2,000	2,000	Unchanged
Southeast	Arkell Well 6	28,800	28,800	Unchanged
Southeast	Arkell Well 7	-[b]	- [b]	Unchanged
Southeast	Arkell Well 8	-	-	Unchanged
Southeast	Arkell Well 14	-	-	Unchanged
Southeast	Arkell Well 15	-	-	Unchanged
Southeast	Glen Collector	6,900	5,100	Revised to reflect available capacity with artificial recharge system inactive
Southeast	Burke Well	6,500	6,500	Unchanged
Southeast	Carter Well 1	5,500[c]	5,184[c]	Decreased by 316 m^3/day based on uncertainty of potential impacts to Torrance Creek
Southeast	Carter Well 2	-[c]	-[c]	Decreased by 316 m^3/day based on uncertainty of potential impacts to Torrance Creek
Southwest	Membro[a]	6,000	5,200	Decreased by 800 m^3/day based on preliminary OTP results
Southwest	Water Street Well	2,700	1,901	Decreased by 799 m^3/day based on well field testing that evaluated mutual interference with Membro Replacement Well
Southwest	Dean Well	1,500	1,500	Unchanged
Southwest	University Well	2,500	2,500	Unchanged
Southwest	Downey Well	5,236	5,237	Unchanged[e]
Northeast	Park Well 1	8,000[d]	8,000[d]	Unchanged
Northeast	Park Well 2	-[d]	-[d]	Unchanged
Northeast	Emma Well	2,800	2,800	Unchanged
Northeast	Helmar Well	1,500	800	Decreased by 700 m^3/day based on performance record, rehabilitation results and interference drawdown.
Northwest	Paisley Well	1,400	1,400	Unchanged
Northwest	Calico Well	1,400	1,400	Unchanged[f]
Northwest	Queensdale Well	1,100	1,100	Unchanged
Total	**-**	**83,836**	**79,422**	**-**

Notes: a) Capacity is total for site (Membro Well and Membro Replacement Well)
b) 28,800 m^3/day is the total daily capacity of the Arkell bedrock wells (Wells 6,7, 8, 14, and 15).
c) Total daily capacity of Carter Well 1 and 3.
d) 8,000 m^3/day is the total daily capacity of Park Well 1 and 2.
e) Capacity increased by 1 m^3/day to match PTTW No. 8468-BCVQAN
f) Well is currently off-line due to casing failure, assigned value represents capacity for the site.

Table 4-3: Summary of Recommendations

City Quadrant	Groundwater Supply Source	Recommendation Operational/ Performance Testing	Recommendation Rehabilitation	Recommendation Modifications to Engineering	Comments/Other
Southeast	Arkell Well 1	Evaluation of sand production and overall sustainability above a rate of 1,125 m^3/day	-	-	-
Southeast	Arkell Well 6	-	-	-	-
Southeast	Arkell Well 7	-	-	-	-
Southeast	Arkell Well 8	-	-	-	-
Southeast	Arkell Well 14	-	-	Lower pump, as required in response to PWL[a]	-
Southeast	Arkell Well 15	-	-	-	-
Southeast	Glen Collector	-	-	Increase capacity of Eramosa River taking	-
Southeast	Burke Well	-	-	-	-
Southeast	Carter Well 1	-	-	-	Review pumping and water quality records against updated MECP GUDI TOR, when available. Completed planned assessment of effects on Torrance Creek.
Southeast	Carter Well 2	-	-	-	Review pumping and water quality records against updated MECP GUDI TOR, when available. Completed planned assessment of effects on Torrance Creek.
Southwest	Membro Well	-	-	Connect Membro Replacement Well (Rocco Well) to distribution system	-
Southwest	Water Street Well	-	-	-	-
Southwest	Dean Well	-	-	-	-

City Quadrant	Groundwater Supply Source	Recommendation Operational/ Performance Testing	Recommendation Rehabilitation	Recommendation Modifications to Engineering	Comments/Other
Southwest	University Well	Performance testing when rehabilitated	On regular 3 to 5 year basis	-	Initiate discussion with University of Guelph staff regarding use of University's Well No. 4
Southwest	Downey Well	Monitor during Dolime Quarry OTP for interference[b]	-	Upgrade booster pump at station, as required	-
Northeast	Park Well 1	Conduct OTP in conjunction with Emma	-	-	-
Northeast	Park Well 2	Conduct OTP in conjunction with Emma	-	-	-
Northeast	Emma Well	Conduct OTP in conjunction with Park	-	Lower pump, as required in response to PWL	-
Northeast	Helmar Well	-	-	-	-
Northwest	Paisley Well	Performance testing when rehabilitated	On regular 3 to 5 year basis	-	-
Northwest	Calico Well	-	-	-	Pursue replacement of existing well
Northwest	Queensdale Well	-	-	-	-

Notes: a) PWL: Pumping Water Level
b) Recommendation is in reference to identified potential additional capacity for well – all wells in SWQ should be monitored during the OTP, as well as the Queensdale and Paisley Wells.

The identified long-term average capacity of the existing system is approximately 15% less than the evaluated short-term maximum system capacity (**Table 4-2**). This result is discussed further in the security of supply section.

This total groundwater supply capacity is the basis for evaluating capacity of the City's groundwater supply system to meet projected demand requirements to 2051. Therefore, in **Table 4-4**, the results of the assessment are compared to both current and future projected supply needs, as presented in the Population and Water Supply Demand Forecast technical memorandum (AECOM and Gauley & Associates, 2021).

Table 4-4: Summary of Existing Capacity Assessment and 2051 Water Supply Demand Projection

Evaluation Parameter	2019	2051
Average Daily Demand (m^3/day)[1]	47,015	68,306
Maximum Daily Demand (m^3/day)[1]	58,441	91,530
Existing System Maximum Capacity (m^3/day)	79,422	79,422
Surplus/Deficit (m^3/day)[2]	20,981	-12,108

Notes: 1. Projected demand value for "Reference" growth rate scenario, as provided in the Province of Ontario's August 28, 2020 report A Place to Grow Growth Plan for the Greater Golden Horseshoe.
2. Surplus/deficit relative to maximum daily demand.

The comparison above provides a simple measure of possible future shortfalls if the City were only to meet future needs through new supply facilities, and without consideration of added redundancy to address risks to the system. An evaluation of various potential risks to the system is included in the following section.

4.2 Security of Supply

Task 3 included a review of existing system capacity under various conditions that could potentially reduce overall capacity. This is an important process for understanding potential risks to the City's groundwater supply and distribution system that could reduce the maximum daily system capacity. If the system is unable to meet the projected maximum demand, the City would need to implement immediate emergency water restrictions and customers would be unable to undertake regular, planned water use.

In addition to this review, on an annual basis the City of Guelph reviews and ranks the risk to the Water Supply through their Drinking Water Quality Management System (DWQMS). The purpose of this risk assessment process (Element 7) as it relates to the WSMP is to consider potential hazardous events and associated hazards. These hazards are identified in the MECP document titled "*Potential Hazardous Events for Municipal Residential Drinking Water System*" (2017), which includes long-term impacts from climate change and water supply shortfalls. These two risks continue to be ranked highly for water services through this assessment. In addition to the identification of risks to the water supply, there are also requirements under the DWQMS to identify controls to mitigate the identified risks. One aspect of these mitigative controls relates to incorporating security of supply, where an additional 15% capacity is to be provided in the event of a loss of supply for any reason.

This review also included drought conditions, loss of a well (i.e., a contamination event, equipment failure, structural failure, etc.), regulatory permitting changes, and risks to the well facilities and distribution system. The following sections summarize the assessment of each listed scenario and the associated estimate of system capacity under each.

4.2.1 Drought Conditions

The Tier Three Study (Matrix, 2017), included a groundwater modelling analysis that assessed the capacity of the City's existing groundwater supply system under drought conditions. The results of the final Tier Three Study concluded that operation of the groundwater supply system at an average rate of 73,450 m^3/day (the Tier 3 Study Allocated rates) to meet the estimated 2031 average demand of 71,597 m^3/day (RMSi, 2009) could not be sustained during a 10-year drought period, as the groundwater level would be drawn below the maximum pumping level in the Queensdale Well. There also was uncertainty as to whether Arkell Well 1 would have sufficient available drawdown. The subsequent Threats Management Strategy (Matrix, 2018), completed to assess the options for mitigating the identified potential water quantity threats (Arkell Well 1 and the Queensdale Well), concluded that potential threats could be mitigated by optimizing pumping rates in municipal production wells up to the total target pumping rate of 71,597 m^3/day, although this system rate produced a moderate risk to some surface water features. The average rates assessed in this optimization scenario do not address the maximum pumping rates that can be sustained from the deep confined bedrock aquifer wells on a short term basis to meet maximum day requirements. The potential maximum rates that could be achieved by each existing well in the system was evaluated by reviewing the model estimated available drawdown under drought conditions (Appendix C in Matrix, 2018). A calculation was completed for those wells predicted to have additional available drawdown under drought conditions, such that additional available drawdown was multiplied by the specific capacity estimated for the well to provide an estimate of the short-term maximum rate that could be achieved. The resulting rate was then compared to the recent performance record for each well and, if required, the rate was adjusted for those results that were unrealistically high. The results of this analysis, presented in **Table 4-5**, indicate that a maximum capacity of approximately 71,500 m^3/day can be expected under drought conditions, or an approximate 10% decrease, relative to the total capacity of the City's existing active groundwater sources (79,422 m^3/day).

Subsequent to the above assessment, an additional modelling analysis was completed to evaluate the average capacity of the existing water supply system under both average climate and drought conditions (**Appendix B**). This assessment concluded that the average capacity of the system (approximately 67,000 m^3/day) could be reduced by approximately 14% (or 57,500 m^3/day) under drought conditions. Although this does not directly address the expected drought reduction in maximum day capacity, it provides a range of approximately 10 to 15% for the purposes of planning for security of supply. As noted above, under drought conditions, the rates that may be achieved by the groundwater supply system could pose a moderate risk to the surface water system. It may not be feasible to construct sufficient redundancy (i.e., additional facilities) to address sustainable drawdown within each supply well in the system, and at the same time, mitigate all risks to local surface water systems. As such, there may be a requirement to combine a security of supply allowance within the system with other approaches to system management, such as the GRCA Low Water Response program, which is designed to address drought conditions. This is discussed further in Section 4.2.4.

Table 4-5: Estimated System Capacity Under Drought Conditions

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Total System Capacity with Drought (m^3/day)	71,477	71,477
Surplus/Deficit (m^3/day)	13,036	-20,053

4.2.2 Contamination Event or Loss of Supply Source

The presence of a contaminant in an aquifer that affects a supply well or the loss of a supply well due to long term maintenance activities are risks that must be considered when planning for future water supply requirements. The affect that these risks could have on the capacity of the City's groundwater supply system was evaluated in the 2014 WSMP through a desktop exercise. This exercise considered the potential impact on overall system capacity that loss of the largest producing well within each quadrant would have. One consideration in this assessment was the selection of wells where the lost capacity could not be made up by increased pumping at nearby wells. Four scenarios were considered in the assessment, as follows:

1. Loss of the Burke Well. This well is evaluated to have a capacity of 6,500 m^3/day, one of the highest capacities in the SEQ. This scenario is consistent with the 2014 WSMP.
2. Loss of the Downey Well. This well is rated for slightly higher production than the Membro Well/Membro Replacement Well and does not have a neighbouring well from which additional capacity could be obtained on a short-term basis. In the 2014 WSMP, the Membro Well was selected for the SWQ assessment; however, since 2014, the City has constructed the replacement well and therefore has redundancy on the site[10].

10. Upgrades to the Membro facility (currently underway) are required to bring the Membro Replacement Well on-line as a production well.

3. Loss of the Park Wells. These wells provide the most capacity in the NEQ (i.e., 8,000 m^3/day) and there is limited capacity to recover lost supply from the Emma Well. This scenario is consistent with the 2014 WSMP.

4. Loss of the Calico Well. The well is evaluated to have the same capacity as the Paisley Well and is currently off-line. Review of water levels in the NWQ since the well went off-line indicates that the Paisley and Queensdale Wells are not capable of recovering the lost capacity.

The results of this analysis, as presented in **Table 4-6**, indicates that the loss of the Park Wells in the NEQ would have the largest impact on overall system capacity, with the total capacity being reduced to approximately 71,400 m^3/day, relative to the total capacity of the City's existing active groundwater sources (79,422 m^3/day). This risk is therefore evaluated as being similar to the drought scenario.

Table 4-6: Estimated System Capacity With Well Failure / Contamination Event

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Total System Capacity with Well Loss (m^3/day)	71,422	71,422
Surplus/Deficit (m^3/day)	12,981	-20,108

4.2.3 Changes to Regulatory Approvals

In previous WSMPs completed by the City, an assumption implicit in the assessment of security of supply has been that supply wells with existing permits would remain permitted. Subsequently, the City has submitted applications to the MECP for renewal of existing Permits To Take Water (PTTW) and encountered challenges in obtaining renewed PTTW at the same maximum rates. As the City possesses multiple PTTWs issued by MECP for the various well fields and each PTTW is evaluated as an individual submission according to the expiry timeline of each PTTW, it cannot be anticipated which of these submissions may be reassessed by MECP over time, potentially resulting in a reduction in the total volume of daily permitted taking. Therefore, an assessment was completed by evaluating the implication of reductions to the maximum PTTW rate for each well of 20% and 30%. These values were selected as the magnitude of reduction that could be contemplated by the MECP based on historical use of a well, maximum pumping requirements, potential interference with other groundwater uses, etc. One exception is the Arkell bedrock wells, which were not included in the assessment. The current permitted taking from these wells was subject to a detailed OTP and Adaptive Management Program (AMP) as a condition of the MECP approval. As the permitted taking from these wells was subject to a rigorous testing program and a wellfield permit, it is not anticipated that MECP would reduce the permitted rates for these wells. Reductions beyond 30% were not considered in this assessment, as it is unlikely that the MECP would request this magnitude of reduction across all City wells.

Where a calculated reduction to the PTTW maximum daily taking did not cause the revised PTTW maximum to drop below the well capacity determined in **Section 4.1**, the estimated existing capacity value was used for that well. The results of this analysis, presented in **Table 4-7**, indicate that, even the 30% reduction scenario would still result in an overall system capacity that is greater than the loss of the Park Wells in the NEQ and the drought scenario.

Table 4-7: Estimated System Capacity With Change in Regulatory Approval

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Total System Capacity with Permit Reduction (m^3/day)	72,801	72,801
Surplus/Deficit (m^3/day)	14,360	-18,729

4.2.4 Other System Risks and Mitigation

In addition to the scenarios assessed in the previous sections, there are a number of risks to the City's groundwater supply and distribution system that should be considered either as part of the WSMP or the Water and Wastewater Servicing Master Plan. In planning for future supply sources, the City could review the potential impact of compounded risks (e.g., loss of a facility during a long term drought). However, in the case of an emergency event, the City could implement demand reductions, such as water use restrictions or temporarily pump above PTTW limits for some wells with permission from MECP.

For completeness, and for the City's further review and planning, some of these risks and possible mitigation measures have been documented below (**Table 4-8**).

A risk management plan to include mitigation and response strategies for the above and any other additional risks should be undertaken by the City to ensure provision of a safe and reliable water supply system now and in the future. This will include current risks to the existing groundwater-based system and may be expanded upon to include additional risks relevant to future water supplies, whether groundwater or surface water based. It is noted that the City reviews the water supply system annually through the DWQMS process. The recommended risk management plan should build on this existing process.

Table 4-8: Potential Additional Risks to Water Supply Capacity, Potential Impacts and Possible Mitigation

Risk to Water Supply Capacity	Potential Impact	Possible Mitigation	Notes
Drought combined with large supply out of service	▪ From Task #3, the available max day capacity during drought of 71,500 m^3/day would be reduced further by 7,200 m^3/day if Park wells were removed from service. This represents a reduction in total supply capacity of 19%	▪ Consider additional supply sources ▪ Implementation of demand management measures to limit max day demands in response to long term drought ▪ Emergency level demand management in response to loss of well supply	▪ The Grand River Low Water Response Program coordinates and supports the response to low water and may require demand reductions to address drought conditions within the watershed
Maintenance – short term, combined with other risks (e.g., large supply out of service)	▪ Regular scheduled maintenance of the facilities is required to complete well rehabilitation, mechanical upgrades, etc.	▪ Generally accommodated through scheduling to limit the supplies offline at any given time ▪ Consideration is also given to longer term projects to ensure that max day demands can be met in the event of loss of a large supply facility	▪ Available excess capacity to accommodate infrastructure upgrades in timeline
Maintenance – long term, combined with other risks (e.g., large supply out of service)	▪ Scheduled upgrades to existing facilities may consist of larger construction projects requiring the well supply to be offline for an extended period of time	▪ Schedule during higher seasonal production capacity not included in annual sustainable production volume (e.g., collector system)	▪ Available excess capacity to accommodate infrastructure upgrades in timeline
Mechanical failures combined with other risks (e.g., large supply out of service)	▪ This failure scenario potentially compounds the 'large supply out of service' scenario above, allowing for multiple facilities offline for a short duration	▪ Consider additional supply sources ▪ Emergency level demand management in response to loss of well supply	
Aqueduct break	▪ Loss of the aqueduct could result in the immediate elimination of the southeast supply sources (excluding Burke) representing 41,100 m^3/day	▪ Represents catastrophic failure - not reasonable to address through additional supply. Requires plan to provide quick response for repair and emergency demand management measures during downtime	▪ Existing recommendation to add secondary connection to system through Arkell should be addressed through the W&WSMP
Watermain breaks	▪ Variable loss of supply for short term period	▪ Strategy in place to address in short duration – not through added supplies	▪ Should be addressed through the W&WSMP – evaluation of risks and mitigative measures
Aquifer contamination	▪ Introduction of contaminant to aquifer resulting in impacts to multiple City wells (local or widespread)	▪ Managed through source water protection, ongoing water quality monitoring, and by MECP through the Environmental Protection Act, Ontario Water Resources Act, Clean Water Act, Safe Drinking Water Act	▪ Multiple wells across City help to mitigate water quality risks in specific areas
Quarry contamination	▪ Introduction of contaminant to aquifer resulting in impacts to multiple City wells	▪ Managed through maintaining water levels (i.e., groundwater divide with inward gradient to quarry)	
Eramosa River contamination	▪ Introduction of contaminant to river resulting in shut down of Arkell recharge system	▪ Managed through source water protection (IPZ), ongoing water quality monitoring, and provincial spill response program	

4.2.5 Security of Supply Summary

The assessment presented in Sections 4.2.1 to 4.2.4 indicates that evaluated risks to security of the City's water supply could cause a reduction in available capacity of up to approximately 15%, as compared to the estimated existing system capacity, with a period of prolonged drought being the most impactful event. This assessment is in-line with a similar exercise completed by the City in the 2014 WSMP, where it was concluded that system capacity was vulnerable to a reduction of approximately 10% to 15%. Consideration of other system risks highlights scenarios where lost capacity could exceed 15%. These results indicate that that City should continue on-going monitoring of available system capacity, with the objective of maintaining a system redundancy of 15%. With respect to the existing system, 15% of the existing available water supply system capacity should continue to be reserved for operational challenges which may be experienced in servicing of existing customers; i.e., not available for future growth. This results in an existing firm capacity of 67,509 m^3/day (**Table 4-9**).

Table 4-9: Projected "Reference" Water Demands vs. Required Water Supply Capacity

Demand Type	2021	2026	2031	2036	2041	2046	2051
Average Demand (m^3/day)	49,254	52,429	55,605	58,780	61,955	65,131	68,306
Maximum Day Demand using MDF of 1.34 (m^3/day)	66,000	70,255	74,510	78,765	83,020	87,275	91,530
Existing Firm Capacity (m^3/day)	67,509						
Existing Total Capacity (m^3/day)	79,422						
Estimated Required Future Total Capacity (m^3/day)		80,793	85,687	90,580	95,473	100,366	105,260

Notes: MDF – Maximum Day Factor

The average annual day demand and maximum day demand for the Places to Grow "reference" growth scenario discussed in Section 3, are again provided in **Table 4-9**. Assuming that a safety factor of 15% is applicable to all future sources (i.e., groundwater based), the required total capacity is calculated as 1.15 times the maximum day demand. This suggests that additional production volume will be needed to satisfy the projected 2026 demand. This short term requirement is anticipated to be addressed by the Clythe Well, which is currently off-line but scheduled to return to service in 2023. In total, a 2051 water supply deficit of approximately 26,000 m^3/day is estimated, relative to the current system total capacity.

4.2.5.1 Future Water Supply Sources

Evaluation of the risks associated with future water supply capacities may differ from those impacting existing supplies depending on the source and other risk factors.

Groundwater based - for additional groundwater supply facilities, the City could continue to plan firm capacity based on incorporating the 15% allowance determined for the existing supply system. However, this should be confirmed with the addition of each supply source to ensure that 15% is sufficient.

Surface water based – typically, for surface water treatment plants and pumping stations, firm capacity is based on pumping and treatment redundancy (i.e., capacity with largest unit out of service). The water supply available to the treatment plant would be based on low flow conditions so would already consider drought conditions encountered within the historical monitoring period. Therefore, as long as sufficient equipment redundancy is included in the design, it may not be necessary to incorporate additional supply capacity for surface water supply sources to determine firm capacity.

The future required municipal water supply firm capacity will be re-assessed with the addition of each new groundwater supply source. A simplistic approach is adopted through this WSMP update to provide general guidance on timeline required for new supply projects and this will be updated through a review of the sufficiency of the water supply surplus after each new water supply is brought on-board. This is in additional to regular (monthly) reviews of the available water supply capacity and required maintenance and upgrade activities.

5. Water Supply Alternatives

5.1 Introduction

Through the 2014 WSMP Update, the following alternatives were evaluated and prioritized with considerable input from the public to develop an implementation plan for the City to ensure sufficient water supply to meet projected demand:

1. Water conservation, efficiency and demand management
2. Groundwater sources inside and outside of the City
3. Aquifer Storage and Recovery (ASR)
4. Local surface water sources
5. Limit community growth
6. Do nothing

During early community engagement events of the WSMP Update, the list of potential water supply alternatives from the 2014 WSMP was reviewed and revised to reflect work completed by the City in the interim, as well as new information. The purpose of this update is to review progress to date and update the status of these alternatives by factoring in new information, innovative technologies, and the most recent public and stakeholder input.

The objective of the WSMP Update is to continue to ensure that the City can provide an adequate, safe and sustainable supply of water to meet the current and future needs of all customers over the next 30 years (i.e., to 2051). As documented in Section 4, the water supply demand forecast, and the existing water supply system capacity assessment concluded that under a “do nothing” scenario with continued growth, in 2051 the City would require an additional water supply capacity of approximately 12,000 m^3/day to satisfy maximum day demand. With a security of supply allowance of 15%, the deficit will be 26,000 m^3/day.

Following the direction of the previous WSMP and incorporating the updates through work completed by the City in the interim, the following alternatives are re-developed and evaluated with respect to their capability to contribute to the total water supply solution. It is acknowledged each does not address the problem statement as a stand-alone alternative. Therefore, each alternative is discussed and evaluated on its own merit as part of the total solution. Some alternatives are better defined than others and some alternatives either may not deliver, or may exceed the supply capacity estimates presented herein. Therefore, the WSMP may need to present additional alternatives (and more supply capacity) than necessary since some of the alternatives are subject to additional investigations and may not be as feasible or sustainable as are presented in this WSMP.

The following provides an overview of each category of potential water supply alternatives:

1. **Water conservation, efficiency and demand management**

   As recommended in the 2014 WSMP, it is anticipated that water conservation, efficiency and demand management will continue to form part of the preferred sustainable water supply solution (via reductions in water demand) in the future. The WSMP develops high level targets/goals for water supply demand reduction that are subsequently utilized to develop specific programming within the Water Efficiency Strategy (WES). These potential targets were assessed via four scenarios developed to consider the potential reductions associated with various combinations of initiatives in order to set a reasonable and publicly supported reduction target. As stated, the details of the water conservation, efficiency and demand management programming, including the preferred initiatives to be implemented to reach proposed targets will be further developed in the next WES update. The developed scenarios explore the following:

   I. Ceasing non-provincially mandated water efficiency measures (baseline scenario)
   II. Potential reduction through maintaining a level of programming similar to the current water conservation, efficiency and demand management program
   III. Potential reduction through a focus on high water use customers
   IV. Potential reduction through a focus on the current level of programming *and* water reuse initiatives

The estimated reclaimed water supply capacity and cost associated with each of the above initiatives is developed for comparison to the cost to implement new water supply sources.

2. **Groundwater sources inside and outside the City**

The groundwater supply alternatives considered in the 2014 WSMP are updated and re-stated to provide clarity between various stages of development of future potential supply sources. The following list represents all opportunities in the order established in the original implementation plan.

a. Optimize existing municipal sources
b. Restore off-line municipal sources
c. Develop municipal test wells
d. Develop new wells inside the City
e. Install new Aquifer Storage and Recovery (ASR) wells inside City to optimize available excess Arkell Collector system volumes
f. Develop new wells outside the City – a distance of less than 5 km from the City boundary was applied to meet the desire to maintain local sustainability

For reference, ASR is a strategy where treated (potable) water is stored within an aquifer during periods of water surplus (i.e., when capacity exceeds demand) and subsequently this volume of stored water is recovered during periods of water shortage (i.e., when demand exceeds existing capacity).

The Tier Three Model, described above, was used to review the total sustainable capacity from a natural environment perspective for all of the above alternatives. However, it is recognized that there is no assurance that all of these possible supplies may be developed. The results should therefore be considered as an evaluation of the additional volume of groundwater that may be available before causing unacceptable stress to local watersheds.

In addition to the above sources, existing non-municipal wells are discussed as these present a potential opportunity or conflict should the well owners propose to change the status of the PTTW or well operation. These sources are included as current water takings in the groundwater flow model.

3. **Local surface water sources**

   Local surface water sources evaluated for the WSMP include the Eramosa River and Speed River. These sources are each investigated for their potential to provide a continuous source of water for treatment and supply to the City's distribution system. Also reviewed is the feasibility of developing additional surface water supply through an ASR strategy.

   Of these two options, the Speed River offers the greatest potential due to the presence of Guelph Lake, a man-made reservoir on the Speed River, in Guelph/Eramosa Township. This reservoir was created in 1974 with the construction of the Guelph Lake dam. Guelph Lake is evaluated as a potential location to withdraw water from the Speed River due to the ability of the Grand River Conservation Authority (GRCA) to monitor and control flows to maintain base flow downstream of this dam. This alternative is discussed in detail in Section 5.4.

4. **Limit community growth; and**

5. **Do nothing.**

   Lastly, as a reference for comparison for all of the above alternatives, the potential impacts of developing any of these options are measured against the "limit community growth" alternative and "do nothing".

5.2 Water Conservation, Efficiency and Demand Management

5.2.1 Approach

In previous WSMPs, the utmost importance was placed on water conservation, efficiency and demand management, and as a result, the City of Guelph has become a renowned leader in water conservation, efficiency and demand management in Canada. This effort has proven to be a cost effective initiative that reduces demand within the City and thereby extends the timeline for when new water supply sources are required. Specific programming is identified within the 2016 Water Efficiency Strategy and this will be updated as early as 2022. Examples of programs that have been implemented include Blue Built Home, eMERGE Home Tune-up, greywater reuse, multi-residential water audits, Water Smart Business and municipal facility water audits and upgrades.

As discussed in Section 3.2, the review of per capita water production and demand rates from 2015 to 2019 indicates that customer water demands may be beginning to stabilize after approximately two decades of significant decline. This observation suggests that future per capita customer water demand declines associated with conservation, efficiency and demand management programming and natural water savings may be more difficult to achieve moving forward. This observation is considered in developing the targets for future conservation, efficiency and demand management programming in this section.

The water conservation, efficiency and demand management scenarios developed for the WSMP Update also consider the results of a recent evaluation of the potential to reduce non-revenue water (NRW) rates in the City below their current level (**Appendix C**). This evaluation found that the City's current infrastructure leakage index (ILI) appears to be very similar to its economic level of leakage (ELL). The ELL of a water system is the leakage level where the cost associated with finding and repairing leakage equals the cost associated with producing and distributing the water lost through leakage, i.e., reducing leakage below the ELL is not financially beneficial. As such, the water conservation, efficiency and demand management scenarios assume that the City will continue to implement the current level of water loss mitigation programming to maintain low NRW to 2051 (i.e., no further reduction in per capita NRW rates).

None of the water conservation, efficiency and demand management scenarios consider the impact of conservation-based water rates on water demands. A study completed for the 2016 WES update evaluated several rate structures to assess their impact on demands: uniform rates, increasing block rates, humpback rates[11], seasonal rates, excess use rates, and water budget rates. While the study found that a very aggressive increasing block rate may be expected to reduce demands by approximately 6%, it also determined that this type of rate was not equitable to all ICI and multi-residential customers. The study concluded that, because of the limited impact on demands and the potential for inequity among customers, the City should not pursue a conservation-based water rate structure at this time.

It should also be noted that the conservation, efficiency and demand management scenarios were developed using pre-pandemic water demand data. In most communities, including in Guelph, pandemic restrictions have resulted in industrial shutdowns, more people working and attending school from home, exercising at home rather than at the gym, preparing meals or getting take-out meals rather than eating in restaurants, etc., and this has resulted in an increase in the average per capita residential water demand and a decrease in the average per capita ICI water demand. The Pacific Institute, a think tank dedicated to global water issues, has stated that the impact of the pandemic on overall water demands is uncertain, with some communities seeing a reduction in total demand and others seeing an increase in total demand depending on their relative proportion of residential and ICI customers and the makeup of their ICI customers[12]. Therefore, the long-term impact of the pandemic on demands is difficult to predict. The current shift in residential and ICI demands may continue or demand patterns may return to their historical pre-pandemic configuration. Because of this uncertainty, it is prudent at this time to project Guelph's future residential and ICI water demands based on long-term historical demand patterns. The City will continue to evaluate the impact of the pandemic on

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11. A humpback rate structure uses a combination of increasing and decreasing block rates: rates first increase, then decrease in steps as consumption increases. This approach targets high volume users, and then provides lower rates for high volume users.
12. https://pacinst.org/how-the-coronavirus-pandemic-is-affecting-water-demand/

residential and ICI demands and the potential long-term effects will be re-evaluated in the next Master Plan Update, as necessary.

Options for consideration in the four scenarios presented herein range from 'do nothing' scenario (i.e., no future conservation, efficiency and demand management efforts beyond those that are provincially mandated), to including water reuse programs in addition to updating current efforts, to include new programs when existing programs are exhausted. In reality, while a 'do nothing' scenario would not incorporate further water conservation, efficiency and demand management programs, some level of natural savings would occur regardless as a function of changes to the Ontario Building Code. Such changes mandate that more efficient plumbing fixtures are installed in new construction and natural replacement cycles of household fixtures and appliances in existing residential homes with newer, more efficient models. It is noted that Guelph's progressive programming to date has leveraged the natural savings opportunities stemming from building code changes and accomplished demand savings under these programs at a higher magnitude and in a shorter period of time than would have occurred naturally. Nevertheless, a 'do nothing' water conservation, efficiency and demand management scenario does not fit with stakeholder feedback nor City Council's commitment to sustainable growth – where the finite supply, if not used efficiently, could result in limiting growth and conflict with Guelph's provincial growth mandate requirements.

5.2.2 Identified Water Conservation, Efficiency and Demand Management Scenarios

Scenario #1 – Static Residential and ICI per Capita Water Demands

This scenario represents the baseline or most conservative case of the four scenarios and assumes the following:

1. the City of Guelph ceases implementing all water efficiency measures that are not provincially mandated; and
2. per capita residential and ICI demands remain static at their average 2015-2019 levels.

An example of provincially mandated programs includes the permit to take water approval process which requires municipalities to demonstrate their commitment to efficient use of the resources they already have available before expansions or additional permits are given to a permit holder. Schedule 1 for water conservation measures as part of the provincial permit process requires the applicant to demonstrate which tactics are being employed to control water demand, including fixtures, metering, loss prevention and water reuse measures, before expansion is considered. Furthermore, the Water Opportunities and Conservation Act, 2010, requires municipalities to develop water sustainability plans, setting performance indicators and targets. While not yet enacted, the City is positioned to meet the necessary requirements. Lastly, the provincial low water response program, which is watershed-based and is administered by the Grand River Conservation Authority, protects supply throughout peak season, monitoring watershed/ subwatershed conditions and putting restrictions on use, as necessary. This is echoed in and forms part of the basis for the City's Outside Water Use Program.

While per capita water demands under this scenario are not projected to decrease over time, they are also not expected to increase over time despite no further water efficiency programming. This is due to the effort the City has already put into educating and replacing water-using fixtures and systems with the public regarding the importance of water efficiency in a groundwater-based system. As Scenario #1 represents the City ceasing water efficiency programming, there are no associated costs or savings and the values in **Table 5-1** represent the baseline projected 2051 water demands presented in Litres Per Capita Per Day (Lcd).

Table 5-1: Static Per Capita Demands

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	166.6	166.6	203,000	33,814
Employment	191.0	191.0	116,000	22,155
NRW	60.8	60.8	203,000	12,338
Total	-	-	-	**68,306**

Scenario #2 – Water Demand Reduction of 6.5% by 2051

This scenario represents the City continuing its investment in water efficiency programming with a similar level of effort to that undertaken historically, i.e., the same level of programming budgets and staffing levels. The anticipated level of reduction in demand is based on the historical gross per capita water demand trend between 2015 and 2019. It is expected that the rate of decline in per capita demands will decrease over time as customers become more efficient and there are fewer opportunities for further reductions in demands. It is also expected that the City will continually revise its selection of water efficiency measures as needed in the future with updates to the WES. Programs that become less effective, experience free ridership[13] or that have reached their target savings may be dropped or modified. New programs may be adopted such as rebates for efficient water softeners, implementing Advanced Metering Infrastructure (AMI), and landscape incentives. With employment growth expected to outpace residential growth in the City through to 2051, the City's water efficiency programming may shift to having a greater focus on ICI-based measures.

The savings target identified in Scenario #2 includes savings directly and indirectly resulting from the implementation of City programs as well as 'natural' savings resulting from changes in the Ontario Building Code and continued improvements in the efficiency of water-using fixtures, appliances, products, and processes.

While it is expected that both ICI and residential per capita demands will continue to experience some level of decline over the next 30 years, it is difficult to accurately predict the percentage reduction in each customer class. For the purpose of evaluating this scenario and estimating water efficiency program budgets, we have assumed a similar target reduction for both customer classes. The actual focus and implementation of programs to achieve the overall savings would be addressed through the next WES update.

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13. Free ridership: a person who would have installed an efficient product or participated in an efficiency program without receiving an incentive.

While customer demands in the City were relatively flat between 2015 and 2019 there was a slight reduction in gross per capita demands (i.e., average annual day production rates divided by the serviced population) during this time.

- 2015 Gross per Capita Demand = 348 Lcd
- 2019 Gross per Capita Demand = 331 Lcd

Through a statistical analysis of gross per capita demands between 2015 and 2019, a 2051 gross per capita demand of 315 Lcd and an average day demand of 63,882 m^3/day, are estimated, equating to a reduction of about 6.5% in 2051 average day demand versus Scenario #1.

As stated above, the City is near or at the ELL with respect to NRW and the current per capita NRW rate of 61 Lcd is expected to be maintained at this level until 2051, with active leak detection programs and planned replacement of linear infrastructure which has met its functional life. With no projected reduction in per capita NRW demands, the projected water savings under this scenario are restricted to declines in per capita residential and ICI demands. To achieve an overall reduction in gross demands of 6.5% while maintaining per capita NRW demands at 61 Lcd it is necessary to reduce customer water demands (including both residential and ICI water demands) by 7.9%. The demand projections in **Table 5-2** assume an equivalent reduction in both the residential and ICI customer sectors. It is anticipated that the City will continue to evaluate its ongoing programs and develop new initiatives to target potential savings and ensure success. Scenario #2 will result in the following:

- 7.9% Decrease in Residential Lcd Rates
- 7.9% Decrease in Employment Lcd Rates
- 0% Decrease in NRW Lcd Rates

Table 5-2: 6.5% Reduction in Average Annual Day Demands by 2051

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	167	153	203,000	31,140
Employment	191	176	116,000	20,404
NRW	61	61	203,000	12,338
Total	-	-	-	**63,882**

Estimated Program Costs

The 2051 water savings in Scenario #2, including direct, indirect, and natural savings is projected at 4,424 m^3/day (in 2051). The total program cost identified in **Table 5-3** of $11.41 million ($380,000 per year for 30 years) is based on an estimated $2021 unit cost of $2,578 per m^3/day of savings.

Table 5-3: Costs and Savings: Scenario #2

Direct Savings, m^3/day	Natural & Indirect Savings, m^3/day	Total Savings, m^3/day	Cost per m^3/day	Total Cost (million $)
1,686	2,739	4,424	$2,578	$11.41

Scenario #3 – Water Demand Reduction of 3.25% by 2051

Although the demand targets expressed in Scenario #2 are based on historical water demand trends, the annual rate of demand reduction has been slowing down – even with the City implementing water efficiency measures during this period. With fewer opportunities to improve efficiency in the future, it is not possible to confirm that the statistical trend in average water demands between 2015 and 2019 will continue for the next 30 years. However, even if overall *average* per capita water demand stabilizes, there will still be an opportunity to focus programming specifically on high water use customers in both the residential and ICI customer sectors. By moving away from broad-based programming to more targeted programming, it is anticipated that the City may achieve a lower demand reduction than Scenario #2 with a corresponding lower budget.

While it is not possible to accurately predict the level of savings that would be achieved under a targeted approach, Scenario #3 is based on achieving 50% of the residential and ICI savings associated with Scenario #2. This results in a 4.0% reduction in both residential and ICI Lcd rates, including natural savings, and a 0% reduction in per capita NRW rates, equating to an overall 3.25% reduction in demands versus Scenario #1 (**Table 5-4**). Scenario #3 will result in the following:

- 4.0% Decrease in Residential Lcd Rates
- 4.0% Decrease in Employment Lcd Rates
- 0% Decrease in NRW Lcd Rates

Table 5-4: 3.25% Reduction in Average Annual Day Demands by 2051

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	167	160	203,000	32,460
Employment	191	184	116,000	21,288
NRW	61	61	203,000	12,338
Total	-	-	-	**66,086**

Estimated Program Costs

Achieving an average annual day demand of 66,086 m^3/day in 2051 equates to a 3.25% (or approximately 2,220 m^3/day, in 2051) reduction versus Scenario #1. It is assumed that the unit cost of implementing this scenario is 17.3% lower than that of Scenario #2, or $2,132 per m^3/day of savings (**Table 5-5**) and the average program implementation cost for 30 years is estimated at approximately $157,670 per year.

Table 5-5: Costs and Savings: Scenario #3

Direct Savings, m^3/day	Natural & Indirect Savings, m^3/day	Total Savings, m^3/day	Cost per m^3/day	Total Cost (million $)
846	1,374	2,220	$2,132	$4.73

Scenario #4 – Water Demand Reduction of 7.3% Reduction by 2051

This scenario includes the savings targets described in Scenario #2 plus additional savings related to water reuse. Thus Scenario #4 represents the most aggressive option with the highest projected costs and water savings.

It is very difficult to estimate the future impact of water reuse over 30 years. In addition to the water reuse opportunities evaluated within the WSMP process, this topic is a consideration within the Wastewater Treatment and Biosolids master planning process, and an integrated approach to evaluating and executing water reuse must be considered.

It is expected that water reuse will become more attractive over time as technology improves and the availability of high-quality fresh water sources becomes scarcer. The City is currently exploring the potential to use appropriately treated wastewater for sewer flushing, with an estimated potable water savings of 5,678 m^3/year (average of 15.6 m^3/day). At this time, however, there are still a number of barriers related to the wide-spread acceptance of water reuse, including:

- Community acceptance of using treated wastewater
- Potentially higher unit cost associated with water reuse than with potable water
- Environmental concerns, e.g., reducing the volume of effluent discharged by a WWTP
- Regulatory issues with uncertain permitting and operational standards for reuse options
- City and private property owner based capital investments to develop municipal system and private plumbing upgrades

Water reuse measures are not restricted to municipal programs and may be implemented in both the residential and ICI customer sectors. Previous reports completed for the City on water reuse opportunities have been referenced to estimate total potential reductions. While a number of reuse programs have been identified as part of past City evaluation of reuse opportunities (shared in **Table 5-6**), many of these are seasonal demands some of which may not rely on municipal supply (e.g., municipal irrigation and golf course irrigation) and therefore would have a minimal impact on average annual day demands. Since future water supply infrastructure requirements are based on maximum day demands, measures that don't significantly reduce demands year-round will not reduce future supply capacity requirements. Therefore, the total projected potential potable water savings in this proposed scenario do not include water reuse related to municipal or golf course irrigation.

Table 5-6: Potential Water Reuse Savings (Genivar, 2011)

Measure	Annual Savings, m^3	Average Annual Day Savings, m^3/day
Street sweeping	3,175	8.7
Sewer flushing	11,223	30.7
Urban applications	168,168	460.7
Construction	10,160	27.8
Municipal irrigation	8,800	24.1
Golf course irrigation	147,000	402.7
Total	**348,526**	**955**
Total without Irrigation	**192,736**	**528**

A reduction in potable water demands by 2051 of 528 m^3/day, in addition to the savings identified in Scenario #2, would equate to a savings of 7.3% versus Scenario #1 (**Table 5-7**).

Table 5-7: 7.3% Reduction in Average Annual Day Demands by 2051

Demand Type	2020, Lcd	2051, Lcd	2051 Population	2051 Avg. Annual Day Demand, m^3/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338
Total Potable	-	-	-	**63,882**
Estimated Water Reuse Savings	-	-	-	**-528**
Total Potable Minus Reuse	-	-	-	**63,354**

<u>Estimated Program Costs</u>

Achieving an average annual day demand of 63,354 m^3/day in 2051 equates to a 7.3% (or 4,952 m^3/day) reduction versus Scenario #1. For the purpose of estimating the costs associated with this scenario, one must consider that Scenario #4 includes the savings targets described in Scenario #2 plus additional savings related to water reuse.

The American Water Works Association (AWWA) states "reuse system assets, configurations, technologies, and operational considerations are tremendously varied[14]". Without knowing any details regarding the reuse format/ measures the City will undertake in the future or the presence of a constant customer base for such water, it is not possible to accurately estimate the costs associated with implementing water reuse measures. However, to be conservative, a unit cost of $6,875 per m^3/day has been assumed for reuse projects based on the results identified in the publication Cost and Energy Intensity of U.S. Potable Water Re-use Systems[15]. Detailed, program-specific costing will be developed through future updates to the WES, subsequent pilot projects and related research. At this time, the cost to achieve the targeted

14. Water Reuse Cost Allocations and Pricing Survey, May 2019
15. Research on 25 water reuse facilities in the USA with capita cost data found that unit capital costs could be as high as $5,300 per m^3/day of capacity and O&M costs could be as high as $200 per m^3/day, for a total of $5,500 per m^3/day (USD) or approximately $6,875 in Canadian dollars. https://pubs.rsc.org/en/content/articlelanding/2021/ew/d1ew00017a

528 m^3/day of water savings through reuse measures is an estimated $3.63 million (**Table 5-8**:). The total cost of implementing Scenario #4 is estimated to be $15.04 million over 30 years with an average program implementation cost estimated as $501,333 per year.

Table 5-8: Costs and Savings: Scenario #4

Program Type	Direct Savings, m^3/day	Natural & Indirect Savings, m^3/day	Total Savings, m^3/day	Cost per m^3/day	Total Cost (million $)
Water Efficiency Programs	1,686	2,739	4,424	$2,578	$11.41
Water Re-use Programs	528	-	528	$6,875	$3.63
Total	**2,214**	**2,739**	**4,952**	**$3,037**	**$15.04**

5.2.3 Water Conservation, Efficiency and Demand Management Summary

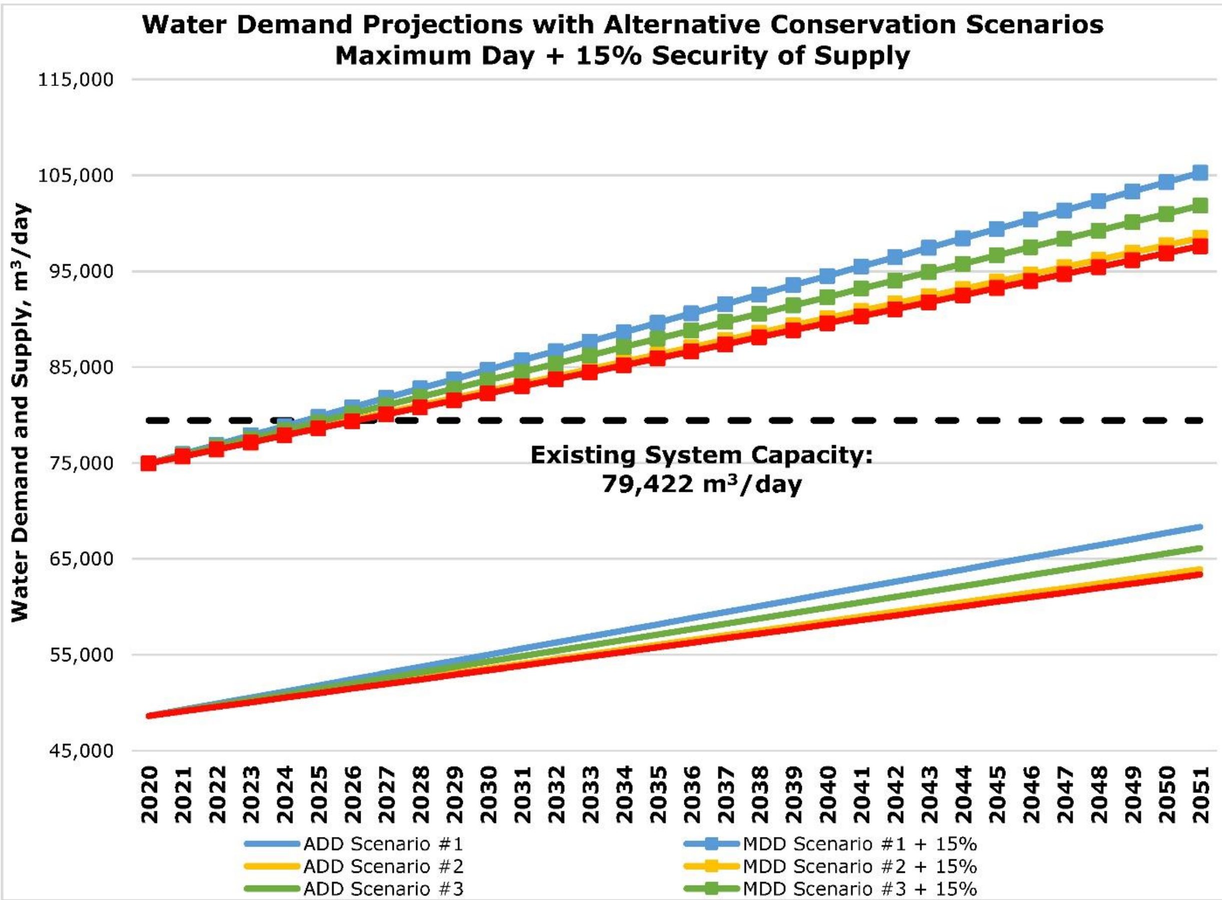
The impact of applying the range of proposed conservation, efficiency and demand management scenarios to the projected water demand over the 30-year WSMP Update study period is demonstrated by applying the estimated reductions associated with each scenario to the average and maximum total demands in year 2051 (**Figure 5-1**). It is observed that the range in scenarios depicted provides a significant reduction in the future supply requirements. Also provided below is a summary of the estimated total and annual program costs for each scenario (**Table 5-9**). The Life Cycle cost is evaluated over a 20-year period in alignment with typical industry practice.

Table 5-9: Summary of Potential Savings and Program Cost Estimates for Each Scenario

Scenario	Projected Reduction in Average Annual Day Demand (m^3/day)	Estimated Program Cost (million $)	Estimated Average Annual Cost ($)	Capital Cost per m^3/day ($)	Life Cycle Cost* – Cost per m^3 avoided ($)
1	-	-	-	-	-
2	4,424	11.41	380,000	2,600	0.53
3	2,220	4.73	157,670	2,100	0.44
4	4,952	15.04	501,333	3,000	0.62

Notes: * Life cycle cost is the cost per m^3 of avoided capacity over a 20-year period.

Figure 5-1: Water Demand Projections with Conservation, Efficiency and Demand Management Alternative Scenarios



5.3 Expand Existing Groundwater System

The approach undertaken in investigating opportunities for optimizing the City's existing groundwater supplies and developing new sources followed direction provided through the previous WSMP consultation processes (2007 and 2014 update). Public response clearly indicated that the City should consider groundwater opportunities within its municipal boundaries prior to exploring beyond. This mandate was reflected in the prioritization given to projects in the 2014 WSMP implementation plan and in updating the review of groundwater alternatives. As noted in the 2014 WSMP, the development of new groundwater supply sources in surrounding Townships (Guelph/Eramosa and Puslinch) would require concurrence of both the respective Townships and the County of Wellington.

Each quadrant within the City has been studied extensively, with the City undertaking monitoring and groundwater exploration programs in support of the existing operating wells, and in reviewing the feasibility of possible future new groundwater supply sources. Of note here is that potential groundwater sources outside of the City boundaries considered in this WSMP Update are consistent with the 2014 WSMP, where the potential source locations considered were limited to a distance within approximately 5 km of the City limits. This parameter was initially determined with consideration to limiting potential impacts on surrounding municipalities, as well as the practicality of connecting to the City's existing water distribution system. However, if insufficient supply was determined to be available to satisfy projected demands to 2051, this distance could be revisited.

5.3.1 Approach

The first step in the evaluation of groundwater sources was to review the potential sources on a City quadrant basis and identify those that could potentially provide additional capacity. Potential opportunities for expansion of the existing groundwater supply system are grouped into the alternatives below, following the order established in the 2014 WSMP:

- Alternative 2A - Optimize existing municipal sources
- Alternative 2B - Restore off-line municipal sources
- Alternative 2C/D - Develop municipal test wells (includes Dolime Quarry)
- Alternative 2E - Develop new sources inside City
- Alternative 2F - Install new ASR wells inside City to optimize excess Arkell Collector system volumes
- Alternative 2G - Develop new wells outside City

Each groundwater source was evaluated using the updated Tier Three Model and documented in two Technical Memoranda (**Appendix B and D**). The memorandum included in **Appendix B** was initiated in response to updated growth targets provided by the Province in August 2020 within the updated Place to Grow plan ('the Growth Plan') (MMAH, 2020). The amended Growth Plan will place increased pressure on water supply resources available to the City within the 2051 planning horizon. Planning for this growth is complicated by the available capacity in existing and potential wells within the City limits. While additional water (surface water and groundwater) is likely available in the surrounding area, there are significant political challenges associated with developing these water supply sources to service the City. Following the completion of this initial assessment, the second memorandum (**Appendix D**) includes the assessment completed on additional potential sources.

The Tier Three Model is applicable to studying potential impacts from long-term average pumping to determine sustainable system pumping rates. It is acknowledged that pumping at higher short-term rates to meet maximum system demand at a given potential well(s) could be locally sustainable. PTTWs previously issued by the MECP to the City have either been single well permits with a maximum rate for the source, or well field permits that include individual maximum well rates and an overall well field maximum rate (e.g., Arkell Spring Grounds). Applications for these permits have been supported by extensive field testing, often consisting of an Operational Testing Program that evaluates the long-term sustainability within an area of the City surrounding a new source. Based on the current permitting process, a conservative approach was taken for the WSMP Update, wherein the average pumping rate evaluated by the Tier Three Model was considered to be sustainable and identified as the available capacity of a given source that would contribute to the overall system capacity. Using this approach, the additional supply that has been demonstrated by the City through field testing to be locally sustainable would contribute to system redundancy and permit operational flexibility.

The cost estimates developed for the evaluation of alternatives consider the maximum capacity of a given source where it has been demonstrated in the field and the modelled sustainable capacity for the sources where field data are not available (i.e., no redundant supply is assumed for these sources). An example of the latter approach is potential new wells outside of the City, where no field work has yet been completed to assess local hydrogeological conditions. As such, the evaluation of these sources is desktop based. With this approach, the best available information is used to estimate the facility size that will be required and associated costs. Through the completion of individual Class EAs for the identified projects that are pursued by the City, detailed cost estimates will be developed that consider the site-specific information that is developed for each project. Review of this information will consider the cost implications of each alternative with an objective of optimizing the overall system capacity such that it balances the cost of operating existing wells and developing new wells.

5.3.2 Optimize Existing Municipal Sources

In general, 'optimizing' existing wells requires a review of operational and maintenance activities for current facilities to ensure that the potential hydrogeological capacity can be achieved to meet peak demands. The only well identified as possibly having additional capacity available as compared to its current PTTW allocation is the Downey Well, which could potentially pump at a rate of 5,700 m^3/day. Based on preliminary outputs from the 2007 SWQ Class EA study and modelling completed for the current WSMP Update, an estimated additional total long-term capacity of 4,500 m^3/day is available from the SWQ without resulting in potential environmental effects (under historical Dolime Quarry water management conditions).

The City is currently undertaking the Southwest Guelph Water Supply Class EA and associated OTP. An increase to the current PTTW allocation for the Downey Well could form part of the Class EA preferred solution; however, this option would need to be evaluated alongside the other SWQ water supply alternatives. As such, the Downey Well was not evaluated in detail herein, but will be evaluated through the noted Class EA process, which will assess the amount of water available within the SWQ following closure of the quarry.

5.3.3 Restoration of Existing Off-line Municipal Sources

This alternative includes wells that are currently permitted by MECP, but that the City has discontinued their use due to concerns regarding existing water quality issues. In general, these wells require upgrades for water quality treatment and to provide the required disinfection contact time. Most of these facilities will require the completion of Class EA studies to establish recommended treatment systems. The primary method for evaluating the potential sustainable capacity associated with each source was use of the Tier Three Model, as documented in **Appendix B and D**. The potential for future operation of these sources is discussed below.

The Edinburgh and Admiral wells, both permitted by MECP, were considered in the preliminary screening step of the WSMP Update but were not carried forward to the detailed evaluation of alternatives. The future incorporation of these wells into the City system should be reviewed through the Southwest Guelph Water Supply EA and the associated OTP.

Southeast Quadrant

Lower Road Collector

Located on the Arkell Spring Grounds, the Lower Road Collector system extends along the lower slope of the Eramosa Valley wall, eastwards from Watson Road to the northern extent of the Glen Collector System. Groundwater taking from the Lower Road Collector is permitted by the Arkell Spring Grounds collector system PTTW. A review of historical collector production records indicates that the Lower Road Collector produced between 600 and 6,000 m^3/day. Due to GUDI water quality concerns and the related treatment requirements for GUDI sources, the Lower Road Collector System was disconnected in October 2000, coincident with reconstruction of the section of aqueduct along this alignment. The collector would require a full re-build to return to service. The Tier Three Model assessment indicated that a re-built collector could add 4,000 m^3/day to the current minimum collector output. Given the level of calibration of the model to collector flows, this should be considered a screening level result that would require detailed field investigation and feasibility assessment prior to implementation.

Coordination with the on-going Water and Wastewater Servicing Master Plan indicates that the F.M. Woods UV system has sufficient capacity for the total flows from Arkell. Limitations, that may be partially addressed through infrastructure upgrades, have been identified for flow rates associated with the combined maximum capacity of the Arkell wells and collector PTTW maximum (C3, 2018). This was completed on a preliminary basis and would require confirmation through a groundwater modelling assessment. As an element of the additional work required to define this alternative, consideration may be given to design aspects that could improve the in-situ water quality such as the use of a sand filter bed at the collector intake (i.e., perforated pipe).

The Arkell Collectors are located near the Eramosa River and Eramosa River Blue Springs Creek Provincially Significant Wetland complex. As this is a previously permitted water source and an increase to the PTTW maximum[16] for the system is not being proposed, it is not anticipated that future operation of the Lower Road Collector would cause an impact to the natural

16. The Glen and Lower Road Collectors are included on a single PTTW with a maximum permitted flow rate of 25,000 m^3/day.

environment. As the system has been offline since 2000, a review of existing conditions would be required to confirm this interpretation.

It is assumed that a Schedule B Class EA would be required to reconstruct the collector as the project would require a review of potential environmental impacts and consideration of treatment requirements.

Modelling was also completed to assess the potential for increasing the capacity of the artificial recharge system on site. This system pumps water from the Eramosa River under a surface water PTTW that allows pumping at variable rates from mid-April to mid-November, when there is sufficient flow at specified downstream flow gauges. The pumped water is discharged to an open-bottom pond and trench system (the infiltration system). The water then infiltrates into the overburden and follows the natural groundwater flow direction towards the river. The Glen Collector intercepts a portion of this additional water (estimated to be approximately 50%; C3 Water Inc., 2019), while the balance is likely naturally discharged back to the river. The current pump that draws water from the river limits the maximum discharge to the infiltration system to about 8,640 m^3/day or about 27% of the PTTW maximum (31,795 m^3/day). The modelling assessment indicated that increasing the capacity of the artificial recharge system would not significantly increase the annual minimum Glen Collector flows; however, an increase to the peak flows was simulated. As additional productivity from the Arkell site provides the City with flexibility in terms of how the overall system is managed and could contribute to a future ASR system, it is recommended that system upgrades be pursued. Further, re-construction of the Lower Road Collector could potentially improve the overall efficiency of the artificial recharge system. These upgrades would generally consist of: i) pump replacement with a single double-stage vertical turbine pump with a variable frequency drive; ii) replacement of the pump support platform within the river; and, iii) installation of a concrete slab at the riverbed to prevent excess sediment from entering the pump. Planning for these upgrades should consider re-construction of the Lower Road Collector, such that the recharge system provides a maximum benefit to both collector systems. The cost estimate to develop the Lower Road Collector alternative is based on a capacity of 4,000 m^3/day (**Table 5-10**)[17].

17. Supply chain issues related to the COVID-19 pandemic have introduced uncertainty into the cost estimating process. Certainty is highest for short-term projects where recent project budgets are available for review and are factored into the estimates presented herein. Cost estimates for medium and long-term projects will be refined through future updates to the WSMP.

Northeast Quadrant

Clythe Well

The Clythe Well is a municipal supply that was taken offline in 1999 due to naturally occurring water quality issues. In 2018, the City completed the Clythe Well Upgrade Municipal Class EA and determined that the well could be brought back into service with the construction of a new water treatment facility. Construction of this new facility is anticipated to be completed in 2023. The Clythe Well has a PTTW with a maximum daily rate of 3,395 m^3/day.

The modelling assessment estimated a sustainable capacity for the Clythe Well with consideration of potential effects on the natural environment. The well is located near Clythe Creek and the Clythe Creek Provincially Significant Wetland (PSW) and under long-term pumping conditions the modelling assessment indicated the potential for a greater than 10% baseflow reduction to Clythe Creek. Although the creek has historically been identified as a coldwater feature, current temperature monitoring suggests that the middle and lower reaches of the creek, in the vicinity of this well, are no longer coldwater. With respect to the modelling results, the Tier Three Study (Matrix, 2017) noted that insufficient data were available to calibrate the model to shallow conditions locally. As such, the results presented herein should be considered preliminary and further evaluated along with future field data, such as that associated with on-going City investigations designed to build on the understanding of the potential for interaction between the well and natural environment. The cost estimate to develop the Clythe Well alternative is based on the upper range of the steady-state modelled capacity of 1,180 m^3/day and the field tested rate of 3,370 m^3/day (**Table 5-10**). It is anticipated that the modelled capacity value is conservative with respect to the potential for impacts to the natural environment.

Northwest Quadrant

Sacco and Smallfield Wells

Two municipal groundwater supply sources (Sacco and Smallfield) are currently permitted for operation; however, these wells remain inactive and off-line since about 1994 due to groundwater quality concerns. The groundwater source from the Smallfield Well has been adversely impacted and has consistently contained TCE concentrations that exceed the ODWQS maximum acceptable concentration (MAC) of 5 μg/L. Low level concentrations of PCE, 1,1-dichloroethylene, 1,1,1-Trichloroethane, dioxin and furans, and 1,4-dioxane have also been detected in the well, and chloride has been reported above the ODWQS Aesthetic Objective of 250 mg/L.

The sources of groundwater contamination have been identified as comprising several industrial properties in the area of the Smallfield Well, where TCE concentrations have been reported as high as 4,000 times the ODWQS MAC. At the request of MECP, investigations of these sites have been ongoing since about 1994; however, no active groundwater remediation has taken place and the aquifer targeted by the Smallfield Well remains unchanged from when the well was shut down in 1994. The City has engaged in ongoing discussions with MECP regarding the status of the contaminated sites and the need for actions to address groundwater contamination and its impact on the City's drinking water sources.

Groundwater quality at the Sacco Well has indicated detectable levels of TCE that remain consistently below the ODWQS MAC and low levels of PCE and 1,1-dichloroethylene.

Potential well capacities for the Smallfield and Sacco well are 1,408 and 1,150 m^3/day, respectively, as concluded in a rehabilitation and performance assessment completed by the City in 2008. However, due to groundwater contamination that is known to exist in the NWQ, operation of the Sacco Well has the potential to re-distribute existing contamination within the bedrock aquifer, resulting in further water quality impacts. With continued pumping of the Sacco Well, there is the potential that groundwater from contaminated sites in the area may be drawn into the capture zone of the well, thereby resulting in further water quality impacts.

The modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from the Sacco, Smallfield and Hauser Wells. Testing completed by the City in 2009 (Stantec, 2009) has demonstrated a capacity of 1,150 m^3/day for the Sacco Well and 1,408 m^3/day for the Smallfield Well. Additional capacity developed from these wells would contribute to system redundancy. In 2014, the City completed a treatment study for these wells that provided cost estimates for four options to return the wells back to service that included manganese dioxide oxidation-filtration followed by granular activated carbon treatment (Gamsby and Mannerow Ltd., 2014). For the purpose of this assessment, it is assumed that the option of constructing a water treatment facility at the City-owned Smallfield Well site would be implemented, as additional property would be required to construct a treatment facility on the Sacco Well site. Currently the Sacco well is not contained within a well house. The cost estimate presented below assumes that the well would be outfitted with a submersible pump and electrical panel to pump water to the Smallfield site via a raw watermain. This strategy is accounted for in the associated cost estimate, which is developed based on the full potential capacity of these wells of 2,560 m^3/day (**Table 5-10**).

The sources of contamination in the NWQ have been identified as several industrial properties in the Smallfield Well Head Protection Area which were assessed as conditions resulting from past activities in the Grand River Source Protection Area Assessment Report (2019). The aquifer targeted by the Smallfield Well remains as contaminated today as when it was taken offline in 1994. The extent of contamination on adjacent properties, the potential liability associated with re-distributing groundwater contamination and lack of remediation or source control are considered to be significant impediments to the development of these wells or other water supply sources in the NWQ. Since the City has limited authority to implement actions related to groundwater contamination on private property, further source investigations and source control/remediation, to be led by MECP, will be required to develop these wells.

For the return to service of these wells, there remains great uncertainty and risk for the City in the design of a treatment system with respect to the maximum raw water contaminant concentrations, the concentration trend with time, the duration of treatment, and the potential liability of pulling contaminated groundwater across areas which are not yet impacted. To that end, the City is proposing to de-prioritize these already permitted water supply sources through the WSMP Update, until such time as the sources of groundwater contamination in the area have been remediated. However, these wells should remain as part of the WSMP as future drinking water sources (i.e., post-2051, or until source remediation occurs).

Summary

The sustainable additional quantity of groundwater that has been determined to be available from these sources through the modelling assessment is 6,030 m^3/day. **Table 5-10** summarizes the cost estimate for capital works for preliminary investigations, design, land acquisition[18] (where required), construction of new wells and treatment systems, and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour, maintenance and energy costs.

Table 5-10: Summary of Cost Estimates for Off-Line Municipal Sources

Description	Clythe Well	Smallfield/ Sacco Wells	Lower Road Collector
Potential Capacity Range [m^3/day]	1,180 – 3,370	850 – 2,560	4,000
Capital Cost (incl. contractor overhead)	**$4,717,000**	**$8,394,000**	**$9,478,480**
Estimating Contingency	$1,356,000	$2,623,125	$2,585,040
Engineering and Construction Service	$707,550	$2,098,500	$1,809,528
GRAND TOTAL^	**$6,781,000**	**$13,116,000**	**$13,874,000**
Cost per m^3/day	$2,012	$5,127	$3,469

Notes: *Included in above cost.
^Total values are rounded.

5.3.4 Develop Existing Municipal Test Wells

An extensive review and assessment of existing municipal test wells was undertaken to determine potential well yields and water quality treatment requirements. Test wells/ observation wells for which modelling has indicated potential capacities are shown in **Figure 4-1**. It is noted that these wells are located in areas both within and outside the City's boundary. The Fleming and Logan wells are located immediately east of the City boundary

18. Land acquisition cost estimates, where required, are based on current market values and will be updated in subsequent WSMP Updates to reflect land values estimates at that time.

on Eastview Road, on City-owned property. Based on the information available from previous studies including pumping tests and water quality testing of the test wells, there is generally more certainty regarding these alternatives in regard to location, potential yields and treatment requirements. The City can more readily move toward next steps including Class EA, treatability studies and permitting, should these be included as part of the recommended solution.

Southwest Quadrant

Steffler, Ironwood, and Guelph South (GSTW1-20)

Through the 2007 SWQ Class EA study, two large diameter test wells (named 'Ironwood' located in University Village Park and 'Steffler' located in Steffler Park; **Figure 4-1**) were installed and tested over an extended period at capacities of 8,000 and 3,600 m^3/day, respectively, to determine potential capacities and to monitor potential effects on other municipal supply wells, private wells, and surface water features. The SWQ Class EA study was put on hold by the City in 2010 due to groundwater quality and quantity concerns related to operations at the Dolime Quarry. Since that time, the City has worked with the quarry owners (River Valley Developments; RVD) to identify a viable solution to protect the drinking water source. Now agreed-upon by both parties, this three-fold strategy includes: i) closing the quarry; ii) bringing the quarry property into the municipal boundary; and, iii) controlling the quarry pond water level via an on-site water management system operated by the City (referred to as Pond Level Management; PLM). The PLM strategy will be evaluated as a source protection strategy within the Southwest Guelph Water Supply Class EA (a continuation of the SWQ Class EA). The water supply opportunity is associated with the use of municipal and/or test wells to capture of some of the water currently pumped to the Speed River as part of the dewatering operations of the quarry.

In 2019, the City initiated the Guelph South Groundwater Supply investigation to assess the capacity of test well GSTW1-20, located in the Hanlon Creek Business Park in southwest Guelph (**Figure 4-1**). This work indicated that the test well has a capacity of approximately 4,320 m^3/day (based on a 30-day pumping test). This project is on-going, and this well will be considered within the Southwest Guelph Water Supply Class EA and this WSMP Update.

A total objective for additional groundwater supply from Southwest Guelph of 4,500 m^3/day may be available through new municipal wells (i.e., Ironwood, Steffler, GSTW1-20) alone, or through a combination of new wells plus optimizing existing wells including reactivating existing off-line wells requiring treatment. The ongoing Southwest Guelph Water Supply Class EA will aim to fulfill two main objectives: i) to manage the operation of existing and new wells in Southwest Guelph to sustainably capture as much groundwater locally as possible thereby minimizing the inflow of groundwater to the quarry; and, ii) to manage the level of the quarry pond through pumping to the Speed River to minimize the potential for quarry water influx to the groundwater aquifer, thereby keeping the municipal supply safe. Subject to the technical assessment process, the Class EA may consider the feasibility of an additional alternative of capturing groundwater directly from the quarry as a potential future source. It is noted that the additional capacity identified in Southwest Guelph of 4,500 m^3/day was under historical quarry operating conditions and that the OTP being completed may determine that additional capacity is available to the surrounding wells through quarry PLM.

As it is assumed that the City will move forward with the Council-approved plan to bring the quarry site into the municipal limits, this alternative is considered alongside those within the City.

Consistent with previous work, the Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,500 m^3/day to the overall system capacity under current quarry dewatering conditions. These wells have demonstrated individual well capacities above this combined capacity of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively. Therefore, additional capacity developed from these wells would contribute to system redundancy. Baseflow reduction of >10% was simulated using the Tier Three Model for Hanlon and Irish Creeks, although there is uncertainty with the results for Irish Creek due to its proximity to the model boundary. These test wells will be further assessed through a detailed Operational Testing Program being completed for the Southwest Guelph Water Supply Class EA, including monitoring of surface water features for baseflow reductions and potential effects to municipal and non-municipal wells. This testing will also further assess the presence of antimony in the groundwater, which was detected in previous testing at the Ironwood and Steffler Wells but deemed to be spurious.

The Ironwood and Steffler Wells are located in municipal parks with sufficient area for well house facilities. The Guelph South Well site also has sufficient available land for a well facility.

The cost estimates for these test wells are presented in **Table 5-11** and are based on the noted individual well capacities of 3,600, 8,000, and 4,320 m^3/day for Steffler, Ironwood and Guelph South, respectively.

Table 5-11: Summary of Cost Estimates for Municipal Test Wells

Description	Fleming/ Logan	Guelph South	Steffler	Ironwood	Hauser	Dolime
Potential Capacity Range [m^3/day]	4,180 – 4,700	2,250 – 4,320	2,250 – 3,600	2,250 – 8,000	425 - 900	1,000 - 3,000
Capital Cost (incl. contractor overhead)	**$6,902,500**	**$3,279,100**	**$4,231,700**	**$3,501,300**	**$3,984,200**	**$13,399,800**
Estimating Contingency (30%)	$1,882,500	$894,300	$1,154,100	$954,900	$1,086,600	$3,485,400
Engineering and Construction Service (15%)	$1,317,750	$626,010	$807,870	$668,430	$760,620	$2,091,240
GRAND TOTAL*	**$10,103,000**	**$4,800,000**	**$6,194,000**	**$5,125,000**	**$5,832,000**	**$18,976,440**
Cost per m^3/day	$2,150	$1,111	$1,721	$640	$6,480	$6,325

Notes: * Total values are rounded.

Dolime Quarry

Significant dewatering occurs within the Dolime Quarry on an on-going basis to maintain the water level within the quarry pond (i.e., to prevent flooding of the quarry). Groundwater inflow into the quarry occurs primarily through the Gasport Formation, the main source of municipal groundwater supply. Historically, dewatering in the quarry has occurred up to the PTTW maximum for the site of 13,750 m^3/day; however, the dewatering rates are influenced by municipal pumping patterns at the surrounding wells. Recent dewatering rates, as reported by the quarry owners (RVD), have typically ranged from 8,000 to 11,000 m^3/day. The agreement in place between the City and RVD includes, in part, the City assuming control of water management, thereby controlling the groundwater elevation within the quarry at a level below the surrounding area, resulting in groundwater inflow to the quarry pond (via a hydraulic gradient). At some distance away from the quarry, a maximum groundwater level would occur and represent a flow divide. On either side of the divide, groundwater would flow in opposite directions (i.e., into the quarry on one side and toward the municipal wells on the other). This strategy will be evaluated as a potential alternative within the on-going Southwest Guelph Water Supply Class EA. The Class EA will include an Operational Testing Program that will evaluate the strategy outlined above with a goal of maximizing the amount of water that is captured by the surrounding municipal wells and test wells (above the 4,500 m^3/day additional capacity estimated with active dewatering), while at the same time minimizing the amount of groundwater that flows into the quarry.

Through this process, the City will determine the pumped flow from the quarry necessary to protect the water supply and, subject to the technical assessment process, the Class EA may consider the feasibility of an additional alternative of capturing groundwater directly from the quarry as a potential future source. In terms of the volume of water that could be available directly from the quarry, it is anticipated that it would be less than the 8,000 to 11,000 m^3/day typically pumped in the 2019 to 2020 period, as a portion of this would be captured by existing and new wells. The groundwater modelling assessment reported daily groundwater discharge to the quarry that ranged from approximately 3,400 to 6,100 m^3. Acknowledging the uncertainty in assigning a potential volume that could be available from the quarry under Pond Level Management, a conservative range of 1,000 to 3,000 m^3/day was carried forward for costing and evaluation purposes. There is little water quality information available for the quarry discharge; for evaluation purposes it is assumed that this source may be considered surface water and therefore would require filtration and enhanced disinfection.

The cost estimate for the Dolime Quarry water treatment facility, provided in **Table 5-11**, is based on a capacity of 3,000 m^3/day. The cost for a full scale water treatment facility is high and will be refined through the Southwest Guelph Water Supply Class EA and associated Operational Testing Program. For example, the primary objective of this testing is to develop a strategy for protecting groundwater quality within the Gasport aquifer, while optimizing the volume of water available to the existing municipal supply wells and potential new supply wells (test wells). Capture of this water through the well network would result in a substantially lower cost, as the bulk of the associated cost is included in the cost estimates for development of the individual test wells. The cost presented in **Table 5-11** should be considered a conservative value that will be refined through the noted process.

Northeast Quadrant

Logan and Fleming

The City has previously installed test wells in the area of Eastview Road and Watson Road; referred to as the Logan and Fleming Wells, respectively. Both wells are located on City-owned property outside of the municipal limits and within Guelph/Eramosa Township.

The Tier Three Model assessment concluded that these wells could contribute an additional capacity of 4,180 m^3/day, similar to the 2014 WSMP result of 4,700 m^3/day. In 2020, testing was completed at the Logan well to assess its integrity and to evaluate water quality within both the shallow and deep aquifer (Well Initiatives, 2020). Based on this testing, the City has initiated a project to reconstruct the Logan Test Well to target the Gasport aquifer by drilling out the existing borehole to below the Vinemount Member (regional aquitard) and installing a new casing. This project will include an assessment of potential effects on surrounding private wells and the natural environment. As this test well is located on City-owned property outside of the City, there is a higher density of active private wells. The test well is also located near the Guelph Northeast PSW and a tributary of the Speed River. The property on which this test well is located is anticipated to be large enough for a future facility. Consultation with Guelph/Eramosa Township will be required to develop the Logan supply. The cost estimate presented in **Table 5-11** is based on a capacity of 4,700 m^3/day.

If the City pursues a potential municipal water supply the Fleming site in the future, a new well would be required as the original test well has been converted to a multi-level monitoring well.

Northwest Quadrant

Hauser

The City possesses a former test well in the NWQ referred to as the Hauser Well. A potential issue within this area of the City is the presence of known contamination (TCE), as discussed in relation to the Smallfield Well.

The groundwater modelling assessment estimated a sustainable additional capacity for the NWQ of 1,275 m^3/day, which would include pumping from Sacco, Smallfield and Hauser. The estimated capacity of a well at this site is approximately 900 m^3/day; however this requires significant study for verification. Additional studies would be required to determine if water quality impacts would occur from long-term pumping due to known contaminated sites in the Smallfield Well area located 2.2 km to the northeast. Future work should also focus on potential effects to the local natural environment, which includes Ellis/ Chilligo Creek and the Ellis Creek PSW Complex. A new well would be required to develop this alternative. For costing purposes, it is assumed that iron and manganese treatment would be required for this well, as water quality data are not available for the test well. This estimate is presented in **Table 5-11** and reflects a capacity of 900 m^3/day.

Summary

The total increase in a potential quantity available from these wells is 12,105 m^3/day; including 4,500 m^3/day from SWQ wells and 3,000 m^3/day from the Dolime Quarry. **Table 5-11** summarizes the cost estimate for capital works for preliminary investigations, design, land acquisition (where required), construction of new wells and treatment systems, and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour, maintenance and energy costs.

5.3.5 Develop New Wells Outside City Boundaries

Guelph Southeast

A potential test well area, located southeast of the City (east of Victoria Road, on Maltby Road) within the Mill Creek catchment area was modelled in the completed assessment. This location, within Puslinch Township, was established through a review of the Tier Three Model parameters, and a nearby municipal monitoring well (MW08-T3-09). No detailed testing or site-specific information is available, and the estimated capacity result is based solely on model interpretation. The rationale for this location is its proximity to an area with high transmissivity within the Gasport Formation bedrock aquifer and limited local groundwater usage (i.e., nearby golf course well operating at 660 m^3/day seasonally). The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 1,600 m^3/day on an average basis with a low potential for impacts to baseflow within Mill Creek. Groundwater quality from a source in this area is unknown and therefore it is conservatively assumed that iron and manganese treatment would be required. The cost estimate for the Guelph Southeast Well is included in **Table 5-12** and is based on the modelled capacity value of 1,600 m^3/day.

Guelph North

A second potential test well area, located north of the City (the western limit of Conservation Road) within the Marden Creek catchment area was modelled in the completed assessment. This location was established through a review of the Tier Three Model parameters, and no detailed testing or site-specific information is available. The estimated capacity result is based solely on model interpretation. The rationale for this location is its proximity to an area with high transmissivity within the Gasport Formation bedrock aquifer and limited local groundwater usage (i.e., two Guelph/Eramosa Township community wells with a combined permitted rate of 2,022 m^3/day). The estimated available sustainable capacity of a modelled groundwater supply well in this general area is 2,935 m^3/day on an average basis. A baseflow reduction greater than 10% was modelled for Marden Creek. Groundwater quality from a source in this area is unknown and therefore it is conservatively assumed that iron and manganese treatment would be required.

Future work associated with the Guelph Southeast and North locations would require a detailed assessment of potential impacts on surrounding private wells and the natural environment after specific potential well locations are identified. As these well areas are located outside of the City, there is a higher density of active private wells. New property would be required for test wells and future well facilities. Consultation and collaboration with

Puslinch Township (Southeast) and Guelph/Eramosa Township (North) would be required in advance of initiating these projects.

The cost estimate for this alternative is included in **Table 5-12** and is based on a capacity of 2,935 m^3/day.

Summary

The total modelled sustainable increase in overall capacity related to these hypothetical well locations is 4,535 m^3/day. **Table 5-12** summarizes the cost estimate for capital works for preliminary investigations, design, land acquisition (where required), construction of new wells and treatment systems, linear distribution and approvals. In addition to the capital costs, operating and maintenance costs were also estimated including labour, maintenance and energy costs.

Table 5-12: Summary of Cost Estimates for New Wells Outside of City

Description	Guelph SE	Guelph N
Potential Capacity (average) [m^3/day]	1,600	2,935
Capital Cost (incl. contractor overhead)	**$4,688,200**	**$8,772,940**
Estimating Contingency (30%)	$1,278,600	$ 2,392,620
Engineering and Construction Service (15%)	$895,020	$ 1,674,834
GRAND TOTAL*	**$6,862,000**	**$12,841,000**
Cost per m^3/day	$4,289	$4,375

Notes: * Total values are rounded.

5.3.6 Arkell Collector System ASR Wells

Review of the current Glen Collector system and off-line Lower Road Collector system flows indicates high seasonal variability, with elevated flows in the spring (April, May, June), which do not correspond to a period of high demand that traditionally occur during the summer months. As a result, this water may not be available to the distribution system and these flows cannot be considered as part of the maximum system daily supply capacity. ASR is a strategy where excess flows from the collector systems would be treated (potable) and then stored within an aquifer during periods of water surplus (i.e., when capacity exceeds demand) and subsequently this volume of stored water would then be recovered during periods of water shortage (i.e., when demand exceeds existing capacity). For this assessment, the Guelph Innovation District Lands were assessed as a potential location for ASR injection and recovery wells.

The advantage of this ASR alternative is that a surface water treatment plant may not be required as it would be if water were to be taken directly from the Eramosa River (the Eramosa River was determined to have insufficient capacity to support additional surface water pumping). The additional seasonal volumes from the collector systems would be discharged to the existing aqueduct to combine with other Arkell wellfield supplies for disinfection at the Woods PS through the UV system as they are currently. Treatment requirements would need to be confirmed through water quality testing and consideration of MECP’s pending, revised GUDI TOR. Through coordination with the Water and Wastewater Servicing Master Plan, it was determined (on a preliminary basis) that the aqueduct and the F.M. Woods facility have sufficient design capacity to accommodate the additional flows contemplated in this alternative, but this would require verification through a detailed assessment of the infrastructure capacity. Limitations, that may be partially addressed through infrastructure upgrades, have been identified for flow rates associated with the combined maximum capacity of the Arkell wells and collector PTTW maximum (C3, 2018).

The excess volume available to the ASR system would be pumped into the distribution system and delivered to the ASR well locations, similar to a large customer demand, for dechlorination, injection and storage in the aquifer.

In concept, the ASR system would consist of a series of wells arranged in one or more wellfields that would inject treated water for storage in the deep bedrock (i.e., injection mode) when excess water is available. When water is required from storage, the same wells would be used to recover the water (i.e., extraction mode). The water recovered from the ASR wells would require disinfection prior to distribution. Depending on the configuration of the system, the wells could pump to reservoirs prior to distribution or directly into the distribution system. Extensive studies are required to evaluate the feasibility of this alternative with respect to excess water available from the Arkell collector systems as well as appropriate areas to install wells to ensure optimal hydrogeological properties. Another important consideration is the location of the system and number of wells needed to ensure the most advantageous input into the distribution system from an operational perspective to facilitate additional supply scenarios. However, from a feasibility perspective, the Gasport Formation bedrock aquifer is known to have high transmissivities and cavernous porosity in areas as well as being confined at depth by the Eramosa Formation, all of which make the aquifer ideal for ASR. While testing would still be required, the Gasport Formation bedrock is considered to be highly feasible for ASR.

To assess the feasibility of an alternative that captures a portion of the excess flow available from the Arkell collector systems, the modelling output for the Lower Road Collector replacement scenario was reviewed. This provided an estimate of combined Glen Collector and Lower Road Collector flows. If upgrades to the artificial recharge system are pursued, excess water above that described herein would be available during the spring period.

The estimated excess flow available from the collectors for ASR in April to June was determined by first removing the volume that would be required to address daily customer demand (i.e., assumed to flow directly to distribution). The remaining monthly volume (451,000 m^3) is that which is excess and available to inject into the ASR system. For the remaining months of the year (July to March), the ASR system would operate in extraction mode for a total extraction of 451,000 m^3 (**Table 5-13**).

Table 5-13: Summary of Estimated Arkell Spring Grounds Flows Available for ASR

Month	Excess Collector Flow (m^3/mo.)	Estimated System Demand (m^3/mo.)	Volume to ASR (m^3/mo.)	Volume from ASR (m^3/mo.)
Jan	0	49,600	0	49,600
Feb	0	51,000	0	51,000
Mar	0	51,700	0	51,700
Apr	93,900	50,600	43,300	0
May	195,100	51,200	143,900	0
June	317,500	53,700	263,800	0
July	0	52,200	0	52,200
Aug	0	50,800	0	50,800
Sept	0	52,100	0	52,100
Oct	0	49,000	0	49,000
Nov	0	48,800	0	48,800
Dec	0	45,800	0	45,800
TOTAL	606,500	606,500	451,000	451,000

The ASR system was simulated with six ASR extraction/injection wells located within the Guelph Innovation District Lands (**Appendix D**). Local hydrogeological conditions within the Tier Three Model (high hydraulic conductivity zone) suggest the potential for developing an ASR system in this area. Further, the Eramosa River passes through the site and is less vulnerable to potential baseflow impacts than smaller creeks within the Study Area. The modelling output suggests that the ASR wells should be operated at 60% of the target extraction rates tested in the model, while the existing municipal wells are operated at baseline rates (i.e., system total of 53,551 m^3/day). These were the rates identified to accomplish extraction at the ASR wells, while allowing the existing municipal wells to continue operating sustainably.

It was noted in the modelling results that some existing municipal wells have considerable available head and therefore there is likely an opportunity to increase pumping rates at those wells to capture more of the injected water. This is supported by other completed model scenarios that indicate sustainable total system pumping rates up to 82,370 m^3/day. The simulations showed that the influence of the injections caused increased groundwater level elevations in the surrounding area that extended as far as 10 km away from the ASR system. This indicates that the influence of the injection is dissipating far from the injection site and the injected volume is unlikely available to be extracted locally in its entirety within the Guelph Innovation District Lands. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option. It is recommended that additional work focus on the potential to site ASR wells that maximize the ability for existing municipal wells to form part of this alternative, thereby greatly reducing the associated cost.

In order to plan and design a full-scale ASR facility, pilot testing is required. Further, there is a need to evaluate site specific issues including water quality, known significant drinking water threats, geochemical reactions, aquifer hydraulics, recharge/ recovery capacity of individual wells, maximum feasible storage volume, maximum possible storage time, an optimal recovery strategy with respect to utilization of existing wells, and treatment requirements.

The Arkell Collectors produce high quality groundwater that is consistent with groundwater produced elsewhere in the City and is not anticipated to affect the feasibility of ASR. However, the design process must consider ASR geochemistry, which can be complex. It is necessary to study potential impacts of recharge water which could result in a decrease in the ability to transmit water into aquifer storage due to clogging of aquifers (i.e., reduction in the hydraulic conductivity of the aquifer matrix). Subsurface chemical reactions will depend on the water chemistry of the source water and native groundwater and the mineral composition of the aquifer materials; reactions are also a function of the temperature of the recharge water and injection pressure. Injection of water with a different geochemistry will establish a new equilibrium which can cause precipitation of minerals, and therefore lead to clogging of the aquifer and reduction in recharge rates; and can also cause increases in concentrations of dissolved minerals to levels above drinking water limits. Injection of ASR water has the potential to improve groundwater quality as in the case of dilution of impacted groundwater resulting from existing land use within urban areas. There are considerable studies to confirm the feasibility of ASR with respect to water quality issues. There are many existing case studies that demonstrate the feasibility of ASR in a number of different geological and hydrogeological settings, and the investigation process is well defined.

The intent of ASR is that on an annual basis, the ASR facility represents zero net withdrawal – therefore, no decline in groundwater levels within the aquifer and subsequently negligible environmental impacts. The completed modelling work indicates that system optimization would be required to develop a specific ASR strategy that best utilizes the existing municipal pumping network to fully capture the injected water. With an optimized strategy, a net zero injection/ withdrawal water balance would be achieved and significant interference effects on existing groundwater dependent natural features or users are not anticipated.

During further development of this alternative consideration should be paid to the possibility of using excess flows from the collector(s) during period of high seasonal flow to service customer demands while resting wells within the system. This strategy could potentially allow for recovery within the groundwater system, thereby allowing for pumping at higher rates when overall system demands are higher but collector flows are lower during annual dry periods. This strategy may require flexibility within the City’s PTTW to reflect variable maximum pumping rates throughout the year. Further, testing would be required to determine whether a strategy of resting wells would realize sufficient water level recovery to impact the maximum rate that a given well could operate at. This should be considered alongside further work to evaluate the ASR strategy, as there is a possibility that this could off-set the high anticipated costs of developing an ASR network.

Summary

The total potential additional system capacity from the Arkell ASR, subject to additional optimization evaluation, is 1,170 m^3/day (in consideration of the 60% extraction constraint). With optimization of both the artificial recharge system and the injection/ extraction strategy, it is anticipated that additional capacity is possible. This total capacity includes the combined direct to distribution volume and ASR extraction volumes averaged on an annual basis. The cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells, dechlorination and rechlorination systems, and approvals are provided in **Table 5-14**. In addition to the capital costs, the operating and maintenance costs were also estimated including labour, maintenance, and energy costs. The total cost presented is very high in comparison to other water supply alternatives and illustrates the need to further develop this alternative through an optimization strategy that maximizes the capacity available through ASR, minimizes the number of new ASR wells required for the system and utilizes existing municipal supply wells as part of the injection/extraction process.

Table 5-14: Arkell ASR Cost Estimate

Item Description	Total Cost
Capital Cost (incl. contractor overhead)	**$17,274,400**
Estimating Contingencies on Subtotal (30%)	$4,711,200
Engineering Design and Construction Services on Total (15%)	$3,297,840
GRAND TOTAL*	**$25,284,000**
Cost per m^3/day	$21,610

Notes: * Total values are rounded.

5.3.7 Non-Municipal Groundwater Supply Sources

The Tier Three Study documented non-municipal groundwater-takings within the study area that are permitted through MECP (Matrix, 2017), as operation of these sources affect the overall water balance within the WSMP Update study area. Should use of any of these groundwater sources be discontinued in future, this could present a potential opportunity to the City to incorporate the well/source into the municipal supply system, and/or optimize existing municipal wells to increase production accordingly. An example of this is the Dolime Quarry, which is discussed in detail within this document. Should any of the identified or new non-municipal groundwater source owners/operators seek to initiate or increase production, this could potentially pose a negative impact on the total capacity of the City's municipal sources within the area. Any new or increased permitted maximum(s) for non-municipal groundwater sources would be completed through the MECP approval process, which allows the City to review and comment on the application.

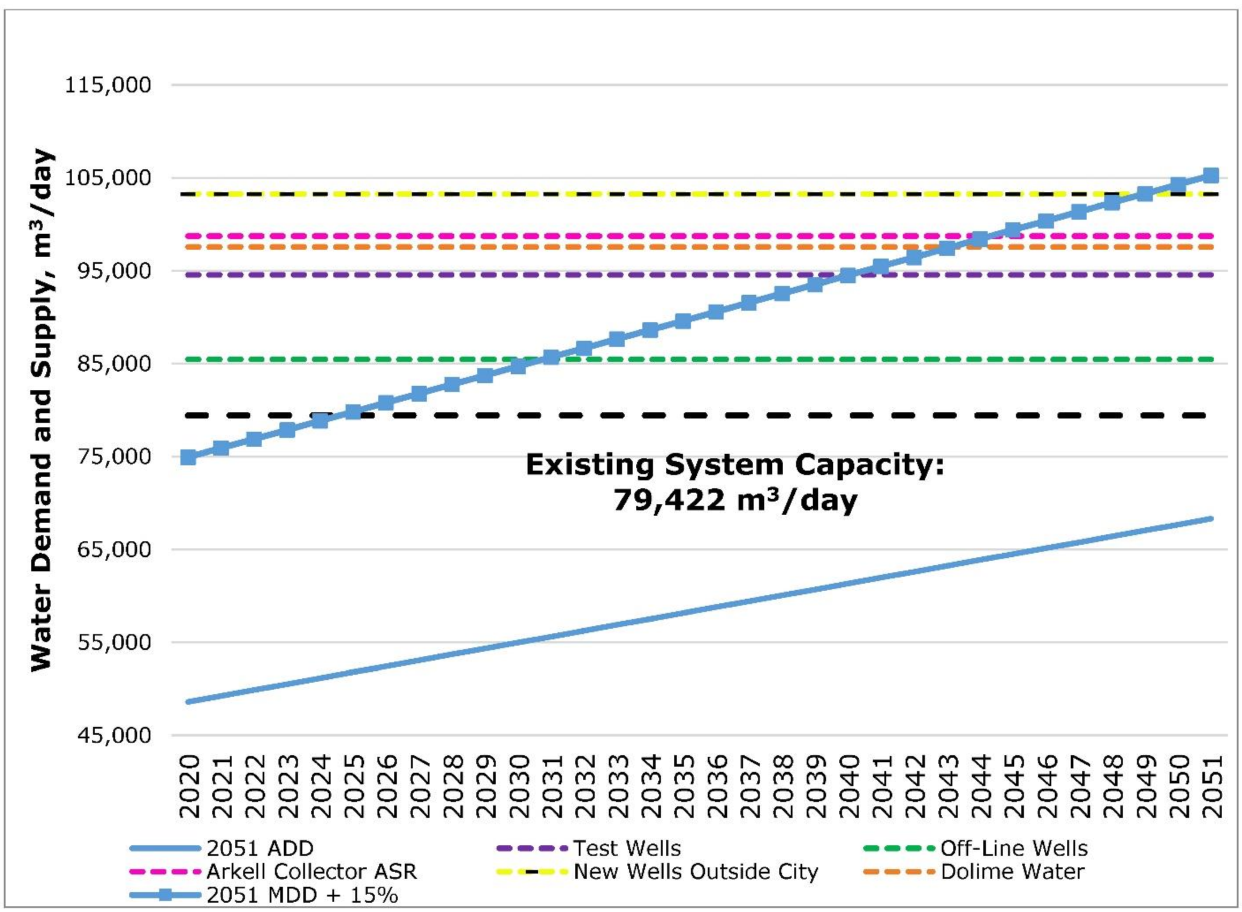
5.3.8 Groundwater Alternatives Summary

The evaluation of groundwater alternatives followed a conservative approach toward identifying potential additional system capacity. The Tier Three Model was used to determine a flow rate that could be achieved on a sustainable basis (average, long-term flow rates), while supporting pumping at existing and new municipal sources and affecting minor to moderate reductions to surface water baseflow.

As with any model, the Tier Three Model is a representation of the system and has associated uncertainties that must be acknowledged when reviewing the output. Previous modelling studies completed by the City indicate that the modelling results are typically conservative and field studies are required to further assess surface water and groundwater conditions with direct measurements and associated interpretation. These field studies would aid in reducing uncertainties and would likely support higher capacities from the evaluated sources. However, the Tier Three Model is the best planning tool available to the City for development of the Master Plan and the results of the modelling assessment have been used to develop a conservative assessment of the sustainable rate that each supply will add to the overall system capacity. A total of approximately 16,000 m^3/day of additional supply capacity from groundwater wells (off-line municipal wells, test wells, and new wells) was identified on an average day basis. This result was utilized in conjunction with available field testing to identify a potential range in capacity that may be achieved by each source. Similarly, other groundwater-based sources (Lower Road Collector, Dolime Quarry PLM, Arkell system optimization, and Arkell ASR strategy) were evaluated in the model to have an average capacity of approximately 8,000 m^3/day of additional flow. Capacity values are also presented for these sources as a range using the model results and available field information. Although individual sources included in the assessment may be able to provide higher short term capacity to meet maximum day demands, the summarized results provide an estimate of the additional available long-term sustainable capacity of groundwater sources within the WSMP Update study area. The work completed indicates that sufficient water supply sources are available to support planned growth within the City (when combined with conservation, efficiency and demand management programs – see Section 8); however, there are limits to the resource. Each detailed study completed to support resource development must assess both the local and City-wide sustainability of the source.

The resulting totals for the groundwater alternatives are shown in **Figure 5-2**, indicating the ability of identified sources to provide a portion of the required water supply capacity to meet the projected 2051 demand.

Figure 5-2: Water Demand Projection with Groundwater Alternatives



5.4 Establish New Surface Water Supply

During completion of the previous master plan updates, public response to the proposed alternatives clearly provided the direction to consider only local surface water as a feasible alternative in the City's goal to grow as a sustainable community. As such, the technical work completed in support of the WSMP Update included two possible local surface waters for assessment of volume available for taking water on a continuous or seasonal basis including the Speed River (at Guelph Lake) and the Eramosa River (at the Arkell Spring Grounds). The preliminary stage of the assessment indicated that the Eramosa River has sufficient flow to support the permitted Arkell taking in support of the artificial recharge system but does not have sustained excess flow that would support a local surface water supply. Therefore, only the Speed River/Guelph Lake option was carried forward to the detailed evaluation stage. The evaluation presented herein is based on results presented in the 2020 GRCA Technical Memorandum on the Surface Water Analysis for City of Guelph Long Term Water Supply Plan (**Appendix E**).

To contribute to the available supply capacity, surface water must either be treated to provide a continuous flow into the distribution system, or alternatively, excess water can be taken from the surface water when available, treated and stored underground in aquifers. This option is referred to as an Aquifer Storage and Recovery (ASR) system. The rate available from this source on a continuous basis is equal to the volume taken from surface water when available, treated and injected within a year, and removed over the period of a full year (i.e., seasonal use) or multiple years (i.e., banked storage).

For both continuous flow and ASR approaches, construction of a water treatment plant (WTP) is required to fully treat the surface water to meet Ontario Drinking Water Quality Standards (prior to distribution/ ASR injection). In the first option (no ASR), the WTP is sized to treat a continuous input to the plant with direct discharge to the City's distribution system. In the second option (with ASR), the WTP would be required to treat varying flows ranging from the continuous flow requirement to the maximum design capacity based on high seasonal river flows.

To evaluate potential quantity available through this alternative, the GRCA provided their expert opinion on the volume of surface water available in this managed watershed, utilizing historical flow information (1951 to 2019 period of record) and modeling tools. Through this evaluation, a base level water taking was established which would be available year-round, while maintaining minimum flows in the river and minimizing potential environmental impacts of reducing total river flows. The GRCA also reviewed historical records to establish the reliability of taking additional volumes during times of higher river flows. This was an iterative process which resulted in capping this higher flow rate at a level which would be reasonable for modular construction and operation of a WTP, such that it would be operating at three capacity levels each for a minimum period in any given year: a conservative scenario consisting of a municipal base taking of 150 L/s 100% of the time and two incremental steps (with regards to treatment capacity) of 300 L/s and 500 L/s was used as a starting basis to construct a stepped taking scenario. (Note that river flows are typically presented in units of Litres per second, L/s. For conversion to m^3/day, 150 L/s = 12,960 m^3/day, 300 L/s = 25,920 m^3/day, and 500 L/s = 43,200 m^3/day.)

The stream inflow supplying flow through the Guelph dam is not constant. It varies within the year and across years. Based on the taking scenarios described above, a chart of the daily inflow probability at the Guelph Dam for the 1950 to 2019 period was constructed which was used to determine which periods of the year were most likely to yield potential for the taking of 500 L/s and 300 L/s. The number of days for each of these takings was placed into different periods of the year that would yield the highest probability of the taking being available. The chart presented as **Figure 5-3** illustrates the inflow probability and the periods of the year when takings of 500 L/s and 300 L/s would most likely be available.

Figure 5-3: Stepped Surface Water Takings from Guelph Dam (GRCA, 2021)

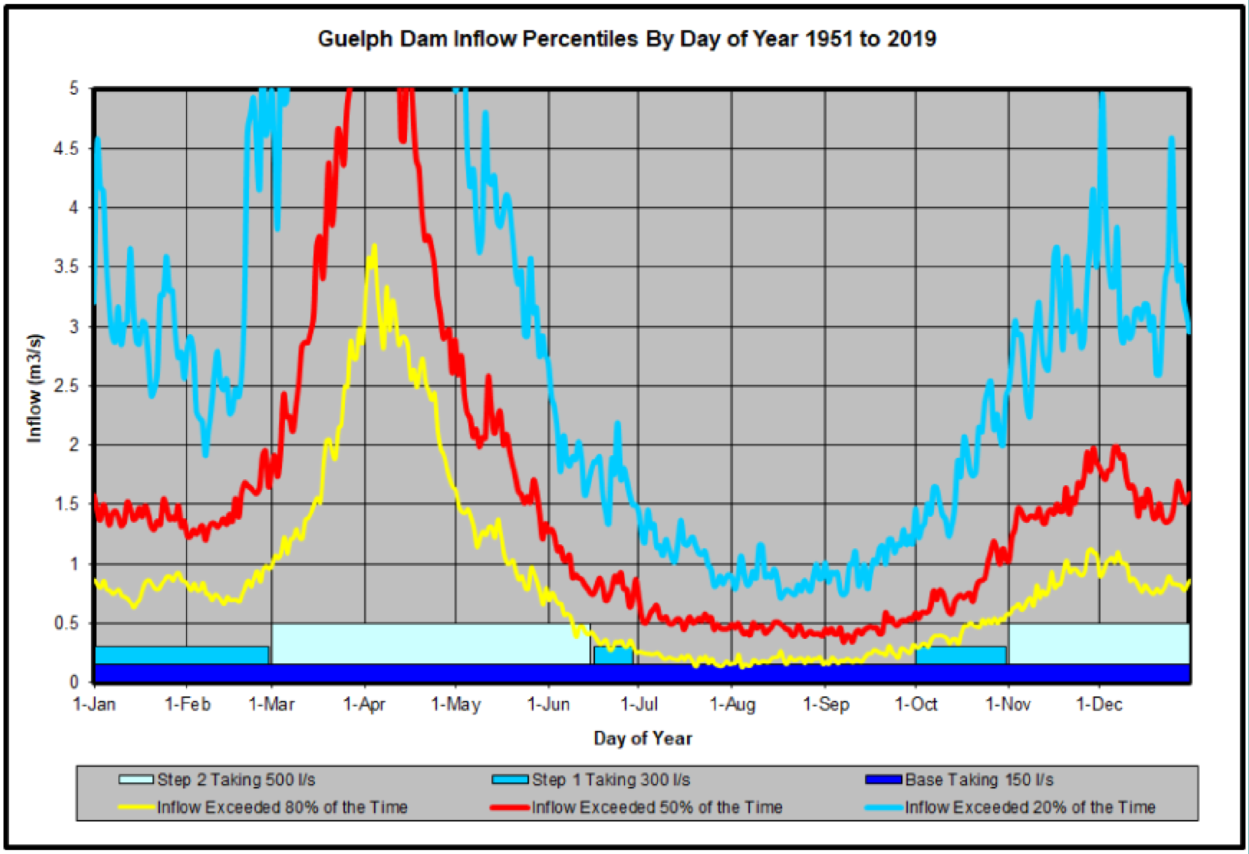


Figure 5-3 illustrates that a 500 L/s taking is most likely available in the March through May period and the November and December period. A 300 L/s taking is most likely available in the January through June and October through December period of the year. During the summer period, only the base taking (150 L/s) is reliably available. The availability of taking will vary depending on the watershed conditions and may not be guaranteed in some years.

Based on the above, rules were set up for the reservoir yield model to represent a two staged taking. First the 500 L/s taking was assumed to occur any month of the year provided the storage in in the Guelph Lake reservoir equaled or exceeded 95% of the upper rule curve storage. This ensured there was ample water to meet downstream low flow augmentation requirements and provided flexibility to accommodate an ASR taking. Next the 300 L/s taking was assumed to occur if the storage in in the Guelph Lake reservoir equaled or exceeded 50% of the upper rule curve storage. The 300 L/s taking was not allowed to occur between July 1st and September 1st but allowed during other periods of the year provided the storage requirements were met. The 150 L/s taking was assumed to occur if storage in in the Guelph Lake reservoir exceeded the lower rule curve storage.

Based on the above scenarios, the reliability of stepped taking was modelled. The reservoir yield modelling assumed the existing permitted Eramosa taking at Arkell was maximized and that downstream low flow targets upstream of the Guelph wastewater treatment plant were achieved 100% of the time. The results provide the reliability of ASR takings which closely follows the inflow reliability. The detailed results are provided in the supporting technical memo (**Appendix E**). In summary, the results indicated that there is a potential for the proposed stepped taking (150 and 300 L/s), but the step to 500 L/s was dismissed. It is not deemed practical to build a WTP for the incremental step to 500 L/s when the reliability is high for only three months. Furthermore, it is anticipated that from a hydrogeological perspective, this flow cannot be injected in a reasonable number of ASR wells.

Therefore, further analysis was completed based on the base taking of 150 L/s and an increase to 300 L/s for a minimum of nine months of the year assuming it is not available for three months (approximately from mid-June to mid-September). This resulted in an identified 940,000 m^3 of water available annually for ASR (**Table 5-15**).

Table 5-15: Calculation of Guelph Lake Annual Volume (for ASR)

Month	Days	Monthly Water Taking at Base Flow Rate (m³)[1]	Additional Monthly Water Taking When Available (m³)[2]	Total Volume from Guelph Reservoir (m³/month)	Base Volume from Guelph Reservoir (m³/month)	Vol > base from Guelph Reservoir (m³/month)	Estimated Demand[3] (m³/month)	Flow minus Demand (m³/month)	Volume to ASR (m³/month)	Volume from ASR (m³/month)
Jan	31	401,760	401,760	803,520	401,760	401,760	688,700	114,820	114,800	
Feb	28	362,880	362,880	725,760	362,880	362,880	639,600	86,160	86,200	
Mar	31	401,760	401,760	803,520	401,760	401,760	718,800	84,720	84,700	
Apr	30	388,800	388,800	777,600	388,800	388,800	680,100	97,500	97,500	
May	31	401,760	401,760	803,520	401,760	401,760	711,400	92,120	92,100	
June	30	388,800	388,800	777,600	388,800	388,800	721,600	56,000	56,000	
July	31	401,760		401,760	401,760	0	725,800	-324,040		324,040
Aug	31	401,760		401,760	401,760	0	705,900	-304,140		304,140
Sept	30	388,800		388,800	388,800	0	701,100	-312,300		312,300
Oct	31	401,760	401,760	803,520	401,760	401,760	680,800	122,720	122,700	
Nov	30	388,800	388,800	777,600	388,800	388,800	656,500	121,100	121,100	
Dec	31	401,760	401,760	803,520	401,760	401,760	637,800	165,720	165,700	
Total	**365**	**4,730,400**	**3,538,080**	**8,268,480**	**4,730,400**	**3,538,080**	**8,268,100**	**380**	**940,800**	**940,480**
Daily pump rate to distribution (m³/day)	**-**	**-**	**-**	**22,653**	**12,960**	**9,693**	**22,652**	**1**	**-**	**-**

Notes: 1 – Base flow rate is 150 L/s
2 – Total flow rate of 300 L/s (additional 150 L/s) when available.
3 - Assumed annual demand pattern to reflect seasonal fluctuations.
General – Alternative would include a water intake within Guelph Lake; however, source of water is a portion of the total Speed River discharge flowing through lake.

5.4.1 Surface Water Treatment

Water quality information available for the Speed River was referenced to determine treatment processes required to achieve drinking water quality. Conventional treatment for surface water is proposed with treatment for taste and odour on a seasonal basis, as needed. The proposed WTP has been sized to accommodate the following alternatives at Guelph Lake:

- continuous taking of 150 L/s – Base Taking
- maximum taking of 300 L/s – ASR option

For the purposes of evaluating the alternatives, cost estimates were provided for (1) a surface water treatment plant sized to treat a maximum day capacity of 150 L/s on a continuous basis, as well as (2) a modular plant which would treat 150 L/s on a continuous basis as well as 300 L/s during nine months of the year. It is assumed that the treatment required would consist of those processes found at the Brantford WTP which draws from the Grand River, for costing purposes:

- screening
- pre-treatment (Dissolved Air Floatation with Coagulant, Flocculation)
- Intermediate Ozonation
- Biologically Active Carbon Filtration
- Chlorination
- Space Allowance for Future UV Disinfection
- residuals management (equalization, thickening, discharge to sewer)
- allowance for connection to ASR with re-chlorination

Depending on pilot scale testing, recharge injection quality may require pH adjustment, and other processes to ensure no chemical reactions occur in the aquifer. Further analysis of surface water and groundwater will be required to determine whether it is suitable for injection. It is anticipated that groundwater recovered from the aquifer would only require disinfection prior to distribution.

It is assumed that the intake at Guelph Lake would be upstream of the Guelph dam with an intake crib (assumed 100 m). A low lift pumping station would be required to draw water from the lake into the WTP. A high lift pumping station would be required to pump treated water to the distribution system.

Summary

The total increase in potential quantity available from surface water treatment based on after treatment flows is 12,312 m^3/day[19] (i.e., continuous taking from Guelph Lake of 150 L/s). The cost estimate for providing a WTP at Guelph Lake is provided in **Table 5-16**.

Table 5-16: Cost Estimate for Guelph Lake WTP

Item Description	Total Cost
Capital Cost (incl. contractor overhead)	**$35,064,128**
Estimating Contingencies on Subtotal (30%)	$9,562,944
Engineering Design and Construction Services on Total (15%)	$6,694,061
GRAND TOTAL*	**$51,322,000**

Notes: * Total values are rounded.

5.4.2 Aquifer Storage Recovery

As discussed under the Arkell ASR alternative, an ASR strategy consists of the storage of treated drinking water in underground aquifers during periods of water surplus (i.e., when capacity exceeds demand) and subsequent recovery of this volume of stored water during periods of water shortage (i.e., when demand exceeds existing capacity).

Aquifer storage provides the advantage of enormous storage volumes compared to conventional distribution system storage in elevated or underground storage tanks. Depending on the availability of surface water for treatment, it may be possible to continuously store water in excess of annual requirements resulting in carry-over storage for future needs or to meet needs in years where the surface water may not be available (e.g., low river flows). This point may apply particularly to the initial years of a WTP construction or expansion where capacity exceeds demand; the WTP could

19. This value assumes that 5% of the total feed water is lost during the treatment process.

be operated to treat excess volumes to be stored in aquifers for future recovery. The concept discussed in this section, in relation to the capture of excess water from Guelph Lake, is similar to the approach applied in the Region of Waterloo at the Mannheim WTP to maximize the supply capability of the Grand River, which is subject to seasonal streamflow limitations, while minimizing downstream impacts.

The Arkell ASR alternative evaluated a potential ASR wellfield within the Guelph Innovation district. The 2014 WSMP evaluated two options related to the Guelph Lake strategy:

- ASR system located at Guelph Lake
- ASR system located in area of Park & Emma wells

The 2014 WSMP concluded that ASR wells in the area of the Park and Emma Wells would require fewer wells and could be accomplished all within the City boundary. As such, this strategy was re-evaluated using the updated Tier Three Model. The furthest north simulated ASR well was placed approximately 300 metre north of the Helmar well and the furthest south simulated ASR well was placed approximately 500 metre north of Park and Emma wells. Due to the proximity to the Helmar well, the Helmar well was turned off in this scenario. The remaining four wells were placed along an interpreted linear higher hydraulic conductivity zone simulated in the Middle Gasport Formation of the Tier Three Model between the Helmar and Park wells.

Similar to the Innovation District scenario, the modelling output suggested that the ASR wells should be operated at 60% of the injection rates, while the existing municipal wells operated at baseline rates (i.e., system total of 53,551 m^3/day), in order to maintain hydraulic heads above low water level thresholds at existing municipal wells. It was noted that some existing municipal wells have considerable available head and therefore there is likely an opportunity to increase pumping rates at other municipal wells to capture more of the injected water. This is supported by other completed scenarios that indicate sustainable total system pumping rates up to 82,370 m^3/day. The injection simulations showed that the influence of the injections, that is increased water level elevations in the surrounding area, extended as far as 10 km away from the ASR system. This indicates that the water level increase resulting from the injected groundwater is dissipating far from the injection site and a water level “mound” is not maintained around the injection wells. The model shows that the water levels recover relatively quickly and the water flows away from the injection sites; therefore not all of the water is available to be extracted locally within the area of the Emma/ Park Wells. Further evaluation to optimize the efficiency of the system is recommended should the City wish to pursue ASR as a future water supply option. Additional work should focus on the potential to site ASR wells that maximize the ability for existing municipal wells to capture injected water.

The recommendations for significant further work provided in the Arkell ASR alternative section also apply to the Guelph Lake ASR alternative. Assumptions included in this evaluation include:

- Allowance for 6 injection/extraction wells for ultimate supply;
- Cost for ASR system includes costs to upgrade WTP to 300 L/s capacity; and
- Approximately 1.2 km of pipeline to connect WTP discharge and/or ASR wells/High Lift Pumping Station to the City system.

Summary

The total increase in potential quantity available from surface water treatment and ASR systems based on after treatment flows is 25,825 m^3/day (i.e., a continuous taking from Guelph Lake of 150 L/s and a step taking of 300 L/s and a 5% loss at the WTP). **Table 5-17** summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition, construction of a WTP, and approvals. In addition to the capital costs, the operating and maintenance costs were also estimated including labour, maintenance and energy costs and were used to calculate the Life Cycle Costs for each alternative (see Section 6.2).

Table 5-17: Cost Estimate for Guelph Lake ASR

Item Description	Total Cost
Capital Cost (incl. contractor overhead)	**$39,136,900**
Estimating Contingencies on Subtotal (30%)	$10,673,700
Engineering Design and Construction Services on Total (15%)	$7,471,590
GRAND TOTAL*	**$57,283,000**

Notes: * Total values are rounded.

5.4.3 Surface Water Alternatives Summary

The estimated volume from the surface water alternatives is applied to the demand projections in **Figure 5-4** and all alternatives are shown in **Figure 5-5**. **Figure 5-5** indicates that the groundwater alternatives, along with water conservation, efficiency and demand management are anticipated to provide the required water supply capacity to meet projected 2051 demand. **Figure 5-5** assumes that all groundwater alternatives are first constructed and that surface water alternatives are implemented subsequently, if required to meet future demands.

As there is uncertainty about the water supply capacity that each potential source will yield, as the City progresses with implementation of the projects, the water supply deficit will subsequently be evaluated, and the implementation plan (Section 8) will be revised as necessary. This process may result in additional projects falling outside of the planning period.

Figure 5-4: Water Demand Projections with Surface Water Alternatives

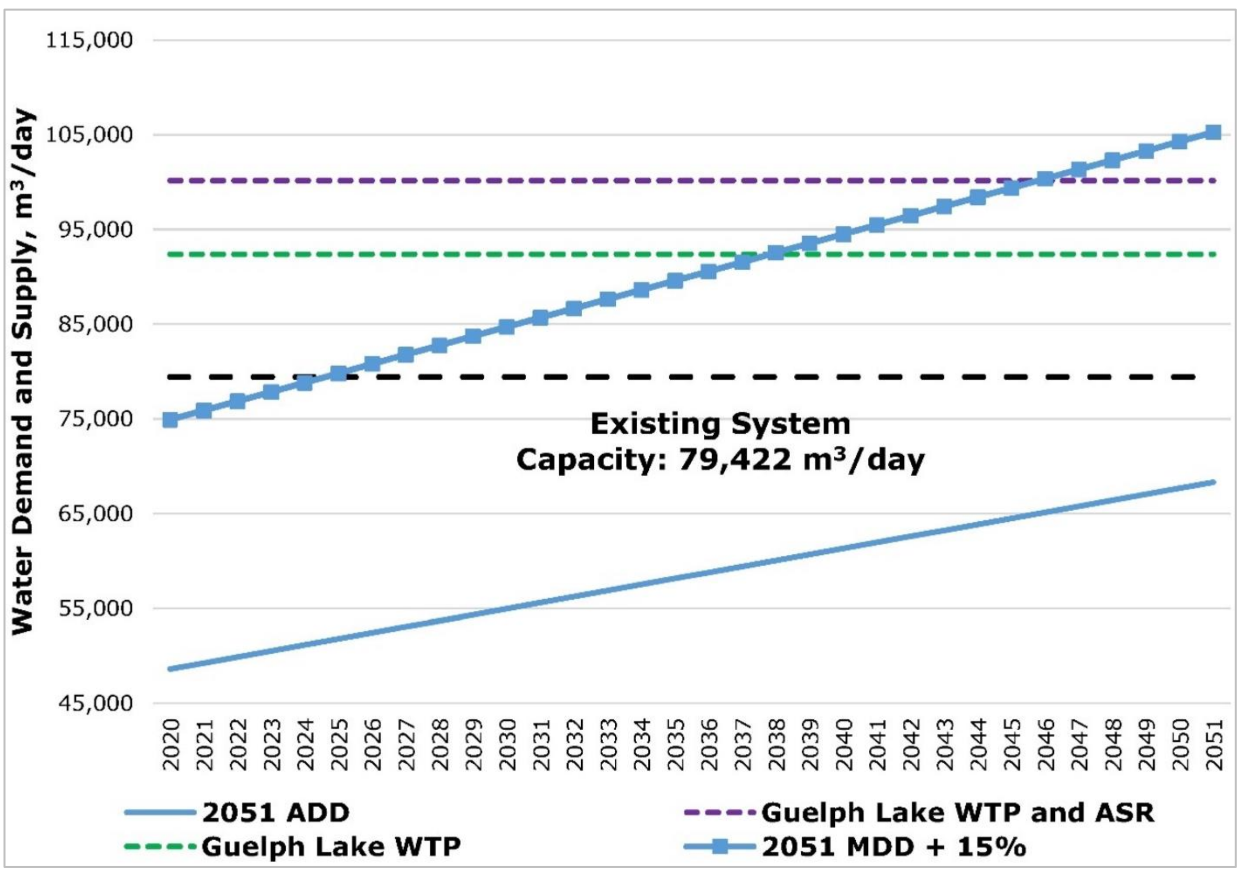
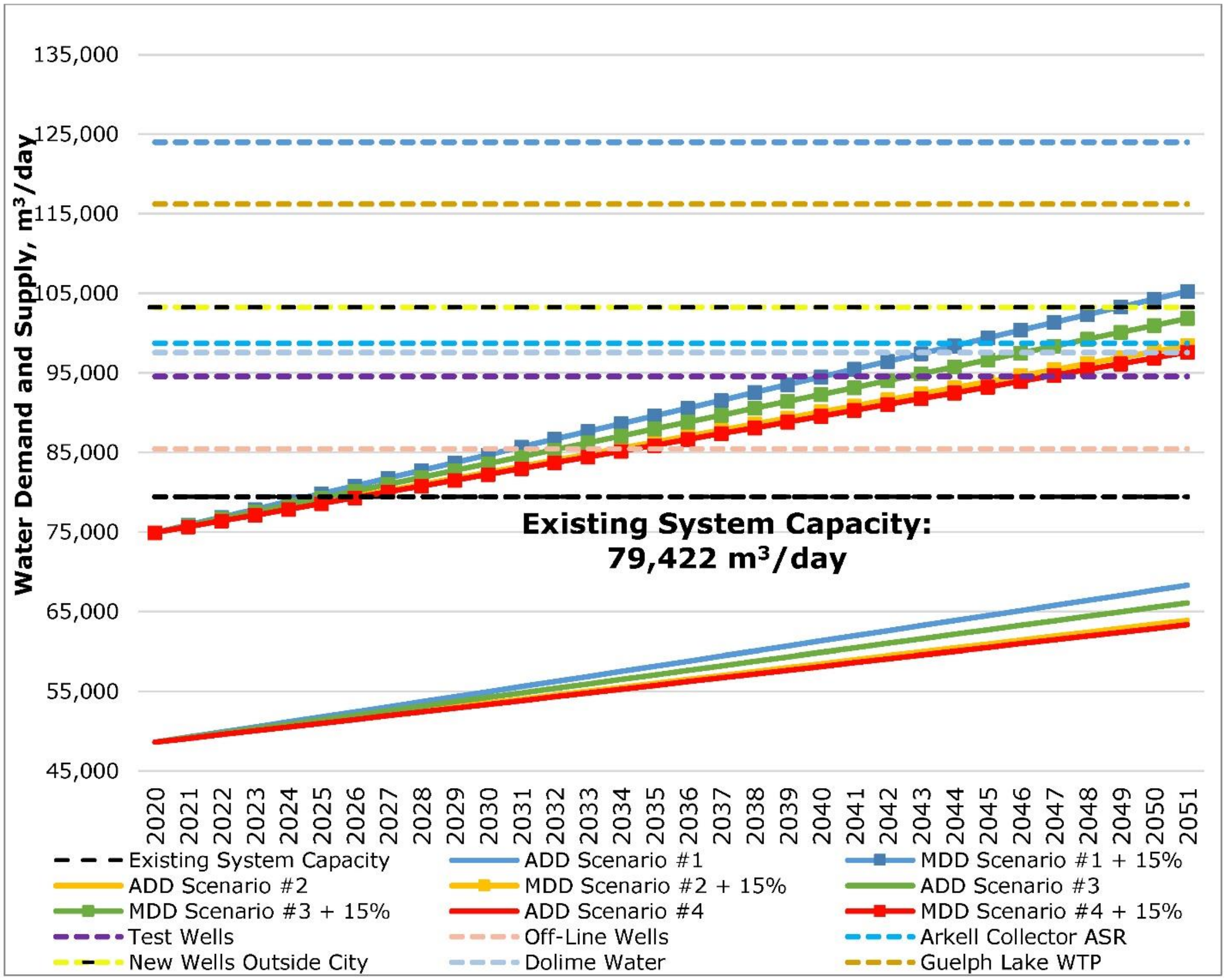


Figure 5-5: Water Demand Projections with All Water Supply Alternatives



5.5 Limit Community Growth

This option consists of reduction in future water supply needs by limiting the extent, density, type and/ or location of future residential, industrial, commercial, and institutional growth in the City below levels identified in recent planning studies. Implementation of this alternative would require changes to municipal planning documents which would not meet Provincial growth targets. Subject to the required future testing identified in this report, the technical work completed indicates that the identified alternatives can be sustainably developed to meet the forecasted future water supply demands. In consideration of this finding and as this alternative does not meet the Purpose Statement for the project, it is not carried forward as part of the preferred alternative.

5.6 Do Nothing

The Do Nothing alternative is that in which no improvements or changes would be undertaken to address present and long-term water supply requirements. This would have a significant impact on the growth potential for the City. The "Do Nothing" alternative represents what would likely occur if none of the alternative solutions were implemented.

6. Environmental Assessment Evaluation Criteria and Process

6.1 Environmental Assessment (EA) Evaluation Criteria

Preliminary EA criteria and a proposed evaluation process were first presented to the project team, agencies and municipalities, Community Liaison Group and the general public between November 2019 and February 2020. The proposed criteria and processes were revised, incorporating the comments received, and then confirmed via the Community Liaison Group and agencies and municipalities through meetings in July and September 2021.

Evaluation criteria were developed based on the environmental components that address the broad definition of the environment described in the Environmental Assessment Act, as summarized in **Table 6-1**.

Table 6-1: Evaluation Criteria Components Summary

Component	Criteria
Effect on Indigenous values, culture, and Traditional use	■ An evaluation of the effect on Indigenous values, culture, and Traditional use. Key themes shared with the Project Team that help guide the evaluation include: – valuing and respecting the agency of water – understanding the spirit and personhood of water, – good stewardship of the connected ecosystem including protection of water's pureness, – consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation.
Technical Considerations	■ Constructability ■ Potential productivity and reliability ■ Water treatment requirements ■ Approval requirements
Natural Environmental	■ Effect of construction and operation on aquatic and terrestrial species and habitat ■ Effect on surface water quantity and quality

Component	Criteria
Built Environment	■ Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities ■ Effect on private and municipal wells
Social/Cultural Environment	■ Ability to meet municipal and provincial growth targets ■ Public acceptance ■ Effect of noise/vibration on sensitive receptors ■ Effect on cultural heritage landscapes and built heritage resources ■ Effect on potential archaeological resources
Legal/Jurisdictional Considerations	■ Location inside versus outside of City boundaries
Financial Considerations	■ Estimated capital costs; capital cost per capacity ■ Estimated operation and maintenance costs ■ Life cycle cost (per volume produced)

An additional objective of the evaluation consists of consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation. The intent is to assess the potential effect of each alternative on Indigenous values, culture, and Traditional use.

This category is not intended to be a comprehensive assessment of how the alternatives could affect Indigenous Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph. Key themes shared with the Project Team that help guide the evaluation include:

- valuing and respecting the agency of water
- understanding the spirit and personhood of water,
- good stewardship of the connected ecosystem including protection of water’s pureness, and
- consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.

The categories and associated evaluation criteria in **Table 6-1** meet the definition of the environment as defined in the Environmental Assessment Act. Indicators, presented in **Table 6-2**, were further detailed for each criterion which provides further information about the how the criteria are applied. These criteria and their indicators reflect input received from a very broad and diverse range of Master Plan study participants. For example, during the Community Liaison Group meetings, Agency and Municipality workshops, and at Township Council meetings, participants from the Townships expressed the need to consider the effects of future Source Water Protection policies on growth and land use and potential well interference (i.e., lowering of water levels in domestic wells and potential affecting the well yields) on the landowners in the vicinity of possible future wells located outside the City. This is consistent with feedback received during the 2014 WSMP Update process and underscores the importance of communication and collaboration with the Townships as the City proceeds with implementation of the Master Plan.

Table 6-2: Evaluation Criteria Indicators Summary

Component	Criteria	Indicator
Technical Considerations	▪ Water Treatment	▪ Review of Wellhead Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks in accordance with Source Water Protection standards of the *Clean Water Act*.
Built Environment	▪ Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	▪ Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future agricultural operations and Environmental Protection Areas.
Legal/ Jurisdictional Considerations	▪ Location Inside vs. Outside City boundaries	▪ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.

6.2 Environmental Assessment (EA) Evaluation Process

Each potential alternative is assessed using a consistent approach and evaluation criteria along with specific indicators for each. The completed evaluation is qualitative – not a numerical ranking system – and considers the suitability of alternative solutions and strategies based on significant advantages and disadvantages. Comparisons and trade-offs are made between alternatives and form the rationale for the identification of the preferred solution or water supply strategy.

The alternatives evaluation is presented in **Table 6-3** to **Table 6-8**, which include a summary table for each group of alternatives and a detailed table that presents the comparison of each alternative relative to other alternatives. The summary versions of these tables were provided in draft format at the Community Liaison Group meeting and Agency and Municipality workshop in September 2021, as well as the second Community Open House, for comment. Comments received, including those noted below, were incorporated into the assessment process:

- Strong support for conservation, efficiency and demand management, including minimizing system leakage
- Preference for groundwater over surface water
- Strong recommendation to maximize water supply potential within the City’s boundaries before going into Townships
- Questions regarding effects on the surrounding land uses/owners from Source Water Protection policies on new wells and surface water taking
- Questions regarding how climate change could impact water supply sources in the future
- Questions about how the Dolime Quarry will be managed, associated potential environmental impacts and water supply opportunity
- Concern expressed about Aquifer Storage and Recovery, in particular the injection of water into the aquifer

As mentioned above, a review of the natural environment considerations was undertaken in detail and is presented in a support technical memorandum in **Appendix A**. The results from this review are incorporated into the summary evaluation tables.

The summary of the evaluation was then further considered with respect to application in the short-, mid- and long-term to address the City’s water supply needs. This is discussed further in **Section 8** as a proposed implementation strategy.

Table 6-3: Summary of Evaluation of Water Supply Alternatives – Conservation, Limit Growth, Do Nothing

Category of Consideration	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
First Nations, Métis and Inuit Peoples Category - Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	▪ Ceasing current conservation and efficiency programs does not reflect good stewardship of the resource	▪ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves medium water savings	▪ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the least water savings	▪ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the most water savings	▪ Limiting growth would effectively reduce demand for the resource and therefore reflect a respect for the resource and good stewardship of the connected ecosystem	▪ Doing nothing does not reflect good stewardship of the resource
Technical Category	▪ Does not achieve demand reductions	▪ Moderately preferred for achieving reduction	▪ Least preferred for achieving reduction	▪ Most preferred for achieving reduction	▪ Does not result in added capacity or demand reduction	▪ Does not result in added capacity or demand reduction
Natural Environment Category	▪ No impact	▪ No impact	▪ No impact	▪ No impact	▪ Limits potential for impact to natural environment	▪ Limits potential for impact to natural environment
Built Environment Category	▪ No impact	▪ Minor changes to existing & planned building	▪ Minor changes to existing & planned building	▪ Minor changes to existing and planned buildings, moderate impact to WWTP infrastructure ▪ Each reuse option to be evaluated on its own merits, risks and costs	▪ High impact to planned growth (does not meet growth targets)	▪ High impact to planned growth (does not meet growth targets)
Social/Cultural Environment Category	▪ Does not contribute to meeting future demands; low public acceptance	▪ Contributes to meeting future demands; high public acceptance	▪ Contributes to meeting future demands; high public acceptance	▪ Contributes to meeting future demands; moderate public acceptance – some reuse options may require public education to gain acceptance	▪ Does not meet growth targets; mixed public acceptance	▪ Does not meet growth targets; mixed public acceptance

Category of Consideration	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
Legal/Jurisdictional Category	▪ In City – no impact	▪ In City – no impact	▪ In City – no impact	▪ In City – no impact ▪ Some reuse options may require regulatory approvals including review by Health Unit for potential public health considerations (e.g., irrigation on sports fields, etc.)	▪ May drive growth to Townships	▪ May drive growth to Townships
Financial Category	▪ No associated costs	▪ Low to moderate costs as compared to supply alternatives	▪ Low costs as compared to supply alternatives	▪ Moderate to high costs as compared to supply alternatives	▪ Not evaluated; does not address problem statement	▪ Not evaluated; does not address problem statement
Overall Results	▪ **Not preferred**	▪ **Preferred as part of short-term strategy**	▪ **Preferred as part of mid- to long-term strategy**	▪ **Reuse preferred as part of long-term strategy**	▪ **Not preferred**	▪ **Not preferred**

Table 6-4: Assessment and Evaluation of Water Supply Alternatives - Conservation, Limit Growth, Do Nothing

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
First Nations, Métis and Inuit Peoples Category	-	-	-	-	-	-	-
Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect Indigenous Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ An evaluation of the effect on Indigenous values, culture, and Traditional use. Key themes shared with the Project Team that help guide the evaluation include, – valuing and respecting the agency of water – understanding the spirit and personhood of water, – good stewardship of the connected ecosystem including protection of water's pureness, – consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.	■ Ceasing current conservation and efficiency programs does not reflect good stewardship of the resource	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves medium water savings	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the least water savings	■ Continuing water conservation and efficiency efforts reflects a respect for and good stewardship of the resource; alternative achieves the most water savings	■ Limiting growth would effectively reduce demand for the resource and therefore reflect a respect for the resource and good stewardship of the connected ecosystem	■ Doing nothing does not reflect good stewardship of the resource
Technical Category	-	■ Does not achieve demand reductions	■ Moderate potential for demand reductions	■ Minimal potential for demand reductions	■ High potential for demand reductions	■ Does not result in added capacity or demand reduction	■ Does not result in added capacity or demand reduction
Constructability	■ An evaluation of the proposed water supply location, based on: 1. Ability to use existing infrastructure 2. Site access 3. Constructability (geotechnical, proximity to adjacent buildings, etc.) 4. Proximity to municipal distribution system/ large diameter watermains 5. Proximity to sanitary collection system for building and process drainage 6. Future expandability	■ No impact	■ New infrastructure required by customer	■ New infrastructure required by smaller customer base	■ New infrastructure required by City and customers	■ No impact	■ No impact
Potential Productivity and Reliability	■ An evaluation of the productivity potential of the water supply alternative based on: 1. Total available supply quantity 2. Aquifer thickness & available drawdown; transmissivity 3. Surface water flows & seasonal reliability	■ No demand reduction	■ Potential demand reduction/ available capacity to service demand = 4,424 m^3/day	■ Potential demand reduction/ available capacity to service demand = 2,220 m^3/day	■ Potential demand reduction/ available capacity to service demand = 4,952 m^3/day	■ No associated capacity	■ No associated capacity
Water Treatment Requirements	■ An evaluation of the raw water quality and review of treatment requirements; based on: 1. Preliminary or estimated water quality results, based on available historical water quality data;	■ None	■ None	■ None	■ Some treatment post-WWTP may be required, depending on end use	■ None	■ None

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
	2. Consideration to be given to difficulty of treatment, operational requirements and associated costs; 3. Ability to respond to change in regulatory treatment requirements 4. Review of Wellhead Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks within that zone in accordance with Source Water Protection standards of the *Clean Water Act*.						
Approval Requirements	■ An evaluation of the approvals requirements specific to a proposed location, based on consideration of: 1. Municipal approvals (site plan approval, building permit) 2. Ministry of Environment, Conservation and Parks (Permit to Take Water, Environmental Compliance Approval/Drinking Water License); 3. Grand River Conservation Authority (GRCA). ■ Ability to respond in change in permitting requirements	■ None	■ None	■ None	■ Non-potable reuse options may require MECP approvals, Health review etc.	■ Changes to Official Plan to revise growth targets	■ Changes to Official Plan, as growth targets could not be met
Natural Environment Category	-	■ No impact to natural environment	■ No impact to natural environment	■ No impact to natural environment	■ No significant impact to natural environment	■ Limits potential for impact to natural environment	■ Limits potential for impact to natural environment
Effect of Construction and Operation of Alternative on Aquatic and Terrestrial Species and Habitat	■ An evaluation of the effects of construction of the well facility or surface water treatment facility on aquatic species and habitat, based on: 1. Presence of aquatic and terrestrial species potentially affected temporarily and/or permanently, including Species at Risk, (Endangered, Threatened, Special Concern), species of provincial, regional and local conservation concern, native and invasive species, and area-sensitive species; 2. Area of temporary or permanent loss of aquatic and terrestrial features or categorical loss of habitat functions by type – including Provincially Significant Wetland, Locally Significant Wetland, Environmentally Significant Areas, Areas of Natural and Scientific Interest, watercourses by sensitivity type, and others.	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
Effect on Surface Water Quantity & Quality	■ An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies due to: 1. Construction or operation. 2. Groundwater drawdown during operation of the well.	■ No impact	■ No impact	■ No impact	■ Minor reduction in WWTP effluent flows	■ No impact	■ No impact
Built Environment Category	-	■ No impact	■ Minor changes to existing and planned buildings	■ Minor changes to existing and planned buildings	■ Minor changes to existing and planned buildings, moderate impact to WWTP infrastructure	■ High impact to planned growth	■ High impact to planned growth
Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	■ An evaluation of the effects on existing or future planned property & buildings, based on: 1. Displacement and/or temporary or permanent disruption to residences, businesses, and / or community, institutional, and recreational facilities; 2. Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future agricultural operations and Environmental Protection Areas. 3. Effect on Property (ownership, size, and willingness of property owner)	■ No impact	■ Potential changes in requirements for existing and future buildings	■ Potential changes in requirements for existing and future buildings	■ New distribution infrastructure at WWTP for non-potable uses	■ High impact to planned community	■ High impact to planned community
Effect on Private and Municipal Wells (groundwater quality and quantity)	■ An evaluation of effects on private and municipal wells, based on: 1. Proximity to and number of private and municipal wells in the vicinity of proposed alternative; 2. The distance to other permitted takers	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact	■ No impact
Social/Cultural Environment Category	-	■ Does not contribute to meeting future demands ■ Low public acceptance	■ Contributes to meeting future demands ■ High public acceptance	■ Contributes to meeting future demands ■ Moderate public acceptance	■ Contributes to meeting future demands ■ Highest public acceptance	■ Will not meet growth targets ■ Mixed public acceptance	■ Will not meet growth targets ■ Low public acceptance
Ability to Meet Municipal and Provincial Growth Targets	■ An evaluation of the water supply alternative to partially or fully meet the future 30-year demands	Partial	Partial	Partial	Partial	Will not meet targets	Will not meet targets
Public Acceptance of Alternative	■ An evaluation of the opportunities for Water Conservation Education through the implementation of the alternatives ■ Expected public acceptance	■ No opportunity for public education ■ Anticipated low public acceptance based on current	■ Significant opportunity for education through current programming ■ Higher public acceptance based on	■ Moderate opportunity for education as included customer base is reduced ■ Moderate public acceptance based on	■ Significant opportunity for education through current programming and addition of reuse	■ None ■ Mixed public acceptance	■ None ■ Low public acceptance

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation – Cease Programs	Conservation – Current Level of Effort	Conservation – Focus on High Demand Customers	Conservation – Current Level of Effort With Reuse	Limit Growth	Do Nothing
		public support for programming	current public support for programming	current public support for programming	■ Highest public acceptance based on current public support for programming and focus on non-potable reuse		
Effect of Noise/Vibration on Sensitive Receptors	■ An evaluation of effects on noise sensitive receptors, based on: 1. Presence of sensitive receptors and duration of construction schedule; 2. Disruption during the operations phase.	■ None	■ None	■ None	■ Potential construction requirements at WWTP to support reuse opportunities	■ Reduction in construction within City	■ Reduction in construction within City
Effect on Cultural Heritage Landscapes and Built Heritage Resources	■ An evaluation of effects on cultural heritage resources, based on: 1. Presence of cultural heritage landscapes; 2. Presence of built heritage resources.	■ None	■ None	■ None	■ None; WWTP is previously disturbed site	■ Reduction in construction within City	■ Reduction in construction within City
Effect on Potential Archaeological Resources	■ An evaluation of effects on archaeological resources, including: 1. Presence of areas with archaeological potential (i.e., lands with potential archaeological resources) affected.	■ None	■ None	■ None	■ None; WWTP is previously disturbed site	■ Reduction in construction within City	■ Reduction in construction within City
Legal/Jurisdictional Category	-	■ In City – no impact	■ In City – no impact	■ In City – no impact	■ In City – no impact	■ City would not meet targets potentially driving growth to Townships	■ City would not meet targets potentially driving growth to Townships
Location Inside vs. Outside City boundaries	■ An evaluation of need to work with adjacent Townships for land requirements for facility and utility easements. ■ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.	■ Solution within the City	■ Solution within the City	■ Solution within the City	■ Solution within the City	■ Lack of allowable growth in City could drive growth to Townships	■ Lack of allowable growth in City could drive growth to Townships
Financial Category	-	■ Low cost but with low benefit	■ Low compared to supply alternatives	■ Low compared to supply alternatives	■ Highest of conservation/efficiency alternatives	■ Not evaluated	■ Not evaluated
Capital Costs (Life cycle cost per m^3)	■ An evaluation of the capital and operation & maintenance costs, including: 1. Estimated Capital Cost of all works in category 2. Capital Cost per Capacity ($/m^3/day) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate	■ No cost associated with alternative	■ Capital cost = $11.41 Million ■ Capital cost per capacity = $2600 per m^3/day of avoided capacity ■ Life cycle cost: $0.53 per m^3 avoided	■ Capital cost = $4.73 Million ■ Capital cost per capacity = $2100 per m^3/day of avoided capacity ■ Life cycle cost: $0.44 per m^3 avoided	■ Capital cost = $15.04 Million ■ Capital cost per capacity = $3000 per m^3/day of avoided capacity ■ Life cycle cost: $0.62 per m^3 avoided (need to fully consider life cycle cost of each reuse option)	■ Cost not evaluated ■ Does not meet growth targets	■ Cost not evaluated ■ Does not meet growth targets

Table 6-5: Summary of Evaluation of Water Supply Alternatives - Groundwater Sources

Category of Consideration	2B – Groundwater - Existing Municipal Off-line Sources (Clythe, Sacco, Smallfield, Lower Road Collector)	2C – Groundwater - Municipal Test Wells (Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])	2D - Groundwater – Dolime Quarry	2F - Arkell Collectors & ASR	2G – Groundwater - New Wells Outside City (Guelph North; Guelph Southeast)
First Nations, Métis and Inuit Peoples Category - Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ Optimizing use of existing resources and treating impacted water reflects good stewardship of the resource; must be done in a way that protects the ecosystem.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. This alternative must be done in a way that protects the ecosystem.	■ This alternative reflects the use of water that is currently taken from the aquifer and discharged to the Speed River. Use of this water as supply reflects good stewardship of the resource.	■ Optimizing use of existing resources (Lower Collector) reflects good stewardship of the resource. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. Spreading out the pumping across a larger area helps to reduce this risk. This alternative must be done in a way that protects the ecosystem.
Technical Category	■ Highest potential capacity due to level of available information regarding quantity, quality; existing facilities with connections to system ■ Prioritization of sources based on ease of implementation and treatability challenges, as follows: – Clythe – Lower Road Collector seasonal variability; uncertainty regarding base flows; potential for optimization with Glen Collector; modelling results require verification – Sacco/Smallfield – investigation into source and nature of TCE contamination plume; contaminant source uncertainties will complicate treatment processes; liability issue if contaminants are re-distributed; return to service not currently feasible if contaminated sites not addressed	■ Moderate to high potential capacity depending on source ■ Prioritization of sources based on ease of implementation and approvals requirements, as follows: – Ironwood/Steffler/Guelph South – based on outcome of Guelph Southwest Water Supply Class EA – Logan/Fleming – need to drill large diameter test wells and complete testing/approvals (underway at Logan) – Hauser – lower capacity well; contamination exists within NWQ	■ High potential for additional capacity within or around quarry ■ Proposed strategy, ease of implementation and approvals requirements, based on outcome of Guelph Southwest Water Supply Class EA; available new capacity could be captured through existing/new municipal wells or alternatively via direct pumping/treatment from Dolime Quarry, or a combination thereof	■ Moderate potential – depends on Lower Rd. re-construction; significant ASR feasibility study required	■ Moderate potential for new capacity due to limited site-specific information ■ Prioritization of new wells outside Guelph lower compared to known sources inside Guelph

Category of Consideration	2B – Groundwater - Existing Municipal Off-line Sources (Clythe, Sacco, Smallfield, Lower Road Collector)	2C – Groundwater - Municipal Test Wells (Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])	2D - Groundwater – Dolime Quarry	2F - Arkell Collectors & ASR	2G – Groundwater - New Wells Outside City (Guelph North; Guelph Southeast)
Natural Environment Category	▪ Existing municipal sources – sustainable pumping established historically with effects within catchments accounted for – City conducting additional study for Clythe Well ▪ Further study required to understand contaminant source(s) around Smallfield site and potential for re-distribution of contaminants	▪ Sustainable pumping rates are conservatively assessed through modelling by evaluating potential reduction to baseflow in local surface water ▪ Test wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from modelled reduction in baseflow	▪ Dolime site is previously disturbed; artificial discharge to Speed River would be reduced ▪ Sustainable pumping rates from existing/new wells to be assessed to optimize water pumped from quarry; risks to natural environment considered low with optimized system as quarry dewatering has occurred for decades	▪ Capturing excess collector system flows has minimal impacts – system is previously permitted; specific ASR locations require significant study	▪ Sustainable pumping rates are conservatively assessed through modelling by evaluating potential reduction to baseflow in local surface water. ▪ New wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from modelled reduction in baseflow
Built Environment Category	▪ Temporary disruption on neighbouring residents during construction due to need for expansion to accommodate treatment requirements ▪ Existing WHPAs	▪ Temporary disruption on neighbouring residents during construction due to need for water supply infrastructure ▪ New WHPAs may affect current and future land use	▪ Source water protection restrictions may affect current and future land use	▪ Property acquisition required for ASR wells inside City ▪ New WHPAs may affect current and future land use	▪ Property acquisition required in areas outside City ▪ New WHPAs may impact current and future land use
Social/ Cultural Environment Category	▪ Moderate ability to meet future demand ▪ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ▪ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	▪ Moderate to high ability to meet future demand ▪ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ▪ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	▪ Moderate to high ability to meet future demand in conjunction with surrounding wells/ test wells ▪ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ▪ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	▪ Low ability to meet future demand ▪ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ▪ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	▪ Moderate ability to meet future demand; extensive study required to explore potential source ▪ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ▪ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction
Legal/ Jurisdictional Category	▪ Potential legal/ liability issues related to re-distribution of contamination around Smallfield site ▪ No jurisdictional issues	▪ Ironwood/Steffler, Guelph South, Hauser – in City of Guelph; Potential interaction with Region of Waterloo wells must be studied ▪ Logan/Fleming well in Guelph/Eramosa Township	▪ Council has approved quarry annexation; Provincial approval required	▪ No jurisdictional issues	▪ Guelph North well in Guelph/Eramosa Township ▪ Guelph Southeast well in Puslinch Township
Financial Category	▪ Low to moderate costs depending on source capacity	▪ Lowest costs due to high capacity wells (except Hauser)	▪ High cost for new WTP; OTP to assess availability of water through surrounding wells rather than within quarry	▪ Very high costs due to seasonal availability, low average production year-round, and number of modelled ASR wells	▪ Moderate to high costs due to assumed Fe/Mn treatment and location outside of City (high infrastructure costs)
Overall Results	▪ **Preferred as part of overall solution (Clythe, Lower Rd); additional investigation/ remediation of Sacco/ Smallfield source of contamination required; additional work required to assess feasibility of Lower Road Collector**	▪ **Preferred as part of overall solution; recommended investigations and Class EA studies proceed to confirm feasibility**	▪ **Preferred as part of overall solution; feasibility based on outcome of Southwest Guelph Water Supply Class EA**	▪ **Preferred as part of overall solution; additional modelling and hydrogeological studies required to assess efficiency and confirm required infrastructure and costs**	▪ **Preferred as part of overall solution; commence communication with Townships regarding project feasibility, followed by groundwater investigation phase to assess feasibility and assess effects**

Table 6-6: Assessment and Evaluation of Water Supply Alternatives - Groundwater Sources

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
First Nations, Métis and Inuit Peoples Category	-	-	-	-	-	-
Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	■ Key themes shared with the Project Team include, valuing and respecting the agency of water, understanding the spirit and personhood of water, good stewardship of the connected ecosystem including protection of water's pureness, consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.	■ Optimizing use of existing resources and treating impacted water reflects good stewardship of the resource; must be done in a way that protects the ecosystem.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. This alternative must be done in a way that protects the ecosystem.	■ This alternative reflects the use of water that is currently taken from the aquifer and discharged to the Speed River. Use of this water as supply reflects good stewardship of the resource.	■ Optimizing use of existing resources (Lower Collector) reflects good stewardship of the resource. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.	■ Adding new wells to the system increases the amount of water being pumped and the risk of impacting the ecosystem. Spreading out the pumping across a larger area helps to reduce this risk. This alternative must be done in a way that protects the ecosystem.
Technical Category	-	■ Highest potential due to level of available information regarding quantity, quality; existing facilities with connections to system	■ Moderate to high potential depending on source	■ High potential for additional capacity within or around quarry; significant infrastructure requirements	■ Moderate potential – depends on Lower Rd. re-construction; significant ASR feasibility study required	■ Moderate potential due to limited site-specific information
Constructability	■ An evaluation of the proposed water supply location, based on: 1. Ability to use existing infrastructure; 2. Site access; 3. Constructability (geotechnical, proximity to adjacent buildings, etc.); 4. Proximity to municipal distribution system/ large diameter watermains; 5. Proximity to sanitary collection system for building and process drainage; and 6. Future expandability.	■ All off-line sources are existing facilities located in the City or on the Arkell Spring Grounds; improvements to existing infrastructure can be accommodated; combined treatment for Sacco/Smallfield required ■ Connections to distribution system exist; close proximity to sanitary sewer where required ■ Lower Road – major infrastructure upgrades required	■ Ironwood/ Steffler – new facilities would be in municipal parks; close proximity to distribution system and sanitary services ■ Logan/ Fleming – requires well reconstruction with consideration of wetland; subject to investigation; just east of City boundary; about 1.5 km from distribution and sanitary system ■ Hauser – in City; about 1.0 km from distribution and sanitary system ■ Guelph South - in City; close proximity to distribution system and sanitary services (Hanlon Creek Business Park development)	■ Groundwater would be captured by surrounding municipal wells/ test wells or on-site facility (subject to Operational Testing Program) ■ Constructability evaluation for off-site capture is assessed under previous column; Off-site groundwater capture would require pond level control pumping station within quarry footprint ■ Council has approved annexation of Site into City; on-site pumping and treatment facility would require connection to distribution system and sanitary in close proximity to site	■ Reliant on reconstruction of Lower Road collector system (Alternative 2B) ■ Takes advantage of existing infrastructure – aqueduct; Woods UV system and PS; distribution system ■ New ASR wells required – location dictated by areas with high hydraulic conductivity (potentially around Park & Emma/ Guelph Innovation District) – requires land acquisition ■ Requires ASR well facilities for dechlorination and disinfection/ rechlorination systems	■ New areas located southeast and north of City – no existing infrastructure; would require connection to nearest large diameter watermain and sanitary sewer in City ■ Land acquisition for well site and utilities required

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Potential Productivity and Reliability	▪ An evaluation of the productivity potential of the water supply alternative based on: 1. Total available supply quantity (field results, modelling studies) 2. Known and modelled aquifer conditions 3. Surface water flows & seasonal reliability	▪ Clythe – known available quantity; system-wide sustainable quantity evaluated with Tier Three Model ▪ Sacco – known available quantity; system-wide sustainable quantity evaluated with Tier Three Model ▪ Smallfield – known available quantity; system-wide sustainable quantity evaluated with Tier Three Model ▪ Lower Road – seasonal variability; uncertainty regarding base flows; potential for optimization with Glen Collector; modelling results require verification	▪ Ironwood/ Steffler/ Guelph South – pumping tests indicate high volumes available; may be limited by possible baseflow reductions in Hanlon/ Irish Creek per Tier Three Model evaluation ▪ Logan/ Fleming – City to reconstruct Logan well; productivity subject to investigation ▪ Hauser – low volume available	▪ Historical quarry dewatering information available, varies seasonably and in response to municipal pumping; reliability of volume available within quarry versus surrounding wells uncertain and subject to Operational Testing Program	▪ Reliability of excess flows during peak seasons to be confirmed; model output of 50,500 m3/month available from combined Glen and Lower Road Collectors for 3 months included in feasibility assessment of ASR	▪ Guelph North – area with high model transmissivity in Gasport aquifer; site-specific field confirmation required ▪ Guelph Southeast - area with reasonably high model transmissivity in Gasport aquifer; site-specific field confirmation required
Water Treatment Requirements	▪ An evaluation of the raw water quality and review of treatment requirements; based on: 1. Preliminary or estimated water quality results, based on available historical water quality data; 2. Consideration to be given to difficulty of treatment, operational requirements and associated costs; 3. Ability to respond to change in regulatory treatment requirements 4. Review of Wellhead Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks within that zone in	▪ Clythe – iron & manganese, H2S (conceptual treatment design completed in 2018 EA); existing WHPA ▪ Sacco – TCE & VOCs below ODWQS; VOC concentrations may increase with return to service; existing WHPA ▪ Smallfield – TCE above ODWQS; extent and range of concentrations of groundwater contamination is unknown; design of treatment system is uncertain; feasibility of return to service is uncertain; existing WHPA ▪ Lower Road – historical bacteria issues can be addressed through infrastructure upgrades and UV disinfection at	▪ Ironwood/ Steffler – good quality; Sb noted; treatment not anticipated subject to additional testing; WHPA delineation required ▪ Logan/ Fleming – Fe noted at Logan, below ODWQS; WHPA delineation required; potential impacts to existing land uses (e.g., agricultural, commercial) ▪ Hauser – iron & manganese treatment assumed; WHPA delineation required ▪ Guelph South – good quality based on available water quality data; treatment not anticipated subject to review of additional data; WHPA delineation required; potential impacts to existing land uses (e.g., agricultural)	▪ Treatment requirements depend on evaluation of groundwater versus surface water source and GUDI status; ▪ Costing assumes WTP consists of following processes: – Low lift pumping station – Screening – Filtration (dual media) – Chlorination – Residues Management – assume direct to WWTP ▪ Need to consider source protection requirements depending on EA evaluation	▪ Arkell wellfield aqueduct flows through UV disinfection at Woods, and secondary chlorination before distribution; preliminary assessment indicates existing UV system sufficient for added flows (to be confirmed) ▪ Dechlorination required prior to ASR injection; disinfection required after recovery prior to distribution ▪ WHPAs to be considered for any new ASR wells in the City; potential effects to existing land use depending on well location(s)	▪ Guelph North – assumed iron & manganese treatment ▪ Guelph Southeast – assumed iron & manganese treatment ▪ WHPAs to be developed for new wells outside City; potential impacts to existing land uses (e.g., agricultural)

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
	accordance with Source Water Protection standards of the *Clean Water Act*.	Woods PS; located in existing WHPA				
Approval Requirements	■ An evaluation of the approvals requirements specific to a proposed location, based on consideration of: 1. Municipal approvals (site plan approval, building permit) 2. Ministry of Environment, Conservation and Parks (Permit to Take Water, Environmental Compliance Approval/Drinking Water License); 3. Grand River Conservation Authority (GRCA). ■ Ability to respond in change in permitting requirements	■ All existing municipal off-line sources have current PTTWs ■ Requirement for treatment to be studied in Schedule B Class EAs ■ Amendments to City DWL ■ Municipal permits required for new/expanded source facilities ■ Consultation with MECP for Smallfield to address existing contaminated sites; Consultation with GRCA for Lower Road replacement	■ All test wells require all approvals for new production wells, including: – Class EA – Schedule B – Municipal – City and Guelph/Eramosa Township (Logan/ Fleming) – PTTW – ECA/ DWL – GRCA (Logan/ Fleming)	■ Approval requirements subject to groundwater versus surface water designation: – Class EA – Schedule B or C (GW/ SW) – Municipal – City and Township (subject to property annexation) – PTTW (Surface water or groundwater) – ECA/ DWL – GRCA	■ New ASR wells require hydrogeological investigation phase; all approvals for new production wells, including: – Class EA – Schedule B or C – Municipal – City – PTTW – ECA/ DWL – GRCA (Depending on proximity to regulated area)	■ New municipal wells require hydrogeological investigation phase; all approvals for new production well, including: – Class EA – Schedule B – Municipal: Township of Puslinch (southeast); Guelph/Eramosa (north) – PTTW – ECA/ DWL – GRCA (Depending on proximity to regulated area)
Natural Environment Category	-	■ Existing municipal sources – sustainable pumping established historically with impacts within catchments accounted for – City conducting additional study for Clythe Well	■ Test wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from reduction in surface water and wetland water levels	■ Site is previously disturbed; artificial discharge to Speed River would be reduced	■ Capturing excess collector system flows has minimal impacts – system is previously permitted; specific ASR locations require significant study	■ New wells near or adjacent to natural heritage features must be investigated to assess potential effects resulting from reduction in surface water and wetland water levels
Effect of Construction and Operation of Alternative on Aquatic and Terrestrial Species and Habitat	■ An evaluation of the effects of construction of the well facility or surface water treatment facility on aquatic species and habitat, based on: 1. Presence of aquatic and terrestrial species potentially affected temporarily and/or permanently, including Species at Risk, (Endangered,	■ All wells in category have existing PTTW and previously evaluated potential impacts; further evaluation to be completed through individual Class EAs ■ Clythe – close to Clythe Creek and Clythe Creek PSW (Class EA complete) ■ Sacco & Smallfield – Speed River catchment; close proximity to Ellis/	■ Further evaluation of potential impacts to be completed through individual Class EAs ■ Steffler/ Ironwood/ Guelph South - near Hanlon Creek Swamp PSW ■ Logan/ Fleming – near Guelph Northeast PSW Complex; new well required ■ Hauser – close proximity to Ellis/ Chilligo Creek;	■ Further evaluation of potential impacts to be completed through upcoming Class EA ■ Site is adjacent to Speed River and Speed River PSW Complex; quarry lands are previously disturbed	■ Further evaluation of potential impacts to be completed through specific Class EA ■ Specific locations of ASR wells not yet determined, to be reviewed and evaluated through EA process	■ Further evaluation of potential impacts to be completed through individual Class EAs ■ Guelph North – near the Marden South PSW Wetland Complex; new well required ■ Guelph Southeast - near Arkell Bog PSW Complex and Mill Creek Puslinch PSW Complex; new well required

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
	Threatened, Special Concern), species of provincial, regional and local conservation concern, native and invasive species, and area-sensitive species; 2. Area of temporary or permanent loss of aquatic and terrestrial features or categorical loss of habitat functions by type – including Provincially Significant Wetland (PSW), Locally Significant Wetland, Environmentally Significant Areas, Areas of Natural and Scientific Interest, watercourses by sensitivity type, and others.	Chilligo Creek; near Marden South PSW Complex; Smallfield near a significant woodland ▪ Lower Road – near Eramosa River and Eramosa River Blue Springs Creek PSW Complex	near Ellis Creek PSW Complex; new well required			
Effect on Surface Water Quantity & Quality	▪ An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies due to: 1. Construction or operation; 2. Groundwater drawdown during operation of the well.	▪ Existing PTTWs – flows accounted for in Tier Three Model and therefore, impacts to watersheds incorporated into combined takings	▪ Ironwood/ Steffler/ Guelph South – pumping rate(s) to be established to avoid impacts to Hanlon/ Irish Creek baseflow; system-wide sustainable quantity evaluated with Tier Three Model, identified potential baseflow reduction >10% ▪ Logan/ Fleming – Speed River catchment, close to tributary; potential effects to surface water; testing of new well will assess surface water/ groundwater interaction; system-wide sustainable quantity evaluated with Tier Three Model, identified potential baseflow reduction >10% to Clythe Creek ▪ Hauser – close proximity to Ellis/ Chilligo Creek; low	▪ Currently, water within quarry is pumped and discharged to Speed River. Developing new wells in area will reduce in-flow to quarry and reduce artificial discharge to Speed River. If water within quarry is utilized for supply, artificial discharge would be further reduced. Not considered an impact to surface water as this input to river is not natural.	▪ Excess flows from collector systems discharge to Eramosa River; excess flows proportional to seasonality of river flows so no reduction in baseflows ▪ ASR wells in high conductivity areas, designed to re-capture injected flow; impacts not anticipated	▪ Guelph North – pumping rate(s) to be established to mitigate effects on Marden Creek baseflow; system-wide sustainable quantity evaluated with Tier Three Model, identified potential baseflow reduction >10% ▪ Guelph Southeast – pumping rate(s) to be established to mitigate effects on Mill Creek baseflow; system-wide sustainable quantity evaluated with Tier Three Model, baseflow impacts not identified

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
			capacity well; potential effects to be assessed through detailed testing; system-wide sustainable quantity evaluated with Tier Three Model, baseflow impacts not identified			
Built Environment Category	-	■ Disruption on neighbouring residents due to need for expansion to accommodate treatment requirements at Clythe, Sacco/ Smallfield ■ Existing WHPAs	■ New WHPAs may affect current and future land use	■ New WHPA may affect current and future land use	■ Property acquisition required for ASR wells inside City ■ New WHPAs may affect current and future land use	■ Property acquisition required in areas outside City ■ New WHPAs may affect current and future land use
Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	■ An evaluation of the effects on existing or future planned property & buildings, based on: 1. Displacement and/or temporary or permanent disruption to residences, businesses, and / or community, institutional, and recreational facilities; 2. Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future agricultural operations and Environmental Protection Areas. 3. Effect on Property (ownership, size, and willingness of property owner)	■ Clythe – City owns required property for well and treatment facility; existing WHPA ■ Sacco – expansion of facility for treatment requires new property; evaluation assumes use of space at Smallfield site; existing WHPA ■ Smallfield – sufficient area for expansion of facility for treatment; existing WHPA ■ Lower Road – no property required; existing WHPA	■ Ironwood/ Steffler – planned locations in municipal parks; potential disruption to park use; historical concern regarding property value from adjacent residents; new WHPAs to consider nearby existing land use (minimal impacts anticipated) ■ Logan/ Fleming – City owns required land at Logan site for new well facility; new WHPA may affect current and future land uses (potential impacts to agricultural/ commercial land use) ■ Guelph South – City owned property; new WHPA to consider nearby existing land use (potential effects on agricultural/ commercial land use) ■ Hauser – City owned property; new WHPA to consider nearby existing land use (potential effects on agricultural/ industrial land use)	■ Required infrastructure within quarry will be incorporated into quarry development plan; new WHPA to consider nearby existing and planned land uses (minimal impacts anticipated)	■ New ASR wells in the City will require property – either private or municipal land. These wells will also result in new WHPAs which may affect current and future uses.	■ Guelph North – land required; new WHPA may affect current and future land use including agricultural ■ Guelph Southeast – land required; new WHPA may affect current and future land use including agricultural

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Effect on Private and Municipal Wells (groundwater quality and quantity)	■ An evaluation of effects on private and municipal wells, based on: 1. Proximity to and number of private and municipal wells in the vicinity of proposed alternative; 2. The distance to other permitted takers	■ Existing sources – interference with other municipal wells already considered in establishing available capacity when system pumped at maximum rate; system-wide sustainable quantity evaluated with Tier Three Model	■ Test wells - system-wide sustainable quantity evaluated with Tier Three Model; field investigations have evaluated potential for private well interference at Ironwood/ Steffler/ Guelph South; future testing will evaluate this for Hauser/ Logan/ Fleming	■ Pond Level Management pumping is an established activity; will be optimized to protect municipal wells	■ New ASR wells in the City require future investigations to review potential interference with municipal wells; low risk of interference with private wells	■ Guelph North – potential effects anticipated to municipal and private wells; to be evaluated through Class EA ■ Guelph Southeast – potential effects anticipated to private wells; to be evaluated through Class EA
Social/Cultural Environment Category	-	■ Moderate ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate to high ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate to high ability to meet future demand in conjunction with surrounding wells/ test wells ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Low ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Moderate ability to meet future demand; extensive study required to explore potential source ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction
Ability to Meet Municipal and Provincial Growth Targets	■ An evaluation of the water supply alternative to partially or fully meet the demands to 2051	■ Existing sources – total available sustainable capacity of 6,030 m^3/day	■ Test wells – total available sustainable capacity of 9,105 m^3/day	■ Dolime Quarry – estimated 3,000 m^3/d available; subject to Southwest Guelph Class EA; water from surrounding wells or directly from quarry	■ New ASR wells total – available minimum capacity of 1,170 m^3/day	■ New Wells outside the City – total available sustainable capacity of 4,535 m^3/day
Public Acceptance of Alternative	■ An evaluation of the opportunities for Public Education through the implementation of the alternatives ■ Expected public acceptance based on health and safety concerns	■ Public will be educated regarding treatment requirements through Class EA; ■ Clythe – evaluated through Class EA, preferred alternative identified and accepted by public ■ Sacco & Smallfield – potential issues with public acceptance due to treatment requirements for TCE, PCE, VOCs;	■ Public will be educated regarding new wells and treatment requirements through individual Class EAs ■ Ironwood/ Steffler – anticipated high public acceptance based on good water quality; some concerns related to use of park land, property value implications ■ Logan/ Fleming – anticipated high public	■ Public consultation occurred through Our Community, Our Water initiative; strong public acceptance of high-level plan for City to annex quarry property and manage on-site water; future consultation related to site will occur through Southwest Guelph Water Supply Class EA	■ Public will be educated regarding ASR strategy through Class EA ■ Non-traditional water source, public education required to communicate other successful applications of technology and extensive water quality study that will occur during feasibility and design stages	■ Public will be educated regarding new wells outside City through Class EA ■ Guelph North – assumed good water quality to be confirmed through future testing; Township residents may oppose ■ Guelph Southeast – assumed good water quality to be confirmed through future testing;

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
		■ Lower Road – anticipated high public acceptance based on good water quality	acceptance based on good water quality ■ Hauser – anticipated high public acceptance based on good water quality (field testing/ confirmation required)	■ No identified health and safety concerns with this source.		Township residents may oppose
Effect of Noise/Vibration on Sensitive Receptors	■ An evaluation of effects on noise sensitive receptors, based on: 1. Presence of sensitive receptors and duration of construction schedule; 2. Disruption during the operations phase.	■ Existing sources – construction of new treatment systems and expansion of source facility will have temporary effects ■ Operations phase will have similar impacts to previous historical operation	■ Ironwood/ Steffler – temporary impacts from construction to adjacent residents and park users; operations phase noise and disruption to be mitigated through design considerations ■ Logan/ Fleming – rural setting minimizes number of adjacent residents during construction and operation ■ Hauser – temporary impacts from construction to adjacent residents (low density locally); operations phase noise and disruption to be mitigated through design considerations ■ Guelph South - temporary impacts from construction to adjacent residents (low density locally); operations phase noise and disruption to be mitigated through design considerations	■ Site is relatively isolated, noise related to construction and operations less than that of operating quarry	■ New ASR wells in the City - locations to be determined; temporary impacts from construction to adjacent residents; operations phase noise and disruption to be mitigated through design considerations	■ Guelph North – to be determined for specific location; anticipate minimal impacts due to rural locations ■ Guelph Southeast – to be determined for specific location; anticipate minimal impacts due to rural locations
Effect on Cultural Heritage Landscapes and Built Heritage Resources	■ An evaluation of effects on cultural heritage resources, based on: 1. Presence of cultural heritage landscapes; 2. Presence of built heritage resources.	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	2B – Groundwater - Existing Municipal Off-line Sources *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Ironwood/ Steffler, Logan/ Fleming, Hauser, Guelph South [GSTW1-20])*	2D - Groundwater – Dolime Quarry	2F – Arkell Collectors & ASR *(Central)*	2G – Groundwater - New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph Southeast – Victoria& Maltby)*
Effect on Potential Archaeological Resources	■ An evaluation of effects on archaeological resources, including: 1. Presence of areas with archaeological potential (i.e., lands with potential archaeological resources) affected.	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities
Legal/Jurisdictional Category	-	■ No jurisdictional issues	■ Logan/Fleming well in Guelph/Eramosa Township	■ Council has approved quarry annexation	■ No jurisdictional issues	■ Guelph North well in Guelph/Eramosa Township ■ Guelph Southeast well in Puslinch Township
Location Inside vs. Outside City boundaries	■ An evaluation of need to work with adjacent Townships for land requirements for facility and utility easements ■ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.	■ All proposed upgrades at existing City facilities/ property; existing WHPAs ■ Smallfield – potential legal liabilities associated with re-distribution of contaminated groundwater	■ All proposed wells are inside City except new well in area of Fleming/Logan just east of City on Eastview Rd. Within G-E Township jurisdiction – effects with respect to WHPA, utility easements. ■ WHPA for Guelph South/ Hauser could extend into surrounding Township	■ City Council and G-E Township/ Wellington County have approved annexation plan. Provincial approval of annexation required. New WHPA may affect surrounding properties (including in G-E Township)	■ Proposed ASR wells are inside City.	■ Proposed wells outside City will require land for facilities and easements for utilities as well as consultation during Class EAs ■ Within G-E and Puslinch Township jurisdictions – effects with respect to WHPAs
Financial Category	-	■ Low to moderate costs depending on source capacity	■ Lowest costs due to high capacity wells (except Hauser)	■ High cost for new WTP; OTP to assess availability of water through surrounding wells rather than within quarry	■ Very high costs due to seasonal availability & low average production year-round	■ Moderate to high costs due to assumed Fe/Mn treatment and location outside of City
Capital Costs (Life cycle cost per m³)	■ An evaluation of the capital and operation & maintenance costs, including: 1. Estimated Capital Cost of all works in category 2. Capital Cost per Capacity ($/m^3/day) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate and capital plus O&M cost	■ Capital cost = $6.78 to 13.87 Million ■ Capital cost per capacity = $2,012 to 5,127 per m^3/day ■ Life cycle cost: $0.58 to $1.24 per m^3 produced	■ Capital cost = $4.8 to 10.1 Million ■ Capital cost per capacity = $640 to 6,480 per m^3/day ■ Life cycle cost: $0.19 to $1.86 per m^3 produced	■ Capital cost = $18.9 Million ■ Capital cost per capacity = $6,325 per m^3/day of total capacity ■ Life cycle cost: $1.71 per m^3 produced	■ Capital cost = $25.3 Million ■ Capital cost per capacity = $21,610 per m^3/day of total capacity ■ Life cycle cost: $4.79 per m^3 produced	■ Capital cost = $6.8 to 12.8 Million ■ Capital cost per capacity = $4,289 to 4,375 per m^3/day ■ Life cycle cost: $1.11 to $1.22 per m^3 produced

Table 6-7: Summary of Evaluation of Water Supply Alternatives - Surface Water Source

Category of Consideration	3A - Surface Water – Guelph Lake WTP	3B - Surface Water - Guelph Lake WTP & ASR
First Nations, Métis and Inuit Peoples Category - Effect on Indigenous values, culture, and Traditional use ***This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph***	▪ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River.	▪ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.
Technical Category	▪ Subject to investigation and feasibility studies ▪ Complex Surface WTP to operate	▪ Subject to investigation and feasibility studies ▪ Complex Surface WTP & ASR system to operate
Natural Environment Category	▪ Impacts to natural environment features to be assessed and mitigated	▪ Impacts to natural environment features to be assessed and mitigated
Built Environment Category	▪ Potential disruption to recreational use of Guelph Lake & Speed River. ▪ Potential effects to agricultural operations from new Source Water intake protection zone	▪ Potential disruption to recreational use of Guelph Lake & Speed River. ▪ Potential effects to agricultural operations from new Source Water intake protection zone
Social/ Cultural Environment Category	▪ High ability to meet future demand ▪ Noise impacts to be mitigated	▪ Highest ability to meet future demand ▪ Noise impacts to be mitigated
Legal/ Jurisdictional Category	▪ WTP intake upstream of Guelph Lake dam east of City boundary ▪ WTP south side of Guelph Lake in or outside City	▪ WTP intake upstream of Guelph Lake dam east of City boundary ▪ WTP & ASR wells options in or outside City
Financial Category	▪ Moderate to high cost	▪ Moderate to high cost
Overall Results	▪ **Preferred as part of overall solution; commence preliminary treatability studies and ecological effects investigations to identify constraints and mitigation required; identify stakeholders and property acquisition requirements**	▪ **Preferred as part of overall solution; additional modelling and hydrogeological studies required to assess efficiency and confirm required infrastructure and costs**

Table 6-8: Assessment and Evaluation of Water Supply Alternatives - Surface Water Source

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
First Nations, Métis and Inuit Peoples Category	-	-	-
This category is not intended to be a comprehensive assessment of how the alternatives could affect the Peoples in the identified communities. Rather it is a summary of what the Project Team has learned about the perspective of individual First Nations, Métis and Inuit Peoples living in Guelph	■ Key themes shared with the Project Team include, valuing and respecting the agency of water, understanding the spirit and personhood of water, good stewardship of the connected ecosystem including protection of water's pureness, consideration of First Nations, Métis and Inuit Peoples culture and worldview in all aspects of the evaluation.	■ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River.	■ Pumping surface water for water supply must be done in a way that protects the connected ecosystem at Guelph Lake and downstream in the Speed River. Injection of water into the aquifer must be done following detailed study so that it is done in a way that protects water purity.
Technical Category	-	■ Complex WTP to operate	■ Complex WTP and ASR System to operate
Constructability	■ An evaluation of the proposed water supply location, based on: 1. Ability to use existing infrastructure; 2. Site access; 3. Constructability (geotechnical, proximity to adjacent buildings, etc.); 4. Proximity to municipal distribution system/ large diameter watermains; 5. Proximity to sanitary collection system for building and process drainage 6. Future expandability	■ Able to use Guelph Lake as a reservoir with level control via Guelph Lake dam ■ Requires new infrastructure at Guelph Lake consisting of intake, WTP, large diameter watermain to distribution system in Guelph; sewer connection to NE City collection/PS for WTP residuals ■ Build for base continuous flow of 150 L/s, expandable to 300 L/s for future ASR	■ Able to use Guelph Lake as a reservoir with level control via Guelph Lake dam ■ Requires new infrastructure at Guelph Lake consisting of intake, WTP, large diameter watermain to distribution system in Guelph; sewer connection to NE City collection/PS for WTP residuals ■ Build in modules of 150 L/s to 300 L/s for future ASR ■ Two options for locating ASR wells: 1. Injection wells in area of Guelph Lake + recovery wells around Park & Emma (assessed in 2014 WSMP) 2. Full ASR wells in Park & Emma area ■ Use of existing municipal wells to maximize recovery to 100% subject to further study and field testing
Potential Productivity and Reliability	■ An evaluation of the productivity potential of the water supply alternative based on: 1. Total available supply quantity 2. Known and modelled aquifer conditions 3. Surface water flows & seasonal reliability	■ Surface water availability determined by GRCA through assessment of decades of data - base flow of 150 L/s determined to be available at a reliability of 100% at any given time	■ Surface water availability determined by GRCA through assessment of decades of data -base flow of 150 L/s determined to be available at a reliability of 100% at any given time; additional flow of 150 L/s (to a total of 300 L/s) also very reliable; conservative assumption that is available 9 months of the year avoiding takings from June to August
Water Treatment Requirements	■ An evaluation of the raw water quality and review of treatment requirements; based on: 1. Preliminary or estimated water quality results, based on available historical water quality data; 2. Consideration to be given to difficulty of treatment, operational requirements and associated costs; 3. Ability to respond to change in regulatory treatment requirements 4. Review of Drinking Water Source Protection Areas to identify any potential future treatment and monitoring requirements by identifying any risks within that zone in accordance with Source Water Protection standards of the *Clean Water Act*.	■ SW requires increased treatment; assumes WTP consists of following processes: – Low lift pumping station – Screening – Pre-treatment (Dissolved Air Floatation with Coagulant, Flocculation) – Intermediate Ozonation – Biologically Active Carbon Filtration – Chlorination – Space Allowance for Future UV Disinfection – Residuals management (equalization, thickening, discharge to sewer) ■ Need to consider Drinking Water Source Protection Area for surface water taking	■ SW requires increased treatment; assumes WTP consists of following processes: – Low lift pumping station – Screening – Pre-treatment (Dissolved Air Floatation with Coagulant, Flocculation) – Intermediate Ozonation – Biologically Active Carbon Filtration – Chlorination – Space Allowance for Future UV Disinfection – Residuals management (equalization, thickening, discharge to sewer) – Allowance for connection to ASR with re-chlorination ■ Need to consider Drinking Water Protection Area for surface water taking

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
Approval Requirements	■ An evaluation of the approvals requirements specific to a proposed location, based on consideration of: – Municipal approvals (site plan approval, building permit) – Ministry of Environment, Conservation and Parks (Permit to Take Water, Environmental Compliance Approval/Drinking Water License) – Grand River Conservation Authority (GRCA) – Ability to respond in change in permitting requirements	■ New Surface WTP require extensive approvals, including: – Class EA – Schedule C – Municipal – City and Township – PTTW (Surface Water) – ECA/DWL – GRCA	■ New Surface WTP and ASR system require extensive approvals, including: – Class EA – Schedule C – Municipal – City and Township – PTTW (Surface water and groundwater) – ECA/DWL – GRCA
Natural Environment Category	-	■ Impacts to natural environment features to be assessed and mitigated	■ Impacts to natural environment features to be assessed and mitigated
Effect of Construction and Operation of Alternative on Aquatic and Terrestrial Species and Habitat	■ An evaluation of the effects of construction of the well facility or surface water treatment facility on aquatic species and habitat, based on: 1. Presence of aquatic and terrestrial species potentially affected temporarily and/or permanently, including Species at Risk, (Endangered, Threatened, Special Concern), species of provincial, regional and local conservation concern, native and invasive species, and area-sensitive species; 2. Area of temporary or permanent loss of aquatic and terrestrial features or categorical loss of habitat functions by type – including Provincially Significant Wetland, Locally Significant Wetland, Environmentally Significant Areas, Areas of Natural and Scientific Interest, watercourses by sensitivity type, and others.	■ Area affected includes Guelph Lake and its associated wetland and aquatic features, i.e., Guelph Northeast PSW and Speed River ■ Impacts mitigated by keeping existing water capacity at base levels; however taking of surface water may affect surface water and wetland water levels with potential impacts of: – Reduction in viable fish/amphibian habitat within lake and river systems – Alteration of plant community composition through change of riparian/emergent and submergent zones – Alteration of sensitive species habitat/range – Alteration of overall water temperatures (i.e., shallower waters result in higher temperature regimes) ■ Investigation and approvals would require field investigations and assessment to determine mitigation measures addressing impacts related to water drawdown	■ Area affected includes Guelph Lake and its associated wetland and aquatic features, i.e., Guelph Northeast PSW and Speed River ■ Impacts mitigated by keeping existing water capacity at base levels; however taking of surface water may affect surface water and wetland water levels with potential impacts of: – Reduction in viable fish/amphibian habitat within lake and river systems – Alteration of plant community composition through change of riparian/emergent and submergent zones – Alteration of sensitive species habitat/range – Alteration of overall water temperatures (i.e., shallower waters result in higher temperature regimes) ■ Investigation and approvals would require field investigations and assessment to determine mitigation measures addressing impacts related to water drawdown
Effect on Surface Water Quantity & Quality	■ An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies due to: 1. Construction or operation; 2. Groundwater drawdown during operation of the well.	■ Reduced water quantity; possible temperature effects per above	■ Reduced water quantity; possible temperature effects per above ■ ASR wells in high conductivity areas, designed to re-capture injected flow; impacts not anticipated
Built Environment Category	-	■ Disruption to recreational use of Guelph Lake and Speed River ■ Potential impact to agricultural operations from new Source Water intake protection zone.	■ Disruption to recreational use of Guelph Lake and Speed River ■ Potential impact to agricultural operations from new Source Water intake protection zone.

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
Effect on Existing and/or Future Planned Residences, Businesses, and / or Community, Institutional and/or Recreational Facilities	■ An evaluation of the effects on existing or future planned property & buildings, based on: 1. Displacement and/or temporary or permanent disruption to residences, businesses, and / or community, institutional, and recreational facilities; 2. Future planned, or approved land uses, including those affected by the addition of new Wellhead Protection Areas. These may include but are not limited to existing and future agricultural operations and Environmental Protection Areas. 3. Effect on Property (ownership, size, and willingness of property owner)	■ Reduction in surface water flow and water levels could affect recreational uses at Guelph Lake and along Speed River upstream of the WWTP (where discharge would be increased proportional to water taking) ■ WTP siting may disrupt use of Guelph Lake area recreational use depending on location ■ Addition of new Source Water protection area around intake (IPZ) may affect existing and future agricultural use in area	■ Reduction in surface water flow and water levels could affect recreational uses at Guelph Lake and along Speed River upstream of the WWTP (where discharge would be increased proportional to water taking) ■ WTP siting may disrupt use of Guelph Lake area recreational use depending on location ■ Addition of new Source Water protection area around intake (IPZ) and new WHPAs for ASR wells may affect existing and future agricultural use in area
Effect on Private and Municipal Wells (groundwater quality and quantity)	■ An evaluation of effects on private and municipal wells, based on: 1. Proximity to and number of private and municipal wells in the vicinity of proposed alternative; 2. The distance to other permitted takers	■ No impacts anticipated on private and municipal wells	■ No impacts anticipated on private and municipal well; potential benefit from ASR
Social/Cultural Environment Category	-	■ High ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction	■ Highest ability to meet future demand ■ Noise sensitive receptors will be disturbed during construction; however, noise effects during operations will be minimized through the use of mitigation measures ■ Cultural heritage landscape and presence of archaeological resources will be documented prior to construction
Ability to Meet Municipal and Provincial Growth Targets	■ An evaluation of the water supply alternative to partially or fully meet the future 25-year demands	■ Available takings of 150 L/s; provides maximum capacity of approx. 12,300 m^3/day after WTP treatment losses ■ Provides significant source to partially meet future 2051 max day demand	■ Available takings of 150 to 300 L/s; provides maximum capacity of approx. 25,800 m^3/day after WTP treatment losses ■ Provides significant source to fully meet future 2051 max day demand
Public Acceptance of Alternative	■ An evaluation of the opportunities for Water Conservation Education through the implementation of the alternatives ■ Expected public acceptance based on health and safety concerns	■ Large volume available may deter conservation efforts ■ Moderate public acceptance	■ Large volume available may deter conservation efforts ■ Moderate public acceptance
Effect of Noise/Vibration on Sensitive Receptors	■ An evaluation of effects on noise sensitive receptors, based on: 1. Presence of sensitive receptors and duration of construction schedule; 2. Disruption during the operations phase.	■ Significant disruption during construction ■ Minimal impact during operation due to remote location	■ Significant disruption during construction ■ Minimal to moderate impact during operation due to remote location of WTP; location of ASR wells in City temporary impacts from construction to adjacent residents; operations phase noise and disruption to be mitigated through design considerations
Effect on Cultural Heritage Landscapes and Built Heritage Resources	■ An evaluation of effects on cultural heritage resources, based on: 1. Presence of cultural heritage landscapes; 2. Presence of built heritage resources.	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities
Effect on Potential Archaeological Resources	■ An evaluation of effects on archaeological resources, including:	■ To be reviewed during Class EA for new facilities	■ To be reviewed during Class EA for new facilities

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
	1. Presence of areas with archaeological potential (i.e., lands with potential archaeological resources) affected.		
Legal/Jurisdictional Category	-	■ WTP intake upstream of Guelph Lake dam east of City boundary; WTP south side of Guelph Lake in or outside City	■ WTP intake upstream of Guelph Lake dam east of City boundary; WTP south side of Guelph Lake in or outside City ■ Two options for ASR include inside and outside City
Location Inside vs. Outside City boundaries	■ An evaluation of need to work with adjacent Townships for land requirements for facility and utility easements ■ Requirement for Townships to implement Source Water Protection requirements within their jurisdiction.	■ WTP intake just east of City boundary; land requirement could be within City by extending raw water transmission main; land outside City could be mitigated through discussions with GRCA; utility easements along Victoria Road in City	■ WTP intake just east of City boundary; land requirement could be within City by extending raw water transmission main; land outside City could be mitigated through discussions with GRCA; utility easements along Victoria Road in City ■ Two options for ASR include combination of ASR wells inside and outside City; or all wells inside City
Financial Category	-	■ Moderate to High Cost	■ Moderate to High Cost
Capital Costs (Life cycle cost per m^3)	■ An evaluation of the capital and operation & maintenance costs, including: 1. Estimated Capital Cost of all works in category 2. Capital Cost per Capacity (\$/m^3/day) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate	■ Capital cost = \$51.3 Million ■ Capital cost per capacity = \$3,960 per m^3/day of total capacity ■ Life cycle cost: \$1.16 per m^3 produced	■ Capital cost = \$77.1 Million ■ Capital cost per capacity = \$4,420 per m^3/day of total additional capacity ■ Life cycle cost: \$0.75 per m^3 produced

6.3 Evaluation Summary

6.3.1 General Approach

The alternatives considered through this WSMP Update do not represent stand-alone solutions to meeting the City's future water supply needs. The preferred solution will consist of several of the available alternatives that, in combination, will satisfy future water demands as well as a contingency for security of supply.

Potential projects were identified earlier in the WSMP process and reviewed from a technical and natural environment (i.e., effects on to surface water baseflow) perspective through modelling. Those that were found to have some merit were carried forward for further evaluation. The potential projects are grouped by type – i.e., conservation, groundwater, surface water etc., due to the common characteristics and impacts, and evaluated against environmental assessment criteria for the purpose of comparing the level of impacts within the context of the categories of natural, social, cultural, and built environments, and regulatory, technical and financial considerations in order to achieve the following:

- To determine whether a project should be recommended for implementation on the basis of acceptable impacts with mitigation; or recommended for additional investigation prior to potential implementation to further assess potential impacts, mitigation measures and technical feasibility; or recommended against further consideration on the basis of unacceptable impacts that cannot be mitigated;
- To prioritize projects with the least amount of impacts for immediate implementation;
- To prioritize projects within the City first versus outside the City following input from the public and stakeholders in previously completed iterations of the WSMP;
- To identify projects with potential future water supply capacity subject to additional investigation; outlining data gaps and areas of uncertainty;

- To identify mitigation measures to reduce potential impacts to the natural, social, and cultural environments;
- To identify considerations for future Class EA Schedule B and C projects including required studies and stakeholders to be consulted; and
- To consider cost of implementation to allow for future budgeting and management.

Furthermore, as described above, an additional objective of the evaluation consists of consideration of First Nations, Métis and Inuit Peoples culture and worldview in aspects of the evaluation. The intent is to assess the potential effect of each alternative on Indigenous values, culture, and Traditional use. Through the draft evaluation of alternatives, this category was used as a guide for how subsequent categories have been evaluated with consideration of the feedback and key themes that were communicated to the City through the process.

It is acknowledged that climate change is an important consideration when evaluating potential impacts to the natural environment, the sustainability of a water supply source and the reliability of a source over a long-term planning period. However, in the case of the alternatives evaluated for the WSMP Update, climate change was not considered to be a criterion that would distinguish between the alternatives being considered. Based on climate change modelling, conducted as part of the Tier 3 Water Budget and Local Area Risk Assessment, it is expected that future changes to the climate will have a more acute impact to surface water resources due to their exposure to extreme weather events and drought that could result from a changing climate. Groundwater drawn from deep bedrock aquifers is afforded the buffering capacity of the overlying rock and sediments and is expected to experience variable recharge that results from extreme weather events and more frequent melting events in winter. As the preference to prioritize groundwater sources within the City in previous master plans was carried forward to this WSMP Update, the potential for surface water resources to be affected by climate change does not cause a change in the evaluation process. Despite this, it is recommended that the City continue to study the ways in which climate change will impact the municipal water supply system and apply, as necessary, future climate models and projections of weather patterns to each water supply project that is pursued in the future.

6.4 Alternatives – Key Findings of Evaluation

Water Conservation and Efficiency Programs – in evaluating the various scenarios developed for water conservation, there are a few considerations worth noting:

- There is a clear preference in the Guelph community to have an active conservation and efficiency program, as opposed to the 'do nothing' scenario
- The level of effort applied to water efficiency programs should be determined by the success and life span of the individual programs – over time, each will reach a point where the cost is not warranted as compared to its benefits; at which point it should cease or alternatively be replaced by a more effective program
- The cost per m^3 reduction varies with program type (direct vs indirect) and whether reuse is implemented; if the unit cost is being compared to the unit cost of implementing new water supply this is also subject to change over time as the supply sources changes from more readily available water, to water requiring treatment, to surface water options.
- Therefore it is recommended that the water efficiency program be viewed as a flexible strategy with the following considerations:
  - Continuation of the current program (Scenario #2) in the short term, winding down programs that are found to be less effective
  - New programming based on a more targeted approach (Scenario #3) that has a higher benefit to cost (more direct accountability) – and lower cost per m^3 reduction
  - Long term consideration and implementation of water reuse programs that provide year-round reliable reductions (Scenario #4) with added public education and acceptance and as cost per m^3 reduction becomes more favourable against more expensive future water supply options

Groundwater Sources – as a groundwater-based community, Guelph is committed to optimizing the available local groundwater supply first within the City, and then within a reasonable distance of the City boundary, prior to pursuing local surface water supply. The City is very cognizant of determining the quantity that can be withdrawn from the aquifer in a sustainable way. Sustainability is assessed through use of the Tier Three Model which is able to quantify the impact of varying well capacities on local surface water features. Therefore, the proposed capacities for each individual well supply, whether existing or proposed, is based on the model outputs. However, while the model uses the best available information, the modelling approach contains some conservativeness that must be considered in the interpretation of the results. The evaluation against environmental criteria as well as review of technical and financial considerations was completed against the various categories of groundwater projects grouped by similar aspects. Additional considerations for each potential project are identified below:

2B – Groundwater – Existing Municipal Off-line Sources

In the 2014 WSMP, the category of existing municipal off-line sources was prioritized as more information was known about these wells, some have current approvals and they are located on City owned land with existing infrastructure; therefore there is greater certainty about capacity and feasibility for implementation. However, each has challenges that will need to be addressed in the next phase of implementation:

- Clythe Well – Schedule B Class EA completed; property acquisition adjacent to well site for treatment facility completed; next steps include design and construction
- Sacco & Smallfield Wells – known groundwater contamination from anthropogenic sources; there remains great uncertainty and risk for the City in the design of a treatment system with respect to the maximum raw water contaminant concentrations, the influent concentration trend with time, the duration of treatment, and the potential liability of pulling contaminated groundwater across areas which are not yet impacted; therefore this potential source has less certainty about next steps; it remains part of the preferred solution but timing delayed until investigation/ contaminant source control undertaken with agency involvement
- Lower Road Collector - uncertainty regarding base flows and variability; requires additional modelling and study to verify potential and feasibility for implementation

2C – Groundwater – Municipal Test Wells

In the 2014 WSMP, the category of municipal test wells was also assigned high priority; while approvals are still required (i.e., PTTW), there is sufficient information available about these wells to provide a high degree of certainty about capacity and feasibility for implementation. Each has unique challenges that will need to be addressed in the next phase of implementation:

- **Ironwood/ Steffler Test Wells** – Previous assessment of these wells indicated that operations at the Dolime Quarry impacted the quantity of water available at these locations. Both of these sources will be considered through the Southwest Guelph Water Supply Class EA. These wells are located within municipal parks and must be developed in a manner that minimizes impact to community use of the parks and disruption to the surrounding residences. Optimization of pumping within southwest Guelph is a critical aspect of managing the overall water balance between groundwater extraction, groundwater protection and surface water ecology.
- **Logan/ Fleming Test Wells** – The City is proceeding with reconstructing and testing the Logan Well to further characterize the well as a future water supply source, evaluate the potential for interaction with the natural environment, and assess the potential effects to other groundwater users. Consultation with Guelph/Eramosa Township will be required to address the jurisdictional aspects of this City-owned property located outside of the City boundary. Future work will address the delineation of a WHPA and the associated land use management through the Source Water Protection process.
- **Hauser Test Well** – This well is anticipated to be relatively low capacity and is located in close proximity to the Sacco and Smallfield Wells, which have been impacted by anthropogenic contaminants. Development of this alternative requires the drilling of a test well, evaluation of local water quality and the potential for interaction with the natural environment.
- **Guelph South [GSTW1-20] Test Well** – This test well will also be evaluated through the Southwest Guelph Water Supply Class EA.

The operation of this well is anticipated to reduce baseflow on the same surface water features (Hanlon Creek, potentially Irish Creek) as the other test wells and municipal wells in southwest Guelph. Similar to previous OTP work completed by the City, detailed testing and field data collection will be completed to critically evaluate the response within the system to pumping at varying rates and varying locations, in order to arrive at an optimized solution.

2D – Groundwater – Dolime Quarry

Subsequent to the City's successful discussions with the owners of the Dolime Quarry regarding a preferred methodology to protect the exposed aquifer that supplies the City's potable water during the 2014 WSMP, the City has undertaken a Class EA study to develop a Pond Level Management strategy that may result in added water available for supply. Operational testing and modelling will indicate whether additional water may be pumped through municipal wells or from the Dolime quarry directly while maintaining a pond level that protects the aquifer.

More information will be available through the Guelph Southwest Water Supply Class EA study to be completed prior to the next update of the WSMP.

2F – Arkell Collectors & ASR (Central)

ASR has been reviewed at a conceptual level to determine whether it warrants further consideration. There are several potential opportunities for locating ASR injection and recovery wells across the City, combined with maximizing existing City wells for optimized extraction.

This particular ASR option takes advantage of the highly seasonal flows in the Arkell collectors (Glenn and Lower Road) and existing available infrastructure including:

- In-situ filtration of shallow groundwater on site
- Available capacity for higher flows in aqueduct to convey flows to Woods PS
- Use of available disinfection capacity in the Woods UV system

- Use of existing distribution system
- Construction of injection wells in highly permeable areas of City (injected directly from distribution system)
- Use of existing municipal wells for extraction

Use of the Tier Three Model identified some limitations of this possible alternative. Therefore, it is recommended that it be carried forward for additional investigation and review by the City to examine its efficiency, infrastructure requirements, and costs and ultimately its long-term feasibility.

2G – Groundwater – New Wells Outside City

In the 2014 WSMP, the category of new wells outside the City was assigned a lower priority for a couple of reasons; the primary reason was that public and stakeholders provided clear direction to maximize sources within the City first, and coordination and approvals will be required from neighbouring Townships; and secondly there is little information available regarding the site-specific geology and hydrogeology in these areas to provide a strong recommendation regarding capacity and feasibility. This previous recommendation is carried forward in this WSMP Update – these potential sources will not be pursued until after the groundwater alternatives within the City and on City-owned land. Groundwater investigation programs are required to identify locations and to conduct test well drilling and testing to evaluate impacts.

- **Guelph North** – Conservation Rd. W: This general well area is located within Guelph/Eramosa Township and will require consultation and coordination with the Township. Significant work will be required to assess the potential baseflow reductions in surface water features. Municipal supply is available to some residents living outside of the City; however, the instance of active private well use is also more common and must be evaluated with respect to the potential for impacts.
- **Guelph Southeast** – Victoria & Maltby: This alternative has the same key aspects outline above and would also require consultation and coordination with Puslinch Township.

Surface Water Source

The proximity of Guelph Lake and dam that provides the opportunity for an intake to a WTP makes this a very possible alternative for the City. Due to its higher cost (compared to groundwater) and location outside the City boundary, it is assigned a lower priority in the overall timeline; however, it is recommended that the City allow for a minimum ten year time period to complete preliminary studies in order to refine the details such as ecological impacts, treatment requirements, property acquisition needs and requirements for connection to the existing distribution system in advance of the eventual Schedule C Class EA study.

- **3A – Surface Water – Guelph Lake WTP:** Development of this source would require significant water quality characterization, evaluation of the local natural environment and ecosystem function, consultation with GRCA, treatability studies, land acquisition, etc. Public education is another important element as this would be the first surface water source developed for direct use by Guelph residents, who have a long history of groundwater-based supply. Downstream conditions were considered in the evaluation of this alternative but would require further review as the WWTP capacity expands in response to City growth and more related data are available for review.
- **3B – Surface Water – Guelph Lake WTP & ASR:** In addition to the above considerations, the development of ASR is a new concept to the residents of Guelph and would require extensive communication and education to generate public approval. However, ASR is a known technology with decades of practical applications including at the Region of Waterloo's Mannheim facility. From a technical perspective, development of this alternative would require a long implementation period to assess feasibility, improve model predictions, develop an optimized system that efficiently injects and captures excess water, and geochemical studies to ensure that the alternative could be implemented long-term without changing the in-situ aquifer characteristics.

7. Engagement and Consultation

7.1 Overview

The WSMP Update follows the requirements of Phases 1 and 2 of the Municipal Class Environmental Assessment in accordance with Approach #1 of the Master Plan Process described in the Municipal Class Environmental Assessment Manual (amended in 2015) by the Municipal Engineers Association. The WSMP will be updated at approximately five-year intervals. This 2021 update will be co-ordinated with the City's future Official Plan update and will contain plans for development of individual projects consisting of Schedule A, B and C Class Environmental Assessment activities.

Community input is an essential part of the Water Supply Master Plan Update process. People care about where their water comes from, and they want to see a safe and sustainable supply maintained for present and future generations, and residents, councils, agencies, stakeholders and Indigenous Peoples from Guelph and the surrounding Townships and County were engaged throughout the project. This report provides a summary of the engagement process and the feedback received for the Water Supply Master Plan Update.

With this in mind, Phase 1 engagement activities included:

- newspaper advertising and electronic mailing to inform people about the start of the Water Supply Master Plan Update;
- a project website to provide useful information, including links to the previous 2014 Water Supply Master Plan Update, contact information and invitations to online and in-person engagement opportunities;
- online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- establishment of an inclusive and diverse Community Liaison Group to advise and provide feedback to the Project Team throughout the process;

- a municipal and agency workshop to provide crucial inputs from a government and approval agency perspective;
- electronic mailing, newspaper and community-wide advertising about the first community open house;
- one community open house (with two time slots) to introduce the Water Supply Master Plan Update, giving community members an opportunity to discuss the project with experts and provide comments;
- one stakeholder meeting with Guelph Wellington Development Association and Guelph and District Home Builder's Association; and
- co-ordination with other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

Phase 2 engagement activities included:

- continued update of the project website to provide useful information, including links to key documents, contact information and invitations to online engagement opportunities;
- online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- the second and third Community Liaison Group workshops to continue updating interested stakeholders and collecting feedback;
- a second municipal and agency workshop to share an update of the project, and collect additional inputs from the government and approval agency perspective;
- two meetings with the Water Conservation and Efficiency Public Advisory Committee
- one meeting with Mississaugas of the Credit First Nation;
- one meeting with Six Nations of the Grand River;
- meetings held with Councils of the Township of Puslinch and Township of Guelph Eramosa; and

- co-ordination other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

7.1.1 Approach to Public Engagement

At the start of the project, a community engagement and communications plan was developed to guide the implementation of the engagement process for the Water Supply Master Plan Update consistent with the Municipal Class EA process and the City's Community Engagement Framework.

The City's Community Engagement Framework (guelph.ca/plans-and-strategies/community-engagement-framework/) is referenced in the plan, and the Water Supply Master Plan Update aims to embrace the guiding principles for community engagement outlined in the framework including inclusive, early involvement, access to decision making, coordinated approach, transparent and accountable, open and timely communication, mutual trust and respect, evaluation and continuous improvement.

As the project progressed, a virtual approach to engagement was adopted to provide a safe and convenient forum for the Project Team, participants, and stakeholders during the COVID-19 pandemic.

7.1.2 Engagement and Communication Goals

During the development and implementation of the 2021 Water Supply Master Plan Update, the Project Team set out with engagement and communication goals to:

- engage the Guelph community to develop a shared vision for managing the City's water supply;
- generate a broad awareness of the Water Supply Master Plan and opportunities for participation;
- obtain an understanding of the community's aspirations and concerns relating to water management;
- keep key stakeholders informed of Water Supply Master Plan activities, and communicate in a timely and clear manner; and

- affirm the City's commitment to community engagement and open planning processes and demonstrate the impact of engagement efforts on the Master Plan Update and the Class Environmental Assessment process.

7.1.3 Engagement and Communication Objectives

Engagement and communication objectives were also established to

- ensure diverse opportunities for local municipalities, Indigenous Peoples, government agencies, non-governmental organizations, institutions, businesses, community groups / associations, and residents to participate;
- educate community members and groups about the study - why it's important, what's included, how key elements relate to stakeholders, the process that will be followed and how decisions will be made;
- inform and educate stakeholders about the 2021 Water Supply Master Plan Update, and any related studies or initiatives like the Tier 3 Water Budget and Water Quantity Risk Assessment, the Outdoor Water Use By-law Update, Water Efficiency Strategy, the "Our Community, Our Water" (the Dolime Quarry Revitalization plan), and the Clean Water Act Source Protection Plan;
- develop plain language communication materials that support the goals of the project and encourage participation;
- consider all feedback provided and document that it has been considered during the development of water supply alternatives by the Project Team; and
- meet the consultation requirements of the Municipal Class Environmental Assessment for Master Plans.

7.1.4 Presentation Materials

Clear, easy-to-understand and engaging materials (including notices, presentations for the Community Liaison Group, agency workshops and the virtual community open house, display boards, survey, a web page and Have

Your Say online community engagement site) were developed for the public for Phases 1 and 2.

The topics addressed during Phase 1 included:

- an overview of why the Water Supply Master Plan is being updated, including a draft problem and opportunity statement;
- an overview of the Municipal Class Environmental Assessment process, including a timeline of major milestones;
- the Water Supply Master Plan Update steps including forecast of future population and water needs, assess existing water supply capacity, develop and evaluate water supply alternatives and update the Water Supply Master Plan;
- the personhood of water as it is understood in the Indigenous worldview of Indigenous Peoples in the Guelph community;
- a closer look at Guelph's current groundwater supply system;
- estimates of our future water supply requirements – i.e., how Guelph's population is expected to grow by 2051 and the water supply it will need;
- challenges related to the City's water supply, including water security, climate change and extreme weather events, contaminated sites and surface water effects;
- proposed water supply alternative solutions being considered and / or updated, including demand management / efficiency programs, groundwater sources in and outside of the city, local surface water sources, and do nothing;
- evaluation criteria and how the proposed alternative solutions will be evaluated, including natural environment, social and cultural (including archeological) resources, economic and financial considerations, legal / jurisdictional considerations and technological considerations;
- other water-related master planning projects that are currently underway at the City; and
- ways to build authentic, long-standing, community-based relationships by reaching out.

The topics addressed in Phase 2 included:

- review of Phase 1 topics;
- a detailed review of Guelph's existing water supply (namely the 25 production wells, the Arkell Spring Grounds and the Eramosa River intake and recharge system);
- reviewing the water supply requirements to accommodate the 2051 population forecast based on population and water demand projection based on average day demand, maximum day demand and system security of supply (i.e., system redundancy);
- a detailed assessment of the water supply alternatives (water conservation and demand management / water reuse programs; optimizing and expanding on existing groundwater systems; establishing new surface water supply sources; and limiting population growth / doing nothing); and
- preliminary evaluation of the water supply alternatives and results.

7.1.5 Engagement topics

The Project Team identified key engagement topics related to Phases 1 and 2 of the Water Supply Master Plan. Stakeholders and the public were invited to provide their input and feedback to these engagement topics through the various engagement tools and activities.

Phase 1 engagement focused on gathering feedback and input into:

- changes or additions to the draft problem and opportunities statement;
- unique challenges that Guelph faces and should be considered regarding our water supply;
- additional water supply alternatives that should be considered; and
- additional evaluation criteria that should be included.

Phase 2 engagement focused on gathering feedback and input into:

- results of the technical work including the future population targets, water supply demand forecasts, and the existing water supply capacity assessment;
- results of the technical assessment and preliminary evaluation of the water supply alternatives, including additional factors or considerations that are missing; and
- prioritization and public acceptance of the preliminary preferred water supply alternatives.

7.2 Feedback

7.2.1 Phase 1 Feedback

7.2.1.1 Introduction

The feedback received during Phase 1 through the various engagement tools and activities indicates that there is a continued interest from community members and stakeholders about water supply in Guelph. Several themes emerged related to the key engagement topics of this phase, including:

- prioritizing conservation;
- protecting the natural environment;
- managing growth and development;
- controlling groundwater impacts from large water users;
- monitoring emerging contaminants;
- limiting impacts to aquatic and terrestrial wildlife; and
- valuing the agency of water.

Each section below includes content that was presented in relation to the consultation questions. All comments and questions received during Phase 1 engagement are summarized in the subsections below and are provided in **Appendix F**.

7.2.2 Draft Challenge and Opportunity Statement

The public was invited to comment on any suggested changes or additions to the following draft problem and opportunity statement:

- The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers. The 2014 Water Supply Master Plan confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting these future needs. It is important to update the water demand forecast, the existing water system capacity and the status of ongoing water supply projects and make adjustments to the plan as required. The proposed implementation strategy must deliver through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

Comments received about the draft problem and opportunity statement were based on the topics of water supply, conservation, capacity and growth, aquifer recharge, infrastructure, wastewater and other. Summaries of themed responses are outlined below. See all comments received in **Appendix F**.

- **Water supply:**
  It was suggested that groundwater cannot be controlled or developed, therefore, the word 'develop' should be removed from the statement or rephrased to water supply infrastructure being developed. Another suggestion was to focus on adequate water supply (without summer restrictions) before population growth.
- **Conservation:**
  Individuals noted that watershed protection and conservation efforts should be the main priorities.
- **Capacity and growth:**
  Concerns were expressed regarding 2041 as too short of a planning horizon and to first determine the future capacity of water supply before determining how to limit growth.

- **Aquifer recharge:**
  One comment suggested recharging aquifers with wetlands, stormwater and treated wastewater.
- **Infrastructure:**
  One comment suggested exploring costs of more rapidly upgrading infrastructure to reduce system losses, and another comment suggested building a pipe to a lake.
- **Wastewater:**
  One comment suggested including wastewater disposal as part of the Water Supply Master Plan process.
- **Other:**
  Several respondents agreed with the draft problem and opportunity statement. One comment suggested declaring that water-taking is not an approved land use.

7.2.3 Unique challenges

There are a number of unique challenges that Guelph faces and will be taken into consideration during the Water Supply Master Plan Update. These challenges include:

- a Tier 3 Water Budget and Local Area Risk Assessment identified the City's water supply as having a 'significant risk level' of not meeting the 2031 water demand under drought conditions;
- whether a 10 per cent 'system redundancy' allowance is sufficient for ensuring security of our water supply;
- understanding impacts from climate change and extreme weather events to our water supply;
- the existing Smallfield and Sacco wells are affected by contaminated sites and may need to be removed from consideration as City water supply options;
- Dolime Quarry – a proposal to close the quarry ahead of schedule and transfer water management to the City is under consideration; and
- how surface water baseflows could be impacted if we pump more groundwater.

When asked about whether there are other unique challenges that Guelph faces and should be considered with regard to the water supply, a wide variety of comments were received. The following six themes summarize the responses provided. See all comments received in **Appendix F**.

- **Development and growth**:
  Several respondents expressed concerns about developers and impacts of their land use, the impacts of Clair-Maltby developments on Carter 1 and 2 well sites and overpopulation. One comment suggested the City should challenge growth targets set by the provincial government. Another comment expressed concerns that condominium owners may lack understanding about water use and efficiency because water is paid for through condominium fees and they don't see information related to water conservation on bills.
- **Industrial and commercial water use**:
  Several respondents expressed concerns about large industrial and commercial water users (e.g., quarries and aggregate pits, breweries bottled water and meat packing companies) and their impacts on local aquifers.
- **Rates**:
  One comment suggested mirroring off-peak electricity rates by reducing water usage rates during off-peak hours and implement higher rates during peak times.
- **Contamination and treatment**:
  Several respondents were concerned about contaminants entering the water supply, including microplastics, perfluorooctanesulfonic acids, hormones and pharmaceuticals. One respondent was concerned about the increased use of salt during winter and suggested education campaigns for property managers. Another individual questioned the use of adding fluoride and removing calcium from the water supply. One respondent was concerned about offline wells with unknown contaminants and potential impacts to nearby residents. There was also a comment about a potential contaminated groundwater plume and a suggestion to address former industrial waste and garbage dumping sites in addition to ongoing contamination of surrounding rivers.

- **Environmental impacts**:
  Two respondents wanted to know how climate change may impact the model and one respondent would like to see how aquatic and terrestrial wildlife would be impacted by any of the City's proposals.
- **Other:**
  One respondent added water-taking from adjacent aquifers (e.g., Erin, Aberfoyle) as an additional unique challenge. Three respondents agreed with the unique challenges listed.

7.2.4 Proposed Alternative Solutions

The following water supply alternatives were considered in Phase 1 for meeting Guelph's drinking water supply needs.

- **Demand management, efficiency and water reuse programs**
  - Maintain commitment to our water conservation initiatives and 2016 Water Efficiency Strategy
  - Determine range of realistic goals and cost for implementation
  - Develop means to measure for effectiveness
- **Groundwater sources in and outside of city**
  - Improve and optimize the existing well supply system
  - Restore offline wells with treatment
  - Identify new potential water supply areas
  - Consider Dolime Quarry as a source of municipal water supply
- **Local surface water sources**
  - Establish feasibility / risks of surface water alternatives including aquifer storage and recovery system
  - Assessment areas include: Guelph Lake / Speed River and Eramosa River
- **Do nothing**
  - Undertake no improvements or changes
  - Significant impact on the growth potential for the City would be expected with this alternative

Members of the public were asked if any proposed alternative solutions were missed. There were several comments received on the existing proposed alternatives solutions in addition to new suggestions. See all comments received in **Appendix F**.

Additional feedback on the alternative solutions was provided in Phase 2 and is referenced below.

- **Demand management, efficiency and water reuse programs**: A few respondents questioned the need for growth and suggested limiting population increase and challenging growth targets. One respondent suggested revising the 2016 Water Efficiency Strategy to better reflect extreme weather events, infrastructure deficiencies and contamination. Another respondent would like to see more water conservation initiatives and increasing the use of grey water for residential, commercial and industrial water users.
- **Groundwater sources in and outside of city**: The majority of comments related to groundwater were about Nestle and the impacts of water extraction for bottled water companies. One respondent suggested quantifying the impact of Nestle on the water supply to show financial implications for residents.
- **Local surface water sources**: There was one suggestion to look at potential sources of water outside of the watershed.
- **Other**: Other proposed alternative solutions included contamination risk management, using stormwater and wastewater to help aquifer restoration, establishing urban rooftop water collection systems and considering how to adapt in the case of extreme floods. Three respondents agreed with the proposed alternative solutions.

7.2.5 Preliminary Evaluation criteria

The following initial evaluation criteria were put forward as potential criteria to be used to evaluate new drinking water sources in the Water Supply Master Plan Update and were subsequently revised based on feedback received and other technical considerations.

- **Public health and safety**
  - Ability to meet provincial water quality requirements
- **Natural environment**
  - Potential effects to natural environment
  - Potential impacts to water resources
  - Potential impacts to natural heritage features
  - Environmental management planning considerations
- **Social and cultural resources**
  - Land use impacts
  - Short-term construction impacts
  - Potential impacts from operations
  - Implications of new / expanded Source Protection areas
- **Economic and financial considerations**
  - Estimated capital costs
  - Estimated operations and maintenance costs, including energy consumption
- **Legal / jurisdictional considerations**
  - Location of facility relative to city boundaries
  - Land requirements
  - Implementation of Source Protection Policies
- **Technological considerations**
  - Ability to implement and meet peak demand
  - Constructability, schedule and timing, and maintaining operations during construction
  - Water quality
  - Allowance for future treatment needs
  - Expandability
  - Ability to respond to changes in regulations
  - Ability to utilize existing infrastructure
- **Additional considerations**
  - Alignment with City 2050 Net Zero Carbon emissions target
  - Impacts on Indigenous peoples and values
  - Climate adaptability and resiliency

The public were asked if there are additional evaluation criteria that should be considered. There were additions to existing 'natural environment', 'economic and financial considerations' and 'additional considerations' categories. See all comments received in **Appendix F**.

- **Natural environment**:
  Comments related to the natural environment include prioritizing the protection of the environment above all else, considering how Clair-Maltby is a recharge area and how development in this area will impact water availability and recharge, and a request to see a breakdown of how any Water Supply Master Plans would impact aquatic and terrestrial wildlife.
- **Economic and financial considerations**:
  There were a range of comments related to economic and financial considerations, including the potential creation of local jobs, socio-economic benefits from managing groundwater and forestry and the economic impacts of current and future scenarios of not having water. One respondent asked who will pay for new water supply and treatment in light of new residential developments, and another respondent asked how much it will cost to bring water to Guelph in 2041 if there isn't enough local supply.
- **Additional considerations**:
  One respondent suggested listening to and understanding Indigenous People's approach to water. Another respondent added the ability to respond to unpredictable climate events as an important consideration.
- **Other**:
  One respondent suggested considering long-term groundwater and surface water impacts of any new facility – both during operation and after being closed. Two respondents agreed with the evaluation criteria.

Additional feedback on the evaluation criteria was provided in Phase 2 and is outlined below.

7.2.6 Questions

During Phase 1, questions were received from the general public, both at the in-person community open house and online via the Q&A tool on Have Your Say. Questions related to the Water Supply Master Plan ranged from overall process, timelines and next steps to projected water demands, development and large water users. Several questions were unrelated to the Water Supply Master Plan, including wastewater and stormwater questions. All questions and responses are captured in **Appendix F**.

7.3 Phase 2 Feedback

7.3.1 Introduction

The feedback received during Phase 2 through the various engagement tools and activities indicates that agencies, municipal representatives and interested community members were invested in Guelph's water supply and the work being undertaken. Feedback was generally requested in these three discussion areas:

- results of the technical work including the future population targets, water supply demand forecasts, and the existing water supply capacity assessment
- results of the assessment and preliminary evaluation of the water supply alternatives, including additional factors or considerations that are missing
- prioritization and public acceptance of the preliminary preferred water supply alternatives

Each section below includes content that was presented in relation to the consultation topics. All comments and questions received during Phase 2 engagement are summarized in the subsections below and are provided in **Appendix F**.

7.3.2 Future population targets and water supply demand forecasts

The Province of Ontario's August 28th, 2020 report **A Place to Grow Growth Plan for the Greater Golden Horseshoe** (P2G) was utilized to identify future population growth to 2051 and combined with a review of past water use patterns to quantify the future water supply requirements. The 2051 population is projected to be 203,000 residential and 116,000 employment. Guelph's current water supply is estimated to provide a maximum of approximately 79,000 cubic metres per day, however by 2051 it is anticipated that we will need an additional 26,000 cubic metres per day to meet the needs of the future population.

Stakeholders were invited to comment on the analysis completed regarding the City's population in 2051 and the water supply capacity needed in order to support the anticipated demand. Some of the feedback from participants who attended the open house included:

- The uncertainty of future water supply demands and forecasts due to climate change was identified. The potential for decreased rainfall was mentioned with concern for what the water demand would be during a drought, and how farmers might need to increasingly rely on irrigation systems. Another comment identified the possibility of increased rainfall in the future due to climate change.
- The price of water was also questioned in terms of how a change in supply and demand would affect residential prices, and if there was a pricing strategy in place for moderating water usage and encouraging conservation efforts.
- One participant mentioned that the anticipated water taking for 2051 coincides with the actual water taking from 2001, and that over 50 years there was enough water conservation to keep the City well supplied. The City clarified that while the water taking numbers may appear similar, water conservation efforts and programs were responsible for ensuring that the City had enough water at an affordable rate.

Phase 2 largely focused on assessing the potential water supply capacity of the alternatives. Each of the water supply alternatives was evaluated against several criteria to identify potential impacts. The evaluation criteria included: First Nations, Metis, and Inuit Peoples, Technical (ability to achieve demand and reduction), Natural Environment, Built Environment, Social / Cultural Environment, Legal / Jurisdictional, and Financial.

Stakeholders and interested community members provided their feedback on the results of the water supply alternatives assessment and evaluation.

Water conservation, efficiency and water reuse programs

Four water conservation, efficiency and reuse program scenarios were presented and each forecasted the demand reduction that could be achieved by 2051. Guelph has a history of leveraging strong water conservation efforts in order to reduce water demand requirements. As a result, there were fewer suggestions for this alternative, but the ones provided considered at how these conservation efforts could be enhanced. Feedback included:

- Suggestions for enhancing water conservation initiatives included: non-revenue water reduction, grey water usage and incentives for increased usage, water recycling programs, and halting major water taking. While some of these initiatives are currently underway, promoting them to a wider audience and incentivizing them would help to increase conservation efforts.
- Suggestions for stormwater clean up and sewage water recycling practices were also provided.

Groundwater sources

Six categories of potential groundwater projects were shared: optimizing existing operating municipal sources, restoring existing off-line municipal sources, developing existing municipal test wells, installing new wells inside City boundaries, installing new wells outside City boundaries, and installing new Aquifer Storage and Recovery wells inside the City. Some of the feedback on the groundwater alternatives included:

- The Dolime Quarry was frequently mentioned during the engagement phase. Some concerns included whether an assimilative capacity study had been conducted as it relates to the City's waste water treatment plant and discharge from the quarry, how the aquifer was being protected and maintained in case dewatering were to stop, and potential impacts to dewatering as a result of annexation.
- The well locations were also a point of interest, including why some locations inside the City, such as the Clair Maltby area, were not selected for well locations.

- Water quality concerns and a recommendation for further study to determine the viability of remediating or adding treatment to the current off-line wells were raised. Water quantity concerns were raised regarding the potential impacts to the baseflow of surrounding waterbodies with restoring offline wells (e.g., impacts to Clythe Creek from restoring and pumping the Clythe well).
- Legal and jurisdictional implications of installing new wells outside of the City (in the surrounding townships) was also brought forth including growth and land use restrictions related to expanded source water protection areas, fair compensation (including for costs related to source water protection policy implementation), potential well interference, water use restrictions and employment opportunities. The Townships were concerned that their water supply would be taken to accommodate Guelph's growing population without fairly and duly consulting the Townships.

Surface water

Guelph Lake was reviewed as a potential source of surface water for direct treatment and distribution and as a potential source for an Aquifer Storage Recovery system to capitalize on peak flow.

- An additional surface water suggestion was to connect to the water supply from the Grand River and Lake Erie.

7.3.3 Prioritization and public acceptance of the preliminary preferred water supply alternatives

Based on the evaluation, a preliminary preferred solution was identified that recommended implementation of all water supply alternatives (except for the 'do nothing' alternative) in the short-, medium- and long-term over a thirty-year period (i.e., between 2021 and 2051) (see **Table 7-1**). Stakeholders and interested community members were asked to provide their feedback on the preliminary preferred solution.

- No objections to the preliminary preferred solution were raised, however there were some questions and concerns regarding the implementation timelines and the prioritization of the water supply alternatives – particularly for the development of new wells outside of the City. While the townships were generally supportive of the preliminary preferred solution, they were also concerned that developing wells in their jurisdiction for Guelph's use could limit the amount of residential and employment growth in the townships and impose source water protection land use constraints.

Table 7-1: Preferred Water Supply Alternatives

Alternative	Timeline	Projects
1A – Conservation, Efficiency & Demand Management	Throughout	■ Blended Conservation Scenario
2B – Groundwater: Restore Off-line Municipal Wells	Short-term	■ Clythe Well (completion in 2023)
2B – Groundwater: Restore Off-line Municipal Wells	Mid-term	■ Lower Road Collector (completion in 2037)
2C/D – Groundwater: Develop Municipal Test Wells	Short-term	■ Ironwood/Steffler (completion in 2027) ■ Guelph South (completion in 2028) ■ Dolime Quarry (pumping station component completed to align with Ironwood/ Steffler) ■ Logan/ Fleming (completion in 2030)
2C/D – Groundwater: Develop Municipal Test Wells	Long-term	■ Hauser (completion in 2047)
2F – Groundwater: Arkell Collectors & ASR Wells	Long-term	■ Arkell ASR (completion in 2045)
2G – Groundwater: Develop New Wells Outside City	Long-term	■ Guelph North (completion in 2048)

7.3.4 Consultation

Consultation has been a vital part of collecting feedback to inform the Water Supply Master Plan. Various parties were interested in additional engagement sessions and reached out for opportunities to stay informed and involved.

- Several individuals including members of the public, municipal representatives, and interested stakeholders asked how they could remain involved with the project.
- A concern was voiced that there was not enough consultation with the Townships over the course of the project. It should be noted

that the City offered several opportunities for engagement to the Townships during the study including providing notices on the Master Plan Update, representation on the Community Liaison Group, participation in the municipal and agency workshops and offers to present to Township Council. The Townships of Puslinch and Guelph-Eramosa opted to invite the Project Team to their respective Council meetings to learn more about the progress and provide feedback. The presentation and corresponding resolutions for the two sessions can be found in **Appendix F**.

7.4 Community engagement tools and activities

As part of the communication and engagement strategy for the Water Supply Master Plan Update, a number of activities were undertaken to notify the Guelph and area community, provide up-to-date information, seek input on the current phase of the study and answer any questions or concerns.

7.4.1 Notifications

7.4.1.1 Notice of Commencement

A formal notice of study commencement was issued on October 31, 2019 to provide an overview of the Water Supply Master Plan Update, an explanation of the master plan process, engagement opportunities and contact information.

Engagement opportunities included joining the Community Liaison Group, attending an open house, reading about progress on the project web page (click here for the City of Guelph's Water Supply Master Plan), joining the electronic mailing list and following the conversation on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph).

The notice was advertised through:

- the project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City’s website guelph.ca/2019/10/notice-of-study-commencement/;

- traditional newspapers including the Guelph Mercury Tribune (City news section), Wellington Advertiser and Milton Champion;
- an initial project email list including agencies, municipalities, Indigenous Peoples and the original contact list from the 2014 Water Supply Master Plan mailing list (over 70 recipients during the week of November 28, 2019);
- organic social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph); and
- internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers.

The notice of commencement and associated advertisements are included in **Appendix F**.

7.4.1.2 Invitation to Community Open House #1

A formal invitation to the first community open house on February 13, 2020 was published on January 23, 2020 and distributed through:

- the project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2020/01/join-us-february-13-for-the-first-water-supply-master-plan-open-house/;
- a project email list (53 recipients on January 30, 2020);
- social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph);
- Internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers; and
- paid advertisements with
  - Guelph Mercury Tribune (print, September 23, 2021)
  - guelphtoday.com.

The community open house invitation is included in **Appendix F**.

7.4.1.3 Invitation to Community Open House #2

A formal invitation to the second community open house on September 29, 2021 was published on September 16, 2021 and distributed through:

- the Project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2021/09/join-us-september-29-to-talk-about-the-future-of-drinking-water-in-guelph/;h
- Have Your Say newsletter list;
- social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph)
  - https://twitter.com/cityofguelph/status/1438500050246774787
  - https://twitter.com/cityofguelph/status/1439937666842337282
  - https://twitter.com/cityofguelph/status/1442867081955868688
  - https://www.facebook.com/permalink.php?story_fbid=10159680867733156&id=90034568155;
- Internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers; and
- paid advertisements with
  - Guelph Mercury Tribune (print, September 23, 2021)
  - guelphtoday.com

The community open house invitation is included in **Appendix F**.

7.4.1.4 Notice of Completion

A Notice of Completion will be issued and included in the final version of this report.

At the completion of the planned 90-day review period, comments will be received, addressed and incorporated into the final report as necessary, and the report will be submitted to City Council for approval.

7.4.2 Project website

A page on the City's website (click here for the City of Guelph's Water Supply Master Plan) was published in November 2019. The purpose of the web page is to help build awareness for the Water Supply Master Plan Update, share updates and engagement opportunities, as well as useful information. The web page provides an up-to-date source of comprehensive and timely information and is linked to Have Your Say for online engagement. Information found on the web page includes:

- notices and latest updates;
- engagement opportunities;
- background and process information;
- resources, including downloads from open houses and the 2014 Water Supply Master Plan final report;
- mailing list subscription link; and
- contact information.

From the launch to October 14, 2021, the project web page has had 2,110 page views, including 926 page views from unique visitors. The average time spent on the web page was more than one minute (1:22).

7.4.3 Social Media

City of Guelph Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph) accounts were used to complement the project web page to reach a larger audience who may otherwise be less engaged in traditional in-person engagement methods, and to share information about the Water Supply Master Plan Update. Social media posts were developed to engage online stakeholders throughout Phases 1 and 2 and helped to invite interested individuals or groups to attend the open houses and take part in online engagement (i.e., the online survey) and provide links to the web page and Have Your Say.

Since the launch there has been five Facebook posts shared organically and combined they reached 10,270 Facebook users. One paid Facebook ad reached 11,500 Facebook users. A total of 11 Tweets have resulted in 22,661 impressions, 30 re-tweets, 22 likes and 32 clicks to the web page.

Social media posts related to the Water Supply Master Plan update can be found in **Appendix F**.

7.4.4 Community Open House #1

The purpose of the first community open house was to provide an opportunity for the public to share feedback to help inform how the City will manage the water supply as the community grows. It was also an opportunity for the public to share what is important to them for the future so that the City can continue to provide excellent drinking water service to Guelph residents.

Logistics for community open house #1:

- **Where:** Marg MacKinnon Community Room, City Hall, 1 Carden Street
- **When:** February 13, from 2:00 p.m. to 4:00 p.m. and 6:00 p.m. to 8:00 p.m.

Topics presented on twelve display boards included:

- the objectives and overview of the Water Supply Master Plan Update;
- the City's current drinking water supply;
- proposed alternatives for meeting our drinking water supply needs;
- proposed criteria and methodology for evaluating new drinking water sources;
- the agency of water/personhood of water/water is life; and
- the next steps as we update the Water Supply Master Plan.

Upon arriving at the open house, attendees were greeted and encouraged to sign-in at the welcome table. A survey was provided for attendees to submit their comments before they left, or they could send in responses via email or complete the online version on Have Your Say. Display boards were situated along the edge of the room with various experts available to answer questions. Printed copies of a map of Guelph Water Services Municipal Wells were available.

The City's water conservation staff also had a booth set-up to answer questions about water conservation and efficiency. Desktop computers were available for attendees to sign-up real-time to the online engagement platform, Have Your Say.

Seventeen attendees signed in, including several students from a university class. Many City staff stopped by without signing in and some attendees entered through the back door and missed the welcome table. Eight people completed the survey in-person.

Display boards, the survey and map are provided in **Appendix F**. Feedback from the open house is available in the feedback section (Section 7.2) of this report.

7.4.5 Community Open House #2

The purpose of the second open house was for the public and interested stakeholders to learn about and share their thoughts on the potential alternative water supply sources that were identified, the detailed evaluation of the alternatives and the preferred solutions that were identified. The open house was hosted virtually due to the COVID-19 pandemic and restrictions for in-person gathering.

Logistics for community open house #2:

- **Where:** Online via Microsoft Teams
- **When:** September 29 from 6:30 p.m. – 8:30 p.m.

Attendees were reminded of the Water Supply Master Plan Update objectives, the challenge and opportunity statement, the municipal class Environmental Assessment process what was it involved in the update. An overview of Phase 1 consultation and engagement was provided, including feedback that was shared. Technical content focused on:

- the population forecasted to 2051 and the anticipated demand for water;
- the potential alternative water supply sources that have been identified and the benefits and considerations for why the alternative is being added to the overall solution;

- the detailed evaluation of the alternatives measured against seven evaluation criteria; and
- the preferred solutions.

After the presentation, a question and answer period was held.

Six attendees joined, along with three representatives from AECOM, and four representatives from the City of Guelph.

At the end of the session, a survey link to Have Your Say was provided for attendees to submit their comments by October 13, 2021.

The presentation and the survey are provided in **Appendix F**. Feedback from the open house is included in the feedback section (Section 7.3) of this report.

7.4.6 Phase 1 Online Engagement

During the first phase of the study, online engagement was used to gather public input related to the Water Supply Master Plan Update. Have Your Say, the City of Guelph's online community engagement platform featured a Water Supply Master Plan page so that the public can share ideas and help shape decisions (haveyoursay.guelph.ca/wsmp). The Water Supply Master Plan Update page includes information about the project, an online survey associated with the open house, a Q&A tool available at any time, key dates, project lifecycle, contact information for 'who is listening', document library and a Have Your Say newsletter subscription.

The Have Your Say page was published February 10, 2020. Since being published, the page received 218 total visits. Twenty-three visitors filled out the online survey and one visitor asked a question with the Q&A tool.

February 2020 and March 2020 newsletters were distributed through the entire Have Your Say Guelph subscribers highlighting the community open house #1 and the online survey. The newsletters are available in **Appendix F**.

7.4.7 Phase 2 Online Engagement

Online engagement continued to be used to gather public input related to the Water Supply Master Plan Update (haveyoursay.guelph.ca/wsmp). The

Water Supply Master Plan Update page included updated information about the project, an online survey associated with the second open house, a video recording of the second open house, the results of the survey associated with the first open house, a question and answer tool available at any time, key dates, project lifecycle, contact information for 'who is listening', document library and a Have Your Say email subscription.

Including results from Phase 1, as of October 14, 2021 the online engagement page received 733 total visits. One person filled out the online survey for the second community open house and four people asked a question with the Q&A tool.

7.5 Indigenous engagement

7.5.1 First Nations, Métis, Inuit Peoples living in Guelph

There are Indigenous Peoples—First Nations, Métis and Inuit Peoples–living in Guelph who are working with the City and contributing in the development of the Water Supply Master Plan Update. Specifically, through the Community Liaison Group, Indigenous Peoples shared their perspectives on the spirit of water and the importance of respecting the agency of water. This involved conversations during the first Community Liaison Group meeting; contribution at the first open house where Indigenous knowledge on water relations was shared with members of the public; and on-going dialogue with the Water Supply Master Plan Project Team around ways the relationships can be enhanced through working with the diversity of local Indigenous voices, on Water Supply Master Plan Update and other water-related projects and initiatives.

Details regarding meetings held with Indigenous communities regarding the Water Supply Master Plan Update are further outlined below.

7.5.2 Duty to Consult

The Crown has a legal duty to consult Indigenous Peoples when it has knowledge of potential project impacts on Indigenous or treaty rights. The Crown may delegate procedural aspects of the duty to consult to project proponents, and the Ministry of the Environment, Conservation and Parks has delegated the procedural aspects of rights-based consultation to the City, as noted in a letter dated November 5, 2019.

Ministry of the Environment, Conservation and Parks notified the Project Team of the Indigenous communities to contact regarding the Water Supply Master Plan Update and included Six Nations of the Grand River, Haudenosaunee Confederacy Chiefs Council and Mississaugas of the Credit First Nation. The Project Team is following the steps outlined in the "Code of Practice for Consultation in Ontario's Environmental Assessment Process". Where the Water Supply Master Plan Update may affect Indigenous and treaty rights, Ministry of the Environment, Conservation and Parks will determine additional consultation-related steps that may be taken.

These contacts were provided with a formal letter, the notice of commencement and invitation to the workshop with agencies and other municipalities, and the notice and invitation to the first community open house. Follow-up with the communities was conducted by the City to determine if there is any specific consultation format that is preferred in addition to the tools and activities utilized to date. In addition, the City conducted general communication and consultation with the Indigenous communities identified above with the intent to improve relationships with the communities and to share information with respect to the City's Municipal Comprehensive Review and updating of a number of the City Master Plans[20]. These contacts resulted in some meetings to discuss the City's general master planning processes and the Water Supply Master Plan Update in particular.

7.5.2.1 Six Nations of the Grand River

One meeting and presentation was held with the Six Nations of the Grand River on July 6, 2021. This meeting was for the purpose of providing a briefing of the water-related master plan projects at the City. A presentation was delivered and included the following topics:

- overview of the Water Supply Master Plan
- overview of the existing water supply system

[20] Communications with the Haudenosaunee Confederacy Chiefs Council were unsuccessful during Phase 2 of the project due to a change in email contact information resulting in undelivered email and unsuccessful phone call attempts (voicemail box was at capacity per recorded message).

- how much water Guelph currently has
- how much water Guelph will need in the future
- water supply alternatives
- overview of engagement conducted to-date

A briefing note was provided to supplement the presentation and the City responded to pre-submitted questions from Six Nations. A meeting summary was also provided.

Following the presentation, there was a question and answer session that provided additional information on the City's water supply, source protection programs and water conservation and efficiency programs.

As an action item from the meeting, the City indicated they would share the draft Water Supply Master Plan report as part of the 90-day review period and prior to being approved by City Council.

All meeting materials are available in **Appendix F**.

7.5.2.2 Haudenosaunee Confederacy Chiefs Council

Efforts were made by the City to contact the Haudenosaunee Confederacy Chiefs Council regarding the Water Supply Master Plan Update.

Communications were directed to the Haudenosaunee Confederacy Chiefs Council, as noted above, to inquire about interest in a one-on-one meeting to discuss the Water Supply Master Plan Update. However, formal contact was not established, and meetings were not conducted.

7.5.2.3 Mississaugas of the Credit First Nation

As noted above, communications were initiated with the Mississaugas of the Credit First Nation on to inquire about interest in a one-on-one meeting to discuss the WSMP Update. A subsequent meeting took place on October 6, 2021.

A presentation was delivered and included the following topics:

- overview of the Water Supply Master Plan
- overview of the existing water supply system

- how much water Guelph currently has
- how much water Guelph will need in the future
- water supply alternatives
- overview of engagement conducted to-date

A briefing note was provided to supplement the presentation and a written follow-up to pre-submitted questions regarding conservation and efficiency programs was also provided.

The Mississaugas of the Credit First Nation confirmed that they do not need to review additional materials for the WSMP Update, however, they did request annual updates on all water-related master plans and would like to be involved in new projects from the outset.

All meeting materials are available in **Appendix F**.

7.6 Additional stakeholder meetings and presentations

Meetings and presentations with key stakeholders were encouraged during Phase 1 and Phase 2 so that organizations and groups could learn about the Water Supply Master Plan Update and be kept informed on how they might specifically be impacted by updates. Meetings were held predominantly in-person for Phase 1 and virtually for Phase 2.

7.6.1 Guelph Wellington Development Association and Guelph and District Home Builders' Association

On November 7, 2019, the City Staff Technical Liaison Committee met with the Guelph Wellington Development Association and Guelph and District Home Builders' Association. Dave Belanger from the Water Supply Master Plan team was invited to present an overview of the Water Supply Master Plan update, including the process for updating the 2014 Water Supply Master Plan.

After the meeting, the Water Supply Master Plan Project Team invited both organizations to participate in the Community Liaison Group.

Meeting minutes and the presentation are available in **Appendix F.**

7.6.2 Our community, our water open house

The City hosted a community open house on November 26, 2019 at Holiday Inn regarding a proposed solution between the City and the owners of the Dolime Quarry. The City's concerns about the Dolime Quarry revolve around how operations at the quarry could affect Guelph's drinking water.

The WSMP Project Team was invited to bring an overview display board about the WSMP Update to the open house. The display board is available in **Appendix F**.

7.6.3 Water Conservation and Efficiency Public Advisory Committee

On September 16, 2020 and on September 28, 2021 the Water Supply Master Plan team presented at the Water Conservation and Efficiency Public Advisory Committee meeting.

The first presentation discussed the 2014 WSMP Preferred solution, conservation and demand management efforts underway, the 2016 Water Efficiency Strategy, potential enhanced water conservation program successes / challenges and the demands projections for the WSMP update. The session also provided an opportunity to ask questions and collect feedback.

The second presentation discussed the summary of water supply requirements to 2051, an overview of water supply alternatives, the environmental assessment evaluation criteria, preliminary preferred solution and opportunity for questions and feedback.

A copy of the presentation is available in **Appendix F**.

7.6.4 Puslinch Township

On December 2, 2019 the City provided an overview presentation of the Water Supply Master Plan Update project to the Township Supervisor of Public Works and Parks. This included an overview of the MCEA process, the draft Problem and Opportunity Statement, a review of the Water Supply Master Plan work plan and the schedule and next steps for the project.

Subsequently, in late 2019 and early 2020, the City offered on several occasions to provide a similar overview presentation to Township Council. Additional offers of meetings and presentations to staff and/or Council on the Water Supply Master Plan Update were provided in mid-2020 (July to September) associated with Water Supply Master Plan field work related to the Guelph South Groundwater Supply Feasibility Project.

Township of Puslinch identified the Mayor and a Councillor as the designated representatives for the Community Liaison Group. Invitations to the meetings as well as presentations and survey forms were provided to the Mayor and Councillor.

Representatives from Township of Puslinch attended the agency meetings on November 28, 2019 and on September 14, 2021 and, while verbal comments were provided at the meetings, written comments were not provided to the City following the meetings.

On October 13, 2021 the Water Supply Master Plan team met with Township of Puslinch's Council to provide an overview of the project and a shortened version of the presentation that was presented at the second agency and municipality workshop. The agency meeting presentation from September 14, 2021 was sent to Puslinch Council in advance of the meeting. Following the presentation the Project Team responded to questions from Council. Feedback generally focused on the following topics:

- concerns about source protection areas and land use constraints particularly with respect to impacts on the Township;
- concerns about potential well interference effects with existing wells particularly with respect to impacts on the Township;
- prioritizing supply within the City before considering sources within Township;

In follow-up to the meeting, Township of Puslinch sent a Council Resolution dated October 13, 2021 to the City (and to the Township of Guelph/Eramosa) which included several requests:

- confirming that the City extended the Township's commenting deadline on the Agency and Municipality Workshop #2 presentation slides from October 22, 2021 to November 5, 2021 despite a request for further extension

- Township staff and consultants review the Water Supply Master Plan Update when made available and provide comments at the November 24, 2021 Puslinch Council meeting
- that the City of Guelph Council provide the opportunity for Puslinch Council to provide comments in advance of the draft report being adopted by City of Guelph Council
- that the City of Guelph Council acknowledge receipt of the Township comments and provide a response
- that the City of Guelph Council authorize the release of the draft report to Puslinch staff in advance of the City of Guelph council meeting

A copy of the presentation and final Council Resolution are available in **Appendix F**. A copy of the meeting minutes can be accessed online at https://puslinch.ca/wp-content/uploads/2020/11/November-3-2021-Council-Agenda.pdf.

City staff responded to Township of Puslinch staff clarifying that feedback from Township was being sought for content in the agency and municipality workshop #2, not on the draft final report of the Water Supply Master Plan Update. The City extended the timeframe to submit comments on the September 14 agency presentation to November 5, 2021, providing a seven-week commenting period. It was noted that the draft final report, under development at the time of the meeting, will be released for public review and will be accompanied by a formal public review period in early 2022. City staff clarified that it was soliciting comments from the Township in order to incorporate Township feedback into the draft final Water Supply Master Plan report. At the time of writing of this report in November 2021, formal comments have not been received.

7.6.5 Township of Guelph/Eramosa

The Township of Guelph Eramosa had representation by a Councillor at all three of the Community Liaison Group meetings, and a Public Works representative at the first Agency / Municipality workshop. Communication was primarily verbal, with email correspondence from a Township of Guelph/Eramosa citizen seeking additional information after the second CLG meeting.

On October 20, 2021 the Water Supply Master Plan team met with Township of Guelph/Eramosa Council to provide an overview of the project and a shortened version of the presentation that was presented at the second agency and municipality workshop. Following the presentation, the Project Team responded to questions from Council. Feedback generally focused on the following topics:

- Location of the Logan test well and primary direction of groundwater drawdown
- Leakage from the City's water distribution network and how it is managed
- The Eramosa River artificial recharge system and opportunities to improve the system efficiency
- How the Guelph Lake alternative could function and details of the GRCA capacity analysis
- The City's experience supporting the installation of residential greywater systems
- Possibility of collaborating on use of Cross-Creek water supply system to help meet future City demands

In a follow-up to the meeting, the Township of Guelph/Eramosa sent a Council Resolution dated October 27, 2021 which included a number of statements and requests:

- that the Township of Guelph/Eramosa has concerns with the City of Guelph's November 5, 2021 deadline for comments regarding the Water Supply Master Plan 2021 Update
- that the City of Guelph Council authorize the release of the draft report to Guelph/Eramosa staff in advance of the City of Guelph's council meeting
- that council direct Township staff and Township consultant(s) to review the City of Guelph Water Supply Master Plan Update correspondence and draft report, when available, and to provide comments for Council's consideration at a subsequent Township of Guelph/Eramosa Council meeting

- that the City of Guelph Council provide the opportunity for Guelph/Eramosa Council to provide comments in advance of the draft report being adopted by City of Guelph Council
- that the City of Guelph Council acknowledge receipt of the Township comments and provide a response
- that the resolution be forwarded to the City of Guelph and the Township of Puslinch

A copy of the presentation and final Council Resolution are available in **Appendix F**.

City staff similarly responded to the Township of Guelph Eramosa staff clarifying that feedback was being sought for content in the agency and municipality workshop #2, not on the draft final report of the Water Supply Master Plan Update. The City extended the timeframe to submit comments on the September 14 agency presentation to November 5, 2021. It was noted that the draft final report will be released for public review and will be accompanied by a formal public review period in early 2022 which will be to solicit commentary and incorporate feedback from the Township into the draft Water Supply Master Plan report. At the time of writing of this report in November 2021, formal comments have not been received.

7.7 Community Liaison Group

An aspect of the WSMP Update included consultation with a Community Liaison Group. The purpose of this group was to inform and provide an opportunity for input on specific issues related to the WSMP Update. Three meetings were planned at key milestones:

1. Introduction of the master plan and gain feedback
2. Update on alternative solutions and evaluation criteria and gain feedback
3. Present draft master plan update and gain feedback

A Community Liaison Group was created during the 2014 Water Supply Master Plan update, and this membership was used as a foundation for the 2021 Community Liaison Group membership. Participants from 2014 were invited to take part again, in addition to new groups and the broader community (invited through the Notice of Commencement and direct emails). The Community Liaison Group included members from a wide cross-section of the community:

- business/ industry (two members);
- environmental organizations (two members);
- agriculture (one member);
- land development (one member);
- community or social organizations (two members);
- academia (three members);
- the Guelph community-at-large (Guelph) (three members);
- the community-at-large outside of Guelph (two members); and
- the Anishinaabe (one member representing the local Indigenous community).

7.7.1 Meeting #1

The first Community Liaison Group meeting was held in-person on December 4, 2019 to share stakeholder and community ideas and perspectives on the Water Supply Master Plan Update. The purpose of the first Community Liaison Group meeting was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment, including:

- the objectives and scope of the Master Plan Update;
- issues and opportunities to be addressed;
- alternative solutions to be assessed; and
- the draft evaluation criteria to be applied.

For the first meeting there were 13 participants, along with four City staff and three AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary, in addition to presentation and discussion guide is provided in **Appendix F**.

Responses to questions in the discussion guide are presented in the feedback table in **Appendix F.**

7.7.2 Meeting #2

The second Community Liaison Group meeting was held virtually on July 27, 2021 to continue sharing stakeholder and community ideas and perspectives on ways to improve the Water Supply Master Plan Update. The purpose of the second Community Liaison Group meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including:

- consultation conducted to-date;
- population targets and water supply demand forecasts;
- existing water supply capacity assessment;
- technical assessment of alternatives to-date; and
- environmental assessment evaluation criteria.

For the second meeting there were nine participants, along with three City staff and three AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary and the presentation (including discussion questions) is provided in **Appendix F**.

7.7.3 Meeting #3

The third Community Liaison Group meeting was held virtually on September 21, 2021 to provide a final opportunity for sharing stakeholder and community ideas and perspectives on ways to improve the Water Supply Master Plan Update. The purpose of the third Community Liaison Group meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including:

- water supply requirements
- work completed since meeting #2
- assessment of water supply alternatives
- evaluation of water supply alternatives

For the third meeting there were twelve (12) participants, along with six (6) City staff and three (3) AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary and the presentation (including discussion questions) is provided in **Appendix F**.

7.8 Agency and municipality workshop

Part of the WSMP Update included two workshops to bring Municipalities and Agencies together, providing a forum to discuss plans for the 2021 WSMP Update and to gather input.

In addition to select City of Guelph staff, organizations that were invited to participate included:

- Grand River Conservation Authority;
- Guelph/Eramosa Township;
- Haudenosaunee Confederacy Chiefs Council;
- Ministry of the Environment, Conservation and Parks;
- Ministry or Natural Resources and Forestry;
- Mississaugas of the Credit First Nation;
- Region of Waterloo;
- Six Nations of the Grand River First Nation;
- Town of Milton;
- Township of Centre Wellington;
- Township of Puslinch;
- Wellington County;
- Wellington Source Water Protection; and
- Wellington-Dufferin-Guelph Public Health.

7.8.1 Workshop #1

The first workshop was held on November 28, 2019 with 10 participants from six organizations, along with four City staff and four AECOM consultants. The purpose of the first workshop was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment, including:

- the objectives and scope of the Master Plan Update;
- issues and opportunities to be addressed;
- alternative solutions to be assessed; and
- the draft evaluation criteria to be applied.

The format of the workshop included a presentation and opportunities for discussion and reflection. A full meeting summary, in addition to presentation and discussion guide is provided in in **Appendix F**.

Responses to questions in the discussion guide are presented in the feedback table in **Appendix F.**

7.8.2 Workshop #2

The second workshop was held virtually on September 14, 2021 with 11 participants from five organizations, along with six City staff and three AECOM consultants. The purpose of the second agency workshop was to gather feedback and concerns from agency and municipality representatives after reviewing progress related to the Master Plan and the Class Environmental Assessment, including:

- water supply requirements;
- work completed since meeting #2;
- assessment of water supply alternatives; and
- evaluation of water supply alternatives.

The format of the workshop included a presentation and opportunities for discussion and reflection. A full meeting summary and the presentation (including discussion questions) are provided in **Appendix F**.

8. Implementation Recommendations

8.1 Financial Evaluation Approach

Based on the evaluation outputs for each of the alternatives, a priority was established for the proposed water supply projects that determines how the City will proceed to develop its water supply over time to meet future needs. This implementation strategy is to ensure that there will always be sufficient supply including an additional allowance for security of supply in place prior to approving growth.

The timeline for this plan is dependent on the water conservation scenarios. For example, a more aggressive conservation strategy would result in lower demands for the same population thereby deferring the schedule for new water supplies which results in some cost savings; however, the more aggressive conservation strategy comes at a higher cost. Therefore, a financial evaluation was carried out to determine the optimal water conservation scenario when viewed in the context of cost, impact on demand and the resulting timeline and costs for all of the water supply projects.

This section provides an overview of the financial evaluation approach including the inputs regarding timeline and budget established for implementing the preferred projects.

The analysis takes into consideration the following:

- Timeline and costs associated with each alternative – including technical investigations, water quality analysis, environmental impact studies, land acquisition, preliminary and detailed design, and construction and commissioning. The timeline allowed in advance of water supply availability is as follows:
  - Groundwater - 5 year timeline
  - Arkell Collector ASR wells – 8 year timeline
  - Surface Water – 10 year timeline
- The exception to the above is that the investigative phase for the test wells and inside-City groundwater options is scheduled to occur early in the implementation timeline so that the City has sufficient information to determine whether the alternative is feasible, to

identify any constraints, and to confirm capacity and treatment requirements prior to the next WSMP Update; the groundwork would then be in place in order to implement the remaining tasks in a timeline such that the supply would be in place as required. For the proposed wells outside the City, budget is allocated in the short- to mid-term for additional modeling work to update and substantiate the estimated capacities and potential effects related to the Guelph North and Guelph Southeast alternatives for use in the next two WSMP Updates.

- An assumed order of groundwater projects is presented in **Table 8-1** and is based on the prioritization of alternatives identified in Section **6.4**. It is important to note that the assumptions made in the prioritization of projects were for the purpose of determining the requirement for new supplies against the demand curve in comparison to varying conservation scenarios. Most of these projects would be in investigation and design phases concurrently and the schedule for each would be a function of constraints and ease of implementation.
- Schedule for implementation such that new water supply projects will be brought online when required capacity reaches 90% of system capacity to ensure sufficient capacity for proposed development commitments, and industrial / commercial applications, as well as to respond to large increases in demand by current customers, in particular major industries or ICI consumers. This flexibility is important to address growth needs or demands that do not follow the planned demand projection. This 90% trigger is to be compared to the calculated maximum day demand and not the redundancy and security of supply allowance which is included in addition to the maximum day demand. The additional 15% added onto the actual maximum day factor in determining the required water supply capacity is intended to provide sufficient volume at any given time to address transitory events such as a short-term loss of supply and drought conditions, or to provide the necessary firm capacity to allow for wells to be off-line for short durations for maintenance or upgrades.

Table 8-1 lists the assumed order of project implementation. The timing for these proposed projects is determined by establishing the need for the water being supplied through each individual source to meet demand, which is a function of which conservation scenario is applied. Detailed descriptions of the individual projects are included as project sheets within **Appendix G**. These expand on the implementation requirements for each project including technical investigations, water quality analysis, environmental impact studies (including Class EA, where required), land acquisition, preliminary and detailed design, and construction and commissioning.

Table 8-1: Assumed Order of Project Implementation

Order of Implementation	Project Name	Project Type
Project 1	Clythe Well	Offline Wells
Project 2*	Ironwood/ Steffler Well	Test Wells
Project 3*	Guelph South Well	Test Wells
Project 4*	Dolime Quarry	Optimization of existing and test wells / potential direct supply source
Project 5	Fleming/ Logan	Test Wells
Project 6	Lower Road Collector	Offline Wells
Project 7	Arkell Collector ASR Wells	Arkell Collector
Project 8	Hauser test well	Test Wells
Project 9	Guelph North	New Wells Outside City
Project 10	Guelph Southeast	New Wells Outside City
Project 11	Guelph Lake WTP	Surface Water
Project 12	Smallfield/ Sacco Wells	Offline Wells
Project 13	Guelph Lake WTP and ASR wells	Surface Water

Notes: *Project implementation subject to outcome of on-going Southwest Guelph Water Supply EA

8.2 Recommended Water Conservation, Efficiency and Demand Management Strategy

From a water supply planning perspective, water conservation, efficiency and demand management programming can help to delay the requirement to implement high cost water supply projects to meet demand. Although it is anticipated that the current level of programming can achieve per capita demand reduction in the short-term, as Guelph continues with initiatives to incrementally reduce water usage, programming will need to be adjusted to align with any opportunities for further reductions. In order to fully understand the trade-offs between demand management and the need for additional water supply, a comparison of water conservation scenarios is appropriate. This comparison needs to forecast the future costs of both water conservation and water supply and compare it to the corresponding reductions in water consumption.

Through the WSMP Update, conservation scenarios were explored to establish the cost associated with different approaches to future programming. As outlined in Section 5.2, four scenarios were developed to represent a range of possible target reductions and associated costs. These programs are forecasted to range in cost from $0/year to approximately $501,333/year, and reduce average day water demand by 0 m^3/day to 4,952 m^3/day. An additional blended scenario was identified as an outcome of the Evaluation of Alternatives step, which indicated that a combination of the conservation, efficiency and demand management scenarios may be required to effectively produce demand reductions through the full planning period to 2051. This scenario envisions implementing the current level of programming in the short-term (approximately years 0-10), adjusting the focus to high demand and/or inefficient customers in the mid-term (approximately years 11-20) and incorporating water reuse in the long-term (approximately years 21-30). Using the costs and demand reduction estimates developed for Scenarios 2-4 as a basis, this scenario is estimated to cost an average of $299,792/yr and reduce average day water demand by 3,683 m^3/day. Each of the water conservation scenarios explored will delay the need to implement proposed projects for increasing the water supply, assuming that conservation is successfully implemented to achieve the desired targets.

While many of the water conservation projects explored have a relatively low capital cost, they do have an annual operating cost. However, water conservation will delay the capital costs associated with new water supply projects as well as their incremental operating costs. This statement is due to the fact that as per capita demand is reduced, overall demand will also be reduced, delaying the occurrence of having water demand equal water supply. If water conservation projects are not put in place, water supply projects will need to be implemented sooner in the schedule. This analysis looked at the range of possible water conservation, efficiency and demand management scenarios which are described in Section 5.2, along with the blended Scenario 5 (**Table 8-2**).

At a high level, each scenario addresses a different strategy for implementation of conservation, efficiency and demand management programming moving forward, as follows:

Scenario 1: No further reductions - ceasing non-provincially mandated water efficiency measures (baseline scenario)

Scenario 2: Potential reduction through maintaining a level of programming similar to the current water conservation, efficiency and demand management program

Scenario 3: Potential reduction through a focus on high water use customers

Scenario 4: Potential reduction through a focus on the current level of programming *and* water reuse initiatives

Scenario 5: A blend of Scenarios 2 to 4

Table 8-2: Water Conservation Scenarios

Scenario	Reduction in Average Day Demand (m^3/day)	Est. Total Program Cost (Non-Discounted; million $)
1	-	-
2	4,424	11.41
3	2,220	4.73
4	4,952	15.04
5	3,683	8.99

This analysis compares the forecasted impacts of the five scenarios on: the demand for potable water, the timing of the City's proposed water supply projects, and the City's capital spending and operating expenditure on water supply projects and water conservation.

For each of the scenarios, the stream of total annual costs (i.e., capital, operating and conservation costs) for each scenario is discounted to a present value using a 3.5% discount rate. Applying a net present value (NPV) calculation to each scenario's unique cost stream is an effective way to compare them in today's dollars. More specifically, expenditures delayed by conservation measures are valuable to the City from a financial management perspective.

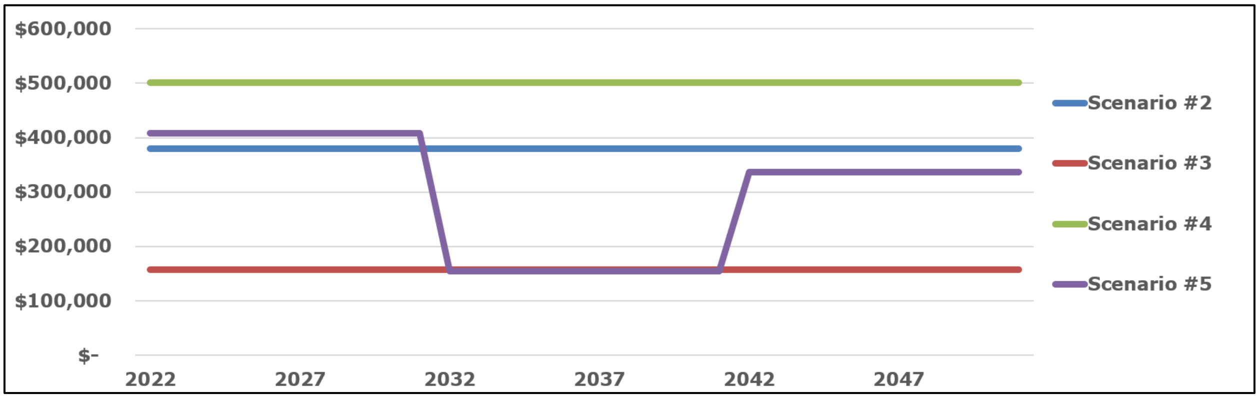
The forecasted timing of proposed water supply projects under the different scenarios is presented in **Table 8-3**. Included in each project expenditure is the preceding timeline for work and associated costs outlined in the assumptions. The annual estimated conservation, efficiency and demand management program costs that trigger the differences in capital and operating costs for each scenario is presented in **Figure 8-1**. **Table 8-3** presents a summary illustration to compare the total annual capital and operating costs by scenario.

Table 8-3: Timing of Proposed Water Supply Projects Under Different Conservation Scenarios

Order of Implementation	Project Name	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Project 1	Clythe Well	2023	2023	2023	2023	2023
Project 2*	Ironwood/ Steffler Well	2027	2027	2027	2027	2027
Project 3*	Guelph South Well	2028	2030	2028	2030	2030
Project 4*	Dolime Quarry	2031	2032	2031	2032	2032
Project 5	Fleming/ Logan	2033	2036	2034	2037	2036
Project 6	Lower Road Collector	2037	2042	2038	2042	2040
Project 7	Arkell Collector ASR Wells	2041	2047	2044	2047	2045
Project 8	Hauser test well	2042	2049	2045	2049	2047
Project 9	Guelph North	2043	2049	2046	2050	2048
Project 10	Guelph Southeast	2046	Post-2051	2048	Post-2051	Post-2051
Project 11	Guelph Lake WTP	2048	Post-2051	2051	Post-2051	Post-2051
Project 12	Smallfield/ Sacco Wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051
Project 13	Guelph Lake WTP and ASR wells	Post-2051	Post-2051	Post-2051	Post-2051	Post-2051

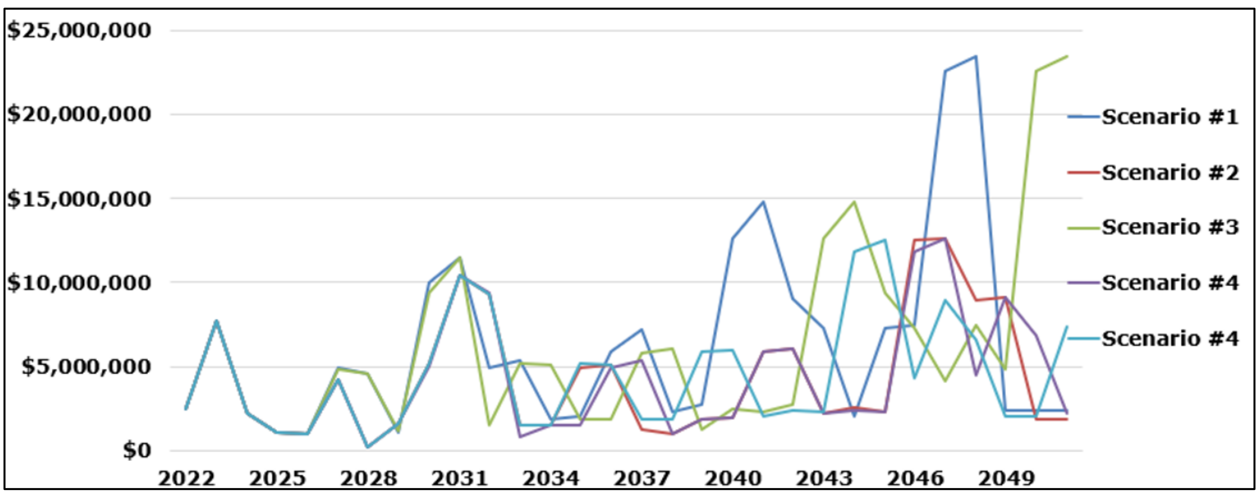
Notes: *Project implementation subject to outcome of on-going Southwest Guelph Water Supply EA

Figure 8-1: Annual Estimated Conservation Program Costs for Scenarios 2-5 (Undiscounted)



Of note in **Figure 8-2** is the difference in timing and magnitude of total capital and operating expenditures over time for each scenario.

Figure 8-2: Total Annual Capital and Operating Costs (Undiscounted) by Scenario



The net consequence of the evaluated scenarios linked to their capital and operating cost impacts over time yields an interesting picture when the cost streams are discounted to present value (**Table 8-4**). The discounted capital (Capx) plus operating (Opx) costs range from approximately $74.4 million (Scenario 4) to as high as $107.2 million (Scenario 1). These savings are incurred by deferring the need for new water supply projects (i.e., demand reduction). As the projects get increasingly expensive over time, as new supplies are more difficult to implement due to distance from the serviced population, smaller quantity sources are developed, etc., the deferral of these projects represents a direct financial benefit to the City.

Table 8-4: Comparison of Alternative Conservation Scenario Discounted Costs and Savings

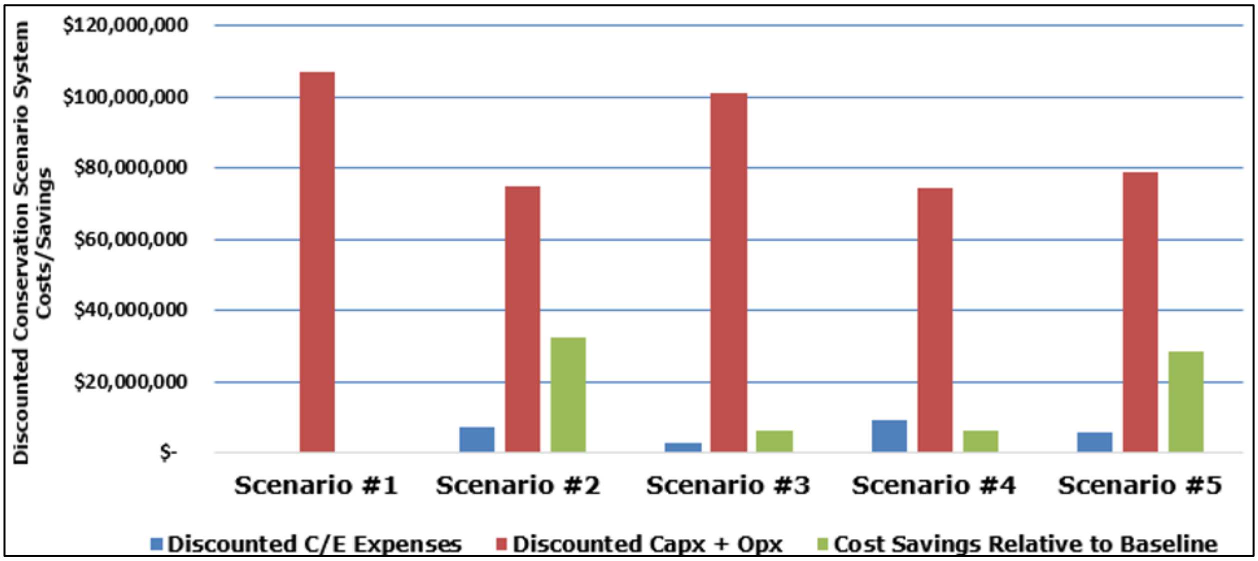
Financial Parameter	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Discounted Annual Capital Cost	91,951,961	63,170,785	87,263,622	62,705,967	66,914,343
Discounted Annual Operating Costs	15,239,422	11,709,923	13,535,273	11,715,192	11,709,923
Discounted Conservation Expenses	0	6,988,977	2,899,874	9,220,539	5,713,115
Discounted Capx + Opx	107,191,383	74,880,707	100,798,896	74,421,159	78,624,266
Savings Relative to Scenario 1	0	32,310,676	6,392,487	6,392,487	28,567,117
Ratio of Savings to Conservation Expenses	0	4.6	2.2	0.7	5.0

When the cost savings relative to the baseline (Scenario 1) are considered (i.e., the difference between Scenarios 2-5 discounted Capx + Opx cost relative to the baseline) we see that the highest cost savings are achieved with Scenarios 2 and 5, respectively (**Figure 8-3**). However, since the estimated conservation, efficiency and demand management program costs for the blended Scenario 5 is lower than Scenario 2 by more than $1 million (discounted), it generates a slightly more favorable cost/benefit ratio of 5.0 to 4.6 (**Table 8-4**).

Based on the completed analysis AECOM recommends implementing the blended strategy, Scenario 5. This scenario will result in a target for reduction in average day demand of 3,683 m^3/day by 2051.

While this analysis has been system focused, the full water system has not been considered. This analysis has included system costs associated with water supply and water conservation. Previous studies have included wastewater treatment in the consideration of system cost, which could be analyzed further in the future. In previous studies, the delay and avoidance of expanded wastewater treatment projects resulted in relatively lower costs for scenarios with higher water conservation. Adding wastewater treatment into the consideration of system costs would not increase the cost of water conservation programs but would increase the benefit from infrastructure avoidance.

Figure 8-3: Comparison of Alternative Financial Scenarios Relative to Baseline



8.3 Preferred Water Supply Alternative

The preferred water supply alternative consists of the blended conservation scenario as well as Projects 1 through 9 listed in **Table 8-1.** These are all groundwater projects included in the preferred alternatives in the evaluation process, consisting of existing municipal off-line wells, existing municipal test wells, Dolime Pond Level Management, Arkell ASR, and a new well (Guelph North) outside of the City.

8.3.1 Recommended Water Supply Alternative Implementation

For completion of the financial analysis undertaken to determine the preferred conservation scenario in the previous section, assumptions were made regarding timeline and costs associated with the individual projects that make up the supply alternatives (**Table 8-3**). This serves as a basis for demonstrating the savings that could be achieved through the conservation, efficiency and demand management programming; however, project timelines are routinely affected by factors exterior to those considered in a implementation schedule built on an ideal timeline.

The detailed implementation schedule for the identified water supply projects was prepared through discussion with the City and considers progress that has been made to date with on-going project work and reflects anticipate timelines to complete the short-term projects where there is the most certainty with respect to timing and potential results. The subsequent projects that fall in the mid- and long-term portions of the 2051 timeline are established based on anticipated requirements stated previously:

- Groundwater – 5 year timeline
- Arkell Collector ASR wells – 8 year timeline
- Surface Water – 10 year timeline

The order and timing of the individual water supplies will be determined as the City moves through development of each. However, an initial timeline was determined to provide a schedule for implementation of each water supply project, with estimated costs for each phase of development based on a portion of the overall capital cost: in reality many of these projects would be in investigation and design phases concurrently and the schedule for each would be a function of constraints and ease of implementation.

Also noted above is the recommendation that regardless of the required timeline for new water supply, the investigative phase for the groundwater options inside the City is scheduled to occur in the short term (2022-2025) so that the City has sufficient information to determine whether the alternative is feasible, to identify any constraints, and to confirm capacity and treatment requirements prior to the next WSMP Update; the groundwork would then be in place in order to implement the remaining tasks for any given project such that the supply would be in place as required.

For the purpose of illustrating the timeline of project development and capital expenditures, the estimated budgets for each project are provided along with the proposed timeline developed for the recommended implementation plan (**Table 8-5**). This table includes the costs for a permanent pumping station at the Dolime Quarry property ($3.3M) that is required for protection of the groundwater resource *regardless of which new water supply projects are implemented in southwest Guelph*. As such, this cost was not included in the financial analysis.

Table 8-5: Capital Cost Forecast

Project	1	2	3	4	5	6	7	8	9	10	11	12	Total Capital Cost for Water Supply Projects	Cumulative Annual Operating Costs	C/E Costs Blended
	Clythe	Ironwood	Guelph South	Dolime Quarry	Fleming/Logan	Lower Collector	Arkell Collector ASR	Hauser	Guelph North	Guelph Southeast	Guelph Lake	Smallfield/Sacco			
Min. Capacity (m^3/d)	1,180	2,250	2,250	3,000	4,180	4,000	1,170	425	2,935	1,600	12,312	850	-	-	-
O&M Cost	$100,000	$111,000	$109,000	$135,000 + $521,000	$126,000	$125,000	$99,000	$96,000	$111,000	$105,000	$900,000	$180,000	-	-	-
2021	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2022	$707,550	$157,729	$157,729	$157,729	$232,000	$420,000	$570,000	$0	$0	$0	$0	$87,500	$2,490,238	$0	$ 408,165
2023	$6,073,450	$157,729	$157,729	$157,729	$100,000	$290,000	$570,000	$82,000	$0	$0	$0	$0	$7,588,638	$100,000	$ 408,165
2024	$0	$157,729	$157,729	$157,729	$112,500	$1,480,000	$0	$0	$148,200	$0	$0	$0	$2,213,888	$100,000	$ 408,165
2025	$0	$157,729	$157,729	$157,729	$112,500	$30,000	$120,000	$0	$337,500	$0	$0	$0	$1,073,188	$100,000	$ 408,165
2026	$0	$668,430	$0	$495,000	$0	$0	$0	$0	$0	$235,000	$0	$0	$1,398,430	$100,000	$ 408,165
2027	$0	$3,667,570	$626,010	$2,805,000	$658,875	$0	$0	$0	$0	$338,000	$0	$0	$8,095,455	$346,000	$ 408,165
2028	$0	$0	$3,384,990	$0	$658,875	$0	$0	$0	$0	$0	$0	$0	$4,043,865	$455,000	$ 408,165
2029	$0	$0	$0	$0	$4,114,125	$0	$0	$0	$0	$0	$0	$0	$4,114,125	$455,000	$ 408,165
2030	$0	$0	$0	$0	$4,114,125	$0	$0	$0	$0	$0	$602,000	$0	$4,716,125	$581,000	$ 408,165
2031	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,520,000	$0	$1,520,000	$581,000	$ 408,165
2032	$0	$0	$0	$0	$0	$250,000	$0	$0	$0	$0	$0	$0	$250,000	$581,000	$ 154,693
2033	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$581,000	$ 154,693
2034	$0	$0	$0	$0	$0	$904,764	$0	$0	$0	$0	$0	$0	$904,764	$581,000	$ 154,693
2035	$0	$0	$0	$0	$0	$904,764	$0	$0	$0	$0	$0	$0	$904,764	$581,000	$ 154,693
2036	$0	$0	$0	$0	$0	$4,797,236	$0	$0	$0	$0	$0	$0	$4,797,236	$581,000	$ 154,693
2037	$0	$0	$0	$0	$0	$4,797,236	$0	$0	$0	$0	$0	$0	$4,797,236	$706,000	$ 154,693
2038	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$706,000	$ 154,693
2039	$0	$0	$0	$1,045,620	$0	$0	$150,000	$0	$0	$0	$0	$0	$1,195,620	$706,000	$ 154,693
2040	$0	$0	$0	$1,045,620	$0	$0	$150,000	$0	$0	$0	$0	$87,500	$1,283,120	$706,000	$ 154,693
2041	$0	$0	$0	$8,442,600	$0	$0	$1,099,280	$0	$0	$0	$0	$0	$9,541,880	$706,000	$ 154,693
2042	$0	$0	$0	$8,442,600	$0	$0	$1,099,280	$200,000	$0	$0	$0	$0	$9,741,880	$1,227,000	$ 336,519
2043	$0	$0	$0	$0	$0	$0	$1,099,280	$0	$125,000	$0	$0	$0	$1,224,280	$1,227,000	$ 336,519
2044	$0	$0	$0	$0	$0	$0	$10,213,080	$380,310	$125,000	$0	$0	$0	$10,718,390	$1,227,000	$ 336,519
2045	$0	$0	$0	$0	$0	$0	$10,213,080	$380,310	$837,417	$0	$0	$0	$11,430,807	$1,326,000	$ 336,519
2046	$0	$0	$0	$0	$0	$0	$0	$2,394,690	$837,417	$0	$0	$0	$3,232,107	$1,326,000	$ 336,519
2047	$0	$0	$0	$0	$0	$0	$0	$2,394,690	$5,215,233	$125,000	$0	$0	$7,734,923	$1,422,000	$ 336,519
2048	$0	$0	$0	$0	$0	$0	$0	$0	$5,215,233	$125,000	$0	$0	$5,340,233	$1,533,000	$ 336,519
2049	$0	$0	$0	$0	$0	$0	$0	$0	$0	$447,510	$200,000	$0	$647,510	$1,533,000	$ 336,519
2050	$0	$0	$0	$0	$0	$0	$0	$0	$0	$447,510	$200,000	$0	$647,510	$1,533,000	$ 336,519
2051	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,571,990	$3,347,030	$0	$5,919,020	$1,533,000	$ 336,519

It will be important for the City to closely track the success of the water conservation and efficiency program to ensure that the predicted reductions are being achieved, and to be able to trigger the initial phases of supply projects noting the lengthy lead-in time to complete all of the necessary investigations, approvals and design such that the water is available when needed. This is particularly important for the mid- and long-term projects as there are five supplies scheduled to come online in the 2022 to 2031 portion of the timeline. The City may decide to take a more conservative approach to complete more of the preliminary steps in advance to allow for a shorter final implementation time required for final construction and commissioning once triggered. This would also assist in identifying project issues early, and also securing land requirements.

In reviewing the preceding tables, it can be seen that depending on the conservation scenario, there are projects for which costs are falling within the study period although the water supply capacity is not required until post-2051. This points to the need to look beyond 30 years to better understand potential future requirements to determine when preliminary work must take place in preparation for the following years.

The presented costs include capital expenditures required to develop the identified water supplies and estimated operating costs associated with each constructed facility (i.e., materials, power, labour, maintenance, etc.). There are additional costs that the City must plan for in order to implement the projects identified in this plan, such as:

- Project management and coordination costs. It is estimated that the current City water supply projects can be implemented by two full time project managers; however, as the water supply system grows and the number of projects in various stages of development increase, up to four full time employees could be required.
- Regular model upgrades. Each of the identified projects will include a modelling component as part of the impact analysis. The model will require regular upgrades to incorporate new information collected in the field for each project and City-wide updates on a regular basis to calibrate to the updated regional dataset. It is estimated that the City-wide updates could cost approximately $500,000, commencing in 2023 and being completed on an approximate five year cycle.

8.4 Recommendations

The WSMP Update has been completed according to the Municipal Class EA process and the WSMP Update report can be used as a plan to implement the preferred solutions to address the anticipated water supply deficit to 2051. As part of this project the following recommendations have been developed.

8.4.1 Individual Project Implementation

Detailed descriptions of the individual projects are included as project sheets within **Appendix G**. These project sheets provide a summary of the required investigations, Class EA Schedule, other approvals, and infrastructure needs in order to implement each. Also indicated are the total estimated costs for each major phase of implementation taken from the cost summaries provided in Section 5, with the estimated timing for each determined through the above analysis based on the blended water conservation, efficiency and demand management programming scenario.

8.5 General Program Recommendations

1. The City of Guelph relies on groundwater sources for its drinking water. The investigations completed as part of this WSMP Update and other studies have indicated that the water supply sources proposed in this plan are sustainable under the current conditions and sufficient groundwater is available to meet the proposed growth targets proposed by the Provincial Places to Grow. However, the groundwater supply is finite, and Guelph may reach a limit in the future whereby additional groundwater extraction may be unsustainable. Future growth outside of Guelph may also affect the available water supply. As a result, as each new supply source is developed, it is recommended that the total water budget be re-evaluated as compared to the conditions at the time of assessment to ensure that additional groundwater extraction does not result in adverse environmental or well interference impacts.
2. Sustainable groundwater supplies will require careful monitoring of surface waters and wetlands as these ecosystems are the most

sensitive to increasing groundwater extraction. As each new water supply project is developed, it is recommended that additional monitoring programs be put in place to monitor for potential environmental effects to adapt the water takings to mitigate impacts, if necessary. Since water taking effects may extend outside of the City, collaboration with the GRCA and the Townships may be required to implement programs outside of the City.

3. Groundwater modelling is recommended as an important tool to assess potential cumulative effects and environmental impacts. It is recommended that the City's groundwater flow model be continuously updated and maintained for application in the various WSMP projects.

4. A basic premise of the WSMP Update is that the existing supply system is protected, and the City does not lose supply through contamination events or as a result of other non-municipal water takings. Therefore, it is important that the City enhance/maintain its source protection programs, particularly with respect to contaminated sites and to support, and in some cases, sponsor source protection programs outside of the City to provide equal protections. In addition, it is recommended that the preferred solution (i.e., future drinking water sources) in this WSMP Update be incorporated into the City's Source Protection Program for protection of water quantity of future drinking sources as required by the purpose of the Clean Water Act and the objective of the Source Protection Plan.

5. In comparison to the 2014 WSMP Update, capital and unit costs for the development of new groundwater supplies have increased. This is primarily due to the addition of treatment costs, particularly for new sources on the east side of the City that have been known to required iron and manganese treatment. Pandemic-related, supply-chain issues have been identified in developing cost estimates but there is uncertainty if some of the increased material and service costs will persist into the future. With Guelph City Council's direction of growth paying for the cost of growth, it is recommended that cost estimates in the WSMP Update be updated as part of Class EA projects once additional design details are available and with each subsequent WSMP Update (approximately every five years in frequency).

6. The Master Plan approach within the Municipal Class EA process addresses Phase 1: Identify and describe the problems and opportunities to be addressed; and Phase 2: Identify and evaluate alternative solutions and establish the preferred solution(s). Subsequent projects will address the remaining phases of the Class EA process. It is recommended, as part of feasibility studies or the Class EA process, that each potential new source of water supply require additional field work and environmental impact assessments, particularly with respect to water budget and sustainability issues.

7. Through the WSMP Community Engagement Plan, the Project Team heard concerns from adjacent municipalities on source protection and land use constraints as well as potential impacts to domestic wells from well interference. While some concerns, such as well interference, can be addressed with technical/operational measures (i.e., lowering of well pumps, deepening of wells), land use and water rights concerns associated with municipal growth are more difficult to address. It is recommended that future programs have a focus on enhanced engagement and development of intergovernmental relations with the goal to promote more regional water resources management, to support water supply needs for all affected municipalities and to address attendant environmental effects with the support of provincial agencies (i.e., Ministry of the Environment, Conservation and Parks) to meet provincial growth targets.

8. The recommendations provided in **Table 4-3** should be implemented in order to maintain and optimize the existing water supply sources.

9. The City should continue its existing raw water quality sampling program at each active water supply source.

10. It is recommended that the City build on the existing DWQMS process by developing a risk management plan that includes mitigation and response strategies. This will include current risks to the existing groundwater-based system and may be expanded upon to include additional risks relevant to future water supplies, whether groundwater or surface water based.

11. The future incorporation of the Edinburgh and Admiral wells into the water supply system should be reviewed through the Southwest Guelph Water Supply EA and the associated OTP.
12. The results presented for the Clythe Well should be considered preliminary and further evaluated along with future field data, such as that associated with on-going City investigations designed to build on the understanding of the potential for interaction between the well and natural environment.
13. As additional productivity from the Arkell site provides the City with flexibility in terms of how the overall system is managed and could contribute to a future ASR system, it is recommended that upgrades to the artificial recharge system be pursued.
14. Further development of the Arkell ASR alternative should consider the possibility of using excess flows from the collector(s) during period of high seasonal flow to service customer demands while 'resting' wells within the system (i.e., extended period with well off-line). This strategy may require flexibility within the City's PTTW to reflect variable maximum pumping rates throughout the year. Further, testing would be required to determine whether a strategy of resting wells would realize sufficient water level recovery to impact the maximum rate that a given well could operate at.
15. The feasibility of both the Arkell and Guelph Lake ASR alternatives should be further developed and this process should include an optimization study to evaluate the placement of ASR wells that best utilize the existing municipal supply wells to efficiently recover injected water.

8.5.1 Water Supply Planning Recommendations

The estimated water supply demand in any given future year is based on the projected residential population and employment numbers for that year multiplied by design values for unit consumption. Actual demand averaged over time generally follows a similar linear trend. In reality, however, required water supply capacity is subject to planning applications for developments which may require commitment of a large volume at one time regardless of the timeline for construction or when the demand will be realized, and proposals from industries which may require a large volume in a short period of time. These planning obligations present challenges for infrastructure planning as they can result in expediting water supply projects and the associated budgets to bring water supply on-line prior to when it is actually needed, or conversely use up available capacity on an accelerated schedule that was intended for future growth. This can be partially addressed by including a conservative trigger for bringing on-line new supply capacity (e.g., at demand/supply of 90%). However, optimizing the schedule for water supply capacity planning may also be addressed through appropriate planning policies that ensure the City has suitable lead-time and budgets in place for required water supplies. As such, it is recommended that the City continue to review on an annual basis, its planning and approvals process for managing allocation of water supply capacity.

Future City policies addressing water supply will address these challenges as follows:

- Build on the current process and guidelines for review of applications from new large volume users (e.g., industry), which considers a balance of employment and water use. Future projections are based on allocated amounts dedicated to the residential and ICI sectors, where the volume for ICI relates to a specified employment number. If high volume water users are not coupled with high employment, water demand projections will need to be revisited to establish a revised schedule for new water supply without jeopardizing the needs of planned growth.
- Investigate more robust policies for supply capacity allocation for both new and existing customers that take into account the relatively large capital expenses and lengthy timelines required to fully commission new water supply facilities. These policies would ensure maximum value to the City for supply capacity allocated to both new and existing customers.
- Complete an update of the 2016 Water Efficiency Strategy, commencing as early as 2022, based on the blended water conservation, efficiency and demand management scenarios presented through the WSMP (Scenario 5). This will include

evaluation of non-potable reuse options in alignment with the City's other water-related Master Plans.

- Continue, and refine as necessary, the tracking system that closely monitors sectoral demand management (i.e., conservation and efficiency programs) and optimization successes and whether results are in-line with the forecasted demand for the preferred scenario and is achieving the goals of the Water Efficiency Strategy. Trends must be monitored with a long-term view recognizing that the effect of some direct programs may be more immediate, resulting in short-term deviations from the forecast.
- Consider time limits on development commitments such that water capacity is not 'held' for long periods of time. Review possible mechanisms to synchronize approvals of significant capacity increases with the proposed timing of new supplies in accordance with the master planning schedule.
- Assess the Development Charges planning process for the ability to provide flexibility in funding in relation to COVID cost increases.
- Review land acquisition requirements for all projects, both short- and long-term, to ensure future flexibility when implementing alternatives. Consider delegation of authority to staff to execute strategic land procurement requirements for future water supply provided property values fall within 20% of study estimates, subject to the approval of the DCAO and City solicitor.

8.5.2 Supply Capacity Management Recommendations

The supply capacity in any given year is dependent on the existing water supply system to deliver the optimal capacity from each of the municipal wells or collector system. Maintaining the system for optimal capacity requires regular reviews of system capacity and consideration of potential threats in quantity and quality. The City's Source Protection Program under the Clean Water Act is designed to protect and improve the quality and quantity aspects of the existing water supply system. The following are recommendations to maintain the water supply capacity:

- Water Services should conduct annual reviews of each component of the water supply system to determine the supply capacity and to identify any changes in the capacity from previous years or any constraints in delivering the optimal supply capacity.

- Based on the annual reviews of water supply capacity, Water Services should develop programs and implement maintenance and upgrades to the water supply system so that the system can deliver its optimal supply capacity.
- To protect water quantity and to mitigate potential impacts on quantity from other water takings, the City should consider implementing a municipal by-law to prohibit new private groundwater supply wells in the City as well as other areas where municipal water services are present.

9. References

AECOM and Gauley and Associates Ltd., 2021:
Technical Memorandum Task #2: Population and Water Supply Demand Forecasts (Final). June 2021. Report Prepared for: City of Guelph

AECOM, 2021:
Technical Memorandum Task #3: City of Guelph Water Supply Master Plan. July 2021. Report Prepared for: City of Guelph

AECOM, 2021:
Technical Memorandum: City of Guelph Water Loss Management Strategy Review. July 2021. Report Prepared for: City of Guelph

Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage and A.R. Couturier (eds.), 2007:
Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp.

City of Guelph, 2016:
2016 Water Efficiency Strategy Update. September 2016. Prepared by: C3 Water and Gauley Associates Ltd.

City of Guelph, 2018:
Natural Heritage Action Plan. Accessed January 2021 from: https://guelph.ca/wp-content/uploads/Recommended-Natural-Heritage-Action-Plan.pdf

City of Guelph, 2021:
City of Guelph Official Plan (June 2021 Consolidation). Accessed June 2021 from: https://guelph.ca/wp-content/uploads/Official-Plan-Consolidation-June-2021.pdf

Dobbyn, J.S., 1994:
Atlas of the Mammals of Ontario. Ontario: Federation of Ontario Naturalists.

Dougan & Associates, 2005:
City of Guelph Natural Heritage Strategy

Fisheries and Oceans Canada (DFO), 2021:
Aquatic Species at Risk map. Retrieved January 2021 from: https://www.dfo- mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html

Gamsby and Mannerow Ltd., 2014:
Sacco Production Well Investigation of Options for Returning Well to Service. February 2014. Report Prepared for: City of Guelph

Genivar, 2011:
City of Guelph Residential Greywater Field Test Draft Final Report. June 2012. Report Prepared for: City of Guelph

Grand River Conservation Authority, 2006:
Information available on the Grand River Information Network on the internet at http://www.grandriver.ca

GRCA, 2020:
Technical Memorandum. Surface Water Analysis for City of Guelph Long Terms Water Supply Plan. September 2020. Prepared for: City of Guelph

Halloran, J., H. Anderson and D. Tassie, 2013:
Clean Equipment Protocol for Industry. Peterborough Stewardship Council and Ontario Invasive Plant Council. Peterborough, ON.

Hoffman, D.W. and B.C. Matthews, 1963:
Soil Survey of Wellington County Ontario: Report No. 35. Department of Agriculture and the Ontario Agricultural College

iNaturalist, 2021:
iNaturalist. Available Online: http://inaturalist.org. Accessed January 2021.

Matrix Solutions Inc., 2017:
City of Guelph and Township of Guelph/Eramosa Tier Three Water Budget and Local Area Risk Assessment. March 2017. Report Prepared for: Lake Erie Source Protection Region

Matrix Solutions Inc., 2021:
City of Guelph Water Supply Master Plan: Places to Grow Scenarios. May 2021. Report Prepared for: AECOM Canada Ltd.

Matrix Solutions Inc., 2021:
Groundwater Modelling Report: The City of Guelph Water Supply Master Plan Update. August 2021. Report Prepared for: AECOM Canada Ltd.

McNaughton, A., R. Layberry, R. Cavasin, B. Edwards and C. Jones, 2021:
Ontario Butterfly Atlas. Accessed January 2021 from: http://www.ontarioinsects.org/atlas_online.htm

Ministry of Municipality Affairs and Housing, 2020:
A Place to Grow. Growth Plan for the Greater Golden Horseshoe. August 2020.

Ministry of the Environment, Conservation and Parks (MECP):
Potential Hazardous Events for Municipal Residential Drinking Water Systems to Consider in the DWQMS Risk Assessment.

Natural Heritage Information Centre (NHIC), 2001:
Information available on the NHIC data base available on the internet at http://www.mnr.gov.on.ca/MNR/nhic/nhic.html

Ontario Ministry of Natural Resources and Forestry (MNRF), 2021:
Make-a-Map: Natural Heritage Areas Application. Website: http://www.giscoeapp.lrc.gov.on.ca/Mamnh/Index.html?site=MNR_NHLUPS_NaturalHeritage&viewer=NaturalHeritage&locale=en-US. January 2021.

Ontario Nature, 2019:
Ontario Reptile and Amphibian Atlas. Available Online: https://www.ontarionature.org/protect/species/herpetofaunal_atlas.php. Accessed January 2021.

Stantec Consulting Ltd., 2009:
Sacco and Smallfield Production Wells Well Rehabilitation and Hydrogeologic Assessment. April 2009. Report Prepared for: City of Guelph

Stantec Consulting Ltd., 2019:
Technical Memorandum. Carter Production Wells, Guelph, Ontario: Effective In-Situ Filtration Source Characterization Confirmation. Spring 2018 Water Quality Review. June 2019. Report Prepared for: City of Guelph

Well Initiatives Ltd., 2020:
Private and Confidential: Logan Well Assessment. October 2020. Prepared for: City of Guelph

Wellington, County of, 2005:
County of Wellington Official Plan (OPA February 12, 2013)

Wellington, County:
Information available on the internet at http://www.county.wellington.on.ca/

Appendix A

Natural Environment Considerations for Alternatives – Guelph Water Supply Master Plan Update Study

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To: Dave Belanger, City of Guelph

From: Jillian deMan, Olga Hropach

Date: October 26, 2021

Project #: 60612820

Memorandum

Subject: Natural Environment Considerations for Alternatives – Guelph Water Supply Master Plan Update Study

1. Introduction

The City of Guelph is completing a water supply master plan update that is investigating a variety of water supply alternatives to service demand to the year 2051. Alternatives include water conservation and demand management, expansion of the existing groundwater supply system, optimization of existing wells, installation of new wells within and outside the City's boundaries and the establishment of new local surface water supply locally.

This memo presents the initial assessment of potential impacts of alternatives in relation to natural heritage features such as wetlands, watercourses, fisheries, Species at Risk, and Areas of Natural and Scientific Interest. Due the conceptual nature of this Master Plan Study, existing information was referenced to determine the location of natural heritage areas. The following documents were reviewed:

Official Plans

- City of Guelph Official Plan
- Wellington County Official Plan

Other Documents

- City of Guelph Natural Heritage Strategy
- Grand River Conservation Authority website
- Soil Survey of Wellington County

- Ontario Reptile and Amphibian Atlas
- Ontario Butterfly Atlas
- Department of Fisheries and Oceans Species at Risk Mapping
- Ministry of Natural Resources and Forestry, Natural Heritage Information Centre website
- Wellington County website Interactive Mapping Tool
- Atlas of the Breeding Birds of Ontario
- Mammals of Ontario
- iNaturalist Online

2. Natural Environment

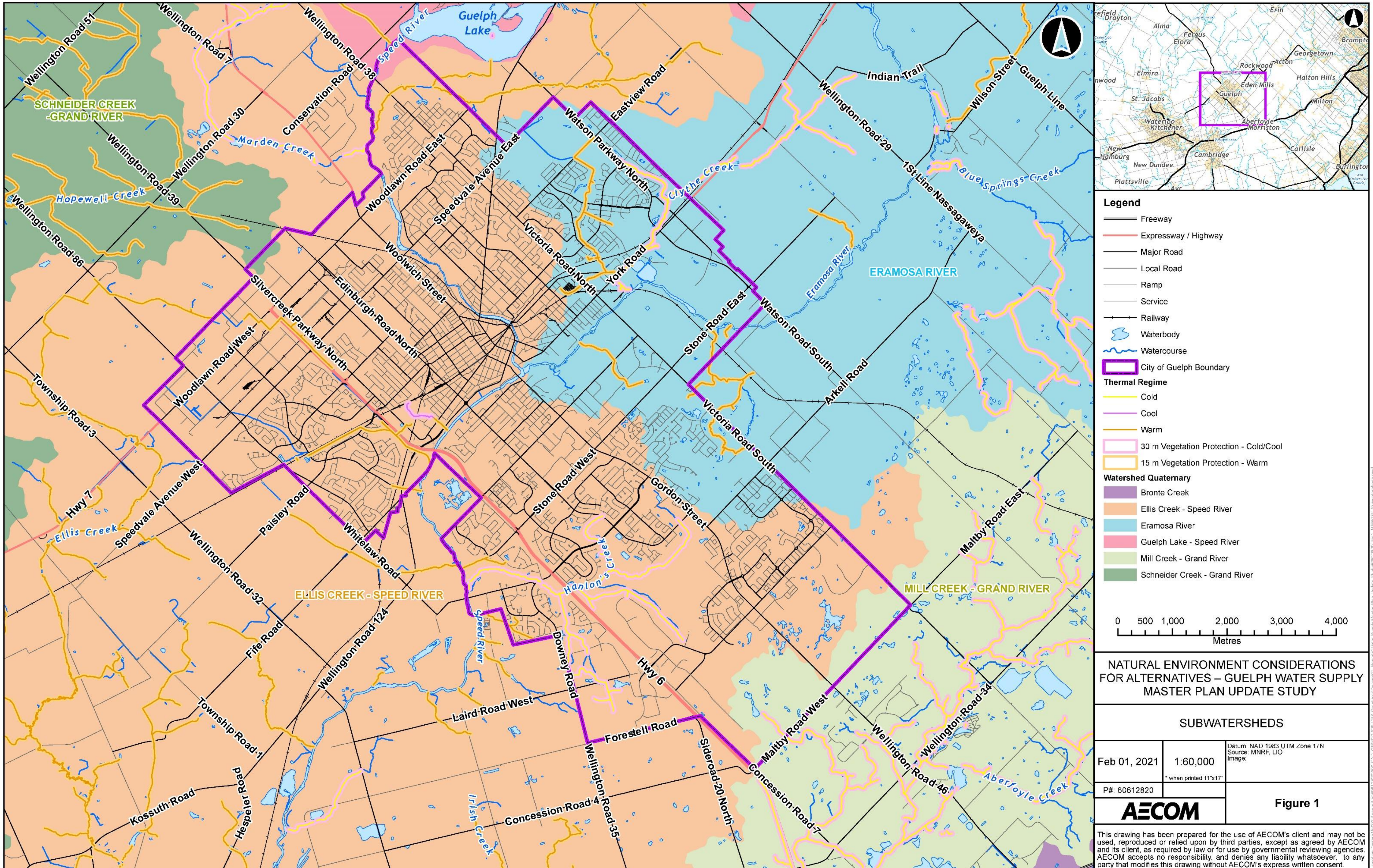
The various servicing alternatives are restricted to Wellington County (City of Guelph, Puslinch Township, Guelph/Eramosa Township).

The following provides a general description of the natural environment within the study area. Each individual Class EA for the identified water supply alternatives will include a more detailed review utilizing Wetland Evaluations, Environmental Significant Area Reports and Fisheries Information.

2.1 City of Guelph

With a total coverage of approximately 22%, the City of Guelph contains a fairly diverse natural heritage system comprised primarily of wetland complexes, woodlands and ravines associated with the City's river systems (City of Guelph, 2018). The City of Guelph includes the following natural heritage features (refer to **Figures 1** and **2**):

- Five Subwatershed/Watershed Areas:
  - Schneider Creek-Grand River;
  - Ellis Creek-Speed River;
  - Eramosa River;
  - Guelph Line-Speed River; and
  - Mill Creek-Grand River.
- Three Areas of Natural and Scientific Interest (ANSIs):
  - Paris Moraine Provincial Earth Science;
  - Guelph Correctional Centre Quarry Provincial Earth Science; and
  - Guelph Interstadial Site Regional Earth Science.



SCHNEIDER CREEK -GRAND RIVER
ERAMOSA RIVER
ELLIS CREEK - SPEED RIVER
MILL CREEK - GRAND RIVER
Guelph Lake
Speed River
Marden Creek
Hopewell Creek
Clythe Creek
Blue Springs Creek
Eramosa River
Ellis Creek
Hanlon's Creek
Irish Creek
Aberfoyle Creek
Wellington Road 51
Wellington Road 7
Wellington Road 38
Conservation Road
Wellington Road 30
Wellington Road 39
Wellington Road 86
Woodlawn Road East
Speedvale Avenue East
Watson Parkway North
Eastview Road
Indian Trail
Wellington Road 29
Wilson Street
Guelph Line
1st Line Nassagaweya
Victoria Road North
York Road
Woolwich Street
Edinburgh Road North
Silvercreek Parkway North
Woodlawn Road West
Stone Road East
Watson Road South
Arkell Road
Victoria Road South
Township Road 3
Hwy 7
Speedvale Avenue West
Paisley Road
Whitelaw Road
Stone Road West
Gordon Street
Maltby Road East
Wellington Road 32
Fife Road
Wellington Road 124
Downey Road
Hwy 6
Laird Road West
Forestell Road
Maltby Road West
Wellington Road 34
Wellington Road 46
Township Road 1
Kossuth Road
Hespeler Road
Concession Road 4
Wellington Road 35
Sideroad 20 North
Concession Road 7
Legend
Freeway
Expressway / Highway
Major Road
Local Road
Ramp
Service
Railway
Waterbody
Watercourse
City of Guelph Boundary
Thermal Regime
Cold
Cool
Warm
30 m Vegetation Protection - Cold/Cool
15 m Vegetation Protection - Warm
Watershed Quaternary
Bronte Creek
Ellis Creek - Speed River
Eramosa River
Guelph Lake - Speed River
Mill Creek - Grand River
Schneider Creek - Grand River
0 500 1,000 2,000 3,000 4,000
Metres
NATURAL ENVIRONMENT CONSIDERATIONS FOR ALTERNATIVES – GUELPH WATER SUPPLY MASTER PLAN UPDATE STUDY
SUBWATERSHEDS
Feb 01, 2021
1:60,000
* when printed 11"x17"
Datum: NAD 1983 UTM Zone 17N
Source: MNRF, LIO
Image:
P#: 60612820
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Figure 1
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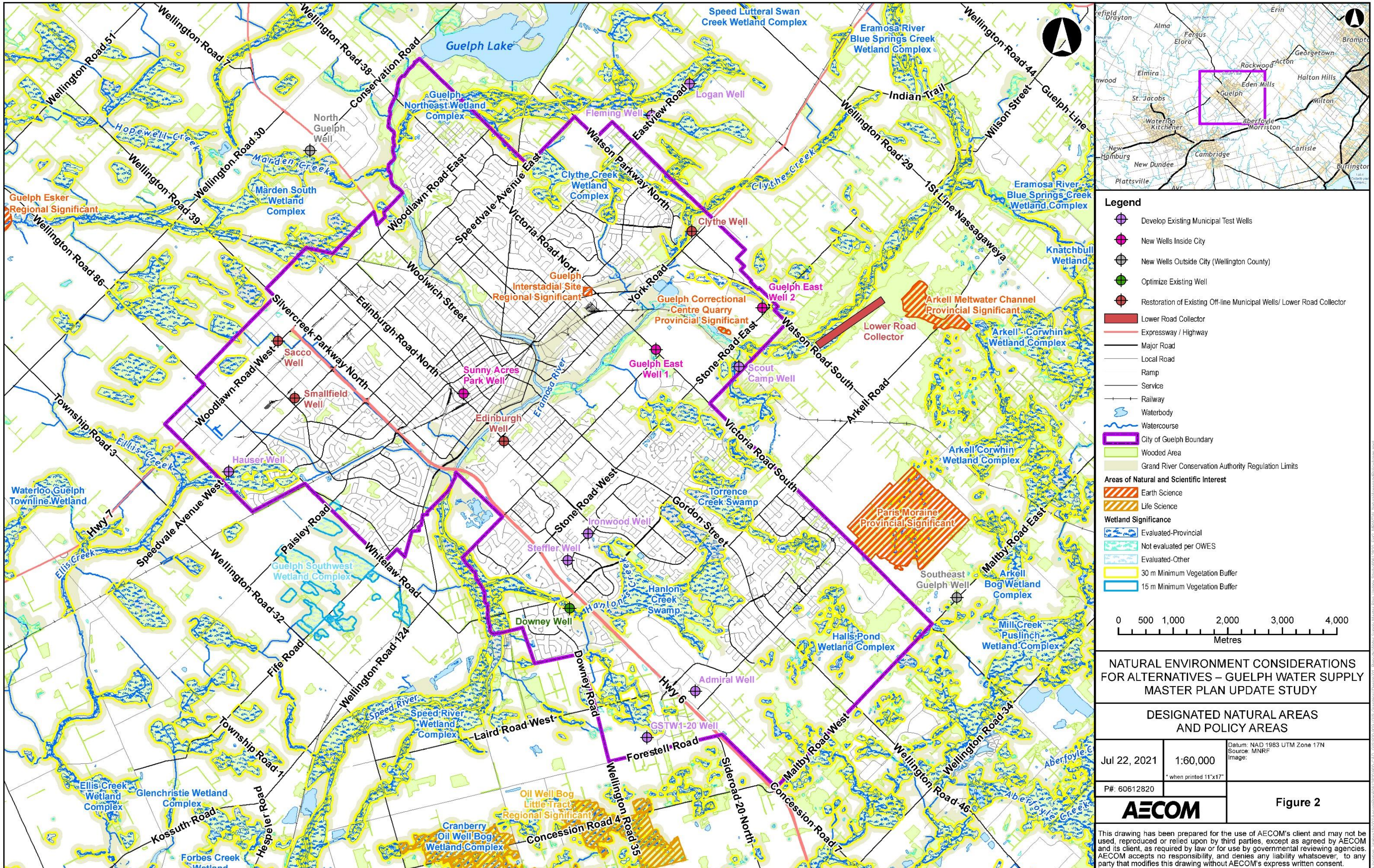
Legend
Develop Existing Municipal Test Wells
New Wells Inside City
New Wells Outside City (Wellington County)
Optimize Existing Well
Restoration of Existing Off-line Municipal Wells/ Lower Road Collector
Lower Road Collector
Expressway / Highway
Major Road
Local Road
Ramp
Service
Railway
Waterbody
Watercourse
City of Guelph Boundary
Wooded Area
Grand River Conservation Authority Regulation Limits
Areas of Natural and Scientific Interest
Earth Science
Life Science
Wetland Significance
Evaluated-Provincial
Not evaluated per OWES
Evaluated-Other
30 m Minimum Vegetation Buffer
15 m Minimum Vegetation Buffer
0 500 1,000 2,000 3,000 4,000
Metres
NATURAL ENVIRONMENT CONSIDERATIONS FOR ALTERNATIVES – GUELPH WATER SUPPLY MASTER PLAN UPDATE STUDY
DESIGNATED NATURAL AREAS AND POLICY AREAS
Jul 22, 2021
1:60,000
* when printed 11"x17"
Datum: NAD 1983 UTM Zone 17N
Source: MNRF
Image:
P#: 60612820
AECOM
Figure 2
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Guelph Lake
Speed Lutteral Swan Creek Wetland Complex
Eramosa River Blue Springs Creek Wetland Complex
Guelph Northeast Wetland Complex
Logan Well
Fleming Well
North Guelph Well
Marden South Wetland Complex
Guelph Esker Regional Significant
Clythe Creek Wetland Complex
Clythe Well
Guelph Interstadial Site Regional Significant
Guelph Correctional Centre Quarry Provincial Significant
Guelph East Well 2
Lower Road Collector
Arkell Meltwater Channel Provincial Significant
Arkell - Corwhin Wetland Complex
Knatchbull Wetland
Sacco Well
Smallfield Well
Sunny Acres Park Well
Guelph East Well 1
Scout Camp Well
Edinburgh Well
Hauser Well
Waterloo Guelph Townline Wetland
Arkell Corwhin Wetland Complex
Torrence Creek Swamp
Paris Moraine Provincial Significant
Ironwood Well
Steffler Well
Guelph Southwest Wetland Complex
Southeast Guelph Well
Arkell Bog Wetland Complex
Hanlon Creek Swamp
Downey Well
Halls Pond Wetland Complex
Mill Creek Puslinch Wetland Complex
Admiral Well
GSTW1-20 Well
Speed River Wetland Complex
Ellis Creek Wetland Complex
Glenchristie Wetland Complex
Oil Well Bog Little Tract Regional Significant
Cranberry Oil Well Bog Wetland Complex
Forbes Creek Wetland
Wellington Road 51
Wellington Road 7
Wellington Road 38
Conservation Road
Wellington Road 30
Wellington Road 39
Wellington Road 86
Eastview Road
Indian Trail
Wellington Road 44
Guelph Line
Wilson Street
Wellington Road 29
1St Line Nassagaweya
Watson Parkway North
Woodlawn Road East
Speedvale Avenue East
Victoria Road North
Woolwich Street
York Road
Edinburgh Road North
Silvercreek Parkway North
Woodlawn Road West
Stone Road East
Watson Road South
Arkell Road
Victoria Road South
Township Road 3
Hwy 7
Speedvale Avenue West
Paisley Road
Whitelaw Road
Stone Road West
Gordon Street
Maltby Road East
Wellington Road 32
Fife Road
Wellington Road 124
Downey Road
Hwy 6
Laird Road West
Township Road 1
Forestell Road
Maltby Road West
Wellington Road 34
Wellington Road 46
Kossuth Road
Hespeler Road
Concession Road 4
Wellington Road 35
Sideroad 20 North
Concession Road 7
Eramosa River
Hopewell Creek
Marden Creek
Clythe Creek
Ellis Creek
Hanlon Creek
Speed River
Aberfoyle Creek
Drayton
Alma
Fergus
Elora
Erin
Rockwood
Acton
Georgetown
Brampton
Elmira
Eden Mills
Guelph
Halton Hills
St. Jacobs
Milton
Waterloo
Kitchener
Aberfoyle
Morriston
New Hamburg
Cambridge
Carlisle
New Dundee
Burlington
Plattsville

- Ten Provincially Significant Wetlands (PSWs) Complexes (partially or entirely):
  - Clythe Creek Wetland Complex;
  - Ellis Creek Wetland Complex;
  - Eramosa River Blue Springs Creek Wetland Complex;
  - Guelph Northeast Wetland Complex;
  - Halls Pond Wetland Complex;
  - Hanlon Creek Swamp;
  - Marden South Wetland Complex;
  - Mill Creek Puslinch Wetland Complex
  - Speed River Wetland Complex; and,
  - Torrance Creek Swamp.
- One Locally Significant Wetland (LSW):
  - Guelph Southwest Wetland Complex.
- The Speed, Eramosa, Hanlon, Torrance, Clythe and Ellis River Systems;
- Several Locally Significant Woodland Areas (i.e., of 1 ha or greater); and
- Large areas of what are currently identified as ecological corridors, buffers and linkages (i.e., 'Other Natural Heritage Features' in the Official Plan, March 2018 consolidation).

Attachment A presents a copy of Schedule 4 "Natural Heritage Features and Development Constraints", from the City Guelph's Official Plan as well a copy of Schedule 2 "Land Use Plan".

Within and surrounding the City, a total of 46 species listed as Endangered, Threatened or Special Concern (referred to as Species at Risk [SAR]) under the Endangered Species Act, 2007 (ESA) have been recorded (refer to **Attachment B** for a comprehensive list). Species that have been observed more recently in the last 20 years within the City of Guelph include: Least Bittern (*Ixobrychus exilis*), Prothonotary Warbler (*Protonotaria* citrea), Butternut (*Juglans cinera*), Blanding's Turtle (*Emydoidea blandingii*) and Redside Dace (*Clinostomus elongatus*).

As stated in the City of Guelph's Official Plan, the protection and enhancement (where appropriate) of natural heritage features and their associated ecological functions is required. Natural heritage features are defined as areas containing significant wetlands and other wetlands, significant habitats of endangered and threatened species, significant ANSIs, surface water features and fish habitat, significant woodlands, significant landform, significant valleylands, ecological linkages and significant wildlife habitat, restoration areas, habitat of significant species and cultural woodlands. Minimum buffer areas are created in order to prevent damage and degradation to associated natural heritage features and areas that are part of the Natural Heritage System. Minimum buffer areas for each type of natural heritage feature are presented in **Table 1** and should be considered for designing and siting alternative solutions (City of Guelph, 2021). Additionally, wildlife crossing locations are another feature included in the natural heritage system which have been created to minimize and mitigate impacts to wildlife, property damage and threats to human safety; however, these areas have no buffer requirements in direct association with them. As an additional consideration, the Grand River Conservation Authority (GRCA) has regulation areas within the City of Guelph which are used to control flooding, erosion, dynamic beaches, pollution and the conservation of land. Development is not permitted within these areas unless a permit is acquired from the GRCA.

Table 1: Minimum Buffers to Natural Heritage Features

Natural Heritage Features and Areas	Width of Minimum Buffers
Significant Areas of Natural and Scientific Interest (ANSIs)	No minimum buffer
Significant Habitat for Provincially Endangered and Threatened Species	No minimum buffer
Significant Wetlands **i. Provincially Significant Wetlands** **ii. Locally Significant Wetlands**	i. 30 m ii. 15 m
Surface Water and Fish Habitat **i. Cold/cool water fish habitat** **ii. Warm water fish habitat, permanent and intermittent streams and undetermined fish habitat**	i. 30 m ii. 15 m
Significant Woodlands	10 m from the drip line
Significant Valleylands	No minimum buffer
Significant Landform	No buffer required
Significant Wildlife Habitat **i. Deer Wintering Areas and Waterfowl Overwintering Areas** **ii. Significant Wildlife Habitat** **iii. Ecological Linkages**	i. No minimum buffer ii. No minimum buffer iii. No buffer required
Other Wetlands	No minimum buffer
Cultural Woodland	No minimum buffer
Potential Habitat for Significant Species (excluding provincially Endangered and Threatened Species)	No minimum buffer

Source: City of Guelph, 2021

2.2 Wellington County

The topography and geology of Wellington County on a whole is made up of elongated hills, known as drumlins. These occupy much of the southern and northern parts of Wellington County, while the central part consists of undulating moraine. In general, the land slopes from east to west and from north to south. Some of the drainage features include the Grand, Speed and Eramosa Rivers, the Grand being the most prominent. Guelph Lake, a result of the construction of Guelph Lake Dam in 1974, is located north of the City.

Loam textured till materials predominate in the northern and southern ends of the County. The till plains in these areas are drumlinized and contain many low broad oval hills with smooth slopes that are characteristic of drumlins.

A total of 46 SAR are known to occur within Wellington County. In addition to this, one species that has been designated as Special Concern by the Committee on the Status of Endangered Wildlife in Canada but has no status in Ontario is also known to occur within Wellington County. A list of these species and their habitat preferences is included in **Attachment B**.

Natural heritage features are located throughout the County and include PSWs, LSWs, unevaluated wetlands, ANSIs and woodlands.

Attachment C presents a copy of Appendix 1 “South Wellington Watershed Study Areas” and Appendix 3 “Provincially Significant Wetlands”.

3. Impact Assessment

This section discusses the potential impacts of the various alternatives on the natural environment. As expected, those alternatives which rely solely on conservation/demand management will not have as many anticipated impacts as those alternatives that require obtaining water supply from groundwater or surface water sources.

It should be noted that this assessment is of a general nature and further investigations will be required in individual Class EA studies to determine potential impacts with regards to specific natural heritage features.

Table 2 presents the potential impacts of each alternative.

Table 2: Potential Impacts of Each Alternative

Sources	Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
Groundwater Sources	■ Optimize Existing Downey Well ■ Improvement of well performance to yield additional capacity	■ The existing Downey Well is located near or adjacent to Hanlon's Creek and the Provincially Significant Hanlon Creek Swamp.	■ By increasing the total water supply capacity through enhancement of the existing well, a slight reduction in surface water and wetland water levels might occur. Potential impacts include: – Reduction of viable fish/ amphibian habitat within wetland and river systems; – Alteration of plant community composition and wildlife habitat through change of riparian/emergent and submergent zones, as well as alteration in hydrology; potential for increase in invasive plant colonization of transition zones; and – Alteration of overall water temperature (i.e. shallower water levels result in higher temperature regimes)	■ Further Studies/ Class EAs should include the following tasks: – Conduct field investigations to determine existing conditions of aquatic/terrestrial habitat within the watercourse and wetland systems within proximity of wells; – Obtain Wetland Evaluation Reports, fisheries and Species at Risk information for within at least 120 m of the proposed site from secondary sources and agency consultation with MECP, MNRF and GRCA; – Provision of more detailed Impact Assessment; and – Determination of Mitigation Measures specifically addressing groundwater impacts.
Groundwater Sources	■ Restoration of Existing Off-line Municipal Wells/ Lower Road Collector ■ Wells/ Collector have existing Permits to Take Water, but City has discontinued use due to concerns with water quality. Wells/ Collector require upgrades to address water quality for the following sites: – Lower Road Collector – Edinburgh well – Clythe well – Sacco well – Smallfield well	■ Those existing wells which require treatment that are near or adjacent to natural heritage features include the Arkell Lower Road Collector (near Eramosa River and the Eramosa River Blue Springs Creek PSW complex), Edinburgh Well (near Speed River), Clythe Creek Well (near Clythe Creek PSW complex and Clythe Creek), Sacco Well (near Marden South PSW Complex) and Smallfield well (near a significant woodland).	■ Low potential adverse impacts are anticipated since this alternative utilizes existing well systems. However, with additional demand from groundwater resources, the following impacts could potentially include: – Reduction of viable fish/ amphibian habitat within wetland and river systems; – Alteration of plant community composition and wildlife habitats through change of riparian/emergent and submergent zones as well as alteration in hydrology; potential for increase in invasive plant colonization of transition zones; – Alteration of overall water temperature (i.e. shallower water levels result in higher temperature regimes); and – Construction related impacts including: loss of vegetation / wildlife habitat, increased sedimentation, noise disturbances, soil compaction, soil contamination etc.	■ Further Studies/ Class EAs should include the following tasks: – Conduct field investigations to determine existing conditions of aquatic/terrestrial habitat within the watercourse and wetland systems within proximity of wells; – Obtain Wetland Evaluation Reports, fisheries and Species at Risk information for within at least 120 m of the proposed site from secondary sources and agency consultation with MECP, MNRF and GRCA; – Provision of more detailed Impact Assessment; and – Determination of Mitigation Measures specifically addressing groundwater impacts. – -Of note, a Class EA for the Clythe Well Treatment Upgrades has already been completed by Blueplan Engineering for the City of Guelph in 2018. The EA report is available at the following link: https://guelph.ca/wp-content/uploads/Clythe-Well-Treatment-Upgrades-Class-Environmental-Assessment.pdf

Sources	Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
Groundwater Sources	■ Develop Existing Municipal Test Wells ■ Construction of wells at or near location of existing municipal test wells at the following sites: – -Scout camp well – -Steffler well – -Ironwood well – -Fleming well – -Logan well – -Hauser well – -GSTW1-20 well – -Admiral well	■ The test wells that may be developed into municipal production wells that are near or adjacent to natural heritage features include Steffler & Ironwood (near Hanlon Creek Swamp PSW); Scout Camp (near Torrance Creek Swamp PSW); Fleming & Logan (near Guelph Northeast PSW Complex); Hauser (near Ellis Creek PSW Complex); and GSTW1-20 (Hanlon Creek Swamp PSW). ■ The Admiral test well is not located near or adjacent to natural heritage features as its situated in a commercial/ industrial urban setting.	■ By increasing the total water supply capacity through enhancement of existing wells, a slight reduction in surface water and wetland water levels might occur. Potential impacts include: – Reduction of viable fish/ amphibian habitat within wetland and river systems; – Alteration of plant community composition and wildlife habitats through change of riparian/emergent and submergent zones as well as alteration in hydrology; potential for increase in invasive plant colonization of transition zones; – Alteration of overall water temperature (i.e. shallower water levels result in higher temperature regimes); and – Construction related impacts including: loss of vegetation / wildlife habitat, increased sedimentation, noise disturbances, soil compaction, soil contamination etc. ■ Minimal potential impact on natural heritage features are anticipated for the Admiral test well as its not located adjacent to natural heritage features.	■ Further Studies/ Class EAs should include the following tasks: – Conduct field investigations to determine existing conditions of aquatic/terrestrial habitat within the watercourse and wetland systems within proximity of wells; – Obtain Wetland Evaluation Reports, fisheries and Species at Risk information for within at least 120 m of the proposed site from secondary sources and agency consultation with MECP, MNRF and GRCA; – Provision of more detailed Impact Assessment; and – Determination of Mitigation Measures specifically addressing groundwater impacts. – Of note, the City has initiated a Class EA to evaluate potential additional water supply sources in southwest Guelph. This project will evaluate the Ironwood, Steffler and GSTW1-20 test wells.
Groundwater Sources	■ New Wells Outside City (Wellington County) ■ The Tier 3 model was used to identify areas of potential water supply without impacting watersheds already identified as under stress for the following sites: – -Guelph Southeast – -Guelph North	■ Those areas where new wells will potentially be installed, include: Guelph Southeast (near the Arkell Bog and the Mill Creek Puslinch PSW Complexes), Guelph North (near the Marden South PSW Complex).	■ By increasing the total water supply capacity through the installation of new wells, reduction in surface water and wetland water levels might occur. Potential impacts include: – Reduction of viable fish/ amphibian habitat within wetland and river systems; – Alteration of plant community composition through change of riparian/emergent and submergent zones; potential for increase in invasive plant colonization of transition zones; – Alteration of overall water temperature (i.e. shallower water levels result in higher temperature regimes); and – Construction related impacts including: loss of vegetation, increased sedimentation, noise disturbances, soil compaction, soil contamination etc.	■ Further Studies/ Class EAs should include the following tasks: – Conduct field investigations to determine existing conditions of aquatic/terrestrial habitat within the watercourse and wetland systems within proximity of wells; – Obtain Wetland Evaluation Reports, fisheries and Species at Risk information for within at least 120 m of the proposed site from secondary sources and agency consultation with MECP, MNRF and GRCA; – Provision of more detailed Impact Assessment; and – Determination of Mitigation Measures specifically addressing potential erosion impacts.

Sources	Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
Groundwater Sources	■ Dolime Quarry Alternatives – Option 1: Capture groundwater that flows to quarry using existing municipal wells and test wells; option requires construction of pumping station to maintain quarry water level at optimal elevation, discharge would remain to Speed River as is currently permitted. – Option 2: Construct Water Treatment Plant to treat raw water from the quarry and pump to distribution. Regular discharge to the Speed River would cease.	■ Option 1: any natural heritage features as identified above for existing wells may be potentially affected. ■ Option 2: Depending on proximity of the new water treatment plant to natural heritage features, there may be potential effects on the natural environment.	■ For both options, by increasing the total water supply capacity through increasing the pumping volume/rate at existing wells, reduction in surface water levels might occur. Potential risks are minimized as long-term dewatering has occurred at the Dolime Quarry and new water supply developed under this alternative will represent a portion of the groundwater typically dewatered from the quarry. Potential impacts to be assessed at the locations of the test wells include: – Reduction of viable fish/ amphibian habitat within the river system; – Alteration of plant community composition through change of riparian/emergent and submergent zones; potential for increase in invasive plant colonization of transition zones; – Alteration of overall water temperature (i.e. shallower water levels result in higher temperature regimes); and, – Construction related impacts including: loss of vegetation, increased sedimentation, noise disturbances, soil compaction, soil contamination etc. ■ Option 1 provides reduced potential impact to the water balance of the Speed River system by maintaining some direct discharge of collected groundwater to the river relative to Option 2, which would treat and pump collected groundwater to distribution and cease discharge to the Speed River.	■ Further Studies/ Class EAs should include the following tasks: – Conduct field investigations to determine existing conditions of aquatic/terrestrial habitat within the watercourse and wetland systems within proximity of wells; – Obtain Wetland Evaluation Reports, fisheries and Species at Risk information for within at least 120 m of the proposed site from secondary sources and agency consultation with MECP, MNRF and GRCA; – Provision of more detailed Impact Assessment; and – Determination of Mitigation Measures specifically addressing groundwater impacts. – Of note, the City has initiated a Class EA to evaluate potential additional water supply sources in southwest Guelph. This project will evaluate the options presented for the Dolime Quarry.
Aquifer Storage Recovery (ASR)	■ ASR Guelph Lake/ Arkell Spring Collectors ■ Storage of treated (potable) water in aquifers near Guelph Lake/ Arkell Spring Grounds during periods of water surplus and subsequent recovery of volume stored during periods of high demand.	■ ASR is most effective in areas where there is high aquifer transmissivity and the potential to develop ASR wells with a corresponding high specific capacity. ■ In concept, the ASR system would consist of a series of wells in a wellfield that would store treated water (dechlorinated) in the deep bedrock (i.e. injection mode) when the water was available from the treatment system. When water was required from storage, the same wells would be used to recover the water (i.e. extraction mode). The recovered water would require disinfection prior to distribution. ■ Areas affected through water storage via Guelph Lake include Guelph Lake and its associated wetland and aquatic features (i.e. Guelph Northeast Provincially Significant Wetland).	■ The process of storage/recovery of surplus water in a given area in theory keeps the existing water capacity at base level. - The potential for groundwater contamination (i.e. nutrient leaching). This potential impact is minimized through treatment to potable standards prior to injection and completion of a geochemical assessment to ensure injection of compatible water. – Depending on the location of the wells, impacts to the natural environment in terms of sedimentation/ vegetation clearing, noise etc. might occur during the construction phase.	■ Further Studies/ Class EAs should include the following tasks: – Field investigations to determine existing conditions and aiding in determination of appropriate location for the well field; – Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; – Provision of more detailed Impact Assessment; – Species at Risk Inventories targeting species sensitive to hydrologic changes; – Amphibian surveys within wetland communities; and

Sources	Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
Surface Water Sources	■ Local Surface Water from Guelph Lake	■ Areas affected through water taking via Guelph Lake include Guelph Lake and its associated wetland and aquatic features (i.e. Guelph Northeast PSW and Speed River)	■ By increasing the total water supply capacity through additional taking of surface water, reduction in surface water and wetland water levels might occur. Potential impacts anticipated to be limited to the area between Guelph Lake and the Guelph Waste Water Treatment Plant where water taken for supply is returned to the river. Potential impacts include: – Reduction of viable fish/ amphibian habitat within lake and river systems; – Alteration of plant community composition through change of riparian/emergent and submergent zones; potential for increase in invasive plant colonization of transition zones; – Alteration of sensitive species habitat/range; – Alteration of overall water temperature (i.e. shallower waters result in higher temperature regimes)	■ Further Studies/ Class EAs should include the following tasks: – Conduct field investigations to determine existing conditions of potentially affected portions of aquatic/terrestrial habitat within proximity to Guelph Lake; – Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; – Provision of more detailed Impact Assessment; – Determination of Mitigation Measures specifically addressing impacts related to water drawdown; – Species at Risk Inventories targeting species sensitive to hydrologic changes; and – Amphibian surveys within wetland communities.
Other Water Source Alternatives	■ Conservation/Demand Management	■ Natural heritage features not affected.	■ No impacts to natural heritage features anticipated.	■ No further recommendations required
Other Water Source Alternatives	■ Limit Growth	■ This option applies to the entire study area.	■ May result in natural heritage feature impacts due to densification.	■ No further recommendations required
Other Water Source Alternatives	■ Do Nothing	■ Natural heritage features not affected.	■ No impacts to natural heritage features anticipated.	■ No further recommendations required

4. Mitigation Measures

The following general mitigation measures should be followed to minimize the potential significant impacts to the natural environment. These address all potential alternatives. More detailed measures should be determined during the Class EAs completed for the individual water supply projects included within the preferred solution and the subsequent Detailed Design phase of each project.

1. **Disruption of Baseflow** – Aside from water conservation, most of the mentioned alternatives rely on taking water from sources such as groundwater and surface water. The main associated potential impact is disruption of riverine/lacustrine baseflow. All alternatives should ensure that impacts to baseflow conditions are minimized to avoid adverse impacts to aquatic/wetland habitat whether it be from other sources or taking at specific times of year etc.
2. **Sedimentation –** There is a high potential for sedimentation within wetland/woodland communities and watercourses as a result of construction activities (i.e. pipe/well installation) where soils are disturbed. To minimize the potential for silt bearing water coming into natural heritage areas, a comprehensive sedimentation and erosion control strategy should be prepared which includes: timing windows for construction near watercourses (obtained from the Ministry of Natural Resources and Forestry and/or GRCA), sediment control fencing and restoration of disturbed areas/habitat etc.
3. **Dewatering Impacts During Construction –** During construction water levels during dewatering need to be maintained and discharge controlled so that it does not significantly alter the natural velocity of the receiving watercourse. A dewatering monitoring plan should be considered if sensitive features (e.g., wetlands) are located within the zone of influence of dewatering activities. Monitoring should include establishing baseline conditions, monitoring during and post dewatering activities to ensure there are no significant changes to potentially affected sensitive features. Associated potential impacts would be short term and not maintained following construction.
4. **Removal of Vegetation –** Proposed sites for wellfields/wells/facilities might require removal of vegetation. If required, a tree preservation plan should be prepared. For vegetation removed along the edge of a woodland, proper root pruning techniques should be utilized. Where

required, areas should be replanted with native species. Vegetation removal is prohibited during the bird nesting season from April 1 to August 31 of any year. Other timing windows for sensitive wildlife may also apply.

5. **Contamination of Soils –** During construction, ensure that fuel storage, refueling and maintenance of equipment are handled properly. Prohibit use of construction equipment within watercourses/waterbodies. Contingency plans must be prepared before projects begin for control and clean up of a spill if one should occur.

6. **Disturbance of Sensitive Species –** If determined that a sensitive species is present within a reasonable distance of a specific alternative, appropriate measures (i.e. transplant, avoidance, buffer determination) should be implemented to ensure their protection. Appropriate permits or authorization from the Ministry of the Environmental, Conservation and Parks (MECP) must be obtained if impacts cannot be avoided in confirmed SAR habitats.

7. **Spread of Invasive Species** – During construction, invasive species such as Common Reed (*Phragmites australis*) may be in advertently introduced or spread into sensitive habitats (e.g., PSWs). Machinery, equipment or vehicles should be cleaned in accordance with the *Clean Equipment Protocol for Industry – Inspecting and Cleaning Equipment for the Purposes of Invasive Species Prevention* (Halloran et al., 2016).

5. References

City of Guelph, 2018:
Natural Heritage Action Plan. Accessed January 2021 from: https://guelph.ca/wp-content/uploads/Recommended-Natural-Heritage-Action-Plan.pdf

City of Guelph, 2021:
City of Guelph Official Plan (June 2021 Consolidation). Accessed June 2021 from: https://guelph.ca/wp-content/uploads/Official-Plan-Consolidation-June-2021.pdf

Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage and A.R. Couturier (eds.). 2007:
Atlas of the Breeding Birds of Ontario, 2001-2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706 pp.

Dobbyn, J.S., 1994:
Atlas of the Mammals of Ontario. Ontario: Federation of Ontario Naturalists.

Dougan & Associates. 2005. City of Guelph Natural Heritage Strategy

Fisheries and Oceans Canada (DFO), 2021:
Aquatic Species at Risk map. Retrieved January 2021 from: https://www.dfo-mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html

Grand River Conservation Authority, 2006:
Information available on the Grand River Information Network on the internet at http://www.grandriver.ca

Halloran, J., H. Anderson, and D. Tassie, 2013:
Clean Equipment Protocol for Industry. Peterborough Stewardship Council and Ontario Invasive Plant Council. Peterborough, ON.

Hoffman, D.W. and B.C. Matthews, 1963:
Soil Survey of Wellington County Ontario: Report No. 35. Department of Agriculture and the Ontario Agricultural College

iNaturalist, 2021:
iNaturalist. Available Online : http://inaturalist.org. Accessed January 2021.

Ontario Ministry of Natural Resources and Forestry (MNRF), 2021:
Make-a-Map: Natural Heritage Areas Application. Website: http://www.giscoeapp.lrc.gov.on.ca/Mamnh/Index.html?site=MNR_NHLUPS_NaturalHeritage&viewer=NaturalHeritage&locale=en-US. January 2021.

Ontario Nature, 2019:
Ontario Reptile and Amphibian Atlas. Available Online: https://www.ontarionature.org/protect/species/herpetofaunal_atlas.php. Accessed January 2021.

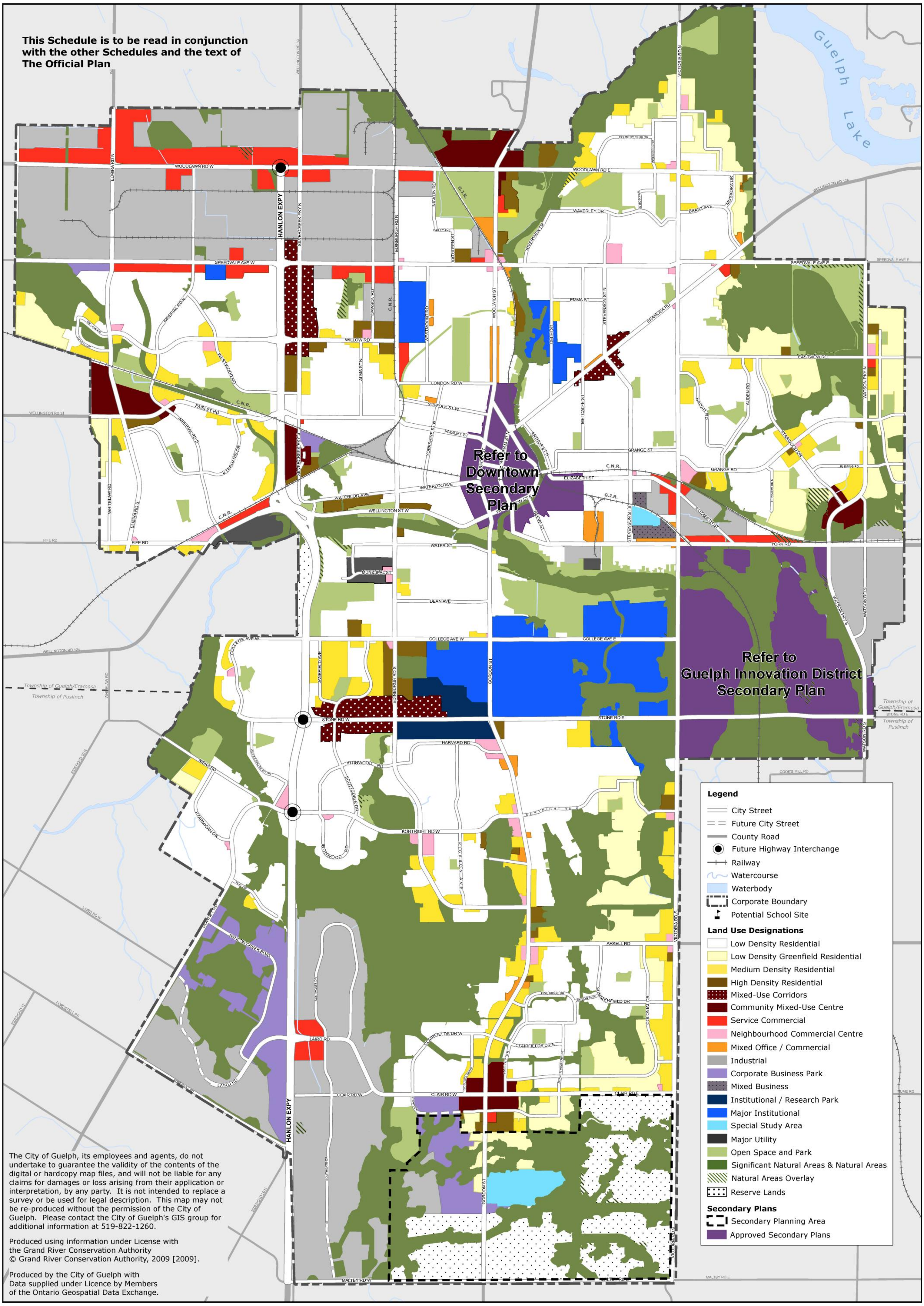
McNaughton, A., R. Layberry, R. Cavasin, B. Edwards and C. Jones, 2021:
Ontario Butterfly Atlas. Accessed January 2021 from: http://www.ontarioinsects.org/atlas_online.htm

Natural Heritage Information Centre (NHIC), 2001:
Information available on the NHIC data base available on the internet at http://www.mnr.gov.on.ca/MNR/nhic/nhic.html

Wellington, County of, 2005:
County of Wellington Official Plan (OPA February 12, 2013)

Wellington, County of:
Information available on the internet at http://www.county.wellington.on.ca/

Attachment A



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CITY OF GUELPH OFFICIAL PLAN

SCHEDULE 2: LAND USE PLAN

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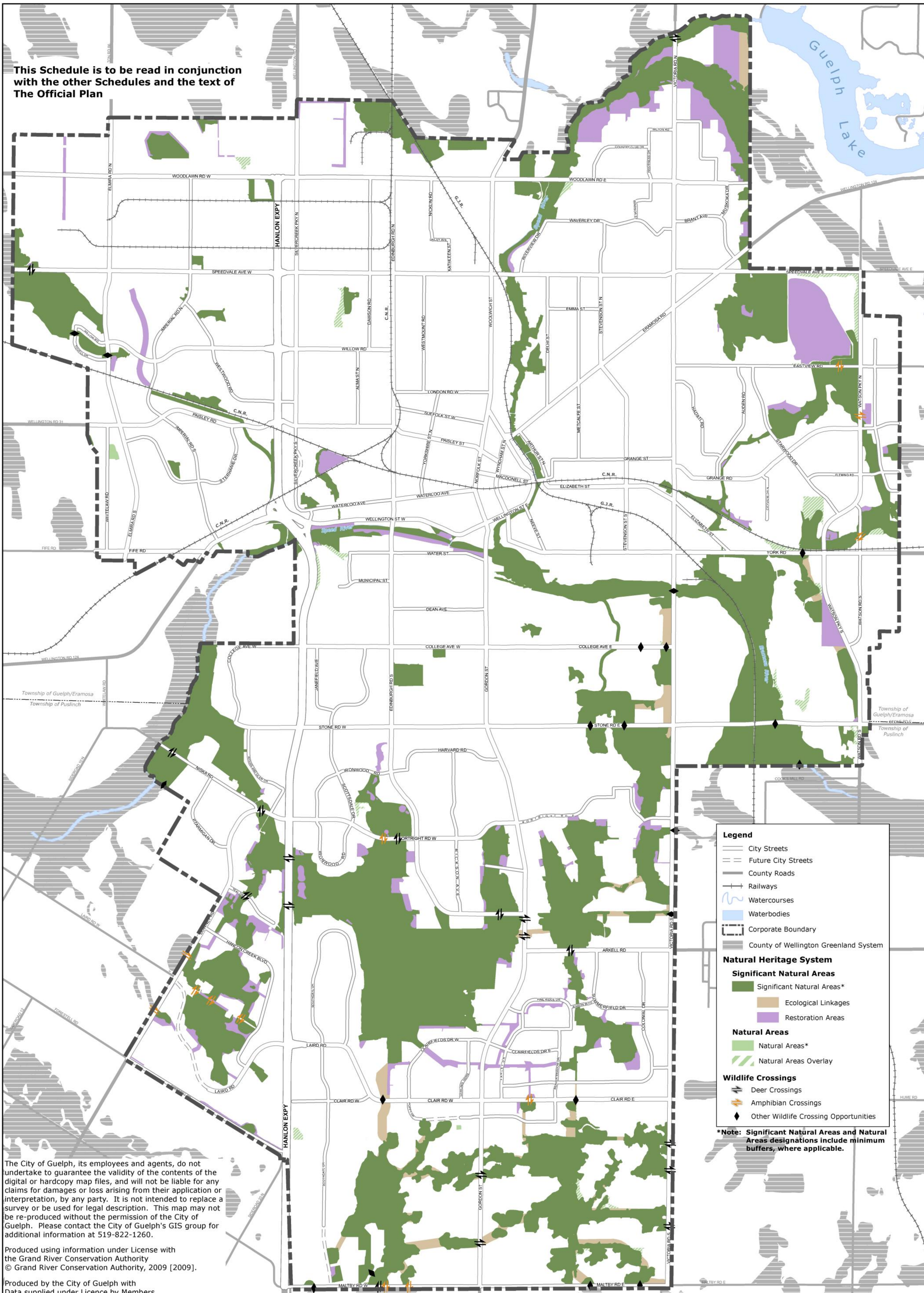

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SCHEDULE 4: NATURAL HERITAGE SYSTEM

Natural Heritage System

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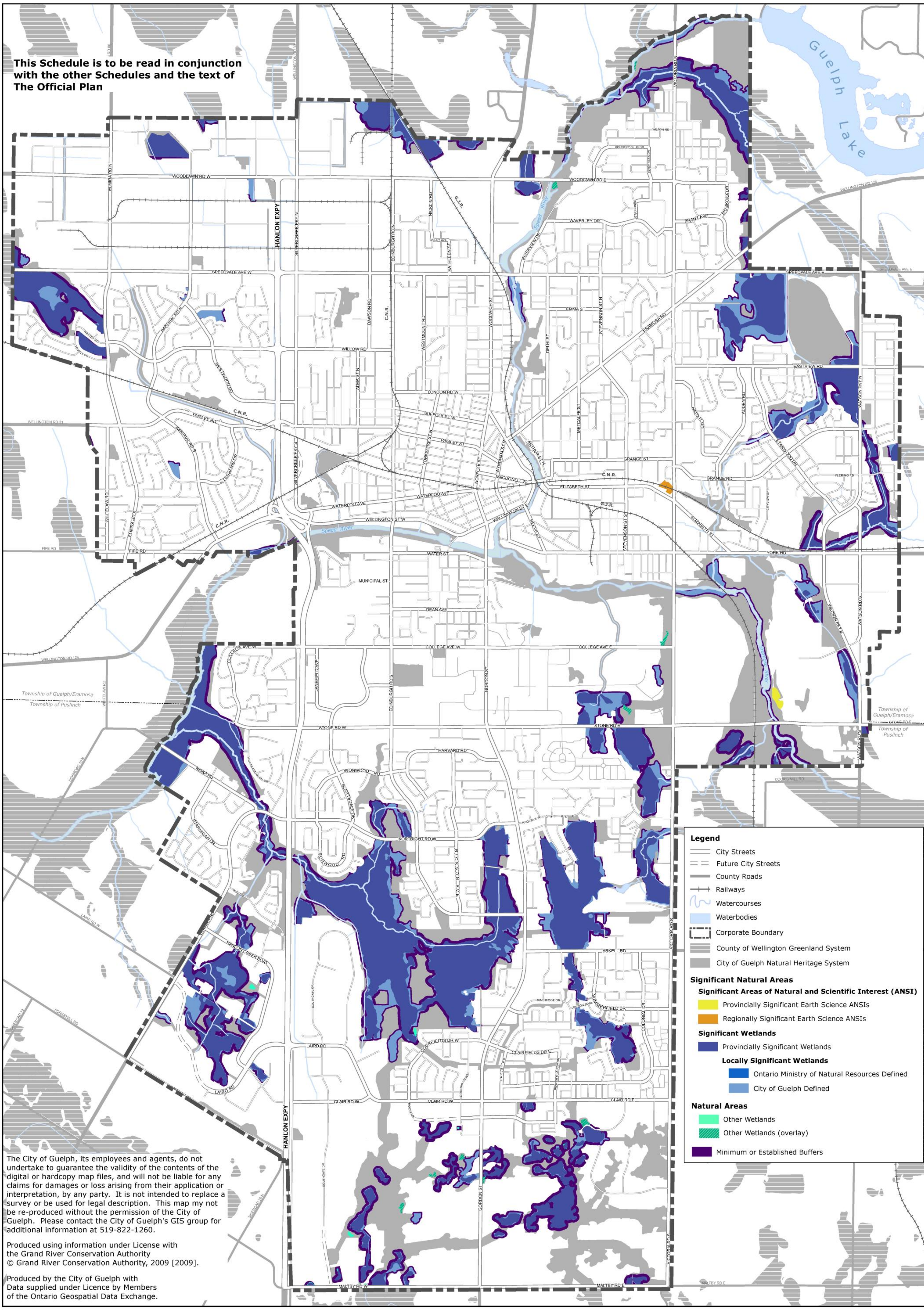

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SCHEDULE 4A: NATURAL HERITAGE SYSTEM

ANSIs and Wetlands

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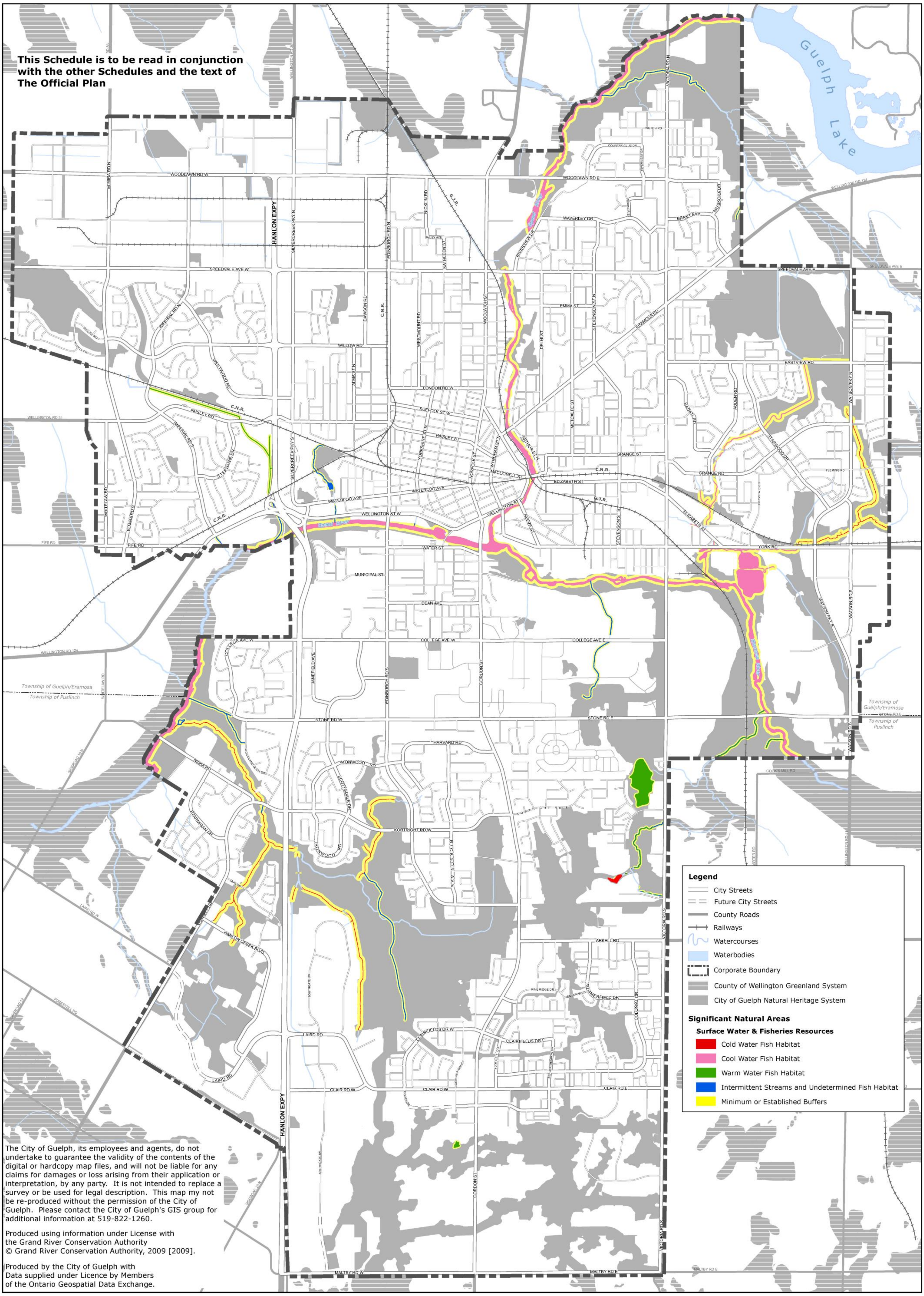

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SCHEDULE 4B: NATURAL HERITAGE SYSTEM

Surface Water and Fish Habitat

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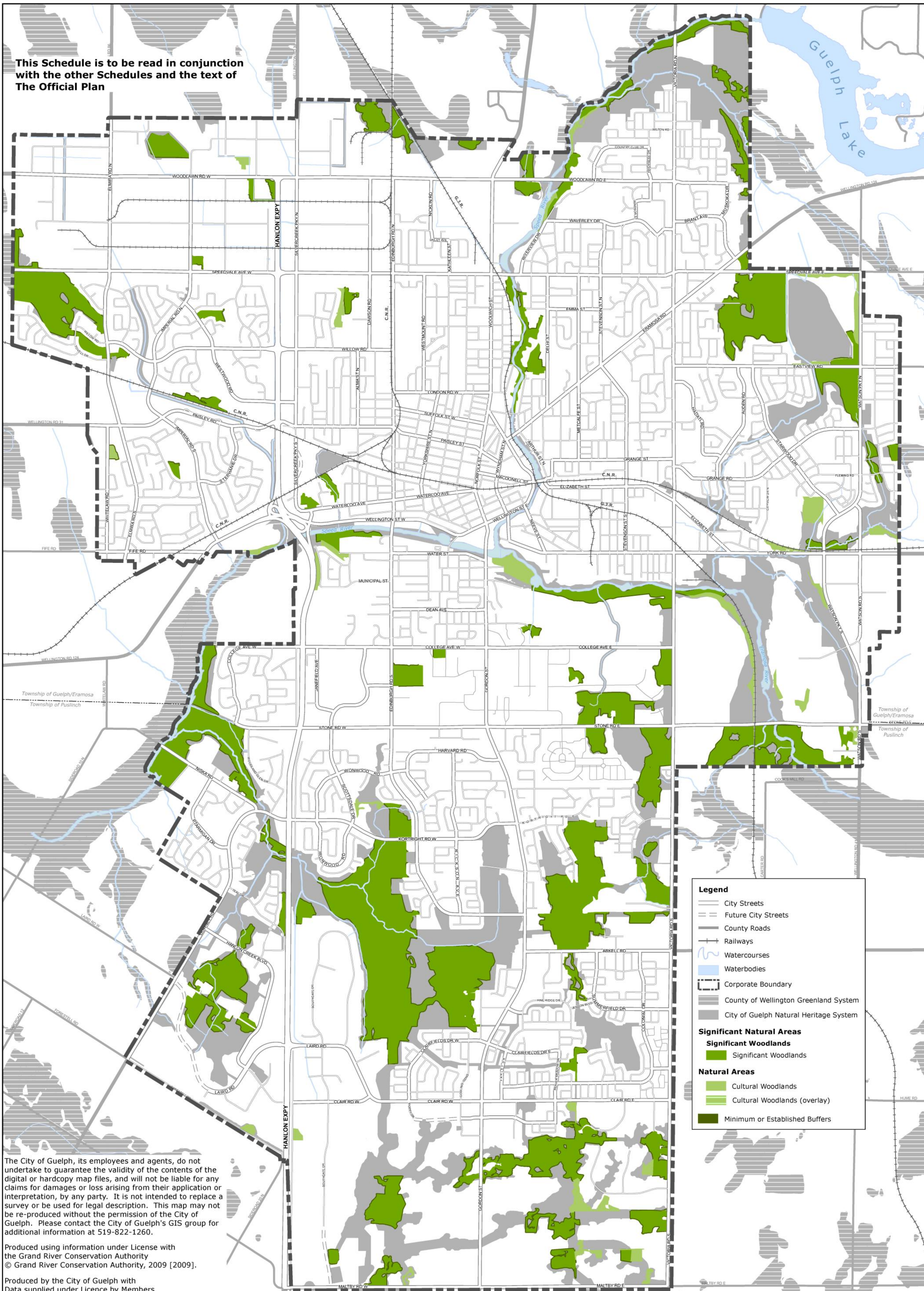
This Schedule is to be read in conjunction with the other Schedules and the text of The Official Plan



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SCHEDULE 4C: NATURAL HERITAGE SYSTEM

Significant Woodlands

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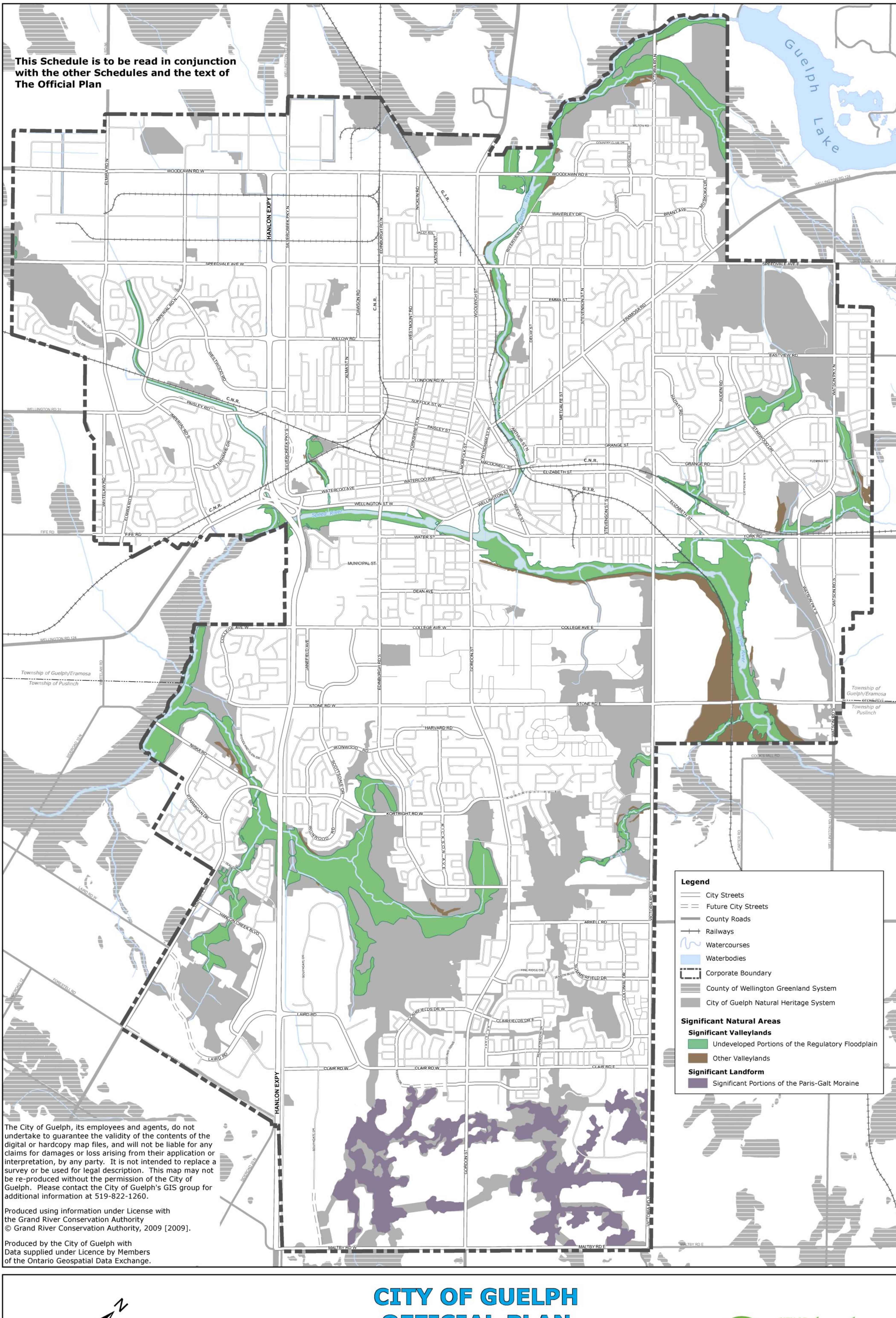

CITY OF GUELPH OFFICIAL PLAN

SCHEDULE 4D: NATURAL HERITAGE SYSTEM

Significant Valleylands & Significant Landform

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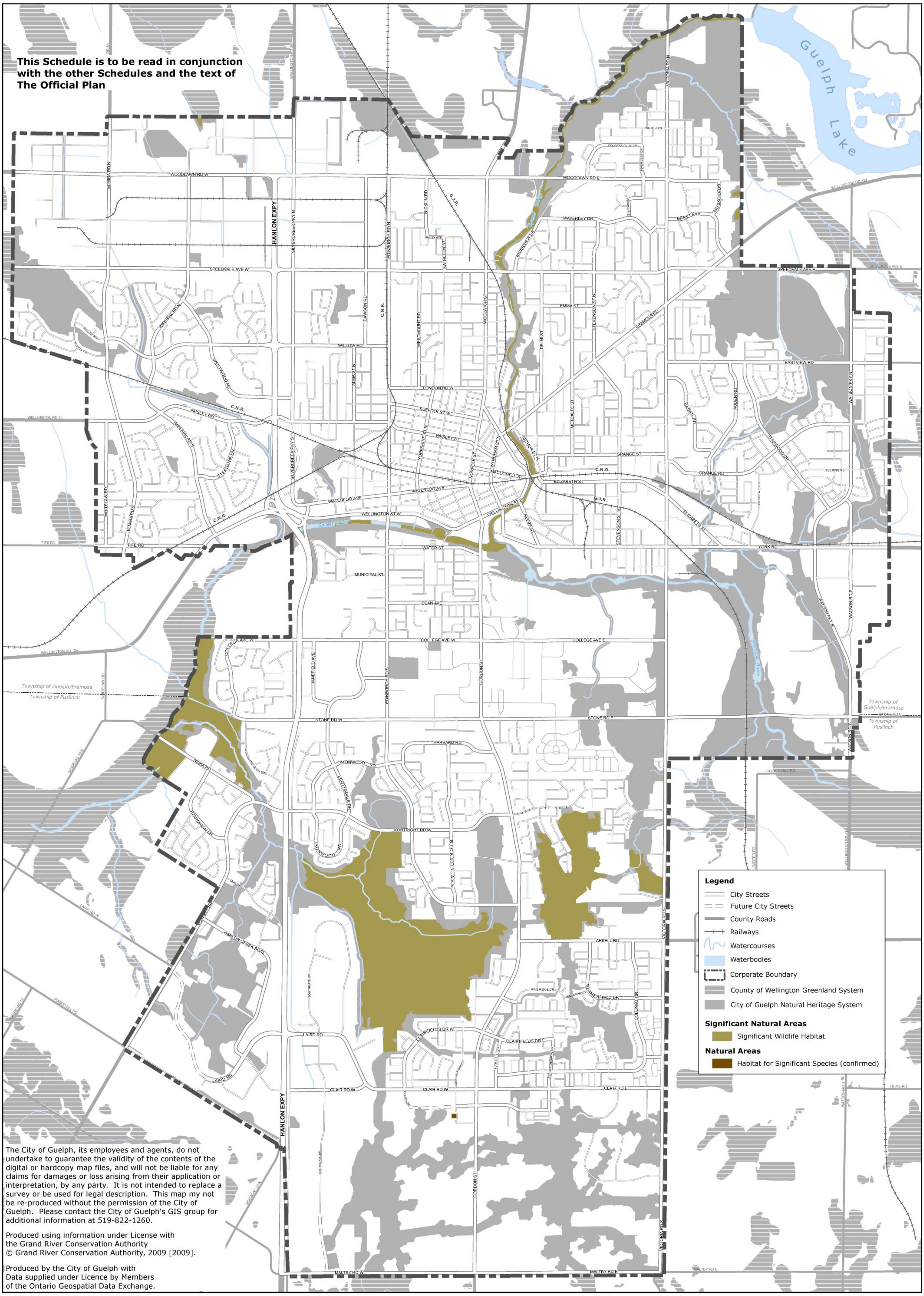

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SCHEDULE 4E: NATURAL HERITAGE SYSTEM

Significant Wildlife Habitat & Habitat for Significant Species

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Attachment B

Attachment B. Guelph Water Supply Master Plan Updated Study
Species at Risk Habitat Screening

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat	Known Species Range	Source Identifying Species Record
Plants	American Chestnut *Castanea dentata*	END	END Schedule 1	END	■ The American Chestnut prefers dryer upland deciduous forests with sandy, acidic to neutral soils. In Ontario, it is only found in the Carolinian Zone between Lake Erie and Lake Huron. The species grows alongside Red Oak, Black Cherry, Sugar Maple, American Beech and other deciduous tree species. ■ This species can typically be associated with the following ELC communities: **FOD** with dry sandy soil.	■ The American Chestnut has almost disappeared from eastern North America due to an epidemic caused by a fungal disease called the chestnut blight (Cryphonectria parasitica). In Canada, the American Chestnut is restricted primarily to southwestern Ontario. Based on information available in 2004, it was estimated that there are 120 to 150 mature trees and 1,000 or more small, young trees in the province.	■ NHIC
Reptiles	Butler's Gartersnake *Thamnophis butleri*	END	END Schedule 1	END	■ The Butler's Gartersnake prefers open, moist habitats, such as dense grasslands and old fields, with small wetlands where it can feed on leeches and earthworms. Burrows made by small mammals and even crayfish are sometimes used as hibernation sites, called hibernacula. This species is also commonly found in rock piles or old stonewalls. ■ This species can typically be associated with the following ELC communities: **CUM** and **MAM.**	■ The only place in the world where Butler's Gartersnake is found is in the lower Great Lakes region. In Ontario, this snake is concentrated in two areas: within 10 kilometres of the Detroit River, Lake St. Clair, the St. Clair River, and Lake Huron from Amherst Point to Errol, in Essex and Lambton counties and the Luther Marsh in Dufferin and Wellington counties. ■ Population sizes can vary. Estimates done at several sites in Ontario in 1997 ranged between 50 and 900 snakes. At some sites it is considered to be locally common.	■ NHIC
Plants	Butternut *Juglans cinerea*	END	END Schedule 1	END	■ In Ontario, Butternut usually grows alone or in small groups in deciduous forests. It prefers moist, well-drained soil and is often found along streams. It is also found on well-drained gravel sites and rarely on dry, rocky soil. This species does not do well in the shade, and often grows in sunny openings and near forest edges. ■ Butternut occurs primarily in neutral to calcareous soils of pH 5.5 to 8, often in regions with underlying limestone, and is generally absent from acidic regions. It tends to reach greatest abundance in rich well-drained mesic loams in floodplains, streambanks, terraces, and ravine slopes, but can occur in a wide range of other situations. In closed-canopy stands, it must be in the overstory to thrive. Seedling establishment, growth, and survival to maturity are most frequent in stand openings, riparian zones, and forest edges.	■ Butternut can be found throughout central and eastern North America. In Ontario, this species is found throughout the southwest, north to the Bruce Peninsula, and south of the Canadian Shield. ■ Butternut's native Canadian range is restricted to southern Ontario and Quebec (primarily south of the area bounded by Georgian Bay, the Ottawa Valley, and the Quebec City region), and western and southern portions of New Brunswick.	■ iNaturalist 2020
Mammals	Eastern Small-footed Myotis (Eastern Small-footed Bat) *Myotis leibii*	END	END Schedule 1	END	■ In the spring and summer, Eastern Small-footed Bats will roost in a variety of habitats, including in or under rocks, in rock outcrops, in buildings, under bridges, or in caves, mines, or hollow trees. These bats often change their roosting locations every day. At night, they hunt for insects to eat, including beetles, mosquitos, moths, and flies. In the winter, these bats hibernate, most often in caves and abandoned mines. They seem to choose colder and drier sites than similar bats and will return to the same spot each year.	■ The Eastern Small-footed Bat has been found from south of Georgian Bay to Lake Erie and east to the Pembroke area. There are also records from the Bruce Peninsula, the Espanola area, and Lake Superior Provincial Park. Most documented sightings are of bats in their winter hibernation sites.	■ Dobbyn, 1994
Plants	False Hop Sedge *Carex lupuliformis*	END	END Schedule 1	END	■ False Hop Sedge is most often grows in riverine swamps and marshes, and around temporary forest ponds. It prefers open areas and areas under forest canopy openings, with lots of sunlight. ■ This species can typically be associated with the following ELC communities: **SWD**, **MAM, MAS** along rivers and **FOD** with temporary forest ponds.	■ False Hop Sedge ranges from Florida and Texas north to Quebec and Ontario. In Ontario, seven occurrences are known to persist. In Quebec, there are three persisting populations and three populations that are being restored where False Hop Sedge is believed to have been extirpated. The largest populations occur in southern Ontario.	■ NHIC

Attachment B. Guelph Water Supply Master Plan Updated Study Species at Risk Habitat Screening

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat	Known Species Range	Source Identifying Species Record
Birds	Henslow's Sparrow *Ammodramus henslowii*	END	END Schedule 1	END	▪ In Ontario, the Henslow's Sparrow lives in open fields with tall grasses, flowering plants, and a few scattered shrubs. It has also been found in abandoned farm fields, pastures, and wet meadows. It tends to avoid fields that have been grazed or are crowded with trees and shrubs. It prefers extensive, dense, tall grasslands where it can more easily conceal its small ground nest. ▪ This species can typically be associated with the following ELC communities: **TPO**, **CUM**, and **MAM** that are a minimum of 30 ha in size with vegetation that is over 30 cm in height with a thick thatch layer and a lack of emergent woody vegetation.	▪ The Henslow's Sparrow breeds in the northeastern and east-central United States, and reaches its northeastern limit in Ontario. It was once fairly common in scattered areas of suitable habitat south of the Canadian Shield. However, steep declines since the 1960s have all but wiped this bird out as a breeding species in Ontario. A few are still seen each spring at migration hotspots such as Point Pelee National Park, and a few may breed at selected locations.	▪ NHIC
Amphibians	Jefferson Salamander *Ambystoma jeffersonianum*	END	END Schedule 1	END	▪ Adults live in moist, loose soil, under logs or in leaf litter. Your best chance of spotting a Jefferson salamander is in early spring when they travel to woodland ponds to breed. They lay their eggs in clumps attached to underwater vegetation. By midsummer, the larvae lose their gills and leave the pond and head into the surrounding forest. Once in the forest, Jefferson salamanders spend much of their time underground in rodent burrows, and under rocks and stumps. They feed primarily on insects and worms. ▪ This species can be associated with the following ELC code: **FOD** where permanent or temporary ponds or pools are present.	▪ In Canada, it is found only in southern Ontario, mainly along the Niagara Escarpment.	▪ NHIC
Mammals	Little Brown Myotis (Little Brown Bat) *Myotis lucifugus*	END	END Schedule 1	END	▪ Bats are nocturnal. During the day they roost in trees and buildings. They often select attics, abandoned buildings, and barns for summer colonies where they can raise their young. Bats can squeeze through very tiny spaces (as small as six millimetres across) and this is how they access many roosting areas. Little Brown Bats hibernate from October or November to March or April, most often in caves or abandoned mines that are humid and remain above freezing. ▪ Their specific physiological requirements limit the number of suitable sites for overwintering. In the east, large numbers (i.e., >3000 bats) of several species typically overwinter in relatively few hibernacula. In the west, there are fewer known hibernacula, and numbers appear lower per site. Females establish summer maternity colonies, often in buildings or large-diameter trees. Foraging occurs over water, along waterways, and forest edges. Large open fields or clearcuts generally are avoided. In autumn, bats return to hibernacula, which may be hundreds of kilometres from their summering areas, swarm near the entrance, mate, and then enter that hibernaculum, or travel to different hibernacula to overwinter.	▪ The Little Brown Bat is widespread in southern Ontario and found as far north as Moose Factory and Favourable Lake. ▪ In Canada, *Myotis lucifugus* occurs from Newfoundland to British Columbia, and northward to near the treeline in Labrador, Northwest Territories and Yukon.	▪ Dobbyn, 1994
Birds	Loggerhead Shrike *Lanius ludovicianus*	END	END Schedule 1	END	▪ In Ontario, the Loggerhead Shrike prefers pasture or other grasslands with scattered low trees and shrubs. It lives in fields or alvars (areas of exposed bedrock) with short grass, which makes it easier to spot prey. It builds its nest in small trees or shrubs and hunts by waiting patiently in tree branches until it swoops down and attacks its unsuspecting prey – usually large insects, such as grasshoppers. Loggerhead Shrikes also require spiny, multi-branched shrubs where they can impale prey before eating it. Barbed wired fencing can also be used for this. ▪ This species can typically be associated with the following ELC communities: **SWT**, **CUM**, **CUT**, **ALO** and **ALS**.	▪ The Loggerhead Shrike currently breeds in central and western North America. Until the 1970s, the Loggerhead Shrike could be found at many locations throughout southern Ontario and other parts of northeastern North America, but it has declined dramatically. Although the occasional bird is still found within the broader former range, most remaining Loggerhead Shrikes are now found in two core grassland habitats - the Carden Plain north of Lindsay, and the Napanee Limestone Plain. Every fall these birds migrate to the southern United States for the winter.	▪ NHIC

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Mammals	Northern Myotis (Northern Long-eared Bat) *Myotis septentrionalis*	END	END Schedule 1	END	■ Northern Long-eared Bats are associated with boreal forests, choosing to roost under loose bark and in the cavities of trees. These bats hibernate from October or November to March or April. ■ The Northern Long-eared Bat overwinters in cold and humid hibernacula (caves/mines). Their specific physiological requirements limit the number of suitable sites for overwintering. In the east, large numbers (i.e., >3000 bats) of several species typically overwinter in relatively few hibernacula. In the west, there are fewer known hibernacula, and numbers appear lower per site. Females establish summer maternity colonies in buildings or large-diameter trees. Foraging occurs along waterways, forest edges, and in gaps in the forest. Large open fields or clearcuts generally are avoided. In autumn, bats return to hibernacula, which may be hundreds of kilometres from their summering areas, swarm near the entrance, mate, and then enter that hibernaculum, or travel to different hibernacula to overwinter.	■ The Northern Long-eared Bat is found throughout forested areas in southern Ontario, to the north shore of Lake Superior and occasionally as far north as Moosonee, and west to Lake Nipigon. ■ In Canada, Myotis septentrionalis occurs from Newfoundland to British Columbia, and northward to near the treeline in Labrador, Northwest Territories, and Yukon.	■ Dobbyn, 1994
Birds	Prothonotary Warbler *Protonotaria citrea*	END	END Schedule 1	END	■ The Prothonotary is the only warbler in eastern North America that nests in tree cavities, where it typically lays four to six eggs on a cushion of moss, leaves, and plant fibres. ■ In Canada, this species breeds only in deciduous swamp forests or riparian floodplain forests. The forests it occupies are typically dominated by Silver Maple, ash, and Yellow Birch. The species nests in naturally formed tree cavities or cavities excavated by other species, mainly Downy Woodpeckers and chickadees. It favours small, shallow holes situated at low heights in dead or dying trees, in which it builds a nest lined with moss. Nests are typically situated over standing or slow-moving water. Artificial nest boxes are also readily accepted and perhaps even preferred. Males often build one or more incomplete “dummy” nests. Females usually select one of these to complete, but they may also build an entirely new nest on their own. In any case, several suitable cavities appear to be required in each territory to accommodate all of these nests.	■ In Canada, the Prothonotary Warbler is only known to nest in southwestern Ontario, primarily along the north shore of Lake Erie. Over half of the small and declining population is found in Rondeau Provincial Park. In Ontario, the Prothonotary Warbler is found in the warmer climate of the Carolinian deciduous forests. ■ This species is very rare in Canada, but is actively monitored by a combination of amateurs and professionals. Many occupied sites are prone to blinking on and off. This level of annual fluctuation makes it difficult to ascertain whether there has been a true change in occupied range, but such a change seems unlikely. Fewer than 10 locations are occupied in Canada in any given year (e.g., no more than 8 in 2015).	■ eBird
Fish	Redside Dace *Clinostomus elongatus*	END	END Schedule 1	END	■ The Redside Dace is found in pools and slow-moving areas of small streams and headwaters with a gravel bottom. They are generally found in areas with overhanging grasses and shrubs, and can leap up to 10 cm out of the water to catch insects. During spawning, they can be found in shallow parts of streams, which are also popular spawning areas for other minnow species. ■ This species can be associated with the following ELC communities: **OAO, SA** stream communities with gravel substrates and overhanging grasses and shrubs.	■ In Canada, Redside Dace are found in a few tributaries of Lake Huron, in streams flowing into western Lake Ontario, the Holland River (which flows into Lake Simcoe), and Irvine Creek of the Grand River system (which flows into Lake Erie).	■ NHIC
Insects	Rusty-patched Bumble Bee *Bombus affinis*	END	END Schedule 1	END	■ This species, like other bumble bees, can be found in open habitat such as mixed farmland, urban settings, savannah, open woods and sand dunes. The most recent sightings have been in oak savannah, which contains both woodland and grassland flora and fauna. ■ This species can typically be associated with the following ELC communities: **CUM, TPO, TPS, TPW, CUS, SDO, SDS** and **SDT**.	■ The Rusty-patched Bumble Bee was once widespread and common in eastern North America, found from southern Ontario south to Georgia and west to the Dakotas. ■ The species has suffered rapid, severe decline throughout its entire range since the 1970s with only a handful of specimens collected in recent years in Ontario. The only sightings of this bee in Canada since 2002 have been at The Pinery Provincial Park on Lake Huron.	■ NHIC

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Mammals	Tri-colored Bat *Perimyotis subflavus*	END	END Schedule 1	END	■ During the summer, the Tri-colored Bat is found in a variety of forested habitats. It forms day roosts and maternity colonies in older forest and occasionally in barns or other structures. They forage over water and along streams in the forest. Tri-colored Bats eat flying insects and spiders gleaned from webs. At the end of the summer they travel to a location where they swarm; it is generally near the cave or underground location where they will overwinter. They overwinter in caves where they typically roost by themselves rather than part of a group. ■ The Tri-colored Bat overwinters in cold and humid hibernacula (caves/mines). Their specific physiological requirements limit the number of suitable sites for overwintering. In the east, large numbers (i.e., >3000 bats) of several species typically overwinter in relatively few hibernacula. In the west, there are fewer known hibernacula, and numbers appear lower per site. Females establish summer maternity colonies in buildings or large-diameter trees. Foraging occurs over water, along waterways, and forest edges. Large open fields or clearcuts generally are avoided. In autumn, bats return to hibernacula, which may be hundreds of kilometres from their summering areas, swarm near the entrance, mate, and then enter that hibernaculum, or travel to different hibernacula to overwinter.	■ This bat is found in southern Ontario and as far north as Espanola near Sudbury. Because it is very rare, it has a scattered distribution. It is also found from eastern North America down to Central America. ■ In Canada, *Perimyotis subflavus* occurs in Nova Scotia, New Brunswick, Quebec, and Ontario.	■ Dobbyn, 1994
Birds	Yellow-breasted Chat *Icteria virens*	END	END Schedule 1	END	■ The Yellow-breasted Chat lives in thickets and scrub, especially locations where clearings have become overgrown. These birds spend their winters in coastal marshes. ■ This species can typically be associated with the following ELC communities: **CUW** and **CUT**.	■ The Yellow-breasted Chat is found in much of the United States. In Canada, it lives in southern British Columbia, the Prairies, and southwestern Ontario, where it is concentrated in Point Pelee National Park and Pelee Island in Lake Erie.	■ NHIC
Birds	Barn Swallow *Hirundo rustica*	THR	THR	THR	■ Barn Swallows often live in close association with humans, building their cup-shaped mud nests almost exclusively on human-made structures such as open barns, under bridges and in culverts. The species is attracted to open structures that include ledges where they can build their nests, which are often re-used from year to year. They prefer unpainted, rough-cut wood, since the mud does not adhere as well to smooth surfaces. ■ This species can typically be associated with the following ELC communities: **TPO**, **CUM1**, **MAM**, **MAS**, **OAO**, **SAS1**, **SAM1**, **SAF1**; containing or adjacent structures that are suitable for nesting.	■ The Barn Swallow may be found throughout southern Ontario and can range as far north as Hudson Bay, wherever suitable locations for nests exist.	■ NHIC, Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, iNaturalist 2020, eBird
Fish	Black Redhorse *Moxostoma duquesnei*	THR	THR Schedule 1	THR	■ In Ontario, the Black Redhorse lives in pools and riffle areas of medium-sized rivers and streams that are usually less than two metres deep. These rivers usually have few aquatic plants, a moderate to fast current, and a sandy or gravel bottom. In the spring, it migrates to breeding habitat where eggs are laid on gravel in fast water. The winter is spent in deeper pools. Adults feed on crustaceans and aquatic insects, while the young fish feed on plankton. ■ This species can typically be associated with the following ELC communities: **SA** and **OAO**; in pools and riffles of medium sized rivers and streams less than two meters in depth with few aquatic plants, a moderate to fast current and a sandy or gravel bottom.	■ In Canada, the Black Redhorse is found only in southwestern Ontario at a few locations in the Bayfield River, Maitland River, Ausable River, Grand River, Thames River, and Spencer Creek watersheds.	■ NHIC

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Reptiles	Blanding's Turtle *Emydoidea blandingii*	THR	THR Schedule 1	THR	■ Blanding's Turtles live in shallow water, usually in large wetlands and shallow lakes with lots of water plants. It is not unusual, though, to find them hundreds of metres from the nearest water body, especially while they are searching for a mate or traveling to a nesting site. Blanding's Turtles hibernate in the mud at the bottom of permanent water bodies from late October until the end of April. ■ This species can typically be associated with the following ELC communities: **SWT2**, **SWT3**, **SWD**, **SWM**, **MAS2**, **SAS1**, **SAM1**, where open water is present.	■ The Blanding's Turtle is found in and around the Great Lakes Basin, with isolated populations elsewhere in the United States and Canada. In Canada, the Blanding's Turtle is separated into the Great Lakes-St. Lawrence population and the Nova Scotia population. Blanding's Turtles can be found throughout southern, central and eastern Ontario.	■ NHIC, ORAA
Birds	Bobolink *Dolichonyx oryzivorus*	THR	THR Schedule 1	THR	■ Historically, Bobolinks lived in North American tallgrass prairie and other open meadows. With the clearing of native prairies, Bobolinks moved to living in hayfields. Bobolinks often build their small nests on the ground in dense grasses. ■ Both parents usually tend to their young, sometimes with a third Bobolink helping. ■ This species can typically be associated with the following ELC communities: **TPO**, **TPS**, **CUM1** and **MAM2**.	■ The Bobolink breeds across North America. In Ontario, it is widely distributed throughout most of the province south of the boreal forest, although it may be found in the north where suitable habitat exists.	■ NHIC, Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, eBird
Birds	Chimney swift *Chaetura pelagica*	THR	THR Schedule 1	THR	■ Before European settlement Chimney Swifts mainly nested on cave walls and in hollow trees or tree cavities in old growth forests. Today, they are more likely to be found in and around urban settlements where they nest and roost (rest or sleep) in chimneys and other manmade structures. They also tend to stay close to water as this is where the flying insects they eat congregate. ■ Foraging habitat for this species can be associated with the following ELC codes: **TPO**, **CUM1**, **MAM**, **MAS**, **OAO**, **SAS1**, **SAM1**, **SAF1** containing or adjacent structures with suitable nesting habitat (i.e. chimneys).	■ The Chimney Swift breeds in eastern North America, possibly as far north as southern Newfoundland. In Ontario, it is most widely distributed in the Carolinian zone in the south and southwest of the province, but has been detected throughout most of the province south of the 49th parallel. It winters in northwestern South America.	■ Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, iNaturalist 2020, ebird
Birds	Eastern Meadowlark *Sturnella magna*	THR	THR Schedule 1	THR	■ Eastern Meadowlarks breed primarily in moderately tall grasslands, such as pastures and hayfields, but are also found in alfalfa fields, weedy borders of croplands, roadsides, orchards, airports, shrubby overgrown fields, or other open areas. ■ Small trees, shrubs or fence posts are used as elevated song perches. ■ This species can typically be associated with the following ELC communities: **TPO**, **TPS**, **CUM1**, **CUS, MAM2** and **MAS2** with elevated song perches.	■ In Ontario, the Eastern Meadowlark is primarily found south of the Canadian Shield but it also inhabits the Lake Nipissing, Timiskaming and Lake of the Woods areas.	■ NHIC, Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, iNaturalist 2020, eBird
Birds	Least Bittern *Ixobrychus exilis*	THR	THR Schedule 1	THR	■ In Ontario, the Least Bittern is found in a variety of wetland habitats, but strongly prefers cattail marshes with a mix of open pools and channels. This bird builds its nest above the marsh water in stands of dense vegetation, hidden among the cattails. The nests are almost always built near open water, which is needed for foraging. This species eats mostly frogs, small fish, and aquatic insects. ■ This species can typically be associated with the following ELC communities: **MAS2-1**, **MAS3-1**, **SA** and **OAO**.	■ In Ontario, the Least Bittern is mostly found south of the Canadian Shield, especially in the central and eastern part of the province. Small numbers also breed occasionally in northwest Ontario. This species has disappeared from much of its former range, especially in southwestern Ontario, where wetland loss has been most severe. In winter, Least Bitterns migrate to the southern United States, Mexico and Central America.	■ NHIC, Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, iNaturalist 2020

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Fish	Silver Shiner *Notropis photogenis*	THR	THR Schedule 1	THR	■ Silver Shiners prefer moderate to large size streams with swift currents that are free of weeds and have clean gravel or boulder bottoms. They live in schools and feed on crustaceans and adult flies that fall in the water or fly just above the surface. In June or July, they spawn by scattering their eggs over gravel riffles. ■ This species can typically be associated with the following ELC communities: **OAO** characterized as moderate to large streams with swift currents, no weeds and gravel or boulder substrates.	■ The Silver Shiner range includes east-central North America throughout the Ohio and Tennessee River drainage basins. In Ontario, it is found in the Thames and Grand Rivers, and in Bronte Creek and Sixteen Mile Creek, which flow into Lake Ontario.	■ NHIC
Birds	Eastern Whip-poor-will *Antrostomus vociferus*	THR	THR Schedule 1	THR	■ The Eastern Whip-poor-will is usually found in areas with a mix of open and forested areas, such as savannahs, open woodlands, or openings in more mature deciduous, coniferous, and mixed forests. It forages in these open areas and uses forested areas for roosting (resting and sleeping) and nesting. It lays its eggs directly on the forest floor, where its colouring means it will easily remain undetected by visual predators. ■ Whip-poor-will breeding habitat is not dependent upon species composition, but rather on forest structure, although common tree associations in both summer and winter are pine and oak. The species shuns both wide-open spaces and dense forest. It prefers to nest in semi-open forests or patchy forests with clearings, such as barrens or forests that are regenerating following major disturbances. Other necessary breeding habitat elements are thought to involve ground-level vegetation and woodland size. Individuals will often feed in nearby shrubby pastures or wetlands with perches. Areas with decreased light levels where forest canopies are closed are generally not occupied, perhaps because of reduced forage success for this aerial-feeding insectivore.	■ The Eastern Whip-poor-will's breeding range includes two widely separate areas. It breeds throughout much of eastern North America, reaching as far north as southern Canada. In Ontario they breed as far north as the shore of Lake Superior. ■ Although Eastern Whip-poor-wills were once widespread throughout the central Great Lakes region of Ontario, their distribution in this area is now fragmented.	■ eBird
Birds	Bald Eagle *Haliaeetus leucocephalus*	SC	No Status	Not at Risk	■ Bald Eagles nest in a variety of habitats and forest types, almost always near a major lake or river where they do most of their hunting. While fish are their main source of food, Bald Eagles can easily catch prey up to the size of ducks, and frequently feed on dead animals, including White-tailed Deer. They usually nest in large trees such as pine and poplar. ■ During the winter, Bald Eagles sometimes congregate near open water such as the St. Lawrence River, or in places with a high deer population where carcasses might be found. ■ This species can typically be associated with the following ELC communities: **FOC**, **FOM**, **FOD**, **SWC**, **SWM** and **SWD**. Nests typically located near major bodies of water.	■ Bald Eagles are widely distributed throughout North America. In Ontario, they nest throughout the north, with the highest density in the northwest near Lake of the Woods. Historically they were also relatively common in southern Ontario, especially along the shore of Lake Erie, but this population was all but wiped out 50 years ago. After an intensive re-introduction program and environmental clean-up efforts, the species has rebounded and can once again be seen in much of its former southern Ontario range.	■ NHIC, eBird
Birds	Black Tern *Chlidonias niger*	SC	No Status	Not at Risk	■ Black Terns build floating nests in loose colonies in shallow marshes, especially in cattails. In winter they migrate to the coast of northern South America. ■ Nesting habitat for this species can be associated with the following ELC communities: **MAS2-1** and **OAO**. These two communities must be present immediately adjacent each other and with sufficient water to provide suitable habitat.	■ In Ontario, Black Terns are found scattered throughout the province, but breed mainly in the marshes along the edges of the Great Lakes.	■ NHIC

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Birds	Canada Warbler *Wilsonia canadensis*	SC	THR Schedule 1	THR	▪ The Canada Warbler breeds in a range of deciduous and coniferous, usually wet forest types, all with a well- developed, dense shrub layer. Dense shrub and understory vegetation help conceal Canada Warbler nests that are usually located on or near the ground on mossy logs or roots, along stream banks or on hummocks. ▪ This species can typically be associated with the following ELC communities: **FOC3**, **FOC4**, **FOM6**, **FOM7**, **FOM8**, **FOD6**, **FOD7**, **FOD8**, **FOD9**, **SWC**, **SWM** and **SWD** with a well-developed shrub layer.	▪ The Canada Warbler only breeds in North America and 80 per cent of its known breeding range is in Canada. Its primary breeding range is in the Boreal Shield, extending north into the Hudson Plains and south into the Mixedwood Plains. Although the Canada Warbler breeds at low densities across its range, in Ontario, it is most abundant along the Southern Shield.	▪ Ontario Breeding Bird Atlas ▪ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, iNaturalist 2020, eBird
Birds	Common Nighthawk *Chordeiles minor*	SC	THR Schedule 1	SC	▪ Traditional Common Nighthawk habitat consists of open areas with little to no ground vegetation, such as logged or burned-over areas, forest clearings, rock barrens, peat bogs, lakeshores, and mine tailings. Although the species also nests in cultivated fields, orchards, urban parks, mine tailings and along gravel roads and railways, they tend to occupy natural sites. ▪ This species can typically be associated with the following ELC communities: **SD**, **BB**, **RB**, **CUM**, **BO**, **FOM**, **FOC** and **FOD** with openings with little vegetation.	▪ The range of the Common Nighthawk spans most of North and Central America. In Canada, the species is found in all provinces and territories except Nunavut. In Ontario, the Common Nighthawk occurs throughout the province except for the coastal regions of James Bay and Hudson Bay. It winters in South America where it is concentrated in Peru, Ecuador and Brazil.	▪ Ontario Breeding Bird Atlas ▪ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
Reptiles	Eastern Ribbonsnake *Thamnophis sauritus*	SC	SC Schedule 1	SC	▪ The Eastern Ribbonsnake is usually found close to water, especially in marshes, where it hunts for frogs and small fish. A good swimmer, it will dive in shallow water, especially if it is fleeing from a potential predator. At the onset of cold weather, these snakes congregate in underground burrows or rock crevices to hibernate together. ▪ This species can typically be associated with the following ELC communities: **FOC**, **FOM**, **FOD**, **SWC**, **SWM**, **SWD**, **MAM**, **MAS**, **OAO**, **SAS**, **SAM** and **SAF** containing or near year round standing or flowing water.	▪ The Eastern Ribbon Snake is found from southern Ontario west to Michigan and Wisconsin (isolated pockets), south to Illinois and Ohio, and east to New York State and Nova Scotia, where there is an isolated population. In Ontario, this snake occurs throughout southern and eastern Ontario and is locally common in parts of the Bruce Peninsula, Georgian Bay and eastern Ontario.	▪ NHIC, ORAA
Birds	Golden-winged Warbler *Vermivora chrysoptera*	SC	THR Schedule 1	THR	▪ Golden-winged Warblers prefer to nest in areas with young shrubs surrounded by mature forest – locations that have recently been disturbed, such as field edges, hydro or utility right-of-ways, or logged areas. ▪ In their breeding areas, Golden-winged Warblers seem to be fond of regeneration zones where young shrubs grow, surrounded by mature forest, and characterized by plant succession of 10 to 30 years. The warblers frequent clusters of herbaceous plants and low bushes (where they place their nests, which are built on the ground). They favour environments where the trees are spread out, as well as the forest edge, and use this setting for perching, singing, and looking for food. Golden-winged Warblers are found in dry uplands, swamp forests, and marshes. This warbler shows a preference for beaver ponds and burned-out or intermittently cultivated areas.	▪ The Golden-winged Warbler is found in southern Saskatchewan, Manitoba, Ontario, and Quebec, as well as the north-eastern United States. In Ontario, these birds breed in central-eastern Ontario, as far south as Lake Ontario and the St. Lawrence River, and as far north as the northern edge of Georgian Bay. Golden-winged Warblers have also been found in the Lake of the Woods area near the Manitoba border, and around Long Point on Lake Erie. ▪ Golden-winged Warblers nest primarily in the northeastern United States, southeastern Saskatchewan, southwestern Manitoba, southwestern Ontario and far southwestern Quebec. In Ontario, they breed from the far southwest of the province north as far as the centre of the Nipissing region, the southern part of the Sudbury and Algoma districts, and the southwest part of the Rainy River district, near Lake of the Woods.	▪ eBird

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Birds	Grasshopper Sparrow *Ammodramus savannarum* Grasshopper Sparrow (pratensis subspecies; Eastern Grasshopper Sparrow) *Ammodramus savannarum pratensis*	SC	SC Schedule 1	SC	■ It lives in open grassland areas with well-drained, sandy soil. It will also nest in hayfields and pasture, as well as alvars, prairies, and occasionally grain crops such as barley. It prefers areas that are sparsely vegetated. Its nests are well-hidden in the field and woven from grasses in a small cup-like shape. The Grasshopper Sparrow is a short-distance migrant and leaves Ontario in the fall to migrate to the southeastern United States and Central America for the winter. ■ In Canada, the Eastern Grasshopper Sparrow typically breeds in large human-created grasslands (5 ha or greater), such as pastures and hayfields, and natural prairies, such as alvars, characterized by well-drained, often poor soil dominated by relatively low, sparse perennial herbaceous vegetation.	■ The Grasshopper Sparrow can be found throughout southern Ontario, but only occasionally on the Canadian Shield. It is most common where grasslands, hay, or pasture dominate the landscape. ■ In Canada, the breeding range of the Eastern Grasshopper Sparrow includes extreme southern Québec and southern Ontario, with the vast majority of birds occurring in Ontario.	■ eBird
Plants	Hart's-tongue Fern *Asplenium scolopendrium americanum*	SC	THR Schedule 1	No Status	■ Hart's-tongue Fern grows on calcareous rocks in deep shade on slopes in deciduous forest. Most Ontario occurrences are in maple-beech forest. Established plants can grow in exposed, rocky crevices and on outcrops, but moist, mossy areas seem to be essential for spore germination and early plant development. ■ This species can typically be associated with the following ELC communities: **FOD** and **FOD5-2** with exposed calcareous rock.	■ Hart's-tongue Ferns are found at sites in New York, Michigan, Tennessee, Alabama, Ontario, Oaxaca, Chiapas and Hispaniola. Ontario has the bulk of populations north of Mexico. In this province the fern has been reported at more than 100 sites, mostly on the Niagara Escarpment, with about 75 of these believed to still exist.	■ NHIC
Plants	Hill's Pondweed *Potamogeton hillii*	SC	SC Schedule 1	SC	■ Hill's Pondweed is found in slow-moving streams, ditches, ponds, lakes and wetlands. It grows in clear, cold alkaline waters. ■ This species can typically be associated with the following ELC communities: **SA** and **OAO** that clear, cold, slow flowing and alkaline.	■ Hill's Pondweed grows in northeastern United States and Ontario, ranging from Wisconsin, Michigan and Ontario south to south-central Pennsylvania and western Viriginia, and east to Vermont, Massachusetts and Connecticut. In Ontario, it has been recorded at 26 sites in the Bruce Peninsula, Manitoulin Island, Wellington County and Peel Region. Only about 14 of these are presumed to still support Hill's Pondweed.	■ NHIC
Birds	Horned Grebe (Western population) *Podiceps auritus*	SC	SC Schedule 1	SC	■ The Horned Grebe usually nests in small ponds, marshes, and shallow bays that contain areas of open water and emergent vegetation. Nests are usually located within a few metres of open water. The Horned Grebe occupies natural habitat more often than man-made reservoirs and artificial ponds. ■ The Horned Grebe breeds primarily in temperate zones such as the Prairies and Parkland Canada, but can also be found in more boreal and subarctic zones. It generally breeds in freshwater and occasionally in brackish water on small semi-permanent or permanent ponds, but it also uses marshes and shallow bays on lake borders. Breeding areas require open water rich in emerging vegetation, which provides nest materials, concealment and anchorage, and protection for the young.	■ The Horned Grebe is found across North America. Most of its North American breeding range is located in Canada, extending from northwestern Ontario to British Columbia and north to Alaska (Western population). The Horned Grebe is a rare breeder in Ontario. Following the breeding season, most individuals migrate from inland freshwater nesting sites to coastal marine sites, although some individuals overwinter on large bodies of freshwater. ■ It breeds in British Columbia, Yukon, the Mackenzie River Valley in the Northwest Territories, the extreme southern part of Nunavut, all of the Prairies, northwestern Ontario, and the Magdalen Islands (Quebec), where a small isolated population has been breeding for at least a century. Most of the North American population winters along the coasts of the continent.	■ iNaturalist, 2020
Reptiles	Milksnake *Lampropeltis triangulum*	No Status	SC Schedule 1	SC	■ The Milksnake can be found in a range of habitats including rocky outcrops, fields and forest edges. In southern Ontario, it is often found in old farm fields and farm buildings where there is an abundance of mice. The Milksnake hibernates underground, in rotting logs or in the foundations of old buildings. ■ This species can be associated with the following ELC communities: **BL, TA, AL, RB, TP, CUM, FOC, FOM** and **FOD.**	■ The Milksnake range extends from Quebec and Maine south to Alabama and Georgia, and west to Minnesota and Iowa. In Ontario, it is widespread and locally common in southern Ontario, and can be found as far north as Lake Nipissing and Sault Ste. Marie.	■ NHIC

Attachment B. Guelph Water Supply Master Plan Updated Study Species at Risk Habitat Screening

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat	Known Species Range	Source Identifying Species Record
Reptiles	Northern Map Turtle *Graptemys geographica*	SC	SC Schedule 1	SC	■ The Northern Map Turtle inhabits rivers and lakeshores where it basks on emergent rocks and fallen trees throughout the spring and summer. In winter, the turtles hibernate on the bottom of deep, slow-moving sections of river. They require high quality water that supports the female's mollusc prey. Their habitat must contain suitable basking sites, such as rocks and deadheads, with an unobstructed view from which a turtle can drop immediately into the water if startled. ■ This species can typically be associated with the following ELC communities: **OAO**, **SA** with emergent rocks and fallen trees suitable habitat for prey.	■ Appalachian mountain barrier. There are isolated populations in New Jersey and New York states. In Canada, it is found in southwestern Quebec and southern Ontario. In southern Ontario, it lives primarily on the shores of Georgian Bay, Lake St. Clair, Lake Erie and Lake Ontario, and along larger rivers including the Thames, Grand and Ottawa.	■ NHIC
Birds	Olive-sided Flycatcher *Contopus cooperi*	SC	THR Schedule 1	SC	■ The Olive-sided Flycatcher is most often found along natural forest edges and openings. It will use forests that have been logged or burned if there are ample tall snags and trees to use for foraging perches. Olive-sided Flycatchers' breeding habitat usually consists of coniferous or mixed forest adjacent to rivers or wetlands. In Ontario, Olive-sided Flycatchers commonly nest in conifers such as White and Black Spruce, Jack Pine, and Balsam Fir. ■ The Olive-sided Flycatcher is most often associated with open areas containing tall live trees or snags for perching. These vantage points are required for foraging. This species generally forages from a high, prominent perch from which it sallies forth to intercept flying insects and then returns to the same perch. Open areas may be forest clearings, forest edges located near natural openings (such as rivers or swamps) or human-made openings (such as logged areas), burned forest, or openings within old-growth forest stands; these forests are characterized by mature trees and large numbers of dead trees. There is evidence that the breeding success of birds nesting in harvested habitats is lower than the breeding success of birds nesting in natural openings. In the boreal forest, suitable habitat is more likely to be in or near wetland areas. Although the amount of old-growth forest obviously decreased during the 20th century, the amount of habitat attractive to Olive-sided Flycatchers may have remained more or less constant, since logging operations continue to create openings favoured by these birds. However, recent studies indicate that these sites are less suitable for breeding.	■ The Olive-sided Flycatcher has a broad breeding range across Canada and the western and northeastern United States. Just over half the range is found in Canada, where it breeds in every province and territory except Nunavut. In Ontario, it is widely distributed throughout the central and northern areas of the province.	■ iNaturalist, 2014, eBird
Birds	Peregrine Falcon *Falco peregrinus* Peregrine Falcon (anatum/tundrius) *Falco peregrinus anatum/tundrius*	SC	SC Schedule 1	No Status	■ Peregrine Falcons usually nest on tall, steep cliff ledges close to large bodies of water. Although most people associate Peregrine Falcons with rugged wilderness, some of these birds have adapted well to city life. Urban peregrines raise their young on ledges of tall buildings, even in busy downtown areas. Cities offer peregrines a good year-round supply of pigeons and starlings to feed on. ■ The Peregrine Falcon is found in various types of habitats, from Arctic tundra to coastal areas and from prairies to urban centres. It usually nests alone on cliff ledges or crevices, preferably 50 to 200 m in height, but sometimes on the ledges of tall buildings or bridges, always near good foraging areas. Suitable nesting sites are usually dispersed, but can be common locally in some areas. The natural nesting habitat has not changed significantly since the population crash and is still largely available. In addition, structures built by humans in both rural and urban areas provide the Peregrine Falcon with other potential nesting sites. And though urbanization and other land uses have had a significant impact on some areas where they feed, Peregrine Falcons can usually modify their diet based on the prey species present in a given area.	■ The historic North American distribution of the eastern subspecies is east of the Rocky Mountains and south of the tree line. Although Peregrine Falcons now nest in and around Toronto and several other southern Ontario cities, the majority of Ontario's breeding population is found around Lake Superior in northwestern Ontario. ■ The anatum Peregrine Falcon breeds in the interior of Alaska and throughout northern Canada up to southern Greenland, and across continental North America up to northern Mexico. In Canada it is found in all territories and provinces except Prince Edward Island, Nunavut, and the Island of Newfoundland. The tundrius Peregrine Falcon breeds in Alaska and throughout northern Canada up to Greenland. In Canada, it breeds from northern Yukon, the low Arctic islands, northern Northwest Territories, and northern Nunavut up to Baffin Island, Hudson Bay, Ungava, and northern Labrador.	■ iNaturalist, 2020, eBird

Attachment B. Guelph Water Supply Master Plan Updated Study Species at Risk Habitat Screening

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat	Known Species Range	Source Identifying Species Record
Birds	Red-headed Woodpecker *Melanerpes erythrocephalus*	SC	THR Schedule 1	END	■ The Red-headed Woodpecker lives in open woodland and woodland edges, and is often found in parks, golf courses and cemeteries. These areas typically have many dead trees, which the bird uses for nesting and perching. This woodpecker regularly winters in the United States, moving to locations where it can find sufficient acorns and beechnuts to eat. A few of these birds will stay the winter in woodlands in southern Ontario if there are adequate supplies of nuts. ■ This species can typically be associated with the following ELC communities: **TPS, TPW, CUW, FOD1, FOD2, FOD4-1, FOD6, FOD7,** and **FOD9** that are open and have an abundance of dead trees.	■ The Red-headed Woodpecker is found across southern Ontario, where it is widespread but rare. Outside Ontario, it lives in Alberta, Saskatchewan, Manitoba and Quebec, and is relatively common in the United States.	■ Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
Birds	Rusty Blackbird *Euphagus carolinus*	SC	SC Schedule 1	SC	■ During the winter, it is found in wet woodlands, swamps, and pond edges and often forages in agricultural lands. ■ The breeding range of the Rusty Blackbird in Canada is almost entirely within the boreal forest. Breeding habitat there is characterized by coniferous-dominated forests adjacent to wetlands, such as slow-moving streams, peat bogs, sedge meadows, marshes, swamps, and beaver ponds. On migration, the Rusty Blackbird is primarily associated with wooded wetlands. In winter, it occurs primarily in lowland forested wetlands, cultivated fields, and pecan groves. Suitable habitat for the species appears to be decreasing on its breeding range and wintering grounds, due mainly to the loss and degradation of wetlands by human activities.	■ The Rusty Blackbird is only found in North America. It breeds in every province and territory in Canada and migrates to most of the central and eastern United States for winter. In Ontario, the breeding range is found in the Hudson Bay Lowlands and northern Boreal Shield ecozones. ■ The Rusty Blackbird has a wide distribution across boreal regions of Canada. The winter range includes most of the central and eastern United States, although it also winters irregularly in extreme southern Canada.	■ eBird
Birds	Short-eared Owl *Asio flammeus*	SC	SC Schedule 1	SC	■ The Short-eared Owl lives in open areas such as grasslands, marshes and tundra where it nests on the ground and hunts for small mammals, especially voles. ■ This species can typically be associated with the following ELC communities: **TPO** and **CUM**.	■ The Short-eared Owl has a world-wide distribution, and in North America its range extends from the tundra south to the central United States. In Ontario, the species has a scattered distribution, found along the James Bay and Hudson Bay coastlines, along the Ottawa River in eastern Ontario, in the far west of the Rainy River District, and elsewhere in southern Ontario, at places such as Wolfe and Amherst Islands near Kingston. Most northern populations are migratory, moving southward in the winter.	■ NHIC
Reptiles	Snapping turtle *Chelydra serpentina*	SC	SC Schedule 1	SC	■ Snapping Turtles spend most of their lives in water. They prefer shallow waters so they can hide under the soft mud and leaf litter, with only their noses exposed to the surface to breathe. During the nesting season, from early to mid summer, females travel overland in search of a suitable nesting site, usually gravelly or sandy areas along streams. Snapping Turtles often take advantage of man-made structures for nest sites, including roads (especially gravel shoulders), dams and aggregate pits. ■ This species can typically be associated with the following ELC communities: **OAO, SA** near gravelly or sandy areas.	■ The Snapping Turtle's range extends from Ecuador to Canada. In Canada this turtle can be found from Saskatchewan to Nova Scotia. It is primarily limited to the southern part of Ontario. The Snapping Turtle's range is contracting.	■ NHIC, iNaturalist 2020, ORAA

Attachment B. Guelph Water Supply Master Plan Updated Study Species at Risk Habitat Screening

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat	Known Species Range	Source Identifying Species Record
Birds	Wood Thrush *Hylocichla mustelina*	SC	THR Schedule 1	END	■ The Wood Thrush can typically be found in the interior and along the edges of well-developed upland deciduous and mixed forests. Key elements of these forests include trees that are greater than 16 m in height, high variety of deciduous tree species, moderate subcanopy and shrub density, shade, fairly open forest floor, moist soils and decaying leaf litter. Wood Thrush is more likely to occur in larger forests but may also nest in 1 ha fragments and semi-wooded residential areas and parks. Smaller habitat fragments have lower fecundity when compared to larger fragments. [3] ■ This species can typically be associated with the following ELC communities: **FOD** and **FOM** that are greater than 1 ha in size.	■ The Wood Thrush ranges across central and southern Ontario, southern Quebec, New Brunswick and southern Nova Scotia and the majority of the eastern United States. ■ It winters in Central American between southern Mexico and Panama. [3]	■ Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, eBird
Birds	Eastern Wood-Pewee *Contopus virens*	SC	SC Schedule 1	SC	■ The Eastern Wood-Pewee can be found in every type of wooded community in eastern North America. The size of the forest does not appear to be an important factor in habitat selection as this species has been found in both small fragmented forests and larger forest tracks. [4] ■ This species can typically be associated with the following ELC communities: **FOC**, **FOM** and **FOD**.	■ The Eastern Wood-Pewee Breed throughout central and eastern North America from Saskatchewan to Nova Scotia south along the Atlantic Coast to North Florida and the Gulf Coast. [4]	■ Ontario Breeding Bird Atlas ■ Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List, iNaturalist 2020, eBird
Insects	Monarch *Danaus plexippus*	SC	SC Schedule 1	END	■ Throughout their life cycle, Monarchs use three different types of habitat. Only the caterpillars feed on milkweed plants and are confined to meadows and open areas where milkweed grows. Adult butterflies can be found in more diverse habitats where they feed on nectar from a variety of wildflowers. ■ Milkweeds (numerous species) are the sole food plant for Monarch caterpillars. These plants grow predominantly in open and periodically disturbed habitats such as roadsides, fields, wetlands, prairies, and open forests. Milkweeds are often planted outside their native range, and sometimes wayward Monarchs are observed at these patches. Monarchs require staging areas which are used to rest, feed, and avoid inclement weather during migration. In Canada, they are found along the north shores of the Great Lakes where Monarchs roost in trees before crossing large areas of open water.	■ The Monarch's range extends from Central America to southern Canada. In Canada, Monarchs are most abundant in southern Ontario and Quebec where milkweed plants and breeding habitat are widespread. During late summer and fall, Monarchs from Ontario migrate to central Mexico where they spend the winter months. During migration, groups of Monarchs numbering in the thousands can be seen along the north shores of Lake Ontario and Lake Erie. ■ The overall native range of the Monarch occurs from Central America northward through the continental United States to southern Canada, and from the Atlantic Coast westward to the Pacific Coast. The Canadian range of occurrence includes portions of all ten provinces and the Northwest Territories. Monarchs are loosely divided into eastern and western subgroups based on their migratory routes and overwintering sites. Eastern Monarchs breed from Alberta east to Nova Scotia and migrate south to overwinter in the mountains of Central Mexico. The breeding range in Canada is south of the 50° latitude in Ontario, Quebec, and the Maritimes. Each fall hundreds of thousands of Monarchs migrate through Long Point in southern Ontario but it's unknown what proportion of the Canadian population these individuals represent.	■ iNaturalist, 2020, OBA

Attachment B. Guelph Water Supply Master Plan Updated Study Species at Risk Habitat Screening

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat	Known Species Range	Source Identifying Species Record
Insects	Yellow-banded Bumble Bee *Bombus terricola*	SC	SC Schedule 1	SC	■ This species is a forage and habitat generalist, able to use a variety of nectaring plants and environmental conditions. It can be found in mixed woodlands, particularly for nesting and overwintering, as well as a variety of open habitat such as native grasslands, farmlands, and urban areas. Nest sites are often underground in abandoned rodent burrows or decomposing logs. ■ Yellow-banded Bumble Bee occurs in a diverse range of habitats, including montane meadows, prairie grasslands, and boreal habitats. It has been recorded foraging on flowers for pollen and nectar from a variety of plant genera. Yellow-banded Bumble Bee queens overwinter underground and in decomposing organic material such as rotting logs.	■ The Yellow-banded Bumble Bee has a large range throughout much of Canada and parts of the United States. The Yellow-banded Bumble Bee ranges from the Mixedwood Plains of southern Ontario to the Hudson Bay Lowlands in the north. In southern Ontario, it is still observed but is less common than it was historically after steep declines. Less is known about historical or recent abundance of Yellow-banded Bumble Bee in the northern portion of its range. ■ Yellow-banded Bumble Bee occurs in eastern North America from New Jersey to Newfoundland and Labrador, and west through the northern United States and most of Canada to southern Northwest Territories, southeastern Yukon, and eastern British Columbia.	■ iNaturalist, 2019

Glossary:

ESA.................. Extirpated - a species that no longer exists in the wild in Ontario but still occurs elsewhere.
SARA............... Extirpated - a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
ESA.................. Endangered - a species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's Endangered Species Act.
SARA............... Endangered - a wildlife species that is facing imminent extirpation or extinction.
ESA.................. Threatened - a species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.
SARA............... Threatened - a wildlife species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.
ESA.................. Special Concern (formerly Vulnerable) - a species with characteristics that make it sensitive to human activities or natural events.
SARA............... Special Concern - a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
OMNR.............. Ontario Ministry of Natural Resources
ESA.................. Endangered Species Act
SARA............... Species at Risk Act (Federal)
Schedule 1....... The official list of species that are classified as extirpated, endangered, threatened, and of special concern.
Schedule 2....... Species listed in Schedule 2 are species that had been designated as endangered or threatened, and have yet to be re-assessed by COSEWIC using revised criteria. Once these species have been re-assessed, they may be considered for inclusion in Schedule 1
Schedule 3....... Species listed in Schedule 3 are species that had been designated as special concern, and have yet to be re-assessed by COSEWIC using revised criteria. Once these species have been re-assessed, they may be considered for inclusion in Schedule 1.
COSEWIC........ Committee on the Status of Endangered Wildlife in Canada - a committee of experts that assesses and designates which wild species are in some danger of disappearing from Canada.

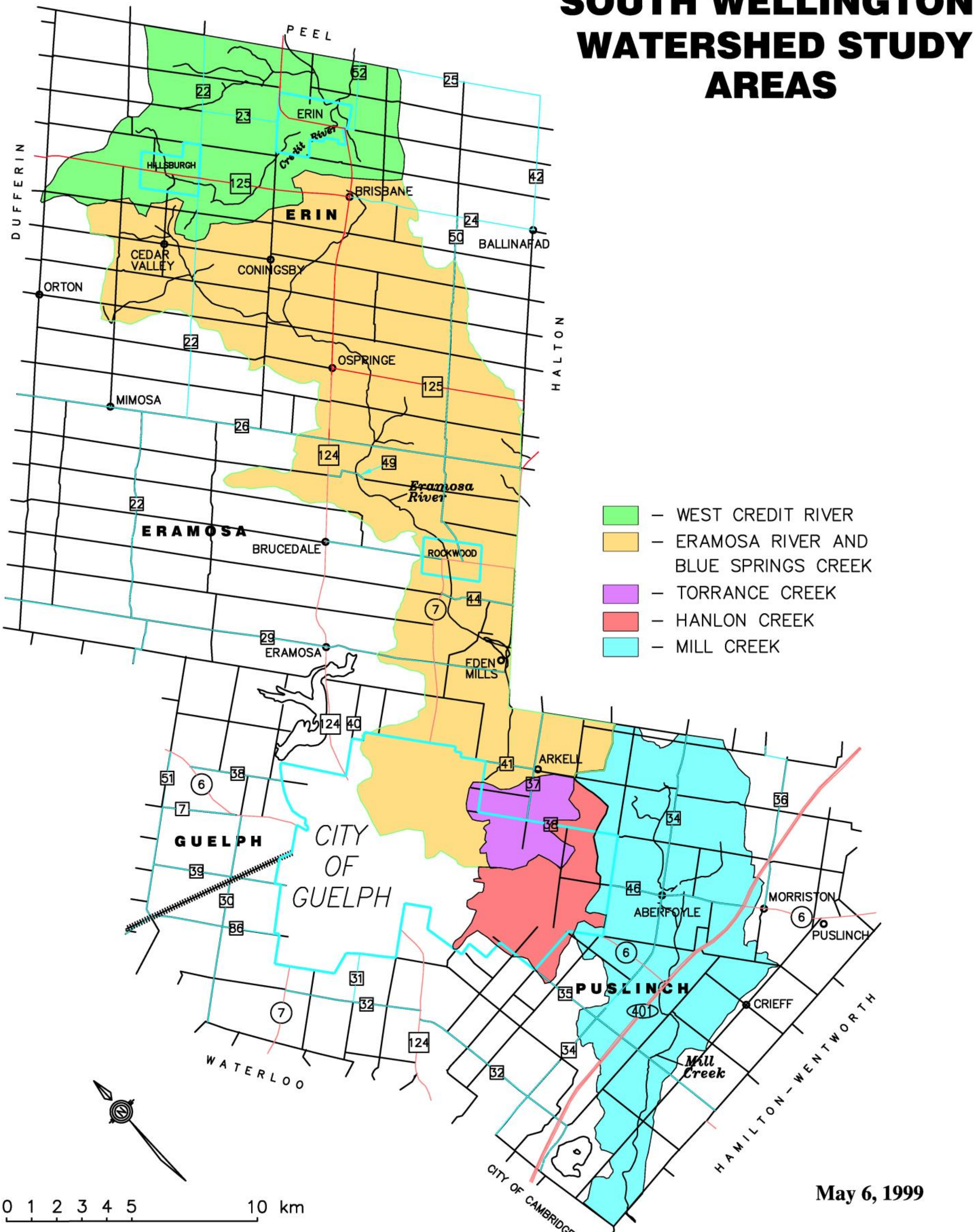
References

1. Species at Risk . Ontario Ministry of Natural Resources. http://www.mnr.gov.on.ca/en/Business/Species/index.html. © Queens Printer For Ontario, 2013.
2. Species at Risk Status Reports. Committed on the Status of Endangered Wildlife in Canada. Ottawa. http://www.sararegistry.gc.ca/search/advSearchResults_e.cfm?stype=doc&docID=18.
3. Evans, Melissa, Elizabeth Gow, R. R. Roth, M. S. Johnson and T. J. Underwood. 2011. Wood Thrush (Hylocichla mustelina), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/246doi:10.2173/bna.246
4. McCarty, John P. 1996. Eastern Wood-Pewee (Contopus virens), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/245doi:10.2173/bna.245

Attachment C

APPENDIX 1

SOUTH WELLINGTON WATERSHED STUDY AREAS

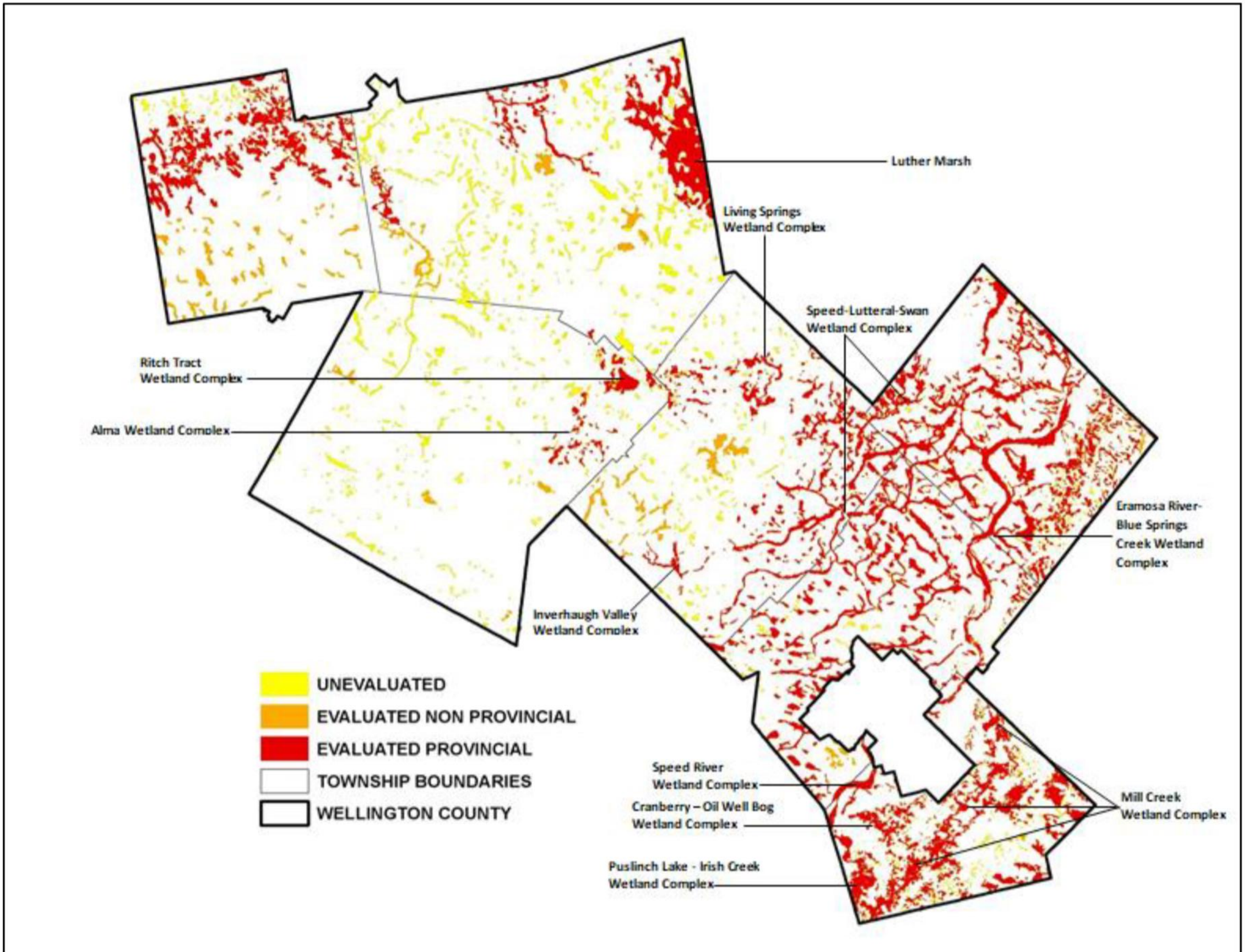


May 6, 1999

Date Printed: March 9, 2015.

F:\Land Information System\Draw\County_Wide_Maps\County_Op-Maps_Townships-OLD MAPS

Figure 8. Evaluated and Unevaluated Wetlands in Wellington County



Appendix B

Water Supply Master Plan
Sustainability Assessment

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Date: October 18, 2021

Project #: 60612820

Memorandum

Subject: **Water Supply Master Plan Sustainability Assessment Summary**

1. Introduction

In August 2020, the province of Ontario updated the Place to Grow plan ('the Growth Plan') to include population targets to the year 2051 (MMAH, 2020). Prior to this update, the Water Supply Master Plan (WSMP) update project planning period extended to 2041 and considered the associated growth targets (MMAH, 2019). The City has adopted the amended planning period included in the Growth Plan, including the 'reference' population targets presented in **Table 1**. Also shown in this table is the 'low' target included in the preliminary June 2020 version of the Growth Plan, issued for discussion. During Task 2 of the WSMP project, these growth projections were utilized, along with historical water demands to estimate future water supply demands (**Table 2** and **Figure 1**).

Table 1: Growth Plan Population and Employment Forecasts

Planning Horizon	Population Forecast	Employment Forecast
2031	177,000	94,000
2041	191,000	101,000
2051: Low	198,000	115,000
2051: Reference	203,000	116,000

Table 2: Projected 'Low' and 'Reference' Growth Rate Average Day and Maximum Day Water Demands

Growth Rate^	Demand Type	2021	2026	2031	2036	2041	2046	2051
Low	Avg. Day Demand (m^3/d)	49,171	52,139	55,107	58,075	61,043	64,011	66,978
Low	Max Day Demand using MDF* of 1.34 (m^3/d)	65,889	69,866	73,843	77,820	81,797	85,774	89,751
Reference	Avg. Day Demand (m^3/d)	49,254	52,429	55,605	58,780	61,955	65,131	68,306
Reference	Max. Day Demand using MDF* of 1.34 (m^3/d)	66,000	70,255	74,510	78,765	83,020	87,275	91,530

Note: ^Values taken from Gauley and Associates and AECOM, 2020.
*MDF = Maximum Day Factor

AECOM also assessed potential risks to the water supply system for the purpose of evaluating the security of the City's water supply (AECOM, 2020). A number of potential risks were identified including:

- Climatic conditions (drought);
- Loss of groundwater supply source to short/long term maintenance or contamination;
- System mechanical failures;
- Reduction in permitted capacity through regulatory approval process; and,
- Surface water contamination.

This assessment concluded that 15% of the existing and future water supply capacity should be reserved such that it is available to manage the identified risk scenarios. Stated another way, the firm capacity of the system is evaluated to be 15% less than the maximum system capacity, meaning that an additional 15% capacity above the future demands identified in **Table 2** will be required. The required future water supply capacity, including this 15%, is provided in **Table 3**.

Table 3: Estimated Future Capacity Required for Security of Supply

Capacity	2026	2031	2036	2041	2046	2051
Future Required Capacity - Low (m^3/d)	80,346	84,919	89,493	94,067	98,640	103,214
Future Required Capacity - Reference (m^3/d)	80,793	85,687	90,580	95,473	100,366	105,260

The amended Growth Plan will place increased pressure on the water supply resources available to the City within the 2051 planning horizon. The Tier 3 Water Budget study (Matrix Solutions Inc., 2017), completed as an element of Source Water Protection requirements under the Clean Water Act, has shown that the City's existing water resources (primarily groundwater) are potentially at risk of not meeting future (2031) system demand, particularly during drought conditions.

Future City water supply planning is further complicated by capacity limitations in the main water supply aquifer within the City limits. While additional water (surface water and groundwater) is likely available in the surrounding area, there are significant political challenges associated with developing these water supply sources to service the City.

In order to evaluate the sustainability of the existing groundwater resources and the potential future resources within the City or on City owned land, the City commissioned a groundwater flow modelling assessment. This assessment was completed by Matrix Solutions Inc., working as a subconsultant to AECOM, and is documented in **Attachment A**. The objective of this Technical Memorandum is to discuss the modelling results within the context of the Growth Plan and the overall WSMP process.

2. Sustainability Assessment Results

2.1 Existing Capacity Assessment

The capacity of the existing City groundwater supply sources was evaluated using the groundwater flow model. This included a steady-state assessment of the long-term sustainable system pumping rates under the constraints of minimum feasible pumping water level elevations (AECOM, 2021) and minimizing baseflow reduction to cold water streams. The modelling assessment identified the long-term sustainable average day capacity of the existing system to be 66,740 m^3/d (**Attachment A**). The maximum day capacity of the system with all wells operating concurrently has been evaluated at 79,422 m^3/d[1], reflecting the ability of the wells to reliably produce higher short-term flow rates to meet high demand periods in the City. Both of these capacity values are below the overall system Permit to Take Water (PTTW) maximum capacity of approximately 124,000 m^3/d. This capacity assessment should not be interpreted to suggest that individual PTTW should be reduced. Rather, the permitted values are required to maintain operational flexibility in the system such that production rates at certain groundwater sources can be increased seasonally to capture additional water available

1. *The maximum day capacity of the existing system was determined by AECOM through a review of operational data for each water source and discussions with City Water Services Operations staff.*

locally, or sources can be pumped at increased rates to support regular well maintenance or wells being off-line for extended periods of time.

The results of the existing capacity assessment are shown in **Figure 1** in relation to the demand projections in **Tables 2** and **3**. As shown on the figure and in **Table 4**, the existing capacity values result in water supply deficits relative to the projected 2051 demand and the total capacity required to address security of supply.

A transient simulation was completed to evaluate the potential impact of drought on the existing system average day capacity. This resulted in an estimated capacity of 57,561 m^3/d (**Attachment A**), or a 14% reduction relative to the estimated existing system average day capacity.

Table 4: Existing Water Supply Capacity Versus 2051 Demand Projections

Demand Type	2051 Low Demand vs. Existing Capacity^	2051 Reference Demand vs. Existing Capacity^
Max. Day (m^3/d)	-10,329	-12,108
Max. Day +15% (m^3/d)*	-23,792	-25,838

Notes: ^Existing maximum day capacity of 79,422 m^3/d.
*Includes 15% capacity to address security of supply.

2.2 Future Water Supply Sources

This assessment includes the potential future sources that are within the City or outside of the City on City-owned lands. This distinction was drawn as it is considerably more challenging to develop sources in other political jurisdictions where land acquisition is required. Future stages of the WSMP update process will assess the viability of these more challenging sources.

The potential future groundwater supply sources (**Table 5**) included in the Sustainability Assessment were evaluated in four categories established by roughly dividing the City in quadrants (i.e., northeast, southeast, southwest, northwest). This project is an update to the 2014 WSMP. As such, the future water supply sources identified in the 2014 plan serve as a basis for the sources being evaluated for the master plan update. The potential sources not considered previously, identified in **Table 5**, are as follows:

- **Increase to Arkell Recharge System Rates** – The City pumps water from the Eramosa River at the Arkell Spring Grounds under a stepped PTTW that allows for a maximum taking of 31,822 m^3/d from April 15th to May 31st, annually. This water is used to recharge the groundwater system via a series of infiltration trenches. Infiltrated water flows according to the local hydraulic gradient towards the Eramosa River, where it is intercepted by the Glen Collector. The current recharge system configuration can provide a maximum of 8,640 m^3/d from the river to the infiltration trenches. The Sustainability Assessment considered potential collector flow increases related to recharging at rates up to the PTTW maximum.

- **Caisson Collector System** – Previous reviews of potential improvements to the Arkell site collector systems (Stantec, 2004; Stantec, 2006; Woerns, 2004) have included recommendations to replace the existing Glen Collector with a caisson system. The Sustainability Assessment evaluated the potential capacity of a replacement caisson system.
- **GSTW1-20 Test Well** – Since the 2014 WSMP was completed, the City has drilled and tested a test well near the southwest City boundary (**Attachment A; Figure 1**). This new potential water supply was included in the Sustainability Assessment.
- **Dolime Quarry Pond Level Management** – The City is currently undertaking the Southwest Guelph Water Supply Class Environmental Assessment to evaluate potential new water supply within this area of the City. This project includes a detailed, long-term Operational Testing Program (OTP), designed to evaluate a strategy for protecting the quality and quantity of the City groundwater supply by managing surface water levels in the Dolime Quarry (referred to as Pond Level Management, or PLM). The Sustainability Assessment evaluated the potential optimized water supply system capacity under PLM, which will be assessed in the field through the OTP.

Table 5: Potential Future Water Supply Sources Evaluated for Sustainability Assessment

City Quadrant	Potential Future Water Supply Source	Sources Not Considered in 2014 Plan
Southeast	Lower Road Collector, Increase to Arkell Recharge System Rates*, Caisson Collector System	Increase to Arkell Recharge System Rates*, Caisson Collector System
Southwest	Edinburgh Well, Steffler Well, Ironwood Well, GSTW1-20 Well, Dolime Quarry Pond Level Management	GSTW1-20 Well, Dolime Quarry Pond Level Management
Northeast	Clythe Well, Fleming Well, Logan Well	-
Northwest	Sacco Well, Smallfield Well, Hauser Well, Sunny Acres Park site (potential future well)	-

Notes: *Recharge rates above the current Eramosa River PTTW maximum are not being considered.

2.2.1 Groundwater Sources

As described above, the potential capacity of additional sources in each City quadrant were evaluated separately, subject to the same pumping level and baseflow reduction restrictions imposed on the existing capacity assessment (**Attachment A**). The result provides an indication of the additional capacity potentially available in each City quadrant (**Table 6**). An additional simulation was completed to evaluate the overall increased system capacity that may be available with new sources located in *all* City quadrants (**Table 6**). This resulted in an estimated 10,000 m^3/d in additional available capacity from the evaluated sources.

Table 6: Results of Additional Groundwater Sources Modelling Analysis

City Quadrant	Average Day System Capacity (m^3/d)	Increased Capacity Over Existing (m^3/d)
Southeast	69,791	3,051
Southwest	71,463	4,723
Northeast	70,347	3,607
Northwest	68,242	1,502
All Quadrants*	76,740	10,000

Notes: Above table is taken from Table 18 in Attachment A.
* This scenario included a series of potential future groundwater wells, none of which are within the southeast quadrant.

2.2.2 Arkell Spring Grounds Collector System

The Arkell Spring Grounds property was developed by the City in 1908 to replace the Eramosa River as a source of water supply. As part of this development, a collector system was installed to intercept groundwater springs/seeps from the outwash sands and gravels that are exposed along the south valley wall of the Eramosa River. An aqueduct was constructed to convey the groundwater collected from the spring grounds to the York Road pumping station. Over the past century, the collector system has been expanded and upgraded. The collector system is subdivided into two sub-systems, referred to as the Lower Road Collector (currently off-line) and the Glen Collector.

A key component of the system is a groundwater infiltration system, where water is pumped from the Eramosa River between mid-April and mid-November and discharged to an infiltration pond that recharges the groundwater locally through a series of infiltration trenches. A portion of the recharge, estimated to range from 22% to 90% and average 51% (C3 Water, 2019), is then captured by the Glen Collector.

The Sustainability Assessment modelling analysis considered three potential modifications to the collector system to increase the system capacity with a focus on optimizing the water supply from the collector system available on a year-round basis, i.e. increase to the City's water supply capacity. These modifications included:

- Replacement of the off-line Lower Road Collector;
- Increasing the volume of water recharged through the infiltration system; and,
- Replacement of the Glen Collector.

The results for each of these potential options are discussed in the following subsections.

2.2.2.1 Lower Road Collector Replacement

This scenario was assessed in the model by simulating a collector in the location of the existing off-line Lower Road Collector and evaluating the combined capacity with the Glen Collector. Both steady-state and transient simulations were completed to evaluate average and seasonal capacity as the collector flow is heavily influenced by seasonal conditions. The steady-state results indicate that the average capacity of the collectors could be increased by about 3,000 m^3/d by replacing the Lower Road Collector and operating both collectors simultaneously.

The transient results provide a range in minimum and maximum combined collector flows during the period of assessment. The minimum flows during the transient period range from approximately 4,000 m^3/d to 10,000 m^3/d. The maximum flows during the transient period range from approximately 11,000 m^3/d to 19,000 m^3/d. The assessed transient period is the Tier Three drought scenario, meaning that the values at the low end of these ranges represent below average recharge conditions while the values at the high end of these ranges represent average to slightly above average conditions (Matrix Solutions Inc., 2017).

The maximum flows from the collector system provide the City with operational flexibility as they allow an increase in total production from the Arkell site, which can off-set the capacity of wells that are off-line for scheduled maintenance, facility upgrades, etc. Due to the seasonal nature of the collector flows, these maximum values cannot be considered in the capacity of the overall City system, as the maximum system demand may not occur during the period of maximum collector flow. Therefore, the minimum reliable collector flow value is used in the estimate of overall system maximum capacity. The determination of the overall existing system maximum capacity of 79,422 m^3/d, included a contribution of 5,100 m^3/d from the Glen Collector, reflecting the average minimum flow value during the period of no artificial recharge between 2017-2019 (AECOM, 2021). The Sustainability Assessment results suggest that the combined flow from the two collector systems, during the low flow period could be 4,900 m^3/d higher than the recent productivity of the Glen Collector during this same period (i.e., 5,100 vs. 10,000 m^3/d). Conservatively, the discussion herein assumes a value of 4,000 m^3/d for the collector replacement as the transient modelling assessment includes variable annual recharge conditions.

2.2.2.2 Recharge System Volume Increase

The modelling analysis considered three pumping rates for the Eramosa River intake, which provides flow to the artificial recharge system. This included the approximate current system maximum of 105 L/s, double this rate or 210 L/s and triple the current maximum or 320 L/s. Both steady-state and transient simulations were completed. The steady-state results indicate that the average capacity of the Glen Collector under increased recharge conditions would range from 7,969 m^3/d (while recharging at a maximum of 105 L/s) to 12,139 m^3/d (while recharging at a maximum of 320 L/s).

The transient results provide a range in minimum combined collector flows during the annual period with no artificial recharge, and maximum combined flows during the annual artificial recharge period. The minimum flows during the transient period range from approximately 2,000 m^3/d to 9,000 m^3/d; however, there is little variability between the minimum values for each recharge rate. This suggests the model does not predict that significant mounding would occur at the water table due to the high transmissivity of the shallow aquifer. The maximum flows during the transient period range from approximately 23,000 m^3/d to greater than the PTTW maximum of 25,000 m^3/d.

These modelling results indicate that increasing the recharge rates and total seasonal recharge volume would not have a significant impact on the minimum annual collector flows. Therefore, this option is not anticipated to contribute significant additional flow to the overall system capacity. Maximum Glen Collector flows between 2017 and 2019 have been on the order of 18,000 to 19,000 m^3/d. The modelling assessment suggests that maximum rates up to the PTTW limit could be achieved; however, significant field testing and modifications to the existing recharge/infiltration system would likely be required to implement the rates tested in the model.

It is noted that re-construction of the Lower Road Collector could improve the overall efficiency of the Collector system, i.e., a higher percentage of the artificial recharge volume could be collected by the overall system as compared to the performance with only the Glen Collector active. Further, the potential effect of increased artificial recharge on shallow groundwater quality would need to be assessed as part of the pilot testing program(s).

2.2.2.3 Caisson Collector System

Previous reviews of potential improvements to the Arkell site collector systems (Stantec, 2004; Stantec, 2006; Woerns, 2004) have included recommendations to replace the existing Glen Collector with a caisson system. The Sustainability Assessment evaluated the potential capacity of a replacement caisson system using the groundwater model. Given the proximity of the recommended conceptual caisson system to the existing Arkell 1, an overburden well, the modelled capacity values represent the total flow that would be derived from the caisson system and Arkell 1 or just the caisson system if Arkell 1 was decommissioned.

The steady-state results indicate that the average capacity of the caisson system would be approximately 9,598 m^3/d, a minor increase above the average flow rate of 9,240 m^3/d modelled for the existing Glen Collector combined with Arkell 1.

The transient results provide a range in minimum and maximum caisson collector flows. The minimum flows during the transient period range from approximately 4,600 m^3/d to 8,000 m^3/d, suggesting that this system may buffer the impact of drought, relative to the existing Glen Collector. The maximum flows during the transient period range from approximately 8,500 m^3/d to 13,000 m^3/d. In consideration of the minimum reliable flow from the caisson collector this assessment indicates that a replacement system could add up to 2,900 m^3/d (5,100 m^3/d vs. 8,000 m^3/d) in capacity, relative to the existing Glen Collector; however, when the capacity of the Arkell 1 well is taken into consideration (2,000 m^3/d), the increase is reduced to 900 m^3/d. It is unlikely that this minor predicted capacity increase would justify the cost associated with installation of a caisson collector.

3. Discussion

The results of the Sustainability Assessment modelling indicate that the evaluated future groundwater sources could provide up to 10,000 m^3/d of additional water supply to the City. Further, the modelling indicates that re-establishing the Lower Road Collector could add up to 4,000 m^3/d in capacity. These results are shown on **Figure 1** along with the future demands estimated based on the Growth Plan population and employment targets and the required 15% additional reserve supply. The maximum available supply shown for 2051 is 93,422 m^3/d, which is the existing system maximum day capacity of 79,422 m^3/d plus the 14,000 m^3/d identified in this assessment. This is considered to be a conservative result, as individual well supplies are routinely operated at flow rates in excess of the steady-state (or average) rates provided by the model. As there is uncertainty regarding which future water sources may prove to be viable when detailed field testing is completed and it is uncertain whether the Ministry of the Environment, Conservation and Parks would permit additional sources at rates in excess of those demonstrated by the model, it is considered prudent to take this approach for the purpose of the Master Plan. There is additional uncertainty associated with the groundwater flow model and continuous improvement in the model through ongoing field studies and additional model calibration will help to reduce uncertainties and improve the reliability of the model scenarios; however, the model, at this time, represents the best available approach to water supply capacity assessments.

When considering the full system capacity requirement, including a 15% reserve for security of supply, the results provided in **Figure 1** and summarized in **Table 7** show that the estimated 2051 deficit is 9,792 m^3/d and 11,838 m^3/d for low and reference demand, respectively.

This assessment includes evaluation of the potential future sources that are within the City or outside of the City on City-owned lands. Future stages of the WSMP update process will also assess the viability of potential sources located outside of the City. This work underscores the potential challenges associated with servicing future growth using the identified sources and the pressure that the revised Growth Plan targets impose on the City water supply planning process.

Table 7: Future Water Supply Capacity Versus 2051 Demand Projections

Demand Type	2051 Low Demand vs. Future Capacity	2051 Reference Demand vs. Future Capacity
Max Day Demand (m^3/d)	89,751	91,530
Max Day Demand +15% (m^3/d)*	103,214	105,260
Existing Water Supply Capacity (m^3/d)	79,422	79,422
Future Estimated Water Supply Capacity (m^3/d)	93,422	93,422
Deficit based on existing supply capacity (m^3/d)	-23,792	-25,838
Deficit based on estimated future supply capacity (m^3/d)	-9,792	-11,838

Notes: *Includes 15% capacity to address security of supply.

4. References

AECOM, 2020:
Determination of Required Water Supply Capacity – Firm Capacity Assessment. (Draft Technical Memorandum).

AECOM, 2021:
City of Guelph Water Supply Master Plan. Task 3 – Water Supply Capacity Assessment. (Draft Technical Memorandum).

Gauley and Associates and AECOM, 2020:
Task #2 – Population and Water Supply Demand Forecasts (Final Draft Technical Memorandum).

Matrix Solutions Inc., 2017:
City of Guelph and Township of Guelph/Eramosa Tier Three Water Budget and Local Area Risk Assessment.

Ministry of Municipal Affairs and Housing (MMAH), 2019:
A Place to Grow – Growth Plan for the Greater Golden Horseshoe.

Ministry of Municipal Affairs and Housing (MMAH), 2020:
A Place to Grow – Growth Plan for the Greater Golden Horseshoe.

Stantec, 2004:
Technical Memorandum No. 3 – Conceptual Assessment of Collector Rehabilitation and/or Replacement Alternatives.

Stantec, 2006:
Hydrogeological Study in Support of a Caisson Collector System, Arkell Spring Grounds, Guelph (Draft).

Woerns. N., 2004:
Rehabilitation of the Lower Road Collector System Arkell Spring Grounds (Draft Report).

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Attachment A

Version 2.0
October 4, 2021 Matrix 15072-527

Mr. Matthew Alexander
AECOM Canada Ltd.
215-55 Wyndam St. N
Guelph, ON N1H 7T8

Subject: City of Guelph Water Supply Master Plan, Places to Grow Scenarios

Dear Mr. Alexander:

AECOM Canada Ltd. and the City of Guelph (the City) retained Matrix Solutions Inc. to apply the City's groundwater flow model to assess current and potential future municipal water supply scenarios to support the City's response to a Places to Grow Amendment from the Province of Ontario. The groundwater model was originally developed and peer reviewed as part of the Tier Three Water Budget and Local Area Risk Assessment (Tier Three Assessment; Matrix 2017) under the province's **Clean Water Act** and has since been refined in local areas of interest by the City as new hydrogeological data has become available. The model scenarios presented in this report are designed to optimize the City's municipal water supply system's long-term constant rate total capacity while considering physical construction constraints in municipal supply wells, estimated operating well capacities, and potential impacts in groundwater discharge to streams. The scenarios evaluated estimate an average-day well capacity. The water supply system can achieve greater production rates over short-term periods. The future scenarios in this report consider potential additional sources of water located on City lands in addition to the existing sources of the current water supply system.

This report summarizes the simulated maximum average day capacity of the current municipal water supply system (Section 1), the maximum average capacity under drought conditions (Section 2), and the maximum average capacity considering alternative future groundwater supply sources (Section 3). Potential additional sources of groundwater include:

- use of inactive wells and collectors, test wells, and hypothetical wells in areas where additional supply may be available (Section 3.1)
- water management in the Dolime Quarry area (Section 3.2)
- optimization and reconfiguration of the Arkell recharge and collector system (Section 3.3)

1 Current Capacity Scenario

The Current Capacity Scenario is designed to estimate the maximum average day capacity of the existing municipal water supply system, including groundwater wells and the Glen Collector, while maintaining groundwater elevations above safe operating levels (i.e., low water thresholds), minimizing reductions in groundwater discharge to coldwater streams, and keeping individual well pumping rates below maximum well withdrawal capacities. Optimization of municipal pumping rates was completed using PESTPP-OPT (Parameter Estimation Software; White et al. 2020). PESTPP-OPT helps to automate the estimation of the maximum pumping rate potentially achievable by each well under each of the three constraints. The scenario represents a point of reference for future supply scenarios for estimating the incremental system capacity and reductions in groundwater discharge to watercourses.

Low water thresholds at the municipal wells are used in the modelling work to evaluate when aquifer water levels fall too low and a municipal well may be unable to reliably withdraw water. Estimates of these thresholds were provided by AECOM (2021) and subsequently adjusted (Table 1) to account for differences between the model's simulated water level and the measured water levels at each well, as well as estimated hydraulic head under average pumping conditions and specific capacities. AECOM also provided the maximum individual well capacities and/or permitted rates as upper bounds to the optimization process (Table 1). Additional details about the development of the Current Capacity Scenario and associated thresholds are provided in the City of Guelph Water Supply Master Plan Update report and associated appendices (e.g., AECOM 2021, Matrix 2021).

Table 1 summarizes the results of the Current Capacity Scenario, including maximum simulated pumping rates and simulated available heads under those rates; available head is calculated as the difference between the simulated low water threshold and the simulated water level in the scenario. The estimated average-day capacity of the current water supply system is 66,760 m^3/day. This estimate includes an average day supply of 7,240 m^3/day from the Glen Collector under average annual recharge rates. The system has a higher total permitted rate and has a greater short-term capacity than this average-day capacity. Also, while this Current Capacity Scenario illustrates a precise series of pumping rates across each of the municipal wells, there are infinite combinations of pumping rates across the City's wells that could achieve a similar overall total capacity. For all scenarios, the simulated results should be interpreted as an estimated total capacity across the complete system, as opposed to evaluating individual well capacities.

Table 2 summarizes the simulated groundwater discharge to various coldwater and warmwater streams under the Current Capacity Scenario. The model computes this discharge as the net sum of all constant head stream boundary conditions shown on Figure 2. The thermal classification of each watercourse is from Matrix (2017) and the references therein (i.e., MNR [2013] and GRCA [2013]). The watercourse was assigned a coldwater classification for the purposes of this evaluation if a segment of the entire reach was assessed as coldwater.

Table 1 Current Capacity Scenario: Municipal Well Constraints and Maximum Pumping Rates

City Quadrant	Municipal Well/Source	Adjusted Simulated Low Water Threshold (m asl)	Maximum Individual Well Capacity Threshold (m^3/day)	Current Capacity Scenario		Drought Capacity Scenario	
				Maximum Pumping Rate (m^3/day)	Available Head (m)	Maximum Pumping Rate	Available Head
Southeast	Arkell 1	319.5	2,000	2,000	-2.0	2,000	-0.8
	Arkell 6	305.7	8,000	1,500	-5.1	2,960	-4.7
	Arkell 7	305.7	8,000	8,000	-3.6	8,000	-3.4
	Arkell 8	311.1	7,000	0	0.1(2)	0	0.2(2)
	Arkell 14	310.9	7,000	3,100	0.0(2)	0	-0.3
	Arkell 15	304.4	7,000	7,000	-5.3	7,000	-5.0
	Burke	323.4	6,500	5,200	-0.2	3,000	0.0(2)
	Carter Wells(1)	318.5	6,400	6,100	-0.0	4,000	-0.6
Southwest	Membro	282.1	5,200	5,200	-0.8	5,200	-0.5
	Water St.	289.2	2,700	1,950	-0.1	1,800	0.1(2)
	Dean	289.9	1,500	540	-0.0	400	0.1(2)
	University	290.4	2,500	850	-0.3	470	0.0(2)
	Downey	286.4	5,237	5,240	-0.9	5,240	-0.1
Northeast	Park Wells(1)	281.0	8,000	6,680	-0.1	6,540	-0.1
	Emma	278.2	2,800	2,390	-0.3	2,360	-0.1
	Helmar	321.4	800	670	-0.1	550	-0.1
Northwest	Paisley	298.5	1,400	940	-0.0	830	0.0(2)
	Calico	294.2	1,400	1,400	-13.2	1,400	-11.8
	Queensdale	295.9	1,100	760	-0.5	680	-0.0
	Glen Collector	-	-	7,240	-	5,130	-
Total (Wells)		**-**	**-**	**59,520**	**-**	**52,430**	**-**
Total (Wells + Collector)		**-**	**-**	**66,760**	**-**	**57,560**	**-**

Notes:
Minor exceedances (<0.2 m) were considered acceptable.
(1) Two or more wells simulated as one well.
(2) Low water level threshold exceedance when positive. Negative values indicate remaining available head at maximum pumping rate.

Table 2 Current Capacity Scenario: Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[1]	Average Groundwater Discharge (m^3/day)
Blue Springs Creek	Coldwater	41,769
Chilligo/Ellis Creek	Coldwater	14,618
Clythe Creek	Coldwater	1,906
Cox Creek	Warmwater	2,354
Eramosa River	Coldwater	122,620
Guelph Lake Tributary	Coldwater	9,430
Hanlon Creek	Coldwater	3,718
Hopewell Creek	Coldwater	21,514
Irish Creek	Warmwater	5,807
Lutteral Creek	Coldwater	34,184
Marden Creek	Warmwater	2,982
Mill Creek	Coldwater	38,566
Moffat Creek	Coldwater	2,061
Speed River	Coldwater	246,216
Swan Creek	Coldwater	5,908
Torrance Creek	Warmwater	771
West Credit River	Coldwater	30,642

Notes:
(1) From MNR (2013) and GRCA (2013) in Matrix (2017)

2 Drought Capacity Scenario

The Drought Capacity Scenario estimates the average-day capacity of the existing municipal water supply system (i.e., groundwater wells and the Glen Collector) under long-term drought conditions, while keeping groundwater elevations above safe operating levels (i.e., low water thresholds) and considering the individual well withdrawal capacities or permitted rates. The same low water thresholds and pumping constraints used for the Current Capacity Scenario apply for the Drought Capacity Scenario.

Table 1 summarizes the results of the Drought Capacity Scenario. Optimization of steady-state municipal pumping rates was completed using PESTPP-OPT (White et al. 2020), using a model with a 25% reduction in applied recharge from the Current Capacity Scenario model. The 25% recharge reduction results in a similar maximum drawdown as predicted using the first 7 years (1960-1967) of the 10-year transient drought scenario (1960-1970) evaluated in the Tier Three Assessment. The first 7 years were assessed to coincide with the period of time where maximum water level declines were predicted in the Tier Three Assessment. After optimizing the pumping rates with the 25% recharge reduction scenario, the optimized rates were evaluated using the 7-year transient drought scenario with monthly recharge (1960-1967). Table 1 lists the simulated transient minimum available heads.

The estimated capacity of the current water supply system under drought conditions is 57,560 m^3/day. This estimated capacity includes a steady-state collection rate of 5,130 m^3/day from the Glen Collector under reduced recharge conditions.

3 Future Supply Scenarios

Matrix assessed three sets of scenarios to estimate the incremental increase in water supply from potential additional water sources located on City property. Table 3 summarizes these sets of scenarios (i.e., A, B, and C). The A scenarios test potential additional supply from inactive or new municipal wells and collectors. The B and C scenarios test potential additional supply relating to the Dolime strategy and Arkell recharge/collector system, respectively.

The Future Potential Supply scenarios estimate the increase in the average-day water supply system capacity relative to the Current Capacity Scenario (Section 1), following the same approach used to estimate the Current Capacity. Changes in groundwater discharge to streams were compared to the Current Capacity Scenario. In addition to the well constraints described in Section 1, each future supply scenario included an additional optimization target of a maximum of 10% reduction of groundwater discharge to the same streams considered as part of the Tier Three Assessment. This threshold is consistent with thresholds used for coldwater streams in the Tier Three Assessment (Matrix 2017), which follow provincial guidance on how to evaluate possible impacts to streams as a result of increased municipal pumping (MOE 2013; MECP 2021).

Table 3 Summary of Future Supply Scenarios

Scenario Set	Potential Supply Area	Scenario Number: Potential Additional Supply Description
A Additional Wells and Existing Collectors	Southeast Quadrant	A1-A: Lower Road Collector
	Southwest Quadrant	A2-A: Additional well supply from Edinburgh, Steffler, Ironwood, and GSTW1-20
	Northeast Quadrant	A3-A: Additional well supply from Clythe, Fleming, and Logan
	Northwest Quadrant	A4-A: Additional well supply from Sacco, Smallfield, Hauser, and hypothetical Sunny Acres Park location
	Multiple Quadrants	A5-A: Additional well supply from Edinburgh, Steffler, Ironwood, GSTW1-20, Clythe, Fleming, Logan, Sacco, Smallfield, and Hauser
B Dolime Quarry Water Capture		B1: Dolime Quarry capture considering current municipal wells
C Arkell Recharge/Collector Optimization		C1: Withdraw more water from the Eramosa River and recharge closer to the Permit to Take Water rates
		C2: Deactivate the Glen Collector and install a Caisson Collector System

3.1 Potential Water Supply from Additional Wells and Existing Collectors

The set of scenarios described in the following subsections (i.e., A1-A to A5-A; Table 3) evaluate the average-day capacity where inactive wells or collectors were restored and put back online or if new hypothetical supply wells were made available (Figure 1).

3.1.1 Southeast Quadrant Scenario A1-A: Lower Road Collector

Scenario A1-A evaluates the potential increase in water supply if the inactive Lower Road Collector were to be brought back into service. The Lower Road Collector is an approximately 1 km continuation of the Glen Collector, running west of the Glen Collector and parallel to the Eramosa River. Similar to the Glen Collector, the Lower Road Collector was originally designed to collect groundwater seeps at the base of the ground surface slope; however, it was taken offline in 2001 due to water quality concerns.

The Lower Road Collector was represented in the groundwater flow model for this scenario by applying constant head boundary conditions in the overburden (model slice 3) with elevations set to the invert elevations of the manholes as reported in the City's Southeast Quadrant Groundwater Study (Jagger Hims 1998).

This scenario was simulated with Current Capacity Scenario pumping rates, under steady-state and transient conditions. The transient scenario evaluates monthly recharge rates associated with the first 7 years of the 10-year Tier Three drought scenario (1960-1970) where maximum water level decline was predicted to occur. The results of these model runs are plotted on Chart 1 and summarized in Table 4 and 5. The estimated steady-state discharge to the Lower Road Collector and Glen Collector is 8,017 m^3/day and 2,274 m^3/day, respectively. The transient discharge rates at the Lower Road Collector range from 5,063 to 11,191 m^3/day and at the Glen Collector range from 0 to 7,558 m^3/day. Table 5 lists the annual minimum simulated discharge rates of the Glen and Lower Road Collectors combined from Chart 1 (cumulative collectors). The lowest simulated cumulative discharge is 4,329 m^3/day, within a drought period. For comparison purposes, Table 5 also includes the annual minimum simulated discharge rate of the Glen Collector if it was operating on its own without the Lower Road Collector.

As illustrated by the scenarios, the Lower Road Collector reduces the amount of water discharged to the Glen Collector but results in an incremental average-day water supply of approximately 3,000 m^3/day under steady-state conditions. The groundwater flow model is not calibrated to field operation of the Lower Road Collector. The simulated discharge rates for the Glen and Lower Road collectors should be considered as a preliminary estimate of the total water that may be available from shallow groundwater collectors in this area, rather than a precise estimate of the relative amounts to be collected by each collector. The certainty of these estimates may be improved should additional calibration data be incorporated into the model from recent and future operational testing data of the collector system.

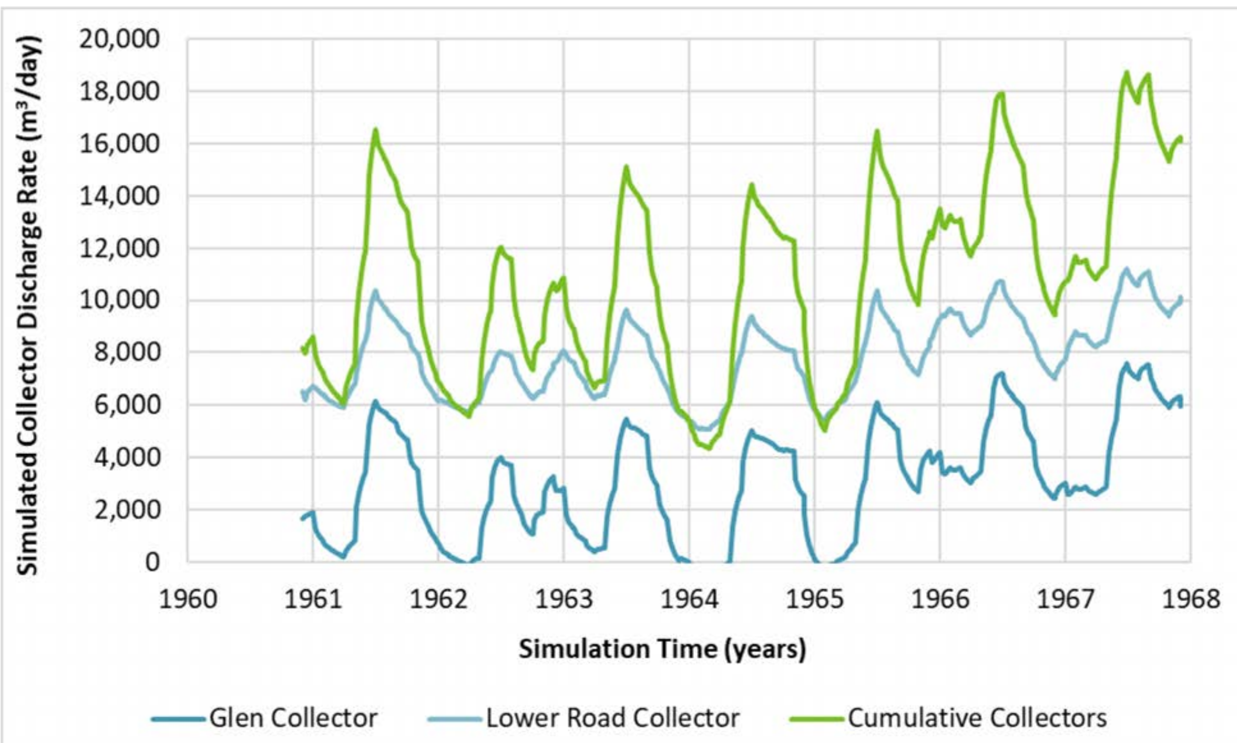

Chart 1 Transient Simulated Discharge Rate at the Glen Collector, Lower Road Collector, and the Sum of the Two Collectors

Table 4 Scenario A1-A: Simulated Lower Road Collector and Glen Collector Rates

Collector	Current Capacity Scenario (m^3/d)	Steady state Discharge (m^3/d)	Transient Scenario (1960 1967)		
			Average Discharge (m^3/day)	Minimum Discharge (m^3/day)	Maximum Discharge (m^3/day)
Lower Road Collector	N/A	8,017	7,835	5,063	11,191
Glen Collector	7,240	2,274	2,988	0	7,558
Total	**7,240**	**10,291**	**10,823**	**5,063**	**18,749**

Table 5 Scenario A1-A: Simulated Lower Road Collector and Glen Collector Annual Minimum Discharge Rates

Year	Minimum Simulated Discharge Rate while Glen Collector is Solely Operating (Current Capacity Rates)(1) (m^3/day)	Minimum Simulated Cumulative Discharge Rate while Lower Road Collector and Glen Collector are Operating (Current Capacity Rates) (m^3/day)
1961	2,442	6,251
1962	1,718	5,652
1963	1,223	5,546
1964	599	4,321
1965	1,146	5,283
1966	4,950	9,429
1967	5,222	10,281

Notes:
(1) minimum simulated discharge rates for Glen Collector if only the Glen Collector was operating (provided for comparison purposes)

3.1.2 Southwest Quadrant Scenario A2-A: Edinburgh, Steffler, Ironwood, and GSTW1-20

The estimated average-day capacity for wells within the southwest quadrant of Guelph (i.e., Membro, Water Street, Dean, University, and Downey wells) in the Current Capacity Scenario is 13,780 m^3/day. Scenario A2-A estimates the increased total system capacity by introducing the inactive Edinburgh well, and the Steffler, Ironwood, and GSTW1-20 test wells. The nearest active municipal wells are the University and Dean wells, which are located approximately 900 m and 1,800 m northwest of the Ironwood well, respectively.

The estimated total system capacity with these four wells added is 71,480 m^3/day (Table 6). These four wells contribute 10,600 m^3/day to this total and the cumulative rate produced by the southwest quadrant wells is estimated to be 19,050 m^3/day. The scenario resulted in shutting off the Dean and University wells, allowing new wells to pump at higher rates, which increased the overall system capacity. Ultimately, the introduction of these new wells, along with the shut down and decreased rates at some other wells, including some in the northeast and northwest quadrants, allowed for an increase in total system capacity of 4,720 m^3/day over the Current Capacity.

The largest simulated reductions in groundwater discharge to watercourses (in comparison to the Current Capacity Scenario) were predicted to be 13% (470 m^3/day) and 17% (977 m^3/day) along Hanlon Creek and Irish Creek, respectively (Table 7). While a 10% groundwater discharge target was applied to the scenarios, the optimization technique does not treat this target as an absolute constraint and weighs the effect of groundwater discharge reductions against the water level constraints. The estimated groundwater discharge reduction is considered as a conservative worst-case value and needs to be further evaluated through pumping tests and operational monitoring. The estimated reduction in groundwater discharge along the remaining streams is estimated to be less than 1%.

Table 6 Scenarios A2-A, A3-A, and A4-A: Summary of Optimized Well Rates and Available Head Exceedances

City Quadrant	Municipal Well/Source	Maximum Individual Well Capacity Threshold (m^3/day)	Adjusted Simulated Low Water Threshold (m asl)	Current Capacity Scenario		Scenario A2 A			Scenario A3 A			Scenario A4 A		
				Pumping Rate (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	A2 A Pumping vs. Current Capacity Pumping (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	A3 A Pumping vs. Current Capacity Pumping (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	A4 A Pumping vs. Current Capacity Pumping (m^3/day)	Available Head (m)
Southeast	Arkell 1	2,000	319.5	2,000	-2.0	2,000	0	-2.0	2,000	0	-2.0	2,000	0	-2.0
	Arkell 6	8,000	305.7	1,500	-5.1	1,500	0	-5.1	1,500	0	-5.0	1,500	0	-5.3
	Arkell 7	8,000	305.7	8,000	-3.6	8,000	0	-3.6	7,000(4)	-1,000	-3.7	8,000	0	-5.1
	Arkell 8	7,000	311.1	0	0.1(2)	0	0	0.1(2)	0	0	0.1(2)	0	0	1.5(2)
	Arkell 14	7,000	310.9	3,100	0.0(2)	3,100	0	0.0(2)	1,800(4)	-1,300	-0.1	3,100	0	0.0(2)
	Arkell 15	7,000	304.4	7,000	-5.3	7,000	0	-5.3	7,000	0	-5.0	7,000	0	-4.9
	Burke	6,500	323.4	5,200	-0.2	5,200	0	-0.1	5,200	0	-0.1	5,200	0	-0.1
	Carter Wells	6,400	318.5	6,100	-0.0	6,100	0	0.1	6,100	0	0.0(2)	6,100	0	0.0(2)
Southwest	Membro	5,200	282.1	5,200	-0.8	4,700(4)	-500	-0.9	5,200	0	-0.7	5,200	0	-0.7
	Water St.	2,700	289.24	1,950	-0.1	1,500(4)	-450	-0.1	1,950	0	0.2(2)	1,950	0	0.1(2)
	Dean	1,500	289.9	540	-0.0	0(5)	-540	-0.2	540	0	0.1(2)	540	0	0.1(2)
	University	2,500	290.4	850	-0.3	0(5)	-850	2.4(2)	850	0	-0.2	850	0	-0.2
	Downey	5,237	286.4	5,240	-0.9	2,250(4)	-2,990	-0.1	5,240	0	-0.8	5,240	0	-0.8
	Edinburgh(1)	3,000	288.0	-	-	1,250(3)	1,250	0.1(2)	-	-	-	-	-	-
	Ironwood(1)	8,000	273.6	-	-	3,750(3)	3,750	-9.6	-	-	-	-	-	-
	GSTW1-20(1)	4,320	288.2	-	-	4,100(3)	4,100	0.1(2)	-	-	-	-	-	-
	Steffler(1)	3,600	285.7	-	-	1,500(3)	1,500	-0.5	-	-	-	-	-	-
Northeast	Park Wells	8,000	281.0	6,680	-0.1	6,580(4)	-100	-1.1	6,300(4)	-380	-1.3	6,600	-80	-0.2
	Emma	2,800	278.2	2,390	-0.3	2,100(4)	-290	-3.8	2,100(4)	-290	-3.4	2,360	-30	-0.3
	Helmar	800	321.4	670	-0.1	650	-20	-0.5	450(4)	-220	-0.0	670	0	0.0(2)
	Clythe(1)	3,395	309.3	-	-	-	-	-	1,500(3)	1,500	-0.6	-	-	-
	Fleming(1)	2,200	310.7	-	-	-	-	-	1,100(3)	1,100	-0.3	-	-	-
	Logan(1)	4,700	281.5	-	-	-	-	-	4,250(3)	4,250	-0.4	-	-	-

City Quadrant	Municipal Well/Source	Maximum Individual Well Capacity Threshold (m^3/day)	Adjusted Simulated Low Water Threshold (m asl)	Current Capacity Scenario		Scenario A2 A			Scenario A3 A			Scenario A4 A		
				Pumping Rate (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	A2 A Pumping vs. Current Capacity Pumping (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	A3 A Pumping vs. Current Capacity Pumping (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	A4 A Pumping vs. Current Capacity Pumping (m^3/day)	Available Head (m)
Northwest	Paisley	1,400	298.5	940	-0.0	840	-100	-0.9	940	0	-0.0	840(4)	-100	0.1(2)
	Calico	1,400	294.2	1,400	-13.2	1,400	0	-13.2	1,400	0	-13.2	1,400	0	-12.0
	Queensdale	1,100	295.9	760	-0.5	660	-100	-0.9	760	0	-0.5	760	0	-0.1
	Hauser(1)	900	317.7	-	-	-	-	-	-	-	-	510(3)	510	-0.1
	Sacco(1)	1,150	321.2	-	-	-	-	-	-	-	-	150(3)	150	-0.7
	Smallfield(1)	1,408	284.3	-	-	-	-	-	-	-	-	980(3)	980	-30.5
	Sunny Acres(1)	5,000	276.7	-	-	-	-	-	-	-	-	0		-22.3
	Glen Collector	-	-	7,240	-	7,300	60	-	7,190	-50	-	7,310	70	-
Total Wells		**131,710**	**-**	**59,520**	**-**	**64,180**	**4,660**	**-**	**63,180**	**3,660**	**-**	**60,950**	**1,430**	**-**
Total (Wells + Collector)		**-**	**-**	**66,760**	**-**	**71,480**	**4,720**	**-**	**70,370**	**3,610**	**-**	**68,260**	**1,500**	**-**

Notes:
(1) Future Scenario Well
(2) Low water level threshold exceedance
(3) Pumping rate is greater than rate in the Current Capacity Scenario
(4) Pumping rate is less than rate in the Current Capacity Scenario
(5) Pumping rate is set to 0 m^3/day

Table 7 Scenario A2-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[(1)]	Current Capacity Groundwater Discharge (m^3/day)	Scenario A2 A Groundwater Discharge (m^3/day)	Change in Groundwater Discharge (m^3/day)	Percent Change in Groundwater Discharge
Blue Springs Creek	Coldwater	41,769	41,716	-53	0%
Chilligo/Ellis Creek	Coldwater	14,618	14,580	-38	0%
Cox Creek	Coldwater	2,354	2,361	7	0%
Clythe Creek	Coldwater	1,906	1,927	21	1%
Eramosa River	Coldwater	122,620	122,556	-64	0%
Guelph Lake Tributary	Coldwater	9,430	9,451	21	0%
Hanlon Creek	Coldwater	3,718	3,249	-469	-13%[(2)]
Hopewell Creek	Coldwater	21,514	21,548	34	0%
Irish Creek	Warmwater	5,807	4,830	-977	-17%[(2)]
Lutteral Creek	Coldwater	34,184	34,208	24	0%
Marden Creek	Warmwater	2,982	3,004	22	1%
Mill Creek	Coldwater	38,566	38,276	-290	-1%
Moffat Creek	Coldwater	2,061	2,058	-3	0%
Speed River	Coldwater	246,216	246,332	116	0%
Swan Creek	Coldwater	5,908	5,919	11	0%
Torrance Creek	Warmwater	771	733	-38	-5%
West Credit River	Coldwater	30,642	30,632	-10	0%

Notes:
(1) From MNR (2013) and GRCA (2013) in Matrix (2017)
(2) Reduction in simulated groundwater discharge is greater than 10%

3.1.3 Northeast Quadrant Scenario A3-A: Clythe, Fleming, and Logan

The wells within the northeast quadrant of Guelph (i.e., Park, Emma and Helmar wells) have an estimated average-day capacity of 9,740 m^3/day in the Current Capacity Scenario. Scenario A3-A estimates the increase in total system capacity by introducing the inactive Clythe well and the Fleming and Logan test wells. Within the Tier Three model, the Clythe well is located within an interpreted zone of relatively high hydraulic conductivity in the Middle Gasport Formation, and Fleming and Logan are just north of this zone (Figure 1). The nearest active municipal wells are all greater than 3 km away.

The estimated total system capacity with these three wells added is 70,370 m^3/day (Table 6). These three new wells contribute 6,850 m^3/day to the total, and the cumulative rate produced by the northeast quadrant wells is estimated to be 15,700 m^3/day. The analysis shows that decreasing the rates at Emma, Helmar, and Park wells allow for more pumping at the new wells, which increases the overall system capacity. Ultimately, the introduction of these new wells, along with decreasing rates at some other wells allows for a net increase in system capacity of 3,610 m^3/day.

In comparison to the Current Capacity Scenario, the estimated reductions in groundwater discharge as a result of Scenario A3-A are less than 10% in all coldwater streams except for Clythe Creek (24%; Table 8). The Tier Three model is not calibrated to groundwater pumping conditions at the Clythe Creek well location. There is resulting uncertainty with the estimated effects on the Creek's baseflow and, as a result, baseflow to the creek was not considered as part of the water supply capacity optimization. However, without additional field data and model calibration, the simulated impacts are the best available estimates of surface water effects from increased pumping. These predicted effects on baseflow may not translate to ecological effects. The headwaters of Clythe Creek are a coldwater stream that has historically sustained a trout population (Amec Foster Wheeler 2017); however, the most recent warmwater temperature results suggests that the lower and mid-reaches of the creek are considerably degraded. Should the City wish to pursue additional groundwater supplies in the northeast quadrant, the estimated effects to Clythe Creek should be evaluated with additional local calibration of the model as well as consideration of the potential local ecological impacts. The City is currently undertaking additional studies in this area (e.g., as part of the return to service of the Clythe well) and this data can be used to supplement the model at a later date. Should the City wish to pursue additional groundwater supplies in the northeast quadrant, the estimated effects to Clythe Creek should be evaluated with additional local calibration of the model as well as consideration of the potential local ecological impacts.

Table 8 Scenario A3-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater(1)	Current Capacity Groundwater Discharge (m^3/day)	Scenario A3 A Groundwater Discharge (m^3/day)	Change in Groundwater Discharge (m^3/day)	Percent Change in Groundwater Discharge
Blue Springs Creek	Coldwater	41,769	41,860	91	0%
Chilligo/Ellis Creek	Coldwater	14,618	14,602	-16	0%
Clythe Creek	Coldwater	1,906	1,450	-456	-24%(2)
Cox Creek	Warmwater	2,354	2,349	-5	0%
Eramosa River	Coldwater	122,620	121,866	-753	-1%
Guelph Lake Tributary	Coldwater	9,430	9,038	-392	-4%
Hanlon Creek	Coldwater	3,718	3,659	-59	-2%
Hopewell Creek	Coldwater	21,514	21,506	-8	0%
Irish Creek	Warmwater	5,807	5,806	-1	0%
Lutteral Creek	Coldwater	34,184	34,166	-18	0%
Marden Creek	Warmwater	2,982	2,939	-43	-1%
Mill Creek	Coldwater	38,566	38,549	-18	0%
Moffat Creek	Coldwater	2,061	2,062	1	0%
Speed River	Coldwater	246,216	242,781	-3,435	-1%
Swan Creek	Coldwater	5,908	5,865	-43	-1%
Torrance Creek	Warmwater	771	752	-19	-2%
West Credit River	Coldwater	30,642	30,603	-39	0%

Notes:

(1) From MNR (2013) and GRCA (2013) in Matrix (2017)

(2) Reduction in simulated groundwater discharge is greater than 10%

3.1.4 Northwest Quadrant Scenario A4-A: Sacco, Smallfield, Hauser, and Sunny Acres

The wells within the northwest quadrant of Guelph (Paisley, Calico and Queensdale wells) have an estimated average-day capacity of 3,100 m^3/day in the Current Capacity Scenario. Scenario A4-A estimates the incremental system capacity with pumping at the inactive Sacco and Smallfield wells and introducing the Hauser test well and a hypothetical well located in Sunny Acres Park (Figure 1). A location in Sunny Acres Park, based on a monitoring well location (MW06-05), was previously considered as part of the last Water Supply Master Plan update (AECOM and Golder 2014) but has not yet been field tested. Sacco, Smallfield, and Hauser wells are all located 1,700 to 2,800 m northwest of Paisley well, within a relatively lower hydraulic conductivity area of the middle Gasport as simulated in the Tier Three model. The hypothetical Sunny Acres well is proposed to the east between the Paisley, Water Street, and Park wells.

The estimated system capacity with these four wells added is 68,260 m^3/day (Table 6). Pumping at Sunny Acres results in a reduction of water levels at the surrounding municipal wells below the applied head constraints. Decreasing the pumping rate at Paisley well allows these new wells to pump at higher rates, which increases the overall system capacity. The three new wells (Hauser, Sacco, and Smallfield wells) contribute 1,640 m^3/day to the total, and the estimated total rate produced by the northwest quadrant wells is 4,640 m^3/day. Ultimately, the introduction of these new wells, along with decreasing rates at some other wells, allows for an increase in average day capacity of 1,500 m^3/day.

In comparison to the Current Capacity Scenario, all reductions in simulated groundwater discharge to streams as a result of Scenario A4-A are predicted to be less than 10% (Table 9).

Table 9 Scenario A4-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater(1)	Current Capacity Groundwater Discharge (m^3/day)	A3 A Groundwater Discharge (m^3/day)	A3 A Change in Groundwater Discharge (m^3/day)	A3 A Percent Change in Groundwater Discharge
Blue Springs Creek	Coldwater	41,769	41,656	-113	-0%
Chilligo/Ellis Creek	Coldwater	14,618	14,118	-500	-3%
Clythe Creek	Coldwater	1,906	1,910	4	0%
Cox Creek	Warmwater	2,354	2,340	-14	-1%
Eramosa River	Coldwater	122,620	122,473	-147	0%
Guelph Lake Tributary	Coldwater	9,430	9,432	2	0%
Hanlon Creek	Coldwater	3,718	3,709	-9	0%
Hopewell Creek	Coldwater	21,514	21,305	-208	-1%
Irish Creek	Warmwater	5,807	5,800	-7	0%
Lutteral Creek	Coldwater	34,184	34,188	4	0%
Marden Creek	Warmwater	2,982	2,961	-21	-1%
Mill Creek	Coldwater	38,566	38,570	3	0%
Moffat Creek	Coldwater	2,061	2,061	0	0%
Speed River	Coldwater	246,216	245,916	-300	0%
Swan Creek	Coldwater	5,908	5,918	11	0%
Torrance Creek	Warmwater	771	747	-24	-3%
West Credit River	Coldwater	30,642	30,638	-5	0%

Notes:

(1) From MNR (2013) and GRCA (2013) in Matrix (2017)

(2) Reduction in simulated groundwater discharge is greater than 10%

3.1.5 Combined Well Sources Scenario A5-A: Edinburgh, Ironwood, GSTW1-20, Steffler, Clythe, Fleming, Logan, Hauser, Sacco, Smallfield

Scenario A5-A combines Scenarios A2-A through A4-A and includes well sources identified to potentially provide additional capacity. These additional wells (in addition to the existing municipal supply sources considered as part of the Current Capacity Scenario) include inactive wells Edinburgh, Sacco, Smallfield, and Clythe and test wells Ironwood, Steffler, GSTW1-20, Fleming, Logan, and Hauser.

The estimated average-day capacity with these ten wells added is 76,740 m^3/day (Table 10). These ten wells contribute 18,820 m^3/day to the total. Decreasing the rates at Arkell 7, Arkell 14, Membro, Water Street, Downey, Park, Helmar, Paisley, and Queensdale wells allows these new wells to pump at higher rates, which increases the system capacity overall. The rate reduction of these wells from the Current Capacity Scenario wells is cumulatively 7,390 m^3/day. The optimized scenarios have Dean and University wells not pumping, a cumulative reduction of 1,390 m^3/day, as in Scenario A2-A. The introduction of the new wells results in an increased average-day capacity of 9,980 m^3/day.

In comparison to the Current Capacity Scenario, the largest simulated reductions in groundwater discharge to streams are 13% (500 m^3/day), 17% (998 m^3/day) and 24% (468 m^3/day) at Hanlon (coldwater), Irish (warmwater) and Clythe (coldwater) Creeks, respectively (Table 11). The simulated reductions at Hanlon and Irish Creeks are caused by the increased rates in the southwest quadrant (comparable to Scenario A2-A). The simulated reduction at Clythe Creek is caused by the increased rates in the northeast quadrant, specifically the Clythe well (comparable to Scenario A3-A). As described previously, the model is not well calibrated in the areas around Clythe Creek and there is some uncertainty relating to the estimated effects on this creek. However, without local model calibration, the simulated impacts are the best available estimates at this time. Furthermore, the creek is degraded with warm temperature conditions in the lower and mid-reaches of the creek and any local ecological effects should consider more recent or current aquatic studies, including additional studies in the area currently being undertaken by the City. This data can be used to supplement the groundwater flow model at a later date. The remaining groundwater discharge reductions are less than 5%.

Table 10 Summary of the Optimized Well Rates and Available Head Exceedances for Current Capacity Scenario and Scenario A5-A

City Quadrant	Municipal Well/Source	Maximum Individual Well Capacity Threshold (m^3/day)	Adjusted Simulated Low Water Threshold (m asl)	Current Capacity Scenario		Scenario A5 A		
				Pumping Rate (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	A5 A versus Current Capacity Pumping (m^3/day)	Available Head (m)
Southeast	Arkell 1	2,000	319.5	2,000	-2.0	2,000	0	-2.0
	Arkell 6	8,000	305.7	1,500	-5.1	1,500	0	-4.9
	Arkell 7	8,000	305.7	8,000	-3.6	7,000(4)	-1,000	-3.6
	Arkell 8	7,000	311.1	0	0.1(2)	0	0	0.2(2)
	Arkell 14	7,000	310.9	3,100	0.0(2)	1,800(4)	-1,300	0.0(2)
	Arkell 15	7,000	304.4	7,000	-5.3	7,000	0	-4.9
	Burke	6,500	323.4	5,200	-0.2	5,200	0	-0.1
	Carter Wells	6,400	318.5	6,100	-0.0	6,100	0	0.1(2)
Southwest	Membro	5,200	282.1	5,200	-0.8	4,700(4)	-500	-0.8
	Water St.	2,700	289.24	1,950	-0.1	1,500(4)	-450	0.1(2)
	Dean	1,500	289.9	540	-0.0	0(5)	-540	-0.1
	University	2,500	290.4	850	-0.3	0(5)	-850	2.5(2)
	Downey	5,237	286.4	5,240	-0.9	2,250(4)	-2,990	0.00
	Edinburgh(1)	3,000	288.0	-	-	980	980	-0.0
	Ironwood(1)	8,000	273.6	-	-	3,750(2)	3,750	-9.5
	GSTW1-20(1)	4,320	288.2	-	-	4,100(2)	4,100	0.1(2)
	Steffler(1)	3,600	285.7	-	-	1,500(2)	1,500	-0.38
Northeast	Park Wells	8,000	281.0	6,680	-0.1	6,300(4)	-380	-0.9
	Emma	2,800	278.2	2,390	-0.3	2,100	-290	-2.9
	Helmar	800	321.4	670	-0.1	400(4)	-270	-0.0
	Clythe(1)	3,395	309.3	-	-	1,500(2)	1,500	-0.5
	Fleming(1)	2,200	310.7	-	-	1,100(2)	1,100	-0.2
	Logan(1)	4,700	281.5	-	-	4,250(2)	4,250	-0.1
Northwest	Paisley	1,400	298.5	940	-0.0	790(4)	-150	-0.1
	Calico	1,400	294.2	1,400	-13.2	1,400	0	-11.9
	Queensdale	1,100	295.9	760	-0.5	700	-60	0.1(2)
	Hauser(1)	900	317.7	-	-	510(2)	510	-0.0
	Sacco(1)	1,150	321.2	-	-	150(2)	150	-0.6
	Smallfield(1)	1,408	284.3	-	-	980(2)	980	-30.4
	Glen Collector	-	-	7,240	-	7,180	-60	-
Total (Wells)		**131,710**	**-**	**59,520**	**-**	**69,560**	**10,040**	**-**
Total (Wells + Collector)		**-**	**-**	**66,760**	**-**	**76,740**	**9,980**	**-**

Notes:
(1) Future Scenario Well
(2) Low water level threshold exceedance
(3) Pumping rate is greater than rate in the Current Capacity Scenario
(4) Pumping rate is less than rate in the Current Capacity Scenario
(5) Pumping rate is set to 0 m^3/day

Table 11 Scenario A5-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[1]	Current Capacity Net Groundwater Discharge	A3 A Net Groundwater Discharge	A3 A Change in Net Groundwater Discharge	A3 A Percent Change in Net Groundwater Discharge
Blue Springs Creek	Coldwater	41,769	41,653	-116	0%
Chilligo/Ellis Creek	Coldwater	14,618	14,043	-575	-4%
Clythe Creek	Coldwater	1,906	1,438	-468	-24%[2]
Cox Creek	Warmwater	2,354	2,331	-23	-1%
Eramosa River	Coldwater	122,620	121,729	-890	-1%
Guelph Lake Tributary	Coldwater	9,430	9,034	-396	-4%
Hanlon Creek	Coldwater	3,718	3,218	-500	-13%[2]
Hopewell Creek	Coldwater	21,514	21,274	-240	-1%
Irish Creek	Warmwater	5,807	4,809	-998	-17%[2]
Lutteral Creek	Coldwater	34,184	34,174	-10	0%
Marden Creek	Warmwater	2,982	2,933	-49	-2%
Mill Creek	Coldwater	38,566	38,213	-354	-1%
Moffat Creek	Coldwater	2,061	2,057	-4	0%
Speed River	Coldwater	246,216	242,381	-3,835	-2%
Swan Creek	Coldwater	5,908	5,907	-1	0%
Torrance Creek	Warmwater	771	733	-38	-5%
West Credit River	Coldwater	30,642	30,640	-3	0%

Notes:

(1) From MNR (2013) and GRCA (2013) in Matrix (2017)

(2) Reduction in simulated groundwater discharge is greater than 10%

3.2 Quarry Water Capture Scenario B1

The Quarry Water Capture Scenario B1 evaluates the potential of increasing pumping from municipal wells near the Dolime Quarry (Figure 1) under the conceptual Pond Level Management strategy. This strategy requires inward gradients to the quarry pond to prevent the outflow of poor quality water to the aquifer. The concept tested as part of Scenario B1 is to evaluate potential increased pumping from municipal wells and reduced dewatering rates, while maintaining a 1 m hydraulic head gradient from the Middle Gasport Formation at the MW08-02A location toward the base of the quarry. This 1 m hydraulic head gradient criteria serves to ensure that there is a groundwater gradient into the pond, and that surface water within the pond does not leak into the water supply aquifer. AECOM provided Matrix initial direction to evaluate the scenario with the water level in the quarry equal to 288.39 m above sea level (asl), which is consistent with the current PTTW.

The Dolime Quarry is simulated with a high hydraulic conductivity zone (i.e., 5.00E-01 m/s) to represent the open excavation and a constant head boundary condition at 288.39 m asl reflecting the current quarry pond level and dewatering operations.

The initial scenario results indicated that the proposed quarry water capture scenario could not offer an incremental water supply given that the MW08-02A water level constraint (i.e., 1 m hydraulic gradient) was already violated under the Current Capacity Scenario. As shown in Table 12, the Current Capacity Scenario had a head difference of 0.23 m between the Dolime Quarry pond elevation and MW08-02A.

Two main components of the groundwater flow system influence the gradient between MW08-02A and the quarry. These two components include the hydraulic head applied to the quarry boundary condition (i.e., the water level to which the quarry is dewatered) and the pumping rate at nearby Membro well. Table 12 summarizes the values of these parameters for the Current Capacity Scenario.

The Quarry Water Capture Scenario was further evaluated by evaluating the effects of making adjustments to both the pond elevation and the Membro pumping rate. Table 12 summarizes seven sub-scenarios carried out to further investigate different combinations of Membro pumping rates, Dolime pond water level constraints, and the resulting Dolime dewatering rates. A head difference greater than 1 m between the quarry pond and MW08-02A was only achieved by sufficiently reducing the pumping rate at the nearby Membro well (i.e., Scenarios B1-5 and B1-7). When increasing the quarry pond boundary condition elevation (Scenarios B1-2 and B1-3), the simulated Dolime dewatering discharge rate decreases by approximately 500 m^3/day per meter increase, while the head difference between MW08-02A and the quarry pond decreases. Under Scenario B1-3, the gradient would be inverted from the quarry to the Middle Gasport Formation, which is not the desired outcome. These results suggest that the total capacity of the water supply system may be lower than that predicted by the Current Capacity Scenario by approximately 2,000 m^3/day if a 1 m gradient is enforced between MW08-02A and the Dolime Quarry. For completeness, the simulated water levels at MW08-02A are also provided for all scenarios (A2 through A5).

While this scenario does not identify additional capacity with the City's existing pumping wells and the constraints employed, there is more work required to evaluate the water supply opportunity at Dolime. Some of the alternatives requiring further evaluation include:

- Model refinement and calibration. The City is currently undertaking detailed field testing, and the results of these testing efforts will be used to refine and calibrate the model. The outcome of this work will be to ensure that the model offers the precision and accuracy needed to evaluate this complex water supply alternative.

- Further evaluation of the pond level and hydraulic head gradient constraints. Lowering the pond level and lowering the hydraulic head gradient to below 1.0 m may increase available water supply.

- Modifying the groundwater divide. Modifying the location of the groundwater divide (i.e., closer to the pond) may also impact the estimate of available water.

- Utilizing quarry discharge. Under the current scenarios, the quarry discharge rate ranges from just over 4,50 m^3/day to almost 6,200 m^3/day. This excess discharge suggests that there are alternatives to pumping additional groundwater such as treating the quarry water to potable conditions.

These above and other alternatives will be examined as part of the more detailed work that comes out of the operational testing program currently underway for the Dolime Quarry. For the purpose of this assessment, the incremental water supply capacity of the Dolime Quarry is assumed to be 5,000 m^3/day under the Current Capacity pumping conditions. This supply capacity represents a combination of additional pumping for existing or new wells or the treatment of quarry discharge water.

Table 12 Scenario B1: Summary of Quarry Water Capture Scenario Results Considering Current Municipal Wells

Scenario	Dolime Quarry BC Elevation (m asl)	Dolime Quarry Boundary Condition Discharge Rate (m^3/day)	MW08 02A Water Level (m^3/day)	Head Difference(1) (m)	Membro Well Water Level (m asl)	Membro Well Pumping Rate (m^3/day)
Current Capacity	288.39	4,966	288.62	0.23	282.82	5,199
B1-2	289.25	4,542	289.33	0.08	283.43	5,199
B1-3	290.25	4,045	290.16	-0.09	284.14	5,199
B1-4	289.25	4,897	289.57	0.32	284.41	4,700
B1-5	289.25	6,109	290.39	1.14	287.76	3,000
B1-6	288.39	5,820	289.20	0.81	285.18	4,000
B1-7	288.39	6,181	289.44	1.05	286.17	3,500
A2-A	288.39	3,643	288.35	-0.04	282.93	4,700
A3-A	288.39	4,877	288.57	0.18	282.72	5,199
A4-A	288.39	4,801	288.56	0.17	282.73	5,200
A5-A	288.39	3,432	288.29	-0.10	282.85	4,700

Note:

(1) Head difference between the Dolime Quarry constant head boundary condition and the MW08-02A simulated head.

3.3 Arkell Recharge/Collector Optimization Scenarios

The City operates an artificial groundwater recharge system with a shallow groundwater collector referred to as the Glen Collector. The City pumps surface water from the Eramosa River, followed by infiltration into groundwater through the Arkell groundwater recharge system consisting of a pond and trench. A portion (approximately 50%) of this infiltrated water supplements groundwater recharge to the Glen Collector.

Under the Current Capacity Scenario, the steady-state infiltration of water from the Eramosa River into the Arkell recharge system is simulated as 3,290 m^3/day. This is an average of annual infiltration, recognizing that infiltration rates vary seasonally according to the requirements of the City's current PTTW. A portion of this water, along with natural shallow groundwater discharge to the Glen Collector, results in 7,240 m^3/day being collected at the Glen Collector (i.e., 220% of what was infiltrated). The Arkell recharge/collector scenarios described in the following sections are designed to evaluate the potential to achieve higher collection rates and efficiencies.

3.3.1 Increased Eramosa River Recharge Scenario C1

Scenario C1 evaluates the increased rate of water collection at the Glen Collector (i.e., total due to Arkell infiltration plus shallow groundwater flow) if the Eramosa River taking is increased to higher rates allowed under the PTTW. The amount of water withdrawn from the Eramosa River is currently limited by:

- seasonal PTTW conditions on maximum daily takings (Table 13)
- a requirement to maintain a minimum flow in the Eramosa River of 37,152 m^3/day (0.43 m^3/s)
- the existing Eramosa pump capacity of 9,072 m^3/d

Table 13 Seasonal Permitted Pumping Rates of the Eramosa River as Listed in the Permit to Take Water

Season	Permitted Pumping Rates (m^3/day)
April 15 to May 31	31,822
June 1 to June 30	22,730
July 1 to July 15	18,184
July 16 to August 31	13,638
September 1 to November 15	9,092

Note:
Water extraction from the Eramosa River is permitted only when the baseflow is greater than 37,152 m^3/day (0.43 m^3/s).

Scenario C1 evaluates the potential increase in Glen Collector flows under both steady-state and transient conditions considering three sets of infiltrations rates. These infiltration rates correspond to the existing pump capacity (0.105 m^3/s or 9,072 m^3/day), double pump capacity (0.21 m^3/s or 18,144 m^3/day), and triple pump capacity (0.32 m^3/s or 27,648 m^3/day).

The objective of the steady-state scenarios is to provide a general prediction of the average annual volumetric rate of water collected by the Glen Collector. The steady-state scenarios include the municipal wells pumping at the Current Capacity Scenario rates, average annual groundwater recharge across the model, and the equivalent average annual infiltration rate into the Arkell pond and trench.

The objective of the transient scenarios is to develop insight into the seasonal variability of the water collected by the Glen Collector. The transient model simulations include the first 7 years of the 10-year Tier Three drought scenario, using the same approach followed for the Lower Road Collector scenario (Section 3.1.1; Scenario A1-A). The transient scenarios use the pumping rates established in the earlier Drought Capacity Scenario and monthly-varying average infiltration rates into the pond and trench for the 7-year transient period.

To complete this evaluation, observed Eramosa River baseflow data from the Water Survey of Canada Eramosa River Gauge between 1962 and 2006 were evaluated to estimate maximum allowable pumping rates under the seasonal conditions of the PTTW. Average monthly groundwater infiltration rates applied to the model were calculated based on the maximum pump capacity and the amount of river water available while maintaining a flow of 37,152 m^3/day (0.43 m^3/s) in the river. Table 14 summarizes the average monthly infiltration rates for the three pump capacities evaluated.

Table 14 Scenario C1: Average Monthly Infiltration Rates

Month	Existing Eramosa Pump Capacity 0.105 m^3/s (9,072 m^3/day)			Double Eramosa Pump Capacity 0.21 m^3/s (18,144 m^3/day)			Triple Eramosa Pump Capacity 0.32 m^3/s (27,648 m^3/day)		
	Monthly Average (m^3/day)	Min Daily Rate (m^3/day)	Max Daily Rate (m^3/day)	Monthly Average (m^3/day)	Min Daily Rate (m^3/day)	Max Daily Rate (m^3/day)	Monthly Average (m^3/day)	Min Daily Rate (m^3/day)	Max Daily Rate (m^3/day)
January	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0
April	4,682	4,682	4,682	9,365	9,365	9,365	14,270	14,270	14,270
May	9,368	9,072	9,374	18,655	15,725	18,749	28,303	19,354	28,570
June	8,435	4,682	8,779	16,414	7,609	17,559	21,099	6,243	22,730
July	8,326	3,326	9,374	12,250	0	15,725	12,595	0	15,911
August	6,880	0	9,072	10,020	0	13,638	9,867	0	13,638
September	6,276	0	8,779	6,886	0	9,092	6,819	0	9,092
October	8,206	907	9,092	8,565	1,210	9,092	8,415	1,843	9,092
November	4,201	1,171	4,390	8,116	1,171	8,779	8,359	892	9,092
December	0	0	0	0	0	0	0	0	0
Average	4,698	1,987	5,295	7,523	2,923	8,500	9,144	3,550	10,200
Minimum	0	0	0	0	0	0	0	0	0
Maximum	9,368	9,072	9,374	18,655	15,725	18,749	28,303	19,354	28,570

Chart 2 illustrates the transient discharge from the Glen Collector for the three pump capacity scenarios based on the transient infiltration rates provided in Table 14. As illustrated in this chart, increasing the pump capacity results in significant increases in maximum discharge; however, minimum discharge rates into the Glen Collector during periods where pumping is not permitted does not increase.

While the simulated total Glen Collector discharge rate exceeds 25,000 m^3/day for the highest pumping scenario, the collector flows are currently limited in the PTTW to 25,000 m^3/day. The simulated annual minimum Glen Collector discharge rates for each Eramosa pump capacity scenario are summarized in Table 15. The lowest simulated discharge is 1,932; 2,050; and 2,126 m^3/day for the existing, double, and triple pump capacity scenarios, respectively.

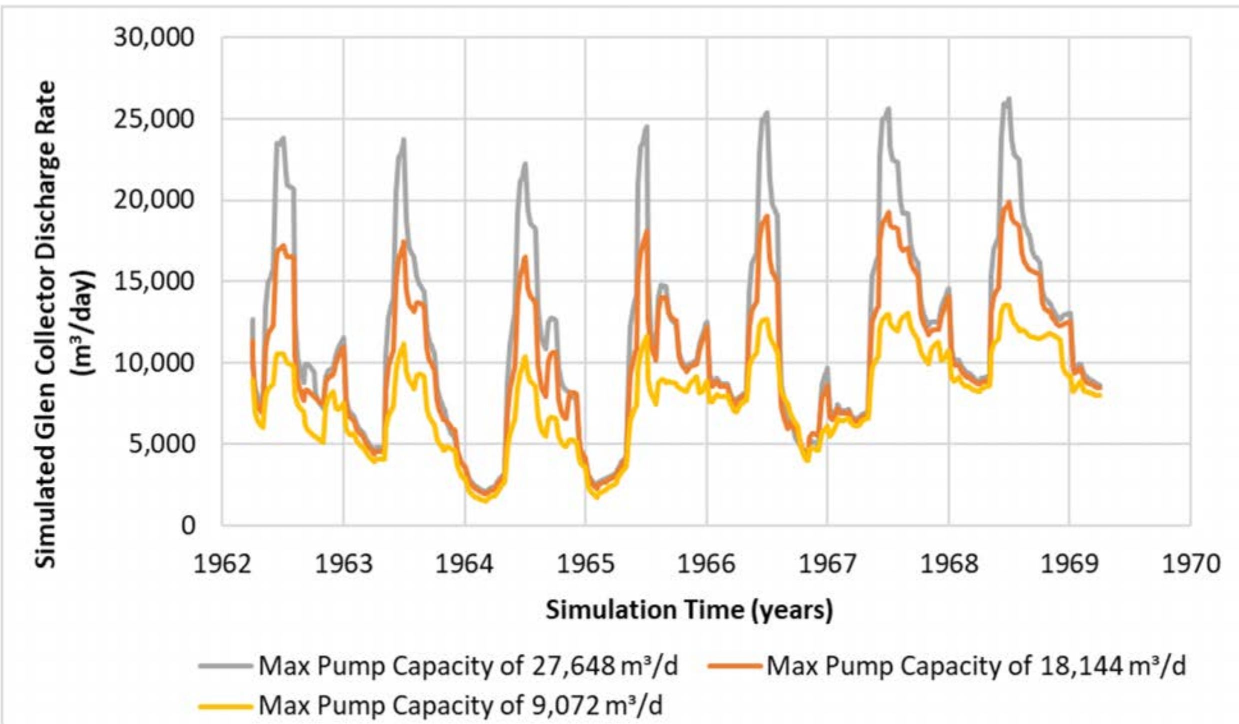

Chart 2 Simulated Total Transient Glen Collector Discharge Under the Various Pump Capacity Scenarios

Table 15 Scenario C1: Simulated Total Glen Collector Annual Minimum Discharge Rates

Year	Glen Collector Discharge (m^3/day)		
	9,072 m^3/d Pump Capacity	18,144 m^3/d Pump Capacity	27,648 m^3/d Pump Capacity
1962	5,126	6,915	7,378
1963	2,353	3,017	3,691
1964	1,957	2,050	2,126
1965	1,932	2,368	2,682
1966	4,269	4,491	4,439
1967	5,519	6,685	6,848
1968	8,268	8,952	8,919

For the evaluation of Glen Collector discharge under steady-state conditions, average annual infiltration rates of 4,698; 7,523; and 9,144 m^3/day were applied for the three pump capacity scenarios (Table 14). Average annual values represent the average pumping rate if the water takings were spread over the whole year. Table 16 summarizes the estimated steady-state discharge rate at the Glen Collector under the three steady-state infiltration rates, as well as the collector efficiency (i.e., calculated as the average annual Glen Collector discharge divided by the average annual infiltration). As illustrated in the table, the efficiency is highest within the Current Capacity Scenario when shallow groundwater discharge into the collector is greater than the amount infiltrated. This efficiency decreases as the amount of infiltrated water is increased in the pump capacity scenarios. As the amount of infiltrated water increases, only a portion of that infiltrated water is collected resulting in an apparent decrease in collector efficiency.

Table 16 Summary of Steady-State Arkell Infiltration and Glen Collector Discharge Scenario Results

	Current Capacity Scenario	Pump Capacity Scenario		
		9,072 (m^3/day)	18,144 (m^3/day)	27,648 (m^3/day)
Average Annual Infiltration (m^3/day)	3,290	4,698	7,523	9,144
Average Annual Glen Collector Discharge (m^3/day)	7,240	7,969	10,779	12,139
Collector Efficiency	220%	170%	143%	133%
Incremental Infiltration Over Current Capacity (m^3/day)	-	1,408	4,233	5,854
Incremental Glen Collector Discharge Over Current Capacity (m^3/day)	-	729	3,539	4,899
Incremental Collector Efficiency Over Current Capacity	-	52%	84%	84%

Table 16 also summarizes the incremental infiltration, discharge, and efficiency over Current Capacity Scenario values. The results show that while the overall collector efficiency decreases, the incremental efficiency over Current Capacity generally increases. This suggests that on an average annual basis, as more water is infiltrated and water levels rise, the Glen Collector is able to capture a higher proportion of the infiltrated water.

Table 16 also shows that at a current pump capacity of 9,072 m^3/day operating at optimal conditions, the incremental increase in Glen Collector discharge over the Current Capacity value increases by 10% (or 729 m^3/day). The incremental increase in discharge for the pump capacity of 27,648 m^3/day (tripling pump capacity) is 4,899 m^3/day.

Chart 3 illustrates a comparison of both the estimated steady-state and transient discharge rate at the Glen Collector under the three pump capacities evaluated. Similar to the steady-state results in Table 16, the results illustrated in Chart 3 indicate that increasing the recharge rate up to the maximum rate allowed by the PTTW does not result in the same proportional increase in collector discharge rate. The minimum transient Glen Collector discharge rates range from 1,519 to 2,094 m^3/day (i.e., an increase by a factor of 1.4 relative to a tripling of the pumping rate), while the maximum transient Glen Collector discharge rates range from 13,545 to 26,252 (i.e., an increase by a factor of 1.9 relative to a tripling of the pumping rate). Regardless, these scenarios indicate that if the Eramosa pump is updated to increase the maximum allowable rate, more water can be pumped from the Eramosa River, while following PTTW constraints, and this will lead to an increase in groundwater recovered from the Glen Collector. Note that while the maximum simulated Glen Collector discharge rate is predicted to exceed 25,000 m^3/day, the PTTW limits the collector flows to 25,000 m^3/day.

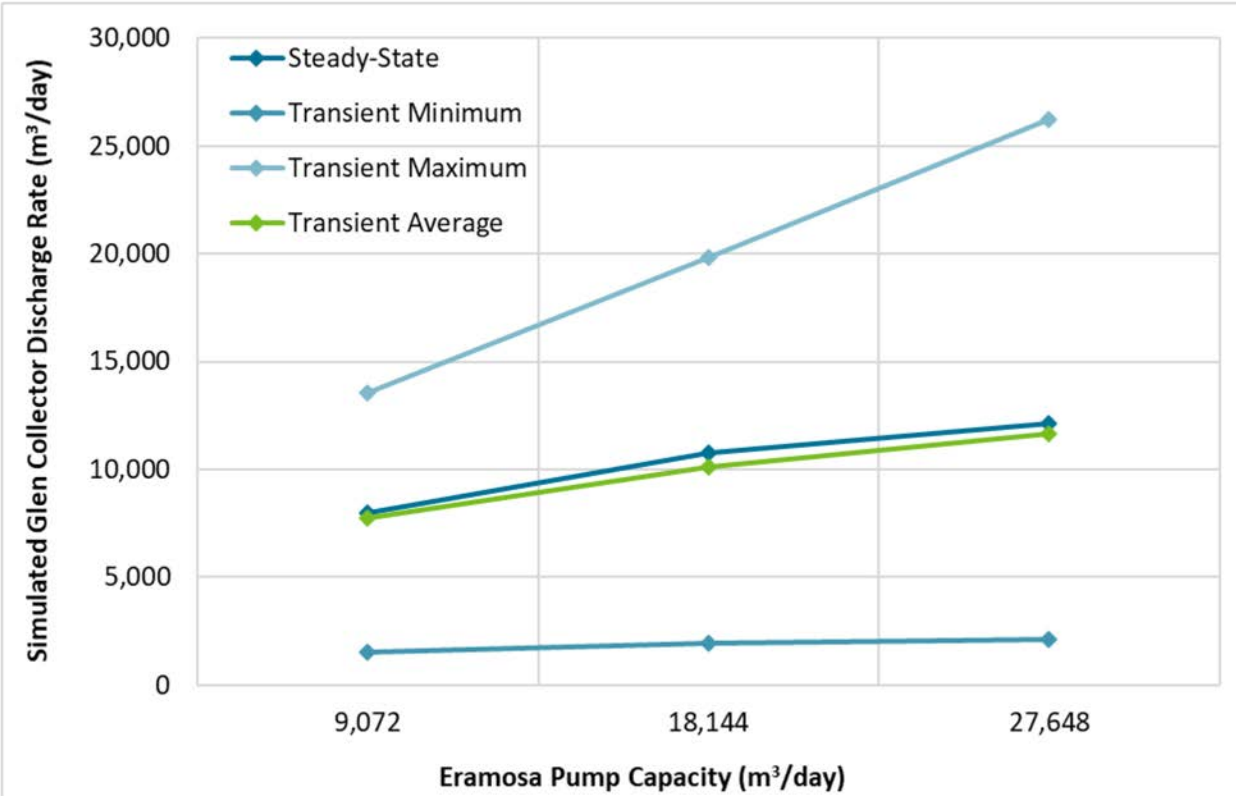

Chart 3 Estimated Glen Collector Collection Rates Versus Maximum Pump Capacity

Note that Scenario C1 only considers the Glen Collector as a possible source of water. Future evaluations may be conducted to predict how much additional water may be collected if the Lower Road Collector were to be reconstructed. Future scenarios may also be designed to evaluate alternative configurations of the collectors, and their influence on the overall efficiency of the system.

3.3.2 Alternative Recharge Gallery/Collector Configuration Scenario C2

This scenario evaluates the effectiveness of replacing the Glen Collector with a new Caisson Collector System upgradient (approximately 300 m southeast of the Glen Collector; Figure 1). The location of the Caisson Collector reflects the recommendation of the Stantec Caisson Collector study (Stantec 2006). This assessment does not consider other locations for this collector. This scenario removes the boundary conditions representing the Glen Collector System, with a corresponding simulated steady-state loss of 7,240 m^3/day. This scenario also removes the Arkell 1 well due to its proximity (within 10 m) to the proposed Caisson Collector System. The removal of Arkell 1 corresponds to a simulated loss of 2,000 m^3/day. The boundary conditions representing the artificial recharge from the Eramosa River remained active, at a constant recharge rate of 3,290 m^3/day.

Matrix initially tested several Caisson Collector System layouts under long-term steady-state conditions. The optimal design brought forward for evaluation included a Caisson Collector

System with one lateral screen projection, 110 m in length, and oriented perpendicular to the groundwater flow direction. This design is consistent with one of the potential configurations reported in Stantec (2006). The model represents the lateral screen and water withdrawal using nine constant head boundary conditions placed at the base of the coarser overburden unit (i.e., model slice 3) at an assigned elevation of 317.5 m asl. This value corresponds to the highest elevation of the underlying till unit along the length of the lateral screen. The steady-state withdrawal from the Caisson Collector System was simulated to be 9,598 m^3/day (Table 17). Under this withdrawal, discharge to the Eramosa River was simulated to decrease by 1,744 m^3/day, which corresponds to a reduction of 1% relative to the Current Capacity Scenario.

To test the range of the Caisson Collector System discharge under variable recharge, the Caisson Collector system was also evaluated transiently (using the 7-year monthly transient drought scenario; Chart 4). Under this transient simulation, the Caisson Collector System withdrawal ranged from 4,585 to 13,124 m^3/day, with an average of 8,348 m^3/day (Table 17 and Chart 4). In comparison, the Glen Collector discharge under this transient scenario ranged from 599 to 12,232 m^3/day, with an average of 6,091 m^3/day.

Relative to the Glen Collector layout, the Caisson Collector System estimated withdrawal under drought conditions is greater than that of the Glen Collector (Table 17 and Chart 4). This indicates that the Caisson Collector System provides a more reliable water supply and is less sensitive to seasonal recharge variability. The Caisson Collector System's estimated minimum withdrawal is 1,986 m^3/day greater than the current system under drought conditions (including the 2,000 m^3/day loss from Arkell 1; Table 17 and 18). The lowest simulated Caisson Collector discharge is 4,585 m^3/day, within a drought period. The Caisson Collector System maximum withdrawal rates under wetter conditions is 1,108 m^3/day less than the current configuration (including the 2,000 m^3/day loss from Arkell 1; Table 17). With the removal of the Glen Collector and Arkell Well 1 and addition of an active Caisson Collector, the system's estimated long-term capacity is 358 m^3/day greater than the Current Capacity Scenario. These results suggest that a deeper configuration such as the Caisson Collector may provide benefits over the Glen Collector by increasing the reliable water supply from the area considering both the infiltrated water and natural groundwater conditions.

The current estimate of the capacity of the Caisson concept is notably smaller than that reported in the Stantec Consulting Ltd. Caisson Collector study (Stantec 2006). Comparison of the current FEFLOW model versus the model reported by Stantec suggests that the overburden sand hydraulic conductivity and saturated thickness of the sand aquifer used by Stantec was twice that of the current model. These combined differences conceptually explain the difference between the current capacity estimates and the Stantec capacity estimate.

Further evaluation of Caisson design alternatives and potentially field studies may be helpful to evaluate the impact of the Caisson design, and its location, on water capture, seasonal variability, and efficiency.

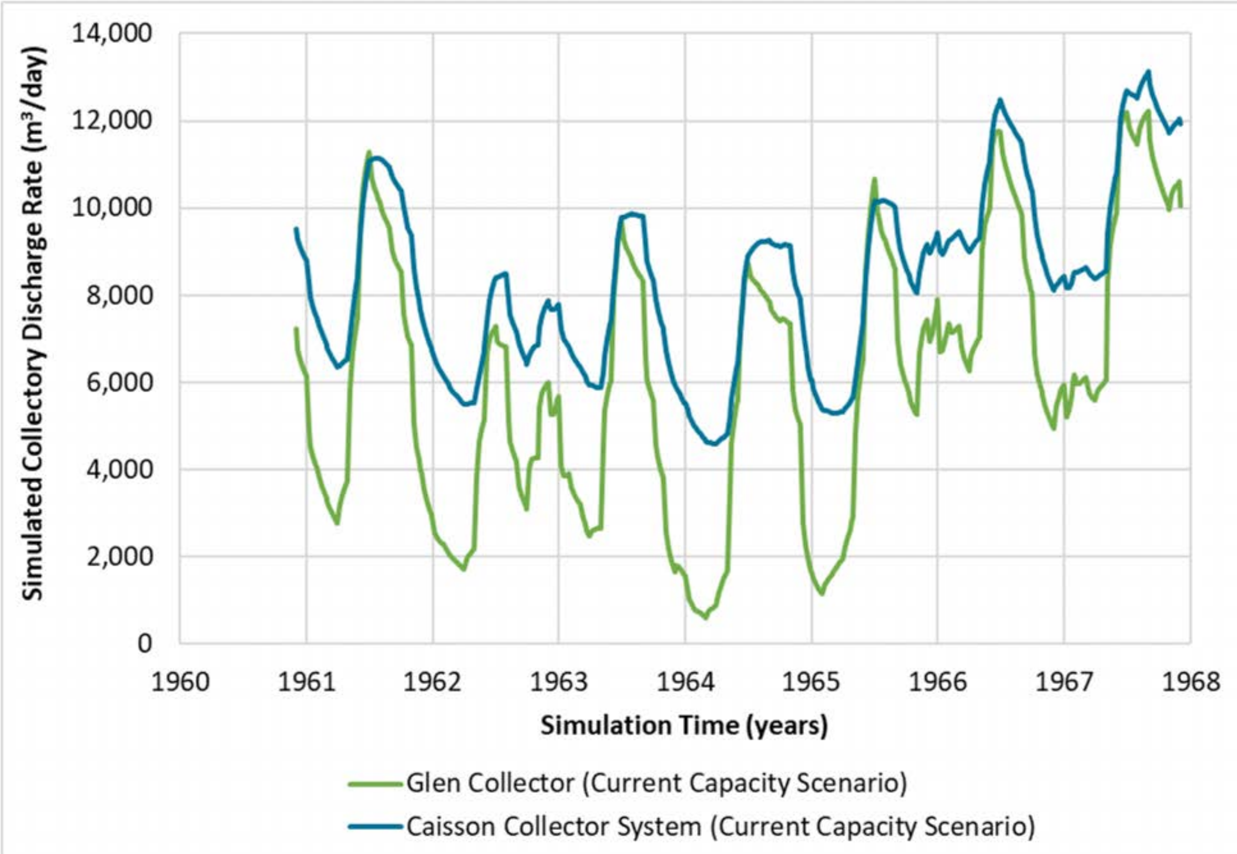

Chart 4 Simulated Transient Glen Collector and Caisson Collector Discharges

Table 17 Summary of Steady-state and Transient Glen Collector and Caisson Collection System Withdrawal Rates

Scenario	System	Steady State Withdrawal (m^3/day)	Transient Minimum Withdrawal (m^3/day)	Transient Maximum Withdrawal (m^3/day)	Transient Average Withdrawal (m^3/day)
Current Capacity	Glen Collector	7,240	599	12,232	6,091
	Arkell 1	2,000	2,000	2,000	2,000
	Glen Collector + Arkell 1	9,240	2,599	14,232	8,091
C2	Caisson Collector System (one lateral screen projection of 110 m)	9,598	4,585	13,124	8,348
Difference between C2 and Current Capacity		358	1,986	-1,108	257

Table 18 Scenario C2: Simulated Caisson Collector Annual Minimum Rates

Year	Glen Collector (Current Capacity Rates) (m^3/day)	Caisson Collector (Current Capacity Rates) (m^3/day)
1961	2,442	6,358
1962	1,718	5,506
1963	1,223	5,541
1964	599	4,585
1965	1,146	5,302
1966	4,950	8,305
1967	5,222	8,163

4 Summary

This report summarizes the modelling results of a number of scenarios evaluated to estimate the average-day capacity of the City's existing water supply sources and potential new sources within the City. Potential future sources of water include:

- use of inactive wells and collectors, test wells, and hypothetical wells in areas where additional supply may be available
- the area of the Dolime Quarry and introduction of the Pond Level Management strategy
- optimization and reconfiguration of the Arkell recharge and collector system

Table 19 summarizes the simulated total system capacities for each scenario, as well as the additional simulated capacity over and above that of the current water supply system.

Table 19 Summary of System Capacity for Future Supply Scenarios

Scenario Set	Potential Supply Area	Scenario Number: Potential Additional Supply Description	Simulated Average Day Capacity (m^3/day)	Capacity Over Current Capacity Scenario (m^3/day)
Current System Capacity		Current municipal wells and Glen Collector	66,760	-
A Additional Wells and Existing Collector	Southeast Quadrant	A1-A: Lower Road Collector	69,811[1]	3,051
	Southwest Quadrant	A2-A: Additional well supply from: Edinburgh, Steffler, Ironwood and GSTW1-20	71,480	4,720
	Northeast Quadrant	A3-A: Additional well supply from: Clythe, Fleming, and Logan	70,370	3,610
	Northwest Quadrant	A4-A: Additional well supply from: Sacco, Smallfield, Hauser and hypothetical Sunny Acres Park location	68,260	1,500
	Multiple Quadrants	A5-A: Additional well supply from: Edinburgh, Steffler, Ironwood, GSTW1-20, Clythe, Fleming, Logan, Sacco, Smallfield, and Hauser	76,740	9,980
B Dolime Quarry Water Capture		B1: Dolime Quarry capture considering current municipal wells	71,760[2]	5,000[2]
C Arkell Recharge/Collector Optimization		C1: Withdraw more water from the Eramosa River, increase pump capacity to 0.32 m^3/s.	71,659[3]	4,899
		C2: De-activate the Glen Collector and install a Caisson Collector System.	66,402[4]	358

Notes:

(1) This is a sum of the Current Capacity Scenario well rates and the A1-A scenario steady-state Lower Road Collector and Glen Collector rates

(2) The increase in water supply capacity associated with the Dolime quarry is assumed to be derived from a combination of increased pumping from new or existing wells in addition to the treatment of quarry discharge water.

(3) This is a sum of the Current Capacity Scenario well rates and the C1 scenario steady-state Glen Collector rates considering an Eramosa pump capacity of 0.32 m^3/s

(4) This is a sum of the Current Capacity Scenario well rates (including the removal of Arkell 15) and the C2 scenario steady-state Caisson Collector rate

The combined set of scenarios, including maximizing the capacity of existing wells, installing new wells, pursuing the Dolime quarry, and optimizing Arkell recharge/discharge, consider alternatives that add up to more than approximately 85,000 m^3/day of average day water capacity for the City of Guelph. Many of these alternatives need additional field investigations and analysis, and some will not be feasible either due to cost, technical practicality, or environmental effects. However, the modelling approach implemented is conservative and should be considered as a reasonable estimate of the water supply capacity available to the City. The model's estimated effects of increased pumping on surface water are also conservative and likely over-estimates what would be observed in actual conditions. However, while these conservative assumptions are built into the modelling approach, the capacity of the water supply may always be limited by the potential for long-term droughts as observed during the 1960's. Most of the City's water supply is taken from the Gasport Formation aquifer, which is relatively resilient to drought conditions. The higher stress associated with long-term dry conditions may decrease the capacity below the steady-state estimates.

4.1 Current Capacity Scenario

The Current Capacity Scenario estimated the average-day capacity of the City's existing municipal wells and the Glen Collector to be 66,760 m^3/day. The estimated capacity of the City's existing municipal wells under drought conditions is 57,560 m^3/day, or 14% lower than the average-day Current Capacity. While this assessment does not evaluate the effect of drought conditions on all water supply alternatives, it could be assumed that long-term drought conditions may have a similar reduction to the estimated capacity for each of the alternatives.

4.2 Additional Wells and Existing Collector

Future scenarios predicted an increase to the capacity of the current water supply system, ranging from 1,500 m^3/day (Scenario A4-A) to 9,980 m^3/day (Scenario A5-A). Potential additional municipal well supplies, including Edinburgh, Ironwood, GSTW1-20, and Steffler in the southwest quadrant offer the greatest amount of additional water supply. All considered scenarios predict groundwater discharge to streams will be reduced by less than 20% as compared to the current capacity scenario, except at Clythe Creek where groundwater discharge is predicted to be reduced by up to 24% (i.e., Scenarios A3-A and A5-A). While the headwaters of Clythe Creek are mapped as coldwater, the lower and mid-reaches of the creek are considerably degraded with recent monitoring work suggesting warmwater conditions. Furthermore, the groundwater model is not well-calibrated to local groundwater levels or groundwater discharge to the creek. However, the model results are indicative of potential effects on surface water. Should the City consider additional supplies in the northeast quadrant, including the Clythe Well, local model updates are recommended along with calibration against aquifer testing results. Additional studies in this area are currently being undertaken by the City (e.g., as part of the return to service of the Clythe well) and this data can be used to supplement the model at a later date.

The groundwater model scenarios identify potential effects on surface water with increased municipal pumping. These results highlight the importance of having more current baseflow monitoring, and it is recommended that the City implement a more comprehensive surface water monitoring program. This program would include surface water monitoring (flow and water level), as well as shallow groundwater level monitoring in areas of important surface water features (e.g., coldwater streams and streams where groundwater discharge is predicted to be reduced). These data would help to improve the characterization of these features in the model and increase the certainty of model predictions.

4.3 Dolime Quarry Water Capture

The Dolime Quarry Scenario (Scenario B1) included a constraint requiring a head difference of 1 m between MW08-02A and the quarry pond to ensure groundwater flows toward the quarry. This constraint was violated under the Current Capacity Scenario, and as a result, the Dolime Quarry scenario, as configured, does not suggest that municipal wells could pump at rates higher than the Current Capacity scenario. However, the Dolime scenario also identifies that under the Current Capacity scenario the rate of discharge from the quarry into the Speed River would remain high, and there is a potential to capture this water into the City's water supply. As a result, the estimated quarry discharge rate of 5,000 m^3/day is assumed as the potential incremental water supply associated with the quarry, and this supply could be achieved through a combination of either new municipal wells or treatment of the quarry discharge water. The City's ongoing Dolime project will consider all of the alternatives available to increase the water supply including strategies such as lowering the pond level, lowering the hydraulic head gradient to below 1 m, and moving the location of the groundwater divide closer to the pond may increase the water supply capacity. These options will require operational testing to confirm the feasibility.

4.4 Arkell Recharge/Collector Optimization

The Arkell Recharge Scenario (Scenario C1) predicted that an increase in takings from the Eramosa River and infiltration at the Arkell lands will increase the groundwater produced by the Glen Collector. Based on the review of historical Eramosa River flow, the City has an opportunity to increase the amount of surface water infiltrated, while respecting the PTTW constraints. Tripling the river pump capacity to 27,648 m^3/day increases the incremental average infiltration rate by 5,854 m^3/day and the incremental average discharge at the Glen Collector by 4,899 m^3/day over the Current Capacity Scenario. The results indicated that as overall collector efficiency decreases with increased infiltration, the incremental efficiency over Current Capacity generally increases. This suggests that on an average annual basis, as more water is infiltrated and water levels rise, the Glen Collector is able to capture a higher proportion of the infiltrated water. However, this increase in water supply remains subject to the seasonality of the infiltration rates, and the dry periods with minimal collection remain the same as the Current Capacity scenario. Future evaluations are recommended to predict how much additional water may be collected if the Lower Road Collector were to be reconstructed.

The replacement of the Glen Collector and Arkell 1 well with a Caisson Collector System (Scenario C2) is not predicted to greatly increase long-term average system capacity. The Caisson System's estimated long-term average capacity results in a gain of 358 m^3/day compared to the Current Capacity Scenario. However, this system would provide a more reliable supply under drought conditions.

5 Closure

We trust that this letter report suits your present requirements. If you have any questions or comments, please call either of the undersigned at 519.722.3777.

Yours truly,

MATRIX SOLUTIONS INC.

Joelle Langford, M.Sc., G.I.T.
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October 4, 2021

JL/vc
Attachments

Disclaimer

Matrix Solutions Inc. certifies that this report is accurate and complete and accords with the information available during the project. Information obtained during the project or provided by third parties is believed to be accurate but is not guaranteed. Matrix Solutions Inc. has exercised reasonable skill, care, and diligence in assessing the information obtained during the preparation of this report.

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Version Control

Version	Date	Issue Type	Filename	Description
V0.1	21-May-2021	Draft	15072-527 Places to Grow Modelling LR 2021-05-21 draft V0.1.docx	Issued to client for review
V1.0	27-May-2021	Final	15072-527 Places to Grow Modelling LR 2021-05-27 final V1.0.docx	Issued to client
V2.0	04-Oct-2021	Final revised	15072-527 Places to Grow Modelling LR 2021-10-04 final V2.0.docx	Revisions issued to client

References

AECOM Canada Ltd. (AECOM). 2021. **City of Guelph Water Supply Master Plan, Task 3 Water Supply Capacity Assessment (Draft)**. Prepared for City of Guelph. Guelph, Ontario. July 2021.

Amec Foster Wheeler. 2017. **Environmental Impact Study (EIS), York Road Environmental Design, City of Guelph**. Prepared in association with Dougan & Associates, Matrix Solutions (including Parish Aquatic Services), and Blackport and Associates. Prepared for City of Guelph, River Systems Advisory Committee (RSAC). March 2017.

Grand River Conservation Authority (GRCA). 2013. **Thermal Classification of Municipal Drains**. 2013.

Jagger Hims Limited. 1998. A**quifer Performance Evaluation, Volume 1, Southeast Quadrant**. Prepared for the City of Guelph. St. Catharines, Ontario. November 1998.

Matrix Solutions Inc. (Matrix). 2021. **Groundwater Modelling Report The City of Guelph Water Supply Master Plan Update**. Version 1.0. Prepared for the City of Guelph. Guelph, Ontario. October 4, 2021.

Matrix Solutions Inc. (Matrix). 2017. **City of Guelph and Township of Guelph/Eramosa, Tier Three Water Budget and Local Area Risk Assessment**. Prepared for Lake Erie Source Protection Region. Breslau, Ontario. March 2017.

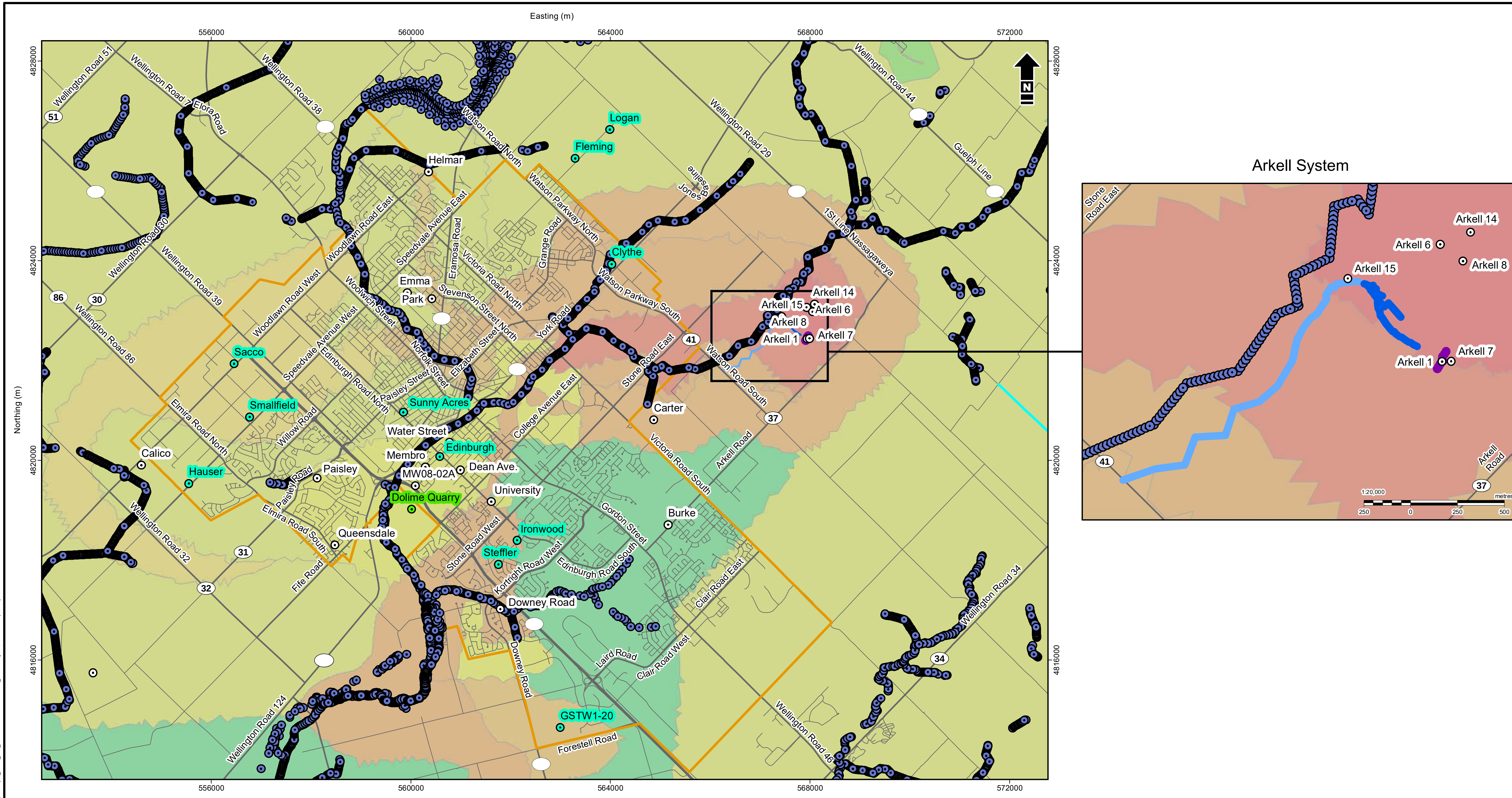
Ontario Ministry of Environment, Conservation and Parks (MECP). 2021. **2017 Technical Rules under the Clean Water Act**. Published June 13, 2017. Updated April 17, 2021. 2021. https://www.ontario.ca/page/2017 technical rules under clean water act

Ontario Ministry of Natural Resources (MNR). 2013. **Provincial stream thermal classification mapping**. 2013.

Ontario Ministry of the Environment. (MOE). 2013. **Memorandum: Assignment of Water Quantity Risk based on the Evaluation of Impacts to Other Water Users**. Memorandum prepared for Source Protection Regions. Toronto, Ontario. December 2, 2013. 2013.

Stantec Consulting Ltd. (Stantec). 2006. "Hydrogeological Study in Support of a Caisson Collector System, Arkell Spring Grounds, Guelph." Draft prepared for City of Guelph. March 2006.

White J.T. et al. 2020. A**pproaches to Highly Parameterized Inversion: PEST++ Version 5, a Software Suite for Parameter Estimation, Uncertainty Analysis, Management Optimization and Sensitivity Analysis: U.S. Geological Survey Techniques and Methods 7C26**. 2020. 52 pp. https://pubs.er.usgs.gov/publication/tm7C26



- Simulated Caisson Collection System
- Simulated Glen Collector
- Simulated Lower Collector
- City Boundary
- Highway
- Road
- Constant Head Boundary Condition
- Constant Head Boundary Condition - Dolime Quarry
- Municipal Well - Future Supply Scenario
- Municipal Well - Current Capacity Scenario

Simulated Middle Gasport Formation Hydraulic Conductivity

1 x10^{-3} m/s

1 x10^{-6} m/s

Reference: Contains information licensed under the Open Government Licence – Ontario.

1:75,000

metres

1,000 0 1,000 2,000

NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

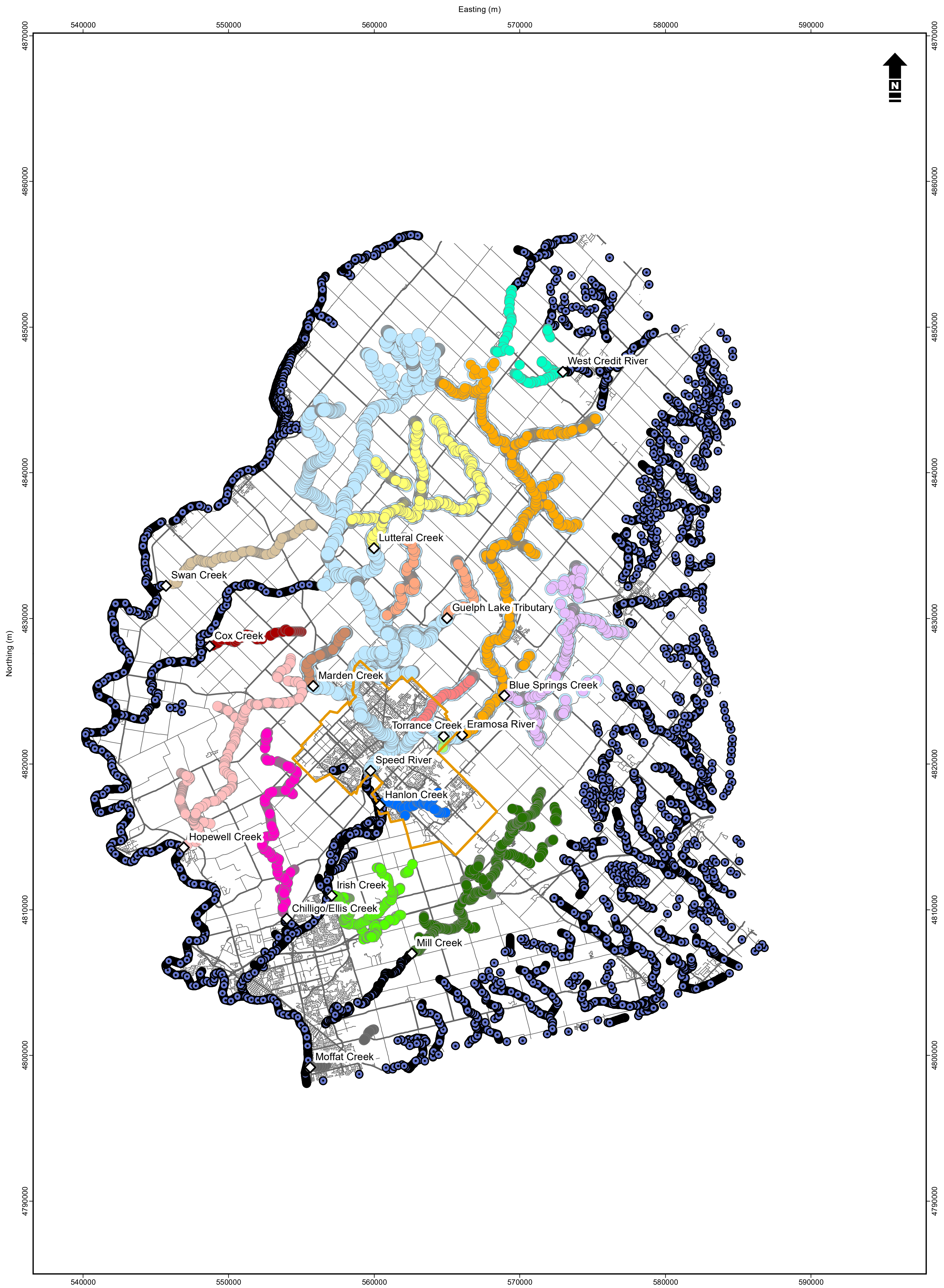
City of Guelph
Water Supply Master Plan

Study Area, Municipal Wells, and Watercourses

Date: May 2021	Project: 15072	Submitter: J. Langford	Reviewer: D. Van Vliet

Figure 1

I:\CityofGuelph\15072\FiguresandTables\QHG\2021\Report\Figure-2-Discharge_Boundary_Condition_Selections_within_Model_Domain.mxd - Tabloid_P - 20-May-21, 03:58 PM - pbishop - TID003



City Boundary
Highway
Road
Baseflow Measurement Station
Constant Head Boundary Condition

Boundary Condition Selection

- Blue Springs Creek
- Chilligo/Ellis Creek
- Clythe Creek
- Cox Creek
- Eramosa River
- Guelph Lake Tributary
- Hanlon Creek
- Hopewell Creek
- Irish Creek
- Lutteral Creek
- Marden Creek
- Mill Creek
- Moffat Creek
- Speed River
- Swan Creek
- Torrance Creek
- West Credit River

1:250,000 metres
2,500 0 2,500 5,000
NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
Water Supply Master Plan

Discharge Boundary Condition Selections within Model Domain

Date:	Project:	Submitter:	Reviewer:
May 2021	15072	J. Langford	D. Van Vliet

Figure
2

Appendix C

City of Guelph Water Loss Management Strategy Review by AECOM

AECOM

AECOM
200 Indiana Avenue
Stevens Point, WI 54481
www.aecom.com

To: Tara Roumeliotis; Heather Yates; Dave Belanger, City of Guelph

From: Richard Hope

Date: July 9, 2021

Project #: 60612820

Technical Memorandum

Subject: City of Guelph Water Loss Management Strategy Review

1. Purpose

The purpose of the technical memorandum (TM) is to summarize the of existing water audit information provided by the City of Guelph (Phase I) and to provide opinions on the following:

1. Water Audit Process
2. Economic Level of Leakage (ELL)
3. Leakage Management Strategy
4. Level of Real Losses to be used in Water Supply Master Plan Update Water Demand Projections

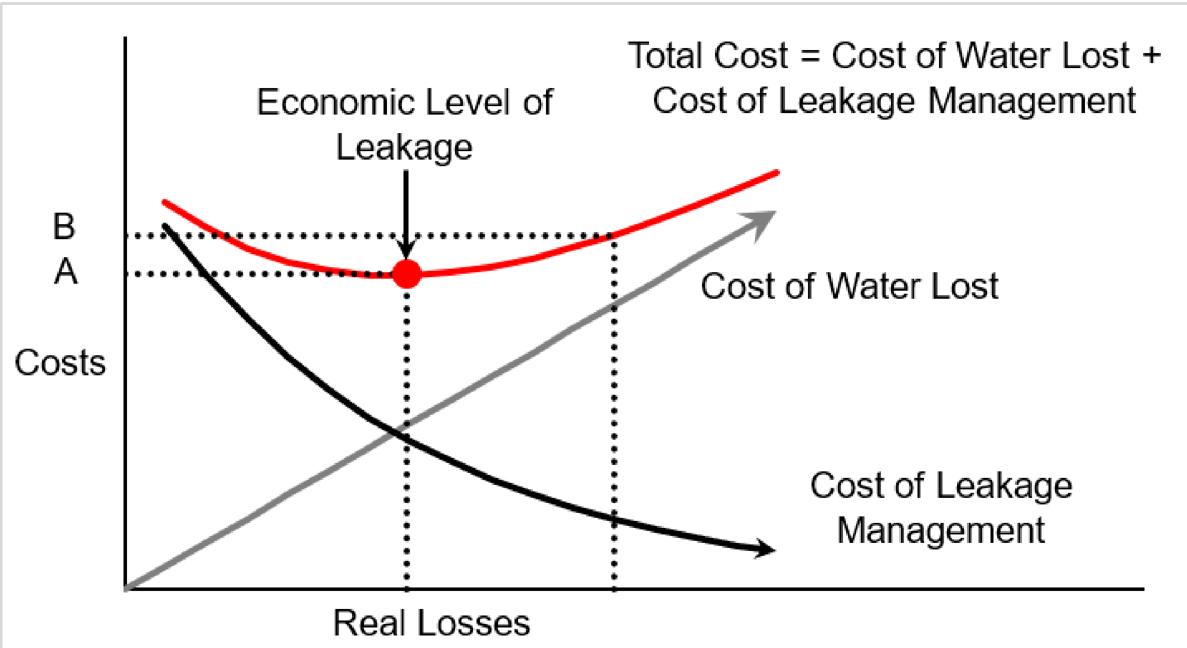
Phase II (if required) will develop the implementation plan for the agreed Water Loss Management Strategy identified in Phase I.

Attachment B provides definitions for several terms and concepts that are used to evaluate the water losses within a water system as a reference.

2. Introduction

As a steward of water resources, the management of real losses is an important activity for all water utilities. A goal of managing real losses is to implement strategies that result in achieving the ELL or close to the ELL. The ELL is the point when the cost of the annual real losses is equal to the cost of the leakage strategy. The ELL concept is illustrated in Figure 1. As illustrated, the cost of water lost increases as real losses increases and the cost of leakage management increases to reduce real losses. Therefore, the total cost is the sum of the cost of water lost plus the cost of leakage management. This cost is a minimum when the ELL is achieved.

Figure 1: Economic Level of Leakage (Real Losses)



The ELL can also be influenced by the availability of water and the infrastructure needed to provide, treat and distribute the water. If capital expenditure can be deferred, reduced or even eliminated by the reduction in water losses, additional expenditure can be justified to support the leakage management strategy.

3. Water Audit Review

The American Water Works Association (AWWA) recommended water balance which is discussed in the following sections is illustrated in Figure 2 for reference.

Figure 2: Water Balance

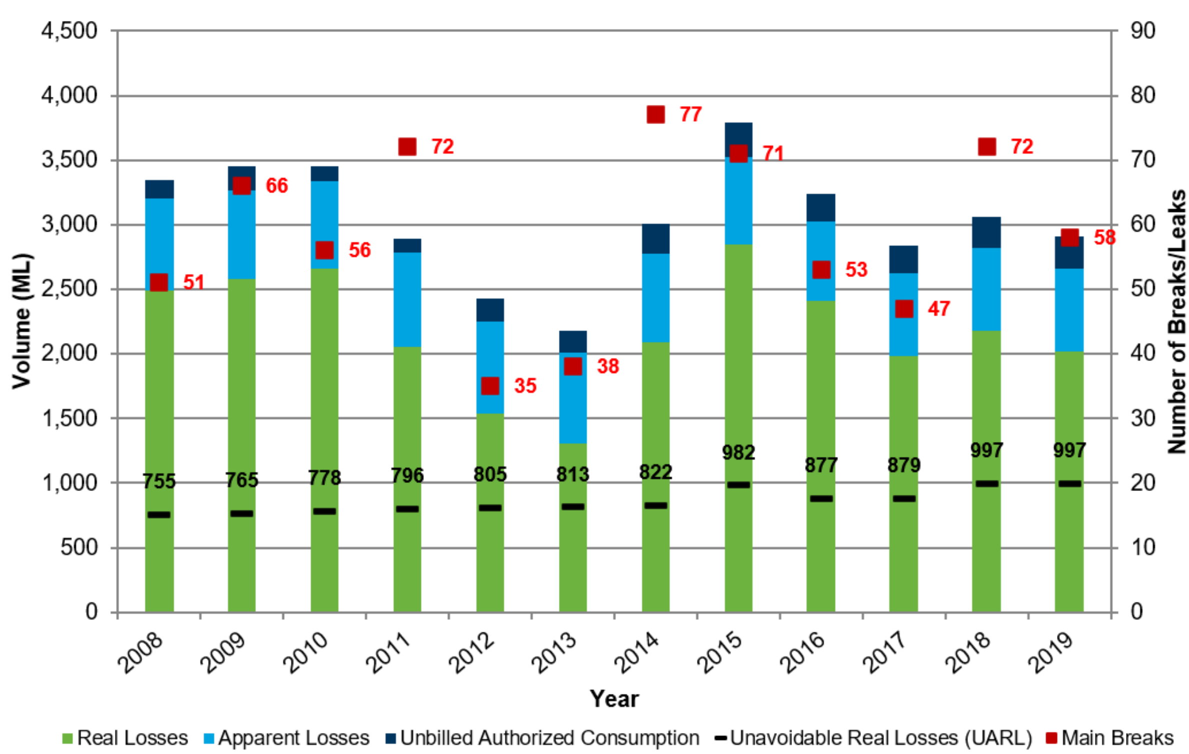
System Input Volume	**Authorized Consumption**	Billed Authorized Consumption	Billed Metered Consumption	Revenue-Generating Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Generating Water
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorized Consumption	
			Metering Inaccuracies	
		Real Losses	Leakage on Transmission and/or Distribution Mains	
			Leakage and Overflows at Utility's Storage Tanks	
			Leakage on Service Connections up to Point of Customer Metering	

3.1 Historical Water Losses

The City of Guelph has been completing a water audit following an industry-wide standard approach presented in the AWWA Manual M36 for over 10 years. To assist in the water audit, the City of Guelph has been using the Water Audit software developed by AWWA. The following section provides a summary of the information from the water audits since 2008.

As can be seen from Figure 3, annual water losses have varied between approximately 2,009 megalitres (ML) in 2013 to approximately 3,521 ML in 2015 with an average of approximately 2,865 ML over the 14-year period. The decline in water losses from 2011 to 2013 is attributed to the leak detection program implemented in 2010 and the two extreme cold winters occurring in 2014 and 2015 resulted in increased leakage along with an increase in unbilled authorized consumption as customers were asked to run their taps to prevent freezing. As illustrated in this figure, the annual real losses have generally declined from 2015 to 2019.

Figure 3: Historical Non-Revenue Water



For evaluating the ELL, the 2019 water audit data was used.

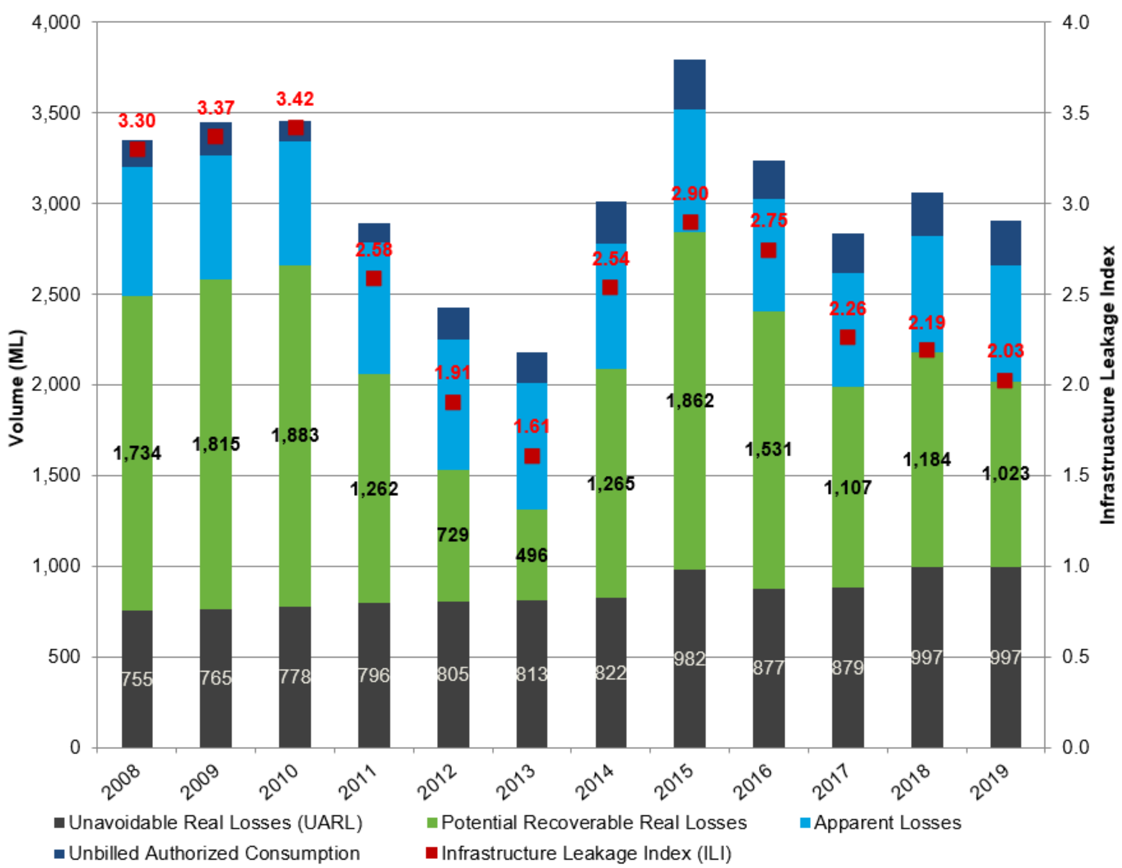
A key concept in the analysis of real losses is that all water systems have a level of leakage that cannot be economically prevented or recovered which is referred to as the

"Unavoidable Annual Real Losses" (UARL) and is dependent on a number of parameters that are specific to each water system, including length of water main, number of service connections, average length of service connection, and system pressure.

A key performance indicator (KPI) referred to as the Infrastructure Leakage Index (ILI) has been introduced in the water industry to help compare water system with respect to leakage. The ILI is the ratio of real losses and UARL. An ILI of one (1) means that the current real losses are equal to the UARL and further reduction in real losses is unlikely to be economically achieved. The ELL is typical between the current value of annual real losses and the UARL.

The ILI for the City of Guelph over the period 2008 through 2019 is illustrated in Figure 4 along with the historical components of NRW. Note the UARL is lower in 2016 and 2017, as the number of service connections was estimated as one per service address and historical values were estimated based on the number of meters. It is AECOM's understanding that Water Services is in the process of determining the number of service connections through a GIS/billing system cross reference and field verification. It is believed that the number of addresses was reflective of those entered in the billing system and is an underestimate. If the UARL was underestimated, that would result in a lower ILI.

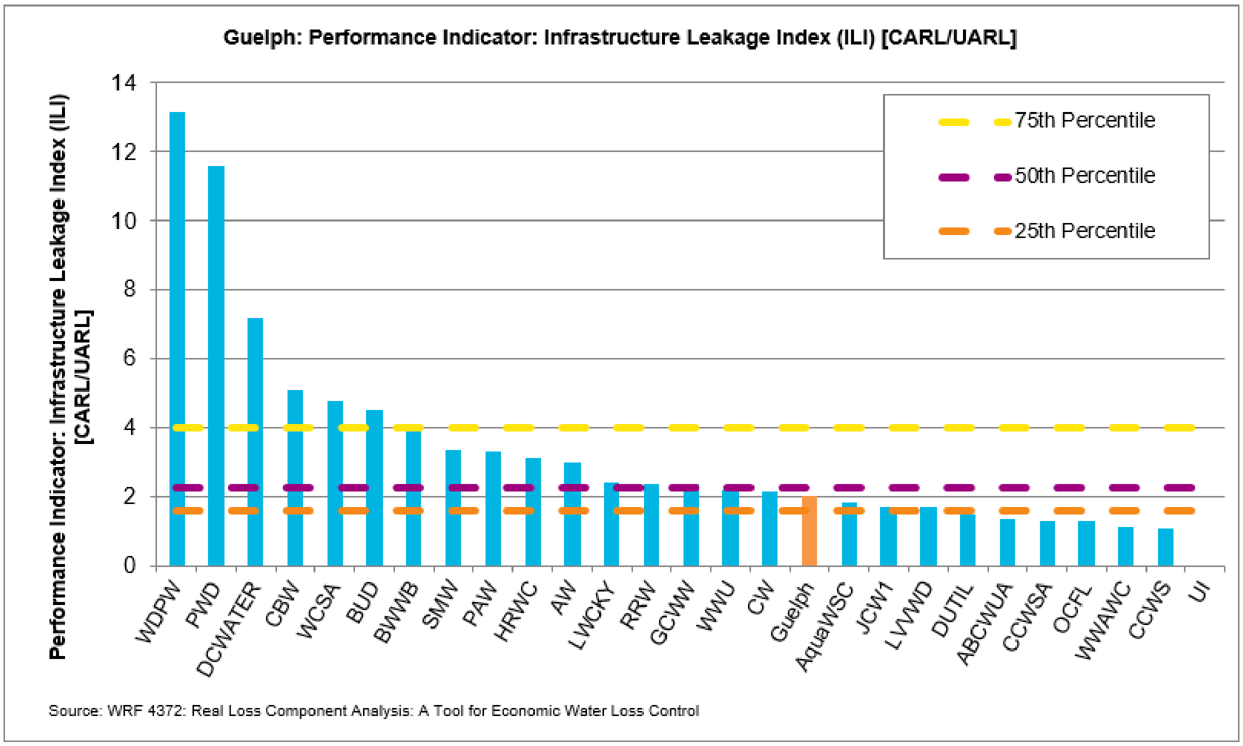
Figure 4: Historical Infrastructure Leakage Index for City of Guelph



As can be seen the ILI has ranged from approximately 1.61 (2013) to approximately 3.42 (2010). More recently, the ILI was at 2.54 in 2014 and has declined to approximately 2.03 in 2019.

Figure 5 illustrates the 2019 City of Guelph ILI compared to other communities based on the data in the Water Research Foundation (WRF) report 4372, Real Loss Component Analysis: A Tool for Economic Water Loss Control. Based on this set of data the City of Guelph ILI is between the 25th percentile and 50th percentile in the data.

Figure 5: Benchmarking of Infrastructure Leakage Index



3.2 Review of Water Audit Process

One task of this project included a review of the water audit process which has been completed annually by the City of Guelph for over ten years. AECOM reviewed the data provided and had discussions with the City personnel responsible for completing the audit to review the process and data used. The completion of a water audit annually, is one of the first steps in developing a leakage management strategy and evaluating the economic level of leakage.

A review meeting was held in April 2021 to discuss the water audit with the City of Guelph stakeholders to ensure validity and accuracy of the data (refer to Attachment C for the slides from the presentation). Another item discussed was the significance of the uncertainty of the data. For example, some components of the water audit include unmetered data; therefore, the volume is estimated. However, the volume may be small compared to the system input volume which although the volume is estimated it has little impact on the water losses.

For the review, AECOM developed a rating system for the data review and potential actions as summarized in Table 1.

Table 1: Rating Criteria for Water Audit Data Review

Rating	Description
● (red)	Improvement, recommend additional effort to improve water audit data.
● (orange)	Potential improvement, may have impact on water audit; therefore, consider change.
● (yellow)	Potential improvement, small impact on overall water audit; therefore, no change recommended.
● (green)	Good practice, continue with same effort/approach going forward.
● (black)	Not applicable.

The only component of the water audit that was rated as “red”, needing improvement, is the customer meter accuracy. In 2017, 200 residential meters were sampled, targeting meters installed 15 or more years ago with higher volumes of water and 20 high volume mid-size meters. The meter testing program resulted in a weighted average of 3.8 percent under-registration which was used in the 2019 water audit to estimate apparent losses associated with customer meter inaccuracies. The estimated 2019 apparent losses associated with customer metering inaccuracies is approximately 564 ML which is approximately 20 percent of the water losses. Note that if the estimated meter accuracy is higher than actual, the real losses would be higher leading to a higher potential recoverable leakage.

The meter accuracy data is based on data from 2017 and may not be representative of the meter accuracy for all meter sizes/ages; therefore, AECOM recommends refining the meter accuracy going forward to get a better understanding of real losses and apparent losses. The WRF study Guidance on Implementing an Effective Water Loss Control Plan, 2019, states the generally accepted factors affecting customer meter accuracy include:

- Mechanical wear over time, excess cumulative volume, poor water quality, damage and vandalism
- Incorrect installation or lack of maintenance
- Incorrect sizing

- Incorrect meter type for the application
- Spinning or jetting
- Environmental problems (freezing, overheating)
- Low flow rates due to evaporative coolers and basement/rooftop storage tanks
- Changing flow patterns due to water conservation changes in building codes and pluming fixture design.

The WRF study states that proper meter sizing, selection and installation; routine testing; and optimal meter replacement mitigates most of the accuracy degradation issues.

It was noted that the City has continued to improve its methods to meter more of the NRW to have a good handle on the actual volumes instead of estimating. The values that are estimated are typically small volumes which do not have a significant impact on water losses.

A summary of the review, which is detailed in Attachment C, includes:

- The City should continue with the good industry practice of completing the AWWA audit and consider using the latest version (Version 6 released in December 2020) along with completing the validation questions and the revised methods for estimating unbilled unmetered authorized consumption, unauthorized consumption, and system data handling errors.
- The City has continued to improve the data for the water audit process including metering additional volumes of water over the years.
- The City should consider a detailed list of the meters used and the accuracy of each meter to determine the volume of water input into the system. The volume in the audit should be adjusted based on the accuracy of the meters.
- The City has a residential meter program with the goal to replace approximately 26,000 meters which was started before the pandemic in 2018. The confidence in the water audit results can be improved through a better understanding of the volume of real and apparent losses and an understanding of the meter accuracy is key. It is recommended that the City develop a meter testing program and continue with the meter replacement program.
- The City should work toward completing the water audit by pressure zone or district metering area (DMA). One step toward this is the completion of the linking of the customer billing data with the GIS.

3.3 Cost of Water Losses

The cost of water losses depends on the type of losses as follows:

- Apparent Losses – Customer retail unit charge (volumetric portion of the charges, not the fixed charges)
- Real Losses – Variable production cost of water

The variable production cost of water is used to determine the cost of leakage (water losses) as discussed in the following section.

3.3.1 Variable Production Cost of Water

The variable production cost of water is the marginal cost of water supplied to the distribution system or the cost to supply the next unit volume of water.

The variable production cost of water is important as it is used to determine the cost to the Utility of leakage (real losses) and is used in the evaluation of the ELL.

Typically, the variable cost of leakage (water) is comprised of the following two main items:

1. Electrical Cost (treatment and pumping)
2. Chemical Cost

Additional costs can be included, if appropriate, and can include:

1. Deferred capital cost
2. Reduction in maintenance/repair/replacement (equipment lasts longer and not being used as much)
3. Cost of wastewater treatment (some of the water losses reaches the wastewater treatment facility)

For the City of Guelph, electrical and chemical costs are tracked annually. Based on the 2019 data summarized in Table 2, the chemical and electricity costs are estimated at \$0.095 per m^3 (cubic metre).

For this analysis consideration was given to the three items that can be part of the variable cost of leakage. No deferred costs for capital have been included in this analysis.

Since the amount of water for wastewater treatment is hard to define, the variable cost of wastewater was not available to AECOM, and the reduction in maintenance/repair/replacement is also challenging to define; AECOM used a band of the variable cost of leakage from approximately \$0.095 per m^3 to \$0.114 per m^3 (approximately \$95 to \$114 per ML). This is based on a 20 percent increase in variable cost of water to account for some of the additional items.

Table 2: 2019 Variable Production Cost of Water

Description	2019 Expenditures	2019 Water Production (m^3)	Cost per Cubic Metre ($\$/m^3$)
Annual Cost of Operating Water System	\$32,168,822	-	-
721-6450 removed (full expense budget)	(\$791,627)	-	-
Total Annual Cost of Operation Water System	**\$31,377,195**	**17,160,653.96**	**\$1.83**
Operating	**-**	**-**	**-**
Hydro (2301/2302)	\$1,542,368	-	-
Treatment Chemicals (2405/2429/2431)	\$79,467	-	-
721-3450 removed (for above expenses)	\$0	-	-
Materials and Supplies (sum 24 Operating)	\$442,261	-	-
Maintenance Costs (sum 31 Repairs and Maintenance)	\$460,211	-	-
721-6450 removed (for above expenses)	(\$29,123)	-	-
Capital	\$1,261,398	-	-
Variable Cost (Unit Cost of Leakage)	\$1,621,835	17,160,653.96	\$0.095
Fixed Cost	\$2,134,747	17,160,653.96	\$0.124
Total Operational and Maintenance Costs	\$3,756,582	17,160,653.96	\$0.22

Source: City of Guelph O&M Cost Breakdown from Water and Wastewater Financial Specialist, Annette Indoe.

3.3.2 Economic Analysis

The following information was provided from the 2019 Water Audit for determining the cost of annual real losses (leakage).

Total Water Supplied: ....17,160 ML

Total Annual Real Losses (TARL): ....2,020 ML

Unavoidable Annual Real Losses (UARL): ....997 ML

Potential Annual Recoverable Real Losses (TARL-UARL): ...1,023 ML

Cost of Potential Annual Recoverable Real Losses: ....\$97,200 to \$116,600

The City of Guelph has an active leakage control program initiated in 2010 that consists of annual leak detection of the entire system at a cost of approximately \$80,000 to \$100,000 per year.

3.3.3 Summary

The City of Guelph reduced their ILI from 2.54 in 2014 to 2.03 in 2019 which indicates that the management of real losses is good. This has been achieved through an active leakage control program of annual leak detection survey at a cost of approximately $80k to $100k per year. It is anticipated that over the last six years the backlog of leaks has been eliminated and current leak detection is locating new leaks or small leaks that have increased in size. AECOM believes that continuing the annual leak detection will keep water losses at the current level but may not achieve substantial further reduction. An additional expenditure of $97k to $116K per year for water loss management is available for additional active leakage management to reduce annual real losses to be equivalent to the UARL (ILI = 1).

4. Economic Level of Leakage (ELL) and Water Supply Projections

The City of Guelph has managed and controlled real losses well which is reflected in an ILI of 2.03 (reduced from 2.54 in 2014).

In the AwwaRF report Evaluating Water Loss and Planning Loss Reduction Strategies, 2007, it was reported that in a study, ILI data was collected from utilities operating at or near ELL in UK and Australia, showing that the economic ILI for utilities are normally below 3.

The current active leakage control (ALC) of regular leak detection survey appears sufficient to keep real losses under control. This history of active leak detection along with the decline in ILI indicates that the backlog of leaks that might have existed in 2014 have been fixed and a stable condition exists with respect to leaks.

With the relative low unit cost of leakage and the low ILI, the potential cost saving ($97,200 to $116,600) of reducing the annual real losses to the UARL is small in comparison with the implementation of more extensive leakage control strategies. For example, if the full $97,200 to $116,600 could be recovered by using DMA/step testing etc. the annual cost of implementation (capital and operations) would have to be less than $97,200 to $116,600 per year. However, it is doubtful if the entire potential recoverable real losses could be recovered.

It is AECOM’s opinion that the City of Guelph could already be at or close to the ELL with an ILI of approximately 2.0.

5. Leakage Management Strategy

The purpose of the leakage management strategy is to reduce and maintain leakage to an acceptable level agreed upon considering the ELL.

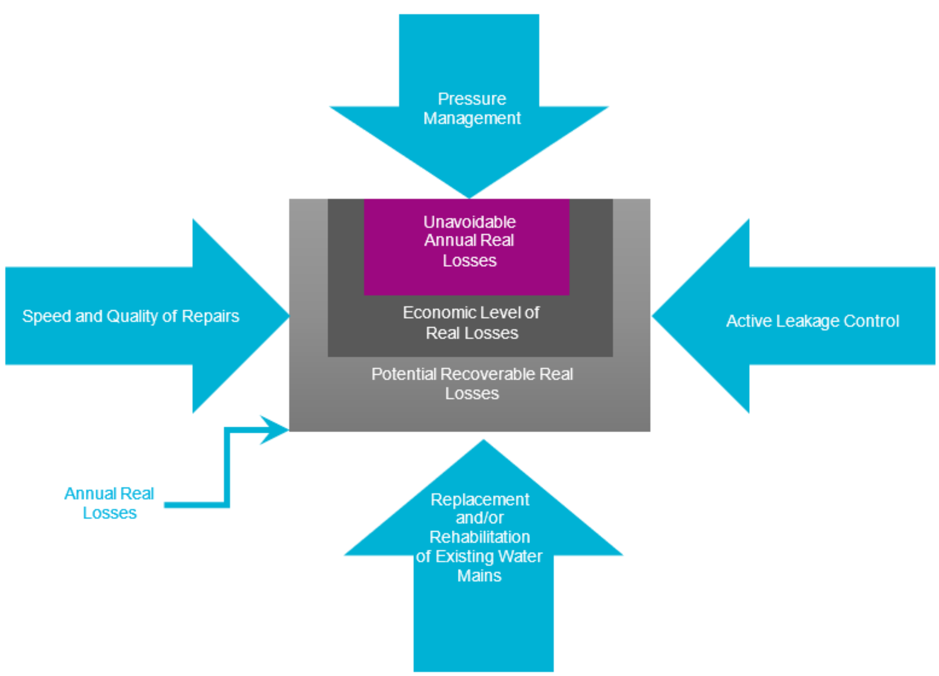
5.1 Introduction

The four pillars of a successful leakage management strategy are illustrated in Figure 6 and are summarized as:

- Pressure management seeks to optimize system pressure to minimize losses, while maintaining adequate levels of service.
- Replacement and/rehabilitation of existing water mains is the replacement/rehabilitation of key infrastructure to reduce water main breaks/leaks and water loss.
- The speed and quality of repairs reduces the time it takes to repair the leak once it is found. Reducing the time it takes from locating the leak to repairing it reduces the water lost.
- ALC is the proactive approach to search for hidden (non-surfacing) leaks and includes such things as leak detection acoustic surveys and sounding.

A brief description of each is provided in the following sections along with how each may be incorporated into an overall leakage management strategy for the City of Guelph.

Figure 6: Four Pillars of Successful Leakage Management Strategy



5.2 Pressure Management

Pressure management is typically the cheapest and easiest approach to decrease annual real losses; however, it does not find and repair the leaks. In addition, the minimum system pressure needs to be maintained in the water distribution system to provide adequate service to the customers. The 2019 water audit reported the average system pressure of 49.4 metres of head. For comparison, Ten State Standards specifies normal working pressure in the distribution system should be approximately 42 to 56 metres of head.

The system is segmented into pressure zones to address pressure/topography; therefore, pressure management is not considered a cost-effective option for the City of Guelph leakage management strategy.

5.3 Replacement and/or Rehabilitation of Existing Water Mains

The City of Guelph continues to replace water mains and while this will over time reduce leakage; it is unlikely in the short-term to have a dramatic impact on real losses. The following quote is from the American Water Works Association Research Foundation (AwwaRF) report, Evaluating Water Loss and Planning Water Loss Reduction Strategies:

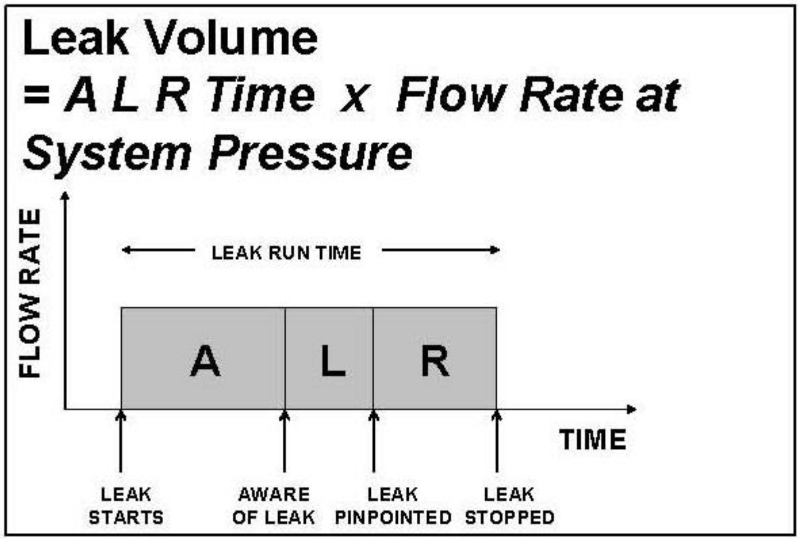
> *"From an economic perspective, it is rarely possible to justify mains replacement purely on the basis of the reduction in leakage anticipated, except in a few of the worst performing mains in the utility. In reality, mains are replaced for many other different reasons such as inadequate capacity, growth in demand, cost of continued repairs, water quality problems and good asset management."*

As water mains age, the pipe will need to be replaced and a proactive water main replacement/rehabilitation program should be implemented by the City if not currently in place. However, replacement and/or rehabilitation of existing water mains is not considered a cost-effective option for the leakage management strategy.

5.4 Speed and Quality of Repairs

The time between the pinpointing of the leak and its repair also affects the volume of water lost. The shorter the repair time, the lower the water loss, as illustrated in Figure 7. The challenge of repairing leaks in a timely manner may increase as a more proactive approach is adopted by the City of Guelph to identify and repair the non-surfacing leaks. Sufficient staff should be available to repair leaks as soon as possible after the leaks are identified and leaks of higher volume should be prioritized over smaller leaks.

Figure 7: Leakage Volume – Speed and Quality of Repairs



Source: AwwaRF report, Evaluating Water Loss and Planning Loss Reduction Strategies

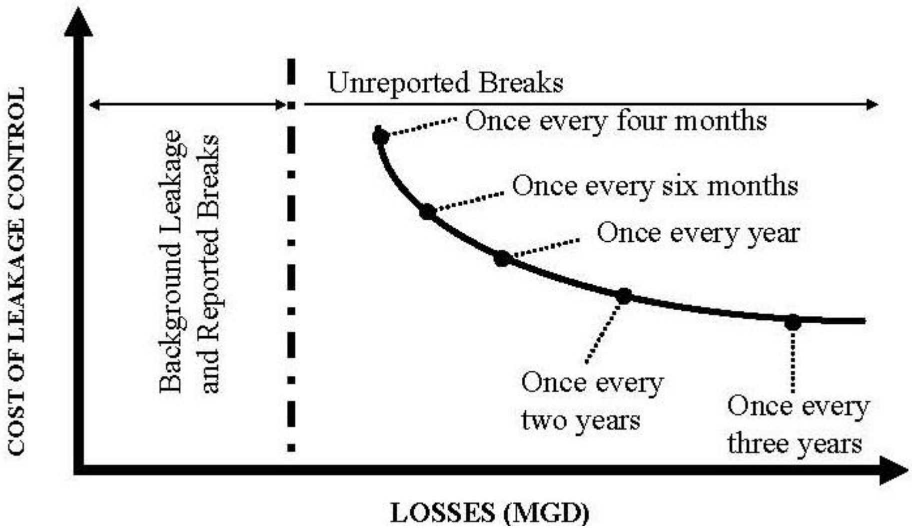
5.5 Active Leakage Control

A number of ALC approaches are available to assist in the detection and location of leaks. The following are the more common approaches as summarized in Table 3:

- Sounding
- Noise Mapping
- Acoustic Survey
- Acoustic Loggers
- AMR/Meter Acoustic Loggers
- Satellite Leak Detection

To address the non-surfacing leaks, the most proactive approach is to increase the level of effort in sounding, noise mapping, acoustic survey, etc. To identify the appropriate level of effort in leak detection, it is necessary to establish the intervention period. In principle, it is a cost beneficial relationship between the cost of intervention (leak detection survey) and the cost of the volume of water lost through leakage. This concept is illustrated in Figure 8.

Figure 8: Leakage Reduction Cost Curve for Regular Acoustic Surveys



It appears that a main contributor to real losses in the City of Guelph may be non-surfacing leaks/breaks; therefore, an initial goal should be to proactively identify and repair the non-surfacing leaks.

Acoustic loggers, satellite leak detection, and customer meter loggers are effective at identifying areas to prioritize leak detection. The greatest benefit of these technologies typically occurs once a steady state of leaks has been reached which is believed to be the case for the City.

Table 3: Summary of Active Leakage Control Measures

Methodology	Description	Advantages	Limitations	Most Appropriate For
Reactive Leakage Control	■ Response to leaks discovered through visual observation.	■ Lowest cost of detection	■ Only locates leaks reaching the ground surface	■ Small systems with a poor maintenance history and large number of leaks
Regular Sounding	■ Identifies areas of high noise and potential non-surfacing leaks by listening at system fixtures such as valves, hydrants, etc.	■ Low cost and easy to implement	■ Does not pinpoint leak ■ Background noise can mask leak noise ■ Sounding may need to be performed during night period	■ All systems
Noise Mapping	■ Expands on regular sounding by tracking, documenting, and mapping the location of system noise to improve prioritization of leak detection.	■ Low cost and easy to implement ■ Helps prioritize of leak detection	■ Does not pinpoint leak ■ Background noise can mask leak noise ■ Sounding may need to be performed during night period	■ All systems

Methodology	Description	Advantages	Limitations	Most Appropriate For
Leak Detection Survey	■ Identification and location of leaks using acoustic equipment.	■ Equipment and operators readily available ■ Relatively inexpensive ■ Preferred method for pinpointing leaks	■ Large leaks can mask smaller leaks ■ Less effective on non-metallic water mains	■ All systems to pinpoint non-surfacing leaks
Acoustic Logger	■ Acoustic loggers attached to system fixture, either permanently or temporarily, that semi-continuously listen for noise that could be associated with a leak.	■ Reduces awareness time ■ Helps prioritize leak detection	■ Does not pinpoint leak ■ High number of acoustic loggers needed to cover system (expensive)	■ All systems
Acoustic Logger on Customer Services	■ Permanent acoustic loggers attached to AMR that semi-continuously listen for noise that could be associated with a leak.	■ Reduces awareness time ■ Helps prioritize leak detection	■ Does not pinpoint leak ■ Expensive unless installed with an AMR system	■ All systems
Satellite Leak Detection	■ Identification of points of interest (POI) on GIS reports using satellite images and patented algorithm	■ Helps prioritize leak detection ■ No equipment required, low cost	■ Does not pinpoint leak/not all POI have leak	■ All systems

The City of Guelph has an ALC program that consists of annual leakage detection of the entire distribution system (both plastic and metallic pipe) at a cost of approximately $80,000 to $100,000 per year which was started in 2010. This is a contributing factor in maintaining the current ILI of 2.0 and has likely removed the backlog of leaks in the system.

The following sections discuss some additional enhancements that the City of Guelph may want to explore to enhance their current ALC program.

5.5.1 Acoustic Loggers

An acoustic logger is a small sound logging device that is attached to suitable existing fittings by means of a strong magnet. Acoustic loggers are designed to be deployed across a network at close enough intervals to ensure that any leak noise between two loggers can be detected. Once deployed, the acoustic loggers monitor leak noise during the quietest part of the night and indicate if a leak noise has been detected. The acoustic loggers are downloaded the next day to indicate if a leak noise has been detected. The leak than can be detected using leak noise correlators.

Acoustic loggers may be used in permanent locations that may historically have had a high number of leaks/breaks and/or may be used in temporary locations which allows them to be relocated in the system.

It is recommended that the City consider budgeting approximately $20,000 to $30,000 to implement a pilot program with acoustic loggers which would include purchasing and installing approximately 15 to 20 acoustic loggers that can be temporarily located in areas of the system to help prioritize areas for leak detection.

5.5.2 Satellite Leak Detection

An interesting recent development in ALC is the use of satellite imagery to help identify areas of potential leaks. The satellite takes a series of spectral aerial images over a subject area and by use of an algorithm technicians can identify soil saturated by treated water to a depth of approximately 12 feet in the ground by detecting its spectral signature. The points of interest (POI) are provided in a geographical information system (GIS) report to allow the field crew to search specific areas and pinpoint the previously undetected leaks. This technology has been adapted from the search for water on other planets, which underscores the high reliability and outstanding capability here on Earth. Further information on satellite leak detection is provided in Attachment E.

The benefits of satellite leak detection include:

- No equipment required, no upfront investment.
- Significant reduction in field labour effort.
- Entire system is surveyed as often as bi-weekly.
- Leaks can be targeted before surfacing, reducing potential damage/additional costs of repairs.
- Reduction in water losses/NRW.
- Provides a good solution for large water networks.

Based on discussions with Utils, the cost is approximately $60 to $65 per kilometre. Using 565 kilometres for the total length of the City of Guelph system, it is estimated the cost for the satellite leak detection (one delivery) for the entire system would be approximately $34,000 to $37,000.

5.5.2.1 Case Study 1

As documented in the AWWA Opflow, January 2020, New Braunfels Utilities (NBU), located in the greater San Antonio area, was able to significantly reduce its NRW because of the satellite leak detection program. The performance and value metrics comparisons of the traditional leak detection program and the satellite pre-locating program for NBU are summarized in Table 4.

Table 4: Satellite Leak Detection Case Study 1: Performance and Value Metrics Comparison

Parameter	Fiscal Year 2018 Traditional Program	Fiscal Year 2019 Satellite Pre-Locating Program
Leaks per Day Found	0.06	4.1
Number of Leaks Found	16	229
Cost per Leak Found	$14,130	$678
Crew Labour Days	249	56
Crew Labour Costs	$173,650	$42,900
Overall Operating Budget	$210,900	$155,500
Capital Costs	$24,000	$0

Source: AWWA, Opflow, January 2020.

5.5.2.2 Case Study 2

According to a March 2021 article in the Journal of New England Water Works Association, the Green Bay Water Utility has lowered water losses in 2019 by approximately 91 million gallons per year (MGY) resulting in lowering their unaccounted-for water from approximately 7 percent to 6.3 percent (a 10 percent reduction) using two satellite surveys and subsequent field inspections. The Utility, which includes approximately 510 miles of transmission and distribution mains and approximately 35,600 service connections, found approximately 1.4 leaks per crew day and 1.0 leaks per mile physically inspected at a total cost of approximately $103,000 (U.S. dollars). Based on the cost of water production, this equates to a $37,400 (U.S. dollars) savings per year with a simple payback period of 2.7 years.

5.5.3 Historical Water Main Breaks and Leaks

A preliminary review of the water main break and leak location history indicates there are areas of the water system that may be more prone to breaks and leaks as illustrated in Attachment D. The areas more prone to breaks and leaks may include geographical areas of the water system with particular pipe diameters, particular pipe materials, and/or based on soil corrosivity/pipe material, etc. For example, approximately 95 percent of the leaks and breaks in the GIS layer were likely on cast iron pipes which comprise approximately 33 percent of the pipes in the water system. Potentially, the City could consider more frequent leak detection on cast iron mains versus other pipe materials in the system. It is recommended that the City of Guelph conduct a focused review of leak and break historical data and use the historical data evaluation to help prioritize areas for leak detection efforts going forward.

5.5.4 District Metered Area (DMA) Program

According to the Final Draft of the Water Loss Management Strategy, November 4, 2020, the City began the DMA program in 2013 with the installation of flow meters and pressure sensors across the water distribution system. However, as the report indicates, the DMA program requires a one-time $2M to $4M capital expenditure to update valving and dead-end infrastructure, a $200K to $600K one-time expenditure to complete necessary telemetry, approximately $70K annual operating budget in cellular charges, batteries, spares, server licenses, server updates, and server support contract, and a $250K annual operating budget for maintenance and additional staff time.

Reducing the ILI from 2.03 to 1.0 (which may be difficult to achieve) would result in a cost savings of approximately $97K to $116K annually; therefore, the additional cost for the DMA program is not cost-effective solely from a water loss perspective.

5.5.5 Summary of Active Leakage Control

It is recommended that the City of Guelph continue with the current ALC program of leak detection to help maintain the current level of real losses and consider exploring the addition of satellite leak detection, acoustic loggers, and/or prioritizing areas for leak detection based on historical leak/break data and/or other means. For example, the City may consider surveying cast iron water mains that have a higher historical leak/break frequency more often than PVC mains that have a lower leak/break frequency.

5.6 Summary of Leakage Management Strategy

The leakage management strategy summarized in the draft Water Loss Management Strategy dated November 2020 along with the recommendations from this evaluation are summarized in Table 5.

Table 5: Recommended Water Loss Management Strategy Programs

Apparent Losses	Real Losses
Residential Meter Replacement Contract	Leak Detection Program Consider exploring the following enhancements: • Satellite Leak Detection • Acoustic Loggers • Prioritizing leak detection survey based on satellite leak detection, acoustic loggers, or historical data
Automatic Meter Reading/ Infrastructure (AMR/AMI)	~~District Metering Areas (DMA) Program~~

Apparent Losses	Real Losses
Industrial, Commercial, Institutional (ICI) and Large Residential Maintenance and Replacement Program	Develop an annual private-side fire hydrant audit program
Construction Development Water Use	Complete retroactive fire suppression metering for tracking and input into the water audit/balance

Key: ~~Not Recommended~~
Recommended
Included in Draft Water Loss Management Strategy, City of Guelph, November 2020

Note: Refer to Draft Water Loss Management Strategy, City of Guelph, November 2020 for additional details regarding the programs.

6. Non-Revenue Water Projections

Typically, projections of water demands are based on per-capita water use with an allowance for NRW which is usually a percentage of the total water supplied. Therefore, NRW projections are assumed to increase proportionately to the population/employment rate growth.

Because the City of Guelph has completed a good deal of work regarding NRW, it is possible to provide a more detailed estimate of NRW in future.

AECOM is proposing that each of the NRW components can be estimated as noted in Table 6.

Table 6: Estimation of NRW Component for Water Demand Projections

Parameter	Approach to Estimate	Notes
Real Losses	Use target ILI of 2 to estimate	Need to estimate projected UARL which may change based on length of water main and number of customer services.
Apparent Losses ▪ **Unauthorized Consumption**	Same as estimate for water audit	
Apparent Losses ▪ **Customer Meter Inaccuracies**	1 to 2% of billed consumption	Assume meters are under-registering
Apparent Losses ▪ **Systematic Data Handling Errors**	Same as estimate for water audit	
Authorized Unbilled Metered Consumption	Similar to water audit method	Increase based on growth
Authorized Unbilled Unmetered Consumption	Same as estimate for water audit	

Assuming an ILI of 2.0 is maintained, the real losses can be estimated from the ILI multiplied by the UARL. The volume of UARL will increase as the growth of the population/ employment forecast (approximately 40 percent by 2051) and the water distribution system expands. The following assumptions were used to estimate the 2051 UARL:

- Length of main in distribution system – increase by 20 percent
- Number of service connections – increase the same percent as the population/employment rate
- Assume average system pressure remains constant (49.5 m of head).
- Assumes average length of services remains constant.

Using these assumptions, the 2051 UARL is estimated to be approximately 3,790 m^3 per day (1,380 ML) which results in the projected 2051 annual real losses of approximately 7,585 m^3 per day (2,770 ML) and total 2051 projected NRW of approximately 9,982 m^3 per day. The current NRW projection for 2051 is approximately 12,342 m^3 per day.

AECOM also suggests the City consider that real losses are typically constant and do not vary daily or seasonally with changes in water use; therefore, real losses should be kept constant when determining the maximum day demand. Currently the maximum day demand is assessed based on total system water production by comparing peak days to average days (e.g. Water Supply Master Plan, etc.); this approach does not consider variable and separate maximum day factors by sector (i.e. residential, ICI and NRW). With more consumer data available on a real time basis, this assessment may be feasible in future studies.

7. Conclusions and Recommendations

7.1 Water Audit

It is recommended that the City continue to complete the water audit using the current version of the AWWA software and recommendations for estimating components if not other data is available.

The City should consider documenting the supply meters used for the volume water input into the system for the water audit along with adjusting the data based on the annual accuracy testing performed.

In addition, the City has a residential meter replacement program to replacement approximately 26,000 meters which was started before the pandemic in 2018; however, was placed on hold during the COVID-19 pandemic. It is recommended that the City develop a meter testing program and continue with the meter replacement program. The water audit accuracy may potentially be improved with a more accurate estimate of accuracy based on meter type and size.

In the longer-term, the City should work toward completing the water audit by pressure zone and/or DMA. One step toward this is the completion of the linking of the customer billing data with the GIS which AECOM understands is in progress.

7.2 Economic Level of Leakage and Active Leakage Control

The current ALC policy (regular leak detection survey and repair) has been effective in reducing real losses and should be continued. AECOM believes the leak detection program has removed the backlog of leaks in the City and has reduced the ILI to approximately 2.03 which based on the low unit cost of water is considered close to, if not at, the ELL. The potential annual recoverable real losses for 2019 are approximately 1,023 ML, assuming an ILI of 1.0. The potential annual recoverable real losses represent approximately 6.0 percent of the total water supplied and an annual cost of approximately $97K to $116K.

The following enhancements to the current leakage management strategy are recommended to be explored further:

- Satellite leak detection
- Acoustic loggers
- Focused leak detection based on strategies above and history of leak locations and pipe materials/diameters with higher leak frequency

This approach should allow the typical rate of rise of leakage to be controlled and leakage to be held constant or potentially reduced.

7.3 Non-Revenue Water Projections

For future water supply planning exercises, it is recommended that the City consider projecting NRW based on the various components and maintaining an ILI of 2.0. The City should also consider that real losses typically are constant and do not vary daily or seasonally.

7.4 General

While DMAs are not recommended solely based on savings due to the reduction in real losses, DMAs have other advantages for the operation and maintenance of a water system. If DMAs are implemented as part of an improvement strategy to the overall operation, they should be used to also support the overall leakage control strategy.

As mentioned earlier, the replacement of water mains is not a cost-effective approach to reduce real losses; however, as water mains age they need to be replaced and a proactive water main replacement/rehabilitation program should be implemented.

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The attached Report (the “Report”) has been prepared by AECOM Canada Ltd. (“AECOM”) for the benefit of the Client (“Client”) in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the “Agreement”).

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- represents AECOM’s professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

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AECOM: 2015-04-13

Attachment A

List of Abbreviations and Acronyms

Attachment A: List of Abbreviations and Acronyms

ALC ....Active Leakage Control

AWWA...........American Water Works Association

AwwaRF........American Water Works Association Research Foundation

DMAs.............District Metering Areas

ELL................Economic Level of Leakage

ILI ....Infrastructure Leakage Index

KPI ....Key Performance Indicator

m^3 ....cubic metres

ML ....Megalitres

NRW..............Non-Revenue Water

POI ....Points of Interest

psi..................pounds per square inch

TARL ....Total Annual Real Losses

UARL.............Unavoidable Annual Real Losses

WRF ....Water Research Foundation

Attachment B

Glossary of Terms

Attachment B: Glossary of Terms

Term	Definition
Real Losses	Physical water losses from the pressurized system (water mains and customer service connections) and the utility's storage tanks, up to the point of customer consumption. In metered systems this is the customer meter, in unmetered situations this is the first point of consumption (stop tap/tap) within the property. The annual volume lost through all types of leaks, breaks and overflows depends on frequencies, flow rates, and average duration of individual leaks, breaks and overflows. Also referred to as Total Annual Real Losses (TARL) and Current Annual Real Losses (CARL)
Apparent Losses	Losses in customer consumption attributed to inaccuracies associated with customer metering, systematic data handling errors, plus unauthorized consumption (theft or illegal use of water). Apparent losses represent nonphysical (paper) losses that result in uncaptured revenue for the Utility and distortion of customer consumption data. Note: Over-estimation of Apparent Losses results in under-estimation of Real Losses. Under estimation of Apparent Losses results in over-estimation of Real Losses.
Unavoidable Annual Real Losses (UARL)	The UARL is a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied. It is a key variable in the calculation of the Infrastructure Leakage Index (ILI). Striving to reduce system leakage to a level close to the UARL. The UARL calculation is based on leakage data gathered from well-maintained and well-managed systems.
Potential Recoverable Real Losses	The difference between real losses and the unavoidable annual real losses is considered the recoverable annual real losses. If the ILI is 1, recoverable annual real losses would be zero. Recoverable Real Losses = TARL – UARL
Infrastructure Leakage Index (ILI)	The ratio of the Total Annual Real Losses (Real Losses/TARL) to the Unavoidable Annual Real Losses (UARL). A performance indicator quantifying how well a distribution system is managed (maintained, repaired, rehabilitated) for the control of real (leakage) losses at the current operating pressure. A low ILI value indicates the Utility has managed its leakage down toward the UARL, or the theoretical low limit of leakage technically achievable.
Variable Cost of Water (Cost of Water Losses)	The cost to produce and supply the next unit of water. This cost is determined by calculating the summed unit costs for ground and surface water treatment and all power used for pumping from the source to the customer. It may also include other miscellaneous unit costs that apply to the production of drinking water. It should also include the unit cost of bulk water purchased as an import if applicable. It is common to apply this unit cost to the volume of Real Losses. However, if water resources are strained and the ability to meet future drinking water demands is in question, then the water auditor can be justified in applying the Customer Retail Rate to the Real Loss volume, rather than applying the Variable Production Cost.
Economic Level of Leakage (ELL)	The level found by determining the level (volume) of real (leakage) losses at which the sum of the cost of the real loss reduction and the cost impact of the real losses is at a minimum. Reducing leakage levels below the ELL is not cost-effective because the cost of the leak abatement activities exceeds the value of water saved. ELL is used for leakage reduction target-setting and setting the frequency of leak survey investigations.

Attachment C

Water Audit Review Summary

Stakeholders - Water Audit
Water Loss Management Strategy

City of Guelph

April 7, 2021

AECOM

Background

Project Purpose

- Objective: Provide a recommended path forward for the Water Loss Management Strategy including economic level of leakage base on a review of water audits, draft Water Loss Management Strategy and Water Efficiency Strategy.

- Tasks:
  - Planning and Data Review
  - Water Audit Review
  - Water Loss Management Strategy Review
  - Reporting

Economic Level of Leakage

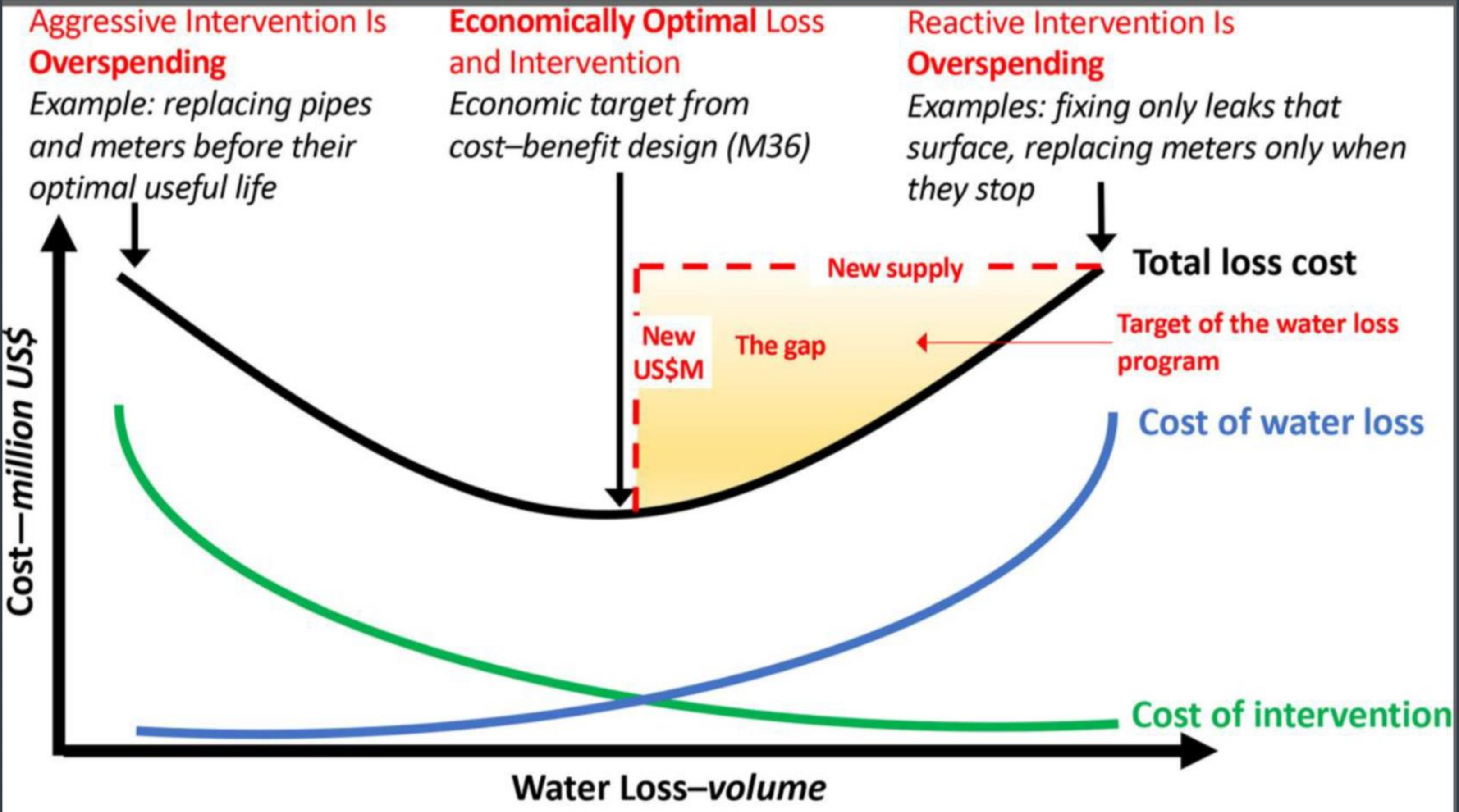

Figure by Cavanaugh & Associates

CWWMG–Catawba-Wateree Water Management Group, M36–AWWA Manual of Water Supply Practices M36, *Water Audits and Loss Control Programs*

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Purpose of Meeting

- Discuss water audit input data with stakeholders

- Why are you on this call?
  - You own some of information that goes into the water audit.
  - Important to engage stakeholders to obtain input.
  - One of the key items for the water audit is to ensure validity/accuracy of data.
  - Another key item is to determine significance of uncertainty of data on the water audit.

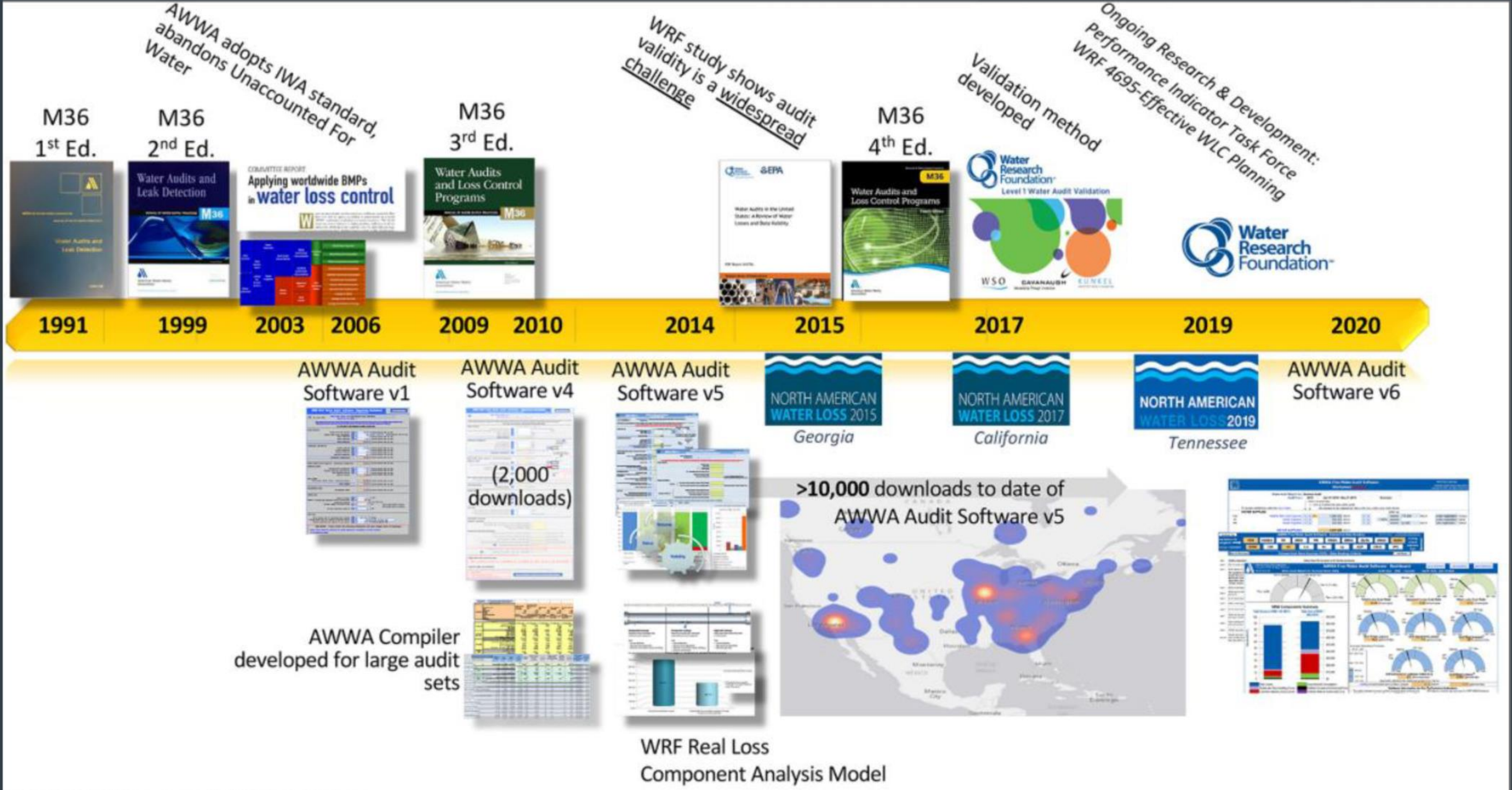


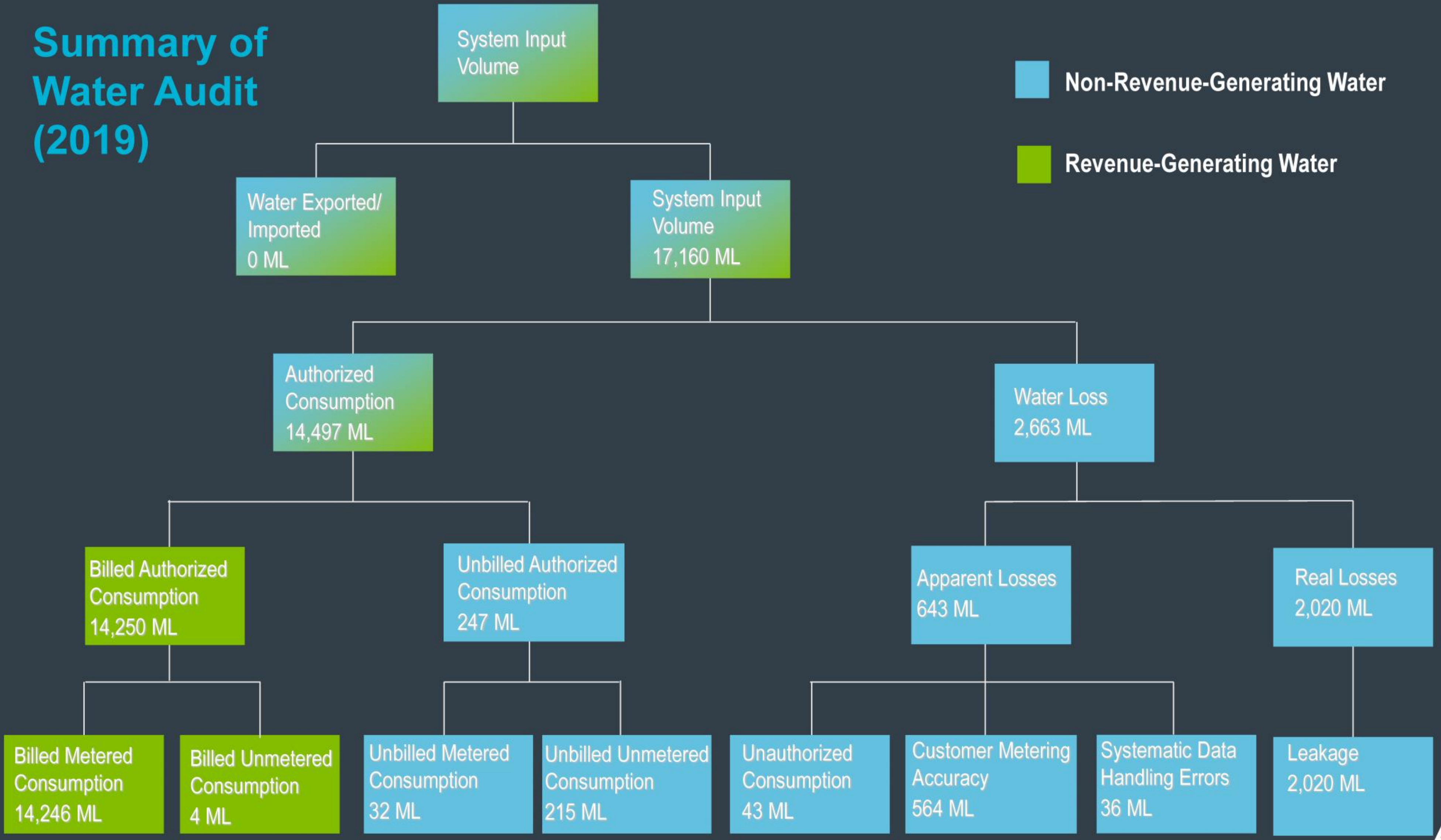
Figure by Cavanaugh & Associates

IWA—International Water Association, M36—AWWA Manual of Water Supply Practices M36, *Water Audits and Loss Control Programs,* WLC—water loss control, WRF—Water Research Foundation

AWWA Water Audit

System Input Volume	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue-Generating Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Generating Water
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorized Consumption	
			Metering Inaccuracies	
		Real Losses	Leakage on Transmission and/or Distribution Mains	
			Leakage and Overflows at Utility's Storage Tanks	
			Leakage on Service Connections up to Point of Customer Metering	

Summary of Water Audit (2019)



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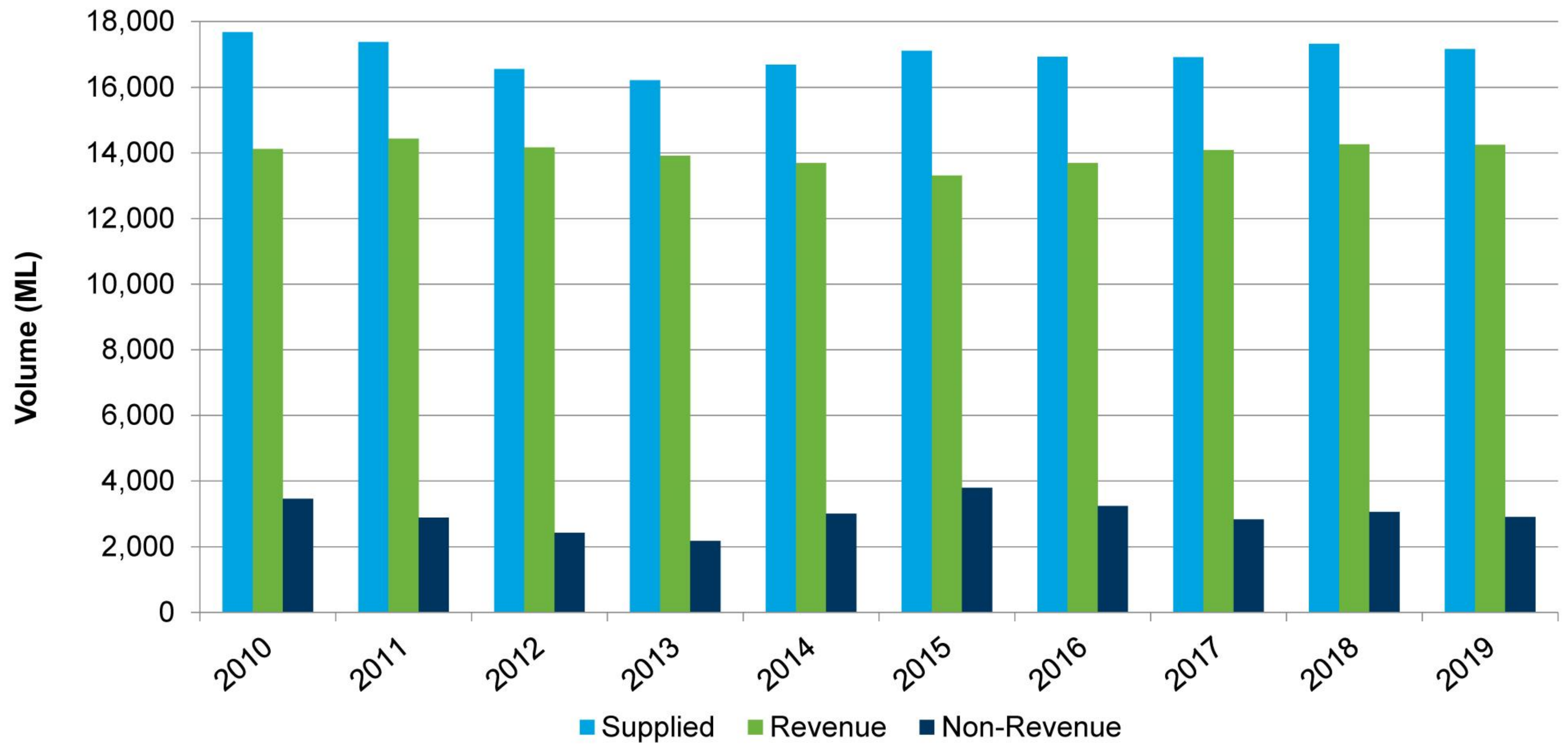
Historical Water Supplied Compared to Revenue and Non-Revenue Water



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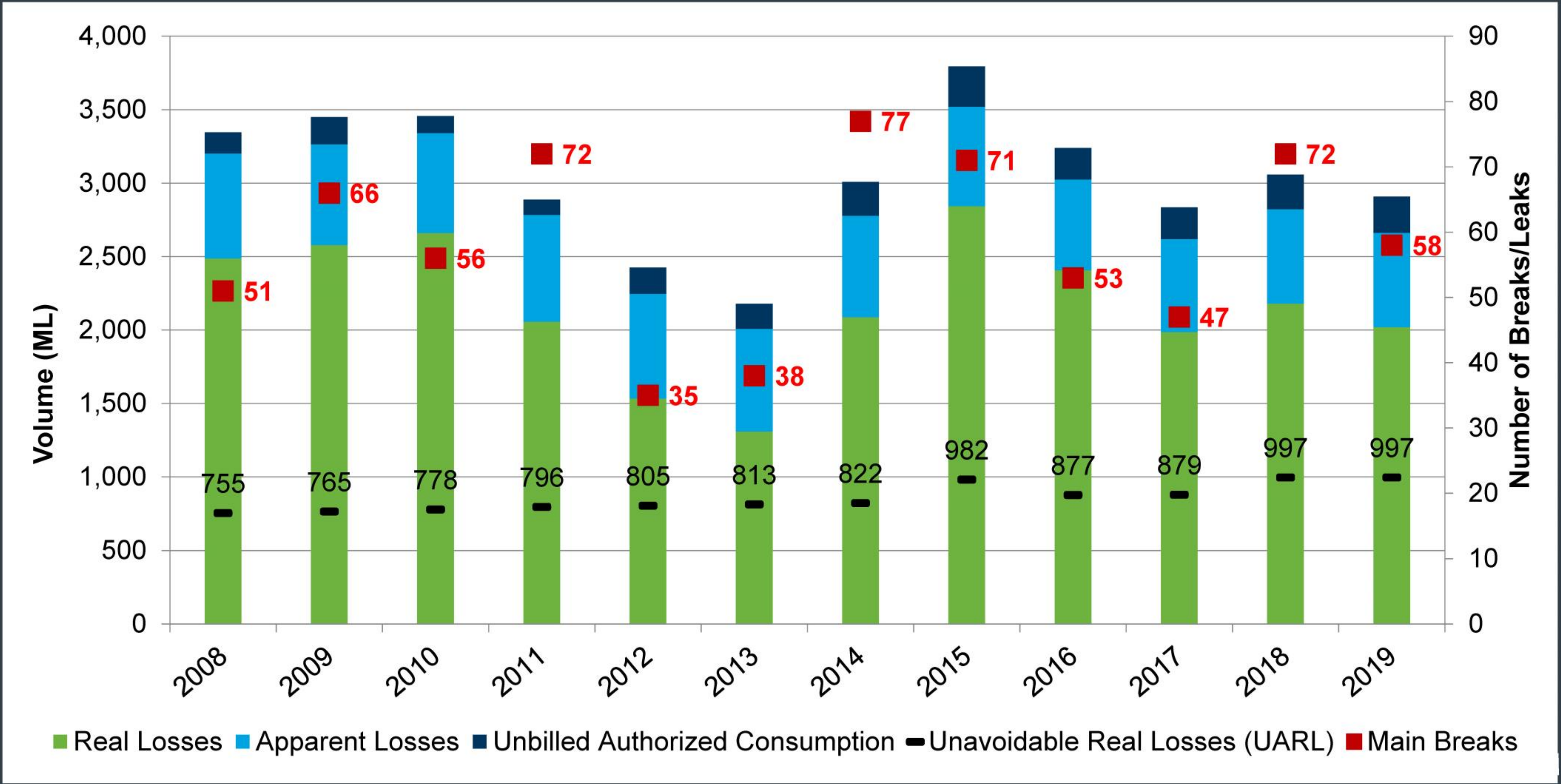
Historical Non- Revenue Water (Volume)



Water Audit Data

Rating Criteria for Data Review

Rating	Description
	Improvement, recommend additional effort to improve water audit data.
	Potential improvement, may have impact on water audit; therefore, consider change.
	Potential improvement, small impact on overall water audit; therefore, no change recommended.
	Good practice, continue with same effort/approach going forward.
	Not applicable.

Water Supplied

Category	Component	Water Use Category	Source of Water Audit Information	Rating	Comments
Water Supplied	Volume from Own Sources	Daily Production	SCADA		• No adjustments made for meter accuracy. • Annual meter validation. • Not all point of entry (POE) meters as other meters in flow process believed to be more accurate. • Review of 2020/2019 records indicate meters accuracy within 0.2% (Clythe Creek Booster). • Compared to Annual Report for verification. • Water Audit results – sensitive to volume/accuracy.
		Net Change in Storage	SCADA		• Adjustment for change in storage. • Good practice, small impact on Water Supplied.
	Water Imported				• City of Guelph does not import/export bulk water supply.
	Water Exported				• City of Guelph does not import/export bulk water supply.

Authorized Consumption - Billed Metered

Category	Component	Water Use Category	Source of Water Audit Information	Rating	Comments
Authorized Consumption	Billed Metered	2020 Consumption from Hydro	Third Party Billing (Hydro)	Yellow	• Inactive Accounts with Consumption, Credited Water Volume due to Leak Forgiveness Program, and Credited Water Volume due to Frozen Services needs to be removed and included in Unbilled Metered if included in Hydro data. • Confirming if adjustments are made for calendar year. • City is working on linking billing data with GIS.
		Bulk Water	Designated Fill Locations, Meter Data	Green	• Clair Tower (noted in spreadsheet)
		Seasonal (parks) + Temporary Meters	Temporary Meters, Meter Data	Green	• Parks Seasonal - Summer, list of individual locations • Parks Seasonal - Winter, billed unmetered • Temporary Meters - Admin (temporary hydrant meters)
		City Departments (i.e. Public Works)	Designated Fill Locations	Green	• WWTP • Street sweeper usage is now metered at 50 Municipal.

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Parks - Seasonal Summer

- Lyons Pool
- Larry Pearson 1
- Larry Pearson 2
- Silvercreek
- Centennial
- Micro Valeriote
- Guelph Lake
- Sunny Acres
- Exhibition Pool
- Castleberry
- Exhibition Softball Diamond
- Hanlon Creek
- Norm Jary
- Curling Club
- Margaret Green
- Exhibition Tennis Courts
- St. George's Park
- Wilson St. Parkade Project
- Speedvale/Hanlon (XACT Drilling)
- Brockville Ave (Varcon Construction)
- Two Rivers Community Garden
- Verney St. (BGL Contractors Corp)
- Phelan Crt (Bright Water Services)
- Arrow Road (Bright Water Services)
- 530 Wellington St. (WWTP)
- Horticulture – Riverside Shop
- JF Ross
- 129 Victoria Rd N (MF Properties)
- Farquar St. Train Hot Box
- Water Services
- Parks and Rec (irrigation of trees/gardens, etc.
- 435 Stone Road (Stone Road Mall)

List from 2018 Seasonal Summer Meters.

Authorized Consumption - Billed Unmetered

Category	Component	Water Use Category	Source of Water Audit Information	Rating	Comments
Authorized Consumption	Billed Unmetered	Outdoor Ice Rinks (Parks Seasonal - Winter)	Metered at one location and estimated based on rink dimensions		
		Sewer Flushing	Need to confirm source.		

Authorized Consumption - Unbilled Metered

Category	Component	Water Use Category	Source of Water Audit Information	Rating	Comments
Authorized Consumption	Unbilled Metered	High Water Leak Forgiveness Program	Admin	●	• Request data from Matt Newman, Meter Technician. Trackable in AMANDA (A.Indoe, Apr 2018). Credit memos (PDF format) to be saved on T drive, individually per credit. Matt Newman estimates 30 to 40 in 2018.
		Temporary Meters	Meter Shop	●	
		Inactive Accounts	Third Party Billing, Hydro	●	• Inactive Accounts: Some accounts become inactive, but the water is not turned off, so water could still be used and is not being paid for. However, Hydro continues to read these meters and this data is available. This report is going to Florence (JL, Feb.2015). This water can only be allocated into theft, if the date the account was closed occurred within the current year and the water use occurred within the current year. This water is not billed, because there is no one to bill. Policy is currently being developed to have Water Services physically turn off water at these locations (JL, Feb. 2016).
		Domestic (Not Read by Hydro Meter Readers)	Meter Reading	●	• Burkes, FM Woods, Heritage (old) Building, UV Building, and Chlorine Building
		UV Bulb Cooling	SCADA	●	• WSupply Water use for UV Bulb cool-down. Changes made at Membro, Water, Emma wells in 2017 to track reverse flows in SCADA. Water pulled from distribution system to cool down UV bulb, which is reverse flow through the POE meter. The total volume of reverse flow through the meter is the volume of water used for UV bulb cool-down (Graham Nasby, discussion, June 13, 2017).
		WSupply Blow-Off/ Bleeders (Scout Camp)	SCADA	●	
		Frozen Services	Admin	●	• Running water credited.

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Authorized Consumption - Unbilled Unmetered

Category	Component	Water Use Category	Source of Water Audit Information	Rating	Comments
Authorized Consumption	Unbilled Unmetered	Guelph Eramosa Twp - within Gazor-Mooney Subdivision Including Sewer Flushing	Township		• Unmetered; however, results not sensitive to estimate (total unbilled unmetered consumption is ~1% to 1.5% of Authorized Consumption) • Noted that water after POE meters should be included. • Discuss how the volume is estimated for each category.
		Capital Water Main Installation Flushing	Distribution/Engineering		
		Curb Stop Replacement	Distribution, Noted No Water Used.		
		Water Main Replacement / Renewal Flushing	Distribution		
		Hydrant Preventative Maintenance	Distribution		
		Hydrant Install/Repair/Replacement	Distribution		
		DMA Integrity Testing	Distribution, Noted No Water Used.		
		Hydrant - Fire Flows / Flow Testing from Hydrants	Distribution		
		Hydrant - Swabbing - Contractor	Distribution		
		Hydrant - Main Flushing - City of Guelph	Distribution		
		Hydrant - Dead End Flushing for Secondary Disinfection Residual Maintenance - City of Guelph	Distribution		
		Service Renewals and Temporary Servicing	Distribution		
		Valve Repair/Replacement	Distribution		

Authorized Consumption - Unbilled Unmetered (cont.)

Category	Component	Water Use Category	Source of Water Audit Information	Rating	Comments
Authorized Consumption	Unbilled Unmetered	Bleeders	Distribution, Distribution System has no Bleeders.		• Unmetered; however, results not sensitive to estimate (total unbilled unmetered consumption is ~1% to 1.5% of Authorized Consumption) • Noted that water after POE meters should be included. • Discuss how the volume is estimated for each category.
		Packing Glands Water Running to waste Drain Lines	Supply		
		Facility Analyzer Water Usage	Supply		
		Faculty & Distribution Sample Water Usage	Supply		
		Reservoir / Contact Chamber / Tower Draining	Supply		
		Water Used after the POE Meter for Supply Maintenance Work	Supply		
		Fire Departments Usage (Incidents and Training)	Fire Department, quarterly reports including incidents and training.		
		Stomwater Maintenance (Catch Basin Cleaning)	Volume Registered at 50 Municipal Flow Meter		
		CCTV Storm and Sewer Mains Flushing	Project Manager		
		Water Wagon	No Feeds in 2019.		

Authorized Consumption – Unbilled Unmetered

Category	Component	Rating	Comments
Authorized Consumption	Unbilled Unmetered		• Use AWWA default value of 1.25% of system input volume. • Recommended default value changes in Version 6.

Water Losses

Category	Component	Rating	Comments
Water Losses	Unauthorized Consumption		• Per IWA Benchmark loss of 0.25% of input volume used for theft allocation. • Version 6 of the AWWA software changes to 0.25% of Billed Authorized Consumption.
	Customer Metering Inaccuracies		• In 2017, 200 residential meters sampled (targeted = >15 years and high volume, plus 20 high volume mid-size meters). Weighted average results from this work show 3.8% inaccuracy. • It was decided to use this number for the 2016 audit over the outdated 2009 study during the July 2017 validation audit with Will Jernigan (AWWA WLCC).
	Systematic Data Handling Errors		• Using default AWWA value of 0.25% of system input volume. • Version 6 of the AWWA software changes to 0.25% of Billed Authorized Consumption.

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System Data

Category	Component	Rating	Comments
System Data	Number of Service Connections		• Asset Management Extract (43316 in 2019). • Uncertainty in number of service connections as system originated in 1879 and records are limited from the early years. City is reconciling this while linking customer billing data to GIS.
	Curb Stop to House		• Legacy Value Used since 2006: 9.8 m
	Average Operating Pressure		• 49.4 m used. • All DMA meter chambers (except 15-2) have a pressure sensor that collects pressure readings and is read in the ClearSCADA server. • Proposed DMAs to be active include: 8,9,10,11,12,21,22,24,30 (confirm this with D.Mutti; R.Puskas). This will create a seasonal change in operations where zones are open part of year and closed part of year. • UARL calculation sensitive to pressure.
	Total Length of Water Main (from GIS)		• Water mains should include all mains in distribution system after treatment is applied (should include Gazor-Mooney) because total production volumes are pumped through these mains. Aquaduct not included. • Confirm includes hydrant leads.

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Cost Data

Category	Component	Source of Water Audit Information	Rating	Comments
Cost Data	Customer Retail Cost	Finance	●	• Applied to Apparent Losses • 2019: $3.60 per 1,000 litres
	Variable Production cost	Finance	●	• Applied to Real Losses • 2019: $243 per Megalitre

AWWA Version 6 (December 2020)

- Defaults
  - Unbilled Unmetered Authorized Consumption (UUAC)
    - Review of validated water audit data suggests UUAC default of 1.25% results in over-estimation.
    - 0.25% of Billed Authorized Consumption (previously water supplied) recommended in short-term.
  - Unauthorized Consumption (UC)
    - 0.25% is maintained as default percent.
    - Deriving this default as a percent of Billed Authorized Consumption, rather than Water Supplied, avoids inappropriate over-stating of the UC volume for high-leakage systems.
  - System Handling Errors (SDHE)
    - 0.25% is maintained as default percent.
- Data Validity Scoring
    - Series of questions which automatically determines the data grade for the given input
- Dashboard and Performance Indicators

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Summary

- Completing AWWA audit historically (good industry practice)
- Additional volumes metered over the years
- Have a residential meter replacement program to replace approximately 26,000 meters (started just before the pandemic)

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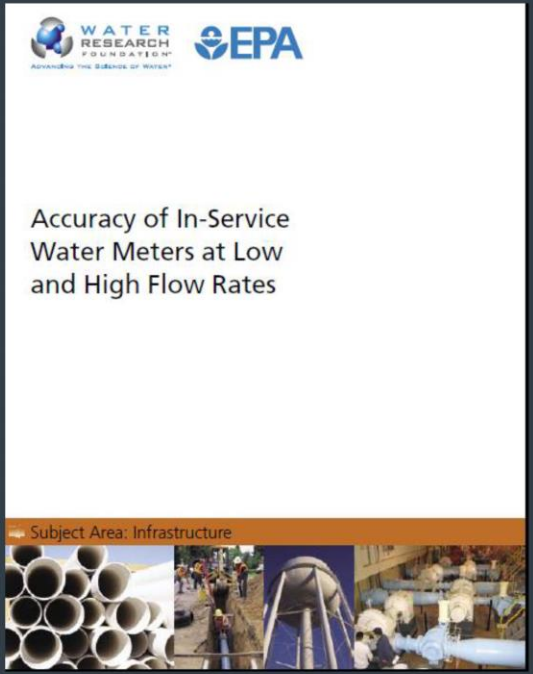
Recommendations (preliminary)

No.	Item	Description
1	Volume of Own Sources	Document accuracy of each meter annually and include in water audit.
2	Documentation	Document calculation/source to determine value for water audit. For example, Volume of Own Sources, which meters are summed to determine the number in the audit.
3	Validation	Use AWWA Water Audit Spreadsheet (Version 6) and complete validation questions.
4	Customer Meter Accuracy	Develop a Meter Testing Program and continue with Meter Replacement Program. Potentially improve accuracy of water audit estimate based on meter type/size, etc.
5	Water Audit by Pressure Zone/DMA	Work toward completing water audit by pressure zone and/or DMA.
6	Private Mains	Industrial areas, strip malls, condos, etc. metered at individual buildings, not capturing leakage on private mains. New developments include bulk meter.

Accuracy of In-Service Water Meters at Low and High Rates, WRF, 2011

- Of the 450 new meters tested for this study, larger-than-expected number of new meters did not meet AWWA flow registry standard applicable to that meter type.
- Not all meter types are equal and some manufacturers produce a better product.
- Some meter types passed the AWWA registry standard tests more consistently than other meter types.
- Most manufacturers that publicize AWWA standard compliancy do not consistently meet AWWA metering standards.



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Next Steps

- Water Audit Review
- Economic Level of Leakage
- Draft Technical Memorandum

Discussion and Questions

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Thank you

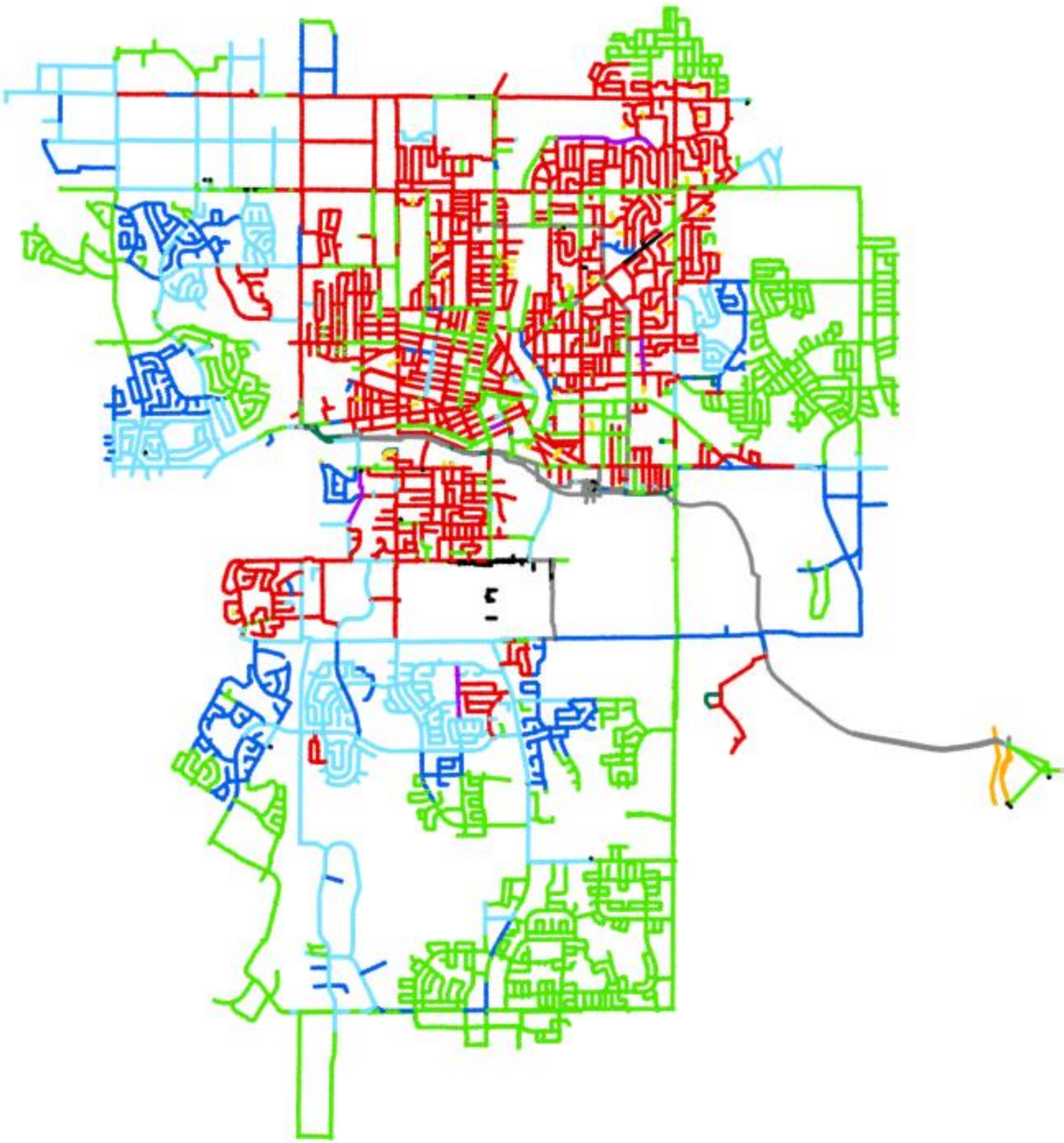
Attachment D

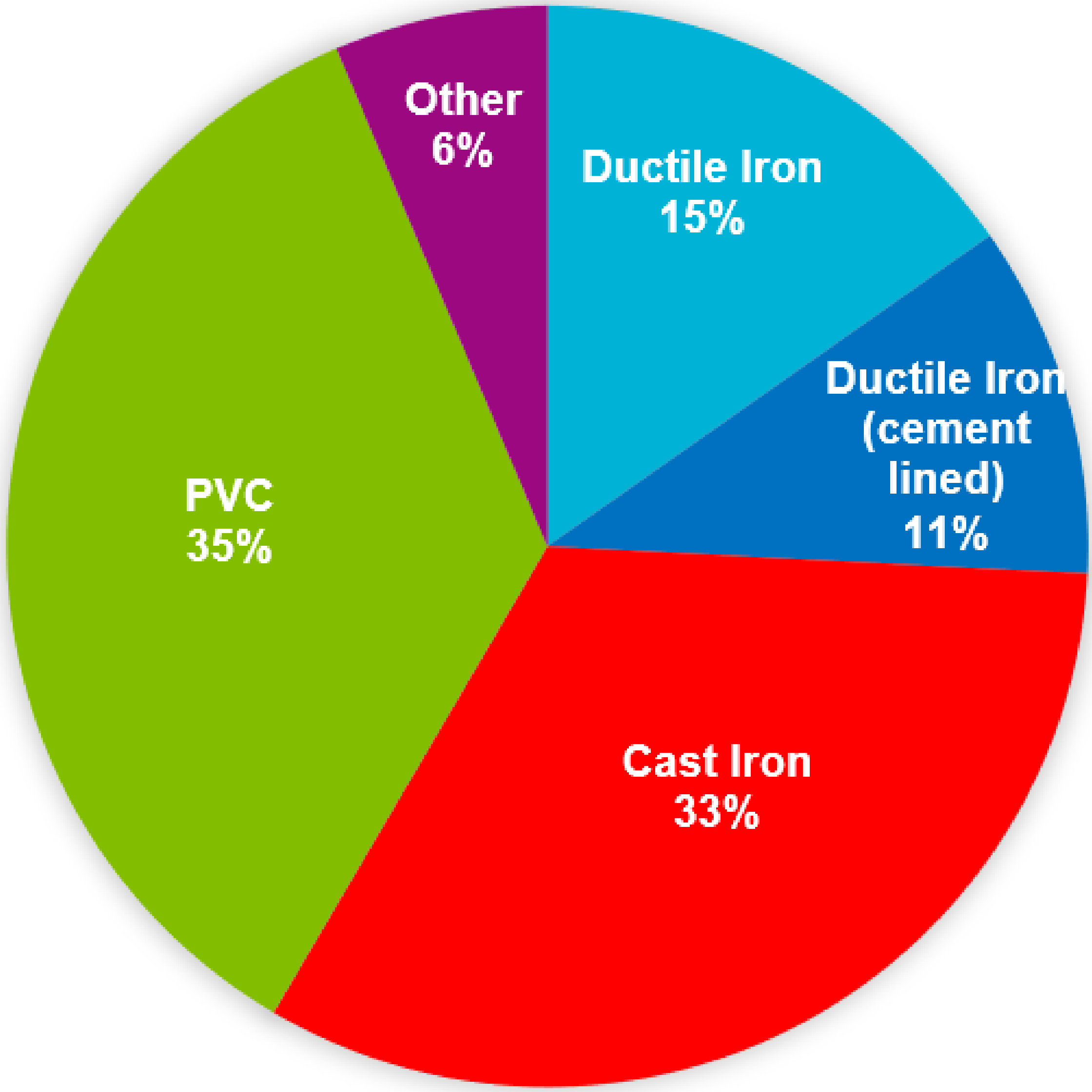
Summary of Water Main Breaks and Leaks

- D.1: Water Main Materials
- D.2: District Metering Areas

D.1: Water Main Materials

Attachment D-1: Water Main Materials

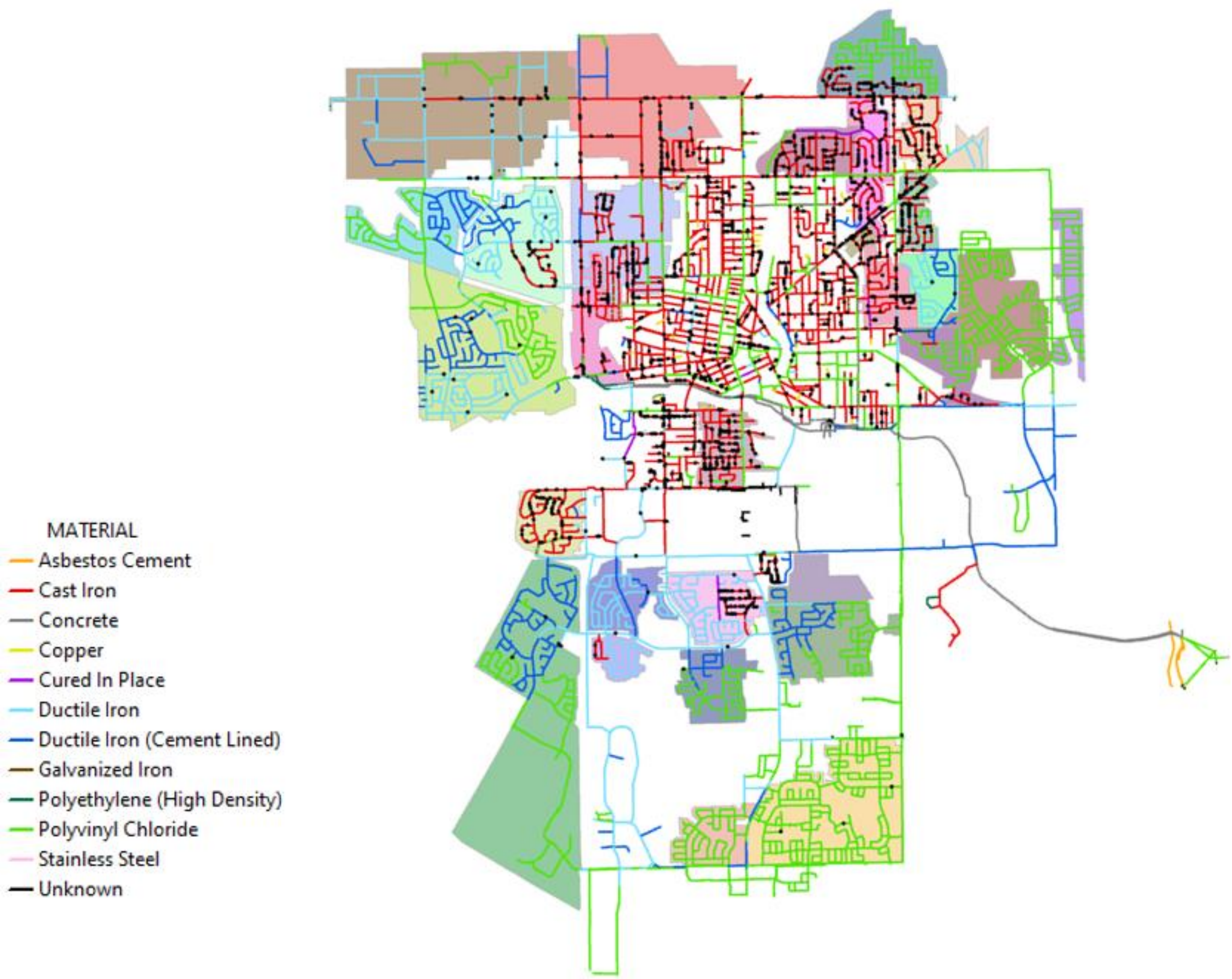




Approximately 585 km (total, GIS)

D.2: District Metering Areas

Attachment D-2: Water Main Materials



Attachment E

Satellite Leak Detection

SATELLITE-BASED INFRASTRUCTURE INTELLIGENCE

LEAK DETECTION

Detecting leaks from space!

The Utilis method uses satellite imagery to cover large areas and quickly narrow down the regions that contain probable leaks. How do we do this?

Specifically, L-band synthetic aperture radar (SAR) sensors are used for their day/night, cloudy/clear capabilities along with the ability to penetrate the first few meters of earth. Using a patented algorithm, Utilis can filter out the signature of drinking water and provide these zones to the customer. They are then displayed in user-friendly GIS reports, and direct the utility's preferred field crew to search within the zones in order to pinpoint the exact leak location.

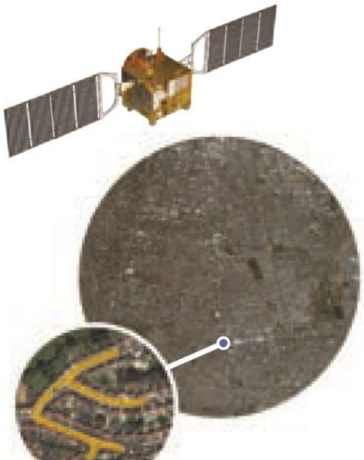
This technology has been adapted from the search for water on other planets, underscoring its innovative and outstanding capability here on Earth. Utilis offers a fresh approach and a non-invasive method to the problem of urban water leakage. When compared with other leak detection methodologies, satellite-based leak detection identifies more leaks per day, saving you water, time, money and energy.

KEY BENEFITS:

- **Reduce your non-revenue water with Utilis!**
- **Maximize leaks found per day** while increasing field crew **efficiency 400%**
- Most cost-effective tool to **support regulatory compliance**
- **Identify trouble spots** for pipe replacement strategy
- **Lowest cost per leak** found on the market

LEAK DETECTION

FROM IMAGE TO REPAIR IN 4 EASY STEPS



Desktop

Dashboard GIS data Mobile

esri Partner Network Silver

Trademarks provided under license from Esri

1 Image acquisition and analysis

2 Delivery

3 Pinpointing of leak

4 Mark for excavation

UTILIS BY THE NUMBERS*

OVER **430 PROJECTS** COMPLETED IN **57 COUNTRIES**

CARBON DIOXIDE EMISSIONS REDUCED BY **14,500 METRIC TONS**

equivalent to 12.5M pounds of coal burned

21,800 MWH of **ENERGY SAVED** yearly

More than **36,000 LEAKS VERIFIED**

3.5 LEAKS FOUND PER CREW DAY

VS. 1.3 found using traditional acoustic methods (on average)

9200M GALLONS (5 million m^3) **WATER SAVED EVERY YEAR**

(EQUIVALENT TO 33% OF THE WATER USED BY A CITY OF 500K RESIDENTS)

*01/2017 - 06/2021

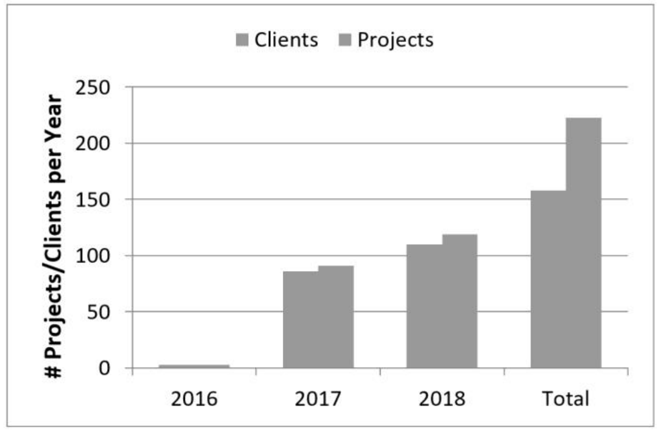
Using Synthetic Aperture Radar for Underground Leak Detection

A White Paper

July 2019

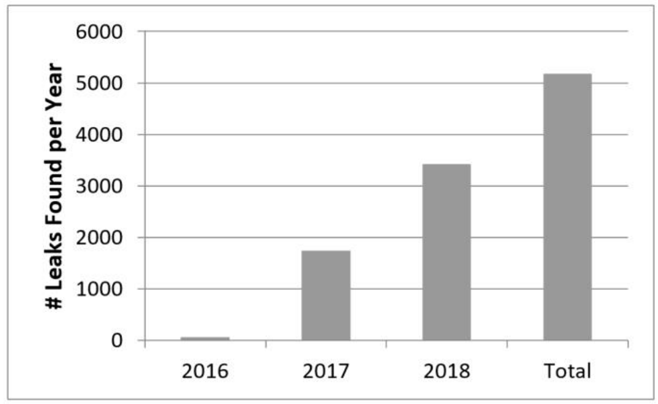
Introduction

Utilis uses satellite data to find potable water leaks underground. This technology was developed in Israel and is now deployed worldwide. The process uses synthetic aperture radar data and passes it through a proprietary algorithm along with application of filtering techniques. This paper will detail the thought behind the development of the technique and explore metrics that benchmark it against traditional leak detection methodology.

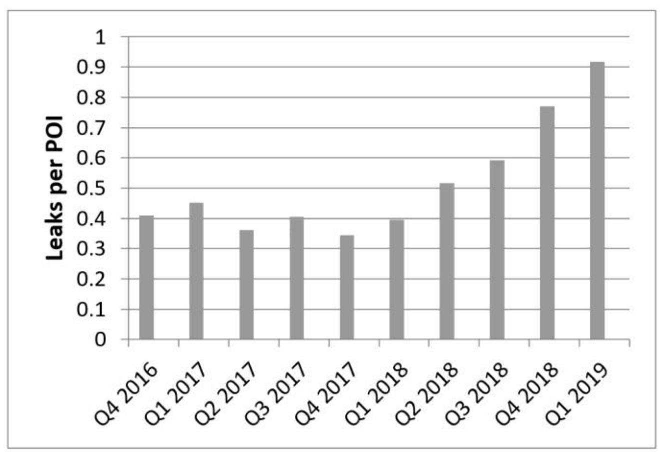


The Company

Utilis was founded in 2013 to commercialize the concept of locating subsurface, background potable water pipe leaks from space. Microwave radar is emitted from a satellite or any other airborne platform and used to detect the signature of wet soil underground with potable water indication. This technology is the same as is used to search for water on other planets such as Mars.



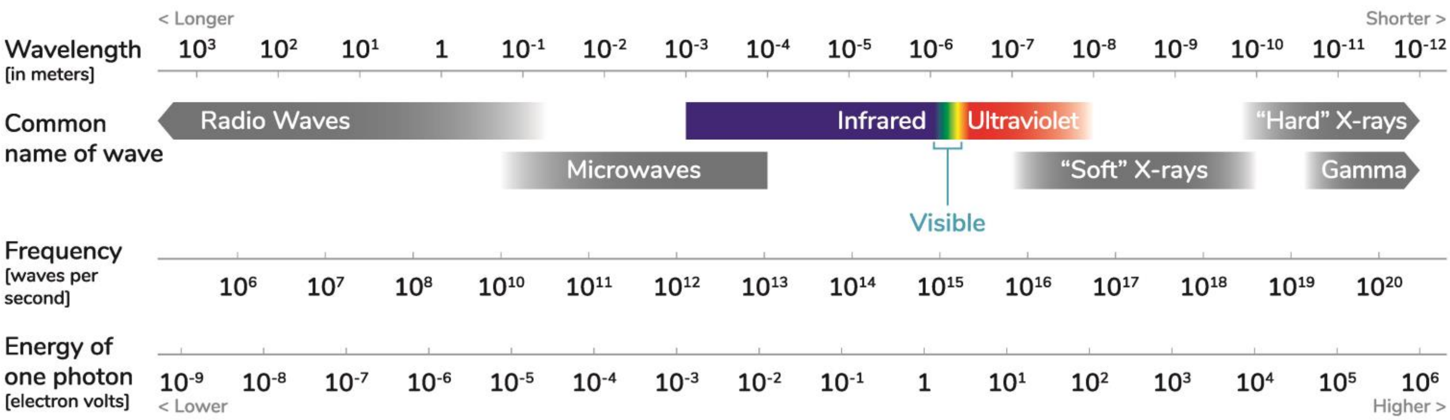
Utilis sales began in 2016. The number of projects completed has risen from three in 2016 to 110 in 2018. A total of 223 projects have been performed worldwide to date, in partnership with 158 unique clients. Over 10,700 points of interest (POI) have been identified and field verified with 5265 leaks being pinpointed in the 223 projects.



Utilis has completed projects in over 40 countries and holds three patents related to systems and methods for underground water detection using radar. Through continuous upgrades to the product, Utilis has increased the efficiency of the service over time.

The Electromagnetic Spectrum

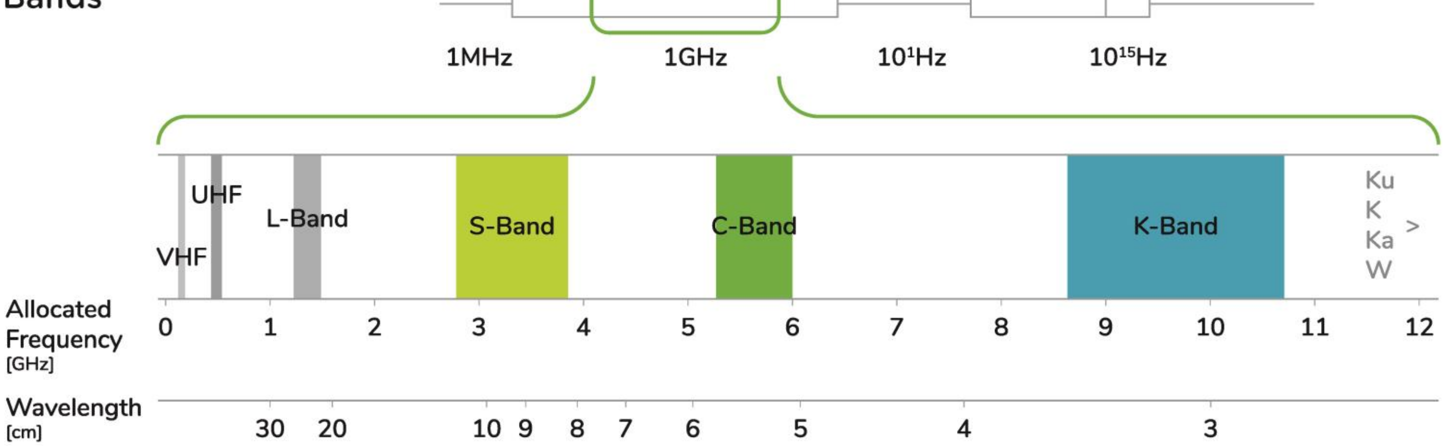
Radiation is energy that travels in the form of waves. Electromagnetic radiation (EM) can travel through empty space within the electromagnetic spectrum. Low energy EM has a long wavelength while high energy EM has short wavelength. Radio and microwaves have the longest wavelengths, and X-rays and gamma rays have the shortest wavelengths. Radar is an object detection system using EM in the microwave domain. Microwaves have a wavelength in the 0.001 to 1-meter range. Radar was developed secretly for military use before WWII. A radar system consists of a transmitter, antenna and receiver. Radar waves are sent from the transmitter and reflected off the subject object. The portion of the waves that are reflected, or backscattered, are returned to the receiver, therefore providing information about the object. Radar waves are more completely reflected by materials with high electrical conductivity including wet soil, and the reflectivity depends on the wavelength. Microwaves can penetrate ground surfaces up to 2 meters in depth, dependent on wavelength and soil type.



Radar

Traditional radar frequency band names originated as code-names during World War II and are still in military and aviation use throughout the world. Radars used to track ballistic missiles, have over-the-horizon, foliage penetrating or ground-penetrating applications, include HF (high frequency), UHF (ultra HF) and VHF (very HF) bands with frequencies in the 3 – 1000 MHz range. Radars used in weather applications, air traffic control and missile guidance have frequencies ranging from 1 – 12 GHz and include L (long), S (short), C (compromise) and X (secret in WW II) bands. Radars in the W band (75 – 100 GHz frequency range) are used in self-driving cars. These land-based applications typically use a pulsed technique whereby an area is illuminated in short bursts and echoes are received in the quiet period in between. Doppler characteristics can determine location, velocity and direction of targets. The performance of radar systems can be gauged by their range, accuracy, ability to filter noise and ability to recognize the intended target. These are greatly impacted by transmitter power and physical size of the antenna. Other systems similar to radar make use of other parts of the EM spectrum. For example, Lidar, uses ultraviolet, visible, or near infrared light from lasers rather than radio waves. Microwave imaging is a science that has evolved from older detecting/locating techniques, such as radar, in order to evaluate hidden or embedded objects in a structure or media using EM waves. Microwave imaging has a variety of applications including nondestructive testing and evaluation (NDT&E), medical imaging, concealed weapon detection at security checkpoints, structural health monitoring, and through-the-wall imaging.

Radar Frequency Bands



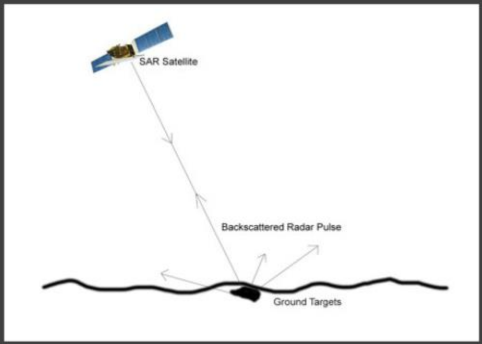
The Process

Utilis mainly, amongst others, leverages the capabilities of the Japanese Advanced Land Observing Satellite (ALOS-2) which is equipped with L-band Synthetic Aperture Radar (PALSAR-2) as an observation device for detailed examination of the earth. The satellite has a polar orbit which allows it to capture data over the same swath of the earth every 14 days. It has the capability to generate a minimum image size on the scale of 30 miles wide by 40 miles long.

SAR can be used for remote detection of underground water such as drinking water leakage from an urban water system. Water sources such as leaking pipes, lakes or swimming pools, reflect EM waves both below and above ground level. Every material has different electric properties, called the dielectric constant, creating an identifying marker that allows distinguishing between backscatter from them with SAR. Therefore, drinking water saturated soil has a specific signature in SAR data that is isolated by Utilis to find water leaks.

SAR sensors placed on an elevated platform such as a satellite or an aircraft send EM waves at a known frequency towards an area and read the EM backscatter from that area. The signals are compiled into an image of the area. This includes backscatter from water sources and other landmarks such as buildings, vegetation and topographical features of the area.

For Utilis to identify the water related backscatter, all other signals (e.g., EM noise reflection) are filtered or removed from the scan. Since different water sources (e.g., drinking water, sewage, seas, lakes swimming pools, etc.) have different dielectric constants, it is possible to distinguish one from the other. Unwanted targets are filtered out or removed from the scan thus leaving only the signal backscattered from pipeline water leakages (the signal from drinking water mixed with soil). The same image at different polarizations (called a quad-pole image) is used to further assist in reducing noise and identifying the desired material. The entire process used by Utilis is propriety and patented. The result is a GIS-based map showing points of interest (POI) where there are likely potable water pipe leaks. This map of POI's is then used to direct the boots-on-the-ground (BOTG) field inspections teams to confirm and pinpoint the leak location.



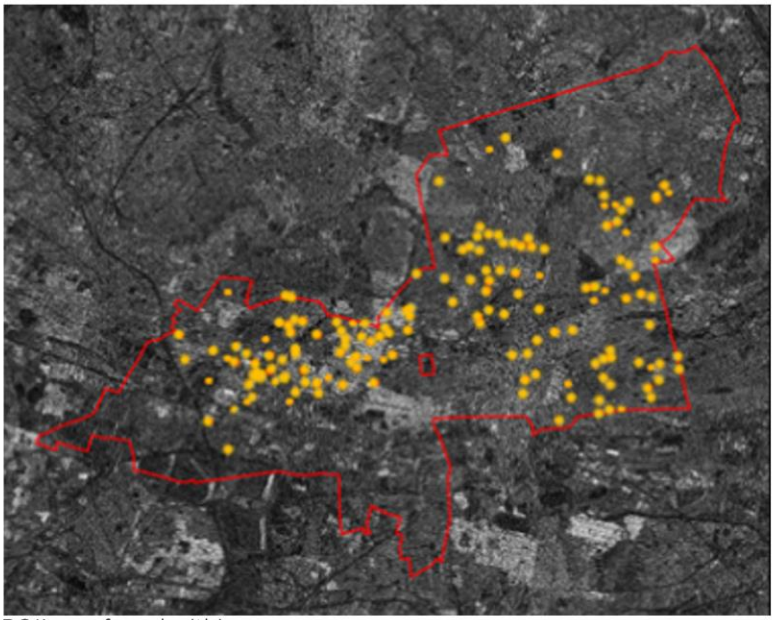
Synthetic Aperture Radar

Seasat was the first earth orbiting satellite designed for earth sensing (of the ocean) using synthetic aperture radar (SAR). SAR is a form of radar that is used to capture two or 3-dimensional images of objects such as landscapes. SAR uses the motion of the radar antenna over a target region to provide finer spatial resolution than conventional radars. SAR is typically mounted on a moving platform such as an aircraft or spacecraft.

The distance the SAR device travels over a target in the time taken for the radar pulses to return to the antenna creates a large "synthetic" antenna aperture (the "size" of the antenna). The larger the aperture the higher the image resolution will be, regardless of whether the aperture is physical (a large antenna) or "synthetic" (a moving aperture). This allows SAR to create high-resolution images with comparatively small physical antennas. To create a SAR image, successive pulses of microwaves are transmitted to "illuminate" a target scene and the echo of each pulse is received and recorded. As the SAR device moves with the aircraft or spacecraft, the antenna location relative to the target changes with time. Signal processing of the successive recorded radar echoes allows combining of the recordings from these multiple antenna positions to produce a correlated image.

The Utilis approach to finding leaks is analogous to a doctor performing triage on a patient to determine where the most acute problems are located. The entire water system is scanned and only the most likely leak locations are identified for further BOTG field inspection. This amounts to 5 -10% of the total length of pipe. The BOTG are trained in the best practices related to looking for and pinpointing leak locations.

The POI's are the centroid of a buffer zone within which the field crews are to focus their attention. The buffer zone stretches up to 300-foot radius from the POI. All pipe within that buffer zone is inspected for leak noise using state-of-art acoustic devices. Typically all of the listening points (e.g. meters, valves, curb stops, hydrants, etc.) within that buffer zone will be accessed to search for leak noises. This can be up to 140 listening points per mile of pipeline. In some cases (e.g. where meters are located inside buildings) fewer listening points are readily available for inspection and thus the field best practices protocols are altered to maximize the number of leaks found per crew day.



POI's are found within a scan area.

Pipe layers within the POI are used to narrow the search area.

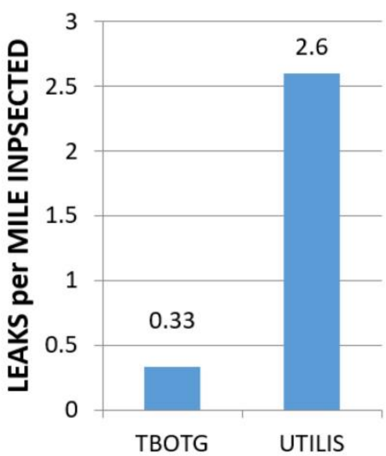
The BOTG field protocols are modified based on the conditions on the ground. The BOTG crews have a large impact on the performance of the Utilis leak detection program. The better trained and the more experience they have the more leaks they find. The Utilis imaging does not locate the point in the pipe that is leaking but senses the result of the leak; wet subsurface soil. Therefore the POI location is typically not the exact location of the leak. In addition, the type of pipe also impacts the success rate of the confirmation stage. PVC, or any plastic pipe, transmits sound less than metal pipe and thus it is harder to confirm by locating and pinpointing a leak.

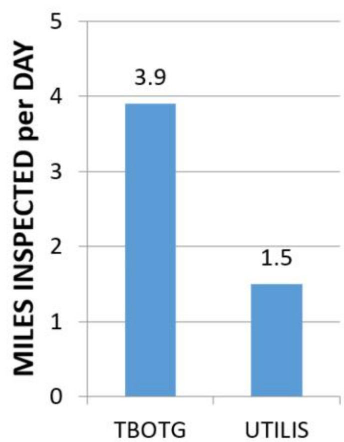
THE UTILIS PROCESS

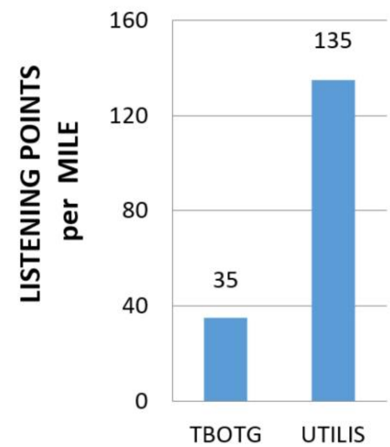
- A microwave sensor on-board a satellite acquires images.
- A corrected microwave image is processed.
- Treated water leaks are identified using a propriety algorithm.
- Data is presented graphically as a GIS data layer and within a data driven application.
- Field crews on the ground receive set of POI's to locate, confirm and repair the leaks.

Benchmarking

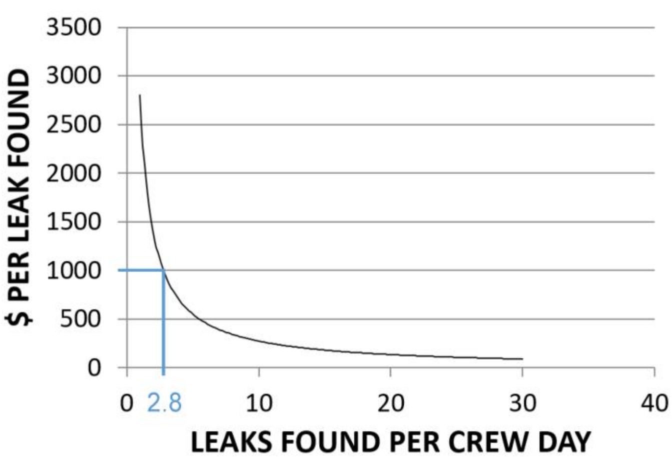
New technologies must always be benchmarked against existing ones to determine technical efficacy and value proposition. Performance metrics can be used to perform an apples-to-apples comparison. The best metric to measure technical efficacy of satellite leak detection is leaks found per mile physically inspected. This shows how well the Utilis satellite triage can reduce the area inspected and focus BOTG to the most likely leak locations. A meta-analysis of over 1600 traditional BOTG projects over ten years was undertaken, showing an average of 0.33 leaks found per mile versus 2.6 leaks per mile using Utilis.

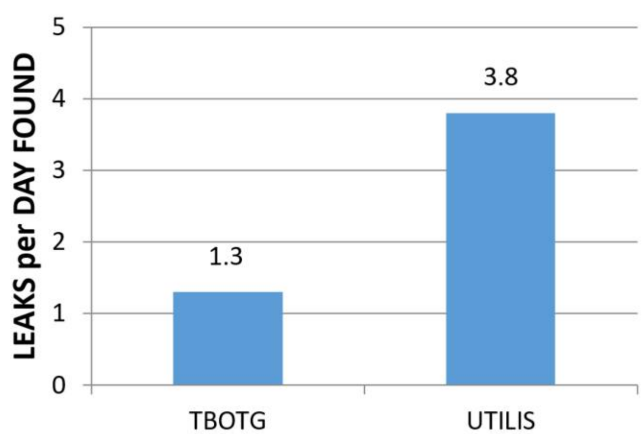






Traditional boots-on-the-ground (TBOTG) vs. Utilis method.





The breakeven point between TBOTG and Utilis is 2.8 leaks per crew day. Above that, Utilis is more cost effective.

Conclusions

Value proposition can best be conveyed using the metric of leaks found per crew day. The more leaks found per day, the lower the unit cost of finding a leak since the major cost of pinpointing a leak is the BOTG labor resources. The Utilis program identifies currently 3.8 leaks per crew day (and growing every day) versus the traditional BOTG services finding an average of 1.3 leaks per day. Using average performance results, satellite survey and BOTG crew pricing, a value metric of dollars per leak found can be calculated. A typical Utilis project will result in a cost per leak found of less than $1000.

Highlights Of Satellite Imagery

- Efficient and accurate survey of a large area, covering an entire water system in a single screening.
- Using the Utilis triage methodology field leak detection crews verify almost 4 leaks per day, resulting in significant reductions in non-revenue water.
- Small leaks down to 0.1 liters per minute are detectable.
- Information generated can be used in any GIS system; the data output can be overlaid with any other data layer.
- There are no installation or capital costs associated with the Utilis program. No changes to existing infrastructure are required. Totally remote solution.
- Knowledge provided via data output is readily accessible and does not require external expertise to interpret.
- Utilis program is the most effective at reducing NRW, both economically and logistically.

Attachment F

Acoustic Loggers

CLEAN WATER

Fluid Conservation Systems

PermaNET+

Data logger

PermaNET + combines a Leak Noise Sensor and our versatile telemetry technology to create a fixed network to monitor leakage.

PermaNET+ works in conjunction with Google Maps to provide live on screen tracking, allowing leakage teams to respond quickly to problem areas and bring them under control.

Key Features and Benefits

- **Quick response:** Enables leakage teams to respond quickly to specific locations when a leak is detected
- **Secondary validation:**
  -Aqualog – detailed noise histogram to reduce 'false positives'
  -Audio – remotely listen to the noise
  -Remote correlation localize leak position
- **Leak sizes can be determined:** By matching daily alarms with flow data to enable leak alerts to be prioritized.
- **Cost effective:** Remote leakage monitoring
- **Easy set up:** Remote set up via GPRS
- **Remote Viewing:** Viewing via server hosted software
- **Precise Logging:** Ability to log noise more frequently to establish the noise profile and profile alarms for precise immediate leakage alarm
- **Fully Waterproof:** The IP68 rating has been tested at 10 m depth over a 24 hour period
- **External antennas:** To improve signal strength
- **Economic:** New communication module is smaller and more economic
- **Latest Technology:** Designed with latest mobile technology to maximize dial in and minimize cost

Applications

Once installed, leak data calculated using the proven Permalog algorithm, and secondary data, is transmitted via low cost GPRS or SMS telemetry. This removes the requirement for expensive site visits and "drive by" data retrieval.

PermaNET+ allows leakage teams to monitor the status of each logger deployed from map based host software any Internet enabled device.

Once the presence of a leak has been identified, secondary measures can be used to check and remove 'false positives' and also to localize the leak position.

PermaNET+

Data Logger

Sensor Input options

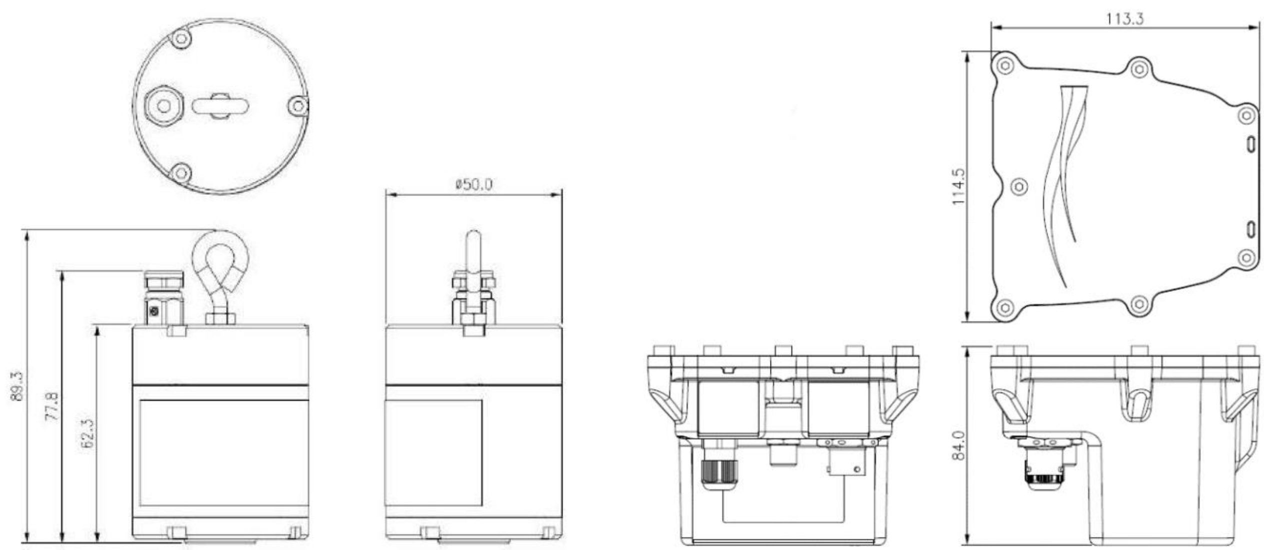
Noise	Permalog LNS Sensor

Communication and programming

Serial	USB Cable for connection to PDA hand held programming and data collection unit, laptop, or desktop PC using 9600 Baud.
Internal Cellular modem	Quad band modem supplying 850/900/1800/1900MHz bands

Logger Features

Operating temperature	Logger: -5°F to +140°F (-20°C to +60°C) Leak Noise Sensor: -5°F to +140°F (-20°C to +60°C)
Memory	Primary recording 1 million readings
Dimensions	Logger without antenna: H = 3.3", W = 4.5", D = 4.4" LNS: H = 3.5", W = 1.9", D =1.9"
Weight	Logger = 0.7 lbs Leak Noise Sensor= 1.0 lbs
Ingress protection	IP68 submersible
Clock	On board 24 hour real time clock with date facility. Automated synchronization
Logger ID	Up to 7 alphanumeric characters. Also readable factory set serial number in firmware
Alarms	Leak/no leak Signal received/not received



Fluid Conservation Systems

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SePem® 155 – Radio Noise Loggers

The principle of noise logging

The duration of time that water leaks from the distribution network has a significant influence on "real water loss" and "non-revenue water" calculations. The goal is to quickly identify water leaks to reduce the dollars lost, reduce the impact on non-revenue water calculations, be efficient, be good stewards of the environment, and reduce potential property damage. This goal can be achieved with ***SePem® 155*** loggers.

In addition to conventional leak detection survey methods, ***SePem® 155*** loggers are an effective, permanent monitoring tool to quickly identify leaks that may never reach the surface. With its ease of reprogramming and versatility, the ***SePem® 155*** loggers can also be redeployed to other locations for shorter-term leak detection surveys. This process is often referred to as "lift and shift".

With the aid of the ***SePem® 01 Master***, the user establishes listening times, frequency and duration, alarm levels and "Patrol Times" for the collection of data. The "listening times" are typically programmed for periods during which flow and traffic noise are at their minimum level. "Patrol Times" are typically set for "regular working hours" eliminating the need for overtime.

The compact design of the ***SePem® 155*** enables the logger to be placed in valve boxes, meter pits, and on unusual contact points. The highly sensitive microphone enables programmed monitoring of distances up to 1,600 linear feet of pipe between loggers. Spacing of the logger is dependent on the pipe size, pipe material, service density, and contact points available.

The ***SePem® 01 Master*** is portable and can be carried, or placed in the vehicle mounting bracket while patrolling for data collection.

During patrol, the result is both an audible and visual "leak/no leak" indicator, substantiated by two pieces of critical leak detection data- "minimum noise level" and "noise consistency". Data results are cataloged by physical location, logger, patrol, date, and can be easily archived for comparison with future data. One ***SePem® 01 Master*** can accommodate up to 500 ***SePem® 155*** loggers.

SePem® Master Communicator for data backup and visualization

The ***SePem® Master Communicator*** software is freeware, which allows you to display the data managed on the ***SePem® 01 Master*** directly on a PC. The patrol lists are transmitted directly after connection and saved in a database. In logger lists you can directly access and easily manage measurements from the individual ***SePem®*** noise loggers.

Appendix D

Groundwater Modelling Report – The City of Guelph Water Supply Master Plan Update by Matrix Solutions Inc.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Groundwater Modelling Report - The City of Guelph Water Supply Master Plan Update

Prepared for:
AECOM Canada Ltd.

Prepared by:
Matrix Solutions Inc.

Version 1.0
October 2021
Guelph, Ontario

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Groundwater Modelling Report -

The City of Guelph Water Supply Master Plan Update

Prepared for AECOM Canada Ltd., October 2021

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October 4, 2021

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Disclaimer

Matrix Solutions Inc. certifies that this report is accurate and complete and accords with the information available during the project. Information obtained during the project or provided by third parties is believed to be accurate but is not guaranteed. Matrix Solutions Inc. has exercised reasonable skill, care, and diligence in assessing the information obtained during the preparation of this report.

This report was prepared for AECOM Canada Ltd and the City of Guelph. The report may not be relied upon by any other person or entity without the written consent of Matrix Solutions Inc., AECOM Canada Ltd, and the City of Guelph. Any uses of this report by a third party, or any reliance on decisions made based on it, are the responsibility of that party. Matrix Solutions Inc. is not responsible for damages or injuries incurred by any third party, as a result of decisions made or actions taken based on this report.

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Version Control

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V0.2	24-Aug-2021	Draft revised	15072-527 WSMP Modelling R 2021-08-24 draft V0.2.docx	Revisions issued to client for review
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Executive Summary

AECOM Canada Ltd. and the City of Guelph (the City) retained Matrix Solutions Inc. to apply the City's groundwater flow model to assess current and potential future municipal water supply scenarios to support the City's Water Supply Master Plan (WSMP) Update. The groundwater model (Tier Three model) was originally developed and peer reviewed as part of the Tier Three Water Budget and Local Area Risk Assessment (Tier Three Assessment; Matrix 2017) under the province's **Clean Water Act** and has since been refined in local areas of interest by the City as new hydrogeological data has become available. As the Tier Three model was originally developed and calibrated in the area of the municipal wells using data representative of 2008 conditions, a recent evaluation was completed to verify the calibration of the model to more recent municipal pumping and water level data (Matrix 2020). This evaluation confirmed that the calibration result and spatial trends were similar to the original Tier Three model applied for the Tier Three Assessment, and therefore, the model was appropriate for application in the WSMP update. Since this evaluation, the Tier Three model was also locally updated in the southwest quadrant of the City for the purposes of the Guelph South Groundwater Feasibility Assessment (Matrix 2021). The Tier Three model version applied for this current project includes these updates.

This report considers new data collected and builds on the previous WSMP update (AECOM and Golder 2014). The 2014 WSMP update included scenarios that explored potential Future Groundwater Supply Sources within 5 km of City limits, including test wells Logan and Ironwood and three hypothetical wells. The 2014 WSMP update also included two Aquifer Storage Recovery Scenarios in the northeast quadrant of Guelph.

As a part of this project, a Current Capacity Scenario was optimized to estimate the maximum average day capacity of the existing municipal water supply system, including groundwater wells and the Glen Collector. This scenario represents a point of reference for remaining future supply scenarios for estimating additional system capacity and impacts to watercourses. The optimization of the capacity considers maintaining groundwater elevations above safe operating levels, minimizing reductions in groundwater discharge to coldwater streams, and the interpreted individual maximum well withdrawal capacities as upper bounds. The estimated average-day capacity of the current water supply system is 66,760 m^3/day. A similar exercise was completed to optimize the current water supply system under drought conditions. The estimated drought capacity of the current water supply system is 57,560 m^3/day.

Below is a table of the scenarios evaluated as part of this modelling work, including scenario descriptions, each scenario's simulated average day capacity and the difference in simulated capacity relative to the Current Capacity scenario.

Table I Summary of System Capacity for Future Supply Scenarios

Scenario Set	Potential Supply Area	Scenario Number: Potential Additional Supply Description	Simulated Average Day Capacity (m^3/day)	Capacity Over Current Capacity Scenario (m^3/day)
Current System Capacity		Current municipal wells and Glen Collector	66,760	-
A Additional Wells and Existing Collector	Southeast Quadrant	A1-A: Lower Road Collector	69,811[a]	3,051
		A1-B: Lower Road Collector and hypothetical Guelph Southeast location well supply	71,960	5,200
	Southwest Quadrant	A2-A: Additional well supply from: Edinburgh, Steffler, Ironwood, and GSTW1-20	71,480	4,720
	Northeast Quadrant	A3-A: Additional well supply from: Clythe, Fleming, and Logan	70,370	3,610
	Northwest Quadrant	A4-A: Additional well supply from: Sacco, Smallfield, Hauser and hypothetical Sunny Acres Park location	68,260	1,500
		A4-B: Additional well supply from Sacco, Smallfield, Hauser, and hypothetical Guelph North location	70,420	3,660
	Multiple Quadrants	A5-A: Additional well supply from: Edinburgh, Steffler, Ironwood, GSTW1-20, Clythe, Fleming, Logan, Sacco, Smallfield, and Hauser	76,740	9,980
		A5-B: Additional well supply from: hypothetical Guelph East 1 and 2	66,760	0
		A5-C: Additional well supply from: Edinburgh, Ironwood, GSTW1-20, Steffler, Clythe, Fleming, Logan, Hauser, Smallfield, and hypothetical Guelph Southeast and Guelph North	82,370	15,610

Scenario Set	Potential Supply Area	Scenario Number: Potential Additional Supply Description	Simulated Average Day Capacity (m^3/day)	Capacity Over Current Capacity Scenario (m^3/day)
B Dolime Quarry Water Capture		B1: Dolime Quarry capture considering current municipal wells	71,760[(b)]	5,000[(b)]
C Arkell Recharge/Collector Optimization		C1: Withdraw more water from the Eramosa River, increase pump capacity to 0.32 m^3/second	71,659[(c)]	4,899
		C2: Deactivate the Glen Collector and install a Caisson Collector System	66,402[(d)]	358
D Aquifer Storage and Recovery System		D1: Inject water from the Glen and Lower Road Collectors into the Middle Gasport Formation in Innovation District Lands and extract during periods of high demand	67,501[(e)]	741[(f)]
		D2: Inject water from Guelph Lake into the Middle Gasport Formation in Northeast Guelph and extract during periods of high demand	68,307[(e)]	1,547[(f)]

Notes:
(a) This is a sum of the Current Capacity Scenario well rates and the A1-A scenario steady-state Lower Road Collector and Glen Collector rates
(b) The increase in water supply capacity associated with the Dolime quarry is assumed to be derived from a combination of increased pumping from new or existing wells in addition to the treatment of quarry discharge water.
(c) This is a sum of the Current Capacity Scenario well rates and the C1 scenario steady-state Glen Collector rates considering an Eramosa pump capacity of 0.32 m^3/second
(d) This is a sum of the Current Capacity Scenario well rates (including the removal of Arkell 15) and the C2 scenario steady-state Caisson Collector rate
(e) This is a sum of the Current Capacity Scenario well rates and the average annual ASR extraction rate applied in Scenarios D1 and D2
(f) This is the annual average extraction rate applied in Scenarios D1 and D2

The model scenarios presented in this report are designed to optimize the City's municipal water supply system's long-term constant rate total capacity while considering low water constraints in municipal supply wells, individual well capacities, and potential impacts to baseflow in streams.

The water supply system can produce greater volumes over short-term periods than the rates presented in this report. In any cases where the model evaluates new well locations, the computer modelling results should only be considered as estimates subject to the results of field tests and local model refinements.

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1 Introduction and Objectives

AECOM Canada Ltd. and the City of Guelph (the City) retained Matrix Solutions Inc. to apply the City's groundwater flow model to assess current and potential future municipal water supply scenarios in support of the City's Water Supply Master Plan (WSMP) Update. This report describes the application of this model to provide estimates of the maximum average-day capacity of the current water supply system, and to evaluate multiple scenarios to estimate the incremental average-day capacity of introducing additional wells or water supply sources within and outside of the city.

The groundwater model (Tier Three model) was originally developed and peer reviewed as part of the Tier Three Water Budget and Local Area Risk Assessment (Tier Three Assessment; Matrix 2017) under the province's **Clean Water Act** and has since been refined in local areas of interest by the City as new hydrogeological data has become available. As the Tier Three model was originally developed and calibrated in the area of the municipal wells using data representative of 2008 conditions, a recent evaluation was completed to verify the calibration of the model to more recent municipal pumping and water level data (Matrix 2020). This evaluation confirmed that the calibration result and spatial trends were similar to that of the original Tier Three model applied for the Tier Three Assessment, and therefore, the model was appropriate for application in the WSMP update. Since this evaluation, the Tier Three model was also locally updated in the southwest quadrant of the City for the purposes of the Guelph South Groundwater Feasibility Assessment (Matrix 2021). The Tier Three model version applied for this current project includes these updates.

The model scenarios presented in this report are designed to optimize the City's municipal water supply system's long-term constant rate total capacity while considering physical construction constraints in municipal supply wells (Figure 1), estimated operating well capacities, and potential impacts in groundwater discharge to streams (Figure 2). The scenarios evaluated estimate an average-day well capacity. The water supply system can achieve greater production rates over short-term periods. The future scenarios in this report consider potential additional sources of water in addition to the existing sources of the current water supply system.

This report summarizes the simulation of current pumping conditions (Baseline Scenario; Section 2), the maximum average day capacity of the current municipal water supply system (Current Capacity Scenario; Section 3), the maximum average capacity under drought conditions (Drought Capacity Scenario; Section 4), and the maximum average capacity considering alternative future groundwater supply sources (Future Potential Supply Scenarios; Section 5). Potential additional sources of groundwater include:

- use of inactive wells and collectors, test wells, and hypothetical wells in areas where additional supply may be available (Section 5.1)
- water management in the Dolime Quarry area (Section 0)
- optimization and reconfiguration of the Arkell recharge and collector system (Section 5.3)
- aquifer storage and recovery systems (Section 5.4)

2 Baseline Scenario

The Baseline Scenario is a steady-state scenario of the most recent representative average pumping conditions in Guelph and establishes the best estimate of baseflow and groundwater levels under current pumping configurations.

2.1 Model Refinements

The Tier Three model has undergone several local updates since its original development in 2008. At the onset of this project, Matrix completed a review of the model to verify that the 2008 calibration statistics remained valid when considering the newer model updates and new groundwater monitoring data collected by the City (Matrix 2020). Various local adjustments were made to the Tier Three model to improve model stability and computation speed prior to scenario optimization. These adjustments include the following:

- the thickness of model layers was increased where needed to a thickness of at least 10 cm
- nodal elevations were updated on the uppermost model slice where needed, to be the same as the elevation of the assigned boundary condition elevation
- local adjustments were made to magnitude and location of local river and wetland boundary conditions
- the magnitude of some bedrock boundary conditions along the outer model boundary were adjusted to represent a smoother gradient
- localized, small hydraulic conductivity adjustments were made around two non-municipal pumping wells that were previously simulated going dry (Permit to Take Water [PTTW] Nos. 3368-9UNH2S and 03-P-2249).

As a result of these minor changes to the model, the model was found to converge in a shorter period of time.

In addition to the refinements made to improve model stability, the representation of the Glen Collector was improved. The Glen Collector is represented by several constant head boundary conditions and the applied elevations of these boundary conditions were refined to better represent the flow gradient toward the Eramosa River in the Glen Collector. The Eramosa infiltration system was previously represented with injection well boundary conditions. These boundary conditions were replaced with lateral multilayer well boundary conditions, which applied a discrete feature along the length of the system. This update was made to simplify the modelling process of updating the applied injection rate.

2.2 Pumping Rates

The Baseline Scenario municipal pumping rates were selected by reviewing average pumping conditions between 2017 and 2019, and selecting the three-year average pumping rate for all municipal wells, except for Burke Well and Calico Well (Table 1, Column C). The 3-year average was not considered representative of current average pumping conditions of the Burke well because it was offline in 2018 and early 2019. Once the Burke well was back online in March of 2019, it was pumped consistently at an average rate of 6,009 m^3/day, which is the rate applied in the Baseline Scenario. Similarly, the Calico well was off-line since August of 2018, but previously pumped at a continuous average rate of 809 m^3/day from 2017 to the fall of 2019. This pumping rate of the Calico well was applied in the Baseline Scenario.

Surface water is seasonally pumped out of the Eramosa River and infiltrated through the Arkell groundwater infiltration system. A portion of this infiltrated water supplements groundwater discharge to the Glen Collector. For the steady-state modelling, the average pumping rate from the Eramosa River between 2017 and 2019 was 3,290 m^3/day. This value represents the average rate of water if evenly spread over the whole year, as opposed to the value representing daily and seasonal variability. The applied Eramosa infiltration rate in the steady-state baseline model was updated from 3,000 to 3,290 m^3/day to represent this 2017-2019 average.

Other permitted pumping rates were also updated in the model within the Wellhead Protection Area for water quantity (WHPA-Q) to represent more recent groundwater pumping conditions. The 2016 reported non-municipal well rates and locations from the Guelph-Guelph Eramosa Threats Management Strategy (Matrix 2018) were applied in the Tier Three model and then updated to 2019 consumptive permitted rates using the province's PTTW database (MECP 2019) where 2016 reported takings were unavailable. Ultimately, three sources from two 2019 PTTWs were added to the model associated with "aggregate washing" (PTTW No. 4551-BBHRVD; 771 m^3/day) and "miscellaneous" (PTTW No. 2370-AWTPH4; 12 m^3/day) purposes. One PTTW was removed associated with aggregate washing (PTTW No. 2718-7S3RM7; 0.6 m^3/day). Finally, the simulated rates of two Guelph/Eramosa Township municipal PTTWs (Nos. 2010-95CQ5Q and 2404-9R8PQV) were updated to reflect 2019 average withdrawals (totalling 251 m^3/day; Guelph/Eramosa Township 2020).

2.3 Low Water Thresholds

Low water thresholds at the municipal wells are used in the WSMP modelling work to evaluate when aquifer water levels fall too low and a municipal well may be unable to reliably withdraw water. Estimates of these thresholds were provided by AECOM (AECOM 2021; Table 1) and may be related to the depth of the pump intake, open borehole interval, water bearing zones, or other operational considerations at a well. Due to differences between the simulated and actual aquifer hydraulics near a well, there are differences between observed and simulated specific capacity and hydraulic head at the municipal wells. The low water threshold of each well was adjusted to account for the difference between simulated and actual specific capacity (Table 1; Column K).

The simulated specific capacity was estimated (Table 1; Column G) by determining the simulated head at each municipal well when its rate is set to zero and when its rate is set to Baseline. There is uncertainty in the estimated specific capacity of each well because of the interaction between some of the municipal wells. For a few wells (i.e., Arkell 8, Membro, Water Street, Dean, University, and Park wells), the specific capacity was re-estimated using municipal water level and pumping data so that the simulated pumping wells could pump at rates closer to what was observed without exceeding the adjusted low water threshold (Table 1).

Historical measured water levels were also reviewed to find the typical water level at the Baseline Scenario pumping rate for each municipal well (Table 1; Column C). From each typical water level and estimated low water level threshold, the available head was calculated (typical water level minus the low water threshold; Table 1 Column E). To account for differences in the well's estimated and simulated specific capacities, the available head was multiplied by the estimated versus simulated specific capacity ratio (Table 1; Column I).

To calculate the adjusted simulated low water threshold, the adjusted available head was then subtracted from the simulated Baseline Scenario head at each municipal well to account for the difference in measured and simulated hydraulic head (Table 1; Column K).

Table 1 Summary of Municipal Pumping Rates and Well Data

City Quadrant	Municipal Well/Source	A Baseline Simulated Pumping Rate (m^3/day)	B AECOM Interpreted Maximum Pumping Rate (m^3/day)	C Typical Measured Water Level at Baseline Pumping Rate (m asl)	D Low Water Level Threshold (AECOM 2021) (m asl)	E Measured Available Head (m) E=C-D	F Estimated Specific Capacity (AECOM 2021) (m^3/day/m)	G Simulated Specific Capacity (m^3/day/m)	H Estimated/ Simulated Specific Capacity Ratio ( ) H=F/G	I Adjusted Simulated Available Head (m) I=E x H	J Baseline Simulated Water Level (m asl)	K Adjusted Simulated Low Water Threshold (m asl) K=J-I
Southeast	Arkell 1	92	600	323.0	319.1	3.9	550	677	0.8	3.2	322.6	319.5
	Arkell 6	4,464	4,900	311.0	301.6	9.4	860	1,309	0.7	6.2	311.9	305.7
	Arkell 7	5,499	4,900	312.0	301.8	10.2	730	1,219	0.6	6.1	311.8	305.7
	Arkell 8	1,310	4,800	310.0	303.8	6.2	260[d]	1,304	0.2	1.2	312.4	311.1
	Arkell 14	4,527	3,300	313.0	308.5	4.5	350	1,334	0.3	1.2	312.0	310.9
	Arkell 15	2,180	3,300	314.5	307.2	7.3	1,490	1,318	1.1	8.3	312.6	304.4
	Burke[b]	6,009	5,500	315.0	313.1	1.9	340	893	0.4	0.7	324.1	323.4
	Carter[a]	2,455	4,000	320.4	315.0	5.4	1,200	1,316	0.9	4.9	323.5	318.5
Southwest	Membro	1,802	4,300	289.5	275.3	14.2	300[d]	521	0.6	8.5	290.6	282.1
	Water St.	1,108	2,400	287.0	275.9	11.1	207[d]	428	0.5	5.4	294.6	289.2
	Dean	1,096	1,500	287.0	277.8	9.2	110[d]	411	0.3	2.8	292.7	289.9
	University	1,178	2,500	289.0	282.0	7.0	200[d]	726	0.3	1.9	292.3	290.4
	Downey	4,278	5,200	291.0	282.3	8.7	240	593	0.4	3.5	289.9	286.4
Northeast	Park[a]	3,163	6,400	302.5	286.9	15.6	250[d]	209	1.2	18.7	299.7	281.0
	Emma	2,276	2,100	297.5	291.9	5.6	170	89	1.9	10.7	288.9	278.2
	Helmar	749	1,500	302.0	299.9	2.1	45	169	0.3	0.6	324.5	321.4[e]
Northwest	Paisley	820	1,400	297.0	290.4	6.6	45	103	0.4	2.9	301.4	298.5
	Calico[b]	809	1,400	305.0	290.2	14.8	110	78	1.4	20.9	315.1	294.2
	Queensdale	624	1,100	282.0	269.9	12.1	25	103	0.2	2.9	298.9	295.9
	Glen Collector[c]	9,112										
Total (Wells		**44,439**										
Total (Wells + Collector)		**53,551**										

Notes:
(a) The Carter and Park Wells are represented by one simulated well each in the numerical model
(b) The Baseline rate represents the average pumping rate when pumping was taking place in 2019 for Burke and 2017 to 2018 for Calico.
(c) This taking is not assigned in the model like the municipal well takings. The value represents the simulated output of the Glen Collector.
(d) This estimated capacity has been adjusted from the AECOM estimate based on hydrographs and pumping data.
(e) This Low water threshold has been adjusted to account for uncertainty in the aquifer representation
asl - above sea level

2.4 Baseline Groundwater Discharge to Streams

The elevations of watercourses are represented in the model with constant head boundary conditions applied to ground surface in the Tier Three model. Simulated groundwater discharge for a given section of a river/stream is calculated as the net flow rate of the selected boundary conditions (Figure 2). Table 2 summarizes the estimated and simulated baseflows for the watercourses evaluated in this study, as well as the classification of each stream as "coldwater" or "warmwater" according to the Ontario Ministry of Natural Resources (currently the Ministry of Natural Resources and Forestry; 2013) and GRCA (2013) as found in Matrix (2017). The watercourse was assigned a coldwater classification for the purposes of this evaluation if a segment of the entire reach was assessed as coldwater. The range of estimated baseflow for the various watercourses are from previous studies including the Tier Three Risk Assessment (Matrix 2017) and the City of Guelph Southwest Quadrant Water Supply Class Environmental Assessment (Golder 2010). For the larger subwatersheds, model predictions of groundwater discharge nearly all fall within the estimated range of values. The simulated groundwater discharge to Mill Creek is lower than the estimated range of baseflow; however, this range may be an over-estimate as there are documented concerns that ice jamming at the Mill Creek gauge may have been impacting the estimates (Matrix 2017). For the smaller subwatersheds, model predictions of groundwater discharge are generally consistent with observations, but there are some inconsistencies. For these smaller streams, there is less certainty that baseflow measurements reflect average annual conditions. In addition, there is greater likelihood that baseflow is influenced by smaller-scale hydrogeologic features not included in the model or that the regional hydrogeologic model is less representative of that area. Most importantly, the baseflow associated with those small features may be outside of the precision of the model. Routine monitoring programs that include surface water monitoring (flow and water level), as well as shallow groundwater level monitoring in areas of important surface water features (e.g., coldwater streams and streams where groundwater discharge is predicted to be reduced), would improve the characterization of these features in the model and increase the certainty of model predictions.

Clythe Creek was included in this analysis to estimate potential impacts; however, insufficient data were available to calibrate overburden groundwater flow and groundwater discharge to Clythe Creek in the development of the Tier Three groundwater flow model. As a result, there is some uncertainty in the simulated baseflow of the creek. While uncertain, the simulated reductions in the effects on baseflow are the best available estimates at this time. Clythe Creek has been recently studied as part of the York Road Environmental Design (Amec Foster Wheeler 2017). According to this study, the headwaters of Clythe Creek are a coldwater stream that has historically sustained a trout population. The most recent warm water temperature results suggests that the lower and mid-reaches of the creek are considerably degraded. Presently, the creek is highly altered, with numerous drop structures and warm pool areas that restrict fish passage and warm the water. Should the City wish to pursue additional groundwater supplies in the northeast quadrant of the city, any estimated effects to Clythe Creek should be evaluated with additional local calibration of the model as well as consideration of the potential local ecological impacts. The City is currently undertaking additional studies in this area (e.g., as part of the return to service of the Clythe well) and this data can be used to supplement the model at a later date.

Table 2 Estimated and Baseline Scenario Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[(a)]	Minimum Baseflow Estimate	Maximum Baseflow Estimate	Simulated Baseline Groundwater Discharge
		(m^3/day)		
Blue Springs Creek	Coldwater	12,614	149,904	42,336
Chilligo/Ellis Creek	Coldwater	864	18,576	14,947
Clythe Creek	Coldwater	n/a	n/a	2,246
Cox Creek	Warmwater	518	3,802	2,419
Eramosa River	Coldwater	115,171	212,026	124,157
Guelph Lake Tributary	Coldwater	4,320	6,566	9,504
Hanlon Creek	Coldwater	3,801	5,357	4,244
Hopewell Creek	Coldwater	1,123	16,157	21,773
Irish Creek	Warmwater	5,357	9,245	5,875
Lutteral Creek	Coldwater	30,758	47,261	34,214
Marden Creek	Warmwater	1,901	5,789	3,110
Mill Creek	Coldwater	50,890	63,331	39,017
Moffat Creek	Coldwater	7,603	10,454	2,074
Speed River	Coldwater	198,893	293,069	251,510
Swan Creek	Coldwater	1,728	20,131	5,875
Torrance Creek	Warmwater	1,382	2,938	2,938
West Credit River	Coldwater	25,920	31,104	30,672

n/a - not available
(a) From MNR (2013) and GRCA (2013) in Matrix (2017)

2.5 Baseline Hydraulic Head Distribution

Most of the City's groundwater supply comes from the Middle Gasport Formation Aquifer. Figure 3 illustrates the simulated hydraulic head distribution in the Middle Gasport Formation aquifer under baseline pumping conditions. Regionally, within the Middle Gasport Formation aquifer (where the City municipal wells predominantly get their water), groundwater flows from the north into the City, which agrees with the regional understanding (Matrix 2017). Pumping from municipal wells and surrounding non-municipal wells results in drawdown, or lowered water levels, in the aquifer within and around the City.

3 Current Capacity Scenario

The Current Capacity Scenario is designed to estimate the maximum average day capacity of the existing municipal water supply system, including groundwater wells and the Glen Collector. The scenario represents a point of reference for future supply scenarios for estimating the incremental system capacity and reductions in groundwater discharge to watercourses. The optimization of the municipal well pumping rates involves estimating the maximum total pumping rate while maintaining groundwater elevations above safe operating levels (i.e., low water thresholds; Table 1), minimizing reductions in groundwater discharge to coldwater streams (Table 2), and keeping individual well pumping rates below maximum well withdrawal capacities (Table 1; Column B). Optimization of municipal pumping rates was completed using PESTPP-OPT (Parameter Estimation Software; White et al. 2020), which automates the estimation of the maximum pumping rate potentially achievable by each well under each of the three listed constraints.

Table 3 summarizes the results of the Current Capacity Scenario, including maximum simulated pumping rates and simulated available heads under those rates. The estimated average-day capacity of the current water supply system is 66,760 m^3/day. This estimate includes an average day supply of 7,240 m^3/day from the Glen Collector under average annual recharge rates. The system has a higher total permitted rate and has a greater short-term capacity than this average-day capacity. Also, while this Current Capacity Scenario illustrates a precise series of pumping rates across each of the municipal wells, there are infinite combinations of pumping rates across the City's wells that could achieve a similar overall total capacity. For all scenarios, the simulated results should be interpreted as an estimated total capacity across the complete system, as opposed to evaluating individual well capacities.

Figure 4 illustrates the simulated drawdown in the Middle Gasport Formation from the Baseline simulated hydraulic head distribution (Figure 3) in response to pumping at Current Capacity rates. The 1 m drawdown contour extends approximately 1 to 2 km beyond active Current Capacity municipal wells. The largest drawdown is simulated to be approximately 18 m surrounding Park well, where the pumping rate is increased from a Baseline rate of 3,163 to 6,680 m^3/day.

Table 3 Current Capacity Scenario: Municipal Well Constraints and Maximum Pumping Rates

City Quadrant	Municipal Well/ Source	Adjusted Simulated Low Water Threshold (m asl)	Maximum Individual Well Capacity Threshold (m^3/day)	Current Capacity Scenario		Drought Capacity Scenario	
				Maximum Pumping Rate (m^3/day)	Available Head (m)	Maximum Pumping Rate (m^3/day)	Available Head (m)
Southeast	Arkell 1	319.5	2,000	2,000	2	2,000	0.8
	Arkell 6	305.7	8,000	1,500	5.1	2,960	4.7
	Arkell 7	305.7	8,000	8,000	3.6	8,000	3.4
	Arkell 8	311.1	7,000	0	-0.1[b]	0	-0.2[b]
	Arkell 14	310.9	7,000	3,100	-0.0	0	0.3
	Arkell 15	304.4	7,000	7,000	5.3	7,000	5
	Burke	323.4	6,500	5,200	0.2	3,000	0
	Carter Wells[a]	318.5	6,400	6,100	0	4,000	0.6
Southwest	Membro	282.1	5,200	5,200	0.8	5,200	0.5
	Water St.	289.2	2,700	1,950	0.1	1,800	-0.1[b]
	Dean	289.9	1,500	540	0	400	-0.1[b]
	University	290.4	2,500	850	0.3	470	0
	Downey	286.4	5,237	5,240	0.9	5,240	0.1
Northeast	Park Wells[a]	281.0	8,000	6,680	0.1	6,540	0.1
	Emma	278.2	2,800	2,390	0.3	2,360	0.1
	Helmar	321.4	800	670	0.1	550	0.1
Northwest	Paisley	298.5	1,400	940	0	830	0
	Calico	294.2	1,400	1,400	13.2	1,400	11.8
	Queensdale	295.9	1,100	760	0.5	680	0
	Glen Collector	-	-	7,240	-	5,130	-
Total (Wells)		-	-	**59,520**	-	**52,430**	-
Total (Wells + Collector)		-	-	**66,760**	-	**57,560**	-

Notes:
Minor exceedances (<0.2 m) were considered acceptable.
(a) Two or more wells simulated as one well.
(b) Low water level threshold exceedance when negative. Positive values indicate remaining available head at maximum pumping rate.
asl - above sea level

Table 4 summarizes the simulated groundwater discharge to various coldwater and warmwater streams under the Current Capacity Scenario. The model computes this discharge as the net sum of groundwater flow into or out of all constant head stream boundary conditions shown on Figure 2. The estimated groundwater discharge under the Current Capacity Scenario is a reference point to compare against estimated groundwater discharge in future supply scenarios described in Section 5.

Table 4 Current Capacity Scenario: Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[(a)]	Average Groundwater Discharge (m^3/day)
Blue Springs Creek	Coldwater	41,769
Chilligo/Ellis Creek	Coldwater	14,618
Clythe Creek	Coldwater	1,906
Cox Creek	Warmwater	2,354
Eramosa River	Coldwater	122,620
Guelph Lake Tributary	Coldwater	9,430
Hanlon Creek	Coldwater	3,718
Hopewell Creek	Coldwater	21,514
Irish Creek	Warmwater	5,807
Lutteral Creek	Coldwater	34,184
Marden Creek	Warmwater	2,982
Mill Creek	Coldwater	38,566
Moffat Creek	Coldwater	2,061
Speed River	Coldwater	246,216
Swan Creek	Coldwater	5,908
Torrance Creek	Warmwater	771
West Credit River	Coldwater	30,642

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)

4 Drought Capacity Scenario

The Drought Capacity Scenario estimates the average-day capacity of the existing municipal water supply system (i.e., groundwater wells and the Glen Collector) under long-term drought conditions, while keeping groundwater elevations above safe operating levels (i.e., low water thresholds) and considering the individual well withdrawal capacities or permitted rates. The same low water thresholds and pumping constraints used for the Current Capacity Scenario apply for the Drought Capacity Scenario.

Table 3 summarizes the results of the Drought Capacity Scenario. Optimization of steady-state municipal pumping rates was completed using PESTPP-OPT (White et al. 2020), using a model with a 25% reduction in applied recharge from the Current Capacity Scenario model. The 25% recharge reduction results in a similar maximum drawdown as predicted using the first 7 years (1960 to 1967) of the 10-year transient drought scenario (1960 to 1970) evaluated in the Tier Three Assessment. The 1960s represents the most significant drought period observed during the period of monitoring in southwestern Ontario. The first seven years were assessed to coincide with the period of time where maximum water level declines were predicted in the Tier Three Assessment. After optimizing the pumping rates with the 25% recharge reduction scenario, the optimized rates were evaluated using the 7-year transient drought scenario with monthly recharge (1960-1967). Table 3 lists the simulated transient minimum available heads.

The estimated capacity of the current water supply system under drought conditions is 57,560 m^3/day. This estimated capacity includes a steady-state collection rate of 5,130 m^3/day from the Glen Collector under reduced recharge conditions.

5 Future Potential Supply Scenarios

Matrix assessed four sets of scenarios to estimate the incremental increase in water supply from potential additional water sources. Table 5 summarizes these sets of scenarios (i.e., A, B, C, and D) described as follows:

- The A scenarios evaluate potential additional supply from inactive or new municipal wells and collectors, as well as hypothetical well locations that have not yet been tested.
- The B and C scenarios test potential additional supply relating to the Dolime Pond Level Management strategy and Arkell recharge/collector system, respectively.
- The D scenario tests potential additional supply from two hypothetical Aquifer Storage and Recovery (ASR) systems.

The Future Potential Supply scenarios estimate the increase in the average-day water supply system capacity relative to the Current Capacity Scenario (Section 3), following the same approach used to estimate the Current Capacity. Simulated pumping was maintained below the interpreted maximum pumping rate of the well (Tables 1 and 6). Similarly, simulated water levels were maintained above the low water level thresholds described in Section 2.3 (Table 1). Low water level thresholds that account for differences in simulated versus estimated specific capacities and hydraulic heads were also calculated for wells evaluated in the future supply scenarios (wells that are currently inactive or are hypothetical; Table 6). These low water thresholds were estimated for these new wells in consultation with AECOM. In most cases an appropriate measured water level was not available at the new wells being evaluated in the future scenarios. In these instances, a nearby (within approximately 1 km of the well) water level observation was used in the estimation of an adjusted simulated low water threshold (Table 6). Similarly, field-derived estimates of specific capacity were not available for the potential well sources. In these cases, specific capacity was estimated as the estimated maximum rate of each well divided by the estimated available head for each well (Table 6).

Changes in groundwater discharge to streams were compared against the Current Capacity Scenario (Section 3, Table 4). In addition to the water level and pumping constraints, each future supply scenario included an additional optimization target of a maximum of 10% reduction of groundwater discharge to the same streams considered as part of the Tier Three Assessment. This threshold is consistent with thresholds used for coldwater streams in the Tier Three Assessment (Matrix 2017), which follow provincial guidance on how to evaluate possible impacts to streams as a result of increased municipal pumping (MOE 2013; MECP 2021).

Table 5 Summary of Future Supply Scenarios

Scenario Set	Potential Supply Area	Scenario Number: Potential Additional Supply Description
A Additional Wells and Existing Collectors	Southeast Quadrant	A1-A: Lower Road Collector
		A1-B: Lower Road Collector and hypothetical Guelph Southeast location well supply
	Southwest Quadrant	A2-A: Additional well supply from Edinburgh, Steffler, Ironwood, and GSTW1-20
	Northeast Quadrant	A3-A: Additional well supply from Clythe, Fleming, and Logan
	Northwest Quadrant	A4-A: Additional well supply from Sacco, Smallfield, Hauser, and hypothetical Sunny Acres Park location
		A4-B: Additional well supply from Sacco, Smallfield, Hauser, and hypothetical Guelph North location
	Multiple Quadrants	A5-A: Additional well supply from Edinburgh, Steffler, Ironwood, GSTW1-20, Clythe, Fleming, Logan, Sacco, Smallfield, and Hauser
		A5-B: Additional well supply from hypothetical wells completed on the Innovation District Lands.
		A5-C: Additional well supply from Edinburgh, Steffler, Ironwood, GSTW1-20, Clythe, Fleming, Logan, Sacco, Smallfield, Hauser and hypothetical Guelph North and Southeast Wells.
B Dolime Quarry Water Capture		B1: Dolime Quarry capture considering current municipal wells
C Arkell Recharge/Collector Optimization		C1: Withdraw more water from the Eramosa River and recharge closer to the Permit to Take Water rates
		C2: Deactivate the Glen Collector and install a Caisson Collector System
D Aquifer Storage and Recovery System		D1: Inject water from the Glen and Lower Road Collectors into the Middle Gasport Formation in Innovation District Lands and extract during periods of high demand.
		D2: Inject water from Guelph Lake into the Middle Gasport Formation in Northeast Guelph and extract during periods of high demand.

Table 6 Summary of Proposed Future Municipal Well Pumping Rates and Adjusted Low Water Level Thresholds

City Quadrant	Municipal Well/Source	A	B	C	D	E	F	G	H	I	J
		Permitted or Estimated Maximum Rate (m^3/day)	Estimated Water Level at Baseline Pumping Rate[(a)] (m asl)	Estimated Low Water Level Threshold (m asl)	Estimated Available Head (m)	Estimated Specific Capacity (m^3/day/m)	Simulated Specific Capacity (m^3/day/m)	Estimated/ Simulated Specific Capacity Ratio ( )	Adjusted Simulated Available Head (m)	Baseline Simulated Water Level (m asl)	Adjusted Simulated Low Water Threshold (m asl)
					D=B-C			G=E/F	H=D x G		J=I-H
Southeast	Guelph Southeast	6,500	332.7	284.2	48.5	134	131.6	1.0	49.4	326.1	276.7
Southwest	Edinburgh	3,000	299.0	282.0	17.0	177	510.7	0.3	5.9	293.9	288.0
	Ironwood	8,000	298.1	274.6	23.5	340	416.9	0.8	19.2	292.8	273.6
	GSTW1-20	4,320	304.0	281.2	22.8	189	227.3	0.8	19.0	307.2	288.2
	Steffler	3,600	298.5	271.7	26.8	134	520.8	0.3	6.9	292.7	285.7
	Sunny Acres	5,000	307.9	285.0	22.9	219	186.6	1.2	26.8	303.5	276.7
Northeast	Clythe	3,395	321.1	294.5	26.6	128	432.7	0.3	7.8	317.2	309.3
	Fleming	2,200	343.8	308.0	35.8	61	119.2	0.5	18.5	329.2	310.7
	Logan	4700	344.0	305.7	38.2	123	89.3	1.4	52.6	334.1	281.5
Northwest	Hauser	900	322.1	280.0	42.1	21	203.5	0.1	4.4	322.1	317.7
	Sacco	1,150	337.9	286.8	51.1	23	232.8	0.1	4.9	326.2	321.2
	Smallfield	1,408	334.2	280.2	54.0	26	203.0	0.1	37.8	322.1	284.3
	Guelph North	5,000	319.5	289.5	54.0	93	156.7	0.6	37.8	335.9	298.1

Notes:
(a) If no water level observations were available at offline or hypothetical well, a water level at a nearby well was used
asl - above sea level

5.1 Potential Water Supply from Additional Wells and Existing Collectors

The set of scenarios described in the following subsections (i.e., Scenarios A1-A to A5-C; Table 5) evaluate the average-day capacity where inactive wells or collectors were restored and put back online or if new hypothetical supply wells were made available (Figure 1).

5.1.1 Southeast Quadrant Scenario A1-A: Lower Road Collector

Scenario A1-A evaluates the potential increase in water supply if the inactive Lower Road Collector were to be brought back into service. The Lower Road Collector is an approximately 1 km continuation of the Glen Collector, running west of the Glen Collector and parallel to the Eramosa River (Figure 1). Similar to the Glen Collector, the Lower Road Collector was originally designed to collect groundwater seeps at the base of the ground surface slope; however, it was taken offline in 2001 due to water quality concerns.

The Lower Road Collector was represented in the groundwater flow model for this scenario by applying constant head boundary conditions in the overburden (model slice 3) with elevations set to the invert elevations of the manholes as reported in the City's Southeast Quadrant Groundwater Study (Jagger Hims 1998).

This scenario was simulated with Current Capacity Scenario pumping rates under steady-state and transient conditions. The transient scenario evaluates monthly recharge rates associated with the first 7 years of the 10-year Tier Three drought scenario (1960-1970) where maximum water level decline was predicted to occur. The results of these model runs are plotted on Chart 1 and summarized in Tables 7 and 8. The estimated steady-state discharge to the Lower Road Collector and Glen Collector is 8,017 m^3/day and 2,274 m^3/day, respectively. The transient discharge rates at the Lower Road Collector range from 5,063 to 11,191 m^3/day and at the Glen Collector range from 0 to 7,558 m^3/day. Table 8 lists the annual minimum simulated discharge rates of the Glen and Lower Road Collectors combined from Chart 1 (cumulative collectors). The lowest simulated cumulative discharge is 4,329 m^3/day, within a drought period. For comparison purposes, Table 8 also includes the annual minimum simulated discharge rate of the Glen Collector if it was operating on its own without the Lower Road Collector.

As illustrated by the scenarios, the Lower Road Collector reduces the amount of water discharged to the Glen Collector but results in an incremental average-day water supply of approximately 3,000 m^3/day under steady-state conditions. The groundwater flow model is not calibrated to field operation of the Lower Road Collector. The simulated discharge rates for the Glen and Lower Road collectors should be considered as a preliminary estimate of the total water that may be available from shallow groundwater collectors in this area, rather than a precise estimate of the relative amounts to be collected by each collector. The certainty of these estimates may be improved should additional calibration data be incorporated into the model from recent and future operational testing data of the collector system.

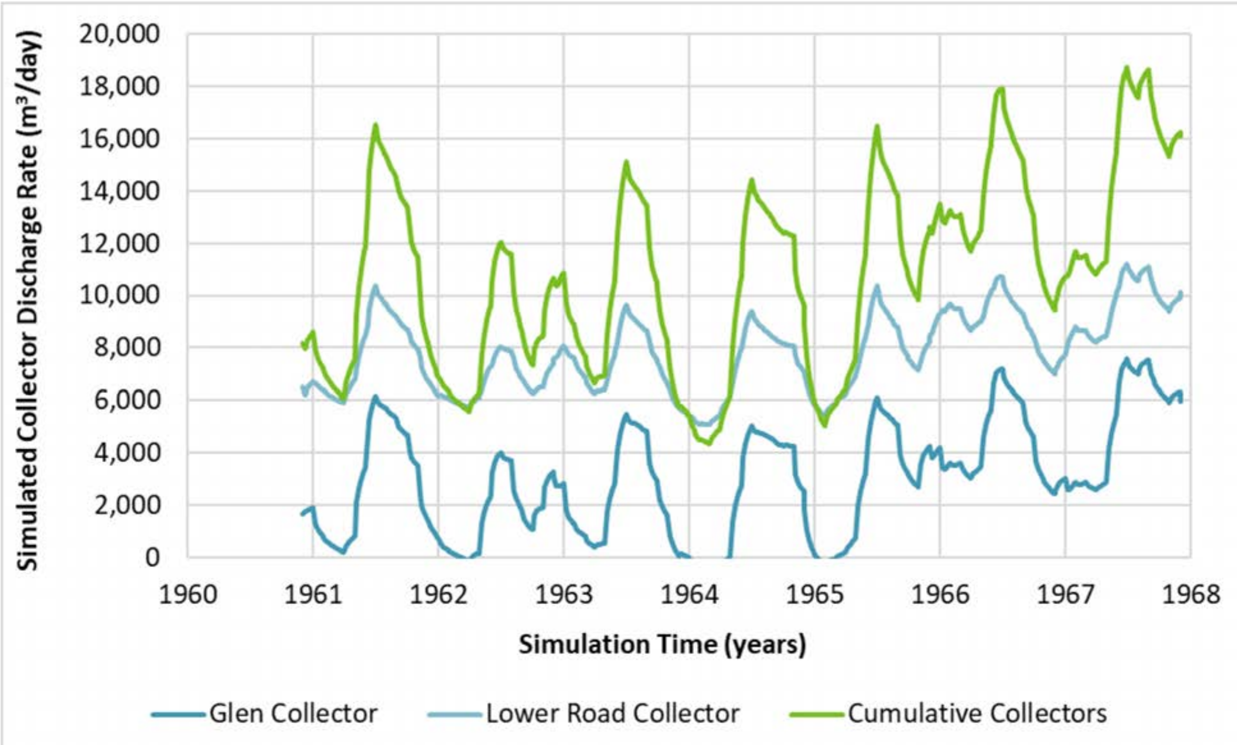


Chart 1 Transient Simulated Discharge Rate at the Glen Collector, Lower Road Collector, and the Sum of the Two Collectors

Table 7 Scenario A1-A: Simulated Lower Road Collector and Glen Collector Rates

Collector	Current Capacity Scenario (m^3/day)	Steady state Discharge (m^3/day)	Transient Scenario (1960 1967)		
			Average Discharge (m^3/day)	Minimum Discharge (m^3/day)	Maximum Discharge (m^3/day)
Lower Road Collector	N/A	8,017	7,835	5,063	11,191
Glen Collector	7,240	2,274	2,988	0	7,558
Total	**7,240**	**10,291**	**10,823**	**5,063**	**18,749**

Table 8 Scenario A1-A: Simulated Lower Road Collector and Glen Collector Annual Minimum Discharge Rates

Year	Minimum Simulated Discharge Rate with Glen Collector Operating[(1)] (m^3/day)	Minimum Simulated Cumulative Discharge Rate with Lower Road Collector and Glen Collector Operating (m^3/day)
1961	2,442	6,251
1962	1,718	5,652
1963	1,223	5,546
1964	599	4,321
1965	1,146	5,283
1966	4,950	9,429
1967	5,222	10,281

(1) minimum simulated discharge rates for Glen Collector if only the Glen Collector was operating (provided for comparison purposes)

5.1.2 Southeast Quadrant Scenario A1-B: Lower Road Collector, Hypothetical Southeast Guelph Well

Scenario A1-B estimates the increased total system capacity by introducing a hypothetical well (Guelph Southeast) on Maltby Road, east of Victoria Road, just outside of the City of Guelph (Figure 1), in addition to bringing the Lower Road Collector back into service (Scenario A1-A). The hypothetical Guelph Southeast well location was originally selected and modelled during the 2014 WSMP update (AECOM and Golder 2014), but has not yet been field tested. Within the Tier Three model, the well is located within an interpreted zone of relatively lower hydraulic conductivity in the Middle Gasport Formation (Figure 1). The hypothetical Guelph Southeast well is over 3 km south of the interpreted high hydraulic conductivity zone in which the Arkell system and Carter wells are completed.

The estimated total system capacity with the Lower Road Collector and the hypothetical Guelph Southeast well added is 71,960 m^3/day (Table 9). The new hypothetical well contributes 4,000 m^3/day to the total, and the cumulative rate produced by the existing Southeast Quadrant wells is estimated to be 31,100 m^3/day. The analysis shows that decreasing the rates at Arkell 14, Burke, and Carter wells allows for more pumping at the new wells, which increases the overall system capacity. Ultimately, the introduction of the new well, along with decreasing rates at some other wells allows for a net increase in system well capacity of 2,200 m^3/day. The introduction of the new southeast well, as well as bringing the Lower Road Collector back into service, contributes to a net increase in system total capacity of 5,200 m^3/day.

In comparison to the Current Capacity Scenario, the estimated reductions in groundwater discharge because of Scenario A1-B are less than 10% in all evaluated streams (Table 10).

Table 9 Scenarios A1-B, A2-A, A3-A, A4-A and A4-B: Summary of Optimized Well Rates and Available Head Exceedances

City Quadrant	Municipal Well/Source	Maximum Individual Well Capacity Threshold (m^3/day)	Adjusted Simulated Low Water Threshold (m asl)	Current Capacity Scenario		Scenario A1 B			Scenario A2 A			Scenario A3 A			Scenario A4 A			Scenario A4 B		
				Pumping Rate (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)
Southeast	Arkell 1	2,000	319.5	2,000	2.0	2,000	0	1.3	2,000	0	2.0	2,000	0	2.0	2,000	0	2.0	2,000	0	2.0
	Arkell 6	8,000	305.7	1,500	5.1	1,500	0	5.3	1,500	0	5.1	1,500	0	5.0	1,500	0	5.3	1,500	0	5.1
	Arkell 7	8,000	305.7	8,000	3.6	8,000	0	3.7	8,000	0	3.6	7,000[e]	-1,000	3.7	8,000	0	5.1	8,000	0	3.6
	Arkell 8	7,000	311.1	0	-0.1[c]	0	0	0.1	0	0	-0.1[c]	0	0	-0.1[c]	0	0	-1.5[c]	0	0	-0.1[c]
	Arkell 14	7,000	310.9	3,100	-0.1[c]	2,100[e]	-1,000	0.3	3,100	0	0.0	1,800[e]	-1,300	0.1	3,100	0	-0.0[c]	3,100	0	-0.1[c]
	Arkell 15	7,000	304.4	7,000	5.3	7,000	0	5.4	7,000	0	5.3	7,000	0	5.0	7,000	0	4.9	7,000	0	5.3
	Burke	6,500	323.4	5,200	0.2	5,000[e]	-200	-0.1[c]	5,200	0	0.1	5,200	0	0.1	5,200	0	0.2	5,200	0	0.2
	Carter Wells	6,400	318.5	6,100	0.0	5,500[e]	-600	0.1	6,100	0	-0.1[c]	6,100	0	0.0	6,100	0	0.0	6,100	0	0.0
	Guelph Southeast[b]	6,500	276.7	-	-	4,000[d]	4,000	20.7	-	-	-	-	-	-	-	-	-	-	-	-
Southwest	Membro	5,200	282.1	5,200	0.8	5,200	0	0.8	4,700[e]	-500	0.9	5,200	0	0.7	5,200	0	0.7	5,200	0	0.6
	Water Street	2,700	289.2	1,950	0.1	1,950	0	0.0	1,500[e]	-450	0.1	1,950	0	-0.2[c]	1,950	0	-0.1[c]	1,950	0	-0.1[c]
	Dean	1,500	289.9	540	0.0	540	0	0.0	0[f]	-540	0.2	540	0	-0.1[c]	540	0	-0.1[c]	540	0	-0.1[c]
	University	2,500	290.4	850	0.3	850	0	0.3	0[f]	-850	-2.4[c]	850	0	0.2	850	0	0.2	850	0	0.2
	Downey	5,237	286.4	5,240	0.9	5,240	0	0.8	2,250[e]	-2,990	0.1	5,240	0	0.8	5,240	0	0.8	5,240	0	0.8
	Edinburgh[b]	3,000	288.0	-	-	-	-	-	1,250[d]	1,250	-0.1[c]	-	-	-	-	-	-	-	-	-
	Ironwood[b]	8,000	273.6	-	-	-	-	-	3,750[d]	3,750	9.6	-	-	-	-	-	-	-	-	-
	GSTW1-20[b]	4,320	288.2	-	-	-	-	-	4,100[d]	4,100	-0.1[c]	-	-	-	-	-	-	-	-	-
	Steffler[b]	3,600	285.7	-	-	-	-	-	1,500[d]	1,500	0.5	-	-	-	-	-	-	-	-	-
Northeast	Park Wells	8,000	281.0	6,680	0.1	6,680	0	0.1	6,580[e]	-100	1.1	6,300[e]	-380	1.3	6,600	-80	0.2	6,400[e]	-280	0.7
	Emma	2,800	278.2	2,390	0.3	2,390	0	0.2	2,100[e]	-290	3.8	2,100[e]	-290	3.4	2,360	-30	0.3	2,360[e]	-30	0.1
	Helmar	800	321.4	670	0.1	670	0	0.1	650	-20	0.5	450[e]	-220	-0.0	670	0	0.0	0[f]	-670	2.5
	Clythe[b]	3,395	309.3	-	-	-	-	-	-	-	-	1,500[d]	1,500	0.6	-	-	-	-	-	-
	Fleming[b]	2,200	310.7	-	-	-	-	-	-	-	-	1,100[d]	1,100	0.3	-	-	-	-	-	-
	Logan[b]	4700	281.5	-	-	-	-	-	-	-	-	4,250[d]	4,250	0.4	-	-	-	-	-	-
Northwest	Paisley	1,400	298.5	940	0.0	940	0	0.0	840	-100	0.9	940	0	0.0	840[e]	-100	-0.1[c]	800[e]	-140	0.1
	Calico	1,400	294.2	1,400	13.2	1,400	0	13.2	1,400	0	13.2	1,400	0	13.2	1,400	0	12.0	1,400	0	11.9
	Queensdale	1,100	295.9	760	0.5	760	0	0.5	660	-100	0.9	760	0	0.5	760	0	0.1	760	0	0.1
	Hauser[b]	900	317.7	-	-	-	-	-	-	-	-	-	-	-	510[d]	510	0.1	300[d]	300	0.8
	Sacco[b]	1,150	321.2	-	-	-	-	-	-	-	-	-	-	-	150[d]	150	0.7	-[f]	-	0.0
	Smallfield[b]	1,408	284.3	-	-	-	-	-	-	-	-	-	-	-	980[d]	980	30.5	980[d]	980	29.9
	Sunny Acres[b]	5,000	276.7	-	-	-	-	-	-	-	-	-	-	-	0	0	22.3	-	-	-
	Guelph North[b]	5,000	298.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,530[d]	3,530	35.4
	Glen Collector	-	-	7,240	-	2,240	-5,000	-	7,300	60	-	7,190	-50	-	7,310	70	-	7,210	-30	-
	Lower Collector	-	-	-	-	8,000	8,000	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Wells		**131,710**	-	**59,520**	-	**61,720**	**2,200**	-	**64,180**	**4,660**	-	**63,180**	**3,660**	-	**60,950**	**1,430**	-	**63,210**	**3,690**	-
Total (Wells + Collectors)		-	-	**66,760**	-	**71,960**	**5,200**	-	**71,480**	**4,720**	-	**70,370**	**3,610**	-	**68,260**	**1,500**	-	**70,420**	**3,660**	-

(a) Scenario pumping rate compared to the Current Capacity Scenario Rate
(b) Future Scenario Well
(c) Low water level threshold exceedance
(d) Pumping rate is greater than rate in the Current Capacity Scenario
(e) Pumping rate is less than rate in the Current Capacity Scenario
(f) Pumping rate is set to 0 m^3/day
asl - above sea level

Table 10 Scenario A1-B: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[(a)]	Current Capacity Groundwater Discharge (m^3/day)	Scenario A1 B Groundwater Discharge (m^3/day)	Change in Groundwater Discharge (m^3/day)	Percent Change in Groundwater Discharge (%)
Blue Springs Creek	Coldwater	41,769	41,486	-283	-1%
Chilligo/Ellis Creek	Coldwater	14,618	14,614	-4	0%
Clythe Creek	Coldwater	1,906	1,919	13	1%
Cox Creek	Warmwater	2,354	2,355	1	0%
Eramosa River	Coldwater	122,620	120,346	-2,274	-2%
Guelph Lake Tributary	Coldwater	9,430	9,433	3	0%
Hanlon Creek	Coldwater	3,718	3,472	-246	-7%
Hopewell Creek	Coldwater	21,514	21,517	3	0%
Irish Creek	Warmwater	5,807	5,761	-46	-1%
Lutteral Creek	Coldwater	34,184	34,185	1	0%
Marden Creek	Warmwater	2,982	2,983	1	0%
Mill Creek	Coldwater	38,566	36,818	-1,748	-5%
Moffat Creek	Coldwater	2,061	2,061	0	0%
Speed River	Coldwater	246,216	243,626	-2,590	-1%
Swan Creek	Coldwater	5,908	5,911	3	0%
Torrance Creek	Warmwater	771	698	-73	-9%
West Credit River	Coldwater	30,642	30,637	-5	0%

Notes:

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)
(b) Reduction in simulated groundwater discharge is greater than 10%

5.1.3 Southwest Quadrant Scenario A2-A: Edinburgh, Steffler, Ironwood, and GSTW1-20

The estimated average-day capacity for wells within the southwest quadrant of Guelph (i.e., Membro, Water Street, Dean, University, and Downey wells) in the Current Capacity Scenario is 13,780 m^3/day. Scenario A2-A estimates the increased total system capacity by introducing the inactive Edinburgh well, and the Steffler, Ironwood, and GSTW1-20 test wells (Figure 1). The nearest active municipal wells are the University and Dean wells, which are located approximately 900 m and 1,800 m northwest of the Ironwood well, respectively.

The estimated total system capacity with these four wells added is 71,480 m^3/day (Table 9). These four wells contribute 10,600 m^3/day to this total and the cumulative rate produced by the southwest quadrant wells is estimated to be 19,050 m^3/day. The scenario resulted in shutting off the Dean and University wells, allowing new wells to pump at higher rates, which increased the overall system capacity. Ultimately, the introduction of these new wells, along with the shut down and decreased rates at some other wells, including some in the northeast and northwest quadrants, allowed for an increase in total simulated system capacity of 4,720 m^3/day over the Current Capacity.

The largest simulated reductions in groundwater discharge to watercourses were predicted to be 13% (470 m^3/day) and 17% (977 m^3/day) along Hanlon Creek and Irish Creek, respectively (Table 11). While a 10% groundwater discharge target was applied to the scenarios, the optimization technique does not treat this target as an absolute constraint and weighs the effect of groundwater discharge reductions against the water level constraints. The estimated groundwater discharge reduction is considered as a conservative worst-case value and needs to be further evaluated through pumping tests and operational monitoring. The estimated reduction in groundwater discharge along the remaining streams is less than 1%.

Table 11 Scenario A2-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[(a)]	Current Capacity Groundwater Discharge (m^3/day)	Scenario A2 A Groundwater Discharge (m^3/day)	Change in Groundwater Discharge (m^3/day)	Percent Change In Groundwater Discharge (%)
Blue Springs Creek	Coldwater	41,769	41,716	-53	0%
Chilligo/Ellis Creek	Coldwater	14,618	14,580	-38	0%
Cox Creek	Coldwater	2,354	2,361	7	0%
Clythe Creek	Coldwater	1,906	1,927	21	1%
Eramosa River	Coldwater	122,620	122,556	-64	0%
Guelph Lake Tributary	Coldwater	9,430	9,451	21	0%
Hanlon Creek	Coldwater	3,718	3,249	-469	-13%[(b)]
Hopewell Creek	Coldwater	21,514	21,548	34	0%
Irish Creek	Warmwater	5,807	4,830	-977	-17%[(b)]
Lutteral Creek	Coldwater	34,184	34,208	24	0%
Marden Creek	Warmwater	2,982	3,004	22	1%
Mill Creek	Coldwater	38,566	38,276	-290	-1%
Moffat Creek	Coldwater	2,061	2,058	-3	0%
Speed River	Coldwater	246,216	246,332	116	0%
Swan Creek	Coldwater	5,908	5,919	11	0%
Torrance Creek	Warmwater	771	733	-38	-5%
West Credit River	Coldwater	30,642	30,632	-10	0%

Notes:

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)
(b) Reduction in simulated groundwater discharge is greater than 10%

5.1.4 Northeast Quadrant Scenario A3-A: Clythe, Fleming, and Logan

The wells within the northeast quadrant of Guelph (i.e., Park, Emma and Helmar wells) have an estimated average-day capacity of 9,740 m^3/day in the Current Capacity scenario. Scenario A3-A estimates the increase in total system capacity by introducing the inactive Clythe well and the Fleming and Logan test wells (Figure 1). Within the Tier Three model, the Clythe well is located within an interpreted zone of relatively high hydraulic conductivity in the Middle Gasport Formation, and Fleming and Logan are just north of this zone (Figure 1). The nearest active municipal wells are all greater than 3 km away.

The estimated total system capacity with these three wells added is 70,370 m^3/day (Table 9). These three new wells contribute 6,850 m^3/day to the total, and the cumulative rate produced by the northeast quadrant wells is estimated to be 15,700 m^3/day. The analysis shows that decreasing the rates at Emma, Helmar, and Park wells allows for more pumping at the new wells, which increases the overall system capacity. Ultimately, the introduction of these new wells, along with decreasing rates at some other wells allows for a net increase in system capacity of 3,610 m^3/day.

In comparison to the Current Capacity Scenario, the estimated reductions in groundwater discharge as a result of Scenario A3-A are less than 10% in all coldwater streams except for Clythe Creek (24%; Table 12). The Tier Three model is not calibrated to groundwater pumping conditions at the Clythe Creek well location. There is resulting uncertainty with the estimated effects on the creek's baseflow and, as a result, baseflow to the creek was not considered as part of the water supply capacity optimization. However, without additional field data and model calibration, the simulated impacts are the best available estimates of surface water effects from increased pumping. These predicted effects on baseflow may not translate to ecological effects. The headwaters of Clythe Creek are a coldwater stream that has historically sustained a trout population (Amec Foster Wheeler 2017); however, the most recent warm water temperature results suggests that the lower and mid-reaches of the creek are considerably degraded. Should the City wish to pursue additional groundwater supplies in the northeast quadrant, the estimated effects to Clythe Creek should be evaluated with additional local calibration of the model as well as consideration of the potential local ecological impacts. The City is currently undertaking additional studies in this area (e.g., as part of the return to service of the Clythe well) and this data can be used to supplement the model at a later date. Should the City wish to pursue additional groundwater supplies in the northeast quadrant, the estimated effects to Clythe Creek should be evaluated with additional local calibration of the model as well as consideration of the potential local ecological impacts.

Table 12 Scenario A3-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[a]	Current Capacity Groundwater Discharge (m^3/day)	Scenario A3 A Groundwater Discharge (m^3/day)	Change in Groundwater Discharge (m^3/day)	Percent Change in Groundwater Discharge (%)
Blue Springs Creek	Coldwater	41,769	41,860	91	0%
Chilligo/Ellis Creek	Coldwater	14,618	14,602	-16	0%
Clythe Creek	Coldwater	1,906	1,450	-456	-24%[b]
Cox Creek	Warmwater	2,354	2,349	-5	0%
Eramosa River	Coldwater	122,620	121,866	-753	-1%
Guelph Lake Tributary	Coldwater	9,430	9,038	-392	-4%
Hanlon Creek	Coldwater	3,718	3,659	-59	-2%
Hopewell Creek	Coldwater	21,514	21,506	-8	0%
Irish Creek	Warmwater	5,807	5,806	-1	0%
Lutteral Creek	Coldwater	34,184	34,166	-18	0%
Marden Creek	Warmwater	2,982	2,939	-43	-1%
Mill Creek	Coldwater	38,566	38,549	-18	0%
Moffat Creek	Coldwater	2,061	2,062	1	0%
Speed River	Coldwater	246,216	242,781	-3,435	-1%
Swan Creek	Coldwater	5,908	5,865	-43	-1%
Torrance Creek	Warmwater	771	752	-19	-2%
West Credit River	Coldwater	30,642	30,603	-39	0%

Notes:

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)
(b) Reduction in simulated groundwater discharge is greater than 10%

5.1.5 Northwest Quadrant Scenario A4-A: Sacco, Smallfield, Hauser and Sunny Acres

The wells within the Northwest Quadrant of Guelph (Paisley, Calico and Queensdale wells) have an estimated average-day capacity of 3,100 m^3/day in the Current Capacity Scenario. Scenario A4-A estimates the incremental system capacity with pumping at the inactive Sacco and Smallfield wells and introducing the Hauser test well and a hypothetical well located in Sunny Acres Park (Figure 1). A location in Sunny Acres Park, based on a monitoring well location (MW06-05), was previously considered as part of the last WSMP update (AECOM and Golder 2014) but has not yet been field tested. Sacco, Smallfield, and Hauser wells are all located 1,700 to 2,800 m northwest of Paisley well, within a relatively lower hydraulic conductivity area of the

Middle Gasport Formation as simulated in the Tier Three model (Figure 1). The hypothetical Sunny Acres well is proposed to the east between the Paisley, Water Street, and Park wells.

The estimated system capacity with these four wells added is 68,260 m^3/day (Table 9). Pumping at Sunny Acres results in a reduction of water levels at the surrounding municipal wells below the applied head constraints, and as result it is removed from consideration as an incremental water supply well. Decreasing the pumping rate at Paisley well allows the new wells to pump at higher rates, which increases the overall system capacity. The three new wells (Hauser, Sacco, and Smallfield wells) contribute 1,640 m^3/day to the total, and the estimated total rate produced by the Northwest Quadrant wells is 4,640 m^3/day. Ultimately, the introduction of these new wells, along with decreasing rates at some other wells, increases the average day capacity by 1,500 m^3/day.

In comparison to the Current Capacity Scenario, all reductions in simulated groundwater discharge to streams as a result of Scenario A4-A are predicted to be less than 10% (Table 13).

Table 13 Scenario A4-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[(a)]	Current Capacity Groundwater Discharge (m^3/day)	A4 A Groundwater Discharge (m^3/day)	Change in Groundwater Discharge (m^3/day)	Percent Change in Groundwater Discharge (%)
Blue Springs Creek	Coldwater	41,769	41,656	-113	-0%
Chilligo/Ellis Creek	Coldwater	14,618	14,118	-500	-3%
Clythe Creek	Coldwater	1,906	1,910	4	0%
Cox Creek	Warmwater	2,354	2,340	-14	-1%
Eramosa River	Coldwater	122,620	122,473	-147	0%
Guelph Lake Tributary	Coldwater	9,430	9,432	2	0%
Hanlon Creek	Coldwater	3,718	3,709	-9	0%
Hopewell Creek	Coldwater	21,514	21,305	-208	-1%
Irish Creek	Warmwater	5,807	5,800	-7	0%
Lutteral Creek	Coldwater	34,184	34,188	4	0%
Marden Creek	Warmwater	2,982	2,961	-21	-1%
Mill Creek	Coldwater	38,566	38,570	3	0%
Moffat Creek	Coldwater	2,061	2,061	0	0%
Speed River	Coldwater	246,216	245,916	-300	0%
Swan Creek	Coldwater	5,908	5,918	11	0%
Torrance Creek	Warmwater	771	747	-24	-3%
West Credit River	Coldwater	30,642	30,638	-5	0%

Notes:

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)

(b) Reduction in simulated groundwater discharge is greater than 10%

5.1.6 Northwest Quadrant Scenario A4-B: Sacco, Smallfield, Hauser, and Hypothetical North Guelph Well

The wells within the Northwest Quadrant of Guelph (Paisley, Calico, and Queensdale wells) have an estimated average-day capacity of 3,100 m^3/day in the Current Capacity Scenario. Scenario A4-B estimates the increased system capacity by pumping at the inactive Sacco and Smallfield wells and introducing the Hauser test well and a hypothetical Guelph North well (Figure 1). The location of the hypothetical Guelph North well just north of the city boundary was previously considered as part of the last WSMP update (AECOM and Golder 2014) but has not yet been field tested. Sacco, Smallfield, and Hauser wells are all located 1,700 to 2,800 m northwest of Paisley well, within a relatively lower hydraulic conductivity area of the Middle Gasport Formation as simulated in the Tier Three model (Figure 1). The hypothetical Guelph North well is simulated to be approximately 3.5 km north of Sacco and 3.3 km west of Helmar.

The estimated system capacity with these four wells added is 70,420 m^3/day (Table 9). Due to a simulated hydraulic connection between the hypothetical Guelph North well and nearby pumping wells, pumping at the Guelph North well results in a reduction of water levels at many municipal wells to below the low water level thresholds. However, there is a degree of uncertainty in the actual hydraulic connection between the hypothetical Guelph North well location and the remaining municipal supply system. Further testing and data are required to refine this understanding.

This analysis suggests that decreasing the pumping rate at Park, Emma, and Paisley wells and not pumping from Helmar or Sacco allows for higher rates at the Guelph North hypothetical well and Hauser and Smallfield wells. This well rate trade-off leads to a net increase of the overall system capacity. The three new wells (Hauser, Smallfield, and Guelph North wells) contribute 4,810 m^3/day to the total, and the estimated total rate produced by the Northwest Quadrant wells is 7,770 m^3/day. Ultimately, the introduction of these new wells, along with decreasing rates at some other wells, allows for an increase in average day capacity of 3,660 m^3/day.

In comparison to the Current Capacity Scenario, all reductions in simulated groundwater discharge because of Scenario A4-B are predicted to be less than 10% at coldwater streams (Table 14). The largest reduction in simulated groundwater discharge is simulated to be 13% at the nearby warmwater Marden Creek.

Table 14 Scenario A4-B: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[a]	Current Capacity Groundwater Discharge (m^3/day)	A4 B Groundwater Discharge (m^3/day)	A4 B Change in Groundwater Discharge (m^3/day)	A4 B Percent Change in Groundwater Discharge (%)
Blue Springs Creek	Coldwater	41,769	41,808	39	0%
Chilligo/Ellis Creek	Coldwater	14,618	14,064	-554	-4%
Clythe Creek	Coldwater	1,906	1,908	2	0%
Cox Creek	Warmwater	2,354	2,200	-154	-7%
Eramosa River	Coldwater	122,620	122,649	29	0%
Guelph Lake Tributary	Coldwater	9,430	9,409	-21	0%
Hanlon Creek	Coldwater	3,718	3,821	103	3%
Hopewell Creek	Coldwater	21,514	20,735	-779	-4%
Irish Creek	Warmwater	5,807	5,800	-7	0%
Lutteral Creek	Coldwater	34,184	34,182	-2	0%
Marden Creek	Warmwater	2,982	2,590	-392	-13%[b]
Mill Creek	Coldwater	38,566	38,564	-2	0%
Moffat Creek	Coldwater	2,061	2,061	0	0%
Speed River	Coldwater	246,216	244,718	-1,498	-1%
Swan Creek	Coldwater	5,908	5,894	-14	0%
Torrance Creek	Warmwater	771	771.0552765	0	0%
West Credit River	Coldwater	30,642	30,627	-15	0%

Notes:

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)
(b) Reduction in simulated groundwater discharge is greater than 10%

5.1.7 Combined Well Sources Scenario A5-A: Edinburgh, Ironwood, GSTW1-20, Steffler, Clythe, Fleming, Logan, Hauser, Sacco, Smallfield

Scenario A5-A combines Scenarios A2-A through A4-A and includes well sources identified to potentially provide additional capacity located on City-owned lands. These additional wells (in addition to the existing municipal supply sources considered as part of the Current Capacity Scenario) include inactive wells Edinburgh, Sacco, Smallfield, and Clythe and test wells Ironwood, Steffler, GSTW1-20, Fleming, Logan, and Hauser.

The estimated average-day capacity with these ten wells added is 76,740 m^3/day (Table 15). These ten wells contribute 18,820 m^3/day to the total. Decreasing the rates at Arkell 7, Arkell 14, Membro, Water Street, Downey, Park, Helmar, Paisley, and Queensdale wells allows these new wells to pump at higher rates, which increases the system capacity overall. The rate reduction of these wells from the Current Capacity Scenario wells is cumulatively 7,390 m^3/day. The optimized scenarios have Dean and University wells not pumping, a cumulative reduction of 1,390 m^3/day, as in Scenario A2-A. The introduction of the new wells results in an increased average-day capacity of 9,980 m^3/day.

The simulated drawdown caused by Scenario A5-A pumping relative to the Baseline Scenario is plotted on Figure 5. The 1 m drawdown contour extends approximately 3.5 km further north and 6.5 km further south of the drawdown simulated under Current Capacity rates (Figure 4) due to the addition of Fleming and Logan wells in the north and GSTW1-20 well in the south. The largest drawdown is simulated to be approximately 53 m surrounding Logan well, where the pumping rate is increased from a Baseline rate of 0 to 4,250 m^3/day.

In comparison to the Current Capacity Scenario, the largest simulated reductions in groundwater discharge to streams are 13% (500 m^3/day), 17% (998 m^3/day), and 24% (468 m^3/day) at Hanlon (coldwater), Irish (warmwater) and Clythe (coldwater) creeks, respectively (Table 16). The simulated reductions at Hanlon and Irish creeks are caused by the increased rates in the southwest quadrant (comparable to Scenario A2-A). The simulated reduction at Clythe Creek is caused by the increased rates in the northeast quadrant, specifically the Clythe well (comparable to Scenario A3-A). As described previously, the model is not well calibrated in the areas around Clythe Creek and there is some uncertainty relating to the estimated effects on this creek. However, without local model calibration, the simulated impacts are the best available estimates at this time. Furthermore, the creek is degraded with warm temperature conditions in the lower and mid-reaches of the creek and any local ecological effects should consider more recent or current aquatic studies, including additional studies in the area currently being undertaken by the City. This data can be used to supplement the groundwater flow model at a later date. The remaining groundwater discharge reductions are less than 5%.

Table 15 Summary of the Optimized Well Rates and Available Head Exceedances for Current Capacity Scenario and Scenarios A5-A, A5-B and A5-C

City Quadrant	Municipal Well/Source	Maximum Individual Well Capacity Threshold (m^3/day)	Adjusted Simulated Low Water Threshold (m asl)	Current Capacity Scenario		Scenario A5 A			Scenario A5 B			Scenario A5 C		
				Pumping Rate (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)	Pumping Rate (m^3/day)	Change in Pumping[a] (m^3/day)	Available Head (m)
Southeast	Arkell 1	2,000	319.5	2,000	2	2,000	0	2	2,000	0	2	2,000	0	2
	Arkell 6	8,000	305.7	1,500	5.1	1,500	0	4.9	1,500	0	5.1	1,500	0	4.8
	Arkell 7	8,000	305.7	8,000	3.6	7,000[e]	-1,000	3.6	8,000	0	3.6	8,000	0	3.5
	Arkell 8	7,000	311.1	0	-0.1[c]	0	0	-0.2[c]	0	0	-0.1	0[f]	0	-0.3[c]
	Arkell 14	7,000	310.9	3,100	-0.0	1,800[e]	-1,300	-0.0	3,100	0	-0.0	1,500[e]	-1,600	-0.1[c]
	Arkell 15	7,000	304.4	7,000	5.3	7,000	0	4.9	7,000	0	5.3	7,000	0	4.8
	Burke	6,500	323.4	5,200	0.2	5,200	0	0.1	5,200	0	0.2	5,000[e]	-200	0
	Carter Wells	6,400	318.5	6,100	0	6,100	0	-0.1[c]	6,100	0	0	5,500[e]	-600	0.5
	Guelph East 1[b]	-	303.4	-	-	-	-	-	0	0	8.1	-	-	-
	Guelph East 2[b]	-	303.1	-	-	-	-	-	0	0	9.1	-	-	-
	Guelph Southeast[b]	6,500	276.7	-	-	-	-	-	-	-	-	4,000[d]	4,000	20.5
Southwest	Membro	5,200	282.1	5,200	0.8	4,700[e]	-500	0.8	5,200	0	0.8	4,700[e]	-500	1
	Water St.	2,700	289.2	1,950	0.1	1,500[e]	-450	-0.1[c]	1,950	0	0.1	1,200[e]	-750	0.6
	Dean	1,500	289.9	540	0	0[f]	-540	0.1	540	0	0	0[f]	-540	0.3
	University	2,500	290.4	850	0.3	0[f]	-850	-2.5[c]	850	0	0.3	0[f]	-850	-2.3[c]
	Downey	5,237	286.4	5,240	0.9	2,250[e]	-2,990	0	5,240	0	0.9	2,250[e]	-2,990	0.1
	Edinburgh[b]	3,000	288.0	-	-	980	980	0	-	-	-	980[d]	980	0.3
	Ironwood[b]	8,000	273.6	-	-	3,750[d]	3750	9.5	-	-	-	3,750[d]	3,750	9.6
	GSTW1-20[b]	4,320	288.2	-	-	4,100[d]	4100	-0.1[c]	-	-	-	3,900[d]	3,900	0.7
	Steffler[b]	3,600	285.7	-	-	1,500[d]	1500	0.4	-	-	-	1,500[d]	1,500	0.5
Northeast	Park Wells	8,000	281.0	6,680	0.1	6,300[e]	-380	0.9	6,680	0	0.1	6,300[e]	-380	0.3
	Emma	2,800	278.2	2,390	0.3	2,100	-290	2.9	2,390	0	0.3	2,100[e]	-290	2
	Helmar	800	321.4	670	0.1	400[e]	-270	0	670	0	0.1	0[f]	-670	0.9
	Clythe[b]	3,395	309.3	-	-	1,500[d]	1,500	0.5	-	-	-	1,500[d]	1,500	0.4
	Fleming[b]	2,200	310.7	-	-	1,100[d]	1,100	0.2	-	-	-	1,100[d]	1,100	0.3
	Logan[b]	4,700	281.5	-	-	4,250[d]	4,250	0.1	-	-	-	4,100[d]	4,100	3.2
Northwest	Paisley	1,400	298.5	940	0	790[e]	-150	0.1	940	0	0	400[e]	-540	3.7
	Calico	1,400	294.2	1,400	13.2	1,400	0	11.9	1,400	0	13.2	1,400	0	11.9
	Queensdale	1,100	295.9	760	0.5	700	-60	-0.1[c]	760	0	0.5	700[e]	-60	0.3
	Hauser[b]	900	317.7	-	-	510[d]	510	0	-	-	-	300[d]	300	0.9
	Sacco[b]	1,150	321.2	-	-	150[d]	150	0.6	-	-	-	0[f]	0	-0.0
	Smallfield[b]	1,408	284.3	-	-	980[d]	980	30.4	-	-	-	980[d]	980	30
	Guelph North[b]	5,000	298.1	-	-	-	-	-	-	-	-	3,530[d]	3,530	13.7
	Glen Collector	-	-	7,240	-	7,180	-60	-	7,240	0	-	7,180	-60	-
Total (Wells)		**131,710**	**-**	**59,520**	**-**	**69,560**	**10,040**	**-**	**59,520**	**0**	**-**	**75,190**	**15,670**	**-**
Total (Wells + Collector)		**-**	**-**	**66,760**	**-**	**76,740**	**9,980**	**-**	**66,760**	**0**	**-**	**82,370**	**15,610**	**-**

(a) Scenario pumping rate compared to the Current Capacity Scenario Rate
(b) Future Scenario Well
(c) Low water level threshold exceedance
(d) Pumping rate is greater than rate in the Current Capacity Scenario
(e) Pumping rate is less than rate in the Current Capacity Scenario
(f) Pumping rate is set to 0 m^3/day
asl - above sea level

Table 16 Scenario A5-A: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[a]	Current Capacity Groundwater Discharge (m^3/day)	A5 A Groundwater Discharge (m^3/day)	A3 A Change in Groundwater Discharge (m^3/day)	A3 A Percent Change in Groundwater Discharge (%)
Blue Springs Creek	Coldwater	41,769	41,653	-116	0%
Chilligo/Ellis Creek	Coldwater	14,618	14,043	-575	-4%
Clythe Creek	Coldwater	1,906	1,438	-468	-24%[b]
Cox Creek	Warmwater	2,354	2,331	-23	-1%
Eramosa River	Coldwater	122,620	121,729	-890	-1%
Guelph Lake Tributary	Coldwater	9,430	9,034	-396	-4%
Hanlon Creek	Coldwater	3,718	3,218	-500	-13%[b]
Hopewell Creek	Coldwater	21,514	21,274	-240	-1%
Irish Creek	Warmwater	5,807	4,809	-998	-17%[b]
Lutteral Creek	Coldwater	34,184	34,174	-10	0%
Marden Creek	Warmwater	2,982	2,933	-49	-2%
Mill Creek	Coldwater	38,566	38,213	-354	-1%
Moffat Creek	Coldwater	2,061	2,057	-4	0%
Speed River	Coldwater	246,216	242,381	-3,835	-2%
Swan Creek	Coldwater	5,908	5,907	-1	0%
Torrance Creek	Warmwater	771	733	-38	-5%
West Credit River	Coldwater	30,642	30,640	-3	0%

Notes:

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)

(b) Reduction in simulated groundwater discharge is greater than 10%

5.1.8 Combined Well Sources Scenario A5-B: Guelph East 1 and 2

Scenario A5-B was designed to evaluate if there is additional capacity with pumping from the simulated high hydraulic conductivity zone that continues west from the Arkell Well system. The scenario includes two hypothetical new well sources located on Guelph Innovation District Lands. These two additional Guelph East wells (in addition to the existing municipal supply sources considered as part of the Current Capacity Scenario) include a well located on the Guelph former

Turf Grass Institute (Guelph East 1) and one at Stone Road East and Watson Road South (Guelph East 2; Figure 1).

Ultimately, the addition of either of these wells to the Current Capacity pumping layout provided no simulated increase in system capacity. Hydraulic heads at wells in the area are interconnected due to the interpreted high transmissivity of the aquifer here, and the addition of any new well sources reduces the heads below assigned low water level thresholds at other municipal wells. The wells that would exceed low water level thresholds if the Guelph East 1 and 2 wells were installed include Arkell 14, Water Street, Park, and Helmar.

5.1.9 Combined Well Sources Scenario A5-C: Edinburgh, Ironwood, GSTW1-20, Steffler, Clythe, Fleming, Logan, Hauser, Sacco, Smallfield, and Hypothetical North and Southeast Guelph Wells

Scenario A5-C was designed based on the combined results of Scenarios A2-A through A5-A and includes well sources, including hypothetical well sources, identified to potentially provide additional capacity both inside and outside City boundaries (Figure 1). These additional wells (in addition to the existing municipal supply sources considered as part of the Current Capacity Scenario) include inactive wells (Edinburgh, Sacco, Smallfield, and Clythe), test wells (Ironwood, Steffler, GSTW1-20, Fleming, Logan, and Hauser), and hypothetical wells (Guelph North and Guelph Southeast wells).

The estimated average-day capacity with these 12 potential wells added is 82,730 m^3/day (Table 15). These twelve wells contribute 25,640 m^3/day to the total. Decreasing the rates at Arkell 14, Burke, Carter, Membro, Water Street, Downey, Park, Emma, Paisley, and Queensdale wells allows these new wells to pump at higher rates, which overall increases the system capacity. The rate reduction of these wells from the Current Capacity Scenario wells is cumulatively 7,910 m^3/day. The optimized scenario has Dean, University, Helmar, and Sacco wells not pumping, which is a cumulative rate reduction of 2,060 m^3/day. The introduction of the 12 new wells results in an incremental average-day capacity of 15,610 m^3/day.

The simulated drawdown caused by pumping at Scenario A5-C rates relative to the Baseline Scenario is plotted on Figure 6. Similar to Scenario A5-A, the 1 m drawdown contour extends approximately 3.5 km further north and 6.5 km further south than the drawdown simulated under Current Capacity rates (Figure 4) due to the addition of Fleming and Logan wells in the north and GSTW1-20 well in the south. The 1 m contour also extends an additional 3.5 km northwest and 6.5 km southeast due to the addition of the hypothetical Guelph North well and Guelph Southeast well, respectively. Also, similar to Scenario A5-A, the largest drawdown is simulated to be nearly 50 m surrounding Logan well, where the pumping rate is increased from a Baseline rate of 0 to 4,100 m^3/day.

In comparison to the Current Capacity Scenario, the largest simulated reductions in groundwater discharge to streams are 30% (578 m^3/day), 18% (662 m^3/day), 17% (990 m^3/day), and 14% (429 m^3/day) at Clythe (coldwater), Hanlon (coldwater), Irish (warmwater), and Marden (warmwater) creeks, respectively (Table 17). The simulated reductions at Hanlon and Irish creeks are in response to the increased rates in the southwest quadrant (comparable to Scenario A2-A). The simulated reduction at Clythe Creek is in response to the increased rates in the northeast quadrant, specifically the Clythe well (comparable to Scenario A3-A). The remaining groundwater discharge reductions are less than 10%.

Simulated steady-state effects on groundwater discharge are conservative estimates of what might be experienced under operation of new wellfields. Under actual operating conditions, municipal pumping rates never occur at a constant rate and vary seasonally and daily. Similarly, streamflow varies daily and seasonally in response to climate events and physical features, such as wetlands and shallow perched aquifers, that are not represented in the model. As a result, decisions to proceed with permitting a municipal well should not be based purely on groundwater model results. Model scenarios identifying areas of higher baseflow effects should be used to focus on the need for additional field data or areas where adaptive environmental monitoring programs can accompany routine water supply operations activities. As an example, the City now has a much larger water supply from the Arkell area, and initial computer modelling predicted potential surface water effects. However, the adaptive monitoring program in the Arkell area has not identified any changes to the surface water flow regime during the period of higher pumping.

As described previously, further calibration work should be completed around Clythe Creek using data from additional studies currently being undertaken by the City for a more accurate evaluation of impacts. While uncertain, the simulated impacts are the best available estimates at this time.

Table 17 Scenario A5-C: Change in Simulated Groundwater Discharge to Streams

Watercourse	Coldwater or Warmwater[(a)]	Current Capacity Groundwater Discharge (m^3/day)	A5 C Groundwater Discharge (m^3/day)	A3 A Change in Groundwater Discharge (m^3/day)	A3 A Percent Change in Groundwater Discharge (%)
Blue Springs Creek	Coldwater	41,769	41,311	-458	-1%
Chilligo/Ellis Creek	Coldwater	14,618	14,030	-588	-4%
Clythe Creek	Coldwater	1,906	1,328	-578	-30%[(b)]
Cox Creek	Warmwater	2,354	2,188	-166	-7%
Eramosa River	Coldwater	122,620	121,315	-1,305	-1%
Guelph Lake Tributary	Coldwater	9,430	9,013	-417	-4%
Hanlon Creek	Coldwater	3,718	3,057	-662	-18%[(b)]
Hopewell Creek	Coldwater	21,514	20,713	-801	-4%
Irish Creek	Warmwater	5,807	4,817	-990	-17%[(b)]
Lutteral Creek	Coldwater	34,184	34,170	-13	0%
Marden Creek	Warmwater	2,982	2,553	-429	-14%[(b)]
Mill Creek	Coldwater	38,566	36,560	-2,007	-5%
Moffat Creek	Coldwater	2,061	2,057	-4	0%
Speed River	Coldwater	246,216	240,624	-5,592	-2%
Swan Creek	Coldwater	5,908	5,891	-17	0%
Torrance Creek	Warmwater	771	812	41	5%
West Credit River	Coldwater	30,642	30,638	-5	0%

Notes:

(a) From MNR (2013) and GRCA (2013) in Matrix (2017)
(b) Reduction in simulated groundwater discharge is greater than 10%

5.2 Quarry Water Capture Scenario B1

The Quarry Water Capture Scenario B1 evaluates the potential of increasing pumping from municipal wells near the Dolime Quarry (Figure 1) under the conceptual Pond Level Management strategy. This strategy requires inward gradients to the quarry pond to prevent the outflow of poor quality water to the aquifer. The concept tested as part of Scenario B1 is to evaluate potential increased pumping from municipal wells and reduced dewatering rates, while maintaining a 1 m hydraulic head gradient from the Middle Gasport Formation at the MW08-02A location toward the base of the quarry. This 1 m hydraulic head gradient criteria serves to ensure that there is a groundwater gradient into the pond, and that surface water within the pond does not leak into the water supply aquifer. AECOM provided Matrix initial direction to evaluate the scenario with the water level in the quarry equal to 288.39 m above sea level (asl), which is consistent with the current PTTW.

The Dolime Quarry is simulated with a high hydraulic conductivity zone (i.e., 5.00E-01 m/s) to represent the open excavation and a constant head boundary condition at 288.39 m asl reflecting the current quarry pond level and dewatering operations.

The initial scenario results indicated that the proposed quarry water capture scenario could not offer an incremental water supply given that the MW08-02A water level constraint (i.e., 1 m hydraulic gradient) was already violated under the Current Capacity Scenario. As shown in Table 18, the Current Capacity Scenario had a head difference of 0.23 m between the Dolime Quarry pond elevation and MW08-02A.

Two main components of the groundwater flow system influence the gradient between MW08-02A and the quarry. These two components include the hydraulic head applied to the quarry boundary condition (i.e., the water level to which the quarry is dewatered) and the pumping rate at nearby Membro well. Table 18 summarizes the values of these parameters for the Current Capacity Scenario.

The Quarry Water Capture Scenario was further evaluated by evaluating the effects of making adjustments to both the pond elevation and the Membro pumping rate. Table 18 summarizes seven sub-scenarios carried out to further investigate different combinations of Membro pumping rates, Dolime pond water level constraints, and the resulting Dolime dewatering rates. A head difference greater than 1 m between the quarry pond and MW08-02A was only achieved by sufficiently reducing the pumping rate at the nearby Membro well (i.e., Scenarios B1-5 and B1-7). When increasing the quarry pond boundary condition elevation (Scenarios B1-2 and B1-3), the simulated Dolime dewatering discharge rate decreases by approximately 500 m^3/day per meter increase, while the head difference between MW08-02A and the quarry pond decreases. Under Scenario B1-3, the gradient would be inverted from the quarry to the Middle Gasport Formation, which is not the desired outcome. These results suggest that the total capacity of the water supply system may be lower than that predicted by the Current Capacity Scenario by approximately 2,000 m^3/day if a 1 m gradient is enforced between MW08-02A and the Dolime Quarry. For completeness, the simulated water levels at MW08-02A are also provided for all scenarios (A2 through A5).

While this scenario does not identify additional capacity with the City's existing pumping wells and the constraints employed, there is more work required to evaluate the water supply opportunity at Dolime. Some of the alternatives requiring further evaluation include:

- Model refinement and calibration. The City is currently undertaking detailed field testing, and the results of these testing efforts will be used to refine and calibrate the model. The outcome of this work will be to ensure that the model offers the precision and accuracy needed to evaluate this complex water supply alternative.

- Further evaluation of the pond level and hydraulic head gradient constraints. Lowering the pond level and lowering the hydraulic head gradient to below 1.0 m may increase available water supply.

- Modifying the groundwater divide. Modifying the location of the groundwater divide (i.e., closer to the pond) may also impact the estimate of available water.

- Utilizing quarry discharge. Under the current scenarios, the quarry discharge rate ranges from just over 4,500 m^3/day to almost 6,200 m^3/day. This excess discharge suggests that there are alternatives to pumping additional groundwater such as treating the quarry water to potable conditions.

These above and other alternatives will be examined as part of the more detailed work that comes out of the operational testing program currently underway for the Dolime Quarry. For the purpose of this assessment, the incremental water supply capacity of the Dolime Quarry is assumed to be 5,000 m^3/day under the Current Capacity pumping conditions. This supply capacity represents a combination of additional pumping for existing or new wells or the treatment of quarry discharge water.

Table 18 Scenario B1: Summary of Simulated Quarry Water Capture Scenario Results Considering Current Municipal Wells

Scenario	Dolime Quarry BC elevation (m asl)	Dolime Quarry Boundary Condition Discharge Rate (m^3/day)	MW08 02A Water Level (m^3/day)	Head Difference[(a)] (m)	Membro Well Water Level (m asl)	Membro Well Pumping Rate (m^3/day)
Current Capacity	288.39	4,966	288.62	0.23	282.82	5,199
B1-2	289.25	4,542	289.33	0.08	283.43	5,199
B1-3	290.25	4,045	290.16	-0.09	284.14	5,199
B1-4	289.25	4,897	289.57	0.32	284.41	4,700
B1-5	289.25	6,109	290.39	1.14	287.76	3,000
B1-6	288.39	5,820	289.20	0.81	285.18	4,000
B1-7	288.39	6,181	289.44	1.05	286.17	3,500
A2-A	288.39	3,643	288.35	-0.04	282.93	4,700
A3-A	288.39	4,877	288.57	0.18	282.72	5,199
A4-A	288.39	4,801	288.56	0.17	282.73	5,200
A5-A	288.39	3,432	288.29	-0.10	282.85	4,700

(a) Head difference between the Dolime Quarry constant head boundary condition and the MW08-02A simulated head

5.3 Arkell Recharge/Collector Optimization Scenarios

The City operates an artificial groundwater recharge system with a shallow groundwater collector referred to as the Glen Collector. The City pumps surface water from the Eramosa River, followed by infiltration into groundwater through the Arkell groundwater recharge system consisting of a pond and trench. A portion (approximately 50%) of this infiltrated water supplements groundwater recharge to the Glen Collector.

Under the Current Capacity Scenario, the steady-state infiltration of water from the Eramosa River into the Arkell recharge system is simulated as 3,290 m^3/day. This is an average of annual infiltration, recognizing that infiltration rates vary seasonally according to the requirements of the City's current PTTW. A portion of this water, along with natural shallow groundwater discharge to the Glen Collector, results in 7,240 m^3/day being collected at the Glen Collector (i.e., 220% of what was infiltrated). The Arkell recharge/collector scenarios described in the following sections are designed to evaluate the potential to achieve higher collection rates and efficiencies.

5.3.1 Increased Eramosa River Recharge Scenario C1

Scenario C1 evaluates the increased rate of water collection at the Glen Collector (i.e., total due to Arkell infiltration plus shallow groundwater flow) if the Eramosa River taking is increased to higher rates allowed under the PTTW. The amount of water withdrawn from the Eramosa River is currently limited by:

- seasonal PTTW conditions on maximum daily takings (Table 19)
- a requirement to maintain a minimum flow in the Eramosa River of 37,152 m^3/day (0.43 m^3/s)
- the existing Eramosa pump capacity of 9,072 m^3/d

Table 19 Seasonal Permitted Pumping Rates of the Eramosa River as Listed in the Permit to Take Water

Season	Permitted Pumping Rates (m^3/day)
April 15 to May 31	31,822
June 1 to June 30	22,730
July 1 to July 15	18,184
July 16 to August 31	13,638
September 1 to November 15	9,092

Note:
Water extraction from the Eramosa River is permitted only when the baseflow is greater than 37,152 m^3/day (0.43 m^3/s).

Scenario C1 evaluates the potential increase in Glen Collector flows under both steady-state and transient conditions considering three sets of infiltrations rates. These infiltration rates correspond to the existing pump capacity (0.105 m^3/s or 9,072 m^3/day), double pump capacity (0.21 m^3/s or 18,144 m^3/day), and triple pump capacity (0.32 m^3/s or 27,648 m^3/day).

The objective of the steady-state scenarios is to provide a general prediction of the average annual volumetric rate of water collected by the Glen Collector. The steady-state scenarios include the municipal wells pumping at the Current Capacity Scenario rates, average annual groundwater recharge across the model, and the equivalent average annual infiltration rate into the Arkell pond and trench.

The objective of the transient scenarios is to develop insight into the seasonal variability of the water collected by the Glen Collector. The transient model simulations include the first 7 years of the 10-year Tier Three drought scenario, using the same approach followed for the Lower Road

Collector scenario (Section 5.1.1; Scenario A1-A). The transient scenarios use the pumping rates established in the earlier Drought Capacity Scenario and monthly-varying average infiltration rates into the pond and trench for the 7-year transient period.

To complete this evaluation, observed Eramosa River baseflow data from the Water Survey of Canada Eramosa River Gauge between 1962 and 2006 were evaluated to estimate maximum allowable pumping rates under the seasonal conditions of the PTTW. Average monthly groundwater infiltration rates applied to the model were calculated based on the maximum pump capacity and the amount of river water available while maintaining a flow of 37,152 m^3/day (0.43 m^3/s) in the river. Table 20 summarizes the average monthly infiltration rates for the three pump capacities evaluated.

Table 20 Scenario C1: Average Monthly Infiltration Rates

Month	Existing Eramosa Pump Capacity 0.105 m³/s (9,072 m³/day)			Double Eramosa Pump Capacity 0.21 m³/s (18,144 m³/day)			Triple Eramosa Pump Capacity 0.32 m³/s (27,648 m³/day)		
	Monthly Average (m³/day)	Minimum Daily Rate (m³/day)	Maximum Daily Rate (m³/day)	Monthly Average (m³/day)	Minimum Daily Rate (m³/day)	Maximum Daily Rate (m³/day)	Monthly Average (m³/day)	Minimum Daily Rate (m³/day)	Maximum Daily Rate (m³/day]
January	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0
April	4,682	4,682	4,682	9,365	9,365	9,365	14,270	14,270	14,270
May	9,368	9,072	9,374	18,655	15,725	18,749	28,303	19,354	28,570
June	8,435	4,682	8,779	16,414	7,609	17,559	21,099	6,243	22,730
July	8,326	3,326	9,374	12,250	0	15,725	12,595	0	15,911
August	6,880	0	9,072	10,020	0	13,638	9,867	0	13,638
September	6,276	0	8,779	6,886	0	9,092	6,819	0	9,092
October	8,206	907	9,092	8,565	1,210	9,092	8,415	1,843	9,092
November	4,201	1,171	4,390	8,116	1,171	8,779	8,359	892	9,092
December	0	0	0	0	0	0	0	0	0
Average	4,698	1,987	5,295	7,523	2,923	8,500	9,144	3,550	10,200
Minimum	0	0	0	0	0	0	0	0	0
Maximum	9,368	9,072	9,374	18,655	15,725	18,749	28,303	19,354	28,570

Chart 2 illustrates the transient discharge from the Glen Collector for the three pump capacity scenarios based on the transient infiltration rates provided in Table 20. As illustrated in this chart, increasing the pump capacity results in significant increases in maximum discharge; however, minimum discharge rates into the Glen Collector during periods where pumping is not permitted does not increase.

While the simulated total Glen Collector discharge rate exceeds 25,000 m^3/day for the highest pumping scenario, the collector flows are currently limited in the PTTW to 25,000 m^3/day. The simulated annual minimum Glen Collector discharge rates for each Eramosa pump capacity scenario are summarized in Table 21. The lowest simulated discharge is 1,932; 2,050; and 2,126 m^3/day for the existing, double, and triple pump capacity scenarios, respectively.

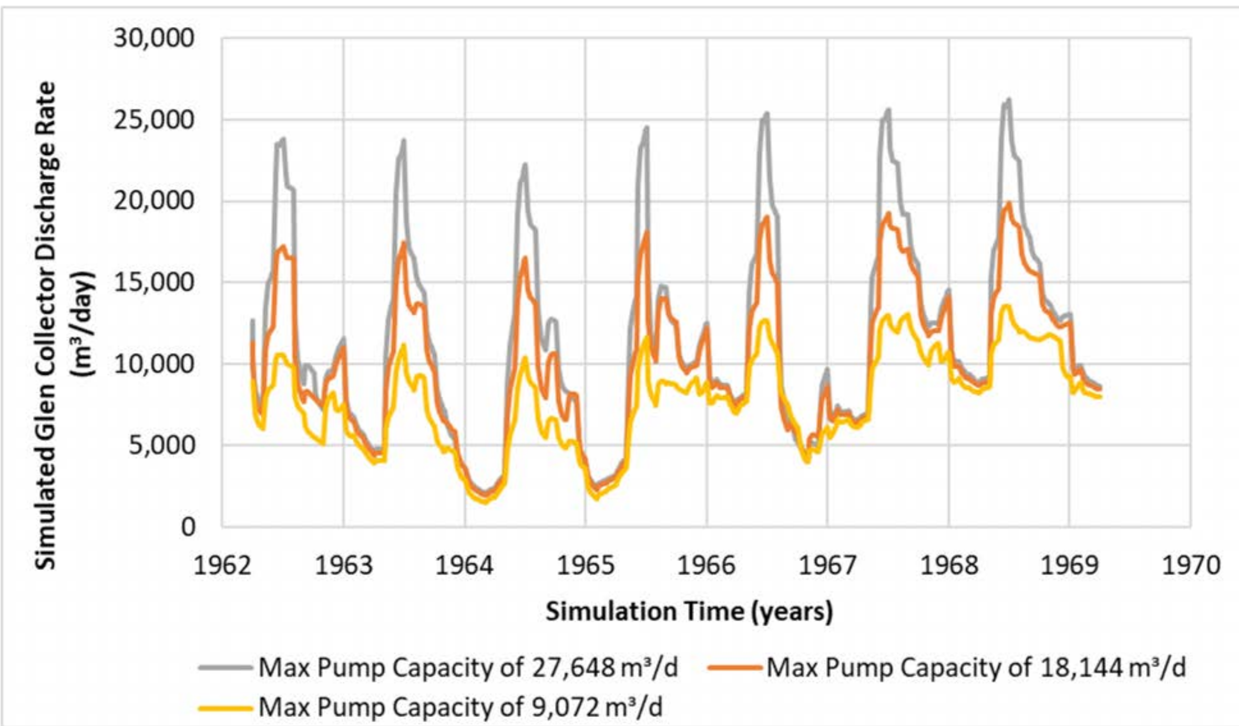


Chart 2 Simulated Total Transient Glen Collector Discharge Under the Various Pump Capacity Scenarios

Table 21 Scenario C1: Simulated Total Glen Collector Annual Minimum Discharge Rates

Year	Glen Collector Discharge (m^3/day)		
	9,072 m^3/d Pump Capacity	18,144 m^3/d Pump Capacity	27,648 m^3/d Pump Capacity
1962	5,126	6,915	7,378
1963	2,353	3,017	3,691
1964	1,957	2,050	2,126
1965	1,932	2,368	2,682
1966	4,269	4,491	4,439
1967	5,519	6,685	6,848
1968	8,268	8,952	8,919

For the evaluation of Glen Collector discharge under steady-state conditions, average annual infiltration rates of 4,698; 7,523; and 9,144 m^3/day were applied for the three pump capacity scenarios (Table 20). Average annual values represent the average pumping rate if the water takings were spread over the whole year. Table 22 summarizes the estimated steady-state discharge rate at the Glen Collector under the three steady-state infiltration rates as well as the collector efficiency (i.e., calculated as the average annual Glen Collector discharge divided by the average annual infiltration). As illustrated in the table, the efficiency is highest within the Current Capacity Scenario when shallow groundwater discharge into the collector is greater than the amount infiltrated. This efficiency decreases as the amount of infiltrated water is increased in the pump capacity scenarios. As the amount of infiltrated water increases, only a portion of that infiltrated water is collected resulting in an apparent decrease in collector efficiency.

Table 22 Summary of Steady-state Arkell Infiltration and Glen Collector Discharge Scenario Results

	Current Capacity Scenario	Pump Capacity Scenario		
		9,072 (m^3/day)	18,144 (m^3/day)	27,648 (m^3/day)
Average Annual Infiltration (m^3/day)	3,290	4,698	7,523	9,144
Average Annual Glen Collector Discharge (m^3/day)	7,240	7,969	10,779	12,139
Collector Efficiency	220%	170%	143%	133%
Incremental Infiltration Over Current Capacity (m^3/day)	-	1,408	4,233	5,854
Incremental Glen Collector Discharge Over Current Capacity (m^3/day)	-	729	3,539	4,899
Incremental Collector Efficiency Over Current Capacity	-	52%	84%	84%

Table 22 also summarizes the incremental infiltration, discharge, and efficiency over Current Capacity Scenario values. The results show that while the overall collector efficiency decreases, the incremental efficiency over Current Capacity generally increases. This suggests that on an average annual basis, as more water is infiltrated and water levels rise, the Glen Collector is able to capture a higher proportion of the infiltrated water.

Table 22 also shows that at a current pump capacity of 9,072 m^3/day operating at optimal conditions, the incremental increase in Glen Collector discharge over the Current Capacity value increases by 10% (or 729 m^3/day). The incremental increase in discharge for the pump capacity of 27,648 m^3/day (tripling pump capacity) is 4,899 m^3/day.

Chart 3 illustrates a comparison of both the estimated steady-state and transient discharge rate at the Glen Collector under the three pump capacities evaluated. Similar to the steady-state results in Table 22, the results illustrated in Chart 3 indicate that increasing the recharge rate up to the maximum rate allowed by the PTTW does not result in the same proportional increase in collector discharge rate. The minimum transient Glen Collector discharge rates range from 1,519 to 2,094 m^3/day (i.e., an increase by a factor of 1.4 relative to a tripling of the pumping rate), while the maximum transient Glen Collector discharge rates range from 13,545 to 26,252 (i.e., an increase by a factor of 1.9 relative to a tripling of the pumping rate). Regardless, these scenarios indicate that if the Eramosa pump is updated to increase the maximum allowable rate, more water can be pumped from the Eramosa River, while following PTTW constraints, and this will lead to an increase in groundwater recovered from the Glen Collector. Note that while the maximum simulated Glen Collector discharge rate is predicted to exceed 25,000 m^3/day, the PTTW limits the collector flows to 25,000 m^3/day.

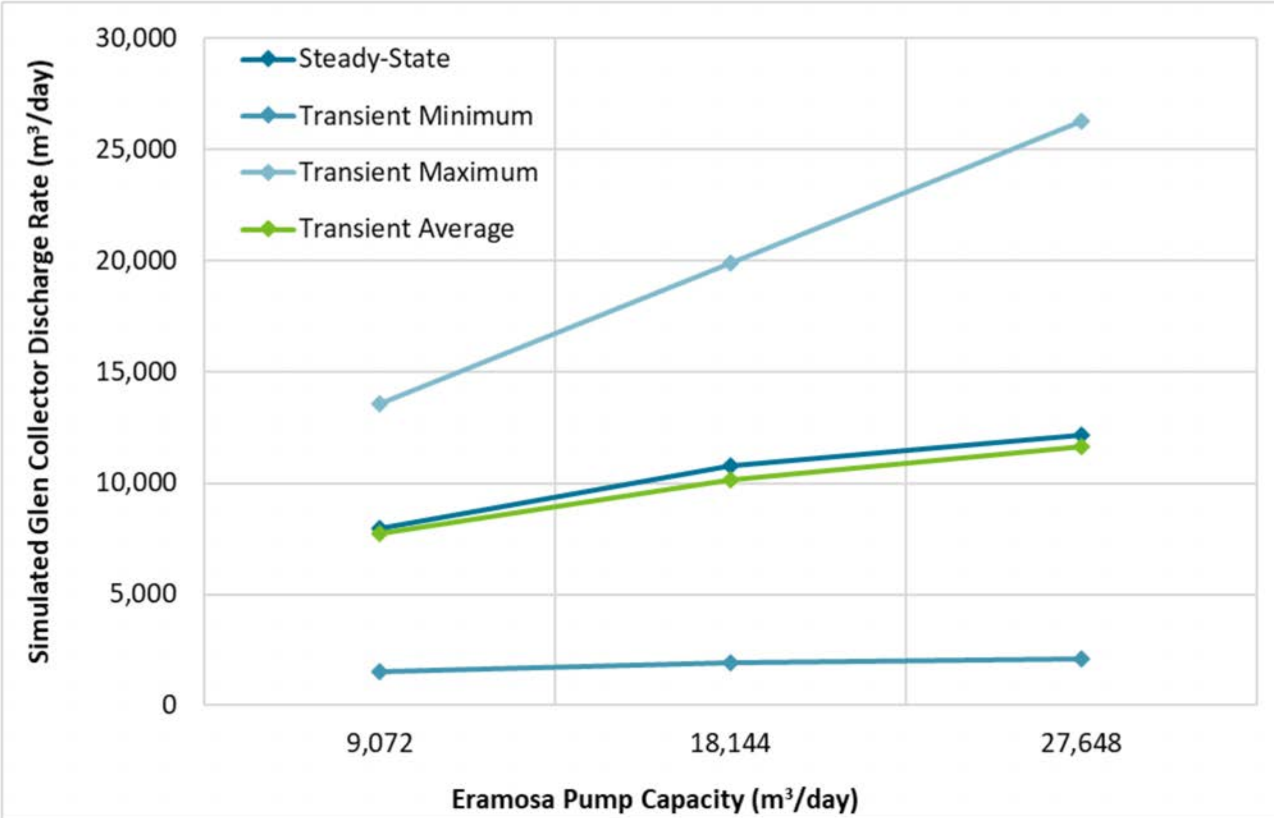


Chart 3 Estimated Glen Collector Collection Rates Versus Maximum Pump Capacity

Note that Scenario C1 only considers the Glen Collector as a possible source of water. Future evaluations may be conducted to predict how much additional water may be collected if the Lower Road Collector were to be reconstructed. Future scenarios may also be designed to evaluate alternative configurations of the collectors and their influence on the overall efficiency of the system.

5.3.2 Alternative Recharge Gallery/Collector Configuration Scenario C2

This scenario evaluates the effectiveness of replacing the Glen Collector with a new Caisson Collector System upgradient (approximately 300 m southeast of the Glen Collector; Figure 1). The location of the Caisson Collector reflects the recommendation of the Stantec Caisson Collector study (Stantec 2006). This assessment does not consider other locations for this collector. This scenario removes the boundary conditions representing the Glen Collector System, with a corresponding simulated steady-state loss of 7,240 m^3/day. This scenario also removes the Arkell 1 well due to its proximity (within 10 m) to the proposed Caisson Collector System. The removal of Arkell 1 corresponds to a simulated loss of 2,000 m^3/day. The boundary conditions representing the artificial recharge from the Eramosa River remained active, at a constant recharge rate of 3,290 m^3/day.

Matrix initially tested several Caisson Collector System layouts under long-term steady-state conditions. The optimal design brought forward for evaluation included a Caisson Collector System with one lateral screen projection, 110 m in length, and oriented perpendicular to the groundwater flow direction. This design is consistent with one of the potential configurations reported in Stantec (2006). The model represents the lateral screen and water withdrawal using nine constant head boundary conditions placed at the base of the coarser overburden unit (i.e., model slice 3) at an assigned elevation of 317.5 m asl. This value corresponds to the highest elevation of the underlying till unit along the length of the lateral screen. The steady-state withdrawal from the Caisson Collector System was simulated to be 9,598 m^3/day (Table 23). Under this withdrawal, groundwater discharge to the Eramosa River was simulated to decrease by 1,744 m^3/day, which corresponds to a reduction of 1% relative to the Current Capacity Scenario.

To test the range of the Caisson Collector System discharge under variable recharge, the Caisson Collector system was also evaluated transiently (using the 7-year monthly transient drought scenario; Chart 4). Under this transient simulation, the Caisson Collector System withdrawal ranged from 4,585 to 13,124 m^3/day, with an average of 8,348 m^3/day (Table 23 and Chart 4). In comparison, the Glen Collector discharge under this transient scenario ranged from 599 to 12,232 m^3/day, with an average of 6,091 m^3/day.

Relative to the Glen Collector layout, the Caisson Collector System estimated withdrawal under drought conditions is greater than that of the Glen Collector (Table 23 and Chart 4). This indicates that the Caisson Collector System provides a more reliable water supply and is less sensitive to seasonal recharge variability. The Caisson Collector System's estimated minimum withdrawal is 1,986 m^3/day greater than the current system under drought conditions (including the 2,000 m^3/day loss from Arkell 1; Tables 23 and 24). The lowest simulated Caisson Collector discharge is 4,585 m^3/day, within a drought period. The Caisson Collector System maximum withdrawal rates under wetter conditions is 1,108 m^3/day less than the current configuration (including the 2,000 m^3/day loss from Arkell 1; Table 23). With the removal of the Glen Collector and Arkell Well 1 and addition of an active Caisson Collector, the system's estimated long-term capacity is 358 m^3/day greater than the Current Capacity Scenario. These results suggest that a deeper configuration such as the Caisson Collector may provide benefits over the Glen Collector by increasing the reliable water supply from the area considering both the infiltrated water and natural groundwater conditions.

The current estimate of the capacity of the Caisson concept is notably smaller than that reported in the Stantec Consulting Ltd. Caisson Collector study (Stantec 2006). Comparison of the current FEFLOW model versus the model reported by Stantec suggests that the overburden sand hydraulic conductivity and saturated thickness of the sand aquifer used by Stantec was twice that of the current model. These combined differences conceptually explain the difference between the current capacity estimates and the Stantec capacity estimate.

Further evaluation of Caisson design alternatives and potentially field studies may be helpful to evaluate the impact of the Caisson design, and its location, on water capture, seasonal variability, and efficiency.

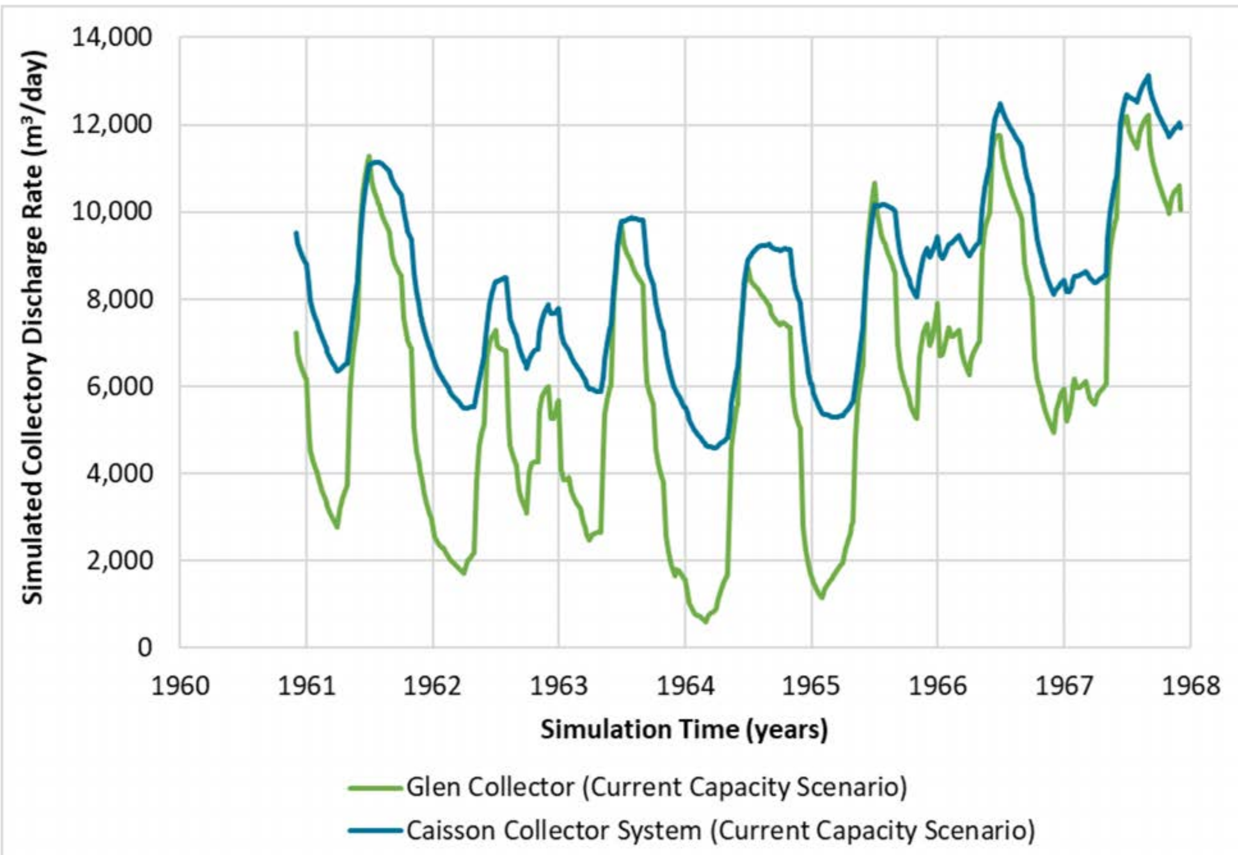


Chart 4 Simulated Transient Glen Collector and Caisson Collector Discharges

Table 23 Summary of Steady-state and Transient Glen Collector and Caisson Collection System Withdrawal Rates

Scenario	System	Steady state Withdrawal (m^3/day)	Transient Minimum Withdrawal (m^3/day)	Transient Maximum Withdrawal (m^3/day)	Transient Average Withdrawal (m^3/day)
Current Capacity	Glen Collector	7,240	599	12,232	6,091
	Arkell 1	2,000	2,000	2,000	2,000
	Glen Collector + Arkell 1	9,240	2,599	14,232	8,091
C2	Caisson Collector System (one lateral screen projection of 110 m)	9,598	4,585	13,124	8,348
Difference between C2 and Current Capacity		358	1,986	-1,108	257

Table 24 Scenario C2: Simulated Caisson Collector Annual Minimum Rates

Year	Glen Collector (Current Capacity Rates)	Caisson Collector (Current Capacity Rates)
	(m^3/day)	
1961	2,442	6,358
1962	1,718	5,506
1963	1,223	5,541
1964	599	4,585
1965	1,146	5,302
1966	4,950	8,305
1967	5,222	8,163

5.4 Aquifer Storage and Recovery Scenarios

Two scenarios were designed to evaluate the effectiveness of implementing an Aquifer Storage and Recovery (ASR) system in the Middle Gasport Formation. Scenario D1 tests an ASR configuration on Guelph Innovation District Lands, with a potential source of water from the Glen Collector and Lower Road Collector (Figure 7). Guelph Innovation District Lands were selected because of the interpreted high hydraulic conductivity zone simulated in the Tier Three model that continues westward from the Arkell well system to below the Innovation District Lands. This zone is interpreted to be a bedrock valley and have high hydraulic conductivity caused by fracturing.

Scenario D2 tests an ASR configuration in the northeast quadrant of Guelph (Figure 7), with a potential water source from Guelph Lake. The simulated ASR injection/extraction wells were positioned between Emma and Helmar municipal wells and based on the ASR configuration tested previously as part of the 2014 WSMP update (AECOM and Golder 2014).

The ASR scenarios are conceived as having a series of new ASR wells that cycle between a period of water injection and a period of extraction (pumping). The model represents the ASR injection/extraction wells as constant head boundary conditions placed at the base of the Middle Gasport Formation; a linear discrete feature with a high hydraulic conductivity (1×10^{-4} m/s) was assigned directly above each boundary condition representing the open well interval through the deep bedrock aquifer (e.g., Middle Gasport Formation to Goat Island Formation). The simulated operation of the ASR systems was defined by time-varying boundary conditions representing annual injection and extraction schedules provided by AECOM.

The first set of ASR scenarios represented the municipal wells pumping at the Current Capacity rates. These scenarios illustrated that during the period of water injection, the water levels in the aquifer quickly increased and dissipated at a large distance from the injection location. During the period of extraction, aquifer drawdown also dissipated quickly resulting in water levels at some of the existing municipal wells dropping below their threshold levels. In response, the ASR scenarios were revised having the municipal wells operating at Baseline Scenario pumping rates.

The following subsections include a summary of each ASR scenario, their simulated efficiencies, and the simulated impacts on heads at municipal wells and discharge to watercourses.

5.4.1 Aquifer Storage and Recovery Scenario D1

The ASR system simulated in Scenario D1 is located within the Guelph Innovation District Lands (Figure 7) and was represented using six ASR extraction/injection wells. The simulated ASR well located furthest to the west was placed at the Guelph Turfgrass Institute (i.e., Guelph East 1 well in Scenario A5-B) and the furthest east ASR well was placed at Stone Road East and Watson Road South (i.e., Guelph East 2 well in Scenario A5-B). The remaining four ASR wells were distributed throughout City-owned land within Innovation District Lands between these two locations. The injection and extraction volumes are summarized in Table 25. Initial tests with the model indicated that the ASR wells could not operate with the extraction volume being equal to the injection volume. An extraction volume of 60% of the maximum extraction volume was applied to maintain hydraulic heads above low water level thresholds at municipal wells. The scenario does not evaluate the opportunity to increase this collection efficiency above 60% by pumping municipal wells (e.g., such as those downgradient) at higher rates.

Table 25   Aquifer Storage and Recovery Scenario D1 Injection and Extraction Flow Rates

Month	Simulation Time (days)	Maximum Extraction Volume	60% of Extraction Volume	Injection Volume
		(m³)		
April	0	-	-	43,300
May	30	-	-	143,900
June	61	-	-	263,800
July	91	52,200	31,320	-
August	122	50,800	30,480	-
September	153	52,100	31,260	-
October	183	49,000	29,400	-
November	214	48,800	29,280	-
December	244	45,800	27,480	-
January	275	49,600	29,760	-
February	306	51,000	30,600	-
March	334	51,700	31,020	-
Total		**451,000**	**270,600**	**451,000**

The scenario results illustrated that the ASR system can function with extraction rates at 60% of the injection rates and the municipal wells pumping at Baseline Scenario rates (Table 26). Within this scenario, some wells have considerable available head and there is likely an opportunity to increase pumping rates at other municipal wells to capture more of the injected water. Further evaluation to optimize the efficiency of the system would be recommended should the City wish to pursue ASR as a future water supply option.

Table 26 Aquifer Storage and Recovery Scenario D1 Summary of Minimum and Maximum Simulated Heads

City Quadrant	Municipal Well/Source	Adjusted Simulated Low Water Threshold (m asl)	Simulated Minimum Head (m asl)	Simulated Available Head (m asl)	Simulated Maximum Head (m asl)	Simulated Range in Head (m)
Southeast	Arkell 1	319.5	321.8	2.3	321.9	0.1
	Arkell 6	305.7	311.4	5.6	315.1	3.7
	Arkell 7	305.7	311.2	5.5	315.1	3.9
	Arkell 8	311.1	311.8	0.7	315.5	3.7
	Arkell 14	310.9	311.5	0.6	315.2	3.7
	Arkell 15	304.4	312.1	7.7	316.1	4.0
	Burke	323.4	323.8	0.5	324.0	0.2
	Carter	318.5	323.0	4.5	323.3	0.2
Southwest	Membro	282.1	290.5	8.4	291.1	0.6
	Water St.	289.2	294.4	5.2	295.6	1.2
	Dean	289.9	292.5	2.6	293.5	0.9
	University	290.4	292.2	1.8	292.7	0.4
	Downey	286.4	289.9	3.5	290.2	0.3
Northeast	Park	281.0	299.4	18.4	301.8	2.5
	Emma	278.2	288.6	10.4	290.7	2.1
	Helmar	321.4	324.3	2.9	325.7	1.4
Northwest	Paisley	298.5	301.4	2.9	301.6	0.3
	Calico	294.2	315.1	20.9	315.1	0.1
	Queensdale	295.9	298.8	2.9	299.0	0.2

asl - above sea level

Chart 5 illustrates the sequence of simulated available head at Arkell 15 and Park Wells. As shown in the figure, water levels in the wells increase during the period of injection but decrease quickly back to baseline levels once the system is extracting. During the period of extraction, the available head at each of these wells is just slightly less than the available head in the Baseline Scenario. It is due to this behaviour that the system cannot operate at higher extraction rates with pumping rates at the Current Capacity Rates; at current capacity rates, many of the water levels at municipal wells operate near their threshold and there is little availability to extract larger volumes of water from the aquifer.

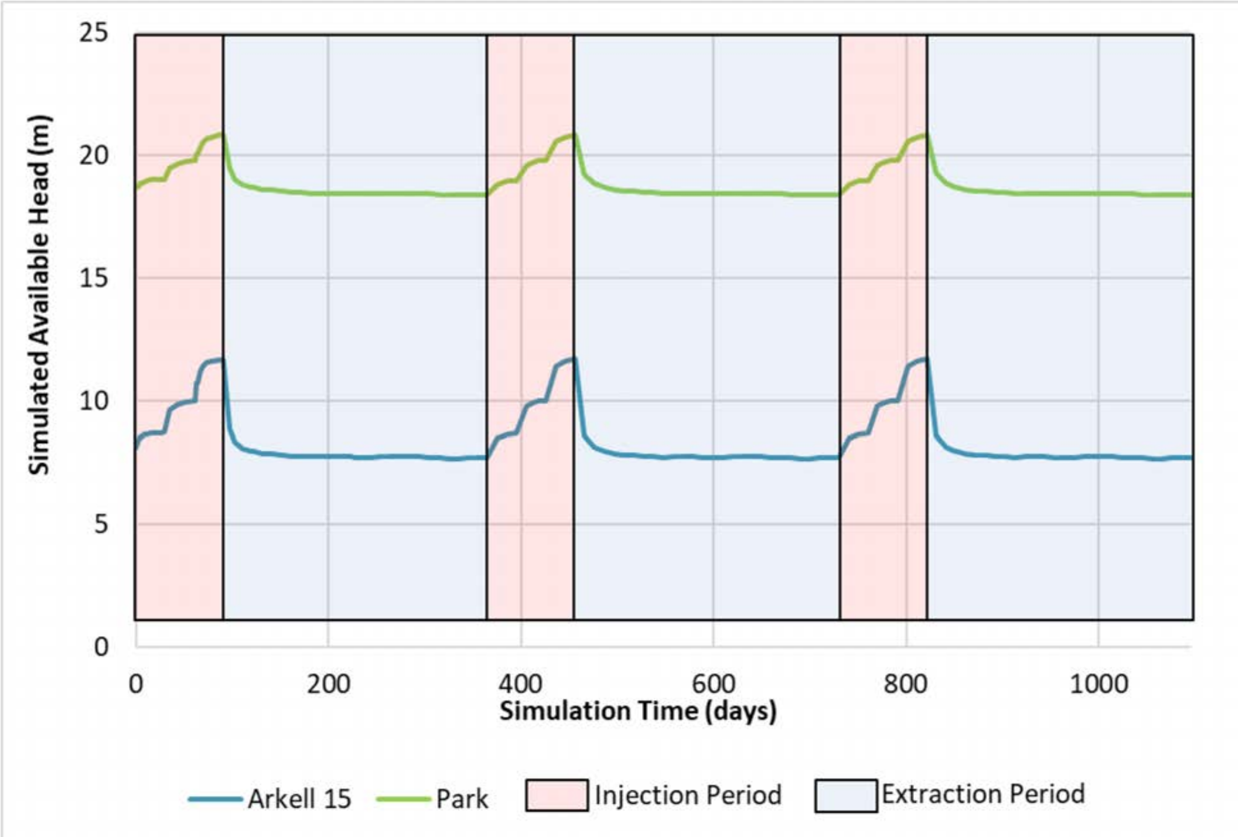


Chart 5 Scenario D1 Simulated Transient Available Head at Arkell 15 and Park Wells

The Arkell wells were simulated as having the largest range in hydraulic head during ASR operation. At the end of the injection period (Simulation Day 91), simulated increase in hydraulic heads greater than 10 cm in the Middle Gasport Formation extended as far as 10 km away from the ASR system (Figure 8). This indicates that aquifer pressure dissipates far from the injection site, and increasing the efficiency of the ASR alternative would require a consideration of increased pumping from existing or new wells a greater distance from the ASR wells.

The Lower Road and Glen Collector were both active for this scenario with the application of a constant average annual infiltration rate. The simulated Baseline Scenario steady-state rate at the Glen Collector is 9,385 m^3/day. With the addition of the Lower Road Collector, the simulated collector cumulative withdrawal rate ranged from 12,543 to 12,955 m^3/day within the transiently simulated extraction and injection periods, respectively (Table 27). The results indicate that the simulated Innovation District Lands ASR system increases the withdrawal rate at the collectors by approximately 400 to 500 m^3/day.

Table 27 Summary of Simulated Flow Rates at Collectors

Collector	Baseline Scenario	Aquifer Storage and Recovery Scenario D1	
	Simulated Withdrawal Rate	Maximum Simulated Withdrawal Rate	Minimum Simulated Withdrawal Rate
	(m^3/day)		
Glen Collector	9,385	4,021	3,788
Lower Collector	-	8,934	8,755
Total	9,385	12,955	12,543

The simulated impact of the ASR system to groundwater discharge to streams is summarized in Table 28. An increase in simulated discharge is due to the increased pressure head in the aquifer after injection, resulting in flow of groundwater vertically upward and discharging to a watercourse. The greatest increase in simulated groundwater discharge during ASR injection is predicted in the Speed River, Eramosa River, and Blue Springs Creek. A reduction in simulated discharge rate is because a portion of the groundwater pumped during the ASR extraction period is sourced from a watercourse. The greatest decrease in groundwater discharge simulated during ASR extraction is predicted in the Eramosa Rivera and Speed River. Finally, while there are both increases and decreases in groundwater discharge in responses to injection and extraction, there is a net average increase in groundwater discharge over the injection and extraction period.

Table 28 Scenario D1: Simulated Groundwater Discharge to Streams

Water Course	Baseline Scenario	Aquifer Storage Recovery Scenario D1			
	Simulated Discharge Rate	Maximum Simulated Discharge Rate	Change in Simulated Discharge Rate from Baseline Scenario	Minimum Simulated Discharge Rate	Change in Simulated Discharge Rate from Baseline Scenario
	(m^3/day)				
Blue Springs Creek	41,715	43,945	2,230	42,300	585
Chilligo/Ellis Creek	15,171	15,216	45	15,196	25
Clythe Creek	2246	2,677	431	2,162	-84
Cox Creek	2,353	2,396	43	2,391	38
Eramosa River	123,226	126,060	2,834	121,920	-1,306
Guelph Lake Tributary	9,499	9,540	41	9,495	-4
Hanlon Creek	4,244	4,167	-77	4,087	-157
Hopewell Creek	21,656	21,826	170	21,798	142
Irish Creek	5,846	5,923	77	5,913	67
Lutteral Creek	34,164	34,189	25	34,188	24
Marden Creek	3,065	3,086	21	3,067	2
Mill Creek	39,017	39,097	80	38,971	-46
Moffat Creek	2,035	2,062	27	2,062	27
Speed River	250,131	255,324	5,193	248,874	-1,257
Swan Creek	5,900	5,916	16	5,915	15
Torrance Creek	2,064	1,949	-115	1,795	-269
West Credit River	30,505	30,638	133	30,637	132

5.4.2 Aquifer Storage and Recovery Scenario D2

The ASR system simulated in Scenario D2 is located between Helmar and Emma wells in the northeast quadrant of Guelph in the same configuration tested previously for the 2014 WSMP update by Golder (2014; Figure 7). The furthest north simulated ASR well was placed approximately 300 m north of the Helmar well and the furthest south simulated ASR well was placed approximately 500 m north of Park and Emma wells. Due to the proximity to the Helmar well, the Helmar well was turned off in this scenario. The remaining four wells were placed along an interpreted linear higher hydraulic conductivity zone simulated in the Middle Gasport Formation of the Tier Three model between the Helmar and Park wells. The injection and extraction volumes are summarized in Table 29. Similar to Scenario D1, 60% of the maximum extraction volume was applied to maintain hydraulic heads above low water level thresholds at municipal wells.

Table 29 Aquifer Storage Recovery Scenario D2 Injection and Extraction Flow Rates

Month	Simulation Time (days)	Maximum Extraction Volume	60% of Maximum Extraction Volume	Injection Volume
		(m^3)		
October	0	-	-	122,700
November	31	-	-	121,100
December	61	-	-	165,700
January	92	-	-	114,800
February	123	-	-	86,200
March	151	-	-	84,700
April	182	-	-	97,500
May	212	-	-	92,100
June	243	-	-	56,000
July	273	324,000	194,400	-
August	304	304,100	182,460	-
September	335	312,700	187,620	-
Total		**940,800**	**564,480**	**940,800**

With municipal wells pumping at baseline rates and the ASR system functioning with 60% efficiency, there were no simulated exceedances of low water thresholds at municipal wells (Table 30). Similar to Scenario D1, it is likely possible to optimize the municipal rates along with the transient ASR extraction rates to increase the system's overall capacity. The municipal wells that were simulated to have the largest range in hydraulic head during ASR operation were the Park and Emma wells. At the end of the injection period (Simulation Day 273), the simulated increase in hydraulic heads (i.e., greater than 10 cm) in the Middle Gasport Formation extended as far as 10 km away from the ASR system (Figure 9). This indicates that water pressure in the aquifer dissipates far from the injection site, and the injected water is unlikely available to be extracted locally in its entirety in the area of the northeast quadrant.

Chart 6 illustrates the available head time series of two of the most impacted municipal wells (Emma well and Park well). The transient responses at these wells show a rapid increase in head at the wells at the start of the injection period. Simulated heads are relatively stable through the 9-month injection period then rapidly drop at the start of the extraction period. During the period of extraction, the available head at each of these wells is less than the available head during baseline conditions.

Table 30 Aquifer Storage Recovery Scenario D2 Summary of Minimum and Maximum Simulated Heads

City Quadrant	Municipal Well/Source	Adjusted Simulated Low Water Threshold (m asl)	Simulated Minimum Head (m asl)	Simulated Available Head (m asl)	Simulated Maximum Head (m asl)	Simulated Range in Head (m)
Southeast	Arkell 1	319.5	322.6	3.1	322.7	0
	Arkell 6	305.7	311.4	5.7	312.5	1.1
	Arkell 7	305.7	311.2	5.5	312.4	1.2
	Arkell 8	311.1	311.8	0.7	313	1.1
	Arkell 14	310.9	311.5	0.6	312.6	1.1
	Arkell 15	304.4	312.1	7.7	313.3	1.2
	Burke	323.4	324.1	0.7	324.1	0.1
	Carter	318.5	323.4	4.9	323.5	0.1
Southwest	Membro	282.1	290.2	8.1	291.1	0.9
	Water Street	289.2	293.9	4.7	295.4	1.5
	Dean	289.9	292.1	2.2	293.2	1.1
	University	290.4	292.1	1.7	292.5	0.5
	Downey	286.4	289.8	3.4	290.1	0.4
Northeast	Park	281.0	292.8	11.8	306.7	13.8
	Emma	278.2	281.5	3.3	296.2	14.7
	Helmar	321.4	312.8	-8.6	342.8	30
Northwest	Paisley	298.5	300.9	2.4	302	1.1
	Calico	294.2	314.9	20.7	315.3	0.4
	Queensdale	295.9	298.7	2.8	299.1	0.4

asl - above sea level

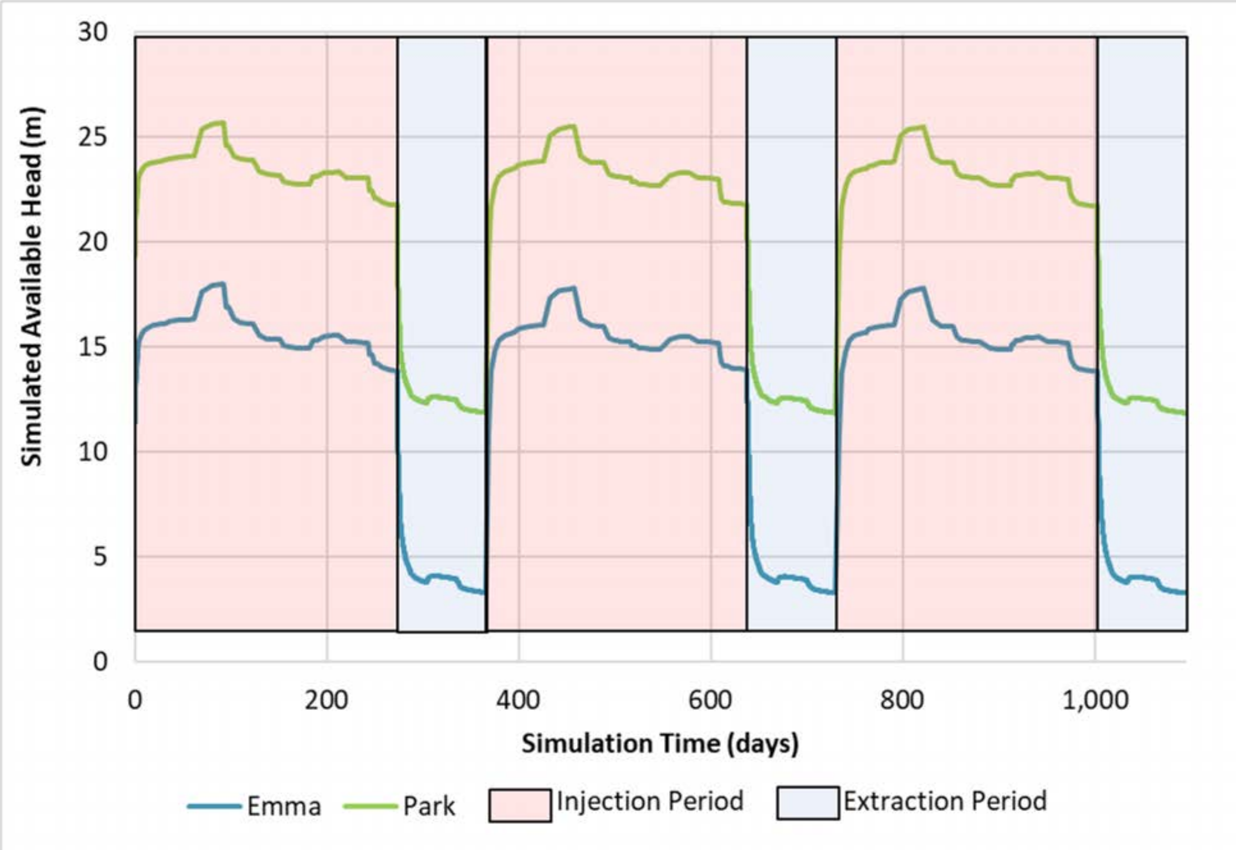


Chart 6 Scenario D2 Simulated Transient Available Head at Emma and Park Wells

The simulated Baseline Scenario steady-state rate at the Glen Collector is 9,385 m^3/day. With the addition of the ASR system in the northeast quadrant of Guelph the Glen Collector withdrawal rate is simulated to range from 9,329 to 9,448 m^3/day (Table 31). This indicates that an ASR system in the northeast quadrant of Guelph would have a relatively low impact to the productivity of the Glen Collector.

Table 31 Summary of Simulated Flow Rates at Collectors

Collector	Baseline Scenario	Aquifer Storage Recovery Scenario D2	
	Simulated Withdrawal Rate	Maximum Simulated Withdrawal Rate	Minimum Simulated Withdrawal Rate
	(m^3/day)		
Glen Collector	9,385	9,448	9,329

The simulated impact of the ASR system to groundwater discharge to streams is summarized in Table 32. Similar to Scenario D1, an increase in simulated discharge is interpreted to be from water that is injected in the ASR wells and flows vertically upwards and discharges to a watercourse. The greatest increase in simulated groundwater discharge during ASR injection is predicted in the Speed River, Eramosa River, and Blue Springs Creek. A reduction in simulated discharge rate is because a portion of the groundwater pumped during the ASR extraction period is sourced from a watercourse. The greatest decrease in groundwater discharge simulated during ASR extraction is predicted in the Speed River and Clythe Creek.

Table 32 Scenario D2: Simulated Groundwater Discharge to Streams

Water Course	Baseline Scenario	Scenario D2			
	Simulated Discharge Rate	Maximum Simulated Discharge Rate	Change in Simulated Discharge Rate from Baseline Scenario	Minimum Simulated Discharge Rate	Change in Simulated Discharge Rate from Baseline Scenario
	(m^3/day)				
Blue Springs Creek	41,715	42,892	1,177	42,248	533
Chilligo/Ellis Creek	15,171	15,305	134	15,163	-8
Clythe Creek	2246	2,317	71	2,026	-220
Cox Creek	2,353	2,446	93	2,364	11
Eramosa River	123,226	125,551	2,325	123,949	723
Guelph Lake Tributary	9,499	9,628	129	9,421	-78
Hanlon Creek	4,244	4,328	84	4,274	30
Hopewell Creek	21,656	21,999	343	21,688	32
Irish Creek	5,846	5,928	82	5,894	48
Lutteral Creek	34,164	34,195	31	34,156	-8
Marden Creek	3,065	3,260	195	2,923	-142
Mill Creek	39,017	39,149	132	39,102	85
Moffat Creek	2,035	2,062	27	2,060	25
Speed River	250,131	256,317	6,186	249,523	-608
Swan Creek	5,900	5,929	29	5,900	0
Torrance Creek	2,064	2,088	24	2,025	-39
West Credit River	30,505	30,638	133	30,438	-67

6 Summary

This report summarizes the modelling results of a number of scenarios evaluated to estimate the average-day capacity of the City's existing water supply sources and potential new sources. Potential future sources of water include:

- use of inactive wells and collectors, test wells, and hypothetical wells in areas where additional supply may be available
- the area of the Dolime Quarry and introduction of the Pond Level Management strategy
- optimization and reconfiguration of the Arkell recharge and collector system
- aquifer storage and recovery systems

Table 33 summarizes the simulated total system capacities for each scenario, as well as the additional simulated capacity over and above that of the current water supply system.

Table 33 Summary of System Capacity for Future Supply Scenarios

Scenario Set	Potential Supply Area	Scenario Number: Potential Additional Supply Description	Simulated Average Day Capacity (m^3/day)	Average Day Capacity Over Current Capacity Scenario (m^3/day)
Current System Capacity		Current municipal wells and Glen Collector	66,760	-
A Additional Wells and Existing Collector	Southeast Quadrant	A1-A: Lower Road Collector	69,811[a]	3,051
		A1-B: Lower Road Collector and hypothetical Guelph Southeast location well supply	71,960	5,200
	Southwest Quadrant	A2-A: Additional well supply from: Edinburgh, Steffler, Ironwood, and GSTW1-20	71,480	4,720
	Northeast Quadrant	A3-A: Additional well supply from: Clythe, Fleming, and Logan	70,370	3,610
	Northwest Quadrant	A4-A: Additional well supply from: Sacco, Smallfield, Hauser and hypothetical Sunny Acres Park location	68,260	1,500
		A4-B: Additional well supply from Sacco, Smallfield, Hauser, and hypothetical Guelph North location	70,420	3,660
	Multiple Quadrants	A5-A: Additional well supply from: Edinburgh, Steffler, Ironwood, GSTW1-20, Clythe, Fleming, Logan, Sacco, Smallfield, and Hauser	76,740	9,980
		A5-B: Additional well supply from: hypothetical Guelph East 1 and 2	66,760	0
		A5-C: Additional well supply from: Edinburgh, Ironwood, GSTW1-20, Steffler, Clythe, Fleming, Logan, Hauser, Smallfield, and hypothetical Guelph Southeast and Guelph North	82,370	15,610

Scenario Set	Potential Supply Area	Scenario Number: Potential Additional Supply Description	Simulated Average Day Capacity (m^3/day)	Average Day Capacity Over Current Capacity Scenario (m^3/day)
B Dolime Quarry Water Capture		B1: Dolime Quarry capture considering current municipal wells	71,760[b]	5,000[b]
C Arkell Recharge/Collector Optimization		C1: Withdraw more water from the Eramosa River, increase pump capacity to 0.32 m^3/second	71,659[c]	4,899
		C2: Deactivate the Glen Collector and install a Caisson Collector System	66,402[d]	358
D Aquifer Storage and Recovery System		D1: Inject water from the Glen and Lower Road Collectors into the Middle Gasport Formation in Innovation District Lands and extract during periods of high demand	67,501[e]	741[f]
		D2: Inject water from Guelph Lake into the Middle Gasport Formation in Northeast Guelph and extract during periods of high demand	68,307[e]	1,547[f]

Notes:
(a) This is a sum of the Current Capacity Scenario well rates and the A1-A scenario steady-state Lower Road Collector and Glen Collector rates
(b) The increase in water supply capacity associated with the Dolime quarry is assumed to be derived from a combination of increased pumping from new or existing wells in addition to the treatment of quarry discharge water.
(c) This is a sum of the Current Capacity Scenario well rates and the C1 scenario steady-state Glen Collector rates considering an Eramosa pump capacity of 0.32 m^3/s
(d) This is a sum of the Current Capacity Scenario well rates (including the removal of Arkell 15) and the C2 scenario steady-state Caisson Collector rate
(e) This is a sum of the Current Capacity Scenario well rates and the average annual ASR extraction rate applied in Scenarios D1 and D2
(f) This is the annual average extraction rate applied in Scenarios D1 and D2

The combined set of scenarios, including maximizing the capacity of existing wells, installing new wells, pursuing the Dolime quarry, and optimizing Arkell recharge/discharge, consider alternatives that add up to more than 90,000 m^3/day of average day water capacity for the City. Many of these alternatives need additional field investigations and analysis and some will not be feasible either due to cost, technical practicality, or environmental effects. However, the modelling approach implemented is conservative and should be considered as a reasonable estimate of the water supply capacity available to the City. The model's estimated effects of increased pumping on surface water are also conservative and likely over-estimates what would be observed in actual conditions. However, while these conservative assumptions are built into the modelling approach, the capacity of the water supply may always be limited by the potential for long-term droughts as observed during the 1960's. Most of the City's water supply is taken from the Gasport Formation aquifer, which is relatively resilient to drought conditions. The higher stress associated with long-term dry conditions may decrease the capacity below the steady-state estimates.

6.1 Current Capacity Scenario

The Current Capacity Scenario estimated the average-day capacity of the City's existing municipal wells and the Glen Collector to be 66,760 m^3/day. The estimated capacity of the City's existing municipal wells under drought conditions is 57,560 m^3/day, or 14% lower than the average-day Current Capacity. While this assessment does not evaluate the effect of drought conditions on all water supply alternatives, it could be assumed that long-term drought conditions may have a similar reduction to the estimated capacity for each of the alternatives.

6.2 Additional Wells and Existing Collector

Future scenarios predicted an increase to the capacity of the current water supply system, ranging from 1,500 m^3/day (Scenario A4-A) to 15,610 m^3/day (Scenario A5-C). Potential additional municipal well supplies, including Edinburgh, Ironwood, GSTW1-20, and Steffler in the Southwest Quadrant offer the greatest amount of additional water supply. Scenario A5-A, considering all potential new supplies within the City or on City property, is predicted to provide 9,980 m^3/day of additional supply. Scenario A5-C, considering all potential new supplies within and outside the City, is predicted to provide 15,610 m^3/day of additional supply. All considered scenarios predict groundwater discharge to streams will be reduced by less than 20% as compared to the current capacity scenario, except at Clythe Creek where groundwater discharge is predicted to be reduced by up to 30% (Scenario A5-C). While the headwaters of Clythe Creek are mapped as coldwater, the lower and mid-reaches of the creek are considerably degraded with recent monitoring work suggesting warmwater conditions. Furthermore, the groundwater model is not well-calibrated to local groundwater levels or groundwater discharge to the creek. However, the model results are indicative of potential effects on surface water. Should the City consider additional supplies in the northeast quadrant, including the Clythe Well, local model updates are recommended along with calibration against aquifer testing results. Additional studies in this area are currently being undertaken by the City (e.g., as part of the return to service of the Clythe well) and this data can be used to supplement the model at a later date.

The groundwater model scenarios identify potential effects on surface water with increased municipal pumping. These results highlight the importance of having more current baseflow monitoring, and it is recommended that the City implement a more comprehensive surface water monitoring program. This program would include surface water monitoring (flow and water level), as well as shallow groundwater level monitoring in areas of important surface water features (e.g., coldwater streams and streams where groundwater discharge is predicted to be reduced). These data would help to improve the characterization of these features in the model and increase the certainty of model predictions.

6.3 Dolime Quarry Water Capture

The Dolime Quarry Scenario (Scenario B1) included a constraint requiring a head difference of 1 m between MW08-02A and the quarry pond to ensure groundwater flows toward the quarry. This constraint was violated under the Current Capacity Scenario, and as a result, the Dolime Quarry scenario, as configured, does not suggest that municipal wells could pump at rates higher than the Current Capacity scenario. However, the Dolime scenario also identifies that under the Current Capacity scenario the rate of discharge from the quarry into the Speed River would remain high, and there is a potential to capture this water into the City's water supply. As a result, the estimated quarry discharge rate of 5,000 m^3/day is assumed as the potential incremental water supply associated with the quarry, and this supply could be achieved through a combination of either new municipal wells or treatment of the quarry discharge water. The City's ongoing Dolime project will consider all of the alternatives available to increase the water supply including strategies such as lowering the pond level, lowering the hydraulic head gradient to below 1 m, and moving the location of the groundwater divide closer to the pond may increase the water supply capacity. These options will require operational testing to confirm the feasibility.

6.4 Arkell Recharge/Collector Optimization

The Arkell Recharge Scenario (Scenario C1) predicted that an increase in takings from the Eramosa River and infiltration at the Arkell lands will increase the groundwater produced by the

Glen Collector. Based on the review of historical Eramosa River flow, the City has an opportunity to increase the amount of surface water infiltrated, while respecting the PTTW constraints. Tripling the river pump capacity to 27,648 m^3/day increases the incremental average infiltration rate by 5,854 m^3/day and the incremental average discharge at the Glen Collector by 4,899 m^3/day over the Current Capacity Scenario. The results indicated that as overall collector efficiency decreases with increased infiltration, the incremental efficiency over Current Capacity generally increases. This suggests that on an average annual basis, as more water is infiltrated and water levels rise, the Glen Collector is able to capture a higher proportion of the infiltrated water. However, this increase in water supply remains subject to the seasonality of the infiltration rates, and the dry periods with minimal collection remain the same as the Current Capacity scenario. Future evaluations are recommended to predict how much additional water may be collected if the Lower Road Collector were to be reconstructed.

The replacement of the Glen Collector and Arkell 1 well with a Caisson Collector System (Scenario C2) is not predicted to greatly increase long-term average system capacity. The Caisson System's estimated long-term average capacity results in a gain of 358 m^3/day compared to the Current Capacity Scenario. However, this system would provide a more reliable supply under drought conditions.

6.5 Aquifer Storage and Recovery

The ASR system Scenarios D1 and D2 demonstrated that the highly transmissive Middle Gasport Formation may be able to accommodate large volumes of injected water. However, the aquifer pressure associated with this injected water will quickly dissipate throughout the aquifer and may be challenging to extract locally in times of need. The simulated average day capacities listed in Table 33 for Scenarios D1 and D2 represent the Current Capacity plus the annual average ASR extraction rate simulated in Scenarios D1 and D2. The ASR scenarios were simulated with baseline municipal rates and not all the incremental capacity may be available under Current Capacity municipal rates. To confirm and optimize the possibility of an efficient ASR system in the City of Guelph, and to better estimate the increase in seasonal water supply capacity, field testing, and further modelling is recommended.

7 References

AECOM Canada Ltd. and Golder Associates Ltd. (AECOM and Golder). 2014. "The Corporation of the City of Guelph Water Supply Master Plan Update." Draft prepared for The Corporation of the City of Guelph. May 2014.

AECOM Canada Ltd. (AECOM). 2021. **City of Guelph Water Supply Master Plan, Task 3 Water Supply Capacity Assessment (Draft)**. Prepared for City of Guelph. Guelph, Ontario. July 2021.

Amec Foster Wheeler. 2017. **Environmental Impact Study (EIS), York Road Environmental Design, City of Guelph**. Prepared in association with Dougan & Associates, Matrix Solutions (including Parish Aquatic Services), and Blackport and Associates. Prepared for City of Guelph, River Systems Advisory Committee (RSAC). March 2017.

Golder Associates Ltd. (Golder). 2010. "City of Guelph Southwest Quadrant Water Supply Class Environmental Assessment Interim Draft Hydrogeologic Report." Prepared for the City of Guelph. August 2010.

Grand River Conservation Authority (GRCA). 2013. Thermal Classification of Municipal Drains. 2013.

Guelph/Eramosa Township. 2020. **2019 Annual Drinking Water Report for: Hamilton Drive Drinking Water System, Rockwood Drinking Water System, and Gazer Mooney Subdivision Distribution System**. Published February 28, 2020, updated March 19, 2020. March 19, 2020.

Jagger Hims Limited. 1998. **Aquifer Performance Evaluation, Volume 1, Southeast Quadrant**. Prepared for the City of Guelph. St. Catharines, Ontario. November 1998.

Matrix Solutions Inc. (Matrix). 2021. "Groundwater Modelling Report for the Guelph South Groundwater Supply Feasibility Assessment." Version 0.1. Draft prepared for City of Guelph. Guelph, Ontario. July 2021.

Matrix Solutions Inc. (Matrix). 2020. "DRAFT City of Guelph Calibration Data Assessment." Version 0.1. Draft prepared for City of Guelph. Guelph, Ontario. September 28, 2020.

Matrix Solutions Inc. (Matrix). 2018. **Guelph Guelph/Eramosa Water Quantity Policy Development Study: Threats Management Strategy**. Version 1.0. Prepared for Lake Erie Source Protection Region. Guelph, Ontario. June 2018.

Matrix Solutions Inc. (Matrix). 2017. **City of Guelph and Township of Guelph/Eramosa, Tier Three Water Budget and Local Area Risk Assessment**. Prepared for Lake Erie Source Protection Region. Breslau, Ontario. March 2017.

Ontario Ministry of Environment, Conservation and Parks (MECP). 2021. **2017 Technical Rules under the Clean Water Act**. Published June 13, 2017. Updated April 17, 2021. 2021. https://www.ontario.ca/page/2017 technical rules under clean water act

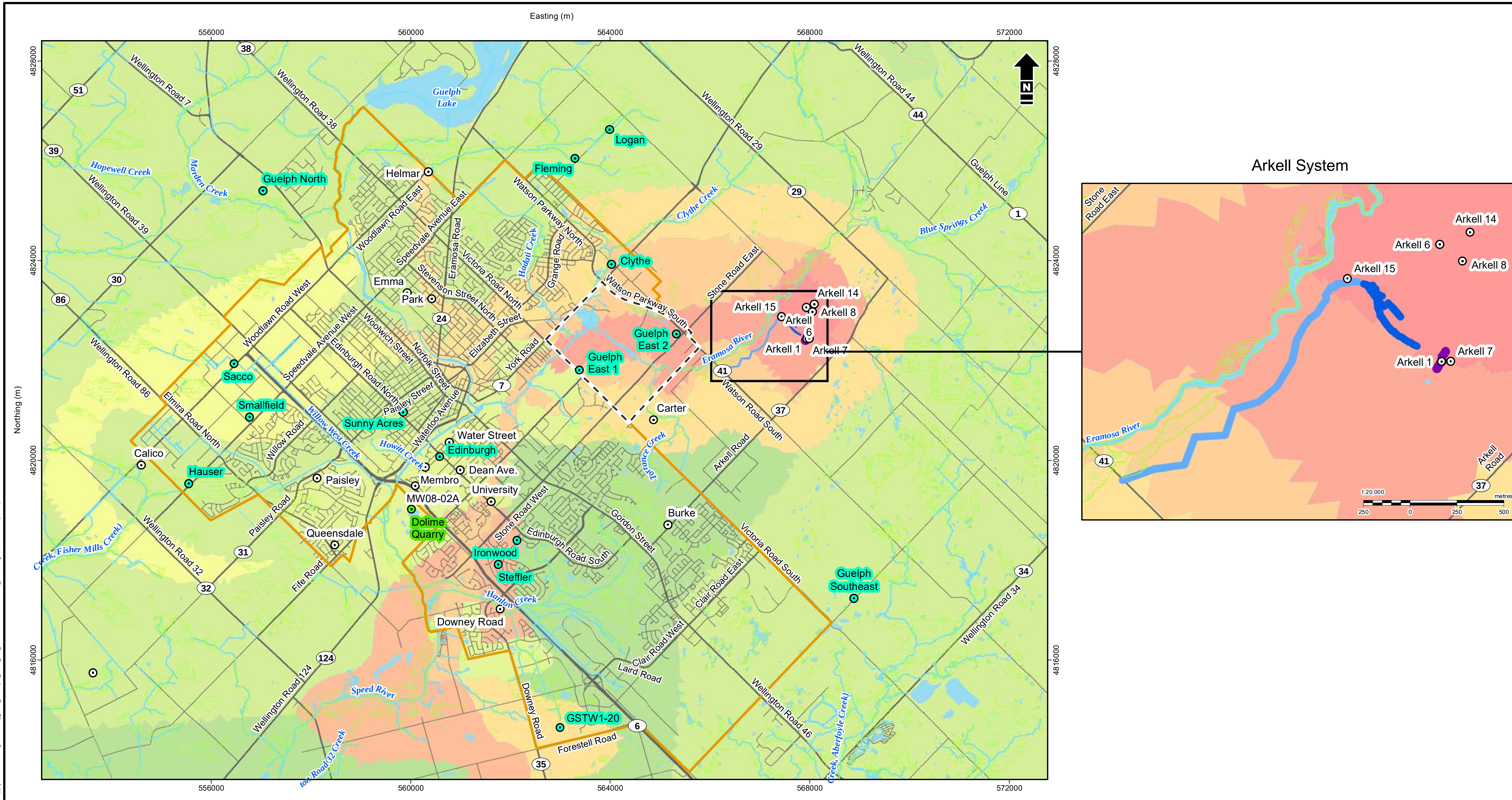
Ontario Ministry of Natural Resources (MNR). 2013. **Provincial stream thermal classification mapping**. 2013.

Ontario Ministry of the Environment, Conservation and Parks (MECP). 2019. **Map: Permits to take water**. Last updated December 31, 2019.

Ontario Ministry of the Environment. (MOE). 2013. **Memorandum: Assignment of Water Quantity Risk based on the Evaluation of Impacts to Other Water Users**. Memorandum prepared for Source Protection Regions. Toronto, Ontario. December 2, 2013. 2013.

Stantec Consulting Ltd. (Stantec). 2006. "Hydrogeological Study in Support of a Caisson Collector System, Arkell Spring Grounds, Guelph." Draft prepared for City of Guelph. March 2006.

White J.T. et al. 2020. **Approaches to Highly Parameterized Inversion: PEST++ Version 5, a Software Suite for Parameter Estimation, Uncertainty Analysis, Management Optimization and Sensitivity Analysis: U.S. Geological Survey Techniques and Methods 7C26**. 2020. 52 pp. https://pubs.er.usgs.gov/publication/tm7C26



Simulated Caisson Collection System	Simulated Dolime Quarry Water Taking
Simulated Glen Collector	Municipal Well - Future Supply Scenario
Simulated Lower Collector	Municipal Well - Current Capacity Scenario
City Boundary	
Guelph Innovation District	
Waterbody	
Wetland	
Watercourse	
Highway	
Road	

Simulated Middle Gasport Formation Hydraulic Conductivity

$1\ x10^{-3}$ m/s

$1\ x10^{-6}$ m/s

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1:75,000 metres

750 0 750 1,500

NAD 1983 UTM Zone 17N

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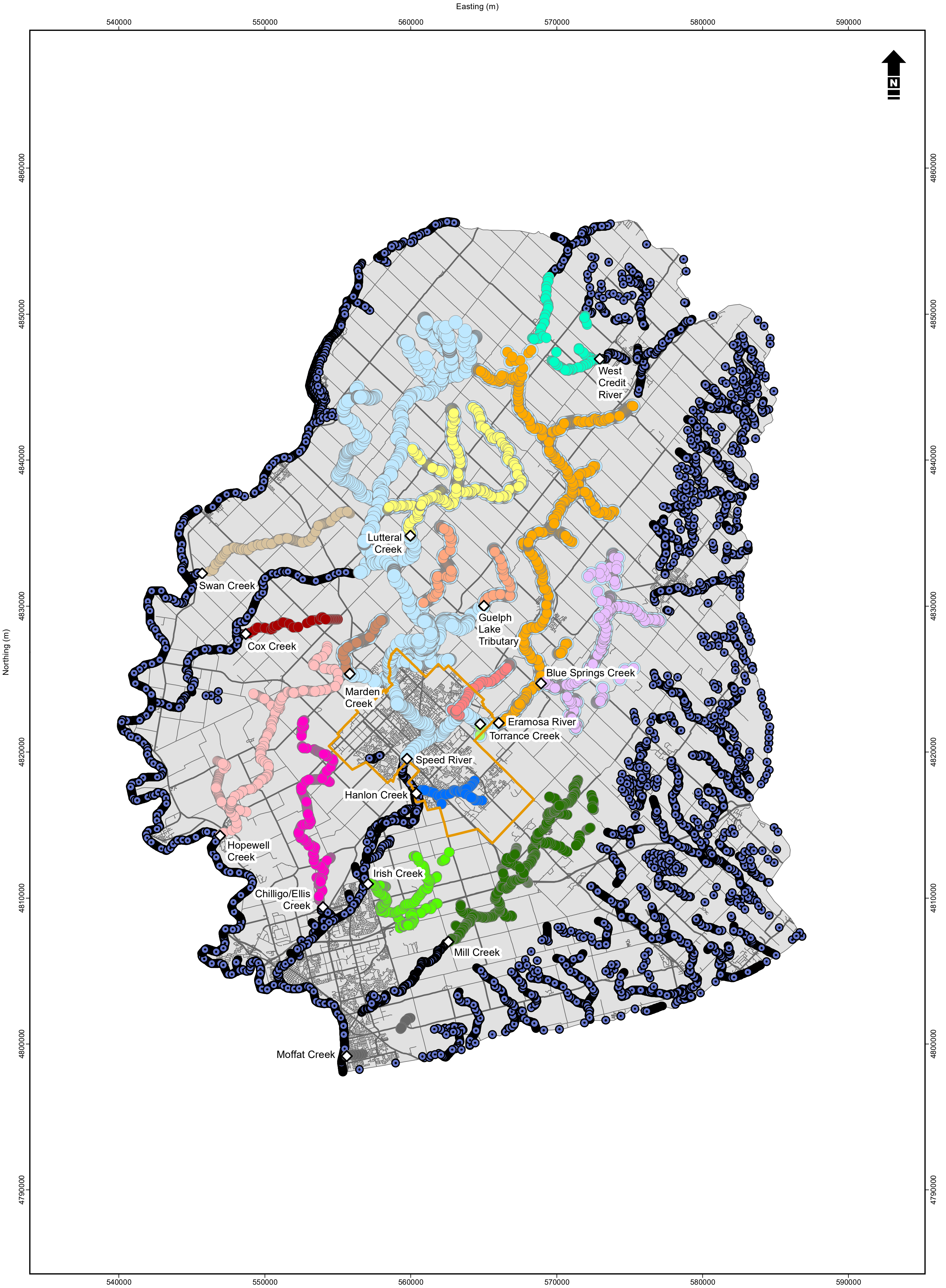
City of Guelph
Water Supply Master Plan

Study Area, Municipal Wells, and Watercourses

Date:	Project:	Submitter:	Reviewer:
August 2021	15072	J. Langford	D. Van Vliet

Figure 1

I:\CityofGuelph\15072\FiguresandTables\QHG\2021\Report\City of Guelph Water Supply Master Plan\Figure-2-Discharge_Boundary_Condition_Selections_within_Model_Domain.mxd - Tabloid_P - 01-Oct-21, 09:59 AM - sylam - TID003



Watercourse Boundary Condition Selection

- Blue Springs Creek
- Chilligo/Ellis Creek
- Clythe Creek
- Cox Creek
- Eramosa River
- Guelph Lake Tributary
- Hanlon Creek
- Hopewell Creek
- Irish Creek
- Lutteral Creek
- Marden Creek
- Mill Creek
- Moffat Creek
- Speed River
- Swan Creek
- Torrance Creek
- West Credit River

- Model Domain
- City Boundary
- Highway
- Road
- Baseflow Measurement Station
- Model Slice 1 Constant Head Boundary Conditions

1:250,000 metres
2,500 0 2,500 5,000
NAD 1983 UTM Zone 17N

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City of Guelph
Water Supply Master Plan

Discharge Boundary Condition Selections within Model Domain

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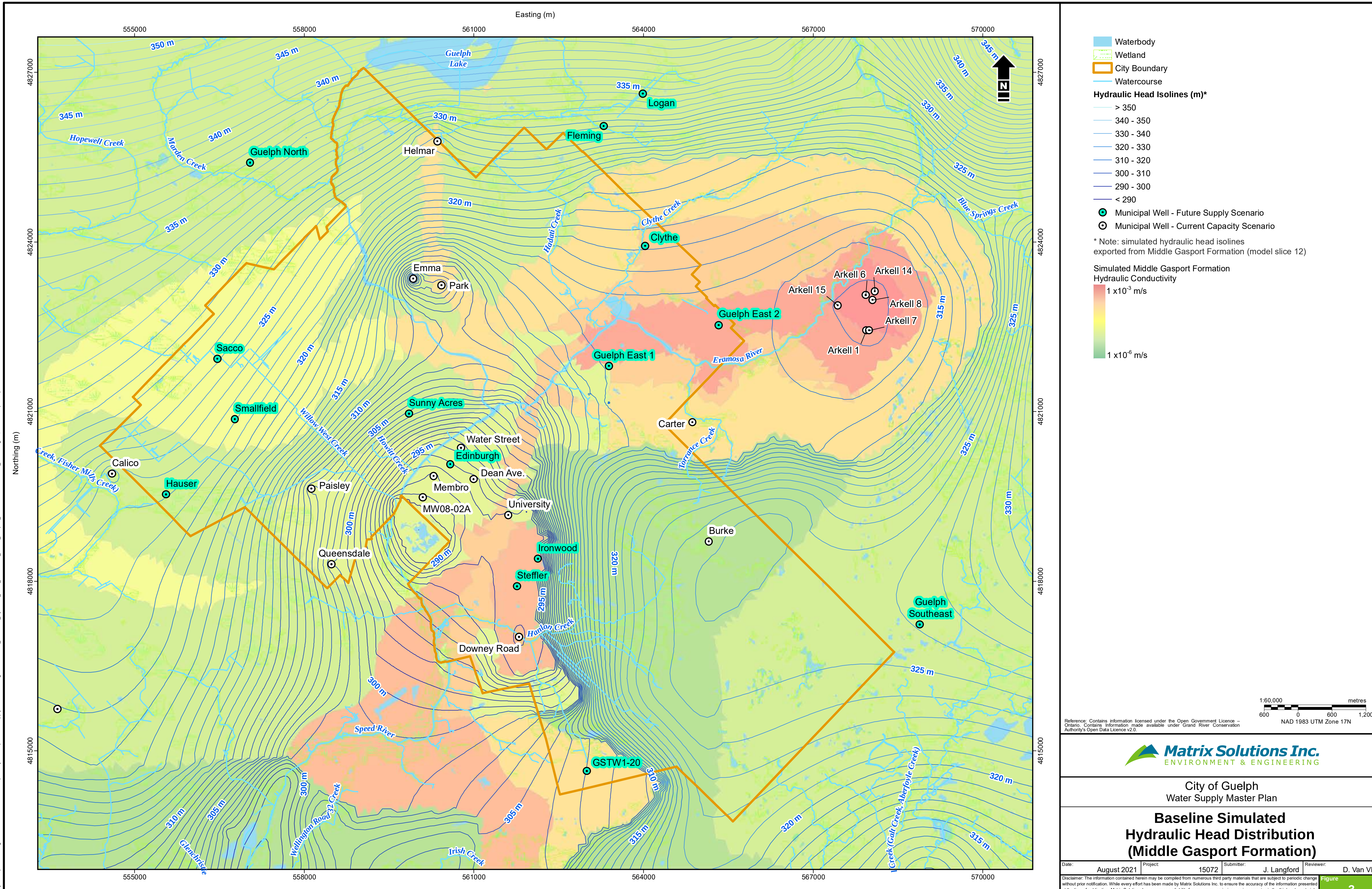
Figure
2



Easting (m)
555000
558000
561000
564000
567000
570000
Northing (m)
4827000
4824000
4821000
4818000
4815000
Waterbody
Wetland
City Boundary
Watercourse
Hydraulic Head Isolines (m)*
> 350
340 - 350
330 - 340
320 - 330
310 - 320
300 - 310
290 - 300
< 290
Municipal Well - Future Supply Scenario
Municipal Well - Current Capacity Scenario
* Note: simulated hydraulic head isolines exported from Middle Gasport Formation (model slice 12)
Simulated Middle Gasport Formation Hydraulic Conductivity
1 x10-3 m/s
1 x10-6 m/s
Guelph Lake
Logan
Fleming
Helmar
Guelph North
Hopewell Creek
Marden Creek
Clythe Creek
Hadati Creek
Clythe
Emma
Park
Arkell 6
Arkell 14
Arkell 15
Arkell 8
Arkell 7
Arkell 1
Guelph East 2
Guelph East 1
Eramosa River
Blue Springs Creek
Sacco
Smallfield
Sunny Acres
Willow West Creek
Howitt Creek
Carter
Torrance Creek
Water Street
Edinburgh
Dean Ave.
Membro
MW08-02A
University
Calico
Hauser
Paisley
Creek, Fisher Mills Creek)
Burke
Queensdale
Ironwood
Steffler
Guelph Southeast
Hanlon Creek
Downey Road
Speed River
GSTW1-20
Wellington Road 32 Creek
Glenchristie
Irish Creek
Creek (Galt Creek, Aberfoyle Creek)
1:60,000
metres
600 0 600 1,200
NAD 1983 UTM Zone 17N
Reference: Contains information licensed under the Open Government Licence – Ontario. Contains information made available under Grand River Conservation Authority's Open Data Licence v2.0.
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City of Guelph
Water Supply Master Plan
Baseline Simulated
Hydraulic Head Distribution
(Middle Gasport Formation)
Date: August 2021
Project: 15072
Submitter: J. Langford
Reviewer: D. Van Vliet
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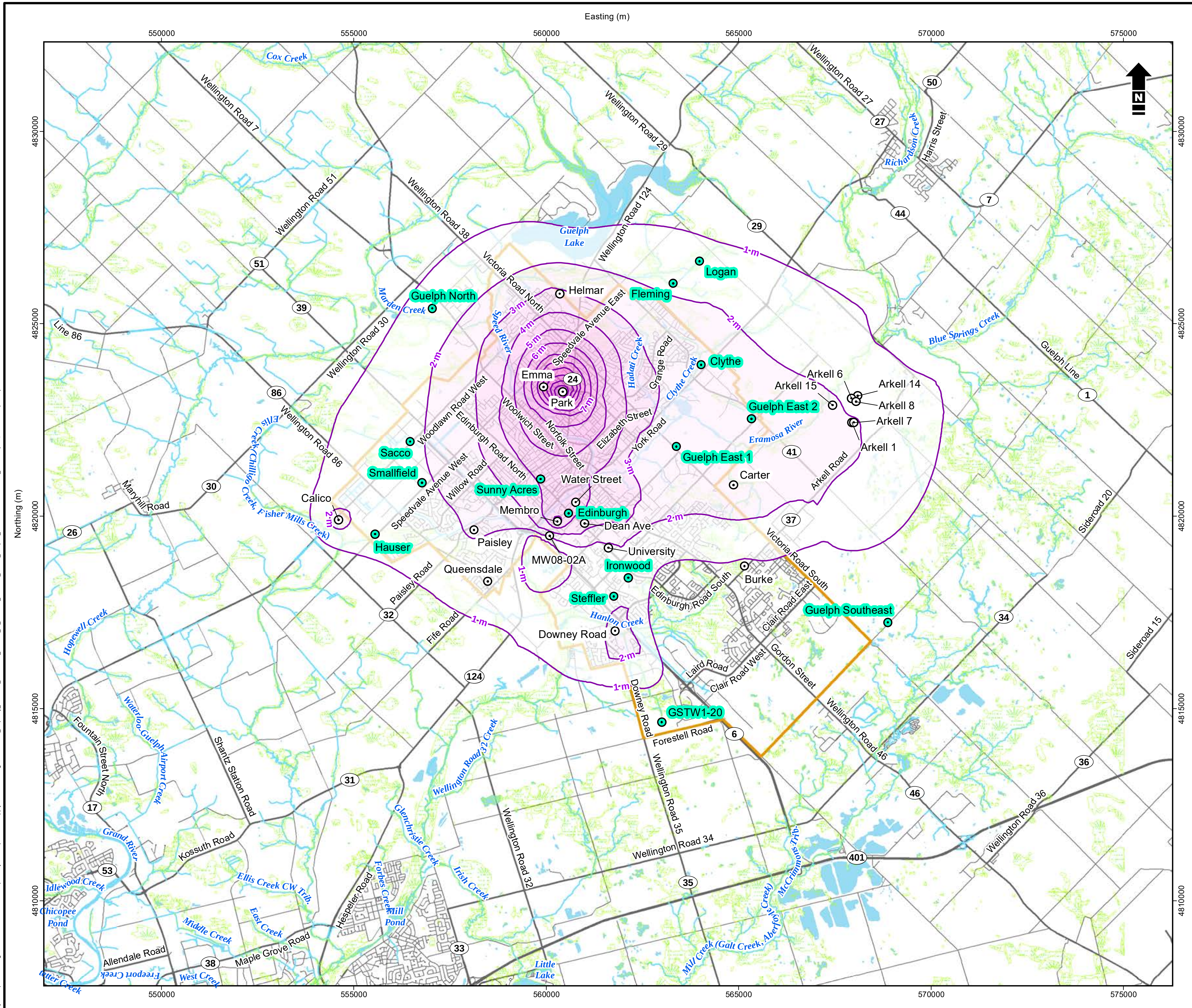
Figure 3



City Boundary

Waterbody

Wetland

Simulated Drawdown*

Highway

Road

Watercourse

Municipal Well - Future Supply Scenario

Municipal Well - Current Capacity Scenario

* Note: Simulated drawdown isolines exported from Middle Gasport Formation (model slice 12) and are compared to baseline hydraulic head (see Figure 3).

1:100,000 metres

1,000 0 1,000 2,000

NAD 1983 UTM Zone 17N

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City of Guelph
Water Supply Master Plan

Current Capacity Scenario Drawdown Relative to Baseline Scenario (Middle Gasport Formation)

Date:	Project:	Submitter:	Reviewer:
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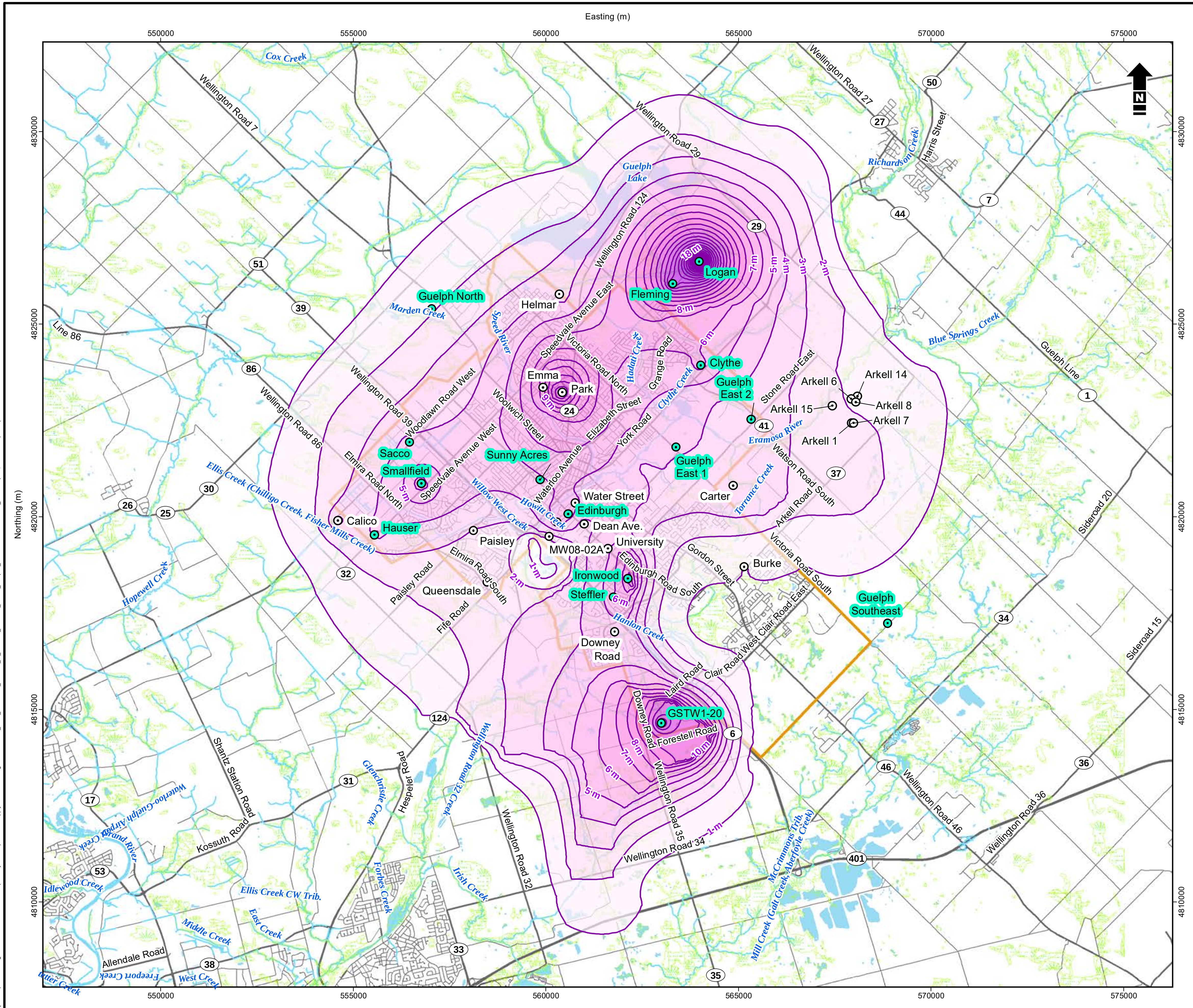
Figure 4



City Boundary
Waterbody
Wetland
Simulated Drawdown*
Highway
Road
Watercourse
Municipal Well - Future Supply Scenario
Municipal Well - Current Capacity Scenario

* Note: Simulated drawdown isolines exported from Middle Gasport Formation (model slice 12) and are compared to baseline hydraulic head (see Figure 3).

1:100,000 metres
1,000 0 1,000 2,000
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Scenario A5-A Drawdown Relative to Baseline Scenario (Middle Gasport Formation)

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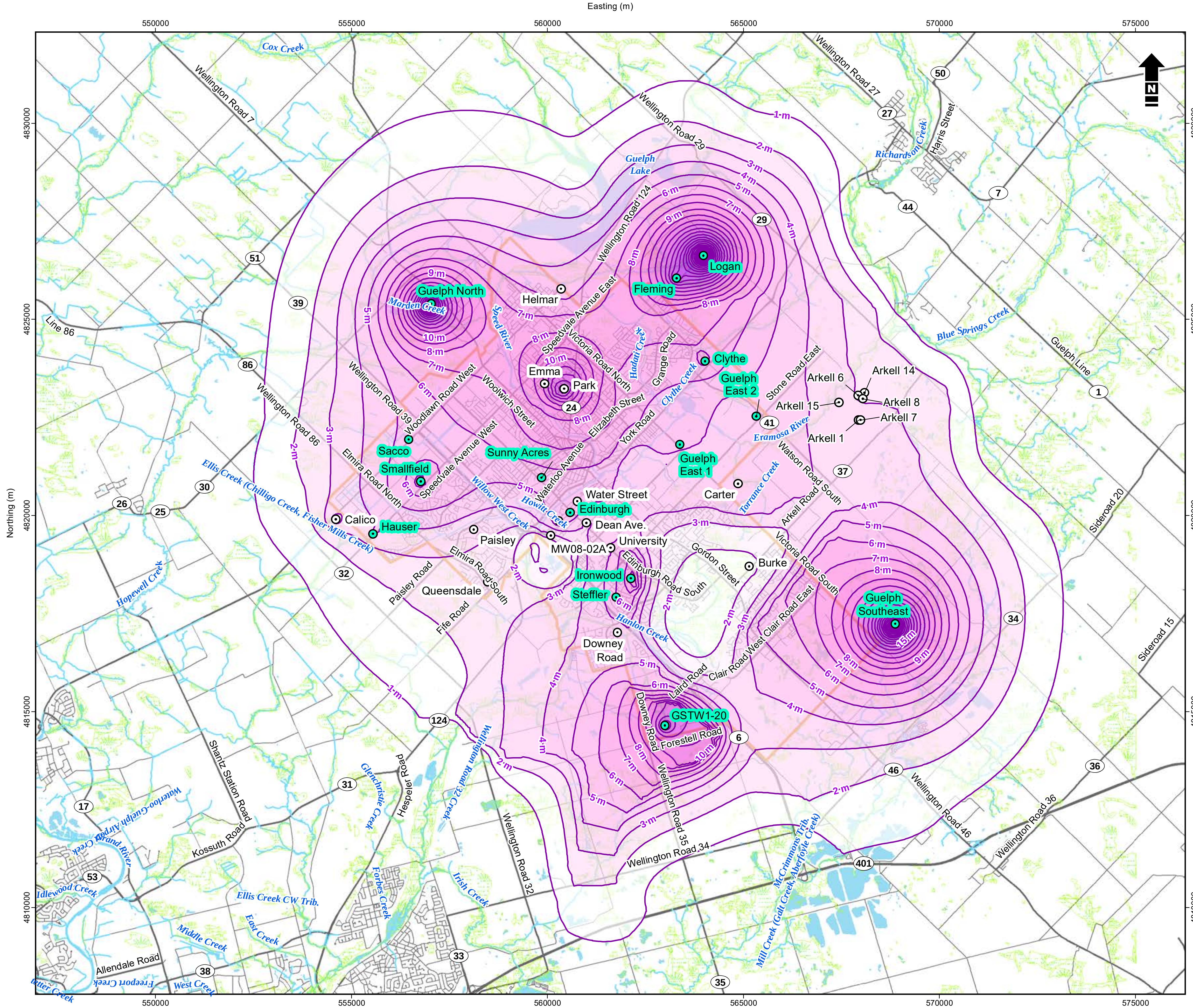
Figure 5



- City Boundary
- Waterbody
- Wetland
- Simulated Drawdown*
- Highway
- Road
- Watercourse
- Municipal Well - Current Capacity Scenario
- Municipal Well - Future Supply Scenario

* Note: Simulated drawdown isolines exported from Middle Gasport Formation (model slice 12) and are compared to baseline hydraulic head (see Figure 3).

1:100,000 metres
1,000 0 1,000 2,000
NAD 1983 UTM Zone 17N

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Water Supply Master Plan

Scenario A5-C Drawdown Relative to Baseline Scenario (Middle Gasport Formation)

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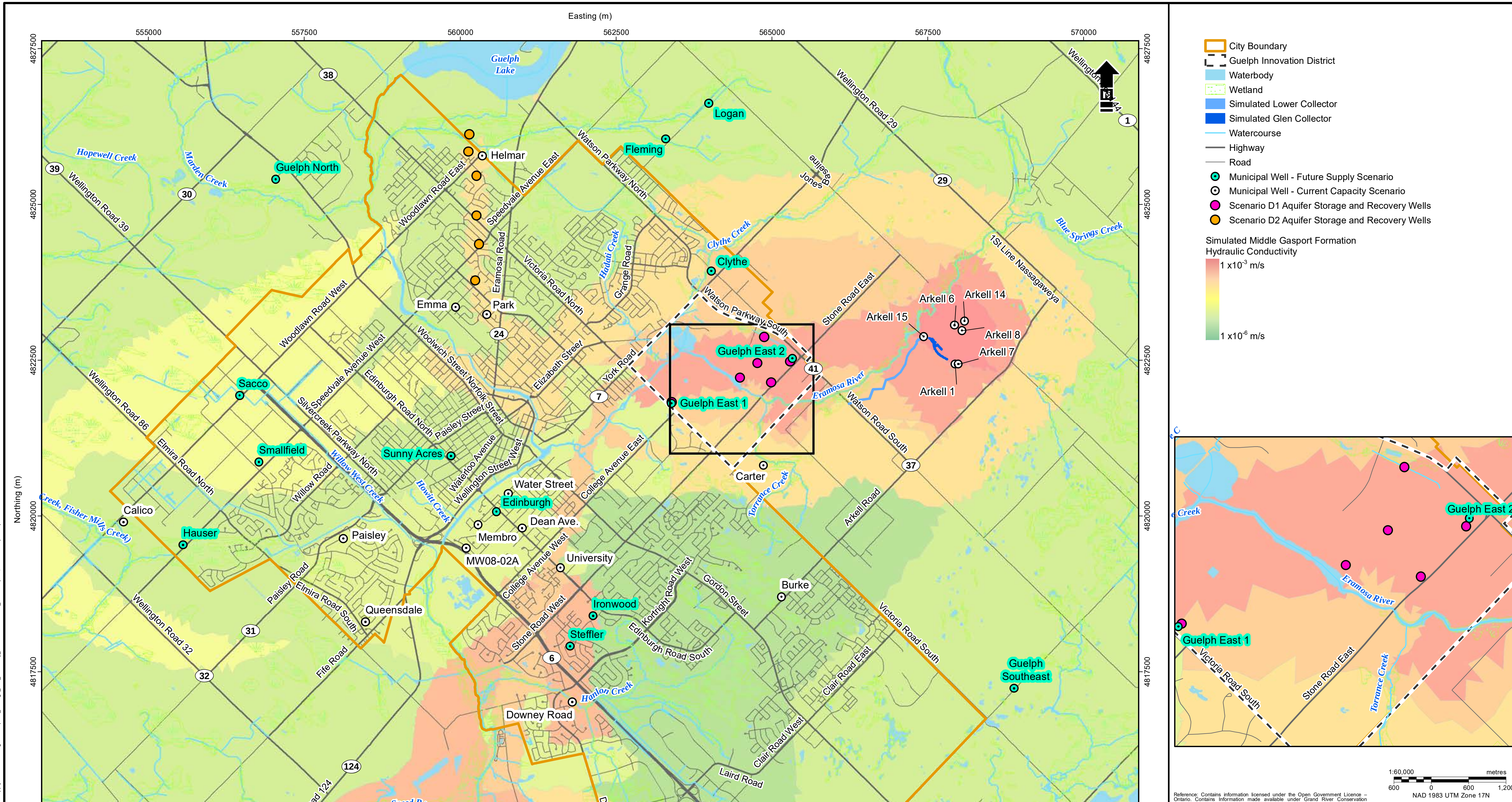
Figure
6



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City of Guelph
Water Supply Master Plan

Aquifer Storage and Recovery Well Locations

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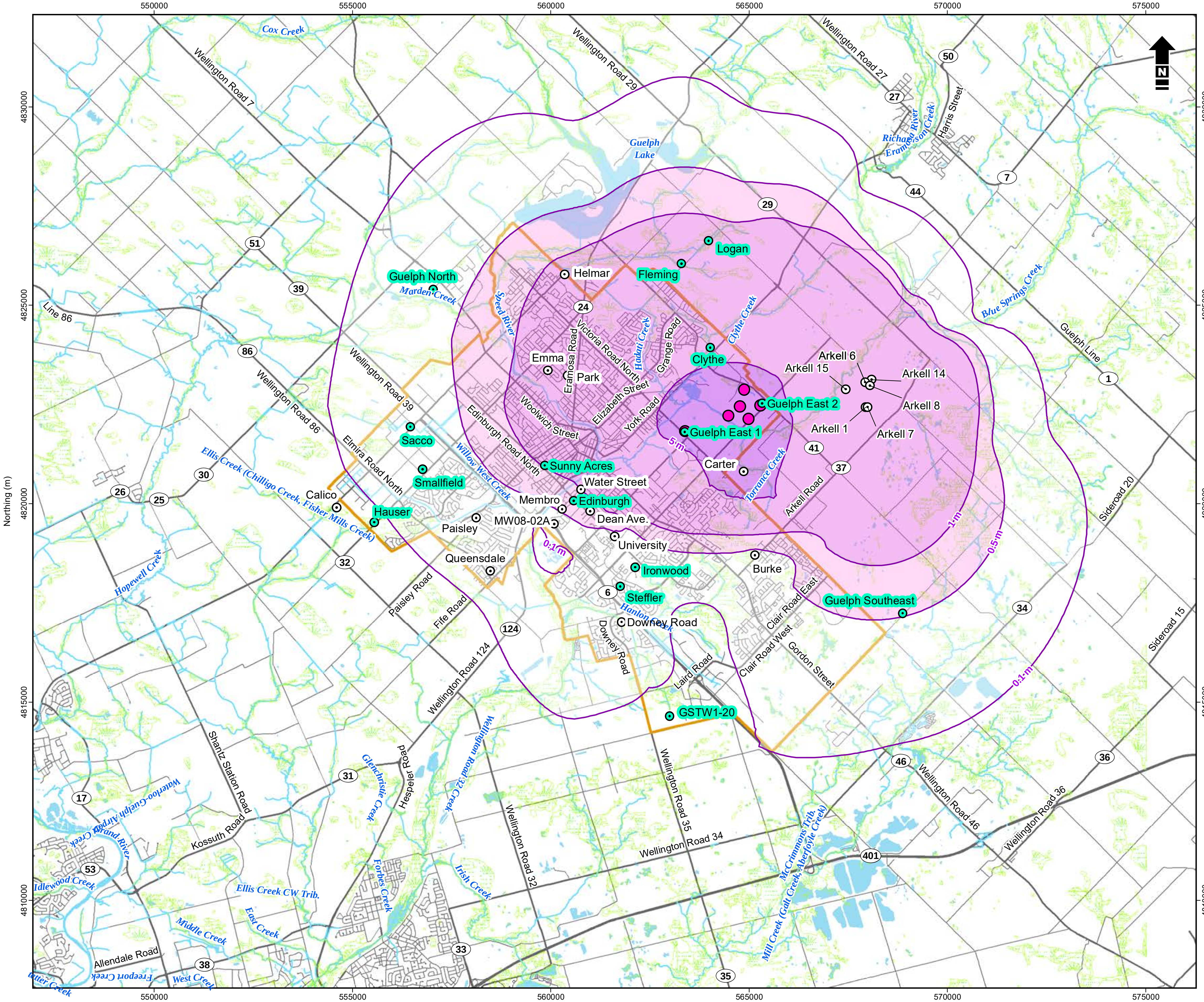
Figure
7



Easting (m)

- City Boundary
- Wetland
- Waterbody
- Change In Head
- Watercourse
- Highway
- Road
- Municipal Well - Future Supply Scenario
- Municipal Well - Current Capacity Scenario
- Scenario D1 Aquifer Storage and Recovery Wells

1:100,000 metres

1,000 0 1,000 2,000

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Water Supply Master Plan

Scenario D1: Hydraulic Head Increase in Middle Gasport Formation After 91 Days of Injection

Date:	Project:	Submitter:	Reviewer:
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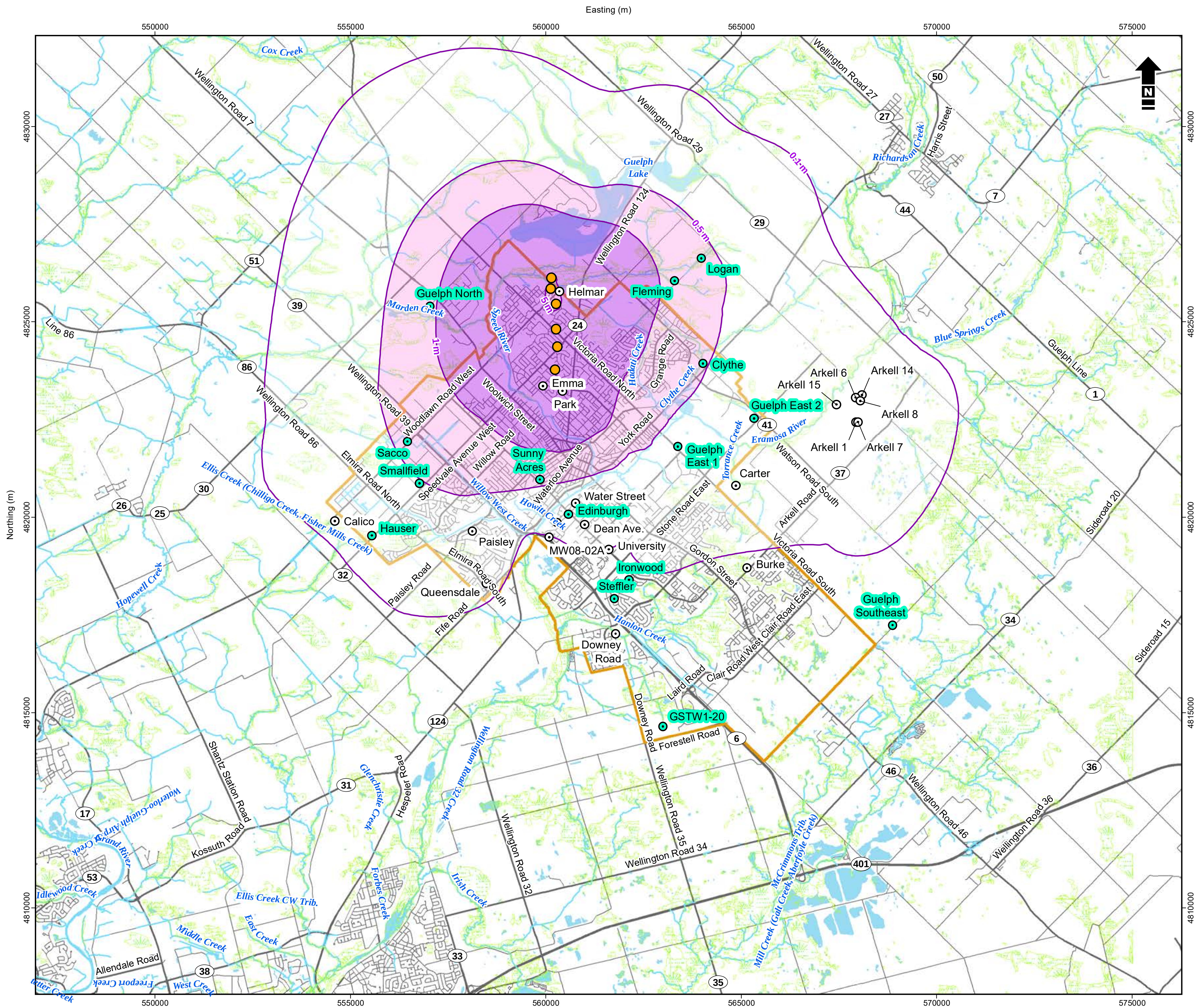
Figure 8



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Scenario D2: Hydraulic Head Increase in Middle Gasport Formation After 273 Days of Injection

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Figure
9

Appendix E

Surface Water Analysis for City of Guelph Long Term Water Supply Plan by GRCA

Grand River Conservation Authority

Technical Memorandum

Title: Surface Water Analysis for City of Guelph Long Term Water Supply Plan

Authors: Stephanie Shifflett, P.Eng., Dwight Boyd P.Eng.

Date: September 29, 2020

Purpose:
The purpose of this memo is to update the surface water taking analysis previously completed in 2005 and updated in 2014 that included surface water taking alternatives from the Guelph Reservoir on the Speed River and the Eramosa Intake on the Eramosa River (also referred to as the Arkell Taking). The updated analysis, described in this memo, covers the period from 1951 to 2019.

This memo includes the results of 19 scenarios for takings from the Guelph Reservoir, an analysis of the Eramosa Intake under its current Permit to Take Water (PTTW) and a potential Aquifer Storage Recovery system (ASR) for the Eramosa Intake. The environmental flow needs assessment included in previous versions of this memo was not updated. Please refer to the 2014 memo for the most recent environmental flow needs assessment.

Guelph Reservoir Analysis:

Methods

A sensitivity analysis was completed to analyze the impacts of takings on: the reliability of filling Guelph Dam reservoir, water elevations in the reservoir and on downstream low flow targets. A total of 19 scenarios where analyzed to investigate differences in taking from both the reservoir and the Eramosa Intake. Scenarios included different rates for a base taking from the reservoir, different rates for an ASR taking from the reservoir and three scenarios for takings at the Eramosa Intake.

Methods and assumptions used are detailed in the following points:

- The period of record analyzed included 1951 to 2019, including 7 additional years compared to the 2014 analysis.
- Discharge from the dam was set as the greater of the following:
    i. Minimum required discharge (0.57 m^3/s) or inflow

ii. The hydro turbine discharge at the given lake elevation

iii. The required downstream discharge to meet the downstream low flow target at the Edinburgh Road gauge. Flow target is 1.7 m^3/s from June 1st to September 30th and 1.1 m3/s from September 30th to May 30th.

iv. The uncontrolled slot discharge plus the turbine discharge

v. The turbine discharge, uncontrolled slot discharge and any required flood discharge required to stabilize levels in Guelph Dam.

- If the reservoir storage exceeds 95% of the upper rule curve storage, it is assumed 50% of the inflow is available for a municipal taking up to a maximum taking of 0.5 or 1 m^3/s depending on the scenario.

- It is assumed there is an upper limit to the size of plant the City would consider to process intermittent takings. For the purposes of this analysis the upper limit was set at 1.0 m^3/s.

- Discharge to meet downstream flow targets was not constrained while water was available in the reservoir.

- The hydro turbine is operated as long as the lake level is above the minimum lake elevation required to allow the turbine to operate, 342.1 m.

- If after all the above conditions were met and the Guelph Lake elevation is above the lower operating range of the rule curve, the municipal base taking is applied for each scenario.

- The Eramosa above Guelph gauge record dates starts in 1962. The Edinburgh Road gauge record dates back to 1950. The Eramosa daily flows prior to 1962 were estimated from the Edinburgh Road daily flows. An empirical relationship was created between the Eramosa gauge and Edinburgh Road gauge using the 1962 to 1975 period of record prior to Guelph Dam coming into operation. This empirical relationship was used to estimate the 1951 to 1962 daily flows at the Eramosa gauge above Guelph.

- To account for the impacts of the Eramosa Intake water taking, three different local flow time series were created. Local flow time series account for inputs of water between the dam and the gauge station and include discharge from the Eramosa River.

    a. existing Eramosa water taking

    b. abandoning the Eramosa water taking

    c. maximizing the Eramosa water taking

- A naturalized Eramosa River flow time series was created where the effects of the Eramosa River taking was removed from the flow series. The Eramosa Above Guelph gauge station daily flow data was modified to add the Eramosa Intake taking of 100 L/s back onto the Eramosa gauge station flow series. Where observed taking records were available these were used to determine dates when the 100 L/s should be added back onto the flow record, for other periods the taking rules in the permit to take water were assumed, essentially if the stream flow exceeded 0.42 m^3/s at the above Guelph gauge station between May 1st and November 1st the flow was added back onto the daily flow record.

- To create the existing water taking time series, 100 L/s was removed based on the rules in the Permit to Take Water.

- To create the abandoned water taking time series, the difference between the naturalized flow series and the existing flows series was used to adjust the local daily flow time series.

- To create the maximize the Water taking time series, the naturalized Eramosa Above Guelph flow series was used along with the permit to take water conditions for the Arkell surface water taking to create a daily flow series that assumed the Arkell surface water taking is maximize to the limits indicated in the existing permit to take water. This assumes there are no infrastructure constraints and the taking can occur to the limits of the PTTW. The difference between the maximized flow series and the naturalized flow series was used to create the adjusted local daily flow series used to simulate maximizing the Arkell surface water taking.

Scenarios

In all, a total of 19 taking scenarios were simulated (Table 1). Five scenarios were simulated for Guelph Dam combined with three scenarios for the Eramosa Intake. This accounted for the first fifteen scenarios. The final four scenarios analyzed different municipal base takings and stepped ASR takings.

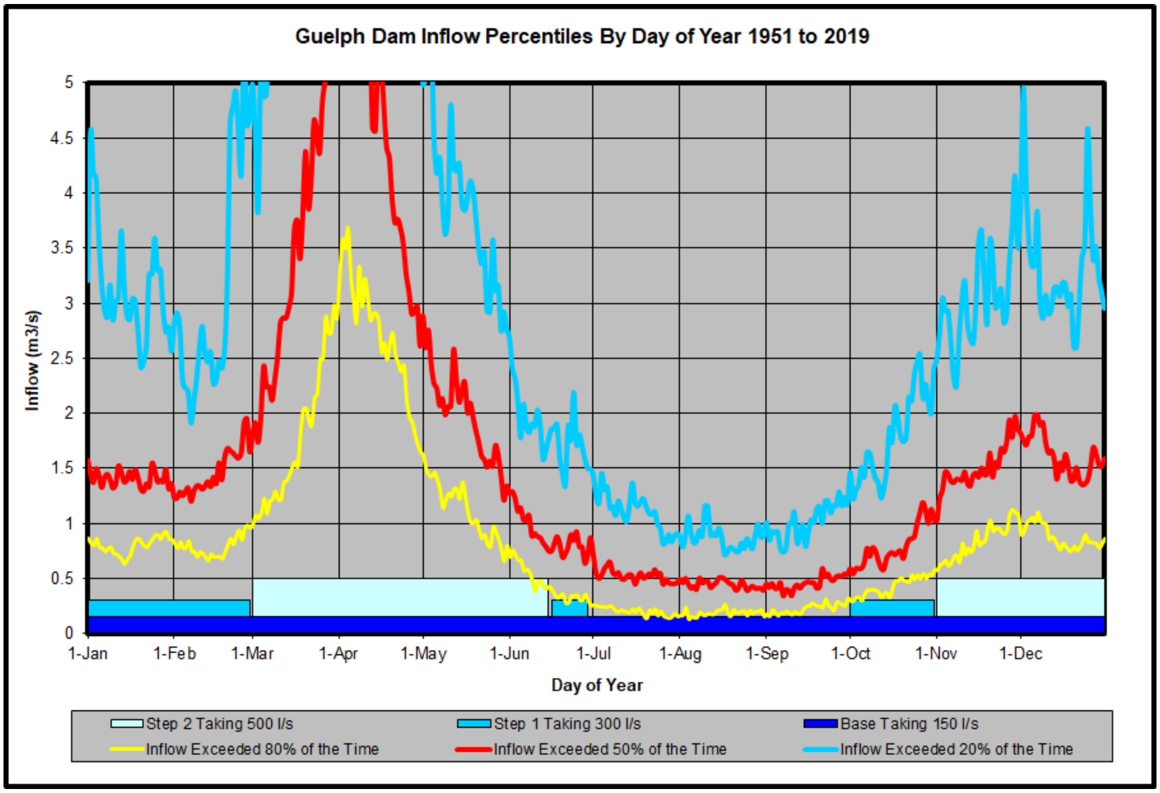
To develop the ASR taking scenario, inflow data for the Guelph Reservoir was analyzed. The stream inflow to Guelph Dam varies within the year and across years. Figure 1 presents a chart illustrating the daily inflow probability into Guelph Dam for the 1950 to 2019 period. This chart illustrates the inflow probability and the periods of the year when takings of 500 L/s and 300 L/s would most likely be available. A 500 L/s taking is most likely available in the March through May period and the November and December period. A 300 L/s taking is most likely available in the January through July and October through December period of the year. During the summer period only the base taking is feasibly available. The availability of taking will vary depending on the watershed conditions and may not be available in some years.

Table 1 Guelph Dam Municipal Base and ASR Taking Scenario Summary

Scenario	Guelph Dam			Eramosa
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption
Scenario 1	150	1000	n/a	Existing
Scenario 2	150	500	n/a	Existing
Scenario 3	200	500	n/a	Existing
Scenario 4	250	500	n/a	Existing
Scenario 5	300	500	n/a	Existing
Scenario 6	150	1000	n/a	Abandon
Scenario 7	150	500	n/a	Abandon
Scenario 8	200	500	n/a	Abandon
Scenario 9	250	500	n/a	Abandon
Scenario 10	300	500	n/a	Abandon
Scenario 11	150	1000	n/a	Maximized
Scenario 12	150	500	n/a	Maximized
Scenario 13	200	500	n/a	Maximized
Scenario 14	250	500	n/a	Maximized
Scenario 15	300	500	n/a	Maximized
Scenario 16	150	500	300	Maximized
Scenario 17	200	500	300	Maximized
Scenario 18	250	500	300	Maximized
Scenario 19	300	500	300	Maximized

Based on observations of stream flows, rules were set up for the reservoir yield model to represent a two staged taking. First the 500 L/s taking was assumed to occur any month of the year provided the storage in Guelph Dam equaled or exceeded 95% of the upper rule curve storage. This ensured there was ample water to meet downstream low flow augmentation requirements and provided flexibility to accommodate an ASR taking. Next an additional 300 L/s taking was assumed to occur if the storage in Guelph Dam equaled or exceeded 50% of the upper rule curve storage. The 300 L/s taking was not allowed to occur between July 1st and September 1st but allowed during other periods of the year provided the storage requirements were met. The 150 L/s taking was assumed to occur if storage in Guelph Dam exceeded the lower rule curve storage

Figure 1 Chart Illustrating Stepped Surface Water Takings from Guelph Dam



Results

Detailed results of the scenarios are given on the following pages. Table 2 gives the reliability of the base municipal taking given by: a) total number of days taking is not available, b) maximum number of days base taking is not available in a given year or month, c) reliability of the taking based on time, and d) reliability of the taking based on occurrence. Table 3 gives the reliability of the ASR taking in addition to the base municipal taking given by the base taking being exceeded: a) average number of days, b) minimum number of days, c) reliability based on time, and d) reliability based on occurrence. Table 4 gives the reliability of the full ASR taking being available given by: a) average number of days, b) minimum number of days, c) reliability based on time, and d) reliability based on occurrence.

Reliability based on time is calculated by taking the total number of days with an occurrence and dividing it by the total number of days in the period of record. Reliability based on occurrence is calculated by taking the total number of years with one occurrence and dividing by the total number of years in the period of record.

Based on information presented in Tables 2 to 4. A base municipal taking of 0.15 m^3/s and a stepped ASR taking of 0.3 m^3/s and 0.5 m^3/s appears to be the most realistic taking option (Scenario 16). This scenario assumes the Eramosa Intake taking is maximized and that downstream low flow targets upstream of the Guelph sewage treatment plant are achieved 100% of the time. A summary of reliabilities for Scenario 16 is given in Table 5.

Detailed tables showing the reliability of Scenario 16 by year and month are given in Tables 6, 7 and 8. The ASR takings reliability closely follows the inflow reliability. The reliability of a 500 L/s taking being available is highest during the months of March, April and May. Note the reliability of a 300 L/s taking assumes a 300 L/s or greater taking being available. Therefore during the summer months of July and August when a 300 L/s taking was not considered, reliabilities reflect the fact that a 500 L/s taking was sometimes available.

Detailed results of all 19 scenarios by year and month are given in Appendices A, B and C. Appendix A includes the reliability summaries for the base municipal taking. Appendix B includes the reliability of exceeding the base municipal taking or the reliability that water is available for an ASR. Appendix C gives the reliability summaries for the maximum ASR taking available.

Table 2 Reliability of base municipal taking for various scenarios 1951 to 2019 simulation

Scenario	Guelph Dam Base Municipal Taking (L/s)	Guelph Dam ASR Taking (L/s)	Guelph Dam ASR Step 1 Taking (L/s)	Eramosa Taking Assumption	Total Number of Days Base Taking Not Available: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	55	1	0	4	32	8	8	27	10	5	53	75	278
Scenario 2	150	500	n/a	Existing	55	0	0	4	31	7	5	16	3	1	46	71	239
Scenario 3	200	500	n/a	Existing	56	29	2	6	32	23	16	40	35	42	99	90	470
Scenario 4	250	500	n/a	Existing	56	48	14	11	33	32	29	60	85	78	112	97	655
Scenario 5	300	500	n/a	Existing	67	70	23	13	36	42	37	84	151	111	117	103	854
Scenario 6	150	1000	n/a	Abandon	55	1	0	3	32	1	8	27	7	1	42	65	242
Scenario 7	150	500	n/a	Abandon	55	0	0	3	31	1	5	16	3	0	34	55	203
Scenario 8	200	500	n/a	Abandon	56	29	2	6	32	18	16	40	22	30	85	90	426
Scenario 9	250	500	n/a	Abandon	56	48	10	10	33	32	29	56	60	63	111	98	606
Scenario 10	300	500	n/a	Abandon	67	68	23	13	36	42	36	76	137	98	116	101	813
Scenario 11	150	1000	n/a	Maximized	55	29	4	4	32	9	13	44	28	52	77	81	428
Scenario 12	150	500	n/a	Maximized	55	29	4	3	31	9	7	33	23	44	75	79	392
Scenario 13	200	500	n/a	Maximized	56	37	5	9	32	23	22	57	61	83	109	97	591
Scenario 14	250	500	n/a	Maximized	57	50	15	12	34	37	33	79	135	111	119	112	794
Scenario 15	300	500	n/a	Maximized	72	76	24	14	37	45	46	118	195	124	119	112	982
Scenario 16	150	500	300	Maximized	55	29	5	8	32	19	10	45	30	59	84	82	458
Scenario 17	200	500	300	Maximized	56	43	5	9	33	28	24	64	73	88	113	103	639
Scenario 18	250	500	300	Maximized	60	50	17	12	34	38	35	83	145	112	119	112	817
Scenario 19	300	500	300	Maximized	72	76	24	14	37	45	46	118	195	124	119	112	982

Scenario	Guelph Dam Base Municipal Taking (L/s)	Guelph Dam ASR Taking (L/s)	Guelph Dam ASR Step 1 Taking (L/s)	Eramosa Taking Assumption	Maximum Number of Days Base Taking Not Available in Given Year or Month: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	31	1	0	4	31	8	8	15	7	5	27	31	67
Scenario 2	150	500	n/a	Existing	31	0	0	4	31	7	5	8	3	1	27	31	66
Scenario 3	200	500	n/a	Existing	31	25	2	5	31	23	10	21	13	18	29	31	96
Scenario 4	250	500	n/a	Existing	31	29	10	7	31	28	15	29	25	27	30	31	118
Scenario 5	300	500	n/a	Existing	31	29	18	8	31	29	17	31	30	31	30	31	135
Scenario 6	150	1000	n/a	Abandon	31	1	0	3	31	1	8	15	7	1	27	29	59
Scenario 7	150	500	n/a	Abandon	31	0	0	3	31	1	5	8	3	0	24	27	59
Scenario 8	200	500	n/a	Abandon	31	25	2	5	31	18	10	21	11	17	29	31	80
Scenario 9	250	500	n/a	Abandon	31	29	6	6	31	28	15	29	23	26	29	31	107
Scenario 10	300	500	n/a	Abandon	31	29	18	8	31	29	17	31	30	31	30	31	124
Scenario 11	150	1000	n/a	Maximized	31	29	4	3	31	9	8	26	15	29	28	31	81
Scenario 12	150	500	n/a	Maximized	31	29	4	3	31	9	5	24	12	26	28	31	73
Scenario 13	200	500	n/a	Maximized	31	29	5	5	31	23	12	28	24	31	30	31	104
Scenario 14	250	500	n/a	Maximized	31	29	10	7	31	29	19	31	30	31	30	31	120
Scenario 15	300	500	n/a	Maximized	31	29	18	8	31	30	22	31	30	31	30	31	137
Scenario 16	150	500	300	Maximized	31	29	5	5	31	19	8	25	16	31	29	31	90
Scenario 17	200	500	300	Maximized	31	29	5	5	31	28	12	28	26	31	30	31	113
Scenario 18	250	500	300	Maximized	31	29	11	7	31	29	18	31	30	31	30	31	123
Scenario 19	300	500	300	Maximized	31	29	18	8	31	30	22	31	30	31	30	31	137

Scenario	Guelph Dam Base Municipal Taking (L/s)	Guelph Dam ASR Taking (L/s)	Guelph Dam ASR Step 1 Taking (L/s)	Eramosa Taking Assumption	Reliability Based On Time Of Municipal Taking Being Available: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	97%	96%	99%
Scenario 2	150	500	n/a	Existing	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	98%	97%	99%
Scenario 3	200	500	n/a	Existing	97%	99%	100%	100%	99%	99%	99%	98%	98%	98%	95%	96%	98%
Scenario 4	250	500	n/a	Existing	97%	98%	99%	99%	98%	98%	99%	97%	96%	96%	95%	95%	97%
Scenario 5	300	500	n/a	Existing	97%	96%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Scenario 6	150	1000	n/a	Abandon	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	98%	97%	99%
Scenario 7	150	500	n/a	Abandon	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	98%	97%	99%
Scenario 8	200	500	n/a	Abandon	97%	99%	100%	100%	99%	99%	99%	98%	99%	99%	96%	96%	98%
Scenario 9	250	500	n/a	Abandon	97%	98%	100%	100%	98%	98%	99%	97%	97%	97%	95%	95%	98%
Scenario 10	300	500	n/a	Abandon	97%	97%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Scenario 11	150	1000	n/a	Maximized	97%	99%	100%	100%	99%	100%	99%	98%	99%	98%	96%	96%	98%
Scenario 12	150	500	n/a	Maximized	97%	99%	100%	100%	99%	100%	100%	98%	99%	98%	96%	96%	98%
Scenario 13	200	500	n/a	Maximized	97%	98%	100%	100%	99%	99%	99%	97%	97%	96%	95%	95%	98%
Scenario 14	250	500	n/a	Maximized	97%	97%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Scenario 15	300	500	n/a	Maximized	97%	96%	99%	99%	98%	98%	98%	94%	91%	94%	94%	95%	96%
Scenario 16	150	500	300	Maximized	97%	99%	100%	100%	99%	99%	100%	98%	99%	97%	96%	96%	98%
Scenario 17	200	500	300	Maximized	97%	98%	100%	100%	98%	99%	99%	97%	96%	96%	95%	95%	97%
Scenario 18	250	500	300	Maximized	97%	97%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Scenario 19	300	500	300	Maximized	97%	96%	99%	99%	98%	98%	98%	94%	91%	94%	94%	95%	96%

Scenario	Guelph Dam Base Municipal Taking (L/s)	Guelph Dam ASR Taking (L/s)	Guelph Dam ASR Step 1 Taking (L/s)	Eramosa Taking Assumption	Reliability Based On Occurance Of Municipal Taking Being Available: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	97%	99%	100%	99%	97%	99%	99%	97%	97%	99%	96%	94%	88%
Scenario 2	150	500	n/a	Existing	97%	100%	100%	99%	99%	99%	99%	97%	99%	99%	96%	94%	88%
Scenario 3	200	500	n/a	Existing	97%	97%	99%	97%	97%	99%	97%	97%	94%	96%	94%	94%	87%
Scenario 4	250	500	n/a	Existing	97%	97%	97%	97%	96%	97%	97%	94%	91%	94%	94%	94%	84%
Scenario 5	300	500	n/a	Existing	96%	96%	97%	97%	96%	97%	96%	91%	90%	93%	94%	94%	83%
Scenario 6	150	1000	n/a	Abandon	97%	99%	100%	99%	97%	99%	99%	97%	99%	99%	97%	94%	88%
Scenario 7	150	500	n/a	Abandon	97%	100%	100%	99%	99%	99%	99%	97%	99%	100%	97%	94%	88%
Scenario 8	200	500	n/a	Abandon	97%	97%	99%	97%	97%	99%	97%	97%	94%	97%	94%	94%	87%
Scenario 9	250	500	n/a	Abandon	97%	97%	97%	97%	96%	97%	97%	96%	93%	94%	94%	94%	84%
Scenario 10	300	500	n/a	Abandon	96%	96%	97%	97%	96%	97%	96%	93%	90%	93%	94%	94%	83%
Scenario 11	150	1000	n/a	Maximized	97%	99%	99%	97%	97%	99%	97%	96%	96%	97%	94%	94%	88%
Scenario 12	150	500	n/a	Maximized	97%	99%	99%	99%	99%	99%	97%	97%	96%	97%	96%	94%	88%
Scenario 13	200	500	n/a	Maximized	97%	97%	99%	97%	97%	99%	97%	96%	93%	94%	94%	94%	86%
Scenario 14	250	500	n/a	Maximized	96%	97%	97%	97%	96%	97%	97%	93%	88%	93%	94%	94%	83%
Scenario 15	300	500	n/a	Maximized	96%	96%	97%	97%	96%	97%	94%	90%	87%	90%	94%	94%	81%
Scenario 16	150	500	300	Maximized	97%	99%	99%	97%	97%	99%	97%	96%	96%	96%	94%	94%	88%
Scenario 17	200	500	300	Maximized	97%	97%	99%	97%	96%	99%	97%	96%	91%	94%	94%	94%	84%
Scenario 18	250	500	300	Maximized	96%	97%	97%	97%	96%	97%	96%	91%	88%	93%	94%	94%	83%
Scenario 19	300	500	300	Maximized	96%	96%	97%	97%	96%	97%	94%	90%	87%	90%	94%	94%	81%

less than 95% reliability

Table 3 Reliability of some ASR taking in addition to base taking for various scenarios 1951 to 2019 simulation

Scenario	Guelph Dam			Eramosa	Average Number of Days Base Taking Is Exceeded												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	19	16	20	27	20	7	3	2	5	10	12	19	160
Scenario 2	150	500	n/a	Existing	22	19	22	28	24	10	4	3	6	11	14	22	186
Scenario 3	200	500	n/a	Existing	22	19	22	28	24	10	4	3	6	11	13	20	181
Scenario 4	250	500	n/a	Existing	21	19	22	27	24	10	4	2	5	10	12	19	176
Scenario 5	300	500	n/a	Existing	20	19	21	27	24	10	4	2	5	9	12	18	172
Scenario 6	150	1000	n/a	Abandon	19	16	20	27	20	7	3	2	5	10	13	19	161
Scenario 7	150	500	n/a	Abandon	22	19	22	28	24	10	4	3	6	11	14	22	187
Scenario 8	200	500	n/a	Abandon	22	19	22	28	24	10	4	3	6	11	13	21	182
Scenario 9	250	500	n/a	Abandon	21	19	22	27	24	10	4	2	5	10	12	20	177
Scenario 10	300	500	n/a	Abandon	20	19	22	27	24	10	4	2	5	9	12	19	172
Scenario 11	150	1000	n/a	Maximized	19	16	20	27	20	7	3	2	5	10	12	19	160
Scenario 12	150	500	n/a	Maximized	22	19	22	28	24	10	4	3	6	11	14	21	185
Scenario 13	200	500	n/a	Maximized	22	19	22	28	24	10	4	3	6	10	13	20	180
Scenario 14	250	500	n/a	Maximized	21	19	22	27	24	10	4	2	5	10	12	19	176
Scenario 15	300	500	n/a	Maximized	20	19	21	27	24	10	4	2	5	9	12	18	171
Scenario 16	150	500	300	Maximized	28	26	29	29	28	24	4	3	18	22	24	27	260
Scenario 17	200	500	300	Maximized	28	25	29	29	28	24	4	3	17	20	23	27	255
Scenario 18	250	500	300	Maximized	27	25	29	29	28	24	4	2	16	18	22	26	250
Scenario 19	300	500	300	Maximized	20	19	21	27	24	10	4	2	5	9	12	18	171

Scenario	Guelph Dam			Eramosa	Minimum Number of Days Base Taking Is Exceeded												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	2
Scenario 2	150	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	5
Scenario 3	200	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 4	250	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 5	300	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 6	150	1000	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	2
Scenario 7	150	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	5
Scenario 8	200	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 9	250	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 10	300	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 11	150	1000	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 12	150	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	1
Scenario 13	200	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 14	250	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 15	300	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 16	150	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	86
Scenario 17	200	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	73
Scenario 18	250	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	65
Scenario 19	300	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	Guelph Dam			Eramosa	Reliability Based On Time Of Municipal Base Taking Being Exceeded												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Scenario 2	150	500	n/a	Existing	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Scenario 3	200	500	n/a	Existing	70%	68%	72%	92%	78%	34%	12%	8%	18%	34%	44%	66%	50%
Scenario 4	250	500	n/a	Existing	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	41%	63%	48%
Scenario 5	300	500	n/a	Existing	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Scenario 6	150	1000	n/a	Abandon	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Scenario 7	150	500	n/a	Abandon	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Scenario 8	200	500	n/a	Abandon	70%	68%	72%	92%	78%	34%	12%	8%	19%	35%	44%	66%	50%
Scenario 9	250	500	n/a	Abandon	69%	67%	70%	91%	78%	33%	12%	8%	18%	32%	41%	63%	48%
Scenario 10	300	500	n/a	Abandon	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Scenario 11	150	1000	n/a	Maximized	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	41%	60%	44%
Scenario 12	150	500	n/a	Maximized	72%	69%	72%	92%	79%	34%	13%	9%	20%	36%	46%	69%	51%
Scenario 13	200	500	n/a	Maximized	70%	68%	71%	92%	78%	34%	12%	8%	18%	33%	43%	65%	49%
Scenario 14	250	500	n/a	Maximized	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	40%	62%	48%
Scenario 15	300	500	n/a	Maximized	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%
Scenario 16	150	500	300	Maximized	89%	91%	94%	97%	91%	80%	12%	9%	60%	69%	79%	86%	71%
Scenario 17	200	500	300	Maximized	89%	90%	93%	97%	91%	79%	12%	8%	56%	64%	76%	86%	70%
Scenario 18	250	500	300	Maximized	88%	90%	92%	97%	90%	79%	12%	8%	52%	59%	73%	84%	69%
Scenario 19	300	500	300	Maximized	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%

Scenario	Guelph Dam			Eramosa	Reliability Based On Occurance Of Municipal Base Taking Being Exceeded												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	83%	80%	93%	97%	94%	61%	28%	16%	26%	43%	62%	77%	100%
Scenario 2	150	500	n/a	Existing	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	64%	77%	100%
Scenario 3	200	500	n/a	Existing	83%	81%	94%	97%	94%	71%	32%	16%	25%	42%	62%	75%	99%
Scenario 4	250	500	n/a	Existing	80%	80%	94%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%
Scenario 5	300	500	n/a	Existing	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	71%	99%
Scenario 6	150	1000	n/a	Abandon	83%	80%	93%	97%	94%	61%	28%	16%	28%	43%	62%	78%	100%
Scenario 7	150	500	n/a	Abandon	84%	81%	94%	97%	96%	72%	33%	17%	28%	46%	64%	78%	100%
Scenario 8	200	500	n/a	Abandon	83%	81%	94%	97%	94%	71%	32%	16%	26%	42%	62%	75%	99%
Scenario 9	250	500	n/a	Abandon	81%	80%	94%	97%	94%	70%	30%	16%	23%	39%	52%	74%	99%
Scenario 10	300	500	n/a	Abandon	77%	78%	93%	97%	94%	68%	29%	13%	23%	39%	48%	71%	99%
Scenario 11	150	1000	n/a	Maximized	83%	80%	93%	97%	93%	61%	28%	16%	28%	43%	62%	77%	99%
Scenario 12	150	500	n/a	Maximized	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	62%	77%	100%
Scenario 13	200	500	n/a	Maximized	83%	81%	94%	97%	94%	71%	32%	16%	25%	41%	57%	75%	99%
Scenario 14	250	500	n/a	Maximized	80%	80%	93%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%
Scenario 15	300	500	n/a	Maximized	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%
Scenario 16	150	500	300	Maximized	91%	93%	94%	99%	97%	90%	30%	17%	65%	77%	90%	88%	100%
Scenario 17	200	500	300	Maximized	91%	93%	99%	99%	97%	90%	29%	16%	62%	72%	87%	88%	100%
Scenario 18	250	500	300	Maximized	90%	93%	99%	99%	97%	88%	29%	14%	58%	65%	86%	88%	100%
Scenario 19	300	500	300	Maximized	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%

less than 95% reliability

Table 4 Reliability of full ASR and base taking for various scenarios 1951 to 2019 simulation

Scenario	Guelph Dam			Eramosa	Average Number of Days ASR Taking Is Available												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	19	16	20	27	20	7	3	2	5	10	12	19	160
Scenario 2	150	500	n/a	Existing	22	19	22	28	24	10	4	3	6	11	14	22	186
Scenario 3	200	500	n/a	Existing	22	19	22	28	24	10	4	3	6	11	13	20	181
Scenario 4	250	500	n/a	Existing	21	19	22	27	24	10	4	2	5	10	12	19	176
Scenario 5	300	500	n/a	Existing	20	19	21	27	24	10	4	2	5	9	12	18	172
Scenario 6	150	1000	n/a	Abandon	19	16	20	27	20	7	3	2	5	10	13	19	161
Scenario 7	150	500	n/a	Abandon	22	19	22	28	24	10	4	3	6	11	14	22	187
Scenario 8	200	500	n/a	Abandon	22	19	22	28	24	10	4	3	6	11	13	21	182
Scenario 9	250	500	n/a	Abandon	21	19	22	27	24	10	4	2	5	10	12	20	177
Scenario 10	300	500	n/a	Abandon	20	19	22	27	24	10	4	2	5	9	12	19	172
Scenario 11	150	1000	n/a	Maximized	19	16	20	27	20	7	3	2	5	10	12	19	160
Scenario 12	150	500	n/a	Maximized	22	19	22	28	24	10	4	3	6	11	14	21	185
Scenario 13	200	500	n/a	Maximized	22	19	22	28	24	10	4	3	6	10	13	20	180
Scenario 14	250	500	n/a	Maximized	21	19	22	27	24	10	4	2	5	10	12	19	176
Scenario 15	300	500	n/a	Maximized	20	19	21	27	24	10	4	2	5	9	12	18	171
Scenario 16	150	500	300	Maximized	21	19	22	27	24	10	4	3	6	10	12	20	177
Scenario 17	200	500	300	Maximized	21	19	22	27	24	10	4	3	5	10	12	19	175
Scenario 18	250	500	300	Maximized	21	19	22	27	24	10	4	2	5	9	12	19	173
Scenario 19	300	500	300	Maximized	20	19	21	27	24	10	4	2	5	9	12	18	171

Scenario	Guelph Dam			Eramosa	Minimum Number of Days ASR Taking Is Available												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	2
Scenario 2	150	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	5
Scenario 3	200	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 4	250	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 5	300	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 6	150	1000	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	2
Scenario 7	150	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	5
Scenario 8	200	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 9	250	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 10	300	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 11	150	1000	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 12	150	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	1
Scenario 13	200	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 14	250	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 15	300	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 16	150	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 17	200	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 18	250	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 19	300	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	Guelph Dam			Eramosa	Reliability Based On Time Of Municipal ASR Taking Being Available												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Scenario 2	150	500	n/a	Existing	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Scenario 3	200	500	n/a	Existing	70%	68%	72%	92%	78%	34%	12%	8%	18%	34%	44%	66%	50%
Scenario 4	250	500	n/a	Existing	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	41%	63%	48%
Scenario 5	300	500	n/a	Existing	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Scenario 6	150	1000	n/a	Abandon	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Scenario 7	150	500	n/a	Abandon	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Scenario 8	200	500	n/a	Abandon	70%	68%	72%	92%	78%	34%	12%	8%	19%	35%	44%	66%	50%
Scenario 9	250	500	n/a	Abandon	69%	67%	70%	91%	78%	33%	12%	8%	18%	32%	41%	63%	48%
Scenario 10	300	500	n/a	Abandon	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Scenario 11	150	1000	n/a	Maximized	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	41%	60%	44%
Scenario 12	150	500	n/a	Maximized	72%	69%	72%	92%	79%	34%	13%	9%	20%	36%	46%	69%	51%
Scenario 13	200	500	n/a	Maximized	70%	68%	71%	92%	78%	34%	12%	8%	18%	33%	43%	65%	49%
Scenario 14	250	500	n/a	Maximized	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	40%	62%	48%
Scenario 15	300	500	n/a	Maximized	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%
Scenario 16	150	500	300	Maximized	69%	67%	70%	91%	78%	33%	12%	9%	18%	32%	41%	63%	49%
Scenario 17	200	500	300	Maximized	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	40%	62%	48%
Scenario 18	250	500	300	Maximized	66%	66%	69%	91%	78%	32%	12%	8%	17%	30%	39%	60%	47%
Scenario 19	300	500	300	Maximized	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%

Scenario	Guelph Dam			Eramosa	Reliability Based On Occurance Of Municipal ASR Taking Being Available												
	Base Municipal Taking (L/s)	ASR Taking (L/s)	ASR Step 1 Taking (L/s)	Taking Assumption	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	83%	80%	93%	97%	94%	61%	28%	16%	26%	43%	62%	77%	100%
Scenario 2	150	500	n/a	Existing	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	64%	77%	100%
Scenario 3	200	500	n/a	Existing	83%	81%	94%	97%	94%	71%	32%	16%	25%	42%	62%	75%	99%
Scenario 4	250	500	n/a	Existing	80%	80%	94%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%
Scenario 5	300	500	n/a	Existing	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	71%	99%
Scenario 6	150	1000	n/a	Abandon	83%	80%	93%	97%	94%	61%	28%	16%	28%	43%	62%	78%	100%
Scenario 7	150	500	n/a	Abandon	84%	81%	94%	97%	96%	72%	33%	17%	28%	46%	64%	78%	100%
Scenario 8	200	500	n/a	Abandon	83%	81%	94%	97%	94%	71%	32%	16%	26%	42%	62%	75%	99%
Scenario 9	250	500	n/a	Abandon	81%	80%	94%	97%	94%	70%	30%	16%	23%	39%	52%	74%	99%
Scenario 10	300	500	n/a	Abandon	77%	78%	93%	97%	94%	68%	29%	13%	23%	39%	48%	71%	99%
Scenario 11	150	1000	n/a	Maximized	83%	80%	93%	97%	93%	61%	28%	16%	28%	43%	62%	77%	99%
Scenario 12	150	500	n/a	Maximized	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	62%	77%	100%
Scenario 13	200	500	n/a	Maximized	83%	81%	94%	97%	94%	71%	32%	16%	25%	41%	57%	75%	99%
Scenario 14	250	500	n/a	Maximized	80%	80%	93%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%
Scenario 15	300	500	n/a	Maximized	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%
Scenario 16	150	500	300	Maximized	80%	81%	94%	97%	94%	70%	30%	17%	25%	39%	54%	74%	99%
Scenario 17	200	500	300	Maximized	80%	80%	94%	97%	94%	70%	29%	16%	23%	39%	51%	74%	99%
Scenario 18	250	500	300	Maximized	78%	78%	93%	97%	94%	68%	29%	14%	23%	39%	48%	71%	99%
Scenario 19	300	500	300	Maximized	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%

less than 95% reliability

Table 5 Reliability of a Step ASR Taking from Guelph Dam 1951 to 2019

Scenario 16 Recommnded Stepped Taking Scenario													
Description	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
500 L/s per second taking													
Total Number of Occurrances (days)	1,467	1,308	1,505	1,891	1,666	674	264	182	381	692	854	1,358	12,242
Total Days Period of Record	2,139	1,949	2,139	2,070	2,139	2,070	2,139	2,139	2,070	2,139	2,070	2,139	25,202
Reliability Based on Time	69%	67%	70%	91%	78%	33%	12%	9%	18%	32%	41%	63%	49%
Reliability Based on Occurrance	80%	80%	94%	97%	94%	70%	30%	17%	25%	39%	54%	74%	99%
300 L/s per second or greater taking													
Total Number of Occurrances (days)	1,910	1,773	2,003	2,011	1,954	1,651	264	182	1,234	1,485	1,640	1,843	17,950
Total Days Period of Record	2,139	1,949	2,139	2,070	2,139	2,070	2,139	2,139	2,070	2,139	2,070	2,139	25,202
Reliability Based on Time	89%	91%	94%	97%	91%	80%	12%	9%	60%	69%	79%	86%	71%
Reliability Based on Occurrance	91%	93%	99%	99%	97%	90%	30%	17%	65%	77%	90%	88%	100%
150 L/s per second or greater taking													
Total Number of Occurrances (days)	2,084	1,920	2,134	2,062	2,107	2,051	2,129	2,094	2,040	2,080	1,986	2,057	24,744
Total Days Period of Record	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	2,139	25,668
Reliability Based on Time	97%	90%	100%	96%	99%	96%	100%	98%	95%	97%	93%	96%	96%
Reliability Based on Occurrance	99%	99%	100%	100%	99%	100%	100%	100%	100%	99%	100%	99%	100%

Table 6 Reliability of 500 L/s ASR Taking from Guelph Dam 1951 to 2019

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		24	20			162
1954		6	31	30	20					16	30	22	155
1955	25		24	30	17						5	31	132
1956	22		20	28	31	13	22	8	30	26	9	31	240
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959			3	30	31	3						26	93
1960	31	29	5	28	31	28							152
1961		2	16	30	22	16							86
1962				28	10								38
1963			4	30	31	1							66
1964													
1965	21	28	26	23	27						27	31	183
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				15	30	31	130
1971	31	28	31	30	17	7	1	3	30	22		15	215
1972	31	29	1	18	28	20	18			9	30	31	215
1973	31	28	31	30	31	15						5	171
1974	31	28	31	30	31	20							171
1975			15	30	25							25	95
1976	18	29	31	30	31	10	18	4	15	31	30	26	273
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			26	30	31	3						16	106
1980	31	11	12	30	31	11				24	30	31	211
1981	16	20	24	30	18				1	31	30	28	198
1982	17		7	29	12	30	5		4	29	30	31	194
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	27	11						16	152
1985	31	10	31	30	14	1		2	30	31	30	31	241
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						1	31	156
1988	31	29	29	30	23						12	31	185
1989	31	22	13	30	31	27	2				3	13	172
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	25	5							150
1992	18	20	31	24	24	7	12	30	30	31	30	31	288
1993	31	28	7	30	17	22	3			30	30	31	229
1994	2	6	15	30	31	9							93
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		20	31	30	31	297
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												24	24
2000	29	4	31	30	28	25	21	25	14	23	2	22	254
2001		27	31	30	9	12						31	140
2002	31	28	31	30	31	6							157
2003			4	30	31	22					26	31	144
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	9	30	28								116
2008	22	29	31	30	28		6	26	30	31	30	31	294
2009	31	28	31	30	30	10				24	30	31	245
2010	20	6	19	24	17	13	6			10	24	26	165
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							10	116
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				11	31	195
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				5	7	179
2018	19	28	19	22	29							21	138
2019	31	28	22	30	31	17					7	25	191
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**3**	**6**	**10**	**12**	**20**	**177**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1467	1308	1505	1891	1666	674	264	182	381	692	854	1358	12242
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	69%	67%	70%	91%	78%	33%	12%	9%	18%	32%	41%	63%	49%
Reliability Based on Occurrance	80%	80%	94%	97%	94%	70%	30%	17%	25%	39%	54%	74%	99%

Table 7 Reliability of 300 L/s ASR Taking from Guelph Dam 1951 to 2019

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	30			30	31	30	31	303
1952	31	29	31	30	31	30			29	31	19	31	292
1953	31	28	31	30	31	30	15		30	31	30	28	315
1954		21	31	30	31	1				17	30	31	192
1955	31	28	31	30	27	15					20	31	213
1956	31	29	31	30	31	30	22	8	30	31	30	31	334
1957	31	28	31	30	31	30	10		30	31	30	31	313
1958	31	28	31	30									120
1959			12	30	31	20				6	30	31	160
1960	31	29	31	30	31	30			30	21	6		239
1961		5	31	30	31	30			30	31	30	31	249
1962	31		3	30	22						19	31	136
1963	31	28	12	30	31	23							155
1964					23	11			30	31	19	7	121
1965	31	28	31	30	31	20			7	31	30	31	270
1966	31	28	31	30	31	30				13	20	31	245
1967	31	28	31	30	31	30	28	3	30	31	30	31	334
1968	31	29	31	30	31	30		8	30	31	30	31	312
1969	31	28	31	30	31	30			30	31	30	31	303
1970	31	28	23	30	31	30			30	31	30	31	295
1971	31	28	31	30	31	30	1	3	30	31	30	31	307
1972	31	29	31	30	31	30	18		30	31	30	31	322
1973	31	28	31	30	31	30			24	27	30	31	293
1974	31	28	31	30	31	30			30	25	10	16	262
1975	19	23	31	30	31	30			30	31	30	31	286
1976	31	29	31	30	31	30	18	4	30	31	30	31	326
1977	31	28	31	30	15				15	31	30	31	242
1978	31	28	31	30	31	18				27	15	31	242
1979	31	28	31	30	31	27					7	31	216
1980	31	29	31	30	31	30			30	31	30	31	304
1981	31	28	31	30	31	3			27	31	30	31	273
1982	31	28	31	30	26	30	5		30	31	30	31	303
1983	31	28	31	30	31	30			22	31	30	31	295
1984	31	29	31	30	31	30			18	31	29	31	291
1985	31	28	31	30	29	28		2	30	31	30	31	301
1986	31	28	31	30	31	30	15	14	30	31	30	31	332
1987	31	28	31	30	7					25	30	31	213
1988	31	29	31	30	31	8				6	30	31	227
1989	31	28	31	30	31	30	2				16	31	230
1990	31	28	31	30	31	30			30	31	30	31	303
1991	31	28	31	30	31	21					4	31	207
1992	31	29	31	30	31	30	12	30	30	31	30	31	346
1993	31	28	31	30	31	30	3		30	31	30	31	306
1994	31	28	31	30	31	30							181
1995	18	28	31	30	31	30			30	31	30	31	290
1996	31	29	31	30	31	30	4		30	31	30	31	308
1997	31	28	31	30	31	30					29	31	241
1998	31	28	31	30	10								130
1999			21	10							24	31	86
2000	31	29	31	30	31	30	21	25	30	31	30	31	350
2001	31	28	31	30	22	30				11	30	31	244
2002	31	28	31	30	31	30							181
2003			10	30	31	30			10	31	30	31	203
2004	31	29	31	30	31	30			30	31	30	31	304
2005	31	28	31	30	31	30			2	20	17	31	251
2006	31	28	31	30	31	28			30	31	30	31	301
2007	31	28	31	30	31	15							166
2008	23	29	31	30	31	30	6	26	30	31	30	31	328
2009	31	28	31	30	31	30			30	31	30	31	303
2010	31	28	31	29	27	30	6		30	31	30	31	304
2011	31	28	31	30	31	30	6		30	31	30	31	309
2012	31	29	31	22	18						28	31	190
2013	31	28	31	30	31	30	21	28	30	31	30	31	352
2014	31	28	31	30	31	30	22	31	30	31	30	31	356
2015	31	28	31	30	23	30	21		30	31	30	31	316
2016	31	29	31	30	31	19							171
2017	21	28	31	30	31	30	8		30	31	30	31	301
2018	31	28	31	30	31	14					8	31	204
2019	31	28	31	30	31	30				16	30	25	252
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**356**
Average	**28**	**26**	**29**	**29**	**28**	**24**	**4**	**3**	**18**	**22**	**24**	**27**	**260**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**86**
Total Number of Occurrances (days)	1910	1773	2003	2011	1954	1651	264	182	1234	1485	1640	1843	17950
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	89%	91%	94%	97%	91%	80%	12%	9%	60%	69%	79%	86%	71%
Reliability Based on Occurrance	91%	93%	99%	99%	97%	90%	30%	17%	65%	77%	90%	88%	100%

Table 8 Reliability of 150 L/s ASR Taking from Guelph Dam 1951 to 2019

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	30	31	31	30	31	30	31	365
1952	31	29	31	30	31	30	31	31	30	31	30	31	366
1953	31	28	31	30	31	30	31	31	30	31	30	31	365
1954	31	28	31	30	31	30	31	31	30	31	30	31	365
1955	31	28	31	30	31	30	31	31	30	31	30	31	365
1956	31	29	31	30	31	30	31	31	30	31	30	31	366
1957	31	28	31	30	31	30	31	31	30	31	30	31	365
1958	31	28	31	30	31	30	29	6	30	31	30	31	338
1959	31	28	31	30	31	30	31	31	30	31	30	31	365
1960	31	29	31	30	31	30	31	31	30	31	30	31	366
1961	31	28	31	30	31	30	31	31	30	31	30	31	365
1962	31	28	31	30	31	30	31	31	30	31	30	31	365
1963	31	28	31	30	31	30	31	31	30	29	1		303
1964			26	27	31	30	31	31	30	31	30	31	298
1965	31	28	31	30	31	30	31	31	30	31	30	31	365
1966	31	28	31	30	31	30	31	31	30	31	30	31	365
1967	31	28	31	30	31	30	31	31	30	31	30	31	365
1968	31	29	31	30	31	30	31	31	30	31	30	31	366
1969	31	28	31	30	31	30	31	31	30	31	30	31	365
1970	31	28	31	30	31	30	31	31	30	31	30	31	365
1971	31	28	31	30	31	30	31	31	30	31	30	31	365
1972	31	29	31	30	31	30	31	31	30	31	30	31	366
1973	31	28	31	30	31	30	31	31	30	31	30	31	365
1974	31	28	31	30	31	30	31	31	30	31	30	31	365
1975	31	28	31	30	31	30	31	31	30	31	30	31	365
1976	31	29	31	30	31	30	31	31	30	31	30	31	366
1977	31	28	31	30	31	30	31	31	30	31	30	31	365
1978	31	28	31	30	31	30	31	31	30	31	30	31	365
1979	31	28	31	30	31	30	31	31	30	31	30	31	365
1980	31	29	31	30	31	30	31	31	30	31	30	31	366
1981	31	28	31	30	31	30	31	31	30	31	30	31	365
1982	31	28	31	30	31	30	31	31	30	31	30	31	365
1983	31	28	31	30	31	30	31	31	30	31	30	31	365
1984	31	29	31	30	31	30	31	31	30	31	30	31	366
1985	31	28	31	30	31	30	31	31	30	31	30	31	365
1986	31	28	31	30	31	30	31	31	30	31	30	31	365
1987	31	28	31	30	31	30	31	31	30	31	30	31	365
1988	31	29	31	30	31	30	31	31	30	31	30	31	366
1989	31	28	31	30	31	30	31	31	30	31	30	31	365
1990	31	28	31	30	31	30	31	31	30	31	30	31	365
1991	31	28	31	30	31	30	31	31	30	31	30	31	365
1992	31	29	31	30	31	30	31	31	30	31	30	31	366
1993	31	28	31	30	31	30	31	31	30	31	30	31	365
1994	31	28	31	30	31	30	31	31	30	31	30	31	365
1995	31	28	31	30	31	30	31	31	30	31	30	31	365
1996	31	29	31	30	31	30	31	31	30	31	30	31	366
1997	31	28	31	30	31	30	31	31	30	31	30	31	365
1998	31	28	31	30	31	30	31	31	30	31	28	6	338
1999	7	28	31	25		11	31	31	30	31	30	31	286
2000	31	29	31	30	31	30	31	31	30	31	30	31	366
2001	31	28	31	30	31	30	31	31	30	31	30	31	365
2002	31	28	31	30	31	30	31	31	30	31	30	31	365
2003	31	28	31	30	31	30	31	31	30	31	30	31	365
2004	31	29	31	30	31	30	31	31	30	31	30	31	366
2005	31	28	31	30	31	30	31	31	30	31	30	31	365
2006	31	28	31	30	31	30	31	31	30	31	30	31	365
2007	31	28	31	30	31	30	31	31	14	5	2	25	289
2008	31	29	31	30	31	30	31	31	30	31	30	31	366
2009	31	28	31	30	31	30	31	31	30	31	30	31	365
2010	31	28	31	30	31	30	31	31	30	31	30	31	365
2011	31	28	31	30	31	30	31	31	30	31	30	31	365
2012	31	29	31	30	30	30	23	18	23	31	30	31	337
2013	31	28	31	30	31	30	31	31	30	31	30	31	365
2014	31	28	31	30	31	30	31	31	30	31	30	31	365
2015	31	28	31	30	31	30	31	31	30	31	30	31	365
2016	31	29	31	30	31	30	31	24	23		5	11	276
2017	31	28	31	30	31	30	31	31	30	31	30	31	365
2018	31	28	31	30	31	30	31	31	30	31	30	31	365
2019	31	28	31	30	31	30	31	31	30	31	30	31	365
Max	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**366**
Average	**34**	**31**	**34**	**33**	**34**	**33**	**34**	**34**	**33**	**34**	**32**	**33**	**399**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	2084	1920	2134	2062	2107	2051	2129	2094	2040	2080	1986	2057	24744
Total Days Period of Record	2139	2139	2139	2139	2139	2139	2139	2139	2139	2139	2139	2139	25668
Reliability Based on Time	97%	90%	100%	96%	99%	96%	100%	98%	95%	97%	93%	96%	96%
Reliability Based on Occurrance	99%	99%	100%	100%	99%	100%	100%	100%	100%	99%	100%	99%	100%

Eramosa River Intake:

Existing PTTW Reliabilities

The existing Permit to Take Water (6126-B64J83) was issued in 2018 and is set to expire in 2028. It allows for a stepped taking over the April to November period as long as the flow at Eramosa flow gauge stays at or above 0.43 m^3/s and the flow at the Edinburgh Rd gauge stays above 0.85m^3/s. The conditions on the most recent PTTW have not changed from past permits for this site. Since Guelph Dam is operated to maintain flows well above 0.85m^3/s at the Edinburgh gauge this permit condition was not included in the analysis. Table 9 gives the permitted flow rates and the required flow rates needed for each of the takings through the year. Currently, the City is limited by infrastructure to a taking of 100 L/s.

Table 9 Eramosa Intake Permit to Take Water Conditions

Time Frame of Permitted Taking	Permitted Daily Rate (m^3/s)	Eramosa River Flow Condition (m^3/s)	Required Eramosa Flow for Given Taking (m^3/s)
April 15 to May 31	0.368	> 0.42	0.788
June 1 to June 30	0.261	> 0.42	0.681
July 1 to July 15	0.211	> 0.42	0.631
July 16 to Aug. 31	0.158	> 0.42	0.578
Sept. 1 to Nov. 31	0.105	> 0.42	0.525

Figure 2 illustrates the flow reliability of the existing permit to take water at the site of the Eramosa Intake. The permitted taking associated with this permit varies throughout the period of April 15th thru Dec 1st as illustrated by the blue line in the lower portion of the chart. Reliability of river flow equaling or exceeding the permitted taking is illustrated by the reliability lines at the top of the chart by day of year for the period 1962 to 2019. This chart illustrates the probability on any given day of the flow exceeding the indicated value and does not take into consideration the seasonal variation in permitted takings.

Figure 2: Flow Reliability – Existing Permit to Take Water

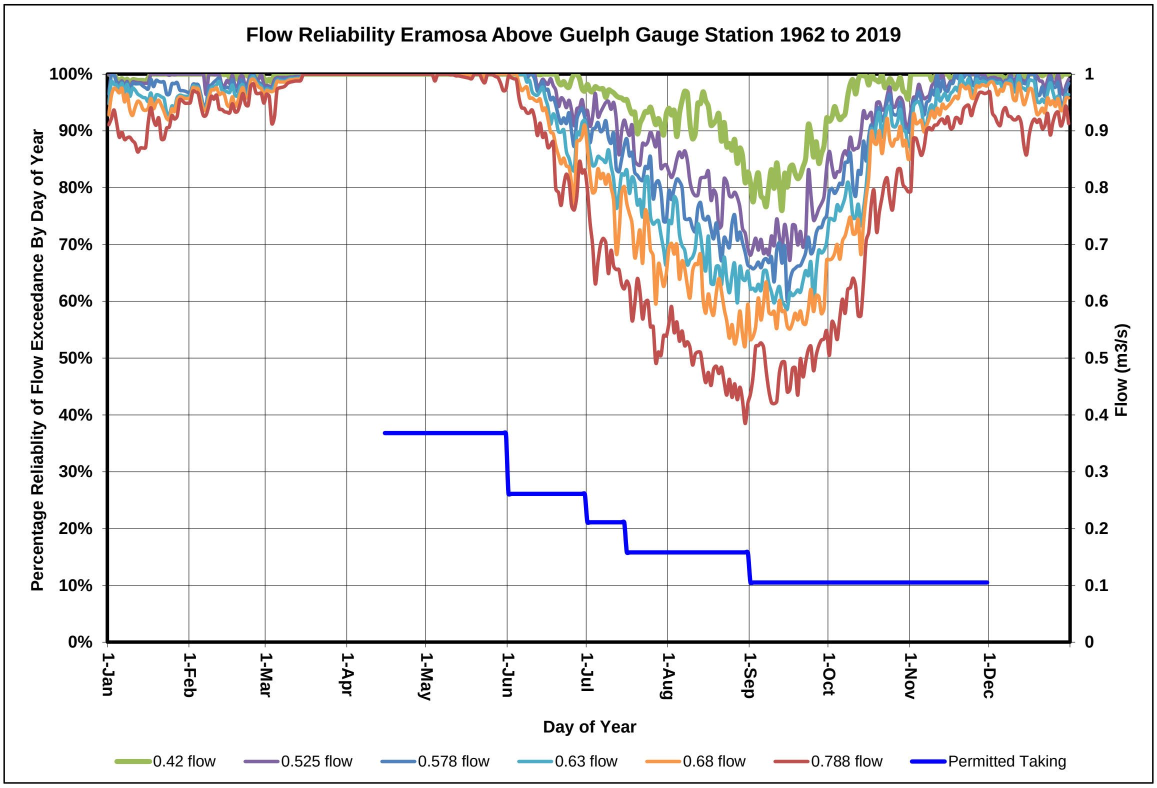


Table 10 summarizes the number of days in a given month and year the river flow exceeds the required flow to support the given taking. A breakdown by year is given in Tables in Appendix D.

Although the results show a high reliability of flow being available to support increasing the existing surface water taking at Arkell to the takings permitted in the current permit to take water, there are a number of years when drought conditions could affect higher taking rates for an extended period. The July to October period can be especially dry. In 2016, 2012, 2007, 1999 and 1998 there were only had a handful of days when flows were high enough for the maximum taking.

Table 10 Summary of Eramosa River at Watson Road Related to Eramosa Intake PTTW 1962 - 2019

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Apr to Nov
Naturalized Flows Exceeding 0.42m^3/s													
Total Number of Occurrences (days)	1786	1630	1795	1740	1798	1734	1714	1675	1534	1755	1735	1785	13685
Total Number of Occurrences (years)	0	0	0	0	0	0	1	0	0	0	0	0	0
Reliability based on Time	99%	100%	100%	100%	100%	100%	95%	93%	88%	98%	100%	99%	97%
Reliability based on Occurrences	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%	100%	100%
Naturalized Flows Exceeding 0.525m^3/s													
Total Number of Occurrences (days)	1780	1625	1783	1740	1798	1697	1643	1505	1323	1655	1715	1769	13076
Total Number of Occurrences (years)	0	0	0	0	0	0	1	0	3	0	0	0	0
Reliability based on Time	99%	99%	99%	100%	100%	98%	91%	84%	76%	92%	99%	98%	92%
Reliability based on Occurrences	100%	100%	100%	100%	100%	100%	98%	100%	95%	100%	100%	100%	100%
Naturalized Flows Exceeding 0.578m^3/s													
Total Number of Occurrences (days)	1755	1610	1781	1740	1797	1679	1584	1411	1254	1595	1696	1752	12756
Total Number of Occurrences (years)	0	0	0	0	0	0	1	0	3	0	0	0	0
Reliability based on Time	98%	98%	99%	100%	100%	96%	88%	78%	72%	89%	97%	97%	90%
Reliability based on Occurrences	100%	100%	100%	100%	100%	100%	98%	100%	95%	100%	100%	100%	100%
Naturalized Flows Exceeding 0.631m^3/s													
Total Number of Occurrences (days)	1723	1581	1780	1740	1796	1661	1514	1324	1184	1532	1664	1737	12415
Total Number of Occurrences (years)	0	0	0	0	0	0	2	2	5	0	0	0	0
Reliability based on Time	96%	97%	99%	100%	100%	95%	84%	74%	68%	85%	96%	97%	88%
Reliability based on Occurrences	100%	100%	100%	100%	100%	100%	96%	96%	91%	100%	100%	100%	100%
Naturalized Flows Exceeding 0.681m^3/s													
Total Number of Occurrences (days)	1698	1570	1780	1740	1794	1635	1433	1218	1105	1481	1637	1713	12043
Total Number of Occurrences (years)	0	0	0	0	0	0	2	2	5	0	0	0	0
Reliability based on Time	94%	96%	99%	100%	100%	94%	80%	68%	64%	82%	94%	95%	85%
Reliability based on Occurrences	100%	100%	100%	100%	100%	100%	96%	96%	91%	100%	100%	100%	100%
Naturalized Flows Exceeding 0.788m^3/s													
Total Number of Occurrences (days)	1622	1547	1769	1740	1781	1564	1226	993	910	1305	1586	1642	11105
Total Number of Occurrences (years)	0	0	0	0	0	0	3	4	7	1	0	0	0
Reliability based on Time	90%	94%	98%	100%	99%	90%	68%	55%	52%	73%	91%	91%	78%
Reliability based on Occurrences	100%	100%	100%	100%	100%	100%	95%	93%	88%	98%	100%	100%	100%

Potential Eramosa ASR

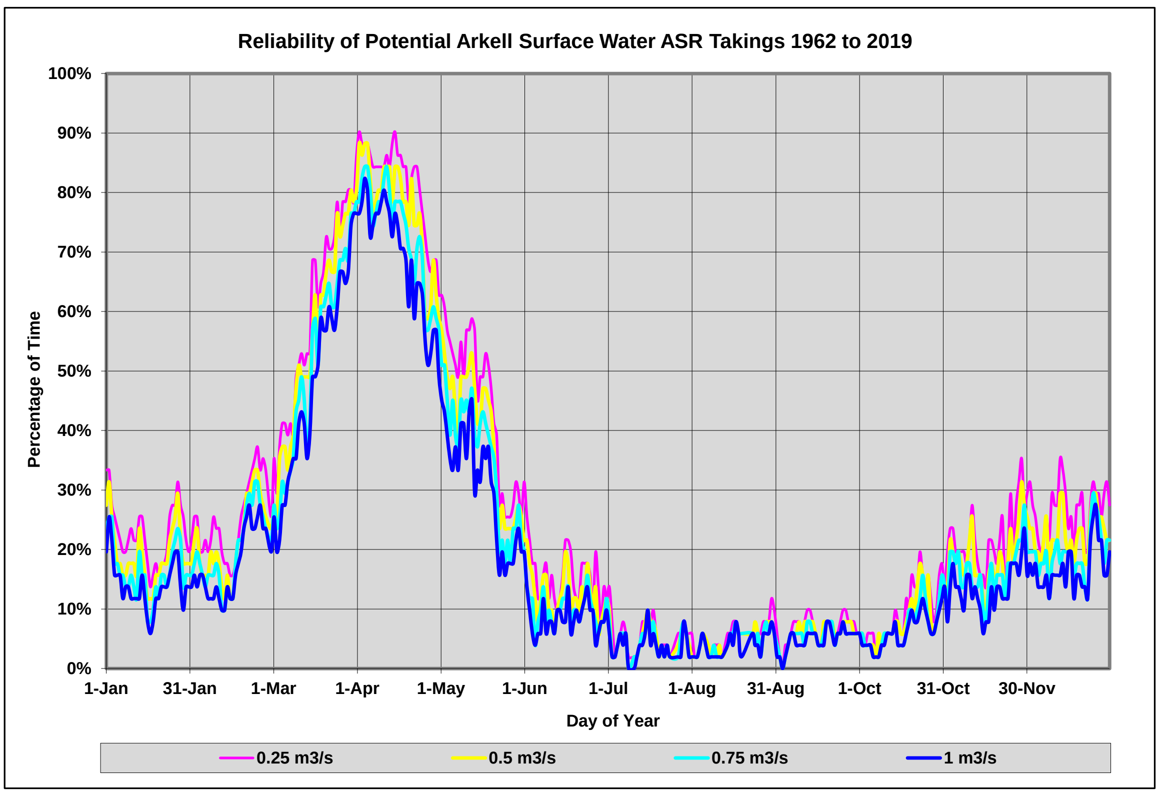
The last analysis looks at the potential for the Eramosa River to handle additional water taking for an ASR. It was assumed that taking for an ASR would be confined to periods when stream flow exceeded the mean annual flow of 2.48 m^3/s, in other words flows greater than 2.5m^3/s. To ensure minimal impact to river flows, takings would be scaled to match increasing flows.

The ASR taking would be further restricted to the following scaled increases:

Between	2.5 and 2.75 m^3/s	no ASR taking
Between	2.75 and 3.0 m^3/s	a taking of 0.25 m^3/s is assumed
Between	3.00 and 3.25 m^3/s	a taking of 0.50 m^3/s is assumed
Between	3.25 and 3.5 m^3/s	a taking of 0.75 m^3/s is assumed
Above	3.5 m^3/s	a taking of 1 m^3/s is assumed

A percentile assessment was used to show the reliability of takings for an ASR over time. The results are given in Figure 3. Other than the spring period, there is limited potential for an increased ASR taking beyond the existing PTTW.

Figure 3 Potential ASR Taking Reliability Statistics



Reference to Previous Technical Memo

February 25, 2014 Memo D. Boyd GRCA to Patty Quackenbush AECOM

October 31st, 2005 Memo D. Boyd GRCA to Patty Quackenbush Earth Tec

Appendix A – Base Municipal Taking Reliability Summaries for Various Scenarios

Scenario #1

Municipal Taking 0.15 m^3/s Eramosa Intake Existing (0.1 m^3/s)

ASR Taking 1.0 m^3/s ASR Step Taking none

Scenario 1 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958								15					15
1959													
1960													
1961													
1962													
1963												29	29
1964	31	1											32
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998											11	31	42
1999	24			4	31	8							67
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									3	5	27	3	38
2008													
2009													
2010													
2011													
2012					1		8	12	7				28
2013													
2014													
2015													
2016											15	12	27
2017													
2018													
2019													
Max	**31**	**1**	**0**	**4**	**31**	**8**	**8**	**15**	**7**	**5**	**27**	**31**	**67**
Total Number of Occurrances (days)	55	1	0	4	32	8	8	27	10	5	53	75	278
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	97%	96%	99%
Reliability Based on Occurrance	97%	99%	100%	99%	97%	99%	99%	97%	97%	99%	96%	94%	88%

Scenario #2

Municipal Taking	0.15 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 2 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958								8					8
1959													
1960													
1961													
1962													
1963												27	27
1964	31												31
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998											9	31	40
1999	24			4	31	7							66
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007										1	27	3	31
2008													
2009													
2010													
2011													
2012							5	8	3				16
2013													
2014													
2015													
2016											10	10	20
2017													
2018													
2019													
Max	**31**	**0**	**0**	**4**	**31**	**7**	**5**	**8**	**3**	**1**	**27**	**31**	**66**
Total Number of Occurrances (days)	55	0	0	4	31	7	5	16	3	1	46	71	239
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	98%	97%	99%
Reliability Based on Occurrance	97%	100%	100%	99%	99%	99%	99%	97%	99%	99%	96%	94%	88%

Scenario #3

Municipal Taking	0.2 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 3 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958							6	21					27
1959													
1960													
1961		4											4
1962													
1963											20	31	51
1964	31	25	2	1	1								60
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998										7	29	31	67
1999	25			5	31	23			12				96
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									13	17	29	9	68
2008													
2009													
2010													
2011													
2012							10	19	8				37
2013													
2014													
2015													
2016									2	18	21	19	60
2017													
2018													
2019													
Max	**31**	**25**	**2**	**5**	**31**	**23**	**10**	**21**	**13**	**18**	**29**	**31**	**96**
Total Number of Occurrances (days)	56	29	2	6	32	23	16	40	35	42	99	90	470
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	99%	100%	100%	99%	99%	99%	98%	98%	98%	95%	96%	98%
Reliability Based on Occurrance	97%	97%	99%	97%	97%	99%	97%	97%	94%	96%	94%	94%	87%

Scenario #4

Municipal Taking 0.25 m^3/s Eramosa Intake Existing (0.1 m^3/s)

ASR Taking 0.5 m^3/s ASR Step Taking none

Scenario 4 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958						4	15	21					40
1959													
1960													
1961		19											19
1962									2				2
1963										5	29	31	65
1964	31	29	4	4	1								69
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998									17	20	30	31	98
1999	25			7	31	28		4	23				118
2000													
2001													
2002													
2003			10										10
2004													
2005													
2006													
2007									25	27	29	13	94
2008													
2009													
2010													
2011													
2012					1		14	29	9				53
2013													
2014													
2015													
2016								6	9	26	24	22	87
2017													
2018													
2019													
Max	**31**	**29**	**10**	**7**	**31**	**28**	**15**	**29**	**25**	**27**	**30**	**31**	**118**
Total Number of Occurrances (days)	56	48	14	11	33	32	29	60	85	78	112	97	655
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	98%	99%	99%	98%	98%	99%	97%	96%	96%	95%	95%	97%
Reliability Based on Occurrance	97%	97%	97%	97%	96%	97%	97%	94%	91%	94%	94%	94%	84%

Scenario #5

Municipal Taking	0.3 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 5 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955									15	3			18
1956													
1957													
1958						13	17	21					51
1959													
1960													
1961	11	22											33
1962									22				22
1963										21	30	31	82
1964	31	29	5	5	3								73
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998							3	6	23	26	30	31	119
1999	25			8	31	29		12	30				135
2000													
2001													
2002													
2003		19	18										37
2004													
2005													
2006													
2007								2	30	31	30	18	111
2008													
2009													
2010													
2011													
2012					2		17	31	16				66
2013													
2014													
2015													
2016								12	15	30	27	23	107
2017													
2018													
2019													
Max	**31**	**29**	**18**	**8**	**31**	**29**	**17**	**31**	**30**	**31**	**30**	**31**	**135**
Total Number of Occurrances (days)	67	70	23	13	36	42	37	84	151	111	117	103	854
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	96%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Reliability Based on Occurrance	96%	96%	97%	97%	96%	97%	96%	91%	90%	93%	94%	94%	83%

Scenario #6

Municipal Taking	0.15 m^3/s	Eramosa Intake	Abandon
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 6 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958								15					15
1959													
1960													
1961													
1962													
1963												29	29
1964	31	1											32
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998												21	21
1999	24			3	31	1							59
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007										1	27	3	31
2008													
2009													
2010													
2011													
2012					1		8	12	7				28
2013													
2014													
2015													
2016											15	12	27
2017													
2018													
2019													
Max	**31**	**1**	**0**	**3**	**31**	**1**	**8**	**15**	**7**	**1**	**27**	**29**	**59**
Total Number of Occurrances (days)	55	1	0	3	32	1	8	27	7	1	42	65	242
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	98%	97%	99%
Reliability Based on Occurrance	97%	99%	100%	99%	97%	99%	99%	97%	99%	99%	97%	94%	88%

Scenario #7

Municipal Taking	0.15 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 7 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958								8					8
1959													
1960													
1961													
1962													
1963												27	27
1964	31												31
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998												17	17
1999	24			3	31	1							59
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007											24	1	25
2008													
2009													
2010													
2011													
2012							5	8	3				16
2013													
2014													
2015													
2016											10	10	20
2017													
2018													
2019													
Max	**31**	**0**	**0**	**3**	**31**	**1**	**5**	**8**	**3**	**0**	**24**	**27**	**59**
Total Number of Occurrances (days)	55	0	0	3	31	1	5	16	3	0	34	55	203
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	100%	100%	100%	99%	100%	100%	99%	100%	100%	98%	97%	99%
Reliability Based on Occurrance	97%	100%	100%	99%	99%	99%	99%	97%	99%	100%	97%	94%	88%

Scenario #8

Municipal Taking	0.2 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 8 Number of Days Base Municipal Taking is not Available

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958							6	21					27
1959													
1960													
1961		4											4
1962													
1963											20	31	51
1964	31	25	2	1	1								60
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998											15	31	46
1999	25			5	31	18			1				80
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									11	13	29	9	62
2008													
2009													
2010													
2011													
2012							10	19	8				37
2013													
2014													
2015													
2016									2	17	21	19	59
2017													
2018													
2019													
Max	**31**	**25**	**2**	**5**	**31**	**18**	**10**	**21**	**11**	**17**	**29**	**31**	**80**
Total Number of Occurrances (days)	56	29	2	6	32	18	16	40	22	30	85	90	426
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	99%	100%	100%	99%	99%	99%	98%	99%	99%	96%	96%	98%
Reliability Based on Occurrance	97%	97%	99%	97%	97%	99%	97%	97%	94%	97%	94%	94%	87%

Scenario #9

Municipal Taking	0.25 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 9 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958						4	15	21					40
1959													
1960													
1961		19											19
1962									2				2
1963										5	29	31	65
1964	31	29	4	4	1								69
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998										9	29	31	69
1999	25			6	31	28			17				107
2000													
2001													
2002													
2003			6										6
2004													
2005													
2006													
2007									23	23	29	14	89
2008													
2009													
2010													
2011													
2012					1		14	29	9				53
2013													
2014													
2015													
2016								6	9	26	24	22	87
2017													
2018													
2019													
Max	**31**	**29**	**6**	**6**	**31**	**28**	**15**	**29**	**23**	**26**	**29**	**31**	**107**
Total Number of Occurrances (days)	56	48	10	10	33	32	29	56	60	63	111	98	606
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	98%	100%	100%	98%	98%	99%	97%	97%	97%	95%	95%	98%
Reliability Based on Occurrance	97%	97%	97%	97%	96%	97%	97%	96%	93%	94%	94%	94%	84%

Scenario #10

Municipal Taking	0.3 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 10 Number of Days Base Municipal Taking is not Available

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955									15	3			18
1956													
1957													
1958						13	17	21					51
1959													
1960													
1961	11	22											33
1962									22				22
1963										21	30	31	82
1964	31	29	5	5	3								73
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998							2	6	14	13	29	31	95
1999	25			8	31	29		6	25				124
2000													
2001													
2002													
2003		17	18										35
2004													
2005													
2006													
2007									30	31	30	16	107
2008													
2009													
2010													
2011													
2012					2		17	31	16				66
2013													
2014													
2015													
2016								12	15	30	27	23	107
2017													
2018													
2019													
Max	**31**	**29**	**18**	**8**	**31**	**29**	**17**	**31**	**30**	**31**	**30**	**31**	**124**
Total Number of Occurrances (days)	67	68	23	13	36	42	36	76	137	98	116	101	813
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	97%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Reliability Based on Occurrance	96%	96%	97%	97%	96%	97%	96%	93%	90%	93%	94%	94%	83%

Scenario #11

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 11 Number of Days Base Municipal Taking is not Available

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958							5	26					31
1959													
1960													
1961													
1962													
1963											25	31	56
1964	31	29	4	1									65
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998											2	25	27
1999	24			3	31	9							67
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									15	23	28	5	71
2008													
2009													
2010													
2011													
2012					1		8	14	7				30
2013													
2014													
2015													
2016								4	6	29	22	20	81
2017													
2018													
2012													
Max	**31**	**29**	**4**	**3**	**31**	**9**	**8**	**26**	**15**	**29**	**28**	**31**	**81**
Total Number of Occurrances (days)	55	29	4	4	32	9	13	44	28	52	77	81	428
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	99%	100%	100%	99%	100%	99%	98%	99%	98%	96%	96%	98%
Reliability Based on Occurrance	97%	99%	99%	97%	97%	99%	97%	96%	96%	97%	94%	94%	88%

Scenario #12

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 12 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958							2	24					26
1959													
1960													
1961													
1962													
1963											25	31	56
1964	31	29	4										64
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998												24	24
1999	24			3	31	9							67
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									12	18	28	4	62
2008													
2009													
2010													
2011													
2012							5	9	6				20
2013													
2014													
2015													
2016									5	26	22	20	73
2017													
2018													
2019													
Max	31	29	4	3	31	9	5	24	12	26	28	31	73
Total Number of Occurrances (days)	55	29	4	3	31	9	7	33	23	44	75	79	392
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	99%	100%	100%	99%	100%	100%	98%	99%	98%	96%	96%	98%
Reliability Based on Occurrance	97%	99%	99%	99%	99%	99%	97%	97%	96%	97%	96%	94%	88%

Scenario #13

Municipal Taking	0.2 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 13 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955									4	5			9
1956													
1957													
1958							12	28					40
1959													
1960													
1961		8											8
1962													
1963										16	30	31	77
1964	31	29	5	4	1								70
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998											20	31	51
1999	25			5	31	23			12				96
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									24	31	29	12	96
2008													
2009													
2010													
2011													
2012							10	21	9				40
2013													
2014													
2015													
2016								8	12	31	30	23	104
2017													
2018													
2019													
Max	**31**	**29**	**5**	**5**	**31**	**23**	**12**	**28**	**24**	**31**	**30**	**31**	**104**
Total Number of Occurrances (days)	56	37	5	9	32	23	22	57	61	83	109	97	591
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	98%	100%	100%	99%	99%	99%	97%	97%	96%	95%	95%	98%
Reliability Based on Occurrance	97%	97%	99%	97%	97%	99%	97%	96%	93%	94%	94%	94%	86%

Scenario #14

Municipal Taking	0.25 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 14 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955									23	6			29
1956													
1957													
1958						8	19	28					55
1959													
1960													
1961	1	21											22
1962									22				22
1963									3	30	30	31	94
1964	31	29	5	5	2								72
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998									6	13	29	31	79
1999	25			7	31	29		4	24				120
2000													
2001													
2002													
2003			10										10
2004													
2005													
2006													
2007								1	30	31	30	23	115
2008													
2009													
2010													
2011													
2012					1		14	31	11				57
2013													
2014													
2015													
2016								15	16	31	30	27	119
2017													
2018													
2019													
Max	31	29	10	7	31	29	19	31	30	31	30	31	120
Total Number of Occurrances (days)	57	50	15	12	34	37	33	79	135	111	119	112	794
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	97%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Reliability Based on Occurrance	96%	97%	97%	97%	96%	97%	97%	93%	88%	93%	94%	94%	83%

Scenario #15

Municipal Taking	0.3 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 15 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955								12	28	6			46
1956													
1957													
1958						15	22	28					65
1959													
1960													
1961	16	22											38
1962									30	6			36
1963									16	31	30	31	108
1964	31	29	6	6	4								76
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998							2	6	17	18	29	31	103
1999	25			8	31	30		12	30	1			137
2000													
2001													
2002													
2003		25	18										43
2004													
2005													
2006													
2007								13	30	31	30	23	127
2008													
2009													
2010													
2011													
2012					2		17	31	18				68
2013													
2014													
2015													
2016							5	16	23	31	30	27	132
2017													
2018									3				3
2019													
Max	**31**	**29**	**18**	**8**	**31**	**30**	**22**	**31**	**30**	**31**	**30**	**31**	**137**
Total Number of Occurrances (days)	72	76	24	14	37	45	46	118	195	124	119	112	982
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	96%	99%	99%	98%	98%	98%	94%	91%	94%	94%	95%	96%
Reliability Based on Occurrance	96%	96%	97%	97%	96%	97%	94%	90%	87%	90%	94%	94%	81%

Scenario #16

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 16 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955													
1956													
1957													
1958							2	25					27
1959													
1960													
1961													
1962													
1963										2	29	31	62
1964	31	29	5	3									68
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998											2	25	27
1999	24			5	31	19							79
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									16	26	28	6	76
2008													
2009													
2010													
2011													
2012					1		8	13	7				29
2013													
2014													
2015													
2016								7	7	31	25	20	90
2017													
2018													
2019													
Max	**31**	**29**	**5**	**5**	**31**	**19**	**8**	**25**	**16**	**31**	**29**	**31**	**90**
Total Number of Occurrances (days)	55	29	5	8	32	19	10	45	30	59	84	82	458
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	99%	100%	100%	99%	99%	100%	98%	99%	97%	96%	96%	98%
Reliability Based on Occurrance	97%	99%	99%	97%	97%	99%	97%	96%	96%	96%	94%	94%	88%

Scenario #17

Municipal Taking	0.2 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 17 Number of Days Base Municipal Taking is not Available													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951													
1952													
1953													
1954													
1955									9	6			15
1956													
1957													
1958							12	28					40
1959													
1960													
1961		14											14
1962									2				2
1963										20	30	31	81
1964	31	29	5	4	1								70
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998											23	31	54
1999	25			5	31	28			13				102
2000													
2001													
2002													
2003													
2004													
2005													
2006													
2007									26	31	30	15	102
2008													
2009													
2010													
2011													
2012					1		12	24	9				46
2013													
2014													
2015													
2016								12	14	31	30	26	113
2017													
2018													
2019													
Max	**31**	**29**	**5**	**5**	**31**	**28**	**12**	**28**	**26**	**31**	**30**	**31**	**113**
Total Number of Occurrances (days)	56	43	5	9	33	28	24	64	73	88	113	103	639
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	97%	96%	96%	95%	95%	97%
Reliability Based on Occurrance	97%	97%	99%	97%	96%	99%	97%	96%	91%	94%	94%	94%	84%

Scenario #18

Municipal Taking	0.25 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 18 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955								1	26	6			33
1956													
1957													
1958						9	18	28					55
1959													
1960													
1961	4	21											25
1962									22				22
1963									5	31	30	31	97
1964	31	29	6	5	2								73
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998									7	13	29	31	80
1999	25			7	31	29		5	24				121
2000													
2001													
2002													
2003			11										11
2004													
2005													
2006													
2007								3	30	31	30	23	117
2008													
2009													
2010													
2011													
2012					1		15	31	13				60
2013													
2014													
2015													
2016							2	15	18	31	30	27	123
2017													
2018													
2019													
Max	**31**	**29**	**11**	**7**	**31**	**29**	**18**	**31**	**30**	**31**	**30**	**31**	**123**
Total Number of Occurrances (days)	60	50	17	12	34	38	35	83	145	112	119	112	817
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	97%	99%	99%	98%	98%	98%	96%	93%	95%	94%	95%	97%
Reliability Based on Occurrance	96%	97%	97%	97%	96%	97%	96%	91%	88%	93%	94%	94%	83%

Scenario #19

Municipal Taking	0.3 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 19 Number of Days Base Municipal Taking is not Available													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951													
1952													
1953													
1954													
1955								12	28	6			46
1956													
1957													
1958						15	22	28					65
1959													
1960													
1961	16	22											38
1962									30	6			36
1963									16	31	30	31	108
1964	31	29	6	6	4								76
1965													
1966													
1967													
1968													
1969													
1970													
1971													
1972													
1973													
1974													
1975													
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													
1988													
1989													
1990													
1991													
1992													
1993													
1994													
1995													
1996													
1997													
1998							2	6	17	18	29	31	103
1999	25			8	31	30		12	30	1			137
2000													
2001													
2002													
2003		25	18										43
2004													
2005													
2006													
2007								13	30	31	30	23	127
2008													
2009													
2010													
2011													
2012					2		17	31	18				68
2013													
2014													
2015													
2016							5	16	23	31	30	27	132
2017													
2018									3				3
2019													
Max	**31**	**29**	**18**	**8**	**31**	**30**	**22**	**31**	**30**	**31**	**30**	**31**	**137**
Total Number of Occurrances (days)	72	76	24	14	37	45	46	118	195	124	119	112	982
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	97%	96%	99%	99%	98%	98%	98%	94%	91%	94%	94%	95%	96%
Reliability Based on Occurrance	96%	96%	97%	97%	96%	97%	94%	90%	87%	90%	94%	94%	81%

Appendix B – Reliability of Available Taking Exceeding Base Municipal Taking

Scenario #1

Municipal Taking	0.15 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 1 Number of Days Allowable Taking Exceeds Base Municipal Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	19	2				9	18	27	195
1952	31	29	25	30	13	3							131
1953	9	8	31	8	28	20	12		13	8			137
1954		7	31	30	15					16	30	7	136
1955	21		27	30	9						12	26	125
1956	3		18	28	31	7	14	8	30	20	9	30	198
1957	15	28	31	30	27	6	8				20	30	195
1958	17		4	25									46
1959			3	30	26						11	26	96
1960	30	26	2	28	31	21							138
1961		3	13	27	18	15							76
1962				30	1							8	39
1963			5	29	22								56
1964					2								2
1965	20	21	19	23	22					8	29	31	173
1966	24	18	31	30	23	8						23	157
1967	7	24	3	30	21	20	21	2	20	30	30	31	239
1968	15	29	19	25	14			8	30	30	22	31	223
1969	22	28	14	30	31						10	4	139
1970				21	23					18	30	31	123
1971	26	19	11	29	13	6	2	3	30	10		17	166
1972	24	12		18	24	16	10			17	30	26	177
1973	31	25	27	30	28	11					3	17	172
1974	20	28	29	28	31	11							147
1975		2	21	27	18	1				3	8	21	101
1976	8	23	31	30	31	7	13		16	31	28	13	231
1977			21	30	4				4	31	30	31	151
1978	31	24	7	30	26								118
1979	6		27	30	25							17	105
1980	31	2	12	30	27	4				23	13	28	170
1981	9	16	18	26	7				6	31	30	19	162
1982	7		8	30	6	30	2		5	22	29	31	170
1983	31	28	31	30	31	13						25	189
1984	15	17	31	30	16	5						21	135
1985	24	5	31	30	7	1		2	30	30	30	31	221
1986	31	22	20	30	20	17	11	12	30	31	29	31	284
1987	31	22	30	29							2	31	145
1988	25	29	23	30	15						14	21	157
1989	31	15	12	30	29	23					3	6	149
1990	14	28	31	30	16					21	30	31	201
1991	31	28	31	30	19	2							141
1992	17	18	25	20	21	6	9	27	30	31	30	31	265
1993	31	23	3	30	13	19	1		2	25	17	24	188
1994		7	14	30	31	6							88
1995	16	13	24	14	30	15				20	30	31	193
1996	19	29	31	30	31	25	2		20	31	30	31	279
1997	31	28	31	30	27								147
1998	25	11	31	26									93
1999												25	25
2000	21	4	31	18	24	20	13	15	12	12	3	12	185
2001	4	28	31	30	5	5					3	31	137
2002	24	28	31	30	28	4							145
2003			4	30	31	20					27	31	143
2004	28	9	29	30	31	14						31	172
2005	31	25	7	30	20						1	29	143
2006	31	28	31	30	23	1				28	30	31	233
2007	31	6	12	30	20								99
2008	22	29	31	30	25		6	26	28	31	27	31	286
2009	31	28	31	30	27	7				25	19	31	229
2010	12		19	20	14	9	5			15	13	18	125
2011	19	10	31	30	31	26					30	31	208
2012	31	29	31	3	6							13	113
2013	27	28	25	30	29	27	16	19	29	31	30	31	322
2014	31	28	29	30	31	4	20	21	29	31	30	31	315
2015	30	7	10	30	7	21	18				21	31	175
2016	31	29	31	30	24								145
2017	18	28	31	30	31	17	7				10	6	178
2018	19	28	16	19	26							24	132
2019	29	24	17	30	31	8					10	29	178
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**322**
Average	**19**	**16**	**20**	**27**	**20**	**7**	**3**	**2**	**5**	**10**	**12**	**19**	**160**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Total Number of Occurrances (days)	1280	1119	1396	1841	1386	503	190	143	364	669	861	1305	11057
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Reliability Based on Occurrance	83%	80%	93%	97%	94%	61%	28%	16%	26%	43%	62%	77%	100%

Scenario #2

Municipal Taking	0.15 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 2 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6	1			15	22	31	226
1952	31	29	30	30	22	6							148
1953	13	13	31	11	31	24	15		26	20			184
1954		7	31	30	20					16	30	23	157
1955	25		31	30	17	1					12	31	147
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				22	31	213
1958	28		4	29									61
1959			3	30	31	3					14	31	112
1960	31	29	5	28	31	28							152
1961		3	20	30	22	16							91
1962				30	10							19	59
1963			5	30	31	1							67
1964					5								5
1965	23	28	26	23	27					8	30	31	196
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					10	20	176
1970				21	31	4				26	30	31	143
1971	31	28	31	30	17	14	3	3	30	23		19	229
1972	31	29	1	18	28	20	18			24	30	31	230
1973	31	28	31	30	31	15					4	30	200
1974	31	28	31	30	31	22	1						174
1975		2	24	30	25	3				8	18	31	141
1976	24	29	31	30	31	13	18	4	18	31	30	26	285
1977			21	30	9				4	31	30	31	156
1978	31	28	14	30	31								134
1979	15		27	30	31	3						21	127
1980	31	13	12	30	31	11				28	30	31	217
1981	18	22	24	30	18				7	31	30	28	208
1982	20		8	30	13	30	5		5	29	30	31	201
1983	31	28	31	30	31	15						26	192
1984	20	20	31	30	28	13						21	163
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						15	31	189
1989	31	22	15	30	31	27	2				3	15	176
1990	14	28	31	30	26	1				21	30	31	212
1991	31	28	31	30	26	5							151
1992	27	29	31	24	24	9	13	31	30	31	30	31	310
1993	31	28	7	30	22	22	3		3	31	30	31	238
1994	2	8	19	30	31	9							99
1995	16	24	24	16	31	17			3	31	30	31	223
1996	30	29	31	30	31	30	4		21	31	30	31	298
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												25	25
2000	29	5	31	30	28	25	21	25	20	22	9	31	276
2001	11	28	31	30	10	15					4	31	160
2002	31	28	31	30	31	9							160
2003			5	30	31	22					27	31	146
2004	31	29	31	30	31	21					1	31	205
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				28	30	31	242
2007	31	18	14	30	28								121
2008	22	29	31	30	28		8	28	30	31	30	31	298
2009	31	28	31	30	30	10				29	30	31	250
2010	21	8	19	24	19	18	6			24	30	26	195
2011	27	11	31	30	31	29	6			1	30	31	227
2012	31	29	31	5	11							13	120
2013	31	28	30	30	31	30	21	28	30	31	30	31	351
2014	31	28	31	30	31	14	22	31	30	31	30	31	340
2015	31	28	11	30	12	22	21				30	31	216
2016	31	29	31	30	30								151
2017	18	28	31	30	31	22	8				10	21	199
2018	19	28	19	25	29							27	147
2019	31	28	23	30	31	17					10	25	195
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**351**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**14**	**22**	**186**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
Total Number of Occurrances (days)	1532	1342	1549	1903	1689	714	272	185	407	782	973	1493	12841
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Reliability Based on Occurrance	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	64%	77%	100%

Scenario #3

Municipal Taking	$0.2\ m^3/s$	Eramosa Intake	Existing ($0.1\ m^3/s$)
ASR Taking	$0.5\ m^3/s$	ASR Step Taking	none

Scenario 3 Number of Days Allowable Taking Exceeds Base Municipal Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6				6	18	31	212
1952	31	29	30	30	21	6							147
1953	5	8	31	10	31	24	15		20	20			164
1954		7	31	30	20					16	30	23	157
1955	25		30	30	17	1					7	31	141
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				16	31	207
1958	27		4	29									60
1959			2	30	31	3					6	31	103
1960	31	29	5	28	31	28							152
1961		2	15	30	22	16							85
1962				29	10								39
1963			5	30	31	1							67
1964													
1965	22	28	26	23	27					6	30	31	193
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	2	30	31	30	31	284
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					8	9	163
1970				21	31	4				21	30	31	138
1971	31	28	31	30	17	13	2	3	30	23		17	225
1972	31	29	1	18	28	20	17			18	30	31	223
1973	31	28	31	30	31	15					1	25	192
1974	31	28	31	30	31	21	1						173
1975		1	20	30	25						9	31	116
1976	23	29	31	30	31	12	18		15	31	30	26	276
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			27	30	31	3						10	101
1980	31	11	12	30	31	11				26	30	31	213
1981	17	21	24	30	18				1	31	30	28	200
1982	19		8	30	13	30	5		4	29	30	31	199
1983	31	28	31	30	31	15						20	186
1984	20	18	31	30	28	12						19	158
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						1	31	156
1988	31	29	29	30	24						11	31	185
1989	31	22	14	30	31	27	2				1	6	164
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	26	5							151
1992	20	23	31	24	24	9	12	30	30	31	30	31	295
1993	31	28	7	30	21	22	3			31	30	31	234
1994	2	7	18	30	31	9							97
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		19	31	30	31	296
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												24	24
2000	29	4	31	30	28	25	21	24	19	23	5	30	269
2001	8	28	31	30	10	13					1	31	152
2002	31	28	31	30	31	8							159
2003			3	30	31	22					26	31	143
2004	31	29	31	30	31	21						30	203
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				27	30	31	241
2007	31	18	13	30	28								120
2008	22	29	31	30	28		7	27	30	31	30	31	296
2009	31	28	31	30	30	10				25	30	31	246
2010	21	7	19	24	17	17	6			18	28	26	183
2011	27	11	31	30	31	29	6				30	31	226
2012	31	29	31	5	11							11	118
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	13	22	31	30	31	30	31	339
2015	31	28	11	30	12	21	21				21	31	206
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				8	15	190
2018	19	28	19	24	29							18	137
2019	31	28	23	30	31	17					8	25	193
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**13**	**20**	**181**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1494	1321	1532	1899	1679	700	267	177	381	733	905	1408	12496
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	70%	68%	72%	92%	78%	34%	12%	8%	18%	34%	44%	66%	50%
Reliability Based on Occurrance	83%	81%	94%	97%	94%	71%	32%	16%	25%	42%	62%	75%	99%

Scenario #4

Municipal Taking	0.25 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 4 Number of Days Allowable Taking Exceeds Base Municipal Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	19	6							145
1953		7	31	10	31	24	15		12	19			149
1954		6	31	30	20					16	30	23	156
1955	25		29	30	17						2	31	134
1956	22		22	29	31	13	23	7	30	26	9	31	243
1957	21	28	31	30	31	9	10				16	31	207
1958	27		3	29									59
1959			1	30	31	3						25	90
1960	31	29	5	28	31	28							152
1961		1	7	30	22	16							76
1962				25	10								35
1963			4	30	31	1							66
1964													
1965	20	22	26	23	27						26	31	175
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	1	30	31	30	31	283
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				20	31	4				13	30	31	129
1971	31	28	31	30	17	9	1	2	30	22		16	217
1972	31	29	1	18	28	20	17			10	30	31	215
1973	31	28	31	30	31	15						14	180
1974	31	28	31	30	31	21							172
1975			12	30	25							26	93
1976	22	29	31	30	31	12	18		14	31	30	26	274
1977			21	30	9				2	31	30	31	154
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				18	30	31	205
1981	17	21	24	30	18					30	30	28	198
1982	18		7	30	12	30	5		3	29	30	31	195
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	28	11						18	155
1985	31	10	31	30	14	1		1	30	31	30	31	240
1986	31	28	27	30	24	20	15	13	30	31	30	31	310
1987	31	28	31	30	4							31	155
1988	31	29	29	30	24						9	31	183
1989	31	22	14	30	31	27	2						157
1990	13	28	31	30	25	1				19	30	31	208
1991	31	28	31	30	25	5							150
1992		18	31	24	24	8	12	29	30	31	30	31	268
1993	31	28	7	30	19	22	3			26	30	31	227
1994	2	7	17	30	31	9							96
1995	16	24	24	15	31	17				21	30	31	209
1996	30	29	31	30	31	30	4		18	31	30	31	295
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												23	23
2000	29	4	31	30	28	25	20	23	16	23	2	28	259
2001	5	28	31	30	9	11						31	145
2002	31	28	31	30	31	8							159
2003			2	30	31	22					26	31	142
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	12	30	28								119
2008	22	29	31	30	28		5	26	30	31	30	31	293
2009	31	28	31	30	30	10				23	30	31	244
2010	20	7	19	24	17	14	6			7	25	26	165
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							9	115
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	12	22	31	30	31	30	31	338
2015	31	28	11	30	12	21	21				12	31	197
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				6	9	182
2018	19	28	19	23	29							10	128
2019	31	28	22	30	31	17					4	25	188
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**10**	**12**	**19**	**176**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1459	1303	1503	1892	1671	683	262	169	365	669	844	1345	12165
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	41%	63%	48%
Reliability Based on Occurrance	80%	80%	94%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%

Scenario #5

Municipal Taking	0.3 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 5 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		4	18			140
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	22		20	28	31	13	22	5	30	26	9	31	237
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959				30	31	3						22	86
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						17	31	143
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15						1	167
1974	24	28	31	30	31	20							164
1975			10	30	25							17	82
1976	12	29	31	30	31	10	18		13	31	30	26	261
1977			21	30	9					31	30	31	152
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					28	30	28	194
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							29	153
1988	31	29	29	30	23						4	25	171
1989	31	22	13	30	31	27	2						156
1990	12	28	31	30	25	1				18	30	31	206
1991	31	28	31	30	25	5							150
1992		8	31	24	24	7	11	29	30	31	30	31	256
1993	31	28	7	30	17	22	3			20	30	31	219
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				2	30	31	189
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	23	28	31	29									111
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						30	135
2002	31	28	31	30	31	6							157
2003			2	30	31	22					25	31	141
2004	31	29	31	30	31	21						27	200
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				22	30	31	243
2010	20	6	19	24	17	13	6			4	17	26	152
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							6	110
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				7	31	191
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8						167
2018	18	28	19	22	29							9	125
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**21**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**18**	**172**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1404	1285	1483	1886	1663	669	254	160	348	610	805	1276	11843
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	71%	99%

Scenario #6

Municipal Taking	0.15 m^3/s	Eramosa Intake	Abandon
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 6 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	19	2				9	18	27	195
1952	31	29	25	30	13	3							131
1953	9	8	31	8	28	20	12		13	8			137
1954		7	31	30	15					16	30	7	136
1955	21		27	30	9						12	26	125
1956	3		18	28	31	7	14	8	30	20	9	30	198
1957	15	28	31	30	27	6	8				20	30	195
1958	17		4	25									46
1959			3	30	26						11	26	96
1960	30	26	2	28	31	21							138
1961		3	13	27	18	15							76
1962				30	1							8	39
1963			5	29	22								56
1964					2								2
1965	20	21	19	23	22					8	29	31	173
1966	24	18	31	30	23	8						23	157
1967	7	24	3	30	21	20	21	2	20	30	30	31	239
1968	15	29	19	25	14			8	30	30	22	31	223
1969	22	28	14	30	31						10	4	139
1970				21	23					18	30	31	123
1971	26	19	11	29	13	6	2	3	30	10		17	166
1972	24	12		18	24	16	10			17	30	26	177
1973	31	25	27	30	28	11					3	17	172
1974	20	28	29	28	31	11							147
1975		2	21	27	18	1				4	9	20	102
1976	8	24	31	30	31	7	13		16	31	28	13	232
1977			21	30	4				4	31	30	31	151
1978	31	24	7	30	26								118
1979	7		27	30	25							17	106
1980	31	2	12	30	27	4				23	13	28	170
1981	9	16	18	26	7				6	31	30	19	162
1982	7		8	30	6	30	2		5	22	29	31	170
1983	31	28	31	30	31	13						25	189
1984	15	17	31	30	16	5						22	136
1985	24	5	31	30	7	1		2	30	30	30	31	221
1986	31	22	20	30	20	17	11	12	30	31	29	31	284
1987	31	22	30	29							2	31	145
1988	25	29	23	30	15						16	21	159
1989	31	15	12	30	29	23					6	8	154
1990	14	28	31	30	16					22	30	31	202
1991	31	28	31	30	19	2						1	142
1992	18	18	25	20	21	6	9	27	30	31	30	31	266
1993	31	23	3	30	13	19	1		2	26	16	24	188
1994		7	14	30	31	6							88
1995	16	13	24	14	30	15			4	20	30	31	197
1996	19	29	31	30	31	25	2		20	31	30	31	279
1997	31	28	31	30	27								147
1998	25	11	31	26									93
1999												25	25
2000	21	4	31	18	24	20	13	15	12	12	3	12	185
2001	4	28	31	30	5	5					3	31	137
2002	24	28	31	30	28	4							145
2003			5	30	31	20					27	31	144
2004	28	9	29	30	31	14						31	172
2005	31	25	7	30	20						1	29	143
2006	31	28	31	30	23	1				28	30	31	233
2007	31	6	12	30	20								99
2008	22	29	31	30	25		6	26	28	31	27	31	286
2009	31	28	31	30	27	7				25	19	31	229
2010	12		19	20	14	9	5			15	13	18	125
2011	19	10	31	30	31	26					30	31	208
2012	31	29	31	3	6							13	113
2013	27	28	25	30	29	27	16	19	29	31	30	31	322
2014	31	28	29	30	31	4	20	21	29	31	30	31	315
2015	30	7	10	30	7	21	18				23	31	177
2016	31	29	31	30	24								145
2017	18	28	31	30	31	17	7				10	6	178
2018	19	28	16	19	26							26	134
2019	29	24	17	30	31	8					10	29	178
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**322**
Average	**19**	**16**	**20**	**27**	**20**	**7**	**3**	**2**	**5**	**10**	**13**	**19**	**161**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Total Number of Occurrances (days)	1282	1120	1397	1841	1386	503	190	143	368	672	868	1310	11080
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Reliability Based on Occurrance	83%	80%	93%	97%	94%	61%	28%	16%	28%	43%	62%	78%	100%

Scenario #7

Municipal Taking	0.15 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 7 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6	1			15	22	31	226
1952	31	29	30	30	22	6							148
1953	13	13	31	11	31	24	15		26	20			184
1954		7	31	30	20					16	30	23	157
1955	25		31	30	17	1					12	31	147
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				22	31	213
1958	28		4	29									61
1959			3	30	31	3					14	31	112
1960	31	29	5	28	31	28							152
1961		3	20	30	22	16							91
1962				30	10							19	59
1963			5	30	31	1							67
1964					5								5
1965	23	28	26	23	27					8	30	31	196
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					10	20	176
1970				21	31	4				26	30	31	143
1971	31	28	31	30	17	14	3	3	30	23		19	229
1972	31	29	1	18	28	20	18			24	30	31	230
1973	31	28	31	30	31	15					4	30	200
1974	31	28	31	30	31	22	1						174
1975		3	25	30	25	3				11	18	31	146
1976	24	29	31	30	31	13	18	4	18	31	30	26	285
1977			21	30	9				4	31	30	31	156
1978	31	28	14	30	31								134
1979	17		27	30	31	3						21	129
1980	31	13	12	30	31	11				28	30	31	217
1981	18	22	24	30	18				7	31	30	28	208
1982	20		8	30	13	30	5		5	29	30	31	201
1983	31	28	31	30	31	15						27	193
1984	20	20	31	30	28	13						23	165
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						17	31	191
1989	31	22	15	30	31	27	2				9	17	184
1990	15	28	31	30	26	1				22	30	31	214
1991	31	28	31	30	26	5						2	153
1992	30	29	31	24	24	9	13	31	30	31	30	31	313
1993	31	28	7	30	22	22	3		3	31	30	31	238
1994	2	8	19	30	31	9							99
1995	17	24	24	16	31	17			13	31	30	31	234
1996	30	29	31	30	31	30	4		21	31	30	31	298
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												25	25
2000	29	5	31	30	28	25	21	25	20	22	9	31	276
2001	11	28	31	30	10	15					4	31	160
2002	31	28	31	30	31	9							160
2003			5	30	31	22					28	31	147
2004	31	29	31	30	31	21					1	31	205
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				28	30	31	242
2007	31	18	14	30	28								121
2008	22	29	31	30	28		8	28	30	31	30	31	298
2009	31	28	31	30	30	10				29	30	31	250
2010	21	8	19	24	19	18	6			24	30	26	195
2011	27	11	31	30	31	29	6			1	30	31	227
2012	31	29	31	5	11							13	120
2013	31	28	30	30	31	30	21	28	30	31	30	31	351
2014	31	28	31	30	31	14	22	31	30	31	30	31	340
2015	31	28	11	30	12	22	21			2	30	31	218
2016	31	29	31	30	30								151
2017	18	28	31	30	31	22	8				10	21	199
2018	19	28	19	25	29							27	147
2019	31	28	23	30	31	17					10	25	195
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**351**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**14**	**22**	**187**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
Total Number of Occurrances (days)	1539	1343	1550	1903	1689	714	272	185	417	788	982	1500	12882
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Reliability Based on Occurrance	84%	81%	94%	97%	96%	72%	33%	17%	28%	46%	64%	78%	100%

Scenario #8

Municipal Taking	0.2 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 8 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6				6	18	31	212
1952	31	29	30	30	21	6							147
1953	5	8	31	10	31	24	15		20	20			164
1954		7	31	30	20					16	30	23	157
1955	25		30	30	17	1					7	31	141
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				16	31	207
1958	27		4	29									60
1959			2	30	31	3					6	31	103
1960	31	29	5	28	31	28							152
1961		2	15	30	22	16							85
1962				29	10								39
1963			5	30	31	1							67
1964													
1965	22	28	26	23	27					6	30	31	193
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	2	30	31	30	31	284
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					8	9	163
1970				21	31	4				21	30	31	138
1971	31	28	31	30	17	13	2	3	30	23		17	225
1972	31	29	1	18	28	20	17			18	30	31	223
1973	31	28	31	30	31	15					1	25	192
1974	31	28	31	30	31	21	1						173
1975		1	21	30	25						12	31	120
1976	23	29	31	30	31	12	18		15	31	30	26	276
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			27	30	31	3						10	101
1980	31	11	12	30	31	11				26	30	31	213
1981	17	21	24	30	18				2	31	30	28	201
1982	19		8	30	13	30	5		4	29	30	31	199
1983	31	28	31	30	31	15						20	186
1984	20	18	31	30	28	12						19	158
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						14	31	188
1989	31	22	14	30	31	27	2				3	14	174
1990	14	28	31	30	25	1				21	30	31	211
1991	31	28	31	30	26	5							151
1992	24	25	31	24	24	9	12	30	30	31	30	31	301
1993	31	28	7	30	21	22	3		1	31	30	31	235
1994	2	7	18	30	31	9							97
1995	16	24	24	15	31	17				30	30	31	218
1996	30	29	31	30	31	30	4		19	31	30	31	296
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												24	24
2000	29	4	31	30	28	25	21	24	19	23	5	30	269
2001	8	28	31	30	10	13					1	31	152
2002	31	28	31	30	31	8							159
2003			3	30	31	22					27	31	144
2004	31	29	31	30	31	21						30	203
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				27	30	31	241
2007	31	18	13	30	28								120
2008	22	29	31	30	28		7	27	30	31	30	31	296
2009	31	28	31	30	30	10				25	30	31	246
2010	21	7	19	24	17	17	6			18	28	26	183
2011	27	11	31	30	31	29	6				30	31	226
2012	31	29	31	5	11							11	118
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	13	22	31	30	31	30	31	339
2015	31	28	11	30	12	21	21				25	31	210
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				8	15	190
2018	19	28	19	24	29							23	142
2019	31	28	23	30	31	17					8	25	193
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**13**	**21**	**182**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1498	1323	1533	1899	1679	700	267	177	383	738	919	1421	12537
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	70%	68%	72%	92%	78%	34%	12%	8%	19%	35%	44%	66%	50%
Reliability Based on Occurrance	83%	81%	94%	97%	94%	71%	32%	16%	26%	42%	62%	75%	99%

Scenario #9

Municipal Taking	0.25 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 9 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	19	6							145
1953		7	31	10	31	24	15		12	19			149
1954		6	31	30	20					16	30	23	156
1955	25		29	30	17						2	31	134
1956	22		22	29	31	13	23	7	30	26	9	31	243
1957	21	28	31	30	31	9	10				16	31	207
1958	27		3	29									59
1959			1	30	31	3						25	90
1960	31	29	5	28	31	28							152
1961		1	7	30	22	16							76
1962				25	10								35
1963			4	30	31	1							66
1964													
1965	20	22	26	23	27						26	31	175
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	1	30	31	30	31	283
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				20	31	4				13	30	31	129
1971	31	28	31	30	17	9	1	2	30	22		16	217
1972	31	29	1	18	28	20	17			10	30	31	215
1973	31	28	31	30	31	15						14	180
1974	31	28	31	30	31	21							172
1975			16	30	25							28	99
1976	22	29	31	30	31	12	18		14	31	30	26	274
1977			21	30	9				2	31	30	31	154
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				19	30	31	206
1981	17	21	24	30	18					31	30	28	199
1982	18		7	30	12	30	5		3	29	30	31	195
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	28	11						18	155
1985	31	10	31	30	14	1		1	30	31	30	31	240
1986	31	28	27	30	24	20	15	13	30	31	30	31	310
1987	31	28	31	30	4							31	155
1988	31	29	29	30	24						11	31	185
1989	31	22	14	30	31	27	2				1	5	163
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	25	5							150
1992	8	19	31	24	24	8	12	29	30	31	30	31	277
1993	31	28	7	30	19	22	3			27	30	31	228
1994	2	7	17	30	31	9							96
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		18	31	30	31	295
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												23	23
2000	29	4	31	30	28	25	20	23	16	23	2	28	259
2001	5	28	31	30	9	11						31	145
2002	31	28	31	30	31	8							159
2003			2	30	31	22					26	31	142
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	12	30	28								119
2008	22	29	31	30	28		5	26	30	31	30	31	293
2009	31	28	31	30	30	10				23	30	31	244
2010	20	7	19	24	17	14	6			7	25	26	165
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							9	115
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	12	22	31	30	31	30	31	338
2015	31	28	11	30	12	21	21				15	31	200
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				6	9	182
2018	19	28	19	23	29							11	129
2019	31	28	22	30	31	17					4	25	188
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**10**	**12**	**20**	**177**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1468	1304	1507	1892	1671	683	262	169	365	678	850	1353	12202
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	69%	67%	70%	91%	78%	33%	12%	8%	18%	32%	41%	63%	48%
Reliability Based on Occurrance	81%	80%	94%	97%	94%	70%	30%	16%	23%	39%	52%	74%	99%

Scenario #10

Municipal Taking	0.3 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 10 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		4	18			140
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	22		20	28	31	13	22	5	30	26	9	31	237
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959				30	31	3						22	86
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						17	31	143
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15						1	167
1974	24	28	31	30	31	20							164
1975			11	30	25							17	83
1976	14	29	31	30	31	10	18		13	31	30	26	263
1977			21	30	9				1	31	30	31	153
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					28	30	28	194
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							30	154
1988	31	29	29	30	23						9	31	182
1989	31	22	13	30	31	27	2						156
1990	13	28	31	30	25	1				19	30	31	208
1991	31	28	31	30	25	5							150
1992		10	31	24	24	7	11	29	30	31	30	31	258
1993	31	28	7	30	17	22	3			21	30	31	220
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				16	30	31	203
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						30	135
2002	31	28	31	30	31	6							157
2003			2	30	31	22					25	31	141
2004	31	29	31	30	31	21						27	200
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				22	30	31	243
2010	20	6	19	24	17	13	6			4	17	26	152
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							6	110
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				9	31	193
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8						167
2018	18	28	19	22	29							9	125
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**19**	**172**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1408	1287	1484	1886	1663	669	254	160	349	626	812	1283	11881
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	23%	39%	48%	71%	99%

Scenario #11

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 11 Number of Days Allowable Taking Exceeds Base Municipal Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	19	2				6	18	27	192
1952	31	29	25	30	13	3							131
1953	8	8	31	8	28	20	12		13	8			136
1954		7	31	30	15					16	30	7	136
1955	21		27	30	9						7	25	119
1956	3		18	28	31	7	14	8	30	20	9	30	198
1957	15	28	31	30	27	6	8				19	30	194
1958	17		4	25									46
1959			3	30	26						6	26	91
1960	29	26	2	28	31	21							137
1961		3	12	27	18	15							75
1962				30	1							3	34
1963			5	29	22								56
1964													
1965	20	21	19	23	22					6	27	31	169
1966	24	18	31	30	23	8						23	157
1967	7	24	3	30	21	20	21	2	19	30	30	31	238
1968	15	29	19	25	14			8	30	30	22	31	223
1969	22	28	14	30	31						10	4	139
1970				21	23					18	30	31	123
1971	26	19	11	29	13	6	2	3	30	10		17	166
1972	24	12		18	24	16	10			15	30	26	175
1973	31	25	27	30	28	11					2	15	169
1974	20	28	29	28	31	11							147
1975		2	20	27	18	1				3	8	20	99
1976	8	24	31	30	31	7	13		16	31	28	13	232
1977			21	30	4				4	31	30	31	151
1978	31	24	7	30	26								118
1979	6		27	30	25							17	105
1980	31	2	12	30	27	4				23	13	28	170
1981	9	16	18	26	7				5	31	30	19	161
1982	7		8	30	6	30	2		5	22	29	31	170
1983	31	28	31	30	31	13						25	189
1984	15	17	31	30	16	5						20	134
1985	24	5	31	30	7	1		2	30	30	30	31	221
1986	31	22	20	30	20	17	11	12	30	31	29	31	284
1987	31	22	30	29							2	31	145
1988	25	29	23	30	15						14	21	157
1989	31	15	12	30	29	23					3	6	149
1990	14	28	31	30	16					21	30	31	201
1991	31	28	31	30	19	2							141
1992	17	17	25	20	21	6	9	27	30	31	30	31	264
1993	31	23	3	30	13	19	1		2	25	16	24	187
1994		7	14	30	31	6							88
1995	16	13	24	14	30	15			1	20	30	31	194
1996	19	29	31	30	31	25	2		20	31	30	31	279
1997	31	28	31	30	27								147
1998	25	11	31	26									93
1999												25	25
2000	21	4	31	18	24	20	13	15	12	12	3	12	185
2001	4	28	31	30	5	5					1	31	135
2002	24	28	31	30	28	4							145
2003			5	30	31	20					27	31	144
2004	28	9	29	30	31	14						31	172
2005	31	25	7	30	20						1	29	143
2006	31	28	31	30	23	1				28	30	31	233
2007	31	6	12	30	20								99
2008	22	29	31	30	25		6	26	28	31	27	31	286
2009	31	28	31	30	27	7				24	19	31	228
2010	12		19	20	14	9	5			14	13	18	124
2011	19	10	31	30	31	26					30	31	208
2012	31	29	31	3	6							13	113
2013	26	28	25	30	29	27	16	19	29	31	30	31	321
2014	31	28	29	30	31	4	19	18	29	31	30	31	311
2015	30	7	10	30	7	21	18				21	31	175
2016	31	29	31	30	24								145
2017	18	28	31	30	31	17	7				10	6	178
2018	19	28	16	19	26							22	130
2019	29	24	17	30	31	8					10	29	178
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**321**
Average	**19**	**16**	**20**	**27**	**20**	**7**	**3**	**2**	**5**	**10**	**12**	**19**	**160**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1277	1119	1395	1841	1384	503	189	140	363	660	844	1293	11008
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	41%	60%	44%
Reliability Based on Occurrance	83%	80%	93%	97%	93%	61%	28%	16%	28%	43%	62%	77%	99%

Scenario #12

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 12 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6	1			10	20	31	219
1952	31	29	30	30	22	6							148
1953	11	12	31	11	31	24	15		26	20			181
1954		7	31	30	20					16	30	23	157
1955	25		31	30	17	1					8	31	143
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				21	31	212
1958	28		4	29									61
1959			3	30	31	3					7	31	105
1960	31	29	5	28	31	28							152
1961		3	19	30	22	16							90
1962				30	10							7	47
1963			5	30	31	1							67
1964					1								1
1965	23	28	26	23	27					7	30	31	195
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					10	20	176
1970				21	31	4				26	30	31	143
1971	31	28	31	30	17	14	3	3	30	23		19	229
1972	31	29	1	18	28	20	18			20	30	31	226
1973	31	28	31	30	31	15					2	29	197
1974	31	28	31	30	31	22	1						174
1975		2	24	30	25	3				7	17	31	139
1976	24	29	31	30	31	13	18	4	18	31	30	26	285
1977			21	30	9				4	31	30	31	156
1978	31	28	14	30	31								134
1979	14		27	30	31	3						21	126
1980	31	13	12	30	31	11				28	30	31	217
1981	18	22	24	30	18				6	31	30	28	207
1982	20		8	30	13	30	5		5	29	30	31	201
1983	31	28	31	30	31	15						26	192
1984	20	20	31	30	28	13						20	162
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						15	31	189
1989	31	22	15	30	31	27	2				3	15	176
1990	15	28	31	30	26	1				21	30	31	213
1991	31	28	31	30	26	5							151
1992	27	29	31	24	24	9	13	31	30	31	30	31	310
1993	31	28	7	30	22	22	3		3	31	30	31	238
1994	2	8	19	30	31	9							99
1995	16	24	24	16	31	17			6	30	30	31	225
1996	30	29	31	30	31	30	4		21	31	30	31	298
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												25	25
2000	29	5	31	30	28	25	21	25	20	22	9	31	276
2001	11	28	31	30	10	15					1	31	157
2002	31	28	31	30	31	9							160
2003			5	30	31	22					27	31	146
2004	31	29	31	30	31	21						31	204
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				28	30	31	242
2007	31	18	14	30	28								121
2008	22	29	31	30	28		8	28	30	31	30	31	298
2009	31	28	31	30	30	10				28	30	31	249
2010	21	8	19	24	19	18	6			23	29	26	193
2011	27	11	31	30	31	29	6			1	30	31	227
2012	31	29	31	5	11							13	120
2013	31	28	30	30	31	30	21	28	30	31	30	31	351
2014	31	28	31	30	31	14	22	31	30	31	30	31	340
2015	31	28	11	30	12	22	21				30	31	216
2016	31	29	31	30	30								151
2017	18	28	31	30	31	22	8				10	21	199
2018	19	28	19	25	29							26	146
2019	31	28	23	30	31	17					10	25	195
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**351**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**14**	**21**	**185**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Total Number of Occurrances (days)	1530	1341	1548	1903	1685	714	272	185	409	768	951	1478	12784
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	72%	69%	72%	92%	79%	34%	13%	9%	20%	36%	46%	69%	51%
Reliability Based on Occurrance	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	62%	77%	100%

Scenario #13

Municipal Taking	0.2 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 13 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					18	31	206
1952	31	29	30	30	21	6							147
1953	1	8	31	10	31	24	15		20	20			160
1954		7	31	30	20					16	30	23	157
1955	25		30	30	17	1					4	31	138
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				16	31	207
1958	27		4	29									60
1959			2	30	31	3						26	92
1960	31	29	5	28	31	28							152
1961		2	13	30	22	16							83
1962				29	10								39
1963			5	30	31	1							67
1964													
1965	22	28	26	23	27					1	30	31	188
1966	31	23	31	30	31	11						22	179
1967	19	28	8	30	27	20	28	2	30	31	30	31	284
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					7	9	162
1970				21	31	4				20	30	31	137
1971	31	28	31	30	17	13	2	3	30	23		17	225
1972	31	29	1	18	28	20	17			15	30	31	220
1973	31	28	31	30	31	15						21	187
1974	31	28	31	30	31	21	1						173
1975		1	19	30	25						9	31	115
1976	23	29	31	30	31	12	18		15	31	30	26	276
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			27	30	31	3						10	101
1980	31	11	12	30	31	11				26	30	31	213
1981	17	21	24	30	18				1	31	30	28	200
1982	19		8	30	13	30	5		4	29	30	31	199
1983	31	28	31	30	31	15						20	186
1984	20	18	31	30	28	12						19	158
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						1	31	156
1988	31	29	29	30	24						11	31	185
1989	31	22	14	30	31	27	2				1	7	165
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	26	5							151
1992	19	23	31	24	24	9	12	30	30	31	30	31	294
1993	31	28	7	30	21	22	3			31	30	31	234
1994	2	7	18	30	31	9							97
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		19	31	30	31	296
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												24	24
2000	29	4	31	30	28	25	21	24	19	23	5	30	269
2001	8	28	31	30	10	13						31	151
2002	31	28	31	30	31	8							159
2003			3	30	31	22					26	31	143
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				27	30	31	241
2007	31	18	13	30	28								120
2008	22	29	31	30	28		7	27	30	31	30	31	296
2009	31	28	31	30	30	10				25	30	31	246
2010	21	7	19	24	17	17	6			15	28	26	180
2011	27	11	31	30	31	29	6				30	31	226
2012	31	29	31	5	11							11	118
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	13	22	31	30	31	30	31	339
2015	31	28	11	30	12	21	21				20	31	205
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				8	15	190
2018	19	28	19	24	29							15	134
2019	31	28	23	30	31	17					8	25	193
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**10**	**13**	**20**	**180**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1488	1321	1529	1899	1679	700	267	177	381	715	891	1395	12442
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	70%	68%	71%	92%	78%	34%	12%	8%	18%	33%	43%	65%	49%
Reliability Based on Occurrance	83%	81%	94%	97%	94%	71%	32%	16%	25%	41%	57%	75%	99%

Scenario #14

Municipal Taking	0.25 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 14 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	19	6							145
1953		7	31	10	31	24	15		12	19			149
1954		6	31	30	20					16	30	23	156
1955	25		29	30	17						1	31	133
1956	22		22	29	31	13	23	7	30	26	9	31	243
1957	21	28	31	30	31	9	10				15	31	206
1958	27		3	29									59
1959				30	31	3						23	87
1960	31	29	5	28	31	28							152
1961		1	6	30	22	16							75
1962				25	10								35
1963			4	30	31	1							66
1964													
1965	16	21	26	23	27						20	31	164
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	1	30	31	30	31	283
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				20	31	4				10	30	31	126
1971	31	28	31	30	17	9	1	2	30	22		16	217
1972	31	29	1	18	28	20	17			8	30	31	213
1973	31	28	31	30	31	15						4	170
1974	31	28	31	30	31	21							172
1975			11	30	25							26	92
1976	22	29	31	30	31	12	18		14	31	30	26	274
1977			21	30	9				1	31	30	31	153
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				18	30	31	205
1981	17	21	24	30	18					30	30	28	198
1982	18		7	30	12	30	5		3	29	30	31	195
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	28	11						16	153
1985	31	10	31	30	14	1		1	30	31	30	31	240
1986	31	28	27	30	24	20	15	13	30	31	30	31	310
1987	31	28	31	30	4							31	155
1988	31	29	29	30	24						9	31	183
1989	31	22	14	30	31	27	2						157
1990	13	28	31	30	25	1				19	30	31	208
1991	31	28	31	30	25	5							150
1992		16	31	24	24	8	12	29	30	31	30	31	266
1993	31	28	7	30	19	22	3			26	30	31	227
1994	2	7	17	30	31	9							96
1995	16	24	24	15	31	17				23	30	31	211
1996	30	29	31	30	31	30	4		18	31	30	31	295
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												22	22
2000	29	4	31	30	28	25	20	23	16	23	2	28	259
2001	5	28	31	30	9	11						31	145
2002	31	28	31	30	31	8							159
2003			2	30	31	22					25	31	141
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	12	30	28								119
2008	22	29	31	30	28		5	26	30	31	30	31	293
2009	31	28	31	30	30	10				22	30	31	243
2010	20	7	19	24	17	14	6			6	22	26	161
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							9	115
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	12	22	31	30	31	30	31	338
2015	31	28	11	30	12	21	21				11	31	196
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				5	9	181
2018	19	28	19	23	29							10	128
2019	31	28	22	30	31	17					4	25	188
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**10**	**12**	**19**	**176**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1455	1300	1500	1892	1671	683	262	169	364	664	830	1330	12120
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	40%	62%	48%
Reliability Based on Occurrance	80%	80%	93%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%

Scenario #15

Municipal Taking	0.3 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 15 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		6	31	10	31	24	15		4	18			139
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	21		20	28	31	13	22	5	30	26	9	31	236
1957	21	28	31	30	31	9	10				14	31	205
1958	26		3	29									58
1959				30	31	3						15	79
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						14	31	140
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15							166
1974	14	28	31	30	31	20							154
1975			10	30	25							17	82
1976	11	29	31	30	31	10	18		13	31	30	26	260
1977			21	30	9					31	30	31	152
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					27	30	28	193
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							29	153
1988	31	29	29	30	23						4	25	171
1989	31	22	13	30	31	27	2						156
1990	12	28	31	30	25	1				18	30	31	206
1991	31	28	31	30	25	5							150
1992		8	31	24	24	7	11	29	30	31	30	31	256
1993	31	28	7	30	17	22	3			19	30	31	218
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				5	30	31	192
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	23	28	31	29									111
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						29	134
2002	31	28	31	30	31	6							157
2003			2	30	31	22					24	31	140
2004	31	29	31	30	31	21						26	199
2005	31	28	14	30	25							30	158
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				21	30	31	242
2010	20	6	19	24	17	13	6			3	15	26	149
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							4	108
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				6	31	190
2016	31	29	31	30	30								151
2017	17	28	31	30	31	21	8						166
2018	18	28	19	22	29							8	124
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**21**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**18**	**171**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1391	1284	1483	1886	1663	669	254	160	348	609	797	1262	11806
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%

Scenario #16

Municipal Taking 0.15 m^3/s Eramosa Intake Maximize

ASR Taking 0.5 m^3/s ASR Step Taking 0.3 m^3/s

Scenario 16 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	30			30	31	30	31	303
1952	31	29	31	30	31	30			29	31	19	31	292
1953	31	28	31	30	31	30	15		30	31	30	28	315
1954		21	31	30	31	1				17	30	31	192
1955	31	28	31	30	27	15					20	31	213
1956	31	29	31	30	31	30	22	8	30	31	30	31	334
1957	31	28	31	30	31	30	10		30	31	30	31	313
1958	31	28	31	30									120
1959			12	30	31	20				6	30	31	160
1960	31	29	31	30	31	30			30	21	6		239
1961		5	31	30	31	30			30	31	30	31	249
1962	31		3	30	22						19	31	136
1963	31	28	12	30	31	23							155
1964					23	11			30	31	19	7	121
1965	31	28	31	30	31	20			7	31	30	31	270
1966	31	28	31	30	31	30				13	20	31	245
1967	31	28	31	30	31	30	28	3	30	31	30	31	334
1968	31	29	31	30	31	30		8	30	31	30	31	312
1969	31	28	31	30	31	30			30	31	30	31	303
1970	31	28	23	30	31	30			30	31	30	31	295
1971	31	28	31	30	31	30	1	3	30	31	30	31	307
1972	31	29	31	30	31	30	18		30	31	30	31	322
1973	31	28	31	30	31	30			24	27	30	31	293
1974	31	28	31	30	31	30			30	25	10	16	262
1975	19	23	31	30	31	30			30	31	30	31	286
1976	31	29	31	30	31	30	18	4	30	31	30	31	326
1977	31	28	31	30	15				15	31	30	31	242
1978	31	28	31	30	31	18				27	15	31	242
1979	31	28	31	30	31	27					7	31	216
1980	31	29	31	30	31	30			30	31	30	31	304
1981	31	28	31	30	31	3			27	31	30	31	273
1982	31	28	31	30	26	30	5		30	31	30	31	303
1983	31	28	31	30	31	30			22	31	30	31	295
1984	31	29	31	30	31	30			18	31	29	31	291
1985	31	28	31	30	29	28		2	30	31	30	31	301
1986	31	28	31	30	31	30	15	14	30	31	30	31	332
1987	31	28	31	30	7					25	30	31	213
1988	31	29	31	30	31	8				6	30	31	227
1989	31	28	31	30	31	30	2				16	31	230
1990	31	28	31	30	31	30			30	31	30	31	303
1991	31	28	31	30	31	21					4	31	207
1992	31	29	31	30	31	30	12	30	30	31	30	31	346
1993	31	28	31	30	31	30	3		30	31	30	31	306
1994	31	28	31	30	31	30							181
1995	18	28	31	30	31	30			30	31	30	31	290
1996	31	29	31	30	31	30	4		30	31	30	31	308
1997	31	28	31	30	31	30					29	31	241
1998	31	28	31	30	10								130
1999			21	10							24	31	86
2000	31	29	31	30	31	30	21	25	30	31	30	31	350
2001	31	28	31	30	22	30				11	30	31	244
2002	31	28	31	30	31	30							181
2003			10	30	31	30			10	31	30	31	203
2004	31	29	31	30	31	30			30	31	30	31	304
2005	31	28	31	30	31	30			2	20	17	31	251
2006	31	28	31	30	31	28			30	31	30	31	301
2007	31	28	31	30	31	15							166
2008	23	29	31	30	31	30	6	26	30	31	30	31	328
2009	31	28	31	30	31	30			30	31	30	31	303
2010	31	28	31	29	27	30	6		30	31	30	31	304
2011	31	28	31	30	31	30	6		30	31	30	31	309
2012	31	29	31	22	18						28	31	190
2013	31	28	31	30	31	30	21	28	30	31	30	31	352
2014	31	28	31	30	31	30	22	31	30	31	30	31	356
2015	31	28	31	30	23	30	21		30	31	30	31	316
2016	31	29	31	30	31	19							171
2017	21	28	31	30	31	30	8		30	31	30	31	301
2018	31	28	31	30	31	14					8	31	204
2019	31	28	31	30	31	30				16	30	25	252
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**356**
Average	**28**	**26**	**29**	**29**	**28**	**24**	**4**	**3**	**18**	**22**	**24**	**27**	**260**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**86**
Total Number of Occurrances (days)	1910	1773	2003	2011	1954	1651	264	182	1234	1485	1640	1843	17950
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	89%	91%	94%	97%	91%	80%	12%	9%	60%	69%	79%	86%	71%
Reliability Based on Occurrance	91%	93%	99%	99%	97%	90%	30%	17%	65%	77%	90%	88%	100%

Scenario #17

Municipal Taking	0.2 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 17 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	30			30	31	30	31	303
1952	31	29	31	30	31	30			24	31	14	31	282
1953	31	28	31	30	31	30	15		30	31	30	28	315
1954		16	31	30	31	1				16	30	31	186
1955	31	28	31	30	27	15					18	31	211
1956	31	29	31	30	31	30	22	8	30	31	30	31	334
1957	31	28	31	30	31	30	10		30	31	30	31	313
1958	31	28	31	30									120
1959			10	30	31	20					26	31	148
1960	31	29	31	30	31	30			30	18			230
1961		4	31	30	31	30			30	31	30	31	248
1962	28		3	30	22						18	31	132
1963	31	28	9	30	31	23							152
1964					17	5			30	31	13	6	102
1965	31	28	31	30	31	20				28	30	31	260
1966	31	28	31	30	31	30					15	31	227
1967	31	28	31	30	31	30	28	2	30	31	30	31	333
1968	31	29	31	30	31	30		8	30	31	30	31	312
1969	31	28	31	30	31	30			30	31	30	31	303
1970	31	28	20	30	31	30			30	31	30	31	292
1971	31	28	31	30	31	30		3	30	31	30	31	306
1972	31	29	31	30	31	30	17		30	31	30	31	321
1973	31	28	31	30	31	30			11	22	30	31	275
1974	31	28	31	30	31	30			16	22	9	10	238
1975	14	15	31	30	31	30			30	31	30	31	273
1976	31	29	31	30	31	30	18		30	31	30	31	322
1977	31	28	31	30	15				13	31	30	31	240
1978	31	28	31	30	31	18				13	7	31	220
1979	31	28	31	30	31	27					6	31	215
1980	31	29	31	30	31	30			30	31	30	31	304
1981	31	28	31	30	31	3			27	31	30	31	273
1982	31	28	31	30	26	30	5		30	31	30	31	303
1983	31	28	31	30	31	30			13	31	30	31	286
1984	31	29	31	30	31	30			11	25	26	31	275
1985	31	28	31	30	29	28		1	30	31	30	31	300
1986	31	28	31	30	31	30	15	14	30	31	30	31	332
1987	31	28	31	30	7					7	30	31	195
1988	31	29	31	30	31	8					25	31	216
1989	31	28	31	30	31	30	2				15	31	229
1990	31	28	31	30	31	30			17	31	30	31	290
1991	31	28	31	30	31	21						31	203
1992	31	29	31	30	31	30	12	30	30	31	30	31	346
1993	31	28	31	30	31	30	3		30	31	30	31	306
1994	31	28	31	30	31	30							181
1995	17	28	31	30	31	30			30	31	30	31	289
1996	31	29	31	30	31	30	4		30	31	30	31	308
1997	31	28	31	30	31	30					28	31	240
1998	30	28	31	30	9								128
1999			10	9							23	31	73
2000	31	29	31	30	31	30	21	24	30	31	30	31	349
2001	31	28	31	30	22	30				5	30	31	238
2002	31	28	31	30	31	30							181
2003			9	30	31	30			5	31	30	31	197
2004	31	29	31	30	31	30			30	31	30	31	304
2005	31	28	31	30	31	30				4	14	31	230
2006	31	28	31	30	31	28			30	31	30	31	301
2007	31	28	31	30	31	15							166
2008	23	29	31	30	31	30	5	26	30	31	30	31	327
2009	31	28	31	30	31	30			30	31	30	31	303
2010	31	28	31	29	27	30	6		30	31	30	31	304
2011	31	28	31	30	31	30	6		30	31	30	31	309
2012	31	29	31	22	18						27	31	189
2013	31	28	31	30	31	30	21	28	30	31	30	31	352
2014	31	28	31	30	31	30	22	31	30	31	30	31	356
2015	31	28	31	30	23	30	21		30	31	30	31	316
2016	31	29	31	30	31	19							171
2017	20	28	31	30	31	30	8		30	31	30	31	300
2018	31	28	31	30	31	14					3	31	199
2019	31	28	31	30	31	30				4	30	25	240
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**356**
Average	**28**	**25**	**29**	**29**	**28**	**24**	**4**	**3**	**17**	**20**	**23**	**27**	**255**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**73**
Total Number of Occurrances (days)	1899	1759	1983	2010	1947	1645	261	175	1157	1373	1577	1836	17622
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	89%	90%	93%	97%	91%	79%	12%	8%	56%	64%	76%	86%	70%
Reliability Based on Occurrance	91%	93%	99%	99%	97%	90%	29%	16%	62%	72%	87%	88%	100%

Scenario #18

Municipal Taking	0.25 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 18 Number of Days Allowable Taking Exceeds Base Municipal Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	30			30	31	30	31	303
1952	31	29	31	30	31	30			12	31	9	31	265
1953	31	28	31	30	31	30	15		30	31	30	26	313
1954		13	31	30	31	1				16	30	31	183
1955	31	28	31	30	27	15					18	31	211
1956	31	29	31	30	31	30	22	7	30	31	30	31	333
1957	31	28	31	30	31	30	10		30	31	30	31	313
1958	31	28	31	30									120
1959			8	30	31	20					23	31	143
1960	31	29	31	30	31	30			30	13			225
1961		4	31	30	31	30			30	31	30	31	248
1962	26		3	30	22						17	31	129
1963	31	28	8	30	31	23							151
1964					3				30	31	6	6	76
1965	31	28	31	30	31	20				22	30	31	254
1966	31	28	31	30	31	30					1	31	213
1967	31	28	31	30	31	30	28	1	30	31	30	31	332
1968	31	29	31	30	31	30		8	30	31	30	31	312
1969	31	28	31	30	31	30			30	31	30	31	303
1970	31	28	18	30	31	30			30	31	30	31	290
1971	31	28	31	30	31	30		2	30	31	30	31	305
1972	31	29	31	30	31	30	17		30	31	30	31	321
1973	31	28	31	30	31	30					30	31	242
1974	31	28	31	30	31	30				3	7	4	195
1975		5	31	30	31	30			30	31	30	31	249
1976	31	29	31	30	31	30	18		30	31	30	31	322
1977	31	28	31	30	15				10	31	30	31	237
1978	31	28	31	30	31	18						27	196
1979	31	28	31	30	31	27					5	31	214
1980	31	29	31	30	31	30			30	31	30	31	304
1981	31	28	31	30	31	3			27	31	30	31	273
1982	31	28	31	30	26	30	5		30	31	30	31	303
1983	31	28	31	30	31	30			9	31	30	31	282
1984	31	29	31	30	31	30					25	31	238
1985	31	28	31	30	29	28			30	31	30	31	299
1986	31	28	31	30	31	30	15	13	30	31	30	31	331
1987	31	28	31	30	7					4	30	31	192
1988	31	29	31	30	31	8					21	31	212
1989	31	28	31	30	31	30	2				15	31	229
1990	31	28	31	30	31	30			9	31	30	31	282
1991	31	28	31	30	31	21						24	196
1992	31	29	31	30	31	30	11	29	30	31	30	31	344
1993	31	28	31	30	31	30	3		30	31	30	31	306
1994	31	28	31	30	31	30							181
1995	17	28	31	30	31	30			30	31	30	31	289
1996	31	29	31	30	31	30	4		30	31	30	31	308
1997	31	28	31	30	31	30					8	18	207
1998	27	28	31	30	8								124
1999			6	7							21	31	65
2000	31	29	31	30	31	30	20	23	30	31	30	31	347
2001	31	28	31	30	22	30					29	31	232
2002	31	28	31	30	31	30							181
2003			9	30	31	30			1	31	30	31	193
2004	31	29	31	30	31	30			30	31	30	31	304
2005	31	28	31	30	31	30					13	31	225
2006	31	28	31	30	31	28			28	31	30	31	299
2007	31	28	31	30	31	15							166
2008	23	29	31	30	31	30	4	26	30	31	30	31	326
2009	31	28	31	30	31	30			30	31	30	31	303
2010	31	28	31	29	27	30	6		30	31	30	31	304
2011	31	28	31	30	31	30	6		30	31	30	31	309
2012	31	29	31	22	17						23	31	184
2013	31	28	31	30	31	30	21	28	30	31	30	31	352
2014	31	28	31	30	31	30	22	31	30	31	30	31	356
2015	31	28	31	30	23	30	21		30	31	30	31	316
2016	31	29	31	30	31	19							171
2017	20	28	31	30	31	30	8		30	31	30	31	300
2018	31	28	31	30	31	14					1	31	197
2019	31	28	31	30	31	30				1	30	25	237
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**356**
Average	**27**	**25**	**29**	**29**	**28**	**24**	**4**	**2**	**16**	**18**	**22**	**26**	**250**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**65**
Total Number of Occurrances (days)	1880	1746	1974	2008	1931	1640	258	168	1086	1268	1502	1804	17265
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	88%	90%	92%	97%	90%	79%	12%	8%	52%	59%	73%	84%	69%
Reliability Based on Occurrance	90%	93%	99%	99%	97%	88%	29%	14%	58%	65%	86%	88%	100%

Scenario #19

Municipal Taking	0.3 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 19 Number of Days Allowable Taking Exceeds Base Municipal Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		6	31	10	31	24	15		4	18			139
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	21		20	28	31	13	22	5	30	26	9	31	236
1957	21	28	31	30	31	9	10				14	31	205
1958	26		3	29									58
1959				30	31	3						15	79
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						14	31	140
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15							166
1974	14	28	31	30	31	20							154
1975			10	30	25							17	82
1976	11	29	31	30	31	10	18		13	31	30	26	260
1977			21	30	9					31	30	31	152
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					27	30	28	193
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							29	153
1988	31	29	29	30	23						4	25	171
1989	31	22	13	30	31	27	2						156
1990	12	28	31	30	25	1				18	30	31	206
1991	31	28	31	30	25	5							150
1992		8	31	24	24	7	11	29	30	31	30	31	256
1993	31	28	7	30	17	22	3			19	30	31	218
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				5	30	31	192
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	23	28	31	29									111
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						29	134
2002	31	28	31	30	31	6							157
2003			2	30	31	22					24	31	140
2004	31	29	31	30	31	21						26	199
2005	31	28	14	30	25							30	158
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				21	30	31	242
2010	20	6	19	24	17	13	6			3	15	26	149
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							4	108
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				6	31	190
2016	31	29	31	30	30								151
2017	17	28	31	30	31	21	8						166
2018	18	28	19	22	29							8	124
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**21**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**18**	**171**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1391	1284	1483	1886	1663	669	254	160	348	609	797	1262	11806
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%

Appendix C Reliability of Available Base Municipal and ASR Taking Equaling Assumed Maximum ASR Taking

Scenario #1

Municipal Taking	0.15 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 1 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	19	2				9	18	27	195
1952	31	29	25	30	13	3							131
1953	9	8	31	8	28	20	12		13	8			137
1954		7	31	30	15					16	30	7	136
1955	21		27	30	9						12	26	125
1956	3		18	28	31	7	14	8	30	20	9	30	198
1957	15	28	31	30	27	6	8				20	30	195
1958	17		4	25									46
1959			3	30	26						11	26	96
1960	30	26	2	28	31	21							138
1961		3	13	27	18	15							76
1962				30	1							8	39
1963			5	29	22								56
1964					2								2
1965	20	21	19	23	22					8	29	31	173
1966	24	18	31	30	23	8						23	157
1967	7	24	3	30	21	20	21	2	20	30	30	31	239
1968	15	29	19	25	14			8	30	30	22	31	223
1969	22	28	14	30	31						10	4	139
1970				21	23					18	30	31	123
1971	26	19	11	29	13	6	2	3	30	10		17	166
1972	24	12		18	24	16	10			17	30	26	177
1973	31	25	27	30	28	11					3	17	172
1974	20	28	29	28	31	11							147
1975		2	21	27	18	1				3	8	21	101
1976	8	23	31	30	31	7	13		16	31	28	13	231
1977			21	30	4				4	31	30	31	151
1978	31	24	7	30	26								118
1979	6		27	30	25							17	105
1980	31	2	12	30	27	4				23	13	28	170
1981	9	16	18	26	7				6	31	30	19	162
1982	7		8	30	6	30	2		5	22	29	31	170
1983	31	28	31	30	31	13						25	189
1984	15	17	31	30	16	5						21	135
1985	24	5	31	30	7	1		2	30	30	30	31	221
1986	31	22	20	30	20	17	11	12	30	31	29	31	284
1987	31	22	30	29							2	31	145
1988	25	29	23	30	15						14	21	157
1989	31	15	12	30	29	23					3	6	149
1990	14	28	31	30	16					21	30	31	201
1991	31	28	31	30	19	2							141
1992	17	18	25	20	21	6	9	27	30	31	30	31	265
1993	31	23	3	30	13	19	1		2	25	17	24	188
1994		7	14	30	31	6							88
1995	16	13	24	14	30	15				20	30	31	193
1996	19	29	31	30	31	25	2		20	31	30	31	279
1997	31	28	31	30	27								147
1998	25	11	31	26									93
1999												25	25
2000	21	4	31	18	24	20	13	15	12	12	3	12	185
2001	4	28	31	30	5	5					3	31	137
2002	24	28	31	30	28	4							145
2003			4	30	31	20					27	31	143
2004	28	9	29	30	31	14						31	172
2005	31	25	7	30	20						1	29	143
2006	31	28	31	30	23	1				28	30	31	233
2007	31	6	12	30	20								99
2008	22	29	31	30	25		6	26	28	31	27	31	286
2009	31	28	31	30	27	7				25	19	31	229
2010	12		19	20	14	9	5			15	13	18	125
2011	19	10	31	30	31	26					30	31	208
2012	31	29	31	3	6							13	113
2013	27	28	25	30	29	27	16	19	29	31	30	31	322
2014	31	28	29	30	31	4	20	21	29	31	30	31	315
2015	30	7	10	30	7	21	18				21	31	175
2016	31	29	31	30	24								145
2017	18	28	31	30	31	17	7				10	6	178
2018	19	28	16	19	26							24	132
2019	29	24	17	30	31	8					10	29	178
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**322**
Average	**19**	**16**	**20**	**27**	**20**	**7**	**3**	**2**	**5**	**10**	**12**	**19**	**160**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Total Number of Occurrances (days)	1280	1119	1396	1841	1386	503	190	143	364	669	861	1305	11057
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Reliability Based on Occurrance	83%	80%	93%	97%	94%	61%	28%	16%	26%	43%	62%	77%	100%

Scenario #2

Municipal Taking	0.15 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 2 Number of Days Allowable Taking Equals Maximum ASR Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6	1			15	22	31	226
1952	31	29	30	30	22	6							148
1953	13	13	31	11	31	24	15		26	20			184
1954		7	31	30	20					16	30	23	157
1955	25		31	30	17	1					12	31	147
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				22	31	213
1958	28		4	29									61
1959			3	30	31	3					14	31	112
1960	31	29	5	28	31	28							152
1961		3	20	30	22	16							91
1962				30	10							19	59
1963			5	30	31	1							67
1964					5								5
1965	23	28	26	23	27					8	30	31	196
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					10	20	176
1970				21	31	4				26	30	31	143
1971	31	28	31	30	17	14	3	3	30	23		19	229
1972	31	29	1	18	28	20	18			24	30	31	230
1973	31	28	31	30	31	15					4	30	200
1974	31	28	31	30	31	22	1						174
1975		2	24	30	25	3				8	18	31	141
1976	24	29	31	30	31	13	18	4	18	31	30	26	285
1977			21	30	9				4	31	30	31	156
1978	31	28	14	30	31								134
1979	15		27	30	31	3						21	127
1980	31	13	12	30	31	11				28	30	31	217
1981	18	22	24	30	18				7	31	30	28	208
1982	20		8	30	13	30	5		5	29	30	31	201
1983	31	28	31	30	31	15						26	192
1984	20	20	31	30	28	13						21	163
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						15	31	189
1989	31	22	15	30	31	27	2				3	15	176
1990	14	28	31	30	26	1				21	30	31	212
1991	31	28	31	30	26	5							151
1992	27	29	31	24	24	9	13	31	30	31	30	31	310
1993	31	28	7	30	22	22	3		3	31	30	31	238
1994	2	8	19	30	31	9							99
1995	16	24	24	16	31	17			3	31	30	31	223
1996	30	29	31	30	31	30	4		21	31	30	31	298
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												25	25
2000	29	5	31	30	28	25	21	25	20	22	9	31	276
2001	11	28	31	30	10	15					4	31	160
2002	31	28	31	30	31	9							160
2003			5	30	31	22					27	31	146
2004	31	29	31	30	31	21					1	31	205
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				28	30	31	242
2007	31	18	14	30	28								121
2008	22	29	31	30	28		8	28	30	31	30	31	298
2009	31	28	31	30	30	10				29	30	31	250
2010	21	8	19	24	19	18	6			24	30	26	195
2011	27	11	31	30	31	29	6			1	30	31	227
2012	31	29	31	5	11							13	120
2013	31	28	30	30	31	30	21	28	30	31	30	31	351
2014	31	28	31	30	31	14	22	31	30	31	30	31	340
2015	31	28	11	30	12	22	21				30	31	216
2016	31	29	31	30	30								151
2017	18	28	31	30	31	22	8				10	21	199
2018	19	28	19	25	29							27	147
2019	31	28	23	30	31	17					10	25	195
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**351**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**14**	**22**	**186**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
Total Number of Occurrances (days)	1532	1342	1549	1903	1689	714	272	185	407	782	973	1493	12841
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Reliability Based on Occurrance	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	64%	77%	100%

Scenario #3

Municipal Taking	0.2 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 3 Number of Days Allowable Taking Equals Maximum ASR Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6				6	18	31	212
1952	31	29	30	30	21	6							147
1953	5	8	31	10	31	24	15		20	20			164
1954		7	31	30	20					16	30	23	157
1955	25		30	30	17	1					7	31	141
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				16	31	207
1958	27		4	29									60
1959			2	30	31	3					6	31	103
1960	31	29	5	28	31	28							152
1961		2	15	30	22	16							85
1962				29	10								39
1963			5	30	31	1							67
1964													
1965	22	28	26	23	27					6	30	31	193
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	2	30	31	30	31	284
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					8	9	163
1970				21	31	4				21	30	31	138
1971	31	28	31	30	17	13	2	3	30	23		17	225
1972	31	29	1	18	28	20	17			18	30	31	223
1973	31	28	31	30	31	15					1	25	192
1974	31	28	31	30	31	21	1						173
1975		1	20	30	25						9	31	116
1976	23	29	31	30	31	12	18		15	31	30	26	276
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			27	30	31	3						10	101
1980	31	11	12	30	31	11				26	30	31	213
1981	17	21	24	30	18				1	31	30	28	200
1982	19		8	30	13	30	5		4	29	30	31	199
1983	31	28	31	30	31	15						20	186
1984	20	18	31	30	28	12						19	158
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						1	31	156
1988	31	29	29	30	24						11	31	185
1989	31	22	14	30	31	27	2				1	6	164
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	26	5							151
1992	20	23	31	24	24	9	12	30	30	31	30	31	295
1993	31	28	7	30	21	22	3			31	30	31	234
1994	2	7	18	30	31	9							97
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		19	31	30	31	296
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												24	24
2000	29	4	31	30	28	25	21	24	19	23	5	30	269
2001	8	28	31	30	10	13					1	31	152
2002	31	28	31	30	31	8							159
2003			3	30	31	22					26	31	143
2004	31	29	31	30	31	21						30	203
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				27	30	31	241
2007	31	18	13	30	28								120
2008	22	29	31	30	28		7	27	30	31	30	31	296
2009	31	28	31	30	30	10				25	30	31	246
2010	21	7	19	24	17	17	6			18	28	26	183
2011	27	11	31	30	31	29	6				30	31	226
2012	31	29	31	5	11							11	118
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	13	22	31	30	31	30	31	339
2015	31	28	11	30	12	21	21				21	31	206
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				8	15	190
2018	19	28	19	24	29							18	137
2019	31	28	23	30	31	17					8	25	193
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**13**	**20**	**181**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1494	1321	1532	1899	1679	700	267	177	381	733	905	1408	12496
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	70%	68%	72%	92%	78%	34%	12%	8%	18%	34%	44%	66%	50%
Reliability Based on Occurrance	83%	81%	94%	97%	94%	71%	32%	16%	25%	42%	62%	75%	99%

Scenario #4

Municipal Taking	0.25 m^3/s	Eramosa Intake	Existing (0.1 m^3/s)
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 4 Number of Days Allowable Taking Equals Maximum ASR Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	19	6							145
1953		7	31	10	31	24	15		12	19			149
1954		6	31	30	20					16	30	23	156
1955	25		29	30	17						2	31	134
1956	22		22	29	31	13	23	7	30	26	9	31	243
1957	21	28	31	30	31	9	10				16	31	207
1958	27		3	29									59
1959			1	30	31	3						25	90
1960	31	29	5	28	31	28							152
1961		1	7	30	22	16							76
1962				25	10								35
1963			4	30	31	1							66
1964													
1965	20	22	26	23	27						26	31	175
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	1	30	31	30	31	283
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				20	31	4				13	30	31	129
1971	31	28	31	30	17	9	1	2	30	22		16	217
1972	31	29	1	18	28	20	17			10	30	31	215
1973	31	28	31	30	31	15						14	180
1974	31	28	31	30	31	21							172
1975			12	30	25							26	93
1976	22	29	31	30	31	12	18		14	31	30	26	274
1977			21	30	9				2	31	30	31	154
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				18	30	31	205
1981	17	21	24	30	18					30	30	28	198
1982	18		7	30	12	30	5		3	29	30	31	195
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	28	11						18	155
1985	31	10	31	30	14	1		1	30	31	30	31	240
1986	31	28	27	30	24	20	15	13	30	31	30	31	310
1987	31	28	31	30	4							31	155
1988	31	29	29	30	24						9	31	183
1989	31	22	14	30	31	27	2						157
1990	13	28	31	30	25	1				19	30	31	208
1991	31	28	31	30	25	5							150
1992		18	31	24	24	8	12	29	30	31	30	31	268
1993	31	28	7	30	19	22	3			26	30	31	227
1994	2	7	17	30	31	9							96
1995	16	24	24	15	31	17				21	30	31	209
1996	30	29	31	30	31	30	4		18	31	30	31	295
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												23	23
2000	29	4	31	30	28	25	20	23	16	23	2	28	259
2001	5	28	31	30	9	11						31	145
2002	31	28	31	30	31	8							159
2003			2	30	31	22					26	31	142
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	12	30	28								119
2008	22	29	31	30	28		5	26	30	31	30	31	293
2009	31	28	31	30	30	10				23	30	31	244
2010	20	7	19	24	17	14	6			7	25	26	165
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							9	115
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	12	22	31	30	31	30	31	338
2015	31	28	11	30	12	21	21				12	31	197
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				6	9	182
2018	19	28	19	23	29							10	128
2019	31	28	22	30	31	17					4	25	188
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**10**	**12**	**19**	**176**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1459	1303	1503	1892	1671	683	262	169	365	669	844	1345	12165
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	41%	63%	48%
Reliability Based on Occurrance	80%	80%	94%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%

Scenario #5

Municipal Taking 0.3 m^3/s Eramosa Intake Existing (0.1 m^3/s)

ASR Taking 0.5 m^3/s ASR Step Taking none

Scenario 5 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		4	18			140
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	22		20	28	31	13	22	5	30	26	9	31	237
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959				30	31	3						22	86
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						17	31	143
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15						1	167
1974	24	28	31	30	31	20							164
1975			10	30	25							17	82
1976	12	29	31	30	31	10	18		13	31	30	26	261
1977			21	30	9					31	30	31	152
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					28	30	28	194
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							29	153
1988	31	29	29	30	23						4	25	171
1989	31	22	13	30	31	27	2						156
1990	12	28	31	30	25	1				18	30	31	206
1991	31	28	31	30	25	5							150
1992		8	31	24	24	7	11	29	30	31	30	31	256
1993	31	28	7	30	17	22	3			20	30	31	219
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				2	30	31	189
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	23	28	31	29									111
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						30	135
2002	31	28	31	30	31	6							157
2003			2	30	31	22					25	31	141
2004	31	29	31	30	31	21						27	200
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				22	30	31	243
2010	20	6	19	24	17	13	6			4	17	26	152
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							6	110
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				7	31	191
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8						167
2018	18	28	19	22	29							9	125
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**21**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**18**	**172**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1404	1285	1483	1886	1663	669	254	160	348	610	805	1276	11843
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	71%	99%

Scenario #6

Municipal Taking	0.15 m^3/s	Eramosa Intake	Abandon
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 6 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	19	2				9	18	27	195
1952	31	29	25	30	13	3							131
1953	9	8	31	8	28	20	12		13	8			137
1954		7	31	30	15					16	30	7	136
1955	21		27	30	9						12	26	125
1956	3		18	28	31	7	14	8	30	20	9	30	198
1957	15	28	31	30	27	6	8				20	30	195
1958	17		4	25									46
1959			3	30	26						11	26	96
1960	30	26	2	28	31	21							138
1961		3	13	27	18	15							76
1962				30	1							8	39
1963			5	29	22								56
1964					2								2
1965	20	21	19	23	22					8	29	31	173
1966	24	18	31	30	23	8						23	157
1967	7	24	3	30	21	20	21	2	20	30	30	31	239
1968	15	29	19	25	14			8	30	30	22	31	223
1969	22	28	14	30	31						10	4	139
1970				21	23					18	30	31	123
1971	26	19	11	29	13	6	2	3	30	10		17	166
1972	24	12		18	24	16	10			17	30	26	177
1973	31	25	27	30	28	11					3	17	172
1974	20	28	29	28	31	11							147
1975		2	21	27	18	1				4	9	20	102
1976	8	24	31	30	31	7	13		16	31	28	13	232
1977			21	30	4				4	31	30	31	151
1978	31	24	7	30	26								118
1979	7		27	30	25							17	106
1980	31	2	12	30	27	4				23	13	28	170
1981	9	16	18	26	7				6	31	30	19	162
1982	7		8	30	6	30	2		5	22	29	31	170
1983	31	28	31	30	31	13						25	189
1984	15	17	31	30	16	5						22	136
1985	24	5	31	30	7	1		2	30	30	30	31	221
1986	31	22	20	30	20	17	11	12	30	31	29	31	284
1987	31	22	30	29							2	31	145
1988	25	29	23	30	15						16	21	159
1989	31	15	12	30	29	23					6	8	154
1990	14	28	31	30	16					22	30	31	202
1991	31	28	31	30	19	2						1	142
1992	18	18	25	20	21	6	9	27	30	31	30	31	266
1993	31	23	3	30	13	19	1		2	26	16	24	188
1994		7	14	30	31	6							88
1995	16	13	24	14	30	15			4	20	30	31	197
1996	19	29	31	30	31	25	2		20	31	30	31	279
1997	31	28	31	30	27								147
1998	25	11	31	26									93
1999												25	25
2000	21	4	31	18	24	20	13	15	12	12	3	12	185
2001	4	28	31	30	5	5					3	31	137
2002	24	28	31	30	28	4							145
2003			5	30	31	20					27	31	144
2004	28	9	29	30	31	14						31	172
2005	31	25	7	30	20						1	29	143
2006	31	28	31	30	23	1				28	30	31	233
2007	31	6	12	30	20								99
2008	22	29	31	30	25		6	26	28	31	27	31	286
2009	31	28	31	30	27	7				25	19	31	229
2010	12		19	20	14	9	5			15	13	18	125
2011	19	10	31	30	31	26					30	31	208
2012	31	29	31	3	6							13	113
2013	27	28	25	30	29	27	16	19	29	31	30	31	322
2014	31	28	29	30	31	4	20	21	29	31	30	31	315
2015	30	7	10	30	7	21	18				23	31	177
2016	31	29	31	30	24								145
2017	18	28	31	30	31	17	7				10	6	178
2018	19	28	16	19	26							26	134
2019	29	24	17	30	31	8					10	29	178
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**322**
Average	**19**	**16**	**20**	**27**	**20**	**7**	**3**	**2**	**5**	**10**	**13**	**19**	**161**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Total Number of Occurrances (days)	1282	1120	1397	1841	1386	503	190	143	368	672	868	1310	11080
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	42%	61%	44%
Reliability Based on Occurrance	83%	80%	93%	97%	94%	61%	28%	16%	28%	43%	62%	78%	100%

Scenario #7

Municipal Taking	0.15 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 7 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6	1			15	22	31	226
1952	31	29	30	30	22	6							148
1953	13	13	31	11	31	24	15		26	20			184
1954		7	31	30	20					16	30	23	157
1955	25		31	30	17	1					12	31	147
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				22	31	213
1958	28		4	29									61
1959			3	30	31	3					14	31	112
1960	31	29	5	28	31	28							152
1961		3	20	30	22	16							91
1962				30	10							19	59
1963			5	30	31	1							67
1964					5								5
1965	23	28	26	23	27					8	30	31	196
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					10	20	176
1970				21	31	4				26	30	31	143
1971	31	28	31	30	17	14	3	3	30	23		19	229
1972	31	29	1	18	28	20	18			24	30	31	230
1973	31	28	31	30	31	15					4	30	200
1974	31	28	31	30	31	22	1						174
1975		3	25	30	25	3				11	18	31	146
1976	24	29	31	30	31	13	18	4	18	31	30	26	285
1977			21	30	9				4	31	30	31	156
1978	31	28	14	30	31								134
1979	17		27	30	31	3						21	129
1980	31	13	12	30	31	11				28	30	31	217
1981	18	22	24	30	18				7	31	30	28	208
1982	20		8	30	13	30	5		5	29	30	31	201
1983	31	28	31	30	31	15						27	193
1984	20	20	31	30	28	13						23	165
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						17	31	191
1989	31	22	15	30	31	27	2				9	17	184
1990	15	28	31	30	26	1				22	30	31	214
1991	31	28	31	30	26	5						2	153
1992	30	29	31	24	24	9	13	31	30	31	30	31	313
1993	31	28	7	30	22	22	3		3	31	30	31	238
1994	2	8	19	30	31	9							99
1995	17	24	24	16	31	17			13	31	30	31	234
1996	30	29	31	30	31	30	4		21	31	30	31	298
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												25	25
2000	29	5	31	30	28	25	21	25	20	22	9	31	276
2001	11	28	31	30	10	15					4	31	160
2002	31	28	31	30	31	9							160
2003			5	30	31	22					28	31	147
2004	31	29	31	30	31	21					1	31	205
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				28	30	31	242
2007	31	18	14	30	28								121
2008	22	29	31	30	28		8	28	30	31	30	31	298
2009	31	28	31	30	30	10				29	30	31	250
2010	21	8	19	24	19	18	6			24	30	26	195
2011	27	11	31	30	31	29	6			1	30	31	227
2012	31	29	31	5	11							13	120
2013	31	28	30	30	31	30	21	28	30	31	30	31	351
2014	31	28	31	30	31	14	22	31	30	31	30	31	340
2015	31	28	11	30	12	22	21			2	30	31	218
2016	31	29	31	30	30								151
2017	18	28	31	30	31	22	8				10	21	199
2018	19	28	19	25	29							27	147
2019	31	28	23	30	31	17					10	25	195
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**351**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**14**	**22**	**187**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
Total Number of Occurrances (days)	1539	1343	1550	1903	1689	714	272	185	417	788	982	1500	12882
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	72%	69%	72%	92%	79%	34%	13%	9%	20%	37%	47%	70%	51%
Reliability Based on Occurrance	84%	81%	94%	97%	96%	72%	33%	17%	28%	46%	64%	78%	100%

Scenario #8

Municipal Taking	0.2 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 8 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6				6	18	31	212
1952	31	29	30	30	21	6							147
1953	5	8	31	10	31	24	15		20	20			164
1954		7	31	30	20					16	30	23	157
1955	25		30	30	17	1					7	31	141
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				16	31	207
1958	27		4	29									60
1959			2	30	31	3					6	31	103
1960	31	29	5	28	31	28							152
1961		2	15	30	22	16							85
1962				29	10								39
1963			5	30	31	1							67
1964													
1965	22	28	26	23	27					6	30	31	193
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	2	30	31	30	31	284
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					8	9	163
1970				21	31	4				21	30	31	138
1971	31	28	31	30	17	13	2	3	30	23		17	225
1972	31	29	1	18	28	20	17			18	30	31	223
1973	31	28	31	30	31	15					1	25	192
1974	31	28	31	30	31	21	1						173
1975		1	21	30	25						12	31	120
1976	23	29	31	30	31	12	18		15	31	30	26	276
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			27	30	31	3						10	101
1980	31	11	12	30	31	11				26	30	31	213
1981	17	21	24	30	18				2	31	30	28	201
1982	19		8	30	13	30	5		4	29	30	31	199
1983	31	28	31	30	31	15						20	186
1984	20	18	31	30	28	12						19	158
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						14	31	188
1989	31	22	14	30	31	27	2				3	14	174
1990	14	28	31	30	25	1				21	30	31	211
1991	31	28	31	30	26	5							151
1992	24	25	31	24	24	9	12	30	30	31	30	31	301
1993	31	28	7	30	21	22	3		1	31	30	31	235
1994	2	7	18	30	31	9							97
1995	16	24	24	15	31	17				30	30	31	218
1996	30	29	31	30	31	30	4		19	31	30	31	296
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												24	24
2000	29	4	31	30	28	25	21	24	19	23	5	30	269
2001	8	28	31	30	10	13					1	31	152
2002	31	28	31	30	31	8							159
2003			3	30	31	22					27	31	144
2004	31	29	31	30	31	21						30	203
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				27	30	31	241
2007	31	18	13	30	28								120
2008	22	29	31	30	28		7	27	30	31	30	31	296
2009	31	28	31	30	30	10				25	30	31	246
2010	21	7	19	24	17	17	6			18	28	26	183
2011	27	11	31	30	31	29	6				30	31	226
2012	31	29	31	5	11							11	118
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	13	22	31	30	31	30	31	339
2015	31	28	11	30	12	21	21				25	31	210
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				8	15	190
2018	19	28	19	24	29							23	142
2019	31	28	23	30	31	17					8	25	193
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**13**	**21**	**182**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1498	1323	1533	1899	1679	700	267	177	383	738	919	1421	12537
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	70%	68%	72%	92%	78%	34%	12%	8%	19%	35%	44%	66%	50%
Reliability Based on Occurrance	83%	81%	94%	97%	94%	71%	32%	16%	26%	42%	62%	75%	99%

Scenario #9

Municipal Taking	0.25 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 9 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	19	6							145
1953		7	31	10	31	24	15		12	19			149
1954		6	31	30	20					16	30	23	156
1955	25		29	30	17						2	31	134
1956	22		22	29	31	13	23	7	30	26	9	31	243
1957	21	28	31	30	31	9	10				16	31	207
1958	27		3	29									59
1959			1	30	31	3						25	90
1960	31	29	5	28	31	28							152
1961		1	7	30	22	16							76
1962				25	10								35
1963			4	30	31	1							66
1964													
1965	20	22	26	23	27						26	31	175
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	1	30	31	30	31	283
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				20	31	4				13	30	31	129
1971	31	28	31	30	17	9	1	2	30	22		16	217
1972	31	29	1	18	28	20	17			10	30	31	215
1973	31	28	31	30	31	15						14	180
1974	31	28	31	30	31	21							172
1975			16	30	25							28	99
1976	22	29	31	30	31	12	18		14	31	30	26	274
1977			21	30	9				2	31	30	31	154
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				19	30	31	206
1981	17	21	24	30	18					31	30	28	199
1982	18		7	30	12	30	5		3	29	30	31	195
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	28	11						18	155
1985	31	10	31	30	14	1		1	30	31	30	31	240
1986	31	28	27	30	24	20	15	13	30	31	30	31	310
1987	31	28	31	30	4							31	155
1988	31	29	29	30	24						11	31	185
1989	31	22	14	30	31	27	2				1	5	163
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	25	5							150
1992	8	19	31	24	24	8	12	29	30	31	30	31	277
1993	31	28	7	30	19	22	3			27	30	31	228
1994	2	7	17	30	31	9							96
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		18	31	30	31	295
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												23	23
2000	29	4	31	30	28	25	20	23	16	23	2	28	259
2001	5	28	31	30	9	11						31	145
2002	31	28	31	30	31	8							159
2003			2	30	31	22					26	31	142
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	12	30	28								119
2008	22	29	31	30	28		5	26	30	31	30	31	293
2009	31	28	31	30	30	10				23	30	31	244
2010	20	7	19	24	17	14	6			7	25	26	165
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							9	115
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	12	22	31	30	31	30	31	338
2015	31	28	11	30	12	21	21				15	31	200
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				6	9	182
2018	19	28	19	23	29							11	129
2019	31	28	22	30	31	17					4	25	188
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**10**	**12**	**20**	**177**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1468	1304	1507	1892	1671	683	262	169	365	678	850	1353	12202
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	69%	67%	70%	91%	78%	33%	12%	8%	18%	32%	41%	63%	48%
Reliability Based on Occurrance	81%	80%	94%	97%	94%	70%	30%	16%	23%	39%	52%	74%	99%

Scenario #10

Municipal Taking	0.3 m^3/s	Eramosa Intake	Abandon
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 10 Number of Days Allowable Taking Equals Maximum ASR Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		4	18			140
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	22		20	28	31	13	22	5	30	26	9	31	237
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959				30	31	3						22	86
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						17	31	143
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15						1	167
1974	24	28	31	30	31	20							164
1975			11	30	25							17	83
1976	14	29	31	30	31	10	18		13	31	30	26	263
1977			21	30	9				1	31	30	31	153
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					28	30	28	194
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							30	154
1988	31	29	29	30	23						9	31	182
1989	31	22	13	30	31	27	2						156
1990	13	28	31	30	25	1				19	30	31	208
1991	31	28	31	30	25	5							150
1992		10	31	24	24	7	11	29	30	31	30	31	258
1993	31	28	7	30	17	22	3			21	30	31	220
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				16	30	31	203
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						30	135
2002	31	28	31	30	31	6							157
2003			2	30	31	22					25	31	141
2004	31	29	31	30	31	21						27	200
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				22	30	31	243
2010	20	6	19	24	17	13	6			4	17	26	152
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							6	110
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				9	31	193
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8						167
2018	18	28	19	22	29							9	125
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**19**	**172**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1408	1287	1484	1886	1663	669	254	160	349	626	812	1283	11881
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	66%	66%	69%	91%	78%	32%	12%	7%	17%	29%	39%	60%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	23%	39%	48%	71%	99%

Scenario #11

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	1.0 m^3/s	ASR Step Taking	none

Scenario 11 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	19	2				6	18	27	192
1952	31	29	25	30	13	3							131
1953	8	8	31	8	28	20	12		13	8			136
1954		7	31	30	15					16	30	7	136
1955	21		27	30	9						7	25	119
1956	3		18	28	31	7	14	8	30	20	9	30	198
1957	15	28	31	30	27	6	8				19	30	194
1958	17		4	25									46
1959			3	30	26						6	26	91
1960	29	26	2	28	31	21							137
1961		3	12	27	18	15							75
1962				30	1							3	34
1963			5	29	22								56
1964													
1965	20	21	19	23	22					6	27	31	169
1966	24	18	31	30	23	8						23	157
1967	7	24	3	30	21	20	21	2	19	30	30	31	238
1968	15	29	19	25	14			8	30	30	22	31	223
1969	22	28	14	30	31						10	4	139
1970				21	23					18	30	31	123
1971	26	19	11	29	13	6	2	3	30	10		17	166
1972	24	12		18	24	16	10			15	30	26	175
1973	31	25	27	30	28	11					2	15	169
1974	20	28	29	28	31	11							147
1975		2	20	27	18	1				3	8	20	99
1976	8	24	31	30	31	7	13		16	31	28	13	232
1977			21	30	4				4	31	30	31	151
1978	31	24	7	30	26								118
1979	6		27	30	25							17	105
1980	31	2	12	30	27	4				23	13	28	170
1981	9	16	18	26	7				5	31	30	19	161
1982	7		8	30	6	30	2		5	22	29	31	170
1983	31	28	31	30	31	13						25	189
1984	15	17	31	30	16	5						20	134
1985	24	5	31	30	7	1		2	30	30	30	31	221
1986	31	22	20	30	20	17	11	12	30	31	29	31	284
1987	31	22	30	29							2	31	145
1988	25	29	23	30	15						14	21	157
1989	31	15	12	30	29	23					3	6	149
1990	14	28	31	30	16					21	30	31	201
1991	31	28	31	30	19	2							141
1992	17	17	25	20	21	6	9	27	30	31	30	31	264
1993	31	23	3	30	13	19	1		2	25	16	24	187
1994		7	14	30	31	6							88
1995	16	13	24	14	30	15			1	20	30	31	194
1996	19	29	31	30	31	25	2		20	31	30	31	279
1997	31	28	31	30	27								147
1998	25	11	31	26									93
1999												25	25
2000	21	4	31	18	24	20	13	15	12	12	3	12	185
2001	4	28	31	30	5	5					1	31	135
2002	24	28	31	30	28	4							145
2003			5	30	31	20					27	31	144
2004	28	9	29	30	31	14						31	172
2005	31	25	7	30	20						1	29	143
2006	31	28	31	30	23	1				28	30	31	233
2007	31	6	12	30	20								99
2008	22	29	31	30	25		6	26	28	31	27	31	286
2009	31	28	31	30	27	7				24	19	31	228
2010	12		19	20	14	9	5			14	13	18	124
2011	19	10	31	30	31	26					30	31	208
2012	31	29	31	3	6							13	113
2013	26	28	25	30	29	27	16	19	29	31	30	31	321
2014	31	28	29	30	31	4	19	18	29	31	30	31	311
2015	30	7	10	30	7	21	18				21	31	175
2016	31	29	31	30	24								145
2017	18	28	31	30	31	17	7				10	6	178
2018	19	28	16	19	26							22	130
2019	29	24	17	30	31	8					10	29	178
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**321**
Average	**19**	**16**	**20**	**27**	**20**	**7**	**3**	**2**	**5**	**10**	**12**	**19**	**160**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1277	1119	1395	1841	1384	503	189	140	363	660	844	1293	11008
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	60%	57%	65%	89%	65%	24%	9%	7%	18%	31%	41%	60%	44%
Reliability Based on Occurrance	83%	80%	93%	97%	93%	61%	28%	16%	28%	43%	62%	77%	99%

Scenario #12

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 12 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6	1			10	20	31	219
1952	31	29	30	30	22	6							148
1953	11	12	31	11	31	24	15		26	20			181
1954		7	31	30	20					16	30	23	157
1955	25		31	30	17	1					8	31	143
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				21	31	212
1958	28		4	29									61
1959			3	30	31	3					7	31	105
1960	31	29	5	28	31	28							152
1961		3	19	30	22	16							90
1962				30	10							7	47
1963			5	30	31	1							67
1964					1								1
1965	23	28	26	23	27					7	30	31	195
1966	31	23	31	30	31	11						23	180
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					10	20	176
1970				21	31	4				26	30	31	143
1971	31	28	31	30	17	14	3	3	30	23		19	229
1972	31	29	1	18	28	20	18			20	30	31	226
1973	31	28	31	30	31	15					2	29	197
1974	31	28	31	30	31	22	1						174
1975		2	24	30	25	3				7	17	31	139
1976	24	29	31	30	31	13	18	4	18	31	30	26	285
1977			21	30	9				4	31	30	31	156
1978	31	28	14	30	31								134
1979	14		27	30	31	3						21	126
1980	31	13	12	30	31	11				28	30	31	217
1981	18	22	24	30	18				6	31	30	28	207
1982	20		8	30	13	30	5		5	29	30	31	201
1983	31	28	31	30	31	15						26	192
1984	20	20	31	30	28	13						20	162
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						2	31	157
1988	31	29	29	30	24						15	31	189
1989	31	22	15	30	31	27	2				3	15	176
1990	15	28	31	30	26	1				21	30	31	213
1991	31	28	31	30	26	5							151
1992	27	29	31	24	24	9	13	31	30	31	30	31	310
1993	31	28	7	30	22	22	3		3	31	30	31	238
1994	2	8	19	30	31	9							99
1995	16	24	24	16	31	17			6	30	30	31	225
1996	30	29	31	30	31	30	4		21	31	30	31	298
1997	31	28	31	30	31	2							153
1998	25	28	31	29									113
1999												25	25
2000	29	5	31	30	28	25	21	25	20	22	9	31	276
2001	11	28	31	30	10	15					1	31	157
2002	31	28	31	30	31	9							160
2003			5	30	31	22					27	31	146
2004	31	29	31	30	31	21						31	204
2005	31	28	14	30	25						1	31	160
2006	31	28	31	30	28	5				28	30	31	242
2007	31	18	14	30	28								121
2008	22	29	31	30	28		8	28	30	31	30	31	298
2009	31	28	31	30	30	10				28	30	31	249
2010	21	8	19	24	19	18	6			23	29	26	193
2011	27	11	31	30	31	29	6			1	30	31	227
2012	31	29	31	5	11							13	120
2013	31	28	30	30	31	30	21	28	30	31	30	31	351
2014	31	28	31	30	31	14	22	31	30	31	30	31	340
2015	31	28	11	30	12	22	21				30	31	216
2016	31	29	31	30	30								151
2017	18	28	31	30	31	22	8				10	21	199
2018	19	28	19	25	29							26	146
2019	31	28	23	30	31	17					10	25	195
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**351**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**11**	**14**	**21**	**185**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Total Number of Occurrances (days)	1530	1341	1548	1903	1685	714	272	185	409	768	951	1478	12784
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	72%	69%	72%	92%	79%	34%	13%	9%	20%	36%	46%	69%	51%
Reliability Based on Occurrance	84%	81%	94%	97%	96%	72%	33%	17%	28%	45%	62%	77%	100%

Scenario #13

Municipal Taking	0.2 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 13 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					18	31	206
1952	31	29	30	30	21	6							147
1953	1	8	31	10	31	24	15		20	20			160
1954		7	31	30	20					16	30	23	157
1955	25		30	30	17	1					4	31	138
1956	22		25	30	31	13	23	8	30	26	9	31	248
1957	21	28	31	30	31	9	10				16	31	207
1958	27		4	29									60
1959			2	30	31	3						26	92
1960	31	29	5	28	31	28							152
1961		2	13	30	22	16							83
1962				29	10								39
1963			5	30	31	1							67
1964													
1965	22	28	26	23	27					1	30	31	188
1966	31	23	31	30	31	11						22	179
1967	19	28	8	30	27	20	28	2	30	31	30	31	284
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8					7	9	162
1970				21	31	4				20	30	31	137
1971	31	28	31	30	17	13	2	3	30	23		17	225
1972	31	29	1	18	28	20	17			15	30	31	220
1973	31	28	31	30	31	15						21	187
1974	31	28	31	30	31	21	1						173
1975		1	19	30	25						9	31	115
1976	23	29	31	30	31	12	18		15	31	30	26	276
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			27	30	31	3						10	101
1980	31	11	12	30	31	11				26	30	31	213
1981	17	21	24	30	18				1	31	30	28	200
1982	19		8	30	13	30	5		4	29	30	31	199
1983	31	28	31	30	31	15						20	186
1984	20	18	31	30	28	12						19	158
1985	31	11	31	30	14	4		2	30	31	30	31	245
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						1	31	156
1988	31	29	29	30	24						11	31	185
1989	31	22	14	30	31	27	2				1	7	165
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	26	5							151
1992	19	23	31	24	24	9	12	30	30	31	30	31	294
1993	31	28	7	30	21	22	3			31	30	31	234
1994	2	7	18	30	31	9							97
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		19	31	30	31	296
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												24	24
2000	29	4	31	30	28	25	21	24	19	23	5	30	269
2001	8	28	31	30	10	13						31	151
2002	31	28	31	30	31	8							159
2003			3	30	31	22					26	31	143
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				27	30	31	241
2007	31	18	13	30	28								120
2008	22	29	31	30	28		7	27	30	31	30	31	296
2009	31	28	31	30	30	10				25	30	31	246
2010	21	7	19	24	17	17	6			15	28	26	180
2011	27	11	31	30	31	29	6				30	31	226
2012	31	29	31	5	11							11	118
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	13	22	31	30	31	30	31	339
2015	31	28	11	30	12	21	21				20	31	205
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				8	15	190
2018	19	28	19	24	29							15	134
2019	31	28	23	30	31	17					8	25	193
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**22**	**19**	**22**	**28**	**24**	**10**	**4**	**3**	**6**	**10**	**13**	**20**	**180**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1488	1321	1529	1899	1679	700	267	177	381	715	891	1395	12442
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	70%	68%	71%	92%	78%	34%	12%	8%	18%	33%	43%	65%	49%
Reliability Based on Occurrance	83%	81%	94%	97%	94%	71%	32%	16%	25%	41%	57%	75%	99%

Scenario #14

Municipal Taking	0.25 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 14 Number of Days Allowable Taking Equals Maximum ASR Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	19	6							145
1953		7	31	10	31	24	15		12	19			149
1954		6	31	30	20					16	30	23	156
1955	25		29	30	17						1	31	133
1956	22		22	29	31	13	23	7	30	26	9	31	243
1957	21	28	31	30	31	9	10				15	31	206
1958	27		3	29									59
1959				30	31	3						23	87
1960	31	29	5	28	31	28							152
1961		1	6	30	22	16							75
1962				25	10								35
1963			4	30	31	1							66
1964													
1965	16	21	26	23	27						20	31	164
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	1	30	31	30	31	283
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				20	31	4				10	30	31	126
1971	31	28	31	30	17	9	1	2	30	22		16	217
1972	31	29	1	18	28	20	17			8	30	31	213
1973	31	28	31	30	31	15						4	170
1974	31	28	31	30	31	21							172
1975			11	30	25							26	92
1976	22	29	31	30	31	12	18		14	31	30	26	274
1977			21	30	9				1	31	30	31	153
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				18	30	31	205
1981	17	21	24	30	18					30	30	28	198
1982	18		7	30	12	30	5		3	29	30	31	195
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	28	11						16	153
1985	31	10	31	30	14	1		1	30	31	30	31	240
1986	31	28	27	30	24	20	15	13	30	31	30	31	310
1987	31	28	31	30	4							31	155
1988	31	29	29	30	24						9	31	183
1989	31	22	14	30	31	27	2						157
1990	13	28	31	30	25	1				19	30	31	208
1991	31	28	31	30	25	5							150
1992		16	31	24	24	8	12	29	30	31	30	31	266
1993	31	28	7	30	19	22	3			26	30	31	227
1994	2	7	17	30	31	9							96
1995	16	24	24	15	31	17				23	30	31	211
1996	30	29	31	30	31	30	4		18	31	30	31	295
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												22	22
2000	29	4	31	30	28	25	20	23	16	23	2	28	259
2001	5	28	31	30	9	11						31	145
2002	31	28	31	30	31	8							159
2003			2	30	31	22					25	31	141
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	12	30	28								119
2008	22	29	31	30	28		5	26	30	31	30	31	293
2009	31	28	31	30	30	10				22	30	31	243
2010	20	7	19	24	17	14	6			6	22	26	161
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							9	115
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	12	22	31	30	31	30	31	338
2015	31	28	11	30	12	21	21				11	31	196
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				5	9	181
2018	19	28	19	23	29							10	128
2019	31	28	22	30	31	17					4	25	188
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**10**	**12**	**19**	**176**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1455	1300	1500	1892	1671	683	262	169	364	664	830	1330	12120
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	40%	62%	48%
Reliability Based on Occurrance	80%	80%	93%	97%	94%	70%	30%	16%	23%	39%	51%	72%	99%

Scenario #15

Municipal Taking	0.3 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	none

Scenario 15 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		6	31	10	31	24	15		4	18			139
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	21		20	28	31	13	22	5	30	26	9	31	236
1957	21	28	31	30	31	9	10				14	31	205
1958	26		3	29									58
1959				30	31	3						15	79
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						14	31	140
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15							166
1974	14	28	31	30	31	20							154
1975			10	30	25							17	82
1976	11	29	31	30	31	10	18		13	31	30	26	260
1977			21	30	9					31	30	31	152
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					27	30	28	193
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							29	153
1988	31	29	29	30	23						4	25	171
1989	31	22	13	30	31	27	2						156
1990	12	28	31	30	25	1				18	30	31	206
1991	31	28	31	30	25	5							150
1992		8	31	24	24	7	11	29	30	31	30	31	256
1993	31	28	7	30	17	22	3			19	30	31	218
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				5	30	31	192
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	23	28	31	29									111
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						29	134
2002	31	28	31	30	31	6							157
2003			2	30	31	22					24	31	140
2004	31	29	31	30	31	21						26	199
2005	31	28	14	30	25							30	158
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				21	30	31	242
2010	20	6	19	24	17	13	6			3	15	26	149
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							4	108
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				6	31	190
2016	31	29	31	30	30								151
2017	17	28	31	30	31	21	8						166
2018	18	28	19	22	29							8	124
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**21**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**18**	**171**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1391	1284	1483	1886	1663	669	254	160	348	609	797	1262	11806
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%

Scenario #16

Municipal Taking	0.15 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 16 Number of Days Allowable Taking Equals Maximum ASR Taking

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		24	20			162
1954		6	31	30	20					16	30	22	155
1955	25		24	30	17						5	31	132
1956	22		20	28	31	13	22	8	30	26	9	31	240
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959			3	30	31	3						26	93
1960	31	29	5	28	31	28							152
1961		2	16	30	22	16							86
1962				28	10								38
1963			4	30	31	1							66
1964													
1965	21	28	26	23	27						27	31	183
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	3	30	31	30	31	285
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				15	30	31	130
1971	31	28	31	30	17	7	1	3	30	22		15	215
1972	31	29	1	18	28	20	18			9	30	31	215
1973	31	28	31	30	31	15						5	171
1974	31	28	31	30	31	20							171
1975			15	30	25							25	95
1976	18	29	31	30	31	10	18	4	15	31	30	26	273
1977			21	30	9				3	31	30	31	155
1978	31	28	14	30	31								134
1979			26	30	31	3						16	106
1980	31	11	12	30	31	11				24	30	31	211
1981	16	20	24	30	18				1	31	30	28	198
1982	17		7	29	12	30	5		4	29	30	31	194
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	27	11						16	152
1985	31	10	31	30	14	1		2	30	31	30	31	241
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4						1	31	156
1988	31	29	29	30	23						12	31	185
1989	31	22	13	30	31	27	2				3	13	172
1990	14	28	31	30	25	1				20	30	31	210
1991	31	28	31	30	25	5							150
1992	18	20	31	24	24	7	12	30	30	31	30	31	288
1993	31	28	7	30	17	22	3			30	30	31	229
1994	2	6	15	30	31	9							93
1995	16	24	24	15	31	17				26	30	31	214
1996	30	29	31	30	31	30	4		20	31	30	31	297
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												24	24
2000	29	4	31	30	28	25	21	25	14	23	2	22	254
2001		27	31	30	9	12						31	140
2002	31	28	31	30	31	6							157
2003			4	30	31	22					26	31	144
2004	31	29	31	30	31	21						29	202
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	9	30	28								116
2008	22	29	31	30	28		6	26	30	31	30	31	294
2009	31	28	31	30	30	10				24	30	31	245
2010	20	6	19	24	17	13	6			10	24	26	165
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							10	116
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				11	31	195
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				5	7	179
2018	19	28	19	22	29							21	138
2019	31	28	22	30	31	17					7	25	191
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**3**	**6**	**10**	**12**	**20**	**177**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1467	1308	1505	1891	1666	674	264	182	381	692	854	1358	12242
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	69%	67%	70%	91%	78%	33%	12%	9%	18%	32%	41%	63%	49%
Reliability Based on Occurrance	80%	80%	94%	97%	94%	70%	30%	17%	25%	39%	54%	74%	99%

Scenario #17

Municipal Taking	$0.2\ m^3/s$	Eramosa Intake	Maximize
ASR Taking	$0.5\ m^3/s$	ASR Step Taking	$0.3\ m^3/s$

Scenario 17 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		16	20			154
1954		6	31	30	20					16	30	22	155
1955	25		24	30	17						2	31	129
1956	22		20	28	31	13	22	8	30	26	9	31	240
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959			2	30	31	3						25	91
1960	31	29	5	28	31	28							152
1961		2	9	30	22	16							79
1962				25	10								35
1963			4	30	31	1							66
1964													
1965	20	20	26	23	27						21	31	168
1966	31	23	31	30	31	10						22	178
1967	19	28	8	30	27	20	28	2	30	31	30	31	284
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				9	30	31	124
1971	31	28	31	30	17	7		3	30	23		15	215
1972	31	29	1	18	28	20	17			8	30	31	213
1973	31	28	31	30	31	15						2	168
1974	31	28	31	30	31	20							171
1975			14	30	25							23	92
1976	16	29	31	30	31	10	18		14	31	30	26	266
1977			21	30	9				2	31	30	31	154
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				17	30	31	204
1981	16	20	24	30	18					31	30	28	197
1982	17		7	29	12	30	5		3	29	30	31	193
1983	31	28	31	30	31	15						19	185
1984	20	17	31	30	27	11						16	152
1985	31	10	31	30	14	1		1	30	31	30	31	240
1986	31	28	27	30	24	20	15	14	30	31	30	31	311
1987	31	28	31	30	4							31	155
1988	31	29	29	30	23						10	31	183
1989	31	22	13	30	31	27	2					4	160
1990	14	28	31	30	25	1				19	30	31	209
1991	31	28	31	30	25	5							150
1992	4	17	31	24	24	7	12	30	30	31	30	31	271
1993	31	28	7	30	17	22	3			27	30	31	226
1994	2	6	15	30	31	9							93
1995	16	24	24	15	31	17				25	30	31	213
1996	30	29	31	30	31	30	4		19	31	30	31	296
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												23	23
2000	29	4	31	30	28	25	21	24	14	23	2	22	253
2001		27	31	30	9	11						31	139
2002	31	28	31	30	31	6							157
2003			2	30	31	22					26	31	142
2004	31	29	31	30	31	21						28	201
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	9	30	28								116
2008	22	29	31	30	28		5	26	30	31	30	31	293
2009	31	28	31	30	30	10				22	30	31	243
2010	20	6	19	24	17	13	6			6	20	26	157
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	10							9	115
2013	31	28	29	30	31	30	21	28	30	31	30	31	350
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				10	31	194
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8				2	3	172
2018	19	28	19	22	29							11	128
2019	31	28	22	30	31	17					6	25	190
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**350**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**3**	**5**	**10**	**12**	**19**	**175**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1450	1297	1494	1888	1666	673	261	175	368	668	830	1318	12088
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	68%	67%	70%	91%	78%	33%	12%	8%	18%	31%	40%	62%	48%
Reliability Based on Occurrance	80%	80%	94%	97%	94%	70%	29%	16%	23%	39%	51%	74%	99%

Scenario #18

Municipal Taking	0.25 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 18 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		7	31	10	31	24	15		10	19			147
1954		6	31	30	20					16	30	22	155
1955	25		24	30	17							30	126
1956	22		20	28	31	13	22	7	30	26	9	31	239
1957	21	28	31	30	31	9	10				15	31	206
1958	26		3	29									58
1959				30	31	3						22	86
1960	31	29	5	28	31	28							152
1961			5	30	22	16							73
1962				24	10								34
1963			4	30	31	1							66
1964													
1965	2	20	26	23	27						16	31	145
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28	1	30	31	30	31	283
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				5	30	31	120
1971	31	28	31	30	17	7		2	30	23		15	214
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15						1	167
1974	28	28	31	30	31	20							168
1975			11	30	25							17	83
1976	15	29	31	30	31	10	18		14	31	30	26	265
1977			21	30	9				1	31	30	31	153
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				11	30	31	198
1981	16	20	24	30	18					29	30	28	195
1982	17		7	29	12	30	5		2	29	30	31	192
1983	31	28	31	30	31	15						18	184
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				30	31	30	31	238
1986	31	28	27	30	24	20	15	13	30	31	30	31	310
1987	31	28	31	30	4							30	154
1988	31	29	29	30	23						9	31	182
1989	31	22	13	30	31	27	2						156
1990	13	28	31	30	25	1				19	30	31	208
1991	31	28	31	30	25	5							150
1992		11	31	24	24	7	11	29	30	31	30	31	259
1993	31	28	7	30	17	22	3			23	30	31	222
1994	2	6	15	30	31	9							93
1995	16	24	24	15	31	17				16	30	31	204
1996	30	29	31	30	31	30	4		18	31	30	31	295
1997	31	28	31	30	31	2							153
1998	24	28	31	29									112
1999												22	22
2000	29	4	31	30	28	25	20	23	14	23	2	22	251
2001		27	31	30	9	9						30	136
2002	31	28	31	30	31	6							157
2003			2	30	31	22					25	31	141
2004	31	29	31	30	31	21						27	200
2005	31	28	14	30	25							31	159
2006	31	28	31	30	28	5				26	30	31	240
2007	31	18	9	30	28								116
2008	22	29	31	30	28		4	26	30	31	30	31	292
2009	31	28	31	30	30	10				22	30	31	243
2010	20	6	19	24	17	13	6			5	17	26	153
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	9							7	112
2013	29	28	29	30	31	30	21	28	30	31	30	31	348
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				8	31	192
2016	31	29	31	30	30								151
2017	18	28	31	30	31	21	8						167
2018	19	28	19	22	29							10	127
2019	31	28	22	30	31	17					3	25	187
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**348**
Average	**21**	**19**	**22**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**19**	**173**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1421	1289	1485	1887	1665	670	258	168	359	640	811	1288	11941
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	66%	66%	69%	91%	78%	32%	12%	8%	17%	30%	39%	60%	47%
Reliability Based on Occurrance	78%	78%	93%	97%	94%	68%	29%	14%	23%	39%	48%	71%	99%

Scenario #19

Municipal Taking	0.3 m^3/s	Eramosa Intake	Maximize
ASR Taking	0.5 m^3/s	ASR Step Taking	0.3 m^3/s

Scenario 19 Number of Days Allowable Taking Equals Maximum ASR Taking													
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951	31	28	31	30	31	6					17	31	205
1952	31	29	30	30	18	6							144
1953		6	31	10	31	24	15		4	18			139
1954		6	31	30	20					16	30	22	155
1955	25		24	30	16							28	123
1956	21		20	28	31	13	22	5	30	26	9	31	236
1957	21	28	31	30	31	9	10				14	31	205
1958	26		3	29									58
1959				30	31	3						15	79
1960	31	29	5	28	31	28							152
1961			4	30	22	16							72
1962				23	10								33
1963			4	30	31	1							66
1964													
1965		19	26	23	27						14	31	140
1966	31	23	31	30	31	10						21	177
1967	19	28	8	30	27	20	28		30	31	30	31	282
1968	31	29	26	30	29			8	30	31	30	31	275
1969	31	28	18	30	31	8							146
1970				19	31	4				1	30	31	116
1971	31	28	31	30	17	7		1	30	23		15	213
1972	31	29	1	18	28	20	17			7	30	31	212
1973	31	28	31	30	31	15							166
1974	14	28	31	30	31	20							154
1975			10	30	25							17	82
1976	11	29	31	30	31	10	18		13	31	30	26	260
1977			21	30	9					31	30	31	152
1978	31	28	14	30	31								134
1979			26	30	31	3						8	98
1980	31	11	12	30	31	11				7	30	31	194
1981	16	20	24	30	18					27	30	28	193
1982	17		7	29	12	30	5		1	29	30	31	191
1983	31	28	31	30	31	15						17	183
1984	20	17	31	30	27	11						13	149
1985	31	10	31	30	14				29	31	30	31	237
1986	31	28	27	30	24	20	15	12	30	31	30	31	309
1987	31	28	31	30	4							29	153
1988	31	29	29	30	23						4	25	171
1989	31	22	13	30	31	27	2						156
1990	12	28	31	30	25	1				18	30	31	206
1991	31	28	31	30	25	5							150
1992		8	31	24	24	7	11	29	30	31	30	31	256
1993	31	28	7	30	17	22	3			19	30	31	218
1994	2	6	15	30	31	9							93
1995	15	24	24	15	31	17				5	30	31	192
1996	30	29	31	30	31	30	4		17	31	30	31	294
1997	31	28	31	30	31	2							153
1998	23	28	31	29									111
1999												22	22
2000	29	4	31	30	28	25	19	21	14	23	2	22	248
2001		27	31	30	9	8						29	134
2002	31	28	31	30	31	6							157
2003			2	30	31	22					24	31	140
2004	31	29	31	30	31	21						26	199
2005	31	28	14	30	25							30	158
2006	31	28	31	30	28	5				25	30	31	239
2007	31	18	9	30	28								116
2008	22	29	31	30	28		1	26	30	31	30	31	289
2009	31	28	31	30	30	10				21	30	31	242
2010	20	6	19	24	17	13	6			3	15	26	149
2011	27	10	31	30	31	29	6				30	31	225
2012	31	29	31	5	8							4	108
2013	25	28	29	30	31	30	21	27	30	31	30	31	343
2014	31	28	31	30	31	11	22	31	30	31	30	31	337
2015	31	28	10	30	12	21	21				6	31	190
2016	31	29	31	30	30								151
2017	17	28	31	30	31	21	8						166
2018	18	28	19	22	29							8	124
2019	31	28	22	30	31	17					2	25	186
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**343**
Average	**20**	**19**	**21**	**27**	**24**	**10**	**4**	**2**	**5**	**9**	**12**	**18**	**171**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1391	1284	1483	1886	1663	669	254	160	348	609	797	1262	11806
Total Days Period of Record	2139	1949	2139	2070	2139	2070	2139	2139	2070	2139	2070	2139	25202
Reliability Based on Time	65%	66%	69%	91%	78%	32%	12%	7%	17%	28%	39%	59%	47%
Reliability Based on Occurrance	77%	78%	93%	97%	94%	68%	29%	13%	22%	39%	48%	70%	99%

Appendix D – Reliability of Eramosa Intake taking over Period of Record

Minimum flow rate required for any taking under PTTW condition 3.4 condition 2

Eramosa Above Guelph Days Flow Exceeds 0.42 (m^3/s)													Apr to Nov
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1962	31	28	31	30	31	30	23	18	22	31	30	31	215
1963	31	28	31	30	31	28	31	20	22	19	25	18	206
1964	31	22	28	30	31	28	20	27	16	28	30	31	210
1965	31	27	31	30	31	30	31	31	30	31	30	31	244
1966	31	28	31	30	31	30	29	29	15	19	30	31	213
1967	31	28	31	30	31	30	31	31	30	31	30	31	244
1968	31	29	31	30	31	30	31	31	30	31	30	31	244
1969	31	28	31	30	31	30	31	31	10	22	30	31	215
1970	31	28	31	30	31	30	31	31	30	31	30	31	244
1971	31	28	31	30	31	30	31	31	30	31	30	31	244
1972	31	29	31	30	31	30	31	31	30	31	30	31	244
1973	31	28	31	30	31	30	31	30	13	31	30	31	226
1974	31	28	31	30	31	30	31	31	30	31	30	31	244
1975	31	28	31	30	31	30	31	31	30	31	30	31	244
1976	31	29	31	30	31	30	31	31	30	31	30	31	244
1977	31	28	31	30	31	30	31	31	30	31	30	31	244
1978	31	28	31	30	31	30	31	31	30	31	30	31	244
1979	31	28	31	30	31	30	31	31	30	31	30	31	244
1980	31	29	31	30	31	30	31	31	30	31	30	31	244
1981	31	28	31	30	31	30	31	31	30	31	30	31	244
1982	31	28	31	30	31	30	31	31	30	31	30	31	244
1983	31	28	31	30	31	30	31	31	30	31	30	31	244
1984	31	29	31	30	31	30	31	31	30	31	30	31	244
1985	31	28	31	30	31	30	31	31	30	31	30	31	244
1986	31	28	31	30	31	30	31	31	30	31	30	31	244
1987	31	28	31	30	31	30	31	31	30	31	30	31	244
1988	31	29	31	30	31	30	23	31	29	31	30	31	235
1989	31	28	31	30	31	30	31	31	30	31	30	31	244
1990	31	28	31	30	31	30	31	31	30	31	30	31	244
1991	31	28	31	30	31	30	31	31	30	31	30	31	244
1992	31	29	31	30	31	30	31	31	30	31	30	31	244
1993	31	28	31	30	31	30	31	31	30	31	30	31	244
1994	31	28	31	30	31	30	31	24	24	31	30	31	231
1995	31	28	31	30	31	30	31	31	27	27	30	31	237
1996	31	29	31	30	31	30	31	31	30	31	30	31	244
1997	31	28	31	30	31	30	31	31	30	31	30	31	244
1998	31	28	31	30	31	30	31	16	6	31	30	31	205
1999	19	28	31	30	31	28	15	7	11	30	30	31	182
2000	31	29	31	30	31	30	31	31	30	31	30	31	244
2001	31	28	31	30	31	30	31	16	10	30	30	31	208
2002	31	28	31	30	31	30	31	31	18	31	30	31	232
2003	31	28	31	30	31	30	31	31	13	31	30	31	227
2004	31	29	31	30	31	30	31	31	30	31	30	31	244
2005	31	28	31	30	31	30	31	31	30	31	30	31	244
2006	31	28	31	30	31	30	31	31	30	31	30	31	244
2007	31	28	31	30	31	30	31	31	27	30	30	31	240
2008	31	29	31	30	31	30	31	31	30	31	30	31	244
2009	31	28	31	30	31	30	31	31	30	31	30	31	244
2010	31	28	31	30	31	30	31	31	30	31	30	31	244
2011	31	28	31	30	31	30	31	31	30	31	30	31	244
2012	31	29	31	30	31	30	0	12	20	31	30	31	184
2013	31	28	31	30	31	30	31	31	30	31	30	31	244
2014	31	28	31	30	31	30	31	31	30	31	30	31	244
2015	31	28	31	30	31	30	31	31	30	31	30	31	244
2016	31	29	31	30	31	30	23	19	21	31	30	31	215
2017	31	28	31	30	31	30	31	31	30	31	30	31	244
2018	31	28	31	30	31	30	31	31	30	31	30	31	244
2019	31	28	31	30	31	30	31	31	30	31	30	31	244
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	31	28	31	30	31	30	30	29	26	30	30	31	236
Min	19	22	28	30	31	28	0	7	6	19	25	18	182
Total Number of Occurrances (days)	1786	1630	1795	1740	1798	1734	1714	1675	1534	1755	1735	1785	13685
Total Days Period of Record	1798	1639	1798	1740	1798	1740	1798	1798	1740	1798	1740	1798	14152
Reliability Based on Time	99%	99%	100%	100%	100%	100%	95%	93%	88%	98%	100%	99%	97%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%	100%	100%

Flow rate corresponding for permitted taking rate from Sept 1 to Nov 31

Eramosa Above Guelph Days Flow Exceeds 0.525(m^3/s)													Apr to Nov
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1962	31	28	31	30	31	30	16	11	12	31	30	31	191
1963	31	28	31	30	31	22	30	15	10	13	14	12	165
1964	29	17	28	30	31	27	15	24	15	19	26	27	187
1965	31	27	31	30	31	17	29	31	30	31	30	31	229
1966	31	28	31	30	31	28	16	13	3	10	30	31	161
1967	31	28	31	30	31	30	31	31	27	31	30	31	241
1968	31	29	31	30	31	30	31	31	30	31	30	31	244
1969	31	28	31	30	31	30	27	23	0	17	30	31	188
1970	31	28	31	30	31	30	31	26	30	31	30	31	239
1971	31	28	31	30	31	30	31	29	30	31	30	31	242
1972	31	29	31	30	31	30	31	31	29	31	30	31	243
1973	31	28	31	30	31	30	31	27	9	31	30	31	219
1974	31	28	31	30	31	30	31	31	30	31	30	31	244
1975	31	28	31	30	31	30	31	29	30	31	30	31	242
1976	31	29	31	30	31	30	31	31	30	31	30	31	244
1977	31	28	31	30	31	30	27	31	30	31	30	31	240
1978	31	28	31	30	31	30	31	31	30	31	30	31	244
1979	31	28	31	30	31	30	31	31	30	31	30	31	244
1980	31	29	31	30	31	30	31	31	30	31	30	31	244
1981	31	28	31	30	31	30	31	31	30	31	30	31	244
1982	31	28	31	30	31	30	31	31	30	31	30	31	244
1983	31	28	31	30	31	30	31	31	30	31	30	31	244
1984	31	29	31	30	31	30	31	31	30	31	30	31	244
1985	31	28	31	30	31	30	31	31	30	31	30	31	244
1986	31	28	31	30	31	30	31	31	30	31	30	31	244
1987	31	28	31	30	31	30	31	31	30	31	30	31	244
1988	31	29	31	30	31	25	13	17	27	31	30	31	204
1989	31	28	31	30	31	30	28	16	6	22	30	28	193
1990	31	28	31	30	31	30	31	31	30	31	30	31	244
1991	31	28	31	30	31	30	31	28	19	31	30	31	230
1992	31	29	31	30	31	30	31	31	30	31	30	31	244
1993	31	28	31	30	31	30	31	31	30	31	30	31	244
1994	28	28	31	30	31	30	28	17	8	31	30	31	205
1995	31	28	31	30	31	30	31	29	7	27	30	31	215
1996	31	29	31	30	31	30	31	31	30	31	30	31	244
1997	31	28	31	30	31	30	31	28	30	31	30	31	241
1998	31	28	31	30	31	30	23	9	0	20	30	31	173
1999	18	28	31	30	31	23	12	3	8	28	29	28	164
2000	31	29	31	30	31	30	31	31	30	31	30	31	244
2001	31	28	31	30	31	30	31	8	9	28	30	31	197
2002	31	28	31	30	31	30	31	14	14	30	30	31	210
2003	31	28	19	30	31	30	31	20	12	30	30	31	214
2004	31	29	31	30	31	30	31	31	30	31	30	31	244
2005	31	28	31	30	31	30	31	20	29	31	30	31	232
2006	31	28	31	30	31	30	31	31	29	31	30	31	243
2007	31	28	31	30	31	30	31	22	0	8	26	31	178
2008	31	29	31	30	31	30	31	31	30	31	30	31	244
2009	31	28	31	30	31	30	31	31	30	31	30	31	244
2010	31	28	31	30	31	30	31	31	30	31	30	31	244
2011	31	28	31	30	31	30	31	31	30	31	30	31	244
2012	31	29	31	30	31	25	0	7	7	18	30	31	148
2013	31	28	31	30	31	30	31	31	30	31	30	31	244
2014	31	28	31	30	31	30	31	31	30	31	30	31	244
2015	31	28	31	30	31	30	31	31	27	31	30	31	241
2016	31	29	31	30	31	30	15	16	6	21	30	31	179
2017	31	28	31	30	31	30	31	31	22	31	30	31	236
2018	31	28	31	30	31	30	31	31	28	31	30	31	242
2019	31	28	31	30	31	30	31	31	30	31	30	31	244
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	31	28	31	30	31	29	28	26	23	29	30	31	225
Min	18	17	19	30	31	17	0	3	0	8	14	12	148
Total Number of Occurrances (days)	1780	1625	1783	1740	1798	1697	1643	1505	1323	1655	1715	1769	13076
Total Days Period of Record	1798	1639	1798	1740	1798	1740	1798	1798	1740	1798	1740	1798	14152
Reliability Based on Time	99%	99%	99%	100%	100%	98%	91%	84%	76%	92%	99%	98%	92%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	95%	100%	100%	100%	100%

Flow rate corresponding for permitted taking rate from July 16 to Aug 31

Eramosa Above Guelph Days Flow Exceeds 0.578(m^3/s)													Apr to Nov
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1962	31	28	31	30	31	30	9	11	11	31	30	31	183
1963	31	28	31	30	30	22	26	15	8	9	10	9	150
1964	24	12	28	30	31	26	11	22	11	17	22	25	170
1965	31	26	31	30	31	15	27	30	30	31	30	31	224
1966	31	28	31	30	31	26	6	9	2	9	29	31	142
1967	31	28	31	30	31	30	31	31	25	31	30	31	239
1968	31	29	31	30	31	30	28	31	30	31	30	31	241
1969	31	28	31	30	31	30	25	22	0	14	30	31	182
1970	31	28	31	30	31	30	31	23	30	31	30	31	236
1971	31	28	31	30	31	30	31	24	30	31	30	31	237
1972	31	29	31	30	31	30	31	30	26	31	30	31	239
1973	31	28	31	30	31	30	31	25	9	31	30	31	217
1974	31	28	31	30	31	30	31	31	30	31	30	31	244
1975	31	28	31	30	31	30	30	25	30	31	30	31	237
1976	31	29	31	30	31	30	31	31	30	31	30	31	244
1977	24	19	31	30	31	30	27	31	30	31	30	31	240
1978	31	28	31	30	31	30	31	29	30	31	30	31	242
1979	31	28	31	30	31	30	31	31	30	31	30	31	244
1980	31	29	31	30	31	30	31	31	30	31	30	31	244
1981	31	28	31	30	31	30	31	31	30	31	30	31	244
1982	31	28	31	30	31	30	31	31	30	31	30	31	244
1983	31	28	31	30	31	30	31	31	30	31	30	31	244
1984	31	29	31	30	31	30	31	31	30	31	30	31	244
1985	31	28	31	30	31	30	31	31	30	31	30	31	244
1986	31	28	31	30	31	30	31	31	30	31	30	31	244
1987	31	28	31	30	31	30	31	31	30	31	30	31	244
1988	31	29	31	30	31	22	12	13	22	31	30	31	191
1989	31	28	31	30	31	30	23	11	2	22	30	18	179
1990	29	28	31	30	31	30	31	29	26	31	30	31	238
1991	31	28	31	30	31	30	31	26	18	31	29	31	226
1992	31	29	31	30	31	30	31	31	30	31	30	31	244
1993	31	28	31	30	31	30	31	31	30	31	30	31	244
1994	18	28	31	30	31	30	26	15	4	28	30	31	194
1995	31	28	31	30	31	30	31	27	2	26	30	31	207
1996	31	29	31	30	31	30	31	31	30	31	30	31	244
1997	31	28	31	30	31	30	31	21	30	31	30	31	234
1998	31	28	31	30	31	30	20	8	0	9	23	30	151
1999	18	28	31	30	31	18	11	1	7	25	29	27	152
2000	30	29	31	30	31	30	31	31	30	31	30	31	244
2001	31	28	31	30	31	30	30	2	9	27	30	31	189
2002	31	28	31	30	31	30	31	5	12	23	30	31	192
2003	31	28	17	30	31	30	29	16	12	26	30	31	204
2004	31	29	31	30	31	30	31	31	23	27	30	31	233
2005	31	28	31	30	31	30	29	14	27	31	30	31	222
2006	31	28	31	30	31	30	31	24	28	31	30	31	235
2007	31	28	31	30	31	30	29	17	0	6	24	31	167
2008	31	29	31	30	31	30	31	31	30	31	30	31	244
2009	31	28	31	30	31	30	31	31	30	31	30	31	244
2010	31	28	31	30	31	30	31	31	30	31	30	31	244
2011	31	28	31	30	31	30	31	31	30	31	30	31	244
2012	31	29	31	30	31	20	0	6	4	18	30	31	139
2013	31	28	31	30	31	30	31	31	30	31	30	31	244
2014	31	28	31	30	31	30	31	31	30	31	30	31	244
2015	31	28	31	30	31	30	31	31	23	25	30	31	231
2016	31	29	31	30	31	30	8	16	4	19	30	31	168
2017	31	28	31	30	31	30	31	31	19	25	30	31	227
2018	31	28	31	30	31	30	31	27	20	31	30	31	230
2019	31	28	31	30	31	30	31	31	30	31	30	31	244
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	30	28	31	30	31	29	27	24	22	28	29	30	220
Min	18	12	17	30	30	15	0	1	0	6	10	9	139
Total Number of Occurrances (days)	1755	1610	1781	1740	1797	1679	1584	1411	1254	1595	1696	1752	12756
Total Days Period of Record	1798	1639	1798	1740	1798	1740	1798	1798	1740	1798	1740	1798	14152
Reliability Based on Time	98%	98%	99%	100%	100%	96%	88%	78%	72%	89%	97%	97%	90%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	95%	100%	100%	100%	100%

Flow rate corresponding for permitted taking rate from July 1 to July 15

Eramosa Above Guelph Days Flow Exceeds 0.631(m^3/s)													Apr to Nov
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1962	31	28	31	30	31	30	6	10	10	30	30	31	177
1963	31	28	31	30	30	21	26	14	7	7	9	9	144
1964	23	12	27	30	30	25	10	20	9	15	15	23	154
1965	31	25	31	30	31	13	26	29	29	31	30	31	219
1966	31	28	31	30	31	24	0	5	2	7	28	31	127
1967	31	28	31	30	31	30	31	31	19	31	30	31	233
1968	31	29	31	30	31	30	27	25	30	31	30	31	234
1969	31	28	31	30	31	30	22	17	0	14	29	31	173
1970	31	28	31	30	31	30	31	20	30	31	30	31	233
1971	31	28	31	30	31	30	29	21	30	26	30	31	227
1972	31	29	31	30	31	30	31	28	24	30	30	31	234
1973	31	28	31	30	31	30	30	21	9	27	30	31	208
1974	31	28	31	30	31	30	31	28	27	31	30	31	238
1975	31	28	31	30	31	30	28	22	30	31	30	31	232
1976	31	29	31	30	31	30	31	31	30	31	30	31	244
1977	11	12	31	30	31	30	26	31	30	31	30	31	239
1978	31	28	31	30	31	30	31	28	30	31	30	31	241
1979	31	28	31	30	31	30	31	31	30	31	30	31	244
1980	31	29	31	30	31	30	31	31	30	31	30	31	244
1981	31	28	31	30	31	30	31	31	30	31	30	31	244
1982	31	28	31	30	31	30	31	31	30	31	30	31	244
1983	31	28	31	30	31	30	31	31	30	31	30	31	244
1984	31	29	31	30	31	30	31	28	30	31	30	31	241
1985	31	28	31	30	31	30	31	31	30	31	30	31	244
1986	31	28	31	30	31	30	31	31	30	31	30	31	244
1987	31	28	31	30	31	30	31	27	23	31	30	31	233
1988	31	29	31	30	31	18	12	12	21	31	30	31	185
1989	31	28	31	30	31	30	16	8	0	21	29	11	165
1990	28	28	31	30	31	30	31	27	18	31	30	31	228
1991	31	28	31	30	31	30	31	24	13	31	29	31	219
1992	31	29	31	30	31	30	30	31	30	31	30	31	243
1993	31	28	31	30	31	30	31	31	30	31	30	31	244
1994	12	28	31	30	31	30	22	12	4	17	30	31	176
1995	31	28	31	30	31	30	30	25	0	26	30	31	202
1996	31	29	31	30	31	30	31	31	30	31	30	31	244
1997	31	28	31	30	31	30	31	21	30	29	30	31	232
1998	30	28	31	30	31	30	17	8	0	3	14	25	133
1999	18	28	31	30	31	16	11	0	5	21	29	26	143
2000	30	8	31	30	31	30	31	31	30	30	29	31	242
2001	31	28	31	30	31	30	24	0	9	26	30	31	180
2002	31	28	31	30	31	30	31	3	10	19	30	31	184
2003	21	28	17	30	31	30	28	15	11	24	30	31	199
2004	31	29	31	30	31	30	31	29	20	21	30	31	222
2005	31	28	31	30	31	30	25	11	25	31	30	31	213
2006	31	28	31	30	31	30	29	18	28	31	30	31	227
2007	31	28	31	30	31	29	17	10	0	5	16	31	138
2008	31	29	31	30	31	30	31	31	30	31	30	31	244
2009	31	28	31	30	31	30	31	31	30	31	30	31	244
2010	31	28	31	30	31	30	31	31	30	31	30	31	244
2011	31	28	31	30	31	30	31	31	30	31	30	31	244
2012	31	29	31	30	31	19	0	6	3	18	30	31	137
2013	31	28	31	30	31	30	31	31	30	31	30	31	244
2014	31	28	31	30	31	30	31	31	30	31	30	31	244
2015	31	28	31	30	31	30	31	31	18	24	30	31	225
2016	31	29	31	30	31	26	3	14	4	14	27	31	149
2017	31	28	31	30	31	30	31	31	15	24	30	31	222
2018	31	28	31	30	31	30	28	25	14	31	30	31	219
2019	31	28	31	30	31	30	31	31	27	31	30	31	241
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	30	27	31	30	31	29	26	23	20	26	29	30	214
Min	11	8	17	30	30	13	0	0	0	3	9	9	127
Total Number of Occurrances (days)	1723	1581	1780	1740	1796	1661	1514	1324	1184	1532	1664	1737	12415
Total Days Period of Record	1798	1639	1798	1740	1798	1740	1798	1798	1740	1798	1740	1798	14152
Reliability Based on Time	96%	96%	99%	100%	100%	95%	84%	74%	68%	85%	96%	97%	88%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	97%	97%	91%	100%	100%	100%	100%

Flow rate corresponding for permitted taking rate from June 1 to June 30

Eramosa Above Guelph Days Flow Exceeds 0.681(m^3/s)													Apr to Nov
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1962	31	28	31	30	31	30	5	9	6	29	30	31	170
1963	31	28	31	30	30	19	22	11	6	5	7	7	130
1964	22	11	27	30	30	25	10	20	8	11	11	19	145
1965	31	25	31	30	31	9	26	21	21	31	30	31	199
1966	31	28	31	30	31	22	0	3	1	6	27	31	120
1967	31	28	31	30	31	30	31	31	19	31	30	31	233
1968	31	29	31	30	31	30	25	23	30	31	30	31	230
1969	31	28	31	30	31	30	20	15	0	13	29	31	168
1970	31	28	31	30	31	28	30	19	30	31	30	31	229
1971	31	28	31	30	31	30	29	16	30	20	30	31	216
1972	31	29	31	30	31	30	31	24	20	28	30	31	224
1973	31	28	31	30	31	30	24	19	8	26	30	31	198
1974	31	28	31	30	31	30	30	26	20	31	30	31	228
1975	31	28	31	30	31	30	26	16	30	31	30	31	224
1976	31	29	31	30	31	30	31	31	30	31	30	31	244
1977	9	6	31	30	31	30	23	31	30	31	30	31	236
1978	31	28	31	30	31	30	31	22	28	31	30	31	233
1979	31	28	31	30	31	30	31	31	29	31	30	31	243
1980	31	29	31	30	31	30	31	31	30	31	30	31	244
1981	31	28	31	30	31	30	30	31	30	31	30	31	243
1982	31	28	31	30	31	30	31	31	30	31	30	31	244
1983	31	28	31	30	31	30	31	31	30	31	30	31	244
1984	31	29	31	30	31	30	28	22	30	31	30	31	232
1985	31	28	31	30	31	30	31	30	30	31	30	31	243
1986	31	28	31	30	31	30	31	31	30	31	30	31	244
1987	31	28	31	30	31	28	31	20	19	31	30	31	220
1988	31	29	31	30	31	17	10	9	16	30	30	31	173
1989	31	28	31	30	31	30	12	6	0	21	29	8	159
1990	27	28	31	30	31	30	29	23	15	31	30	31	219
1991	31	28	31	30	31	30	30	24	12	28	28	31	213
1992	31	29	31	30	31	30	30	31	30	31	30	31	243
1993	31	28	31	30	31	30	31	30	30	31	30	31	243
1994	10	28	31	30	31	28	19	7	4	10	30	31	159
1995	27	28	31	30	31	29	27	24	0	25	30	31	196
1996	31	29	31	30	31	30	31	31	30	31	30	31	244
1997	31	28	31	30	31	30	31	21	27	28	30	31	228
1998	28	28	31	30	31	30	13	6	0	2	8	23	120
1999	17	28	31	30	29	14	9	0	5	21	29	25	137
2000	25	6	31	30	31	30	31	31	30	26	24	31	233
2001	31	28	31	30	31	30	16	0	9	26	30	31	172
2002	31	28	31	30	31	30	26	2	7	15	30	31	171
2003	14	26	17	30	31	29	25	12	11	21	30	31	189
2004	31	29	31	30	31	30	31	27	19	18	30	31	216
2005	31	28	31	30	31	30	20	8	20	31	30	31	200
2006	31	28	31	30	31	30	28	15	27	31	30	31	222
2007	31	28	31	30	31	29	11	2	0	2	13	31	118
2008	31	29	31	30	31	30	31	31	30	31	30	31	244
2009	31	28	31	30	31	30	31	31	30	31	30	31	244
2010	31	28	31	30	31	30	31	29	28	31	30	31	240
2011	31	28	31	30	31	30	31	31	30	31	30	31	244
2012	31	29	31	30	31	17	0	5	2	18	30	31	133
2013	31	28	31	30	31	30	31	31	30	31	30	31	244
2014	31	28	31	30	31	30	31	30	30	31	30	31	243
2015	31	28	31	30	31	30	31	30	11	23	30	31	216
2016	31	29	31	30	31	21	2	13	4	13	22	19	136
2017	31	28	31	30	31	30	31	31	14	24	30	31	221
2018	31	28	31	30	31	30	23	21	9	31	30	31	205
2019	31	28	31	30	31	30	31	31	20	31	30	31	234
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	29	27	31	30	31	28	25	21	19	26	28	30	208
Min	9	6	17	30	29	9	0	0	0	2	7	7	118
Total Number of Occurrances (days)	1698	1570	1780	1740	1794	1635	1433	1218	1105	1481	1637	1713	12043
Total Days Period of Record	1798	1639	1798	1740	1798	1740	1798	1798	1740	1798	1740	1798	14152
Reliability Based on Time	94%	96%	99%	100%	100%	94%	80%	68%	64%	82%	94%	95%	85%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	97%	97%	91%	100%	100%	100%	100%

Flow rate corresponding for permitted taking rate from Apr 15 to May 31

Eramosa Above Guelph Days Flow Exceeds 0.788(m^3/s)													Apr to Nov
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
1962	31	21	31	30	31	29	4	8	5	24	30	27	161
1963	31	28	31	30	30	18	11	8	4	0	6	3	107
1964	18	10	27	30	29	22	10	18	6	7	6	15	128
1965	27	25	29	30	31	7	18	10	16	31	30	31	173
1966	31	28	31	30	31	20	0	0	0	2	24	29	107
1967	26	28	31	30	31	30	31	27	15	29	30	31	223
1968	31	29	31	30	31	28	19	21	30	31	30	31	220
1969	31	28	31	30	31	30	17	13	0	9	29	31	159
1970	10	26	31	30	31	21	23	12	29	31	30	31	207
1971	31	28	31	30	31	30	21	13	21	15	26	31	187
1972	31	29	31	30	31	30	28	12	14	23	30	31	198
1973	31	28	31	30	31	30	13	10	4	15	30	31	163
1974	31	28	31	30	31	30	27	16	7	26	30	31	197
1975	31	28	31	30	31	30	14	14	30	31	30	31	210
1976	31	29	31	30	31	30	31	29	30	31	30	31	242
1977	4	5	31	30	31	27	19	29	29	31	30	31	226
1978	31	28	31	30	31	30	18	10	23	31	30	31	203
1979	31	28	31	30	31	30	31	31	27	31	30	31	241
1980	31	29	29	30	31	30	31	24	30	31	30	31	237
1981	31	22	31	30	31	30	24	31	30	31	30	31	237
1982	31	28	31	30	31	30	31	31	30	31	30	31	244
1983	31	28	31	30	31	30	29	31	30	28	30	31	239
1984	31	29	31	30	31	30	24	10	29	27	30	31	211
1985	31	28	31	30	31	30	31	20	30	31	30	31	233
1986	31	28	31	30	31	30	31	31	30	31	30	31	244
1987	31	28	31	30	31	25	28	15	11	24	30	31	194
1988	26	29	31	30	31	11	7	4	13	28	30	31	154
1989	31	28	24	30	31	30	6	2	0	11	27	4	137
1990	20	28	31	30	31	29	23	17	6	31	30	31	197
1991	31	28	31	30	31	27	21	19	4	26	19	31	177
1992	31	29	31	30	31	30	26	31	30	31	30	31	239
1993	31	28	31	30	31	30	31	25	23	31	30	31	231
1994	6	28	31	30	31	26	16	5	1	4	24	29	137
1995	20	28	31	30	31	24	19	21	0	24	30	31	179
1996	31	29	31	30	31	30	31	23	30	31	30	31	236
1997	31	28	31	30	31	30	23	18	16	15	30	25	193
1998	28	28	31	30	31	26	12	6	0	2	4	10	111
1999	16	28	31	30	23	10	7	0	5	12	29	23	116
2000	18	6	31	30	31	30	31	31	23	8	21	31	205
2001	31	28	31	30	31	29	11	0	7	26	30	31	164
2002	31	28	31	30	31	30	19	1	4	13	29	18	157
2003	10	20	17	30	31	25	15	5	10	18	30	31	164
2004	31	29	31	30	31	30	31	25	16	15	30	31	208
2005	31	28	31	30	31	26	5	7	13	23	30	31	165
2006	31	28	31	30	31	27	26	13	21	31	30	31	209
2007	31	28	31	30	31	24	8	0	0	1	10	28	104
2008	31	29	31	30	31	30	31	31	30	31	30	31	244
2009	31	28	31	30	31	30	31	31	19	31	30	31	233
2010	31	28	31	30	31	30	31	25	24	31	30	31	232
2011	31	28	31	30	31	30	31	28	22	27	30	31	229
2012	31	29	31	30	25	15	0	4	0	17	30	31	121
2013	31	28	31	30	31	30	31	31	30	31	30	31	244
2014	31	28	31	30	31	30	31	24	29	31	30	31	236
2015	31	28	31	30	31	30	29	25	1	18	30	31	194
2016	31	29	31	30	31	18	0	9	3	6	12	15	109
2017	31	28	31	30	31	30	31	25	8	21	30	21	206
2018	29	28	31	30	31	30	17	14	2	21	30	31	175
2019	31	28	31	30	31	30	31	19	10	27	30	31	208
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	28	27	31	30	31	27	21	17	16	23	27	28	191
Min	4	5	17	30	23	7	0	0	0	0	4	3	104
Total Number of Occurrances (days)	1622	1547	1769	1740	1781	1564	1226	993	910	1305	1586	1642	11105
Total Days Period of Record	1798	1639	1798	1740	1798	1740	1798	1798	1740	1798	1740	1798	14152
Reliability Based on Time	90%	94%	98%	100%	99%	90%	68%	55%	52%	73%	91%	91%	78%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	95%	93%	88%	98%	100%	100%	100%

Appendix F

Consultation Summary Report

Water Supply Master Plan Update

Draft Engagement Summary Report

City of Guelph

60612820

November 2021

Delivering a better world

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

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- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
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- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

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AECOM: 2015-04-13

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Executive Summary

The City of Guelph (City) is updating its 2014 Council-approved Water Supply Master Plan to define how Guelph will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2051[1]. The Water Supply Master Plan Update follows the requirements of Phases 1 and 2 of the Municipal Class Environmental Assessment process and will be co-ordinated with the City's future Official Plan update.

Reviewing the existing water supply system is an opportunity to discuss with Guelph and the surrounding communities how best to work with this vital supply so that the City continues to provide a responsible level of service into the future.

This report provides an overview of engagement activities and summarizes feedback received during Phase 1 and Phase 2 of the Water Supply Master Plan Update.

Phase 1

Phase 1 engagement took place between October 2019 and March 2020 and included

- newspaper advertising and electronic mailings to inform people about the start of the Water Supply Master Plan Update and the first community open house;
- a project website to provide useful information, including links to the previous 2014 Water Supply Master Plan Update, contact information and invitations to online and in-person engagement opportunities;
- online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- establishment of a Community Liaison Group to advise and provide feedback to the Project Team throughout the process;
- a municipal and agency workshop to provide crucial inputs from a government and approval agency perspective;
- one community open house (with two time slots) to introduce the Water Supply Master Plan Update, giving community members an opportunity to discuss the project with a unique knowledge holder from the Project Team, and provide comments;

1. As of August 2020, Ontario has consulted on a proposed amendment to A Place to Grow: Growth Plan for the Greater Golden Horseshoe that extended the 2041 planning horizon to 2051.

- one stakeholder meeting with Guelph Wellington Development Association and Guelph and District Home Builder's Association; and
- co-ordination with other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

Topics covered and presented to the community during Phase 1 engagement included

- an overview of why the Water Supply Master Plan is being updated, including a draft problem and opportunity statement;
- an overview of the Municipal Class Environmental Assessment process, including a timeline of major milestones;
- the Water Supply Master Plan Update steps including forecast of future population and water needs, assess existing water supply capacity, develop and evaluate water supply alternatives and update the Water Supply Master Plan);
- the personhood of water as it is understood in the worldview of Indigenous Peoples residing in the Guelph area;
- a closer look at Guelph's current groundwater supply system;
- estimates of our future water supply requirements – i.e., how Guelph's population is expected to grow by 2041[2] and the water supply it will need;
- challenges related to the City's water supply, including water security, climate change and extreme weather events, contaminated sites and surface water quantity and quality;
- proposed water supply alternative solutions being considered and / or updated, including demand management, efficiency and water reuse programs, groundwater sources in and outside of the city, local surface water sources, and do nothing;
- evaluation criteria and how the proposed alternative solutions will be evaluated, including public health and safety, natural environment, social and cultural resources, economic and financial considerations, legal / jurisdictional considerations and technological considerations;
- other water-related master planning projects that are currently underway at the City; and
- ways to get involved and contact information.

2. Population projections changed in the middle of the project to 2051 (30 years). In August 2020, the Province of Ontario provided updated population forecasts for the City of Guelph to 2051.

Guided by a series of engagement questions, the community provided their input to the project. Key themes that emerged from the feedback included

- prioritizing conservation;
- protecting the natural environment;
- managing growth and development;
- controlling groundwater impacts from large water users;
- monitoring emerging contaminants;
- limiting impacts to aquatic and terrestrial wildlife; and
- valuing the agency of water.

Phase 2

Phase 2 engagement took place between March 2020 and October 2021 and included

- updating the project website to provide useful information, including links to the previous 2014 Water Supply Master Plan Update, contact information and invitations to online and in-person engagement opportunities, and details regarding the second open house;
- online engagement through Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list and social media;
- the second and third Community Liaison Group workshops to continue updating interested stakeholders and collecting feedback;
- the second municipal and agency workshop to provide crucial inputs from a government and approval agency perspective;
- newspaper advertising and electronic mailings to invite participation in the second community open house;
- the second community open house (held virtually) to provide an update on work completed to date for the Water Supply Master Plan Update, giving community members an opportunity to discuss the project with the Project Team and provide comments;
- one meeting with Mississaugas of the Credit First Nation;
- one meeting with Six Nations of the Grand River;
- meetings held with the Councils of the Township of Puslinch and Township of Guelph Eramosa; and

- co-ordination with other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

Topics covered and presented to the community during Phase 2 engagement included

- a review of Phase 1 topics;
- a detailed review of Guelph's existing water supply (namely the 25 production wells, the Arkell Spring Grounds and the Eramosa River intake and recharge system);
- reviewing the water supply requirements to accommodate the 2051 population and water demand projection based on average day demand, maximum day demand and system redundancy;
- a detailed assessment of the water supply alternatives (water conservation, efficiency and water reuse programs; optimizing and expanding on existing groundwater systems; establishing new surface water supply sources; and limiting population growth / doing nothing); and
- the preliminary results of the water supply alternatives evaluation.

Public and agency input was focused on the preferred alternatives based off of the preliminary evaluation. Key themes that emerged from the feedback included:

- enhancing conservation efforts and options including water taking limitations, grey water usage, increased water recycling programs, and addressing non-revenue water leakage;
- concerns regarding the viability of returning wells impacted by contamination to service, and related safety precautions;
- the need for ongoing protection of water quality throughout the revitalization of the Dolime Quarry;
- the recommendation to consider climate change impacts in the assessment of water supply alternatives;
- general support for the preferred alternative, with some questions and concerns regarding the implementation timelines and the prioritization of the water supply alternatives; and
- jurisdictional concerns regarding source protection and the installation of wells outside of the City of Guelph and the need for ongoing cooperation and consultation efforts with surrounding Townships to ensure any water taking is reasonable, fairly considered and, where appropriate, fairly compensated.

After input was received, the Water Supply Master Plan Update report was drafted and included an implementation strategy for a water supply plan that meets the future needs of the community, including estimated timelines and budget.

Council and the public will have an opportunity to review the Water Supply Master Plan Update report before it is finalized.

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1. Overview

The City is updating its Council-approved Water Supply Master Plan, from 2014, to define how Guelph will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2051. Reviewing the existing water supply system is an opportunity to discuss with Guelph and the surrounding communities how best to work with this vital supply so that the City continues to provide a responsible level of service.

As currently proposed, the updated Water Supply Master Plan will provide short-term, mid-term and long-term water supply options to ensure the City can continue to meet the needs of Guelph's growing population. When the updated Water Supply Master Plan is reviewed by the Guelph community and Council, constraints and opportunities related to the existing water supply system will have been identified. There will also be an evaluation and prioritization of individual projects to increase the capacity of the City's existing system. The Water Supply Master Plan Update follows the requirements of Phases 1 and 2 of the Municipal Class Environmental Assessment in accordance with Approach #1 of the Master Plan Process described in the Municipal Class Environmental Assessment Manual (amended in 2015) by the Municipal Engineers Association. The Water Supply Master Plan Update will be updated at approximately five-year intervals. This Update, initiated in 2019, will be co-ordinated with the City's future Official Plan update and will contain plans for development of individual projects consisting of Schedule A, B and C Class Environmental Assessment activities.

Community input is an essential part of the Water Supply Master Plan Update process. People care about where their water comes from, and they want to see a safe and sustainable supply maintained for present and future generations, and residents, councils, agencies, stakeholders and Indigenous Peoples from Guelph and the surrounding Townships and County were engaged throughout the project. This report provides a summary of the engagement process and the feedback received for the Water Supply Master Plan Update.

With this in mind, Phase 1 engagement activities included

- newspaper advertising and electronic mailing to inform people about the start of the Water Supply Master Plan Update;
- a project website to provide useful information, including links to the previous 2014 Water Supply Master Plan Update, contact information and invitations to online and in-person engagement opportunities;
- online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted

via the electronic mailing list, social media and a monthly Have Your Say newsletter;

- establishment of an inclusive and diverse Community Liaison Group to advise and provide feedback to the Project Team throughout the process;
- a municipal and agency workshop to provide crucial inputs from a government and approval agency perspective;
- electronic mailing, newspaper and community-wide advertising about the first community open house;
- one community open house (with two time slots) to introduce the Water Supply Master Plan Update, giving community members an opportunity to discuss the project with experts and provide comments;
- one stakeholder meeting with Guelph Wellington Development Association and Guelph and District Home Builder's Association; and
- co-ordination with other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

Phase 2 engagement activities included

- continued update of the project website to provide useful information, including links to key documents, contact information and invitations to online engagement opportunities;
- online engagement through the City's online community engagement site, Have Your Say Guelph, linked through the project website and promoted via the electronic mailing list, social media and a monthly Have Your Say newsletter;
- the second and third Community Liaison Group workshops to continue updating interested stakeholders and collecting feedback;
- a second municipal and agency workshop to share an update of the project, and collect additional inputs from the government and approval agency perspective;
- two meetings with the Water Conservation and Efficiency Public Advisory Committee
- one meeting with Mississaugas of the Credit First Nation;
- one meeting with Six Nations of the Grand River;
- meetings held with Councils of the Township of Puslinch and Township of Guelph Eramosa; and

- co-ordination other related master plan updates (i.e., Water and Wastewater Servicing Master Plan, Wastewater and Biosolids Master Plan, Stormwater Master Plan and the Municipal Comprehensive Review / Official Plan Update).

1.1 Approach to public engagement

At the start of the project, a community engagement and communications plan was developed to guide the implementation of the engagement process for the Water Supply Master Plan Update consistent with the Municipal Class EA process and the City's Community Engagement Framework.

The City's Community Engagement Framework (guelph.ca/plans-and-strategies/community-engagement-framework/) is referenced in the plan, and the Water Supply Master Plan Update aims to embrace the guiding principles for community engagement outlined in the framework including inclusive, early involvement, access to decision making, coordinated approach, transparent and accountable, open and timely communication, mutual trust and respect, evaluation and continuous improvement.

As the project progressed, a virtual approach to engagement was adopted to provide a safe and convenient forum for the Project Team, participants, and stakeholders during the COVID-19 pandemic.

1.2 Engagement and communication goals

During the development and implementation of the 2021 Water Supply Master Plan Update, the Project Team set out with engagement and communication goals to:

- engage the Guelph community to develop a shared vision for managing the City's water supply;
- generate a broad awareness of the Water Supply Master Plan and opportunities for participation;
- obtain an understanding of the community's aspirations and concerns relating to water management;
- keep key stakeholders informed of Water Supply Master Plan activities, and communicate in a timely and clear manner; and
- affirm the City's commitment to community engagement and open planning processes and demonstrate the impact of engagement efforts on the Master Plan Update and the Class Environmental Assessment process.

1.3 Engagement and communication objectives

Engagement and communication objectives were also established to

- ensure diverse opportunities for local municipalities, Indigenous Peoples, government agencies, non-governmental organizations, institutions, businesses, community groups / associations, and residents to participate;
- educate community members and groups about the study - why it's important, what's included, how key elements relate to stakeholders, the process that will be followed and how decisions will be made;
- inform and educate stakeholders about the 2021 Water Supply Master Plan Update, and any related studies or initiatives like the Tier 3 Water Budget and Water Quantity Risk Assessment, the Outdoor Water Use By-law Update, Water Efficiency Strategy, the "Our Community, Our Water" (the Dolime Quarry Revitalization plan), and the Clean Water Act Source Protection Plan;
- develop plain language communication materials that support the goals of the project and encourage participation;
- consider all feedback provided and document that it has been considered during the development of water supply alternatives by the Project Team; and
- meet the consultation requirements of the Municipal Class Environmental Assessment for Master Plans.

1.4 Presentation materials

Clear, easy-to-understand and engaging materials (including notices, presentations for the Community Liaison Group, agency workshops and the virtual community open house, display boards, survey, a web page and Have Your Say online community engagement site) were developed for the public for Phases 1 and 2.

The topics addressed during Phase 1 included

- an overview of why the Water Supply Master Plan is being updated, including a draft problem and opportunity statement;
- an overview of the Municipal Class Environmental Assessment process, including a timeline of major milestones;
- the Water Supply Master Plan Update steps including forecast of future population and water needs, assess existing water supply capacity, develop and evaluate water supply alternatives and update the Water Supply Master Plan;

- the personhood of water as it is understood in the Indigenous worldview of Indigenous Peoples in the Guelph community;
- a closer look at Guelph's current groundwater supply system;
- estimates of our future water supply requirements – i.e., how Guelph's population is expected to grow by 2051 and the water supply it will need;
- challenges related to the City's water supply, including water security, climate change and extreme weather events, contaminated sites and surface water effects;
- proposed water supply alternative solutions being considered and / or updated, including demand management / efficiency programs, groundwater sources in and outside of the city, local surface water sources, and do nothing;
- evaluation criteria and how the proposed alternative solutions will be evaluated, including natural environment, social and cultural (including archeological) resources, economic and financial considerations, legal / jurisdictional considerations and technological considerations;
- other water-related master planning projects that are currently underway at the City; and
- ways to build authentic, long-standing, community-based relationships by reaching out.

The topics addressed in Phase 2 included

- review of Phase 1 topics;
- a detailed review of Guelph's existing water supply (namely the 25 production wells, the Arkell Spring Grounds and the Eramosa River intake and recharge system);
- reviewing the water supply requirements to accommodate the 2051 population forecast based on population and water demand projection based on average day demand, maximum day demand and system security of supply (i.e., system redundancy);
- a detailed assessment of the water supply alternatives (water conservation and demand management / water reuse programs; optimizing and expanding on existing groundwater systems; establishing new surface water supply sources; and limiting population growth / doing nothing); and
- preliminary evaluation of the water supply alternatives and results.

1.5 Engagement topics

The Project Team identified key engagement topics related to Phases 1 and 2 of the Water Supply Master Plan. Stakeholders and the public were invited to provide their input and feedback to these engagement topics through the various engagement tools and activities.

Phase 1 engagement focused on gathering feedback and input into

- changes or additions to the draft problem and opportunities statement;
- unique challenges that Guelph faces and should be considered regarding our water supply;
- additional water supply alternatives that should be considered; and
- additional evaluation criteria that should be included.

Phase 2 engagement focused on gathering feedback and input into

- results of the technical work including the future population targets, water supply demand forecasts, and the existing water supply capacity assessment;
- results of the technical assessment and preliminary evaluation of the water supply alternatives, including additional factors or considerations that are missing; and
- prioritization and public acceptance of the preliminary preferred water supply alternatives.

2. Feedback

2.1 Phase 1 Feedback

2.1.1 Introduction

The feedback received during Phase 1 through the various engagement tools and activities indicates that there is a continued interest from community members and stakeholders about water supply in Guelph. Several themes emerged related to the key engagement topics of this phase, including

- prioritizing conservation;
- protecting the natural environment;
- managing growth and development;
- controlling groundwater impacts from large water users;
- monitoring emerging contaminants;
- limiting impacts to aquatic and terrestrial wildlife; and
- valuing the agency of water.

Each section below includes content that was presented in relation to the consultation questions. All comments and questions received during Phase 1 engagement are summarized in the subsections below and are provided in **Appendix A**.

2.1.2 Draft problem and opportunity statement

The public was invited to comment on any suggested changes or additions to the following draft problem and opportunity statement:

- The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers. The 2014 Water Supply Master Plan confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting these future needs. It is important to update the water demand forecast, the existing water system capacity and the status of ongoing water supply projects and make adjustments to the plan as required. The proposed implementation strategy must deliver through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

Comments received about the draft problem and opportunity statement were based on the topics of water supply, conservation, capacity and growth, aquifer recharge, infrastructure, wastewater and other. Summaries of themed responses are outlined below. See all comments received in **Appendix A**.

- **Water supply:**
  It was suggested that groundwater cannot be controlled or developed, therefore, the word 'develop' should be removed from the statement or rephrased to water supply infrastructure being developed. Another suggestion was to focus on adequate water supply (without summer restrictions) before population growth.

- **Conservation:**
  Individuals noted that watershed protection and conservation efforts should be the main priorities.

- **Capacity and growth:**
  Concerns were expressed regarding 2041 as too short of a planning horizon and to first determine the future capacity of water supply before determining how to limit growth.

- **Aquifer recharge:**
  One comment suggested recharging aquifers with wetlands, stormwater and treated wastewater.

- **Infrastructure:**
  One comment suggested exploring costs of more rapidly upgrading infrastructure to reduce system losses, and another comment suggested building a pipe to a lake.

- **Wastewater:**
  One comment suggested including wastewater disposal as part of the Water Supply Master Plan process.

- **Other:**
  Several respondents agreed with the draft problem and opportunity statement. One comment suggested declaring that water-taking is not an approved land use.

2.1.3 Unique challenges

There are a number of unique challenges that Guelph faces and will be taken into consideration during the Water Supply Master Plan Update. These challenges include

- a Tier 3 Water Budget and Local Area Risk Assessment identified the City's water supply as having a 'significant risk level' of not meeting the 2031 water demand under drought conditions;
- whether a 10 per cent 'system redundancy' allowance is sufficient for ensuring security of our water supply;
- understanding impacts from climate change and extreme weather events to our water supply;
- the existing Smallfield and Sacco wells are affected by contaminated sites and may need to be removed from consideration as City water supply options;
- Dolime Quarry – a proposal to close the quarry ahead of schedule and transfer water management to the City is under consideration; and
- how surface water baseflows could be impacted if we pump more groundwater.

When asked about whether there are other unique challenges that Guelph faces and should be considered with regard to the water supply, a wide variety of comments were received. The following six themes summarize the responses provided. See all comments received in **Appendix A**.

- **Development and growth**:
  Several respondents expressed concerns about developers and impacts of their land use, the impacts of Clair-Maltby developments on Carter 1 and 2 well sites and overpopulation. One comment suggested the City should challenge growth targets set by the provincial government. Another comment expressed concerns that condominium owners may lack understanding about water use and efficiency because water is paid for through condominium fees and they don't see information related to water conservation on bills.
- **Industrial and commercial water use**:
  Several respondents expressed concerns about large industrial and commercial water users (e.g., quarries and aggregate pits, breweries bottled water and meat packing companies) and their impacts on local aquifers.
- **Rates**:
  One comment suggested mirroring off-peak electricity rates by reducing water usage rates during off-peak hours and implement higher rates during peak times.

- **Contamination and treatment**:
  Several respondents were concerned about contaminants entering the water supply, including microplastics, perfluorooctanesulfonic acids, hormones and pharmaceuticals. One respondent was concerned about the increased use of salt during winter and suggested education campaigns for property managers. Another individual questioned the use of adding fluoride and removing calcium from the water supply. One respondent was concerned about offline wells with unknown contaminants and potential impacts to nearby residents. There was also a comment about a potential contaminated groundwater plume and a suggestion to address former industrial waste and garbage dumping sites in addition to ongoing contamination of surrounding rivers.
- **Environmental impacts**:
  Two respondents wanted to know how climate change may impact the model and one respondent would like to see how aquatic and terrestrial wildlife would be impacted by any of the City's proposals.
- **Other:**
  One respondent added water-taking from adjacent aquifers (e.g., Erin, Aberfoyle) as an additional unique challenge. Three respondents agreed with the unique challenges listed.

2.1.4 Proposed alternative solutions

The following water supply alternatives were considered in Phase 1 for meeting Guelph's drinking water supply needs.

- **Demand management, efficiency and water reuse programs**
  - Maintain commitment to our water conservation initiatives and 2016 Water Efficiency Strategy
  - Determine range of realistic goals and cost for implementation
  - Develop means to measure for effectiveness
- **Groundwater sources in and outside of city**
  - Improve and optimize the existing well supply system
  - Restore offline wells with treatment
  - Identify new potential water supply areas
  - Consider Dolime Quarry as a source of municipal water supply

- **Local surface water sources**
  - Establish feasibility / risks of surface water alternatives including aquifer storage and recovery system
  - Assessment areas include: Guelph Lake / Speed River and Eramosa River
- **Do nothing**
  - Undertake no improvements or changes
  - Significant impact on the growth potential for the City would be expected with this alternative

Members of the public were asked if any proposed alternative solutions were missed. There were several comments received on the existing proposed alternatives solutions in addition to new suggestions. See all comments received in **Appendix A**.

Additional feedback on the alternative solutions was provided in Phase 2 and is referenced in Section 2.2 below.

- **Demand management, efficiency and water reuse programs**:
  A few respondents questioned the need for growth and suggested limiting population increase and challenging growth targets. One respondent suggested revising the 2016 Water Efficiency Strategy to better reflect extreme weather events, infrastructure deficiencies and contamination. Another respondent would like to see more water conservation initiatives and increasing the use of grey water for residential, commercial and industrial water users.
- **Groundwater sources in and outside of city**:
  The majority of comments related to groundwater were about Nestle and the impacts of water extraction for bottled water companies. One respondent suggested quantifying the impact of Nestle on the water supply to show financial implications for residents.
- **Local surface water sources**:
  There was one suggestion to look at potential sources of water outside of the watershed.
- **Other**:
  Other proposed alternative solutions included contamination risk management, using stormwater and wastewater to help aquifer restoration, establishing urban rooftop water collection systems and considering how to adapt in the case of extreme floods. Three respondents agreed with the proposed alternative solutions.

2.1.5 Preliminary Evaluation criteria

The following initial evaluation criteria were put forward as potential criteria to be used to evaluate new drinking water sources in the Water Supply Master Plan Update and were subsequently revised based on feedback received and other technical considerations.

- **Public health and safety**
  - Ability to meet provincial water quality requirements
- **Natural environment**
  - Potential effects to natural environment
  - Potential impacts to water resources
  - Potential impacts to natural heritage features
  - Environmental management planning considerations
- **Social and cultural resources**
  - Land use impacts
  - Short-term construction impacts
  - Potential impacts from operations
  - Implications of new / expanded Source Protection areas
- **Economic and financial considerations**
  - Estimated capital costs
  - Estimated operations and maintenance costs, including energy consumption
- **Legal / jurisdictional considerations**
  - Location of facility relative to city boundaries
  - Land requirements
  - Implementation of Source Protection Policies
- **Technological considerations**
  - Ability to implement and meet peak demand
  - Constructability, schedule and timing, and maintaining operations during construction
  - Water quality
  - Allowance for future treatment needs
  - Expandability
  - Ability to respond to changes in regulations
  - Ability to utilize existing infrastructure

- **Additional considerations**
  - Alignment with City 2050 Net Zero Carbon emissions target
  - Impacts on Indigenous peoples and values
  - Climate adaptability and resiliency

The public were asked if there are additional evaluation criteria that should be considered. There were additions to existing 'natural environment', 'economic and financial considerations' and 'additional considerations' categories. See all comments received in **Appendix A**.

- **Natural environment**:
  Comments related to the natural environment include prioritizing the protection of the environment above all else, considering how Clair-Maltby is a recharge area and how development in this area will impact water availability and recharge, and a request to see a breakdown of how any Water Supply Master Plans would impact aquatic and terrestrial wildlife.
- **Economic and financial considerations**:
  There were a range of comments related to economic and financial considerations, including the potential creation of local jobs, socio-economic benefits from managing groundwater and forestry and the economic impacts of current and future scenarios of not having water. One respondent asked who will pay for new water supply and treatment in light of new residential developments, and another respondent asked how much it will cost to bring water to Guelph in 2041 if there isn't enough local supply.
- **Additional considerations**:
  One respondent suggested listening to and understanding Indigenous People's approach to water. Another respondent added the ability to respond to unpredictable climate events as an important consideration.
- **Other**:
  One respondent suggested considering long-term groundwater and surface water impacts of any new facility – both during operation and after being closed. Two respondents agreed with the evaluation criteria.

Additional feedback on the evaluation criteria was provided in Phase 2 and outlined below in Section 2.2.

2.1.6 Questions

During Phase 1, questions were received from the general public, both at the in-person community open house and online via the Q&A tool on Have Your Say.

Questions related to the Water Supply Master Plan ranged from overall process, timelines and next steps to projected water demands, development and large water users. Several questions were unrelated to the Water Supply Master Plan, including wastewater and stormwater questions. All questions and responses are captured in **Appendix A**.

2.2 Phase 2 Feedback

2.2.1 Introduction

The feedback received during Phase 2 through the various engagement tools and activities indicates that agencies, municipal representatives and interested community members were invested in Guelph's water supply and the work being undertaken. Feedback was generally requested in these three discussion areas:

- results of the technical work including the future population targets, water supply demand forecasts, and the existing water supply capacity assessment
- results of the assessment and preliminary evaluation of the water supply alternatives, including additional factors or considerations that are missing
- prioritization and public acceptance of the preliminary preferred water supply alternatives

Each section below includes content that was presented in relation to the consultation topics. All comments and questions received during Phase 2 engagement are summarized in the subsections below and are provided in **Appendix A**.

2.2.2 Future population targets, water supply demand forecasts, and the existing water supply capacity assessment

The Province of Ontario's August 28th, 2020 report **A Place to Grow Growth Plan for the Greater Golden Horseshoe** (P2G) was utilized to identify future population growth to 2051 and combined with a review of past water use patterns to quantify the future water supply requirements. The 2051 population is projected to be 203,000 residential and 116,000 employment. Guelph's current water supply is estimated to provide a maximum of approximately 79,000 cubic metres per day, however by 2051 it is anticipated that we will need an additional 26,000 cubic metres per day to meet the needs of the future population.

Stakeholders were invited to comment on the analysis completed regarding the City's population in 2051 and the water supply capacity needed in order to support the anticipated demand. Some of the feedback from participants who attended the open house included:

- The uncertainty of future water supply demands and forecasts due to climate change was identified. The potential for decreased rainfall was mentioned with concern for what the water demand would be during a drought, and how farmers might need to increasingly rely on irrigation systems. Another comment identified the possibility of increased rainfall in the future due to climate change.
- The price of water was also questioned in terms of how a change in supply and demand would affect residential prices, and if there was a pricing strategy in place for moderating water usage and encouraging conservation efforts.
- One participant mentioned that the anticipated water taking for 2051 coincides with the actual water taking from 2001, and that over 50 years there was enough water conservation to keep the City well supplied. The City clarified that while the water taking numbers may appear similar, water conservation efforts and programs were responsible for ensuring that the City had enough water at an affordable rate.

Phase 2 largely focused on assessing the potential water supply capacity of the alternatives. Each of the water supply alternatives was evaluated against several criteria to identify potential impacts. The evaluation criteria included: First Nations, Metis, and Inuit Peoples, Technical (ability to achieve demand and reduction), Natural Environment, Built Environment, Social / Cultural Environment, Legal / Jurisdictional, and Financial.

Stakeholders and interested community members provided their feedback on the results of the water supply alternatives assessment and evaluation.

Water conservation, efficiency and water reuse programs

Four water conservation, efficiency and reuse program scenarios were presented and each forecasted the demand reduction that could be achieved by 2051. Guelph has a history of leveraging strong water conservation efforts in order to reduce water demand requirements. As a result, there were fewer suggestions for this alternative, but the ones provided considered at how these conservation efforts could be enhanced. Feedback included:

- Suggestions for enhancing water conservation initiatives included: non-revenue water reduction, grey water usage and incentives for increased usage, water recycling programs, and halting major water taking. While some of these initiatives are currently underway, promoting them to a wider audience and incentivizing them would help to increase conservation efforts.

- Suggestions for stormwater clean up and sewage water recycling practices were also provided.

Groundwater sources

Six categories of potential groundwater projects were shared: optimizing existing operating municipal sources, restoring existing off-line municipal sources, developing existing municipal test wells, installing new wells inside City boundaries, installing new wells outside City boundaries, and installing new Aquifer Storage and Recovery wells inside the City. Some of the feedback on the groundwater alternatives included:

- The Dolime Quarry was frequently mentioned during the engagement phase. Some concerns included whether an assimilative capacity study had been conducted as it relates to the City's waste water treatment plant and discharge from the quarry, how the aquifer was being protected and maintained in case dewatering were to stop, and potential impacts to dewatering as a result of annexation.
- The well locations were also a point of interest, including why some locations inside the City, such as the Clair Maltby area, were not selected for well locations.
- Water quality concerns and a recommendation for further study to determine the viability of remediating or adding treatment to the current off-line wells were raised. Water quantity concerns were raised regarding the potential impacts to the baseflow of surrounding waterbodies with restoring offline wells (e.g., impacts to Clythe Creek from restoring and pumping the Clythe well).
- Legal and jurisdictional implications of installing new wells outside of the City (in the surrounding townships) was also brought forth including growth and land use restrictions related to expanded source water protection areas, fair compensation (including for costs related to source water protection policy implementation), potential well interference, water use restrictions and employment opportunities. The Townships were concerned that their water supply would be taken to accommodate Guelph's growing population without fairly and duly consulting the Townships.

Surface water

Guelph Lake was reviewed as a potential source of surface water for direct treatment and distribution and as a potential source for an Aquifer Storage Recovery system to capitalize on peak flow.

- An additional surface water suggestion was to connect to the water supply from the Grand River and Lake Erie.

2.2.3 Prioritization and public acceptance of the preliminary preferred water supply alternatives

Based on the evaluation, a preliminary preferred solution was identified that recommended implementation of all water supply alternatives (except for the 'do nothing' alternative) in the short-, medium- and long-term over a thirty-year period (i.e., between 2021 and 2051) (see Table 1). Stakeholders and interested community members were asked to provide their feedback on the preliminary preferred solution.

- No objections to the preliminary preferred solution were raised, however there were some questions and concerns regarding the implementation timelines and the prioritization of the water supply alternatives – particularly for the development of new wells outside of the City. While the townships were generally supportive of the preliminary preferred solution, they were also concerned that developing wells in their jurisdiction for Guelph's use could limit the amount of residential and employment growth in the townships and impose source water protection land use constraints.

Table 1: Preferred Water Supply Alternatives

Alternative	Timeline	Projects
1A – Conservation, Efficiency & Water Reuse	Throughout	■ Blended Conservation Scenario
2B – Groundwater: Restore Off-line Municipal Wells	Short-term	■ Clythe Well (completion in 2023)
2B – Groundwater: Restore Off-line Municipal Wells	Mid-term	■ Lower Road Collector (completion in 2037)
2C/D – Groundwater: Develop Municipal Test Wells	Short-term	■ Ironwood/Steffler (completion in 2027) ■ Guelph South (completion in 2028) ■ Dolime Quarry (pumping station component completed to align with Ironwood/ Steffler) ■ Logan/ Fleming (completion in 2030)
2C/D – Groundwater: Develop Municipal Test Wells	Long-term	■ Hauser (completion in 2047)
2F – Groundwater: Arkell Collectors & ASR Wells	Long-term	■ Arkell ASR (completion in 2045)
2G – Groundwater: Develop New Wells Outside City	Long-term	■ Guelph North (completion in 2048)

2.2.4 Consultation

Consultation has been a vital part of collecting feedback to inform the Water Supply Master Plan. Various parties were interested in additional engagement sessions and reached out for opportunities to stay informed and involved.

- Several individuals including members of the public, municipal representatives, and interested stakeholders asked how they could remain involved with the project.
- A concern was voiced that there was not enough consultation with the Townships over the course of the project. It should be noted that the City offered several opportunities for engagement to the Townships during the study including providing notices on the Master Plan Update, representation on the Community Liaison Group, participation in the municipal and agency workshops and offers to present to Township Council. The Townships of Puslinch and Guelph-Eramosa opted to invite the Project Team to their respective Council meetings to learn more about the progress and provide feedback. The presentation and corresponding resolutions for the two sessions can be found in **Appendix E**.

3. Community engagement tools and activities

As part of the communication and engagement strategy for the Water Supply Master Plan Update, a number of activities were undertaken to notify the Guelph and area community, provide up-to-date information, seek input on the current phase of the study and answer any questions or concerns.

3.1 Notifications

3.1.1 Notice of commencement

A formal notice of study commencement was issued on October 31, 2019 to provide an overview of the Water Supply Master Plan Update, an explanation of the master plan process, engagement opportunities and contact information.

Engagement opportunities included joining the Community Liaison Group, attending an open house, reading about progress on the project web page (click here for the City of Guelph's Water Supply Master Plan), joining the electronic mailing list and following the conversation on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph).

The notice was advertised through

- the project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2019/10/notice-of-study-commencement/;
- traditional newspapers including the Guelph Mercury Tribune (City news section), Wellington Advertiser and Milton Champion;
- an initial project email list including agencies, municipalities, Indigenous Peoples and the original contact list from the 2014 Water Supply Master Plan mailing list (over 70 recipients during the week of November 28, 2019);
- organic social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph); and
- internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers.

The notice of commencement and associated advertisements are included in **Appendix B**.

3.1.2 Invitation to community open house #1

A formal invitation to the first community open house on February 13, 2020 was published on January 23, 2020 and distributed through

- the project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2020/01/join-us-february-13-for-the-first-water-supply-master-plan-open-house/;
- a project email list (53 recipients on January 30, 2020);
- social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph);
- Internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers; and
- paid advertisements with
  - Guelph Mercury Tribune (print, September 23, 2021)
  - guelphtoday.com.

The community open house invitation is included in **Appendix C**.

3.1.3 Invitation to community open house #2

A formal invitation to the second community open house on September 29, 2021 was published on September 16, 2021 and distributed through

- the Project website guelph.ca/plans-and-strategies/water-supply-master-plan/;
- the City's website guelph.ca/2021/09/join-us-september-29-to-talk-about-the-future-of-drinking-water-in-guelph/;h
- Have Your Say newsletter list;
- social media posts on Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph)
  - https://twitter.com/cityofguelph/status/1438500050246774787
  - https://twitter.com/cityofguelph/status/1439937666842337282
  - https://twitter.com/cityofguelph/status/1442867081955868688
  - https://www.facebook.com/permalink.php?story_fbid=10159680867733156&id=90034568155;

- Internal City staff including the Executive team, the Mayor and council, and all Water Services staff and other City Master Plan Project Managers; and
- paid advertisements with
  - Guelph Mercury Tribune (print, September 23, 2021)
  - guelphtoday.com.

The community open house invitation is included in **Appendix C**.

3.1.4 Notice of Completion

A Notice of Completion will be issued and included in the final version of this report.

At the completion of the planned 90-day review period, comments will be received, addressed and incorporated into the final report as necessary, and the report will be submitted to City Council for approval.

3.2 Project website

A page on the City's website (click here for the City of Guelph's Water Supply Master Plan) was published in November 2019. The purpose of the web page is to help build awareness for the Water Supply Master Plan Update, share updates and engagement opportunities, as well as useful information. The web page provides an up-to-date source of comprehensive and timely information and is linked to Have Your Say for online engagement. Information found on the web page includes

- notices and latest updates;
- engagement opportunities;
- background and process information;
- resources, including downloads from open houses and the 2014 Water Supply Master Plan final report;
- mailing list subscription link; and
- contact information.

From the launch to October 14, 2021, the project web page has had 2,110 page views, including 926 page views from unique visitors. The average time spent on the web page was more than one minute (1:22).

3.3 Social media

City of Guelph Facebook (facebook.com/cityofguelph) and Twitter (twitter.com/cityofguelph) accounts were used to complement the project web page to reach a larger audience who may otherwise be less engaged in traditional in-person engagement methods, and to share information about the Water Supply Master Plan Update. Social media posts were developed to engage online stakeholders throughout Phases 1 and 2 and helped to invite interested individuals or groups to attend the open houses and take part in online engagement (i.e., the online survey) and provide links to the web page and Have Your Say.

Since the launch there has been five Facebook posts shared organically and combined they reached 10,270 Facebook users. One paid Facebook ad reached 11,500 Facebook users. A total of 11 Tweets have resulted in 22,661 impressions, 30 re-tweets, 22 likes and 32 clicks to the web page.

Social media posts related to the Water Supply Master Plan Update can be found in **Appendix D**.

3.4 Community open house #1

The purpose of the first community open house was to provide an opportunity for the public to share feedback to help inform how the City will manage the water supply as the community grows. It was also an opportunity for the public to share what is important to them for the future so that the City can continue to provide excellent drinking water service to Guelph residents.

Logistics for community open house #1:

- **Where:** Marg MacKinnon Community Room, City Hall, 1 Carden Street
- **When:** February 13, from 2:00 p.m. to 4:00 p.m. and 6:00 p.m. to 8:00 p.m.

Topics presented on twelve display boards included

- the objectives and overview of the Water Supply Master Plan Update;
- the City's current drinking water supply;
- proposed alternatives for meeting our drinking water supply needs;
- proposed criteria and methodology for evaluating new drinking water sources;
- the agency of water/personhood of water/water is life; and
- the next steps as we update the Water Supply Master Plan.

Upon arriving at the open house, attendees were greeted and encouraged to sign-in at the welcome table. A survey was provided for attendees to submit their comments before they left, or they could send in responses via email or complete the online version on Have Your Say. Display boards were situated along the edge of the room with various experts available to answer questions. Printed copies of a map of Guelph Water Services Municipal Wells were available.

The City's water conservation staff also had a booth set-up to answer questions about water conservation and efficiency. Desktop computers were available for attendees to sign-up real-time to the online engagement platform, Have Your Say.

Seventeen attendees signed in, including several students from a university class. Many City staff stopped by without signing in and some attendees entered through the back door and missed the welcome table. Eight people completed the survey in-person.

Display boards, the survey and map are provided in **Appendix C**. Feedback from the open house is available in Section 2.1 of this report.

3.5 Community open house #2

The purpose of the second open house was for the public and interested stakeholders to learn about and share their thoughts on the potential alternative water supply sources that were identified, the detailed evaluation of the alternatives and the preferred solutions that were identified. The open house was hosted virtually due to the COVID-19 pandemic and restrictions for in-person gathering.

Logistics for community open house #2:

- **Where:** Online via Microsoft Teams
- **When:** September 29 from 6:30 p.m. – 8:30 p.m.

Attendees were reminded of the Water Supply Master Plan Update objectives, the challenge and opportunity statement, the municipal class Environmental Assessment process what was it involved in the update. An overview of Phase 1 consultation and engagement was provided, including feedback that was shared. Technical content focused on

- the population forecasted to 2051 and the anticipated demand for water;
- the potential alternative water supply sources that have been identified and the benefits and considerations for why the alternative is being added to the overall solution;
- the detailed evaluation of the alternatives measured against seven evaluation criteria; and
- the preferred solutions.

After the presentation, a question and answer period was held.

Six attendees joined, along with three representatives from AECOM, and four representatives from the City of Guelph.

At the end of the session, a survey link to Have Your Say was provided for attendees to submit their comments by October 13, 2021.

The presentation and the survey are provided in **Appendix C**. Feedback from the open house is included in Section 2.2 of this report.

3.6 Phase 1 online engagement

During the first phase of the study, online engagement was used to gather public input related to the Water Supply Master Plan Update. Have Your Say, the City of Guelph's online community engagement platform featured a Water Supply Master Plan page so that the public can share ideas and help shape decisions (haveyoursay.guelph.ca/wsmp). The Water Supply Master Plan Update page includes information about the project, an online survey associated with the open house, a Q&A tool available at any time, key dates, project lifecycle, contact information for 'who is listening', document library and a Have Your Say newsletter subscription.

The Have Your Say page was published February 10, 2020. Since being published, the page received 218 total visits. Twenty-three visitors filled out the online survey and one visitor asked a question with the Q&A tool.

February 2020 and March 2020 newsletters were distributed through the entire Have Your Say Guelph subscribers highlighting the community open house #1 and the online survey. The newsletters are available in **Appendix D**.

3.7 Phase 2 online engagement

Online engagement continued to be used to gather public input related to the Water Supply Master Plan Update (haveyoursay.guelph.ca/wsmp). The Water Supply Master Plan Update page included updated information about the project, an online survey associated with the second open house, a video recording of the second open house, the results of the survey associated with the first open house, a question and answer tool available at any time, key dates, project lifecycle, contact information for 'who is listening', document library and a Have Your Say email subscription.

Including results from Phase 1, as of October 14, 2021 the online engagement page received 733 total visits. One person filled out the online survey for the second community open house and four people asked a question with the Q&A tool.

4. Indigenous engagement

4.1 First Nations, Métis, Inuit Peoples living in Guelph

There are Indigenous Peoples—First Nations, Métis and Inuit Peoples–living in Guelph who are working with the City and contributing in the development of the Water Supply Master Plan Update. Specifically, through the Community Liaison Group, Indigenous Peoples shared their perspectives on the spirit of water and the importance of respecting the agency of water. This involved conversations during the first Community Liaison Group meeting; contribution at the first open house where Indigenous knowledge on water relations was shared with members of the public; and on-going dialogue with the Water Supply Master Plan Project Team around ways the relationships can be enhanced through working with the diversity of local Indigenous voices, on Water Supply Master Plan Update and other water-related projects and initiatives.

Details regarding meetings held with Indigenous communities regarding the Water Supply Master Plan Update are further outlined below.

4.2 Duty to Consult

The Crown has a legal duty to consult Indigenous Peoples when it has knowledge of potential project impacts on Indigenous or treaty rights. The Crown may delegate procedural aspects of the duty to consult to project proponents, and the Ministry of the Environment, Conservation and Parks has delegated the procedural aspects of rights-based consultation to the City, as noted in a letter dated November 5, 2019.

Ministry of the Environment, Conservation and Parks notified the Project Team of the Indigenous communities to contact regarding the Water Supply Master Plan Update and included Six Nations of the Grand River, Haudenosaunee Confederacy Chiefs Council and Mississaugas of the Credit First Nation. The Project Team is following the steps outlined in the "Code of Practice for Consultation in Ontario's Environmental Assessment Process". Where the Water Supply Master Plan Update may affect Indigenous and treaty rights, Ministry of the Environment, Conservation and Parks will determine additional consultation-related steps that may be taken.

These contacts were provided with a formal letter, the notice of commencement and invitation to the workshop with agencies and other municipalities, and the notice and invitation to the first community open house. Follow-up with the communities was conducted by the City to determine if there is any specific consultation format that is preferred in addition to the tools and activities utilized to date. In addition, the City conducted general communication and consultation with the Indigenous communities identified above with the intent to improve relationships with the communities and to share information with respect to the City's Municipal Comprehensive Review and updating of a number of the City Master Plans. These contacts resulted in some meetings to discuss the City's general master planning processes and the Water Supply Master Plan Update in particular.

4.2.1 Six Nations of the Grand River

One meeting and presentation was held with the Six Nations of the Grand River on July 6, 2021. This meeting was for the purpose of providing a briefing of the water-related master plan projects at the City. A presentation was delivered and included the following topics:

- overview of the Water Supply Master Plan
- overview of the existing water supply system
- how much water Guelph currently has
- how much water Guelph will need in the future
- water supply alternatives
- overview of engagement conducted to-date

A briefing note was provided to supplement the presentation and the City responded to pre-submitted questions from Six Nations. A meeting summary was also provided.

Following the presentation, there was a question and answer session that provided additional information on the City's water supply, source protection programs and water conservation and efficiency programs.

As an action item from the meeting, the City indicated they would share the draft Water Supply Master Plan report as part of the 90-day review period and prior to being approved by City Council.

All meeting materials are available in **Appendix H.**

4.2.2 Haudenosaunee Confederacy Chiefs Council

Efforts were made by the City to contact the Haudenosaunee Confederacy Chiefs Council regarding the Water Supply Master Plan Update.

Communications were directed to the Haudenosaunee Confederacy Chiefs Council as noted above to inquire about interest in a one-on-one meeting to discuss the Water Supply Master Plan Update. However, formal contact was not established, and meetings were not conducted.

4.2.3 Mississaugas of the Credit First Nation

As noted above, communications were initiated with the Mississaugas of the Credit First Nation to inquire about interest in a one-on-one meeting to discuss the Water Supply Master Plan Update. A subsequent meeting took place on October 6, 2021.

A presentation was delivered and included the following topics:

- overview of the Water Supply Master Plan
- overview of the existing water supply system
- how much water Guelph currently has
- how much water Guelph will need in the future
- water supply alternatives
- overview of engagement conducted to-date

A briefing note was provided to supplement the presentation and a written follow-up to questions regarding conservation and efficiency programs was also provided.

The Mississaugas of the Credit First Nation confirmed that they do not need to review additional materials for the Water Supply Master Plan, however, they did request annual updates on all water-related master plans and would like to be involved in new projects from the outset.

All meeting materials are available in **Appendix H**.

5. Additional stakeholder meetings and presentations

Meetings and presentations with key stakeholders were encouraged during Phase 1 and Phase 2 so that organizations and groups could learn about the Water Supply Master Plan Update and be kept informed on how they might specifically be impacted by updates. Meetings were held predominantly in-person for Phase 1 and virtually for Phase 2.

5.1 Guelph Wellington Development Association and Guelph and District Home Builders' Association

On November 7, 2019, the City Staff Technical Liaison Committee met with the Guelph Wellington Development Association and Guelph and District Home Builders' Association. Dave Belanger from the Water Supply Master Plan team was invited to present an overview of the Water Supply Master Plan Update, including the process for updating the 2014 Water Supply Master Plan.

After the meeting, the Water Supply Master Plan Project Team invited both organizations to participate in the Community Liaison Group.

Meeting minutes and the presentation are available in **Appendix E.**

5.2 Our community, our water open house

The City hosted a community open house on November 26, 2019 at Holiday Inn regarding a proposed solution between the City and the owners of the Dolime Quarry. The City's concerns about the Dolime Quarry revolve around how operations at the quarry could affect Guelph's drinking water.

The Water Supply Master Plan Project Team was invited to bring an overview display board about the Water Supply Master Plan Update to the open house. The display board is available in **Appendix E.**

5.3 Water Conservation and Efficiency Public Advisory Committee

On September 16, 2020 and on September 28, 2021 the Water Supply Master Plan team presented at the Water Conservation and Efficiency Public Advisory Committee meeting.

The first presentation discussed the 2014 Water Supply Master Plan Preferred solution, conservation and demand management efforts underway, the 2016 Water Efficiency Strategy, potential enhanced water conservation program successes / challenges and the demands projections for the Water Supply Master Plan Update. The session also provided an opportunity to ask questions and collect feedback.

The second presentation discussed the summary of water supply requirements to 2051, an overview of water supply alternatives, the environmental assessment evaluation criteria, preliminary preferred solution and opportunity for questions and feedback. Feedback generally focused on the following topics:

- How climate change is considered in the WSMP
- How sustainability is considered in the WSMP

A copy of the presentation is available in **Appendix E**.

5.4 Township of Puslinch

On December 2, 2019 the City provided an overview presentation of the Water Supply Master Plan Update project to the Township Supervisor of Public Works and Parks. This included an overview of the MCEA process, the draft Problem and Opportunity Statement, a review of the Water Supply Master Plan work plan and the schedule and next steps for the project.

Subsequently, in late 2019 and early 2020, the City offered on several occasions to provide a similar overview presentation to Township Council. Additional offers of meetings and presentations to staff and/or Council on the Water Supply Master Plan Update were provided in mid-2020 (July to September) associated with Water Supply Master Plan field work related to the Guelph South Groundwater Supply Feasibility Project.

Township of Puslinch identified the Mayor and a Councillor as the designated representatives for the Community Liaison Group. Invitations to the meetings as well as presentations and survey forms were provided to the Mayor and Councillor.

Representatives from Township of Puslinch attended the agency meetings on November 28, 2019 and on September 14, 2021 and, while verbal comments were provided at the meetings, written comments were not provided to the City following the meetings.

On October 13, 2021 the Water Supply Master Plan team met with Township of Puslinch's Council to provide an overview of the project and a shortened version of the presentation that was presented at the second agency and municipality workshop. The agency meeting presentation from September 14, 2021 was sent to Puslinch Council in advance of the meeting. Following the presentation the Project Team responded to questions from Council. Feedback generally focused on the following topics:

- concerns about source protection areas and land use constraints particularly with respect to impacts on the Township;
- concerns about potential well interference effects with existing wells particularly with respect to impacts on the Township;
- prioritizing supply within the City before considering sources within Township;

In follow-up to the meeting, Township of Puslinch sent a Council Resolution dated October 13, 2021 to the City (and to the Township of Guelph/Eramosa) which included several requests:

- confirming that the City extended the Township's commenting deadline on the Agency and Municipality Workshop #2 presentation slides from October 22, 2021 to November 5, 2021 despite a request for further extension
- Township staff and consultants review the Water Supply Master Plan Update when made available and provide comments at the November 24, 2021 Puslinch Council meeting
- that the City of Guelph Council provide the opportunity for Puslinch Council to provide comments in advance of the draft report being adopted by City of Guelph Council
- that the City of Guelph Council acknowledge receipt of the Township comments and provide a response
- that the City of Guelph Council authorize the release of the draft report to Puslinch staff in advance of the City of Guelph council meeting

A copy of the presentation and final Council Resolution are available in **Appendix E**. A copy of the meeting minutes can be accessed online at https://puslinch.ca/wp-content/uploads/2020/11/November-3-2021-Council-Agenda.pdf.

City staff responded to Township of Puslinch staff clarifying that feedback from Township was being sought for content in the agency and municipality workshop #2, not on the draft final report of the Water Supply Master Plan Update. The City extended the timeframe to submit comments on the September 14 agency presentation to November 5, 2021, providing a seven-week commenting period. It was noted that the draft final report, under development at the time of the meeting, will be released for public review and will be accompanied by a formal public review period in early 2022. City staff clarified that it was soliciting comments from the Township in order to incorporate Township feedback into the draft final Water Supply Master Plan report. At the time of writing of this report in November 2021, formal comments have not been received.

5.5 Township of Guelph/Eramosa

The Township of Guelph Eramosa had representation by a Councillor at all three of the Community Liaison Group meetings, and a Public Works representative at the first Agency / Municipality workshop. Communication was primarily verbal, with email correspondence from a Township of Guelph/Eramosa citizen seeking additional information after the second CLG meeting.

On October 20, 2021 the Water Supply Master Plan team met with Township of Guelph/Eramosa Council to provide an overview of the project and a shortened version of the presentation that was presented at the second agency and municipality workshop. Following the presentation the Project Team responded to questions from Council. Feedback generally focused on the following topics:

- Location of the Logan test well and primary direction of groundwater drawdown
- Leakage from the City's water distribution network and how it is managed
- The Eramosa River artificial recharge system and opportunities to improve the system efficiency
- How the Guelph Lake alternative could function and details of the GRCA capacity analysis
- The City's experience supporting the installation of residential greywater systems
- Possibility of collaborating on use of Cross-Creek water supply system to help meet future City demands

In a follow-up to the meeting, the Township of Guelph/Eramosa sent a Council Resolution dated October 27, 2021 which included a number of statements and requests:

- that the Township of Guelph/Eramosa has concerns with the City of Guelph's November 5, 2021 deadline for comments regarding the Water Supply Master Plan 2021 Update
- that the City of Guelph Council authorize the release of the draft report to Guelph/Eramosa staff in advance of the City of Guelph's council meeting
- that council direct Township staff and Township consultant(s) to review the City of Guelph Water Supply Master Plan Update correspondence and draft report, when available, and to provide comments for Council's consideration at a subsequent Township of Guelph/Eramosa Council meeting
- that the City of Guelph Council provide the opportunity for Guelph/Eramosa Council to provide comments in advance of the draft report being adopted by City of Guelph Council
- that the City of Guelph Council acknowledge receipt of the Township comments and provide a response
- that the resolution be forwarded to the City of Guelph and the Township of Puslinch

A copy of the presentation and final Council Resolution are available in **Appendix E**.

City staff similarly responded to the Township of Guelph Eramosa staff clarifying that feedback was being sought for content in the agency and municipality workshop #2, not on the draft final report of the Water Supply Master Plan Update. The City extended the timeframe to submit comments on the September 14 agency presentation to November 5, 2021. It was noted that the draft final report will be released for public review and will be accompanied by a formal public review period in early 2022 which will be to solicit commentary and incorporate feedback from the Township into the draft Water Supply Master Plan report. At the time of writing of this report in November 2021, formal comments have not been received.

6. Community Liaison Group

An aspect of the Water Supply Master Plan Update included consultation with a Community Liaison Group. The purpose of this group was to inform and provide an opportunity for input on specific issues related to the Water Supply Master Plan Update. Three meetings were planned at key milestones:

1. Introduction of the master plan and gain feedback
2. Update on alternative solutions and evaluation criteria and gain feedback
3. Present draft master plan update and gain feedback

A Community Liaison Group was created during the 2014 Water Supply Master Plan Update, and this membership was used as a foundation for the 2019 Community Liaison Group membership. Participants from 2014 were invited to take part again, in addition to new groups and the broader community (invited through the Notice of Commencement and direct emails). The Community Liaison Group included members from a wide cross-section of the community:

- business/ industry (two members)
- environmental organizations (two members)
- agriculture (one member)
- land development (one member)
- community or social organizations (two members)
- academia (three members)
- the Guelph community-at-large (Guelph) (three members)
- the community-at-large outside of Guelph (two members)
- the Anishinaabe (one member representing the local Indigenous community).

6.1 Meeting #1

The first Community Liaison Group meeting was held in-person on December 4, 2019 to share stakeholder and community ideas and perspectives on the Water Supply Master Plan Update. The purpose of the first Community Liaison Group meeting was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment including

- the objectives and scope of the Master Plan Update;
- issues and opportunities to be addressed;

- alternative solutions to be assessed; and
- the draft evaluation criteria to be applied.

For the first meeting there were 13 participants, along with four City staff and three AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary, in addition to presentation and discussion guide is provided in **Appendix F**.

Responses to questions in the discussion guide are presented in the feedback table in **Appendix A.**

6.2 Meeting #2

The second Community Liaison Group meeting was held virtually on July 27, 2021 to continue sharing stakeholder and community ideas and perspectives on ways to improve the Water Supply Master Plan Update. The purpose of the second Community Liaison Group meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including

- consultation conducted to-date;
- population targets and water supply demand forecasts;
- existing water supply capacity assessment;
- technical assessment of alternatives to-date; and
- environmental assessment evaluation criteria.

For the second meeting there were nine participants, along with three City staff and three AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary and the presentation (including discussion questions) is provided in **Appendix F**.

6.3 Meeting #3

The third Community Liaison Group meeting was held virtually on September 21, 2021 to provide a final opportunity for sharing stakeholder and community ideas and perspectives on ways to improve the Water Supply Master Plan Update. The purpose of the third Community Liaison Group meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including

- water supply requirements;
- work completed since meeting #2;
- assessment of water supply alternatives; and
- evaluation of water supply alternatives.

For the third meeting there were twelve participants, along with six City staff and three AECOM consultants. The format of the workshop included a presentation and opportunities for discussion and reflection.

A full meeting summary and the presentation (including discussion questions) is provided in **Appendix F**.

7. Agency and municipality workshop

Part of the Water Supply Master Plan Update included two workshops to bring Municipalities and Agencies together, providing a forum to discuss plans for the 2021 Water Supply Master Plan Update and to gather input.

In addition to select City of Guelph staff, organizations that were invited to participate included

- Grand River Conservation Authority;
- Haudenosaunee Confederacy Chiefs Council;
- Ministry of the Environment, Conservation and Parks;
- Ministry or Natural Resources and Forestry;
- Mississaugas of the Credit First Nation;
- Region of Waterloo;
- Six Nations of the Grand River First Nation;
- Town of Milton;
- Township of Centre Wellington;
- Township of Guelph / Eramosa;
- Township of Puslinch;
- Wellington County;
- Wellington Source Water Protection; and
- Wellington-Dufferin-Guelph Public Health.

7.1 Workshop #1

The first workshop was held on November 28, 2019 with 10 participants from six organizations, along with four City staff and four AECOM consultants. The purpose of the first workshop was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment, including

- the objectives and scope of the Master Plan Update;
- issues and opportunities to be addressed;
- alternative solutions to be assessed; and
- the draft evaluation criteria to be applied.

The format of the workshop included a presentation and opportunities for discussion and reflection. A full meeting summary, in addition to presentation and discussion guide is provided in in **Appendix G**.

Responses to questions in the discussion guide are presented in the feedback table in **Appendix A.**

7.2 Workshop #2

The second workshop was held virtually on September 14, 2021 with 11 participants from five organizations, along with six City staff and three AECOM consultants. The purpose of the second agency workshop was to gather feedback and concerns from agency and municipality representatives after reviewing progress related to the Master Plan and the Class Environmental Assessment, including

- water supply requirements;
- work completed since meeting #2;
- assessment of water supply alternatives; and
- evaluation of water supply alternatives.

The format of the workshop included a presentation and opportunities for discussion and reflection. A full meeting summary and the presentation (including discussion questions) are provided in **Appendix G**.

Appendix A

Feedback and correspondence tracking

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
12/2/2019	Corinne Taylor, MECP	Email	Thank you for the invitation to the City's Water Supply Master Plan Update meeting last week. After the meeting, I reached out to our surface water specialists and we thought it would be important to highlight to the team the importance of working with your wastewater counterparts on this study (as you discussed at the meeting). Any new water source considerations, especially surface water (Guelph Lake, Eramosa River at Arkell and/or Dolime "lake") in the water supply master plan needs to carefully consider the impact the additional water taking may have on the river and assimilative capacity for the river.	12/3/2019	Thank you for attending on Thursday and thank you for your comment. We recognize the concerns regarding impacts on the river and the assimilative capacity of the river that may result from a river water taking (i.e., Speed River or Eramosa River). In the 2014 Water Supply Master Plan, the City worked with the GRCA to assess the feasibility the timing and the rate at which water could be taken from the rivers. GRCA (Dwight Boyd) conducted the flow analyses. An underlying assumption in the flow modelling was "that downstream low flow targets upstream of the Guelph sewage treatment plant were achieved 100% of the time". See the 2014 WSMP, Section 5.4 and Appendix D - https://guelph.ca/wp-content/uploads/2014-Water-Supply-Master-Plan-Update.pdf For the Dolime Quarry, the discharges from the quarry are not used in the assimilative capacity assessments for the City's wastewater treatment plant. This is because the discharge is granted by permit which could end at any time and is variable throughout the year (i.e. lowest flows in the summer). In addition, the assimilative capacity is based on the upstream flows in the Speed River and the quarry dewatering is discharged downstream of the plant. The settlement proposal for Dolime would only move forward if accepted by Council. At present, the strategy is to capture groundwater in the area of the quarry using the existing network of production and test wells in the area of the quarry. We are not considering a direct use of the quarry pond water at this time; however, it may be an option in future plans. This information can be included in the 2019 WSMP update.	N/A
12/3/2019	Corinne Taylor, MECP	Email	I only wanted to highlight the surface water taking from Guelph Lake because back in 2016, I sat in on a meeting with the City and Paul Odom (who was the Surface Water Specialist reviewing Guelph's rerating) and he mention the concern about taking from Guelph Lake and referenced the 2014 Water Master Plan. I didn't want to bring it up at the our meeting during the surface water question because the re-rating meeting was long ago and I didn't remember all of the specifics. I looked up his minutes from that meeting and this was what Paul wrote: If part of the City's planning and EA exercises includes potential removal of additional water from the Eramosa River at Arkell or from the Guelph Lake area, these must be factored into impact assessments as the Table B flows are based on existing withdrawal at Arkell and no sourcing at Guelph Lake. Any additional withdrawal for municipal water supply will likely equate to a reduction in the dilution capacity of the Speed River at the WPCP discharge. With respect to Dolime, in Jan 2019 the City of Guelph and Dolime gave a presentation to Tech support. It is my understanding that the City mentioned at this meeting it was considering putting in a well to capture additional	12/3/2019	We understand. Thank you for the additional information.	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
			groundwater at Dolime so that less water would be discharged to the Speed River. Tech Support Surface Water Group identified at this meeting that the impact to the assimilative capacity would have to be assessed. My comments was mostly an FYI since I am not a hydrogeologist or surface water specialist and I was happy to hear that you had a plan in place to work with the wastewater group. I know the City has initiated an assimilative capacity study of the Speed River and are working on it as we speak so I'm sure all of this will be identified and updated with new numbers. Tim has been working hard to get the Wastewater Plant rerated and I know that the rerating of the plant has not been an easy task for the City. I just wanted to stress this comment about surface water so that it is not even harder for the City to move to phase III of their re-rating in the future. Just some things to consider.			
1/6/2020	Stan Denhoed	Email	I am having a meeting with the new CAO of the Township of Puslinch and the mayor next week. I will not respond until I speak with them. I understood that the City of Guelph was to have a meeting with the Township (either a presentation to council or meeting with the CAO) to discuss the master plan. Is this meeting still in the works or has it already occurred?	1/6/2020	The Puslinch Mayor and Councillor Bulmer were invited to the Community Liaison Group meeting on December 4 and although Matt (Bulmer) rsvp'ed, they didn't attend the meeting. They were provided similar materials to what you received for the Workshop. We also met with Puslinch staff (Mike Fowler) on December 2 and briefed him on the WSMP. We also sent the Notice of Commencement to the Township. That's the extent of our communications with the Township so far. If, in your meeting, they have more questions/comments, let us know. We could meet with the CAO and/or the Mayor and Council at their convenience if they want.	N/A
1/6/2020	Eric Hodgins, Region of Waterloo	Agency and Municipality Workshop discussion guide (Email)	Q. 12. It is not clear how changes in the WHPA-Q will be considered in the overall selection of alternatives. From the Region of Waterloo's perspective, it would be better to use the water currently being pumped from the Dolime quarry for additional supply rather than develop new supplies in the southwest quadrant as there will be no net increase in the amount of water removed and the latter may move the WHPA-Q further into Waterloo Region. Not increasing the overall amount of taking would also minimize any reduction in groundwater flow from Guelph toward Cambridge. The evaluation criteria could be broadened to consider impacts to overall water budget and/or increases in potential water quantity policy implementation costs.	1/8/2020	Thank you for the comments on the Water Supply Master Plan. Your comments are consistent with our proposed approach. Let me address the Dolime comment first. It is our intention to develop a groundwater supply option around the Dolime Quarry. We are in the process of developing a settlement pathway that would allow the City to gain control of the dewatering operations at the quarry. Details are provided here - https://guelph.ca/living/environment/our-community-our-water/rolling-out-the-proposed-solution-for-the-dolime-quarry/ .While there are lots of challenges to get to a final solution, our approach is to continue dewatering of the quarry to maintain the inward gradients to the quarry to protect water quality but at the same time, try to optimize the water taking around the quarry. We have proposed an operational testing program and a Class EA to confirm how to do this. Our expectation is that we will be able to use existing and new wells to capture most of the water currently pumped from the quarry which may result in additional water supply capacity but the actual amount will be derived from the OTP and the Class EA. The OTP and Class EA will also assess direct use of the dewatering water, although the pumping rate may be low and	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
					treatment costs may be high therefore it may be a lower priority water source. We agree that this would be a preferred supply source but we also expect we will need more water than just from around Dolime and we may need to advance a number of water supply projects to meet 2041 demands. This may include a new source in the southwest corner of the City. It is not our intention to specifically define changes to WHPA's as part of the Master Planning process; that level of detail will be reserved for the Class EA process for the individual projects. We will however, assess the impacts of new source protection areas in the Evaluation Criteria. The Tier 3 water budget model, in a general sense, will be used to assess the potential environmental impacts of new sources using the Natural Environment criteria. This modelling work will also consider the impact of individual projects on the total water budget. The Social and Cultural Resources category is intended to capture impacts from land use changes such as the delineation of new WHPA either for quality or quantity. We would expect that new sources would result in new WHPA's or changes to boundaries of existing WHPA's which would result in new land use constraints on residents and businesses within the areas. Additional costs associated with the new WHPA's, both for delineation and policy implementation, would also be considered as part of the Economic and Financial Considerations. I hope this addresses your comments, but if you would like more information or want to discuss this, please let us know.	
1/9/2020	[redacted]	Email	I wasn't necessarily expecting a direct response from my comments but rather I wanted to make sure that the Region's comments were provided as part of the Master Plan and I was unable to attend the first workshop hosted by the City. With that being said, I appreciate receiving your response and getting some further information on the City's thought process around looking for new water supplies. I appreciate that the Dolime Quarry is still a challenging issue and may not be sufficiently resolved for the outcomes to be confirmed in the Master Plan. Your approach to dealing with new supply areas seems reasonable and we will see where it all leads to in the end.	12/31/2021	Noted.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[What do you think of the City's current water conservation goals and strategies? Are there other goals or strategies that should be considered?]* Further monies should be focused on retrofitting the ICI sector to facilitate reductions	12/31/2021	Industrial, commercial and institutional (ICI) conservation and efficiency measures will be included in the 2019 WSMP update.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
1/9/2020	[redacted]	CLG discussion guide (email)	*[Would you support a bylaw that regulates new high water demand land uses in the City? Why or why not?]* Yes, new development should be required to implement LID practices.	12/31/2021	In accordance with section 4.3.2 of the City of Guelph Official Plan (Water Resource Protection and Conservation), the City actively promotes efficient and sustainable use of water resources in new development and existing built form. This includes reduction in water consumption encouraged by City planning staff consultations and conservation programming through upgrading/retrofitting of existing buildings and facilities. Furthermore, the official plan identifies that the City may require a Water Conservation Efficiency Study in conjunction with new development as well as encourage the implementation of Low Impact Development (LID) and alternate water supply through local development, where appropriate. In assessing the City's ability to meet the servicing needs of new business growth Economic Development and Engineering staff carry out a consultation with business proponents to understand the water servicing and other needs of their proposed operations. Through ongoing consultations City members staff commonly discuss proposed process water use of the proponent versus industry efficiency benchmarks with proponents as well as local water and wastewater user rate forecasts and development charges to servicing capacity to help encourage water efficiency investments in their operations from the time of commencement. Thereafter the City's ability to meet the proponents servicing needs (average day, peak day and fire flow water demands) are technically confirmed by the City's hydraulic water servicing model in the area(s) of the water distribution system where a new business proposal is being considered (a capacity analysis is also undertaken on the wastewater collection system to ensure the proponents servicing needs are met and that there are no adverse impacts on the City's infrastructure). If available servicing capacity does not meet proponent needs this would drive additional consultation on process conservation measures to be employed should the proposed business location still be desired by the proponent. In City staff's opinion the above noted process helps to effectively allocate and manage available servicing capacity between proponents and a bylaw to regulate this demand is not recommended. The basis for this position is such a bylaw could not be easily administered or enforced without significant capital and operational investments for field technology to limit flow to large consumers as they met their permitted capacity under the bylaw. Furthermore, the presence of such a bylaw may impose competitive disadvantage for the City to retain and attract business due to future uncertainties regarding availability on future servicing availability which would constrain potential for business growth, which would not be present in other Ontario based communities.	

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
1/9/2020	[redacted]	CLG discussion guide (email)	*[What issues, concerns or questions related to water supply should be considered while updating the WSMP?]* The issue that under 2031 demand and drought, the designation of Wellhead Protection Area is under significant risk. Look into what year (now to 2031) is the demand under the threshold. Approach government with that year for maximum population.	12/31/2021	The WSMP will consider the risks associated with drought and the related mitigation options that the City has developed and evaluated. Future growth target planning will consider the availability of water supply as a critical aspect of the planning process. The Significant Risk designation is for the existing water supply system. The risk can be mitigated by provide new sustainable water supply system(s) in addition to the existing supply capacity.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[Is the purpose statement adequate for the WSMP update?]* I question whether the last sentence in the second paragraph can be fully fulfilled. How can we ensure that environmental sustainability is not compromised in the year 2040?	12/31/2021	The available science in 2019/2020 will be utilized to evaluate potential environmental sustainability of the preferred solution. The WSMP will map out the detailed field studies that are required to assess the specific environmental concerns related to each water supply project. Each detailed field project will use the science available when the project is implemented and the WSMP will be updated approximately every five years. Through this process, the water supply required to support growth of the City will be developed in an environmentally sustainable manner.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[Are there other ways to engage community members you would like to see the City consider?]* Presence at community events, locations that are accessible to all demographics (or several that together make-up Guelph's residents and ICI community).	12/31/2021	The City is considering additional engagement opportunities outside of the formal open houses. Some examples include library events and the H20 Go Festival. Unfortunately in-person events have been cancelled in Spring 2020 due to COVID-19. The Have Your Say online engagement platform is available for all demographics to use.	City to consider additional engagement opportunities.
1/9/2020	[redacted]	CLG discussion guide (email)	*[What types of information do community members need to be engaged?]* Proposed alternatives, evaluation criteria, future growth plans, proposed bylaws.	12/31/2021	Proposed alternatives and evaluation criteria are key questions that we are looking for feedback on from the public. Future growth plans inform population and demand figures in the WSMP update content presented to the public. The growth plans will be updated separately from the WSMP update. Proposed bylaws are not in the scope of this WSMP update.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[Who else needs to be engaged?]* Youth (25 and under), new immigrants to Guelph, multiple property owners (multi-use and residential).	12/31/2021	We agree that the opinion of youth and new Canadians would be target audiences to inform different perspectives on water supply. Several students from the University of Guelph attended the community open house #1. We hope to continue to engage these communities and find ways to involve them, including multiple property owners.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[How can community members outside of Guelph be properly consulted to evaluate water supply sources outside of the City?]* I do not support water supply sources outside of the City.	12/31/2021	Noted.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[Do you have concerns regarding any of the alternatives presented? Should any be added or removed from consideration?]* For consideration: decentralized stormwater management for non-potable water needs, i.e., industrialized areas. Remove 'outside of the City groundwater sources'.	12/31/2021	Grey water reuse options will be considered in the WSMP update. At this time 'outside of the City groundwater sources' will not be removed from consideration but will be evaluated and ranked using the same methodology as the other alternatives presented. The current water supply system derives a significant portion of its water from outside the City (i.e., Arkell Spring Grounds)	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
1/9/2020	[redacted]	CLG discussion guide (email)	*[New water supply sources may have some environmental impact. For example, long-term groundwater pumping from wells may affect surface water features. In your opinion, is it reasonable to take water to support population growth even if there are environmental impacts? What level of impact is acceptable?]* In my opinion it is not reasonable or responsible to support population growth through increased water uptake from wells that would not be able to sustain the drawdown without a negative environmental impact.	12/31/2021	Noted. The potential environmental impacts associated with each alternative will be evaluated in the WSMP update. The WSMP is to identify sustainable water supply alternatives to minimize environmental impacts to prevent negative or adverse environmental impacts.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[Should water supply sources inside the City be prioritized over those outside City boundaries? Why or why not?]* Yes, I consider outside water sources a 'Las Vegas situation' where it isn't sustainable and should not exist. Growth should be limited by the resources available.	12/31/2021	Noted. This is consistent with City Council's position to prioritize sources inside the City first. Previous Council direction also promoted sustainable water supply system as a priority over growth. The WSMP is to identify sustainable water supply alternatives to minimize environmental impacts to prevent negative or adverse environmental impacts.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[Is it appropriate to consider obtaining water from sources that require treatment to remove contaminants (i.e., natural or industrial), assuming all regulatory standards are met after treatment?]* Yes, and could be used solely for non-potable applications.	12/31/2021	Noted.	N/A
1/9/2020	[redacted]	CLG discussion guide (email)	*[Are the evaluation criteria suitable for this study? Is there anything you would add or change?]* I agree with the evaluation criteria.	12/31/2021	Noted.	N/A
1/10/2020	Sonja Strynatka, Grand River Conservation Authority	Agency and Municipality Workshop #1 discussion guide (email)	*[Certain City supply wells are pumped at maximum permitted (PTTW) rates during high demand periods or to make up capacity when other supply wells are shut down. On average, these wells pump below the permitted maximum, but the maximum capacity is required to support current and/or future demand. Does well use, in this manner, support PTTW renewal at the established maximum values?]* Yes; the permitted maximum is needed to support current demand on an as needed basis for the reasons noted such as high demand periods, for well maintenance where other supply wells are shut down, and for unexpected events such as well contamination. Permitted maximum is also necessary to support future demand. The GRCA supports PTTW renewal at the established maximum values and not reducing these values.	12/31/2021	Noted.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
1/10/2020	Sonja Strynatka, Grand River Conservation Authority	CLG discussion guide (email)	*[The City's well system was developed over an 85+ year period and permits were issued for each well based on environmental conditions at the time of construction. In the absence of a demonstrated environmental impact caused by a well, should additional environmental study be required to renew a PTTW?]* No; according to the Permit to Take Water Manual (MOE 2005), the renewal of an existing permit for the same or a lessor amount that has had no past interference is classified as a Category 1. Category 1 permit applications are anticipated to have a lower risk of causing adverse environmental impact and therefore do not require additional environmental study. The GRCA supports additional environmental study in cases where an existing permit has a noted past interference.	12/31/2021	Noted.	N/A
1/10/2020	Sonja Strynatka, Grand River Conservation Authority	CLG discussion guide (email)	*[Three wells in the City's system are impacted by industrial contaminants and off-line. Is it reasonable to assume source remediation may improve water quality for these wells, should the City consider adding treatment to the wells to remove the contaminants, or should the wells be removed from the assessment of existing system capacity?]* If remediation or treatment is not feasible in the near term, the impacted wells should be considered for removal from the existing system capacity.	12/31/2021	Noted.	N/A
1/10/2020	Sonja Strynatka, Grand River Conservation Authority	CLG discussion guide (email)	*[What are the benefits and drawbacks of using the Tier Three Groundwater model for evaluation of the water quantity impacts of source development?]* The GRCA supports the continued use of the Tier 3 model for the development of the WSMP. The Tier 3 model represents the best available regional science for the City's groundwater system. Every model has uncertainties and limitations to its use. The GRCA supports the City to use the Tier 3 model to scope potential areas for future municipal well locations. Local field testing and modelling should support establishing well locations and pumping rates. The use of the regional Tier 3 model also allows the City to evaluate potential drawdown impacts within neighbouring Townships such that early engagement with the Townships can be initiated.	12/31/2021	Noted.	N/A
1/10/2020	Sonja Strynatka, Grand River Conservation Authority	CLG discussion guide (email)	*[Is there anything else you think is important as we move forward with this process?]* The GRCA supports the use of the Tier 3 model as a part of the WSMP, and encourages continued and early engagement with the neighbouring Townships and the community.	12/31/2021	Noted.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
1/13/2020	[redacted]	CLG discussion guide (email)	*[What do you think of the City's current water conservation goals and strategies? Are there other goals or strategies that should be considered?]* The short and intermediate term goals are reasonable given constraints within the current framework for using potable water supplies for all residential, commercial, industrial and operational water needs, but we are on a critical path for major change to our integrated water and wastewater management strategies. Here is where we must begin with major change - "start over", transformative approach. The total rethink has to do with reducing demand per capita for water consumption through degradation of water quality via wastewater reduction, i.e. replace flushing toilets with dry, compostable toilets that allow removal of toxic / harmful substances in wastewater streams currently not treatable or costly.	12/31/2021	The feedback will be considered in the context of the conservation/ efficiency alternative solution and provided to the City's Water Efficiency team for their consideration.	Provide comment to the City's Water Efficiency Supervisor
1/13/2020	[redacted]	CLG discussion guide (email)	*[Would you support a bylaw that regulates new high water demand land uses in the City? Why or why not?]* Yes, in the short term we have gained insights in current system operational constraints so new water demands must be reviewed - but, I strongly recommend encouraging futuristic views, an eye to the future conditions with government changes to how we use water, reduce wastewater streams and regulate / manage stormwater (road salt and other pollutants avoided by pretreatment) allowing alternative use as re-use or strategic recharge to groundwater for flow system replenishment. We also need to rethink stormwater collection to improve quality (remove salt) before managed aquifer recharge where / when storage exists.	12/31/2021	The feedback will be considered in the context of the evaluation of the alternatives (Aquifer Storage and Recovery opportunities) and through coordination with the Wastewater Master Plan project.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[What issues, concerns or questions related to water supply should be considered while updating the Water Supply Master Plan]* The city already has excellent focus with important ideas for short term improvements, however, delays with consideration of bold changes in the distant future occur if not considered immediately. The major changes to water management, use, and recycling need consideration and agreement now - the new future with no water toilets are possible, fecal waste separation and partial treatment at the source may be essential for human and ecosystem health due to the harmful constituents. Every day decisions now that do not account for different future conditions, delays the much needed changes.	12/31/2021	The feedback will be considered in the context of the conservation/ efficiency alternative solution and through coordination with the Wastewater Master Plan project.	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
1/13/2020	[redacted]	CLG discussion guide (email)	*[Is the Purpose Statement adequate for the WSMP Update?]* Yes, but consider previous comments in that we need a very different approach in the future to meet a net zero carbon target (energy sources and consumption) and accommodate emerging contaminants known and unknown in various water streams (toilet water contaminants, including: viruses, bacteria, chemotherapy drugs and antibiotics as examples) that should be avoided. No flush toilets create 45% more available water, change future infrastructure needs but remove toxins from ecosystem currently impairing health of humans and ecosystems. We can add water availability and reduce impacts significantly.	12/31/2021	Noted.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[Are there other ways to engage community members you would like to see the City consider?]* It must be more than a select few groups - it has to be a massive communication campaign, beyond the organized special interest groups, but also larger term views are lacking. I believe municipal water and wastewater infrastructure and management plans require a start from scratch perspective to provide a seriously new strategy with prospects for short and intermediate term activities to be assessed and change decisions to be realigned and compatible with the new long range plan.	12/31/2021	The engagement strategy for the WSMP update project includes communication with individuals of the local Indigenous population and wide-spread advertising throughout Guelph as an attempt to reach population sub-groups that are traditionally “hard to reach”. We were encouraged to see several university students attend the first project community open house.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[What types of information do community members need to be engaged?]* Information on the broader goals providing guidance and constraints; population growth locally, regionally and globally - how this sets constraints and needs. Carbon zero /neutral - how this relates to water master plan challenges now and in the future. Our biggest threat to humanity will be health, climate / weather variability and direct effect on the water master plan must be articulated. How might this create drivers and guide a very different approach to water use and infrastructure. We need to think big, differently, and engage the youth.	12/31/2021	Noted.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[Who else needs to be engaged?]* Guelph is a University town and should engage the massive young demographic - we must solicit wild and crazy ideas as part of the brainstorming process. Youth, young and mid-career adults have their future at stake. The experience needs to be captured “what not to do” or how to avoid what we see now as our challenge. Consider an “ounce of prevention is worth a pound of cure” meaning a whole new approach likely implemented for components of system and a few at a time in a logical sequence to reduce costs, carbon and water footprints, etc., rather than small adjustments to the existing approach.	12/31/2021	The project team will reach out to you for perspectives on how the student population can best be engaged on this project.	Project team to reach out for further discussion.

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
1/13/2020	[redacted]	CLG discussion guide (email)	*[How can community members outside of Guelph be properly consulted to evaluate water supply sources outside of the City?]* Communication needs to be continual, but the community itself must be rallied first as a priority. Guelph is becoming almost too large, too fast to ignore the need for "community connectivity" and the creation of shared values; compatibility alignments locally would be a good forum for discussion.	12/31/2021	A comprehensive Engagement Plan has been created for the WSMP update project. This plan will be adjusted as needed to achieve the City's engagement goals.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[Do you have concerns regarding any of the alternatives presented? Should any be added or removed from consideration?]* At the moment, my concern for our planning is that the solutions that result are too constrained by old-fashioned infrastructure. Regulations, economic incentives and metrics to new progress are essential for change. Our master plan exercise needs to be two-fold, short term improvements but a long-term strategy that boldly addresses our societal needs in a much longer term. So what is missing is the strategy rethink. This cannot be left to politicians.	12/31/2021	Although the WSMP project is an update and therefore has similarities to the 2007 and 2014 projects, all aspects will be re-evaluated and new and/ or updated alternatives will be assessed where identified.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[New water supply sources may have some environmental impact. For example, long-term groundwater pumping from wells may affect surface water features. In your opinion, is it reasonable to take water to support population growth even if there are environmental impacts? What level of impact is acceptable?]* No, one must continue the process of optimization of these systems, including reduction of water use and ecosystem sustainability. Constraints are needed to promote invention and drastic change to achieve positive outcomes, not the negative outcomes eluded to here.	12/31/2021	Noted.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[Should water supply sources inside the City be prioritized over those outside City boundaries? Why or why not?]* A combination of both - the water is recharged both regionally (hence outside boundary takings and is the same source water as internal city takings in many circumstances, but not all) and locally where aquitards and many water supply wells vertically cross-connect facilities near vertical flow, hence recharge within the city to these wells. Overall, closer proximity wells to users makes most sense.	12/31/2021	Noted.	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
1/13/2020	[redacted]	CLG discussion guide (email)	*[Is it appropriate to consider obtaining water from sources that require treatment to remove contaminants (i.e., natural or industrial), assuming all regulatory standards are met after treatment?]* It is absolutely required, more than believed currently and likely more in the future, however this issue has multiple facets. Our second biggest challenge (becoming our biggest challenge in the future) is water quality and our expectation that it should be considered contaminated until verified or proven otherwise. Therefore, it is paramount we think more holistically about the waste streams, removing salts and PAH's from stormwater before being discharged back to the natural surface water or managed recharge to groundwater, as an important example. Remove water softener discharges to sewers and consider alternatives and moving away from septic systems and wastewater for human and animal fecal waste streams. This would provide a more sustainable path to accessing freshwater resources for consumption with natural properties and without minimal pretreatment, but also pursues improved ecosystem health and leads to lower energy consumption. The concepts require avoiding the use of water to convey waste for energy intensive treatment for only a partial list of contaminants.	12/31/2021	The feedback will be considered in the context of coordination with the Wastewater Master Plan project. The City will continue to monitor water quality and ensure delivery of supply that is compliant with the standards established by the Ministry of the Environment, Conservation and Parks.	N/A
1/13/2020	[redacted]	CLG discussion guide (email)	*[Are the evaluation criteria suitable for this study? Is there anything you would add or change?]* The criteria are suitable but as expressed, not quantifiable enough to guide the process - the attributes are not sufficiently defined that the evaluation can be done transparently or even consistently. This next level of detail is essential for implementation.	12/31/2021	Noted.	N/A
1/21/2020	Kyle Davis, Wellington Source Water Protection	Email	Kyle Davis provided two emails containing information on known land uses in the vicinity of City test wells.	12/31/2021	The information provided will be considered in the evaluation of alternatives.	N/A
2/6/2020	Stan Denhoed, Township of Puslinch	Email	*NOTE: this email was sent from the City of Guelph Project of Team to Stan Denhoed* Hi Stan. Kathryn Ross/AECOM passed on your message about meeting with Puslinch Township to discuss the Water Supply Master Plan. We are glad to do this. Who would we contact at the Township to set this up? Do you think they would like a meeting (less formal) or a presentation at a Council meeting? [redacted] passed on your advice for the meeting (see below) but if there is anything else, please send it our way and we will try to cover it off. Let us know and we will try to set something up. Thank you for your help.	12/31/2021	*NOTE: this response was sent from Stan Denhoed to the City of Guelph Project Team* Dave I have added Glenn Schwendinger to this conversation. When Glenn and I met with Mayor Seeley there was interest in having the township Councillors hearing directly from City staff (or their agents) specifically about potential future well development by the City near enough to the municipal boundary to have Well Head Protection Areas extend into the Township. The areas of interest include; what role the Township has in the development of the Water Supply Management Plan, potential land use restrictions within future WHPA's, the potential expansion of the WHPA Q1 , when groundwater model updates will occur and Source Protection Plan policies that may restrict future growth of employment lands in the	*02/20/2020 Response to Glenn Schwendinger:* Hi Glenn. Let us know what you would like from us. We would be happy to meet with you either in a meeting or at Council. Thank you.

Date	Name	Source	Comment	Response Date	Response	Action Required
					Township. After a presentation by the City, I may be directed by council to provide a formal response. I will leave it up to Glenn to further the conversation in regard to how the Water Supply Management Plan information should be conveyed to the Councillors and mayor.	
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Concerns or areas of focus]* Increasing concentrations of salt parameters in City and County wells.	12/31/2021	Current water quality data and water quality trends are being reviewed.	N/A
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Concerns or areas of focus]* New City wells in the County leading to increased County and Township requirements and cost.	12/31/2021	The potential impacts to surrounding municipalities is an element of the evaluation criteria.	N/A
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Concerns or areas of focus]* City's ability to optimize/ maximize water from existing wells/ systems and address water loss (in order to reduce the need for new wells).	12/31/2021	Well optimization and non-revenue water will be assessed as part of the technical aspects of the WSMP update.	N/A
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Concerns or areas of focus]* Tier 3 study/ policy development and how that relates to municipal (City and County) and non-municipal takings.	12/31/2021	The policies under development for the Guelph-Eramosa Wellhead Protection Areas for Water Quantity (WHPA-Q) will be considered as part of the alternative evaluation as will the water quality threat policies.	N/A
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Concerns or areas of focus]* Existing contaminated sites and status of remediation efforts and impacts to ability of City to bring wells back online.	12/31/2021	Feedback from the Ministry of the Environment, Conservation and Parks (MECP) on existing contaminated sites has been solicited as part of the WSMP update. MECP has primary responsibility for addressing water quality issues associated with contaminated sites.	N/A
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Concerns or areas of focus]* Guelph Dolime and how its taking interacts with City and other takings and ability for City to bring south Guelph test wells online (i.e., Ironwood, Steffler).	12/31/2021	Both of the noted alternatives will be considered during the WSMP update technical analysis.	N/A
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Concerns or areas of focus]* Regarding Logan well, the presence of the existing Nicklin Auto Recyclers should be assessed when evaluating whether this location is appropriate.	12/31/2021	This land use will be included in the evaluation criteria under the water quality and source water protection categories.	N/A
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Consultation]* Consultation should include Town of Erin given the presence of the intake protection zone into the Town if the City feels the WSMP will result in increased surface water takings.	12/31/2021	The project team will reach out to Town of Erin staff to see if there is interest in meeting and/or being added to the project mailing list.	Contact Town of Erin.

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Date	Name	Source	Comment	Response Date	Response	Action Required
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Consultation]* Consultation should include public meetings, presentations to Township/ County Councils especially GET and Puslinch, newspaper, radio, social media and direct mailings.	12/31/2021	The project team is hosting two community open houses and will consider presenting to surrounding Township and County Council members if they are interested. Project team has offered to provide presentations to Township Councils. Newspaper and social media are being used to advertise the WSMP project. We can consider radio and direct mailings.	Consider expanding project notifications to radio and direct mailings
2/7/2020	Kyle Davis, Wellington Source Water Protection	Agency and Municipality Workshop discussion guide (Email)	*[Consultation]* There should be a connection between the WSMP and the Tier 3 policies.	12/31/2021	Both water quality and draft water quantity policies will be considered.	N/A
2/13/2020	Member of the public	Engagement HQ	How have the projected future water demands been considered with the current and future capacity of the Guelph WWTP? Realistically, it seems unlikely that water reclamation efforts would be implemented fast and vastly enough to keep up with the growing water demand (and consequent increased wastewater production).	2/13/2020	The Water Supply Master Plan is integrated with the Wastewater Master Plan through the water demand forecasts. The water demand forecasts are based on the number of people in Guelph by 2041 and how much water they will use during the same time period. The water demand forecast is used in the Water Supply Master Plan to determine how much new water is needed and when it is needed in the future. Similarly, the water demand forecast is used as an input into the Wastewater Master Plan since most of the water demand ends up as wastewater. The Wastewater Master Plan then identifies alternatives to address the future wastewater treatment requirements as well as improvements and upgrades to ensure that there is existing wastewater treatment capacity when it is needed. The Wastewater Master Plan will be updated in 2020, similarly to the Water Supply Master Plan. Interested persons should watch the City News for more information on the Wastewater Master Plan.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Regarding the following sentence: "The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers." Guelph's water supply is primarily groundwater. You cannot control nor develop this supply, only monitor how your water extraction is affecting groundwater levels over time. If the City continues to promote that our drinking water supply is from groundwater, then it sounds terribly wrong to say you are going to develop that supply when in fact you have no ability to develop a groundwater source. Perhaps you mean to say you will develop and supply water infrastructure.	12/31/2021	In this context, 'developing' refers to the City providing the necessary supply of water to the community, not the development of groundwater itself. The City can control the supply of water by managing the facilities and distribution to ensure that it is sustainable.	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Sufficient water supply without any summer water restrictions on use, then population growth, not the other way around.	12/31/2021	The summer water restrictions are imposed as part of the Province's Low Water Response Program and, for the City, is co-ordinated through the Grand River Conservation Authority (https://www.grandriver.ca/en/our-watershed/Low-Water-Response.aspx). It is largely in response to low rainfall and hot weather in the summer in the Grand River Watershed which can result in low flows in rivers and streams and in low levels in some groundwater systems. The City's drinking water sources are mostly from deep, confined bedrock aquifers which are less affected by periodic dry summer conditions. The summer water restrictions are directed at holders of Permits to Take Water which includes the permits for the City's water supply system. Therefore, the City co-ordinates its Outdoor Water Use Program (https://guelph.ca/living/house-and-home/lawn-and-garden/outdoor-water-use-and-restrictions-in-guelph/) with the Low Water Response Program. When the Provincial Low Water Response Program identifies low water levels based on trends in surface flows and rainfall, the City implements similar outdoor water use restrictions. While the City has adequate water supply capacity during these low level periods, the City reduces it water supply demand, to help preserve the river and stream flows.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Intensive watershed protection and stringent/ enforced conservation efforts (including banning withdrawal for profit - Nestle) should absolutely be top priorities.	12/31/2021	In accordance with section 4.3.2 of the City of Guelph Official Plan (Water Resource Protection and Conservation), the City actively promotes efficient and sustainable use of water resources in new development and existing built form. This includes reduction in water consumption encouraged by City planning staff consultations and conservation programming through upgrading/retrofitting of existing buildings and facilities. Furthermore, the official plan identifies that the City may require a Water Conservation Efficiency Study in conjunction with new development as well as encourage the implementation of Low Impact Development (LID) and alternate water supply through local development, where appropriate. In assessing the City's ability to meet the servicing needs of new business growth Economic Development and Engineering staff carry out a consultation with business proponents to understand the water servicing and other needs of their proposed operations. Through ongoing consultations City members staff commonly discuss proposed process water use of the proponent versus industry efficiency benchmarks with proponents as well as local water and wastewater user rate forecasts and development charges to servicing capacity to help encourage water efficiency investments in their operations from the time of commencement. Thereafter the City's ability to meet the proponents servicing needs (average day, peak day and fire flow water demands) are technically confirmed by the City's hydraulic water servicing model in the area(s) of the water distribution system where a new business proposal is being considered (a capacity analysis is also undertaken on the wastewater collection system to ensure the proponents servicing needs are met and that there are no adverse impacts on the City's infrastructure). If available servicing capacity does not meet proponent needs this would drive additional consultation on process	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
					conservation measures to be employed should the proposed business location still be desired by the proponent. In City staff's opinion the above noted process helps to effectively allocate and manage available servicing capacity between proponents and a by-law to regulate this demand is not recommended. The basis for this position is such a by-law could not be easily administered or enforced without significant capital and operational investments for field technology to limit flow to large consumers as they met their permitted capacity under the by-law. Furthermore, the presence of such a by-law may impose competitive disadvantage for the City to retain and attract business due to future uncertainties regarding availability on future servicing availability which would constrain potential for business growth, which would not be present in other Ontario based communities.	
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Determine what the future capacity of water is and use that as a limit of growth.	12/31/2021	Noted. Determining the future capacity of water and demonstrate how that may limit growth is a potential outcome of the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Just wondering about "2041" date? Is this the most accurate future date with the data available now? It seems we should be planning further into the future. 20 years is a blink!	12/31/2021	2041 was selected in order to bring the City Official Plan and the associated Master Plans in line with the Provincial 2041 planning horizon utilized in the Places to Grow document.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* In addition to conservation measures, consider means of recharging aquifer with wetland systems with stormwater as well as treated wastewater.	12/31/2021	The Aquifer Storage and Recovery alternative will consider the use of available surface water supply to support groundwater takings. The City, as part of its land development, actively promotes low impact development and "at source" recharge of stormwater.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Could we explore costs of more rapidly upgrading infrastructure to reduce system losses to leakage?	12/31/2021	Yes, reductions to the loss in non-revenue water (water loss from the distribution system) will be considered in the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Build the pipe to one of the lakes.	12/31/2021	As with past City of Guelph WSMPs and as directed by City Council, this update will not consider a Great Lakes pipeline. This approach aligns with City mandate to be locally environmentally sustainable.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Any consideration of water supply MUST also include the disposal of the wastewater. Our sewage output may overwhelm any of the local river flows.	12/31/2021	Consideration of wastewater will be accomplished through coordination with the Wastewater Master Plan project.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* No x4.	12/31/2021	Noted.	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Declare that water-taking is not an approved land use within the City of Guelph.	12/31/2021	Water taking is regulated by the Province. The City is considering limits on water taking inside the City as part of water quantity policy development.	N/A
2/13/2020	Member of the public	Community open house #1	*[Do you have any suggested changes or additions to the draft problem and opportunity statement?]* Does residential cover people without fixed residences? Does it cover the land?	12/31/2021	Population projections are based on the number of anticipated residents of Guelph and the number of people employed in Guelph.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Guelph may finally have to get tough with the developers. They bought land as a pure speculation. Their purchase did NOT come with a guarantee of their huge profits.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* These are serious concerns and the required population growth as set out by the Province, should be challenged by the City. We do not have sufficient water to manage population growth.	12/31/2021	This will be evaluated as part of the WSMP.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Clair-Maltby development will impact recharge for carter 1 & 2 well sites.	12/31/2021	The Tier 3 groundwater model can be utilized to evaluate future increases or reduction in recharge to the aquifer and it will be used for the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* This concern is specific – but water use and efficiency are a concern to me as a condo owner. My water is paid for through condo fees. Without a monthly bill I worry that residents and tenants don't have the "visual" reminder about water conservation. I'm optimistic that working with condo boards and property managers would be beneficial. More high-rise, high-density housing in our future.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Overpopulation.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Local industrial/ commercial water use in the area.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Nestle supplies so few jobs per litre of water that maybe it should be closed down.	12/31/2021	Noted.	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Dolime Quarry.	12/31/2021	The future of Dolime Quarry as a potential source of water supply will be considered as part of the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Yes. Guelph should be concerned with the water supply being exploited by Nestle waters. The proximity of this facility to Guelph and their extensive extraction of groundwater cannot be ignored in the years to come, especially as local aquifers become stressed by the growing water demand by the city.	12/31/2021	The Tier 3 groundwater model incorporates all of the water takings permitted by the Ministry of the Environment, Conservation and Parks and will be used for the WSMP update. The City's Threat Management Strategy (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx) evaluated the impact of the Nestle water taking on the City's water supply.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Heavy industry consumers of water including Nestle, Cargill and Sleeman Brewery.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Banning Nestle and anyone who would take the water for profit.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Companies extracting water from the water table for sale.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Nestle draws from the area and could have impact here.	12/31/2021	Noted. The City's Threat Management Strategy (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx) evaluated the impact of the Nestle water taking on the City's water supply.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Large companies using up our water.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Similar to off-peak hydro, consider a system of reduced rates during low demand and higher prohibition during times of peak use – for high-use industries that could have their own storage – for swimming pool and other high-volume residential use.	12/31/2021	User rates will be evaluated through modeling scenarios.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* I understand there a contaminated groundwater plume heading this way that might put the Speed River more at risk. Liz Sandals hinted at this once.	12/31/2021	Water quality concerns will be assessed from the perspective of current City wells that are off-line due to contamination and consideration of the impact of future contamination events.	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Campaign regarding winter safety salt use. The application of this by property management companies, in particular, and the general public is often overboard. It is being over-used as organizations do not want to risk a fall. Mitigating for icy walkways is important of course, but perhaps the responsibility should be placed back on the individual for risk of falling. Winter melts are contaminating our freshwater creeks, rivers and Great Lakes.	12/31/2021	This type of campaign is outside of the project scope. Salt management is an issue considered in the City's Source Protection Program.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* While not our drinking water, all waterways are sources for nonhumans, and need to better respected. Need to address historical (former industrial waste and garbage dump sites) and ongoing (recent sewage leak, PDI industry's trains dumping micro plastics into river) contamination/pollution of our rivers. Eramosa river floodplains are a disaster and reflective of how we care for our environment.	12/31/2021	The potential impacts to surface water related to Guelph's water supply will be assessed as part of the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* The water quality related to new and emerging contaminants, including perfluorooctanesulfonic acids, hormones and pharmaceuticals. We don't know what we are drinking today, and it should be monitored and shared with the society. Remedial/ treatment plans should be discussed and implemented if possible.	12/31/2021	The City's water meets all of the water quality standards established by the Ministry of the Environment, Conservation and Parks.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Is the cost of adding fluoride and removing calcium from the water supply less than the extra money spent on dental cleaning, water softeners, supply pipe cleaning, faucet and small appliance replacement? Is there a conflict of interest for the people making this decision?	12/31/2021	The WSMP update is focused on the amount of water required to 2041 and the potential sources of this water. The City does not add fluoride to its water supply nor does it remove calcium from the water supply.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Having offline wells with unknown contamination concerns me greatly, especially as someone who lives in the vicinity of two of these wells. I am concerned that this issue has not been adequately addressed by the City in terms of determining current potential risk.	12/31/2021	Water quality concerns will be assessed from the perspective of current City wells that are off-line due to contamination and consideration of the impact of future contamination events. MECP is responsible for groundwater contamination associated with contaminated sites.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Contamination.	12/31/2021	Water quality concerns will be assessed from the perspective of current City wells that are off-line due to contamination and consideration of the impact of future contamination events.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* I also wonder how aquatic and land wildlife would be impacted by any of the City's proposals.	12/31/2021	Both of these elements will be considered in the assessment of alternatives.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* How climate change may impact the model.	12/31/2021	Climate change is a consideration included in the WSMP update. The City has completed a study that looks at climate change and water quantity threats (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx).	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Climate change.	12/31/2021	Climate change is a consideration included in the WSMP update. The City has completed a study that looks at climate change and water quantity threats (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx).	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Water taking from adjacent aquifers as in Erin, Aberfoyle, etc.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* Not that I can think of.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?]* No x2.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Please explain to me why growth is so essential. Cancers grow forever, but they KILL the host. I do not see control of water use for things like pools and lawns.	12/31/2021	The City has an obligation to provide sustainable water supply to meet the growth requirements of the Council approved Official Plan. In addition, the province set growth targets for municipalities under the Places to Grow Act. A discussion on population growth is outside of the project scope except as it relates to how much water is required to meet the growth targets set by the province.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Increase our water conservation initiatives and aggressively pursue increasing the use of grey water throughout our city in residential, commercial and industrial settings.	12/31/2021	Consideration of wastewater reuse options will be accomplished through coordination with the Wastewater Master Plan project.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Limit demand by limiting population increase.	12/31/2021	This will be assessed in the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Challenge population growth targets so residents do not suffer from water shortage.	12/31/2021	The population targets established by the Province will form the basis of projections completed for the project.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* The water efficiency strategy should be revised to better reflect the climate crisis with increased drought, severe weather events, infrastructure deficiencies, contamination, etc.	12/31/2021	Water conservation and efficiency opportunities will be considered and the WSMP will provide water efficiency goals for the next Water Efficiency Strategy update; however, the Water Efficiency Strategy update is outside of the project scope.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Guelph must consider complications of the water supply impact resulting from the water extraction by Nestle. Guelph should work with surrounding municipalities to stand up against the privatization of local groundwater supplies.	12/31/2021	The Tier 3 groundwater model incorporates all of the water takings permitted by the Ministry of the Environment, Conservation and Parks and will be used for the WSMP update. The City's Threat Management Strategy (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx) evaluated the impact of the Nestle water taking on the City's water supply.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Quantify the impact of Nestle – why are the citizens paying to solve an issue likely caused by a corporation that has no local interests?	12/31/2021	The Tier 3 groundwater model incorporates all of the water takings permitted by the Ministry of the Environment, Conservation and Parks and will be used for the WSMP update. The City's Threat Management Strategy (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx) evaluated the impact of the Nestle water taking on the City's water supply.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Stop Nestle.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Potentially surface water sources outside of the watershed.	12/31/2021	At this time surface water options outside of the watershed will not be considered.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* If 'do nothing' is honestly an option, you are fools and we are all doomed.	12/31/2021	Noted. The "do nothing" is a standard for comparison of alternatives in a Class Environmental Assessment process. As in previous WSMP updates, the "do nothing" alternative is not a viable alternative since it does not address the project problem statement.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* I think the City is missing an opportunity to significantly engage with the Indigenous Community and make an effort in terms of how best not only to manage but to love and respect water.	12/31/2021	The City recognizes the significance and importance of water to Guelph's local Indigenous community and is actively engaging Indigenous residents in the development of the WSMP update. Community Liaison Group members representing Guelph's Indigenous population brought their unique perspective to the conversation during the first CLG meeting, provided input to and attended the first open house to speak with members of the public, and have also met with the WSMP project team on different occasions to discuss how the City can better engage and involve the local Indigenous community on this, and other water-related projects. Discussions to find a better path forward for engaging Guelph's Indigenous community are important and will continue into phase 2 of the project.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Ensure water-taking is not approved land use so we never have to worry about Nestle trying to set up in our City.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Contamination risk management.	12/31/2021	Water quality concerns will be assessed from the perspective of current City wells that are off-line due to contamination and consideration of the impact of future contamination events.	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Stormwater and wastewater are more efficient of recycling back to aquifer. Stormwater – more on site in-filtration compared to channeling to rivers. Restoration of aquatic (marshes) and terrestrial (fresh) natural system to maximize water retention.	12/31/2021	Consideration of wastewater reuse options will be considered through coordination with the Wastewater Master Plan project and via Aquifer Storage and Recovery opportunities. The City, as part of its land development, actively promotes low impact development and "at source" recharge of stormwater.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* No x3.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* Establish urban rooftop water collection systems that are stored in local cisterns. Even the roof of the City's building can collect water – cisterns could be built under streets for common local use. Have a look at that.	12/31/2021	Consideration of wastewater reuse options will be considered through coordination with the Wastewater Master Plan project.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* How to adapt in the case of extreme floods.	12/31/2021	Flooding will be considered from the perspective of impacts related to water supply facilities.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Did we miss any alternatives?]* How to adapt to current pollution to our water by industry.	12/31/2021	Water quality concerns will be assessed from the perspective of current City wells that are off-line due to contamination and consideration of the impact of future contamination events.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Again, this could fall under "Climate Adaptability" but I would like to see a breakdown of how each of the proposals would impact aquatic and land-based wildlife.	12/31/2021	Both of these elements will be considered in the assessment of alternatives.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Remember that Clair-Maltby is the recharge area for three watershed areas. Keep in mind how development on this hydrologically important area will affect water availability movement and recharge.	12/31/2021	Noted. As part of the City Threats Management Strategy (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx), the City has considered potential impacts to its water supply resulting from land development and reductions in groundwater recharge.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* The environment is extremely important in this decision-making process and should not be interfered with nor compromised in any manner.	12/31/2021	The assessment of alternatives completed for the WSMP update will include environmental criteria and field-based technical studies will be completed as part of the Class Environmental Assessment projects required to develop future water supply.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Listen to and understand Indigenous people's approach to water and how to reduce damage and cost of restoration.	12/31/2021	The City is committed to communicating with Indigenous peoples for this project and welcomes feedback on all aspects of the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Ability to respond to unpredictable climate events.	12/31/2021	Drought conditions are particularly important for water supply and these will be evaluated in the WSMP update. The City has completed a study that looks at climate change and water quantity threats (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx).	N/A

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Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* In the new growth of the city who will pay for the new water treatment, supply and waste treatment? The current residents or the new ones who are responsible for the costs?	12/31/2021	Development of new water supply in the City is funded through development charges.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Economic impact and what is the current and future economic impact of not having water.	12/31/2021	Detailed cost estimates will be developed for each water supply project.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* How much will it cost to bring water to Guelph in 2041 if we run out. What will that mean for all of the above?	12/31/2021	Detailed cost estimates will be developed for each water supply project.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* If land, then creation of socioeconomic benefits from managing for groundwater and forestry.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Potential creation of local jobs.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Yes. Long term impacts of any new facility. This includes the long-term impact environmentally to the groundwater and surface level of the site. Long term impact of the site if/ when the facility is eventually closed.	12/31/2021	Use of the groundwater flow model allows for the assessment of potential long-term environmental impacts. Detailed field studies completed as part of Class EAs for the facilities will further refine environmental impact assessments.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* No x2.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1 survey	*[Are there additional evaluation criteria we should include?]* Stop letting Nestle drain the aquifer.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	Can you explain the master planning process?	12/31/2021	Our WSMP update is completed every five years and follows the Municipal Class Environmental Assessment (EA) process. The process starts phase 1 that focuses on identifying and describing the problem(s) and opportunities statement. Phase 2 identifies and evaluates alternative solutions and establishes the preferred solution. Both phases include agency and public consultation. After phase 2, the WSMP report is updated. After the report, individual projects and conceptual feasibility, including anticipated project triggers and impacts happens. Then individual projects will process in accordance with the remaining class EA requirements. Visit municipalclassea.ca to learn more about the Environmental Assessment process.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1	Why are there so many WSMP studies?	12/31/2021	The WSMP is updated on an approximate 5-year basis to review progress made by the City, the current status of the City's water supply and update the projections of future water demand.	N/A
2/13/2020	Member of the public	Community open house #1	What are the main water supply sources currently?	12/31/2021	Guelph's water supply system includes production wells primarily installed in the Guelph Gasport bedrock aquifer and the Arkell Spring Grounds collector system: • 25 production wells, 21 wells in continuous operation, four wells offline (due primarily to water quality) • a shallow groundwater system that collects spring water in the Arkell Spring Grounds • a seasonally operated Eramosa River Intake and Recharge system. River water is pumped to an infiltration pond and trench where it is captured by the Arkell subsurface collector system. Availability is subject to river flow conditions (i.e., reduced capacity during summer when river flows are low)	N/A
2/13/2020	Member of the public	Community open house #1	What are the offline wells?	12/31/2021	In 2019, there are four wells that are offline, due primarily to water quality concerns. These include: • Clythe Creek Well • Edinburgh Road Well • Smallfield Well • Sacco Well	N/A
2/13/2020	Member of the public	Community open house #1	How will future development be considered?	12/31/2021	Future development will be considered by including population projections that consider growth within the City.	N/A
2/13/2020	Member of the public	Community open house #1	How does the wastewater treatment plant handle stormwater?	12/31/2021	This comment is outside of the scope of the WSMP update.	N/A
2/13/2020	Member of the public	Community open house #1	How does the Dolime Quarry fit with the WSMP update?	12/31/2021	A proposal for the future use of the Dolime Quarry lands is currently under consideration by the City. The proposal includes the protection of the quality and quantity of the primary aquifer system utilized by the City for water supply. Alternatives will consider how to potentially capture and treat a portion of the 11,000 m^3/day of groundwater that is extracted during quarry operations for City supply.	N/A
2/13/2020	Member of the public	Community open house #1	How does wastewater and stormwater fit with the WSMP update?	12/31/2021	The WSMP update is focused on water supply, i.e., where our water comes from, rather than stormwater and wastewater. There are other master plans related to stormwater and wastewater that might be of interest: https://guelph.ca/plans-and-strategies/water-and-wastewater-servicing-master-plan/ and https://guelph.ca/plans-and-strategies/stormwater-management/	N/A
2/13/2020	Member of the public	Community open house #1	Will there be enough water to meet needs for 2038?	12/31/2021	This will be addressed by the WSMP update.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
2/13/2020	Member of the public	Community open house #1	Where will we get surface water from if we run out of groundwater?	12/31/2021	Surface water options could include Guelph Lake/ Speed River and the Eramosa River.	N/A
2/13/2020	Member of the public	Community open house #1	Are residents drinking wastewater effluent? Does the City monitor pharmaceuticals in the water?	12/31/2021	Guelph residents are not drinking the City's wastewater effluent. The City monitors drinking water quality against the standards established by the Ministry of the Environment, Conservation and Parks.	N/A
2/13/2020	Member of the public	Community open house #1	Are drugs and chemicals filtered out of our drinking water?	12/31/2021	The City treats drinking water to the standards established by the Ministry of the Environment, Conservation and Parks.	N/A
2/13/2020	Member of the public	Community open house #1	How does the Guelph Lake dam work?	12/31/2021	The dam is meant for flood control and not related to water supply. It is operated by the Grand River Conservation Authority.	N/A
2/13/2020	Member of the public	Community open house #1	What are the impacts on wetlands from developments in the south end of Guelph?	12/31/2021	These potential impacts are addressed outside of the WSMP study.	N/A
2/13/2020	Member of the public	Community open house #1	At one point, Guelph used to be a wetland. How can we use this knowledge to inform the WSMP?	12/31/2021	The existing wetlands, as defined by the Grand River Conservation Authority, will be considered when evaluating the water supply alternatives.	N/A
2/13/2020	Member of the public	Community open house #1	Dollar values should be assigned to natural heritage features.	12/31/2021	Noted.	N/A
2/13/2020	Member of the public	Community open house #1	Does the Tier 3 model consider development (paving), droughts and recharge areas?	12/31/2021	Yes, the Tier 3 model has been used to evaluate these factors. The City has completed a study that looks at threats to water quantity including land development, droughts and recharge reduction (https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx).	N/A
2/13/2020	Member of the public	Community open house #1	What is the target liter per day per person?	12/31/2021	The project will not define a target daily water use, rather past water use will be evaluated along with population projections to forecast demand.	N/A
2/13/2020	Member of the public	Community open house #1	What is the timeframe of this project?	12/31/2021	The project started in October 2019 and is expected to be complete by early 2021.	N/A
2/13/2020	Member of the public	Community open house #1	Who are the biggest water users in Guelph?	12/31/2021	The City does not release information with respect to individual water users.	N/A
03/12/2020	Hydro One Networks Inc.	Letter	In our preliminary assessment, we have confirmed that Hydro One has existing high voltage Transmission facilities within your study area (see attached map). At this point in time we do not have enough information about your project to provide you with meaningful input with respect to the impacts that your project may have on our infrastructure. As such, this response does not constitute any sort of approval for your plans and is being sent to you as a courtesy to inform you that we must be consulted on your project.	3/13/2020	Thank you very much for providing input to the Water Supply Master Plan (WSMP) update project. The WSMP is a high-level planning project that will not include detailed planning/work at a site level. Therefore, it will not include or immediately trigger EA work such as the example in your letter of replacing/relocating Hydro One infrastructure. The WSMP will identify and outline future studies that are required to implement the preferred solution identified for the WSMP EA. The mapping information that you have provided will be reviewed and considered within the context of evaluating the	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
			In addition to the existing infrastructure mentioned above, the affected transmission corridor may have provisions for future lines or already contain secondary land uses (i.e. pipelines, watermains, parking, etc.). Please take this into consideration in your planning. Also, we would like to bring to your attention that should (Water Supply Master Plan Update) result in a Hydro One station expansion or transmission line replacement and/or relocation, an environmental assessment (EA) will be required as described under the Class Environmental Assessment for Minor Transmission Facilities (Hydro One, 2016). This EA process would require a minimum of 6 months to be completed and associated costs will be allocated and recovered in accordance with the Transmission System Code. Furthermore, to complete an EA it can take from 6 months (to complete a Class EA Screening Process) to 18 months (to complete a Full Class EA Process) based on the level of assessment required for the EA. In order to achieve speedy completion of the EA, Hydro One will need to rely on studies and/or reports completed as part of the EA for your project. Please allow the appropriate lead-time in your project schedule in the event that your proposed development impacts Hydro One infrastructure to the extent that it would require modifications to our infrastructure. In planning, please note that developments should not reduce line clearances or limit access to our facilities at any time in the study area of your Proposal. Any construction activities must maintain the electrical clearance from the transmission line conductors as specified in the Ontario Health and Safety Act for the respective line voltage. Be advised that any changes to lot grading and/or drainage within or in proximity to Hydro One transmission corridor lands must be controlled and directed away from the transmission corridor. Please note that the proponent will be held responsible for all costs associated with modification or relocation of Hydro One facilities, as well as any added costs that may be incurred due to increase efforts to maintain our facilities. We reiterate that this message does not constitute any form of approval for your project. Hydro One must be consulted during all stages of your project. Please ensure that all future communications about your project are sent to us electronically to secondarylanduse@hydroone.com		potential alternatives and identifying future studies required during the implementation phase.	

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Date	Name	Source	Comment	Response Date	Response	Action Required
04/13/2020	Lin Grist, Council of Canadians Guelph Chapter	Email	Many thanks for sending info to the Council of Canadians Guelph [redacted]. I am planning to do an eblast to our membership in May of this year on All Things Water. I wonder if there is a summary of the work that you have completed on the Guelph Water Supply that I could include in the eblast. Could you let me know? Many thanks Lin Grist Council of Canadians Guelph Chapter	04/30/2021	Hi Lin, Thank you for your email and including a section in the newsletter about the City's Water Supply Master Plan update. As part of Phase 1 of the project, the City hosted the first Water Supply Master Plan update community open house in February. The display boards are available for review as a PDF on the project webpage (https://guelph.ca/plans-and-strategies/water-supply-master-plan/). Results from an in-person and online survey associated with information in the display boards will be made available in a Phase 1 Engagement Summary Report in May/ June. We will share a link to the report in our electronic newsletter, the webpage and the interactive engagement project page Have Your Say Guelph (https://www.haveyoursay.guelph.ca/wsmp). The report will also include feedback received from the Community Liaison Group and a workshop held with Agencies and municipalities. We welcome questions, comments and feedback at any time and you can reach the City's Water Supply Program Manager, Dave Belanger, at dave.belanger@guelph.ca or 519-822-1260 extension 2186 or the consultant Project Manager, Matthew Alexander, at matthew.alexander@aecom.com.	N/A
05/09/2020	Lin Grist, Council of Canadians Guelph Chapter	Email	Thank you for getting back to me; just so that I am no misunderstanding anything. AECOM is an organization that is helping the staff at city hall who deal with water supply management. Am I correct in assuming that you are not experts in water management, however you have expertise is communicating messages from the city staff to the general public. could you confirm or explain? thank you for the URL I will take a look at it and see if it would be useful to our mailing list. of aobut 300+ We are doing a special eblast on Water issues this month Regards Lin Grist Council of Canadians Guelph Chapter	05/11/2020	Thanks for reaching out for clarification. AECOM has been retained by Guelph Water Services through a competitive proposal process to manage the update of the Water Supply Master Plan. AECOM is responsible for developing the Water Supply Master Plan update according to the Water Services Terms of Reference. This includes the technical aspects of the project including development of water demand projections, assessments of existing water supply capacity, development of water supply alternatives and creating the update to the WSMP. This work is being done in collaboration with City staff from several departments, but primarily from Water Services. Examples of experts on the AECOM project team include hydrogeologists, water resource engineers, numerical modellers, ecologists and communications specialists.	N/A
09/28/2020	[redacted]	Email	Thanks, Dave for your very comprehensive response. 2051 is coming a lot quicker than we think, and I tend to think in terms of the "very long range". Some point in the not too distance future (2060 – 2080) I still believe the population of Guelph and Waterloo Region is going to grow to the point that well-water and surface water sources will be hard pressed to keep up with the demand. A pipeline from Lake Erie to service this entire area with a population of almost 2 million residents will be a massive financial and time-consuming undertaking. We may not need any of that water for another 30 years, but just initiating the conversation with the senior levels of government and the Six Nations people will take some work and intensive discussions. The	09/28/2020	Thank you for your additional comments. We are in agreement on the need for advanced and long-term planning for municipal water supply. The WSMP is updated every five years and, as we consider growth and the ability of the local water resources to service it, we will need to have ongoing discussions with local and regional stakeholders, the Province and Indigenous communities on where the water will come from and the environmental and economic impacts it may have on our community. We will certainly consider your advice as we continue with the Water Supply Master Plan Update. As added information, we are considering a concept called Aquifer Storage and Recovery (ASR) as part of a Guelph Lake surface water option. In this concept, we take water from the river when there is excess capacity (i.e. spring and fall under high surface water flow	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
			construction phase (possibly 10 – 15 years) is a long way off. I presume it's a strong argument for the City to take to the governments that the construction cost for Guelph is prohibitive and is a significant constraint on our growth capacity. Of course, the $500M cost (2006) is now in excess of $1B, but with interest rates at 3.5% (conservative number) and amortized over 40 years, that would be a cost per household (80K) of about $580/household/year, and that doesn't include the offset revenue from industrial uses. But, I understand that's only for the pipeline itself. Regardless, that is not an unreasonable number. Fortuitously, some of those underground caverns that we are currently drawing from may be able to be used for the storage of pipeline water when the time comes. Regards, [redacted]		conditions), treat it to a drinking water quality and storage in our bedrock aquifers. We then bring the water back to surface when it is needed for high summer demand periods. Details are in the 2014 Water Supply Master Plan Update. Thanks again.	
09/11/2020	[redacted]	Email	I understand that many people in Guelph like the current well-based system of water supply, but it has it's limitations, and few people understand those. Firstly, we are extracting water from deep underground (I think about 600 feet), but it took a very long time for water to permeate that deeply into the soil/rock structure. At the current rate (about 75,000 cubic meters each day) we are removing close to 30 million cubic meters of water from beneath us each year, and I don't know if anyone knows how quickly the system is recharged. It's highly unlikely that the rate of recharge is close to the rate of extraction. People wonder why we hear about "sink holes" swallowing homes and cars. I understand there's a lot of bedrock structure between the surface and the water source, but at some point there will be a failure! Secondly, Guelph water is very hard, and most residents employ water softeners to make the water more usable. It would be interesting to know the amount of salt that ends up in the river because of the use of softening technology; it definitely contributes to a lessened quality of river water as it flows towards Lake Erie. Thirdly, with the population expected to increase by 50% over the next 30 years, the current source of our water will simply be pushed to the limit well before we get close to that population base. Finally, we are taking great pains to protect the areas around the wells so they do not become contaminated and unusable. This is creating an obstacle to gaining better access to Hwy 401 east of the 2 current interchanges. There are 2 feasible alternatives, but neither will be inexpensive.	09/28/2020	Hello and thank you for your comments on the City's Water Supply Master Plan. Our team has reviewed your comments and we can provide some additional information in response. The City's water supply is primarily derived from wells in a deep confined bedrock aquifer with well depths of approximately 80 m (262 ft) in the western part of the City and 40 m (131 ft) in the east. In the Arkell Spring Grounds, the City also has a shallow groundwater collection system, which has a seasonal recharge system using Eramosa River water. Additional information on the City's water supply system can be found in the Grand River Source Protection – Approved Assessment Report (June, 2020, Chapter 7) here - https://www.sourcewater.ca/en/source-protection-areas/resources/Documents/Grand/GRSPA_AR_updated_S7_City-of-Guelph_clean_reduced.pdf. The Assessment Report provides information on the recharge of the bedrock aquifer. In general, groundwater travel times to the aquifer are on the order of 2 years to 25 years depending on location. Precipitation recharges the shallow groundwater collection system in the Arkell Spring Grounds in a matter of days to weeks. The average day demand for the City's water supply system was approximately 47,015 m^3/day (cubic metres per day) in 2019, 47,449 m^3/day in 2018, 46,360 m^3/day in 2017 and 46,285 m^3/day in 2016. Details are provided in the Water Services annual reports located here - https://guelph.ca/plans-and-strategies/performance-reporting/. We have completed a Tier 3 Water Budget and Local Area Risk Assessment that describes in detail the rate of recharge of our bedrock aquifers. This study indicates that we may have difficulties achieving our maximum water supply capacity under future (2038) demand conditions during prolonged drought conditions but at present, our water supply system is sustainable. The Tier 3 Water Budget Report, completed in 2017 is located here - https://www.sourcewater.ca/en/source-protection-areas/Guelph-	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
			The first is to embark on a water recycling program where we take the discharge from the water treatment facility and purify the water to the point that it meets/exceeds the water quality standards that are required. The problem with this proposal is that if the system should ever fail, there would not likely be an adequate back-up supply without the expense of constructing a massive reservoir complex. I know this is not what people want to hear, but the "best" approach, from my perspective is to begin now to work with the municipalities along the Grand River to build a comprehensive water supply system from Lake Erie to the headwaters of the river (Guelph and Fergus are the 2 metropolitan areas furthest upstream). I believe the current engineering and environmental approach is to construct such pipelines along the river itself (taking some meandering out). It would be designed to supply the needs of about 2.5 million residents, enough to deal with the projected needs of Brantford, Waterloo Region, and southern Wellington County for the next 75 – 100 years. We're probably looking at twin 2 metre diameter pipelines (with the design to include a provision for a 3rd line as the population grows) at the source with reductions as the water comes to the major distribution points. That would require a flow rate of about 1.5 metres/second. Capacity could also be increased by increasing the flow rate but the economics of construction vs. operating costs need to be considered and the design would need to account for the practical pressure limits of such a large diameter pipeline. Such a massive project clearly needs the support and involvement of the Province, the Grand River Conservation Authority, and the Six Nations of the Grand River. It will also take at least 20 years to complete, with the first phase (to Brantford) being serviceable in 10 – 12 years. The key is to start the discussion now so the project can get off the ground before the critical timeframe for the requirement comes. This is especially important for Guelph since we are effectively "at the end of the road". Just my thoughts on the future of Guelph water. Regards, [redacted]		and-Guelph-Eramosa-Tier-3.aspx. Under the City's Source Protection Program, we have delineated a Wellhead Protection Area for water quantity (WHPA-Q). We are developing water quantity policies under the Clean Water Act to protect and manage water quantity in and around the City to ensure the groundwater is protected for drinking water use. Details on the water quantity policy development project are found here - https://www.sourcewater.ca/en/source-protection-areas/water-quantity-policy-development-study.aspx. The City's bedrock aquifers are known to contain karst features such as solution-enlarged fractures and caverns. However, these are paleo-karst features that occurred in prehistoric times and karst formation does not occur today. Water extraction will not result in sink holes in the Guelph area. Information on karst in Ontario can be found here - http://www.geologyontario.mndm.gov.on.ca/mndmfiles/pub/data/imaging/GRS005/karst-map.pdf. We agree that Guelph's groundwater is hard water which means it has a naturally-occurring, high mineral content consisting mostly of calcium and magnesium carbonate. This mineral content is derived from the dolomite bedrock that makes up our water supply aquifers. We also agree that water softening salt is a source of contamination in our surface waters. Salt content is also compounded by road de-icing in the winter months. We are addressing salt as part of our Source Protection Program and additional details are found here - https://guelph.ca/living/environment/water/groundwater/can-help-protect-source-water/source-water-fact-sheet-road-salt/. Population growth is dictated by the Province of Ontario and the Province has just released population and employment forecasts to 2051 (Environmental Registry of Ontario - https://ero.ontario.ca/notice/019-1680) which will increase Guelph's population to 203,000 and employment to 116,000. As part of our Water Supply Master Plan Update, we are evaluating the water demand for these forecasts and evaluating whether our groundwater supply is sustainable with this additional growth. The WSMP Update will assess sustainable water supply alternatives including groundwater and local surface water sources to meet the provincial growth forecasts. We have delineated wellhead protection areas around our water supply and only the WHPA-Q extends to Highway 401. We are not aware of any water quantity constraints imposed on Highway 401 as a result of the WHPA-Q. The City's WHPA's for water quality do not extend to Highway 401. If you have more details on this, please provide them to us. Mapping of the WHPA for water quality are provided in the Assessment Report referenced above. For the feasible alternatives you have presented, starting with the water recycling program, the WSMP Update includes consideration of water reuse as part of the City's Water Efficiency Strategy (WES – see information here - https://guelph.ca/plans-and-strategies/water-efficiency-strategy/). The WES is the highest	

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					priority alternative for the WSMP. As a result, Guelph has among the lowest per capita residential water consumption in the Province and the WSMP Update will continue to support water demand management including water reuse to reduce water consumption. However, as you have pointed out, water reuse is an expensive alternative with costs that are in the range of three to four times more expensive than groundwater sources to achieve potable water quality standards. As part of the WSMP Update, we are likely to look at less expensive water reuse options first such as for non-potable applications (i.e., irrigation, cooling water, etc.) and then consider more complicated treatment options later in the plan to bring wastewater to potable water quality standards. The risk associated with system failure, noted in your email, will be evaluated in the WSMP Update, as it has been in previous master plans. The Firm Capacity of the system will be determined, and the City will continue to plan for sufficient water supply capacity to achieve the projected demand to 2051 with reserve supply and infrastructure to address potential risks such as required system maintenance/repair, a contamination event, drought conditions, etc. The projects required to meet future demand, including reserve supply, will be detailed in the Implementation Plan, within the WSMP Update documentation and this will include the estimated costs associated with the projects. With regards to a Great Lakes pipeline to Lake Erie, the City had considered this alternative as part of the 2006 Water Supply Master Plan. The proposed plan was to tap into a pipeline from Lake Erie proposed by the Region of Waterloo. The Great Lakes pipeline option was generally panned by the public since it was considered to be contrary to the City's water conservation and sustainability programs. The public generally recommended "living within its means" and to rely on local water resources as a method to manage growth. In addition, the Great Lakes pipeline option (capacity of ~175,000 m^3/day) had Guelph's portion of the costs (2006) on the order of $500,000,000 to $700,000,000 which was considered to be "unaffordable" for a municipality like Guelph. In the end, City Council approved the 2006 Water Supply Master Plan with the exclusion of the Great Lakes pipeline option. We also understand that the Region of Waterloo has extended the timing for its Great Lake pipeline to beyond 2051. Based on the previous direction of Council, the Great Lakes pipeline option was not considered in 2014 nor is it being considered in the current WSMP Update. The current WSMP Update is considering conservation/efficiency programs and groundwater sources inside and outside of the City as well as local surface water sources (i.e. Speed River and Eramosa River). We expect the WSMP to address the water demand to 2041 and potentially to 2051 with the use of surface water sources. As we continue through the WSMP Update, we would suggest that you check into the project webpage for updates here - https://guelph.ca/plans-and-strategies/water-supply-master-plan/. Thank you for your comments and we hope this additional information has addressed your email. If you require more information, please contact us.	

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
07/27/2021	Susan McSherry	Email	As a member of Wellington Watchers Board [redacted] from the DoLime lands, several questions have been raised by WWW's Executive Director and I specific to the DoLime site annexation and water impacts that I'd appreciate any answers you can provide. While unsure whether tonight's meeting will provide any focus on this subject, I thought it best to just send you this email and ask that if the DoLime annexation's impact on the Master Water Plan is not on tonight's agenda, that these questions be forwarded to the City's waterworks division for response. 1. After Dolime closes and the dewatering stops, will there be a difference in the flow of the Speed River? 2. If river flow will change, how will this impact sewage treatment needs? 3. Will there be more water released from Guelph Lake? 4. If more water will be released from Guelph Lake, what are the ecological impacts? 5. What impacts will the development of the Dolime site have on water demands, city well capacity, the aquifer, surrounding wetlands, woodland, eco-systems, parkland, and roadways/infrastructure? 6. What commitment(s), if any, have been made to a Green development at the Dolime site? 7. What timeframe is the City proposing? Appreciate your consideration, [redacted] See you at 7 p.m. Kind Regards, Susan [redacted]	07/30/2021	Here's hoping all is well. I copy of your questions regarding Dolime Quarry received in advance of WSMP Community Liaison Group Meeting earlier this week were shared with me for response. As requested, I would ask that you please find responses to your questions below: **1. After Dolime closes and the dewatering stops, will there be a difference in the flow of the Speed River?** WG - The short answer is, we don't expect so. We expect that a management system to protect local groundwater resources will also require pumping water which would be diverted to the Speed River, and as we complete testing to determine the need for, design and function of a management system and whether there's water available to supplement the City's growing needs, we'll learn more about any changes that could affect water flows in the Speed River, and ensure that our natural habitats are protected. It should be noted that dewatering from the quarry has varied by season, often with no flow to the river in the drier (summer) months, and that the average annual average discharge from the quarry is less than 10 per cent of the river flow through summer, so not a major impact. **2. If river flow will change, how will this impact sewage treatment needs?** WG -Changes to the discharge from the quarry will not affect the operation of the City's wastewater treatment plant (WWTP). The assimilative capacity (i.e., the natural ability of waters to dilute and disperse wastes without harm to the aquatic environment) is calculated based on the upstream flows of the river. The discharge from the quarry occurs downstream of the outfall of the WWTP. The assimilative capacity of the river is currently under review by the MECP as part of the ongoing Wastewater Treatment and Biosolids Master Plan. **3. Will there be more water released from Guelph Lake? 4. If more water will be released from Guelph Lake, what are the ecological impacts?** WG - The Grand River Conservation Authority (GRCA) is responsible for managing local waterways and operates the Guelph Lake dam. The GRCA controls the release of water as needed to meet the requirements for wastewater treatment plants and municipal water supplies downstream. Given that we don't expect major changes to the river flows based on quarrying dewatering stopping, we also don't expect that the GRCA will need to make any changes to how they manage river flows through the dam. The GRCA is a key stakeholder in all our water supply planning work, including upcoming testing to inform the need for, and design and function of a groundwater protection management system. They will be at the table to review information and provide input as we complete this work, and we will work with all responsible agencies to	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
					address any impacts or changes to local waterways should it be necessary. **5. What impacts will the development of the Dolime site have on water demands, city well capacity, the aquifer, surrounding wetlands, woodland, eco-systems, parkland, and roadways/infrastructure?** WG - At this time, we don't know. This will all be determined through required environmental and servicing studies that will need to take place to inform the development plan. The testing we're doing to assess water supply capacity in the area and what's needed to protect Guelph's drinking water would also inform what kind of development the City can support from a servicing perspective. **6. What commitment(s), if any, have been made to a Green development at the Dolime site?** WG -The City's Official Plan includes environmental objectives that developments in Guelph must meet. These include reducing development resource impact and future-proofing communities to mitigate the impacts of climate change. The developer also understands the City's, Council's and the community's commitments and vision toward a sustainable future, particularly around water conservation efforts, energy use and our urban forest targets, and these priorities will be considerations throughout the development planning process. **7. What timeframe is the City proposing?** WG - There's no concrete timeline established at this time as associated timelines are dependent on subsequent Provincial and local planning approvals. The City is submitting the boundary and zoning change requests to the Province and we don't know how quickly they'll make their decision. Following that, as we promised the community when we engaged in 2019, and per Council's direction on the zoning change request, the developer will be required to follow proper planning procedures, including a block or secondary plan, then site plan approvals and so forth. These steps can take upwards of a year. Rest assured it will take as long as it takes to ensure all proper studies are done, and planning processes followed, including opportunities for community input. Please let us know should you have any further questions. Best regards, Wayne	

Date	Name	Source	Comment	Response Date	Response	Action Required
07/29/2021	Lin Grist	Email	Thank you for an excellent presentation. Could you please explain why you need to constantly push water into the ponds in the Dolime Quarry and why that Is important for the water supply for Guelph residents? I am planning to send out an eblast on the presentation to the mailing list of: • Council of Canadians Guelph chapter • Guelph Wellington Coalition for Social Justice • Guelph Old City Residents' Association The eblast will go out on Monday August 2nd	08/03/2021	Hi Lin. Thank you for your questions. The quarry has excavated to the licensed limit of an elevation of approximately 285 m above sea level which is approximately 17 m below the elevation of the Speed River. The quarry excavation has breached the Vinemount Aquitard and therefore the City's water supply aquifer (Gasport Formation) is exposed in the base of the quarry, causing groundwater to flow into the quarry. If the dewatering were to stop, groundwater from the aquifer would fill the quarry. If the dewatering were to stop, the quarry would fill with water. Once the quarry fills, water would flow out of the bottom of the quarry through the breach and flow to our municipal water wells. The water quality of the pond may be similar to surface water and contain bacteria and viruses which could, potentially, contaminate our wells. To protect the water quality of our wells, the proposed concept is to continually pump the quarry pond to maintain the inward flow into the quarry to prevent the outward flow of poor quality water. The water pumped out of the quarry would continue to be discharged to the Speed River. Also, as part of the water management concept, we would optimize the amount of water to be collected by our water supply wells while still maintaining the inward flow to the quarry. All of this will be confirmed in future years through an operational testing program and municipal Class Environmental Assessment. More information on the Dolime Quarry can be found here - https://guelph.ca/living/environment/our-community-our-water/ . I hope this answers your questions. If you need more or have other questions, please contact us. Thank you for your interest in our project.	N/A
08/03/2021	Lin Grist	Email	Thanks so much for providing this information, I am afraid I had already sent out the summer eblast, so just gave general information that I knew to be factually correct. One of our [redacted] who is an expert in the area wrote a piece for the eblast on the quarry as he has a special interest in it I would be really interested to know how your planning team are going to include climate change into the predictions to 2051. I am assuming that this will be part of the report which you bring to council Regards Lin Grist	08/03/2021	Hi Lin. Sorry I didn't get this to you in time for your Eblast. If there are more comments or questions that come out of the communication, please pass them along to us. Climate change and the impact on our groundwater resources have been evaluated in our Source Protection program as part of the Tier 3 Water Budget and Water Quantity Risk Assessment. The report is located here - https://www.sourcewater.ca/en/source-protection-areas/resources/Documents/Grand/15072-527-Climate-Change-R-2018-11-21-final-V1.0.pdf . In summary, the report predicts that there may be more recharge and more available groundwater in the future resulting from higher winter temperatures (i.e., more freeze/thaw events in winter months resulting in more groundwater recharge). We will continue to evaluate the effects of climate change in our Source Protection Programs and include these evaluations in subsequent updates to the Water Supply Master Plan. Thank you for your help in our project.	N/A
09/23/2021	Kyle Davis, Wellington Source Water Protection	Email	Hi Dave, Separately from my formal requests for Council presentations, I wanted to touch base with you. Regarding formal comments on the Water Supply Master Plan, a deadline of mid-October was discussed, as you can see from the Council meeting timing, we will need longer	09/24/2021	Hi Kyle. Thank you for the information. As we indicated at the Agency and Municipality Workshop on September 14, our schedule has us completing our Public Engagement Program in October. This timing is so that we can incorporate public input into our draft report and our Council Report for early November. Is there a way you can get your comments to us in this time period so that we can include	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
			than mid-October if possible in order to complete our comments and to allow Council to comment. At this point I don't know exactly how long we will need but am thinking likely sometime in November. Also, please advise if there are other draft documents to review beyond the slide decks presented to the agency workshop and CLG. I looked quickly but didn't see a draft WSMP document. I may have missed it. Thanks, Kyle		them? If we extended receipt of comments to October 22, would that help? The draft report is in preparation, however, the bulk of the report including the water supply alternatives and the alternatives evaluation matrix will be as provided at the Workshop. You will note that the presentation provides the relevant information on the alternatives in summary form including locations, proposed supply capacities and costs, while the evaluation matrix provides the reviews against the evaluation criteria. We would appreciate your help in keeping to our schedule. Please let us know. Thank you.	
09/24/2021	[redacted]	Email	To Whomever: Dave Belanger, Mathew Alexander... REFERENCE: Meeting Notice: Join Us September 29 to talk about the future of drinking water in Guelph. All water master planning has done is raise the price of water, sewage and an added stormwater tax slap, to look for more revenue constantly, as the City cries wolf while building more development beyond its pretended capacities. You want water? 1. Then recycle the sewage water rather than dumping it into the Eramosa river with continuous court cases on their way. 2. Collect and use the city stormwater to clean-up and recycle. 3. CONNECT THE EAVESTROUGH OF GUELPH INTO THE STORMWATER SYSTEM reservoirs. 4. Fix the aging water infrastructures to stop the leakage that the City keeps talking about. 5. Locallize water management within each new sub-community for #1,2,3,4, since the building of infrastructure cross-connections are becoming too expensive. My present master plan is cutting the city off by harvesting my own water to use and recycle and a future needing for me to look after both my drinking water, sewage and gardening/ cleaning needs. The city infrastructure for water/ sewage/ stormwater is becoming too costly to support with ever-increasing taxes and utility cost increases above the incomes that are not keeping up with the cost of living in a city that is moving towards a third-world dump of squalor for the poor while rich folk live in mansions, with swimming pools. I want to see a Master Plan that reduces the cost of water, sewage and stormwater, based upon the affordable cost of living rather than increasing potential bankruptcy of homeowners, businesses and manufacturers that cannot		City staff called [redacted] to discuss his email. General topics discussed included: - The purpose of the WSMP and Places to Grow, how the WSMP links to the Water Efficiency Strategy, which in turn affects our water rates and the amount of water available. - Water rates. Mr. Demonte was primarily interested in storm water ratesvand was directed to engineering to discuss this further. - The water-reuse program we are starting in the City - Storm water treatment and use of this water through collection techniques - The Water Efficiency Strategy and opportunities to contribute ideas	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
			afford to live in Guelph that cannot manage its water risks reasonably. Thank you for hearing me out and I look forward to a progressive Water Master Plan that uses available untapped resources rather than digging for more wells and increasing the costs of the so-called "service" that is becoming unsustainable, while the unstoppable building nonsense keeps rolling onto the water tables. Instead of oil pipelines, start thinking about water pipelines across communities to harvest flooding opportunities to feed community drought threats, by sharing. Sincerely [redacted]			
09/23/2021	Kyle Davis, Wellington Source Water Protection	Email	Hi Wayne and Dave, I am just following up on offers that you both have made regarding presenting on the WSMP and SW Quadrant EA to Township Council. Thank you very much for the offer and in discussion with Ian, we would like to invite you or your staff / consultants to present to Guelph / Eramosa Committee of the Whole on October 20th. The meeting starts at 9:30 am. Please advise if that date would work and how long you feel your presentation would be. [redacted], is copied on this email and can advise on meeting and presentation format, presentation lengths and timing. I will also be emailing separately on behalf of Puslinch. If you have any questions, please do not hesitate to contact us. We are looking forward to your presentation to Council. Thank you, Kyle	09/23/2021	Hi Kyle. This date is far enough out, we can likely make it work. Wayne has his monthly Water Services staff meeting at that time so he may not be able to attend. We will review with our team and get back to you to confirm. A presentation in the range of 20 to 30 minutes including questions would be appreciated. We have a lot of information to present but could make it shorter if time does not permit. Our presentation materials will likely be similar to the presentation and materials provided at the Agency and Municipality Workshop on September 14. Please let us know if this is OK. Thank you for the invitation and we look forward to presenting to Guelph-Eramosa Township Council.	N/A
09/27/2021	Kyle Davis, Wellington Source Water Protection	Email	Hi Wayne and Dave, I am just following up on offers that you both have made regarding presenting on the WSMP and SW Quadrant EA to Township Council. Thank you very much for the offer and in discussion with Glenn, we would like to invite you or your staff / consultants to present to Puslinch Council on October 13th. The meeting starts at 10:00 am. Please advise if that date would work and how long you feel your presentation would be. Courtenay Hoytfox, our Clerk, is copied on this email and can advise on meeting and presentation format, presentation lengths and timing. If you have any questions, please do not hesitate to contact us. We are looking forward to your presentation to Council. Thank you, Kyle	09/27/2021	Thanks Kyle. Meeting with Puslinch Council and describing the Water Supply Master Plan to the Township is important to us. We will discuss internally and find a way to make this work. I'll get back to you on some details and to confirm. Thank you for the offer.	

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
09/27/2021	[redacted]	Email	n/a	09/27/2021	Hi [redacted]. First off, thank you for attending the Community Liaison Group meeting last Tuesday and thank you for your input. I wanted to follow up with you on your question of the Dolime Quarry and provide you with a link to the City's project site for Our Community, Our Water - https://guelph.ca/living/environment/our-community-our-water/ This link provides the overview on the Dolime issues, the proposed settlement pathway and the latest updates. I hope that this provides some additional information to you on how we propose to protect our water supply. Feel free to pass this information along to others, as necessary. If you have any additional questions, please send them along and we will try to answer them. Thank you for your interest in the Water Supply Master Plan.	N/A
09/29/2021	[redacted]	Community open house #2	The Clythe well is located right beside Clythe Creek, and Clythe Creek has already a critical low flow difficulty that affects the fishery. There has, to my knowledge, been no assessment of continued pumping from the Clythe well having an effect on the Clythe Creek baseflow. Is their a plan to do an actual on site investigation of the impact of Clythe well pumping on Clythe Creek before it's introduced into the supply system.	09/29/2021	Thanks for the question [redacted]. There is a plan to do additional testing associated with the Clythe well and it is a requirement of the current permit to take water. It is an existing well that was previously online and has had a permit since I believe the mid 80s. The project itself did go through a class environmental assessment and we are proceeding with the construction of the treatment system for that well. The permit to take water does require some monitoring both of domestic wells and the impact on the Creek as part of the permits to take water and the monitoring program associated with the permit.	N/A
09/29/2021	[redacted]	Community open house #2	The water taking at Dolime is said to have no requirement and meeting the water treatment plant downstream. Water quality requirements. Is that assessment based on water quality modeling that's been done with the reduced groundwater flows entering the speed up stream of the wastewater treatment plant discharge and with increased wastewater plant discharges? IE. future modeling that would take into account water taking at Dolime and the effect on the water treatment plant outflow. The comment was made that using the Dolime supply as an additional water source restricts the outflow into the Speed River. A very high quality water and the comment was that that wouldn't influence the requirement that the wastewater treatment plant has for water quality and the speed downstream of its discharge point.	09/29/2021	Are you referring to the requirements of the quarry operators and their discharge permit? There is an assimilative capacity study that is being completed as part of the wastewater and biosolids master plan. It's in its final stages of completion. Our understanding is that the Dolime discharge has not been used in those assimilative capacity studies because it is granted by permit, and could end at any time when the quarry stopped operating the discharge would end and was therefore not considered. It's my understanding that the assimilative capacity takes into consideration the upstream water quantity and that's what's used to determine the assimilative capacity from the wastewater, not the downstream. It is recognized that while it was occurring, it does have a benefit, because it is perhaps colder as it is a groundwater source and does have some benefit. But it was never considered because it wasn't considered to be a long-term permanent discharge into the river.	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
09/29/2021	[redacted]	Community open house #2	In 2001, the average daily pumping was 55,616 meters cubed per day which included the lower article contribution, which is now closed but didn't include several wells that are now open. So in 2001, the system adequately produced 55,600 meters cubed per day. My observation of the predicted demand is that all except the top prediction with no added conservation was below 55,600 in 2051. I pulled up the projections here just as a refresher; for 2051 it was about 68,000 for the average day demand and I believe it's 91,000 for the maximum day demand.	09/29/2021	That would have been the demand at that time and the per capita consumptions have been reduced significantly through the conservation programs and our average daily rate is now around 47,000 (m^3/day). I think when we completed some of our water budget work it was down around 42,000 cubic meters per day on average. So it is creeping back up as the city continues to grow, but it's significantly less than the demand that we had back in the in the 2000s. Our water supply capacity is a little bit higher than what it was back then. We've added in Arkell 14 and 15 and that increased our water supply capacity. Back in the late 1990s, in the early 2000s we did have some maximum day demands, that were up around the 65,000, so the system has in the past produced a lot more water than it is now. We've never operated the system with all of our wells running at 100% capacity. We'd have no place to put the water, so when we do these calculations of that 79,000 as what we say is our existing capacity, I always like to describe it as all of our treatment operators outstanding at every wellhead and every valve to get the absolute maximum out of that system. It may not be sustainable over a long term, but certainly in the short term, the system is likely to be able to produce that amount of water.	N/A
09/29/2021	Kyle Davis, Wellington Source Water Protection	Email	Thank you Dave. In speaking with Glenn today, please correspond with Courtenay to confirm that you will be available on the 13th and who the presenters will be. Thank you, Kyle	10/1/2021	Hi Courtenay. This email is to inform you that the Guelph Water Services will attend the Puslinch Council meeting on October 13 to provide a presentation on the City's Water Supply Master Plan Update. Representing Guelph will be Wayne Galliher, Emily Stahl, Scott Cousins and I. Matt Alexander, our consultant from AECOM will also attend. I will deliver the presentation. Could we have 20 minutes plus time for questions? To help facilitate questions and discussion on the WSMP, I have attached the presentation from the WSMP Agency and Municipality Workshop #2 from September 14 in which there were representatives from Puslinch Township. I expect they may have already provided the presentation to your Council. The attached presentation provides much more detail on our project to further inform Council. For the October 13 Council meeting, we will provide a much abbreviated presentation to fit into the allocated time. Please provide us with any further information if necessary. Thank you for this opportunity.	N/A
09/29/2021	Kyle Davis, Wellington Source Water Protection	Email	Hi Dave and Wayne, Thank you for your email Dave and the additional information related to your timelines in getting this to City Council. I have spoken with Ian, Glenn and Aldo about an October 22nd timeline to provide comments. Given that the October 13th and October 20th presentations to our Township Councils will be the first water supply master plan presentation in a number of years, it will not be possible to have written comments by October 22nd. Staff recommendations to our respective Councils on Oct 13th and Oct 20th will be to ask for Council direction for staff to bring back a report and comments to a future meeting of each Council. At this point, we do not know what our Council's	10/1/2021	Hello Kyle. Thank you for your email. Under the strict timing of our ongoing Municipal Comprehensive Review, timing of receipt of the Water Supply Master Plan Update (WSMP) draft final report is locked down with City of Guelph Council and unfortunately we are unable to delay this process. We understand and appreciate the process needs of County and Township staff to interface with their respective Councils. To accommodate this process while respecting project deadlines, the City will extend the comment submission deadline for your municipalities from October 22, 2021 to November 5, 2021 to allow additional time for County/Township input.	N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
			comments / direction will be on the 13th and 20th and therefore, how much time it will take staff, and possibly Township consultants, to prepare reports in response. It is also likely that staff and Township consultants may wish to meet and consult with City staff / consultants in between Council meetings while our reports are being written. Once we have brought staff reports to a subsequent meeting of our Councils and received Council's comments and endorsement, then the Townships will be in a position to submit formal written comments to the City on the Water Supply Master Plan. This process will take a period of time and is simply not possible to be completed in October. We are looking forward to continuing to work collaboratively with the City to manage our shared water resource and to help the City and our Townships plan for future growth. There have been a number of very encouraging discussions this summer between the City, Townships and County and we hope discussions on the water supply master plan can continue that trend. We hope that you will be able to adjust your project timelines to accommodate more time for in depth and meaningful discussion leading up to submission of formal comments. I am available to discuss this in more detail if you wish, I look forward to your response. Regards, Kyle		We have upcoming presentations with GET and Puslinch Councils in the coming weeks and we will use these meetings to solicit feedback, knowing that this feedback is preliminary in nature. Beyond this initial feedback, the WSMP will be posted for a 30 day public feedback period starting in January 2022 at which time we would welcome any additional comments both respective Township Councils may have. Thank you for your help and we look forward to receiving your comments on behalf of Guelph-Eramosa and Puslinch Township Councils. We would encourage you to provide comment as soon as possible so that we can consider your comments in finalizing our Plan and preparing for presentation to our Council. Thank you, Wayne	
10/5/2021	Anon	Community open house #2 survey	*[Are there any considerations missing from the evaluation of the water conservation and* *efficiency alternatives or anything you would evaluate differently?]* Repair of leaking water mains		The City runs a very successful water main leak detection and repair program that has significantly reduced leakage in the system. The City will continue to operate this program, using new technologies to detect system leaks, where appropriate.	N/A
10/5/2021	Anon	Community open house #2 survey	*[Are there any considerations missing from the evaluation of the groundwater alternatives* *or anything you would evaluate differently?]* More study to determine viability of decontaminating affected decommissioned wells		Of the water sourcess off-line for water quality related concerns, one (Clythe Well) will be returned to service in about 2023 and three (Sacco and Smallfield Wells, Lower Road Collector) will be studied to evaluate the possibility of returning these sources to service in the future.	N/A
10/5/2021	Anon	Community open house #2 survey	*[Are there any considerations missing from the evaluation of this alternative or anything* *you would evaluated differently?]* Review water available during drought conditions. Acccording to GRCA more precipitation is expected due to climate change		It is anticipated that climate change will affect extreme weather patterns, including increased severe storms and drought conditions. WSMP planning closely evaluates the potential effects of drought conditions as this poses a risk to the water supply system. Although it is recognized that climate change could result in increased groundwater avaialibity at times, the supply capacity planning does not account for this as it is uncertain.	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
10/7/2021	Kyle Davis, Wellington Source Water Protection		Hi Wayne, Thank you very much for your response. I've discussed with Ian, Glenn and Aldo and in light of your email, Township staff will advise our Councils of the November 5, 2021 commenting timeline and ask for direction to provide preliminary staff / consultant comments by that date, followed by formal comments being submitted to the City once we are able to bring the formal comments back to our Councils at a later date. That being said, our Councils ultimately will decide on the direction they wish our staff and consultants to take regarding provision of comments and timelines and we should have a clear idea of that direction following the Oct 13th and 20th meetings. I hope that helps clarify a path forward on comments and we look forward to working with you and your team on this. Regards, Kyle			N/A
10/13/2021	Courtenay Hoytfox, Township of Puslinch	Email	Hi Dave, just providing an update on timing for your presentation. 1:30 is the best estimate at this time. Thanks, Kind regards	10/14/2021	Hi Courtenay. Thank you for your help yesterday. It is appreciated. We want to include the question and answer portion of the presentation in our community engagement portion of the WSMP report. Can we get this from the video and is it OK to use the video for this purpose? When will the video be posted to your website? Could you also please send us a copy of the final resolution for our records? Thanks again for your help.	N/A
10/14/2021	Glenn Schwendinger, Township of Puslinch	Email	*NOTE: This email was sent to Puslinch Township Council from the City of Guelph Project Team* Good Morning Glenn and Kyle, Thank you for the opportunity to present to Puslinch Township Council yesterday concerning the City of Guelph Water Supply Master Plan Update (WSMP). As a point of clarification following yesterday's meeting, I just wanted to send a quick note to confirm what the City is seeking feedback on as part of the WSMP schedule at this time as I am concerned there may be a misunderstanding present at this time. At this time, the City is seeking your feedback on information and questions presented at the September 14, 2021 WSMP Agency and Municipal Stakeholder Workshop and not the Water Supply Master Plan draft final report. The Water Supply Master draft final report is currently under development, as Dave discussed at yesterday's presentation, and your feedback on this September 14, 2021 meeting content by November 5th will greatly help to shape this draft document. Beyond this current opportunity for feedback, the draft final Water Supply Master Plan report will be released for public reference in early December 2021 and be accompanied by a	10/14/2021	*NOTE: This response was sent from Glenn Schwendinger from the Township of Puslinch to the City of Guelph Project Team* Hi Wayne Thanks for your message. As you can probably gather form the comments during the discussion yesterday, there is frustration on our part. Yes, we understand that this draft report is being finalized and then will be going out for public comment and that we have the opportunity to comment then as well. The primary concern we have is to simply get a copy of a slide deck (not even a complete report) and asked to have comments compiled in 2 weeks. With all due respect, you have been working on this for years and we re provided 2 weeks. Our primary point is to involve us in the process along the way, not once you have studied and compiled everything and made conclusions from your perspective. Puslinch is not just a commenting body engaged for the interest of the project alone. We are asking to be engaged as the decisions made through this process have significant and permanent impacts on our municipality and our residents and businesses. That is why we asked from what I understand was 2 years ago to be involved in the process as it is ongoing, not 2 weeks before finalizing your report. Interesting comment made during the presentation yesterday was that Guelph	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
			formal public review period to solicit stakeholder feedback in accordance with the Municipal Class EA process. Through this process the detailed reports and information of interest discussed at yesterday's Council meeting will be shared with all local stakeholders and we would greatly welcome the respective feedback of Puslinch Council and staff once you have had the opportunity to review the draft final report. Thereafter, the City will document feedback received and related responses in the Water Supply Master Plan final report in accordance with requirements of our EA process. I hope this has helped to clarify the WSMP process and upcoming opportunities for feedback. I would welcome you to give me a call should you have any further questions or like to discuss. Otherwise, we would be pleased to create time to meet at a staff level in the short-term to discuss any questions you may have concerning information shared at the September 14th meeting should this assist you in forming your comments. Please let me know if this is of interest and we can work to coordinate a time via email. Thank you again and best regards, Wayne		said it would not be realistic to receive our comments 2 weeks before you want to finalize your report and present it to you council. I'm glad you appreciate that because that is exactly what you are asking us to do (without any supporting documentation or a report, just a set of slides). The reality is that there perspectives and considerations that we can offer based on the impacts for our community that you may not consider, and these could help improve your work so it is better for all involved, not just Guelph. These impacts and perspectives may even create other scenarios or options that may have been totally missed now because we weren't included during the process. This approach is not a big or unusual ask. This is the process we were a part of with the Region of Waterloo in the Cambridge area. We were engaged often through the process at various milestones. This is all we are asking Guelph to do as well. We will work to put together some preliminary comments on the slide deck, however we need to take these to our council first which will take place on November 3rd. Our complete comments will not be able to be provided until we actually have the report to review. Attached for your information is a copy of the resolution passed at yesterday's Council meeting.	
10/18/21	Haudenosaunee Confederacy Chiefs Council	Email	N/A	10/18/21	Dear Haudenosaunee Confederacy Chiefs Council, RE: Guelph Water Supply Master Plan Update – Virtual Meeting It has been some time since we discussed the City of Guelph Water Supply Master Plan Update. Our last correspondence was in June 2020. As a reminder, the goal of the Water Supply Master Plan Update is to review our water supply sources and identify priorities, including sustainable municipal supply options, from now until 2051. Our work for the Project continues, including our desire to engage with Haudenosaunee Confederacy Chiefs Council, the public and those who may be impacted and/or interested in the project. For more information, you can visit our webpage or stay involved with our engagement page. If Haudenosaunee Confederacy Chiefs Council is interested, we would like to offer a virtual project meeting for yourself and other members of Haudenosaunee Confederacy Chiefs Council consultation team. The intent of this meeting would be to re-introduce the project, gain any input and insight your community may have related to water supply in Guelph and answer any questions you may have.	N/A

Date	Name	Source	Comment	Response Date	Response	Action Required
					If you are interested in meeting, please reply at the contact information below with a preferred date and time. We can set up the meeting using Microsoft Teams or another preferred meeting platform. Also, you are welcome to share any questions or concerns that you may have in advance so we can address them in our meeting. If you have any questions, comments or concerns related to the Water Supply Master Plan or would like to meet virtually to discuss the project, please do not hesitate to contact me at dave.belanger@guelph.ca or (519) 822-1260 ext. 2186 or AECOM's Project Manager, Matthew Alexander, at matthew.alexander@aecom.com or (226) 821-4906. Please note that we will also follow up by phone to confirm receipt of this letter and see if you have any questions or comments. Sincerely, Dave Belanger, M.Sc., P.Geo.	
10/27/2021	Jenni Spies, Guelph Eramosa Township	Email	Mr. Dave Belanger, M.Sc., P.Geo. Water Supply Program Manager Water Services - Infrastructure, Development and Enterprise City of Guelph 1 Carden Street Guelph, ON N1H 3A1 Dave.Belanger@guelph.ca Re: Water Supply Master Plan 2021 Update Dear Mr. Belanger, At the Committee of the Whole meeting held on October 20, 2021, the following resolution was put forward and passed: Be it resolved that the Committee of the Whole of the Township of Guelph/Eramosa has received Guelph Water Services Presentation regarding the Water Supply Master Plan 2021 Update; and That the Committee recommend to Council that a resolution be passed, stating the following: That the Township of Guelph/Eramosa has concerns with the City of Guelph's November 5, 2021, deadline for comments regarding the Water Supply Master Plan 2021 Update; and That Guelph/Eramosa Council request the City of Guelph Council to authorize the release of the draft report to Guelph/Eramosa staff in advance of the City of Guelph			N/A

City of Guelph 2019 Water Supply Master Plan Update - Correspondence Tracking Table

Date	Name	Source	Comment	Response Date	Response	Action Required
			Council meeting so that the Township of Guelph/Eramosa may prepare comments; and That Council direct Township staff and Township consultant(s) to review the City of Guelph Water Supply Master Plan Update correspondence and draft report, when available, and to provide comments for Council's consideration at a subsequent Township of Guelph/Eramosa Council meeting; and That the City of Guelph Council permit Guelph/Eramosa Council to provide comments in advance of the draft report being adopted by City of Guelph Council; and That Council request that, when received, the City of Guelph Council acknowledge receipt of the Township comments and that the City of Guelph provide a response to the Township's comments; and That this resolution be forwarded to the City of Guelph and the Township of Puslinch. Please accept this for your information and any necessary action. Sincerely, Jenni Spies Deputy Clerk			

Appendix B

Notice of Commencement

- Notice
- Formal Letters
- Email Content
- Advertisements

Public Notice

Notice of study commencement

City of Guelph Municipal Class Environmental Assessment for Water Supply Master Plan Update

We're updating our Water Supply Master Plan!

The City of Guelph is updating the 2014 Water Supply Master Plan (WSMP) to review our municipal water supply sources and identify priorities, including sustainable water supply options from now until 2041.

Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water. Our WSMP update will look to the community to discuss how best to manage this vital supply so that we continue to provide the same high level of service to Guelph residents.

The updated WSMP will provide short-term, mid-term and long-term water supply options to ensure we can continue to meet the demands of Guelph's growing population. When investigating existing and new water supply options – like new groundwater sources in and outside of the City and local surface water sources – we'll consider things like water quality and quantity, climatic conditions, economic factors and any relevant regulations.

When we're done – after our WSMP update is reviewed by the Guelph community and approved by Council – we'll have identified constraints and opportunities related to our existing water supply system. We'll also have evaluated and prioritized individual projects to increase the capacity of our existing system.

We want to hear from you

Your feedback is an important part of the WSMP update.

- **Join our Community Liaison Group**. You'll help us set objectives for the WSMP update and assess alternative water supply options. If you're interested, please contact Matthew Alexander at 519-840-2223 or at matthew.alexander@aecom.com.
- **Attend our open houses and let us know what you think**. Our first open house will be scheduled early in 2020. Dates for this event will be posted at Guelph.ca/WSMP, in the City News pages of the Guelph Mercury Tribune and sent to the project mailing list.
- **Read about our progress**. Project information will be posted on our project page Guelph.ca/WSMP
- **Join our mailing list**. Send us your name and how you would like to be contacted (e.g., email or mail) and we will keep you informed.
- **Follow the conversation on Twitter and Facebook**.

The process

Our Water Supply Master Plan update will follow the requirements of Phases 1 & 2 of the Municipal Class Environmental Assessment (MCEA) in accordance with Approach #1 of the Master Plan Process described in the MCEA Manual (amended in 2015) by the Municipal Engineers Association. The WSMP update will be readily updated at approximately five-year intervals. This 2019 update will be coordinated with the Official Plan, and will contain plans for execution of individual projects consisting of Class EA Schedule A, B and C activities.

For more information

Please visit Guelph.ca/WSMP for the latest information about the WSMP update.

To provide your comments, request additional information, be added to the project mailing list, or if you require this notice to be provided in an alternative format as per the Accessibility for Ontarians with Disabilities Act (2005), please contact:

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

This notice was first issued on October 31, 2019.

Thursday, October 31, 2019

Anneleis Eckert
Rural Planner, Central-West Ontario, Land Use Policy and Stewardship
Ministry of Agriculture, Food, and Rural Affairs
Elora Resource Ctr Unit 10
6484 Wellington Rd 7
Elora, ON, N0B 1S0

Dear Anneleis Eckert,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

The City of Guelph is updating its Water Supply Master Plan (WSMP) to define how we will continue to provide a sustainable supply of municipal water from now until 2041. This is a chance to review our existing water supply system, and to discuss with the community how best to manage this vital resource so that we continue to provide the high level of service Guelph citizens have come to expect. The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City. Included with this letter is the Notice of Study Commencement which will appear in the Guelph Mercury Tribune on October 31, 2019.

AECOM has been retained by the City of Guelph to conduct the Master Plan update. Our Water Supply Master Plan update will follow the requirements of Phases 1 & 2 of the Municipal Class Environmental Assessment (MCEA) in accordance with Approach #1 of the Master Plan Process described in the MCEA Manual (amended in 2015) by the Municipal Engineers Association. The WSMP update will be readily updated at approximately five-year intervals. This 2019 update will be coordinated with the Official Plan update, and will contain plans for execution of individual projects consisting of Class EA Schedule A, B and C activities.

Potential Involvement of Your Agency/ Organization

If your Agency/ organization would like to be notified for continued involvement in this Project, please indicate this by contacting us at the coordinates below by **November 14, 2019**. We recognize that this Project may not impact your mandate or programs, and should this be the case, we would appreciate you advising us either by email or letter by **November 14, 2019**.

We know that water is everyone's business and look forward to your input. We would be happy to meet with you to provide more information about the study and the progress made. In the meantime, to find out more about the Water Supply Master Plan Update please visit Guelph.ca/WSMP or contact:

City Hall
1 Carden St
Guelph, ON
Canada
N1H 3A1

T 519-822-1260
TTY 519-826-9771

guelph.ca

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Adriana Ibarguchi
Director
Community Safety and Corrections Policy Branch
Strategic Policy, Research and Innovation Division
George Drew Bldg 9th Flr
25 Grosvenor St
Toronto, ON, M7A 1Y6

Dear Adriana Ibarguchi,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

The City of Guelph is updating its Water Supply Master Plan (WSMP) to define how we will continue to provide a sustainable supply of municipal water from now until 2041. This is a chance to review our existing water supply system, and to discuss with the community how best to manage this vital resource so that we continue to provide the high level of service Guelph citizens have come to expect. The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City. Included with this letter is the Notice of Study Commencement which will appear in the Guelph Mercury Tribune on October 31, 2019.

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We know that water is everyone's business and look forward to your input. We would be happy to meet with you to provide more information about the study and the progress made. In the meantime, to find out more about the Water Supply Master Plan Update please visit Guelph.ca/WSMP or contact:

City Hall
1 Carden St
Guelph, ON
Canada
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T 519-822-1260
TTY 519-826-9771

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Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
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Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

D Belanger

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Environmental Assessment Coordination
Crown-Indigenous Relations and Northern Affairs Canada
10 rue Wellington
Gatineau QC, K1A 0H4

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

The City of Guelph is updating its Water Supply Master Plan (WSMP) to define how we will continue to provide a sustainable supply of municipal water from now until 2041. This is a chance to review our existing water supply system, and to discuss with the community how best to manage this vital resource so that we continue to provide the high level of service Guelph citizens have come to expect. The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City. Included with this letter is the Notice of Study Commencement which will appear in the Guelph Mercury Tribune on October 31, 2019.

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We know that water is everyone's business and look forward to your input. We would be happy to meet with you to provide more information about the study and the progress made. In the meantime, to find out more about the Water Supply Master Plan Update please visit Guelph.ca/WSMP or contact:

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Wednesday, November 13, 2019

Hohahes Leroy Hill
Haudenosaunee Confederacy Chiefs Council
2634 6th Line Road, RR#2
Ohsweken, ON N0A 1M0

Dear Hohahes Leroy Hill,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

The City of Guelph is updating its Water Supply Master Plan (WSMP) to define how we will continue to provide a sustainable supply of municipal water from now until 2041. This is a chance to review our existing water supply system, and to discuss with the community how best to manage this vital resource so that we continue to provide the high level of service Guelph citizens have come to expect. The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City. Included with this letter is the Notice of Study Commencement which appeared in the Guelph Mercury Tribune on October 31, 2019.

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Potential Involvement of Your Community

As part of our notification efforts, we value your community's participation in this Water Supply Master Plan update. The Project Team is asking for your input in determining the extent that your community would like to be involved in the process. We also wish to give you an opportunity to ensure that your Indigenous interests and concerns are taken into consideration and addressed in a timely manner.

Please advise the Project Team of your interest in this Study by responding to this letter with the following information at your convenience:

- the representative from your community/organization who will participate as part of the Study;
- if you would like to be removed from the Project Contact List because your community/ organization has no concerns; and/or,

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Canada
N1H 3A1

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Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

Wednesday, November 13, 2019

Chief Stacey LaForme
Mississaugas of the Credit First Nation
2789 Mississauga Road R.R. #6
Hagersville, ON N0A 1H0

Dear Chief Stacey LaForme,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Wednesday, November 13, 2019

Chief Mark Hill
Six Nations of the Grand River
P.O. BOX 5000
Ohsweken, ON., N0A 1M0

Dear Chief Mark Hill,

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Sincerely,

D Belanger

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Wednesday, November 13, 2019

Chief Ava Hill
Six Nations of the Grand River
P.O. BOX 5000
Ohsweken, ON., N0A 1M0

Dear Chief Ava Hill,

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Thursday, October 31, 2019

Environmental Assessment Review Team
160 Bloor Street East, 4th Floor
Toronto, ON, M7A 2E6

Dear

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CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Fisheries and Oceans Canada
867 Lakeshore Rd
Burlington, ON, L7S 1A1

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Karla Barboza
Team Lead – Heritage (Acting)
Heritage Planning Unit
Programs and Services Branch
Culture Division
Ministry of Heritage, Sport, Tourism, and Culture Industries
401 Bay St
Toronto, ON, M7A 0A7

Dear Karla Barboza,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Lisa Myslicki
Environmental Specialist
Infrastructure Ontario
1 Dundas St W, Toronto, Suite 2000
Toronto, ON, M5G 1Z3

Dear Lisa Myslicki,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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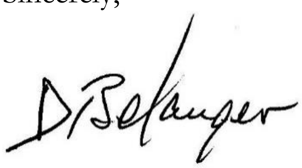

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CC Kate Bishop, City of Guelph

Ministry of the Environment,
Conservation and Parks
Drinking Water and Environmental
Compliance Division
West Central Region

119 King Street West, 12th Floor
Hamilton, Ontario L8P 4Y7
Tel.: 905 521-7640
Fax: 905 521-7820

Ministère de l'Environnement de la
Protection de la nature et des Parcs
Division de la conformité en matière
d'eau potable et d'environnement
Direction régionale du Centre-Ouest

119 rue King Ouest, 12e étage
Hamilton (Ontario) L8P 4Y7
Tél.: 905 521-7640
Téléc.: 905 521-7820

Ontario

November 5, 2019

Mr. D. Belanger
City of Guelph

Mr. M. Alexander
AECOM Canada Ltd.

Dear Messrs. Belanger and Alexander

Re: City of Guelph Municipal Class Environmental Assessment
Water Supply Master Plan Update
Response to Notice of Study Commencement

This letter is in response to the Notice of Commencement for the above noted project. The Ministry of the Environment, Conservation and Parks (MECP) acknowledges that the City of Guelph has indicated that its study is following the master planning process to complete Phases 1 and 2 under the MEA Class EA. It is understood that the purpose of the master planning exercise is to enable the City to review the existing water supply system to ensure that it is relevant with current and future needs

Identification of specific projects should consider whether they have the potential to result in impacts to source protection related features such as highly vulnerable aquifers or significant groundwater recharge areas. It is recognized that a more detailed analysis of source protection implications and any mitigation measures will be assessed in the project specific EAs that may be identified through the master planning process.

The Crown has a legal duty to consult Aboriginal communities when it has knowledge, real or constructive, of the existence or potential existence of an Aboriginal or treaty right and contemplates conduct that may adversely impact that right. Before authorizing this project, the Crown must ensure that its duty to consult has been fulfilled, where such a duty is triggered. Although the duty to consult with Aboriginal peoples is a duty of the Crown, the Crown may delegate procedural aspects of this duty to project proponents while retaining oversight of the consultation process.

Your proposed project may have the potential to affect Aboriginal or treaty rights protected under Section 35 of Canada's *Constitution Act* 1982. Where the Crown's duty to consult is triggered in relation to your proposed project**, the MECP is delegating the procedural aspects of rights-based consultation to you through this letter.** The Crown intends to rely on the delegated consultation process in discharging its duty to consult and maintains the right to participate in the consultation process as it sees fit.

Based on information you have provided to date and the Crown`s preliminary assessment you are required to consult with the following communities who have been identified as potentially affected by your proposed project.

First Nation	Contact Information
Six Nations of the Grand River	Six Nations of the Grand River P.O. BOX 5000, Ohsweken, ON., N0A 1M0 (519) 445-2201 Chief Ava Hill avahill@sixnations.ca Other Contact: Lands and Resources Director, Lonny Bomberry lonnybomberry@sixnations.ca 519-753-0665 Consultation Point Person: Matthew Jocko mjocko@sixnations.ca 2498 Chiefswood Road, P.O. Box 5000 Ohsweken, ON N0A 1M0
Haudenosaunee Confederacy Chiefs Council	Haudenosaunee Confederacy Chiefs Council 2634 6th Line Road, RR#2 Ohsweken, ON N0A 1M0 Hohahes Leroy Hill, Secretary jocko@sixnations.com
Mississaugas of the New Credit First Nation	Mississaugas of the New Credit First Nation 2789 Mississauga Road R.R. #6, Hagersville, ON N0A 1H0 519-768-1133 Chief Stacey LaForme Stacey.Laforme@mncfn.ca Other Contact: Fawn Sault, Consultation Coordinator Department of Consultation & Accommodation Fawn.Sault@mncfn.ca 6 First Line Rd., Unit 1 R.R.#6 Hagersville, ON N0A 1H0 905-768-4260

Steps that you may need to take in relation to Aboriginal consultation for your proposed project are outlined in the “Code of Practice for Consultation in Ontario’s Environmental Assessment Process” which can be found at the following link: https://www.ontario.ca/document/consultation-ontarios-environmental-assessment-process
Additional information related to Ontario’s Environmental Assessment Act is available online at: www.ontario.ca/environmentalassessments

You must contact the Director of Environmental Assessment and Permissions Branch under the following circumstances subsequent to initial discussions with the communities identified by MECP:

- Aboriginal or treaty rights impacts are identified to you by the communities
- You have reason to believe that your proposed project may adversely affect an Aboriginal or treaty right
- Consultation has reached an impasse
- A Part II Order request or elevation request is expected

The Director can be notified either by email with the subject line “Potential Duty to Consult” to MOECCpermissions@ontario.ca or by mail or fax at the address provided below:

Email:	MOECCpermissions@ontario.ca Subject: Potential Duty to Consult

Fax:	416-314-8452
Address:	Environmental Assessment and Permissions Branch 135 St. Clair Avenue West, 1st Floor Toronto, ON, M4V 1P5

The MECP will then assess the extent of any Crown duty to consult for the circumstances and will consider whether additional steps should be taken, including what role you will be asked to play in them.

While Master Plans themselves are not subject to Part II Orders, any projects identified and for which the Master Plan completes the EA process would be subject. As of July 1st 2018, a standardized form is to be used by anyone who believes that the environmental assessment process was incomplete, incorrect or that it failed to follow the required process. The required form can be found on the Forms Repository website (http://www.forms.ssb.gov.on.ca/) by searching "Part II Order" or "012-2206E (the form ID number). Once completed, the form is then to be sent to both the Minister and Director of the Environmental Assessment and Permissions Branch. Their addresses are:

Minister
Ministry of the Environment, Conservation and Parks
Minister.mecp@ontario.ca

Director, Environmental Assessment and Permissions Branch
Ministry of the Environment, Conservation and Parks
135 St. Clair Ave. West, 1st Floor
Toronto, ON M4V 1P5
MOECCpermissions@ontario.ca

Should you have questions, please contact me either at (905) 521-7864 or at Barbara.slattery@ontario.ca

With regards,

Barbara Slattery

EA/Planning Coordinator

Encl.

Thursday, October 31, 2019

Amy Shaw
Manager
Guelph District Office
Drinking Water and Environmental Compliance Division
Ministry of the Environment, Conservation and Parks
Ontario Government Bldg 4th Flr
1 Stone Rd W
Guelph, ON, N1G 4Y2

Dear Amy Shaw,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

The City of Guelph is updating its Water Supply Master Plan (WSMP) to define how we will continue to provide a sustainable supply of municipal water from now until 2041. This is a chance to review our existing water supply system, and to discuss with the community how best to manage this vital resource so that we continue to provide the high level of service Guelph citizens have come to expect. The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City. Included with this letter is the Notice of Study Commencement which will appear in the Guelph Mercury Tribune on October 31, 2019.

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City Hall
1 Carden St
Guelph, ON
Canada
N1H 3A1

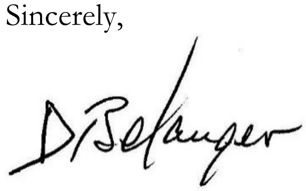
T 519-822-1260
TTY 519-826-9771

guelph.ca

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,



Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
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City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Annamaria Cross
Manager
Environmental Assessment Services
Environmental Assessment and Permissions Division
Ministry of the Environment, Conservation and Parks
1st Flr, 135 St Clair Ave W
Toronto, ON, M4V 1P5

Dear Annamaria Cross,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Matthew Alexander, M.Sc., P.Geo.
Project Manager
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519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

D Belanger

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CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Heather Malcolmson
Director (Acting)
Environmental Assessment and Permissions Branch
Ministry of the Environment, Conservation and Parks
1st Flr, 135 St Clair Ave W
Toronto, ON, M4V 1P5

Dear Heather Malcolmson,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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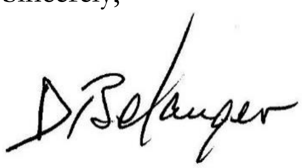
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,



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CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Ling Mark
Director
Great Lakes and Inland Waters Branch
Land and Water Division
Ministry of the Environment, Conservation and Parks
Foster Bldg 10th Flr
40 St Clair Ave W
Toronto, ON, M4V 1M2

Dear Ling Mark,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
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AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

D Belanger

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
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CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Natalie Stacey
Supervisor (Acting)
Air, Pesticides and Environmental Planning
Drinking Water and Environmental Compliance Division
Ministry of the Environment, Conservation and Parks
Ellen Fairclough Bldg 12th Flr
119 King St W
Hamilton, ON, L8P 4Y7

Dear Natalie Stacey,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

Dave Belanger, M.Sc., P.Geo.
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CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Paul Widmeyer
Manager (Acting)
Hamilton District Office
Drinking Water and Environmental Compliance Division
Ministry of the Environment, Conservation and Parks
Ellen Fairclough Bldg 9th Flr
119 King St W
Hamilton, ON L8P 4Y7

Dear Paul Widmeyer,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Matthew Alexander, M.Sc., P.Geo.
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Sincerely,

D Belanger

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Water Services
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City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Peter Brown
Indigenous Consultation Advisor
Ministry of the Environment, Conservation and Parks
1st Flr, 135 St Clair Ave W
Toronto, ON, M4V 1P5

Dear Peter Brown,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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City of Guelph
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Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
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Sincerely,

D Belanger

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Water Services
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T **519-822-1260 x 2186**
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E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Erick Boyd
Manager (Acting)
Community Planning and Development
Western Municipal Services Office
Ministry of Municipal Affairs and Housing
Exeter Road Complex 2nd Flr
659 Exeter Rd
London, ON N6E 1L3

Dear Erick Boyd,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
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519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Jennifer McKay
Coordinator, Water Resources (Acting)
Ministry of Natural Resources and Forestry
6th Flr S
300 Water St
Peterborough, ON, K9J 3C7

Dear Jennifer McKay,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

DBelanger

Dave Belanger, M.Sc., P.Geo.
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Water Services
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City of Guelph

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F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Tammy Verhaeghe
District Manager
Guelph District
Ministry of Natural Resources and Forestry
Ontario Government Bldg
1 Stone Rd W
Guelph, ON, N1G 4Y2

Dear Tammy Verhaeghe,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

The City of Guelph is updating its Water Supply Master Plan (WSMP) to define how we will continue to provide a sustainable supply of municipal water from now until 2041. This is a chance to review our existing water supply system, and to discuss with the community how best to manage this vital resource so that we continue to provide the high level of service Guelph citizens have come to expect. The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City. Included with this letter is the Notice of Study Commencement which will appear in the Guelph Mercury Tribune on October 31, 2019.

AECOM has been retained by the City of Guelph to conduct the Master Plan update. Our Water Supply Master Plan update will follow the requirements of Phases 1 & 2 of the Municipal Class Environmental Assessment (MCEA) in accordance with Approach #1 of the Master Plan Process described in the MCEA Manual (amended in 2015) by the Municipal Engineers Association. The WSMP update will be readily updated at approximately five-year intervals. This 2019 update will be coordinated with the Official Plan update, and will contain plans for execution of individual projects consisting of Class EA Schedule A, B and C activities.

Potential Involvement of Your Agency/ Organization

If your Agency/ organization would like to be notified for continued involvement in this Project, please indicate this by contacting us at the coordinates below by **November 14, 2019**. We recognize that this Project may not impact your mandate or programs, and should this be the case, we would appreciate you advising us either by email or letter by **November 14, 2019**.

We know that water is everyone's business and look forward to your input. We would be happy to meet with you to provide more information about the study and the progress made. In the meantime, to find out more about the Water Supply Master Plan Update please visit Guelph.ca/WSMP or contact:

City Hall
1 Carden St
Guelph, ON
Canada
N1H 3A1

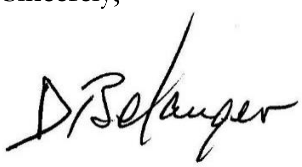
T 519-822-1260
TTY 519-826-9771

guelph.ca

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,



Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph

T **519-822-1260 x 2186**
F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Transport Canada
330 Sparks St
Ottawa, ON, K1A 0N5

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

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Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Sincerely,

D Belanger

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F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Thursday, October 31, 2019

Neil Zohorsky
Regional Director (Acting)
West Region
Provincial Highways Management Division
Ministry of Transportation
Exeter Road Complex 4th Flr
659 Exeter Rd
London, ON, N6E 1L3

Dear Neil Zohorsky,

RE: Notice of Commencement—City of Guelph Water Supply Master Plan/Class Environmental Assessment

The City of Guelph is updating its Water Supply Master Plan (WSMP) to define how we will continue to provide a sustainable supply of municipal water from now until 2041. This is a chance to review our existing water supply system, and to discuss with the community how best to manage this vital resource so that we continue to provide the high level of service Guelph citizens have come to expect. The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City. Included with this letter is the Notice of Study Commencement which will appear in the Guelph Mercury Tribune on October 31, 2019.

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We know that water is everyone's business and look forward to your input. We would be happy to meet with you to provide more information about the study and the progress made. In the meantime, to find out more about the Water Supply Master Plan Update please visit Guelph.ca/WSMP or contact:

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guelph.ca

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Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
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Sincerely,

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Water Services
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City of Guelph

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F 519-822-8837
E **Dave.Belanger@guelph.ca**

CC Kate Bishop, City of Guelph

Guelph Water Supply Master Plan Notice of Commencement

Email Content

November 4, 2019

The City of Guelph is initiating a Municipal Class Environmental Assessment Study for a Water Supply Master Plan update. AECOM has been retained by the City of Guelph to conduct the Master Plan update and is contacting you on behalf of the City. Included with this email is the Notice of Study Commencement. Please reply to this email to indicate if you would like to be notified for continued involvement, and/ or if you would like to receive a hard copy of the attached documents.

You may also contact the City of Guelph's Water Supply Program Manager, Dave Belanger, at dave.belanger@guelph.ca or (519) 822-1260 ext. 2186 or AECOM's Project Manager, Matthew Alexander, at matthew.alexander@aecom.com or (519)840-2223.

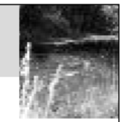
Notice of Commencement advertisements

City of Guelph

guelph.ca/news

City News

NOTICE OF STUDY COMMENCEMENT



City of Guelph Municipal Class Environmental Assessment for Water Supply Master Plan Update

We're updating our Water Supply Master Plan!

The City of Guelph is updating the 2014 Water Supply Master Plan (WSMP) to review our municipal water supply sources and identify priorities, including sustainable water supply options from now until 2041.

Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water. Our WSMP update will look to the community to discuss how best to manage this vital supply so that we continue to provide the same high level of service to Guelph residents.

The updated WSMP will provide short-term, mid-term and long-term water supply options to ensure we can continue to meet the demands of Guelph's growing population. When investigating existing and new water supply options—like new groundwater sources in and outside of the City and local surface water sources—we'll consider things like water quality and quantity, climatic conditions, economic factors and any relevant regulations.

When we're done—after our WSMP update is reviewed by the Guelph community and approved by Council—we'll have identified constraints and opportunities related to our existing water supply system. We'll also have evaluated and prioritized individual projects to increase the capacity of our existing system.

We want to hear from you

Your feedback is an important part of the WSMP update.

- Join our Community Liaison Group. You'll help us set objectives for the WSMP update and assess alternative water supply options. If you're interested, please contact Matthew Alexander at 519-840-2223 or at matthew.alexander@aecom.com.
- Attend our open houses and let us know what you think. Our first open house will be scheduled early in 2020. Dates for this event will be posted at **guelph.ca/WSMP**, in the City News pages of the Guelph Mercury Tribune and sent to the project mailing list.
- Read about our progress. Project information will be posted on our project page **guelph.ca/WSMP**
- Join our mailing list. Send us your name and how you would like to be contacted (e.g., email or mail) and we will keep you informed.
- Follow the conversation on Twitter and Facebook.

The process

Our Water Supply Master Plan update will follow the requirements of Phases 1 and 2 of the Municipal Class Environmental Assessment (MCEA) in accordance with Approach #1 of the Master Plan Process described in the MCEA Manual (amended in 2015) by the Municipal Engineers Association. The WSMP update will be readily updated at approximately five-year intervals. This 2019 update will be coordinated with the Official Plan, and will contain plans for execution of individual projects consisting of Class EA Schedule A, B and C activities.

For more information

Please visit **guelph.ca/WSMP** for the latest information about the WSMP update.

To provide your comments, request additional information, be added to the project mailing list, or if you require this notice to be provided in an alternative format as per the Accessibility for Ontarians with Disabilities Act (2005), please contact:

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260, x 2186
dave.belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo., Project Manager
AECOM Canada Ltd
519-840-2223
matthew.alexander@aecom.com

This notice was first issued on October 31, 2019.

Appendix C

Community Open House #1 and #2

- Open House #1 Notice
- Open House #1 Advertisements
- Email Content #1
- Display Boards #1
- Survey #1
- Map #1
- Open House #2 Notice
- Open House #2 Advertisements
- Email Content #2
- Presentation #2
- Survey #2

Public Notice

Join us February 13 for the first Water Supply Master Plan open house

Help guide the City's Water Supply Master Plan

The City is updating the 2014 Water Supply Master Plan (WSMP), the City's long-term plan for ensuring we sustain our drinking water sources and services as our community grows.

The WSMP update includes reviewing our current drinking water sources and identifying options for more sources, from now until 2041.

Have your say

We need your help! Over the next several months, the City will ask the community to share feedback, both in person and online, to help inform how we will manage our water supply as our community grows. We want to know how you use water today, and what is important to you for the future so that we can continue to provide excellent drinking water service to Guelph residents.

The City is hosting the first of two community open houses at City Hall on February 13.

What: 2019 Water Supply Master Plan update open house
Where: Marg MacKinnon Community Room, City Hall, 1 Carden Street (enter from the Galleria)
When: February 13, from 2-4 p.m. and 6-8 p.m.

Join us to learn about and share your thoughts on:

- the objectives and overview of the WSMP update
- the City's current drinking water supply
- proposed alternatives for meeting our drinking water supply needs
- proposed criteria and methodology for evaluating new drinking water sources
- next steps as we update the WSMP

Other ways to get involved

Your feedback is an important part of the WSMP update.

- **Register, join the conversation and share thoughts** at haveyoursay.guelph.ca.
- **Read about our progress**. Project information will be posted on our project page at guelph.ca/wsmp.
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Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

This notice was first issued on January 30, 2020.

Open house #1 advertisements

CITY OF GUELPH OPEN HOUSE

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Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
dave.belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
matthew.alexander@aecom.com

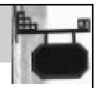
This notice was first issued on January 23, 2020.

City of Guelph
Making a Difference

City News

Your weekly source of City information

NOTICE FOR NEW SIGNS



The City received applications for variances from the City of Guelph Sign By-law Number (1996)-15245, as amended. The requests for variances are for the following properties:

10 Woodlawn Road East

Request for variance from Table 1, Row 1 of Sign By-law Number (1996)-15245, as amended, to permit one (1) non-illuminated building sign with an area of 1.76 metres squared (m^2) to be located 2.08 m above the ground surface.

435 Stone Road West

Request for variance from Table 2, Row 13 of Sign By-law Number (1996)-15245, as amended, to permit one (1) illuminated menu board/ order board with a height of 3.13 m above the adjacent roadway.

Request for a variance from Table 2, Row 13 of Sign By-law Number (1996)-15245, as amended, to permit one (1) illuminated pre-sell menu board with a height of 1.81 m above the adjacent roadway.

Read the report

Reports relating to these applications will be available online on Thursday, January 16, 2020 at **guelph.ca**. For questions about these applications please email **building@guelph.ca**.

How to participate

These variance applications will be addressed at the Council Planning meeting in Council Chambers, City Hall, 1 Carden Street, Guelph at **6:30 p.m. on Monday, January 27, 2020**. If you wish to speak about either of these applications or provide a written submission, please register online at **guelph.ca** using the "Request to speak at a meeting" form, email **clerks@guelph.ca**, or call the City Clerk's office at **519-837-5603 (TTY 519-826-9771) by Friday, January 24, 2020 at 10 a.m.**

OPEN HOUSE

Join us February 13 for the first Water Supply Master Plan open house

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City of Guelph
519-822-1260 x 2186
dave.belanger@guelph.ca

Matthew Alexander
Project Manager
AECOM Canada Ltd
519-840-2223
matthew.alexander@aecom.com

This notice was first issued on January 23, 2020.

Be careful about what you put in your waste carts

Help keep us safe. Guelph Solid Waste Resources staff working the line at the Material Recovery Facility.

Things like syringes, propane tanks, helium tanks, partially full paint cans, toner cartridges and cleaning products should not go in your carts.

When hazardous items end up in your carts, they can injure a worker, get stuck in equipment, shut down the facility, or contaminate clean material.

Please drop off your hazardous waste for free at the Waste Resource Innovation Centre (110 Dunlop Drive) all year round.

For more information

Solid Waste Resources
519-767-0598
waste@guelph.ca

Give Waste a New Life

Not sure what goes where? Download the Guelph Waste app or use the Waste Wizard at **guelph.ca/waste**

Like us on **facebook.com/cityofguelph**

Accessible formats available by calling **519-822-1260** or **TTY 519-826-9771**

City of Guelph

City News

Your weekly source of City information

Have your say

on four proposed community gardens by February 14

New community gardens have been proposed for:

- Mollison Park
- Stephanie Drive Park
- St. George's Park
- Burns Drive Park

We want to know how you feel about the proposed community garden, the proposed location, and if you want to participate if it's approved.

Take the survey at haveyoursay.guelph.ca

Holiday hours

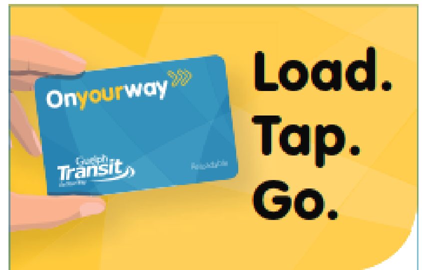
Monday, February 17

City Hall will be closed on Monday, February 17 and will reopen at 8:30 a.m. on February 18.

Other City facilities, services and programs will operate on reduced holiday hours. Visit **guelph.ca/holidayhours** for a full listing of hours.

Visit **guelphtransit.ca** for Guelph Transit service hours.

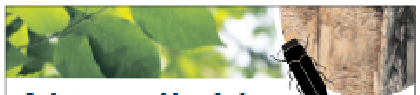
Waste collection moves one day forward.



Load. Tap. Go.

Available at select retailers/City facilities.

guelphtransit.ca



Ash tree and buckthorn removals in Westwood sugartree woodlot starting February 10

Crews will treat the invasive buckthorn from the natural area starting the week of February 10, to prepare the area for tree removals.

We're starting work on February 17 to remove ash and hazard trees from the Westwood sugartree woodlot. This work is a part of our larger strategy to manage ash trees affected by the emerald ash borer and manage invasive species.

Sidewalks on Imperial Road at Bond Court will have intermittent closures

Sidewalks at the intersection of Imperial Road North at Bond Court will be closed intermittently between February 17-21. Trail closures through the woodlot should be expected. We ask that residents stay out of the area while crews complete their work.

Approximately 100 trees, in addition to buckthorn, will be removed between February 17-21, weather permitting. Trees scheduled for removal will be marked with an orange "x".

For more information

Timea Filer, Urban Forestry Field Technologist
Parks Operations and Forestry
519-822-1260 x 3352
timea.filer@guelph.ca

guelph.ca/environment

Open House

Join us February 13 for the first Water Supply Master Plan open house

Help guide the City's Water Supply Master Plan

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519-840-2223
matthew.alexander@aecom.com

This notice was first issued on January 23, 2020.

City of Guelph Water Supply Master Plan Open House –February 13
Email Content
January 30, 2020

The City of Guelph is hosting the first of two community open houses for the Water Supply Master Plan at City Hall on February 13. The open house notice is attached with this email.

What: 2019 Water Supply Master Plan update open house
Where: Marg MacKinnon Community Room, Guelph City Hall, 1 Carden Street (enter from the Galleria)
When: February 13, from 2-4 p.m. and 6-8 p.m.

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- proposed criteria and methodology for evaluating new drinking water sources
- next steps as we update the WSMP

Visit the project page to learn more, and join the conversation at haveyoursay.guelph.ca. You are receiving this email because you have indicated interest in receiving updates about the City of Guelph's Water Supply Master Plan update. You can opt out at any time by replying to this email.

Guelph Water Supply Master Plan open house #1 email
Email content
March 2, 2020

The City of Guelph hosted the first of two open houses for the Water Supply Master Plan (WSMP) update on February 13, 2020. For those of you who were able to make it out, thank you for attending and sharing your comments and questions with the project team.

The display boards are available on our project page under the resources section. We also have a digital version of the survey available and we are looking for your input until March 16, 2020. The survey is available through the City's online community engagement site, Have Your Say Guelph. We encourage you to both complete the survey and register to Have Your Say Guelph so you can stay up-to-date on current and future City of Guelph digital engagement opportunities.

The WSMP team is available to answer any questions, comments or concerns you may have. You can contact the City of Guelph's Water Supply Program Manager, Dave Belanger, at dave.belanger@guelph.ca or (519) 822-1260 ext. 2186 or AECOM's Project Manager, Matthew Alexander, at matthew.alexander@aecom.com or (519) 840-2223.

Water Supply Master Plan

Welcome

Help shape the City's Water Supply Master Plan

The City is updating the 2014 Water Supply Master Plan (WSMP), the City's long-term plan for ensuring we sustain our drinking water sources and services as our community grows.

The WSMP update includes reviewing our current water supply sources and identifying priorities for a sustainable municipal water supply from now until 2041.

This is the first of two open houses to provide you with an opportunity to formally participate in the Master Plan process.

The purpose of this open house is to learn about and share your thoughts on:

- the objectives and overview of the WSMP update
- the City's current drinking water supply
- proposed alternatives for meeting our drinking water supply needs
- proposed criteria and methodology for evaluating new drinking water sources
- next steps as we update the WSMP

Read through the information on display and complete a comment form in-person or online (haveyoursay.guelph.ca) after reviewing the boards and talking with our experts.

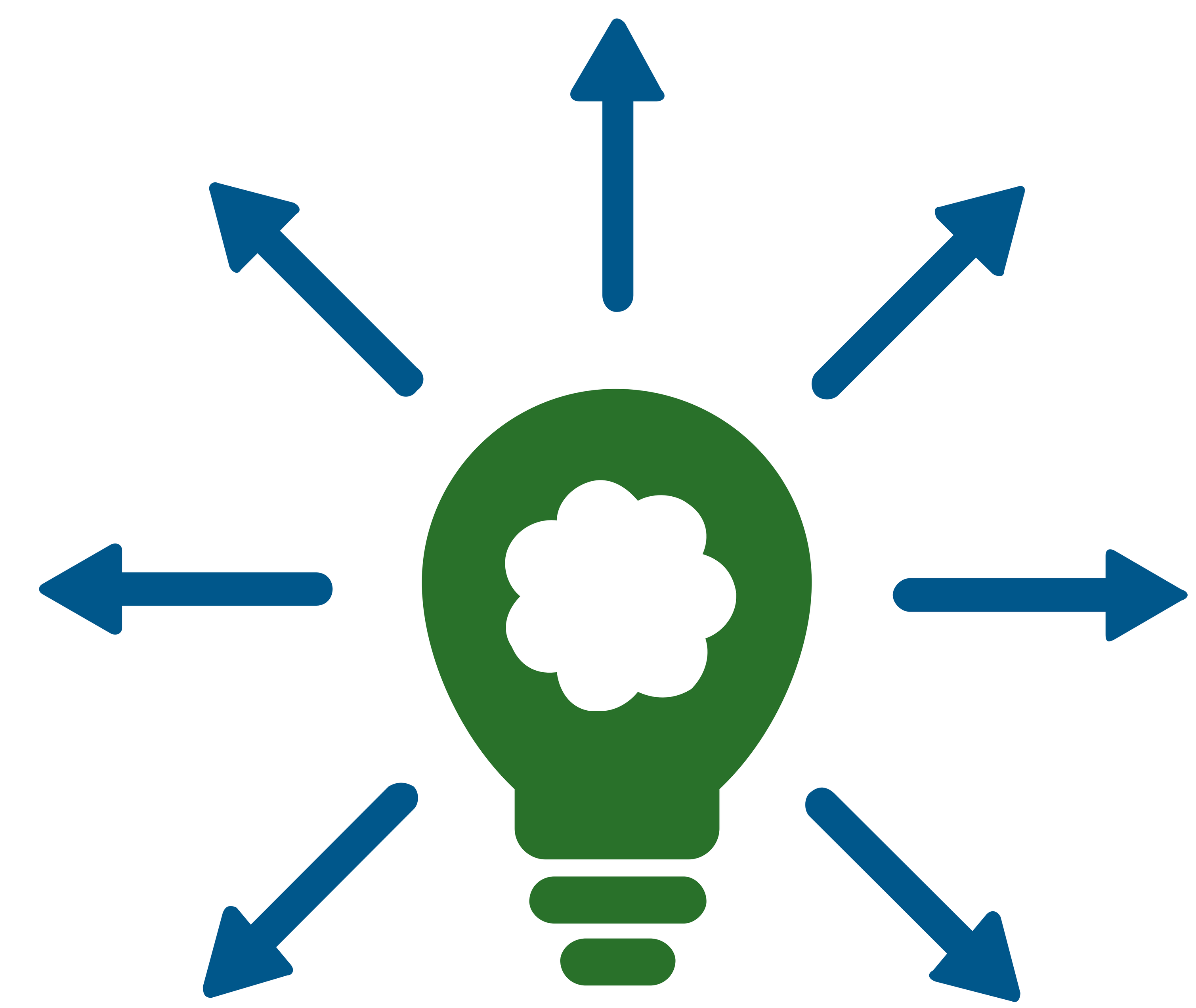
Our team is available to answer any questions you may have.

Water Supply Master Plan

Why are we updating the Water Supply Master Plan?

Draft problem and opportunity statement

The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.



The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.

The proposed implementation strategy must deliver, through to 2041, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

Do you have any suggested changes or additions to the draft problem and opportunity statement?

“The water is sick and people need to really fight for that water, to speak for that water, to love that water.”

Josephine Mandamin, Mother Earth Water Walker

https://m.facebook.com/story.php?story_fbid=3400290223331295&id=100000510517006&sfnsn=mo

Jospehine’s Water Song

Ne-be Gee Zah- gay- e- goo

Gee Me-gwetch -wayn ne- me – goo

Gee Zah Wayn ne- me- goo

Water, we love you.

We thank you.

We respect you.

The story of the Nibi (Water) song

Written by Doreen Day at the request of her grandson Mashkoonce. Doreen and her grandson gifted this to Josephine Mandamin, who gives permission for everyone to share this song and to sing it to water every day.

http://www.motherearthwaterwalk.com/?attachment_id=2244

The process

The Municipal Class Environmental Assessment (EA) process

Our WSMP update is completed every five years and follows the Municipal Class Environmental Assessment (EA) process. There are many opportunities to provide your input and comments throughout the process. Visit municipalclassea.ca to learn more about the Environmental Assessment process.

Review agency/ public consultation

Phase 1
Identify and describe problem(s) and opportunities

We are here

Review agency/ public consultation

Phase 2
Identify and evaluate alternative solutions and establish the preferred solution

Spring, Summer and Fall 2020

Provide comments, stay involved and help the City ensure a sustainable supply of water for our community!

You can help us ensure that we have enough water for the future as the city grows by participating in the WSMP update.

Fall 2020

Report
City of Guelph Water Supply Master Plan

The WSMP identifies the need for individual projects and the conceptual feasibility, including anticipated project triggers and impacts

Individual projects will proceed in accordance with remaining class Environmental Assessment requirements

Remaining approvals will be completed with a focus on addressing site specific environmental impacts, and the required consultation and documentation

Water Supply Master Plan

What is involved in the WSMP update?

From now until 2041

The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands. The 2019 WSMP update will re-examine Guelph's water supply and water demand and will make recommendations on how best to meet the community's water needs from now to 2041. The 2019 WSMP update will include the following steps:

Ongoing public engagement

1

Step 1:
Forecast future population and water demand

- consider anticipated growth in Guelph, both residential and industrial, commercial and institutional (ICI)
- develop water demand projections

2

Step 2:
Assess existing water supply capacity

- update the assessment of existing water well performance, maximum capacity and potential constraints for each water supply source
- compare existing capacity with the water demand projections

3

Step 3:
Develop and evaluate water supply alternatives

- develop and evaluate water supply alternatives, including water conservation and efficiency programs

4

Step 4:
Update the WSMP

- develop a WSMP update report, including recommendations and an implementation plan for defined projects

Get Involved
guelph.ca/wsmp | haveyoursay.guelph.ca

Master Planning

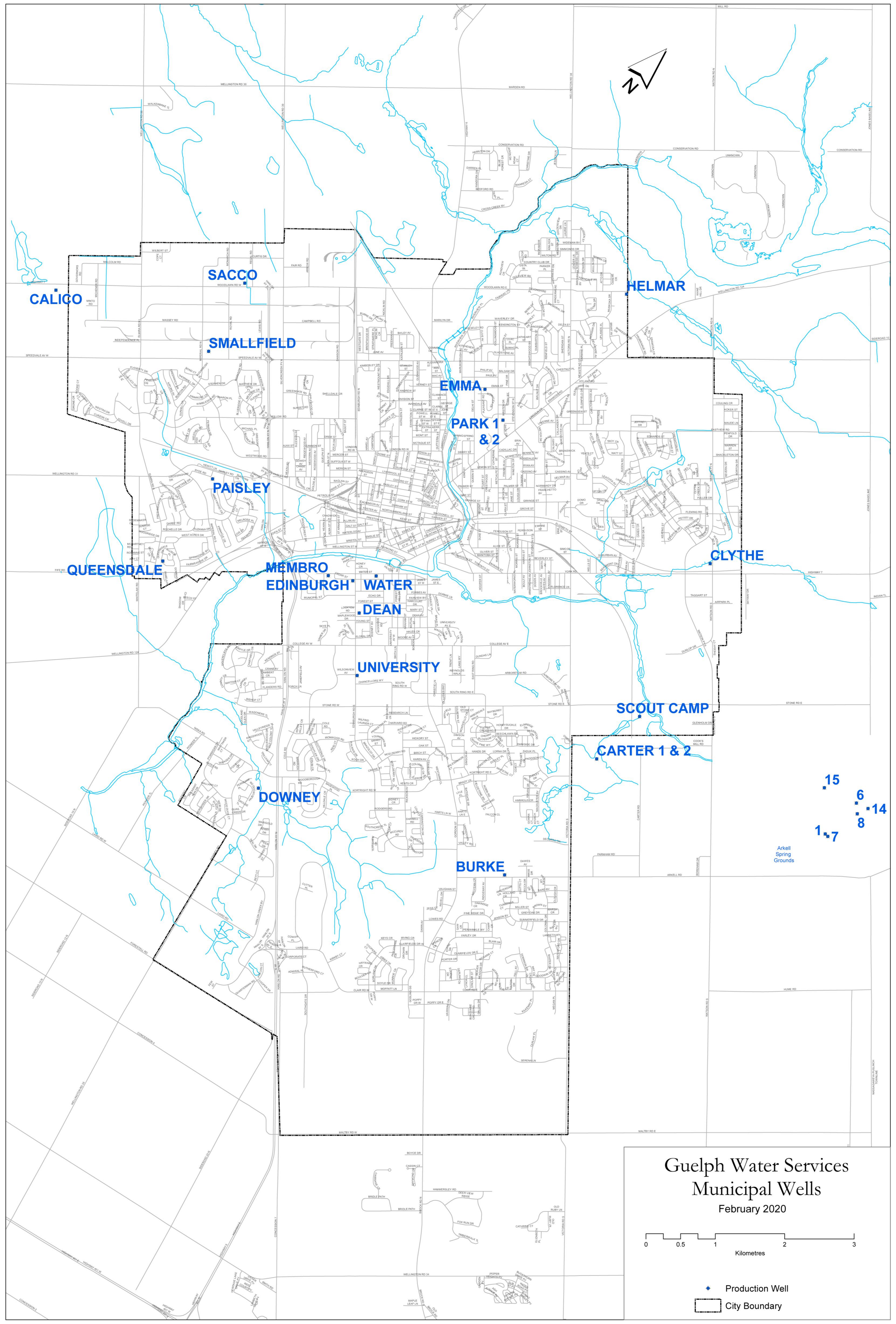
Guelph's water supply

A closer look at our current groundwater supply

Guelph has had a groundwater-based water supply since 1879. Our water is clean, safe and reliable, and meets the Ontario Drinking Water Quality Standards, which are among the strictest in the world.

Guelph's water supply system includes production wells primarily installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system:

- 25 production wells, 21 wells in continuous operation, four wells offline (due primarily to water quality concerns)
- a shallow groundwater system that collects spring water in the Arkell Spring Grounds
- a seasonally operated Eramosa River Intake and Recharge system. River water is pumped to an infiltration pond and trench where it is captured by the Arkell subsurface collector system. Availability is subject to river flow conditions (i.e., reduced capacity during summer when river flows are low)
- the 2014 WSMP identified a system capacity of approximately 84,000 cubic metres per day



Water Supply Master Plan

How much water do we need?

Estimating water supply capacity projections

The City's water supply capacity (pumping) requirements – i.e., what we need – are based on meeting peak day demand and providing system redundancy. In 2018, Guelph's:

- Average Day Demand was approximately 47,500 cubic metres per day
- Peak Day Demand was approximately 57,000 cubic metres per day

Therefore, with redundancy, Guelph currently requires approximately **71,250 cubic metres per day.** This is the same as roughly 29 Olympic-sized swimming pools.

Average Day Demand
is the total volume of water consumed in a year divided by 365 days.

Peak Day Demand
is the volume of water consumed on the highest water use day of the year; estimated as approximately 1.35 times Average Day Demand.

System Redundancy
is the amount of system capacity 'set aside' as contingency to allow for regular facility maintenance, and to safeguard against unplanned events. This is estimated as 1.5 times the Average Day Demand or an additional 10 per cent.

The WSMP update includes:

- developing population projections for residential and employment growth to 2041
    - will reflect Ontario 2019 Growth Plan (191,000 residents and 101,000 jobs by 2041)
- developing water demand projections for average daily use, peak daily use and system redundancy
    - will be based on City water consumption and production data from 2010 to 2018

Guelph's population is expected to grow by more than 35 per cent by 2041 – from 140,000 to 191,000 residents. As we update our WSMP to plan for the water supply requirements of 191,000 residents, we will consider sustainable solutions for both water supply and growth.

Get Involved
guelph.ca/wsmp | haveyoursay.guelph.ca

Master Planning

Water Supply Master Plan

Challenges we face

Challenges related to our water supply

A Tier 3 Water Budget and Local Area Risk Assessment identified the City's water supply as having a 'significant risk level' of not meeting the 2031 water demand under drought conditions

Whether a 10 per cent 'system redundancy' allowance is sufficient for ensuring security of our water supply

Understanding impacts from climate change and extreme weather events to our water supply

The existing Smallfield and Sacco wells are affected by contaminated sites and may need to be removed from consideration as City water supply options

Dolime Quarry – a proposal to close the quarry ahead of schedule and transfer water management to the City is under consideration

How surface water quantity and quality could be impacted if we pump more groundwater

Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?

Tier 3 Water Budget
As part of Ontario's Clean Water Act, the Tier 3 Water Budget provides an assessment of current and future sustainability of municipal drinking water systems. Growth, development and climate change impacts are considered.

Local Area Risk Assessment
As part of the Tier 3 Water Budget, a risk assessment determines an area where the municipal drinking water systems could be affected by other existing, new or expanded water takings.

Water Supply Master Plan

Proposed alternative solutions

A snapshot of the water supply alternatives being considered/ updated

Demand management/ efficiency programs

- Maintain commitment to our water conservation initiatives and 2016 Water Efficiency Strategy
- Determine range of realistic goals and cost for implementation
- Develop means to measure for effectiveness

Groundwater sources in and outside of city

- Improve and optimize the existing well supply system
- Restore offline wells with treatment
- Identify new potential water supply areas
- Consider Dolime Quarry as a source of municipal water supply

Local surface water sources

- Establish feasibility/ risks of surface water alternatives including aquifer storage and recovery system
- Assessment areas include: Guelph Lake/ Speed River and Eramosa River

Do nothing

- Undertake no improvements or changes
- Significant impact on the growth potential for the City would be expected with this alternative

Did we miss any alternatives?

Conservation is key!

Thanks to conservation efforts we now use about 20 per cent less water in Guelph than the average person in Ontario. One of our conservation goals is reducing the City's water use by 6.2 million litres per day by 2026.

Water Supply Master Plan

City of Guelph — Making a Difference

How will the proposed alternatives be evaluated?

A detailed evaluation of each proposed water supply alternative will be completed to assess the impact, if any, to the following:

Public health and safety
- Ability to meet provincial water quality requirements

Natural environment
- Potential effects to natural environment
- Potential impacts to water resources
- Potential impacts to natural heritage features
- Environmental management planning considerations

Social and cultural resources
- Land use impacts
- Short-term construction impacts
- Potential impacts from operations
- Implications of new/ expanded Source Protection areas

Additional considerations
- Alignment with City 2050 Net Zero Carbon emissions target
- Impacts on Indigenous peoples and values
- Climate adaptability and resiliency

Economic and financial considerations
- Estimated capital costs
- Estimated operations and maintenance costs, including energy consumption

Legal/ jurisdictional considerations
- Location of facility relative to city boundaries
- Land requirements
- Implementation of Source Protection Policies

Technological considerations
- Ability to implement and meet peak demand
- Constructability, schedule and timing, and maintaining operations during construction
- Water quality
- Allowance for future treatment needs
- Expandability
- Ability to respond to changes in regulations
- Ability to utilize existing infrastructure

Are there additional evaluation criteria we should include?

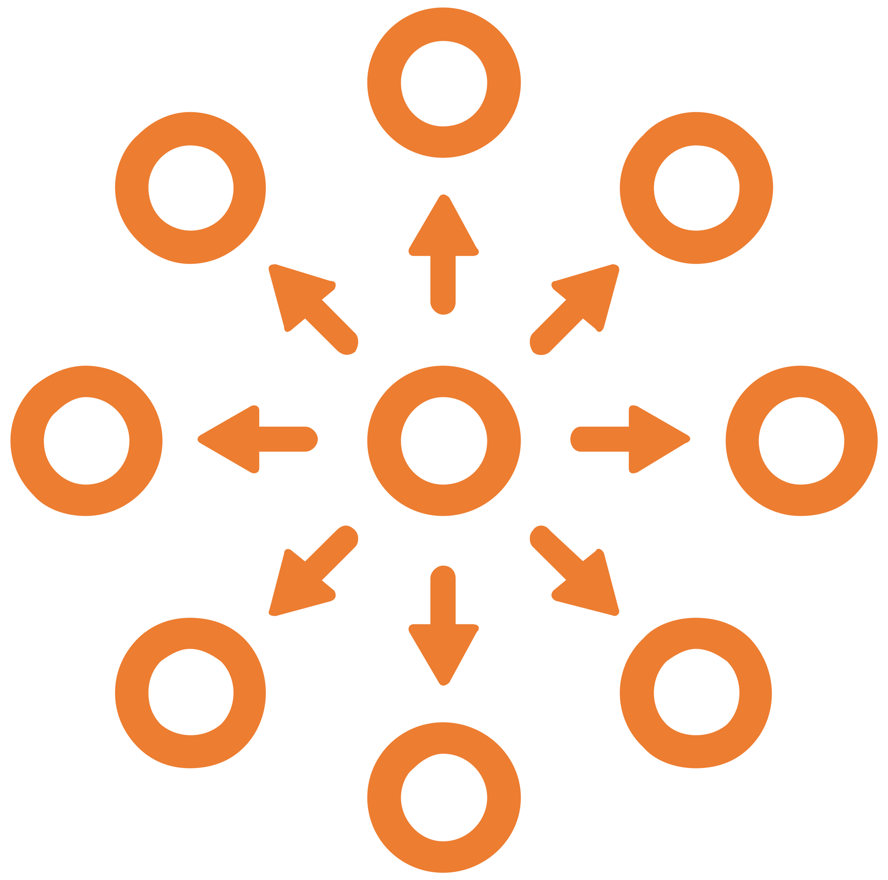
Aligning with other City project

If you are interested in the Water Supply Master Plan, you may also be interested in other water master planning projects that are underway at the City.

These include:

- Wastewater and Biosolids Master Plan;
- Water and Wastewater Servicing Master Plan; and
- Stormwater Master Plan.

These projects are being conducted to support the City's Official Plan Update to be completed in 2021.



Watch the City news for information on community engagement for these projects.

Next Steps

Thank you for your interest in learning about the City of Guelph’s WSMP update.

Get involved

Your feedback is an important part of the WSMP update.

- Register, join the conversation and share thoughts at haveyoursay.guelph.ca.
- Read about our progress. Project information will be posted on our project page at guelph.ca/wsmp.
- Join our mailing list. Send us your name to the contacts below and provide your address (email or post mail), and we’ll keep you informed.
- Follow the conversation on Twitter (twitter.com/cityofguelph) and Facebook (facebook.com/cityofguelph).

Contact us with any additional comments or questions at any time:

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260, ext. 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

Please remember to drop off your completed comment form in the comment box.

City of Guelph Territorial Acknowledgement

As we gather, we are reminded that Guelph is situated on treaty land that is steeped in rich indigenous history and home to many First Nations, Inuit and Métis people today.

As a City we have a responsibility for the stewardship of the land on which we live and work.

Today we acknowledge the Mississaugas of the Credit First Nation of the Anishinaabek Peoples on whose traditional territory we are meeting.

Open house #1
Feedback Form

We want to hear your ideas, suggestions and opinions! Thank you for attending and participating in the first community open house for the City of Guelph Water Supply Master Plan (WSMP) on February 13, 2020. Please complete this feedback form so your valued input may be considered and documented as part of the Municipal Class Environmental Assessment (EA).

- Name:
- Mailing address:
- Email address:
- Telephone:

Future communications
How would you prefer to receive information about this study in the future?

- Email (please provide email above)
- I do not wish to receive further information
- Regular Mail
- Are there better ways to let you know about future meetings?

How did you hear about the open house? Please check all that apply.

- Advertisement
- Received the notice via email
- Project website
- Other, please specify:

What parts of this open house were of the most interest to you? (please check all that apply)

- Viewing the information displays
- Having the opportunity to meet and talk directly with the project team
- Providing feedback regarding the WSMP
- Other, please specify:

Draft problem and opportunity statement

The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.

The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.

The proposed implementation strategy must deliver, through to 2041, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

1. **Do you have any suggested changes or additions to the draft problem and opportunity statement?**

Challenges we face

- A Tier 3 Water Budget and Local Area Risk Assessment identified the City's water supply as having a 'significant risk level' of not meeting the 2031 water demand under drought conditions
- Whether a 10 per cent 'system redundancy' allowance is sufficient for ensuring security of our water supply
- Understanding impacts from climate change and extreme weather events to our water supply
- The existing Smallfield and Sacco wells are affected by contaminated sites and may need to be removed from consideration as City water supply options
- DolimeQuarry –a proposal to close the quarry ahead of schedule and transfer water management to the City is under consideration
- How surface water quantity and quality could be impacted if we pump more groundwater

2. **Are there other unique challenges that Guelph faces and should be considered with regards to our water supply?**

Proposed alternative solutions

Demand management/ efficiency programs

- Maintain commitment to our water conservation initiatives and 2016 Water Efficiency Strategy
- Determine range of realistic goals and cost for implementation
- Develop means to measure for effectiveness

Groundwater sources in and outside of city

- Improve and optimize the existing well supply system
- Restore offline wells with treatment
- dentify new potential water supply area
- Consider Dolime Quarry as a source of municipal water supply

Local surface water sources

- Establish feasibility/ risks of surface water alternatives including aquifer storage and recovery system
- Assessment areas include: Guelph Lake/ Speed River and Eramosa River

Do nothing

- Undertake no improvements or changes
- Significant impact on the growth potential for the City would be expected with this alternative

3. **Did we miss any alternatives?**

Evaluation criteria

Public health and safety

- Ability to meet provincial water quality requirements

Natural environment

- Potential effects to natural environment
- Potential impacts to water resources
- Potential impacts to natural heritage features
- Environmental management planning considerations

Social and cultural resources

- Land use impacts
- Short-term construction impacts
- Potential impacts from operations
- Implications of new/ expanded Source Protection areas

Economic and financial considerations

- Estimated capital costs
- Estimated operations and maintenance costs, including energy consumption

Legal/ jurisdictional considerations

- Location of facility relative to city boundaries
- Land requirements
- Implementation of Source Protection Policies

Technological considerations

- Ability to implement and meet peak demand
- Constructability, schedule and timing, and maintaining operations during construction
- Water quality
- Allowance for future treatment needs
- Expandability
- Ability to respond to changes in regulations
- Ability to utilize existing infrastructure

Additional considerations

- Alignment with City 2050 Net Zero Carbon emissions target
- Impacts on Indigenous peoples and values
- Climate adaptability and resiliency

4. **Are there additional evaluation criteria we should include?**

We appreciate the time you have taken to learn more about our plans and contribute your input!

Please submit this form at the welcome table before you leave. You can also submit your feedback online by registering at haveyoursay.guelph.ca

Other ways to get involved

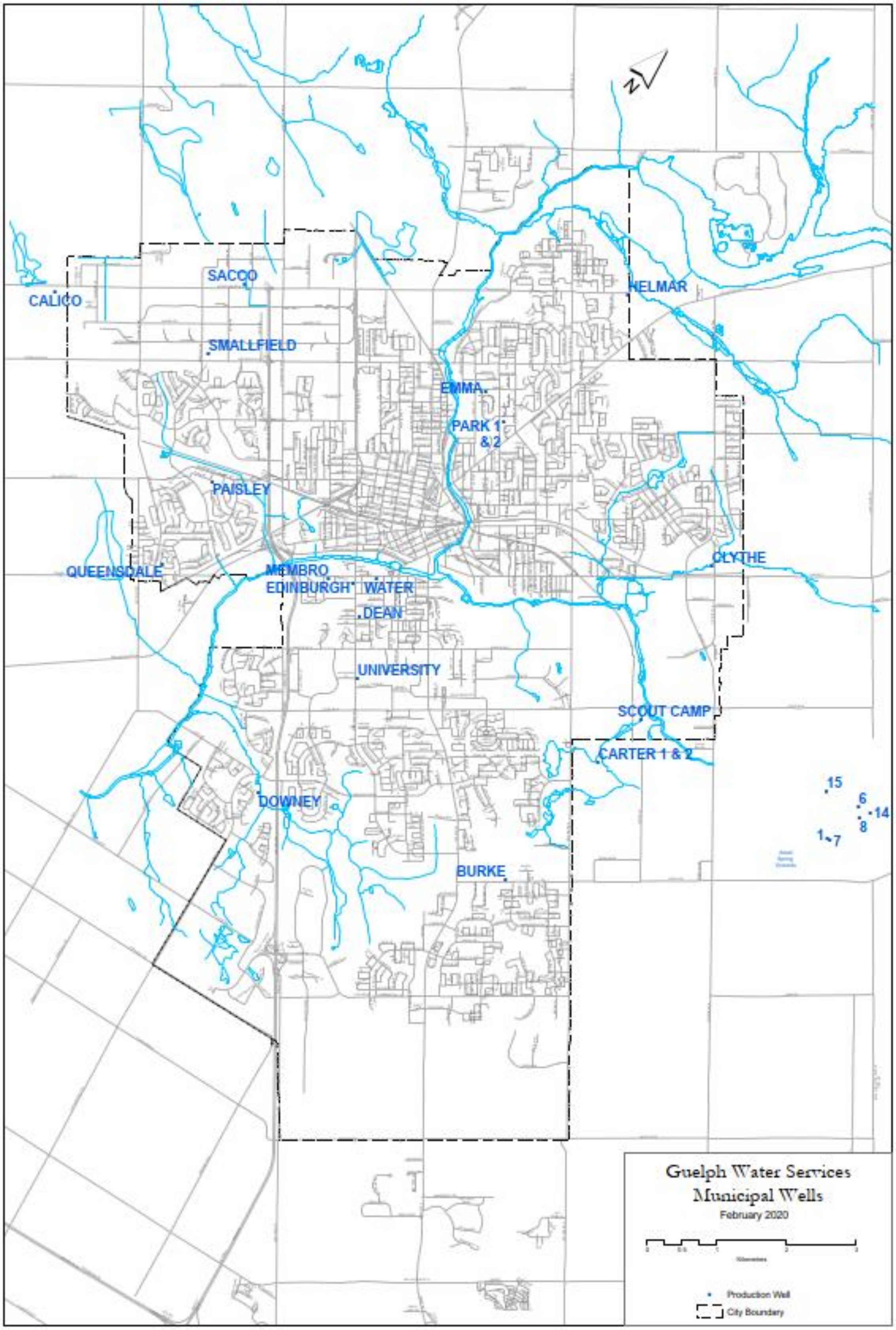
- Read about our progress. Project information will be posted on our project page at guelph.ca/wsmp
- Join our mailing list. Send us your name to the contacts below and provide your address (email or post mail), and we'll keep you informed.
- Follow the conversation on Twitter (twitter.com/cityofguelph)and Facebook (facebook.com/cityofguelph).

Contact us with additional comments or questions at any time:
Dave Belanger
Water Supply Program Manager
City of Guelph
519-822-1260 x 2186 / dave.belanger@guelph.ca

Matt Alexander
Project Manager, Senior Hydrogeologist
AECOM Canada Ltd.
519-840-2223 / matthew.alexander@aecom.com

Notice of collection: Personal information, as defined by the Municipal Freedom of Information and Protection of Privacy Act (MFIPPA) is collected under the authority of the Municipal Act, 2001, and in accordance with the provisions of MFIPPA. Personal information on this form will be used to send out electronic project updates related to the 2019 Water Supply Master Plan update. If you have questions about this collection; use, and disclosure of this information, contact the City of Guelph's Access, Privacy and Records Specialist at 519-822-1260 x 2349 or Jennifer.Slater@guelph.ca

Guelph Water Services Municipal Wells Map



Public Notice

Join us September 29 for the second Water Supply Master Plan virtual open house

Help guide the City's Water Supply Master Plan

The City is updating the Water Supply Master Plan (WSMP), the City's long-term plan for ensuring we sustain our drinking water sources and services as our community grows.

The WSMP update includes reviewing our current drinking water sources and identifying options for more sources, from now until 2051.

Our first open house was held in February 2020 and we would like to share our progress since then.

Have your say

We need your help! The City will ask the community to share feedback to help inform how we will manage our water supply as our community grows. We want your input on the project progress, and upcoming developments. The City is hosting a virtual open house to discuss the WSMP update and future plans. The open house will include a presentation and opportunity for questions and answers.

What: 2021 Water Supply Master Plan update virtual open house
Where: Online via Teams Meeting
When: September 29 from 6:30 p.m. – 8:30 p.m.

How to register in advance

Contact Tracey McKenna at tracey.mckenna@aecom.com or 416-605-6678 to register in advance with your name, email address and telephone number (if you are joining by telephone only) and a meeting invite will be provided. Please let us know if you have any accessibility requirements. A direct access link and phone number will also be uploaded on the project engagement page https://www.haveyoursay.guelph.ca/wsmp the day of the open house. We welcome any questions submitted in advance. You can also contact Dave Belanger or Matthew Alexander (information below)

Join us to learn about and share your thoughts on:

- the objectives and overview of the WSMP update
- the projected water supply requirements to 2051
- the City's current drinking water supply
- results and recommendation(s) from the evaluation of alternatives for meeting our drinking water supply needs
- next steps as we update the WSMP

Other ways to get involved

Your feedback is an important part of the WSMP update.

- **Register, join the conversation and share thoughts** at https://www.haveyoursay.guelph.ca/wsmp.
- **Read about our progress**. Project information will be posted on our project page at guelph.ca/wsmp.
- **Join our mailing list**. Send us your name and provide your address (email or post mail), and we'll keep you informed.
- **Follow the conversation on Twitter and Facebook**.

For more information

Please visit guelph.ca/wsmp for the latest information about the WSMP update.

To provide your comments, request additional information, be added to the project mailing list, or if you require this notice to be provided in an alternative format as per the Accessibility for Ontarians with Disabilities Act (2005), please contact:

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
519-822-1260 x 2186
Dave.Belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
Matthew.Alexander@aecom.com

This notice was first issued on September 10, 2021.

Open house #2 advertisements

City of Guelph

guelph.ca/news

City News

Notice of the passing of a zoning bylaw by the City of Guelph

Guelph City Council passed **By-law (2021)–20626, for property at 29-31 Fountain Street West** (OZS21-005) on September 13, 2021 under section 34 of the Planning Act, R.S.O. 1990, c. P.13, as amended.

An explanation of the purpose and effect of the bylaw as well as a key map of the lands are included. For more information regarding the zoning amendment, contact the Planning Services at **519-837-5616**, email at **planning@guelph.ca** or in person at Guelph City Hall. (8:30 a.m. to 4:00 p.m., Monday to Friday)

Only individuals, corporations and public bodies may appeal a bylaw to the Ontario Land Tribunal (OLT). A notice of appeal may not be filed by an unincorporated association or group. However, a notice of appeal may be filed in the name of an individual who is a member of the association or the group on its behalf. An appeal must be filed with the City Clerk **no later than October 13, 2021 at 4 p.m.** The appeal must set out the reasons for the appeal and be accompanied by the **fee of $1,100.00, paid by credit card, certified cheque or money order** payable to the Minister of Finance. The forms are available from ServiceGuelph, Guelph City Hall or on OLT's website, **www.olt.gov.on.ca**.

No person or public body will be added as a party to the hearing of the appeal of the decision unless, before the bylaw was passed, the person or public body made oral submissions at a public meeting or written submissions to the council or, in the opinion of the LPAT, there are reasonable grounds to add the person or public body as a party.

Any and all written submissions relating to this application that were made to City Council before its decision and any and all oral submissions related to this application that were made at a public meeting, held under the Planning Act, have been, on balance, taken into consideration by City Council as part of its deliberations and final decision on this matter.

DATED at the City of Guelph September 23, 2021.

Stephen O'Brien
City Clerk
City of Guelph, 1 Carden Street, Guelph, ON N1H 3A1
clerks@guelph.ca
519-837-5603

By-law (2021)–20626

Explanation of purpose and effect and key map

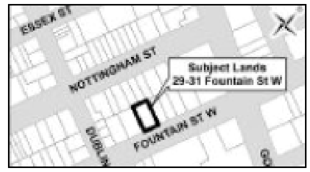
By-law (2021)–20626 has the following purpose and effect:

This bylaw authorizes a zoning bylaw amendment affecting the lands municipally known as 29-31 Fountain Street West, City of Guelph from the "Residential Single Detached" (R.1B) Zone to the "Residential Semi-Detached/Duplex" (R.2) Zone to recognize the existing semi-detached dwelling and allow for future consent applications to divide the subject lands into separate parcels.

The proposed zoning amendment was considered by City Council at a public meeting held on June 14, 2021

For more information, call Planning Services at **519-837-5616 extension 2492**.

The key map showing the location of the subject lands to which By-law (2021)–20626 applies:



Meeting notice

Join us September 29 to talk about the future of drinking water in Guelph

Help guide the City's Water Supply Master Plan

The City is updating the Water Supply Master Plan, the City's long-term plan for ensuring we sustain our drinking water sources and services as our community grows.

This master plan update includes reviewing our current drinking water sources and identifying options for more sources from now until 2051.

Our first open house was held in February 2020. We used your input to guide our plans and now it's time to share what we've learned and what we're recommending.

Have your say

We want your thoughts on potential drinking water sources we've evaluated with criteria you told us was important. Join us for a virtual open house to learn about Guelph's Water Supply Master Plan, our current drinking water sources, our expected needs to 2051 and our recommendations for meeting them, what the next steps are. This live, virtual open house includes a presentation and an opportunity to ask questions.

Water supply master plan update virtual open house

September 29
6:30–8:30 p.m.
Online via Teams Meeting

Register in advance

To register for this live, virtual event, provide your name, email address and telephone number (if you are joining by telephone only) to Tracey McKenna at **tracey.mckenna@aecom.com** or **416-605-6678**.

Please include any accessibility requirements you have and feel welcome to submit questions in advance.

The link to the live event will also be posted at **haveyoursay.guelph.ca/wsmp** the day of the open house.

Other ways to get involved

- Join the conversation and share your thoughts at **haveyoursay.guelph.ca/wsmp**
- Read about our progress. Project information is posted and updated at **guelph.ca/wsmp**
- Join our mailing list by sending your name and address (email or post mail) to **dave.belanger@guelph.ca**
- Follow the City on Twitter and Facebook

For more information

Visit **guelph.ca/wsmp** for the latest information about the Water Supply Master Plan update.

To provide your comments, request additional information, be added to the project mailing list, or if you require this notice to be provided in an alternative format as per the Accessibility for Ontarians with Disabilities Act (2005), please contact:

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager, Environmental Services
City of Guelph
519-822-1260 extension 2186
dave.belanger@guelph.ca

Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
226-821-4906
matthew.alexander@aecom.com

This notice was first issued on September 16, 2021.

Follow us on **twitter @cityofguelph**

Accessible formats available by calling **519-822-1260** or **TTY 519-826-9771**

Subject line: Guelph Water Supply Master Plan Virtual Open House #2
To: Attendees
Date: September 28, 2021

Good afternoon,

The City of Guelph is updating the 2014 Water Supply Master Plan to review our water supply sources and identify priorities, including sustainable municipal water supply options, from now until 2051. The Open House will feature a presentation about the work done to date along with a question and answer period with the project team.

For more information about how to use Teams, we've attached a Best Practices guide for your reference.

For more information visit: https://guelph.ca/plans-and-strategies/water-supply-master-plan/

Thanks!

Master Planning

Welcome

Water Supply Master Plan Open House #2

September 29, 2021

6:30 p.m. to 8:30 p.m.

We will begin shortly. Please make sure you are muted.

For your convenience, you will find a chat window on the screen where you can type in a question at any time. We will address the questions at the end of the presentation.

Territorial acknowledgement

- As we gather, we are reminded that Guelph is situated on treaty land that is steeped in rich indigenous history and home to many First Nations, Inuit and Métis people today.
- As a City we have a responsibility for the stewardship of the land on which we live and work.
- Today we acknowledge the Mississaugas of the Credit First Nation of the Anishinaabek Peoples on whose traditional territory we are meeting.

Housekeeping

- We kindly ask attendees to be muted throughout the presentation until the Question and Answer portion of today's session
- If you have any technological issues, please also use the chat window
- All materials and a survey will be sent out to attendees following the open house
- This open house is being recorded

Agenda

- 6:30 p.m. – 8:30 p.m.
- Introductions and purpose
- Presentation
- Questions and answers

Introductions

Dave Belanger
Water Supply Program Manager
WSMP Project Manager
City of Guelph

Matthew Alexander
Project Manager
AECOM Canada Ltd.

Bill Gauley
Water Conservation and
Efficiency Lead
Gauley Associates Ltd.

Introduction

The City is updating the 2014 Water Supply Master Plan (WSMP), the City's long-term plan for ensuring we sustain our drinking water sources and services as our community grows.

- The WSMP update includes reviewing our current water supply sources and identifying priorities for a sustainable municipal water supply from now until 2051.
- This is the second open house to provide you with an opportunity to formally participate in the Master Plan process.

Open house purpose

The purpose of this open house is to learn about and share your thoughts on:

- the potential alternative water supply sources that have been identified
- the detailed evaluation of the alternatives
- the preferred solution(s) that has been identified

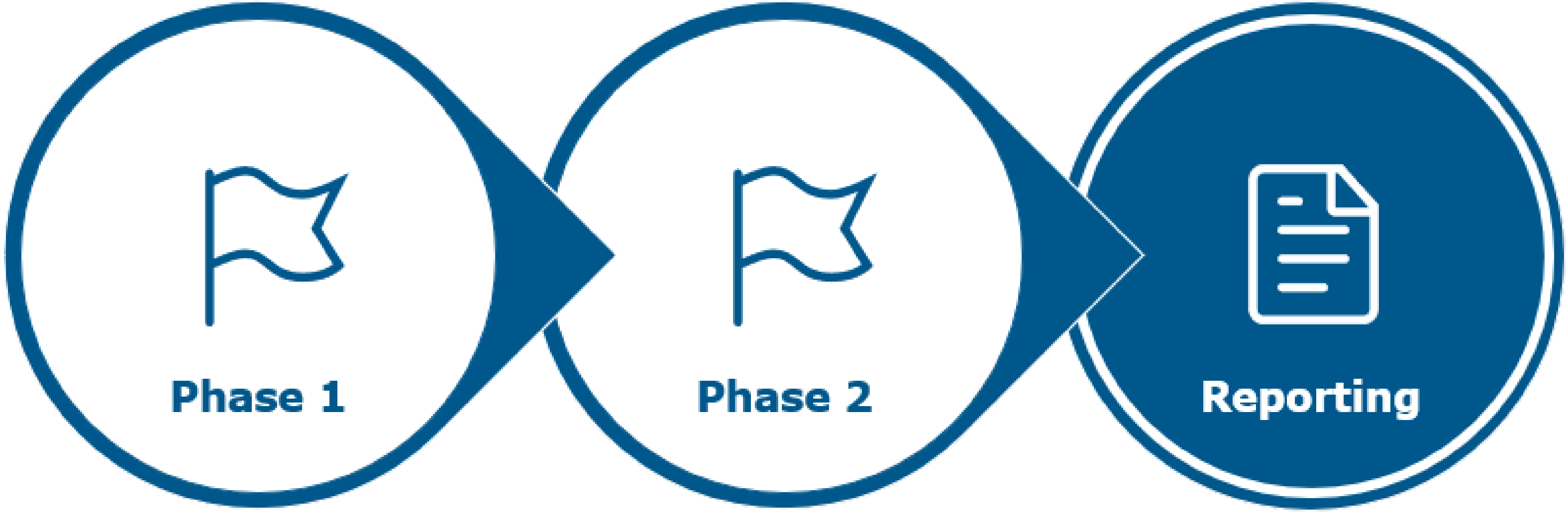
Master plan challenge and opportunity statement

- The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply
- The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers

Master plan challenge and opportunity statement (cont'd)

- The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting future demand to 2038
- It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects
- The proposed implementation strategy must deliver, through to 2051, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised

The Municipal Class Environmental Assessment process



WE ARE HERE

Fall 2021

What is involved in the WSMP Update

Ongoing Public Engagement

Task 1

Forecast future population and water demand

- consider anticipated growth in Guelph, both residential and industrial, commercial and institutional (ICI)
- develop water demand projections to 2051

Task 2

Assess existing water supply capacity

- update the assessment of existing municipal water wells performance, maximum capacity and potential constraints for each water supply source
- compare existing capacity with the water demand projections

Task 3

Develop and evaluate water supply alternatives

- develop and evaluate water supply alternatives, including water conservation and efficiency programs

Task 4

Update the WSMP

- develop a WSMP update report, including recommendations and an implementation plan for defined projects

Public consultation

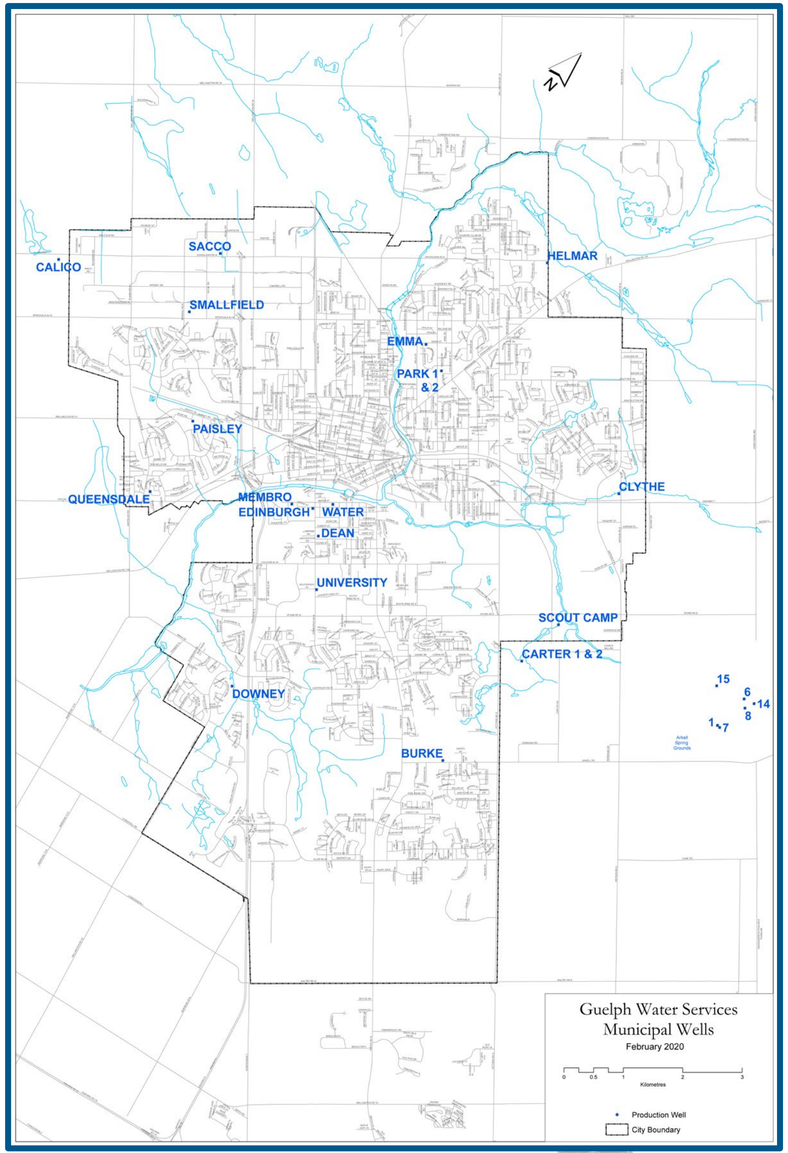
- One in-person and one virtual Open House
- Project overview meetings with Six Nations of the Grand River and Mississaugas of the Credit First Nation (October 2021)
- Project information and updates provided to the above communities and the Haudenosaunee Confederacy of Chiefs
- Two Agency & Municipality Workshops
- Three Community Liaison Group Meetings
- Two Water Conservation & Efficiency Public Advisory Committee Meetings
- Project information provided at other City events:
  - Guelph Wellington Development Association and Guelph and District Home Builders' Association
  - Our Community, Our Water Open House

Consultation feedback

- Prioritizing conservation
- Protecting the natural environment
- Managing growth and development
- Controlling groundwater impacts from large water users
- Monitoring emerging contaminants
- Limiting impacts to aquatic and terrestrial wildlife
- Prioritize supply within City before sources within Township(s)
- Consider potential climate change impacts on water supply
- Valuing the agency of water

Guelph’s water supply

- Groundwater-based water supply since 1879
- Includes production wells primarily installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system:
  - 25 production wells, 21 wells in continuous operation, four wells offline (due primarily to water quality concerns)
  - a shallow groundwater system that collects spring water in the Arkell Spring Grounds
  - a seasonally operated Eramosa River Intake and Recharge system
  - an updated assessment identified a system capacity of approximately 79,000 cubic metres per day



How much water do we need?

The WSMP update:

- developed population projections for residential and employment growth to 2051
  - population projections provided by Ontario 2020 Growth Plan – 203,000 residential and 116,000 employment
- developed water demand projections for average daily use, maximum daily use and system redundancy
  - City water consumption and production data from 2010-2019 were reviewed to develop projections

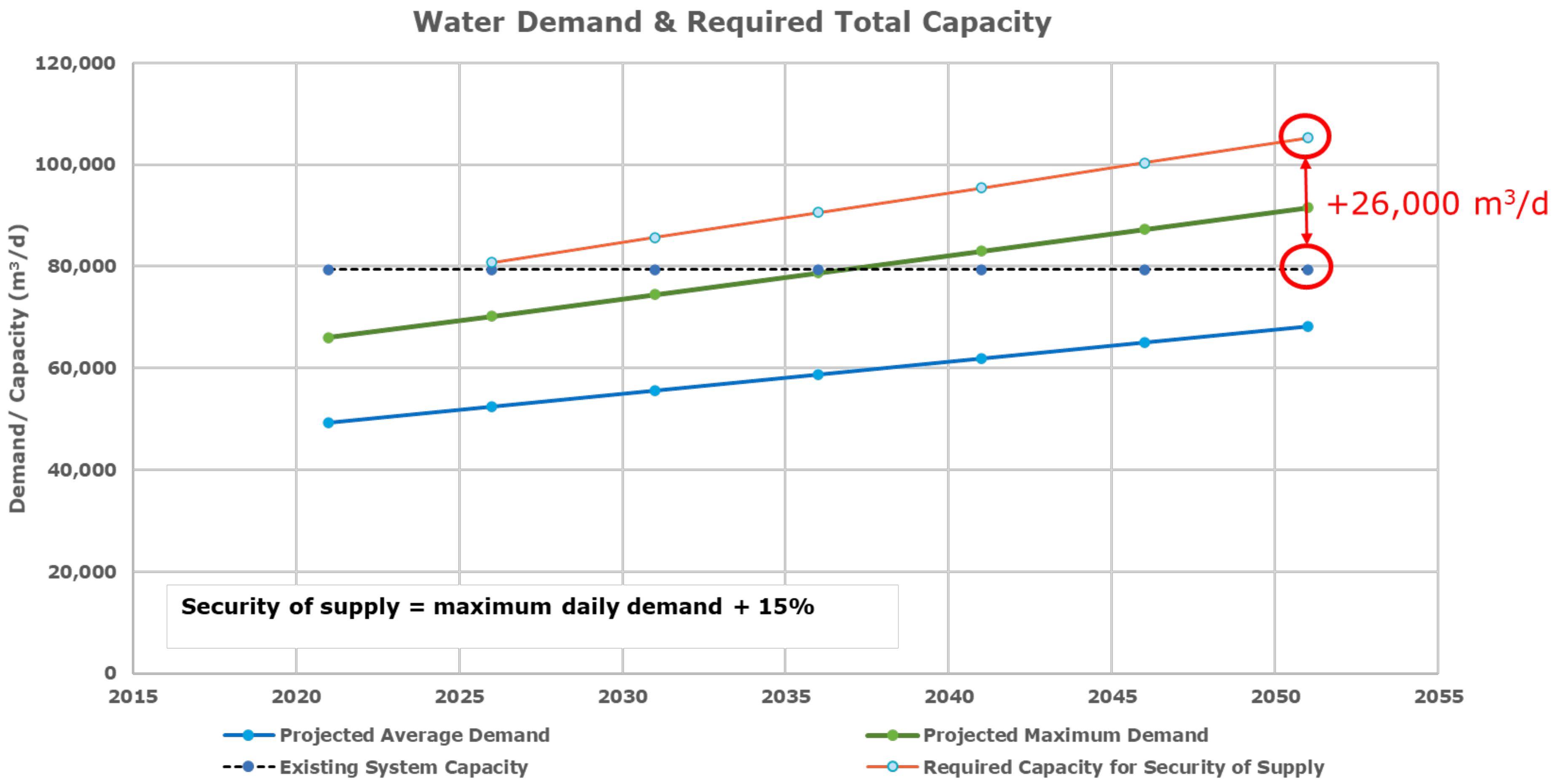
How much water do we need?

Average day demand is the total volume of water consumed in a year divided by 365 days. This is estimated to be 68,300 m^3/day in 2051.

Maximum day demand is the volume of water consumed on the highest water use day of the year; estimated as approximately 1.34 times Average Day Demand. This is estimated to be 91,500 m^3/d in 2051.

System redundancy is the amount of system capacity ‘set aside’ as contingency to address uncertainty in planning process, to accommodate regular facility maintenance, and to safeguard against unplanned events. This is estimated as an additional 15%.

How much water do we need?



Identified alternative solutions

The water supply alternatives considered in the evaluation

Demand management/ efficiency and water reuse programs

- Maintain commitment to our water conservation initiatives and 2016 Water Efficiency Strategy
- Review success of programs since 2014 and evaluate trends in other jurisdictions
- Determine range of realistic goals and cost for implementation

Groundwater sources in and outside of city

- Improve and optimize the existing well supply system
- Restore offline sources with treatment
- Identify new potential groundwater supply areas, including the Dolime Quarry
- Install aquifer storage and recovery wells

Identified alternative solutions

The water supply alternatives considered in the evaluation

Local surface water sources

- Establish feasibility/ risks of surface water alternatives including aquifer storage and recovery system
- Assessment areas include: Guelph Lake/ Speed River and Eramosa River

Do nothing/ limit growth

- Undertake no improvements or changes
- Significant impact on the growth potential for the City would be expected with this alternative

WSMP study area

- New water supply sources were limited to an approximately 5-kilometer area around the City to align with a desire to maintain local sustainability

Water Conservation and Efficiency Alternative

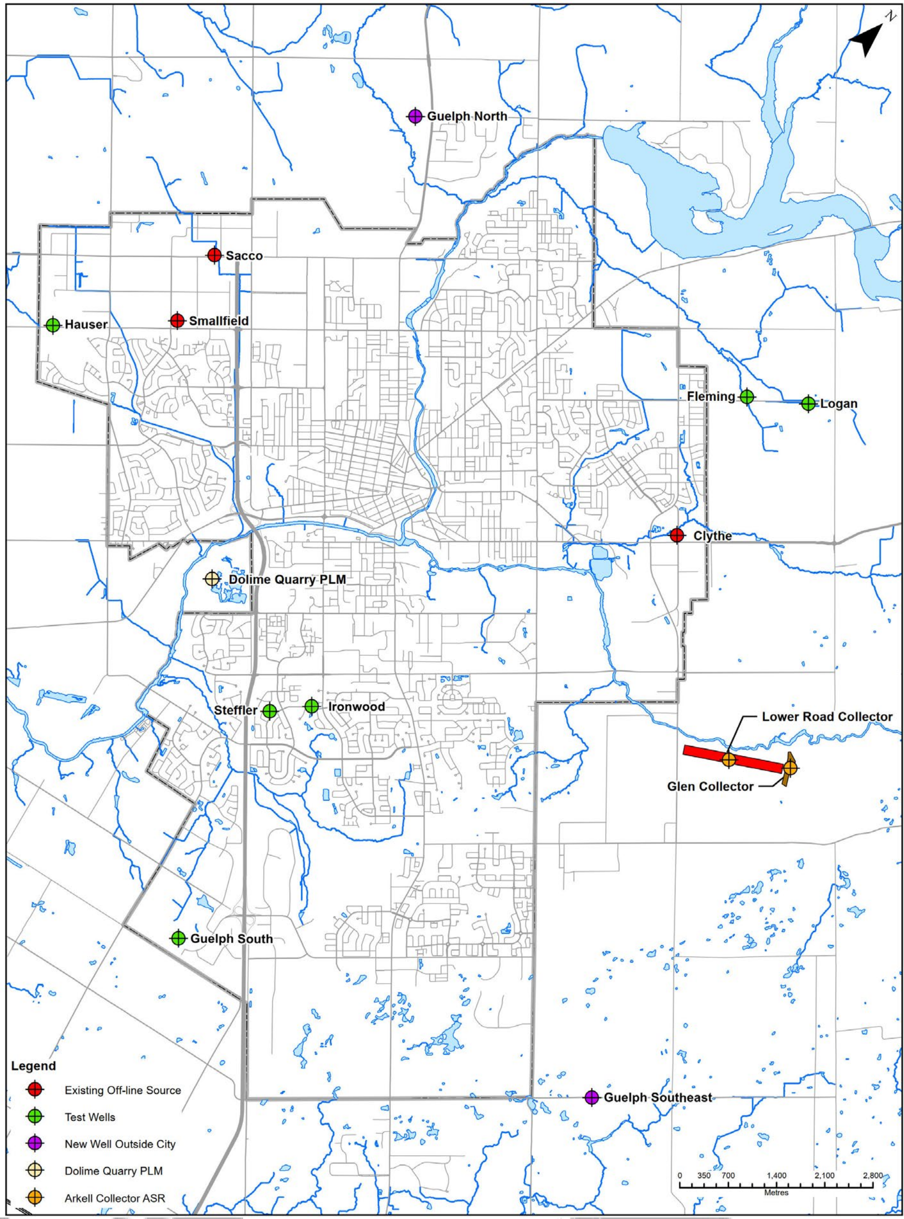
- Four scenarios identified for alternative
- High level of detail for evaluation purposes; detailed programs will be developed through Water Efficiency Strategy
- Demand reduction targets and estimated cost established for each scenario

Scenario	Description	Reduction in 2051 Demand	Estimated Cost ($/m^3/day)
1	Baseline – Cease Non-mandatory Programs	No reduction	No cost
2	Current Level of Effort	4,400 m^3/day	$2,600
3	Focus on High Demand Customers	2,200 m^3/day	$2,100
4	Current Level of Effort with Water Reuse	4,900 m^3/day	$3,000

Groundwater Alternative

- Five categories of groundwater sources evaluated
- Groundwater flow model used to evaluate amount of water available and potential impacts

Water Source	Description	Location
Existing off-line source	Three supply wells, one groundwater collector	In City and City-owned land
Test wells	Six existing test wells	In City and City-owned land
Quarry Pond Level Management	Dolime quarry water management strategy	Borders City, annexation process in progress
Arkell Collectors Aquifer Storage and Recovery	Treat excess water from collectors to potable standard, inject into deep aquifer for later use	In City and City-owned land
New Wells	Hypothetical wells outside of City	Outside City (north and southeast)



Surface Water Alternative

- Guelph Lake as surface water supply under two scenarios:
  - Water Treatment Plant (WTP) to potable water standards; and
  - WTP with excess water for Aquifer Storage and Recovery
- Grand River Conservation Authority analysis of long-term flow data to identify amount of water available for supply
- Considers down stream flow requirements

Evaluation criteria

First Nations, Métis and Inuit Peoples

- Effect on Indigenous values, cultural and Traditional use

Built Environment

- Potential effect on existing/ planned structures
- Potential effects on private and municipal wells

Natural Environment

- Potential effects to natural environment
- Potential impacts to water resources
- Potential impacts to natural heritage features
- Environmental management planning considerations

Evaluation criteria

Social and Cultural Environment

- Land use impacts
- Short-term construction impacts
- Potential impacts from operations
- Cultural heritage/ archaeology impacts
- Ability to meet growth targets
- Public acceptance

Economic and Financial Considerations

- Estimated capital costs
- Estimated operations and maintenance costs, including energy consumption

Legal/ Jurisdictional Considerations

- Location of facility relative to city boundaries
- Land requirements
- Implementation of Source Protection Policies

Evaluation criteria

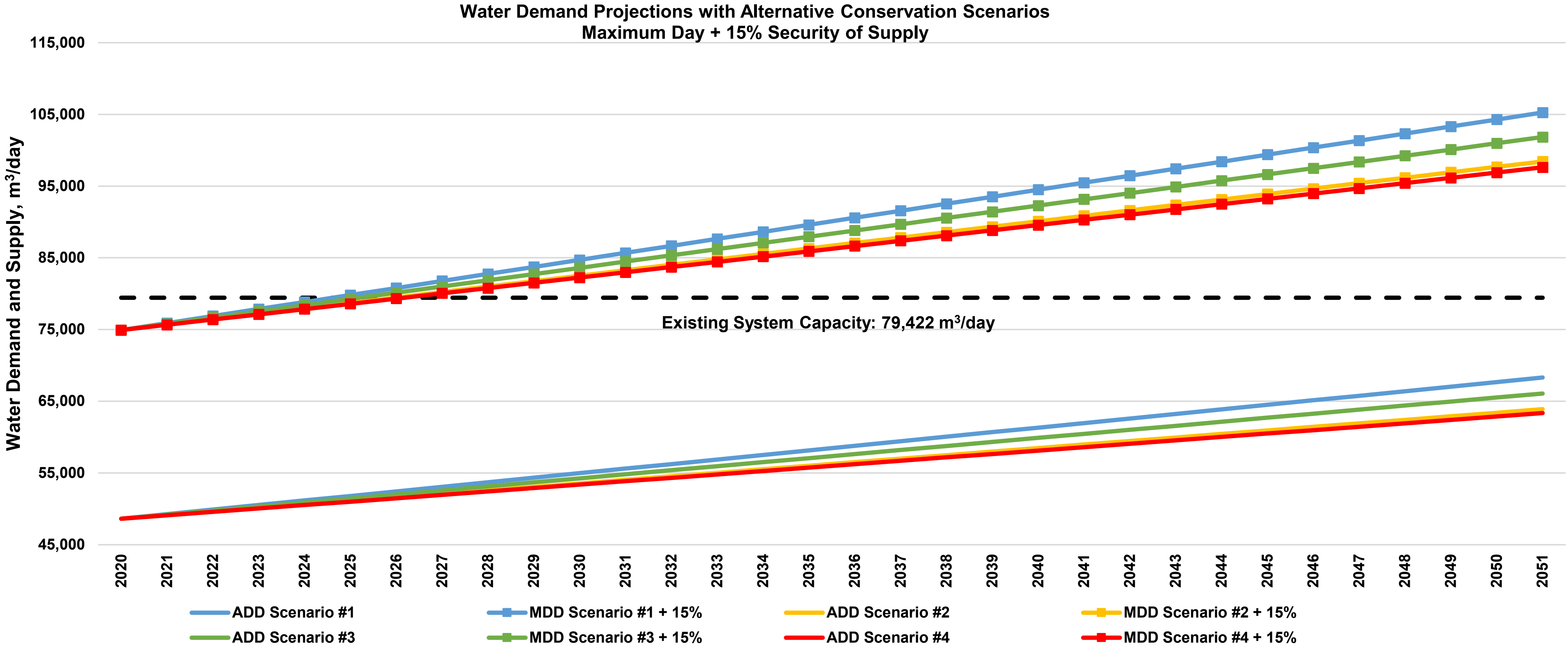
Technological Considerations

- Ability to implement and meet maximum demand
- Constructability of alternative
- Water treatment requirements (current and future)
- Expandability of facility
- Ability to respond to changes in regulations
- Ability to utilize existing infrastructure
- Approval requirements

Detailed alternatives evaluation – conservation and efficiency

Scenario	Description	Key Evaluation Considerations	Outcome
1	Baseline – Cease Programs	• Does not achieve demand reductions • Inferred low public acceptance • No associated costs	• Not preferred
2	Current Level of Effort	• Moderate demand reduction • Inferred high public acceptance • Minor changes to existing/ planned buildings • Low to moderate costs relative to supply alternatives	• Preferred as part of short-term strategy
3	Focus on High Demand Customers	• Least demand reduction • Inferred high public acceptance • Minor changes to existing/ planned buildings • Low costs relative to supply alternatives	• Preferred as part of short to mid-term strategy
4	Current Level of Effort with Water Reuse	• Most demand reduction • Inferred moderate public acceptance (some education may be required) • Minor changes to existing/ planned buildings, moderate impact to WWTP infrastructure • Reuse options can require regulatory approvals • Moderate to high costs relative to supply alternatives	• Preferred as part of long-term strategy

Conservation/ efficiency alternative summary



Detailed alternatives evaluation – off-line municipal sources

Groundwater Source	Description	Key Evaluation Considerations	Outcome
Existing Off-Line Sources	Wells: Clythe, Sacco, Smallfield, Lower Road Collector (LRC)	• High certainty of available water volume, water quality • Some infrastructure in place; upgrades required • Past operation demonstrates low environmental impacts, some additional study required • Risk of contaminant movement–potential environmental and legal issue; remediation of contamination prior to 2051 is unlikely; returning well to service not currently considered feasible • Low to high costs	• Preferred as part of overall solution • Clythe Class EA complete, can be implemented in short-term • Lower Road Collector to be studied further • Uncertain timeline for Sacco/ Smallfield due to contamination issue; returning well to service not currently considered feasible • High priority as sources are within City, on City-owned land; Clythe can be implemented in short-term; work required to advance LRC and Sacco/ Smallfield

Conservative Estimate of Added Water Supply Capacity	**6,000 cubic metres per day**

Detailed alternatives evaluation – municipal test wells

Groundwater Source	Description	Key Evaluation Considerations	Outcome
Existing Test Wells	Wells: Ironwood, Steffler, Guelph South, Logan/ Fleming, Hauser	• Moderate to high certainty of available water volume, water quality • Hauser – low capacity well in area with known contamination • New infrastructure required • Wells near surface water/ wetlands require field assessment of potential interaction • New well head protection areas required; potential land use restrictions • Logan/ Fleming wells on City-owned land in Guelph-Eramosa Township • General low cost, Hauser exception	• Preferred as part of overall solution • Ironwood, Steffler, Guelph South included in Southwest Guelph Class EA • Logan well being reconstructed and tested • Hauser requires further study • High priority as sources are within City, on City-owned land

Conservative Estimate of Added Water Supply Capacity	**9,100 cubic metres per day**

Detailed alternatives evaluation – Dolime Quarry

Groundwater Source	Description	Key Evaluation Considerations	Outcome
Dolime Quarry	Additional water from quarry pond level management (PLM)	• High certainty of available water volume, water quality assessment required • Availability of water through surrounding wells (existing and new) or directly from quarry to be assessed in Southwest Guelph Class EA • New infrastructure required • Low anticipated risk to natural environment; quarry has been dewatered long-term; discharge to river not required to support WWTP assimilative capacity • New source water protection designation required; potential land use restrictions • Council has approved quarry annexation, Provincial approval required • Cost significantly lower for water capture by surrounding wells; high cost for new WTP.	• Preferred as part of overall solution • Alternative included in Southwest Guelph Class EA
Conservative Estimate of Added Water Supply Capacity			**3,000 cubic metres per day**

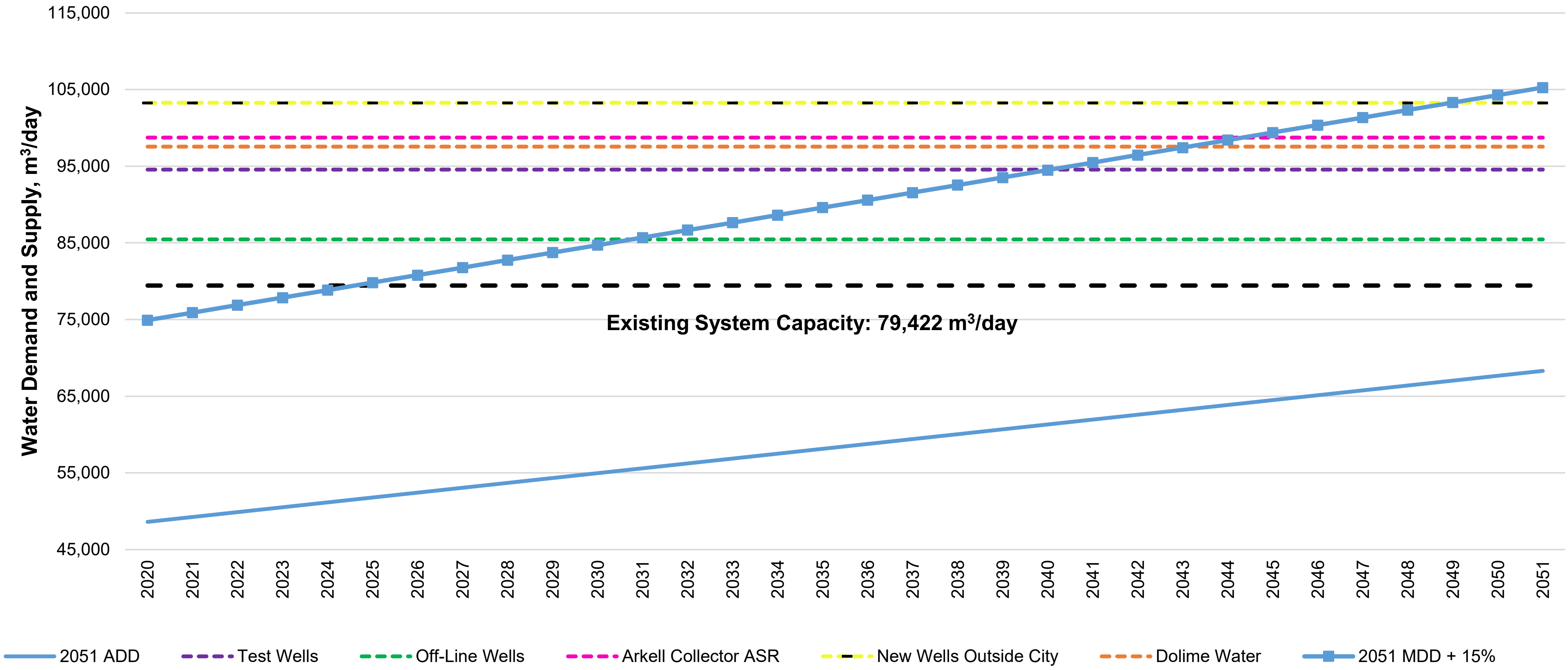
Detailed alternatives evaluation – Arkell Aquifer Storage and Recovery (ASR)

Groundwater Source	Description	Key Evaluation Considerations	Outcome
Arkell Collectors	Capture excess spring flow for treatment and storage in aquifer, extract when water demand is high	• Low certainty of available water volume, Lower Road Collector re-construction required, ASR optimization study required • Low anticipated risk to natural environment; Collector is currently permitted, was operated long-term; ASR system would be designed to pump volume equal to injected volume • New infrastructure required (Collector and ASR wells) • New wellhead protection areas required for ASR well locations; potential land use restrictions • Refinement of cost estimate required through optimization study; assessed locations reflect high cost for relatively low supply capacity	• Preferred as part of overall solution • Significant additional work required to define alternative and refine estimated costs
Conservative Estimate of Added Water Supply Capacity			**1,200 cubic metres per day**

Detailed alternatives evaluation – new wells outside City

Groundwater Source	Description	Key Evaluation Considerations	Outcome
New Groundwater Wells	Construction of new groundwater wells outside City boundary (two locations, north and southeast of City)	• Moderate certainty of available water volume due to limited site-specific information • Wells near surface water/ wetlands require field assessment of potential interaction • New infrastructure required • New wellhead protection areas required; potential land use restrictions • Locations are within Guelph-Eramosa and Puslinch Townships • Moderate to high costs	• Preferred as part of overall solution • Significant additional work required to define alternative and collaborate with Townships • Lower priority than sources within City
Conservative Estimate of Added Water Supply Capacity			**4,500 cubic metres per day**

Groundwater alternative summary



Master Planning

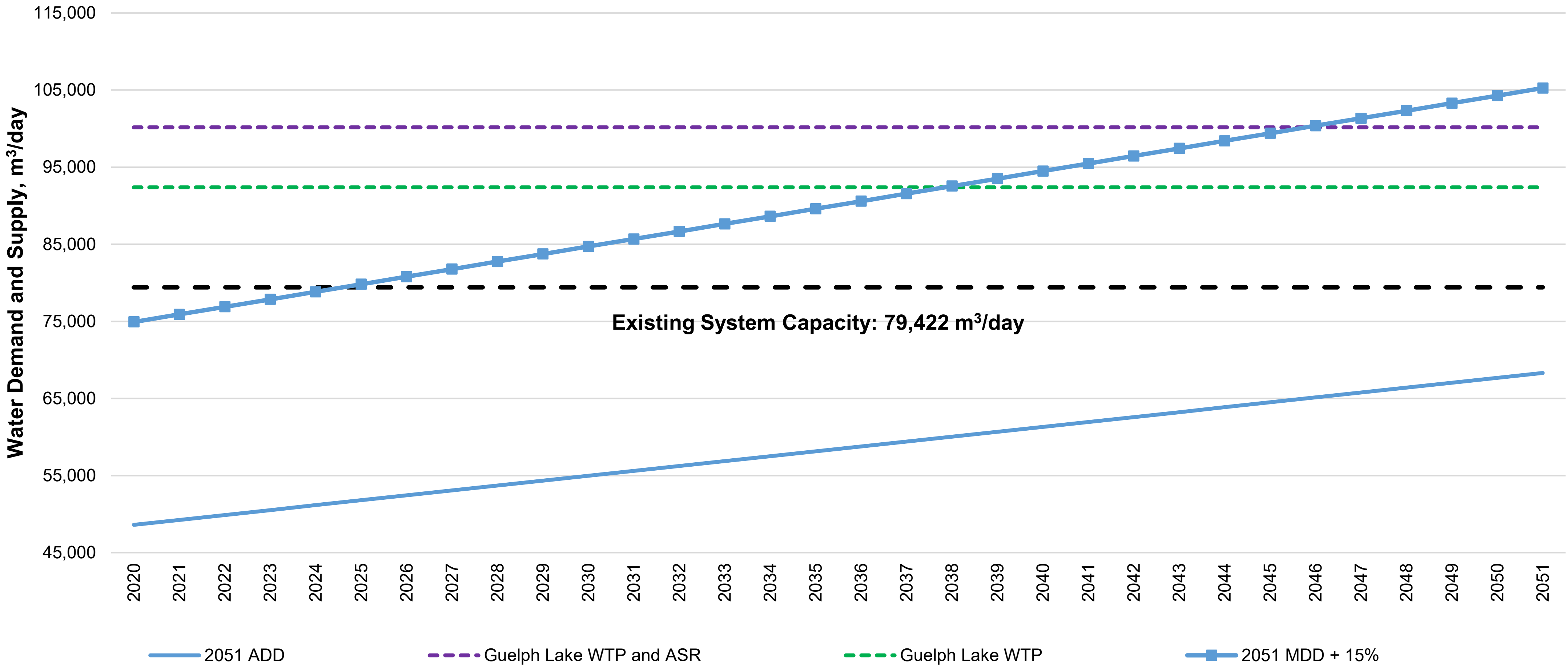
Detailed alternatives evaluation – surface water

Groundwater Source	Description	Key Evaluation Considerations	Outcome
Guelph Lake	Construction of Guelph Lake intake and new water treatment plant	• High certainty of available water volume due to long-term record of river flow • Complex system to operate • Detailed assessment of potential impacts to natural environment and recreational use of Guelph Lake required • New infrastructure required • New intake protection zone required; potential land use restrictions • Location within Guelph-Eramosa Township • Moderate to high costs	• Preferred as part of overall solution • Significant additional work required to define alternative and collaborate with Township • Lower priority than sources within City
Conservative Estimate of Added Water Supply Capacity			**13,000 cubic metres per day**

Detailed alternatives evaluation – surface water with Aquifer Storage and Recovery (ASR)

Groundwater Source	Description	Key Evaluation Considerations	Outcome
Guelph Lake and ASR System	Expansion of Guelph Lake water treatment plant (13,000 m^3/day additional capacity) and construction of ASR system	• High certainty of available water volume due to long-term record of river flow; ASR optimization study required • Complex system to operate • Detailed assessment of potential impacts to natural environment and recreational use of Guelph Lake required; ASR system would be designed to pump volume equal to injected volume (low risk of impacts) • New infrastructure required • New intake protection zone and well head protection area required; potential land use restrictions • Location within Guelph-Eramosa Township and City (ASR wells) • Moderate to high costs	• Preferred as part of overall solution • Significant additional work required to define alternative and collaborate with Township • Lower priority than sources within City
Conservative Estimate of Added Water Supply Capacity			**Up to 13,000 cubic metres per day (additional)**

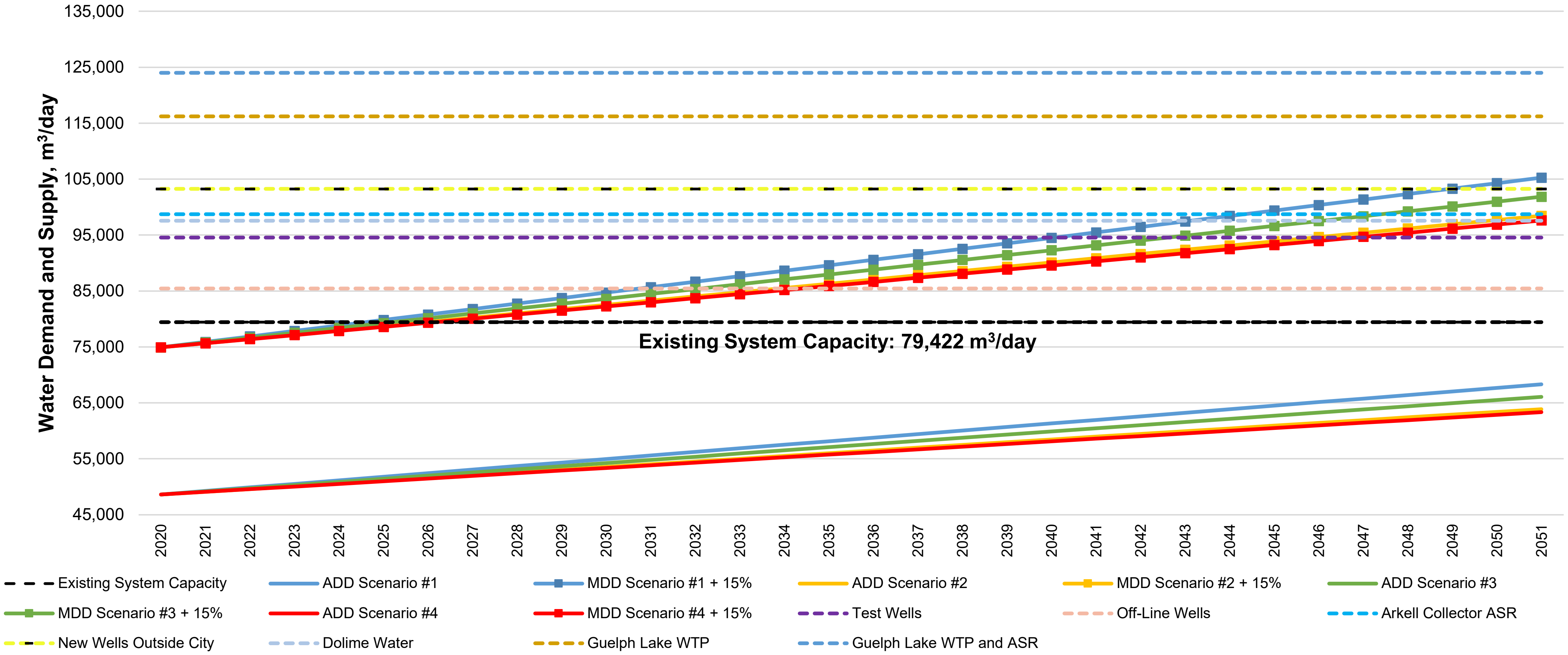
Surface water alternative summary



Detailed alternatives evaluation – limit growth/ do nothing

Water Source	Description	Key Evaluation Considerations	Outcome
None	Limit growth to align with current system capacity	• Does not address EA objective; no increase in capacity or reduction in demand • Limits potential for impacts to natural environment • High impact to meeting growth targets • Mixed public acceptance anticipated • Could drive growth to Townships	• Not preferred
Conservative Estimate of Added Water Supply Capacity			**None**

All water supply alternatives summary



Preliminary preferred solution – initial implementation timeline

Short Term (0-10 Years)

- Conservation and efficiency – current level of effort
- Clythe well (offline)
- SW Guelph test well(s)
- Dolime Quarry PLM
- Logan/ Fleming test well(s)

Medium Term (10-20 Years)

- Conservation and efficiency – focus on high demand customers
- Lower Road Collector (offline)
- Arkell ASR

Long Term (20-30 Years)

- Conservation and efficiency – water reuse
- Hauser test well
- Guelph North well (new well outside City)
- Guelph Southeast well (new well outside City)
- Guelph Lake surface water
- Smallfield/ Sacco (offline) >30 yrs

Next steps

- Incorporate public feedback from today's session and the online survey
- Further communications with First Nations communities (virtual meeting and review of draft report)
- Develop implementation plan
- Deliver a Council presentation
- Post the draft Water Supply Master Plan report for public review
- Address any comments or concerns from the public review
- Implement the preferred strategy

Questions and answers

Stay involved

Thank you for your interest in learning about the City of Guelph's WSMP update.

- Fill out the survey on haveyoursay.guelph.ca by October 13
- Register, join the conversation and share thoughts at haveyoursay.guelph.ca.
- Read about our progress. Project information will be posted on our project page at guelph.ca/wsmp.
- Join our mailing list. Send us your name to the contacts below and provide your address (email or post mail), and we'll keep you informed.
- Follow the conversation on Twitter (twitter.com/cityofguelph) and Facebook (facebook.com/cityofguelph).

Contact us if you have any questions or comments:

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Infrastructure, Development and Enterprise
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matthew.alexander@aecom.com

Phase 2 Online Survey

We want your feedback! This survey asks about the preliminary evaluation of water supply alternatives from now until 2051. Your feedback will be considered in the development of recommendations about how our water supply will be managed as Guelph grows.

Before you complete the survey, we encourage you to review the presentation and evaluation matrix that were presented at the second open house on September 29, 2021.

Your participation in this survey is voluntary. All individual responses will be kept confidential and will be used only for the purposes of helping to develop the updated water supply master plan for Guelph. Non-identifiable summaries of responses may be developed and shared publicly.

This survey will take approximately 10 to 15 minutes to complete and will be open until October 13, 2021.

Preliminary Evaluation of Water Supply Alternatives

The goal of the Water Supply Master Plan Update is to identify a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers in Guelph.

The following water supply alternatives were studied and each alternative was considered using a specific set of evaluation criteria:

Demand management/ efficiency programs

- Maintain commitment to our water conservation initiatives and 2016 Water Efficiency Strategy
- Review success of programs since 2014 and evaluate trends in other jurisdictions
- Determine range of realistic goals and cost for implementation

Groundwater sources in and outside of city

- Improve and optimize the existing well supply system
- Restore offline sources with treatment
- Identify new potential groundwater supply areas, including the Dolime Quarry
- Evaluate aquifer storage and recovery wells

Local surface water sources*

- Establish feasibility/ risks of surface water alternatives including aquifer storage and recovery system
- Assessment areas include: Guelph Lake/ Speed River and Eramosa River (*Includes facility to treat water to drinking water quality)

Do nothing/ limit growth

- Undertake no improvements or changes
- Significant impact on the growth potential for the City would be expected with this alternative

A preliminary evaluation of these water supply alternatives was conducted to identify the preferred solution to address Guelph's water supply need. Please review the results of this preliminary evaluation and timeline here. Click to the next question to provide your feedback.

Water Conservation and Efficiency Alternatives

Four water conservation and efficiency scenarios were evaluated:

Scenario 1 – Cease Non-Mandatory Programs

- This alternative does not achieve demand reductions, would have low public acceptance but no associated costs
- Not preferred

Scenario 2 – Maintain the Current Level of Effort

- This alternative would result in a moderate water demand reduction, would have a high public acceptance, would require minor changes to existing/ planned buildings and has low to moderate costs relative to other alternatives
- Preferred as part of the short-term strategy

Scenario 3 – Focus on High Demand Customers

- This alternative would result in the least water demand reduction, would have a high public acceptance, would require minor changes to existing/ planned buildings, and has low costs relative to other alternatives
- Preferred as part of the short to mid-term strategy

Scenario 4 – Maintain the Current Level of Effort with Water Reuse

- This alternative would result in the greatest water demand reduction, would have moderate public acceptance (some education may be required), would require minor changes to existing/ planned buildings, would have a moderate impact to wastewater treatment plant infrastructure, may require regulatory approvals, and would have moderate to high costs relative to other alternatives
- Preferred as part of the long-term strategy

Review the evaluation matrix.

Do you agree with the preliminary evaluation of the water conservation and efficiency alternatives?

Do you agree with including the water conservation and efficiency alternatives in the preferred solution?

Are there any considerations missing from the evaluation of the water conservation and efficiency alternatives or anything you would evaluate differently?

Groundwater Alternatives

Several groundwater supply alternatives were evaluated:

Groundwater Alternative 1 – Restore Currently Off-Line Municipal Wells

- This alternative has a high certainty of available water volume, water quality, would require some upgrades, would have low environmental impacts (but some additional study is required), may have a risk of contaminant movement– potential environmental and legal issue, would have an unlikely need for remediation of contamination prior to 2051, and would have low to high costs.
- This alternative is preferred as part of the overall solution and is a high-priority as the sources are within the City of Guelph, on city-owned land.

Groundwater Alternative 2 – Use the Municipal Test-Wells

- This alternative has a moderate to high certainty of available water volume, water quality, includes a low capacity well in area with known contamination (Hauser), would require new infrastructure, would require field assessments of potential interaction for wells near surface water/ wetlands, would require new well head protection areas (potential land use restrictions), some wells are on City-owned land in Guelph-Eramosa Township, and would have general low cost (except for Hauser).
- This alternative is preferred as part of the overall solution and is high priority as sources are within the City, on City-owned land.

Groundwater Alternative 3 - Dolime Quarry

- This alternative has a high certainty of available water volume, would require a water quality assessment, has an availability of water through surrounding wells or directly from quarry, would require new infrastructure, has a low anticipated risk to natural environment, would require a new source water protection designation, requires Provincial approval, and would cost significantly lower for water capture by surrounding wells, although a high cost for new WTP.
- This alternative is preferred as part of the overall solution.

Groundwater Alternative 4 - Arkell Aquifer Storage and Recovery (ASR)

- This alternative has low certainty of available water volume, would require re-construction for the Lower Road Collector, would require an ASR optimization study, has low anticipated risk to natural environment, is currently permitted, ASR system would be designed to pump volume equal to injected volume, would require new infrastructure, would require new wellhead protection areas, and would require refinement of cost estimate.
- This alternative is preferred as part of the overall solution, with significant additional work required to define alternative and refine estimated costs.

Groundwater Alternative 5 - New Wells Outside the City

- This alternative has a moderate certainty of available water volume due to limited site-specific information, would require field assessment of potential interaction for wells near surface water/ wetlands, would require new infrastructure, would require new wellhead protection areas required, has wells located within Guelph-Eramosa and Puslinch Townships, and would have moderate to high costs.
- This alternative is preferred as part of overall solution, and would require significant additional work required to define alternative and collaborate with Townships. This alternative is also a lower priority than sources within City.

Review the evaluation matrix.

Do you agree with the preliminary evaluation of the groundwater alternatives?

Did we miss any alternatives?

Do you agree with including the groundwater alternatives in the preferred solution?

Are there any considerations missing from the evaluation of the groundwater alternatives or anything you would evaluate differently?

Surface Water Alternatives

Several surface water alternatives were evaluated

Surface Water Alternative 1 – Surface Water

- This alternative would have a high certainty of available water volume due to long-term record of river flow, would require a complex system to operate, would require a detailed assessment of potential impacts to natural environment and recreational use of Guelph Lake, would require new infrastructure, would require new intake protection zone required, would be located within Guelph-Eramosa Township and would have moderate to high costs.
- This alternative is preferred as part of overall solution. Significant additional work would be required to define the alternative and collaborate with Township, and is a lower priority than sources within City.

Surface Water Alternative 2 – Surface Water with Aquifer Storage and Recovery (ASR)

- This alternative would have a high certainty of available water volume due to long-term record of river flow, would require an ASR optimization study, would be a complex system to operate, would require a detailed assessment of potential impacts to natural environment and recreational use of Guelph Lake, the ASR system would be designed to pump volume equal to injected volume (low risk of impacts), would require new infrastructure, would require new intake protection zone and well head protection area, is located within Guelph-Eramosa Township and City (ASR wells) and would have moderate to high costs.
- This alternative is preferred as part of overall solution. It would require significant additional work to define the alternative and collaborate with Township. It is a lower priority than sources within City.

Review the evaluation matrix.

Do you agree with the preliminary evaluation of the surface water alternatives?
Do you agree with including the surface water alternatives in the preferred solution?
Are there any considerations missing from the evaluation of this alternative or anything you would evaluated differently?
We appreciate the time you have taken to learn more about our plans and contribute your input.

Other ways to get involved

- Read about our progress. Project information will be posted on our project page at guelph.ca/wsmp
- Join our mailing list. Send us your name to the contacts below and provide your address (email or post mail), and we'll keep you informed.

- Follow the conversation on Twitter (twitter.com/cityofguelph) and Facebook (facebook.com/cityofguelph).

Contact us with additional comments or questions at any time:

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Water Supply Program Manager
City of Guelph
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Matt Alexander
Project Manager, Senior Hydrogeologist
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AECOM

Appendix D

Social Media Posts and Have Your Say Newsletters

EngagementHQ Newsletter
February 2020

City of Guelph online participation opportunities

Hello!

In February we are looking for your feedback and have some updates on these projects:

1. Baker District redevelopment and new central library
2. Clair-Maltby Secondary Plan
3. Community gardens
4. Dallan Park
5. Growth Management Strategy - shaping Guelph
6. Guelph Farmers Market
7. Our Community Our Water - quarry site revitalization
8. Parks and Recreation Master Plan
9. Parks playground replacements
10. Solid Waste Management Master Plan - give waste a new life
11. Transportation Master Plan - moving Guelph forward
12. Water Supply Master Plan

Baker District redevelopment and new central library

The Baker District redevelopment project is ongoing. We're working on the draft Urban Design Master Plan and schematic design for the new central library. We'll share both with the community at upcoming engagement sessions this spring. Stay tuned for more information.

Clair-Maltby Secondary Plan - parks and open spaces

Thank you to everyone who participated in the engagement sessions for the parks and open space system in Clair-Maltby! This feedback will help establish policy directions that will inform the creation of the secondary plan for the Clair-Maltby area. The Open Space System Strategy will be presented to Council in the near future and the final secondary plan will become part of the City's Official Plan.

Community gardens

Four new community gardens are proposed for St. George's Park, Mollison Park, Burns Drive Park and Stephanie Drive Park. Access all four surveys here.

We want to hear what you think about the garden proposals by participating in the survey for your park before February 14, 2020.

We want to know:

- What you think of the proposed location?
- What feedback you have about the proposed community garden?
- How do you feel about participating in the garden if it's approved?

Next steps

We will use your feedback to help determine if the proposed garden will benefit each of the four park's users. Once we've made a decision, we will follow up with you to let you know our final results.

Dallan Park

We're starting the process to create a master plan for a new neighbourhood park at Poppy Drive East and Dallan Drive. We want you to be a part of the design process.

Starting February 12 until February 28, find the project on our Have your Say home page to review two design concepts for the future park and vote on your preferred concept. You can also share your ideas about playground equipment and provide comments to us. We'll use that feedback to help create one final park concept that we will share with you this spring.

Construction of the new park is expected to start June 2021.

Why we create park master plans
A park master plan is a blueprint that guides park design according to the space and community needs. We look at everything that makes a park a place to play, including how it's graded, what surfaces to use, pathways, tables and benches, playground equipment, shelters and more! Some things you can see on the surface and some things are invisible. Master plans make sure our parks are functional, aesthetically pleasing and create a sense of community space.

Growth Management Strategy - shaping Guelph

Guelph needs to plan to meet provincial growth forecasts of a population of 191,000 and 101,000 jobs by 2041. How we meet those forecasts is up to us. Growth doesn't mean putting high-rise apartment buildings in every neighbourhood; thoughtful planning will identify the right growth for all areas of the city so that Guelph can attract new residents, businesses and services that add to our community. Planning how and where we grow helps us create a people-oriented city full of essential amenities, walkable neighbourhoods, thriving community hubs and an interconnected transportation network. We need your help to ensure that we develop a Guelph-made approach to accommodate this growth.

There’s lots of ways to get involved in this new project:

- Learn more about the project
- Take an online survey about your preferences for future growth to 2041 (coming this February to haveyoursay.guelph.ca, stay tuned!)
- Attend a public event “Guelph 2041: A conversation about a growing city” on February 27. Please register by February 26.

Guelph Farmers Market

The Farmers’ Market bylaw review: Refreshing our Local Tradition will be complete in June 2020. We are reviewing results of the survey, taken by nearly 1,000 people!

We will share the survey results with the participants, vendors, stakeholder committee and Council in early March.

The draft policies and bylaw will be presented to Council at Committee of the Whole on June 9, with the final Council decision on June 29.

Our Community Our Water - quarry site revitalization

We’ve shared our concerns and a possible solution to protect Guelph’s drinking water. Formal opportunities for in-person and online engagement on Our Community, Our Water (the proposed solution between the City of Guelph and the owners of the Dolime Quarry) have ended. Thanks for sharing your thoughts with us. We’re summarizing your feedback in a report which we’ll share in spring 2020 when City Council is expected to make its decision about whether or not to pursue the proposed solution. In the meantime, if you have more questions you can email us anytime at ocow@guelph.ca.

Parks and Recreation Master Plan

The Parks and Recreation Master Plan and Trails Master Plan updates are ongoing. We continue to develop draft strategies and a draft master plan. More public engagement is planned for later this year. Stay tuned for updates!

Parks playground replacements

We’re inviting you to participate in engagement to help us design four playgrounds we’re replacing in 2020 starting the week of February 24. The playgrounds include:

- Bullfrog Pond Park, 13 Walnut Drive
- Clair Park, 22 Eugene Drive
- Kortright Hills Park, 165 Milson Crescent
- Westminster Woods Park, 146 Clairfields Drive East

Is one of your favourite parks on our list?

When we replace play equipment, we consider available budget, maintenance, how to make the play equipment fun for everyone and your comments. Your participation in engagement will help us choose the right play equipment for your neighbourhood. We want you to tell us:

- What kind of equipment you would like to see
- What you like about the existing playground
- If there are any specific accessibility features you would like to see included

What's next?

Once we've collected and reviewed all of the information received from you, we will use the information to develop requirements for the design of new play equipment. We will send this information to specialized playground designers as part of our process for selecting new play equipment. We will review the design submissions and select the best two designs for each park where we will then invite you to vote on which one you like best.

Construction is anticipated to begin in summer and be completed by fall 2020.

Solid Waste Master Plan - give waste a new life

The City is updating the 2014 Solid Waste Management Master Plan, which will shape how Guelph manages its waste over the next 25 years. To kick off the master plan process, the City hosted a launch event on December 9, 2019 with a talk by Dr. Dianne Saxe, the former Environmental Commissioner of Ontario. Dr. Saxe spoke about the climate crisis within our local context, the role of waste, and what the City of Guelph and its residents can do to affect positive change.

If you couldn't make the launch event, you can view the **video** of Dr. Dianne Saxe's talk, read the **public engagement update**, and participate online by visiting **haveyoursay.guelph.ca/waste**.

For more details about the Solid waste master Plan, visit https://guelph.ca/plans-and-strategies/solid-waste-management-master-plan/

Transportation Master Plan - moving Guelph forward

During the Fall of 2019, we have asked Guelph residents: What are your transportation issues and what opportunities exist? Thank you to all who gave us your feedback! The team also tested potential solutions such as complete streets and bus-only lanes through demonstration projects as a way to experiment with the types of changes we could see on our roads in the future. For a summary of the most commonly heard feedback and some bold ideas, please see the **Phase 2 Community Engagement Summary**.

Over the next month, the technical team will continue their analysis of Guelph's current transportation network and will begin work to identify potential solutions for the future. Stay tuned at haveyoursay.guelph.ca/transportation for more opportunities coming this Spring to help shape the future of transportation in Guelph.

For more details about the Transportation Master Plan visit guelph.ca/plans-and-strategies/transportation-master-plan/

Water Supply Master Plan

Where will our water supply come from over the next 20 years?

Join us as we discuss Guelph's water supply at the first Water Supply Master Plan (WSMP) open house on February 13 from 2-4 p.m. and 6-8 p.m. in the Marg MacKinnon community room at City Hall, 1 Carden Street.

Drop-in and play a part in our discussions on how to best manage this vital resource so that we can continue to provide a sustainable, high level of service to Guelph residents now and into the future. The open house will not have a formal presentation, and will be an information and idea sharing opportunity for the Guelph community.

Can't make the open house? We still want to hear from you. You can share your thoughts on haveyoursay.guelph.ca starting on February 14.

For more details about the WSMP, visit guelph.ca/wsmp.

Thank you for being part of the City of Guelph's online engagement program. We appreciate your time, ideas and feedback!

EngagementHQ Newsletter
March 2020

City of Guelph online engagement

Hello,

In February we are looking for your feedback and have some updates on these projects:

1. Baker District redevelopment and new central library
2. Community Gardens
3. Community Road Safety Strategy
4. Dallan subdivision park
5. Give waste a new life: Solid Waste Master Plan
6. Moving Guelph forward: Transportation Master Plan
7. Our Community Our Water - quarry site revitalization
8. Playground replacements
9. Shaping Guelph: Guelph's growth management strategy
10. Smoking and Alcohol Regulations
11. Water Supply Master Plan

Current engagement opportunities

Community Road Safety Strategy

The community road safety strategy (CRSS) is a high-level road safety plan for Guelph. Road safety impacts all members of our community, regardless of their ability, age, or mode of transportation. The strategy will provide a range of road safety measures, such as education campaigns, enforcement strategies (e.g. red-light cameras) and engineering modifications (e.g. leading pedestrian intervals).

Complete an online survey by March 22 to help us determine and rank road safety priorities. https://www.haveyoursay.guelph.ca/community-road-safety-strategy

Give waste a new life: Solid Waste Master Plan

The City is updating the 2014 Solid Waste Management Master Plan, which will shape how Guelph manages its waste over the next 25 years. Look for the Solid Waste Management Master Plan (SWMMP) team at these events in the community. Stop by to learn more about the SWMMP and leave your feedback.

Off Campus Living Winter Fair

University Centre Courtyard, University of Guelph

March 10 from 10 a.m. to 3 p.m.

eMERGE EcoMarket 2020

Old Quebec Street Shoppes

March 21 from 10 a.m. to 3 p.m.

Stay tuned for details about our first SWMMP open house which will take place on April 18. Details will be shared on our project page.

Playground replacements

We're replacing four playgrounds in 2020 at Bullfrog Pond Park, Clair Park, Kortright Hills Park and Westminster Woods Park. From March 5-23, we want your feedback on:

- What kind of equipment you would like to see.
- What you like about the existing playground.
- What accessibility features you would like to see included.

We will use the survey information to develop requirements for the design of new play equipment. We will review proposed playground designs and select two for the community to choose from in spring 2020. Construction will start in summer and be completed in late fall, weather permitting.

Shaping Guelph: Guelph's growth management strategy

On February 27, the City of Guelph launched Shaping Guelph: Guelph's Growth Management Strategy to 2041. To conform to provincial laws, Guelph needs to plan for a population of 191,000 and an employment base of 101,000 jobs by 2041. We want your feedback about how and where we grow to 2041. Learn more about the project and take our surveys, by March 8.

Water Supply Master Plan

Where will our water supply come from over the next 20 years?

We hosted the first of two open houses for the Water Supply Master Plan update on February 13, 2020. For those of you who were able to make it out, thank you for attending and sharing your comments and questions with the project team.

The display boards are available on our project page under the resources section.

We want to hear what you think about the Water Supply Master Plan update by participating in a survey by March 16, 2020. This survey asks about our municipal water supply sources and priorities, including sustainable water supply options from now until 2041. Your feedback will be considered in the development of recommendations for how our water supply will be managed as Guelph grows. Take the survey.

Project Updates

Baker District redevelopment and new central library

Open houses: Urban Design Master Plan for Baker District redevelopment and library schematic design

You are invited! On Monday, March 23, we'll show how your input over 18 months has influenced the Urban Design Master Plan for the Baker District redevelopment. Join us from 2 to 4 p.m. or 7 to 9 p.m. at River Run Centre as Windmill Development Group presents our plan.

Also, a second set of open house sessions—specific to the new central library's programming and design plans—are happening on Thursday, April 2 from 2 to 4 p.m. and 7 to 9 p.m. at the Italian Canadian Club. Diamond Schmitt Architects will reveal how the library's programs and services will be laid out over the four floors and work with the schematic design that was informed by community input over the past 18 months.

Learn more about the open house sessions. If you can't attend these open houses we post the presentations guelph.ca/bakerdistrict by March 27 (Urban Design Master Plan) and April 6 (Library schematic design). After you view the presentations, you can ask us questions at on haveyoursay.guelph.ca

Community gardens

Thanks to everyone that participated in the online survey for the four proposed community gardens.

We're reviewing your comments and feedback as we consider each garden proposal. We'll share the results of the community engagement and our next steps for the proposed sites online at guelph.ca/communitygardens in the coming weeks.

Dallan subdivision park

Thanks to everyone that participated in the online survey for the new park we're designing for Dallan subdivision.

We're using your feedback to create a final park concept, which we will share with the community for feedback from March 23 to April 7. We expect construction of the new park to start in June 2021.

Moving Guelph forward : Transportation Master Plan

We've summarized feedback from the community engagement that took place during Phase 2 of the Guelph Transportation Master Plan. The report is now posted online. Over the next month, the technical team will continue their analysis of Guelph's current transportation network and will begin work toward identifying potential solutions for the future. Stay tuned at haveyoursay.guelph.ca/transportation for more opportunities to help shape the future of transportation in Guelph.

Our Community, Our Water

We've summarized your feedback from the Our Community, Our Water engagement program. The report is now posted online and was presented to Council on March 2, with a final decision on whether to pursue the proposed solution expected at the March 30 Council meeting. If you have questions you can email us anytime at ocow@guelph.ca.

Smoking and alcohol regulations

In October 2019, we launched two surveys to explore whether new smoking and alcohol regulations.

We received 4580 survey responses and are preparing to share engagement summaries about what we heard during the online surveys and the two statistically-valid telephone surveys on our website. Stay tuned!

Thank you for being part of the City of Guelph's online engagement program. We appreciate your time, ideas and feedback!

Phase 1 Social Media Posts

Facebook February 2020

Feb 5

How do you use water in your daily life? Let us know at the Water Supply Master Plan open house on February 13 from 2-4 p.m. and 6-8 p.m. at City Hall. https://guelph.ca/2020/01/join-us-february-13-for-the-first-water-supply-master-plan-open-house/

Total reach: 1462 / Engaged users: 5

Feb 13

We're discussing Guelph's water supply at the Water Supply Master Plan open house today - join us! Drop in between 2-4 p.m. or 6-8 p.m. at City Hall in the Marg MacKinnon community room. We'd love to hear your thoughts. https://guelph.ca/2020/01/join-us-february-13-for-the-first-water-supply-master-plan-open-house/

Total reach: 1565 / Engaged users: 9

Twitter February 2020

Feb 2

Guelph’s population is growing. How will we manage our water supply as our community grows? Join us for the Water Supply Master Plan discussion on February 13 at City Hall. 2-4 p.m. and 6-8 p.m. https://t.co/XJIEeXcYv5 #GuelphWater #Guelph https://t.co/5w7UWynK7j

Impressions: 2794 / Engagements: 17

Feb 12

What kind of challenges does Guelph face when it comes to our water supply? We're talking about it tomorrow at the Water Supply Master Plan open house at City Hall from 2-4 p.m. and 6-8 p.m. Don't miss it! https://t.co/9FWN2ZcIRp #GuelphWater #Guelph https://t.co/XQQNB8kg6R

Impressions: 2606 / Engagement: 12

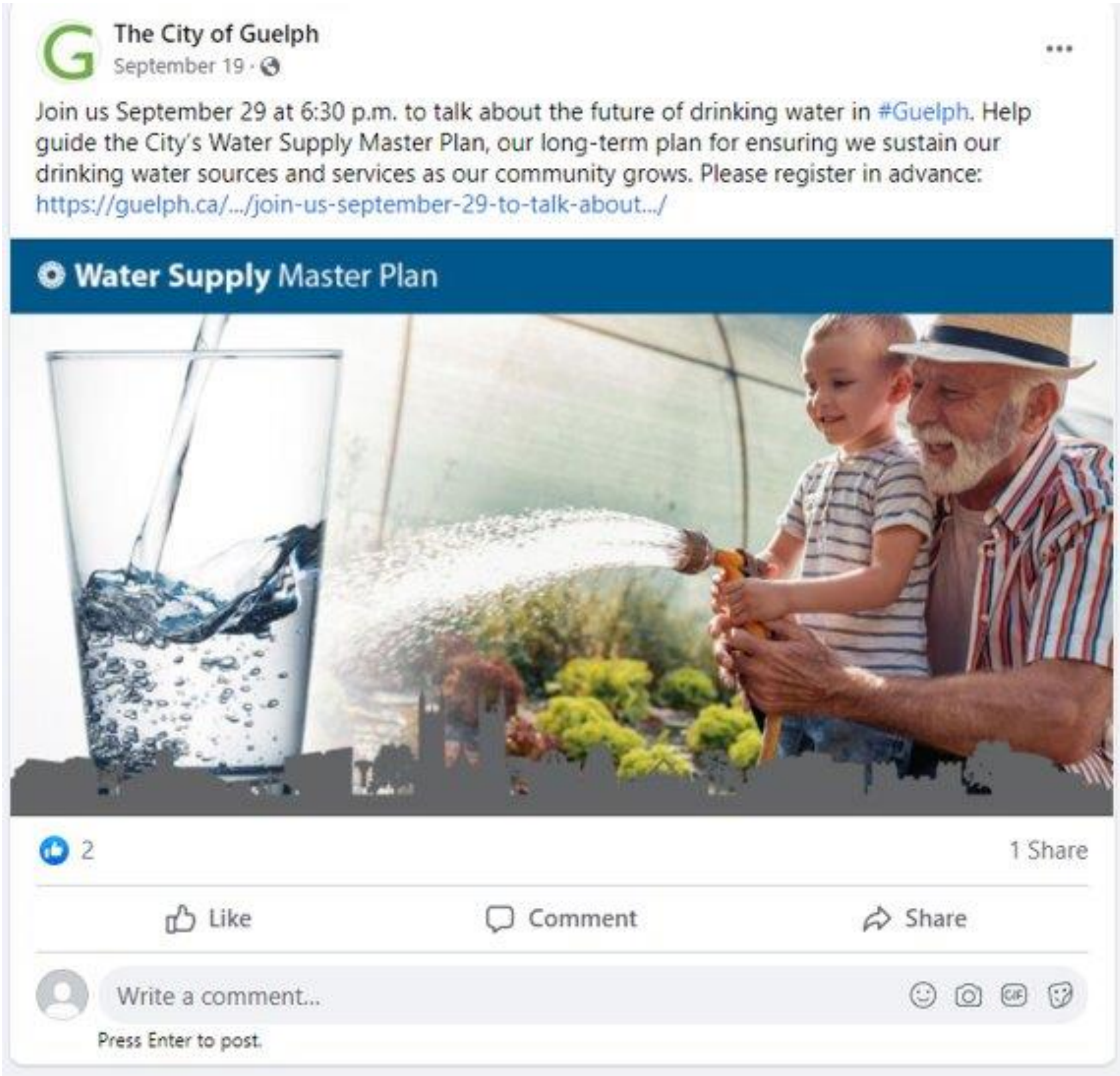
Feb 13

We're discussing Guelph's water supply at the Water Supply Master Plan open house today - join us! Drop in between 2-4 p.m. or 6-8 p.m. at City Hall in the Marg MacKinnon community room. We'd love to hear your thoughts. https://t.co/rBHJDhdiae #GuelphWater #Guelph https://t.co/HcljvrIceF

Impressions: 1746 / Engagement: 12

Phase 2 Social Media Posts

Facebook September 2021



Twitter September 2021

← **Tweet**

City of Guelph
@cityofguelph

Join us September 29 at 6:30 p.m. to talk about the future of drinking water in #Guelph. Help guide the Water Supply Master Plan, our long-term plan to sustain our drinking water sources & services as our community grows. Please register in advance: ow.ly/rYvD50Gb8eH

9:48 AM · Sep 16, 2021 · Hootsuite Inc.

2 Retweets **2** Likes

← **Tweet**

City of Guelph
@cityofguelph

#ICYMI Join us Sept 29 at 6:30 p.m. to talk about the future of drinking water in #Guelph. Help guide the Water Supply Master Plan, our long-term plan to sustain our drinking water sources and services as our community grows. Please register in advance: ow.ly/Roin50Gb8o2

9:01 AM · Sep 20, 2021 · Hootsuite Inc.

5 Retweets **4** Likes

← **Tweet**

City of Guelph
@cityofguelph

#ICYMI Join us tomorrow at 6:30 p.m. to talk about the future of drinking water in #Guelph. Help guide the Water Supply Master Plan, our long-term plan to sustain our drinking water sources and services as our community grows. Please register in advance: ow.ly/xGQy50Gb8s8

11:01 AM · Sep 28, 2021 · Hootsuite Inc.

1 Retweet

T Tweet your reply Reply

Aleksander @sailor4life52 · Sep 28
Replying to @cityofguelph
Good to be aware how much water we use. But, water supply in Guelph since it is groundwater it is so rich in minerals that is not suitable to make good quality tea, coffee, etc. Guelph residents are using other sources of water for that purpose. W/softener don't helps for above

1

Appendix E

Additional Stakeholder Meetings and Presentations

- Guelph Wellington Development Association and Guelph and District Home Builders' Association Presentation
- Guelph Wellington Development Association and Guelph and District Home Builders' Association Minutes
- Our Community, Our Water open house Display board
- Water Conservation and Efficiency Public Advisory Committee Presentations (2020 and 2021)
- Water Conservation and Efficiency Public Advisory Committee Minutes (2020 and 2021)
- Township of Puslinch Presentation (2019)
- Township of Puslinch Council Presentation (2021)
- Township of Puslinch Council Resolution
- Township of Guelph Eramosa Council Presentation (2021)
- Township of Guelph Eramosa Council Resolution

City of Guelph
2019 Water Supply Master Plan - Overview

November 7, 2019

WATER SUPPLY MASTER PLAN UPDATE

Overview

- Follows the Municipal Class Environmental Process
- Problem/Opportunity Statement;
- Review Work Plan for 2019 WSMP; and
- Review schedule and next steps

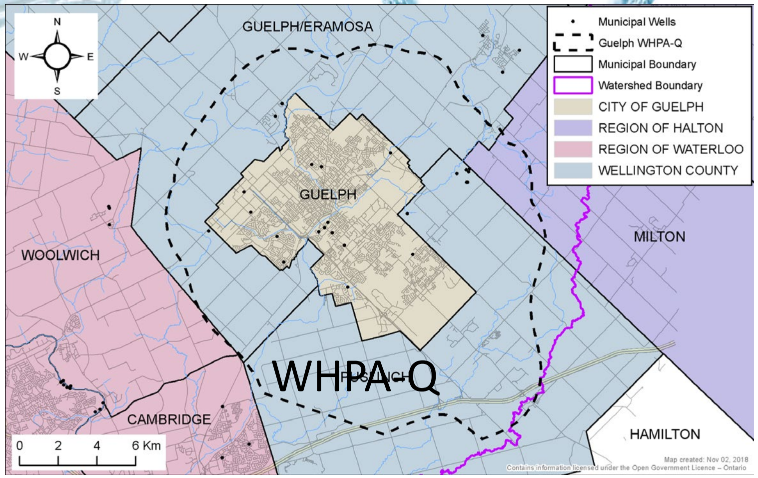
WATER SUPPLY MASTER PLAN UPDATE

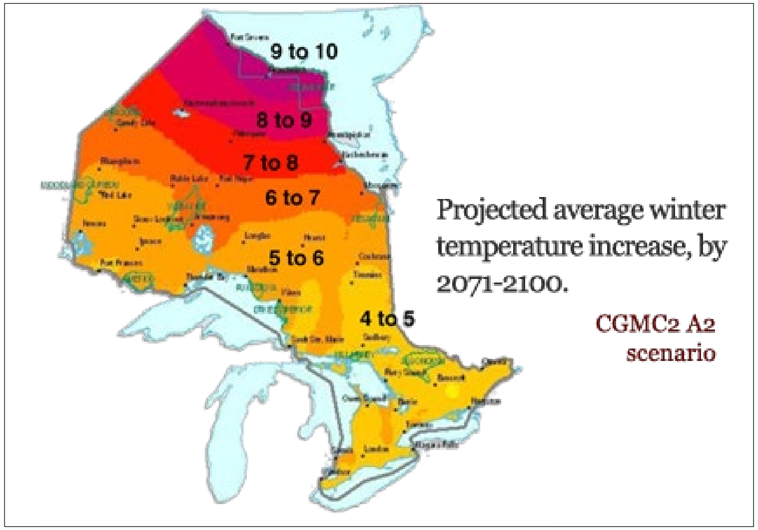
2019 Problem / Opportunity Statement

- City is responsible for supplying clean, safe drinking water;
- City will provide a reliable and sustainable supply to meet current and future needs of all customers for the next 20 years (2041);
- Question: How best to manage vital supply to provide the high level of service our residents expect?
- The updated Master Plan will identify and prioritize individual projects required to implement the Master Plan.

2019 WSMP – SPECIAL ISSUES

- Tier 3 Water Budget and Local Area Risk Assessment
- Contaminated Sites
- Dolime
- Surface Water Impacts
- Firm Capacity and Security of Supply
- Climate Change

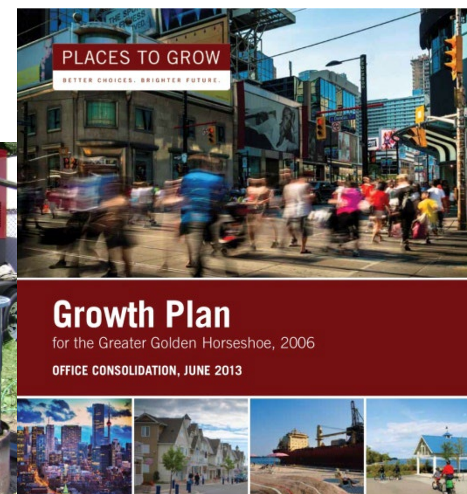




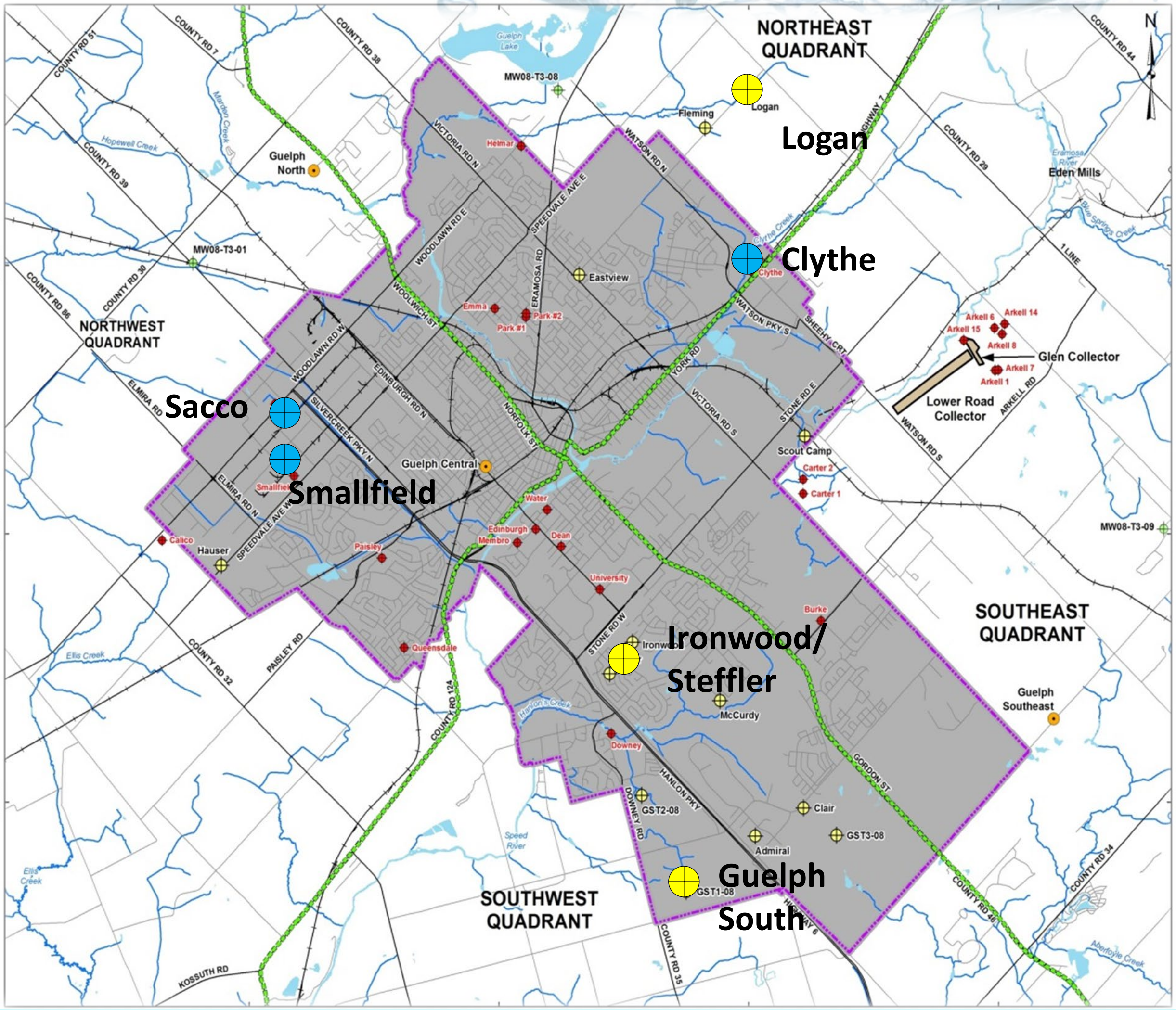
2019 WSMP WORK PLAN

- Same approach as in 2014
- Task 1 - Develop Community Engagement Plan
- Task 2 - Population and Water Demand forecasts
- Task 3 – Water Supply Capacity
- Task 4 – Water Supply Alternatives (similar to 2014)
- Task 5 – WSMP Report





OFFLINE WELLS AND TEST WELLS



Offline Well

Test Well

EVALUATION OF ALTERNATIVES

- Criteria (2014):
  - Financial Consideration
  - Legal and Jurisdictional Considerations
  - Technological Consideration - constructability
  - Built Environment – effect on existing infrastructure
  - Natural Environment
  - Social and Cultural Environment – meet growth, public acceptance
- Evaluate alternatives, prioritize projects and estimate costs

2019 WSMP – SCHEDULE AND NEXT STEPS

- Schedule – one year +/- (Community Engagement Plan)
- Next Steps:
  - AECOM retained to manage the project
  - Notice of Study Commencement – October
  - Formation of Community Liaison Group
  - First Community Engagement
    - Introduce the project
    - Discuss/define problem statement
    - Discuss Community Engagement Plan
    - Outline next steps and schedule
  - GWDA welcome to provide input
  - GWDA to provide a representative for the Community Liaison Group

QUESTIONS?

For more information - https://guelph.ca/plans-and-strategies/water-supply-master-plan/

Meeting Minutes

Meeting: Guelph Wellington Development Association/Guelph & District Home Builders' Association/City Staff Technical Liaison Committee

Date: Thursday, November 7, 2019

Location: City Hall, Meeting Room C

Time: 12:00 – 1:30pm

Present: Astrid Clos, Alfred Artinger, Nancy Shoemaker, Paul Magahay, Steve Conway, Angela Kroetsch, Shawn Marsh, David Brix, Tom McLaughlin, Kevin Brousseau, Frank Cernuk, Ian Panabaker, Chris DeVriendt, Arun Hindupur, Dave Belanger, Dylan McMahon, Trista Di Lullo, Laurie Iversen (recording secretary)

Regrets: Larry Kotseff, Terry Gayman

Meeting Minutes

Welcome from the Chair

1. Agenda and minutes of July 18, 2019 accepted.

2. **Committee of Adjustment Fee Increase –** Dylan McMahon (attachment)
   An explanation was provided on the method of calculating the increase to the Committee of Adjustment fees for 2020.

3. **Water Supply Master Plan - Overview** – Dave Belanger (attachment)
   An overview of the process for updating the 2014 Water Supply Master Plan was provided. The master plan will review water supply sources and identify priorities, including sustainable municipal water supply options from now until 2041.

   The consultant will be reaching out to GWDA and the Home Builders' Association asking for representatives to participate in a community liaison group.

4. **Water & Wastewater Services/Stormwater Master Plans** – Arun Hindupur
   Looking at a collaborative engagement process to combine with other master plan updates that are occurring within the city. Stormwater Master Plan will include the entire city. Similar to the Water Supply Master Plan, industry associations will be contacted to participate in a community liaison group.

   Action: Arun to provide timelines for the Master Plans.

5. **Engineering Matters** – Arun Hindupur
   November 19, will be the first of two Clair-Maltby Secondary Plan workshops for parks and open spaces.

Sanitary Flow
Inflow and infrastructure study will be begin on November 13 and last approximately five weeks.

6. **Comprehensive Zoning By-law Update –** Chris DeVriendt

Phase 2 discussion papers were released in October. There are numerous engagement workshops taking place in November.

Goal is to have a draft completed by the end of 2020.

Astrid Clos posed a question regarding the two year moratorium and whether the Zoning By-law should be considered a comprehensive update.

Action: Chris DeVriendt
The preliminary recommendation of the CZBR is to repeal and replace the entirety of the zoning by-law. Since this will deliver one complete new zoning by-law at one time, the provision of the Planning Act that does not allow for amendments to the zoning by-law for two years from adoption of the new by-law would be applicable. However, the Planning Act also allows Council to pass a motion to waive this provision.

7. **Additional Items**

a) **Turnaround time**
A request was made for a minimum of four weeks turnaround when asked to provide comments on city documents. Example provided related to the commenting period provided to review the DEM.

b) **Bulk Water Meter** – Angela Kroetsch
The city no longer approves water commissioning plans.

Action: Arun Hindupur
Where did this change come from and why wasn't it communicated externally?
City to follow up with GWDA for additional information/specifics.

c) **Staff comments**
Concern there is incorrect information related to stormwater management criteria provided by staff at the Site Plan Review Committee meetings. Need to ensure city internal departments are providing the correct criteria.

Action: City to follow up on specifics.

d) **Noise Studies**
Why are Guelph's new noise guidelines more stringent than the provincial regulations? Example provided related to City not accepting board on board fence for noise mitigation, whereby this would meet Provincial standard.

Action: Arun Hindupur
City to follow up with GWDA for additional information/specifics.
Why can't Guelph use the provincial standards?

e) **Legal condo registration process**
Question raised why General Manager is not exercising their delegated authority to sign mylars for condominium registrations expressing opinion that this could save time.

Action: Chris DeVriendt
Review this process with General Manager.

Next Meeting Date: Thursday, April 2, 2020 12:00 – 1:30pm
City Hall, Meeting Room C

WE ARE UPDATING OUR WATER SUPPLY MASTER PLAN!

The City of Guelph is updating the 2014 Water Supply Master Plan (WSMP) to review our municipal water supply sources and identify priorities, including sustainable water supply options from now until 2041.

What is a WSMP update?

The purpose of the 2019 WSMP update is to review and revise the 2014 plan to make it consistent with the current and future needs of the City.

The updated WSMP will provide short-term, mid-term and long-term water supply options to ensure we can continue to meet the demands of Guelph's growing population. When investigating existing and new water supply options we'll consider things like water quality and quantity, climatic conditions, economic factors and any relevant regulations.

Through the WSMP update we'll:

» Identify constraints and opportunities related to our existing water supply system; and

» Evaluate and prioritize individual projects to increase the capacity of our existing system.

Stay informed and engaged!

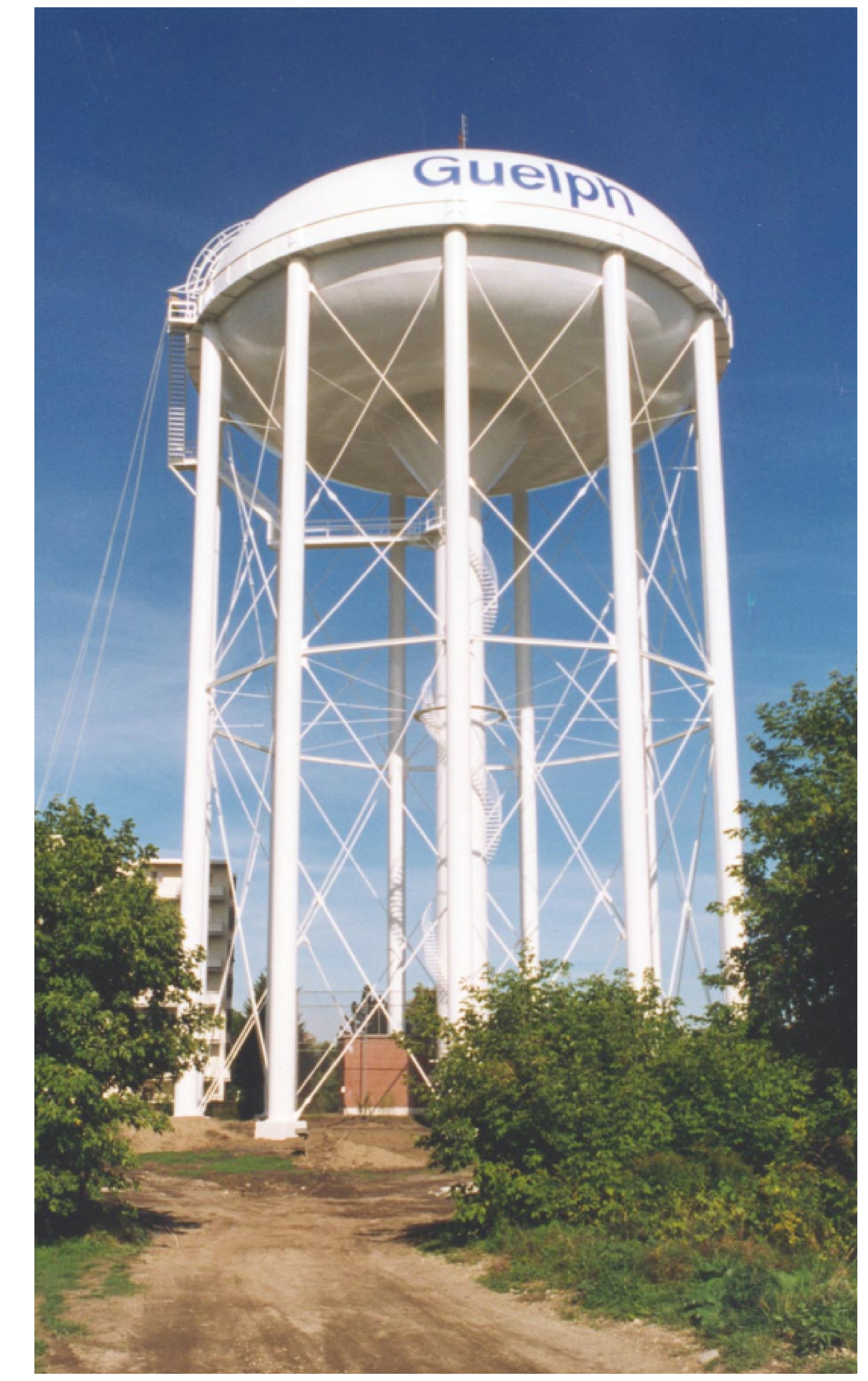
» **Join our Community Liaison Group.** You'll help us set objectives for the WSMP update and assess alternative water supply options. Contact us if you are interested in applying.

» **Attend our Open Houses and let us know what you think.** Our first Open House will be scheduled in early 2020. Dates for this event will be posted at guelph.ca/WSMP, in the City News pages of the Guelph Mercury Tribune and sent to the project mailing list.

» **Read about our progress.** Project information will be posted on our project page guelph.ca/WSMP.

» **Join our mailing list.** Send us your name and how you would like to be contacted (e.g., email or mail) so we can keep you informed.

» **Follow the conversation** on Twitter (twitter.com/cityofguelph) and Facebook (facebook.com/cityofguelph).



Do you have any questions or comments? Contact us:

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Infrastructure, Development and Enterprise
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Matthew Alexander, M.Sc., P.Geo.
Project Manager
AECOM Canada Ltd
519-840-2223
matthew.alexander@aecom.com

CITY OF Guelph
Making a Difference

Water Supply Master Plan 2019 Update

Water Conservation and Efficiency Public Advisory Committee

City of Guelph Making a Difference

AECOM

September 16, 2020

Water Supply Master Plan
guelph.ca/WSMP

Presentation Outline

- Opening Remarks
- 2014 WSMP Preferred Solution
- Enhanced Water Conservation Alternative
- 2016 Water Efficiency Strategy
- Enhanced Water Conservation Program Successes/Challenges
- Water Supply Master Plan Update
- Feedback

2014 WSMP Preferred Solution

1 – Conservation & Demand Management

- Implementation is on-going

2A – Groundwater: Existing Off-Line Municipal Wells

- Clythe in 2024, Sacco in 2029, Smallfield in 2030

2B – Groundwater: Municipal Test Wells

- SWQ in 2019, Logan in 2027, Scout Camp 2036, Hauser post-2038

2C – Groundwater: New Well Inside City

- Sunny Acre in 2033

2D – Arkell Collectors & ASR Wells

- Collector in 2031, ASR post-2038

2E – Groundwater: New Wells Outside City

- Guelph South and North post-2038

3A – Surface Water: Guelph Lake Water Treatment Plant

- post-2038

3B - Surface Water: Guelph Lake Water Treatment Plant & ASR Wells

- post-2038

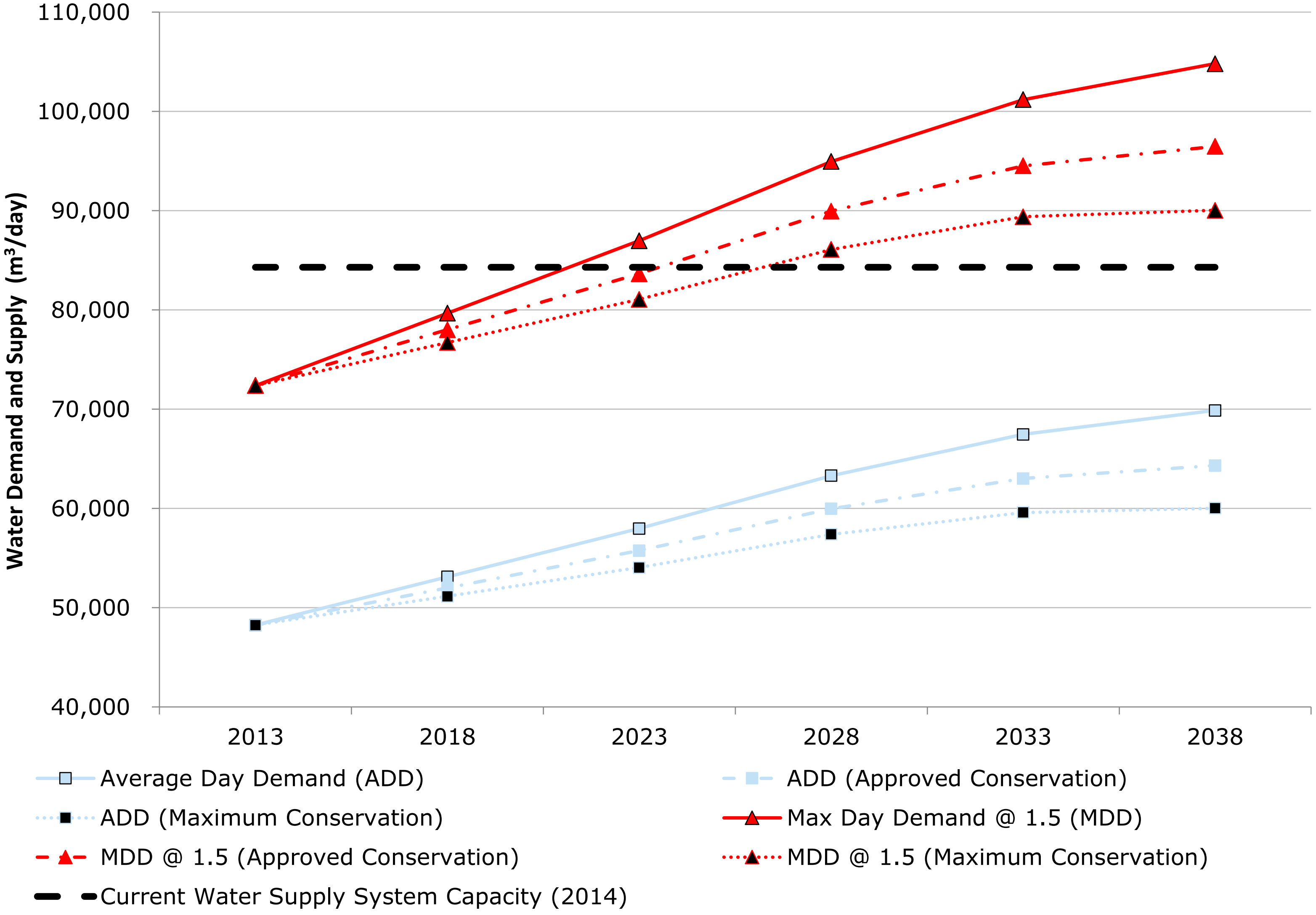
Conservation and Demand Management

- **Enhanced Water Conservation** recommended as primary preferred alternative
    - Average day demand (ADD) reduction target: 9,147 m^3/d by 2038
    - Represents a 13% reduction in projected 2038 ADD
    - Total program cost (to 2038) estimated at $22.6 to 43.8 million
    - ADD reduction results in three water supply projects no longer being required within 2038 planning horizon

Impact of Conservation on Implementation Timeline

Project No.	Project Name	Timing Base Case	Timing Approved Conservation	Timing Enhanced Conservation	Timing Maximum Conservation
Project 1	Ironwood test well	2015	2017	2019	2019
Project 2	Clythe Well	2018	2022	2024	2024
Project 3	Logan test well	2020	2025	2027	2027
Project 4	Sacco Well	2022	2026	2029	2029
Project 5	Smallfield Well	2023	2027	2030	2030
Project 6	Lower Road Collector System	2023	2028	2031	2032
Project 7	Sunny Acre (new well inside City)	2025	2029	2033	2035
Project 8	Scout Camp test well	2026	2030	2036	2038
Project 9	Hauser test well	2027	2033	Post 2038	Post 2038
Project 10	Arkell Collector ASR wells	2028	2034	Post 2038	Post 2038
Project 11	Guelph South (new well outside City)	2030	2038	Post 2038	Post 2038
Project 12	Guelph North (new well outside City)	2034	Post 2038	Post 2038	Post 2038
Project 13	Guelph Lake WTP	2038	Post 2038	Post 2038	Post 2038
Project 14	Guelph Lake WTP and ASR wells in NEQ	Post 2038	Post 2038	Post 2038	Post 2038

Water Demand Projection with Conservation Alternative Scenarios



Water Conservation & Demand Management Post-2014

2016 Water Efficiency Strategy

Preferred water conservation and efficiency programs to achieve WSMP target demand reduction

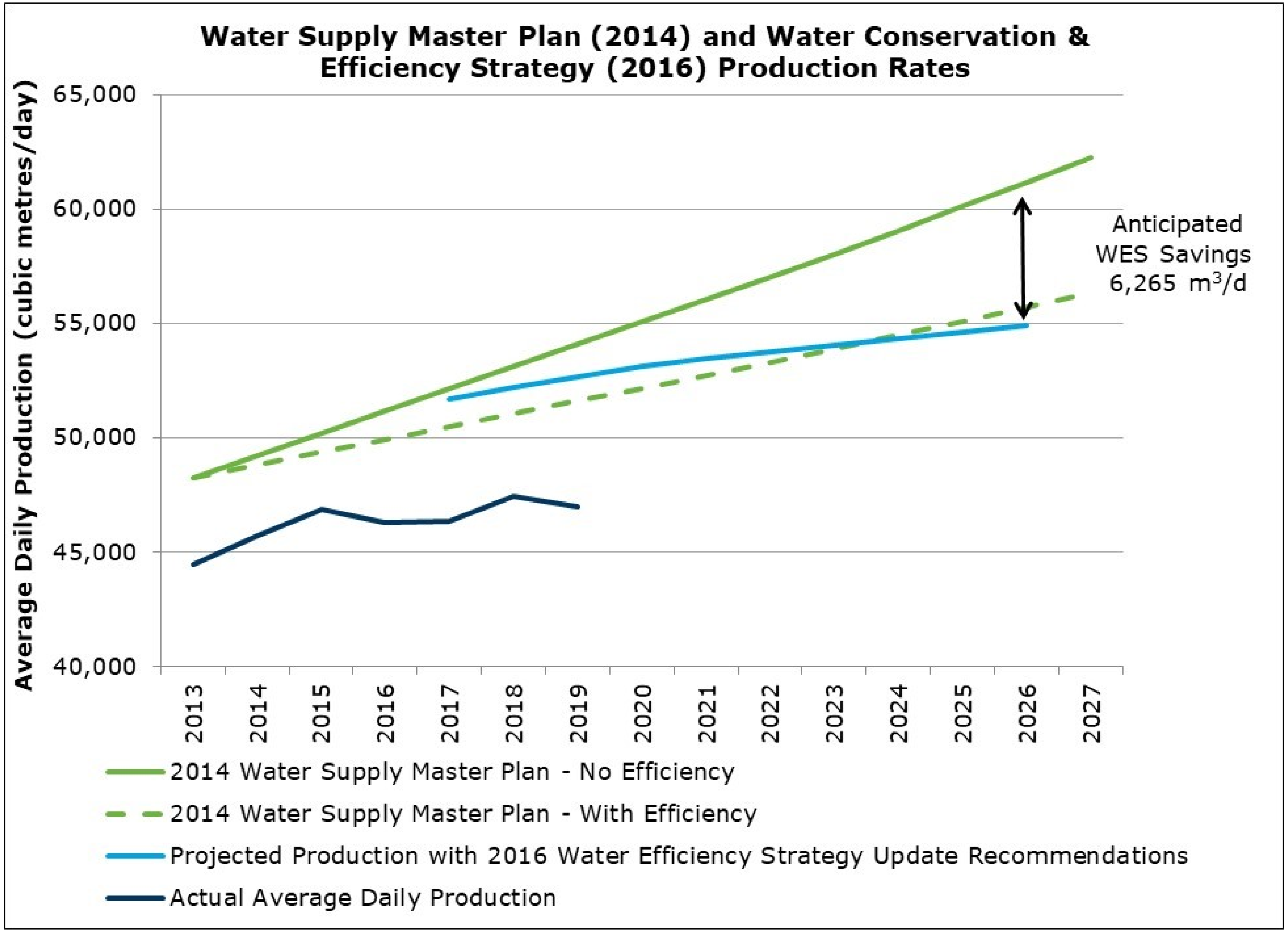
Water Efficiency Strategy community demand management, efficiency and conservation goals:

- Reduce water use as part of new growth
- Develop/ pilot new technologies to save water
- Reduce water use in existing buildings
- The technology is proven and easily implementable in the City
- Stimulate the Guelph economy
- Minimize costs to the City

Final strategy endorsed by Council in September of 2016.

- 10 year, $13.6 million community-driven water efficiency and demand management programming
- Goal: Reduce water use by 6.2 Million Litres per Day by 2026

Water Conservation & Demand Management



Enhanced Conservation Program Successes/Challenges

2016 Water Efficiency Strategy and delivery:

- Saturating “low hanging fruit”; shift in marketplace
- First time addressing multi-residential consumption
- Interdependence of rebate, audit programs
- Expanding residential programming for retrofits
- Formalized pilots and research to support reduction targets
    - App and other technology – stop gap for smart metering technology

Enhanced Conservation Program Successes/Challenges

2016 Water Efficiency Strategy and delivery (continued):

- Improving datasets i.e., multi-residential consumption challenging to quantify, invested in methodology improvement
- Water Smart Business emphasis enhanced; relationship building
- Community interest, want, desire to see water reuse
  - Impacts of residential softeners (to inform update)
  - Establishment of the Stormwater utility, rebates, credits

Enhanced Conservation Program Successes/Challenges

Program	2014-2020 Summary Total Average Daily Water Savings (m^3/d)	2014-2020 Summary Total Units/Rebates/Audits
Blue Built Home	12.3	48
eMERGE Home Tune-up	64.3	1,670
Humidifier Rebate	0.3	3
Leak Detection	10,110.0	105
Multi-Residential Audit	76.7	15
Multi-Residential Sub-metering	8.7	20
Municipal Facility	39.4	7
Royal Flush	623.7	6,779
Smart Wash Rebate	102.6	1,333
Water Smart Business	456.3	10
Totals	11,494.3	9,990

Water Supply Master Plan Update – 2014 Demand Projections

- The 2014 WSMP provided water demand projections until 2038 under both “without water efficiency” and “with water efficiency” scenarios
- The projections included in the 2014 WSMP have been extended until 2041 by assuming that the annual rate of growth between 2033 and 2038 continues until 2041
- This has been done to allow a direct comparison between the 2014 WSMP and the 2019 WSMP values

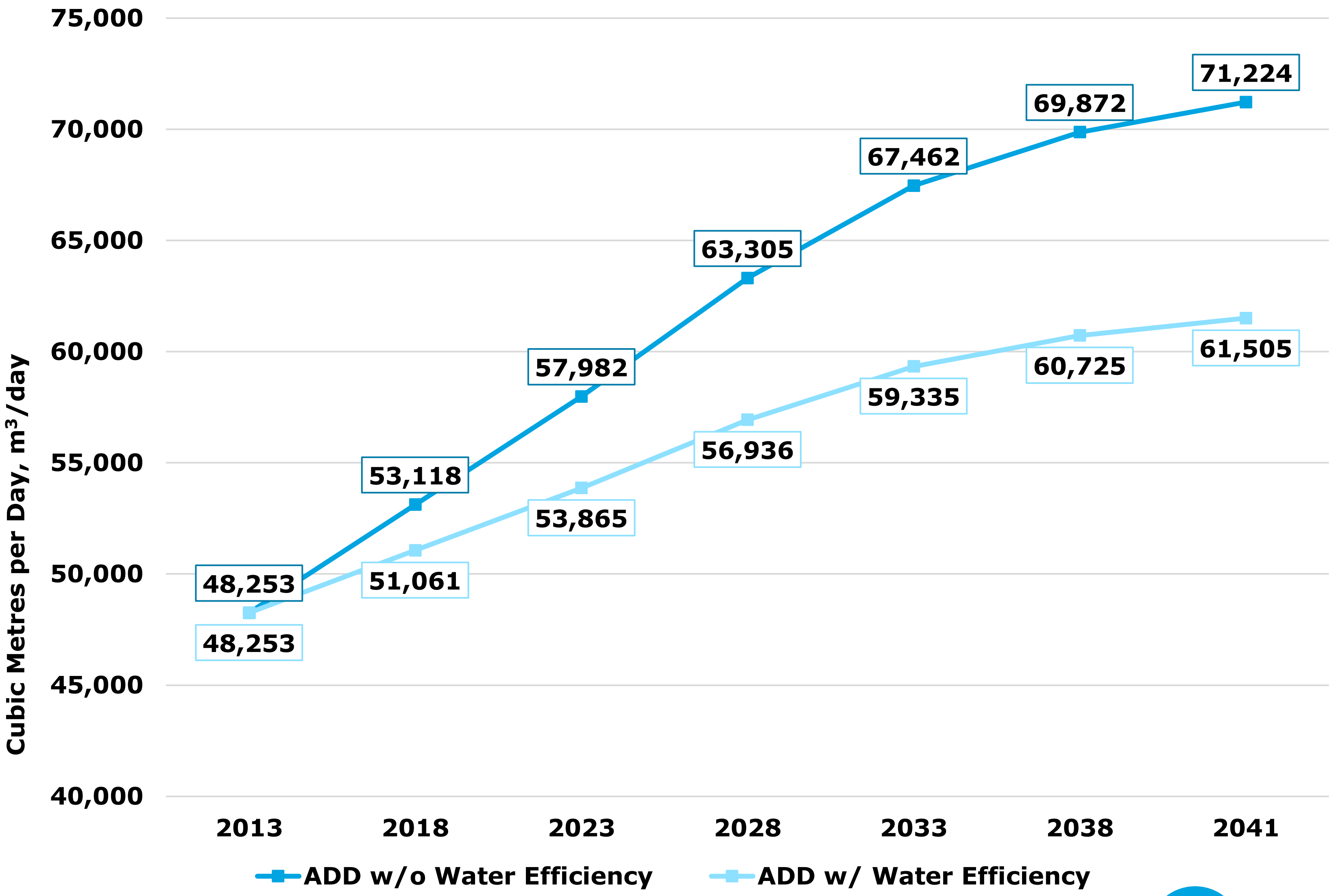
Water Supply Master Plan Update – 2014 Demand Projections

Year	Residential Lcd No Efficiency	Residential Lcd With Efficiency	Employment Lcd No Efficiency	Employment Lcd With Efficiency	NRW Lcd No Efficiency	NRW Lcd With Efficiency
2013	180	180	286	286	43	43
2018	180	173	286	275	43	41
2023	180	167	286	265	43	40
2028	180	162	286	257	43	39
2033	180	158	286	251	43	38
2038	180	157	286	248	43	37
2041	180	156	286	246	43	36

Water Supply Master Plan Update – 2014 Demand Projections

Year	Reference Population	Reference Employment	Average Day Demand, m^3 No Efficiency	Average Day Demand, m^3 With Efficiency
2013	130,670	66,730	48,253	48,253
2018	143,480	73,874	53,118	51,061
2023	156,290	81,017	57,982	53,865
2028	168,190	90,340	63,305	56,936
2033	178,464	96,947	67,462	59,335
2038	186,299	99,480	69,872	60,725
2041	191,000	101,000	71,224	61,505

2104 WSMP Average Annual Day Projections (demands extrapolated to include 2041)



September 16, 2020

Water Supply Master Plan
guelph.ca/WSMP

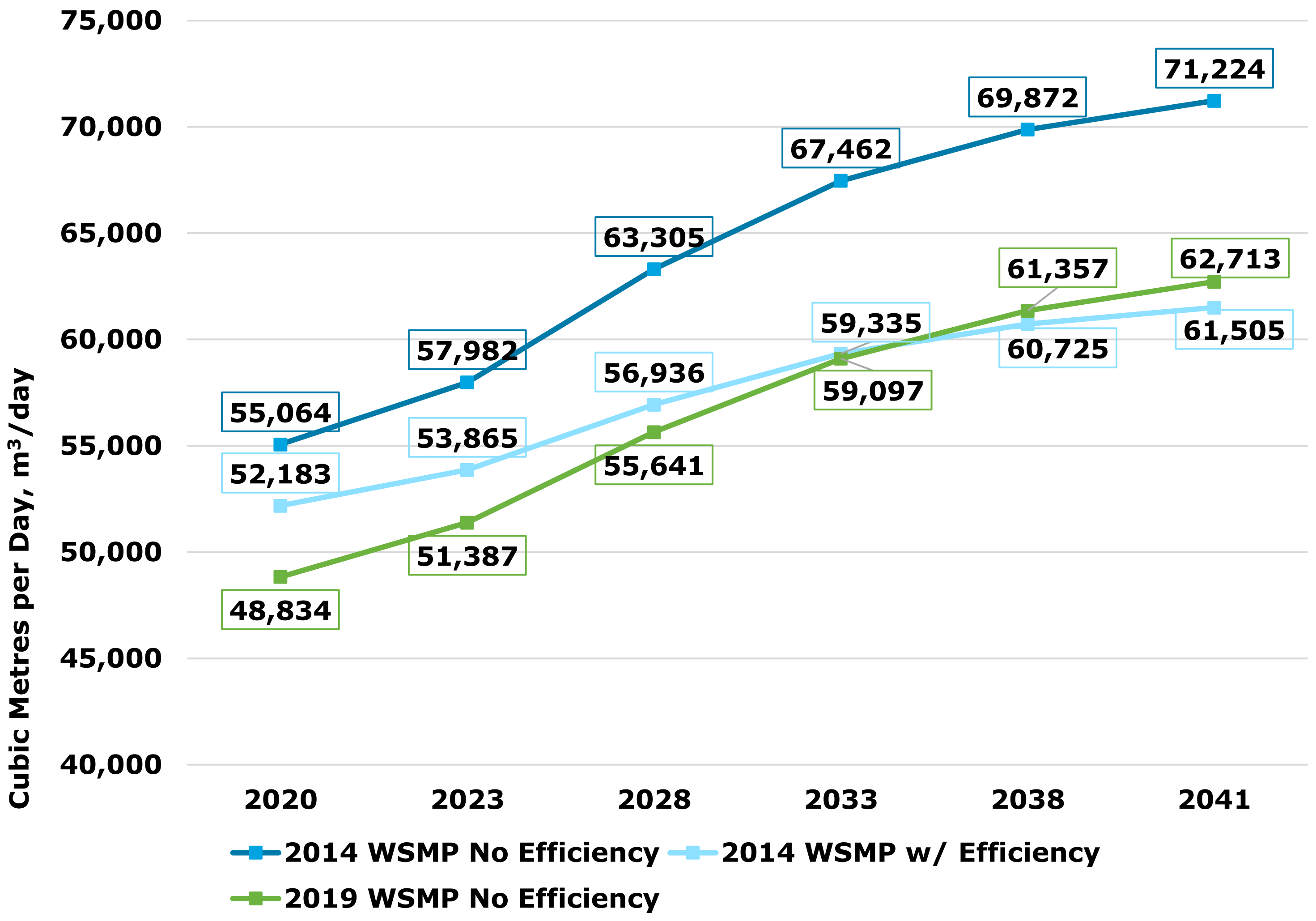
Water Supply Master Plan Update – 2019 Demand Projections

- Between 2014 and 2019 per capita *water demands declined significantly* for several reasons, including:
  - Direct and indirect water savings due to Guelph water efficiency programs
  - Improved codes and standards
  - Improved efficiencies of water-using fixtures and appliances
  - Growing environmental awareness, etc.
- Residential Demands = 167 Lcd in 2019 (vs. 180 Lcd in 2014)
- Employment Demands = 191 Lcd in 2019 (vs. 286 Lcd in 2014)
- Per capita NRW demands fluctuate from year to year but have leveled off at approximately 61 Lcd (vs. an estimated 43 Lcd in 2014)

Water Supply Master Plan Update - 2019 Demand Projections

- As stated earlier, the 2014 WSMP projected:
  - 2041 ADD of 71,224 m^3 <u>without</u> additional efficiency measures
  - 2041 ADD of 61,505 m^3 <u>with</u> additional efficiency measures
- The 2019 WSMP is projecting:
  - 2041 ADD of 62,713 m^3 <u>without</u> additional efficiency measures (i.e. do nothing DIFFERENT scenario)
- The potential for Guelph to reduce the projected 2041 ADD by implementing additional water efficiency measures will be evaluated in the WSMP update
- We know that, when per capita demands are very low, there are fewer opportunities to achieve additional savings

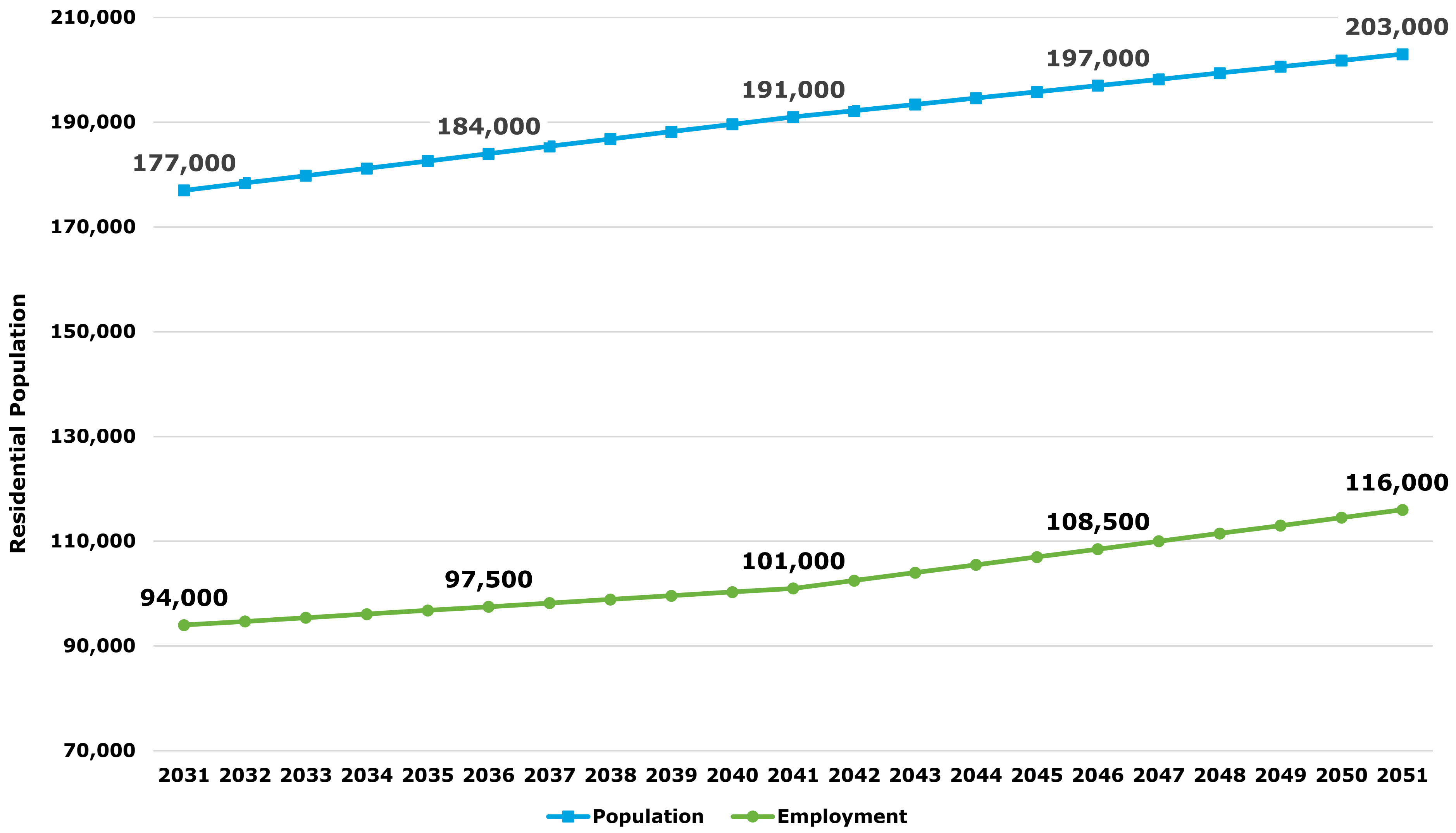
2104 WSMP vs. 2019 WSMP Average Annual Day Demand



Water Supply Master Plan Update – P2G Amendment

- In August 2020, the Province of Ontario's **A Place to Grow Growth Plan for the Greater Golden Horseshoe** (P2G) plan was updated to include population and employment projections until 2051 (vs. 2041)
- This included target population and employment projections for Guelph of 203,000 and 116,000 in 2051, respectively
- Importantly, the amended P2G anticipates a significant growth in Guelph's employment population between 2041 and 2051
- The WSMP demand projections completed to date will be updated to reflect the amended targets

P2G Population Projections for Guelph



Water Supply Master Plan Update – Conservation Target

- WSMP update will review/update 2016 WES water use reduction target by considering:
  - Alignment with Council objectives and public input
  - Conservation/efficiency program successes/challenges to date
  - Potential ‘natural savings’ during planning period
  - Economic benefit to City and water rate payers
  - Potential for water reclamation/re-use, in conjunction with on-going Master Plan update projects: Water and Wastewater Servicing, Wastewater Treatment and Biosolids Management, and Stormwater Management
  - P2G amendment

We'd Like Your Input…

Given the demand reductions achieved to date and projected future demands, should the City be targeting similar future reductions (i.e., ~13%) or a higher/lower target?

Is there a particular water use sector and/or type of program that the City should emphasize in future conservation/efficiency programs?

Other questions/comments?

Thank You!

Meeting Minutes

City of Guelph

Water Conservation and Efficiency Public Advisory Committee (WCEPAC)

September 16, 2020

Online, Webex

From 7:00 to 9:00 p.m.

Meeting Chair: Grant Parkinson (GP)

Vice-Chair: Jaime Boutilier (JB)

Present: David Worden (DW), Eric Meliton (EM), Justin Arbuckle (JA),

Regrets: Louise Cottreau (LC), Robert Orland (RO), Emma Thompson (ET)

Staff: Arun Hindupur (AH), Dave Belanger (DB), Heather Yates (HY), Mari McNeil (MM), Nathan Siniowski (NS), Stephanie Shouldice (SS), Tara Roumeliotis (TR), Tim Robertson (TR), Travis Pawlick (TP)

Guest Presenters: Matthew Alexander (MA) (AECOM), Bill Gauley (BG) (Gauley Associates), Mike Newbigging (MN) (Jacobs Engineering Group)

Agenda Items

Item 1

Procedure using WebEx for Committee of Council meeting –H. Yates

- This session will be recorded.
- Please mute when not speaking to reduce background noise.
- Questions will be held to end of each presentation.
- Questions may be typed into the "Chat" function throughout the presentation; please do not use the Q&A function.
- During the question period, please physically raise your hand or use the "raise hand" button to indicate that you have a question. The Chair will note and call upon meeting attendants in order.

Item 2

Introductions and confirmation of meeting notes (February 5, 2020)– All

Motion: To approve the February 5, 2020 meeting notes.

Motion approved by DW

Motion seconded by JB

Carried

Item 3

Committee updates – departures, extensions, and vacancy posting –H. Yates

Attachment A: WCEPAC Presentation

Sincerest gratitude's extended to LC for completing her maximum number of years on the City's Water Conservation and Efficiency Public Advisory Committee.

There are currently two committee vacancies posted.

Action Item: All committee members are asked to share the vacancies with their networks and any contacts they believe would be interested and valuable to the committee.

Item 4

COVID impacts and program updates –H. Yates

Attachment A: WCEPAC Presentation

Due to Covid-19 most Water Efficiency programs were halted and staff impacted for approximately 3 months this summer. Staff have resumed work and most programs have been reinstated in some form. The Water Smart Business Program is still on hold. Program timelines have been reevaluated and various programs and tools are being adjusted to online formats. For example, the eMerge Home Tune-ups, school presentations, and site tours. The Water Efficiency Team will provide final reporting and project updates to the committee later this year.

Item 5

Water Supply Master Plan Update – Enhanced Water Conservation Scenario Review and Considerations for Setting Future Conservation and Efficiency Targets –M. Alexander, D. Belanger, B. Gauley, and H. Yates

Description: The Water Supply Master Plan project team presented on reduced water production and reclaimed supply since the approved 2014 WSMP Enhanced Water Conservation Scenario. This presentation will be a discussion on program successes and challenges, and considerations in developing water conservation scenarios for the WSMP update.

Attachment B: Water Supply Master Plan Update

The 2014 Water Supply Master Plan highlighted water efficiency's importance. Guelph's per capita water demands have declined significantly for many reasons, including water efficiency program effectiveness. Water efficiency programs to date have resulted in significant water savings that justify the investments made to enhance the community's water supply. The updated Water Supply Master Plan will continue to highlight and lean on water efficiency as the most important, immediate and cost-effective community water supply. The updated Water Supply Master Plan will include a projection for community water use to 2051 both with and without water efficiency measures.

Discussion:

DW: Max day factor is preferred over average day demand and recommends considering the cost saving estimates as well. The savings on an average day in September will be significantly different than on the maximum day in July. It will also be important to consider residential perception around rate increases despite engagement in water conservation efforts due to the resources required for infrastructure upgrades.

MA: Max day factor will be evaluated and extended to 2051. The firm system capacity, infrastructure requirements, maintenance needs, and potential supply impacts (i.e. drought, contamination, well/equipment failure, etc.) will be considered when investigating infrastructure needs.

JB: Guelph has been so successful that a similar target does not seem feasible. Water reclamation is a hot topic in places with high water restrictions and drought prone areas. People in Guelph would like to see how we can utilize this practice.

MA: Agrees. Water reuse is a high priority under consideration.

DB: Also agrees. Notes that water reuse applications will be part of the long-term plans within the Water Supply Master Plan. Regulation constraints and current capacity for practical application create barriers for quick adoption. But they will look at pilot scale projects, feasibility investigations, and planning needs to make water reuse part of the long-term supply solution.

JB: Recognizes water reuse obstacles, especially regulations, but notes that many organizations in Ontario have been talking about water reclamation and might provide good case examples.

GP: Guelph's max day is lower than theoretical factors, which is in our favor correct?

BG: Yes, Guelph's max day factor is low. Guelph does not have a typical municipal water use profile. Sometimes Guelph's day with the highest water use occurs in February when water is run to prevent freezing pipes, instead of during the summer when temperatures are high. This anomaly is likely due to limited irrigation happening in Guelph compared to other municipalities.

GP: City has installed District Metered Areas in recent years across the city. Will this data feed into the Water Supply Master Plan?

HY: District Metered Areas have not been functioning in a way that we can apply the data at this time. Issues are associated with lack of smart meters and aging infrastructure. The Servicing Master Plan will also consider the DMA infrastructure.

EM: For the targeted industrial, commercial and institutional (ICI) sector participants, is there a selection based on the Climate Change Action Plan?

DB: Will take that question under advisement and get back to EM.

RESPONSE UPON FOLLOW UP: that level of analysis of ICI sector consumption/emphasis (especially through Places to Grow amendment) will be addressed through the update to the Water Efficiency Strategy; this is typically when specific sector impact and analysis occurs. Staff will engage with the City's Economic Development team for their advice in this evaluation. The City does not have a climate change action plan. The Community Energy Initiative's sectoral review/representation would also be considered when we get to the Strategy stage when soliciting participation, advice and alignment.

Item 6

Wastewater Treatment and Biosolids Management Master Plan - Mike Newbigging

Description: The Wastewater Treatment and Biosolids Management Master Plan is a long-term plan. It will consider how the City is currently managing and treating wastewater and guides how the City will continue to meet growing community demands over the next 30 years.

Attachment C: WTBMMP Overview

Discussion:

JB: Many downstream communities rely on the Speed River feeding into surface water drinking supplies. But water reuse practices will result in the City discharging less water in the Speed River. Will you be connecting with potentially impacted communities about this?

MN: Plans to discuss impacts with the Grand River Conservation Authority, but will consider whether more communities should be brought directly into the discussion.

TP: The ongoing Assimilative Capacity Study is investigating discharge impacts on the Speed River and considers both water quality and quantity. This study will also inform the Master Plan.

DW: What percentage of our capacity is taken by Rockwood's wastewater? Does their agreement have provisions for expansion if they pay into their proportional use?

MN: It is a small capped amount. Rockwood consists of 2,100 units and a population of approximately 6,000 people. Their wastewater only accounts for approximately 3% of the wastewater transported to the Treatment Plant.

RO: Reducing discharge into the Speed River is likely not a problem due to increase in surface waters from expanded urban areas and impervious surfaces in upstream areas.

TP: In consultation with the Grand River Conservation Authority, various modelling scenarios will be considered.

GP: It is anticipated that climate change will result in slight net water increase in this area.

DB: Climate change modelling for the Tier Three Water Budget did predict more recharge events. With increasing temperature, more freeze-thaw events are anticipated in the winter months that will result in more recharge. But models are still based 50 years into the future with lots of uncertainty. The model presents an interpretation that will be updated in future years and the higher recharge with be re-evaluated.

TP: Encourage any committee members that would like to provide input to sign-up on Guelph.ca to remain connected and updated on Master Plan developments.

Item 7

Water and Wastewater Servicing Master Plan Update–A. Hindupur

Description: The City has progressed in updating this Master Plan since last presenting to WCEPAC in late 2019. This presentation will provide the committee an update on the tasks, deliverables and timeline for the completion of this Master Plan.

Attachment A: WCEPAC Presentation

Studies for the Wastewater Servicing Master Plan began earlier this year. Hydraulic modelling and analysis will take place for the distribution and collection systems once appropriate tools and methods have been determined. Once appropriate tools are established, this analysis will take place under consideration for both existing and potential future circumstances. For example, storm intensities, residential and ICI growth patterns, and plans for intensification corridors. Such factors can all impact infrastructure needs and have associated costs and risks.

A community engagement plan has been developed. It adopts a more virtual approach due to Covid and will include a story map which has been successful for other City master plans.

It is anticipated that a Project File Report collating this information will be completed within one year to a year and six months from now.

Discussion:

AH: Requests continuation to final slide before questions and comments.

No objection from the committee.

GP: Approves continuation onto item 8 before questions are posed.

Item 8

Stormwater Management Master Plan –A. Hindupur

Description: The City has progressed in updating this Master Plan since last presenting to WCEPAC in late 2019. This presentation will provide the committee an update on the tasks, deliverables and timeline for the completion of this Master Plan and solicit feedback on the interplay with the water efficiency mandate of the committee.

Attachment A: WCEPAC Presentation

As part of this project, staff will be examining existing stormwater management facilities throughout the City for their design and functionality. Consideration will be made for how inefficient facilities can be addressed as well as opportunities to install retrofits in areas where no current stormwater management facilities exist.

A watercourse condition assessment will be conducted to evaluate erosion along watercourses. Anecdotal reports and observations suggest that watercourse erosion is not a major issue in Guelph. Proactive measures will still be taken to consider where issues may lie and devise mitigation strategies.

Hydraulic modelling and analysis will also be conducted to develop a comprehensive overview of the stormwater system.

To understand current and future infrastructure needs, an updated analysis of our Rainfall and Intensity Duration Frequency Curve will take place. This analysis considers current and future anticipated precipitation trends. A stormwater management and drainage assessment will be conducted to understand how the system reacts to these weather conditions. The output from this assessment is a new capital infrastructure plan.

Standard stormwater management criteria for developers is that 80% of suspended solids must be removed from the water. This project will consider where this standard is acceptable and where more strict or specific criteria is needed.

Low Impact Development is a green infrastructure standard that is gaining attention. In Guelph, we need to consider the impacts of Low Impact Development on our groundwater quality. Because this form of stormwater management encourages infiltration there are associated source water protection implications.

Communications and community engagement around this project will be virtually based. This work will include an interactive map that allows people to identify where they have seen flooding or erosion in the community.

It is anticipated that this project will take approximately one year and result in a final Project File Report and Innovation Strategy.

Discussion (Items 7 and 8):

EM: Has the City incorporated ICI surcharge reconciliations for Low Impact Development or green infrastructure projects?

AH: Yes, the City offers both a residential and ICI credit rebate program. ICI uptake has been modest, though applications are received every year.

EM: In City of Mississauga and Brampton design and implementation loans are offered to increase the return on investment for ICI. Research suggests that upfront design costs are a limiting factor. Funding this project aspect has been helpful for increasing interest and uptake.

AH: Will connect further with EM about this approach.

RO: Will the City investigate to ensure the developer followed through on the approved plan?

AH: The City can conduct inspections.

GP: In recent years, land development patterns have shifted towards intensification. This leads to greater impervious areas instead of sprawl. Is this impacting the Master Plan?

AH(subsequent editing by **HY** for clarity)**:** The impact has not been as prominent as expected. There are more stormwater issues where infrastructure is old, not as prevalent in the new areas. We are not seeing many new stormwater issues – with the exception, as anticipated, of St. Patrick's ward (a portion of Guelph's Ward 1).

Item 9

Next meeting –H. Yates

The next Water Conservation and Efficiency Public Advisory Committee Meeting is scheduled for December 9, 2020.

Item 10

Meeting ended at 9:18 pm.

Water Supply Master Plan 2021 Update

Water Conservation and Efficiency Public Advisory Committee

Presentation Outline

- Summary of Water Supply Requirements to 2051
- Overview of Water Supply Alternatives
- Environmental Assessment Evaluation Criteria
- Preliminary Preferred Solution
- Q&A, feedback

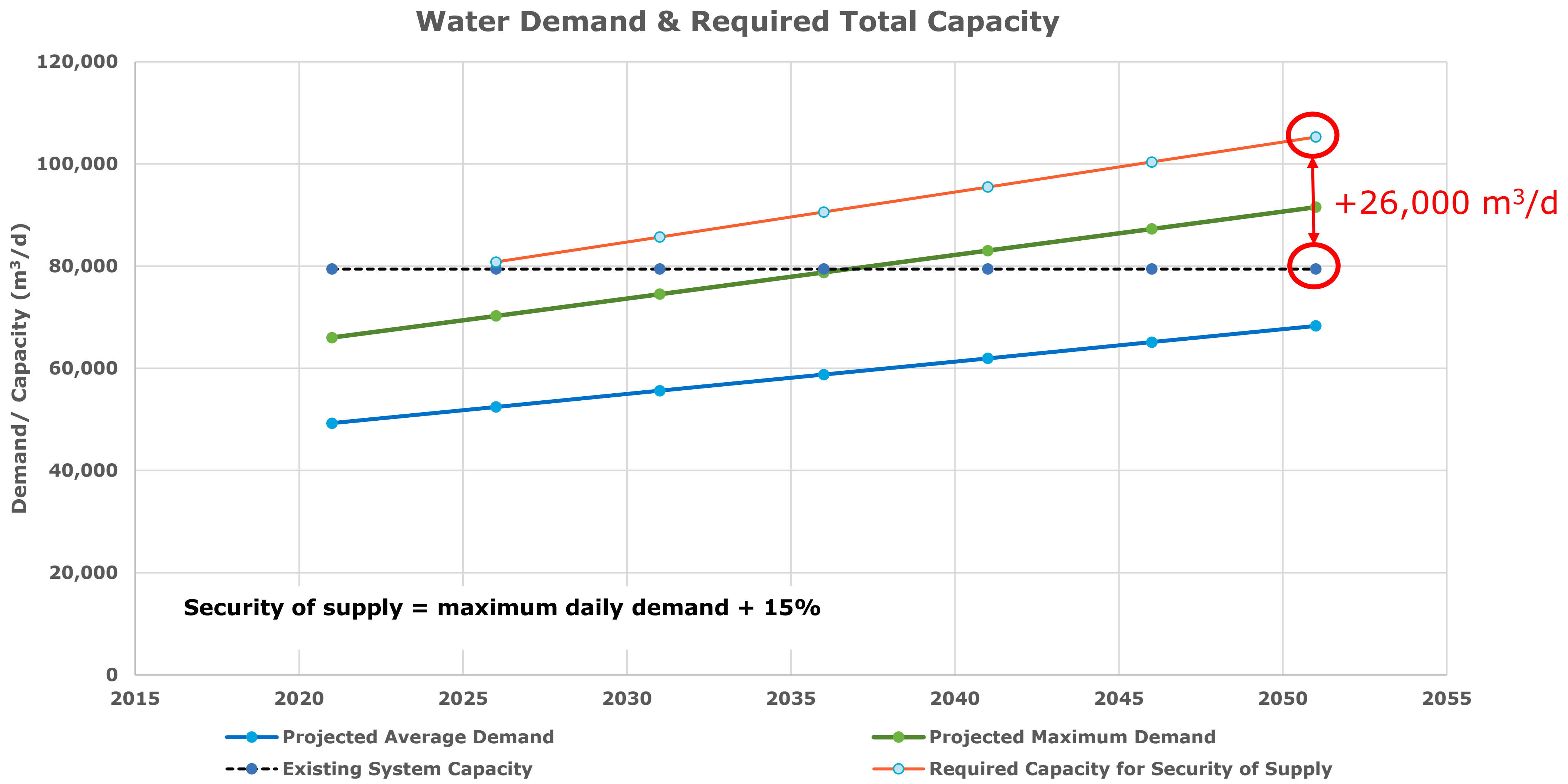
Water Supply Master Plan Update

Summary of water supply requirements

September 28, 2021

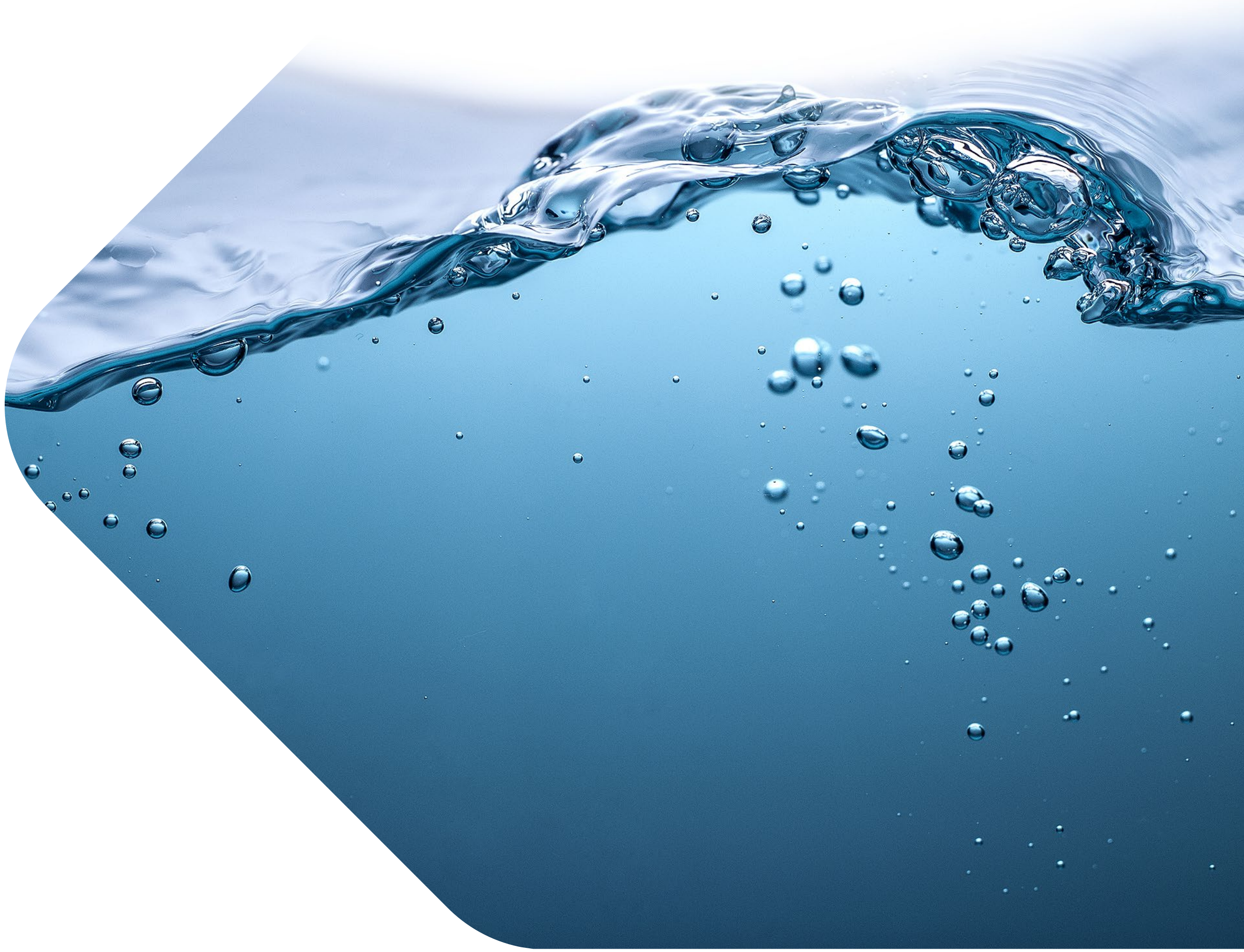
Water Supply Master Plan
guelph.ca/WSMP

Required Capacity for Security of Supply



Water Supply Master Plan Update

Task 4 – Water Supply Alternatives Assessment



September 28, 2021

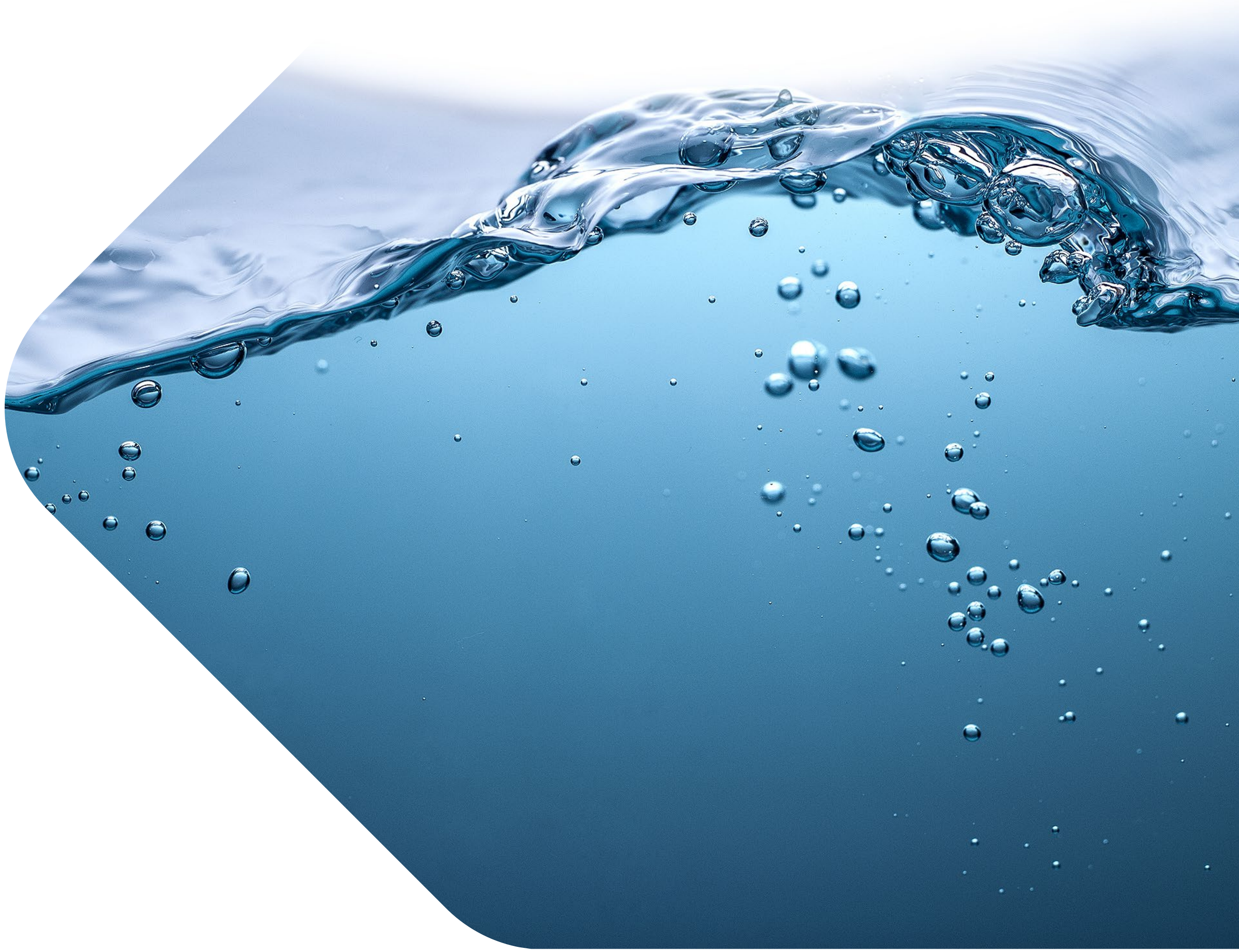
Alternatives Assessment

Assessment of proposed water supply alternatives under consideration:

1. Water conservation, efficiency and demand management, including water reuse
2. Optimize and expand existing groundwater system
3. Establish new surface water supply
4. Limit growth/ do nothing

Water Supply Master Plan Update

Water Supply Alternatives – Water Conservation and Efficiency



City of Guelph
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September 28, 2021

Water Supply Master Plan
guelph.ca/WSMP

Conservation/ Efficiency Programming Scenarios

- Four scenarios to investigate future demand reduction and associated costs:
  - 1 – Static Residential and ICI per capita demands
  - 2 – Demand Reduction of 6.5% in 2051
  - 3 – Demand Reduction of 3.25% in 2051
  - 4 – Demand Reduction of 7.3% in 2051

Non-revenue Water

Economic Level of Leakage (ELL): point at which the cost of lost water (leakage) = costs of leakage prevention programs

Infrastructure leakage index (ILI) = Real Losses / Unavoidable Real Losses

- ILI=2.0 for Guelph in 2019
- Other jurisdictions (UK, Australia) have reported ELL when the ILI is below 3
- Results indicate that Guelph is near or at its ELL
- Recommended focus in future is to maintain the ILI, or improve where possible

Scenario 1

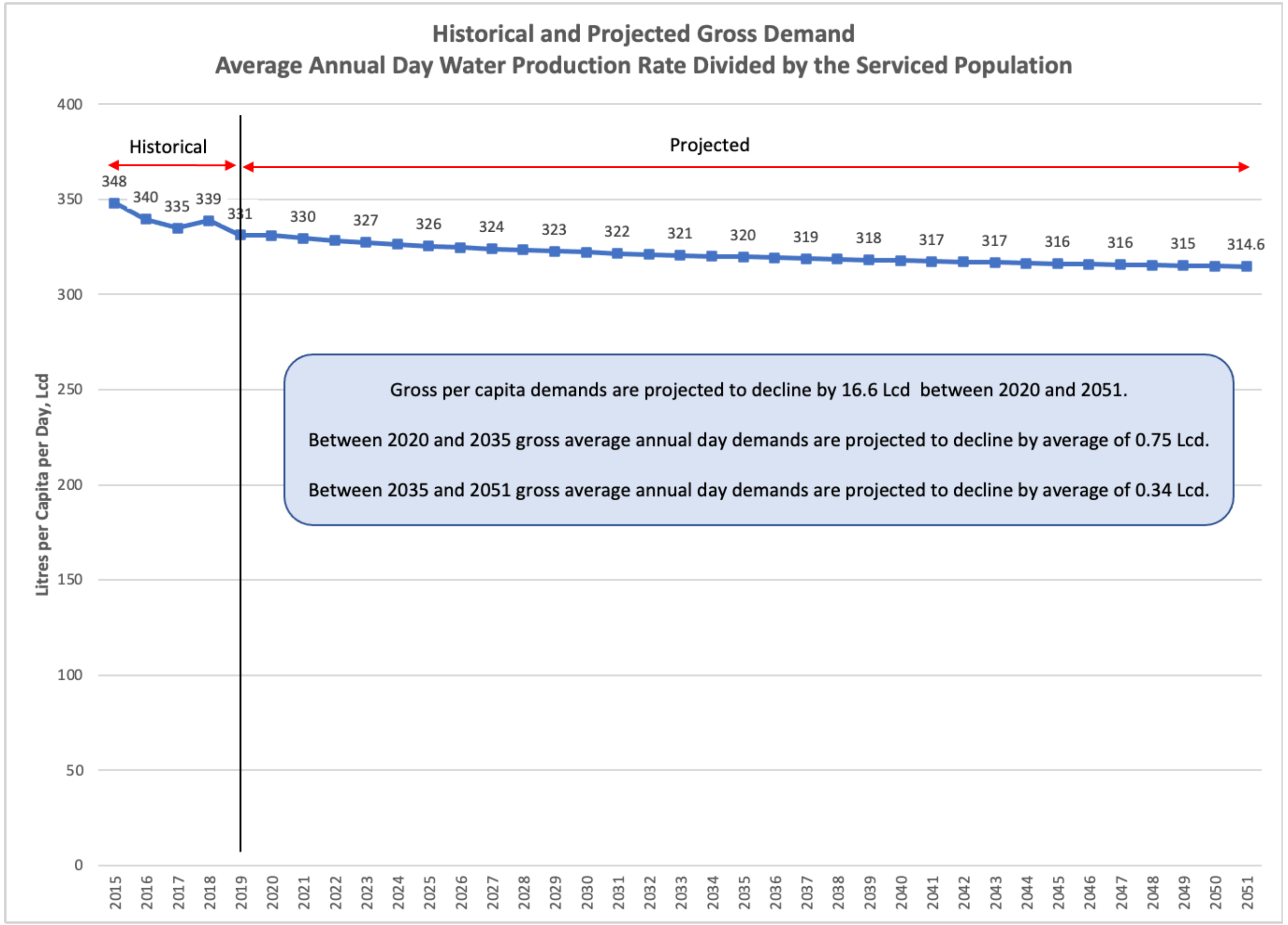
- Assumes the City ceases non-mandatory programming
- Sets a baseline against which to compare scenarios
- Based on effort City has put into educating public, no resulting increase in demand is anticipated
- Scenario does not reduce demands
- No cost associated with scenario

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	166.6	203,000	33,814
Employment	191.0	191.0	116,000	22,155
NRW	60.8	60.8	203,000	12,338

Total is 68,305 m^3/day (2051)

Scenario 2

- Continuation of current level of programming
- Decline in per capita demands has slowed over time
- Apply avg. rate of per capita demand decline observed from 2015-2019 as target for future decline
- Requires regular review of programs, replace those no longer effective
- Assume matching target reductions for residential and ICI



Scenario 2

- Results in 6.5% decline in 2051 demand
- Reduction of ~4,400 m^3/day vs. Scenario 1
- Associated cost estimate: $11.41 M or $2,600 m^3/day; $380,000/a operating costs

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338

Total is 63,882 m^3/day (2051)

Scenario 3

- Acknowledges that effective conservation and efficiency programming becomes more challenging with success
- City may elect to focus programs on high water use customers if per capita demand trend continues to stabilize
- Approach would result in lower demand reduction at a lower cost to City
- Overall reduction of 3.25% in 2051 demand
- Reduction of ~2,200 m^3/day vs. Scenario 1
- Associated cost estimate: $4.73 M or $2,100 m^3/day; $158,000/a operating costs

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	159.9	203,000	32,460
Employment	191.0	183.5	116,000	21,288
NRW	60.8	60.8	203,000	12,338

Total is 66,086 m^3/day (2051)

Scenario 4

- Addition of water reuse opportunities to Scenario 2 demand reductions
- Most aggressive option – highest demand reduction and program costs
- Review of water reuse options previously compiled
- Consideration of those most likely to reduce average daily demand (i.e., remove seasonal uses like irrigation)
- Total daily savings of 528 m^3/day estimated

Measure	Annual Savings, m^3	Average Annual Day Savings, m^3/day
Street sweeping	3,175	8.7
Sewer flushing	11,223	30.7
Urban applications	168,168	460.7
Construction	10,160	27.8
Municipal irrigation	8,800	24.1
Golf course irrigation	147,000	402.7
Total	348,526	955
Total without Irrigation	192,736	528

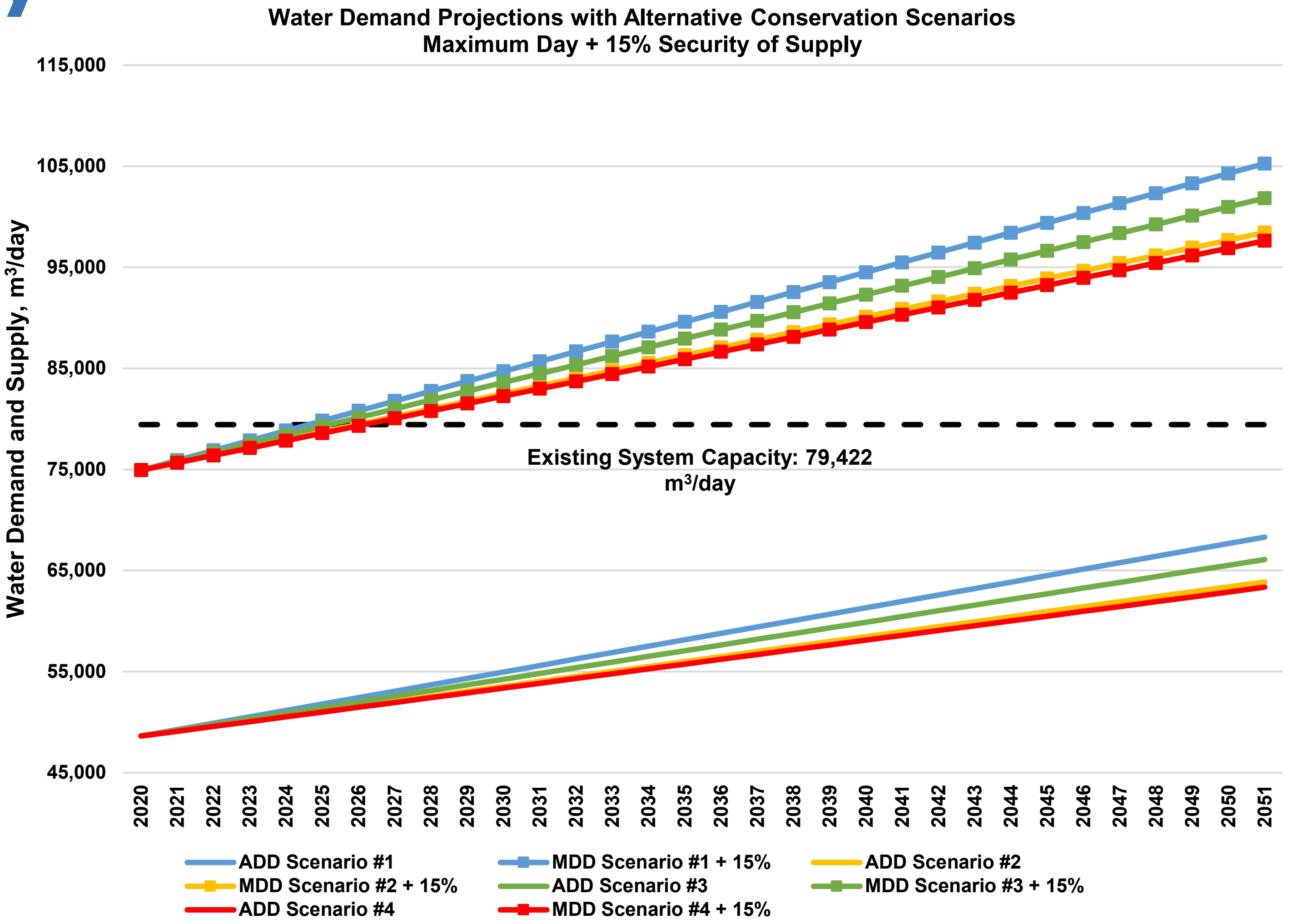
Scenario 4

- Overall reduction of 7.3% in 2051 demand
- Reduction of ~4,900 m^3/day vs. Scenario 1
- Associated cost estimate: $15.04 M or $3,000 m^3/day; $586,000/a operating costs

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338

- Total Potable is 683,992 m^3/day (2051)
- Minus Estimated Water Reuse Savings -528 m^3/day (2051)
- **Total Potable Minus Reuse is 63,354 m^3/day (2051)**

Conservation/ Efficiency Programming Scenario Summary



Water Supply Master Plan Update

Water Supply Alternatives – Groundwater Sources

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September 28, 2021

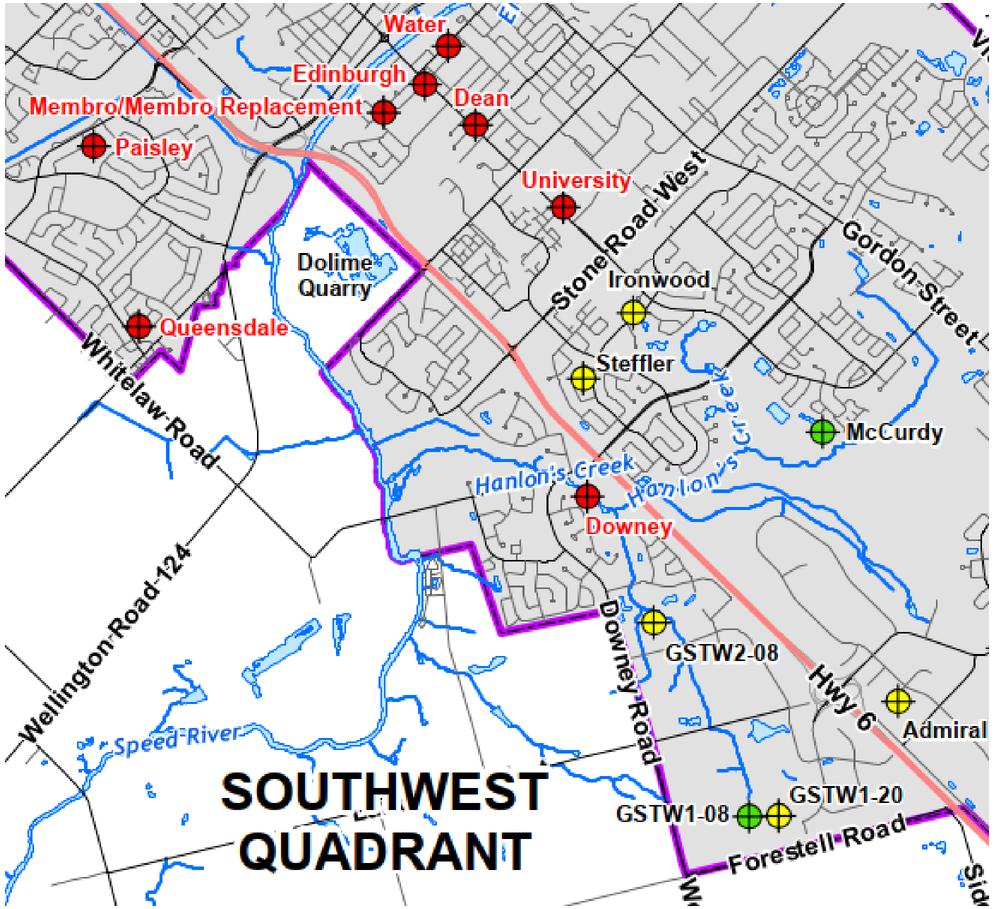
Groundwater Alternatives

The potential opportunities for expansion of the existing groundwater supply system are grouped into the following alternatives:

- **Optimize** existing operating municipal sources
- **Restore** existing off-line municipal wells
- **Develop** existing municipal test wells
- **Install new wells inside** City boundaries (screened out through prelim. modelling)
- **Install new wells outside** City boundaries
- **Install new ASR wells** inside City to optimize excess Arkell Collector system volumes

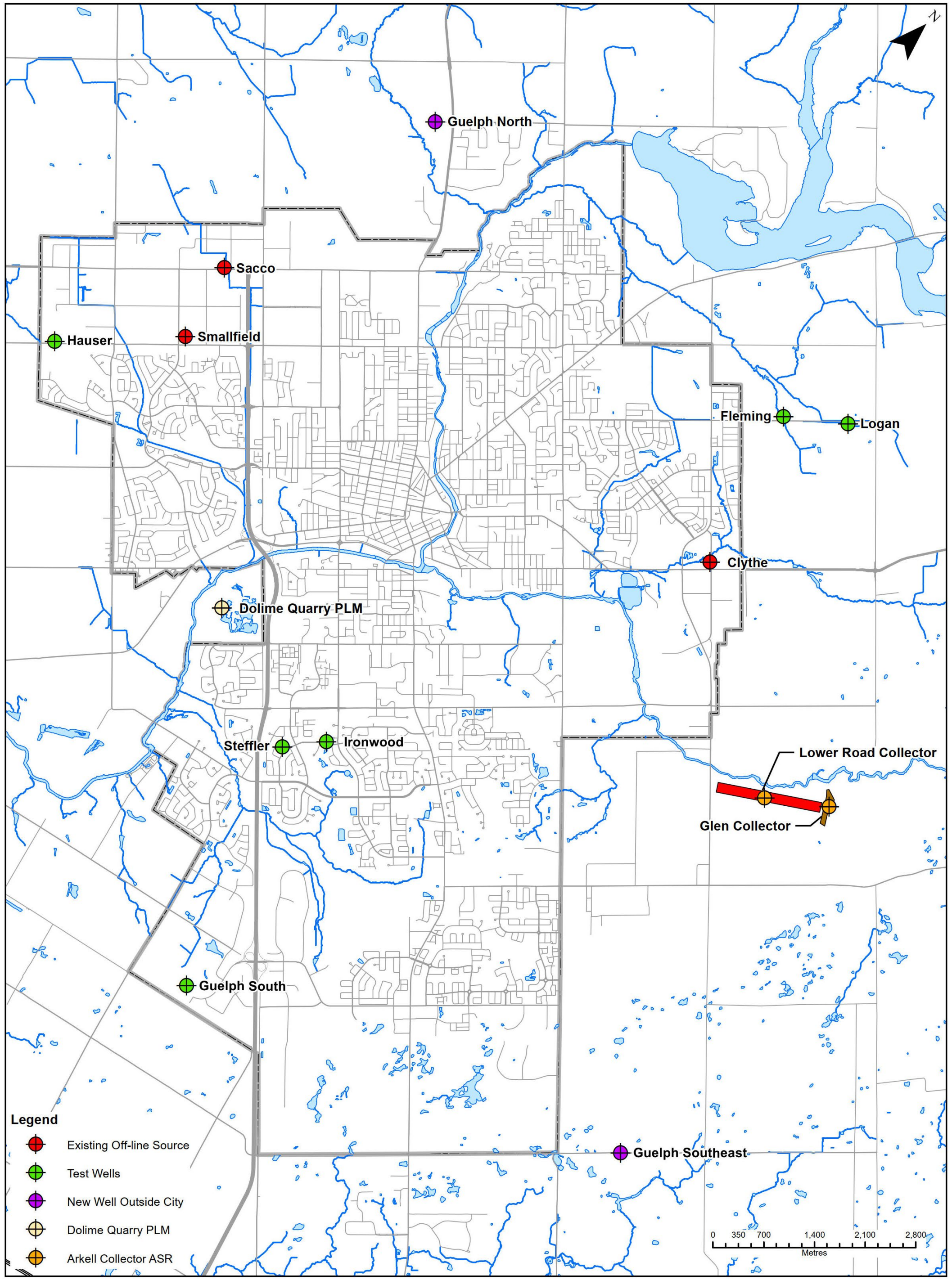
Optimize existing operating municipal wells

- Reviewed optimization opportunities through historical well performance and discussions with Operations staff
- Potential for additional capacity from Downey Well
  - Located within southwest quadrant
  - Must be evaluated alongside test wells in quadrant
  - Consideration of Dolime Pond Level Management
  - Detailed assessment of additional water supply to be completed through Southwest Guelph Water Supply EA



Off-line/ New Sources

- Four off-line sources shown in red
- Six test well locations shown in green



Restore existing off-line municipal wells

Quadrant	Well	Required Upgrades	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Northeast	Clythe	Well house upgrade; H_2S, Fe&Mn treatment (EA complete)	1,180-3,400	$6.8M	$2,000
Northwest	Sacco/ Smallfield	wellhouse upgrade; VOC treatment	850-2,560	$13.1M	$5,100
Southeast	Lower Road Collector	new perforated pipe system & associated infrastructure	4,000	$14.67M	$3,700
		Total	**6,030**		

- Uncertainty about Clythe Creek requires additional field program to address as part of PTTW
- Sacco/ Smallfield alternative assumes combined treatment facility on Smallfield property; MECP correspondence: achieving clean up goals (i.e. ODWQS by 2051) is unlikely
- Full re-construction of Lower Road Collector anticipated; additional modelling recommended to optimize design; would benefit from recharge system upgrades
- Additional capacity in table represents modelled long-term average
- Costing developed for maximum capacity where existing data are available

Develop existing municipal test wells

Quadrant	Well	Required Infrastructure	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southwest	Guelph South	SWG EA/OTP; land acquisition; well house; connect to distribution	2,250-4,300	$5.3M	$1,200
Southwest	Ironwood/ Steffler	SWG EA/OTP; well house; disinfection; connect to distribution	2,250-8,000	$5.1 to 6.2M	$650 to 1,700
Northeast	Logan/ Fleming	new well; well house; connect to distribution	4,180-4,700	$10.1M	$2,150
Northwest	Hauser	new well; property in area; well house; connect to distribution	425-900	$6.6M	$7,300
Total			**9,105**		

- Modelled long-term average additional capacity of 4,500 m^3/day in SWQ (with active Dolime Quarry dewatering)
- Southwest Guelph EA initiated to assess additional water supply in SWQ in detail
- City has initiated project on Logan site to re-construct and test well

Assessment of Dolime Pond Level Management

Quadrant	Source	Required Infrastructure	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southwest	Dolime	SWG EA/OTP; pumping station; WTP (if supply is direct from quarry); connect to distribution	3,000	$18.9M	$6,300

- SWG Class EA will assess optimal strategy for capturing available water
- Water quality assessment will determine treatment requirements
- Capture of quarry water would reduce current artificial discharge to Speed River – not relied upon for WWTP assimilative capacity
- Cost would be reduced if additional capacity is captured by surrounding wells

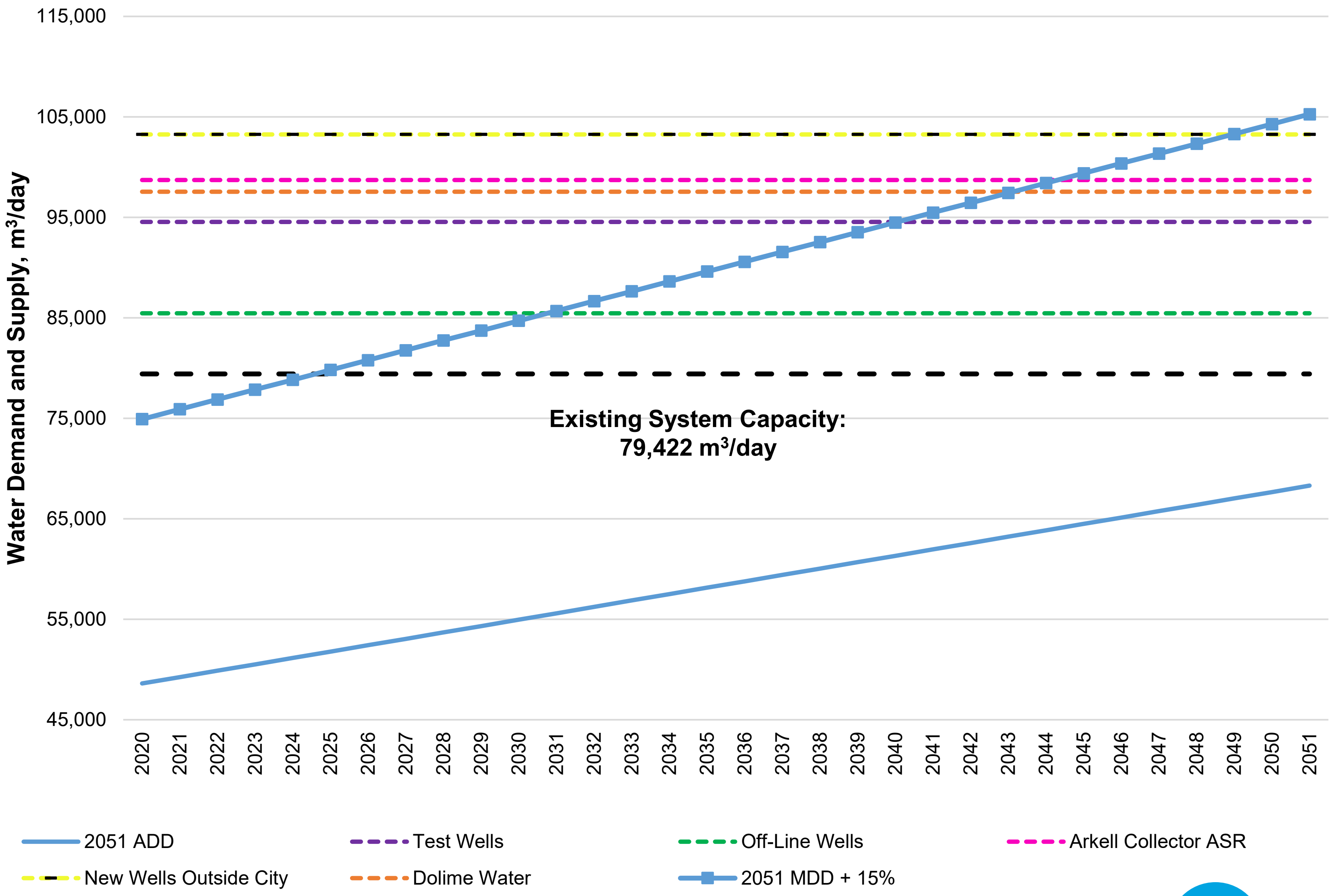
Install new wells outside City boundaries – Guelph North

- Approximate location – G-E Township North of the City (City does not currently own land here)
- Consultation and collaboration with G-E Township
- Rationale - proximity to an area with high transmissivity within the Gasport aquifer
- Estimated available capacity – 2,935 m^3/day on an average basis
- Model output: >10% baseflow reduction to Marden Creek; near the Marden South PSW Complex
- Field study would assess potential for interference with G-E Township wells, private wells
- Fe&Mn treatment assumed as conservative cost assumption
- Estimated capital cost: $12.8 M, $4,375/$m^3$

Install new wells outside City boundaries – Guelph Southeast

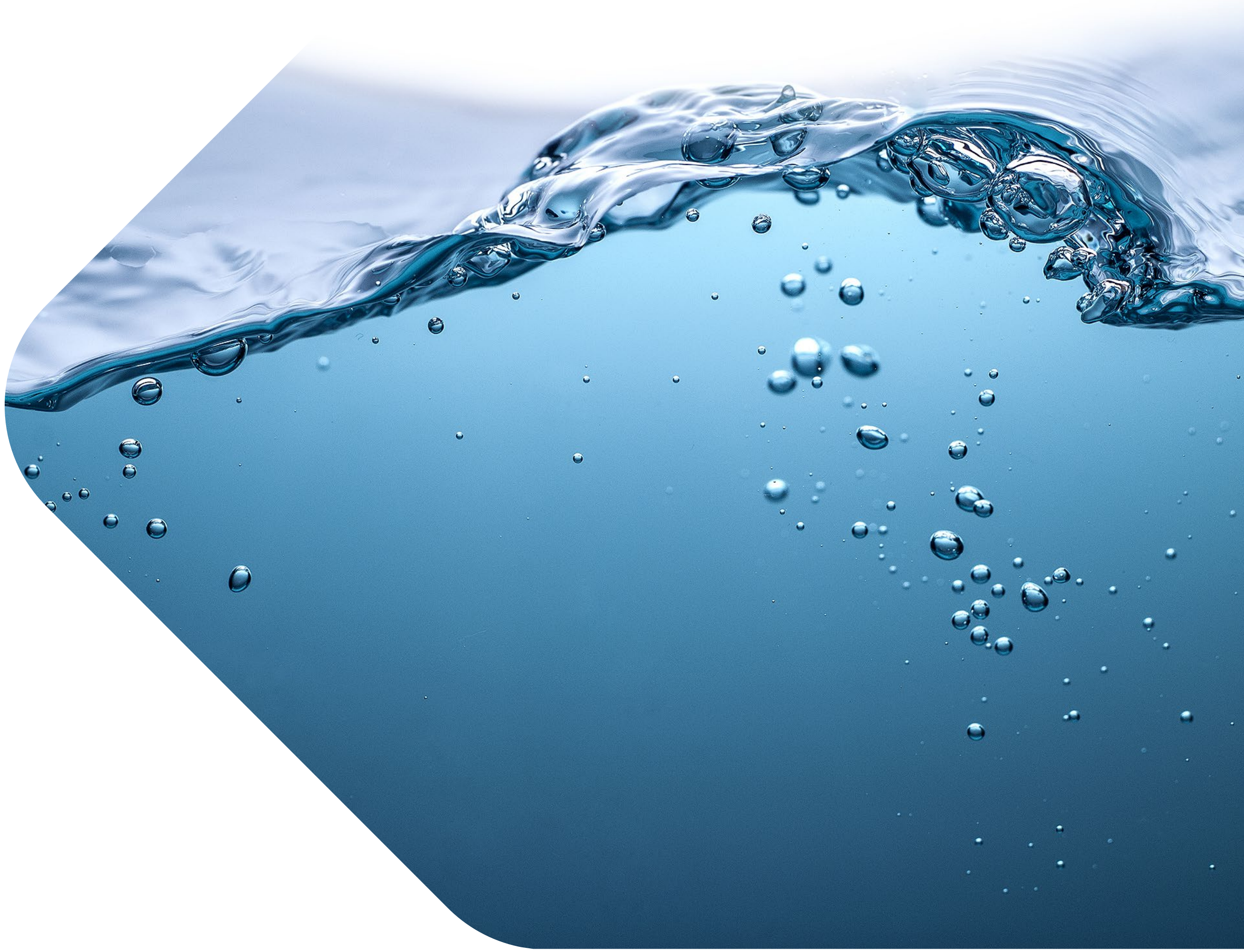
- Approximate location – in Puslinch Township southeast of the City (City does not own land here)
- Consultation and collaboration with Puslinch Township
- Rational - Proximity to area with high transmissivity within the Gasport aquifer and limited local groundwater usage
- Estimated available capacity – 1,600 m^3/day on an average basis
- Model output: <10% baseflow reduction to Mill Creek; near Arkell Bog PSW Complex
- Field study would assess potential for interference with private wells
- Fe&Mn treatment assumed as conservative cost assumption
- Estimated capital cost: \$10.3 M, \$6,400/m^3

Groundwater Alternative Summary



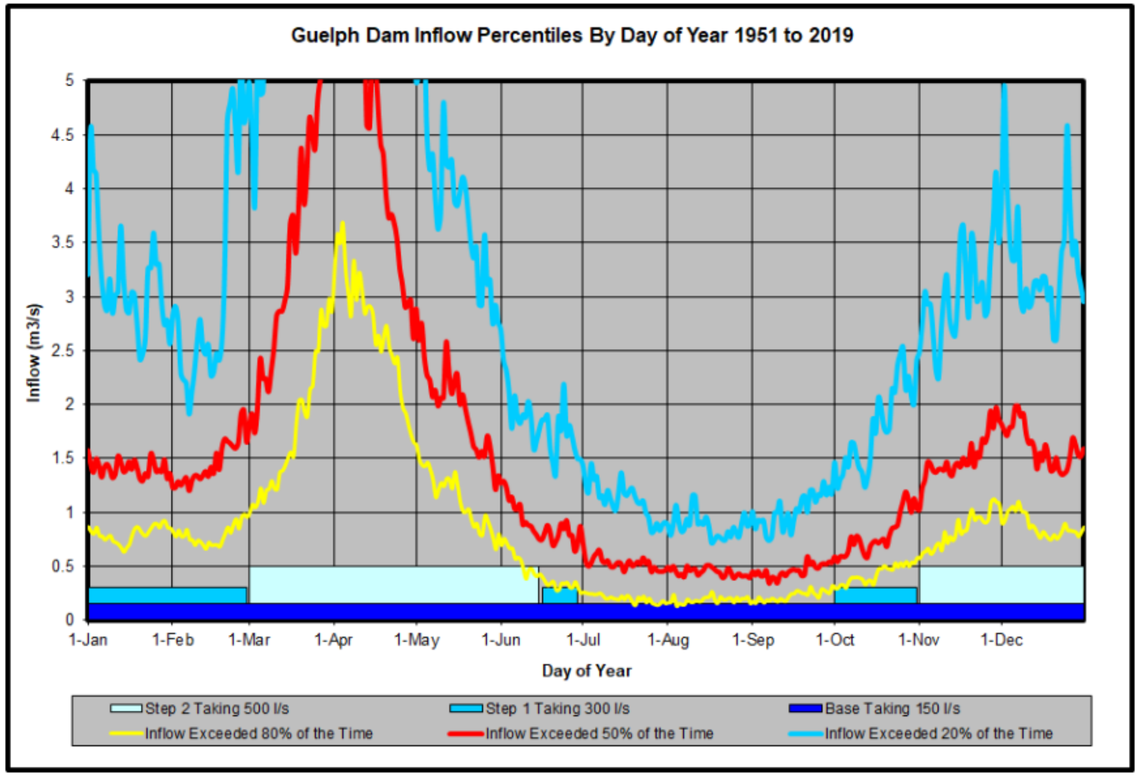
Water Supply Master Plan Update

Surface Water Alternatives Assessment



September 28, 2021

Surface Water – Guelph Lake



<u>Guelph Lake Yield Analysis (GRCA):</u>

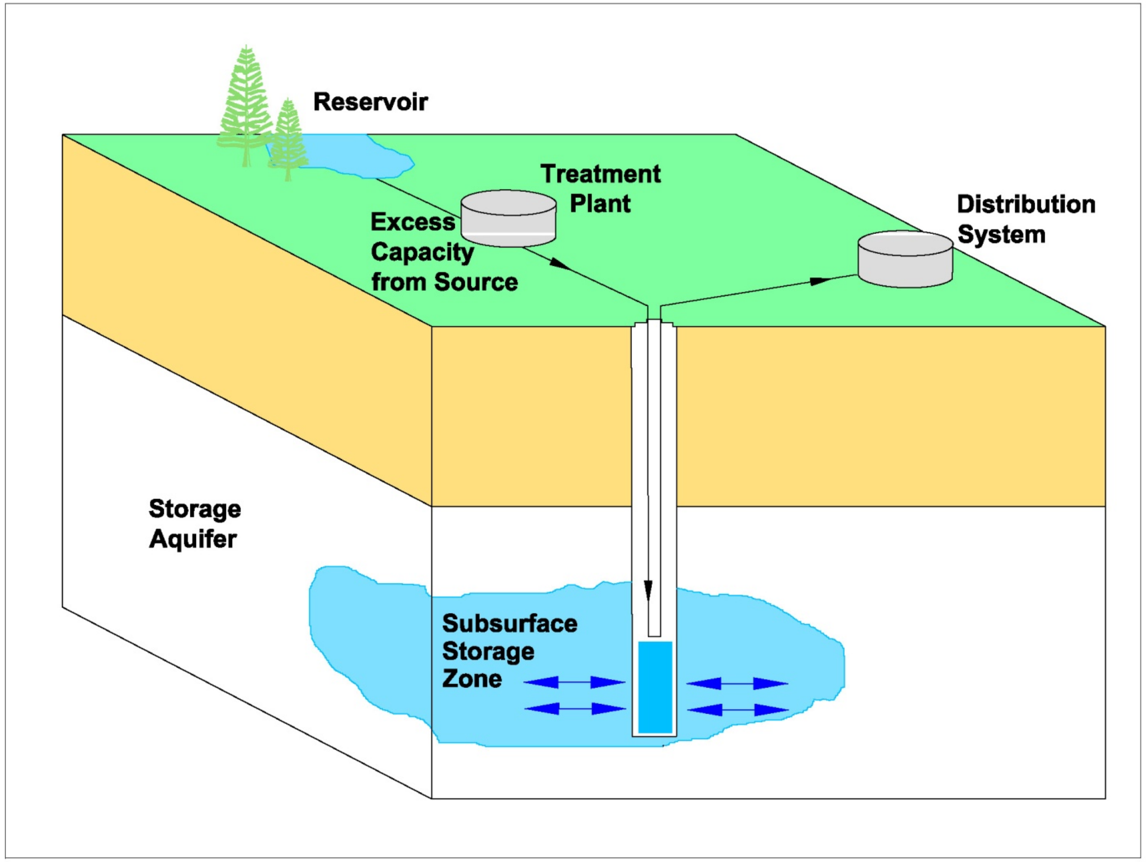
- Modelling results indicate that there is a potential for proposed stepped taking: 150 L/s and 300 L/s
- 500 L/s step dismissed for two reasons:
  - not practical to build a WTP for three months
  - flow cannot be injected in a reasonable number of ASR wells
- ASR alternative assumes base taking of 150 L/s with increase to 300 L/s for nine months of the year

Summary – Guelph Lake Water Treatment Plant

Location	**WTP at Guelph Lake or NE part of City**
Description	Surface WTP consisting of conventional/ advanced treatment and distribution pipeline
Intake Rate (m^3/d)	12,960 (continuous annual base taking of 150 L/s)
Distribution Rate (m^3/d)	12,300
Existing Approvals	None
Required Approvals	• Class EA – Schedule C • Municipal – City and Township • MNRF/ MECP - PTTW (Surface Water) • ECA/ DWL • GRCA
Water Quality Issues	High turbidity, colour, odour
Environmental Constraints	Area affected includes Guelph Lake and its associated wetland and aquatic features
Past Studies/Work	GRCA review of water taking reliability
Required Studies	• Field investigations; environmental baseline/ impact • Feasibility Studies • Treatment study • Class EA
Required Infrastructure	• Water intake structure • Surface water treatment plant & associated infrastructure • Connection to distribution water main
Estimated Capital Cost	$ 51,322,000
Cost per m^3/day	$3,960

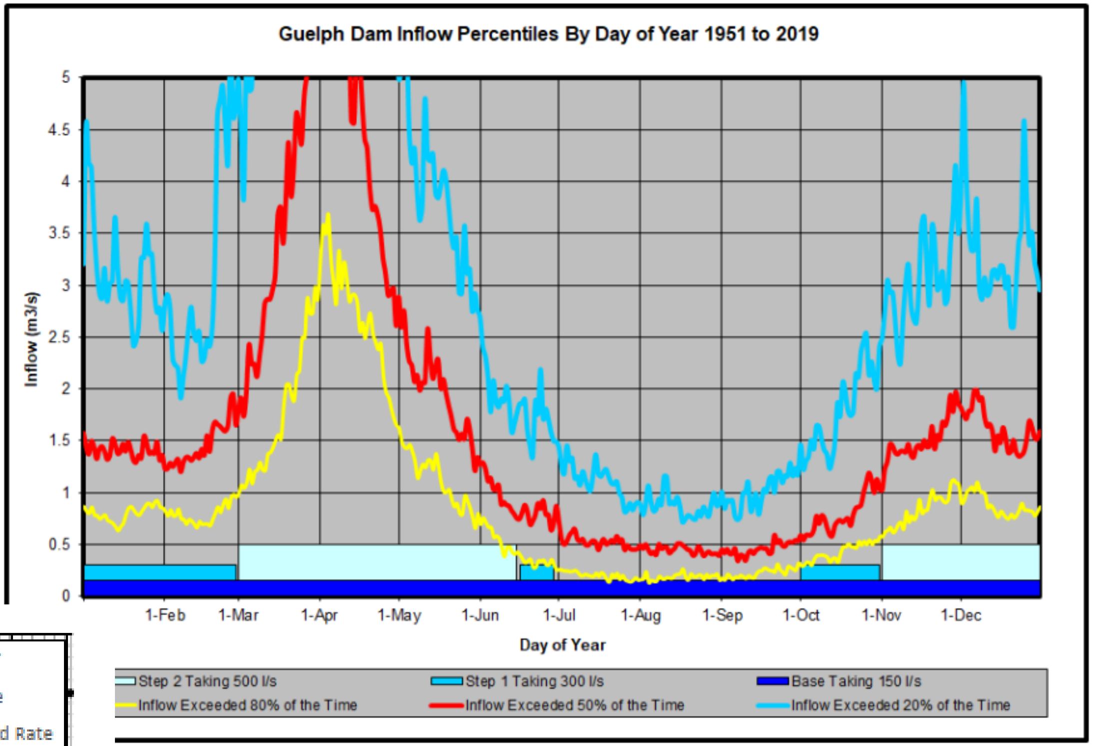
Install new ASR wells inside City

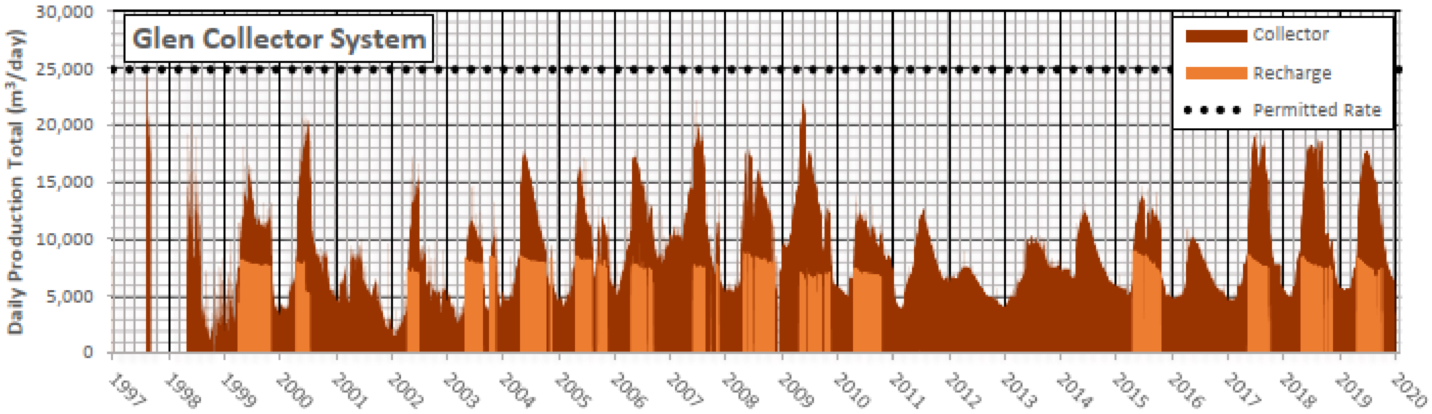
- **Aquifer Storage and Recovery (ASR)** - injection of potable water into an aquifer for later recovery and use



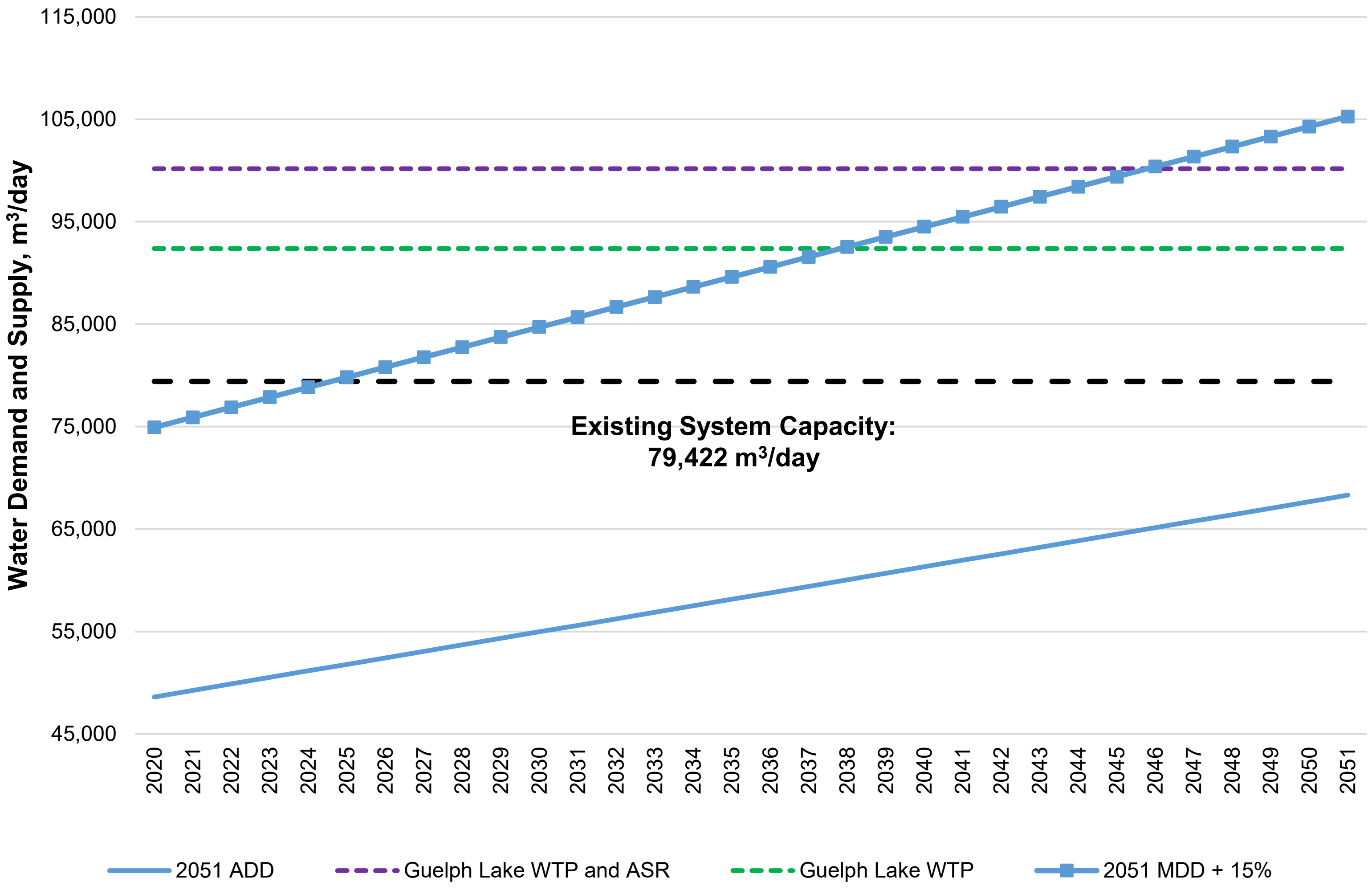
Aquifer Storage and Recovery

- Two potential sources: Guelph Lake following future potential WTP plant construction; Arkell collector system
- Estimated annual excess volume: Arkell – 451,000 m^3; Guelph Lake – 941,000 m^3

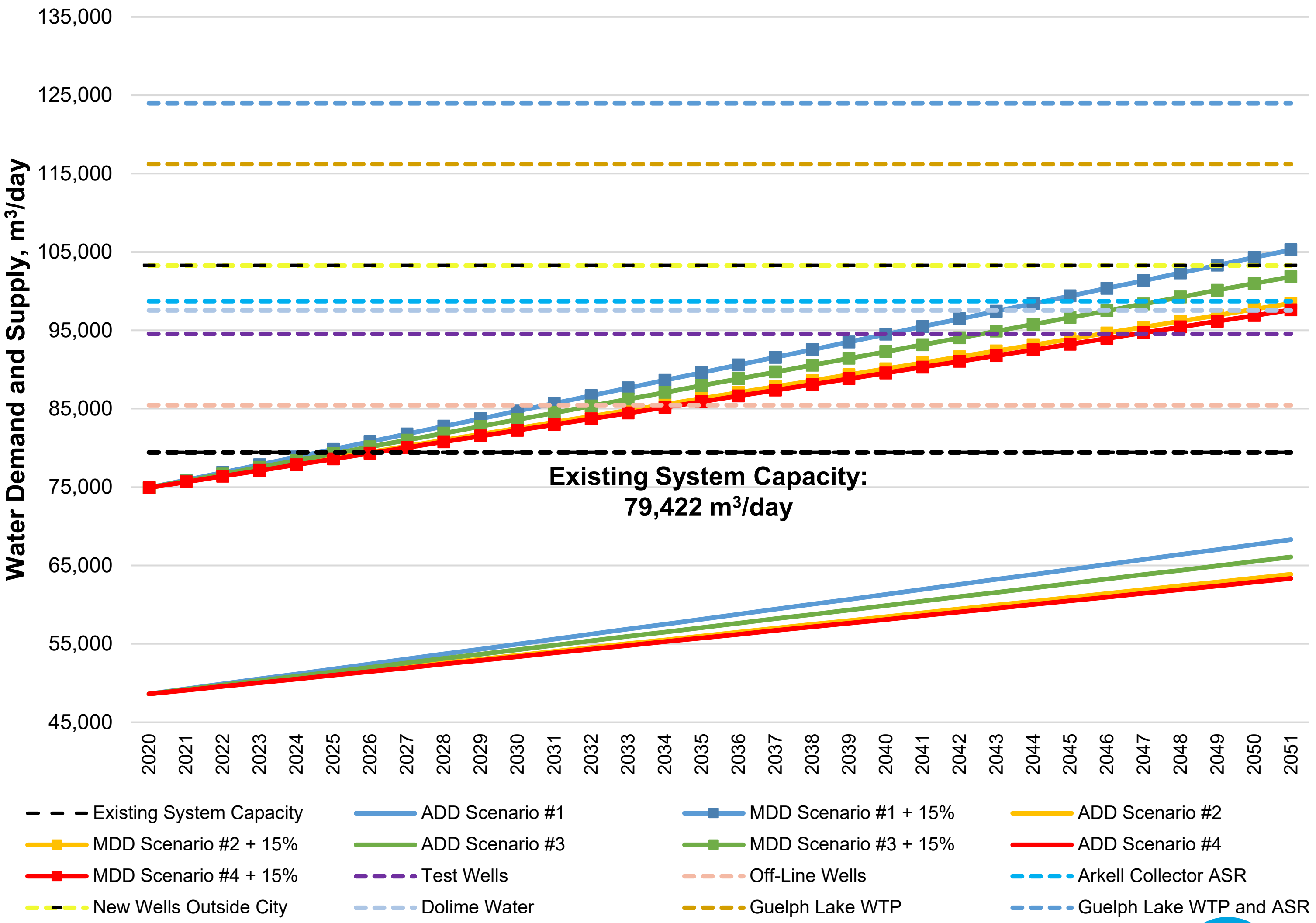




Surface Water Alternative Summary



All Water Supply Alternatives Summary



Other Alternatives

Limit Growth / Do Nothing

- Represents what would likely occur if none of the alternative solutions were implemented
- Reduction in future water supply needs by limiting the extent, density, type and/or location of future residential, industrial, commercial and institutional growth in the City below levels identified in recent planning studies
- Implementation of this alternative would require change to municipal planning documents which would not meet Provincial growth targets
- Will have a significant impact on the growth potential for the City
- Does not meet EA challenge and opportunity statement

Water Supply Master Plan Update

Evaluation Criteria

September 28, 2021

Water Supply Master Plan
guelph.ca/WSMP

Evaluation criteria

First Nations, Métis and Inuit Peoples

- Effect on Indigenous values, cultural and Traditional use

Built Environment

- Potential effect on existing/ planned structures
- Potential effects on private and municipal wells

Natural Environment

- Potential effects to natural environment
- Potential impacts to water resources
- Potential impacts to natural heritage features
- Environmental management planning considerations

Evaluation criteria

Social and Cultural Environment

- Land use impacts
- Short-term construction impacts
- Potential impacts from operations
- Cultural heritage/ archaeology impacts
- Ability to meet growth targets
- Public acceptance

Economic and Financial Considerations

- Estimated capital costs
- Estimated operations and maintenance costs, including energy consumption

Legal/ Jurisdictional Considerations

- Location of facility relative to city boundaries
- Land requirements
- Implementation of Source Protection Policies

Evaluation criteria

Technological Considerations

- Ability to implement and meet maximum demand
- Constructability of alternative
- Water treatment requirements (current and future)
- Expandability of facility
- Ability to respond to changes in regulations
- Ability to utilize existing infrastructure
- Approval requirements

Preliminary preferred solution – initial implementation timeline

Short Term (0-10 Years)

- Conservation and efficiency – current level of effort
- Clythe well (offline)
- SW Guelph test well(s)
- Dolime Quarry PLM
- Logan/ Fleming test well(s)

Medium Term (10-20 Years)

- Conservation and efficiency – focus on high demand customers
- Lower Road Collector (offline)
- Arkell ASR

Long Term (20-30 Years)

- Conservation and efficiency – water reuse
- Hauser test well
- Guelph North well (new well outside City)
- Guelph Southeast well (new well outside City)
- Guelph Lake surface water
- Smallfield/ Sacco (offline) >30 yrs

Questions?

- We welcome any questions or feedback you have about the information shared tonight

Thank You!

Visit our website: guelph.ca/WSMP

Meeting Minutes

Water Conservation and Efficiency Public Advisory Committee

Tuesday, September 28th, 2021 at 7:00 pm

Online, Webex

To access the meeting's recording follow:

Water Conservation and Efficiency Public Advisory Committee meeting-20210928 2303-1

Password

hPBig2F8

From 7:00 to 9:00 p.m.

Committee Membership Present: Grant Parkinson (GP), Emma Thompson (ET), Rahim Kanji (RK), Taylor Dorland (TD)

Regrets: David Worden (DW), Eric Meliton (EM), Jaime Boutilier (JB), Justin Arbuckle (JA)

Staff: Beatriz Gomez-Canizo (BGC), Heather Yates (HY), Donna Tremblay (DT), Dave Belanger (DB), Matthew Alexander – AECOM (MA), Bill Gauley – AECOM (BG)

Agenda Items

Item 1

Procedure using WebEx for Committee of Council meeting and recording – 7:00 p.m. – H. Yates

Item 2

Land Acknowledgement – 7:05 p.m. – G. Parkinson

Item 3

Introductions and confirmations on meeting notes (February 3rd, 2021) -7:10 p.m. – G. Parkinson

Motion: To approve the February 3rd, 2021 meeting notes.

Committee did not meet quorum and the meeting minutes were not approved.

Item 4

Updates to Advisory Committees of Council Policy – 7:15 p.m. – D. Tremblay

Description: On July 19th, 2021 Council approved new policy changes to Advisory Committees of Council, including Meeting Procedures Policy, Administration Policy and Public Appointment Policy. This item will be presented to the committee regarding process, procedure and training.

Discussion:

GP-Difference between presenter and delegate?

DT-Revisions to the Administration Policy now permit Chairs or a designated member from the committee to attend Council and Committee meetings to speak to committee advice which has been incorporated into staff reports. The Chair or their designated will not be required to register as a delegate, instead, upon instructions from the Chair, staff liaisons will communicate to Clerks Office Staff that the Chair or their designate have requested to speak to the staff report and will be listed as a presenter and not public delegate on the Council or Committee Agenda.

Item 5

All-Season Rainwater Harvesting Rebate Terms and Conditions review – 7:40 p.m. – B. Gomez-Canizo

Description: Seeking committee's feedback as subject matter experts in regards to proposed changes to the All-Season Rainwater Harvesting Rebate Terms and Conditions that changes in municipal bylaw, Ontario Building Code, technology advancements and system availability and the market that the City would like to consider.

Discussion:

TD- Agree with the proposed changes. Would it be possible to mandate reuse water systems like rainwater harvesting systems for new homes and new developments.

BG- There is no intention from the City to mandate or change bylaws right now to incorporate reuse systems. We have been part of pilot projects in the past and will keep promoting water reuse systems in Guelph.

TD- Understand why people are not signing up and barriers that are preventing our messages to reach their targets. Use other channels to reach different audiences, like using the property tax letter as an opportunity to add a bill insert.

BG- We have tried different communication channels, business and social groups. We are open to suggestions and ideas.

TD-Could it be possible that Grey water and Rainwater harvesting systems are cannibalizing each other?

BG- There had not been many applications for the Greywater rebate after the pilot project. Although RWH rebates have not been very common, we are still seeing some uptake. Both reuse systems could help meet our targets.

AECOM BG- Are backflow preventions inspections needed for these systems? These constant inspections increase the costs of these systems.

BG-Yes, they are needed.

GP- Could there be opportunity to increase uptake by talking more about the benefits of the natural soft water, like preventing scale on laundry and dishwashers, extra savings when reducing the use of water softeners.

Item 6

Water Supply Master Plan updates. – 8:05 p.m. – M. Alexander, B. Gauley

Description: Water supply alternatives, including conservation scenarios, have been proposed for the Water Supply Master Plan update. This presentation will share the results of this technical review, the evaluation criteria and seek the Committee's input and feedback on the proposed.

Different water conservation and efficiency scenarios and proposed water supply alternatives were shared.

Conversation:

RK- Was climate change considered in the projections?

MA- Security of supply looking at the potential of it being dryer in the future considering drought, which was part of the decision to include the extra 15% of extra capacity due to those extended droughts. From the groundwater perspective, based on modeling from the City for source water protection, we may see overall higher recharge levels due to more melting in the winter. From the City's perspective there is legislation for thresholds to be met for water treatment. As we learn more about contaminants present in the water it becomes a revolving area that needs to be revisited

DB- The Water Supply master plan and Source Protection Plans are in place to protect quality and quantity, including risk management plans to protect water supply from those risks. Develop policies to protect and take priority over other source protection policies, incorporate drought and climate change into the plans. Falls into source protection and water supply master plan.

RK –Sustainability and lower risks were considered?

MA-Climate change was considered, in both cases, ground water and surface water. The priority is ground water as we want to prioritize the sources within City limits. The City has a ground water supply, which is less vulnerable to climate change. Surface water is more vulnerable.

DB- Reuse built in the projections and will become more important in the future.

Next Meeting

Virtual meeting - December 1, 2021

Meeting ended at 9:09p.m.

City of Guelph
2019 Water Supply Master Plan – Overview for Puslinch Township

December 2, 2019

WATER SUPPLY MASTER PLAN UPDATE

Overview

- Follows the Municipal Class Environmental Process
- Problem/Opportunity Statement;
- Review Work Plan for 2019 WSMP; and
- Review schedule and next steps

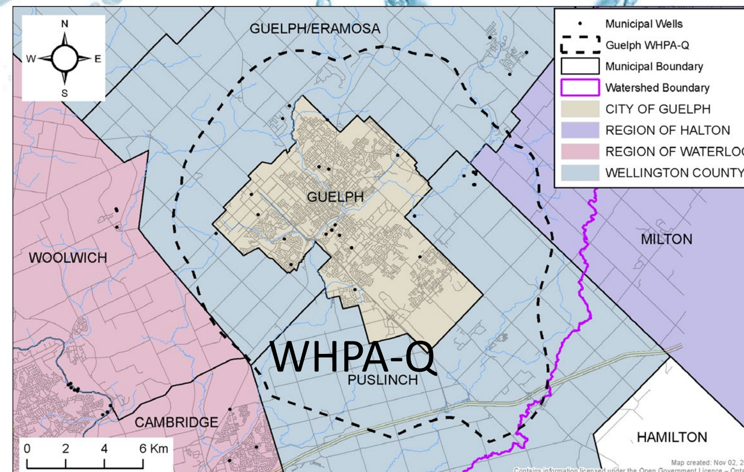
WATER SUPPLY MASTER PLAN UPDATE

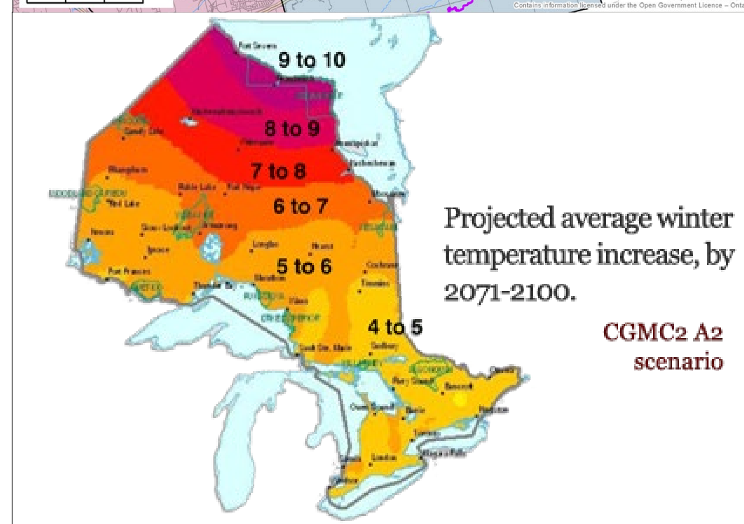
2019 PROBLEM / OPPORTUNITY STATEMENT

- City is responsible for supplying clean, safe drinking water;
- City will provide a reliable and sustainable supply to meet current and future needs of all customers for the next 20 years (2041);
- The updated Master Plan will identify and prioritize individual projects required to implement the Master Plan.

2019 WSMP – SPECIAL ISSUES

- Tier 3 Water Budget and Local Area Risk Assessment
- Contaminated Sites
- Dolime
- Surface Water Impacts
- Firm Capacity and Security of Supply
- Climate Change

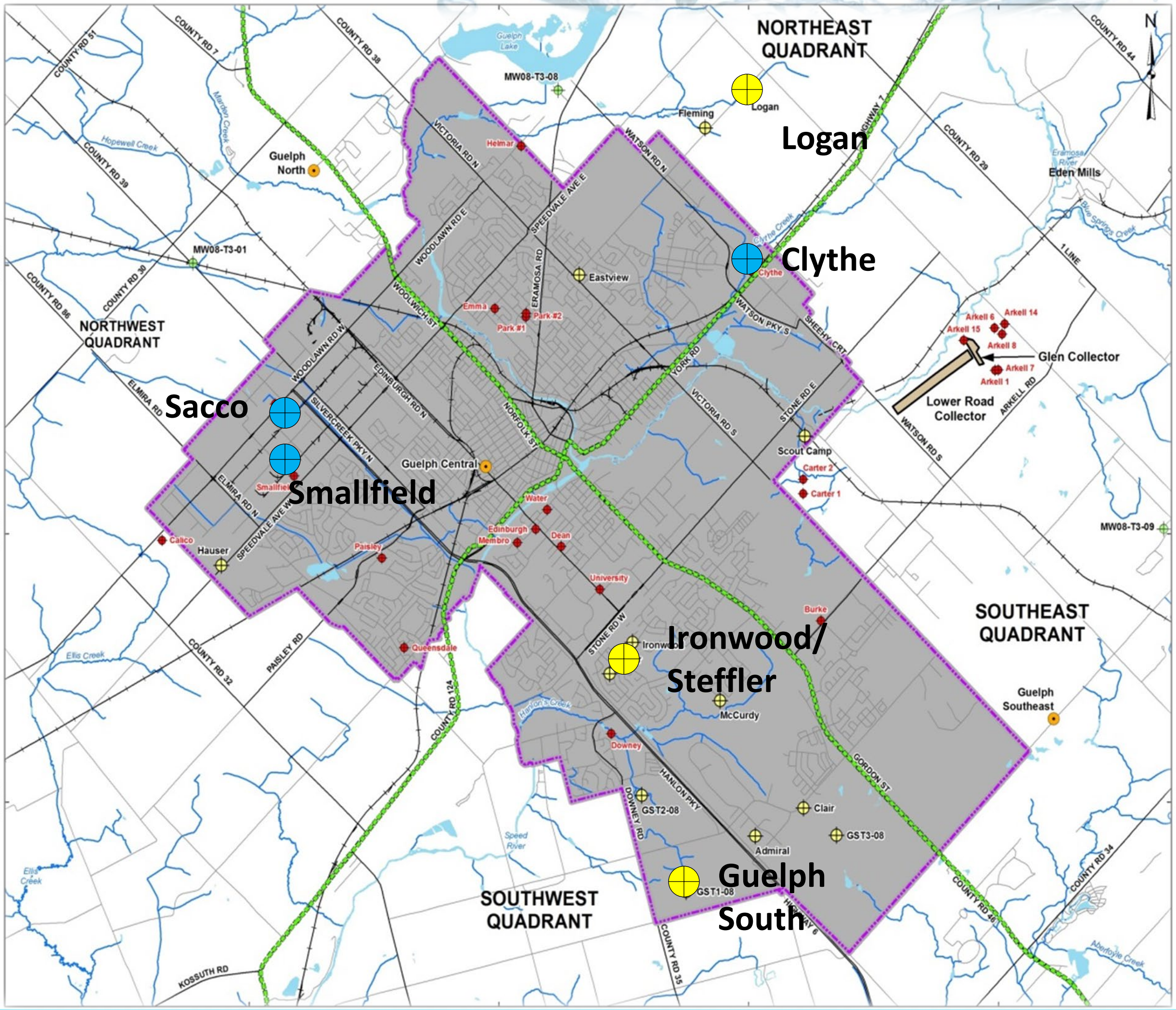




2019 WSMP WORK PLAN

- Same approach as in 2014
- Task 1 - Develop Community Engagement Plan
  - Community Liaison Group, Municipality/Agency Workshops, Open Houses
- Task 2 - Population and Water Demand forecasts
- Task 3 – Water Supply Capacity
- Task 4 – Water Supply Alternatives (similar to 2014)
- Task 5 – WSMP Report

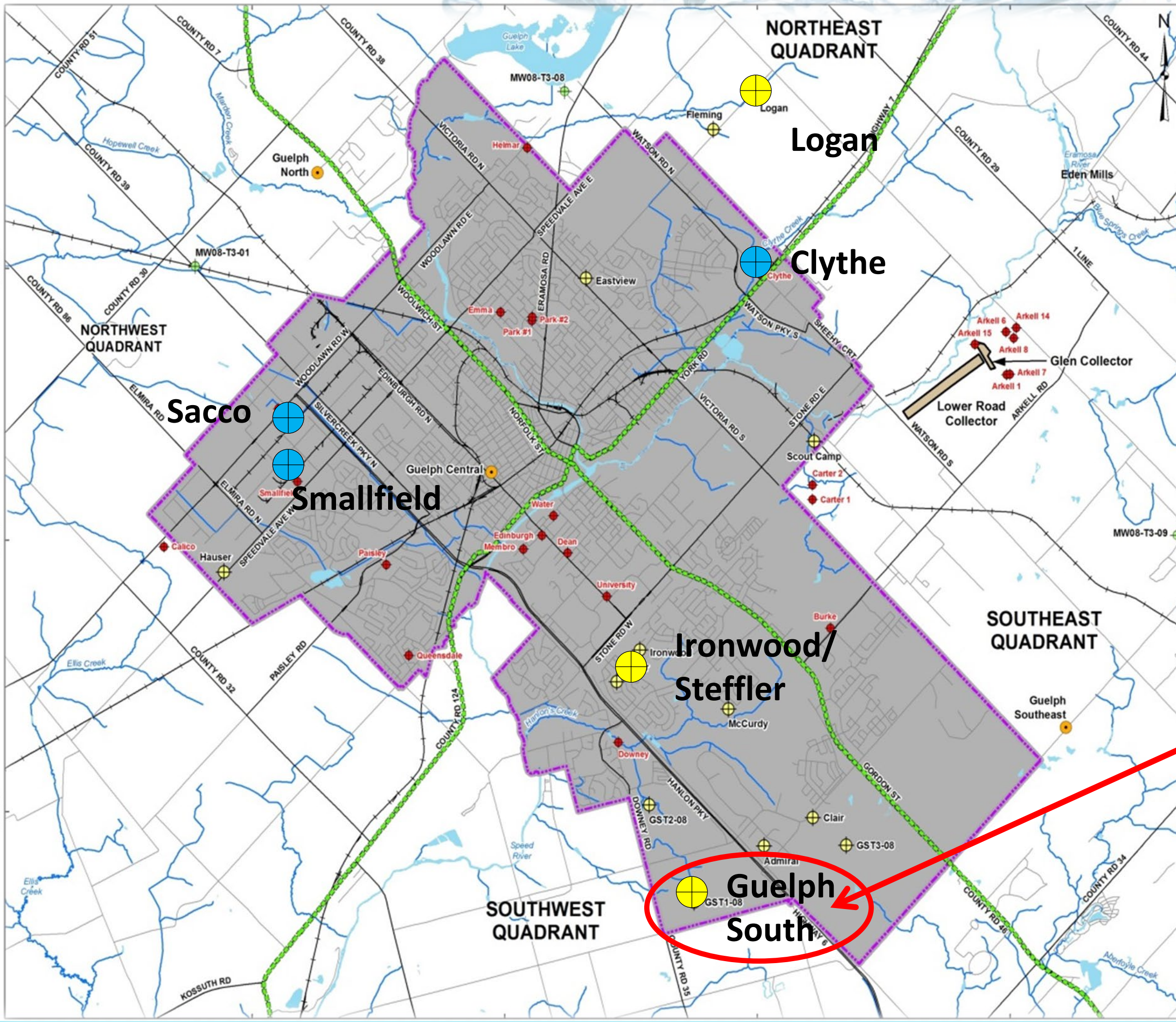
OFFLINE WELLS AND TEST WELLS



Offline Well

Test Well

OFFLINE WELLS AND TEST WELLS



Offline Well

Test Well

Guelph South Groundwater Investigation Feasibility Study

GUELPH SOUTH GROUNDWATER INVESTIGATION FEASIBILITY STUDY

- Investigation of Test Well in Hanlon Creek Business Park
- Test well converted to larger diameter production well
- Construction of multi-level monitoring wells
- Domestic well survey – identify wells in the area
- 30 day pumping test to assess well interference and potential impacts (late Spring, 2020)
- Information used to support Water Supply Master Plan

EVALUATION OF ALTERNATIVES

- Criteria (2014):
  - Financial Consideration
  - Legal and Jurisdictional Considerations
  - Technological Consideration - constructability
  - Built Environment – effect on existing infrastructure
  - Natural Environment
  - Social and Cultural Environment – meet growth, public acceptance
- Evaluate alternatives, prioritize projects and estimate costs

2019 WSMP – SCHEDULE AND NEXT STEPS

- Schedule – one year +/- (Community Engagement Plan)
- Next Steps:
  - AECOM retained to manage the project
  - Notice of Study Commencement – October
  - Formation of Community Liaison Group
  - First Community Engagement
    - Introduce the project
    - Discuss/define problem statement
    - Discuss Community Engagement Plan
    - Outline next steps and schedule
  - Puslinch Township welcome to provide input
  - Puslinch has provided representatives for the Community Liaison Group

QUESTIONS?

For more information - https://guelph.ca/WSMP

Water Supply Master Plan Update - Overview

Puslinch Township Council

Guelph Water Services

October 13, 2021

Water Supply Master Plan Update

Update of the 2014 WSMP – consistent with Guelph City Council 2003 direction “that the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth”

The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers

Five parts of the WSMP:

- How are we engaging on the WSMP Update?
- How much water do we have now?
- How much water do we need in the future?
- What are the water supply alternatives?
- What is the plan for new supply?

Overview of Our Existing System

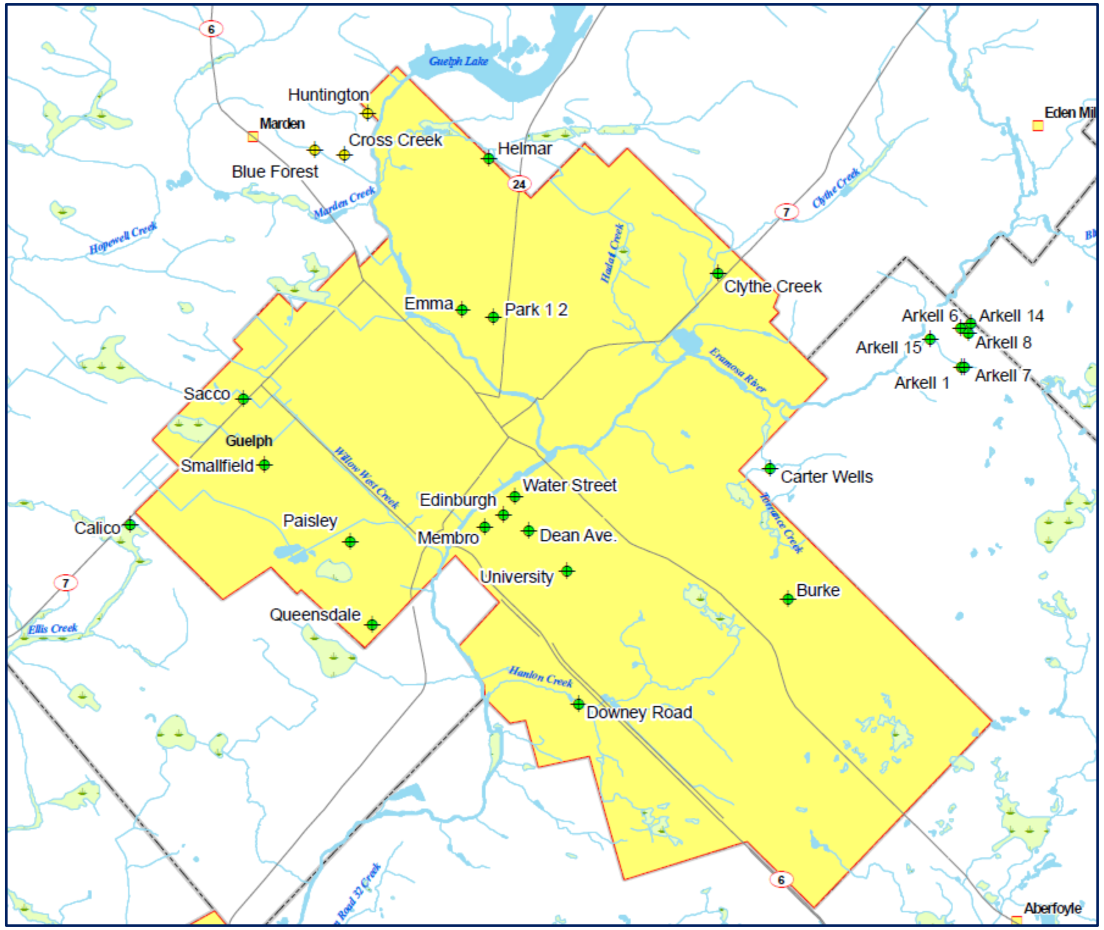
Groundwater-based water supply since 1879

Water supply system - production wells in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system

21 wells in continuous operation - 4 wells offline due primarily to water quality concerns

A shallow groundwater collector system that collects spring water in the Arkell Spring Grounds

Eramosa River Intake and Recharge system (seasonal): river water pumped to an infiltration pond and trench provides water to the collector system; subject to river flow conditions



How are we engaging on the WSMP?

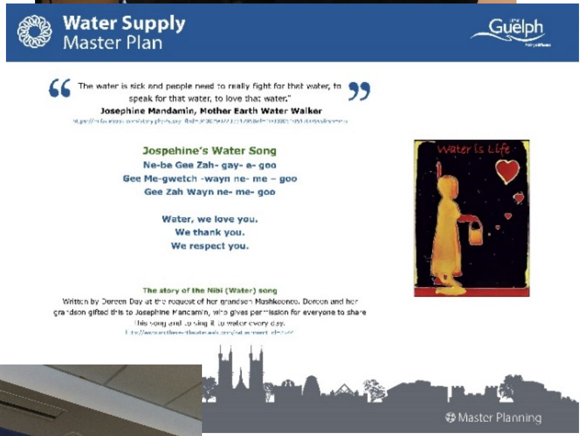
Guelph Community Engagement Framework

Community engagement plan:

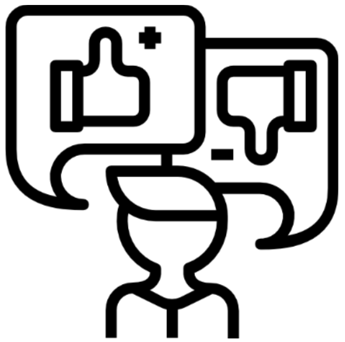
- 3 Community Liaison Group meetings
- 2 Multi-agency workshops with Puslinch representation
- 2 Public information centres
- Indigenous Engagement: Mississaugas of the Credit First Nations, Six Nations, local Indigenous people
- Puslinch Twp staff (M. Fowler) presentation (Dec./19)
- Puslinch and Guelph-Eramosa Township Councils presentations
- Online and social media engagement
- Completion of Community Engagement – Fall, 2021

Project web page – https://guelph.ca/plans-and-strategies/water-supply-master-plan/

Have your say Guelph - https://www.haveyoursay.guelph.ca/wsmp



Consultation feedback



Prioritizing conservation

Protecting the natural environment

Managing growth and development

Controlling groundwater impacts from large water users

Concerns on source protection areas and land use constraints

Concerns on potential well interference effects with existing wells

Prioritize supply within City before sources within Township(s)

Consider potential climate change impacts on water supply

Valuing the agency of water

How much water do we have now?

Water supply capacity:

- “Normal” conditions: 79,422 m^3/day
- Drought conditions: 65,447 m^3/day
- Loss of source: 73,437 to 76,200 m^3/day
- Regulatory approvals: 73,300 to 77,200 m^3/day

For planning purposes:

- 65,447 to 79,422 m^3/day – range of ~15%

Current water supply demand (2020):

- Average day – 45,000 m^3/day
- Maximum day (highest single day demand) – 61,000 m^3/day

How much water do we need in the future?

Provincial Places to Grow projections to 2051

Guelph 2051 population:

- Residential – 203,000
- Employment – 116,000

Per person water demand:

- Residential – 167 Litres per day
- Employment – 191 L/day
- Non-revenue water – 61 L/day (leaks, main flushing, fire flows, etc.)

2051 Water demand:

- Average day – 68,300 m^3/day
- Maximum day – 91,500 m^3/day

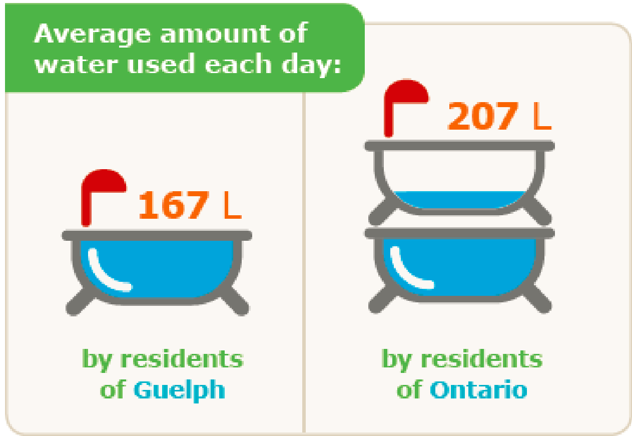
Water supply deficit:

- Average day – ~3,000 m^3/day
- Maximum day – ~26,000 m^3/day

What are the water supply alternatives?

Water Conservation and Efficiency Strategy

- Most important component of the WSMP; Guelph is a leader in water conservation and demand management
- Four Scenarios considered as alternatives:
  1. Static Residential and ICI per capita demands – cease non-mandatory programs
  2. Demand Reduction of 6.5% in 2051 – continue current level of programming
  3. Demand Reduction of 3.25% in 2051 – focus on high water use customers
  4. Demand Reduction of 7.3% in 2051 – Scenario 2 plus water reuse opportunities



Groundwater alternatives inside and outside of the City

- See next slide

Surface water alternative

- Guelph Lake intake and Water Treatment Plant
- Guelph Lake plus Aquifer Storage and Recovery (ASR)
- Long-term alternative – 20 to 30 yr timeframe

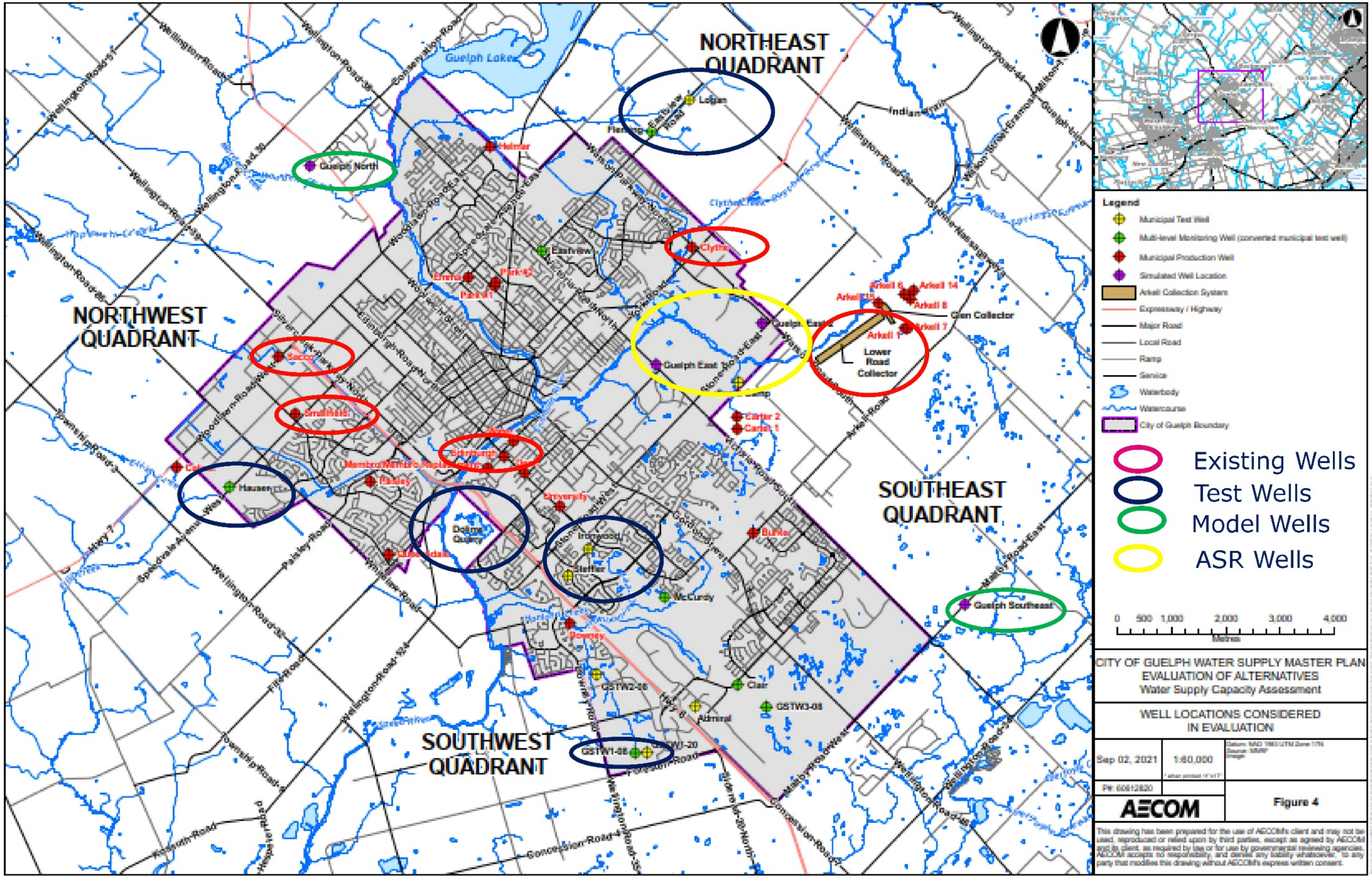
Groundwater Alternatives

The potential opportunities for expansion of the existing groundwater supply system are grouped into the following alternatives:

- **Optimize** existing operating municipal sources (Downey Well)
- **Restore** existing off-line municipal wells (Clythe, Smallfield, Sacco, Edinburgh Wells, Lower Road Collector)
- **Develop** existing municipal test wells (Steffler/Ironwood, Guelph South, Logan, Hauser Test Wells, Dolime Pond Level Management)
- **Install new wells inside** City boundaries (screened out through prelim. modelling)
- **Install new wells outside** City boundaries (Guelph North, Guelph Southeast)
- **Install new ASR wells** inside City to optimize excess Arkell Collector system volumes

Evaluated using the City's groundwater flow model to assess sustainability and potential for environmental effects

Off-line/ New Sources



Criteria used to evaluate alternatives

First Nations, Metis and Inuit people - Effect on Indigenous values, cultural and traditional use

Built environment - Potential effect on existing/ planned structures and on private and municipal wells

Natural environment - Potential effects to natural environment, water resources, natural heritage features and environmental management/planning considerations

Social and cultural environment - Land use, construction, operational, heritage and archaeology impacts; meet growth targets; public acceptance

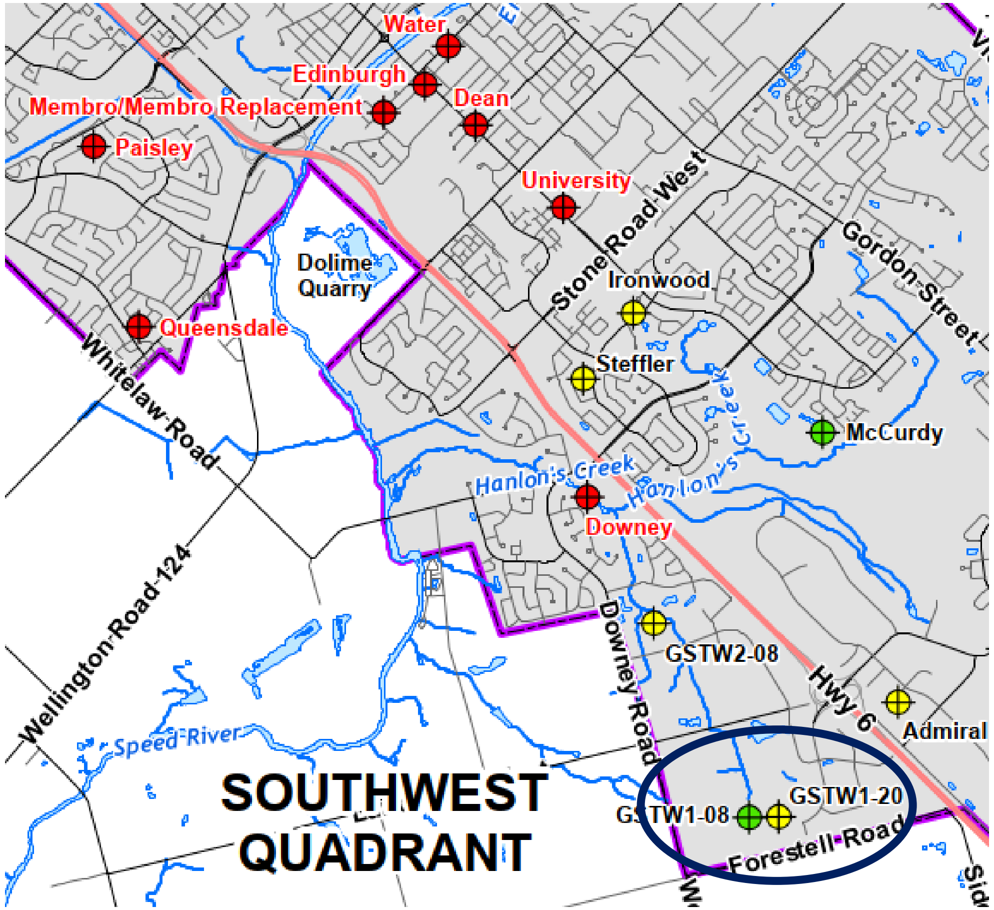
Economic and financial considerations - Estimated capital costs and operations and maintenance costs, including energy consumption

Legal and jurisdictional considerations - Location of facility relative to city boundaries; land requirements; implementation of Source Protection Policies

Technological considerations – Implementability, constructability and expandability of alternative; treatment requirements (current and future); ability to respond to changes in regulations; ability to utilize existing infrastructure; approval requirements

Example – Develop Existing Test Wells (Guelph South – GSTW1-20)

- City-owned property located in Hanlon Creek Business Park – access to infrastructure
- Moderate to high capacity from 30-day pumping test - ~4,000 m^3/day
- Model output: potential for <10% baseflow reduction to Hanlon Creek and wetlands; potential for well interference
- Source protection - within existing WHPA's for quality and quantity – changes to WHPA's (Guelph and RMOW) may affect current and future land uses
- Estimated capital cost: \$4.8 M, \$1,200/m^3
- Complete assessment including public engagement to be conducted in the SW Guelph Water Supply Class Environmental Assessment (September/21)



Example - New wells outside City – Guelph Southeast

- Model-defined, approximate location – in Puslinch Township southeast of the City (City does not own land here)
- Consultation and collaboration required with Puslinch Township
- Rationale – Model assessment - Proximity to area with high transmissivity within the Gasport aquifer and limited local groundwater usage
- Estimated available capacity (average) – 1,600 m^3/day
- Model output: <10% baseflow reduction to Mill Creek; near Arkell Bog PSW Complex
- Field study would assess potential for interference with private wells; Source protection constraints
- Iron and Manganese treatment assumed for costing purposes
- Estimated capital cost: $10.3 M, $6,400/$m^3$
- Low priority – potential future source (20–30 yr timeframe

Preliminary preferred solution – initial implementation timeline

Short Term (0-10 Years)

- Conservation and efficiency – current level of effort
- Clythe well (offline)
- SW Guelph test well(s)
- Dolime Quarry Pond Level Management
- Logan/ Fleming test well(s)

Medium Term (10-20 Years)

- Conservation and efficiency – focus on high demand customers
- Lower Road Collector (offline)
- Arkell ASR

Long Term (20-30 Years)

- Conservation and efficiency – water reuse
- Hauser test well
- Guelph North well (new well outside City)
- Guelph Southeast well (new well outside City)
- Guelph Lake surface water
- Smallfield/Sacco (offline) >30 yrs

What’s the Plan for new supply?

New supply projects - Class EA process to evaluate environmental, social, and economic impacts (such as impacts to surface water systems and sustainability) in and around the City and including public engagement/consultation

Draft Water Supply Master Plan Update Report to be presented to Council in late 2021

Update WSMP every 5 years approximately

For more information:

- Project web page – https://guelph.ca/plans-and-strategies/water-supply-master-plan/
- Have your say Guelph - https://www.haveyoursay.guelph.ca/wsmp

Questions?

Comments?

Thank you!

TOWNSHIP OF
PUSLINCH
EST. 1850

Dave Belanger
Water Supply Program Manager
City of Guelph
VIA EMAIL:
Dave.Belanger@guelph.ca>

Wayne Galliher
Division Manager Water Services
City of Guelph
VIA EMAIL:
Wayne.Galliher@guelph.ca

Township of Puslinch
7404 Wellington Road 34
Puslinch, ON N0B 2J0
www.puslinch.ca

October 14, 2021

RE: 10.1 City of Guelph Water Supply Master Plan 2021 Update – Agency and Municipality Workshop No. 2 and the City of Guelph presentation Water Supply Master Plan Update – Overview

Please be advised that Township of Puslinch Council, at its meeting held on October 13, 2021 considered the aforementioned topic and subsequent to discussion, the following was resolved:

Resolution No. 2021-309: Moved by Councillor Sepulis and
Seconded by Councillor Goyda

THAT Council receives Correspondence item 10.1 from the City of Guelph entitled Water Supply Master Plan 2021 Update – Agency and Municipality Workshop No. 2 and the City of Guelph presentation; and

WHEREAS the City of Guelph staff have extended the Township commenting deadline from October 22, 2021 to only November 5, 2021 despite Township staff requesting a longer review window given the technical nature of the topic, the absence and availability of City draft report to review and the potential impact to the Township;

THEREFORE BE IT RESOLVED:

TOWNSHIP OF
PUSLINCH
EST. 1850

THAT Council pass a resolution stating their concerns to the City of Guelph staff's stipulation that Township comments to be provided no later than November 5, 2021 and direct staff to submit the resolution to the City of Guelph; and

THAT Council direct Township staff and consultant(s) to review the City of Guelph Water Supply Master Plan Update correspondence and draft report, when available, and to provide comments for Council's consideration at the November 24 Puslinch Council meeting; and

That the City of Guelph Council provide the opportunity for Puslinch Council to provide comments in advance of the draft report being adopted by City of Guelph Council; and

That Council request that the City of Guelph Council acknowledge receipt of Township comments and that the City of Guelph provide a response to the Township's comments; and

That Council request City of Guelph Council to authorize the release of the draft report to Puslinch staff in advance of the City of Guelph Council meeting in order to prepare comments; and

That this resolution be forwarded to the Township of Guelph Eramosa.

CARRIED

As per the above resolution, please accept a copy of this correspondence for your information and consideration.

Sincerely,
Glenn Schwendinger
CAO

CC:
Ian Roger, CAO, Guelph Eramosa Township, iroger@get.on.ca
Kyle Davis, Risk Management Official, KDavis@centrewellington.ca

Water Supply Master Plan Update - Overview

Guelph Eramosa Township Council

Guelph Water Services

October 20, 2021

Water Supply Master Plan Update

Update of the 2014 WSMP – consistent with Guelph City Council 2003 direction "that the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth"

The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers

Five parts of the WSMP:

- How are we engaging on the WSMP Update?
- How much water do we have now?
- How much water do we need in the future?
- What are the water supply alternatives?
- What is the plan for new supply?

Overview of Our Existing System

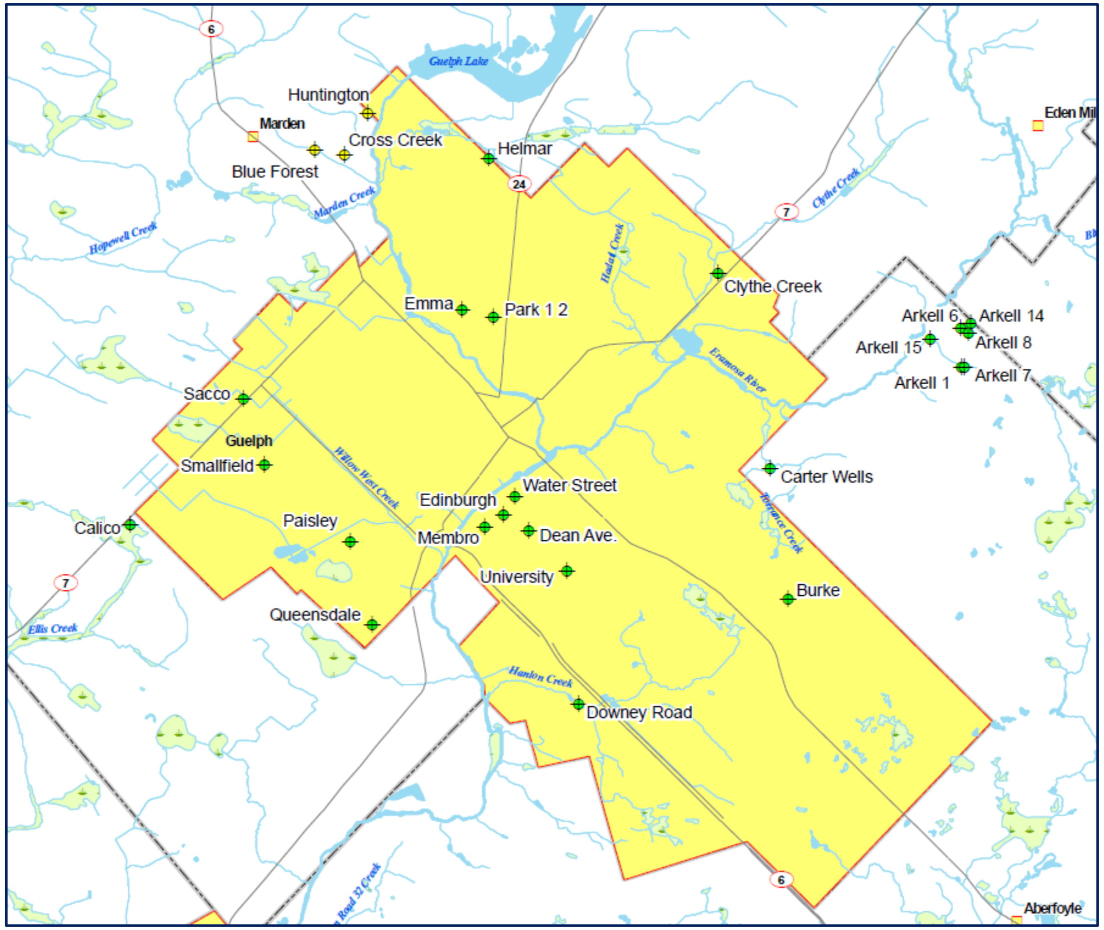
Groundwater-based water supply since 1879

Water supply system - production wells in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system

21 wells in continuous operation - 4 wells offline due primarily to water quality concerns

A shallow groundwater collector system that collects spring water in the Arkell Spring Grounds

Eramosa River Intake and Recharge system (seasonal): river water pumped to an infiltration pond and trench provides water to the collector system; subject to river flow conditions



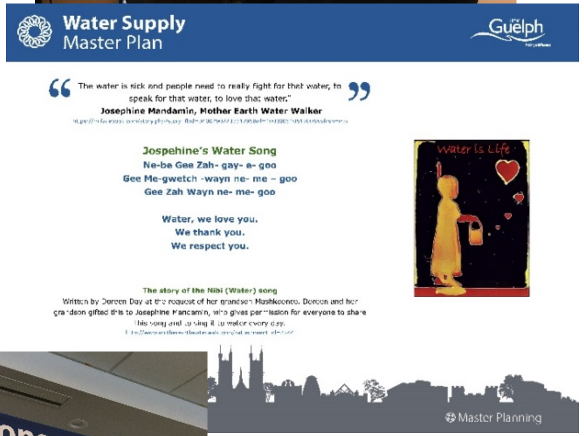
How are we engaging on the WSMP?

Guelph Community Engagement Framework

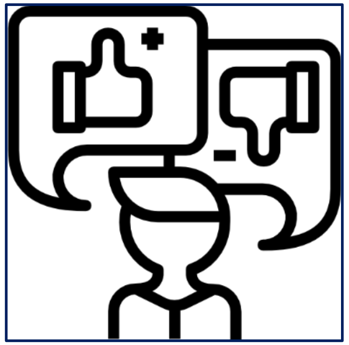
- Community engagement plan:
  - 3 Community Liaison Group meetings
  - 2 Multi-agency workshops with GET representation
  - 2 Public information centres
  - Indigenous Engagement: Mississaugas of the Credit First Nations, Six Nations, local Indigenous people
  - Guelph-Eramosa and Puslinch Township Councils presentations
  - Online and social media engagement
  - Completion of Community Engagement – Fall, 2021

Project web page – https://guelph.ca/plans-and-strategies/water-supply-master-plan/

Have your say Guelph - https://www.haveyoursay.guelph.ca/wsmp



Consultation feedback



- Prioritizing conservation
- Protecting the natural environment
- Managing growth and development
- Controlling groundwater impacts from large water users
- Concerns on source protection areas and land use constraints
- Concerns on potential well interference effects with existing wells
- Prioritize supply within City before sources within Township(s)
- Consider potential climate change impacts on water supply
- Valuing the agency of water

How much water do we have now?

Water supply capacity:

- “Normal” conditions: 79,422 m^3/day
- Drought conditions: 65,447 m^3/day
- Loss of source: 73,437 to 76,200 m^3/day
- Regulatory approvals: 73,300 to 77,200 m^3/day

For planning purposes:

- 65,447 to 79,422 m^3/day – range of ~15%

Current water supply demand (2020):

- Average day – 45,000 m^3/day
- Maximum day (highest single day demand) – 61,000 m^3/day

How much water do we need in the future?

Provincial Places to Grow projections to 2051

Guelph 2051 population:

- Residential – 203,000
- Employment – 116,000

Per person water demand:

- Residential – 167 Litres per day
- Employment – 191 L/day
- Non-revenue water – 61 L/day (leaks, main flushing, fire flows, etc.)

2051 Water demand:

- Average day – 68,300 m^3/day
- Maximum day – 91,500 m^3/day

Water supply deficit:

- Average day – ~3,000 m^3/day
- Maximum day – ~26,000 m^3/day

What are the water supply alternatives?

Water Conservation and Efficiency Strategy

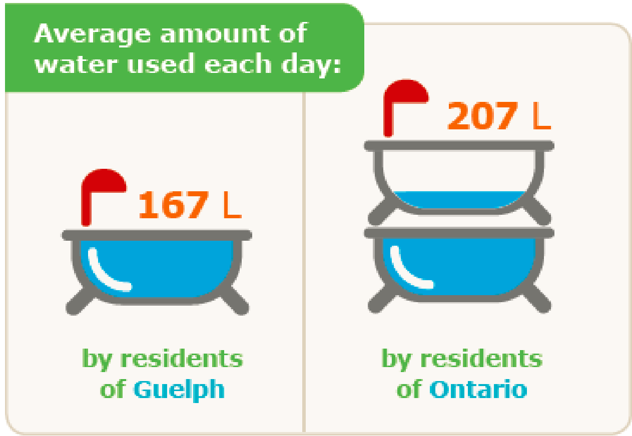
- Most important component of the WSMP; Guelph is a leader in water conservation and demand management
- Four Scenarios considered as alternatives:
  1. Static Residential and ICI per capita demands – cease non-mandatory programs
  2. Demand Reduction of 6.5% in 2051 – continue current level of programming
  3. Demand Reduction of 3.25% in 2051 – focus on high water use customers
  4. Demand Reduction of 7.3% in 2051 – Scenario 2 plus water reuse opportunities

Groundwater alternatives inside and outside of the City

- See next slide

Surface water alternative

- Guelph Lake intake and Water Treatment Plant
- Guelph Lake plus Aquifer Storage and Recovery (ASR)



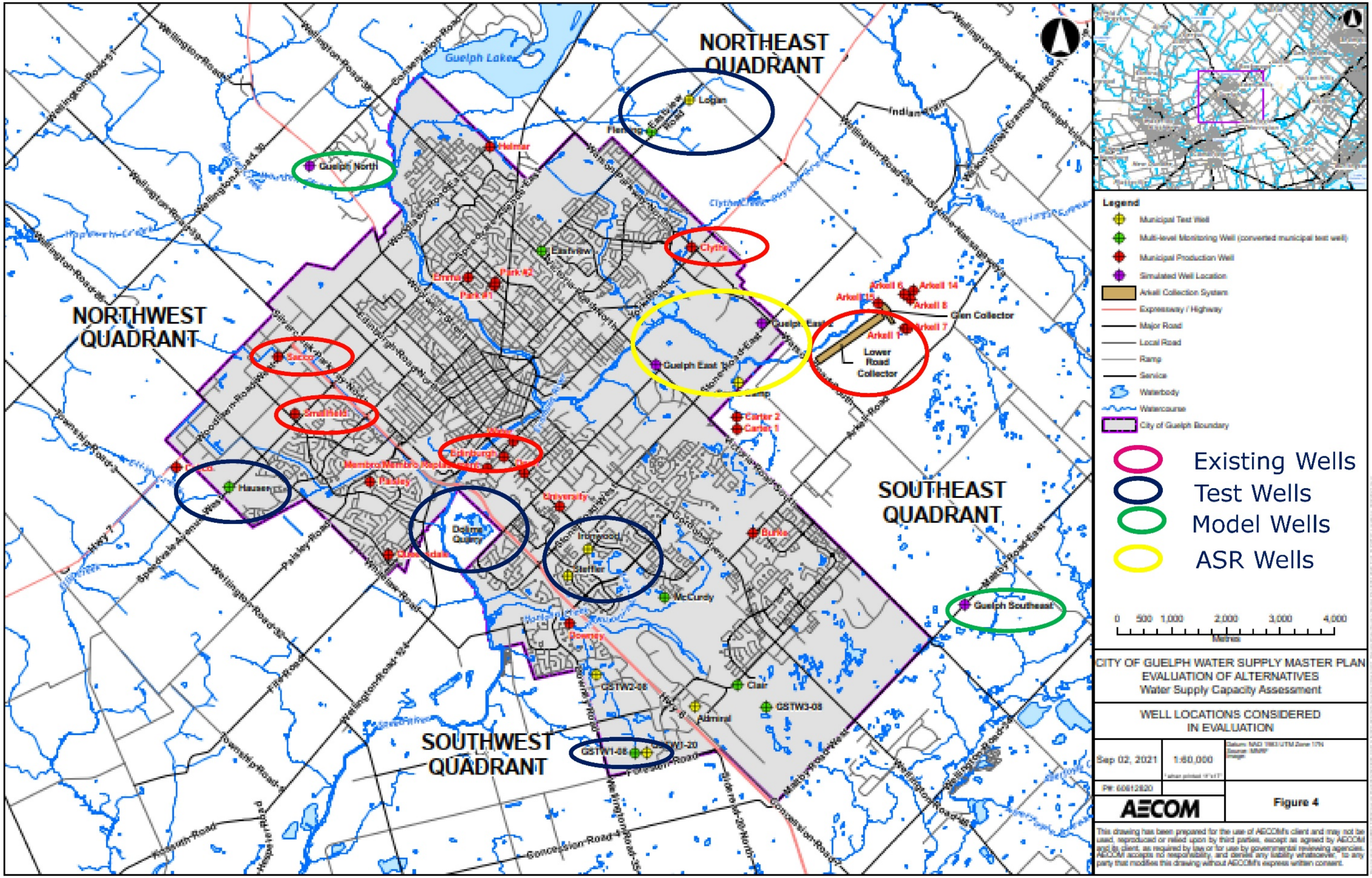
Groundwater Alternatives

The potential opportunities for expansion of the existing groundwater supply system are grouped into the following alternatives:

- **Optimize** existing operating municipal sources (Downey Well)
- **Restore** existing off-line municipal wells (Clythe, Smallfield, Sacco, Edinburgh Wells, Lower Road Collector)
- **Develop** existing municipal test wells (Steffler/Ironwood, Guelph South, Logan, Hauser Test Wells, Dolime Pond Level Management)
- **Install new wells inside** City boundaries (screened out through prelim. modelling)
- **Install new wells outside** City boundaries (Guelph North, Guelph Southeast)
- **Install new ASR wells** inside City to optimize excess Arkell Collector system volumes

Evaluated using the City's groundwater flow model to assess sustainability and potential for environmental effects

Off-line/ New Sources



Surface Water Alternative

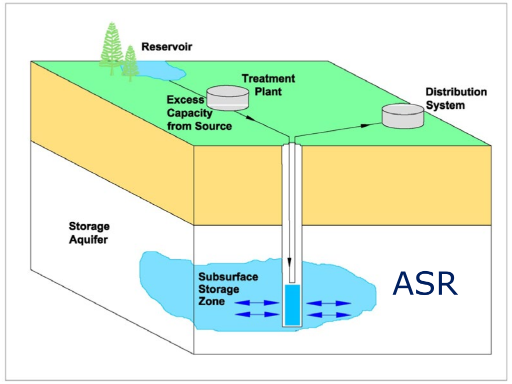
Guelph Lake as surface water supply under two scenarios:

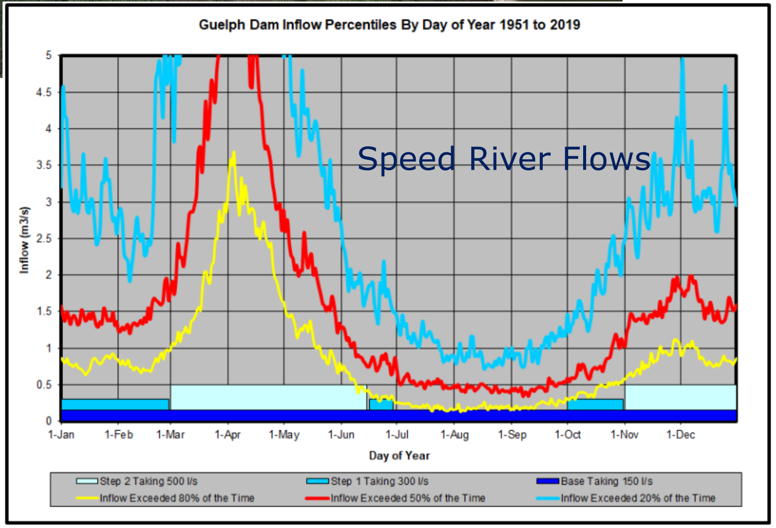
- Water Treatment Plant (WTP) to potable water standards; and
- WTP with excess water for Aquifer Storage and Recovery

Grand River Conservation Authority analysis of long-term flow data to identify amount of water available for supply

Considers down stream flow requirements

Long-term alternative – 20 to 30 yr timeframe





Criteria used to evaluate alternatives

First Nations, Metis and Inuit people - Effect on Indigenous values, cultural and traditional use

Built environment - Potential effect on existing/ planned structures and on private and municipal wells

Natural environment - Potential effects to natural environment, water resources, natural heritage features and environmental management/planning considerations

Social and cultural environment - Land use, construction, operational, heritage and archaeology impacts; meet growth targets; public acceptance

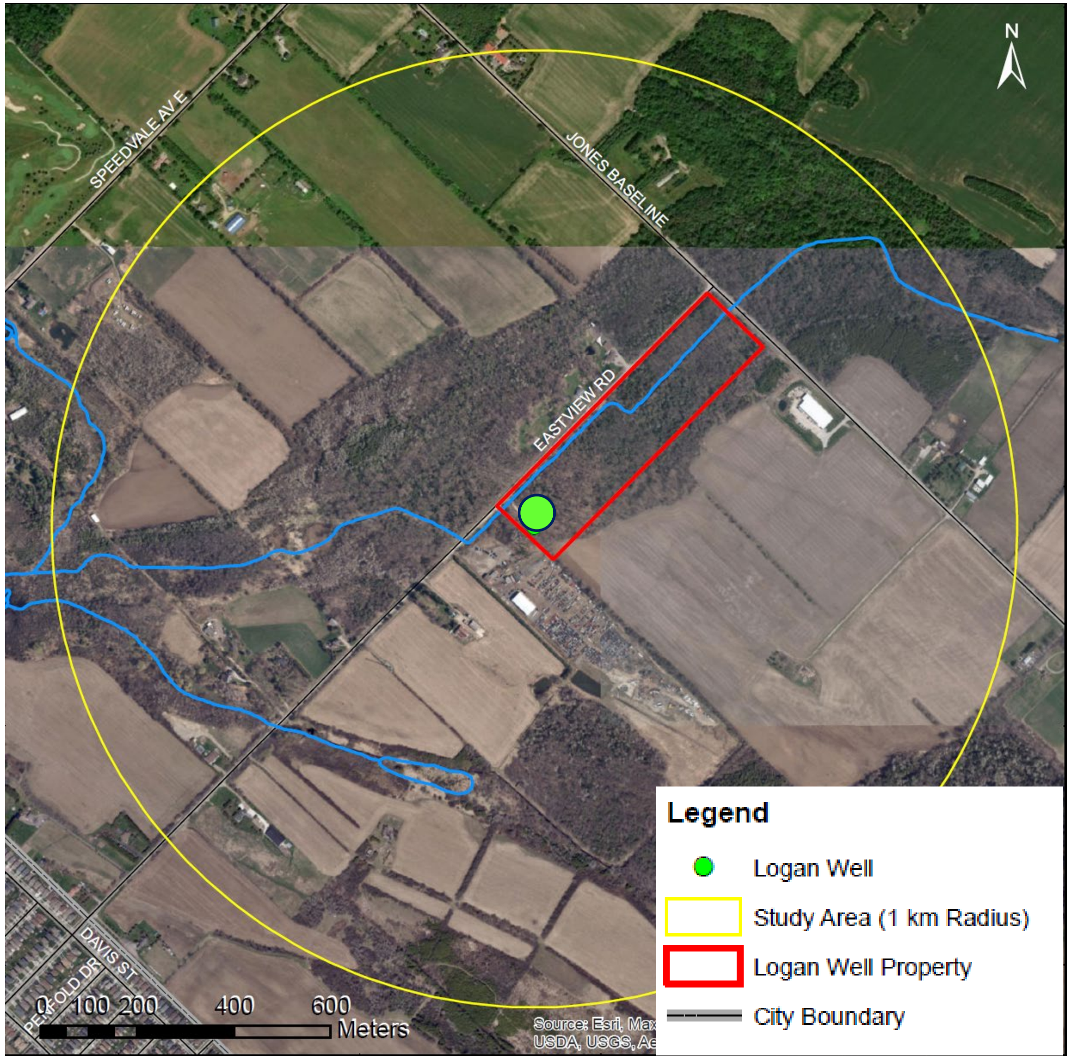
Economic and financial considerations - Estimated capital costs and operations and maintenance costs, including energy consumption

Legal and jurisdictional considerations - Location of facility relative to city boundaries; land requirements; implementation of Source Protection Policies

Technological considerations – Implementability, constructability and expandability of alternative; treatment requirements (current and future); ability to respond to changes in regulations; ability to utilize existing infrastructure; approval requirements

Example – Develop Existing Test Wells (Logan Test Well)

- City-owned property located in Guelph-Eramosa Township (GET)(Eastview Rd and Jones Baseline Rd)
- Consultation and collaboration required with GET - utility easements for water main along Eastview Rd
- Moderate capacity from previous tests - ~4,700 m^3/day
- Model output: potential for effects on Guelph NE PSW; potential for well interference
- Source protection - within existing WHPA's for quality and quantity – changes to WHPA's may affect current and future land uses
- Estimated capital cost: $10.1 M, $2,160/$m^3$
- City has initiated Logan Well Rehabilitation project to provide an initial feasibility assessment including well casing replacement, multi-level monitoring well, domestic well survey, short pumping test – Fall/21



Example - New wells outside City – Guelph North

- Model-defined, approximate location – GET North of the City (City does not currently own land here)
- Consultation and collaboration required with GET
- Rationale - proximity to an area with high transmissivity within the Gasport aquifer
- Estimated available capacity (average) – 2,935 m^3/day
- Model output: >10% baseflow reduction to Marden Creek; near the Marden South PSW Complex
- Field study would assess potential for interference with GET wells, private wells; Source protection constraints
- Iron and Manganese treatment assumed for costing purposes
- Estimated capital cost: $12.8 M, $4,375/$m^3$
- Low priority – potential future (20 – 30 yr source)

Preliminary preferred solution – initial implementation timeline

Short Term (0-10 Years)

- Conservation and efficiency – current level of effort
- Clythe well (offline)
- SW Guelph test well(s)
- Dolime Quarry Pond Level Management
- Logan/ Fleming test well(s)

Medium Term (10-20 Years)

- Conservation and efficiency – focus on high demand customers
- Lower Road Collector (offline)
- Arkell ASR

Long Term (20-30 Years)

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- Guelph Lake surface water
- Smallfield/ Sacco (offline) >30 yrs

What’s the Plan for new supply?

New supply projects - Class EA process to evaluate environmental, social, and economic impacts (such as impacts to surface water systems and sustainability) in and around the City including public engagement/consultation

Draft Water Supply Master Plan Update Report to be presented to Council in late 2021

Update WSMP every 5 years approximately

For more information:

- Project web page – https://guelph.ca/plans-and-strategies/water-supply-master-plan/
- Have your say Guelph - https://www.haveyoursay.guelph.ca/wsmp

The Municipal Class EA process

Phase 1
Identify and describe problem(s) and opportunities

Review agency/CLG/ public consultation

Fall 2019/ Winter 2020

Phase 2
Identify and evaluate alternative solutions and establish the preferred solution

Review agency/CLG/ public consultation

Summer/ Fall 2021

We are here

Fall 2021

Report
Water Supply Master Plan

The WSMP identifies the need for individual projects and the conceptual feasibility, including anticipated project triggers and impacts

Individual projects - in accordance with remaining Class EA requirements (Phases 3, 4 and 5)

Remaining approvals completed by addressing site specific environmental impacts, and consultation and documentation requirements

Questions?

Comments?

Thank you!

Guelph/Eramosa Township

8348 Wellington Road 124
P.O. Box 700
Rockwood ON N0B 2K0
Tel: 519-856-9596
Fax: 519-856-2240
Toll Free: 1-800-267-1465

October 27, 2021

Mr. Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services - Infrastructure, Development and Enterprise
City of Guelph
1 Carden Street
Guelph, ON N1H 3A1
Dave.Belanger@guelph.ca

Re: Water Supply Master Plan 2021 Update

Dear Mr. Belanger,

At the Committee of the Whole meeting held on October 20, 2021, the following resolution was put forward and passed:

> Be it resolved that the Committee of the Whole of the Township of Guelph/Eramosa has received Guelph Water Services Presentation regarding the Water Supply Master Plan 2021 Update; and
>
> That the Committee recommend to Council that a resolution be passed, stating the following:
>
> That the Township of Guelph/Eramosa has concerns with the City of Guelph's November 5, 2021, deadline for comments regarding the Water Supply Master Plan 2021 Update; and
>
> That Guelph/Eramosa Council request the City of Guelph Council to authorize the release of the draft report to Guelph/Eramosa staff in advance of the City of Guelph Council meeting so that the Township of Guelph/Eramosa may prepare comments; and
>
> That Council direct Township staff and Township consultant(s) to review the City of Guelph Water Supply Master Plan Update correspondence and draft report, when available, and to provide comments for Council's consideration at a subsequent Township of Guelph/Eramosa Council meeting; and

That the City of Guelph Council permit Guelph/Eramosa Council to provide comments in advance of the draft report being adopted by City of Guelph Council; and

That Council request that, when received, the City of Guelph Council acknowledge receipt of the Township comments and that the City of Guelph provide a response to the Township's comments; and

That this resolution be forwarded to the City of Guelph and the Township of Puslinch.

Please accept this for your information and any necessary action.

Sincerely,

Jenni Spies
Deputy Clerk

c.c. - Wayne Galliher, City of Guelph Division Manager Water Services
Scott Cousins, City of Guelph Hydrogeologist
Emily Stahl City of Guelph Manager of Technical Services
Matthew Alexander, AECOM Project Manager
Chris Knechtel, RJ Burnside Project Engineer
Dwight Smikle, RJ Burnside Senior Hydrogeologist
Kyle Davis, Risk Management Officer - Wellington Source Water Protection

Meaghen Reid
Clerk

Tel: 519-856-9596 ext. 107
mreid@get.on.ca

AECOM

Appendix F

Community Liaison Group #1, #2, and #3

- Meeting #1 Presentation
- Meeting #1 Discussion Guide
- Meeting #1 Summary
- Meeting #2 Presentation
- Meeting #2 Summary
- Meeting #3 Presentation
- Meeting #3 Summary

Water Supply Master Plan 2019 Update

Community Liaison Group Meeting No. 1

December 4, 2019

City of Guelph — Making a Difference

AECOM

Water Supply Master Plan
guelph.ca/WSMP

Our Focus on Sustainability

- We recognize that the resources that supply water to the City are vital to others in the community and to the natural environment
- This is reflected in Council's direction on water supply planning: "the focus of the Water Supply Master Plan is to establish a sustainable water supply to regulate future growth."
- The City works closely with MECP to evaluate the sustainability of each permitted water source and to develop policies that address the quantity of available water resources

Agenda

- Welcoming & Opening Remarks
- Water Supply Master Plan Update – Overview
- CLG Draft Terms of Reference
- Guelph’s Current Water Supply System
- City Updates since 2014 Water Supply Master Plan (WSMP)
- Water Supply Master Plan Update – Project Scope
- Next Steps

Meeting Purpose

- To review and provide input on key aspects of the Master Plan and the Class Environmental Assessment (EA), including:
  - Objectives and scope of the Master Plan Update
  - Issues and opportunities to be addressed
  - Alternative solutions to be assessed
  - Evaluation criteria to be applied

Check-In

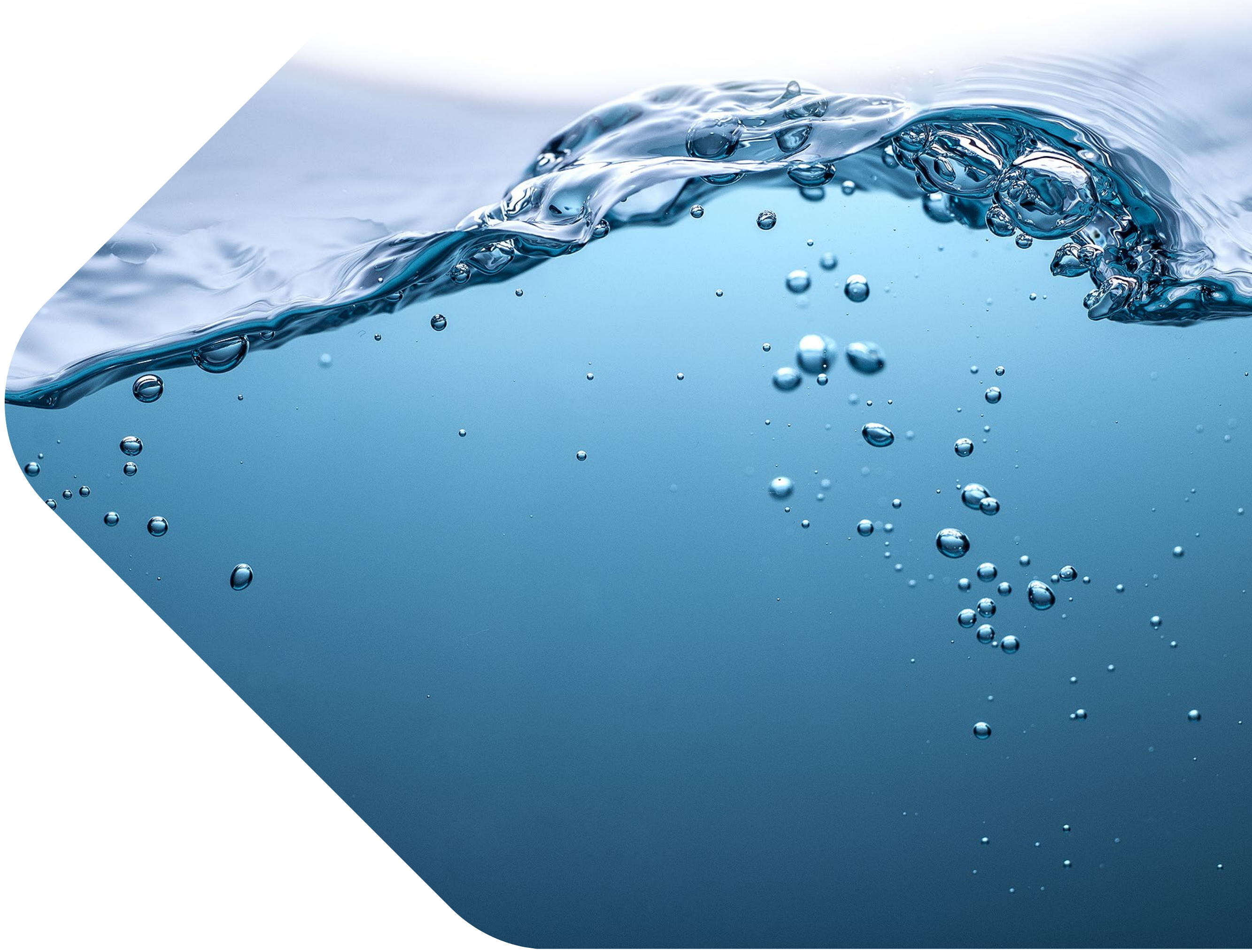
- Find someone you don't yet know (or know well).
- In pairs, introduce yourself and answer the check-in question.
- In one sentence, introduce your partner to the large group.

What am I bringing to this group?

(i.e. interest in/ experience/ knowledge of water supply)

Water Supply Master Plan Update

Overview



December 4, 2019

Purpose Statement (Draft)

The City of Guelph is committed to develop a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers.

The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.

The proposed implementation strategy must deliver an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

Water Supply Master Plan Update

- Will define where and how City gets safe and reliable water to the year 2041 and identify challenges beyond this timeframe
- We'll review Guelph's demand forecast and existing water supply and discuss with the community how to continue to meet the City's needs
- Additional sources to supplement our existing supply will be identified. As will alternative ways to conserve supply and manage demands
- When investigating existing and new water supply options we'll consider things like climate change, water quality and quantity, economic factors, social/ cultural environment, and any relevant regulations
- Regardless of source, our water supply will continue to meet the service requirements of Guelph and the high standards set by the Ministry of the Environment, Conservation and Parks (MECP), including Source Water Protection requirements
- Short-term, mid-term and long-term water supply options will be recommended

Water Supply Master Plan Update

CLG Terms of Reference (Draft)

City of Guelph — Making a Difference

AECOM

December 4, 2019

Water Supply Master Plan

guelph.ca/WSMP

CLG Terms of Reference

The Community Liaison Group (CLG) provides a forum for community input and guidance to the project team, during the update of the current Water Supply Master Plan (WSMP). The CLG will be established at the outset of the project and will help the City understand and consider the aspirations and concerns of the community as they relate to our current water supply demands, needs and supply sources.

CLG Terms of Reference

In addition to the Participant Responsibilities identified in the City's Community Engagement Framework (see Appendix A,) CLG members will:

- Consider matters, issues or information provided by the project team relating to the Master Plan process and provide guidance and input as requested.
- Liaise with the organization they represent (if applicable) to bring forward issues or comments from their organization and return information and results to the organization from the CLG.
- Ensure that the results of CLG discussions are accurately recorded in the meeting summary, or in any additional documents that the CLG or the project team may determine are needed.
- Embrace the City of Guelph's Guiding Principles for Community Engagement and Community Engagement Framework when providing guidance and input, and when interacting with CLG members and the project team.

CLG Terms of Reference

In addition to the Employee Responsibilities identified in the City's Community Engagement Framework (see Appendix A,) project team members will:

- Strive to provide accurate, understandable information to CLG members, so they can contribute informed ideas and input.
- Ensure that appropriate City staff – or other resource people – are present at discussions on specific issues or components of the planning process.
- Ensure that guidance and input from the CLG are fully considered in developing the Master Plan.
- Be open, receptive, and give careful consideration to ideas and input received from CLG members and strive to reflect this in the Master Plan.
- Embrace the City of Guelph's Guiding Principles for Community Engagement and Community Engagement Framework when interacting or planning to interact with the CLG.

Maintaining a Safe and Sustainable Supply

Guelph's Current Water Supply

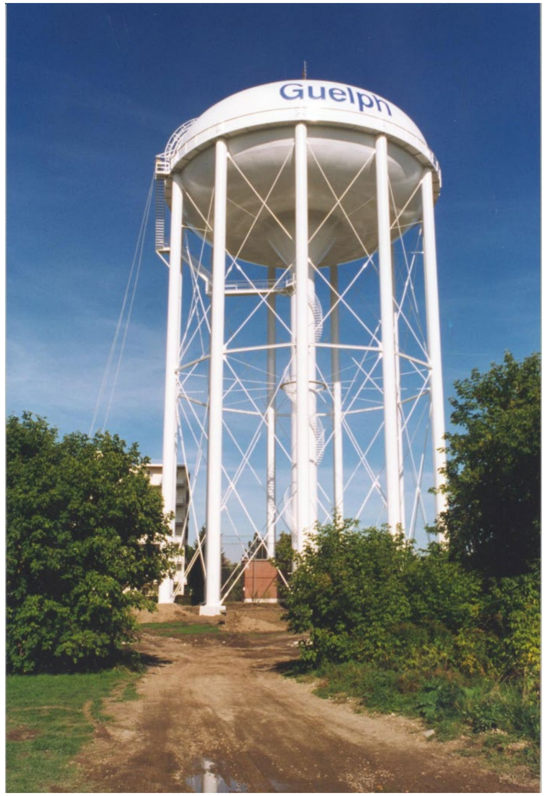
December 4, 2019

Water Supply Master Plan

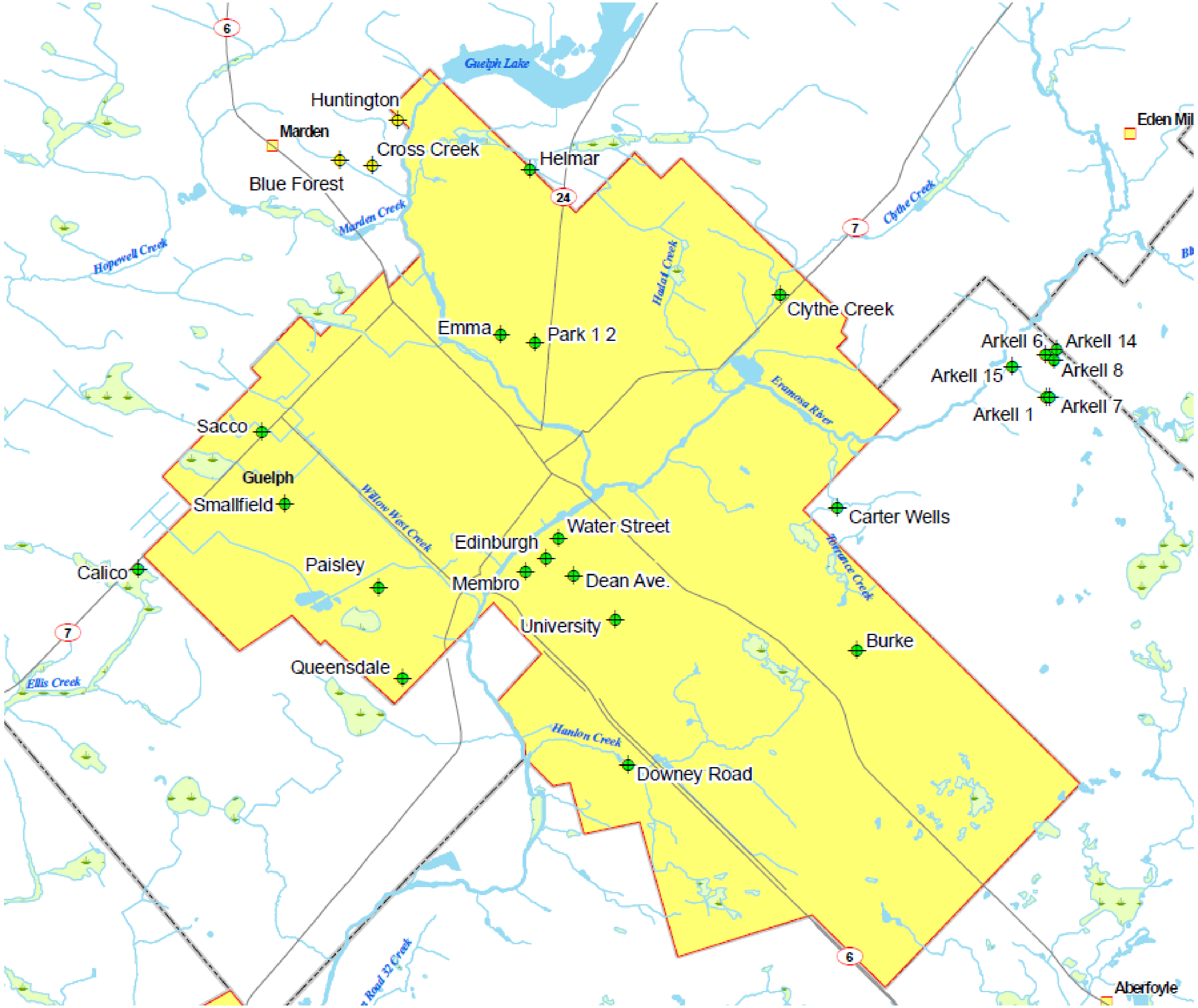
guelph.ca/WSMP

Overview of Our Existing System

- Groundwater-based water supply since 1879
- Guelph's water supply system includes production wells installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system:
    - 25 production wells, 21 wells in continuous operation - 4 wells offline due primarily to water quality concerns
    - A shallow groundwater system that collects spring water in the Arkell Spring Grounds
    - Eramosa River Intake and Recharge system (seasonal): river water pumped to a infiltration pond and trench; where it is captured by a subsurface collector system; availability is subject to river flow conditions (i.e., lower flow in summer)



Overview of Our Existing System



December 4, 2019

Water Supply Master Plan
guelph.ca/WSMP

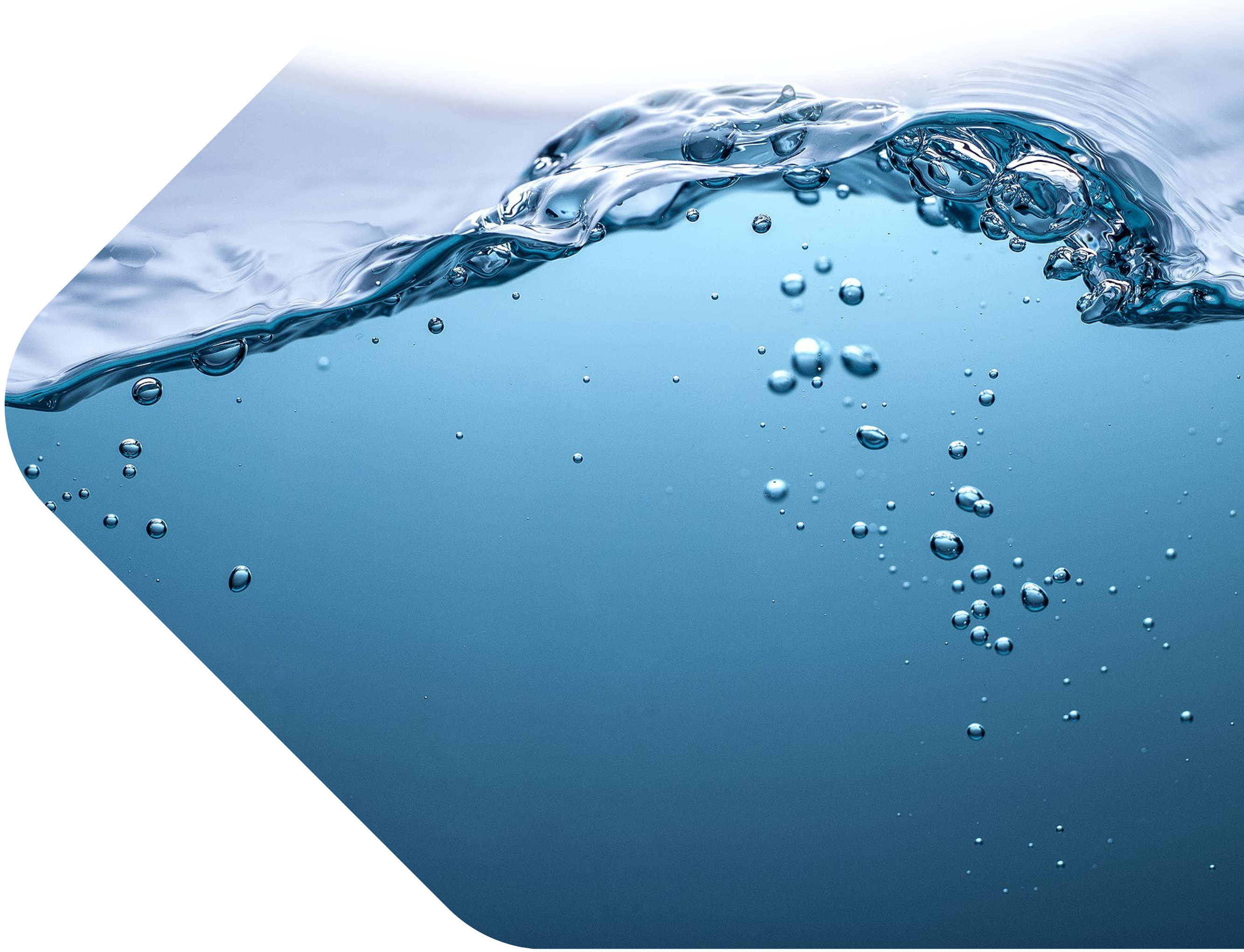
Arkell Spring Grounds

Overview of Our Existing System

2014 WSMP

Well/ System Capacities (m^3/day)

SE Quadrant	Arkell 1	2,000	**NE Quadrant**	Park 1	8,000
	Arkell 6	28,800		Park 2	
	Arkell 7			Emma	2,800
	Arkell 8			Helmar	1,500
	Arkell 14			Clythe Creek	0
	Arkell 15		**NW Quadrant**	Paisley	1,400
	Burke	6,500		Calico	1,400
	Carter 1	5,500		Queensdale	1,100
	Carter 2			Sacco	0
	Arkell Infiltration Galleries - Glen Collector	6,900		Smallfield	0
SW Quadrant	Membro	6,000	**Total Sustainable Capacity – 83,836 m^3/day**		
	Water Street	2,700			
	Dean	1,500			
	University	2,500			
	Downey	5,236			



A lot has been going on…

Progress Since 2014 WSMP

December 4, 2019

Water Supply Master Plan
guelph.ca/WSMP

2014 WSMP Preferred Solution and Timeline

1 – Conservation & Demand Management

- Implementation is on-going

2A – Groundwater: Existing Off-Line Municipal Wells

- Clythe in 2024 Sacco in 2029, Smallfield in 2030

2B – Groundwater: Municipal Test Wells

- SWQ in 2019, Logan in 2027, Scout Camp 2036, Hauser post-2038

2C – Groundwater: New Well Inside City

- Sunny Acre in 2033

2D – Arkell Collectors & ASR Wells

- Collector in 2031, ASR post-2038

2E – Groundwater: New Wells Outside City

- Guelph South and North post-2038

3A – Surface Water: Guelph lake Water Treatment Plant

- post-2038

3B - Surface Water: Guelph lake Water Treatment Plant & ASR Wells

- post-2038

Water Conservation & Demand Management

Progress 2006 to 2014

- City of Guelph has invested $10.2 million+ in water conservation programming.
- Delayed the need for close to $40.6 million+ in water and wastewater infrastructure by using less water.
- Saved $534,000+ per year in operational costs.
- Decreased peak day water use by 11,800 m^3 since 1999.
- Decreased non-revenue water lost to the "system" before reaching customers by almost 50 per cent.

GUELPH WATER
OURS TO CONSERVE

Water conservation and efficiency remain **most cost effective form of "new" supply** to assist in meeting Provincial growth targets.

Water Conservation & Demand Management

2016 Water Efficiency Strategy

2014 Water Supply Master Plan demand reduction target of 9,147 m^3/day by 2038.

Water Efficiency Strategy community demand management, efficiency and conservation goals:

- Reduce water use as part of new growth
- Develop/ pilot new technologies to save water
- Reduce water use in existing buildings
- The technology is proven and easily implementable in the City
- Stimulate the Guelph economy
- Minimize costs to the City

Final strategy endorsed by Council in September of 2016.

- 10 year, $13.6 million community-driven water efficiency and demand management programming
- Goal: Reduce water use by 6.2 MLD by 2026

Arkell Spring Grounds

Progress since 2014

Arkell Adaptive Management Plan and Operational Testing Program (2011 – 2016)

- Increase water taking from the Arkell bedrock wells from 19,584 to 28,800 m^3/day
- OTP did not result in any drawdown in the aquifer below Blue Springs Creek
- No impacts (water level drawdown, change in hydraulic gradient, water temperature impacts) to Blue Springs Creek were observed
- Permit-To-Take-Water (PTTW) issued by MECP for the requested 28,880 m^3/day

Arkell Spring Glen Collector Improvements

- Trench upgrades completed to improve the capacity of the groundwater recharge system
- Testing and monitoring completed to optimize pumping and recovery

Clythe Well Class EA & Membro Well Replacement

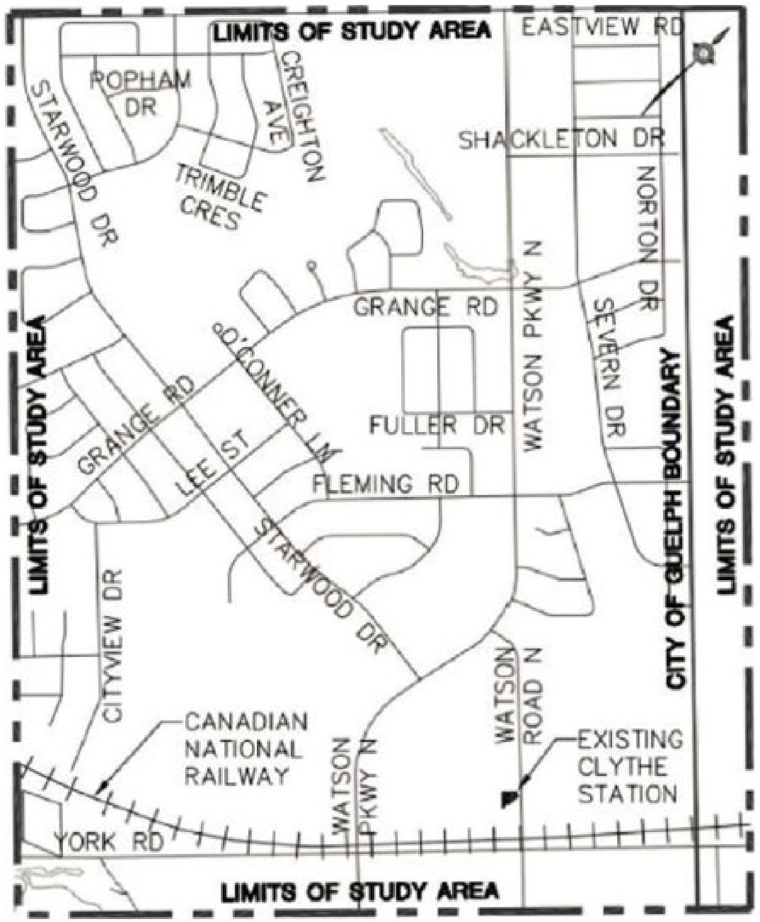
Progress since 2014

Clythe Well Class EA (2018):

- Location selected for water treatment facility
- Conceptual design of facility and raw & treated watermains
- Detailed design in 2019/ 2020
- Construction of project in 2021

Membro Well Replacement:

- Drilled in 2016 to depth of 49 m
- Addressed well diameter constraints for higher pumping rates to 6,000 m^3/day
- Well testing to be conducted in 2020



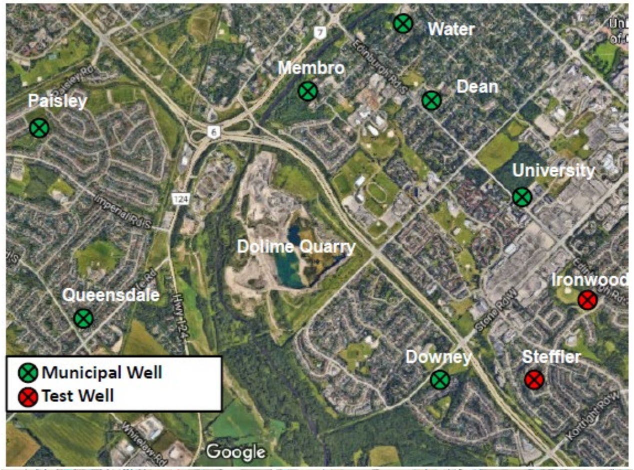
Southwest Quadrant Groundwater Investigations

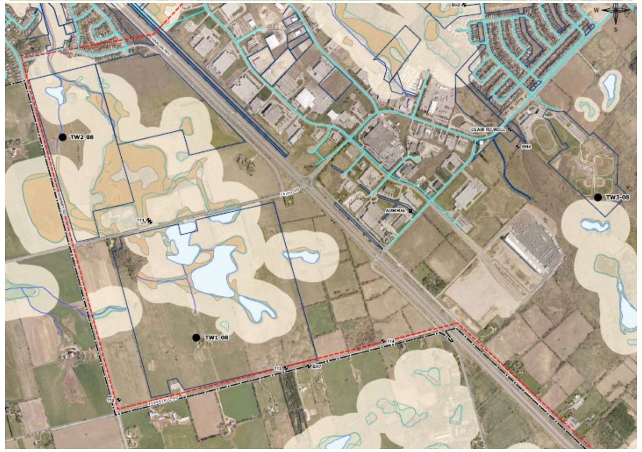
Ironwood/Steffler Wells (2016)

- Class EA put on hold due to concerns on Dolime Quarry
- Modelling studies to evaluate quality protection and additional quantity

Guelph South Groundwater Supply Investigation (2019)

- GSTW-1 - high potential supply source
- Convert to large diameter production well – test program
- Target capacity of ~5,200 m^3/day





Water Supply Master Plan Update

2019 Special Issues

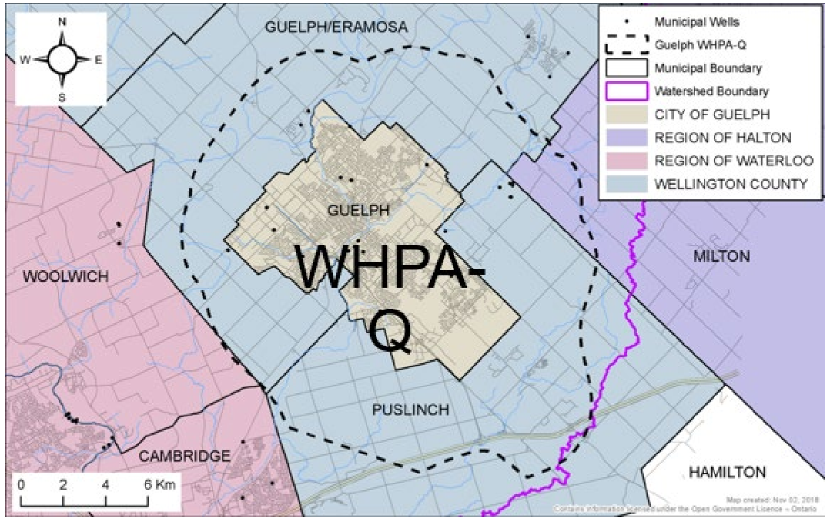
City of Guelph
Making a Difference

AECOM

December 4, 2019

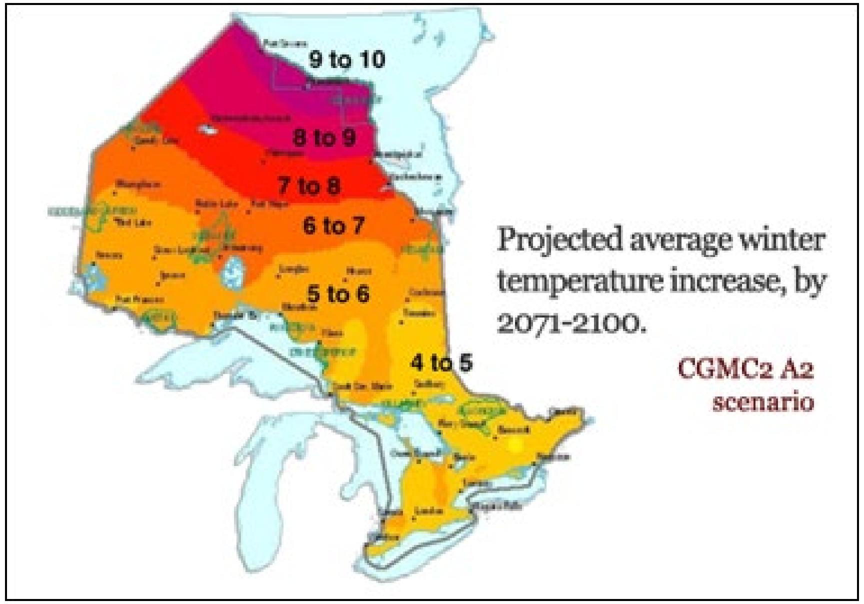
2019 WSMP – Special Issues

- Tier 3 Water Budget and Local Area Risk Assessment
  - Designation of Wellhead Protection Area – Quantity and Significant Risk under 2031 demand and drought
  - Potential for impacts on surface water
- Contaminated Sites
  - Northwest Quadrant – Smallfield and Sacco Wells
  - May need to abandon wells and "write-off" area for new supply
- Dolime
  - PTTW appeal - water quality and quantity concerns
  - Ironwood and Steffler test wells at risk
  - Settlement pathway proposed



2019 WSMP – Special Issues

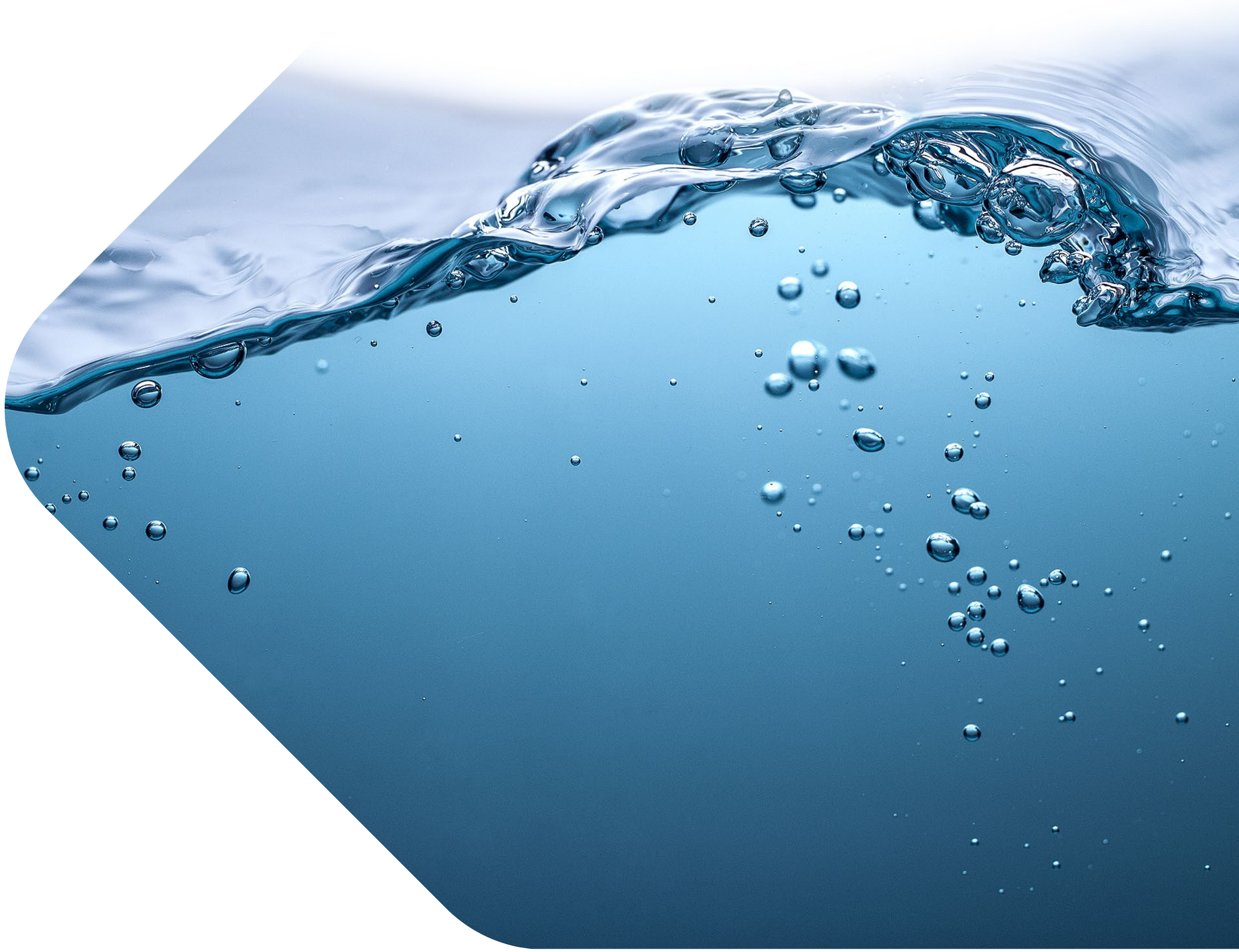
- Surface Water Impacts
  - Tier 3 Water Budget shows potential impacts on surface water with additional groundwater takings
- Firm Capacity and Security of Supply
  - Typically consider drought and loss of supply due to contamination event
  - Is 10 % "security of supply" allowance sufficient?
- Climate Change
  - Modelling studies indicate more recharge in future will supplement water supplies
  - Climate not expected to be an supply issue
  - Expectation that it be addressed in the WSMP



We'd Like Your Input...

What other questions, issues or concerns related to water supply should we consider while updating the Water Supply Master Plan?

- 1-2-All:
  - **Individual** silent reflection – 2 mins
  - Discuss in **pairs or groups of three**, building on reflection – 3 mins
  - Shareback – 10 mins



Ensuring a sustainable supply to 2041

2019 WSMP Update

December 4, 2019

Water Supply Master Plan
guelph.ca/WSMP

Objectives

- To provide a community-endorsed framework for provision of an adequate and sustainable supply of water to meet the current and future needs of all customers; to the year 2041
- To coordinate with other City master plans in developing a sustainable water/wastewater strategy
- To develop a "strategic plan" for implementation of specific projects (future works/ developments) in a phased approach with identified triggers
- To provide the basis for individual studies under the Class EA process

Scope of Work – WSMP Update

Forecast Population and Water Demand	• Develop population projections – residential and ICI (employment) • Develop water demand projections
Assess Existing Water Supply Capacity	• Update the assessment of existing well performance, maximum capacity and potential constraints for each supply source • Comparison of existing capacity with demand forecast
Develop and Evaluate Water Supply Alternatives	• Demand management & efficiency programs • Groundwater sources inside city • Groundwater sources outside city • Local surface water supply & ASR • Do nothing
Update the Water Supply Master Plan	• Evaluation of alternatives • Risk assessment • Develop WSMP Update Report

Community Engagement Goals

- Engage the Guelph community to develop a shared vision for managing the City's water supply
- Generate a broad awareness of the Water Supply Master Plan and the opportunities for participation
- Obtain an understanding of the community's aspirations/concerns relating to water management
- Keep key stakeholders informed of WSMP activities, and communicate in a timely and clear manner
- Affirm the City's commitment to community engagement and open planning processes, and demonstrate the impact of engagement efforts on the Master Plan Update and the Class EA process

Class EA Phase 1

Additional groundwater & alternative municipal supplies are identified

Class EA Phase 2

Constraints / opportunities identified, and evaluation methodology /criteria defined.

Servicing strategies identified

Preferred alternatives determined and Draft Plan submitted

Community Engagement

- Notice of Project Initiation
- CLG Recruitment
- Agency Notifications
- CLG #1
- Workshop#1
- Notice of Public Meeting #1
- Public Meeting #1
- Newsletter/ Media Release #1

- CLG #2
- Workshop #2
- Notice of Public Meeting #2
- Public Meeting #2
- Newsletter/ Media Release #2

- CLG #3
- Notice of Completion

Indigenous Engagement and Stakeholder Meetings

Communications and Social Media

Issue Management, Tracking, and Reporting

We’d Like Your Input…

Group A: Are there other ways to engage community members you would like the City to consider? What types of information is needed? Who else needs to be engaged?

Group B: How can community members outside of Guelph be properly consulted to evaluate water supply sources outside of the City?

Small Group Discussions:

- Split into **Group A** or **Group B** according to your interest
- Discuss in groups

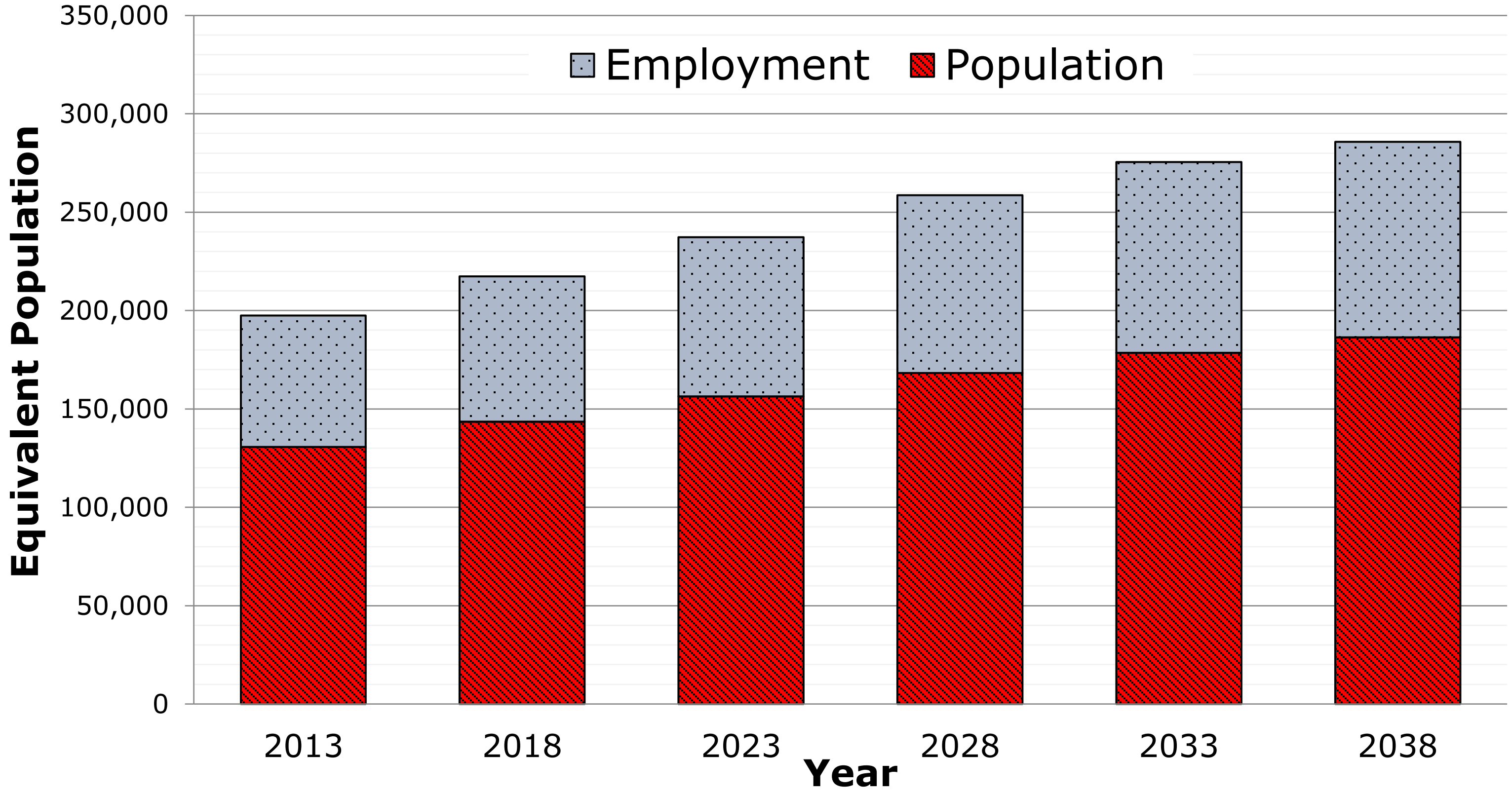
Maintaining a Safe and Sustainable Supply to 2014
Work Underway

December 4, 2019

Water Supply Master Plan
guelph.ca/WSMP

Population and Water Supply Demand Forecasts

Population Projection (2013-2038):



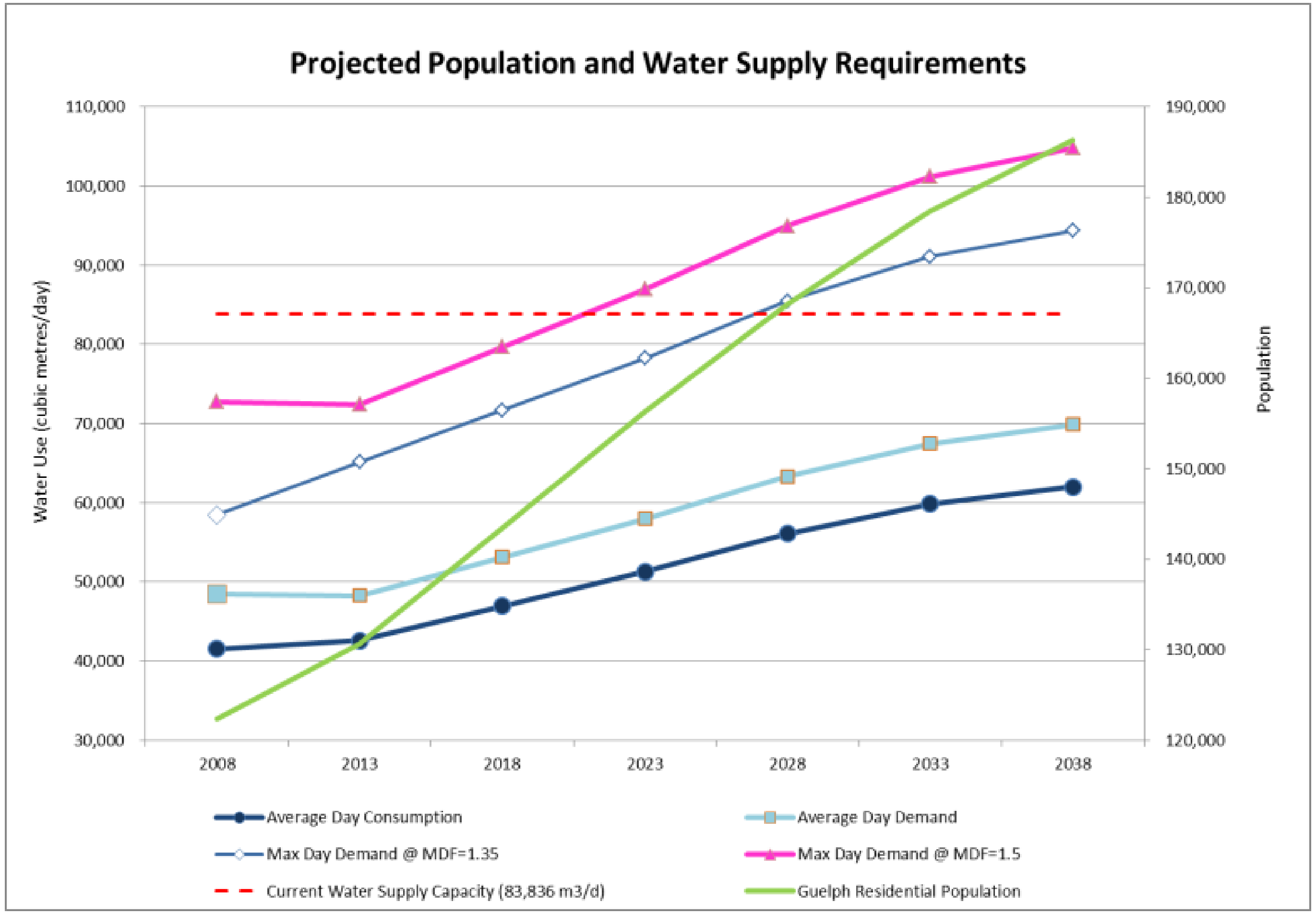
Develop **population projections** – residential and employment

- Will reflect Ontario 2019 Growth Plan (191,000 residents and 101,000 jobs by 2041)

Develop **water demand projections** – average daily and maximum daily

- Based on City consumption and well production data
- Quantify use reduction due to Efficiency programs
- Quantify non-revenue use

Population and Water Supply Demand Forecasts



Existing Water Supply Capacity Assessment

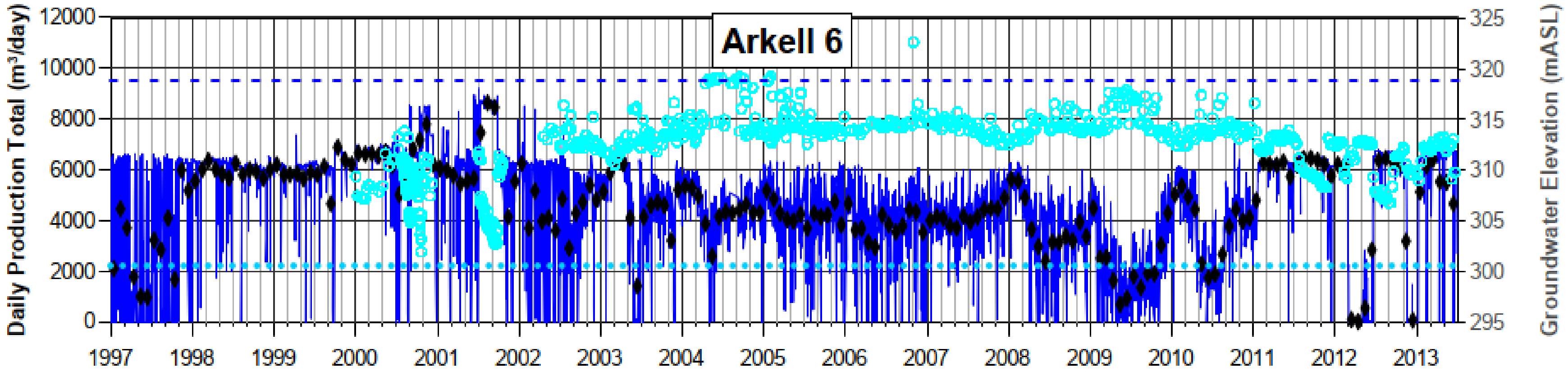
Existing Well Capacity Assessment

- Review historical performance of each well in system
- Conduct Waterworks Operations Workshop to identify constraints
- Determine maximum capacity for each supply source

Review Range of System Capacity

- Predictive / modeling assessment to review scenarios: loss of supply well, drought and short term high demand.

Comparison of Capacity Assessment with Demand Forecast



Developing Water Supply Alternatives

	Scope of Work
Demand Management/ Efficiency Programs	• Maintain commitment to these initiatives and 2016 WES • Determine range of realistic goals, and cost to implement • Develop means of measurement to evaluate
Groundwater Sources In & Outside of City	• Restore lost capacity through optimization of existing well supplies (i.e. infrastructure improvements) • Restore existing wells with treatment • Identify new potential water supply areas • Dolime Quarry – groundwater/surface water source
Local Surface Water Sources	• Establish feasibility/ risks of surface water alternatives including ASR • Assessment areas include: Eramosa River/ Guelph Lake
Do Nothing	• Undertake no improvements or changes • Significant impact on the growth potential for the City would be expected with this alternative

Note: A regional water system – like a Great Lakes pipeline – will **NOT** be considered during this Update.

We’d Like Your Input…

For each alternative, what are your questions and concerns?

Should any be added or removed from consideration?

Brainwriting:

- Individual silent reflection
- Write one question/ concern per sticky note, and post on wall beside the alternative

Maintaining a Safe and Sustainable Supply to 2041

Assessing Alternatives

December 4, 2019

Water Supply Master Plan

guelph.ca/WSMP

How We Will Assess Alternatives

Scope of Work

- Each potential alternative will be assessed using a consistent approach and evaluation criteria
- A short-list of alternatives will be ranked and further evaluated. This may include screening by:
  - Primary Criteria (e.g., ability to meet regulations, costs, technical feasibility, environmental or social affects)
  - Secondary Criteria (e.g., manageable impacts like construction truck traffic)
  - The technical assessment will include use of the Tier 3 Groundwater model to assess well system optimization and potential impacts related to development of new supplies
  - Comparisons and trade-offs will be made between alternatives and will form the rationale for the identification of the preferred solution or water strategy

Evaluation Criteria

Public Health and Safety	• Ability to meet provincial requirements
Natural Environment	• Potential effects to natural environment • Potential impacts to water resources • Potential impacts to natural heritage features • Environmental management planning considerations
Social and Cultural Resources	•Land use impacts •Short-term construction impacts •Potential impacts from operations •Potential impacts to Indigenous Peoples and values
Economic and Financial Considerations	• Estimated capital costs • Estimated operations and maintenance costs, including energy consumption
Legal / Jurisdictional Considerations	• Location of facility relative to city boundaries • Land requirements • Ability to address outside control
Technological Considerations	•Ability to implement and meet peak demand •Constructability, schedule and timing, and maintaining operations during construction • Water quality •Allowance for future treatment needs •Expandability •Ability to respond to changes in regulations •Ability to utilize existing infrastructure

We’d Like Your Input…

Are the evaluation criteria suitable for this study? Is there anything you would add or change?

Large Group Discussion:

- Individual silent reflection.
- Share your thoughts!

Next Steps

December 4, 2019

Next Steps

- Incorporate/ consider feedback from this workshop
- Prepare meeting summary and circulate to CLG members
- Complete current work and develop water supply alternatives
- Conduct preliminary evaluation of alternatives
- On-going Community Engagement
  - Community Liaison Group Meeting #1 – Wednesday Dec. 4
  - Community Open House #1 – late January 2020 (tentative)
  - CLG # 2 – Summer 2020 (tentative)
  - Workshop #2 – Summer 2020 (tentative)
  - Community Open House #2 – Late Summer 2020 (tentative)

Thank You!

Guelph's Water Supply Master Plan Update

Discussion Guide – Fall 2019

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The Corporation of the City of Guelph

Why Update the Water Supply Master Plan?

The City of Guelph is updating its council-approved Water Supply Master Plan, from 2014, to define how we will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2041. Reviewing our existing water supply system is an opportunity to discuss with Guelph and surrounding communities how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water in the future. Guelph is a growing community, and new water supply will be required to support the City's continued growth. In keeping with the 2014 Water Supply Master Plan, any development of water supply options outside of the City will only be considered with the co-operation and participation of the County and the relevant Township/Town.

When investigating existing and new water supply options—like new groundwater sources in and outside of the City, and local surface water sources—we'll consider things like water quality and quantity, economic factors, environmental and social/cultural concerns and any relevant regulations. Regardless of source, our water supply will continue to meet the service requirements of the Guelph community and the high regulatory standards of the Ontario Ministry of the Environment, Conservation and Parks (MECP).

What's Included in this Discussion Guide?

Page

Getting the Conversation Started

Community input is an essential part of our Water Supply Master Plan update process. We know that people care about where our water comes from, and that they want to maintain a safe and sustainable supply for present and future generations.

That's why we're making it easy for people to get involved. We'll be gathering input and suggestions from people and organizations in a number of ways to help update the Water Supply Master Plan:

- A **Community Liaison Group** (CLG) is in place to provide feedback to the project team throughout the process. The CLG has members from a wide cross-section of the community including residents, community groups, local government and business leaders. They will meet on at least three occasions to share ideas and perspectives on ways to improve the Water Supply Master Plan update.

- Two **Workshops** are planned to gather crucial input from the perspective of **Indigenous Communities, Municipalities and Agencies** to help ensure that concerns and interests are considered and addressed, and that the Water Supply Master Plan process meets all local and provincial By-laws and Acts, as well as environmental assessment and approval requirements.

- Two **Community Open Houses** are planned for the wider community to participate. These events will give interested individuals and groups an opportunity to review plans, ask questions directly to the project team members, and provide feedback.

In addition, we will be offering various online feedback opportunities at https://www.haveyoursay.guelph.ca/ throughout the process.

The Water Supply Master Plan update process is designed with you in mind. If you have any questions, comments, or concerns, please contact either Dave Belanger or Matt Alexander by telephone or email. We can also add you to the project email list if you would like to receive project notifications.

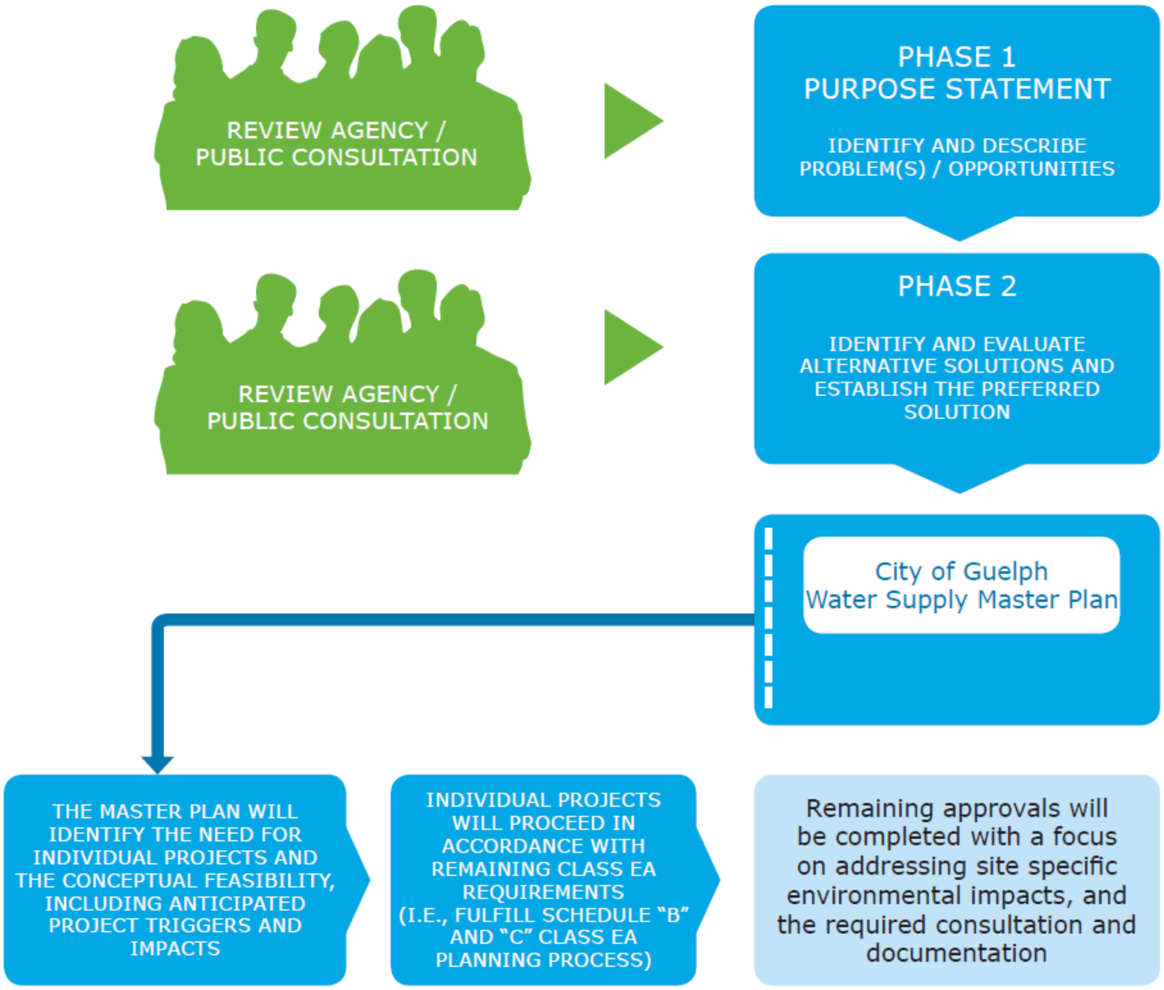
Everything you wanted to know about Master Planning

Our update follows the requirements of a Municipal Class Environmental Assessment (Class EA). When we are finished — after our Water Supply Master Plan Update is reviewed by the Guelph community and approved by Council — we will have identified constraints and opportunities related to our existing water supply system. We'll also have evaluated and prioritized a number of individual projects to increase the capacity of our existing system.

Master Plans differ from project specific studies. They:

- **Are broad in scope.** They analyze a system in order to develop a framework for the provision of future works and development.
- **Recommend Individual Projects.** Specific projects recommended in a Master Plan are part of the larger management system and may be distributed geographically throughout the study area. The implementation of specific projects may occur over an extended time frame. These individual projects will also follow the Municipal Class EA process.
- **Must Satisfy Requirements of the Class EA.** According to the Class EA document, a Master Plan must at least satisfy the requirements of Phases 1 and 2 of the Class EA process. **Figure 1** illustrates the Class EA Master Planning Process.

Figure 1: The Master Planning Process



The Master Plan will include an Implementation Plan that will recommend a series of Class EA water supply projects required to achieve the preferred solution. The Municipal Engineers Association (MEA) Class EA document classifies projects as either Schedule "A", "B" or "C" according to the type of environmental effect(s) anticipated. Each of these classifications requires a different level of review to complete the requirements of the Class EA, and comply with the Environmental Assessment Act:

- **Schedule 'A' Projects** are limited in scale, have minimal adverse effects and include the majority of municipal sewage, stormwater management and water operations and maintenance activities. These projects are approved and may be implemented without following the Class EA planning process.

Schedule **'A'** projects typically include normal or emergency operational maintenance activities. Examples of Schedule "A" projects include facilities that are located within a municipal road allowance or an existing utility corridor.

The sub-classification, Schedule 'A+', ensures that people are notified of certain projects that are pre-approved under the Municipal Class EA. For example, it would be appropriate to notify the public of planned construction in their area. This allows people the opportunity to direct questions or concerns to their municipal council.

- **Schedule 'B' Projects** have the potential for some adverse environmental effects. The proponent is required to conduct a screening process that involves contact with directly affected public and relevant review agencies to ensure that they are aware of the project and that their concerns are addressed.

  Schedule **'B'** projects require that Phases 1 and 2 of the Class EA planning process be followed and an Environmental Screening Document be prepared and submitted for review by the public and relevant agencies. If there are no outstanding concerns raised by the public and/or review agencies, then the proponent may proceed to project implementation. If, however, the screening process raises a concern that cannot be resolved, then the Part II Order procedure (commonly referred to as a "bump-up") may be invoked.

  Schedule **'B'** projects generally include improvements and expansions to existing facilities where there is the potential for some adverse environmental impacts. Examples of Schedule "B" projects include activities such as siting of water storage facilities or new municipal wells (including wellhead protection).

- **Schedule 'C' Projects** have the potential for significant environmental effects and must proceed under the full planning and documentation procedures (Phases 1 to 4) specified in the MEA Class EA document.

  Schedule **'C'** projects require that an Environmental Study Report (ESR) be prepared and submitted for review by the public. If concerns are raised that cannot be resolved, then the Part II Order procedure may be invoked.

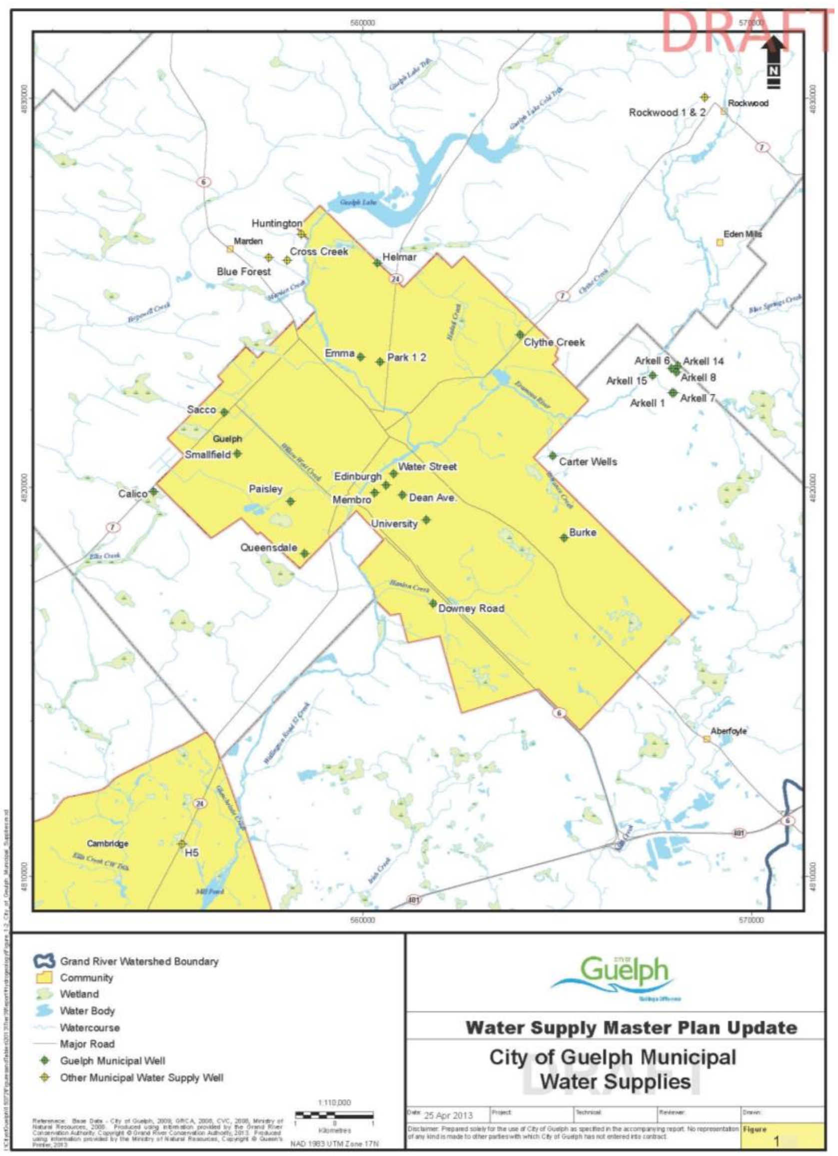
  Schedule **'C'** projects typically include the siting and construction of new facilities, such as water treatment plants, and major expansions to existing facilities.

Guelph’s Current Water Supply System

The City of Guelph relies almost exclusively on groundwater to meet the municipality’s residential and industrial, commercial and institutional (ICI) water demands. Other municipal water uses including fire fighting, street washing, and watermain flushing. The following describes the City’s water supply system and its capacity.

The City has used groundwater as its primary source of water since 1879. Guelph’s water supply system includes production wells installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system. The locations of the various wells and the collector are shown on **Figure 2** – Existing Water Supply System.

Figure 2: City of Guelph Municipal Water Supplies



There are currently 25 production wells in the municipal supply system. In 2019, 21 municipal wells were operated on a near continuous basis while the other four wells were offline, due primarily to water quality concerns. **Table 1** Municipal Production Wells – Operational Status summarizes the operational status of the individual production wells.

In addition to the municipal wells, there is a shallow groundwater system, called the Glen Collector, that collects spring water in the Arkell Spring Grounds. The City has the infrastructure to augment flow in the collector system during summer months by pumping water from the Eramosa River to a drainage area to recharge the groundwater where it is captured by the collector system. This system is occasionally shut down under low river flow conditions resulting in less water to the system at times when the water is most needed (i.e., summer demand).

Table 1: Municipal Production Wells – Operational Status

Quadrant	Pumping Well	Service Dates	Status in 2019
Northeast Quadrant	Emma Street Well PW1/31(COG)	1931 to present	continuous operation
	Park Wells PW1/37(COG) & PW1/47(COG)	1937 to present	continuous operation
	Clythe Creek Well PW2/76(COG)	1984 to present	off line for treatment upgrade (back on line 2022 est.)
	Helmar Well PW6/66(COG)	1975 to present	continuous operation
Northwest Quadrant	Sacco Well PW8/52(COG)	1953 to 1991	removed from service, low level volatile organic compound contamination
	Paisley Road Well PW4/59(COG)	1962 to present	continuous operation
	Smallfield Well PW3/66(COG)	1970 to 1993	removed from service, low level volatile organic compound contamination
	Queensdale Well PW1/70(COG)	1973 to present	continuous operation
	Calico Well PW4/76(COG)	1979 to present	continuous operation
Southwest Quadrant	Membro Well PW1/53(COG)	1997 to present	continuous operation
	Edinburgh Road Well PW2/53(COG)	1955 to 1996	removed from service, low level volatile organic compound contamination
	Dean Avenue Well PW3/58(COG)	1972 to present	continuous operation
	Water Street Well PW16/53(COG)	1956 to present	continuous operation
	Downey Road Well PW5/67(COG)	1980 to present	continuous operation
	Univ. of Guelph PW1/73(COG)	1970 to present	continuous operation

Quadrant	Pumping Well	Service Dates	Status in 2019
Southeast Quadrant	Carter Wells PW2/62(COG) & PW1/89(COG)	1963 to present	continuous operation
	Arkell 6 PW6/63(COG)	1967 to present	continuous operation
	Arkell 7 PW7/63(COG)	1964 to present	continuous operation
	Arkell 8 PW8/63(COG)	1989 to present	continuous operation
	Arkell 1 PW1/66(COG)	1967 to present	continuous operation
	Arkell 14	2012 to present	continuous operation since 2015 (end of Operational Testing Program)
	Arkell 15	2012 to present	continuous operation since 2015 (end of Operational Testing Program)
	Burkes Well PW2/66(COG)	1975 to present	continuous operation

We’ve made improvements since our 2014 WSMP

Since the completion of the Water Supply Master Plan in 2014, the City has initiated several projects recommended in the Master Plan.

The Arkell Spring Grounds Operational Testing Program, designed to evaluate potential impacts associated with increased groundwater pumping, was successfully completed between 2011 and 2015. The result is an increase in the City water supply capacity by about 9,000 m^3/day. For more information visit http://guelph.ca/plans-and-strategies/water-supply-master-plan/arkell-spring-grounds/.

The Membro production well (PW1/53) was replaced in 2016 with a new well (Membro Replacement Well). The original Membro Well contained a liner which reduced the diameter of the well and the size of the pump that could fit into the well. The Replacement Well was constructed at a larger diameter for increased pumping up to the permitted amount of 6,050 m^3/day. Long term testing of the replacement well will be conducted in 2020.

Structural improvements have been made to the Clythe Well to improve water quality. This well is expected to be online in 2022, following construction of a new water treatment facility and associated watermains. The Clythe well is currently limited to 3,396 m^3/day. However, subject to a testing program assessing potential impacts to surface water and groundwater users, the permitted rate may be increased to 5,237 m^3/day.

Improvements have been made to the Glen Collector at the Arkell Spring Grounds. This includes trench upgrades that have increased the capacity of the groundwater recharge system.

The City is currently undertaking a project in the Southwest Quadrant to upgrade a test well into a test production well and conduct long-term testing of the well capacity and monitoring of associated pumping effects on the aquifer/natural environment. If this becomes a production well site, it will add to the overall system capacity.

A proposal for the future use of the Dolime Quarry lands is currently under consideration by the City. The proposal includes the protection of the quality and quantity of the primary aquifer system utilized by the City for water supply. Alternatives will consider how to potentially capture and treat a portion of the 11,000 m^3/day of groundwater that is extracted during quarry operations for City supply.

In addition to these ongoing projects, the City is actively implementing source protection programs to protect its existing water supply and to prevent loss of water supply capacity in the future. These Source Protection programs included the Tier Three Water Budget Assessment, conducted in association with the Grand River Conservation Authority (GRCA), to determine the amount of water that may be available for municipal water supply. This assessment resulted in a Significant water quantity risk rating for the City's supply. Subsequently, an assessment was completed to develop a strategy for managing the identified water quantity risk. In addition to this strategy, the City is working with MECP, GRCA and Wellington County to develop Source Protection Policies to help manage groundwater resources within the delineated vulnerable area (WHPA-Q). For more information on the City's source protection programs visit the following websites:

- http://guelph.ca/plans-and-strategies/drinking-water-source-protection/
- https://www.sourcewater.ca/en/source-protection-areas/Guelph-and-Guelph-Eramosa-Tier-3.aspx
- https://www.sourcewater.ca/en/source-protection-areas/resources/Documents/Grand/GGET-Threats-Management-Strategy-2018-06-14-final.pdf

Water Efficiency and Demand Management

In Guelph we depend mostly on groundwater for our water supply, so we know it makes sense to use our water wisely. Water efficiency and demand management will be as important during this Master Plan Update as they were during the 2014 Water Supply Master Plan. We are committed to using less water per capita than comparable Canadian cities! Since 2006, because of our many successful water conservation initiatives, we have reduced our community's average daily water production by twelve per cent, with Guelph residents using 20 per cent less water per person per day than the average person in Ontario. For more information regarding Guelph's current water efficiency opportunities and initiatives, go to http://guelph.ca/ourstoconserve.

The 2016 Guelph Water Efficiency Strategy Update identifies the preferred program, policy and resource requirements to achieve and sustain the water use reduction targets of the City's Water Supply Master Plan, Community Energy Plan and City Council's Strategic Plan. This report can be found at: http://guelph.ca/plans-and-strategies/water-efficiency-strategy/.

Updating our Water Supply Master Plan

Our updated Water Supply Master Plan will provide a community endorsed framework for ensuring an adequate and sustainable supply of water to meet current and future needs of all our customers, until the year 2041 and will identify challenges beyond this timeframe. It will be our strategic plan for implementing – in a phased manner – specific projects to increase our current water supply capacity and will provide the basis for individual studies under the Class EA process.

The Master Plan will be a key document considered during the Municipal Comprehensive Review (MCR), which will be completed by the City between 2020 and 2021. Through the MCR, the City will bring its Official Plan into conformity with the Provincial document "A Place to Grow: The Growth Plan for the Greater Golden Horseshoe" (the Growth Plan). The Master Plan update will incorporate the population targets to 2041 outlined in the Growth Plan.

Our Proposed Purpose Statement

Phase 1 of the Class EA planning process requires proponents to consider why a change is required and to document their reasons. This leads to the development of the Purpose Statement: a clear statement that identifies the problems, deficiencies and opportunities to be investigated. The Purpose Statement is the principle starting point of a Class EA study and becomes the central theme and integrating element of the project. It also assists in setting the scope of the project.

The **Purpose Statement** in the previous WSMP has been updated to provide a starting point for discussion:

> The City of Guelph is committed to manage population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.
>
> The 2014 Master Plan confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required. The proposed implementation strategy must deliver, through to 2041, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

This 2019 update will build on the recommendations made during the 2014 Water Supply Master Plan, including water conservation/efficiency measures and additional sources of water supply.

Proposed Alternatives (Preliminary)

To identify the optimal water supply system to go forward with, we'll start by updating the alternatives considered in the 2014 WSMP. We'll consider the following:

1. **Water Efficiency & Demand Management:** Reducing or reusing water can have the same effect as increasing water supply – each litre of water saved by an existing customer can be made available for the growth needs of the community. Water conservation and demand management will be as important during this Master Plan update as it was during the 2014 Water Supply Master Plan.
2. **Groundwater Sources – In & Outside of the City:** We'll update information related to existing supplies and new supply sources recommended in the 2014 study, as well as investigate new water supply areas, including:
   a. Increasing water takings from established sources
   b. Re-establishing sources (includes treatment) that are currently not used because of poorer water quality
   c. Water takings from new sources
3. **Local Surface Water Sources:** New local surface water sources — with or without Aquifer Storage & Recovery (ASR) — will be considered, including possibly the Speed River, Eramosa River and Guelph Lake.
4. **Do Nothing:** Assumes no improvements to the current water supply system. It is expected that this alternative would have significant impact on the City's growth potential and would be contrary to the City's Official Plan.

Evaluating our Options – Evaluation Criteria

The Water Supply Master Plan (2014) provided a process to evaluate the proposed water supply options. This same process is intended to be used again during this update.

A detailed evaluation of each water supply alternative will be completed to assess the impact, if any, to each of the following environmental components[1]:

- **Public Health & Safety.** Addresses public's health and safety.
- **Natural Environment.** Addresses the protection of significant natural and physical elements of the environment (i.e., air, land, water, plants and animal life) including natural heritage environmentally-sensitive policy areas.
- **Social / Cultural.** Evaluates potential effects on residents, neighbourhoods, businesses, Indigenous Peoples and values, community character, social cohesion, community features and historical/archaeological and heritage components, in addition to municipal development objectives.
- **Economic / Financial.** Addresses the potential effect on water supply system capital costs and operating and maintenance costs.
- **Legal / Jurisdictional.** Considers regulatory and land requirements for each water supply alternative (and has regard to political boundaries).
- **Technical.** Considers technical suitability and other engineering aspects of the water supply system.

1. The Environmental Assessment Act (Section 1. (c) (i) to (vi)) defines the "environment" as: "air, land, water, plant and animal life including humans; the social and cultural conditions that influence the life of humans or a community; any building, structure, machine or other device or thing made by humans; any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities; or; any part of combination of the foregoing and the interrelationships between any two or more of them, in or of Ontario." This definition of the environment is used and is reflected in the environmental components used in the Phase 2 evaluation.

In keeping with our 2014 Water Supply Master Plan, we are proposing to use the following evaluation criteria to assess the feasibility of the identified water supply alternatives.

Evaluation Category	Evaluation Criteria
Public Health & Safety Considerations	• Ability of Alternative to meet provincial water quality and security requirements
Natural Environmental Considerations	• Potential effects to natural environment including siting/routing considerations and/or constraints. • Potential impacts to water resources (e.g., stream crossings, stream base flow, aquifer groundwater levels). • Potential impacts to natural heritage features, including provincially significant wetlands (PSWs), environmentally significant areas (ESAs), Areas of Natural and Scientific Interest (ANSIs), and sensitive species habitat. • Environmental management planning considerations.
Social / Cultural Considerations	• Short-term construction related impacts including dust, traffic, access, and noise. • Potential siting/routing considerations including cultural/heritage (e.g., archaeological) and/or tourist recreational resources. • Potential impacts to Indigenous Peoples and values. • Potential impacts from operations including impacts to groundwater and surface water users.
Economic / Financial Considerations	• Estimated capital costs. • Estimated operations and maintenance costs, including energy consumption.
Legal / Jurisdictional Considerations	• Location inside vs. outside City boundaries and associated jurisdictional issues. • Land requirements • Ability to address outside control (independence and reliability) of City with respect to participation in decision making, rate structures and risk related to location/position on proposed water supply scheme (e.g., end of pipe). • Consideration towards Political Boundaries.

Evaluation Category	Evaluation Criteria
Technical Considerations	• Ability to implement alternative • Maintaining operation during construction • Minimizing disruptions/ downtime • Constructability • Schedule and Timing • Water quality – requirement for treatment • Allowance for future treatment needs • Expandability • Ability to respond to change in regulatory treatment requirements/standards • Ability of alternative to use existing infrastructure

Agenda

Community Liaison Group Meeting #1
December 4, 2019 from 6:30 to 9:00 pm
Guelph City Hall, 1 Carden Street, Marg MacKinnon Community Room

Time	Agenda Item
6:15 pm	Registration and Welcome • **Participants will be welcomed at the door and asked to sign-in**
6:30 pm to 9:00 pm	**Meeting** • Opening Remarks • WSMP – Overview • Guelph's Current Water Supply System • City Updates – Since 2014 WSMP • WSMP Update – Objectives / Scope of Work • Next Steps **Discussion** • Ample opportunity for discussion will be provided – and encouraged – throughout the meeting.
8:50 pm	**Next Steps & Adjournment**

Discussion Topics and Questions – Community Liaison Group Meeting #1

Guelph primarily depends on groundwater for its water supply, so we know it makes sense to use this finite but renewable resource wisely. Keeping our Water Supply Master Plan up to date gives Guelph short-term, mid-term and long-term water supply options to meet predicted demand.

We want people to join the conversation! We understand that good planning involves the community so we're making it easy for people from Guelph, the

County, Townships and Town of Milton to be involved and kept up-to-date on our progress. Today, we want to gather your perspectives on many topics. Today's meeting will focus primarily on planning aspects of the Water Supply Master Plan update, such as the:

- Current level of water supply service provided, and any overall concerns or issues
- Proposed Purpose Statement for the WSMP
- Preliminary water supply alternatives we are considering
- Evaluation Criteria we will use

Providing your Feedback

The following sheets include many of the questions we will be discussing today. Although we will be documenting much of the meeting conversation, it would valuable to also receive your individual feedback, including for those questions we do not discuss. Feel free to make note of your thoughts. A team member will gather your feedback at the end of the meeting. All feedback will be used to prepare recommendations to improve the Water Supply Master Plan update project and will be included in the Consultation Summary Report for the project.

General Questions

1. What do you think of the City's current water conservation goals and strategies? Are there other goals or strategies that should be considered?

2. Would you support a bylaw that regulates new high water demand land uses in the City? Why or why not?

3. What issues, concerns or questions related to water supply should be considered while updating the Water Supply Master Plan?

Water Supply Master Plan Update

4. Is the Purpose Statement adequate for the WSMP Update?

5. What do you think of our proposed community engagement plans:

a) Are there other ways to engage community members you would like to see the City consider?

b) What types of information do community members need to be engaged?

c) **Who else needs to be engaged?**

6. **How can community members outside of Guelph be properly consulted to evaluate water supply sources outside of the City?**

Preliminary Water Supply Alternatives

7. **Do you have concerns regarding any of the alternatives presented? Should any be added or removed from consideration?**

8. **New water supply sources may have some environmental impact. For example, long-term groundwater pumping from wells may affect surface water features. In your opinion, is it reasonable to take water to support population growth even if there are environmental impacts? What level of impact is acceptable?**

9. **Should water supply sources inside the City be prioritized over those outside City boundaries? Why or why not?**

10. **Is it appropriate to consider obtaining water from sources that require treatment to remove contaminants (i.e., natural or industrial), assuming all regulatory standards are met after treatment?**

Evaluation Criteria

11. Are the evaluation criteria suitable for this study? Is there anything you would add or change?

Water Supply Master Plan Update
Community Liaison Group #1 – Summary

Date and Time of Meeting: December 4, 2019 from 6:30 to 9:00pm

Location: Guelph City Hall, 1 Carden Street, Marg MacKinnon Community Room

Overview

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP), from 2014, to define how we will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2041. Reviewing our existing water supply system is an opportunity to discuss with Guelph and surrounding communities how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Part of our WSMP update includes a Community Liaison Group (CLG). The CLG includes members from a wide cross-section of the community including community and environmental groups, agricultural organizations, business leaders, and residents from in and outside the City. This was the first of three (3) meetings to share ideas and perspectives on ways to improve the WSMP update. The purpose of the first CLG meeting was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment, including:

- Objectives and scope of the Master Plan Update
- Issues and opportunities to be addressed
- Alternative solutions to be assessed
- Draft evaluation criteria to be applied

There were 13 participants, along with four (4) City staff and three (3) AECOM consultants.

The format of the workshop included a presentation and opportunities for discussion and reflection.

Attendance

The following CLG members were present:

- Andrea Williams, Guelph resident

- Angela Kroetsch, Guelph Wellington Development Association
- Beth Parker, University of Guelph
- Brady Deaton, University of Guelph
- Brendan Bumbaco, Sleeman Breweries
- Carol Tyler, Guelph resident
- Corey Woods, Guelph Eramosa Township
- Grant Parkinson, Guelph Water Conservation and Efficiency Public Advisory Committee
- Janet Harrop, Wellington Federation of Agriculture
- Maya Wariyar, Guelph resident
- Sheri Longboat, Guelph resident
- Susan McSherry, Wellington Water Watchers
- Steve Nyman, University of Guelph
- William Castledine, Cargill Meat Solution

Dave Belanger, Scott Cousins, Peter Rider and Emily Stahl from the City of Guelph were present. Matthew Alexander, Alicia Evans and Kathryn Ross from AECOM were also present.

The following members were unable to attend:

- Matthew Bulmer, Puslinch Township
- Ron East, Council of Canadians
- Steve Chomyc, Resident

Meeting Format

Dave Belanger (City of Guelph) opened with a Statement of Territorial Acknowledgement and highlighted the project's focus on sustainability. Alicia Evans (AECOM) provided an overview of the meeting and asked attendees to introduce themselves. Attendees were provided with copies of the Terms of Reference (Draft), PowerPoint presentation, Discussion Guide, a Municipal Production Wells and Test Well Locations map and an Aquifer Storage and Recovery graphic. The presentation was delivered by Dave Belanger (City of Guelph) and Matthew Alexander (AECOM). Alicia Evans (AECOM) facilitated the discussions.

The main sections of the presentation included:

- Overview of the WSMP Update and CLG Terms of Reference (Draft)
- Guelph's Current Water Supply
- Progress Since the 2014 WSMP
- Details About the 2019 WSMP Update and Special Issues
- Work Underway
- Assessing Alternatives
- Next Steps

Discussion questions related to the content provided in the presentation were asked at various points during the workshop. Attendees shared their comments with the group and had the opportunity to ask additional questions related to the specific presentation topic.

The discussion captured throughout the workshop is summarized in the sections that follow. Questions are noted with a "Q", answers with "A", comments with a "C" and responses with an "R". Answers were primarily provided by Dave Belanger (City of Guelph).

System Overview and Current Water Supply

Discussion Question: What other questions, issues or concerns related to water supply should we consider while updating the WSMP?

- Water supply and sustainability is a major concern
- Consider large water users. Companies like Lafarge are extending their permit-to-take-water and wanting to increase to half of what the City uses daily
- Concern about the impacts of water-taking from new wells and surface water recharge areas on private agricultural water levels
- Concern about using drinking water for carrying fecal waste out of our homes and public places

- Concern about impacts of personal care products and contaminants entering drinking water system
- Focus on healthy water when we are making water supply decisions
    - Response: Focusing on healthy water is the basis of the City's source water protection program. We want to see that the water quality we have today is the same water quality we have in the future. Protecting water quality and quantity is a high priority.
- Consider impacts of road salt and water softeners
- Consider ways to store water and save it for using at peak times
    - Response: This project is focused on water supply. A separate Master Plan is being done for water and wastewater servicing, which includes water storage.
- Better describe how the whole system works together: how is the need to increase water supply determined; how is population used as an empirical measure to drive our expectation of the water supply we need; and how does that reconcile with what the City's done in the past?
    - Response: The City recently assessed how per capita water demand is trending. The current water demand is at approximately 156 litres per capita. The challenge moving forward is maintaining such low water demand. Population growth will lead to increasing water demand even with the per capita consumption at the same or similar level.

Q1: Is there a contract between the City and Puslinch for the Arkell Springs?
A1: There is no contract. Arkell Springs is on City-owned property. The City has a permit-to-take-water and water distributed from site through a City easement.

Q2: What is Guelph's peak day water use?
A2: Peak day demand is the maximum amount of water taken in any single day in a one-year period. In 2018, peak day demand was 57,000 m^3/day on July 11 which is only a 20 percent increase above the average day demand of 47,500 m^3/day. Generally, the peak day occurs on a hot day in the summer but there can be anomalies. We have experienced peak water day demand in February because of extreme cold when we actively tell people to run water to reduce freezing pipes.

Q3: Did you run the model for the Tier 3 Water Budget Study? Where and when did it fall below 'significant risk'?
A3: The Tier 3 Model was used according to the Technical Rules under the Clean Water Act to characterize the water quantity risk for the City's water supply system. We've completed a threats management strategy to understand our options for

addressing the ‘significant water quantity risk’. One potential solution is to add more wells. The issue is taking a large amount of water out of a small area and creating impacts. If we spread our water taking over a larger footprint, we could reduce that risk.

Q4: Are we at a significant risk now?
Q4: No. In a drought scenario we are classified at a significant water quantity risk under projected 2031 water demand.

Q5: Where is the threshold for significant risk? Can we appeal to the province if their growth targets are pushing us into a significant risk?
A5: We need to have this discussion as part of this Master Plan process: how much growth can be supported in the City while maintaining a sustainable water supply system. The significant risk is a future projection and we will manage the risk through our Source Protection Program (i.e., water quantity policies in our Source Protection Plan) and the WSMP. If we spread our wells over a larger area, we might need to be able to capture more water and reduce the risk. However, increasing the area of our water taking introduces other factors such as jurisdiction issues, new impacts, and potential land use constraints.

Q6: What strategy is there to reduce the current losses in the system?
A6: We’re currently at a 10-12% system loss. We are at, or likely below, industry standards for system losses. Some communities are at 20% or 30% system losses. These losses depend on things like the age of the system and soil conditions. The City is focused on continuing to reduce system losses.

Q7: Do you keep statistics on residential versus industrial water use?
A7: We do. The City has a dedicated water conservation coordinator that works with businesses. The City also has a water efficiency strategy and a Water Smart Business Program. We’ve found that multi-residential buildings are higher water users compared to businesses, municipal buildings and single detached homes.

C1: Recent residential development has been multi-unit townhouses and condominiums. These developments might lower per person water use because they don’t have lawns, have less linear infrastructure to service and more intensive development.

Q8: Is there a model for tracking the growth of large water users in the area due to the *Places to Grow Act?* For example, Guelph was once attracting the food processing industry. How do we track large water users’ growth in this Master Plan process?
A8: The City attempted to address this in the 2014 WSMP update by setting standards for types of industry. When a large water user is interested in the City, the proportion of water-taking versus the number of jobs is considered. If it’s a reasonable number of jobs with a reasonable water-taking, the company may be

considered (compared to a high amount of water-taking and low number of jobs). This is all taken into consideration before an approval or denial. If a company requires 5 to 10 million litres of water a day, we immediately say no – we do not have the capacity to support this.

> Follow-up question: Do businesses see that as a policy?
> Answer: Since 2016, the City's source protection program includes asking questions in terms of how much anticipated water will be used for a proposed development. These questions are asked early on at a conceptual level.

Q9: What is the relationship between capacity, availability and use? How do we define capacity?
A9: Parts of the Tier 3 Water Budget Study work tries to define water supply capacity. The challenges we are faced with is knowing how much water is out there and how much water we can sustainably use. If we take more water for supply, that means there is less water for other water uses such as wetlands, streams and rivers. Some systems respond very slowly to water taking so impacts would not be observed for years. The Tier 3 groundwater model is the best, comprehensive tool that we have available to assess potential long-term impacts associated with groundwater supply.

Details About the 2019 WSMP Update

Discussion Question: Are there other ways to engage community members you would like the City to consider? What types of information is needed? Who else needs to be engaged?

- Set up a booth where crowds are. Consider the College Royal Open House, Jazz Festival, Farmers' Market, central neighbourhood locations, Guelph Storm games
- Continue to communicate with companies like Sleeman Breweries to get the word out to other Industrial, Commercial and Institutional companies
- Engage with students and young people at schools and universities. Consider organizing an activity and a print-out for children to take home to their parents
- Organize an event like the Waterloo Wellington Children's Groundwater Festival as a public education opportunity

- Be a guest speaker at a university class or work with university students on a project related to the WSMP
- Be a guest speaker on a podcast
- Create a dedicated Twitter account to the WSMP
- Host a controversial lecture at Memorial Hall on campus (e.g., Nestle) and combine with information about the WSMP

Two CLG representatives who are members of the local Indigenous Community engaged in a discussion with the Group and provided the following in-sights into engagement with the local Indigenous Communities:

- There are 30,000 First Nations, Métis and Inuit people living in the Guelph area and they will not participate in this process for City government, however, they will participate for the water and it starts on a spiritual basis
- Create a sense of ownership in the Master Plan process
- Mobilize young people in the community, attend water walks, ceremonies, learn about plans that help the ecosystem
- The members are willing to participate in further discussion with the City to assist with this aspect of the overall engagement strategy.

Details About the 2019 WSMP Update

Discussion Question: How can community members outside of Guelph be properly consulted to evaluate water supply sources outside of the City?

- Email sign-up sheet for those interested; updates can be provided to those interested through the EA process
- Wellington Advertiser, Puslinch Pioneer and other local newspapers
- A lot of people in the townships are not “connected” through social media, internet or television; other avenues are required for certain demographics
- Engagement needs to be active as opposed to passively posting information on websites
- Access to information is at a premium. Project notices aren’t communicated past political circles

- Coordination between municipalities or provincial ministries is not shared readily
- Mailouts to individual residents are effective (at least a great first communication to lead to other medias)
- Political boundaries are not prescribed by water and the City's boundaries will likely change
- Actively monitor private wells and include these residents in a broader monitoring program to help inform them as to what impacts or implications could be of the City expanding water supply
- Watershed scale information sharing should be common practice to obtain a broader perspective in a holistic way
- Being upfront with outside of the City or near boarder takings that could affect other water users; communicate early and often
- Region of Waterloo model is a great visualization tool; share the City's model via some type of visualization to help educate the broader public
- Continue to empower members of the CLG to cast a broader net and push the information outward to their respective communities that they represent.

Work Underway

Discussion Question: For each alternative, what are your questions and concerns? Should any be added or removed from consideration?

Alternative #1 Demand Management/ Efficiency Programs

- The City did a study on wastewater effluent reclamation for non-potable water. As water becomes scarce, looking at sewer flushing, and different maintenance activities are needed
- Consider stormwater as a supply source

Alternative #2 Groundwater Sources In and Outside the City

Q10: Does the City own land outside of the boundaries?
A10: The City owns some land outside of City such as the Arkell Spring Grounds (about 350 hectare), the Carter Wells property, the Calico Well

property and the Logan test well property which are already used for water supply purposes.

Alternative #3 Local Surface Water Sources

- Consider adding maximization of aquifer recharge areas as an option

Other Alternatives

- Low Impact Developments to capture and store water to increase supply as another technical option to consider
    - Response: This is considered in the stormwater master plan.

Q11: Do you know where the aquifers are that are impacted?
A11: Yes. It's the regional Gasport Formation bedrock aquifer that extends beyond Fergus, along the Niagara Escarpment to the Bruce Peninsula.

Q12: Are we confident that the price of water is an accurate reflection?
A12: Guelph water rates are an accurate reflection of the costs to produce the water. As rates get increased, water use goes down. We need to be careful about how rates get implemented because they can grossly affect certain parts of the community, particularly people on fixed incomes. We try to keep costing fair and set it so that it pays for the water supply system that we have.

Q13: There is a goal to be zero carbon in 2030. How does this impact the WSMP?
A13: This is something we should consider.

Assessing Alternatives

Discussion Question: Are the evaluation criteria suitable for this study? Is there anything you would add or change?

Q14: What about a full ecological assessment?
A14: The Natural Environment is part of the evaluation criteria and includes potential impacts and effects to the natural environment, water resources, natural heritage features and environmental management planning considerations.

Q15: Is there any consideration to how many wetlands have been covered over by pavement?
A15: Yes, wetlands fall under the Natural Environment evaluation criteria. The Tier 3 model will look at potential effects to wetlands, rivers, lakes and more. The completed Tier 3 Water Budget Study considered future land use scenarios

based on approved City planning information to understand how land use will change and what it means to the recharge of the groundwater system.

C2: Add Indigenous communities to the Natural Environmental evaluation criteria section.

Next Steps and Adjournment

The project team reminded participants to fill out the discussion guide, sign the Terms of Reference (draft) and submit their feedback and comments.

Next steps in the project include incorporating and considering feedback from this workshop, developing water supply alternatives, conducting a preliminary evaluation of alternatives and on-going community engagement.

Upcoming engagement opportunities include:

- Community Open House #1 February 13, 2020
- Community Liaison Group Meeting #2 in Summer 2020 (tentative)
- Workshop #2 in Summer 2020 (tentative)
- Community Open House #2 in late Summer 2020 (tentative)

The meeting was adjourned at 9:00 pm.

Water Supply Master Plan 2021 Update

Community Liaison Group Meeting No. 2

July 27, 2021

Water Supply Master Plan
guelph.ca/WSMP

City of Guelph Territorial Acknowledgement

As we gather, we are reminded that Guelph is situated on treaty land that is steeped in rich indigenous history and home to many First Nations, Inuit and Métis people today.

As a City we have a responsibility for the stewardship of the land on which we live and work.

Today we acknowledge the Mississaugas of the Credit First Nation of the Anishinaabek Peoples on whose traditional territory we are meeting.

Agenda

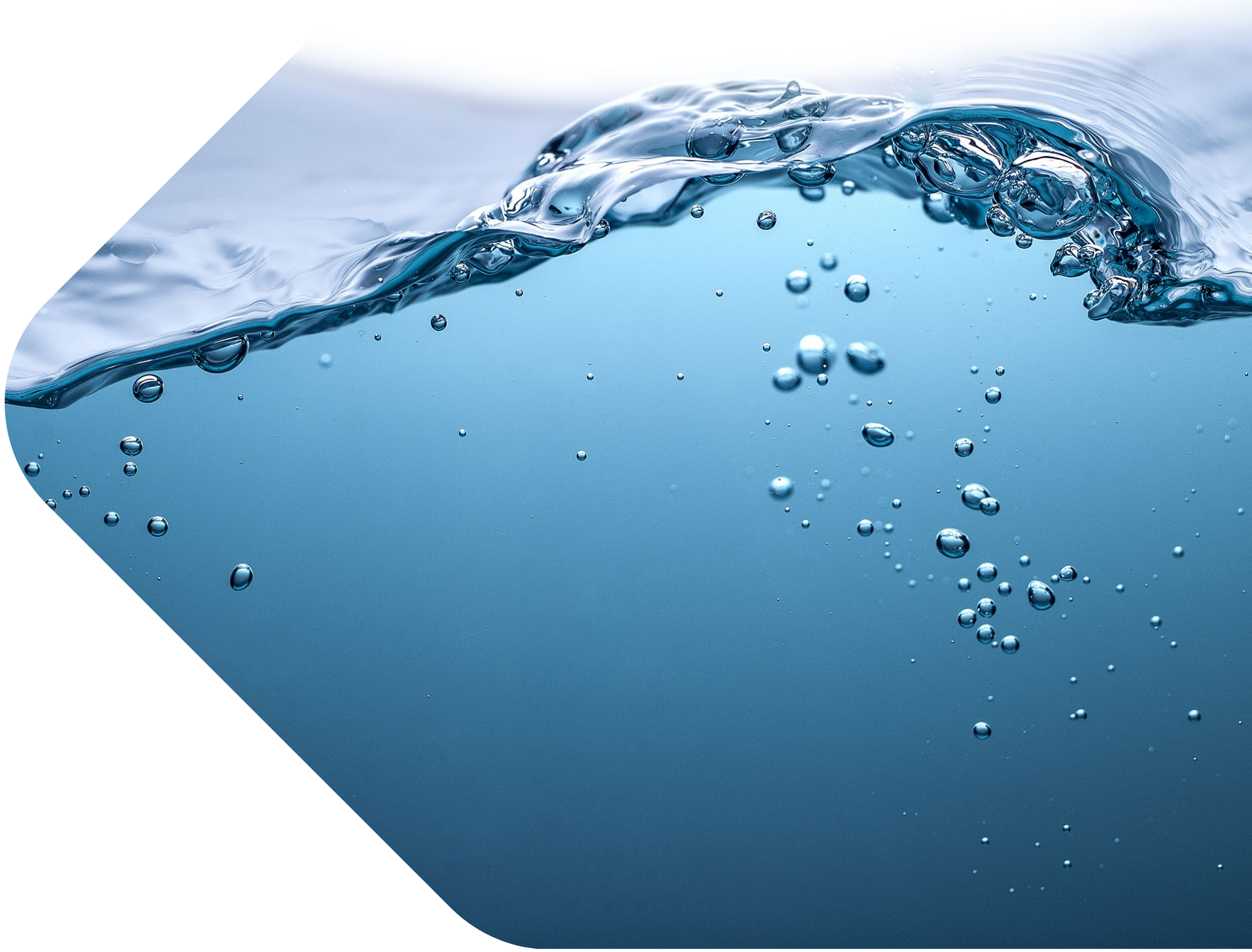
1. Welcome & Check-In
    a) Opening remarks
    b) Meeting purpose and objectives
    c) Introductions
2. Project Update Presentation Q&A and Discussion
    a. Review of WSMP Objectives
    b. Overview of Major WSMP Tasks
    c. Major Task Progress Update
        i. Task 1 – Summary of Consultation Conducted to Date
        ii. Task 2 – Review of Population Targets and Water Supply Demand Forecasts
        iii. Task 3 – Review of Existing Water Supply Capacity Assessment
        iv. Task 4 – Review of Technical Assessment of Alternatives to Date
    d. Environmental Assessment Evaluation Criteria
3. Next Steps

Housekeeping

- Teams features
  - Camera, microphone, raise hand, chat (speech bubble)
  - If using a computer – access the features by hovering the mouse over the screen
  - If using a phone or tablet – tap on the screen to access features (may need to click on '…')
  - If using a phone or tablet – you can change the orientation and zoom in as needed
- Attendees will be muted until the discussion periods
  - Press the 'raise hand' button if you wish to speak and we will prompt you when it is your turn (be sure to enable your device's audio function and unmute when speaking)
  - Add questions and comments in the chat box
- If you have technological issues, please type your issue into the chat box
- Meeting recorded for purpose of preparing meeting summary

Introductions

Share your name and if you are representing an organization or group.



Water Supply Master Plan Update

Project Objectives and Major Tasks

July 27, 2021

Water Supply Master Plan
guelph.ca/WSMP

Water Supply Master Plan Update

- Will define where and how City gets safe and reliable water to the year 2051 and identify challenges beyond this timeframe
- Will review Guelph’s water supply demand forecast and existing water supply and discuss with the community how to continue to meet the City’s needs sustainably
- Additional sources to supplement our existing supply will be identified. As will alternative ways to conserve supply and manage demands
- When investigating existing and new water supply options we will consider things like climate change, water quality and quantity, economic factors, social/ cultural environment, and any relevant regulations
- Regardless of source, the water supply will continue to meet the service requirements of Guelph and the high standards set by the Ministry of the Environment, Conservation and Parks (MECP), including Source Water Protection requirements
- Short-term, mid-term and long-term water supply options will be recommended

Scope of Work – WSMP Update

Task 1 – Public Consultation	• Indigenous engagement • WSMP Community Liaison Group (CLG) meetings (3) • Municipality / Agency workshops (2) • Community Open Houses (2) • Water Conservation and Efficiency Public Advisory Committee
Task 2 – Population and Water Demand Forecasts	• Develop population projections – residential and ICI (employment) • Develop water supply demand projections
Task 3 – Existing Water Supply Capacity Assessment	• Update the assessment of existing well performance, maximum capacity and potential constraints for each supply source • Comparison of existing water supply capacity with demand forecast
Task 4 – Water Supply Alternatives	• Demand management & efficiency programs • Groundwater sources inside city • Groundwater sources outside city • Local surface water supply & Aquifer Storage and Recovery • Do nothing
Task 5 – Water Supply Master Plan Update	• Evaluation of alternatives • Risk Assessment • Develop WSMP Update Report

Water Supply Master Plan Update

Task 1 - Public Consultation To Date

City of Guelph Making a Difference

AECOM

July 27, 2021

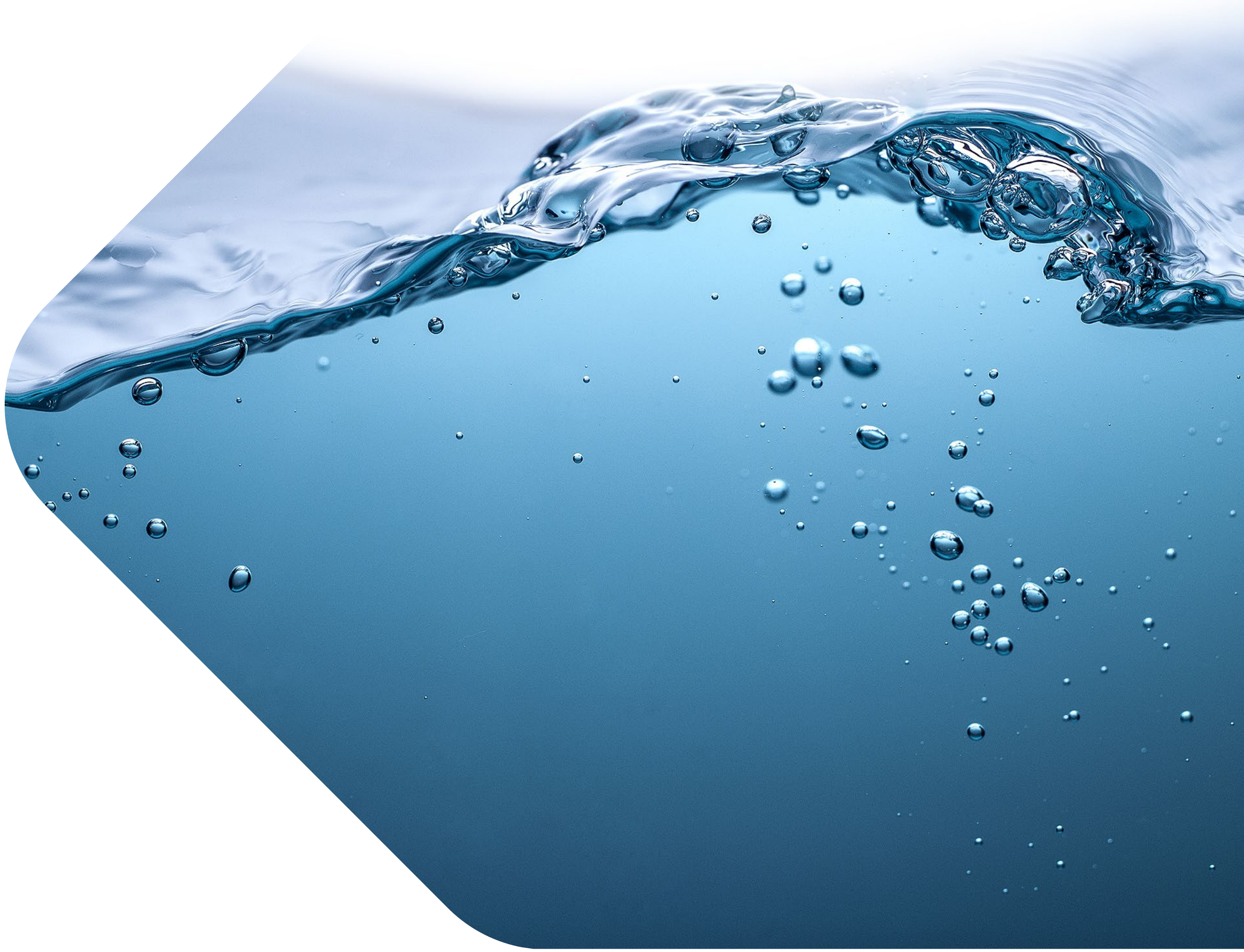
What We Heard: Public Consultation Round #1

- **Guelph Wellington Development Association and Guelph and District Home Builders' Association –** Nov 7, 2019
  - the City Staff Technical Liaison Committee met with the Guelph Wellington Development Association and Guelph and District Home Builders' Association
- **Our community, our water open house** – Nov 26, 2019
  - Regarding a proposed solution between the City and the owners of the Dolime Quarry
- **Agency & Municipality Workshop #1** – Nov 28, 2019
  - 10 participants from 6 organizations, along with 4 City staff and 4 AECOM consultants
- **Community Liaison Group Meeting #1** – Dec 4, 2019
  - 13 of 17 members attended, along with 4 City staff and 3 AECOM consultants
- **Community Open House #1** – Feb 13, 2020
  - Attended by 17 members of the general public, including several students from a university class
- **Water Conservation & Efficiency Public Advisory Committee Meeting –** Sept 16, 2020

Feedback from Consultation Round #1

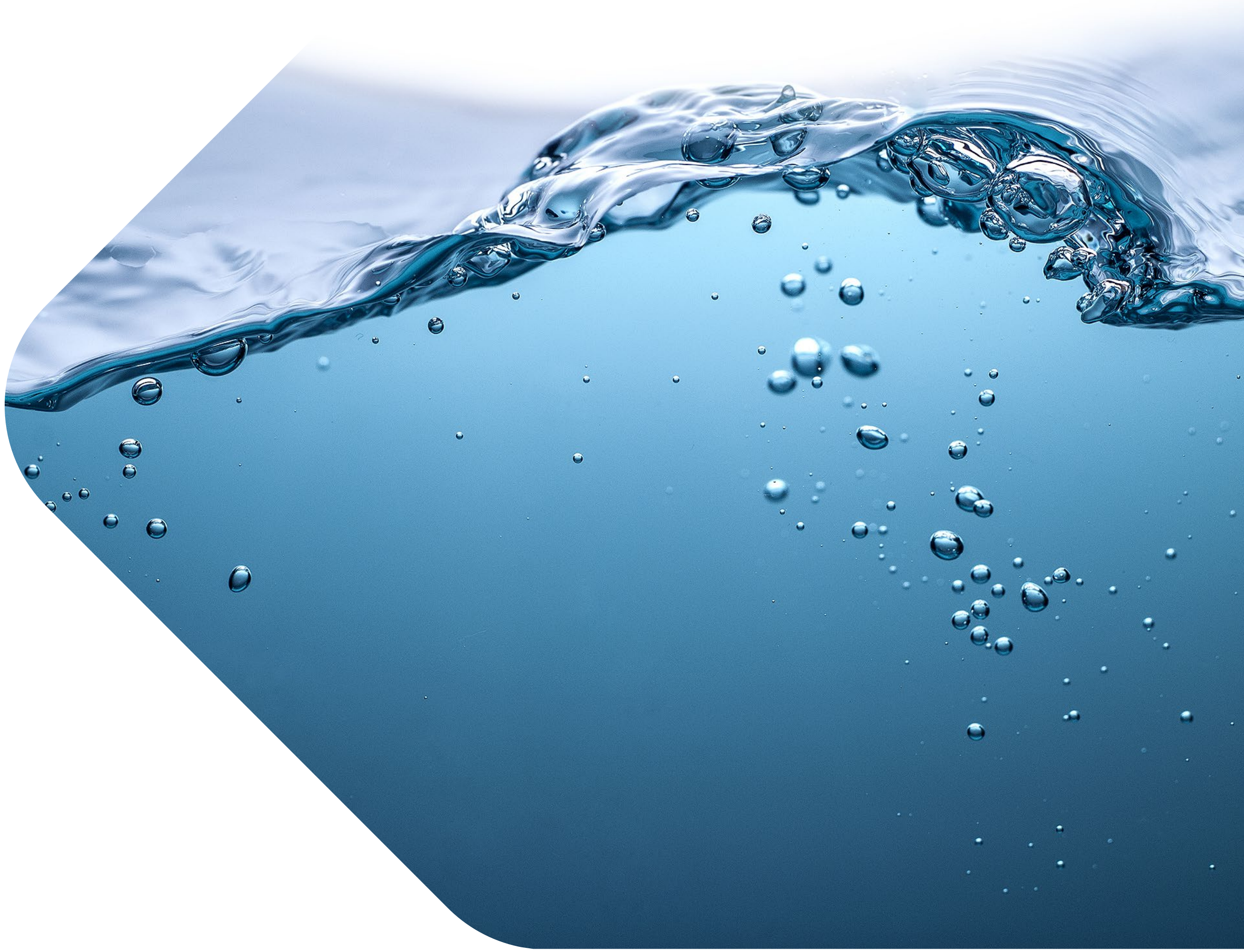
- Prioritizing conservation;
- Protecting the natural environment;
- Managing growth and development;
- Controlling groundwater impacts from large water users;
- Monitoring emerging contaminants;
- Limiting impacts to aquatic and terrestrial wildlife; and,
- Valuing the agency of water.

Questions or comments about the Phase 1 public consultation?



Water Supply Master Plan Update

Task 2 – Population and Water Supply Demand Forecasts



July 27, 2021

Water Supply Master Plan
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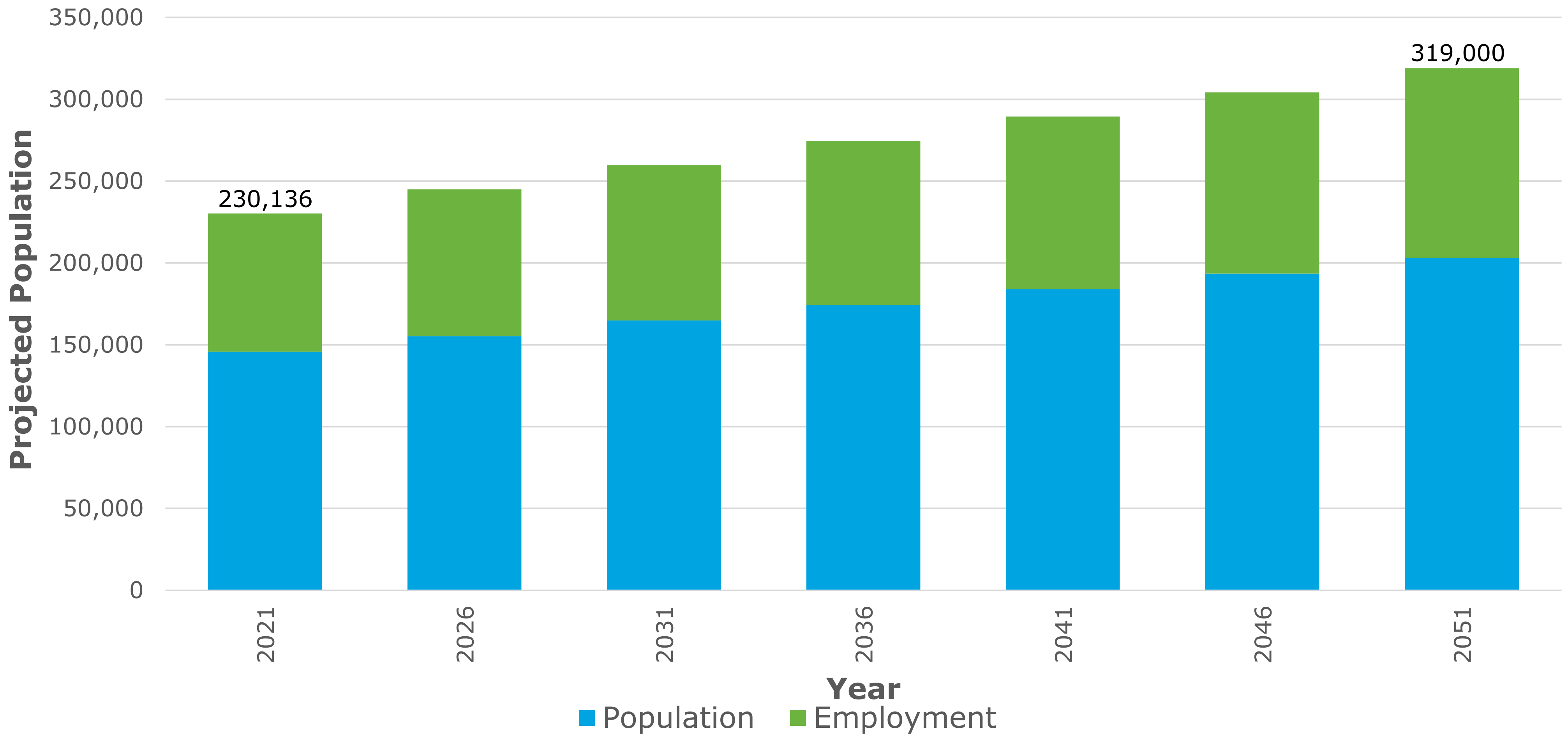
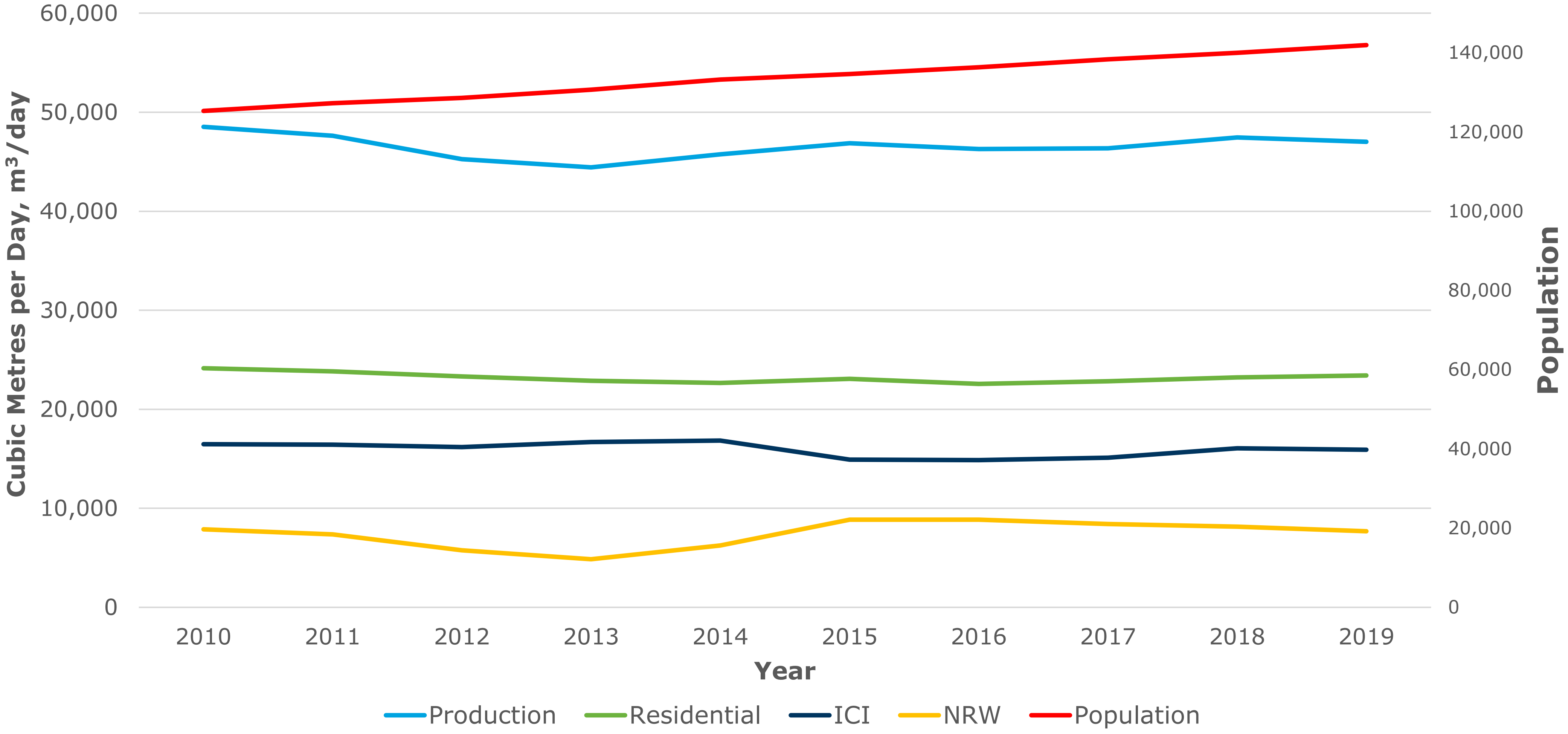
Task 2 Summary

- Population projections changed in the middle of the project to 2051 (30 years)
  - In August 2020, the Province of Ontario provided updated population forecasts for the City of Guelph to 2051 (203,000 residential population, 116,000 employment population)
  - Prior to this update, the WSMP Update project planning period extended to 2041 and considered the associated growth targets
- Review of City historical water supply demand data
- Design basis for projecting future water supply demand, including:
  - Residential
  - Industrial, Commercial and Institutional (ICI)
  - Non-Revenue Water (NRW)
- Projected water supply demands to 2051

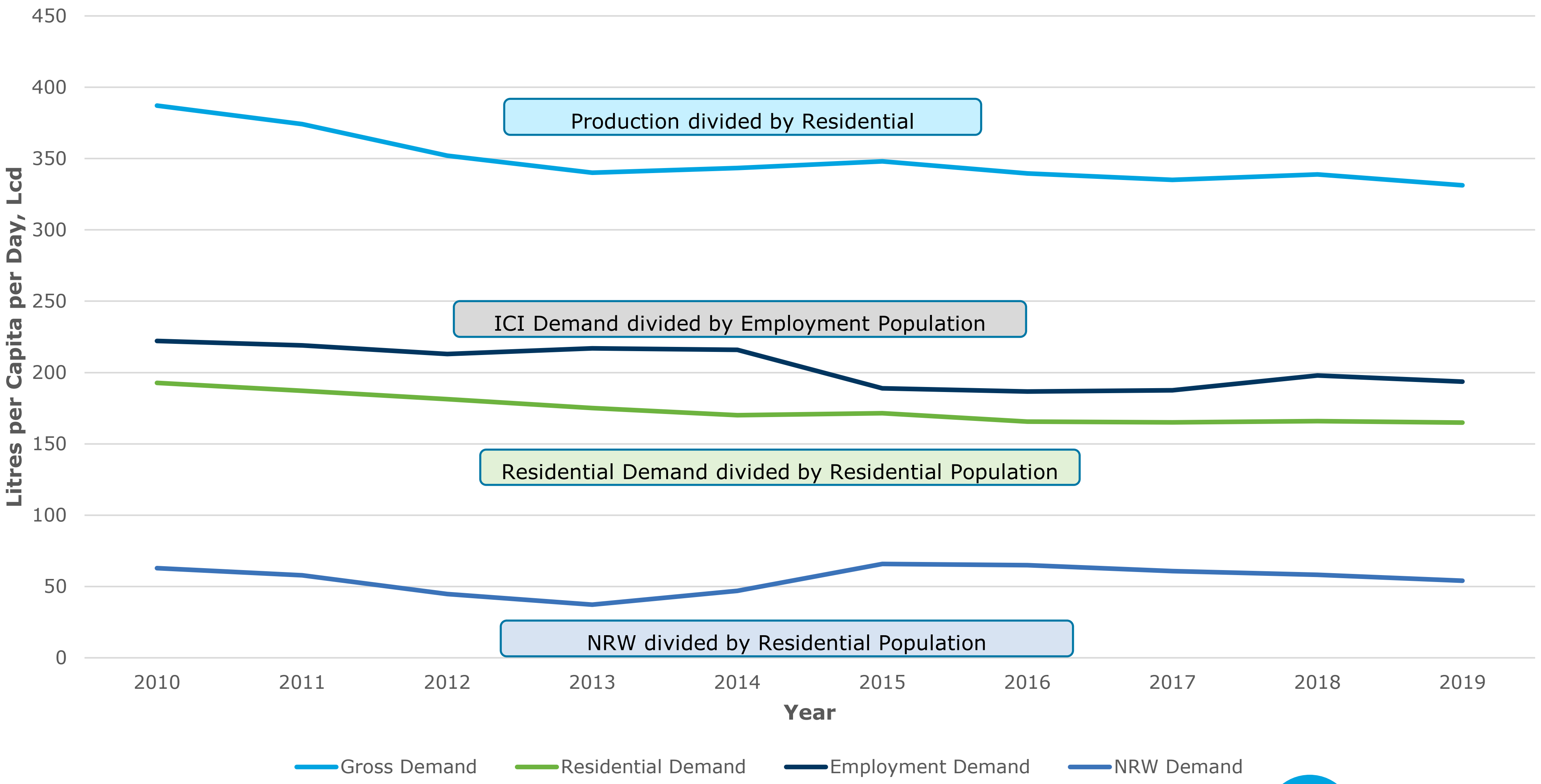
"Reference" Population Projections: 2021 - 2051



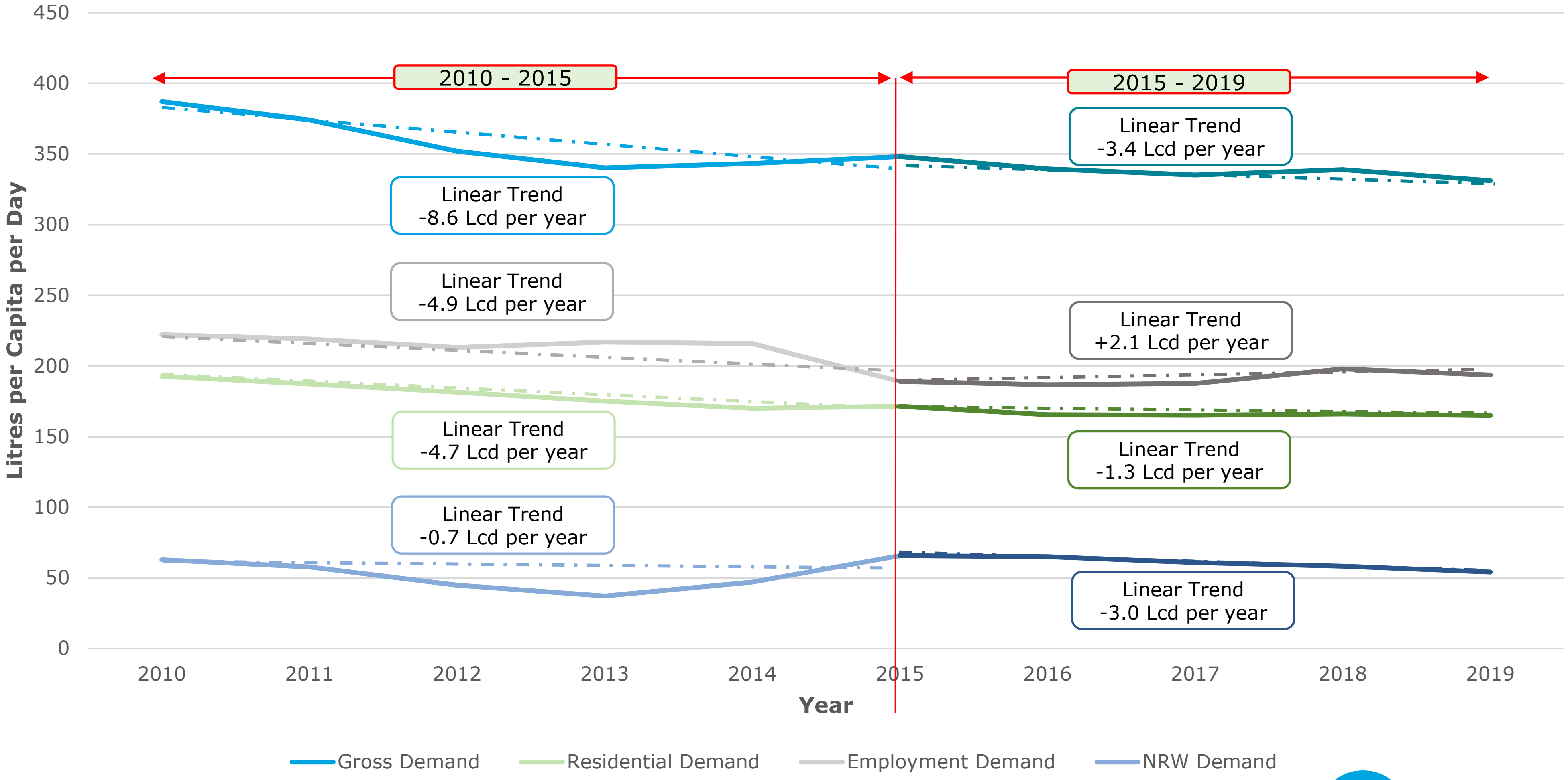
Average Annual Day Production, Demand, NRW & Population



Average Annual Day Per Capita Water Production, Demand and NRW Rates



Average Annual Day Per Capita Water Production, Demand and NRW Trend Analysis

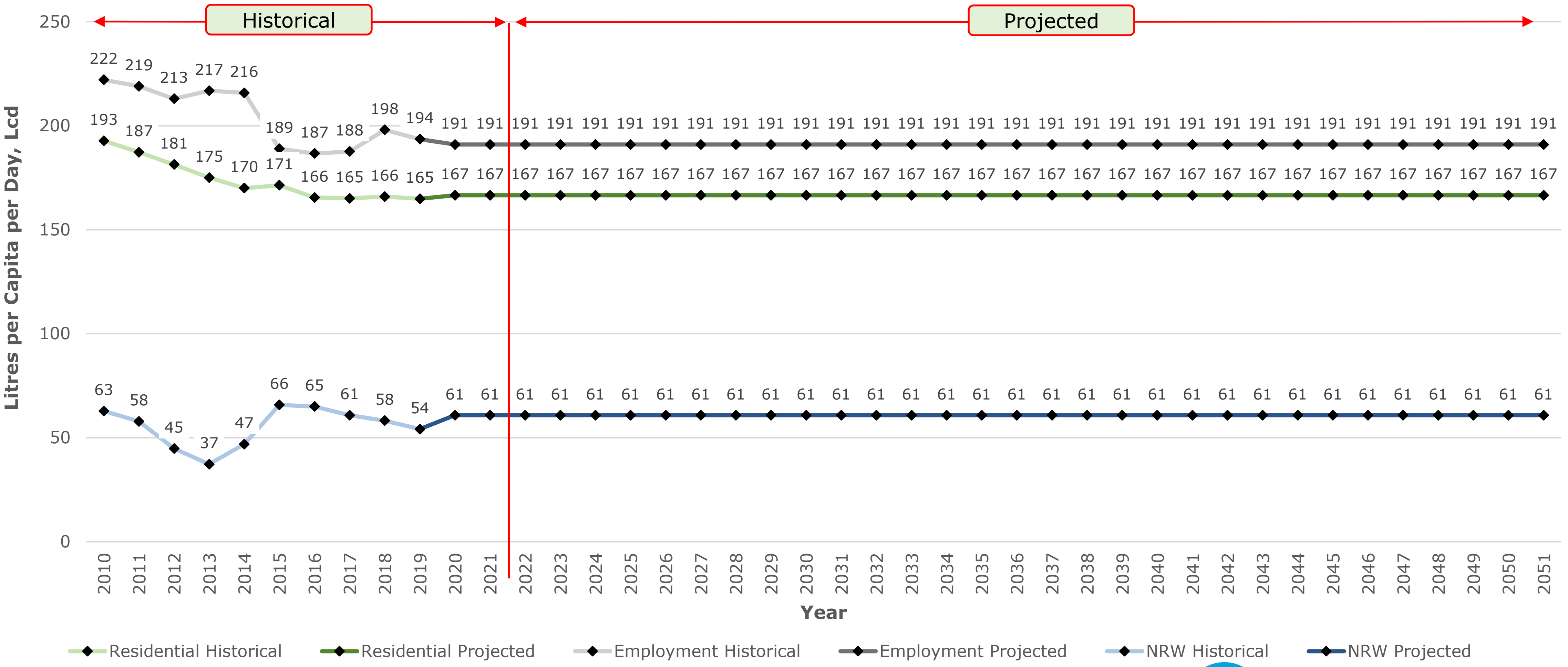


Guelph AECOM

July 27, 2021

Water Supply Master Plan
guelph.ca/WSMP

Historical and Projected Per Capita Water Demand Rates



Water Demand Projections – Design Basis

Average Per Capita Day Demand (2015-2019)

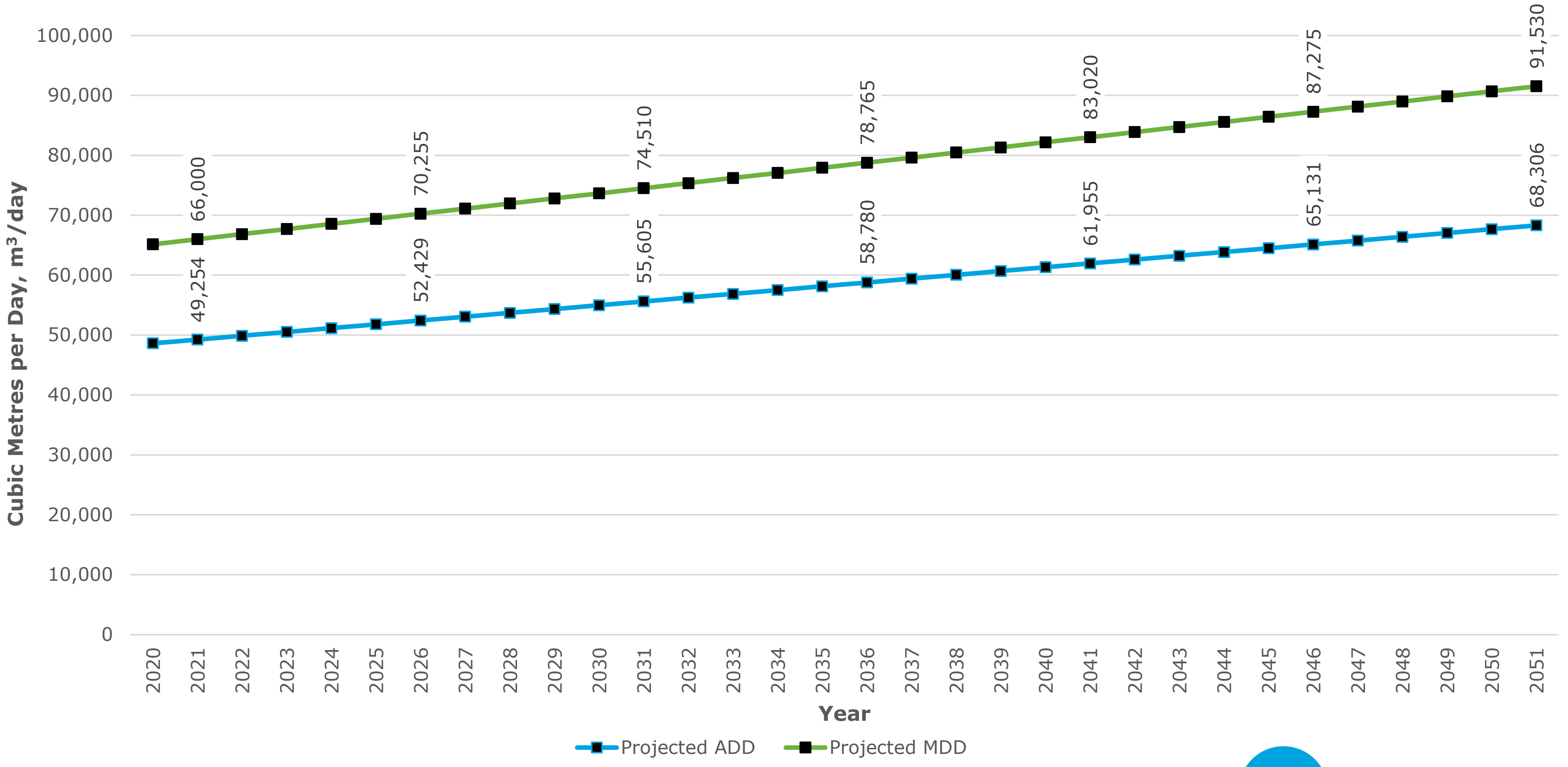
- Average per capita residential demand rate 2015-2019: **167** Litres per capita per day (Lcd)
- Average per capita employment demand rate 2015-2019: **191** Lcd
- Average per capita NRW rate 2015-2019: **61** Lcd

Maximum Day Demand

- Average Maximum Day Demand Factor (2010-2019): **1.24**
- Design Maximum Day Demand Factor: **1.34** (Highest value, 2010-2019)

Year	Total Average Day Demand (m^3/d)	Max Day Demand @ 1.34 MDF (m^3/d)
2021	49,254	66,000
2026	52,429	70,255
2031	55,605	74,510
2036	58,780	78,765
2041	61,955	83,020
2046	65,131	87,275
2051	68,306	91,530

Projected "Reference" Growth Average Day and Maximum Day Demands



We’d Like Your Input…

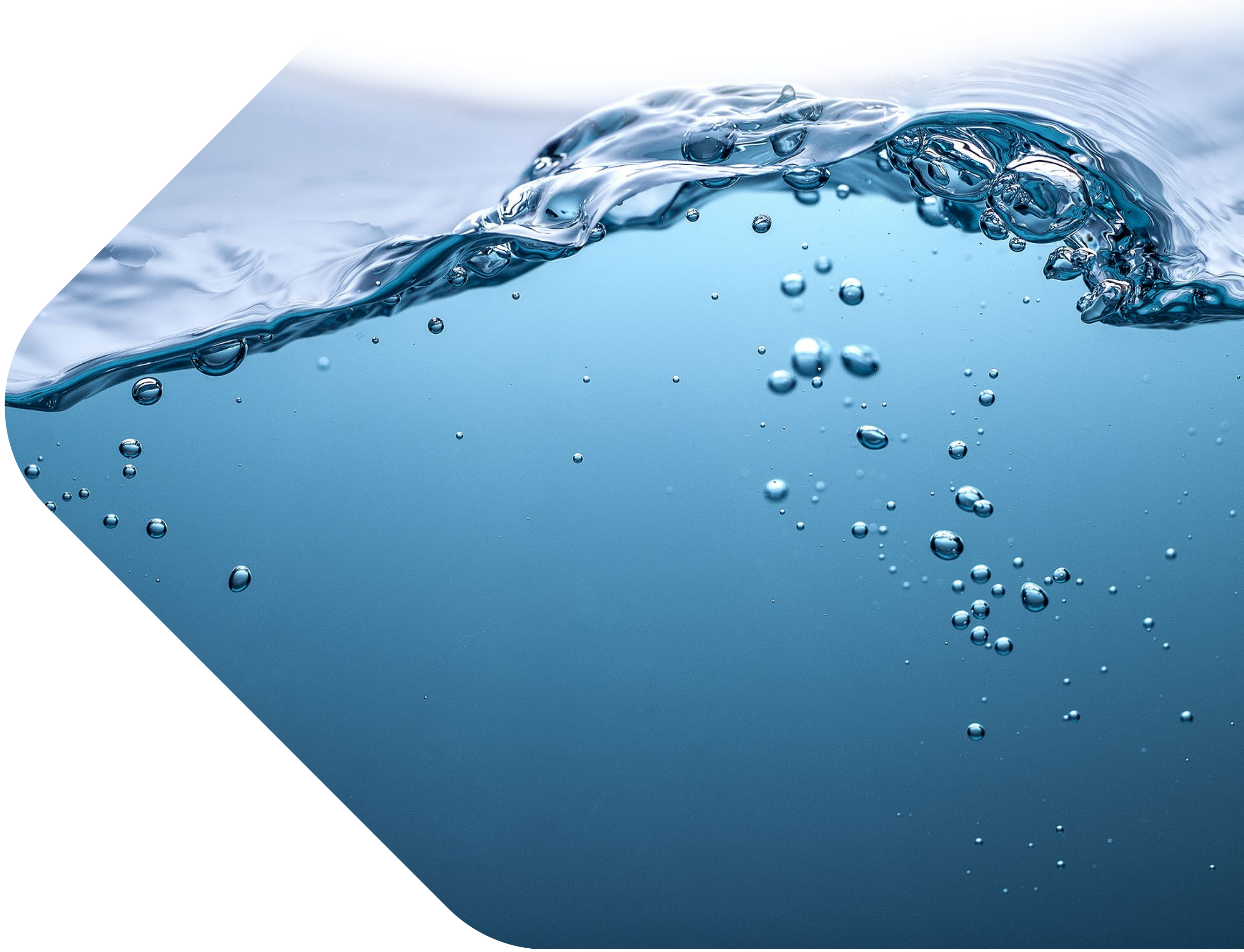
Our analysis suggests that the decline in per capita water demand in Guelph is slowing down.

Our future water demand projections assume no further decline.

Do you agree with this approach for projecting future demands?

Water Supply Master Plan Update

Task 3 – Existing Water Supply Capacity Assessment



July 27, 2021

Task 3 Summary

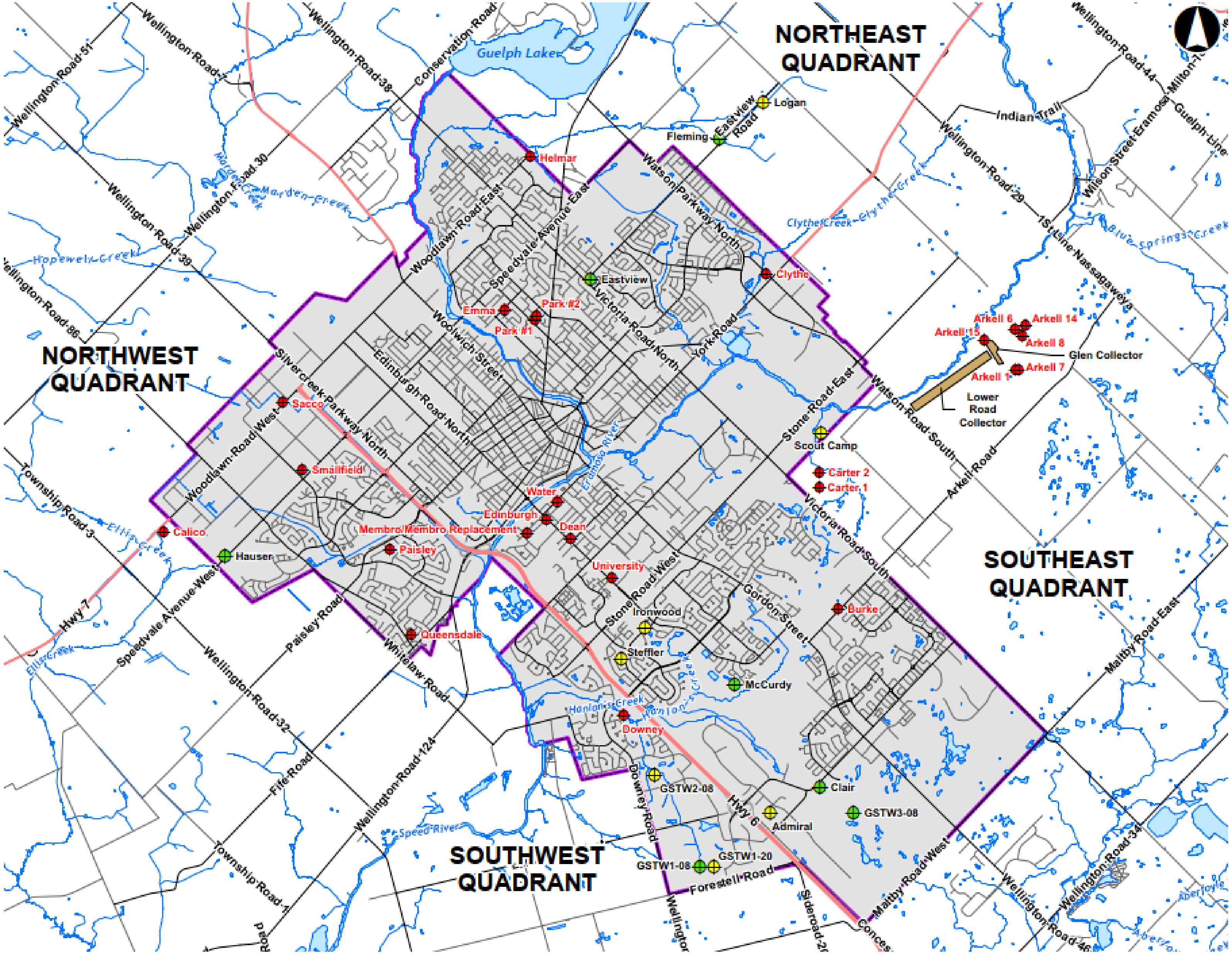
This task includes:

- Evaluation of the maximum capacity of each individual City well (how much each well can pump each day);
- The sustainable capacity of the existing total water supply system (how much can the entire system pump each day); and
- An assessment of the potential risks to the system (Security of Supply)

Overview of Guelph's Existing Water Supply System

- Reliance on groundwater to meet the City's water demands since 1879
- Guelph's water supply system includes production wells primarily installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system:
    - 25 production wells in the municipal supply system, with 21 wells in continuous operation - 4 wells offline due primarily to water quality concerns
    - Glen Collector captures shallow spring water in the Arkell Spring Grounds
    - Artificial recharge system: water is pumped from the Eramosa River to an infiltration pond/ trench – water infiltrates into the ground and some is captured by the collector system

Locations of Existing City of Guelph Water Supply Sources



July 27, 2021

Arkell Spring Grounds

Well Capacity Assessment – Summary

City Quadrant	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Net Change
SE	49,700	47,584	2,116 m^3/d reduction
SW	17,936	16,338	1,598 m^3/d reduction
NE	12,300	11,600	700 m^3/d reduction
NW	3,900	3,900	Unchanged
TOTAL	83,836	79,422	4,414 m^3/d reduction

- Glen Collector (SE) – capacity reduced to reflect available year-round flow
- Carter Wells (SE) – capacity reduced to balance groundwater pumping with ecosystem function
- Water Street Well Field (SW) – capacity reduced to reflect available flow with all wells pumping
- Other reductions reflect lower well performance (Helmar - NE)

Existing System Capacity vs. 2051 Demand

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Surplus/Deficit (m^3/day)	20,981	-12,108

- Existing system capacity has not been field-tested
- Pumping individual wells effects other wells in system, overall system function at maximum rates is uncertain
- Security of supply assessment completed to address risks and uncertainties in evaluation

Security of Supply Assessment

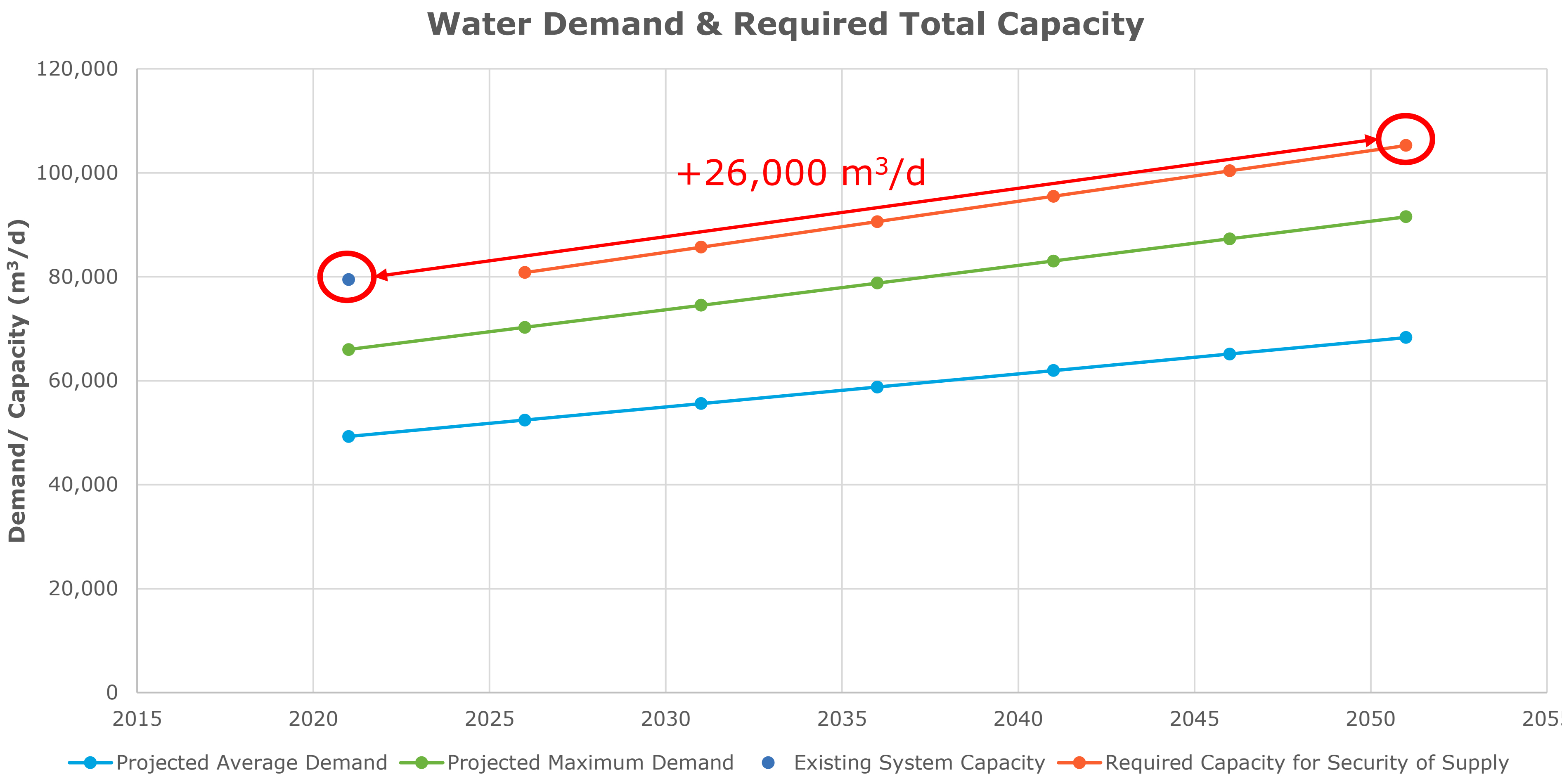
- Reviewed several risks to the City water supply:
    - Prolonged drought conditions
    - Contamination event
    - Loss of supply (well failure, damage, etc.)
    - Regulatory reduction in permitted pumping rate(s)
- Estimated reduction in capacity associated with each risk
- Evaluate amount of required "reserve" supply

Scenario	Capacity (m^3/day)	Capacity Reduction
Existing System Capacity	79,422	-
Prolonged Drought	71,477	10%
Contamination Event/ Loss of Well	71,422 to 78,022	2 to 10%
Reduction to Permitted Rate(s)	72,801 to 76,385	4 to 8%

Additional System Risks

- Additional potential risks to the system were reviewed:
  - Drought combined with largest supply out of service
  - Regular maintenance/ mechanical failures combined with largest supply out of service
  - Distribution disruption/ damage
  - Specific contamination events (i.e. quarry, Eramosa River, etc.)
- Most of the reviewed additional risks are currently managed by the City:
  - Demand management during drought conditions
  - Climate change models
  - Scheduling of maintenance
  - Response plan for watermain breaks
  - Source water protection
- Ultimately, 15% security of supply allowance was recommended

Required Capacity for Security of Supply



We'd Like Your Input…

Questions to consider:

- **Are there risks to the system that have not been considered?**
- **Do you think that 15% security of supply is sufficient?**

Water Supply Master Plan Update

Task 4 – Water Supply Alternatives Assessment

July 27, 2021

Alternatives Assessment

Assessment of proposed water supply alternatives under consideration:

- Water conservation and demand management/ water reuse
- Optimize and expand existing groundwater system
- Establish new surface water supply
- Limit growth/ do nothing

Water Supply Master Plan Update

Water Supply Alternatives – Water Conservation and Efficiency

July 27, 2021

Water Conservation and Efficiency

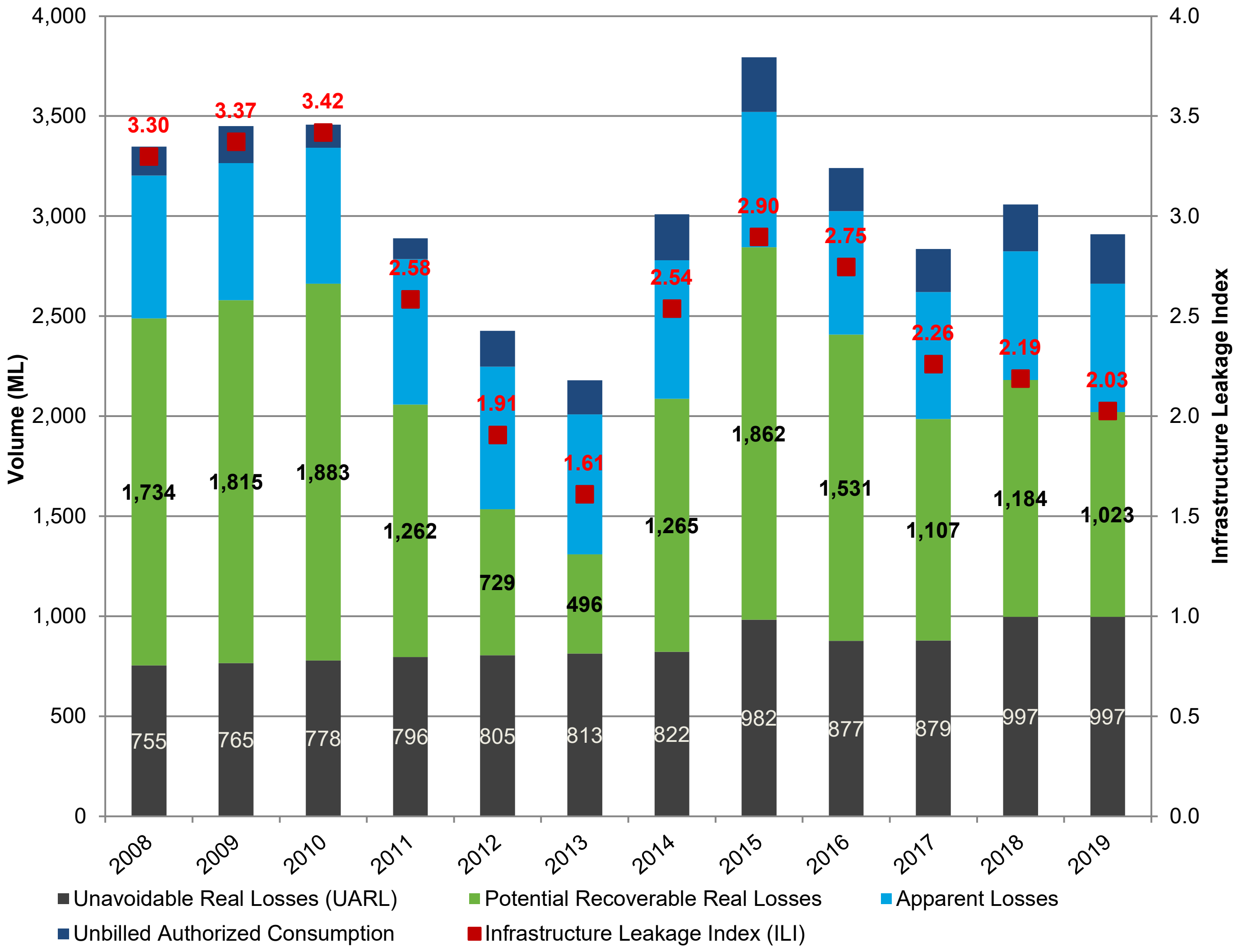
- Currently establishing potential demand reduction scenarios
- Focus to date on success City has had reducing non-revenue water and potential for future reductions

Non-revenue water (NRW): water produced by the City that does not generate revenue. Sources:

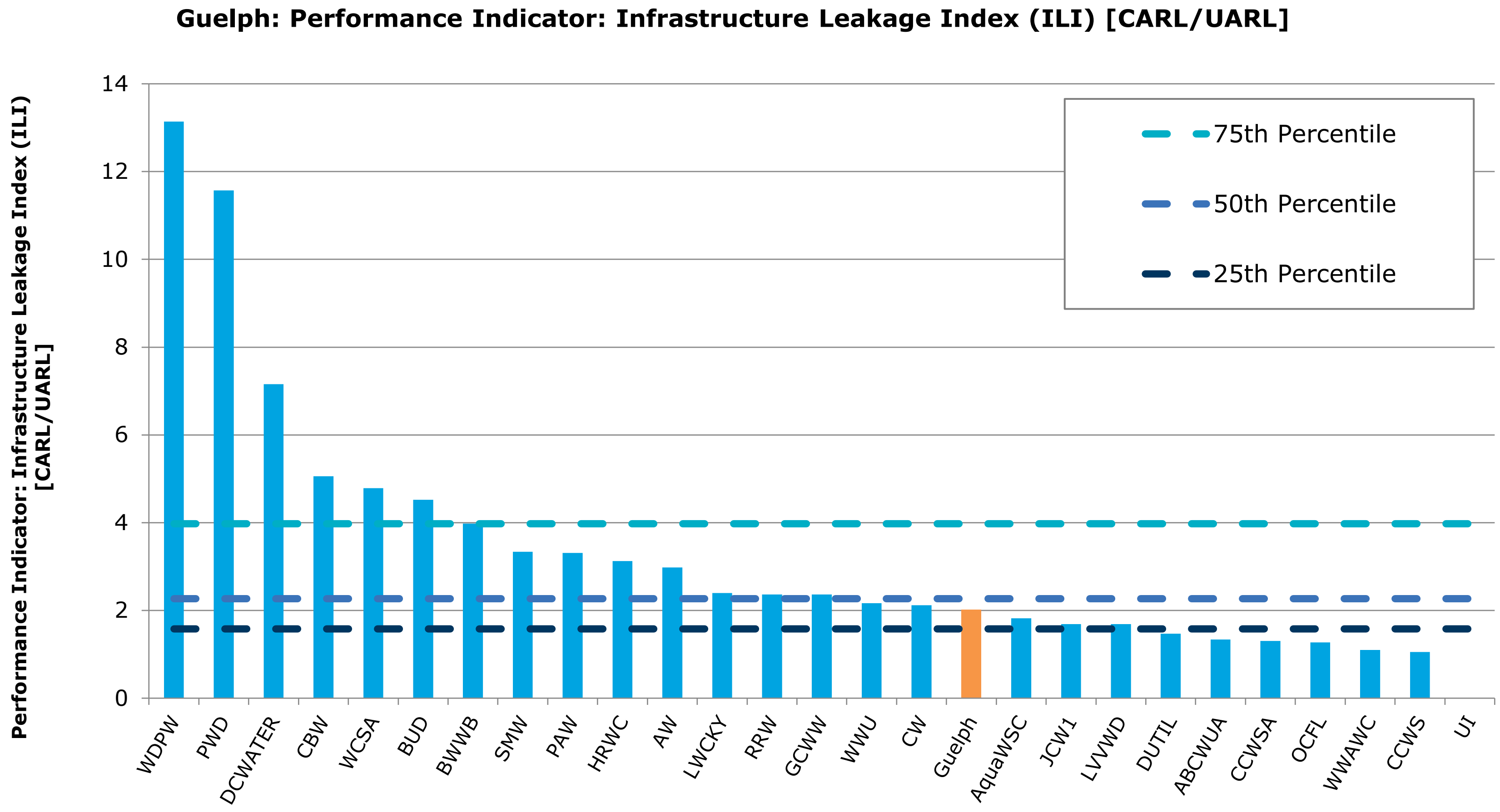
- Unbilled consumption
- Unauthorized consumption
- Metering inaccuracies
- Leakage

Historical NRW

Infrastructure leakage index = Real Losses / Unavoidable Real Losses



Infrastructure Leakage Index



Source: WRF 4372: Real Loss Component Analysis: A Tool for Economic Water Loss Control

Economic Level of Leakage

Economic Level of Leakage (ELL): point at which the cost of lost water (leakage) = costs of leakage prevention programs

- Other jurisdictions (UK, Australia) have reported ELL when the ILI is below 3 (ILI=2.0 for Guelph in 2019)
- Results indicate that Guelph is near or at its ELL
- Recommended focus in future is to maintain the ILI, or improve where possible

Future Conservation/ Efficiency Programming Scenarios

- Next steps are to finalize conservation and efficiency scenarios that consider:
  - "Levelling out" of per capita demands
  - Current status of ILI and ELL in City
  - Use of new technologies to maintain ILI/ decrease NRW
  - Continue to educate population as City grows
  - Opportunities for water reuse in the City, including:
    - Residential sector
    - Employment sector
    - Municipal water uses

Water Supply Master Plan Update

Water Supply Alternatives – Groundwater Sources

City of Guelph
Making a Difference

AECOM

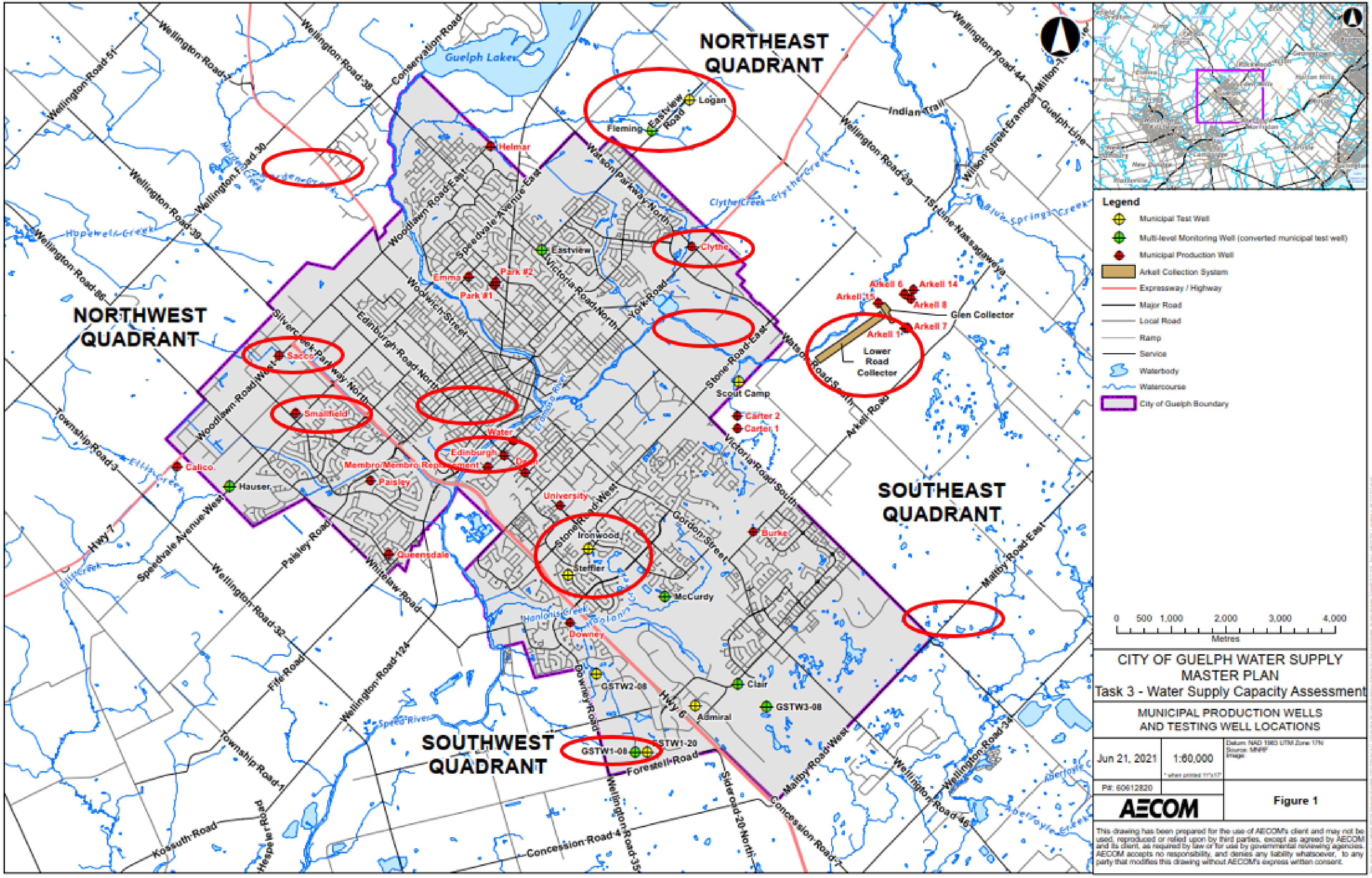
July 27, 2021

Water Supply Master Plan
guelph.ca/WSMP

Evaluation Approach – Groundwater Flow Model

- Updated version of model used for Tier Three Water Budget and Local Risk Assessment under the province's *Clean Water Act*
- Simplification of system, subject to uncertainties – best tool for evaluation of potential sources
- Categories of future groundwater supply assessed:
  - Inactive municipal wells
  - New wells inside and outside of City
  - Dolime Quarry Pond Level Management
  - Optimization of Arkell collector system

Inactive/ New Sources



July 27, 2021

Water Supply Master Plan
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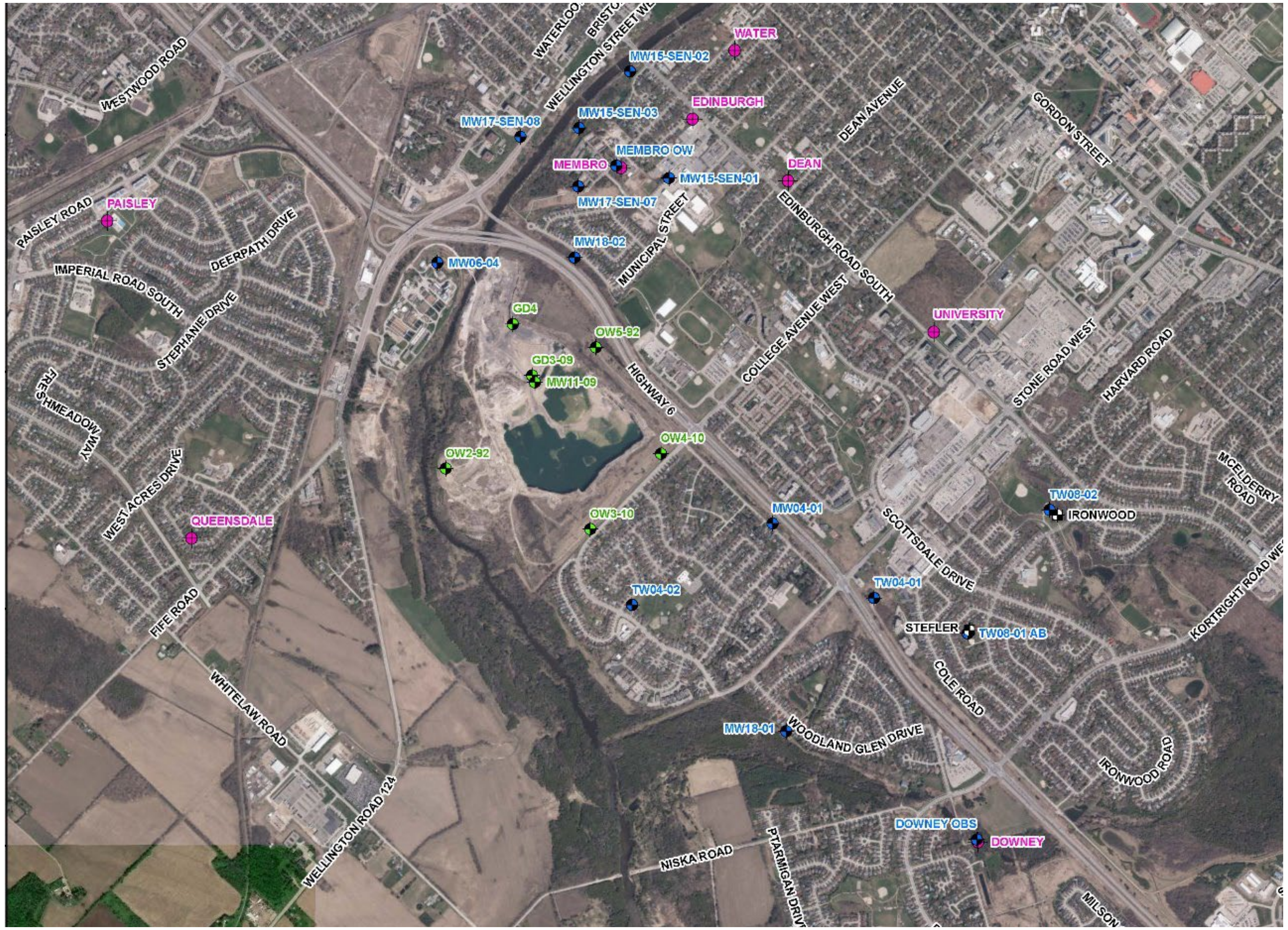
Inactive/ New Sources - Results

- First assessed sources in City and on City-owned land
- Then moved to new wells outside of City
- Finally assessed all sources simultaneously

Location	Assessed Source(s)	Potential Capacity (m^3/d)	Comments
City SE	Lower Rd Collector	4,000	Full reconstruction of collector required
City SW	Edinburgh Well (inactive); Steffler, Ironwood, GSTW1-20 (test wells)	4,700	Irish Creek: 17% baseflow reduction
City NE	Clythe Well (inactive); Fleming, Logan (test wells); Guelph East (hypothetical)	3,600	Clythe Creek: 24% baseflow reduction
City NW	Sacco/ Smallfield Wells (inactive); Hauser (test wells); Sunny Acres Park (hypothetical)	1,500	Contamination in Smallfield Well; No contribution from Sunny Acres due to interference
New Wells Outside City	Guelph North and Southeast Wells (hypothetical)	5,600	Hanlon/ Irish Creek: 17% baseflow reduction
Full study area	All sources	15,600	Clythe Creek: 24% baseflow reduction

Assessment of Dolime Pond Level Management

- Concept:
  - City has agreement in place to take over quarry water management
  - Potential opportunity to increase pumping of municipal wells near the quarry while managing water quality concerns
- Scenario Results:
  - Model sensitive to changes in flow divide
  - Minor to moderate adjustments to pond level and/ or City pumping rate effects divide
  - Results are uncertain and require field testing: Operational Testing Program; Class EA



Optimization of Arkell Collectors

- About half of artificial recharge water is captured by the Glen Collector
- Can system be optimized/ improved
- Modelling Assessment:
  - Increase Eramosa River recharge volume
  - Alternate Glen Collector configuration

Optimization of Arkell Collectors - Results

Recharge System Modelling

- Three flow rates assessed: existing, 2x rate, 3x rate
- Max. flow rates increase; min. flow rates do not vary significantly between scenarios
- Field testing/ upgrades required to increase recharge

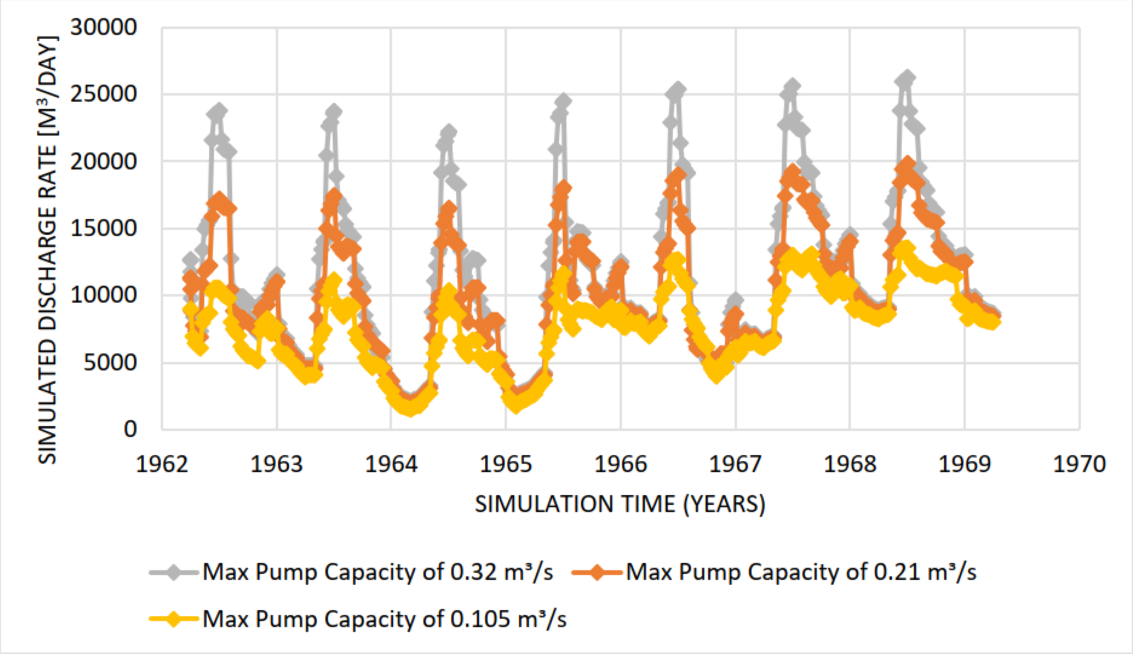


CHART 2 **Simulated Transient Glen Collector Discharge Under the Various Pump Capacity Scenarios**

Optimization of Arkell Collectors - Results

- Replacement of Glen Collector with Caisson Collector system per 2006 study
- Located 300 m SE of existing collector; anticipated to compete with Arkell Well 1
- Results indicate minimal flow increase compared to existing collector + Well 1
- Caisson system could be less sensitive to variable recharge

Groundwater Modelling Assessment Summary

Demand Type	2051 Low Demand vs. Future Capacity	2051 Reference Demand vs. Future Capacity
Projected Maximum Day Demand (m^3/d)	89,751	91,530
Projected Maximum Day Demand with Security of Supply (m^3/d)	103,214	105,260
Existing Water Supply Capacity (m^3/d)	**79,422**	**79,422**
Future Estimated Water Supply Capacity (m^3/d)	98,982	98,982
Deficit Based on Estimated Future Supply Capacity (m^3/d)	-4,232	-6,277

Water Supply Master Plan Update

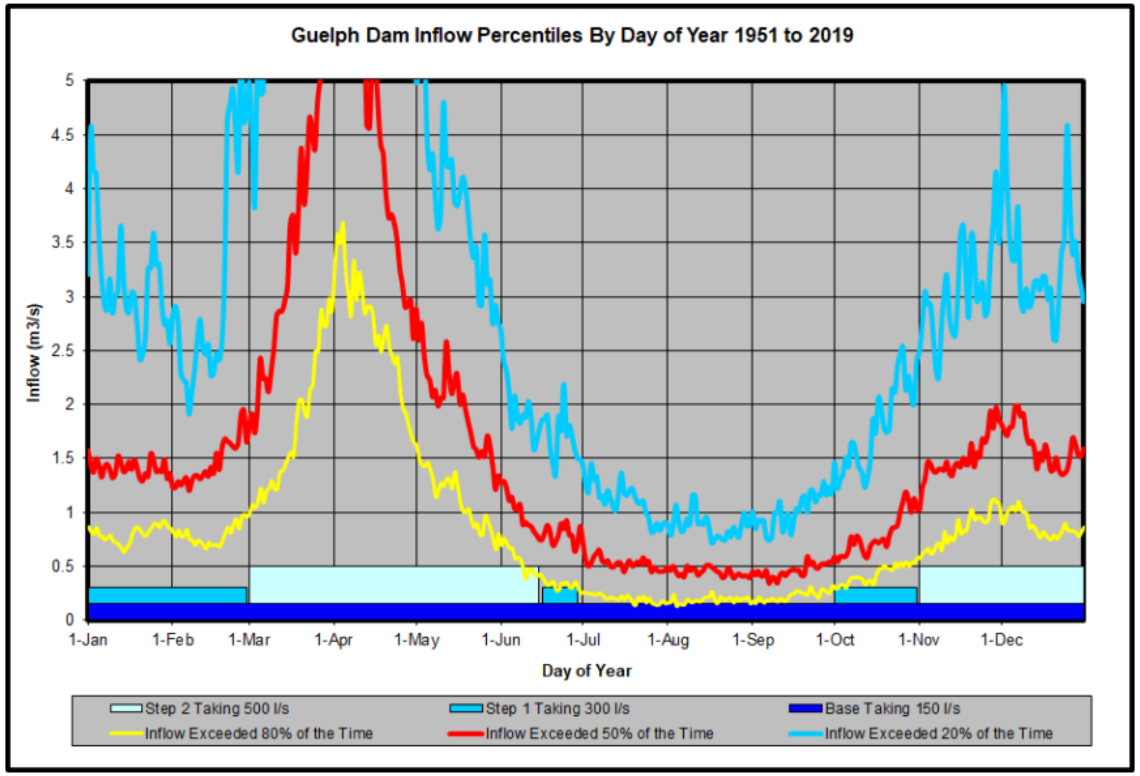
Surface Water Alternatives Assessment

July 27, 2021

New Surface Water Supply

- Two possible local surface water sources for water taking
  - Guelph Lake – downstream of the dam
  - Eramosa River – at Arkell
- Alternatives:
  - Treatment & direct continuous flow into the distribution system
  - Treatment & store in ASR wells; recovery as required
- New water treatment plant (WTP) required to fully treat the surface water to meet Ontario Drinking Water Quality Standards (ODWQS)
- Assumptions - conventional treatment with treatment for taste and odour on a seasonal basis, as required
- Wastewater treatment plant assimilative capacity study (underway) will be considered in evaluation

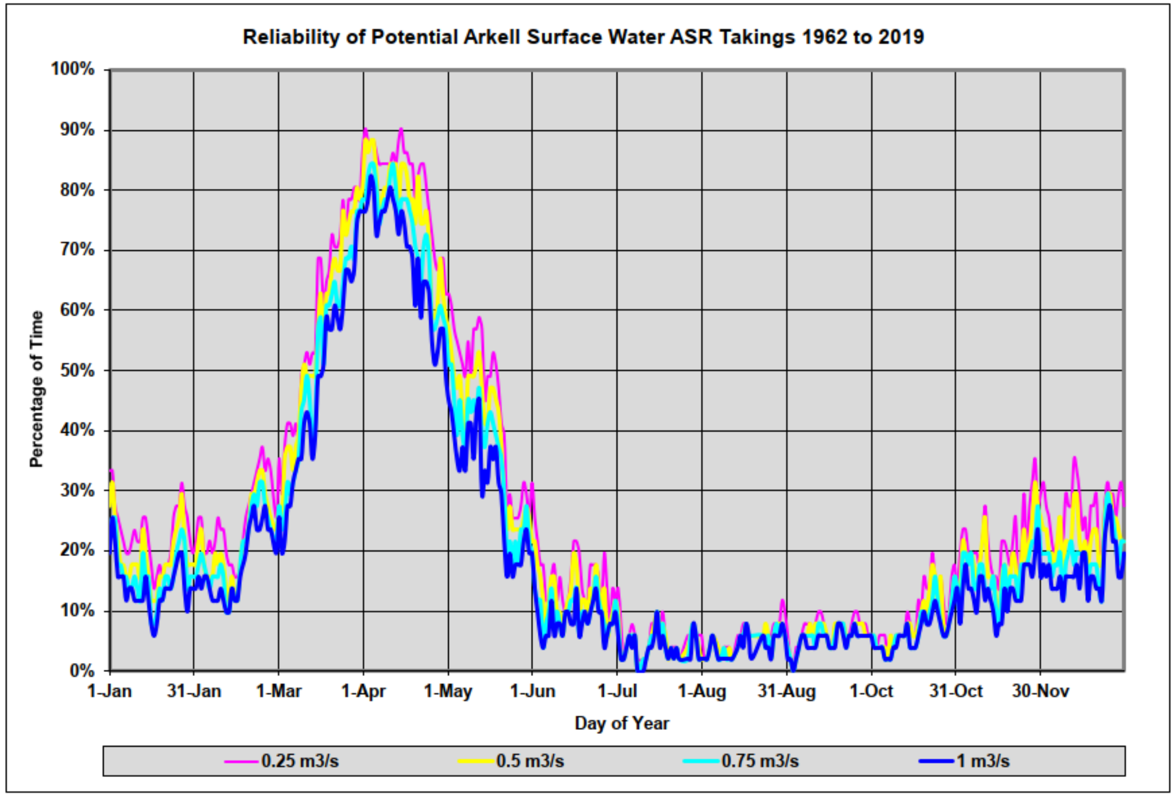
Surface Water – Guelph Lake



Guelph Lake Yield Analysis (GRCA):

- Modelling results indicate that there is a potential for proposed stepped taking: 150 L/s and 300 L/s
- 500 L/s step dismissed for two reasons:
  - not practical to build a WTP for three months
  - flow cannot be injected in a reasonable number of ASR wells
- ASR alternative assumes base taking of 150 L/s with increase to 300 L/s for nine months of the year

Surface Water – Eramosa



Eramosa River Yield Analysis (GRCA)

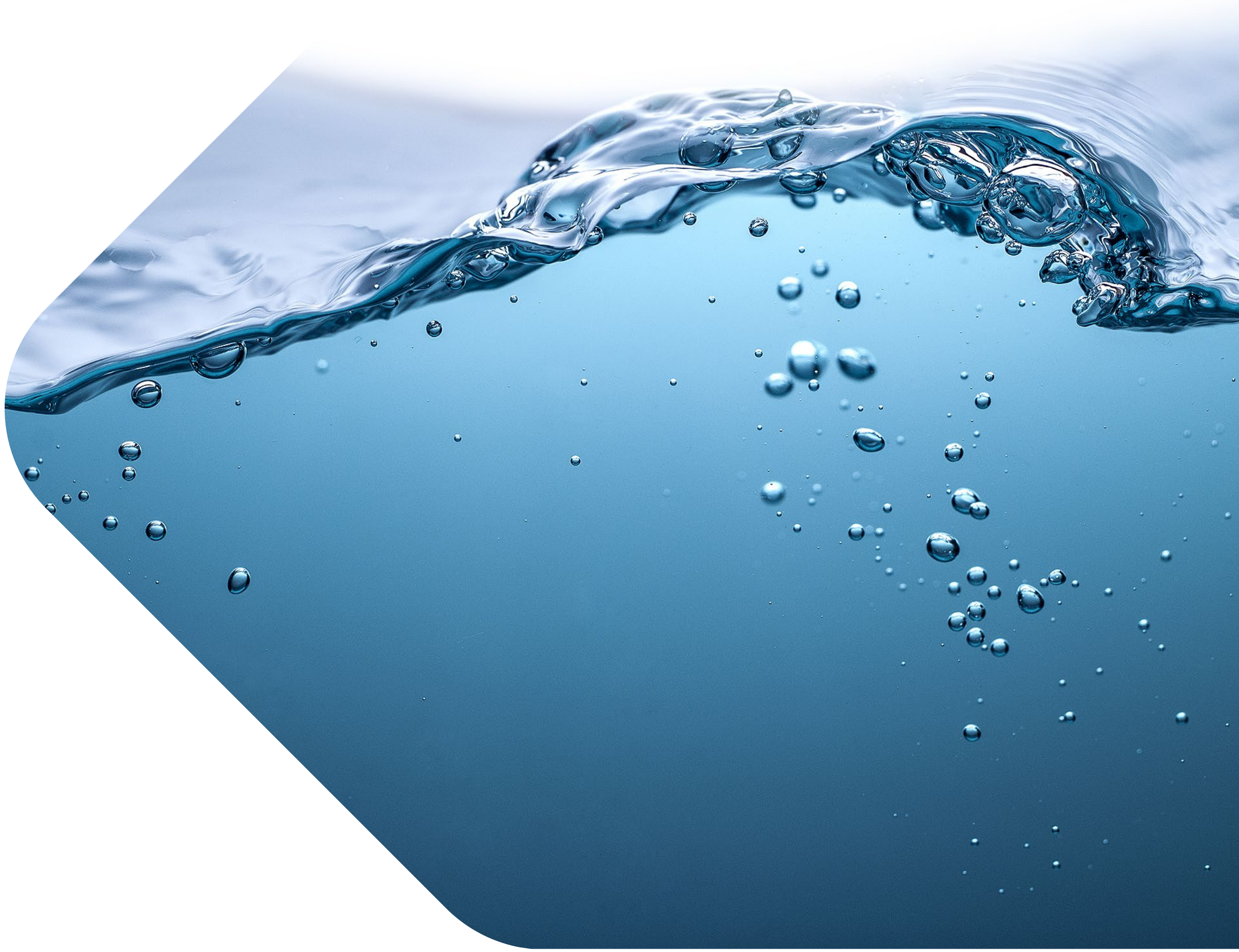
- Continuous flow not available for providing a constant rate supply to the distribution system
- Very limited potential for significant increased takings beyond the existing Arkell PTTW at any time other than the spring period

We'd Like Your Input…

Questions to consider:

- Are there other aspects of conservation and efficiency that should be considered?
- Does the average Guelph resident think about water conservation and take actions to use less water?
- The modelling results suggest that long term groundwater pumping could reduce surface water flow. Is it acceptable to potentially effect surface water in this way?

Water Supply Master Plan Update
Evaluation Criteria



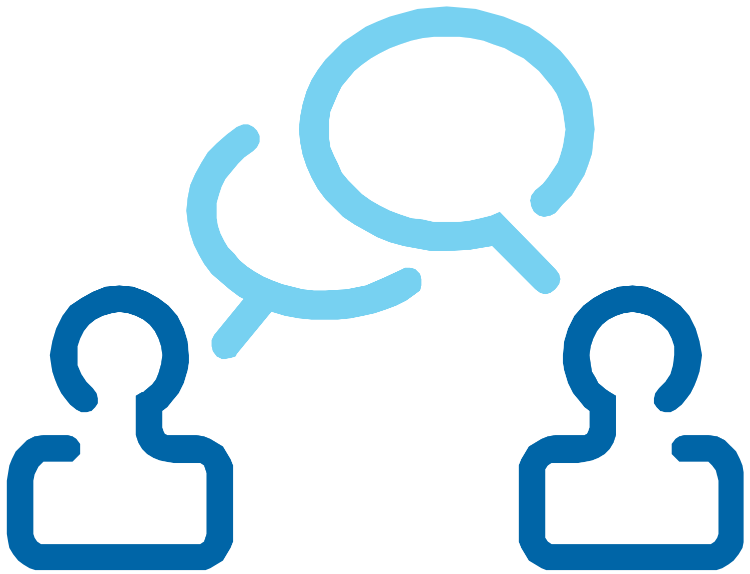
July 27, 2021

Evaluation Criteria

Public Health and Safety	• Ability to meet provincial requirements
Natural Environment	• Potential effects to natural environment and Indigenous Peoples • Potential impacts to water resources • Potential impacts to natural heritage features • Environmental management planning considerations
Social and Cultural Resources	•Land use impacts •Short-term construction impacts •Potential impacts from operations •Potential impacts to Indigenous Peoples and values •Implications of new/ expanded Source Protection areas
Economic and Financial Considerations	• Estimated capital costs • Estimated operations and maintenance costs, including energy consumption
Legal / Jurisdictional Considerations	• Location of facility relative to city boundaries • Land requirements • Implementation of Source Protection policies
Technological Considerations	•Ability to implement and meet peak demand •Constructability, schedule and timing, and maintaining operations during construction • Water quality •Allowance for future treatment needs •Expandability •Ability to respond to changes in regulations •Ability to utilize existing infrastructure

We'd Like Your Input...

Are the evaluation criteria suitable for this study? Is there anything you would add or change?



Next Steps

July 27, 2021

Water Supply Master Plan
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Next Steps

- Incorporate/ consider feedback from this workshop
- Prepare meeting summary and circulate to CLG members
- Discuss project with representatives of Six Nations community
- Complete remaining technical work – Aquifer Storage and Recovery modelling
- Conduct preliminary evaluation of alternatives
- On-going Community Engagement
  - Agency and Municipal Workshop #2 – Week of September 13^{th}
  - Community Liaison Group Meeting #3 – Week of September 20^{th}
  - Community Open House #2 – Week of September 27^{th}

Thank You!

Visit our website: guelph.ca/WSMP

Water Supply Master Plan Update Community Liaison Group #2 – Summary

Date and Time of Meeting: July 27, 2021 from 7:00 to 9:00pm

Location: Virtual teleconference using Microsoft Teams

Overview

The City of Guelph is updating the Water Supply Master Plan (WSMP) Council-approved in 2014, to define how we will continue to access a sustainable supply of water and to meet residential, industrial, commercial and institutional demands to the year 2051. Reviewing our existing water supply system is an opportunity to discuss with Guelph and surrounding communities how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Part of our WSMP update includes a Community Liaison Group (CLG). The CLG includes members from a wide cross-section of the community including community and environmental groups, agricultural organizations, business leaders, and residents from in and outside the City. This was the second of three (3) meetings to share ideas and perspectives on ways to improve the WSMP update. The purpose of the second CLG meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including:

- Consultation conducted to-date
- Population targets and water supply demand forecasts
- Existing water supply capacity assessment
- Technical assessment of alternatives to-date
- Environmental Assessment evaluation criteria

There were nine (9) participants, along with three (3) City staff and three (3) AECOM consultants.

The format of the workshop included a presentation and opportunities for discussion and questions.

Attendance

The following CLG members were present:

- Andrea Williams, Guelph resident
- Brady Deaton, University of Guelph
- Brendan Bumbaco, Sleeman Breweries
- Carol Tyler, Guelph resident
- Corey Woods, Guelph Eramosa Township
- Grant Parkinson, Guelph Water Conservation and Efficiency Public Advisory Committee
- Janet Harrop, Wellington Federation of Agriculture
- Lin Grist, Council of Canadians, Guelph resident, Guelph Wellington Coalition for Social Justice
- Ron East, Council of Canadians
- Sheri Longboat, Guelph resident
- Susan McSherry, Wellington Water Watchers
- Steve Chomyc, Resident
- Steve Nyman, University of Guelph

Dave Belanger, Scott Cousins, Wayne Galliher and Jennifer Rose from the City of Guelph were present. Matthew Alexander, Alicia Evans and Kathryn Ross from AECOM were also present.

The following members were unable to attend:

- Angela Kroetsch, Guelph Wellington Development Association
- Beth Parker, University of Guelph
- Matthew Bulmer, Puslinch Township
- Maya Wariyar, Guelph resident
- William Castledine, Cargill Meat Solution

Meeting Format

Dave Belanger (City of Guelph) opened with a Statement of Territorial Acknowledgement and spoke to the lapse of time since the CLG last meeting (pre-COVID-19). Dave Belanger (City of Guelph) also referenced the new growth targets from 2041 to 2051 and the importance of exploring whether the new population targets can be met while still maintaining sustainable groundwater supply. Alicia Evans (AECOM) provided an overview of the meeting and attendees introduced themselves. Attendees were provided with a copy of the presentation with discussion questions in advance. The presentation was delivered by Matthew Alexander (AECOM). Alicia Evans (AECOM) facilitated the discussions and Dave Belanger (City of Guelph) and Matthew Alexander (AECOM) responded to questions during discussions.

The main sections of the presentation included:

- Review of WSMP objectives
- Overview of major WSMP tasks
- Major task progress update
    - Summary of consultation conducted to-date
    - Review of population targets and water supply demand forecasts
    - Review of existing water supply capacity assessment
    - Review of technical assessment of alternatives to-date
- Environmental Assessment evaluation criteria
- Next steps

Discussion questions related to the content provided in the presentation were asked at various points during the meeting. Attendees shared their questions/ comments with the group and had the opportunity to ask additional questions related to the specific presentation topics.

The discussion captured throughout the meeting is summarized in the sections that follow. Questions are noted with a "Q", answers with "A", comments with a "C" and responses with an "R". Answers were provided by Matthew Alexander (AECOM) and Dave Belanger (City of Guelph).

It is recommended to review the discussion below alongside the presentation; notes are provided under applicable sections below when

the presenter added additional details that are not captured in the presentation.

Task 1 – Public Consultation To-Date

An overview of results and feedback from the first round of public consultation was provided. It was also noted that the Phase 1 Engagement Summary Report is available online and contains more detailed information than what is presented.

Discussion Question: Are there any questions or comments about the Phase 1 public consultation?

There were no comments or questions.

Task 2 – Population and Water Supply Demand Forecasts

A summary of task 2 population and water supply demand forecasts was provided, including population projections changing to 2051 instead of 2041, a review of historical water supply demand, the design basis for projecting future water supply demand and projected water supply demands. Additional notes are provided below to support the technical data presented on the graphs in the presentation.

Slide 15 showed the City of Guelph population targets from 2021 to 2051 as set by the Province of Ontario. The total population and employment target is 230,136 in 2019 and 319,000 by 2051. Additional context:

- Reference population includes population and employment targets
- The word 'reference' in the title is terminology the Province of Ontario uses when developing targets

Slide 16 showed a line graph of the City of Guelph's population between 2010 and 2019, the average daily volume of water produced by the water supply system and the water demand from the residential, industrial/ commercial/ institutional sectors and non-revenue water. The purpose of the graph is to display the historical data that were analyzed to develop the 2051 water demand projections. Additional context:

- The first step was evaluating past water demand in the City
- Non-revenue water (NRW) stands for water produced by the City that does not generate revenue (e.g., water consumed but not billed like fire

fighting flows, watermain flushing, unauthorized water consumption or leaks from system)

- The top red line indicates the population of the City is rising from 2010 to 2019
- The light blue line is the average daily production and shows a flat production curve with some variability
- The green line is the residential demand and shows a fairly flat trend
- The dark blue line is for Industrial, Commercial and Institutional and shows a fairly flat trend
- The yellow line is for non-revenue water and it shows variability, but overall similar values

Slide 17 showed a line graph with the per capita daily volume of water produced by the water supply system and the per capita daily demand from the residential, industrial/ commercial/ institutional sectors and non-revenue water, between 2010 and 2019. Reviewing the data in this format allows for an analysis of how the customer water demands changed as the City's population increased. Additional context:

- Provides demand and water production data on a per capita or per person basis

Slide 18 showed a line graph with trends in the data presented on the previous slide 17. The data were reviewed independently for the two identified time periods as the data indicated variability in the water use patterns between the time periods. Additional context:

- The trend analysis is done separately for the periods 2010-2015 and 2015-2019 to assess apparent differences in water use
- Generally, the trend is downward for both time periods with the decline slowing in the 2015-2019 period

Slide 19 showed a line graph with the projected per capita daily water supply demand for the residential, employment sectors and non-revenue water until 2051. This graph provides the results of the water demand projection task.

The results from the water demand projections (slide 20) were prepared by assuming that the average per capita demands between 2015-2019 in each category will continue in the future, i.e. no further decline in per capita demands. The City will continue to implement conservation and efficiency programs; however, the effect of the programming will be assessed through the evaluation of alternatives evaluation. The maximum day demands were projected using the highest Maximum Day Factor from the 2010-2019 period.

Discussion Question: Our analysis suggests that the decline in per capita water demand in Guelph is slowing down. Our future water demand projections assume no further decline. Do you agree with this approach?

Q1: What is the definition of Employment Population, is it the number of full-time jobs that exist across all industrial, commercial and institutional sectors in the City?
A1: Employment Population is the target of employed people within the City.

Q2: The leakage of non-revenue water looks quite high. We are pumping water, treating it and returning it back to the aquifer, but losing a certain amount per person. How is the lost 44 million litres of water per day part of the projection if it is returned to the aquifer? Could the City pump more water a day because of the 44 million litres of water being lost per day (which ultimately returns back into the system)?
A2: Every water system does leak to a certain degree, and we do need to include non-revenue water in the projection (more information to be provided later in the presentation). Guelph does quite well in comparison to other municipalities. The non-revenue water forms a portion of the total water produced by the City on a daily basis. Despite the fact it doesn't make its' way to the customers, it does have to be accounted for as part of the overall volume of water produced by the system and used in calculations for planning for the future.

Q3: This is a 30-year timeframe and technology will play a role in cutting the non-revenue water number in half (e.g., new flow metre and leak detection) so the system has to be sized to deliver that water. Also, the flatline assumption is safe and conservative assumption for the 30-year outlook. It's clear that everyone is taking part in conservation efforts and there is more opportunities that we aren't discussing, including grey water, high time of use and new technology. Conservation and cutting the non-revenue water number in half should be looked at.
A3: There are additional slides in the presentation related to how the City has progressed with non-revenue water. Even though the City is keeping demand projections constant, the City is still pushing the demand management program and making sure there are comprehensive conversation and efficiency programs (e.g., focused on industrial, commercial and institutional uses, water re-use programs). From a design perspective the City is assuming conservation efforts are relatively constant, however, these opportunities are still being looked at.

Q4: The presentation mentioned that demand in Guelph is slowing down. How does Guelph compare to other municipalities in Canada and Europe in terms of per capita water consumption? We could learn a lot from European countries.
A4: European per capita water consumption isn't the team's area of expertise, however, Guelph compares well against other Canadian jurisdictions.

Q5: Was any consideration given to the pricing strategy for water for forecasting?
A5: The pricing strategy was not considered in the development of the demand curves. It will be part of the water conservation and efficiency scenarios we're looking at, including conducting a financial analysis to understand the value of those kinds of programs and a review of previous detailed variable pricing work completed for the City water efficient strategy.

C1: I lived in Perth Australia for 8 years; water there has a non-trivial cost like $1,500 per annum for the average resident yet consumption per capita is more than double that of Guelph.

Task 3 – Existing Water Supply Capacity Assessment

A summary of task 3 existing water supply capacity assessment was provided, including an overview of Guelph's existing water supply system, how 2019 system capacity compares to 2051 demand, a security of supply assessment, additional system risks and required capacity for security of supply. The supply capacity assessment is a review of the maximum volume of water that the City's existing water supply sources can provide on a daily basis. The security of supply assessment is a review of risks to the City's water supply system and an identification of how much water should be reserved as a risk contingency. It was also noted that additional system risks are considered to better understand if there is a need to be more conservative to plan for additional eventualities.

Additional context for slide 28's well capacity assessment table to explain where reductions in capacity were identified relative to 2014:

- The existing capacity within the southeast quadrant was reduced to reflect the capacity that is available year-round. The Glen collector system[1] captures the highest flow during the artificial recharge period and the lowest flow when artificial recharge does not occur. As the timing of the maximum demand is unknown, the City needs to be prepared to supply that maximum demand any day of the year. Therefore the capacity of the Glen Collector was

[1] *The Glen collector system, located in the Arkell Spring Grounds, is a series of below ground perforated pipes that intercept groundwater located within sands and gravels that are exposed along the south valley wall of the Eramosa River.*

reduced to reflect the minimum reliable flow available from this system

- Within the southeast quadrant, the Water Street well field includes four active wells that experience mutual interference. The cumulative capacity for these four wells was reduced to reflect the maximum reliable flow that can be pumped from the well field

- The full system has not been tested at the identified existing capacity. There is confidence in number based on the available performance records but there are uncertainties in how the system would perform under maximum system-wide conditions

Discussion Questions: Are there risks to the system that have not been considered? Do you think that 15% security of supply is sufficient? Any suggestions for how to ensure security of supply?

Q6: What does the 79,422 m^3/day mean in the existing system capacity table?
A6: It means that 79,422 m^3/day is the estimated maximum capacity of the existing system.

Q7: In terms of climate change, we could experience temperatures to mid-40s within five to six years. If those high temperatures are combined with drought, farmers will be forced to resort to irrigation to save crops. How would that affect water supply for the City?
A7: This is a difficult question to answer because there are unknowns. The City has looked at climate change modelling. Along with dry conditions from the changing climate, there will be periods of more intense rainfalls and increased winter snow melt that assist with the recharge of the aquifer system. Further, previous assessments suggest that there is a buffer and capacity of the system because it is a confined aquifer system and we do know there will be times of intense recharge that could offset the dry periods. In terms of irrigation, that is something we would need to address on an on-going basis. The Water Supply Master Plan is updated approximately every five years and we see how the climate and behaviours are changing on an on-going basis. Also, the goal for source water protection is to protect water quantity for drinking water sources. A wellhead protection area has been identified for water quantity that surrounds the City. This gives us some ability to manage water quantity as a whole moving forward to make sure we have enough water in the future (as required by the Clean Water Act). This is part of developing water quantity policies and making sure practices are sustainable.

Q8: On the required capacity for security of supply graph (slide 32), is the 15% security of supply to maximum day factor a 1.5 factor? Is this the same maximum day factor used in the previous Water Supply Master Plan?
A8: Yes, a 1.5 maximum day factor was used. This number was a water supply

system design recommendation from the Ministry of the Environment, Conservation and Parks. The City has the data and can pick out what a maximum day is but has added security of supply to be conservative.

C2: 15% seems like a reasonable security of supply.

C3: There are other things we aren't discussing that could change the security of supply, like putting water restrictions in place.

Task 4 – Water Supply Alternatives

An overview was provided for the following proposed water supply alternatives under consideration:

- Water conservation and efficiency
- Groundwater sources
- Surface water sources

As part of the water conservation and efficiency alternative, historical non-revenue water data, infrastructure leakage index, economic level of leakage and considerations for future programming scenarios were presented. Additional context:

- Patterns in the data of historical non-revenue water (slide 38) showed the following:
    - A leak detection program was implemented in 2010 and success in the following years brought down the non-revenue water numbers
    - There were cold winters in 2015 and 2016, resulting in increased leakages and customers being asked to run water at certain times to prevent freezing, without being billed for this use
    - After 2016 there is success in reducing non-revenue water
- The red numbers in the Infrastructure Leakage Index (slide 38) mean that the bigger the number, the more opportunities there are to capture water lost to leakage.

As part of the groundwater sources alternative, the evaluation approach using the groundwater flow model was presented along with inactive and new sources of groundwater, an assessment of the Dolime quarry Pond Level Management, optimization of the Arkell collectors and a summary of the groundwater modelling assessment. Additional context:

- The groundwater flow model has uncertainties but is the best tool currently available for pumping groundwater

- Table showing results of the inactive/ new sources of groundwater (slide 44-45)

  - In the southeast quadrant, the Lower Road Collector on the Arkell Spring grounds historically collected shallow groundwater similar to how the Glen collector currently does. It has been out of service for some time and would require reconstruction

  - More field data is needed for the southwest quadrant and this will be collected through the upcoming Southwest Guelph Water Supply Environmental Assessment

  - In the northwest quadrant the Smallfield well is offline due to contamination. Note that the model evaluates water quantity and not specifically how contaminants move. We need to further understand through field testing the level of contamination, presence and treatment options

- Assessment of Dolime Pond Level Management (slide 46)

  - In the west side of City there is up to 11,000 m^3 of water pumped from the quarry and discharged into Speed River. This pond represents a potential pathway for contamination to reach the aquifer after closure of the quarry.

  - Pond Level Management would control the elevation of the pond in the Dolime quarry and causing water around the quarry to flow into the pond thereby preventing any contamination from moving into the aquifer

  - There is an opportunity to increase pumping at City wells outside of the quarry while managing the pond level and monitoring surrounding water levels in the aquifer

  - There is uncertainty in the flow dynamics in the aquifer and more field testing is required to investigate. This work is being completed in the upcoming Southwest Water Supply Guelph Class Environmental Assessment

- Optimization of Arkell Collectors (slide 47-49)

  - For the purpose of increasing overall capacity, we are looking at the minimum amount of flow—what is the reliable amount of water we can provide from the system at any point in the year? The results don’t show a significant difference in annual minimum collector flows.

As part of the surface water supply alternative, an overview was provided along with graphs related to Guelph Lake and the Eramosa River as two possible local surface water sources for water taking. These graphs were used to assess the availability of sufficient surface water to support natural creek function as well as contribute water as a supply source.

Discussion Questions: Are there other aspects of conservation and efficiency that should be considered? Does the average Guelph resident think about water conservation and take actions to use less water?

Q9: Is it fair to say that the Economic Level of Leakage (ELL) holds true until the system can no longer be expanded and then the justifiable incremental cost to reduce loss would be quite high?
A9: The ELL is not a static number and would need to be evaluated as the City grows and as less additional water is available. This could be something to revisit.

Discussion Questions: The modelling results suggest that long term groundwater pumping could reduce surface water flow. Is it acceptable to potentially affect surface water in this way?

Q10: Was that 11,000m^3 per day of dewatering in related to the Dolime quarry?
A10: Yes.

Q11: The Paris Galt Moraine runs through Clair Maltby and development in the area. How would the Paris Galt Moraine be affected?
A11: City wells traditionally target deep groundwater (groundwater held in deep bedrock aquifers). This deep groundwater is less connected to shallow groundwater (e.g., groundwater that supports streams, creeks and wetlands). Deep groundwater has less of an impact on shallow groundwater and places like streams, creeks and wetlands associated with the moraine. Any groundwater takings have to assess the impact on shallow groundwater, and this will be subject to future testing and Class Environmental Assessments.

Q12: Can you further explain the City monitoring water quality at the Dolime quarry?
A12: The Pond Level Management strategy is looking at how to manage the pond level to keep water flowing inwards towards the pond and at the same

time try to take more groundwater in the area. It's a balancing act to determine through a testing program.

Q13: You mentioned injecting water back into the aquifer, which concerns me. How does that make sense for water quality? How is it controlled from an environmental, quality or economics perspective?
A13: Aquifer storage recovery means taking excess capacity, treating the water to drinking water quality standards, and storing it in an aquifer and bringing it back when you need it. For example, where there's variation in flows (high flow) in the Speed River, you could use the aquifer as a storage reservoir and bring back the water in future years when it is needed. The water goes into the aquifer meeting drinking water quality standards and gets disinfected when it comes back out.

A14: Injecting water back into the aquifer is changing a natural part of the environment. Will it impact supply where water is taken by private wells or other means?
A14: Water quality is a big issue in any aquifer storage recovery operation. Geochemical testing and treatment is done before injecting water to make sure waters are compatible and that the treatment process is compatible. Water quality also needs to be of drinking water standards. Part of the process also means ensuring existing wells in that area drawing from the same source of water are not impacted; permits would not allow this kind of adverse impact. Florida and California already use aquifer storage recovery and have shown a well defined and proven way of taking surface water and storing it in the ground safely. This is also currently in use at the Region of Waterloo.

Discussion Question: Are there any questions or comments about the surface water source evaluation?

Q15: Has there been any consideration to having more capacity in Guelph Lake if it was dredged?
A16: If Guelph Lake were dredged, there would be an increase in storage, however, the flow through Guelph Lake is what is needed to be defined as a volume. The data in the chart showing the increase in the spring and low flow in the summer (slide 53) demonstrates that it is the low flow that dictates how much water is available. The Grand River Conservation Authority has completed an analysis to determine that 150-300 litres per second may be available. Dredging the lake does not change the flow through the lake.

Q17: What about other storage capacities (e.g., water tanks)?
A17: The majority of storage capacities are designed for emergency uses (e.g., fighting fires). Storage reservoir capacity is three days of flow capacity. Building

storage reservoirs can help on a maximum day demand but we couldn’t build enough storage capacity to manage what could be needed. Consistent average day supply is required so that’s why we’re looking beyond storage capacities.

Evaluation Criteria

An overview of the evaluation criteria was presented and there will be an opportunity to review and comment on this information in more detail at the next CLG meeting. Additional context:

- Since the last CLG meeting, some of the source protection bullets were further defined and impacts to Indigenous Peoples and values were added to both the social and cultural resources category and the natural environment category.

Discussion Questions: Are the evaluation criteria suitable for this study? Is there anything you would add or change?

Q18: When we are evaluating the quantity of water needed to provide, has there been a consideration of a cost-effective way of doing that? Is that implied in the economic calculations (e.g., reviewing the alternative that is the most cost effective) or is it something that could be considered?
A18: The estimated cost for each alternative is considered on a per cubic metre basis regardless of where water source is coming from, including costs required and operating/ maintenance.

C4: The WSMP Update presented in an excellent plan. You could consider adding environmental management under the natural environment. Over a 30-year period it is assumed that the environment is relatively stable environment, however, we are entering a period of environmental instability. Perhaps there needs to be an alternative plan to address extreme weather events.
R: That is a good comment. The City’s source protection programs are intended to look at quantity and quality, which is related to both water resource management and environment resource management. We have on-going discussions with the Ministry of the Environment, Conservation and Parks about how to develop water resource management plans to make sure we have sustainable water supply going forward. We will need to adapt and manage resources collectively.

Feedback Received Post-Meeting

Three emails were received following the meeting.

Email 1: I'm so very grateful for the passion, skill, care to detail and cooperative efforts of all those working together on all the Water-related Master Plans. It was obvious in the Source Water Protection session that no one Master Plan had worked as a 'silo'.

The presentation, information session and Q&A were open, positive, well-thought out, and held with such respect! The content and how the content was shared in many ways reflected one of the main gleanings from session #1 and that is to value the agency of the water itself.

Although not articulated in that way specifically within session #2 I heard or read whispers of careful observations, and stewardship of surrounding ecosystems that included water, earth, plants, animal, birds, microbial life and also the relational elements which are fundamental to indigenous worldview, in the conversations of the behaviour of gathering from wells, one, some, all on the individual draw and impact on each and the group.

Valuing the agency of water itself, is not usually included or even referred to indirectly in engineering, hydrology, geology reports. So, I commend the team's courage to speak clearly about how they value the agency of the water itself in such documents, especially under each of the 4 Tasks, the New Surface Water Supply Options. I especially appreciated the comments regarding the significance of 'motion' as it relates to capacity and reciprocity of a sustained healthy relationship to maintain the pureness of water.

In the Evaluation Criteria section, within my ancestral teachings [of which I'm still and will always be learning] I would make note that "Indigenous culture" should be included in each/ all of the 6 aspects.... and even more specifically because we're on this land, using the specific label, First Nations cultures and worldview.

Also, the assumption that Environment is always Stable is a Western worldview and is an assumption that in Anishinaabeg teachings is not made. Just a point of interest perhaps.

Very much appreciated the team providing next steps.

Perhaps with some reflection it might also be considered at this time in the process, that the team personally request the Indigenous, especially Anishinaabeg they know living in the Guelph-Wellington area to gather in a traditional circle way to share conversation [within context of your reports/ presentation] on 'the value of the Agency of Water'.

Local Elders, Knowledge Keepers could guide this.

Or as the idea aligns with the City's current agreement to work with Elder Bob Goulais [Anishinaabe] on City of Guelph's Indigenous Community Engagement re: 2020-2050 Strategic Growth Plan, the City staff and Council members who over many years know well, and have friendships with many Indigenous living within the community, could extend the welcome to share conversation. Just a thought from a nookomis to bring a bit of balance within the next steps.

Response 1: Thank you. We appreciate your thoughtful comments and insights on the WSMP. I am learning more each time we communicate. By this email, I am passing them on the team for further considerations as we continue to develop the plan. We have another meeting of the CLG planned for late September and hopefully we can include more discussion on your points below, particularly valuing the agency of water. Thank you for your help and support on this project.

Email 2: Could you please explain why you need to constantly push water into the ponds in the Dolime Quarry and why that is important for the water supply for Guelph residents?

Response 2: Thank you for your questions. The quarry has excavated to the licensed limit of an elevation of approximately 285 m above sea level which is approximately 17 m below the elevation of the Speed River. The quarry excavation has breached the Vinemount Aquitard and therefore the City's water supply aquifer (Gasport Formation) is exposed in the base of the quarry, causing groundwater to flow into the quarry. If the dewatering were to stop, groundwater from the aquifer would fill the quarry. If the dewatering were to stop, the quarry would fill with water. Once the quarry fills, water would flow out of the bottom of the quarry through the breach and flow to our municipal water wells. The water quality of the pond may be similar to surface water and contain bacteria and viruses which could, potentially, contaminate our wells. To protect the water quality of our wells, the proposed concept is to continually pump the quarry pond to maintain the inward flow into the quarry to prevent the outward flow of poor quality water. The water pumped out of the quarry would continue to be discharged to the Speed River. Also, as part of the water management concept, we would optimize the amount of water to be collected by our water supply wells while still maintaining the inward flow to the quarry. All of this will be confirmed in future years through an operational testing program and municipal Class Environmental Assessment. More information on the Dolime Quarry can be found here: https://guelph.ca/living/environment/our-community-our-water/ .

I hope this answers your questions. If you need more or have other questions, please contact us. Thank you for your interest in our project.

Email 3: How is your team planning to include climate change into the predictions to 2051. I am assuming that this will be part of the report which you bring to council.

Response 3: Climate change and the impact on our groundwater resources have been evaluated in our Source Protection program as part of the Tier 3 Water Budget and Water Quantity Risk Assessment. The report is located here - https://www.sourcewater.ca/en/source-protection-areas/resources/Documents/Grand/15072-527-Climate-Change-R-2018-11-21-final-V1.0.pdf. In summary, the report predicts that there may be more recharge and more available groundwater in the future resulting from higher winter temperatures (i.e., more freeze/ thaw events in winter months resulting in more groundwater recharge). We will continue to evaluate the effects of climate change in our Source Protection Programs and include these evaluations in subsequent updates to the WSMP.

Next Steps and Adjournment

The project team reminded participants to reach out to Dave Belanger (City of Guelph) and Matthew Alexander (AECOM) if they had any questions, comments or concerns about the technical information presented. Participants were encouraged to provide additional feedback to the discussion questions in the presentation by August 6, 2021.

Next steps in the project include incorporating and considering feedback from this meeting, completing the remaining technical work (aquifer storage and recovery modelling), conducting a preliminary evaluation of alternatives and on-going community engagement.

Upcoming engagement opportunities include:

- Agency and Municipal Workshop #2 – week of September 13th, 2021
- Community Liaison Group Meeting #3 – week of September 20th, 2021
- Community Open House #2 – week of September 27th, 2021

The meeting was adjourned at 9:00 pm.

Water Supply Master Plan 2021 Update

Community Liaison Group Meeting No. 3

September 21, 2021

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Water Supply Master Plan
guelph.ca/WSMP

City of Guelph Territorial Acknowledgement

As we gather, we are reminded that Guelph is situated on treaty land that is steeped in rich indigenous history and home to many First Nations, Inuit and Métis people today.

As a City we have a responsibility for the stewardship of the land on which we live and work.

Today we acknowledge the Mississaugas of the Credit First Nation of the Anishinaabek Peoples on whose traditional territory we are meeting.

Agenda

1. Welcome & Check-In
    a) Opening remarks
    b) Meeting purpose and objectives
    c) Introductions
2. Project Update Presentation Q&A and Discussion
    a. Brief summary of the water supply requirements
    b. Work completed since meeting #2
        i. Assessment of water supply alternatives
        ii. Preliminary evaluation of water supply alternatives
    c. Interactive discussion - Evaluation of water supply alternatives
3. Next Steps

Housekeeping

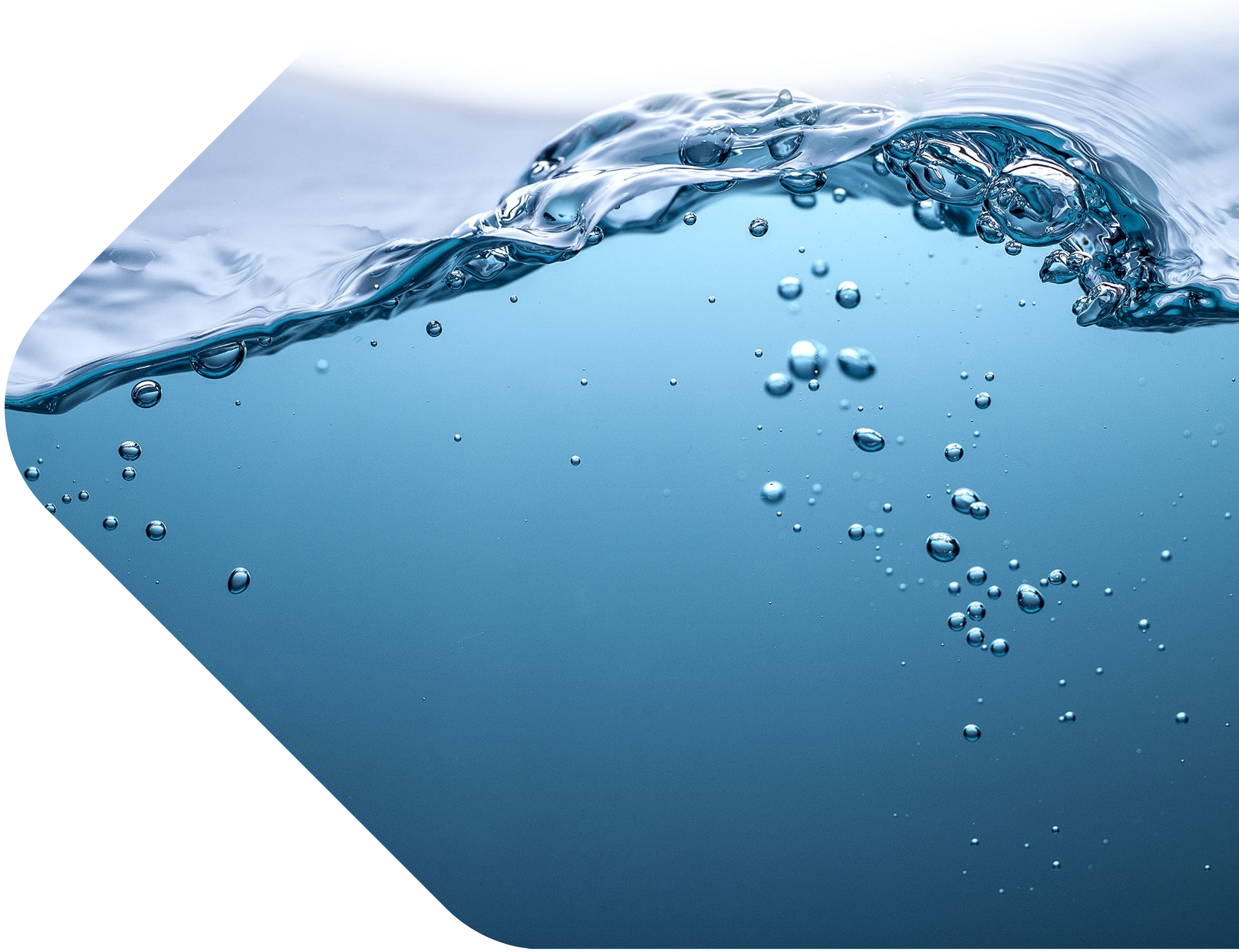
- Teams features
  - Camera, microphone, raise hand, chat (speech bubble)
  - If using a computer – access the features by hovering the mouse over the screen
  - If using a phone or tablet – tap on the screen to access features (may need to click on '…')
  - If using a phone or tablet – you can change the orientation and zoom in as needed
- Attendees will be muted until the discussion periods
  - Press the 'raise hand' button if you wish to speak and we will prompt you when it is your turn (be sure to enable your device's audio function and unmute when speaking)
  - Add questions and comments in the chat box
- If you have technological issues, please type your issue into the chat box
- Meeting recorded for purpose of preparing meeting summary

Introductions

Share your name and if you are representing an organization or group.

Water Supply Master Plan Update

Summary of water supply requirements



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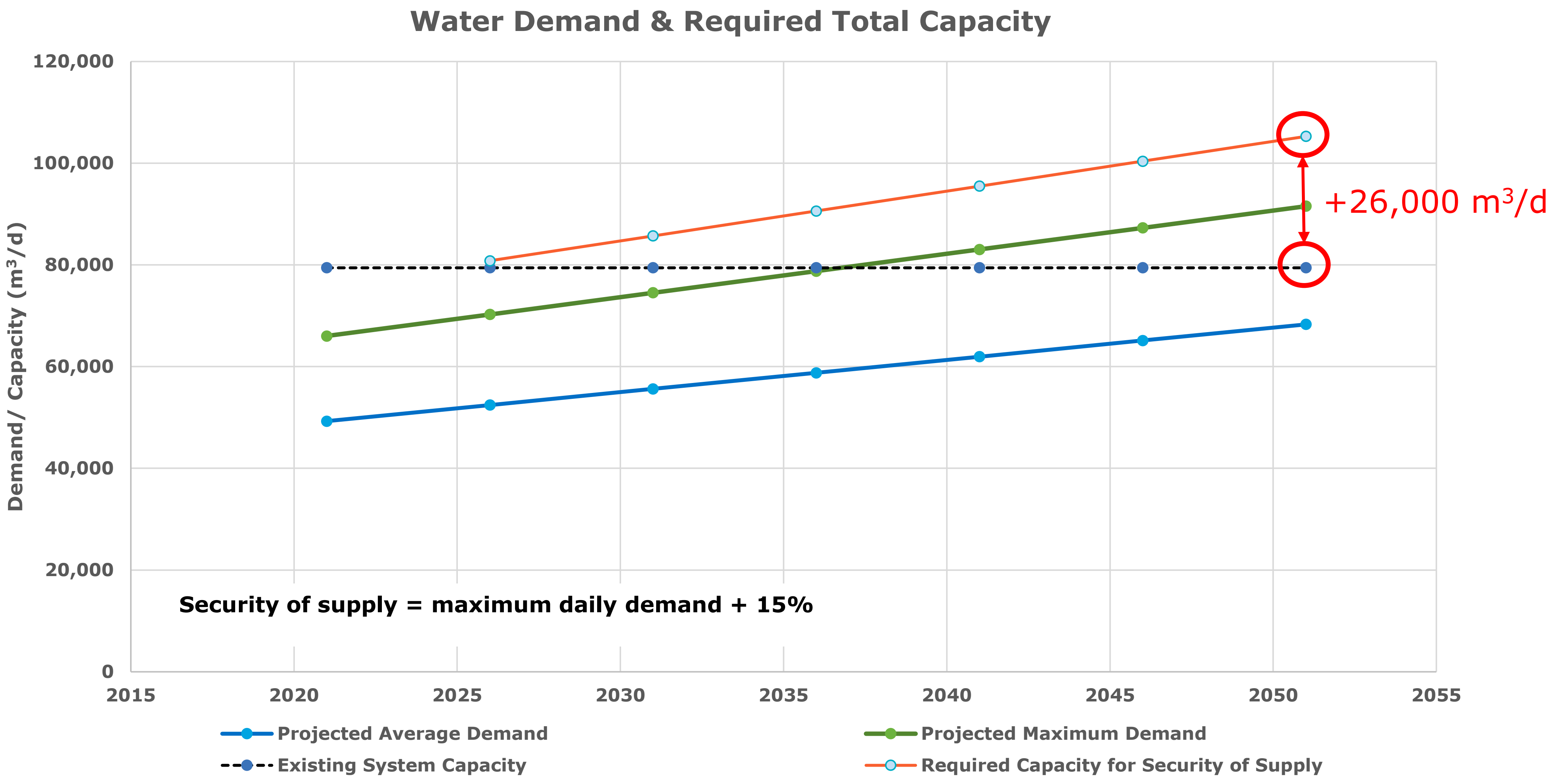
September 21, 2021

Required Capacity for Security of Supply



Water Supply Master Plan Update

Task 4 – Water Supply Alternatives Assessment

September 21, 2021

Alternatives Assessment

Assessment of proposed water supply alternatives under consideration:

1 - Water conservation and demand management/ water reuse

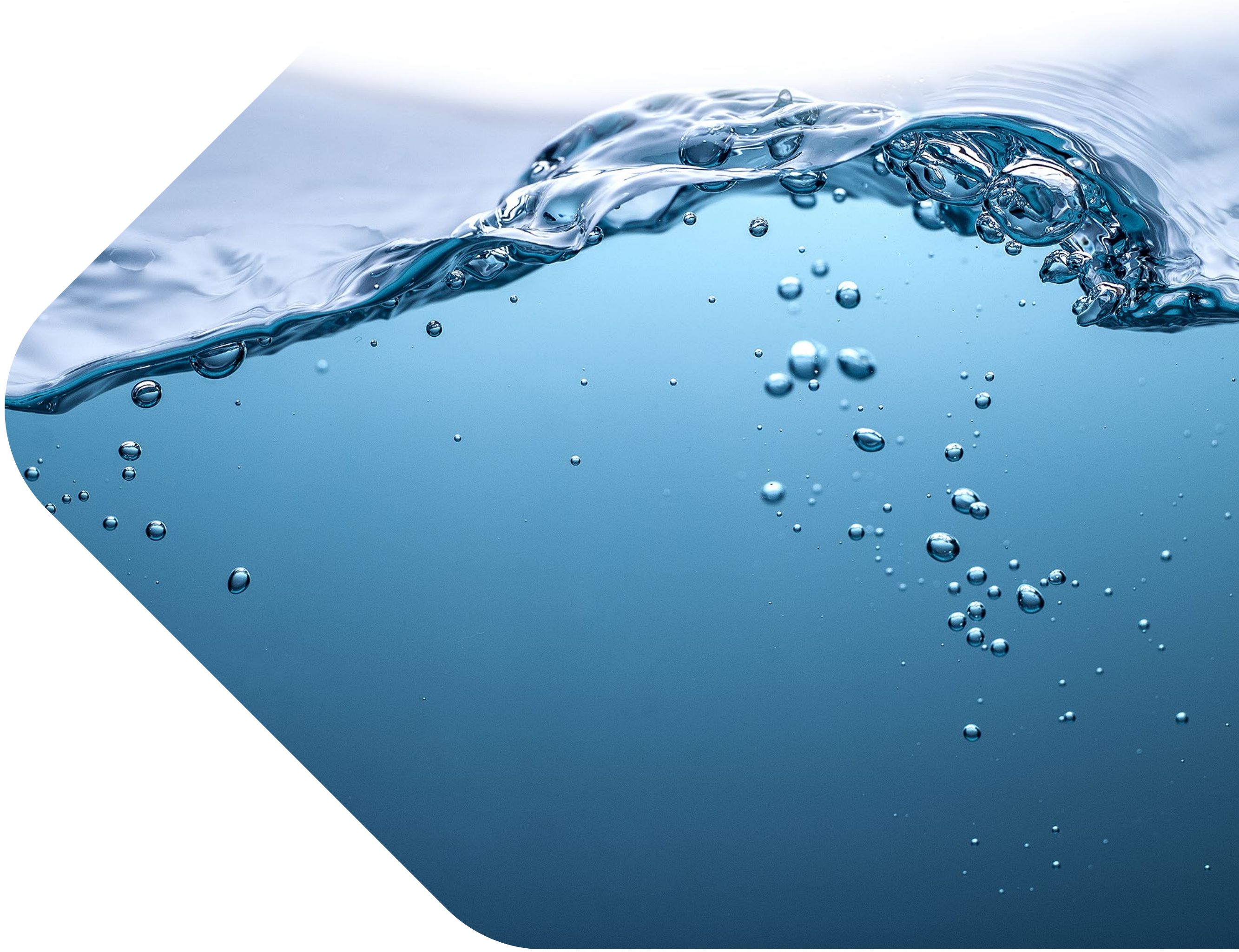
2 - Optimize and expand existing groundwater system

3 - Establish new surface water supply

4 - Limit growth/ do nothing

Water Supply Master Plan Update

Water Supply Alternatives – Water Conservation and Efficiency



September 21, 2021

Conservation/ Efficiency Programming Scenarios

- Four scenarios to investigate future demand reduction and associated costs:
  - 1 – Static Residential and ICI per capita demands
  - 2 – Demand Reduction of 6.5% in 2051
  - 3 – Demand Reduction of 3.25% in 2051
  - 4 – Demand Reduction of 7.3% in 2051

Non-revenue Water

Economic Level of Leakage (ELL): point at which the cost of lost water (leakage) = costs of leakage prevention programs

Infrastructure leakage index (ILI) = Real Losses / Unavoidable Real Losses

- ILI=2.0 for Guelph in 2019
- Other jurisdictions (UK, Australia) have reported ELL when the ILI is below 3
- Results indicate that Guelph is near or at its ELL
- Recommended focus in future is to maintain the ILI, or improve where possible

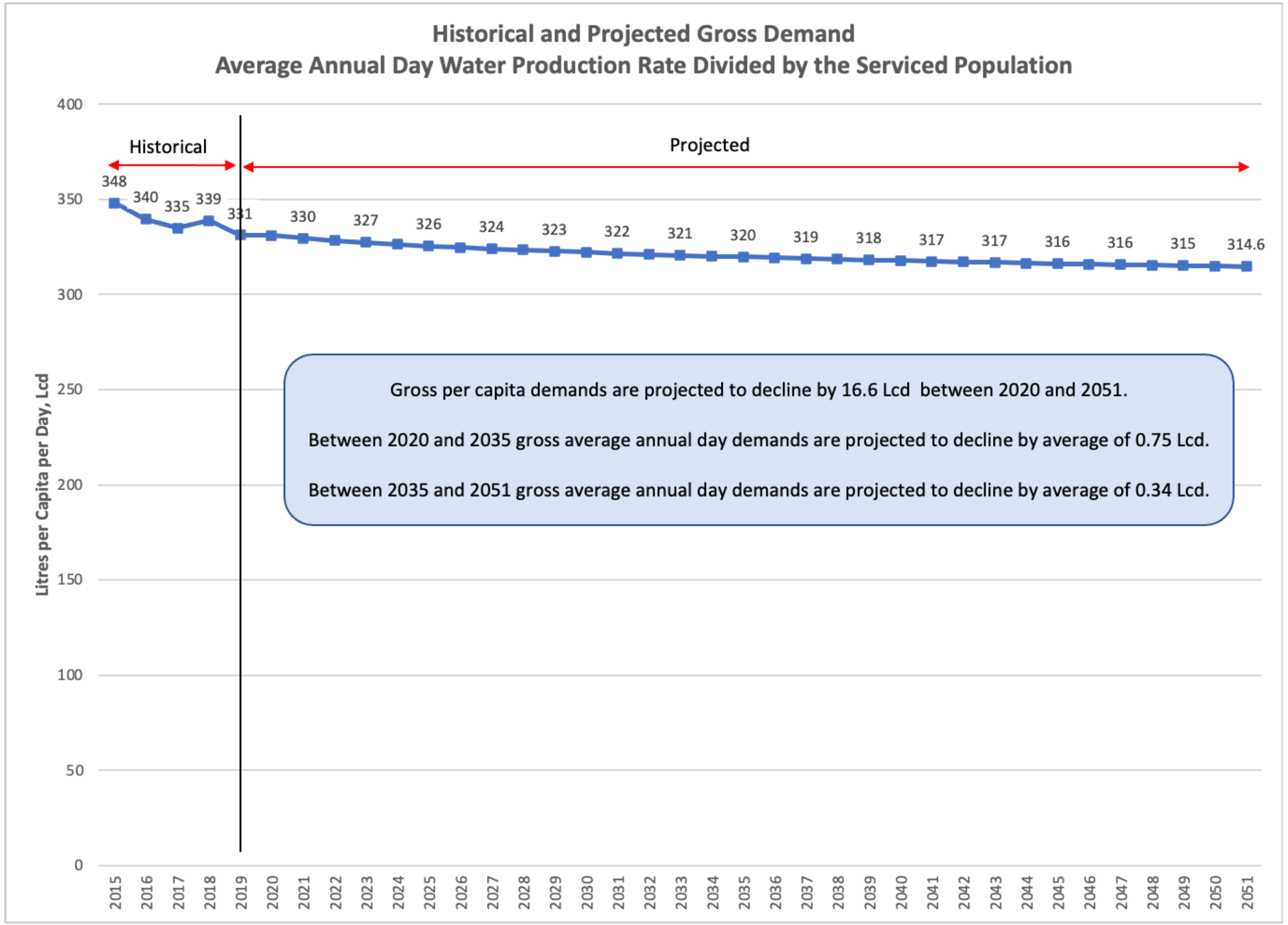
Scenario 1

- Assumes the City ceases non-mandatory programming
- Sets a baseline against which to compare scenarios
- Based on effort City has put into educating public, no resulting increase in demand is anticipated
- Scenario does not reduce demands
- No cost associated with scenario

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	166.6	203,000	33,814
Employment	191.0	191.0	116,000	22,155
NRW	60.8	60.8	203,000	12,338
			Total	68,306

Scenario 2

- Continuation of current level of programming
- Decline in per capita demands has slowed over time
- Apply avg. rate of per capita demand decline observed from 2015-2019 as target for future decline
- Requires regular review of programs, replace those no longer effective
- Assume matching target reductions for residential and ICI



Scenario 2

- Results in 6.5% decline in 2051 demand
- Reduction of ~4,400 m³/day vs. Scenario 1
- Associated cost estimate: $11.41 M or $2,600 m³/day; $380,000/a operating costs

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m³/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338
			Total	**63,882**

Scenario 3

- Acknowledges that effective conservation programming becomes more challenging with success
- City may elect to focus programs on high water use customers if per capita demand trend continues to stabilize
- Approach would result in lower demand reduction at a lower cost to City
- Overall reduction of 3.25% in 2051 demand
- Reduction of ~2,200 m^3/day vs. Scenario 1
- Associated cost estimate: $4.73 M or $2,100 m^3/day; $158,000/a operating costs

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	159.9	203,000	32,460
Employment	191.0	183.5	116,000	21,288
NRW	60.8	60.8	203,000	12,338
			Total	**66,086**

Scenario 4

- Addition of water reuse opportunities to Scenario 2 demand reductions
- Most aggressive option – highest demand reduction and program costs
- Review of water reuse options previously compiled
- Consideration of those most likely to reduce average daily demand (i.e., remove seasonal uses like irrigation)
- Total daily savings of 528 m^3/day estimated

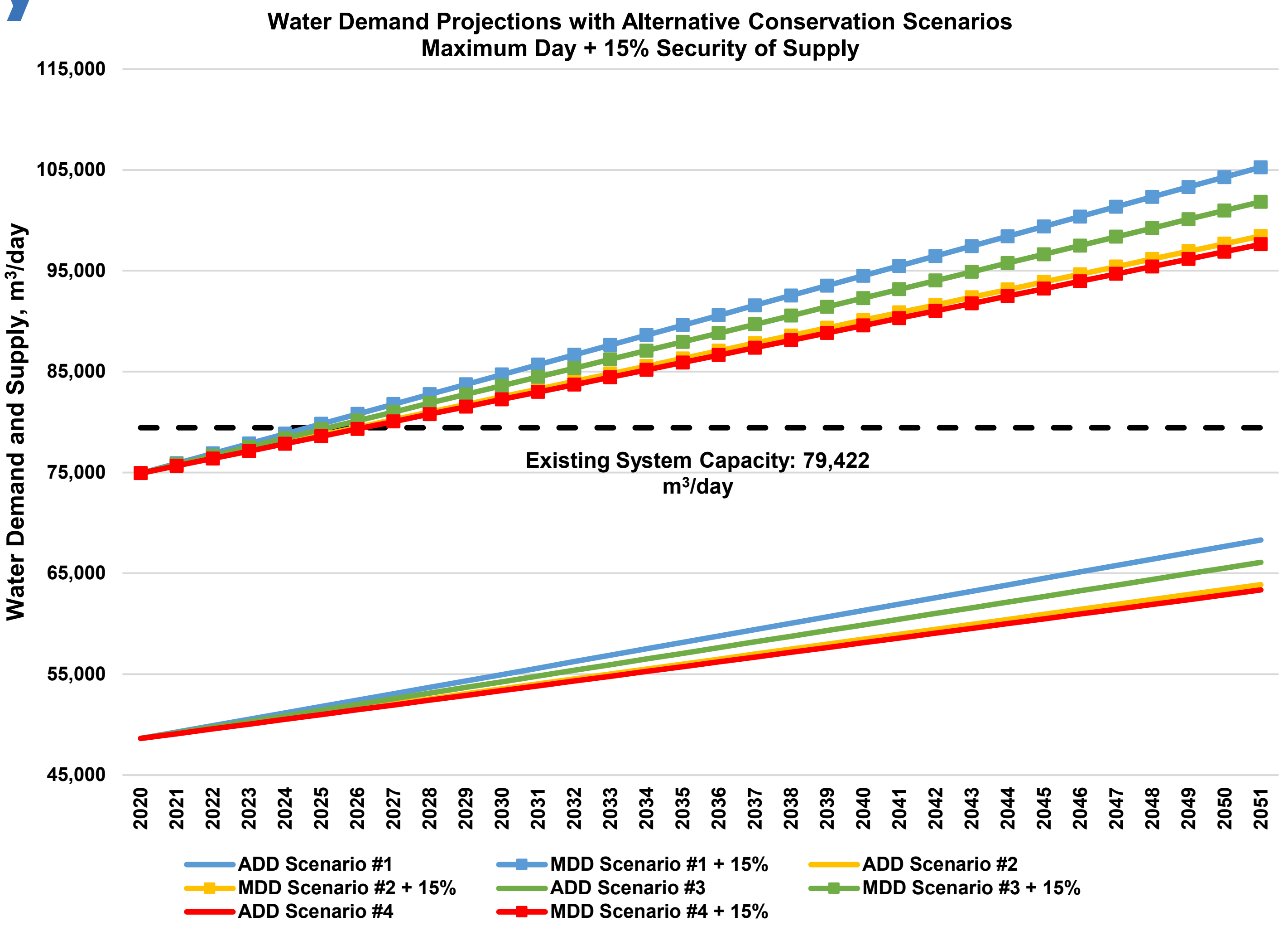
Measure	Annual Savings, m^3	Average Annual Day Savings, m^3/day
Street sweeping	3,175	8.7
Sewer flushing	11,223	30.7
Urban applications	168,168	460.7
Construction	10,160	27.8
Municipal irrigation	8,800	24.1
Golf course irrigation	147,000	402.7
Total	348,526	955
Total without Irrigation	192,736	528

Scenario 4

- Overall reduction of 7.3% in 2051 demand
- Reduction of ~4,900 m^3/day vs. Scenario 1
- Associated cost estimate: $15.04 M or $3,000 m^3/day; $586,000/a operating costs

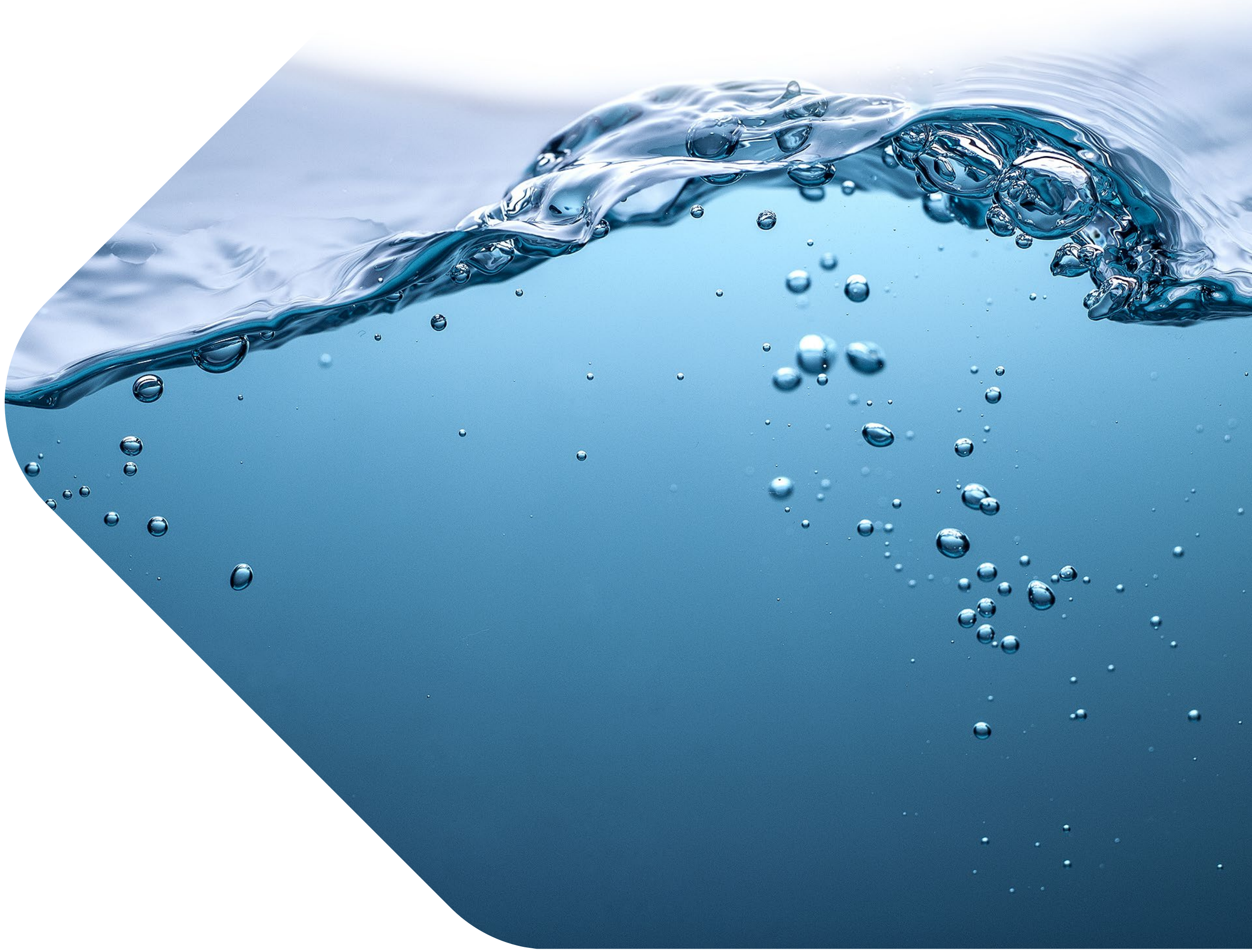
Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338
			Total Potable	**63,882**
			Minus Estimated Water Reuse Savings	**-528**
			Total Potable Minus Reuse	**63,354**

Conservation/ Efficiency Programming Scenario Summary



Water Supply Master Plan Update

Water Supply Alternatives – Groundwater Sources



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September 21, 2021

Water Supply Master Plan
guelph.ca/WSMP

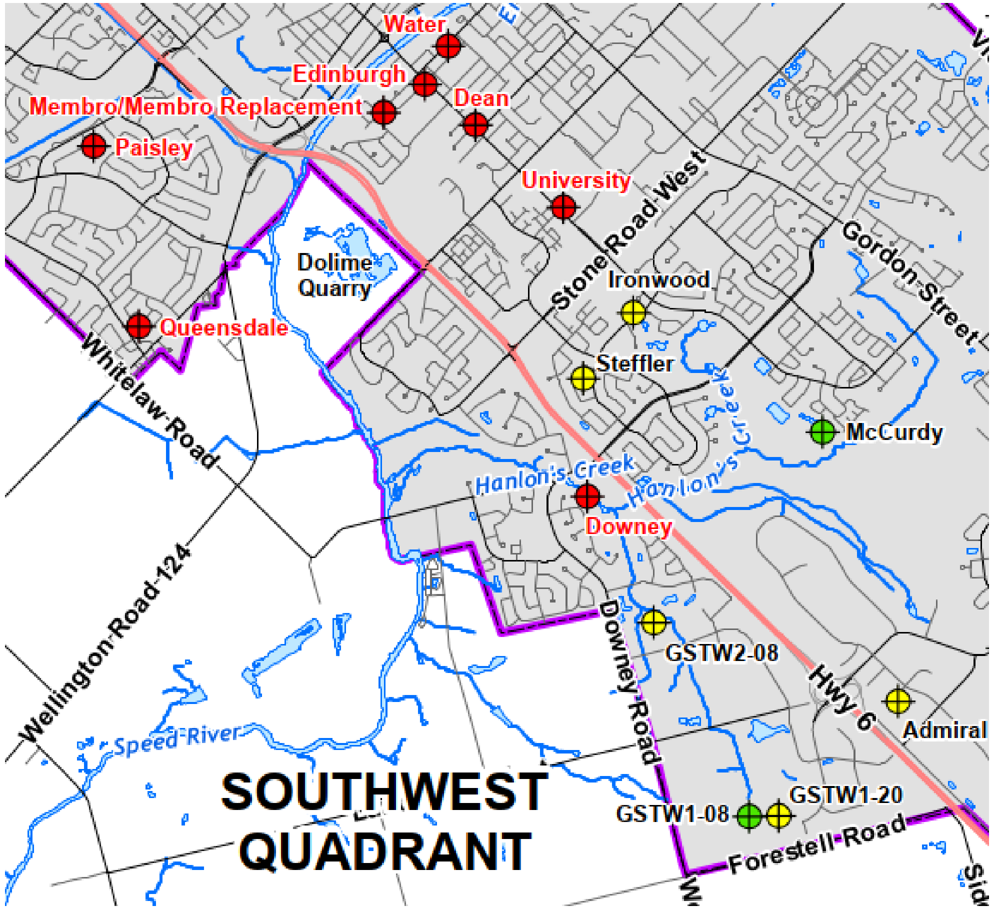
Groundwater Alternatives

The potential opportunities for expansion of the existing groundwater supply system are grouped into the following alternatives:

- **Optimize** existing operating municipal sources
- **Restore** existing off-line municipal wells
- **Develop** existing municipal test wells
- **Install new wells inside** City boundaries (screened out through prelim. modelling)
- **Install new wells outside** City boundaries
- **Install new ASR wells** inside City to optimize excess Arkell Collector system volumes

Optimize existing operating municipal wells

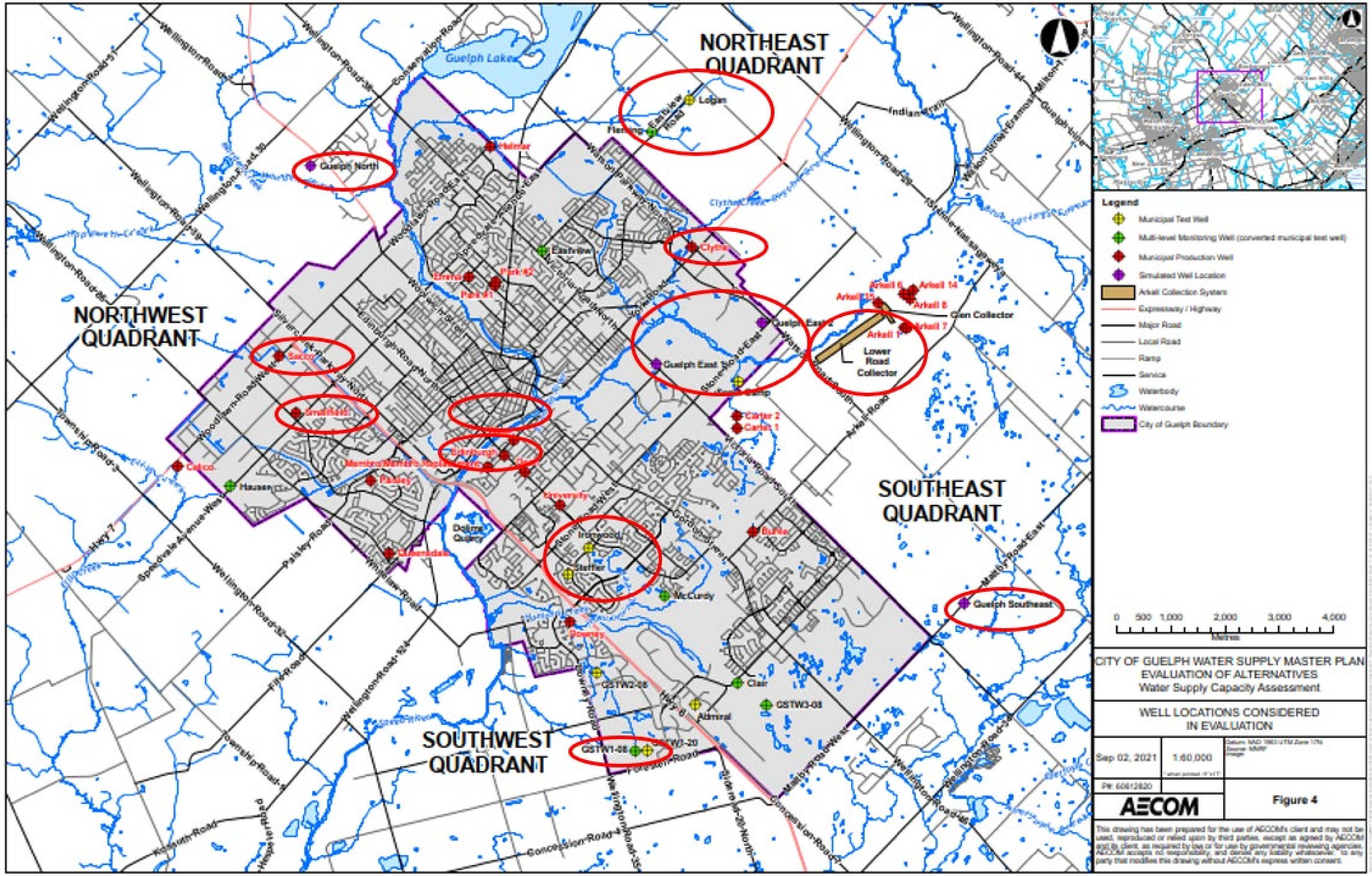
- Reviewed optimization opportunities through historical well performance and discussions with Operations staff
- Potential for additional capacity from Downey Well
  - Located within southwest quadrant
  - Must be evaluated alongside test wells in quadrant
  - Consideration of Dolime Pond Level Management
  - Detailed assessment of additional water supply to be completed through Southwest Guelph Water Supply EA



Optimize existing operating municipal wells

- Recommendations:
  - Confirm capacity where uncertain (Arkell 1)
  - General maintenance, rehabilitation, replacement of equipment where required
  - Replace Calico well (same capacity anticipated)
  - Opportunity to increase Arkell recharge system within existing permit
    - Assessed using groundwater flow model
    - Primary benefit to supporting collector peak flow rates
    - Significant increase to flow rates during period of no artificial recharge not expected
    - Upgraded system would benefit new Lower Road Collector
- Review of previous recommendation to replace Glen Collector – screened out through preliminary modelling

Off-line/ New Sources



Restore existing off-line municipal wells

Quadrant	Well	Required Upgrades	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Northeast	Clythe	Well house upgrade; H2S, Fe&Mn treatment (EA complete)	1,180-3,400	$6.8M	$2,000
Northwest	Sacco/ Smallfield	wellhouse upgrade; VOC treatment	850-2,560	$13.1M	$5,100
Southeast	Lower Road Collector	new perforated pipe system & associated infrastructure	4,000	$14.67M	$3,700
		Total	**6,030**		

- Uncertainty about Clythe Creek requires additional field program to address as part of PTTW
- Sacco/ Smallfield alternative assumes combined treatment facility on Smallfield property; MECP correspondence: achieving clean up goals (i.e. ODWQS by 2051) is unlikely
- Full re-construction of Lower Road Collector anticipated; additional modelling recommended to optimize design; would benefit from recharge system upgrades
- Additional capacity in table represents modelled long-term average
- Costing developed for maximum capacity where existing data are available

Develop existing municipal test wells

Quadrant	Well	Required Infrastructure	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southwest	Guelph South	SWG EA/OTP; land acquisition; well house; connect to distribution	2,250-4,300	$5.3M	$1,200
Southwest	Ironwood/ Steffler	SWG EA/OTP; well house; disinfection; connect to distribution	2,250-8,000	$5.1 to 6.2M	$650 to 1,700
Northeast	Logan/ Fleming	new well; well house; connect to distribution	4,180-4,700	$10.1M	$2,150
Northwest	Hauser	new well; property in area; well house; connect to distribution	425-900	$6.6M	$7,300
Total			**9,105**		

- Modelled long-term average additional capacity of 4,500 m^3/day in SWQ (with active Dolime Quarry dewatering)
- Southwest Guelph EA initiated to assess additional water supply in SWQ in detail
- City has initiated project on Logan site to re-construct and test well

Assessment of Dolime Pond Level Management

- City has agreement in place to take over quarry water management
- Potential opportunity to increase municipal water supply while managing water quality concerns
- Maintain flow divide around quarry to isolate quarry water
- Quarry inflow ranges 8,000 – 11,000 m^3/day
- Managing quarry pond will allow for capture of additional water by surrounding wells or directly from quarry
- Modelling indicates 3,000 m^3/day of available capacity
- SWG Water Supply EA will assess available capacity, associated potential impacts and costs in detail

Assessment of Dolime Pond Level Management

Quadrant	Source	Required Infrastructure	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southwest	Dolime	SWG EA/OTP; pumping station; WTP (if supply is direct from quarry); connect to distribution	3,000	$18.9M	$6,300

- SWG Class EA will assess optimal strategy for capturing available water
- Water quality assessment will determine treatment requirements
- Capture of quarry water would reduce current artificial discharge to Speed River – not relied upon for WWTP assimilative capacity
- Cost would be reduced if additional capacity is captured by surrounding wells

Install new wells outside City boundaries – Guelph North

- Approximate location – G-E Township North of the City (City does not currently own land here)
- Consultation and collaboration with G-E Township
- Rationale - proximity to an area with high transmissivity within the Gasport aquifer
- Estimated available capacity – 2,935 m^3/day on an average basis
- Model output: >10% baseflow reduction to Marden Creek; near the Marden South PSW Complex
- Field study would assess potential for interference with G-E Township wells, private wells
- Fe&Mn treatment assumed as conservative cost assumption
- Estimated capital cost: \$12.8 M, \$4,375/m^3

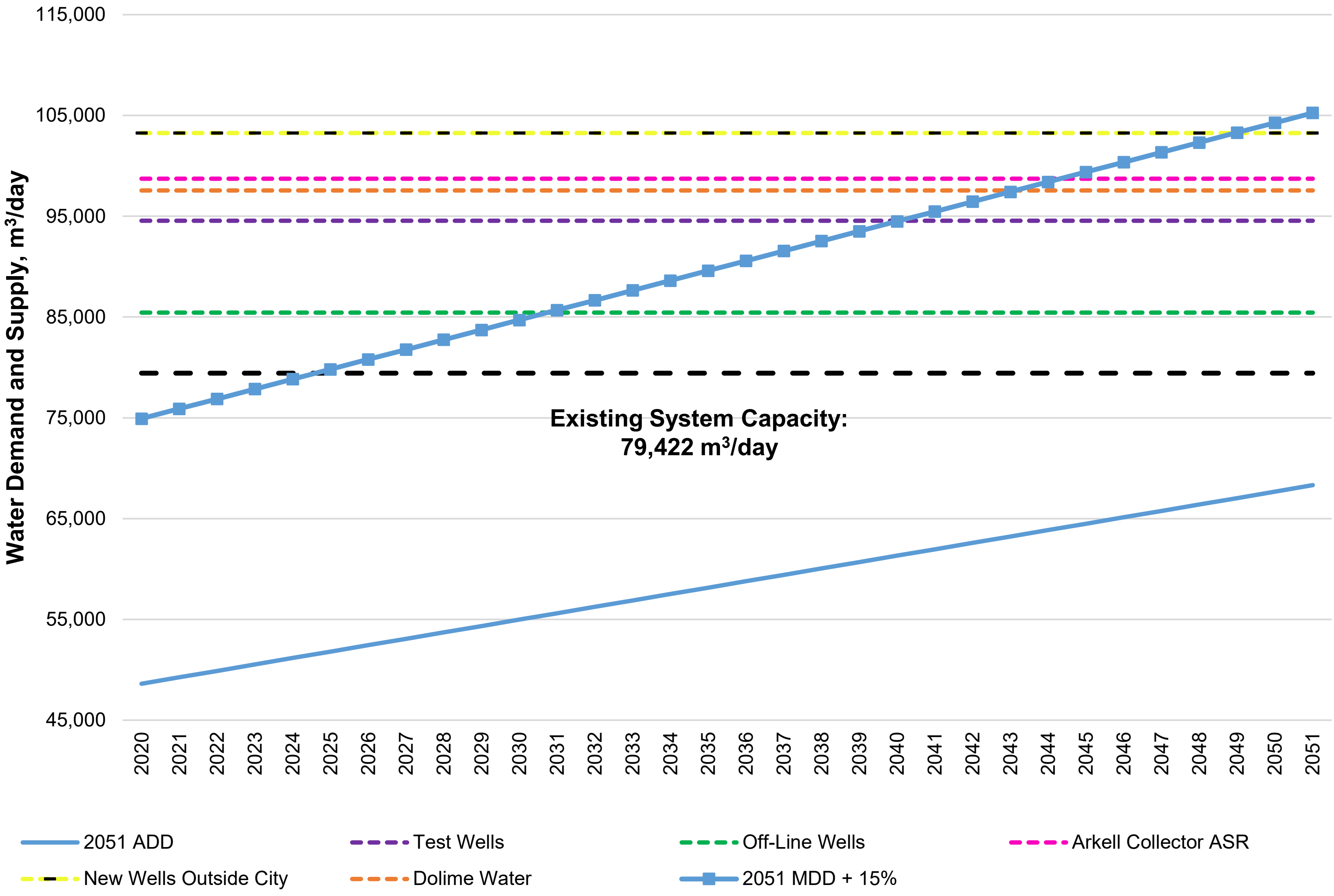
Install new wells outside City boundaries – Guelph Southeast

- Approximate location – in Puslinch Township southeast of the City (City does not own land here)
- Consultation and collaboration with Puslinch Township
- Rational - Proximity to area with high transmissivity within the Gasport aquifer and limited local groundwater usage
- Estimated available capacity – 1,600 m^3/day on an average basis
- Model output: <10% baseflow reduction to Mill Creek; near Arkell Bog PSW Complex
- Field study would assess potential for interference with private wells
- Fe&Mn treatment assumed as conservative cost assumption
- Estimated capital cost: $10.3 M, $6,400/$m^3$

Install new ASR wells inside City

- Will be discussed under surface water alternative section

Alternative #2 Summary



Water Supply Master Plan Update

Surface Water Alternatives Assessment

September 21, 2021

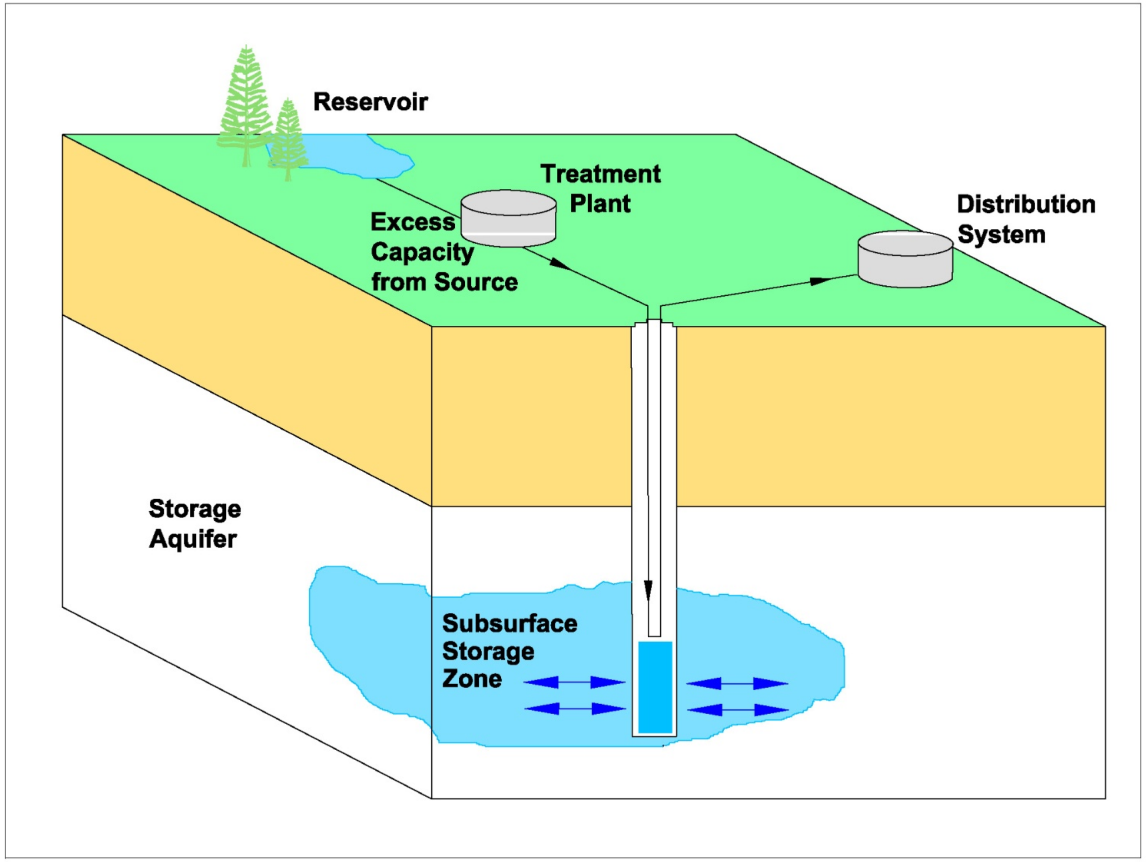
Water Supply Master Plan
guelph.ca/WSMP

Summary – Guelph Lake Water Treatment Plant

Location	WTP at Guelph Lake or NE part of City
Description	Surface WTP consisting of conventional/ advanced treatment and distribution pipeline
Intake Rate (m^3/d)	12,960 (continuous annual base taking of 150 L/s)
Distribution Rate (m^3/d)	12,300
Existing Approvals	None
Required Approvals	• Class EA – Schedule C • Municipal – City and Township • MNRF/ MECP - PTTW (Surface Water) • ECA/ DWL • GRCA
Water Quality Issues	High turbidity, colour, odour
Environmental Constraints	Area affected includes Guelph Lake and its associated wetland and aquatic features
Past Studies/Work	GRCA review of water taking reliability
Required Studies	• Field investigations; environmental baseline/ impact • Feasibility Studies • Treatment study • Class EA
Required Infrastructure	• Water intake structure • Surface water treatment plant & associated infrastructure • Connection to distribution water main
Estimated Capital Cost	$ 51,322,000
Cost per m^3/day	$3,960

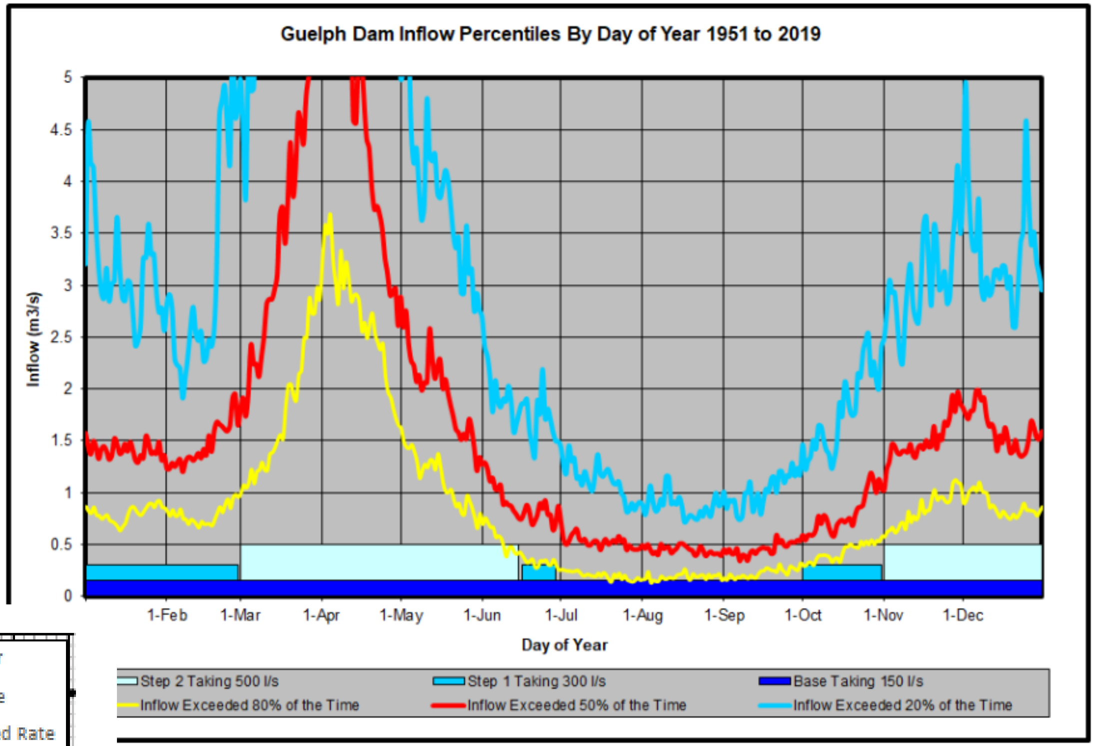
Install new ASR wells inside City

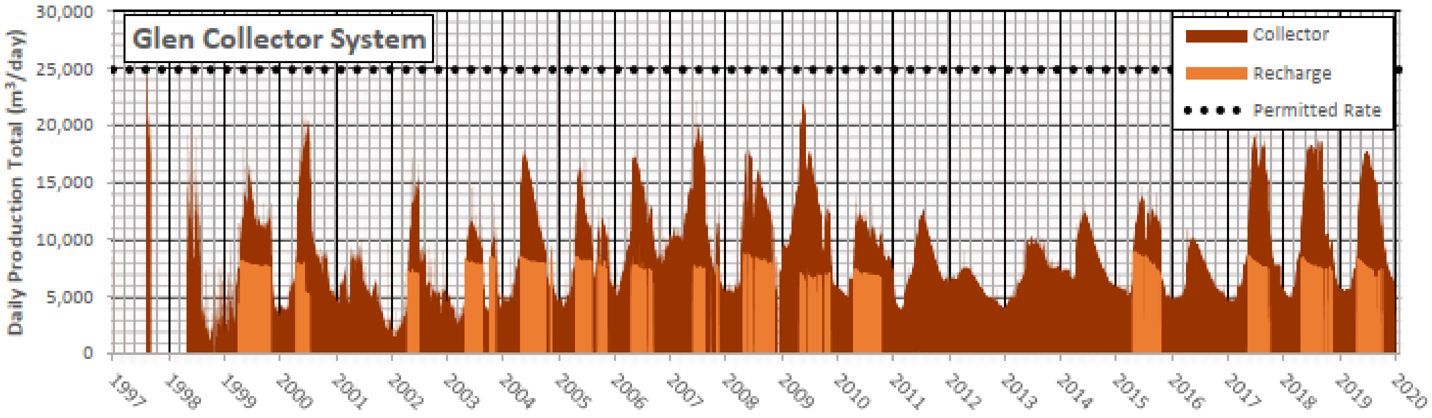
- **Aquifer Storage and Recovery (ASR)** - injection of potable water into an aquifer for later recovery and use



Aquifer Storage and Recovery

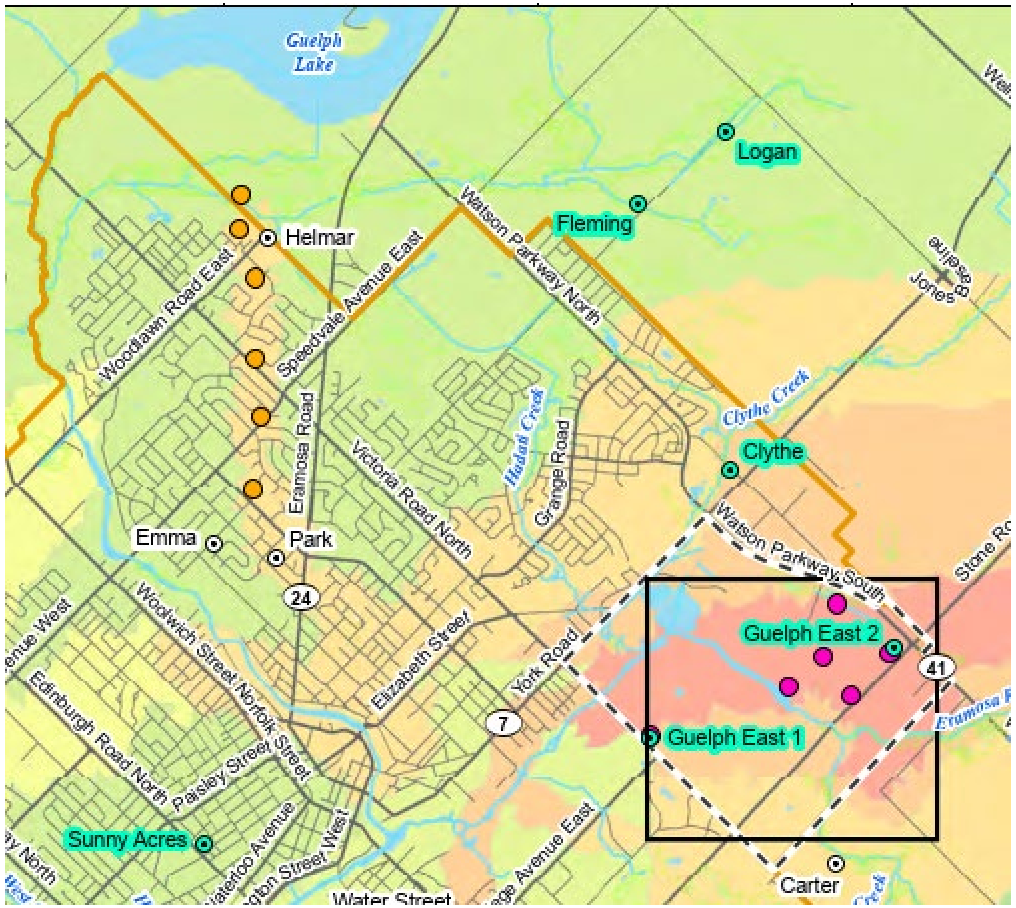
- Two potential sources: Guelph Lake following future potential WTP plant construction; Arkell collector system
- Estimated annual excess volume: Arkell – 451,000 m³; Guelph Lake – 941,000 m³





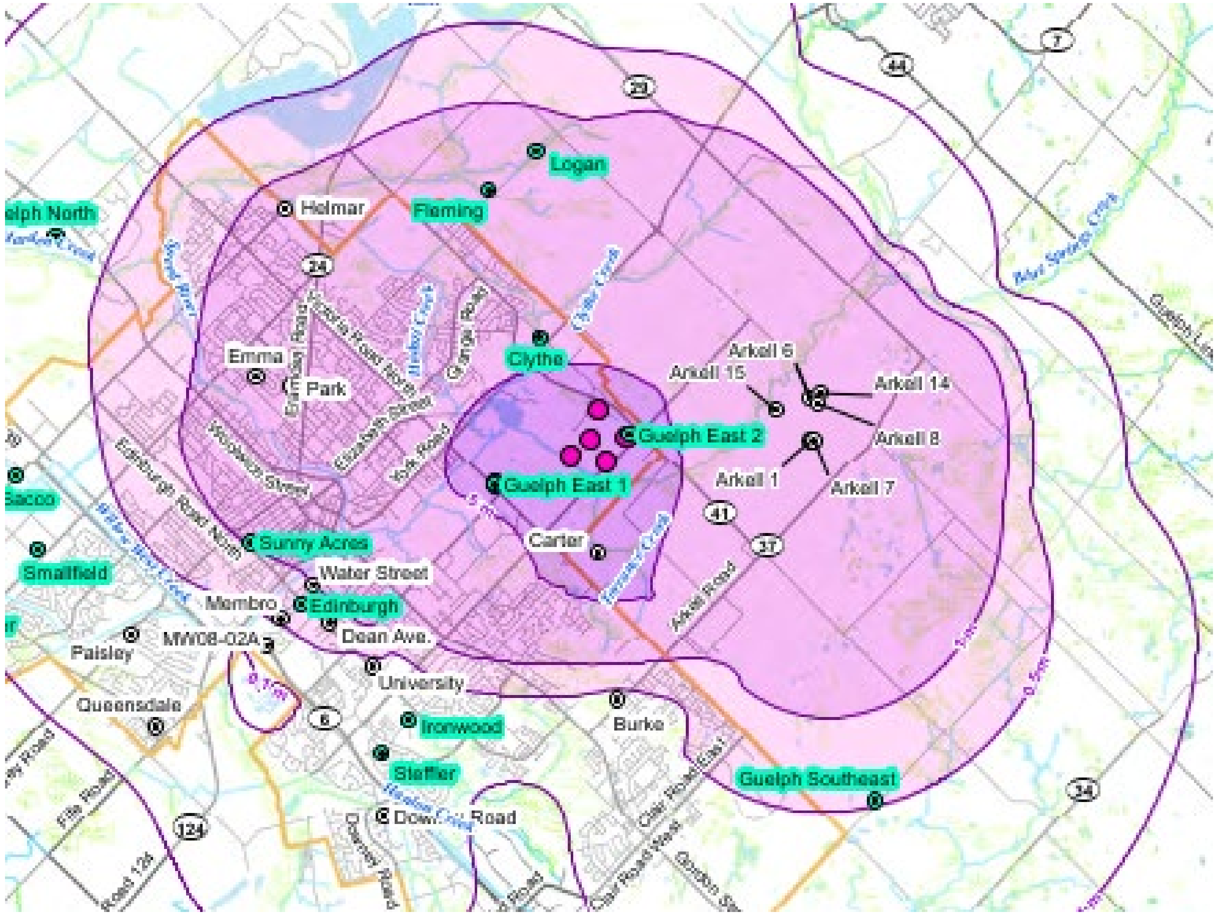
Aquifer Storage and Recovery

- Two injection locations assessed: NE Guelph – between Helmar and Emma/Park wells; East Guelph in area of simulated production wells
- All ASR wells simulated as injection and extraction
- Impact assessment:
  - Sustainability of surrounding production wells
  - Water level elevation during injection
  - Changes to stream baseflow



Aquifer Storage and Recovery

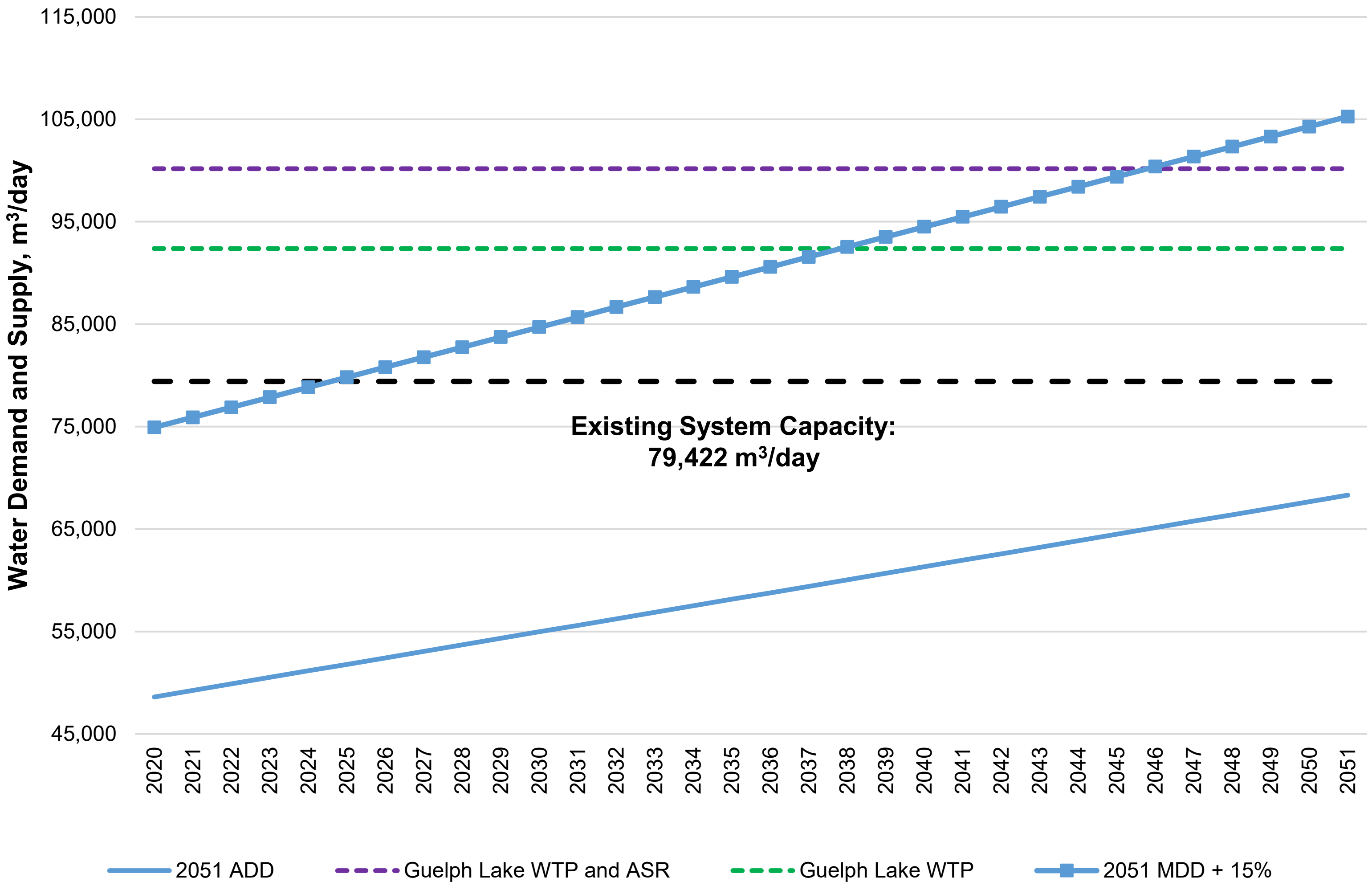
- Results:
  - Model predicts large area of injection influence (area of water level increase)
  - Extraction of 60% of injection volume to maintain function of existing wells
- Interpretation:
  - With well field approach, system efficiency is below target
  - System optimization study is required to effectively utilize production wells for recovery
  - Focus on core of City to minimize influence beyond boundary
- Arkell ASR cost: $25.3M; $21,600/m^3
- Further study required to evaluate optimized system, fewer ASR wells and increased recovery efficiency will reduce cost



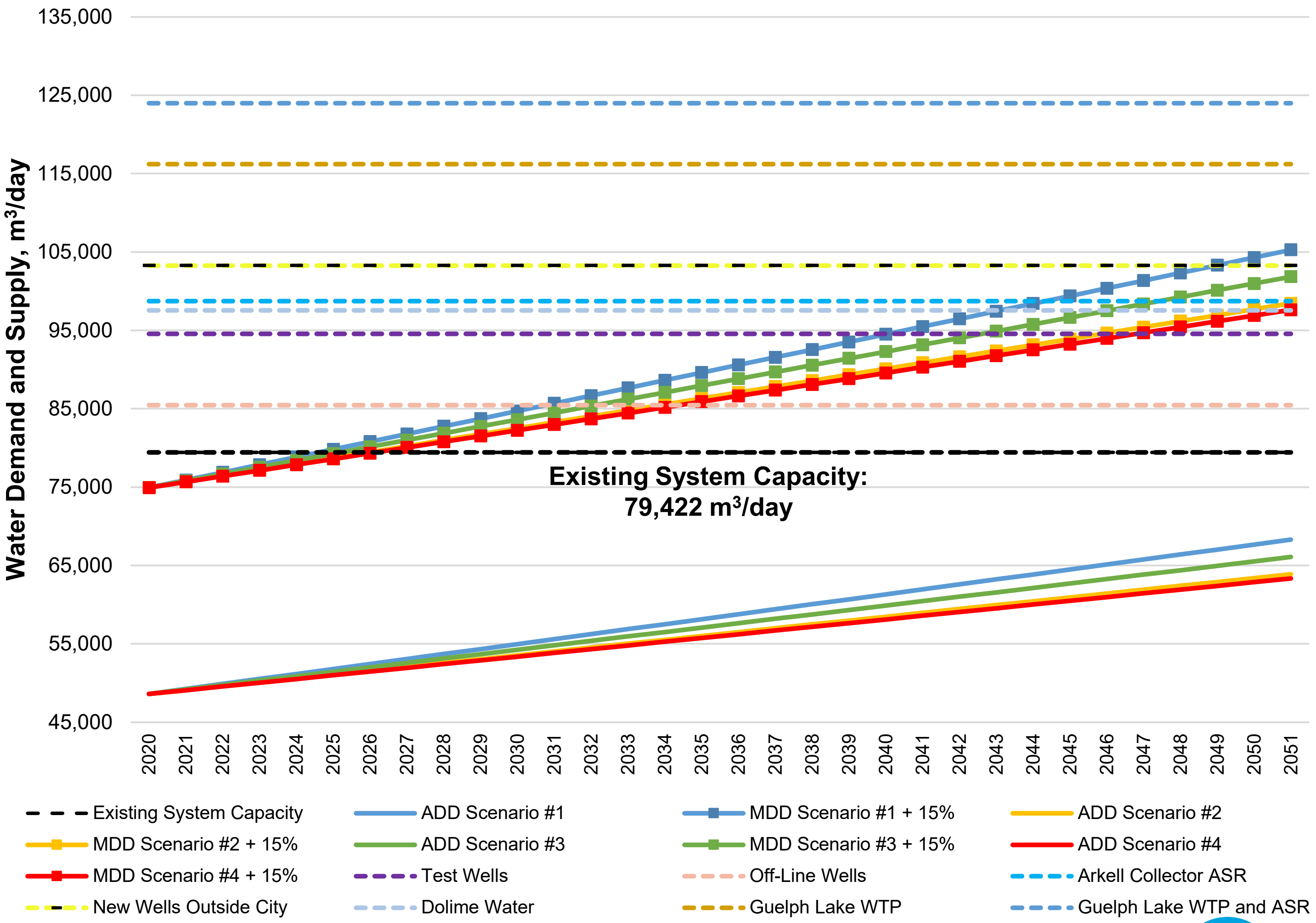
Summary – Guelph Lake WTP + ASR

Location	WTP at Guelph Lake/dam, ASR wells at NEQ in the vicinity of Park/Emma wells
Description	A surface water treatment plant consisting of conventional treatment and distribution pipelines, ASR wells
Intake Rate (m^3/d)	12,960 – 25,920
Distribution Rate (m^3/d)	Up to 25,825 m^3/day (subject to ASR optimization)
Existing Approvals	None
Required Approvals	• Class EA – Schedule C • Municipal – City and Township • MNR/MECP - PTTW (Surface Water/ Groundwater); • ECA/DWL • GRCA
Water Quality Issues	High turbidity, colour, odour
Environmental Constraints	Area affected includes Guelph Lake and its associated wetland and aquatic features
Past Studies/Work	GRCA review of water taking reliability
Required Studies	• Field investigations; environmental baseline/ impact • Feasibility Studies • Treatment study • Class EA
Required Infrastructure	• Water intake structure • Surface water treatment plant & associated infrastructure • Connection to distribution water main; ASR well facilities
Estimated Capital Cost	$ 57,283,000
Cost per m^3/day	$4,420

Alternative #3 Summary



All Water Supply Alternatives Summary



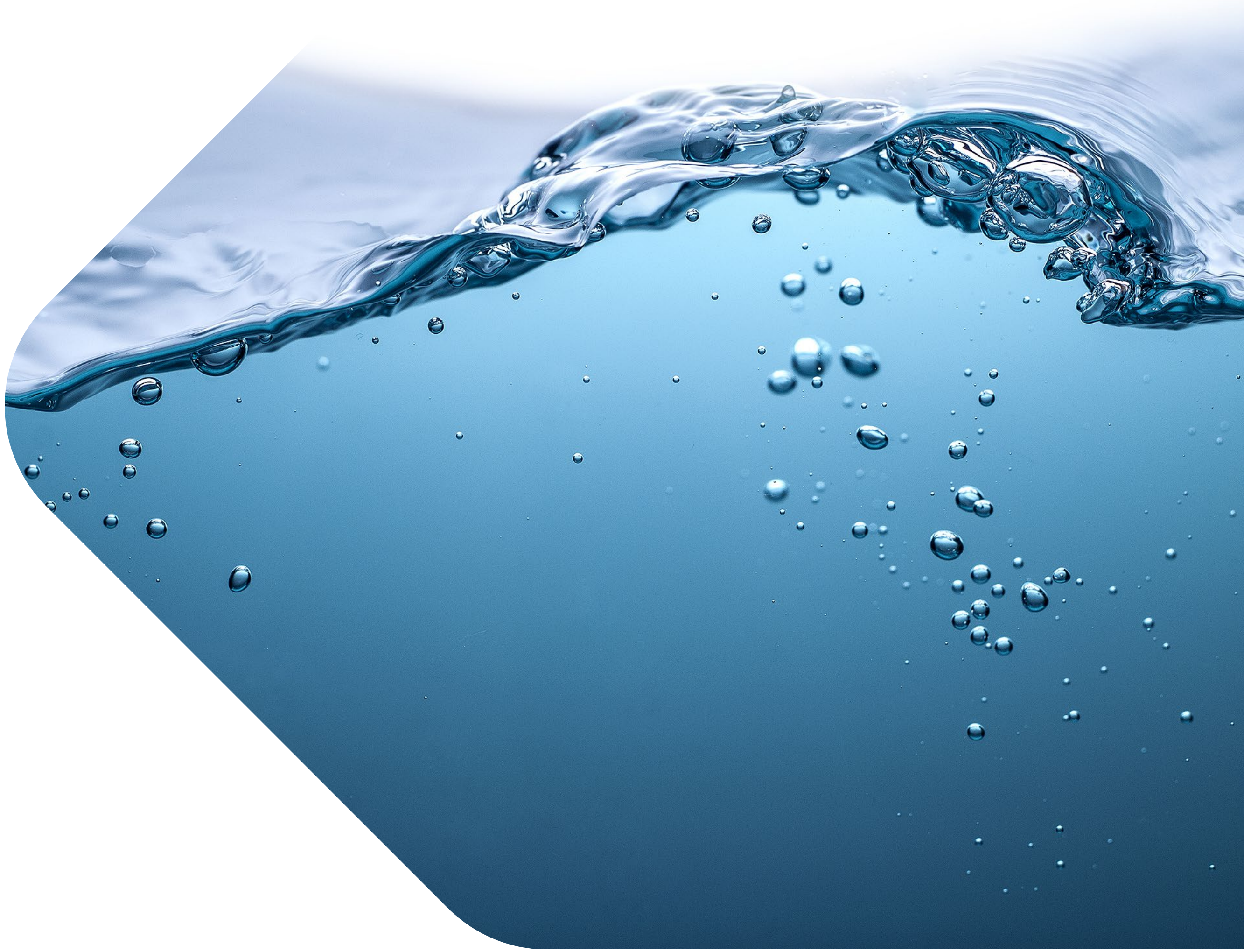
Other Alternatives

Limit Growth / Do Nothing

- Represents what would likely occur if none of the alternative solutions were implemented
- Reduction in future water supply needs by limiting the extent, density, type and/or location of future residential, industrial, commercial and institutional growth in the City below levels identified in recent planning studies
- Implementation of this alternative would require change to municipal planning documents which would not meet Provincial growth targets
- Will have a significant impact on the growth potential for the City
- Does not meet EA challenge and opportunity statement

Water Supply Master Plan Update

Preliminary Evaluation of Alternatives

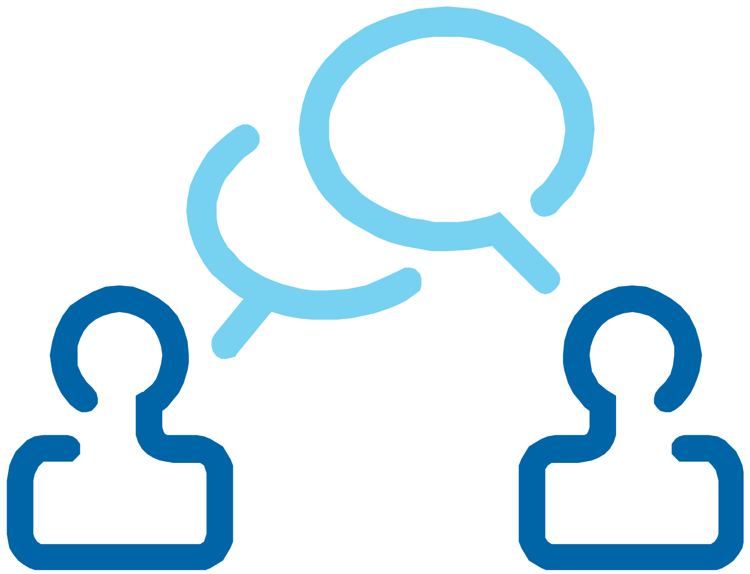


September 21, 2021

Evaluation Summary Tables

We'd Like Your Input…

Are there additional factors that should considered in the evaluation? Is there anything you would evaluate differently or change?



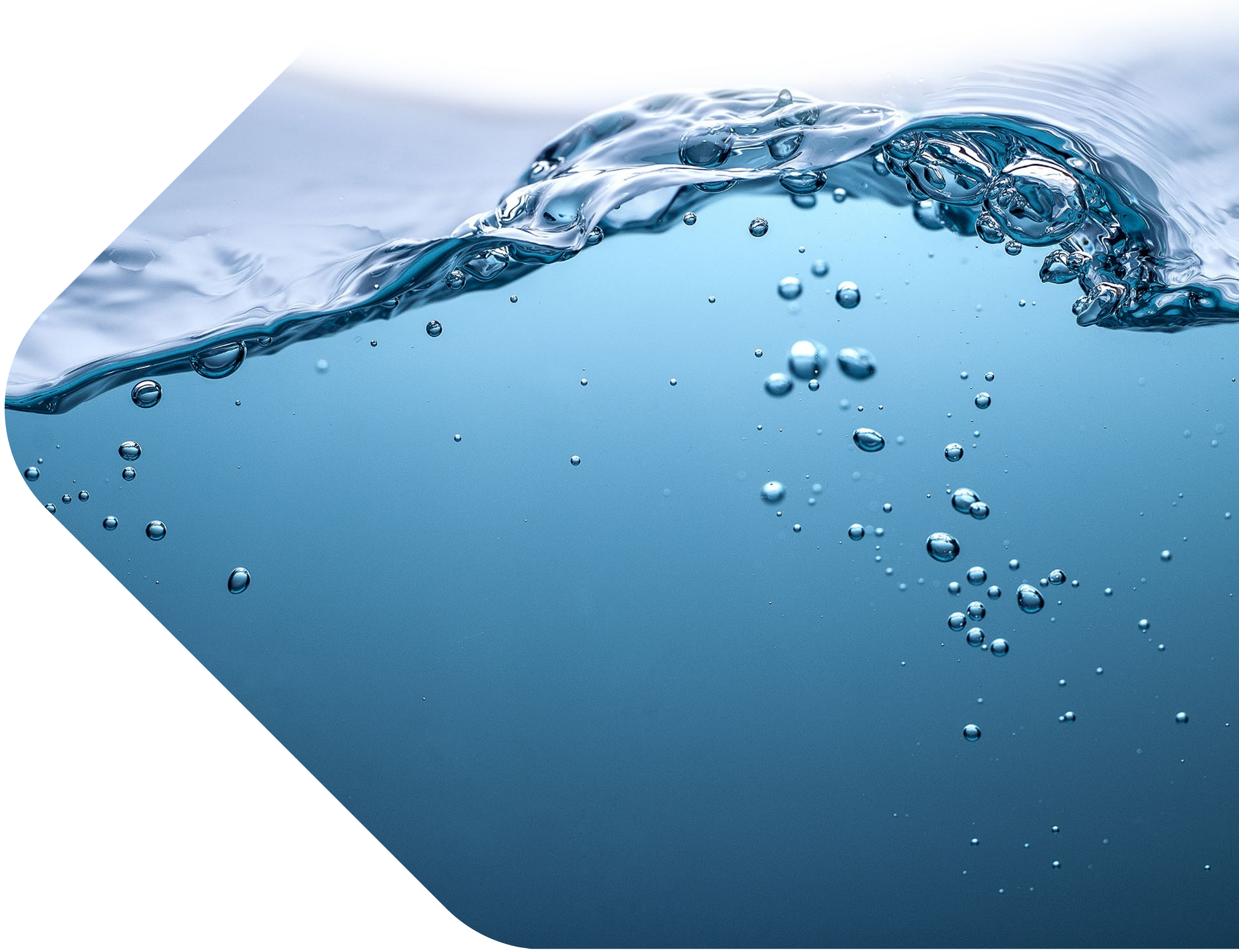
Should any alternatives be prioritized differently? Why?

We’d Like Your Input…

Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; off-line sources; ASR; wells outside the City; surface water.

What advice do you have for presenting this information at the upcoming virtual Open House?

Next Steps



September 21, 2021

Water Supply Master Plan
guelph.ca/WSMP

Next Steps

- Incorporate/ consider feedback from this meeting
- Prepare meeting summary and circulate to attendees
- Meeting with Mississaugas of the Credit First Nation in October
- Water Conservation & Efficiency Public Advisory Committee Meeting – September 28th
- Community Open House #2 – September 29th
- Refine assessment/ evaluation based on feedback received
- Update Master Plan document

Thank You!

Visit our website: guelph.ca/WSMP

Water Supply Master Plan Update Community Liaison Group #3 – Summary

Date and Time of Meeting: September 22, 2021 from 7:00 to 9:00pm

Location: Virtual teleconference using Microsoft Teams

Overview

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP), from 2014, to define how we will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2051. Reviewing our existing water supply system is an opportunity to discuss with Guelph and surrounding communities how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Part of our WSMP update includes a Community Liaison Group (CLG). The CLG includes members from a wide cross-section of the community including community and environmental groups, agricultural organizations, business leaders, and residents from in and outside the City. This was the final of three (3) meetings to share ideas and perspectives on ways to improve the WSMP update. The purpose of the CLG meeting was to review and provide input on major technical task progress related to the Master Plan and the Class Environmental Assessment, including:

- Water supply requirements
- Work completed since meeting #2
- Assessment of water supply alternatives
- Evaluation of water supply alternatives

There were twelve (12) participants, along with six (6) City staff and three (3) AECOM consultants.

The format of the workshop included a presentation and opportunities for discussion and questions.

Attendance

The following CLG members were present:

- Andrea Williams, Guelph resident

- Brady Deaton, University of Guelph
- Brendan Bumbaco, Sleeman Breweries
- Carol Tyler, Guelph resident
- Corey Woods, Guelph Eramosa Township
- Grant Parkinson, Guelph Water Conservation and Efficiency Public Advisory Committee
- Janet Harrop, Wellington Federation of Agriculture
- Lin Grist, Council of Canadians, Guelph resident, Guelph Wellington Coalition for Social Justice
- Ron East, Council of Canadians
- Susan McSherry, Wellington Water Watchers
- Steve Chomyc, Resident
- Steve Nyman, University of Guelph

Dave Belanger, Scott Cousins, Wayne Galliher and Jennifer Rose from the City of Guelph were present. Matthew Alexander, Alicia Evans and Kathryn Ross from AECOM were also present.

The following members were unable to attend:

- Angela Kroetsch, Guelph Wellington Development Association
- Beth Parker, University of Guelph
- Matthew Bulmer, Puslinch Township
- Maya Wariyar, Guelph resident
- Sheri Longboat, Guelph resident
- William Castledine, Cargill Meat Solution

Meeting Format

Dave Belanger (City of Guelph) opened with a Statement of Territorial Acknowledgement and acknowledged Truth and Reconciliation Day and the importance of honouring Indigenous Peoples.

Alicia Evans (AECOM) provided an overview of the meeting and asked attendees to introduce themselves. Attendees were provided with a copy of the presentation in advance. The presentation was delivered by Matthew Alexander (AECOM). Alicia Evans (AECOM) facilitated the discussions and Dave Belanger (City of Guelph) and Matthew Alexander (AECOM) responded to questions during discussions.

The presentation included:

- Brief summary of the water supply requirements
- Work completed since meeting #2
    - Assessment of water supply alternatives
        - Water conservation and demand management
        - Optimize and expand existing groundwater systems
        - Establish a new surface water supply
        - Limit growth / do nothing
    - Preliminary evaluation of water supply alternatives
- Next Steps

Discussion questions related to the content provided in the presentation were asked at various points during the meeting. Attendees shared their questions/ comments with the group and had the opportunity to ask additional questions related to the specific presentation topics.

The discussion captured throughout the meeting is summarized in the sections that follow. Questions are noted with a "Q", answers with "A", comments with a "C" and responses with an "R". Answers were provided by Matthew Alexander (AECOM) and Dave Belanger (City of Guelph).

It is recommended to review the discussion below alongside the presentation; notes are provided under applicable sections below when the presenter added additional details that are not captured in the presentation.

Summary of Water Supply Requirements

An review of projected population growth from now until 2051, the existing water supply capacity, and the required water supply capacity to meet the projected demand of the population in 2051 was provided.

Task 4 – Water Supply Alternatives

An overview was provided for the following proposed water supply alternatives under consideration:

- Water conservation, efficiency and demand management
- Groundwater sources
- Surface water sources
- Limit growth / do nothing

Additional context:

Water Conservation, Efficiency and Demand Management

A reminder of the analysis completed to evaluate non-revenue water and the fact that the City is currently at or near the Economic Level of Leakage. Therefore, the conservation, efficiency and demand management scenarios include a static non-revenue water value.

As part of the water conservation, efficiency and demand management alternative, four scenarios were established to evaluate potential future demand reduction and associated costs.

1. Scenario One: Static Demands
    - Baseline scenario where City ceases non-mandatory programming and therefore does not achieve demand reduction. There is no cost associated with this scenario.
2. Scenario Two: Demand Reduction of 6.5% by 2051
    - Continue current level of effort in programming, with routine program review to replace ones that are no longer effective or have matured. Assumes similar level of demand reduction to that achieved by the City between 2015 and 2019.
3. Scenario Three: Demand Reduction of 3.25% by 2051
    - Implementation of effective conservation programming makes reduction more challenging with success. This scenario assumes that programming is scaled back in response to a slowing demand reduction trend, with a switch in focus to less efficient and higher demand customers. Lower demand reduction at a lower cost to the City.

4. Scenario Four: Demand Reduction of 7.3% by 2051

    - Scenario Two with additional water reuse opportunities. Most aggressive approach with highest demand reduction and highest estimated cost.

Groundwater Sources

The following groundwater alternatives were discussed in detail:

- *Optimize existing operating municipal sources*: review of existing municipal sources to identify any that could potentially contribute additional capacity. The Downey well was identified as a possibility but would have to be considered alongside other existing and potential new sources in southwest Guelph.

- *Restore existing off-line municipal sources*: evaluated the possibility of restoring the Clythe, Sacco, and Smallfield wells and the Lower Road Collector.

- *Develop existing municipal test wells*: considered three test wells in southwest Guelph (Ironwood, Steffler, Guelph South) and the Dolime Quarry, one test well in northwest Guelph (Hauser) and two test wells in Northeast Guelph (Logan and Fleming).

- *Install new wells inside City boundaries*: evaluated one well location in the City included within the 2014 WSMP; however, the location was screened out through preliminary modelling.

- *Install new wells outside City boundaries*: considered one potential well location north of Guelph within Guelph-Eramosa Township and one potential well location south of Guelph in Puslinch Township.

- *Install new ASR wells inside City*: Aquifer Storage and Recovery (ASR) system to collect excess water from the Arkell Collectors, treat to potable standards and inject into the deep aquifer for later recovery and use.

Surface Water Alternatives Assessment

Guelph Lake was reviewed as a potential source of surface water for direct treatment and distribution and as a potential source for an ASR system to capitalize on peak flow.

Q&A – Water Supply Alternatives

Q1. All Water Supply Alternatives Summary: were these plotted in priority sequence based on some evaluation?

A1. No, they reflect the order that they were evaluated. In the preliminary evaluation tables (4-3, 4-5, 4-7) that we will review next, we will talk about prioritization of the alternatives.

Q2. Regarding the Dolime Quarry, the assimilative capacity was not a factor, but should it be?

A2. It has not been considered in the past because it's a permitted discharge by the Ministry of Environment, Conservation and Parks (MECP). The quarry dewatering permit has an expiry and the quarry itself has a lifespan, so we know that it's not a permanent practice. Further, the way the MECP requires the assimilative capacity to be calculated is based on upstream flows. There needs to be adequate upstream flows to dilute the wastewater being discharged. With changes to the water management on site, there's going to be variability in the discharge to the Speed River and ultimately we're anticipating that it will significantly reduce as that water is targeted for supply.

Q3: Because of climate change there is going to be an increased need for farmers to irrigate their land as opposed to relying on rainfall. In the presentation the suggestion is to go outside the city limits for Guelph's water supply. How has the position of farmland and the possibility of them requiring irrigation been factored in the plans?

A3: Under the Source Water Protection process, we are having discussions with MECP to ensure that we have adequate supplies for drinking water, and water supply in the future. We have also undertaken studies to look at climate change impacts on groundwater over the next 50 years; preliminary work indicates that there may be more groundwater recharge, and this is because as the temperature increases there will be more freeze/thaw events in winter which generates recharge, and this is more than we lose from evaporation in the summer.

We're also working with MECP to develop a water resources strategy for in and around Guelph to ensure we are using the water to its greatest efficiency to meet the communal needs of everyone.

Q4:Regarding the Dolime Quarry, it is my understanding than an agreement has been entered into with the City, Province, and quarry where the City will try and reseal the aquitard at a cost of $20m, and that the citizens of Guelph will fund the process. It has been presented to citizens (and the local MP, MPP) that this is an imminent threat to our water supply and must be handled immediately. Is the quarry / breach of the aquitard an imminent threat to our water supply? Why have we not approached the Province long ago to mediate the problem.

A4: There is a threat to the water supply if the quarry shuts down and stops dewatering. It they stop the dewatering it could fill with water that contains bacteriological contaminants that would threaten the water supply. The plan is not to seal the breach; our plan is to continue with the dewatering operations to maintain inward flow into the quarry and maintain the groundwater divide so that we can get more water quantity and protect the quality. We have had a lot of discussion with the quarry owners (who are operating with a legal license). The City is in a position where we needed to come up with an appropriate solution to protect the water supply; which is why we will annex the property and the City will take over the water management so that we can protect the water supply. We have some idea of what the required costs will be for the pumping station and monitoring program but will complete an operational testing program and environmental assessment (Southwest Guelph Water Supply Class EA) to refine the costs and discuss the alternatives with the public before reaching a conclusion.

Q5: Is there modeling for a Greywater usage and / or recovery plan? Or any incentive for people to continue to, or more actively use Greywater?

A5: Greywater is definitely a component of the Water Efficiency Strategy stemming from the Water Supply Master Plan. It hasn't been a mandated component because we have to look at integrated water management, and there are other implications from a wastewater perspective. We have an active greywater reuse rebate program through Blue Built Home, and through a number of rebates that the City offers; however there is a lot of management and work on the homeowners' side in participating in the initiatives and adoption is not an easy process.

Regarding the pricing of the water, we want to ensure a fair price and it's been carefully monitored through the Master Plan update process.

Preliminary Evaluation of Alternatives

A summary of the evaluation tables were presented for Water Supply Alternatives including Conservation / Limit Growth / Do Nothing (Table 4-3), Groundwater Sources (Table 4-5), and Surface Water Sources (Table 4-7).

For each table the alternatives were considered using the following criteria categories: First Nations, Metis, and Inuit Peoples, Technical (ability to achieve demand and reduction), Natural Environment, Built Environment, Social / Cultural Environment, Legal / Jurisdictional, and Financial.

For Conservation, Efficiency and Demand Management, Limit Growth, Do Nothing (Table 4-3)

The most favourable alternative for the short-term strategy is to maintain the current level of effort (Scenario Two). For the medium-term the preferred alternative is to shift focus to less efficient and high demand customers (Scenario Three). For the long-term, Scenario Four with water reuse is preferred. The least favourable alternatives, not included in the preferred solution are, Scenario One (cease programming), limit growth / do nothing.

Q6: Are there efforts to develop a pricing strategy that addresses your concern but helps conservation efforts?

A6: We have done some work in the past and will revisit with each update to the water efficiency strategy, and we'll continue to pursue research as long as it coincides with one of the conservation scenarios. We've determined that a conservation pricing scheme has not necessarily had the effect in Guelph that we'd like to see based on modelling, but we continue to look at that as we go through a rate analysis, balancing affordability and similar considerations.

Q7: Is there any consideration to halting or limiting any major consumers of water?

A7: Through the review of applications for new businesses within the City, the associated water consumption requirements are reviewed. If a proposed business has a high water demand it may not be feasible to approve it for operation in the City.

Significant water taking has to be granted with a permit (Permit to Take Water) issued by the province. As part of our source protection programs, we're working with the province to undertake water quantity studies to develop appropriate programming that manages the quantity of water available in Guelph and the surrounding area. This would consider the water taking collectively within the City and surrounding area.

For Groundwater (Table 4-5)

All the five groundwater alternatives are recommended for inclusion in the preferred solution with various limitations. For leveraging the Existing Municipal Off-line Sources, uncertainty surrounding the extent of the contamination affecting the Smallfield and Sacco wells and whether it can be remediated, dictates that it cannot be relied upon within the 2051 planning horizon. For the Municipal Test Well alternative, the water quality conditions would need to be confirmed around the Hauser well location; the Southwest Guelph Water Supply Class EA study is required to evaluate the capacity of test wells within southwest Guelph under Dolime Pond Level Management. For the Arkell Collectors and ASR, modelling and hydrogeological studies would be needed to assess efficiency and confirm infrastructure and costs. For New Wells Outside the City, this is not a priority alternative as the City has committed to first developing the available water within the City. After the available water within the City has been integrated into the system, sources outside of the City will be considered.

For the Surface Water Source (Table 4-7)

Both alternatives were preferred as part of the overall solution, although they have a lower priority than Conservation, Efficiency and Demand Management and development of the groundwater sources. Significant study will be required to develop the Guelph Lake Water Treatment Plant alternative and modelling and hydrogeological studies would be needed to assess efficiency and confirm infrastructure and costs associated with ASR.

Q8: Regarding climate change modelling, what average temperature increase is anticipated?

A8: A report on the Grand River Conservation Authority (GRCA) website provides more detail on the climate change modelling work that was completed as part of the Tier 3 Water Budget and Local Area Risk Assessment, which is part of our Source Protection Program conducted with the GRCA under the Clean Water Act.

Climate Change Report - https://www.sourcewater.ca/en/source-protection-areas/resources/Documents/Grand/15072-527-Climate-Change-R-2018-11-21-final-V1.0.pdf

Q9: Regarding the aquifer storage and recovery, if the current pipeline is filled to 100% capacity, why wouldn’t you use the current supply versus borrowing from additional wells?

A9: ASR is an opportunistic strategy that would be employed when we have maxed out the capacity of groundwater wells in the system. It captures additional capacity from surface water or shallow groundwater sources when it is available but not required to meet demand, treats it to a potable standard and stores it in the deep aquifer until it is required during high demand periods.

Next Steps and Adjournment

The project team reminded participants to reach out to Dave Belanger (City of Guelph) and Matthew Alexander (AECOM) if they had any questions, comments or concerns about the technical information presented. Participants were encouraged to provide additional feedback to the discussion questions in the presentation.

Next steps in the project include incorporating and considering feedback from this meeting.

Upcoming engagement opportunities include:

- Community Open House #2 – September 29th, 2021

The meeting was adjourned at 9:00 pm.

Appendix G

Agency and Municipality Workshop #1 and #2

- Workshop #1 Presentation
- Workshop #1 Discussion Guide
- Workshop #1 Summary
- Workshop #2 Presentation
- Workshop #2 Summary

Water Supply Master Plan 2019 Update

Workshop No. 1

AECOM

November 28, 2019

Water Supply Master Plan
guelph.ca/WSMP

Agenda

- Welcoming & Opening Remarks
- Water Supply Master Plan Update – Overview
- Guelph's Current Water Supply System
- City Updates since 2014 Water Supply Master Plan (WSMP)
- Water Supply Master Plan Update
- Next Steps

Meeting Purpose

- To review and provide input on key aspects of the Master Plan and the Class Environmental Assessment (EA), including:
  - Objectives and scope of the Master Plan Update
  - Issues and opportunities to be addressed
  - Alternative solutions to be assessed
  - Evaluation criteria to be applied

Check-In

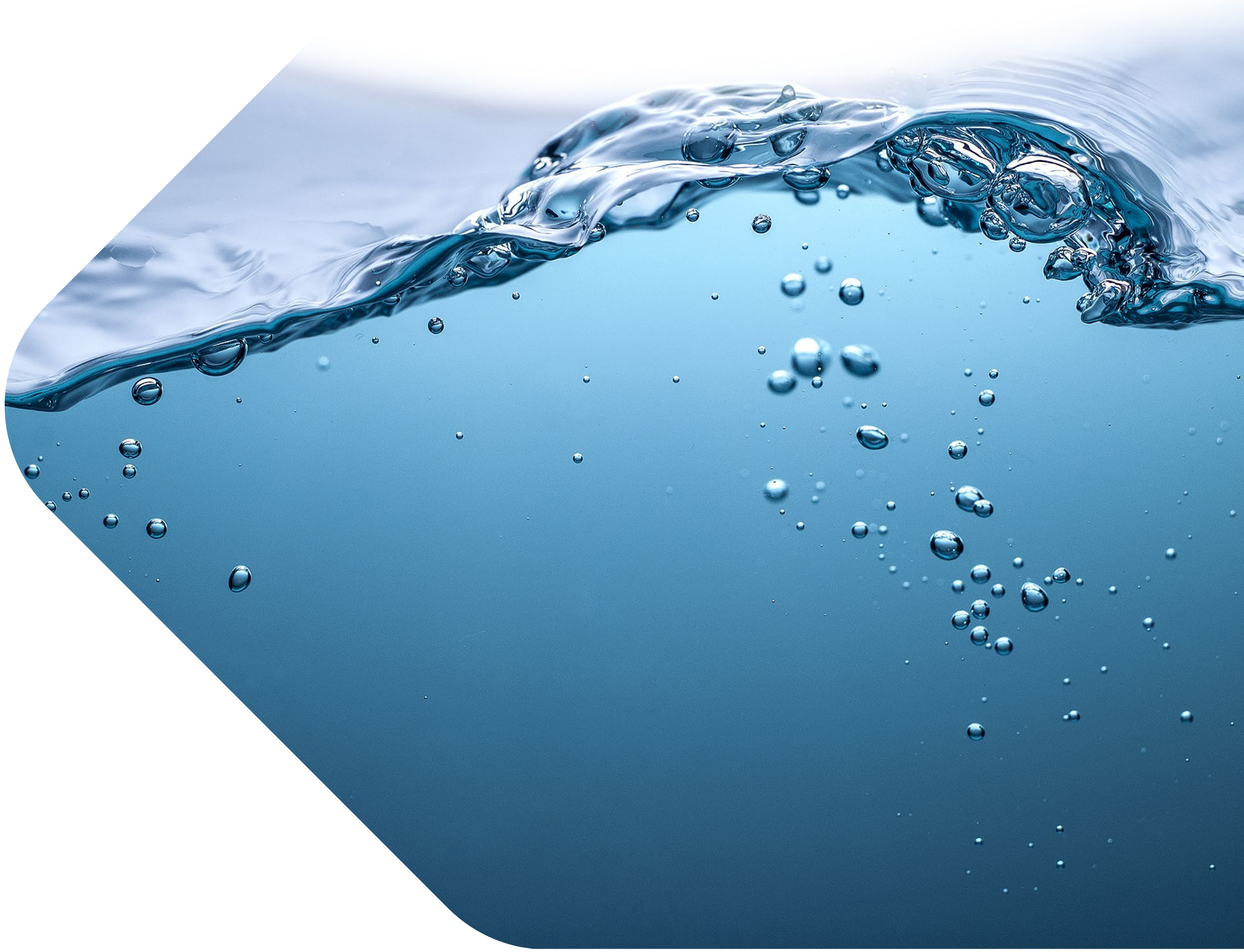
- Find someone you don’t yet know (or know well).
- In pairs, introduce yourself and answer the check-in question.
- In one sentence, introduce your partner to the large group.

What am I bringing to this group?

(i.e. experience/ knowledge of water supply)

Water Supply Master Plan Update

Overview

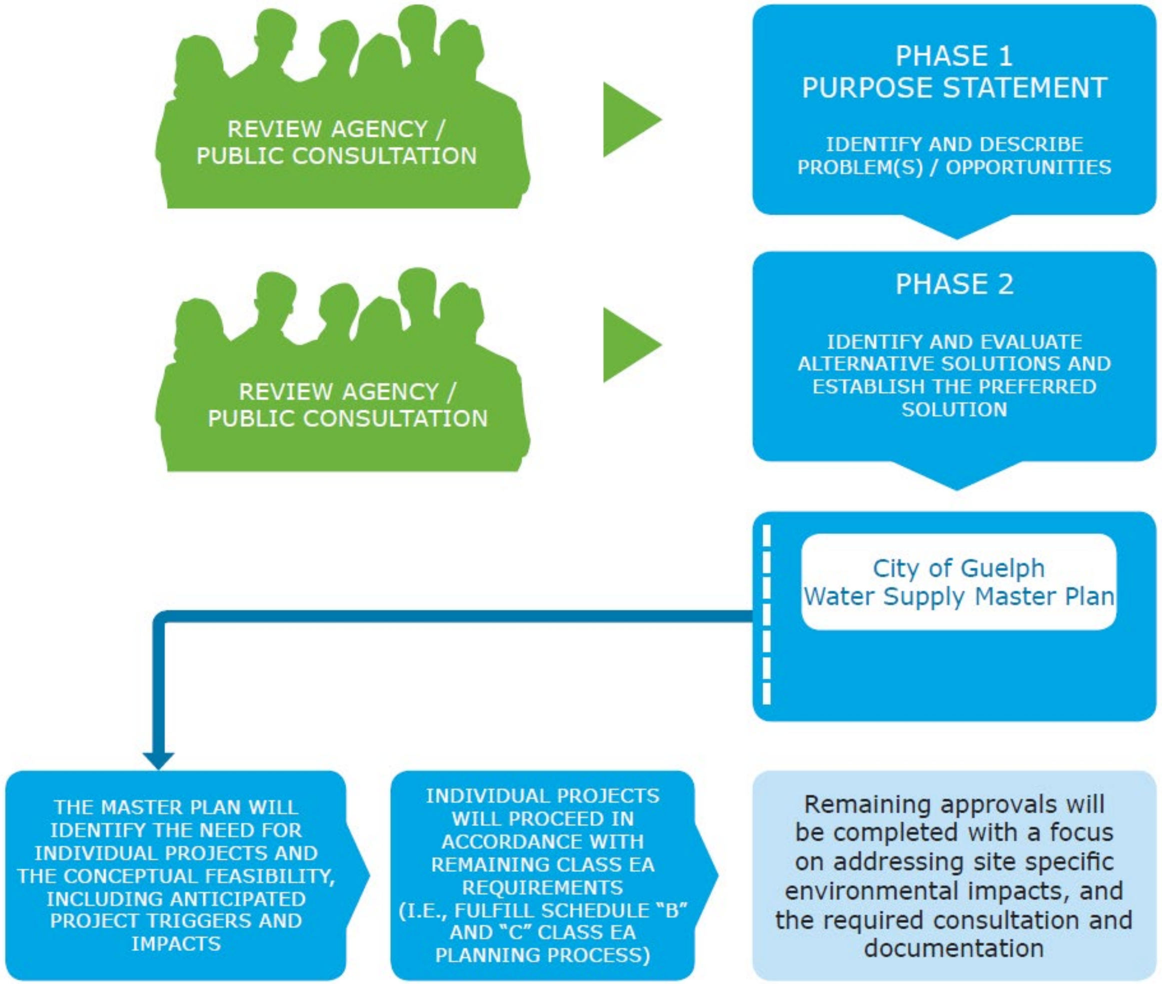


November 28, 2019

Water Supply Master Plan Update

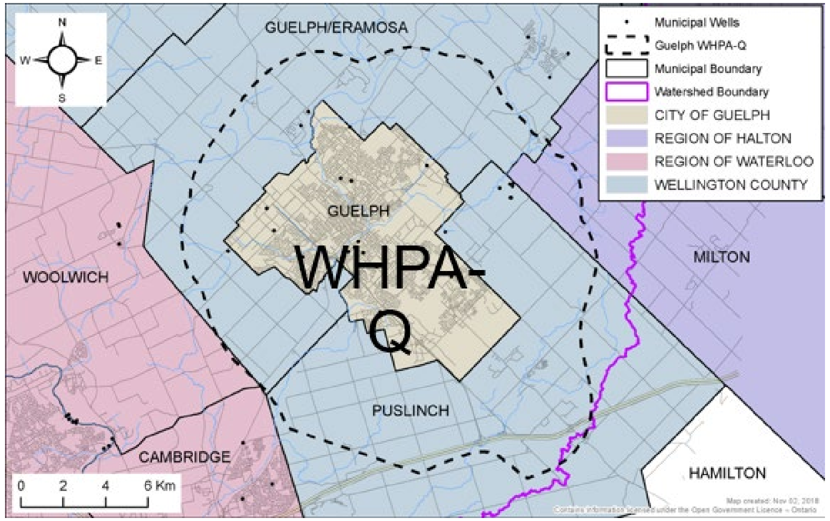
- Will define where and how City gets safe and reliable water for residential and Industrial, Commercial and Institution (ICI) use to the year 2041 and identify challenges beyond this timeframe
- We'll review Guelph's demand forecast and existing water supply and discuss with the community how to continue to meet the City's needs
- Additional sources to supplement our existing supply will be identified. As will alternative ways to conserve supply and manage demands
- When investigating existing and new water supply options we'll consider things like climate change, water quality and quantity, economic factors, social/ cultural environment, and any relevant regulations
- Regardless of source, our water supply will continue to meet the service requirements of Guelph and the high standards set by the Ministry of the Environment, Conservation and Parks (MECP), including Source Water Protection requirements
- Short-term, mid-term and long-term water supply options will be recommended

Master Planning Process



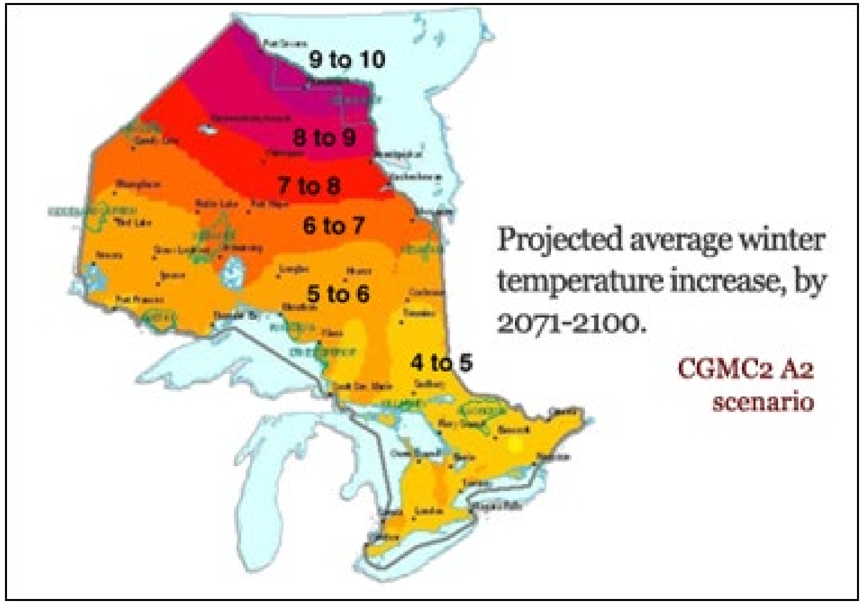
2019 WSMP – Special Issues

- Tier 3 Water Budget and Local Area Risk Assessment
  - Designation of Wellhead Protection Area – Quantity and Significant Risk under 2031 demand and drought
  - Potential for impacts on surface water
- Contaminated Sites
  - Northwest Quadrant – Smallfield and Sacco Wells
  - May need to abandon wells and "write-off" area for new supply
- Dolime
  - PTTW appeal - water quality and quantity concerns
  - Ironwood and Steffler test wells at risk
  - Settlement pathway proposed



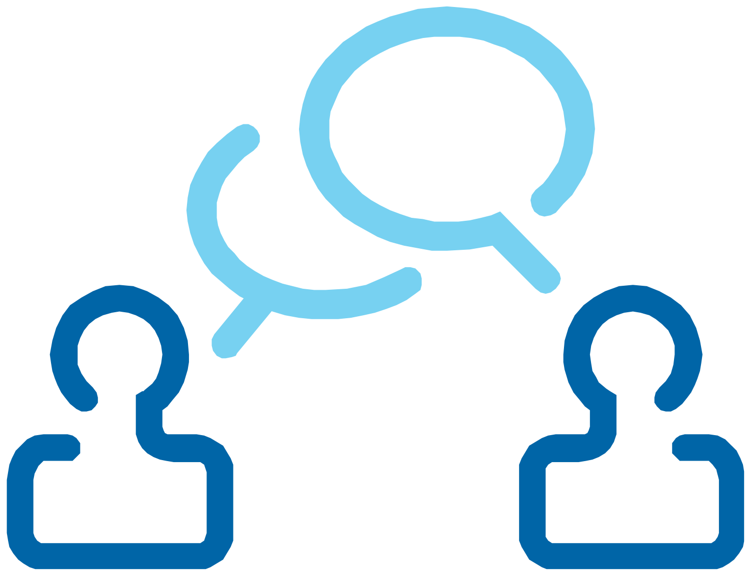
2019 WSMP – Special Issues

- Surface Water Impacts
  - Tier 3 Water Budget shows potential impacts on surface water with additional groundwater takings
- Firm Capacity and Security of Supply
  - Typically consider drought and loss of supply due to contamination event
  - Is 10 % "security of supply" allowance sufficient?
- Climate Change
  - Modelling studies indicate more recharge in future will supplement water supplies
  - Climate not expected to be a supply issue
  - Expectation that it be addressed in the WSMP



We'd Like Your Input...

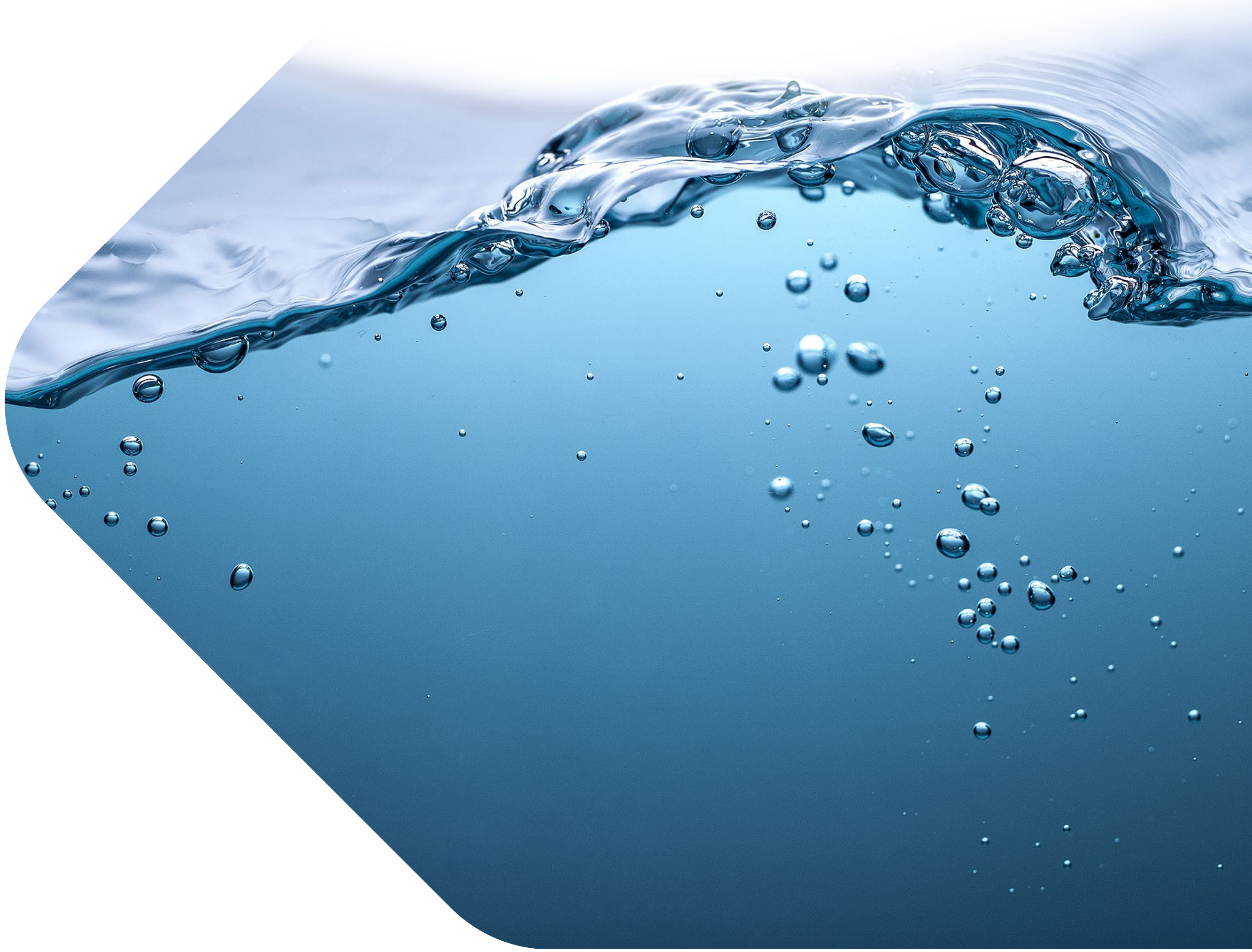
What other questions, issues or concerns related to water supply should we consider while updating the Water Supply Master Plan?



- 1-2-4-All:
  - **Individual** silent reflection – 2 mins
  - Discuss in **pairs or groups of three**, building on reflection – 3 mins
  - Shareback – 10 mins

Maintaining a Safe and Sustainable Supply

Guelph's Current Water Supply



City of Guelph Making a Difference

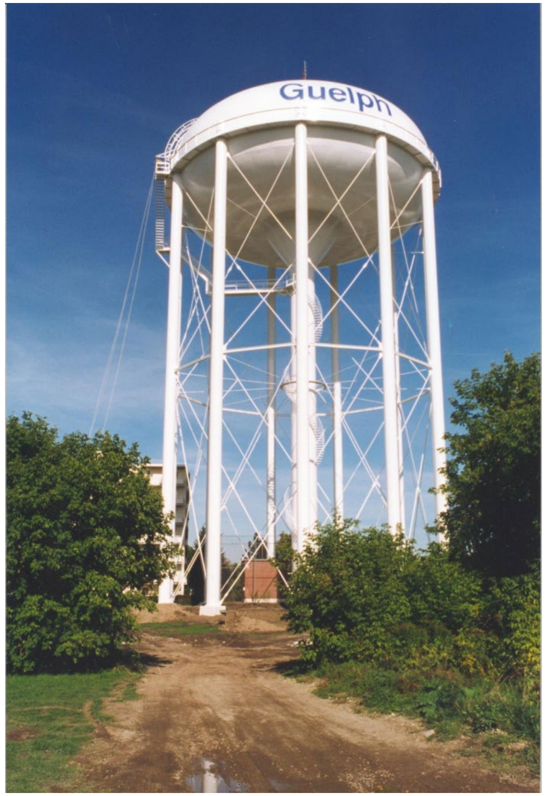
AECOM

November 28, 2019

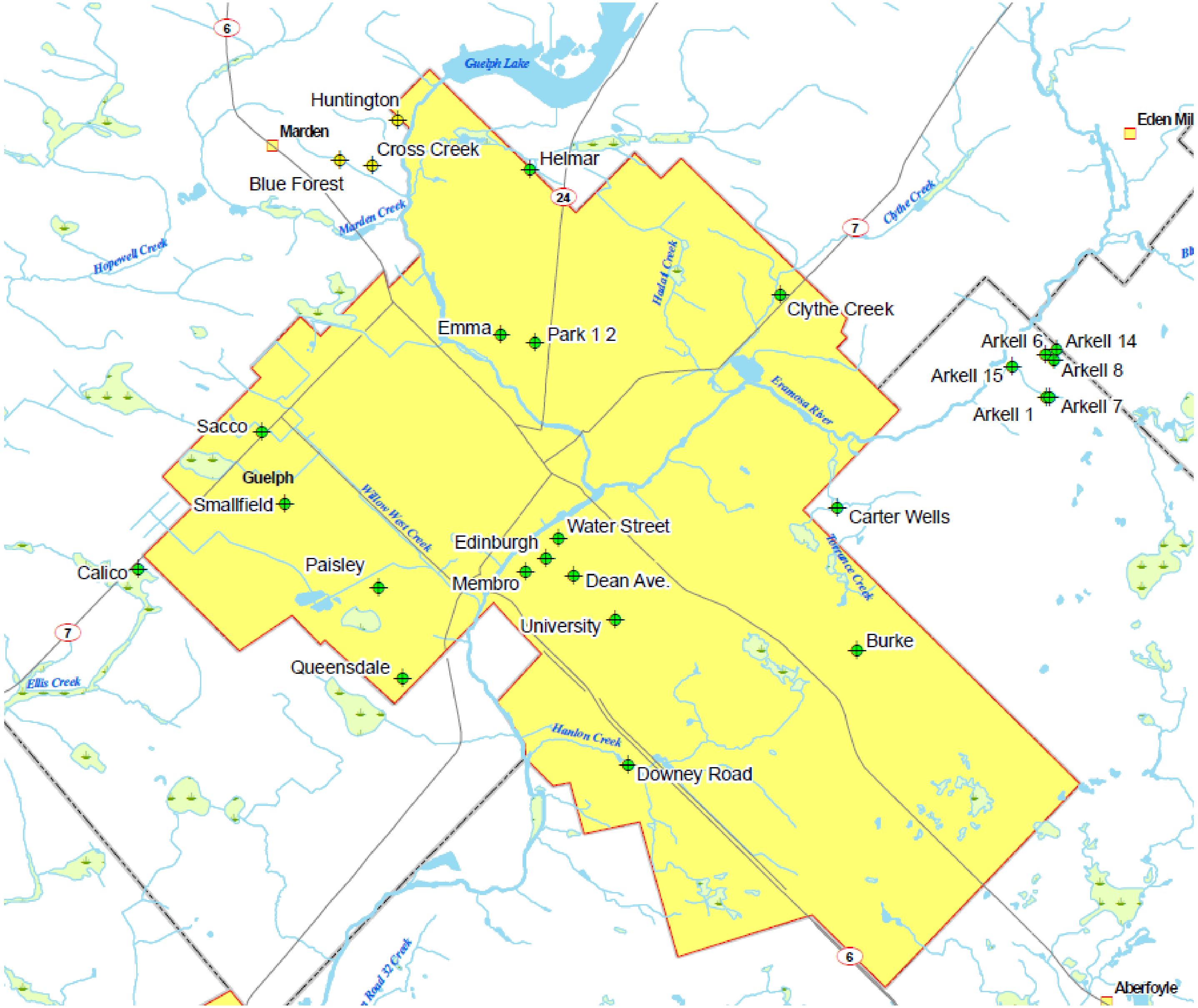
Water Supply Master Plan
guelph.ca/WSMP

Overview of Our Existing System

- Groundwater-based water supply since 1879
- Guelph's water supply system includes production wells installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system:
    - 25 production wells, 21 wells in continuous operation - 4 wells offline due primarily to water quality concerns
    - A shallow groundwater system that collects spring water in the Arkell Spring Grounds
    - Eramosa River Intake and Recharge system (seasonal): river water pumped to a infiltration pond and trench; where it is captured by a subsurface collector system; availability is subject to river flow conditions (i.e., lower flow in summer)



Overview of Our Existing System



November 28, 2019

Water Supply Master Plan
guelph.ca/WSMP

Arkell Spring Grounds

Overview of Our Existing System

2014 WSMP

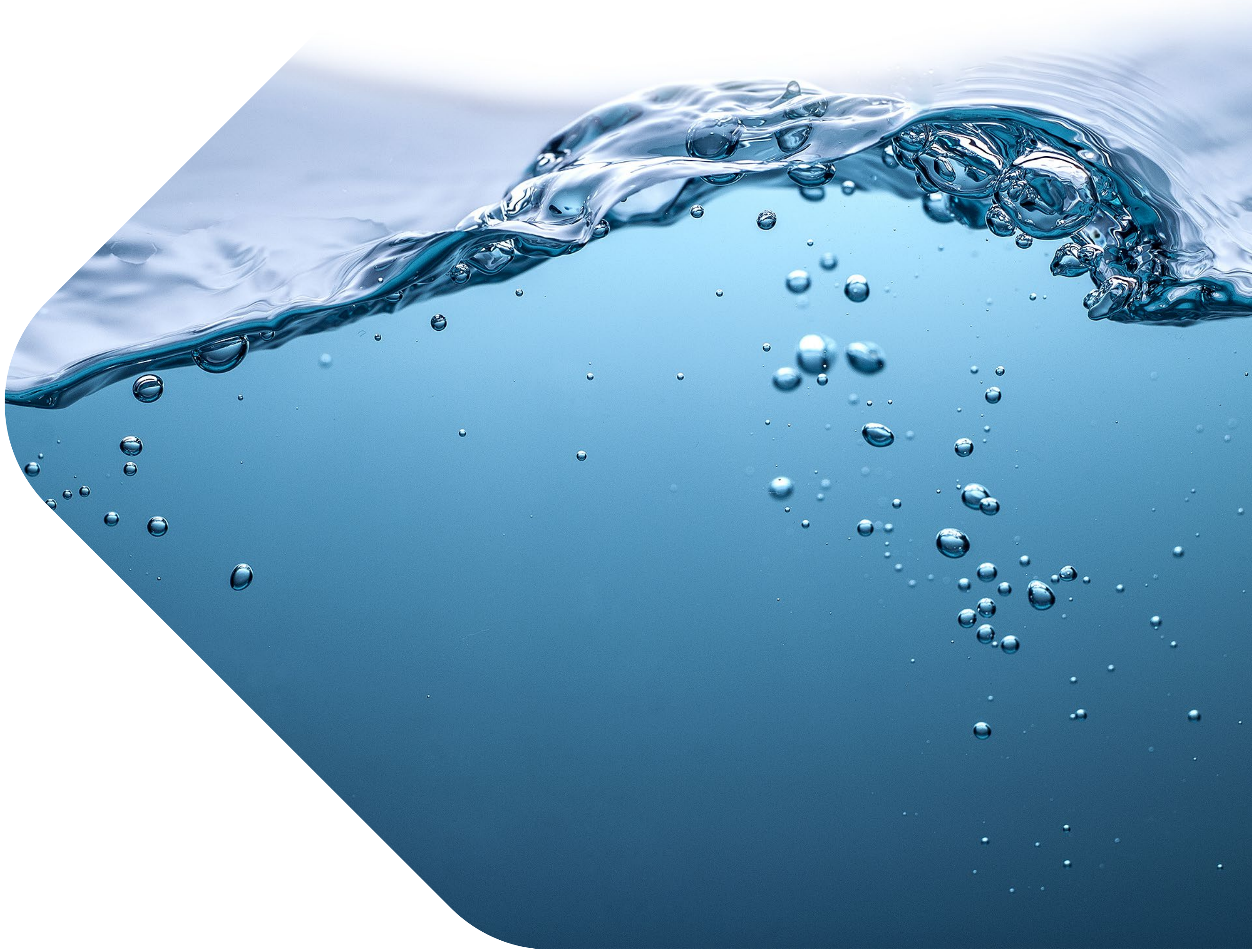
Well/ System Capacities (m^3/day)

Quadrant	Well/System	Capacity
SE Quadrant	Arkell 1	2,000
	Arkell 6	28,800
	Arkell 7	
	Arkell 8	
	Arkell 14	
	Arkell 15	
	Burke	6,500
	Carter 1	5,500
	Carter 2	
	Arkell Infiltration Galleries - Glen Collector	6,900
SW Quadrant	Membro	6,000
	Water Street	2,700
	Dean	1,500
	University	2,500
	Downey	5,236
NE Quadrant	Park 1	8,000
	Park 2	
	Emma	2,800
	Helmar	1,500
	Clythe Creek	0
NW Quadrant	Paisley	1,400
	Calico	1,400
	Queensdale	1,100
	Sacco	0
	Smallfield	0

Total Sustainable Capacity – 83,836 m^3/day

A lot has been going on...

Progress Since 2014 WSMP



November 28, 2019

2014 WSMP Preferred Solution and Timeline

1 – Conservation & Demand Management

- Implementation is on-going

2A – Groundwater: Existing Off-Line Municipal Wells

- Clythe in 2024, Sacco in 2029, Smallfield in 2030

2B – Groundwater: Municipal Test Wells

- SWQ in 2019, Logan in 2027, Scout Camp 2036, Hauser post-2038

2C – Groundwater: New Well Inside City

- Sunny Acre in 2033

2D – Arkell Collectors & ASR Wells

- Collector in 2031, ASR post-2038

2E – Groundwater: New Wells Outside City

- Guelph South and North post-2038

3A – Surface Water: Guelph lake Water Treatment Plant

- post-2038

3B - Surface Water: Guelph lake Water Treatment Plant & ASR Wells

- post-2038

Water Conservation & Demand Management

Progress 2006 to 2014

- City of Guelph has invested $10.2 million+ in water conservation programming.
- Delayed the need for close to $40.6 million+ in water and wastewater infrastructure by using less water.
- Saved $534,000+ per year in operational costs.
- Decreased peak day water use by 11,800 m^3 since 1999.
- Decreased non-revenue water lost to the "system" before reaching customers by almost 50 per cent.

Water conservation and efficiency remain **most cost effective form of "new" supply** to assist in meeting Provincial growth targets.

GUELPH WATER
OURS TO CONSERVE

Water Conservation & Demand Management

2016 Water Efficiency Strategy

2014 Water Supply Master Plan demand reduction target of 9,147 m^3/day by 2038.

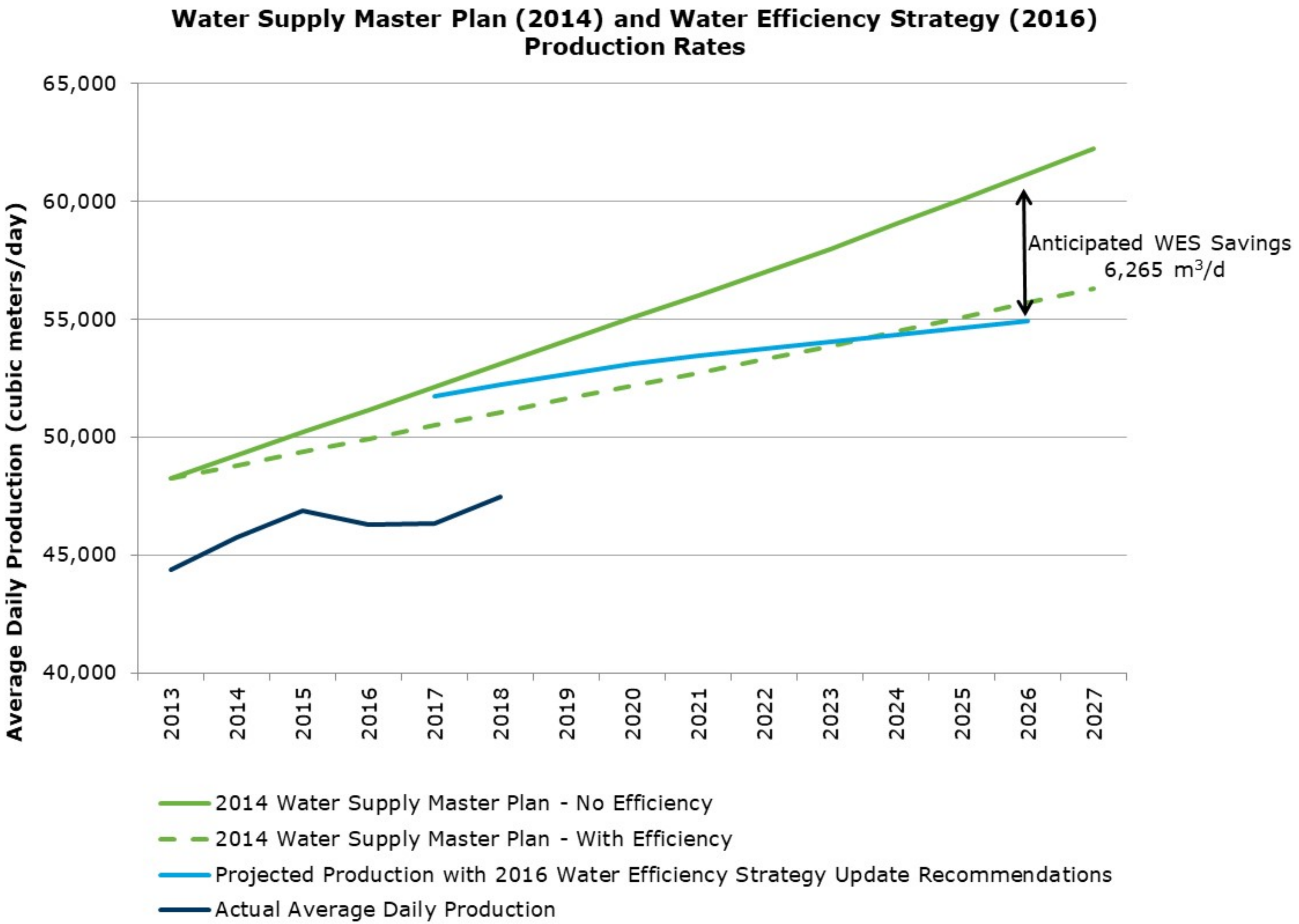
Water Efficiency Strategy community demand management, efficiency and conservation goals:

- Reduce water use as part of new growth
- Develop/ pilot new technologies to save water
- Reduce water use in existing buildings
- The technology is proven and easily implementable in the City
- Stimulate the Guelph economy
- Minimize costs to the City

Final strategy endorsed by Council in September of 2016.

- 10 year, $13.6 million community-driven water efficiency and demand management programming
- Goal: Reduce water use by 6.2 Million Litres per Day by 2026

Water Conservation & Demand Management



Water Efficiency 5-Year Program Participation & Savings

Water Efficiency and Conservation Program	5-Year Totals	
	Number of Audits or Rebates	Average Daily Water Savings (m3/day)
Blue Built Home Certification	42	40
eMERGE Home Visits	1,300	52
Multi-Residential Audit Program	13	7
Multi-Residential Sub-metering Program	20	1
Municipal Facility Upgrades	4	36
Royal Flush Rebate Program	4,702	409
Smart Wash Rebate Program	756	58
Water Smart Business Program	9	456
Leak Detection Program	-	10,333
Grand Total	6,846	11,393

City-Wide Studies

Progress since 2014

Tier 3 Water Budget and Local Area Risk Assessment (2017)

- Identified Significant risk level to Guelph groundwater supply system under drought conditions
- Applies to Well Head Protection Area - Quantity (WHPA-Q) and Intake Protection Zone - Quantity (IPZ-Q)
- Water Quantity Threats Management Strategy completed to guide water quantity policy development

Drinking Water Source Protection Plan and Policies

- Source Protection Plan amended in August 2019
- Includes policies to address drinking water quality threats
- Policies to address water quantity threats currently under development

Arkell Spring Grounds

Progress since 2014

Arkell Adaptive Management Plan and Operational Testing Program (2011 – 2016)

- Increase water taking from the Arkell bedrock wells from 19,584 to 28,800 m^3/day
- OTP did not result in any drawdown in the aquifer below Blue Springs Creek
- No impacts (water level drawdown, change in hydraulic gradient, water temperature impacts) to Blue Springs Creek were observed
- Permit-To-Take-Water (PTTW) issued by MECP for the requested 28,880 m^3/day

Arkell Spring Glen Collector Improvements

- Trench upgrades completed to improve the capacity of the groundwater recharge system
- Testing and monitoring completed to optimize pumping and recovery

Clythe Well Class EA & Membro Well Replacement

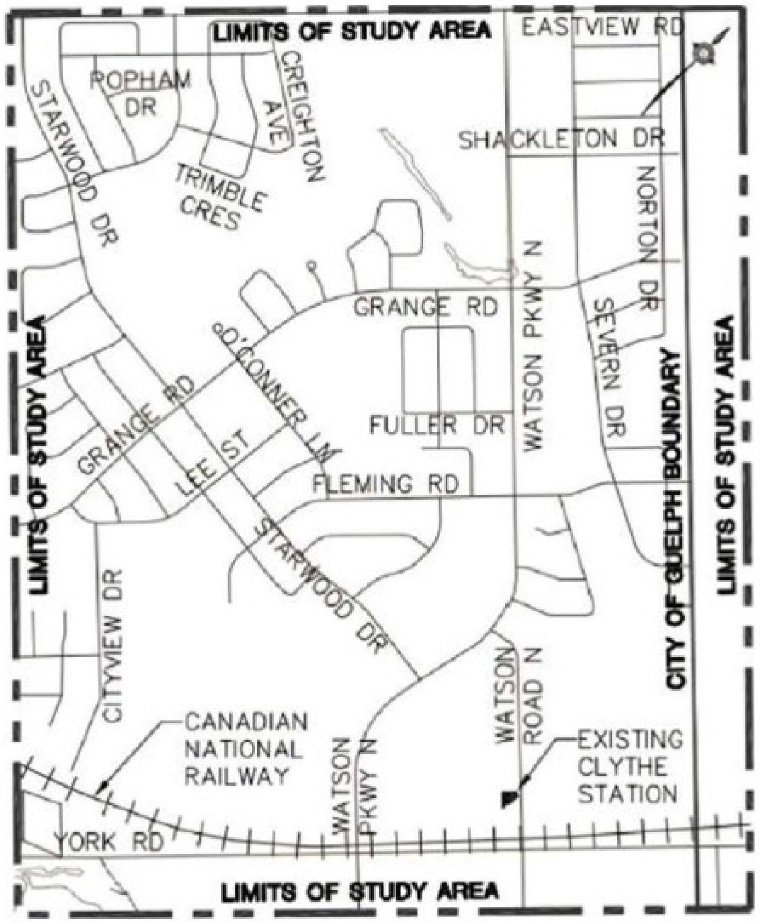
Progress since 2014

Clythe Well Class EA (2018):

- Location selected for water treatment facility
- Conceptual design of facility and raw & treated watermains
- Detailed design in 2019/ 2020
- Construction of project in 2021

Membro Well Replacement:

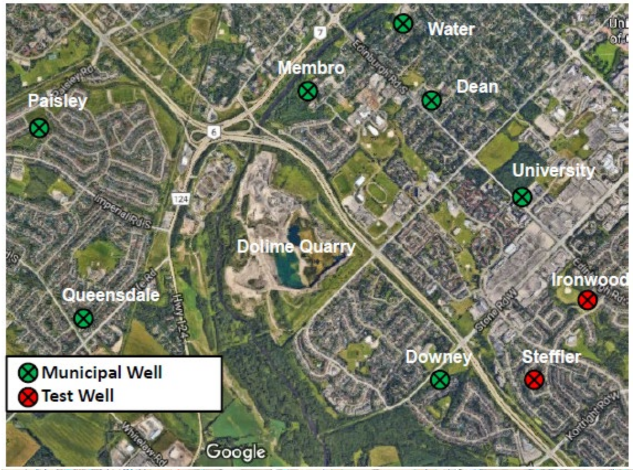
- Drilled in 2016 to depth of 49 m
- Addressed well diameter constraints for higher pumping rates to 6,000 m^3/day
- Well testing to be conducted in 2020



Southwest Quadrant Groundwater Investigations

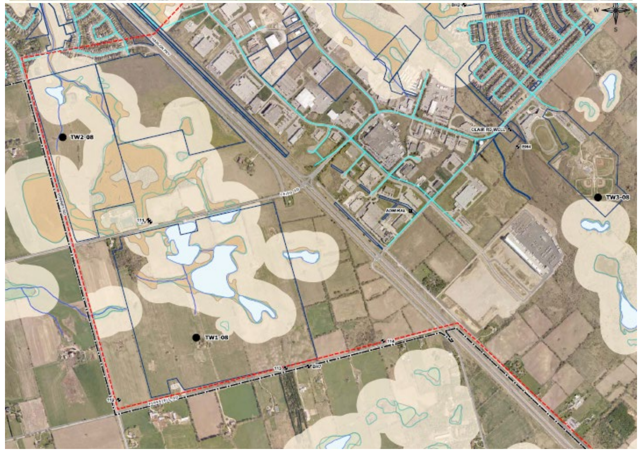
Ironwood/Steffler Wells (2016)

- Class EA put on hold due to concerns on Dolime Quarry
- Modelling studies to evaluate quality protection and additional quantity



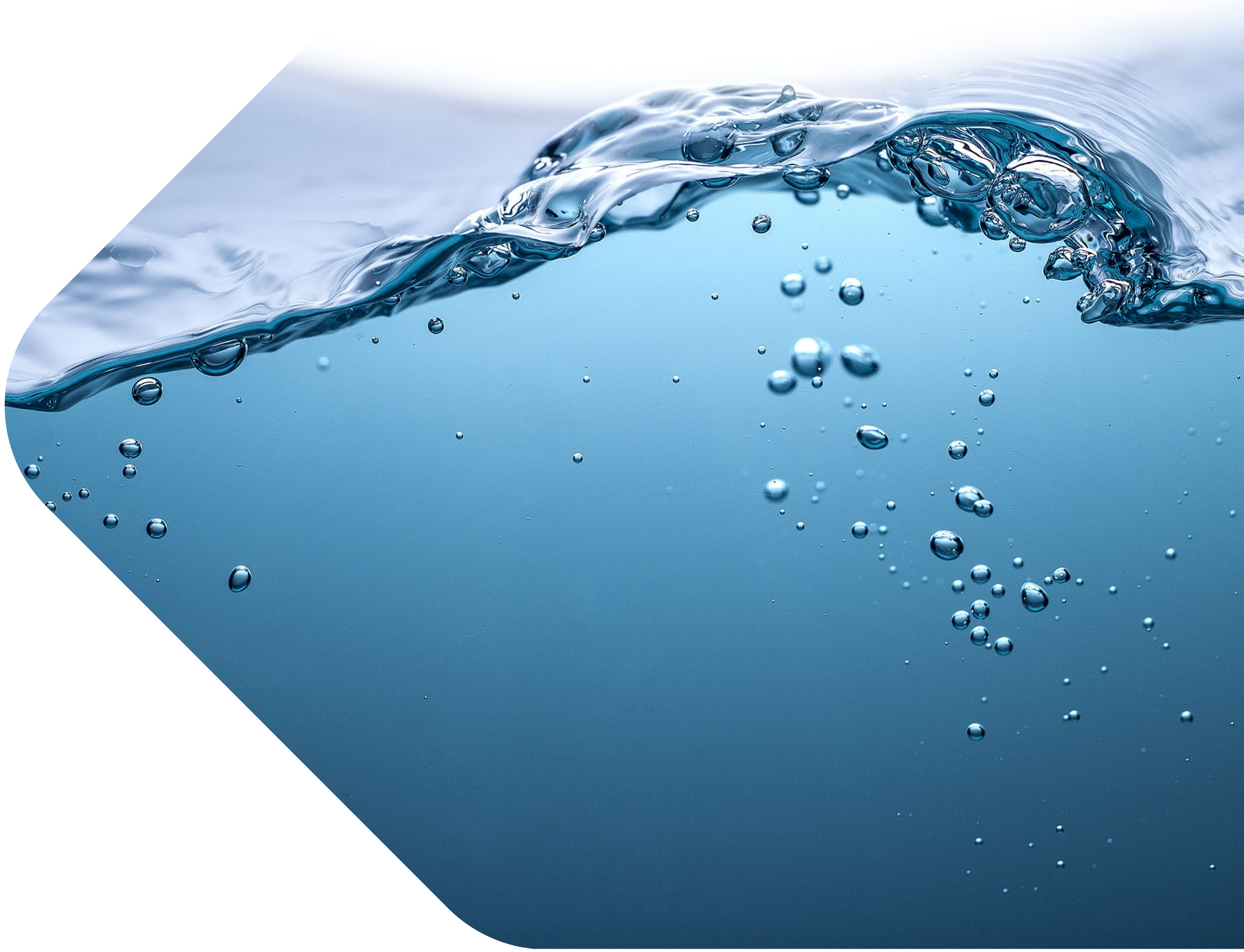
Guelph South Groundwater Supply Investigation (2019)

- GSTW-1 - high potential supply source
- Convert to large diameter production well – test program
- Target capacity of ~5,200 m^3/day



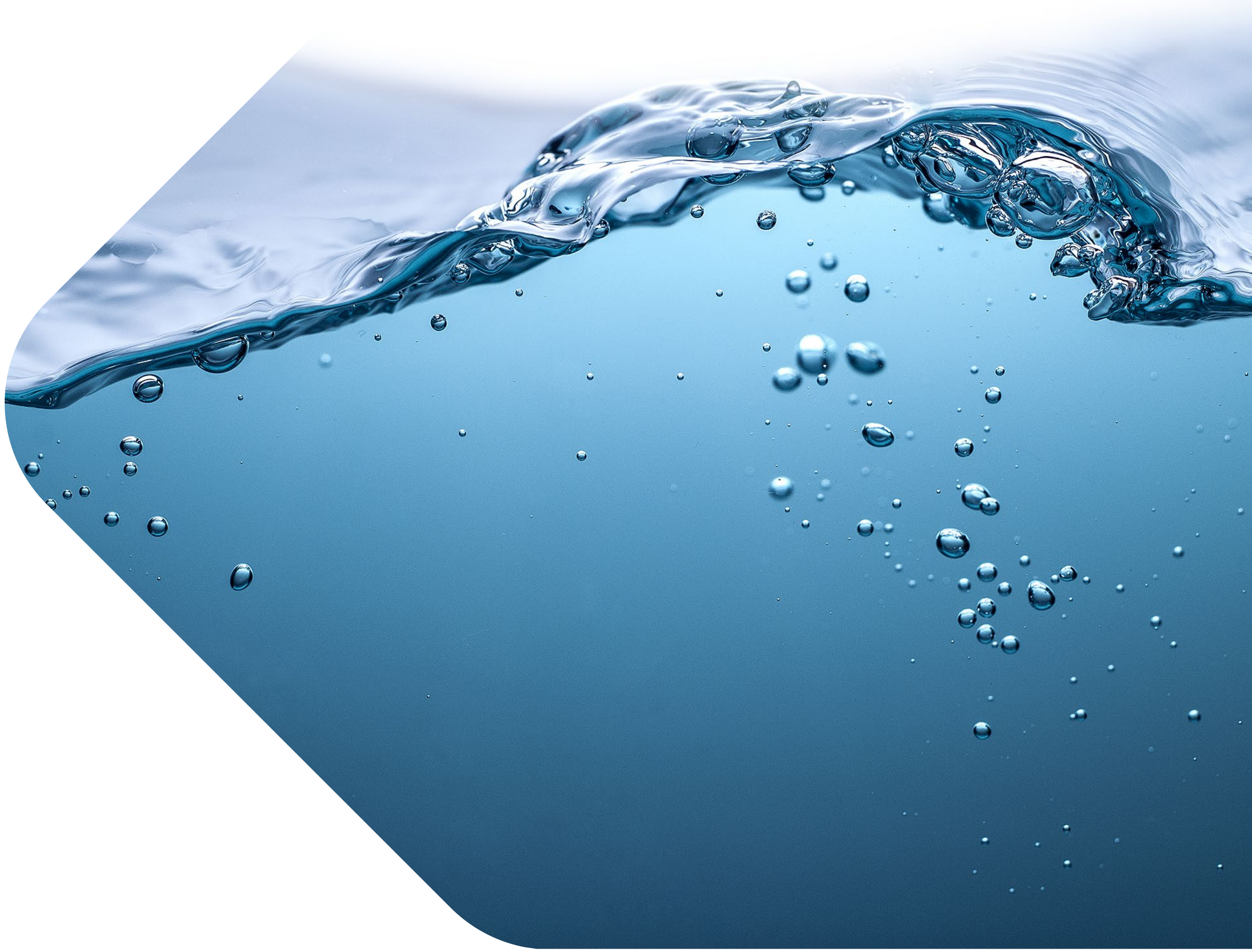
Take 10 minutes to relax!

Break



Ensuring a sustainable supply to 2041

2019 WSMP Update



November 28, 2019

Water Supply Master Plan

guelph.ca/WSMP

Objectives

- To provide a community-endorsed framework for provision of an adequate and sustainable supply of water to meet the current and future needs of all customers; to the year 2041
- To coordinate with other City master plans in developing a sustainable water/wastewater strategy
- To develop a “strategic plan” for implementation of specific projects (future works/ developments) in a phased approach with identified triggers
- To provide the basis for individual studies under the Class EA process

Purpose Statement

The City of Guelph is committed to develop a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers.

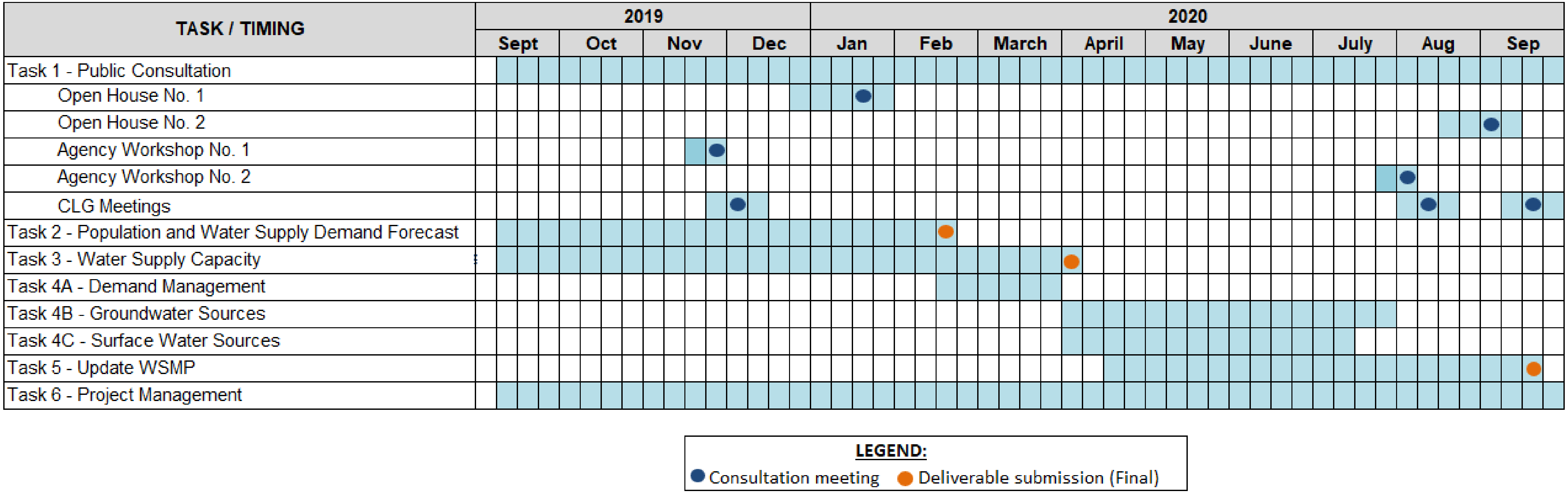
The 2014 WSMP confirmed that the existing water supply capacity will not meet future demands. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required.

The proposed implementation strategy must deliver an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

Scope of Work – WSMP Update

Task	Activities
Task 1 – Public Consultation	• Community Liaison Group (CLG) meetings (2 or 3) • Workshops (2) • Community Open Houses (2)
Task 2 – Population and Water Demand Forecasts	• Develop population projections – residential and ICI (employment) • Incorporate Provincial Growth Plan targets • Develop water demand projections
Task 3 – Existing Water Supply Capacity Assessment	• Update the assessment of existing well performance, maximum capacity and potential constraints for each supply source • Comparison of existing capacity with demand forecast
Task 4 – Water Supply Alternatives	• Demand management & efficiency programs • Groundwater sources inside city • Groundwater sources outside city • Local surface water supply & Aquifer Storage and Recovery • Do nothing
Task 5 – Water Supply Master Plan Update	• Evaluation of alternatives • Risk assessment • Develop WSMP Update Report

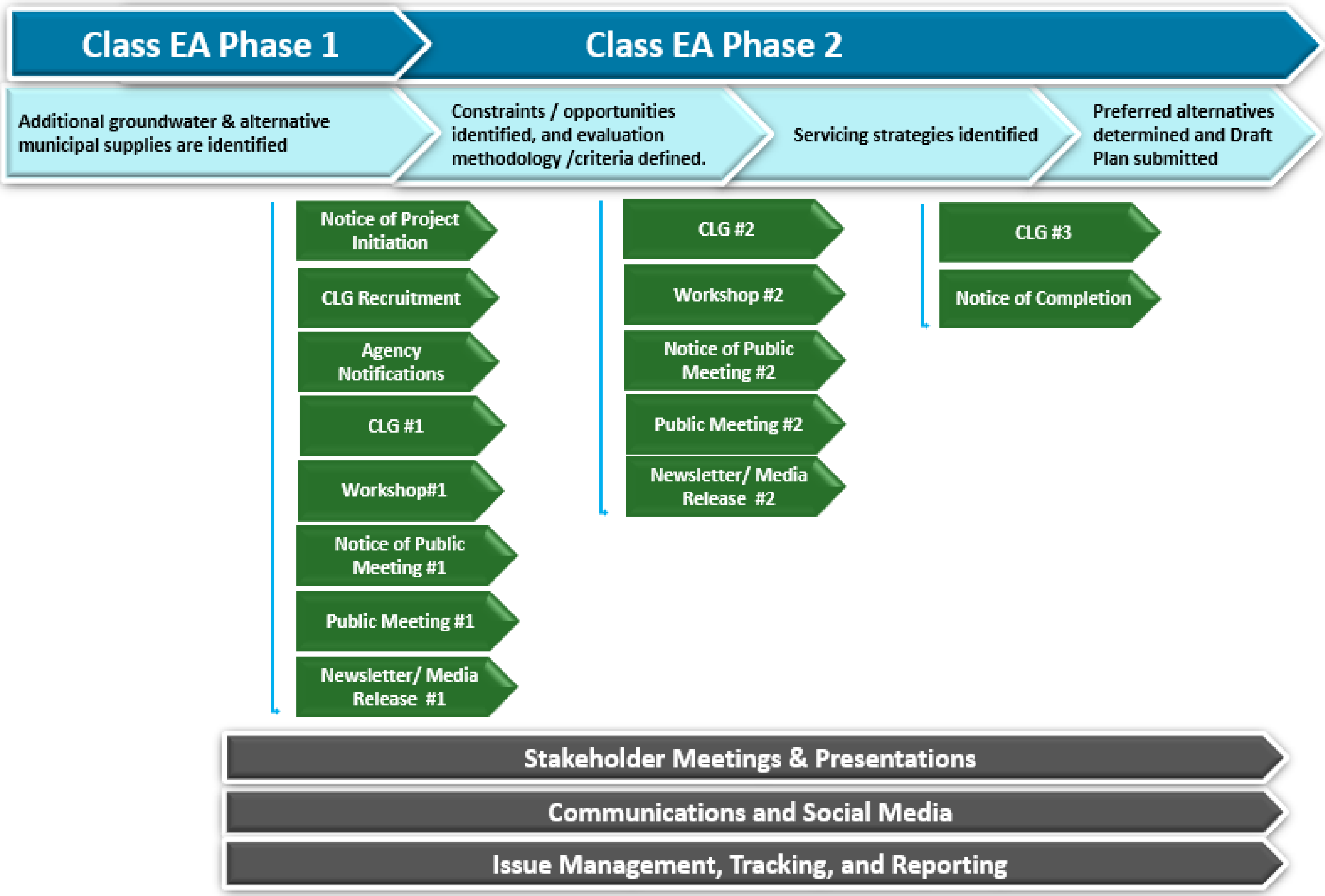
Proposed WSMP Update Project Schedule



Community Engagement Goals

- Engage the Guelph community to develop a shared vision for managing the City's water supply
- Generate a broad awareness of the Water Supply Master Plan and the opportunities for participation
- Obtain an understanding of the community's aspirations/concerns relating to water management
- Keep key stakeholders informed of WSMP activities, and communicate in a timely and clear manner
- Affirm the City's commitment to community engagement and open planning processes, and demonstrate the impact of engagement efforts on the Master Plan Update and the Class EA process

Environmental Assessment Process

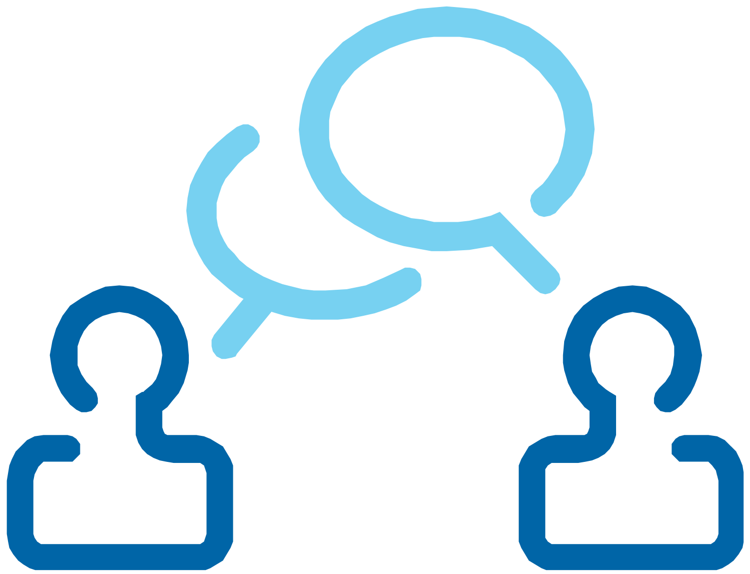


We'd Like Your Input…

Group A: Is the proposed project consultation appropriate for engagement of Indigenous Communities?

How can it be adjusted/ improved?

Group B: How can residents outside of Guelph be properly consulted to evaluate water supply sources outside of the City?



Small Group Discussions:

- Split into **Group A** or **Group B** according to your interest
- Discuss in groups, and record on the flipchart – 15 mins

Maintaining a Safe and Sustainable Supply to 2041

Work Underway

November 28, 2019

Water Supply Master Plan

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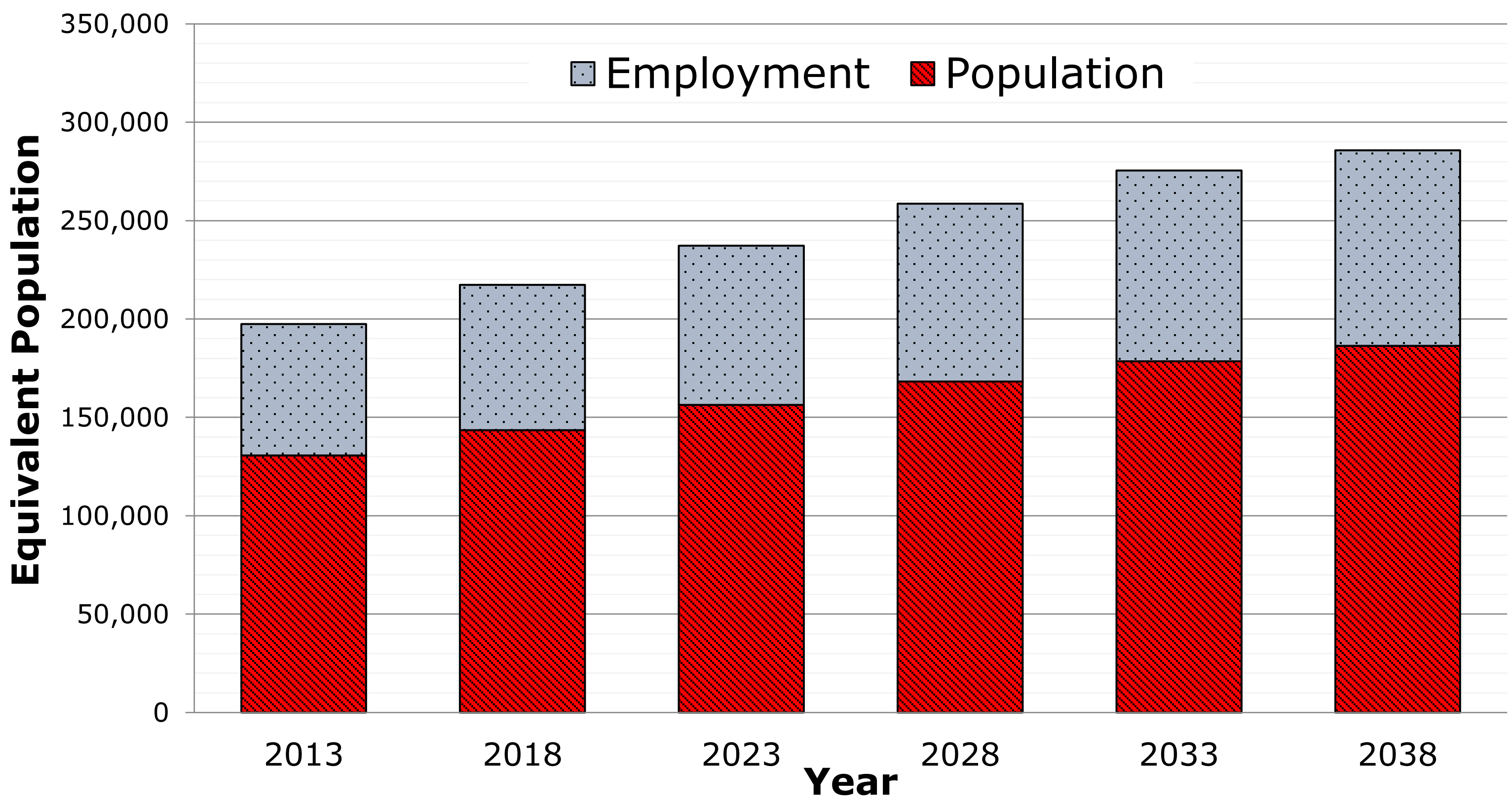
City of Guelph

Making a Difference

AECOM

Population and Water Supply Demand Forecasts

Population Projection (2013-2038):



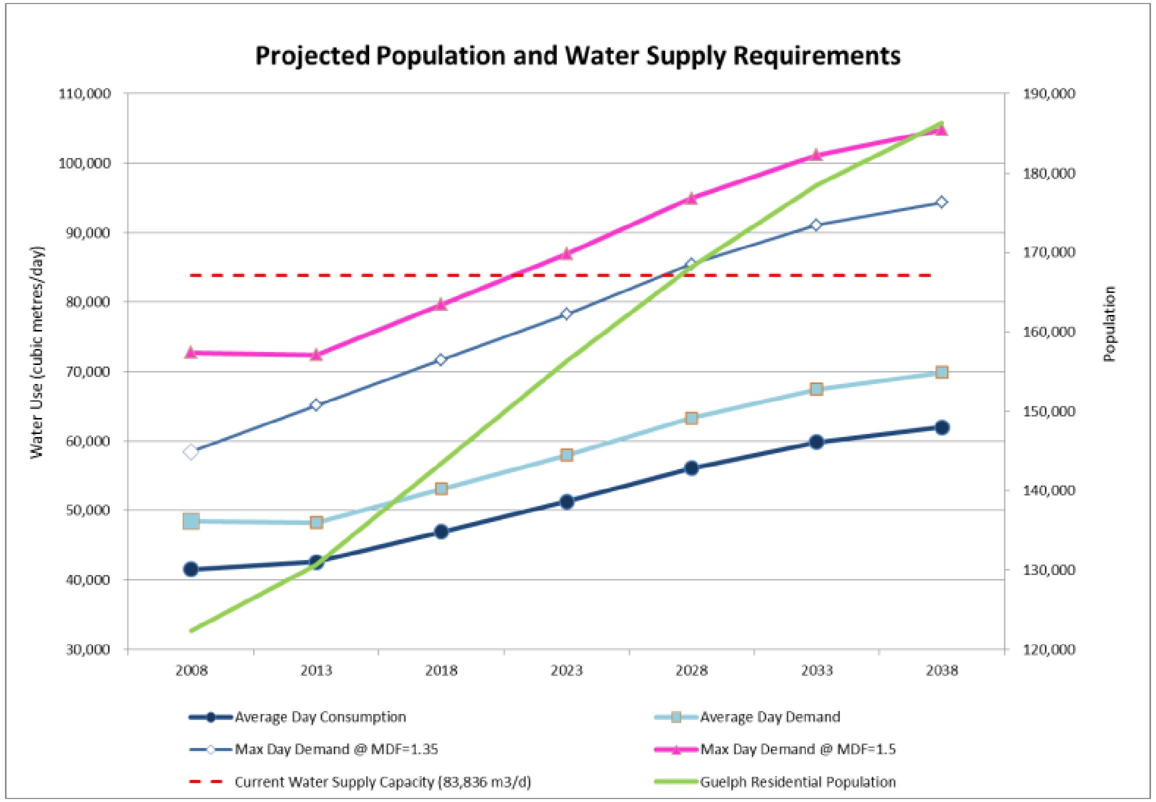
Develop population projections – residential and ICI

- Projections included in 2014 WSMP
- 2019 WSMP will update projection to reflect Ontario 2019 Growth Plan (191,000 residents and 101,000 jobs by 2041)

Population and Water Supply Demand Forecasts

Develop water demand projections – Proposed Methodology

- Review water consumption (billings) and production (pumping) data
- By sector: Residential + Employment + Non-Revenue Water
- Quantify reduction attributed to City's efficiency initiatives
- Develop a new conservative baseline for each sector
- Develop projected demand
- Determine design Maximum Day Factor
- Comparison to existing capacity



Water Supply Master Plan
guelph.ca/WSMP

Existing Water Supply Capacity Assessment

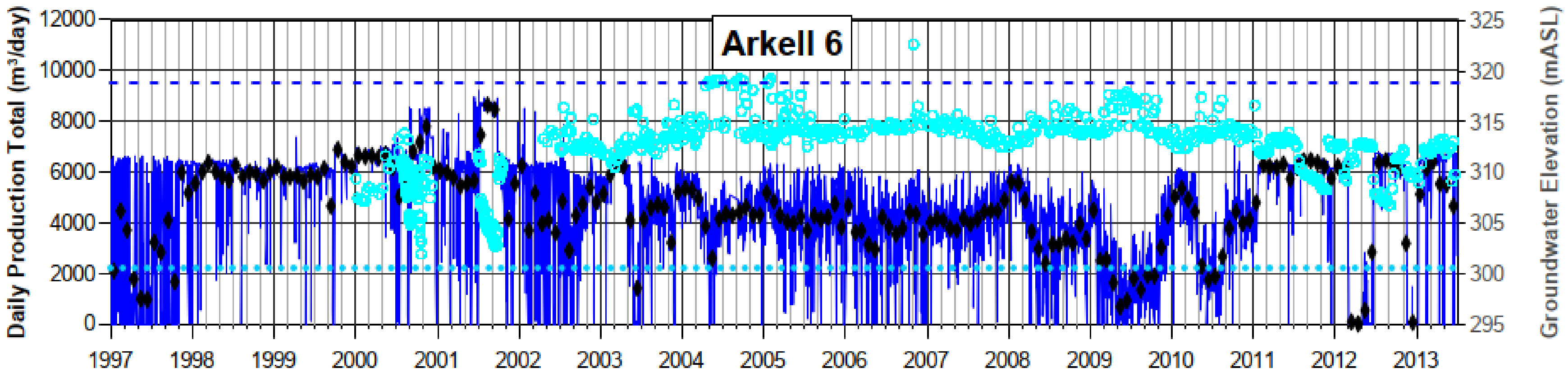
Existing Well Capacity Assessment

- Review historical operational data for assessment of well performance
- Waterworks Operations Workshop to identify constraints
- Determine maximum capacity for each supply source

Review Range of System Capacity

- Predictive / modeling assessment to review scenarios: loss of supply well, drought and short term high demand.

Comparison of Capacity Assessment with Demand Forecast



Developing Water Supply Alternatives

Scope of Work

Demand Management/ Efficiency Programs	• Maintain commitment to these initiatives and 2016 WES • Determine range of realistic goals, and cost to implement • Develop means of measurement to evaluate
Groundwater Sources In & Outside of City	• Restore lost capacity through optimization of existing well supplies (i.e. infrastructure improvements) • Restore existing wells with treatment • Identify new potential water supply areas • Dolime Quarry – groundwater/surface water source
Local Surface Water Sources	• Establish feasibility/ risks of surface water alternatives including Aquifer Storage and Recovery • Assessment areas include: Eramosa River/ Guelph Lake
Do Nothing	• Undertake no improvements or changes • Significant impact on the growth potential for the City would be expected with this alternative

Note: A regional water system – like a Great Lakes pipeline – will **NOT** be considered during this Update.

Water Supply Alternatives

Recommended Groundwater Supplies (2014)

New Sources Inside City:

- Sunny Acre

New Sources Outside City:

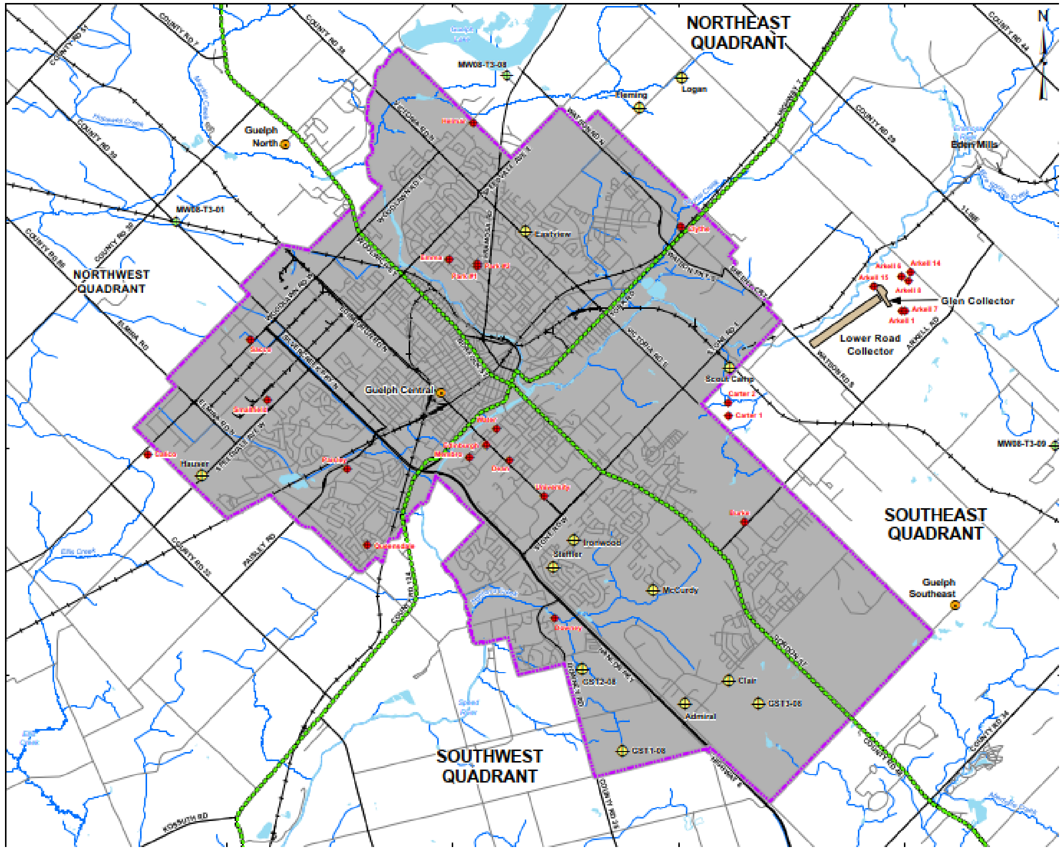
- Guelph North
- Guelph South

Re-establish Off-Line Supplies:

- Clythe
- Sacco
- Smallfield

Municipal Test Wells:

- SWQ – Ironwood/ Steffler/ Guelph South
- Logan
- Scout Camp
- Hauser

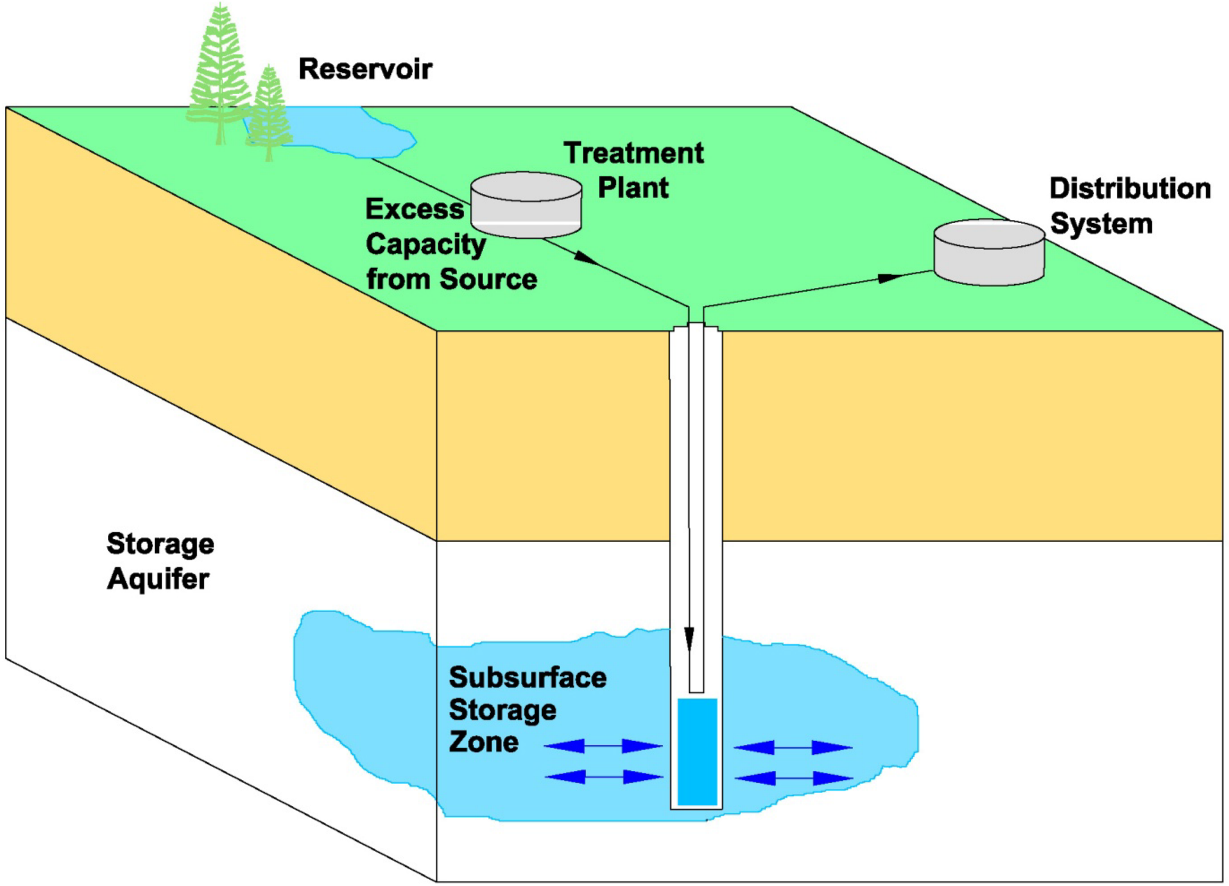


Water Supply Alternatives

Aquifer Storage and Recovery (ASR) - re-injection of potable water back into an aquifer for later recovery and use

Will include consultation with GRCA – assessment of quantity of surface water available through the year in Guelph Lake and Eramosa River

- Base level water taking
- Additional volumes and duration



We'd Like Your Input…

Do you have concerns regarding any of the alternatives presented? Should any of these not be considered?

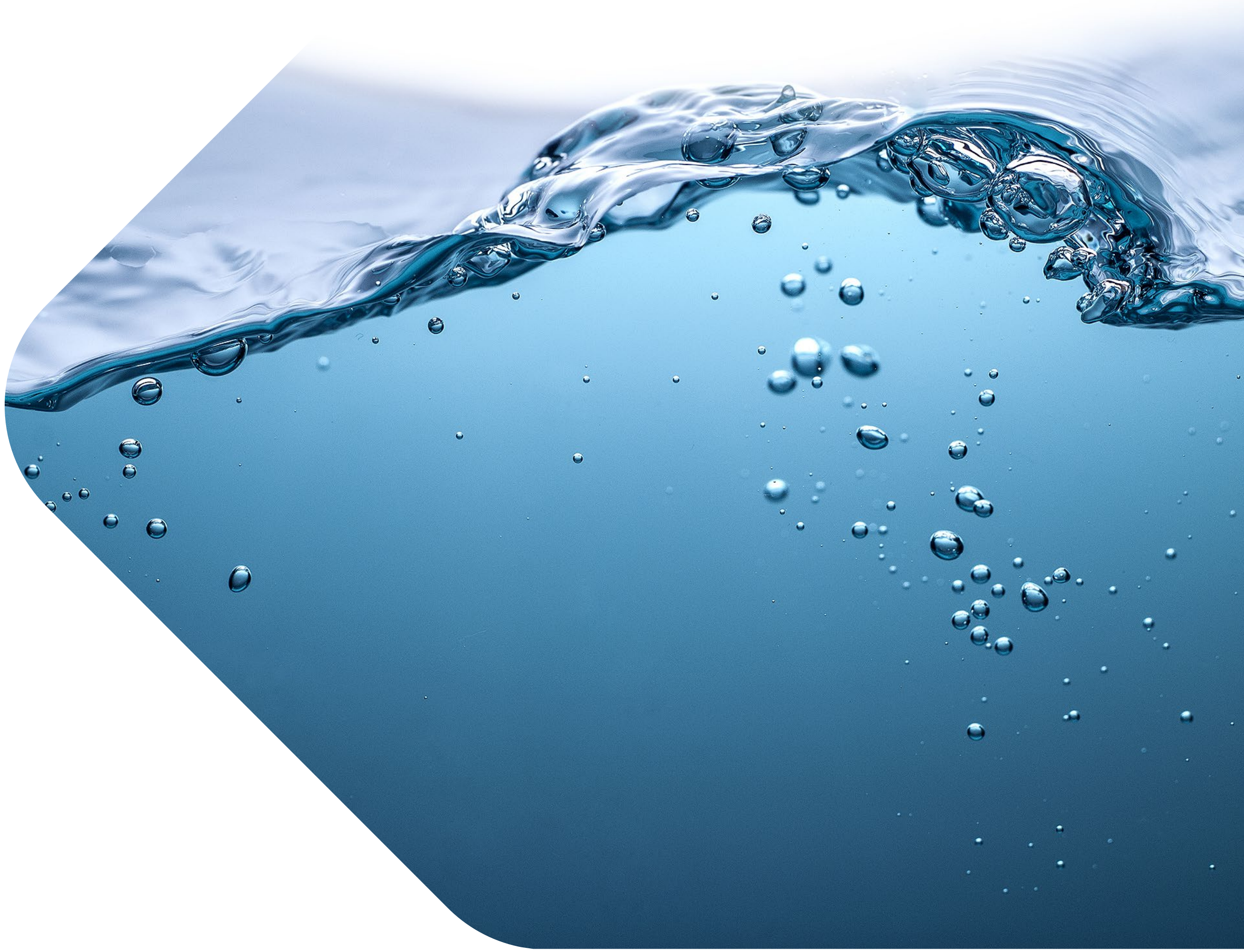
Are there other water supply alternatives that should be considered by the project team?

Gallery Walk:

- Each alternative is identified on a flipchart
- **Write down your concerns and ideas** using the sticky notes provided
- Project team members are available to answer questions

Maintaining a Safe and Sustainable Supply to 2041

Assessing Alternatives



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Water Supply Master Plan

guelph.ca/WSMP

How We Will Assess Alternatives

Scope of Work

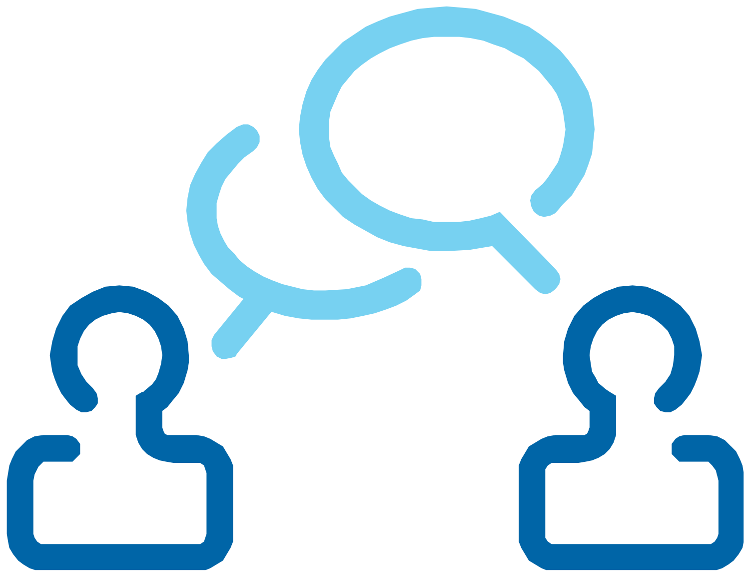
- Each potential alternative will be assessed using a consistent approach and evaluation criteria
- A short-list of alternatives will be ranked and further evaluated. This may include screening by:
  - Primary Criteria (e.g., ability to meet regulations, costs, technical feasibility, environmental or social affects)
  - Secondary Criteria (e.g., manageable impacts like construction truck traffic)
  - The technical assessment will include use of the Tier 3 Groundwater model to assess well system optimization and potential impacts related to development of new supplies
  - Comparisons and trade-offs will be made between alternatives and will form the rationale for the identification of the preferred solution or water strategy

Evaluation Criteria

Public Health and Safety	• Ability to meet provincial requirements
Natural Environment	• Potential effects to natural environment • Potential impacts to water resources • Potential impacts to natural heritage features • Environmental management planning considerations
Social and Cultural Resources	•Land use impacts •Short-term construction impacts •Potential impacts from operations •Potential impacts to Indigenous Peoples and values
Economic and Financial Considerations	• Estimated capital costs • Estimated operations and maintenance costs, including energy consumption
Legal / Jurisdictional Considerations	• Location of facility relative to city boundaries • Land requirements • Ability to address outside control
Technological Considerations	•Ability to implement and meet peak demand •Constructability, schedule and timing, and maintaining operations during construction • Water quality •Allowance for future treatment needs •Expandability •Ability to respond to changes in regulations •Ability to utilize existing infrastructure

We'd Like Your Input…

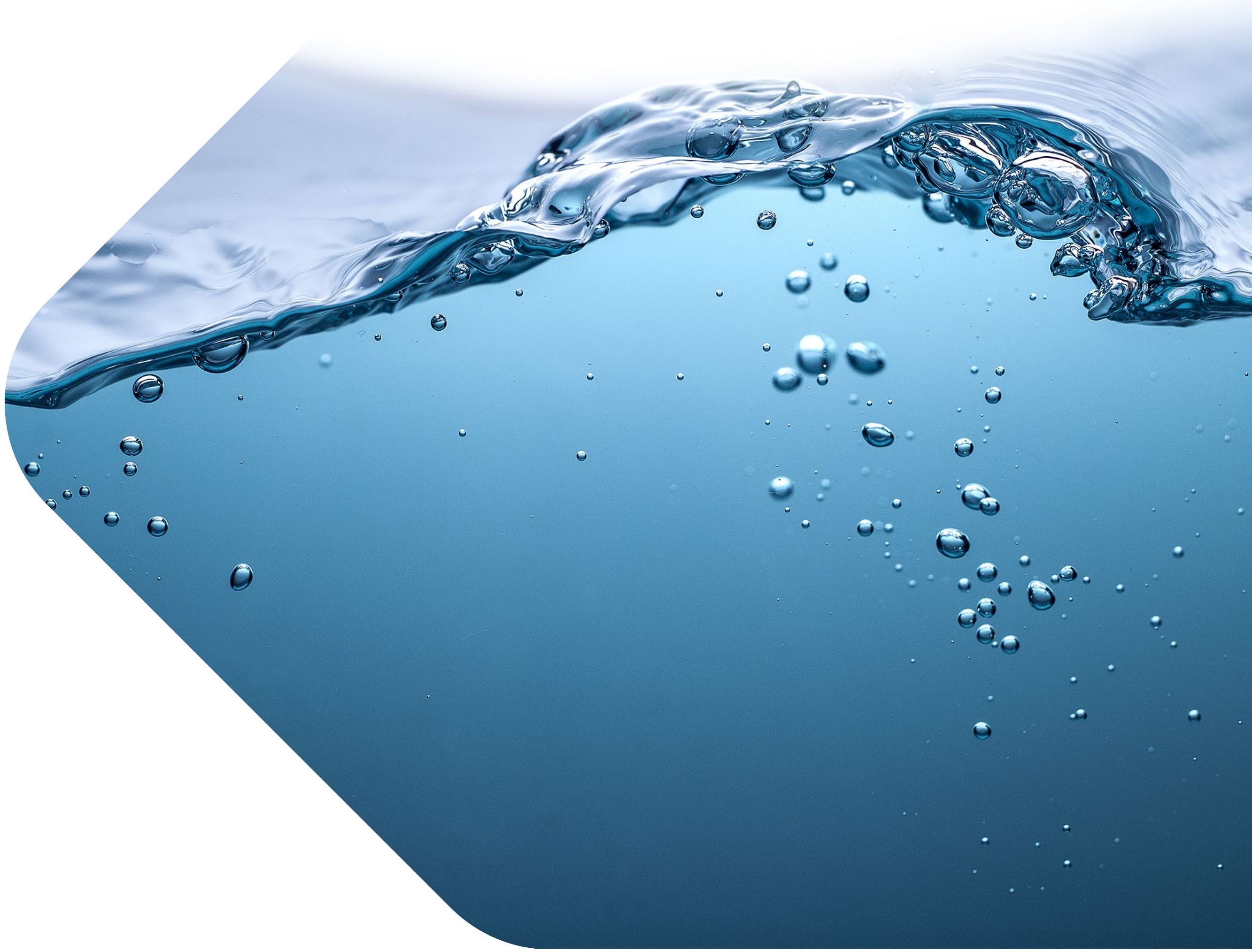
What are the benefits and drawbacks of using the Tier Three Groundwater model for evaluation of the water quantity impacts of source development?



Large Group Discussion:

- Share your thoughts!

Next Steps



November 28, 2019

Next Steps

- Incorporate/ consider feedback from this workshop
- Complete current work and develop water supply alternatives
- Conduct preliminary evaluation of alternatives
- On-going Community Engagement
  - Community Liaison Group Meeting #1 – Wednesday Dec. 4
  - Community Open House #1 – late January 2020 (tentative)
  - CLG # 2 – Aug 2020 (tentative)
  - Workshop #2 – Aug 2020 (tentative)

Thank You!

Guelph's Water Supply Master Plan Update

Discussion Guide – Fall 2019

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The Corporation of the City of Guelph

Why Update the Water Supply Master Plan?

The City of Guelph is updating its council-approved Water Supply Master Plan, from 2014, to define how we will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2041. Reviewing our existing water supply system is an opportunity to discuss with Guelph and surrounding communities how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water in the future. Guelph is a growing community, and new water supply will be required to support the City's continued growth. In keeping with the 2014 Water Supply Master Plan, any development of water supply options outside of the City will only be considered with the co-operation and participation of the County and the relevant Township/Town.

When investigating existing and new water supply options—like new groundwater sources in and outside of the City, and local surface water sources—we'll consider things like water quality and quantity, economic factors, environmental and social/cultural concerns and any relevant regulations. Regardless of source, our water supply will continue to meet the service requirements of the Guelph community and the high regulatory standards of the Ontario Ministry of the Environment, Conservation and Parks (MECP).

What's Included in this Discussion Guide?

Getting the Conversation Started

Community input is an essential part of our Water Supply Master Plan update process. We know that people care about where our water comes from, and that they want to maintain a safe and sustainable supply for present and future generations.

That's why we're making it easy for people to get involved. We'll be gathering input and suggestions from people and organizations in a number of ways to help update the Water Supply Master Plan:

- A **Community Liaison Group** (CLG) is in place to provide feedback to the project team throughout the process. The CLG has members from a wide cross-section of the community including residents, community groups, local government and business leaders. They will meet on at least three occasions to share ideas and perspectives on ways to improve the Water Supply Master Plan update.
- Two **Workshops** are planned to gather crucial input from the perspective of **Indigenous Communities, Municipalities and Agencies** to help ensure that concerns and interests are considered and addressed, and that the Water Supply Master Plan process meets all local and provincial By-laws and Acts, as well as environmental assessment and approval requirements.
- Two **Community Open Houses** are planned for the wider community to participate. These events will give interested individuals and groups an opportunity to review plans, ask questions directly to the project team members, and provide feedback.

In addition, we will be offering various online feedback opportunities at https://www.haveyoursay.guelph.ca/ throughout the process.

The Water Supply Master Plan update process is designed with you in mind. If you have any questions, comments, or concerns, please contact either Dave Belanger or Matt Alexander by telephone or email. We can also add you to the project email list if you would like to receive project notifications.

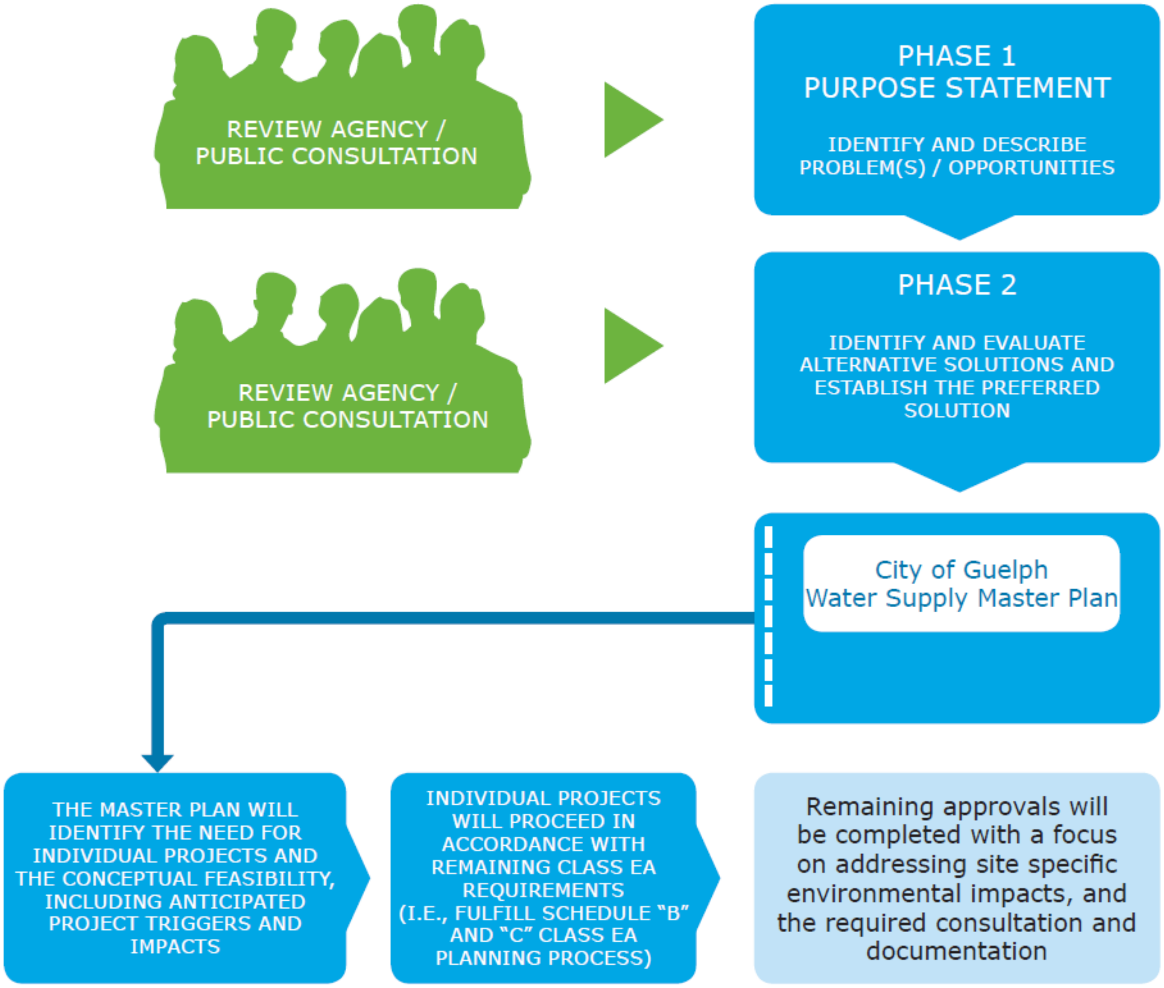
Everything you wanted to know about Master Planning

Our update follows the requirements of a Municipal Class Environmental Assessment (Class EA). When we are finished — after our Water Supply Master Plan Update is reviewed by the Guelph community and approved by Council — we will have identified constraints and opportunities related to our existing water supply system. We'll also have evaluated and prioritized a number of individual projects to increase the capacity of our existing system.

Master Plans differ from project specific studies. They:

- **Are broad in scope.** They analyze a system in order to develop a framework for the provision of future works and development.
- **Recommend Individual Projects.** Specific projects recommended in a Master Plan are part of the larger management system and may be distributed geographically throughout the study area. The implementation of specific projects may occur over an extended time frame. These individual projects will also follow the Municipal Class EA process.
- **Must Satisfy Requirements of the Class EA.** According to the Class EA document, a Master Plan must at least satisfy the requirements of Phases 1 and 2 of the Class EA process. **Figure 1** illustrates the Class EA Master Planning Process.

Figure 1: The Master Planning Process



The Master Plan will include an Implementation Plan that will recommend a series of Class EA water supply projects required to achieve the preferred solution. The Municipal Engineers Association (MEA) Class EA document classifies projects as either Schedule "A", "B" or "C" according to the type of environmental effect(s) anticipated. Each of these classifications requires a different level of review to complete the requirements of the Class EA, and comply with the Environmental Assessment Act:

- **Schedule 'A' Projects** are limited in scale, have minimal adverse effects and include the majority of municipal sewage, stormwater management and water operations and maintenance activities. These projects are approved and may be implemented without following the Class EA planning process.

Schedule **'A'** projects typically include normal or emergency operational maintenance activities. Examples of Schedule "A" projects include facilities that are located within a municipal road allowance or an existing utility corridor.

The sub-classification, Schedule 'A+', ensures that people are notified of certain projects that are pre-approved under the Municipal Class EA. For example, it would be appropriate to notify the public of planned construction in their area. This allows people the opportunity to direct questions or concerns to their municipal council.

- **Schedule 'B' Projects** have the potential for some adverse environmental effects. The proponent is required to conduct a screening process that involves contact with directly affected public and relevant review agencies to ensure that they are aware of the project and that their concerns are addressed.

  Schedule **'B'** projects require that Phases 1 and 2 of the Class EA planning process be followed and an Environmental Screening Document be prepared and submitted for review by the public and relevant agencies. If there are no outstanding concerns raised by the public and/or review agencies, then the proponent may proceed to project implementation. If, however, the screening process raises a concern that cannot be resolved, then the Part II Order procedure (commonly referred to as a "bump-up") may be invoked.

  Schedule **'B'** projects generally include improvements and expansions to existing facilities where there is the potential for some adverse environmental impacts. Examples of Schedule "B" projects include activities such as siting of water storage facilities or new municipal wells (including wellhead protection).

- **Schedule 'C' Projects** have the potential for significant environmental effects and must proceed under the full planning and documentation procedures (Phases 1 to 4) specified in the MEA Class EA document.

  Schedule **'C'** projects require that an Environmental Study Report (ESR) be prepared and submitted for review by the public. If concerns are raised that cannot be resolved, then the Part II Order procedure may be invoked.

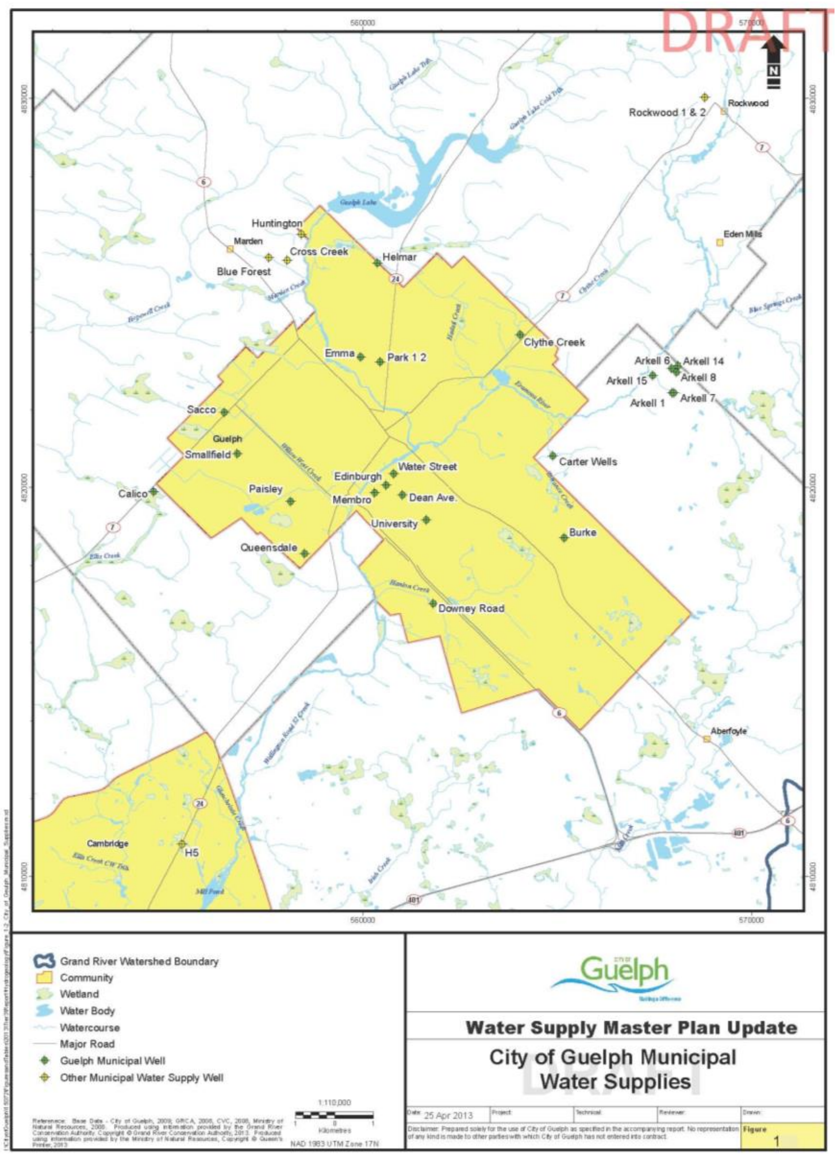
  Schedule **'C'** projects typically include the siting and construction of new facilities, such as water treatment plants, and major expansions to existing facilities.

Guelph's Current Water Supply System

The City of Guelph relies almost exclusively on groundwater to meet the municipality's residential and industrial, commercial and institutional (ICI) water demands. Other municipal water uses including fire fighting, street washing, and watermain flushing. The following describes the City's water supply system and its capacity.

The City has used groundwater as its primary source of water since 1879. Guelph's water supply system includes production wells installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system. The locations of the various wells and the collector are shown on **Figure 2** – Existing Water Supply System.

Figure 2: City of Guelph Municipal Water Supplies



There are currently 25 production wells in the municipal supply system. In 2019, 21 municipal wells were operated on a near continuous basis while the other four wells were offline, due primarily to water quality concerns. **Table 1** Municipal Production Wells – Operational Status summarizes the operational status of the individual production wells.

In addition to the municipal wells, there is a shallow groundwater system, called the Glen Collector, that collects spring water in the Arkell Spring Grounds. The City has the infrastructure to augment flow in the collector system during summer months by pumping water from the Eramosa River to a drainage area to recharge the groundwater where it is captured by the collector system. This system is occasionally shut down under low river flow conditions resulting in less water to the system at times when the water is most needed (i.e., summer demand).

Table 1: Municipal Production Wells – Operational Status

Quadrant	Pumping Well	Service Dates	Status in 2019
Northeast Quadrant	Emma Street Well PW1/31(COG)	1931 to present	continuous operation
	Park Wells PW1/37(COG) & PW1/47(COG)	1937 to present	continuous operation
	Clythe Creek Well PW2/76(COG)	1984 to present	off line for treatment upgrade (back on line 2022 est.)
	Helmar Well PW6/66(COG)	1975 to present	continuous operation
Northwest Quadrant	Sacco Well PW8/52(COG)	1953 to 1991	removed from service, low level volatile organic compound contamination
	Paisley Road Well PW4/59(COG)	1962 to present	continuous operation
	Smallfield Well PW3/66(COG)	1970 to 1993	removed from service, low level volatile organic compound contamination
	Queensdale Well PW1/70(COG)	1973 to present	continuous operation
	Calico Well PW4/76(COG)	1979 to present	continuous operation
Southwest Quadrant	Membro Well PW1/53(COG)	1997 to present	continuous operation
	Edinburgh Road Well PW2/53(COG)	1955 to 1996	removed from service, low level volatile organic compound contamination
	Dean Avenue Well PW3/58(COG)	1972 to present	continuous operation
	Water Street Well PW16/53(COG)	1956 to present	continuous operation
	Downey Road Well PW5/67(COG)	1980 to present	continuous operation
	Univ. of Guelph PW1/73(COG)	1970 to present	continuous operation

Quadrant	Pumping Well	Service Dates	Status in 2019
Southeast Quadrant	Carter Wells PW2/62(COG) & PW1/89(COG)	1963 to present	continuous operation
	Arkell 6 PW6/63(COG)	1967 to present	continuous operation
	Arkell 7 PW7/63(COG)	1964 to present	continuous operation
	Arkell 8 PW8/63(COG)	1989 to present	continuous operation
	Arkell 1 PW1/66(COG)	1967 to present	continuous operation
	Arkell 14	2012 to present	continuous operation since 2015 (end of Operational Testing Program)
	Arkell 15	2012 to present	continuous operation since 2015 (end of Operational Testing Program)
	Burkes Well PW2/66(COG)	1975 to present	continuous operation

We’ve made improvements since our 2014 WSMP

Since the completion of the Water Supply Master Plan in 2014, the City has initiated several projects recommended in the Master Plan.

The Arkell Spring Grounds Operational Testing Program, designed to evaluate potential impacts associated with increased groundwater pumping, was successfully completed between 2011 and 2015. The result is an increase in the City water supply capacity by about 9,000 m^3/day. For more information visit http://guelph.ca/plans-and-strategies/water-supply-master-plan/arkell-spring-grounds/.

The Membro production well (PW1/53) was replaced in 2016 with a new well (Membro Replacement Well). The original Membro Well contained a liner which reduced the diameter of the well and the size of the pump that could fit into the well. The Replacement Well was constructed at a larger diameter for increased pumping up to the permitted amount of 6,050 m^3/day. Long term testing of the replacement well will be conducted in 2020.

Structural improvements have been made to the Clythe Well to improve water quality. This well is expected to be online in 2022, following construction of a new water treatment facility and associated watermains. The Clythe well is currently limited to 3,396 m^3/day. However, subject to a testing program assessing potential impacts to surface water and groundwater users, the permitted rate may be increased to 5,237 m^3/day.

Improvements have been made to the Glen Collector at the Arkell Spring Grounds. This includes trench upgrades that have increased the capacity of the groundwater recharge system.

The City is currently undertaking a project in the Southwest Quadrant to upgrade a test well into a test production well and conduct long-term testing of the well capacity and monitoring of associated pumping effects on the aquifer/natural environment. If this becomes a production well site, it will add to the overall system capacity.

A proposal for the future use of the Dolime Quarry lands is currently under consideration by the City. The proposal includes the protection of the quality and quantity of the primary aquifer system utilized by the City for water supply. Alternatives will consider how to potentially capture and treat a portion of the 11,000 m^3/day of groundwater that is extracted during quarry operations for City supply.

In addition to these ongoing projects, the City is actively implementing source protection programs to protect its existing water supply and to prevent loss of water supply capacity in the future. These Source Protection programs included the Tier Three Water Budget Assessment, conducted in association with the Grand River Conservation Authority (GRCA), to determine the amount of water that may be available for municipal water supply. This assessment resulted in a Significant water quantity risk rating for the City's supply. Subsequently, an assessment was completed to develop a strategy for managing the identified water quantity risk. In addition to this strategy, the City is working with MECP, GRCA and Wellington County to develop Source Protection Policies to help manage groundwater resources within the delineated vulnerable area (WHPA-Q). For more information on the City's source protection programs visit the following websites:

- http://guelph.ca/plans-and-strategies/drinking-water-source-protection/
- https://www.sourcewater.ca/en/source-protection-areas/Guelph-and-Guelph-Eramosa-Tier-3.aspx
- https://www.sourcewater.ca/en/source-protection-areas/resources/Documents/Grand/GGET-Threats-Management-Strategy-2018-06-14-final.pdf

Water Efficiency and Demand Management

In Guelph we depend mostly on groundwater for our water supply, so we know it makes sense to use our water wisely. Water efficiency and demand management will be as important during this Master Plan Update as they were during the 2014 Water Supply Master Plan. We are committed to using less water per capita than comparable Canadian cities! Since 2006, because of our many successful water conservation initiatives, we have reduced our community's average daily water production by twelve per cent, with Guelph residents using 20 per cent less water per person per day than the average person in Ontario. For more information regarding Guelph's current water efficiency opportunities and initiatives, go to http://guelph.ca/ourstoconserve.

The 2016 Guelph Water Efficiency Strategy Update identifies the preferred program, policy and resource requirements to achieve and sustain the water use reduction targets of the City's Water Supply Master Plan, Community Energy Plan and City Council's Strategic Plan. This report can be found at: http://guelph.ca/plans-and-strategies/water-efficiency-strategy/.

Updating our Water Supply Master Plan

Our updated Water Supply Master Plan will provide a community endorsed framework for ensuring an adequate and sustainable supply of water to meet current and future needs of all our customers, until the year 2041 and will identify challenges beyond this timeframe. It will be our strategic plan for implementing – in a phased manner – specific projects to increase our current water supply capacity and will provide the basis for individual studies under the Class EA process.

The Master Plan will be a key document considered during the Municipal Comprehensive Review (MCR), which will be completed by the City between 2020 and 2021. Through the MCR, the City will bring its Official Plan into conformity with the Provincial document "A Place to Grow: The Growth Plan for the Greater Golden Horseshoe" (the Growth Plan). The Master Plan update will incorporate the population targets to 2041 outlined in the Growth Plan.

Our Proposed Purpose Statement

Phase 1 of the Class EA planning process requires proponents to consider why a change is required and to document their reasons. This leads to the development of the Purpose Statement: a clear statement that identifies the problems, deficiencies and opportunities to be investigated. The Purpose Statement is the principle starting point of a Class EA study and becomes the central theme and integrating element of the project. It also assists in setting the scope of the project.

The **Purpose Statement** in the previous WSMP has been updated to provide a starting point for discussion:

> The City of Guelph is committed to manage population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residential, industrial, commercial and institutional customers.
>
> The 2014 Master Plan confirmed that the existing water supply capacity will not meet future demands and set out a strategy for meeting future demand. It is, therefore, prudent to undertake an update to the water demand forecast, the existing water system capacity and the status of ongoing projects, in order to review the plan and make adjustments as required. The proposed implementation strategy must deliver, through to 2041, an adequate amount of water in a safe and cost-effective manner and ensure that environmental sustainability is not compromised.

This 2019 update will build on the recommendations made during the 2014 Water Supply Master Plan, including water conservation/efficiency measures and additional sources of water supply.

Proposed Alternatives (Preliminary)

To identify the optimal water supply system to go forward with, we'll start by updating the alternatives considered in the 2014 WSMP. We'll consider the following:

1. **Water Efficiency & Demand Management:** Reducing or reusing water can have the same effect as increasing water supply – each litre of water saved by an existing customer can be made available for the growth needs of the community. Water conservation and demand management will be as important during this Master Plan update as it was during the 2014 Water Supply Master Plan.
2. **Groundwater Sources – In & Outside of the City:** We'll update information related to existing supplies and new supply sources recommended in the 2014 study, as well as investigate new water supply areas, including:
    a. Increasing water takings from established sources
    b. Re-establishing sources (includes treatment) that are currently not used because of poorer water quality
    c. Water takings from new sources
3. **Local Surface Water Sources:** New local surface water sources — with or without Aquifer Storage & Recovery (ASR) — will be considered, including possibly the Speed River, Eramosa River and Guelph Lake.
4. **Do Nothing:** Assumes no improvements to the current water supply system. It is expected that this alternative would have significant impact on the City's growth potential and would be contrary to the City's Official Plan.

Evaluating our Options – Evaluation Criteria

The Water Supply Master Plan (2014) provided a process to evaluate the proposed water supply options. This same process is intended to be used again during this update.

A detailed evaluation of each water supply alternative will be completed to assess the impact, if any, to each of the following environmental components[1]:

- **Public Health & Safety.** Addresses public's health and safety.
- **Natural Environment.** Addresses the protection of significant natural and physical elements of the environment (i.e., air, land, water, plants and animal life) including natural heritage environmentally-sensitive policy areas.
- **Social / Cultural.** Evaluates potential effects on residents, neighbourhoods, businesses, Indigenous Peoples and values, community character, social cohesion, community features and historical/archaeological and heritage components, in addition to municipal development objectives.
- **Economic / Financial.** Addresses the potential effect on water supply system capital costs and operating and maintenance costs.
- **Legal / Jurisdictional.** Considers regulatory and land requirements for each water supply alternative (and has regard to political boundaries).
- **Technical.** Considers technical suitability and other engineering aspects of the water supply system.

1. The Environmental Assessment Act (Section 1. (c) (i) to (vi)) defines the "environment" as: "air, land, water, plant and animal life including humans; the social and cultural conditions that influence the life of humans or a community; any building, structure, machine or other device or thing made by humans; any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities; or; any part of combination of the foregoing and the interrelationships between any two or more of them, in or of Ontario." This definition of the environment is used and is reflected in the environmental components used in the Phase 2 evaluation.

In keeping with our 2014 Water Supply Master Plan, we are proposing to use the following evaluation criteria to assess the feasibility of the identified water supply alternatives.

Evaluation Category	Evaluation Criteria
Public Health & Safety Considerations	• Ability of Alternative to meet provincial water quality and security requirements
Natural Environmental Considerations	• Potential effects to natural environment including siting/routing considerations and/or constraints. • Potential impacts to water resources (e.g., stream crossings, stream base flow, aquifer groundwater levels). • Potential impacts to natural heritage features, including provincially significant wetlands (PSWs), environmentally significant areas (ESAs), Areas of Natural and Scientific Interest (ANSIs), and sensitive species habitat. • Environmental management planning considerations.
Social / Cultural Considerations	• Short-term construction related impacts including dust, traffic, access, and noise. • Potential siting/routing considerations including cultural/heritage (e.g., archaeological) and/or tourist recreational resources. • Potential impacts to Indigenous Peoples and values. • Potential impacts from operations including impacts to groundwater and surface water users.
Economic / Financial Considerations	• Estimated capital costs. • Estimated operations and maintenance costs, including energy consumption.
Legal / Jurisdictional Considerations	• Location inside vs. outside City boundaries and associated jurisdictional issues. • Land requirements • Ability to address outside control (independence and reliability) of City with respect to participation in decision making, rate structures and risk related to location/position on proposed water supply scheme (e.g., end of pipe). • Consideration towards Political Boundaries.

Evaluation Category	Evaluation Criteria
Technical Considerations	• Ability to implement alternative • Maintaining operation during construction • Minimizing disruptions/ downtime • Constructability • Schedule and Timing • Water quality – requirement for treatment • Allowance for future treatment needs • Expandability • Ability to respond to change in regulatory treatment requirements/standards • Ability of alternative to use existing infrastructure

Agenda

Water Supply Master Plan Update Workshop #1
November 28, 2019 from 1:00 to 4:00 pm
Guelph City Hall, 1 Carden Street, Meeting Room B

Time	Agenda Item
12:45 pm	Registration and Welcome • **Participants will be welcomed at the door and asked to sign-in**
1:00 pm to 4:00 pm	**Workshop** • Opening Remarks • WSMP – Overview • Guelph's Current Water Supply System • City Updates – Since 2014 WSMP • WSMP Update – Objectives / Scope of Work • Next Steps **Discussion** • Ample opportunity for discussion will be provided – and encouraged – throughout the meeting.
3:50 pm	**Next Steps & Adjournment**

Discussion Topics and Questions – Workshop #1

Guelph primarily depends on groundwater for its water supply, so we know it makes sense to use this finite but renewable resource wisely. Keeping our Water Supply Master Plan up to date gives Guelph short-term, mid-term and long-term water supply options to meet predicted demand.

We want people to join the conversation! We understand that good planning involves the community so we're making it easy for people from Guelph, the

County, Townships and Town of Milton to be involved and kept up-to-date on our progress. Today, we want to gather your perspectives on many topics. Today's meeting will focus primarily on planning aspects of the Water Supply Master Plan update, such as the:

- Current level of water supply service provided, and any overall concerns or issues
- Proposed Purpose Statement for the WSMP
- Preliminary water supply alternatives we are considering
- Evaluation Criteria and Methodology we will use

Providing your Feedback

The following sheets include many of the questions we will be discussing today. Although we will be documenting much of the meeting conversation, it would valuable to also receive your individual feedback, including for those questions we do not discuss. Feel free to make note of your thoughts. A team member will gather your feedback at the end of the meeting. All feedback will be used to prepare recommendations to improve the Water Supply Master Plan update project and will be included in the Consultation Summary Report for the project.

General Questions

1. Are you aware of pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan?

Evaluating Existing System Capacity and Security of Supply

2. Certain City supply wells are pumped at maximum permitted (PTTW) rates during high demand periods or to make up capacity when other supply wells are shut down.

On average, these wells pump below the permitted maximum, but the maximum capacity is required to support current and/or future demand. Does well use, in this manner, support PTTW renewal at the established maximum values?

3. **The City's well system was developed over an 85+ year period and permits were issued for each well based on environmental conditions at the time of construction. In the absence of a demonstrated environmental impact caused by a well, should additional environmental study be required to renew a PTTW?**

4. **Three wells in the City's system are impacted by industrial contaminants and off-line. Is it reasonable to assume source remediation may improve water quality for these wells, should the City consider adding treatment to the wells to remove the contaminants, or should the wells be removed from the assessment of existing system capacity?**

Engagement Plan

5. **Do you have any suggestions to improve our community engagement plans?**

6. **Is the proposed project consultation appropriate for engagement of Indigenous Communities? How can it be adjusted/improved?**

7. **How can residents outside of Guelph be properly consulted to evaluate water supply sources outside of the City?**

Preliminary Water Supply Alternatives – To be Considered

8. Do you have concerns regarding any of the alternatives presented? Should any of these not be considered through the Water Supply Master Plan update?

9. Are there other water supply alternatives that should be considered by the project team?

10. Recognizing that new water supply sources will have an environmental impact of some extent, what level of potential

environmental impact related to municipal water supply is acceptable?

11. **Do you believe it is appropriate for the project team to consider obtaining water from sources that required treatment to remove contaminants (i.e., natural or industrial)? (Assumes that all regulatory standards are met after treatment)**

Evaluation Criteria & Methodology

12. **Are the evaluation criteria suitable for this study? Is there anything you would like to add or change?**

13. What are the benefits and drawbacks of using the Tier Three Groundwater model for evaluation of the water quantity impacts of source development?

Implementation Plan

14. MEA has proposed amendments to the MCEA process. Is it anticipated that these amendments will be adopted during the course of this project (approx. Q2/Q3 2020)?

Anything Else?

15. Is there anything else you think is important as we move forward with this process?

Water Supply Master Plan Update Workshop #1 – Summary

Date and Time of Workshop: November 28, 2019 from 1:00 to 4:00pm

Location: Guelph City Hall, 1 Carden Street, Meeting Room B

Overview

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP), from 2014, to define how we will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2041. Reviewing our existing water supply system is an opportunity to discuss with Guelph and surrounding communities how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Part of our WSMP update includes two (2) workshops to bring organizations together, providing a forum to discuss plans for the 2019 WSMP update and to gather input. The purpose of the first workshop was to review and provide input on key aspects of the Master Plan and the Class Environmental Assessment, including:

- Objectives and scope of the Master Plan Update
- Issues and opportunities to be addressed
- Alternative solutions to be assessed
- Evaluation criteria to be applied

There were 10 participants from six (6) organizations, along with four (4) City staff and four (4) AECOM consultants.

The format of the workshop included a presentation and opportunities for discussion and reflection.

Attendance

In addition to those listed below, the following organizations were invited: Wellington County, Township of Centre Wellington, Region of Waterloo, Ministry of Natural Resources and Forestry, Six Nations of the Grand River First Nation, Haudenosaunee Confederacy Chiefs Council, Mississaugas of the Credit First Nation, and Wellington-Dufferin-Guelph Public Health.

Organization	Name
Grand River Conservation Authority	Sonja Stynatka
Guelph/Eramosa Township	Harry Niemi
Ministry of the Environment, Conservation and Parks	Barbara Slattery
Ministry of the Environment, Conservation and Parks	Corrine Taylor
Ministry of the Environment, Conservation and Parks	Cynthia Doughy
Ministry of the Environment, Conservation and Parks	Lisa Williamson
Town of Milton	Nancy Reid
Township of Puslinch	Stan Denhoed
Wellington Source Water Protection	Emily Vandermeulen
Wellington Source Water Protection	Kyle Davis
City of Guelph	Dave Belanger
City of Guelph	Mary Angelo
City of Guelph	Scott Cousins
City of Guelph	Wayne Galliher

Organization	Name
AECOM	Alicia Evans
AECOM	Matthew Alexander
AECOM	Patricia Quackenbush
AECOM	Kathryn Ross

Meeting Format

Dave Belanger (City of Guelph) opened with a Statement of Territorial Acknowledgement and Alicia Evans (AECOM) provided an overview of the meeting and asked attendees to introduce themselves. Attendees were provided with copies of the PowerPoint presentation and Discussion Guide. The presentation was delivered by Dave Belanger (City of Guelph) and Matthew Alexander (AECOM). Alicia Evans (AECOM) facilitated the discussion.

The main sections of the presentation included:

- Overview of the WSMP Update and 2019 Special Issues
- Guelph's Current Water Supply
- Progress Since the 2014 WSMP
- Details About the 2019 WSMP Update
- Work Underway
- Assessing Alternatives
- Next Steps

Discussion questions related to the content provided in the presentation were asked at various points during the workshop. Attendees shared their comments with the group and had the opportunity to ask additional questions related to the specific presentation topic.

The discussion captured throughout the workshop is summarized in the sections that follow. Questions are noted with a "Q", answers with "A", comments with a

“C” and responses with an “R”. Answers were primarily provided by Dave Belanger (City of Guelph).

Overview of the WSMP Update and 2019 Special Issues

Discussion Question: What other questions, issues or concerns related to water supply should we consider while updating the WSMP?

Growth

- Impacts on surrounding industry, including expanding employment lands
- Interest in how the WSMP update will impact aspirational growth and growth plans of surrounding municipalities
- Consider how growth could impact sewage capacity and receiving waters

Security of Supply and Risk Assessment

- Look to other groundwater-based communities to see how they have addressed security of supply and risk assessments
- Consider how the Tier 3 Water Budget Study could provide input into determining the acceptable level of risk and whether the 10% security of supply allowance is enough or if it should be higher

Identifying B and C Projects

- Consider at what point it is appropriate to approach property owners who may find themselves near a Wellhead Protection Area (WHPA) that they weren’t previously in. This should happen early in the process during the Master Plan process or wait until subsequent Class EA B or C projects

Tier 3 Water Budget Study

- The City might be updating its Tier 3 Water Budget Study. Consider how the update may impact the WSMP update

Permit-To-Take-Water

- Private takings within the City and the cumulative impacts tied into some of the Tier 3 Water Budget Study impacts
- Consider impacts of non-permit-to-take-water takings, including agriculture

- Consider the City's ability to optimize and maximize water takings and minimize water loss from their system

Other

- Impacts to physical infrastructure outside of City boundaries
- Salt in drinking water has not been mentioned yet in the Master Plan update

C1: The Project Team should consider what the minimum level of technical assessment is to demonstrate the viability of Class EA B and C projects identified in the Master Plan and represent only viable projects to the public and other stakeholders.
R1: The City typically conducts field programs to assess the feasibility of a new supply such as it is doing today in the SW quadrant (Guelph South well). Other projects in the Master Plan will be assessed at the desktop level.

Q1: Would you engage other Agencies, including Grand River Conservation Authority, and landowners in terms of newly identified Wellhead Protection Areas?
R1: Yes. We would engage with the landowners first. Typically, contact with land owners would occur as part of a Class EA project once preliminary Wellhead Protections Areas have been identified.

Q2: Will the WSMP coordinate with other Master Plans related to wastewater and sewage?
A2: We will coordinate this Master Plan with other concurrent Master Plans, including wastewater.

Details About the 2019 WSMP Update

Discussion Question: Is the proposed project consultation appropriate for Indigenous Communities?

- Be extra diligent about reaching out for feedback to Indigenous Communities
- Engage the communities early in the project and consider asking for specific feedback
- Be more direct in communication and ask for impacts
- Lessons learnt from previous projects are that notices are sent out early in the Environmental Assessment process and continuous follow-up is conducted to solicit a response

- Municipalities do not act on behalf of the Crown and the Duty to Consult still lies with the Crown
- Feedback from an Indigenous Community on another project was that the problem statement should include issues around land claims or treaty rights – consideration of this feedback this requires early response from Indigenous Communities
- Ministry of the Environment, Conservation and Parks is available to help if there are questions about how to move forward/address communication received from Indigenous Communities
- The City's community engagement team is defining consultation within its own boundaries; the strategy is to supplement the MECP process requirements with additional local engagement
- Financial assistance is often requested for Indigenous Communities to assess issues

Details About the 2019 WSMP Update

Discussion Question: How can residents outside of Guelph be properly consulted to evaluate water supply sources outside of the City?

- Consider mail-outs, council presentations and public meetings
- Consider including Halton Region and the Town of Erin
- Engage directly with people living and working within a 100-metre distance of a Wellhead Protection Area

Q3: Where are the Class Environmental Assessment projects on the schedule?
A3: Those would not appear on the schedule. The schedule is only showing tasks related to the WSMP update. The WSMP prepares a priority list of Class EA projects and each Class EA project would have its own schedule. Not all the Class Environmental Assessment projects will be feasible. They could be downgraded or pushed into the future.

C2: Some of the Class Environmental Assessment projects will impact neighbours.
R2: Some projects will have greater impacts than others. WSMP considers impacts at a high level. Detailed impacts considered in the Class EA projects

C3: Provide more concise understanding of what potential projects will mean for neighbouring communities and what types of policies can be expected.
R3: Any potential projects outside of the City will be done in cooperation with other municipalities.

Work Underway

Discussion Question: Do you have concerns regarding any of the alternatives presented? Should any of these not be considered? Are there other water supply alternatives that should be considered by the project team?

Alternative #1 Demand Management/ Efficiency Programs

- Demand management and efficiency programs is an obvious alternative to consider, and should be the first priority
- The WSMP mentions that the City has water losses (e.g., leaks), therefore fixing infrastructure is an important element
- Consider how much the City can realistically expect the public to take on in terms of more water conservation efforts
- Consider efficiency on the consumer side; there are still gains to be made in terms of demand management and loss prevention

Q4: Are conservation measures dictated by building codes?
A4: Yes, to some extent. Building codes, such as water efficient fixtures, support conservation. There is interests for grey water use, however, incentives are local and cannot be mandated as part of growth. We do have conservation advocates for grey water use, but it is a big undertaking and is cost prohibitive.

Alternative #2 Groundwater Sources In and Outside the City

- Groundwater sources inside the City is an obvious alternative — it is the City’s land and supply
- Milton isn’t close in terms of an urban area
- Maximize sources inside the City
- Concerns about going outside of the City
    - Response: The Tier 3 Water Budget Study concluded that staying in the boundaries could create impacts on surface water; the issue

becomes staying in the boundaries and creating impacts versus spreading water-takings out beyond the boundaries and reducing impacts

- Financial impacts on people and businesses outside of the City
- Consider opportunities in the south-end for new wells beyond Ironwood, Steffler and Guelph South Test Well-1
- Consider impacts of auto scrap yard near the Logan test well and if it will increase the Wellhead Protection Area

Q5: There are a few wells in the north end of Guelph that are approaching 85 to 90 years old. How are updates to water supply infrastructure being considered?
A5: We continually optimize and maintain our water supply system. Even though these wells have been in use long-term, they are in good condition. They are bedrock wells that do not have the same issues related to aging well screens that sand and gravel wells do. The City regularly has rehabilitation programs that maintain the wells.

Q6: Are you looking at the Edinburgh well?
Q6: We are — any well within the City is currently under review during this Master Plan process. It's surrounded by other wells but is currently offline due to historical trichloroethylene impacts. There is an opportunity for use of the Edinburgh well to spread water takings out.

Q7: Are there any plans to look at getting rid of nitrates? For example, nitrate produced by horses in nearby agricultural areas.
A7: It is the City's understanding that some of the farms that may have contributed to nitrate impacts are no longer active. Nitrate concentrations have levelled off in the affected wells, this may be related to land use changes in the area.

Alternative #3 Local Surface Water Sources

- Quality concerns about the impact of nearby farmland on surface water (e.g. algae blooms)
- Water will be cleaner if source water is spring-fed

Q8: Does the definition of 'local surface water' mean Guelph Lake?
A8: Yes, although it's not the most readily accessible. If water were to be taken out of Guelph lake it would need to be when there is lots of water available (during high flow conditions). There are limitations—spring and fall have significant highs and lows, and there are constraints to how much water we can take. The Eramosa River is also a proposed option.

Q9: Is piping water from Lake Ontario off the table?
A9: We were directed by Council that a Great Lakes pipeline is not to be considered in the WSMP.

Other Alternatives

- Closed loop systems
- Harvesting grey water

Assessing Alternatives

Discussion Question: What are the benefits and drawbacks of using the Tier Three Groundwater model for evaluation of the water quantity impacts of source development?

Benefits

- Use the Tier 3 model to look at non-municipal sources and permits-to-take-water
- The model would be useful to demonstrate physical and policy implications
- A Tier 3 model was used in the Centre Wellington WSMP and it worked well in terms of evaluating potential water supply sources. The model can provide input to where feasible locations might be versus traditional best alternatives.
- The City has the benefit of having the model in-house so it can be run more cost efficiently

Drawbacks

- Consider whether the existing model has a large enough domain for the WSMP study area.
    - Response: When we originally set up the model, we purposely extended the model boundaries as far as we could to avoid boundary effects.

Q10: What is the model assessment graph showing on the Existing Water Supply Capacity Assessment slide?
A10: This graph is looking at existing capacity — what the wells produce and where the water levels are in the well. We will use the model for analysis as it is the best comprehensive tool to do the evaluation. The model was used during

the 2014 WSMP update to look at environmental impacts of water-takings and the effects on the water table and base flows.

Q11: Which wells have you not done a field test on to assess viability?
A11: The Guelph North and Guelph South locations identified in the 2014 WSMP. The Sunny Acres Park location was based on a monitoring well constructed by the City. Guelph North and Guelph South were generated by the model. These theoretical wells will require full field programs and feasibility studies to confirm viability.

Evaluation Criteria

Q12: Have you considered whether each evaluation criteria will be weighted equally? Or will you ask stakeholders about ranking criteria? It's common for some Environmental Assessments to have issues about where communities place greater importance on evaluation criteria and re-evaluations are required.
A12: A slide about the evaluation methodology was removed from the presentation because it is too early in the process. We will introduce the topic in future rounds of consultation. The previous WSMP update in 2014 took a qualitative approach. There can be issues with everyone agreeing on how to score evaluation criteria quantitatively.

C4: Consider including climate adaptability and resilience as evaluation criteria.

Next Steps and Adjournment

The project team reminded participants to fill out the discussion guide and submit their feedback and comments.

Next steps in the project include developing water supply alternatives, conducting a preliminary evaluation of alternatives and on-going community engagement.

Upcoming engagement opportunities include:

- Community Liaison Group Meeting #1 on Wednesday, December 4
- Community Open House #1 in late January 2020 (tentative)
- Community Liaison Group Meeting #2 in late April 2020 (tentative)
- Workshop #2 in August 2020 (tentative)

The workshop was adjourned at 4:00 pm.

Water Supply Master Plan 2021 Update

Agency and Municipality Workshop No. 2

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City of Guelph Territorial Acknowledgement

As we gather, we are reminded that Guelph is situated on treaty land that is steeped in rich indigenous history and home to many First Nations, Inuit and Métis people today.

As a City we have a responsibility for the stewardship of the land on which we live and work.

Today we acknowledge the Mississaugas of the Credit First Nation of the Anishinaabek Peoples on whose traditional territory we are meeting.

Agenda

1. Welcome & Check-In
    a) Opening remarks
    b) Meeting purpose and objectives
    c) Introductions
2. Project Update Presentation Q&A and Discussion
    a. Review of WSMP Objectives Purpose Statement and Objectives
    b. Overview of Major WSMP Tasks
    c. Major Task Progress Update
        i. Task 1 – Summary of Consultation Conducted to Date
        ii. Task 2 – Review of Population Targets and Water Supply Demand Forecasts
        iii. Task 3 – Review of Existing Water Supply Capacity Assessment
        iv. Task 4 – Review of Draft Evaluation of Alternatives
    d. Interactive Discussion - Evaluation of Alternatives
3. Next Steps

Housekeeping

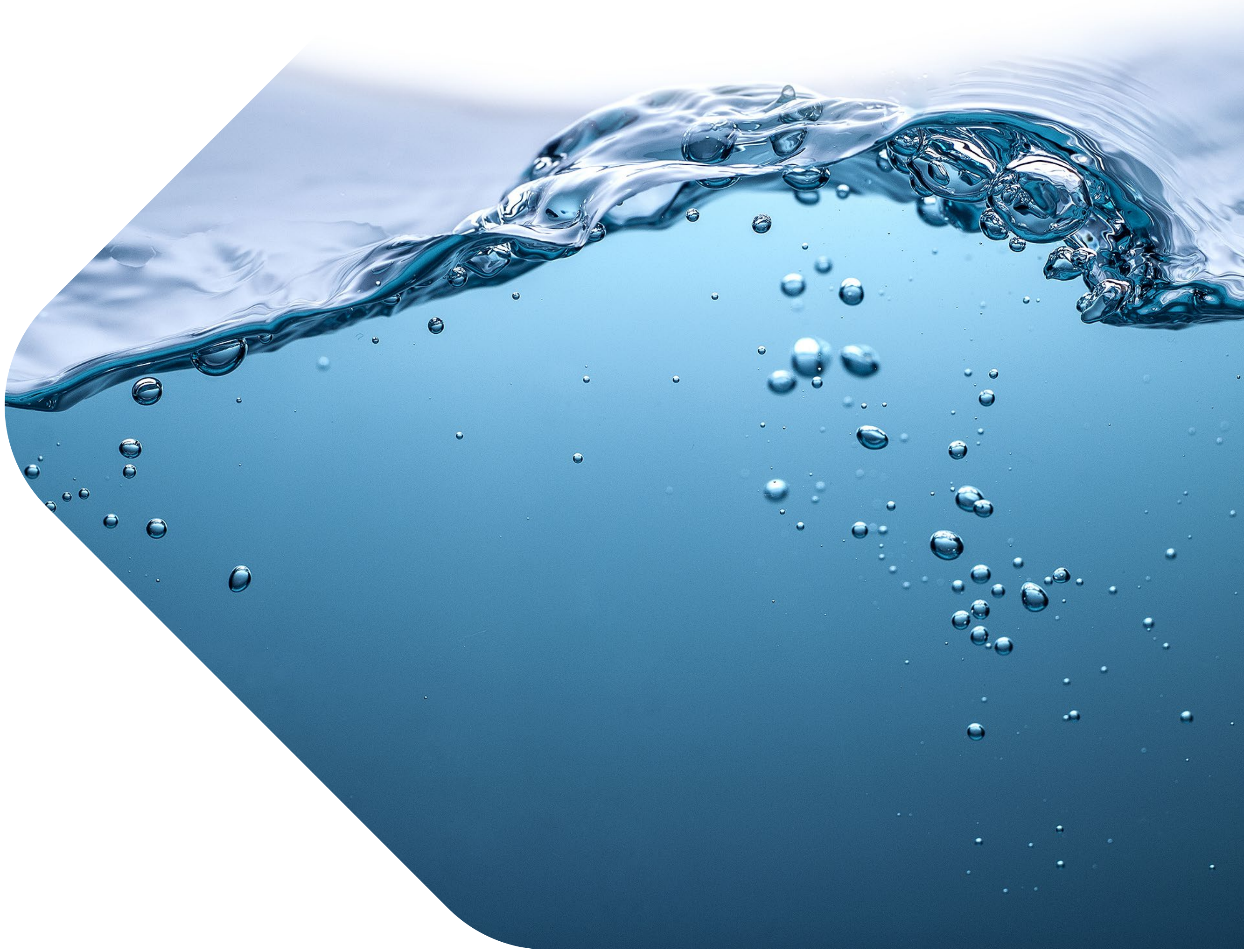
- Teams features
  - Camera, microphone, raise hand, chat (speech bubble)
  - If using a computer – access the features by hovering the mouse over the screen
  - If using a phone or tablet – tap on the screen to access features (may need to click on '…')
  - If using a phone or tablet – you can change the orientation and zoom in as needed
- Attendees will be muted until the discussion periods
  - Press the 'raise hand' button if you wish to speak and we will prompt you when it is your turn (be sure to enable your device's audio function and unmute when speaking)
  - Add questions and comments in the chat box
- If you have technological issues, please type your issue into the chat box
- Meeting recorded for purpose of preparing meeting summary

Introductions

Share your name and if you are representing an organization or group.

Water Supply Master Plan Update

Project Objectives and Major Tasks



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Water Supply Master Plan Update

- Will define where and how City gets safe and reliable water to the year 2051 and identify challenges beyond this timeframe
- Will review Guelph's water supply demand forecast and existing water supply and discuss with the community how to continue to meet the City's needs sustainably
- Additional sources to supplement our existing supply will be identified. As will alternative ways to conserve supply and manage demands
- When investigating existing and new water supply options we will consider things like climate change, water quality and quantity, economic factors, social/ cultural environment, and any relevant regulations
- Regardless of source, the water supply will continue to meet the service requirements of Guelph and the high standards set by the Ministry of the Environment, Conservation and Parks (MECP), including Source Water Protection requirements
- Short-term, mid-term and long-term water supply options will be recommended

Scope of Work – WSMP Update

Task 1 – Public Consultation	• Indigenous engagement • WSMP Community Liaison Group (CLG) meetings (3) • Municipality / Agency workshops (2) • Community Open Houses (2) • Water Conservation and Efficiency Public Advisory Committee
Task 2 – Population and Water Demand Forecasts	• Develop population projections – residential and ICI (employment) • Develop water supply demand projections
Task 3 – Existing Water Supply Capacity Assessment	• Update the assessment of existing well performance, maximum capacity and potential constraints for each supply source • Comparison of existing water supply capacity with demand forecast
Task 4 – Water Supply Alternatives	• Demand management & efficiency programs • Groundwater sources inside city • Groundwater sources outside city • Local surface water supply & Aquifer Storage and Recovery • Do nothing
Task 5 – Water Supply Master Plan Update	• Evaluation of alternatives • Risk Assessment • Develop WSMP Update Report

Water Supply Master Plan Update

Task 1 - Public Consultation To Date

September 14, 2021

Public Consultation Round #1

- **Guelph Wellington Development Association and Guelph and District Home Builders' Association –** Nov 7, 2019
    - the City Staff Technical Liaison Committee met with the Guelph Wellington Development Association and Guelph and District Home Builders' Association
- **Our community, our water open house** – Nov 26, 2019
    - Regarding a proposed solution between the City and the owners of the Dolime Quarry
- **Agency & Municipality Workshop #1** – Nov 28, 2019
    - 10 participants from 6 organizations, along with 4 City staff and 4 AECOM consultants
- **Community Liaison Group Meeting #1** – Dec 4, 2019
    - 13 of 17 members attended, along with 4 City staff and 3 AECOM consultants
- **Community Open House #1** – Feb 13, 2020
    - Attended by 17 members of the general public, including several students from a university class
- **Water Conservation & Efficiency Public Advisory Committee Meeting –** Sept 16, 2020

Public Consultation Round #1

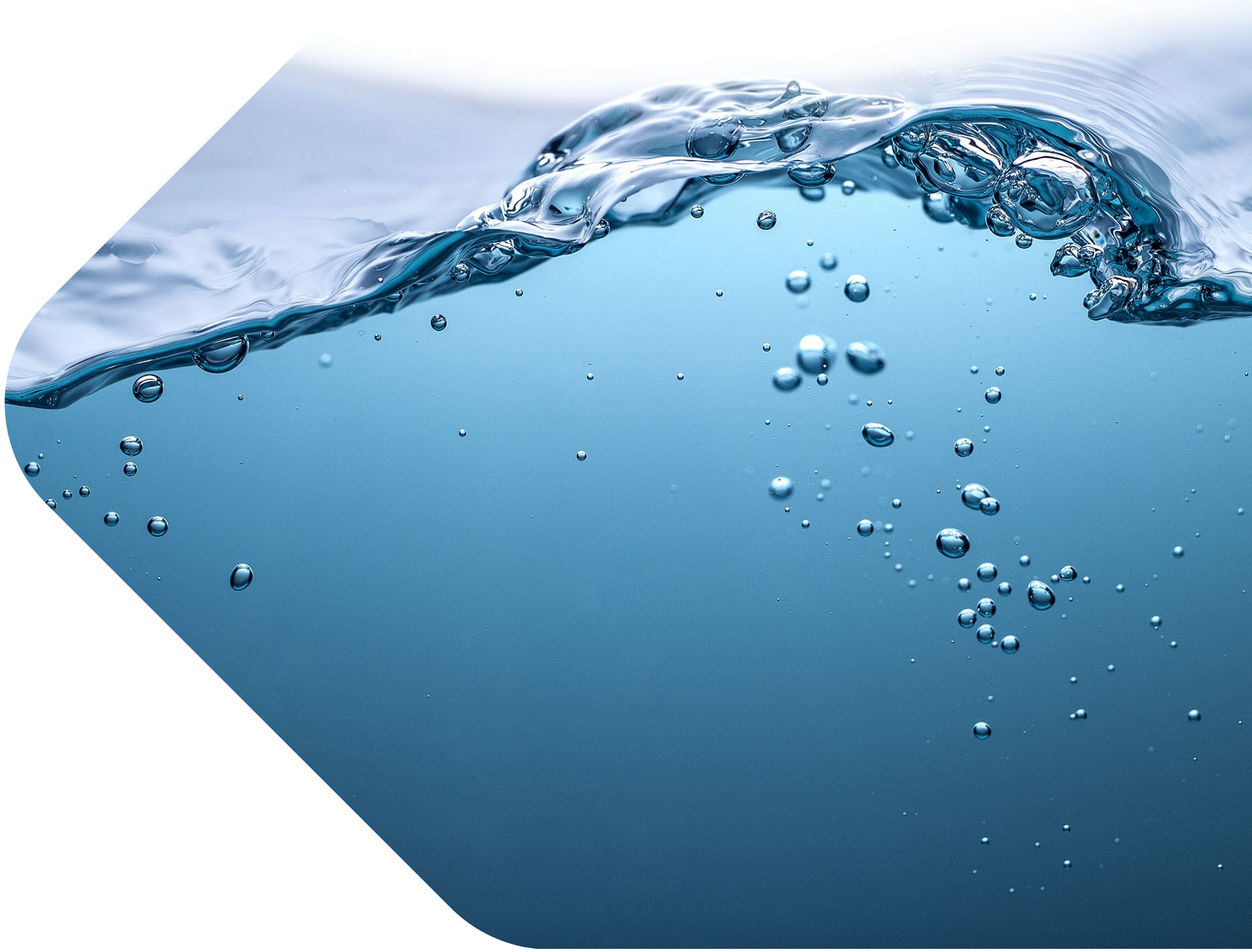
- **Project notifications and invitations to meet provided to:**
  - Six Nations of the Grand River
  - Haudenosaunee Confederacy of Chiefs
  - Mississaugas of the New Credit First Nation
- **In July 2021 City had opportunity to meet with Six Nations of the Grand River to discuss the water-related master plans being completed, including an introduction to the WSMP Update project**

Feedback from Consultation Round #1

- Prioritizing conservation;
- Protecting the natural environment;
- Managing growth and development;
- Controlling groundwater impacts from large water users;
- Monitoring emerging contaminants;
- Limiting impacts to aquatic and terrestrial wildlife; and,
- Valuing the agency of water.

Water Supply Master Plan Update

Task 2 – Population and Water Supply Demand Forecasts



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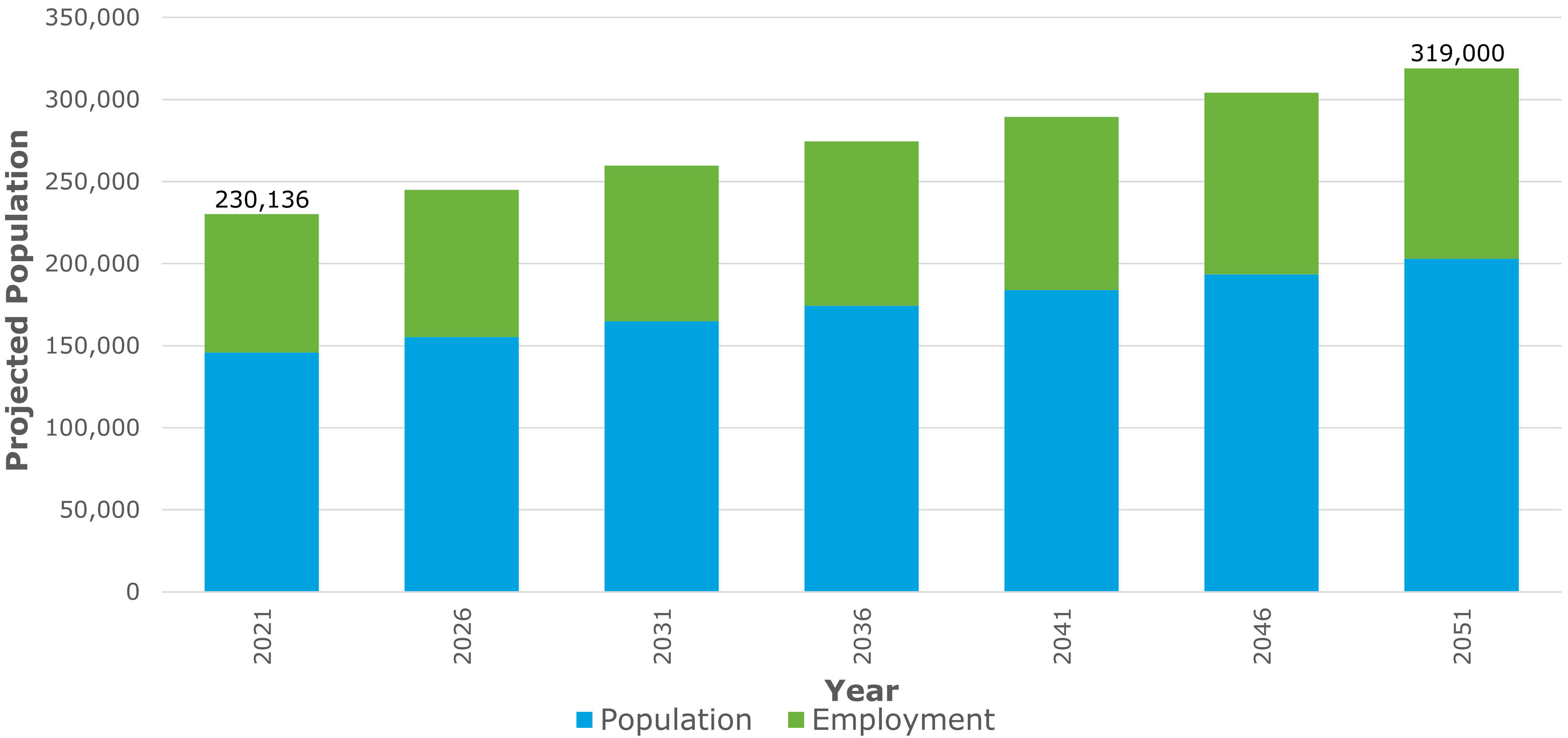
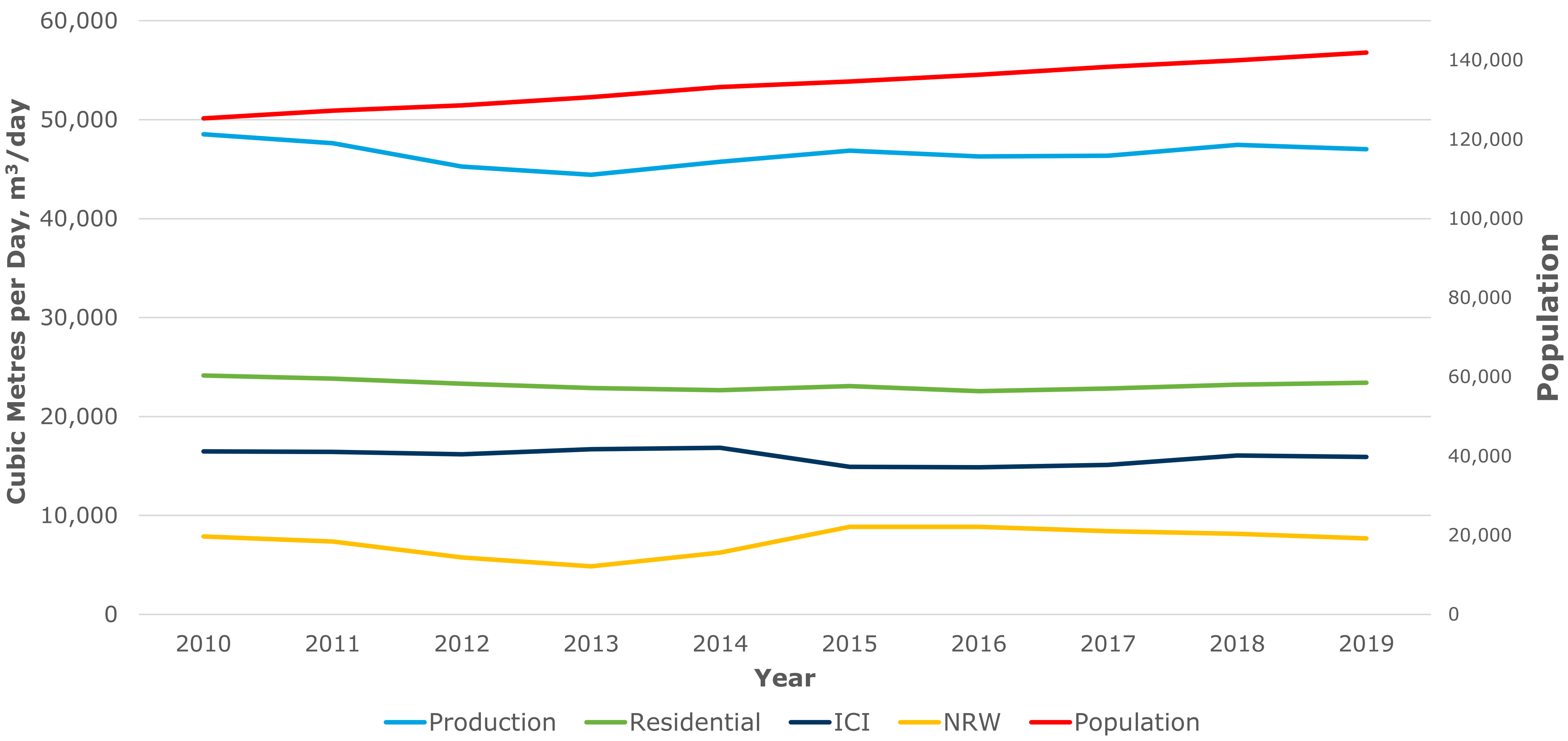
Task 2 Summary

- Population projections changed in the middle of the project to 2051 (30 years)
  - In August 2020, the Province of Ontario provided updated population forecasts for the City of Guelph to 2051 (203,000 residential population, 116,000 employment population)
  - Prior to this update, the WSMP Update project planning period extended to 2041 and considered the associated growth targets
- Review of City historical water supply demand data
- Design basis for projecting future water supply demand, including:
  - Residential
  - Industrial, Commercial and Institutional (ICI)
  - Non-Revenue Water (NRW)
- Projected water supply demands to 2051

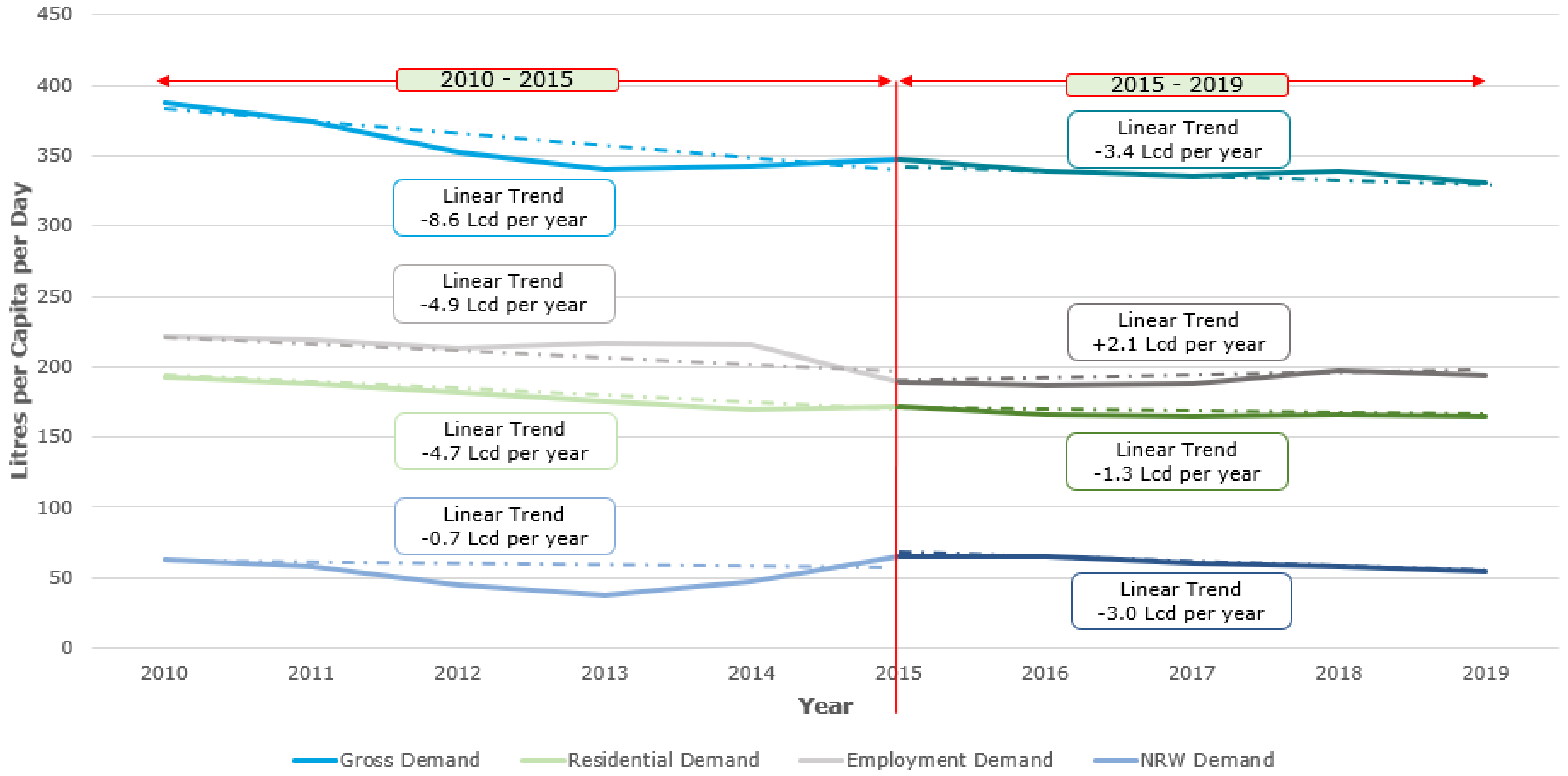
"Reference" Population Projections: 2021 - 2051



Average Annual Day Production, Demand, NRW & Population



Average Annual Day Per Capita Water Production, Demand and NRW Trend Analysis



Water Demand Projections – Design Basis

Average Per Capita Day Demand (2015-2019)

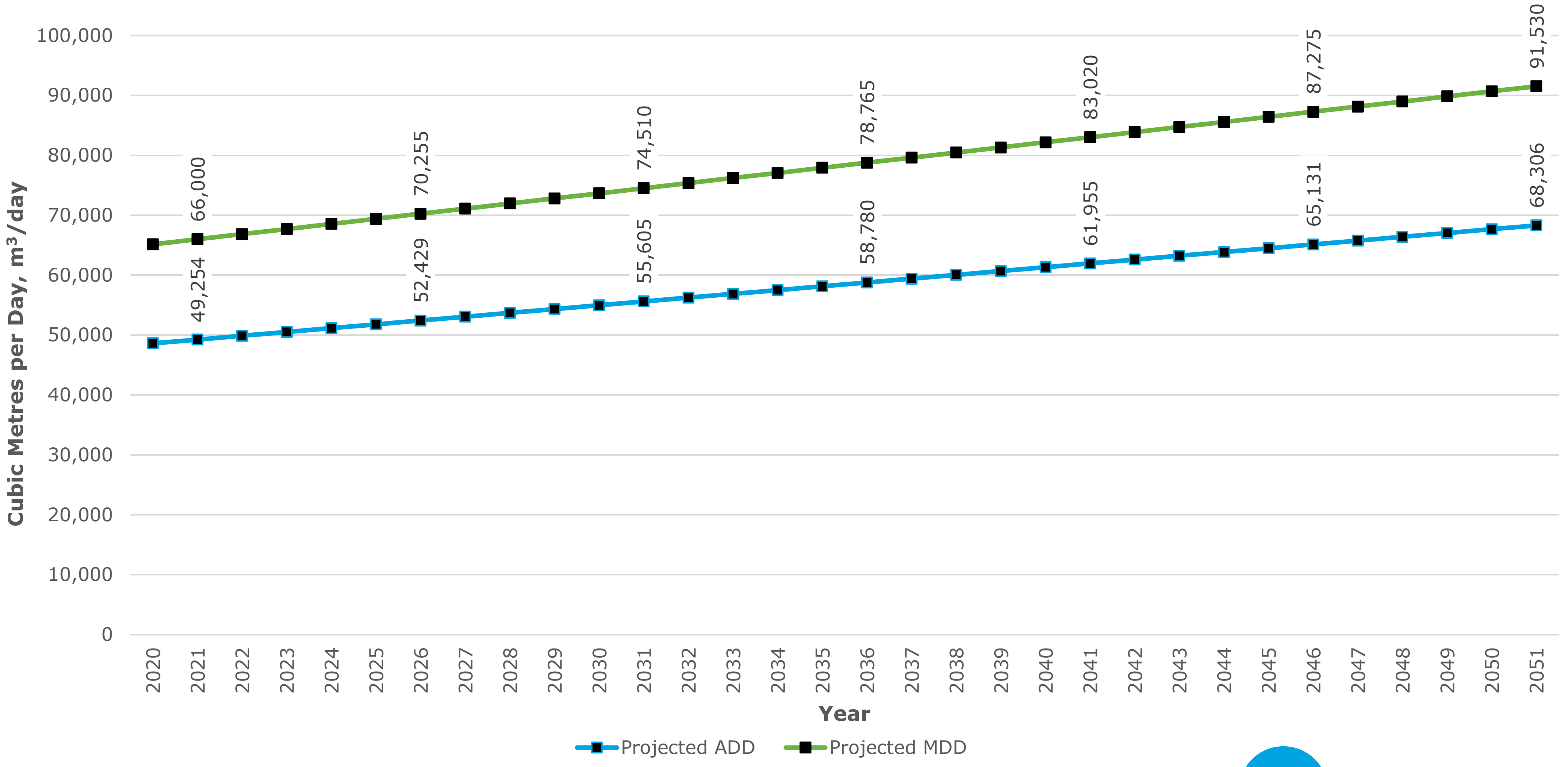
- Average per capita residential demand rate 2015-2019: **167** Litres per capita per day (Lcd)
- Average per capita employment demand rate 2015-2019: **191** Lcd
- Average per capita NRW rate 2015-2019: **61** Lcd

Maximum Day Demand

- Average Maximum Day Demand Factor (2010-2019): **1.24**
- Design Maximum Day Demand Factor: **1.34** (Highest value, 2010-2019)

Year	Total Average Day Demand (m^3/d)	Max Day Demand @ 1.34 MDF (m^3/d)
2021	49,254	66,000
2026	52,429	70,255
2031	55,605	74,510
2036	58,780	78,765
2041	61,955	83,020
2046	65,131	87,275
2051	68,306	91,530

Projected "Reference" Growth Average Day and Maximum Day Demands



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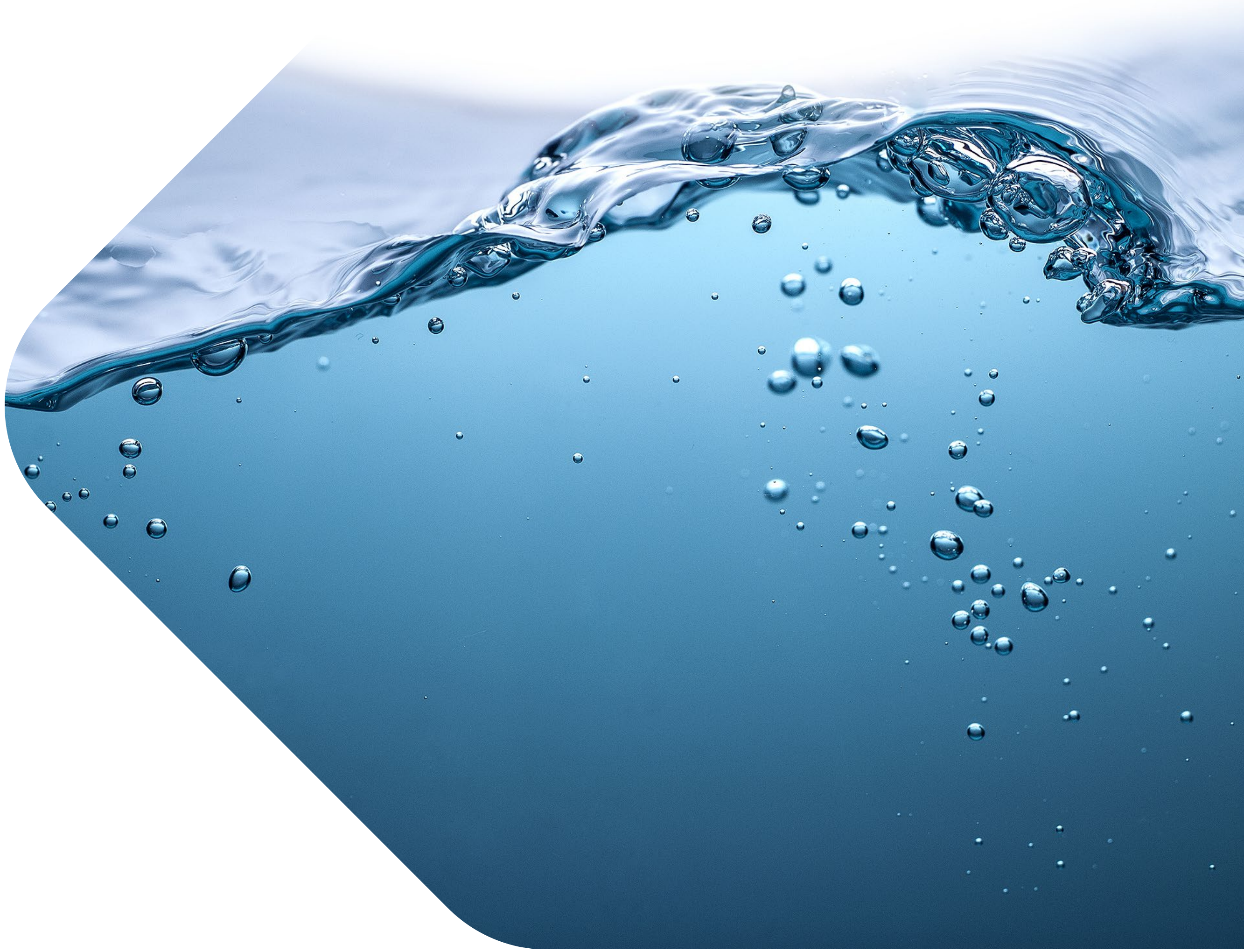
Water Supply Master Plan Update

Task 3 – Existing Water Supply Capacity Assessment



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Task 3 Summary

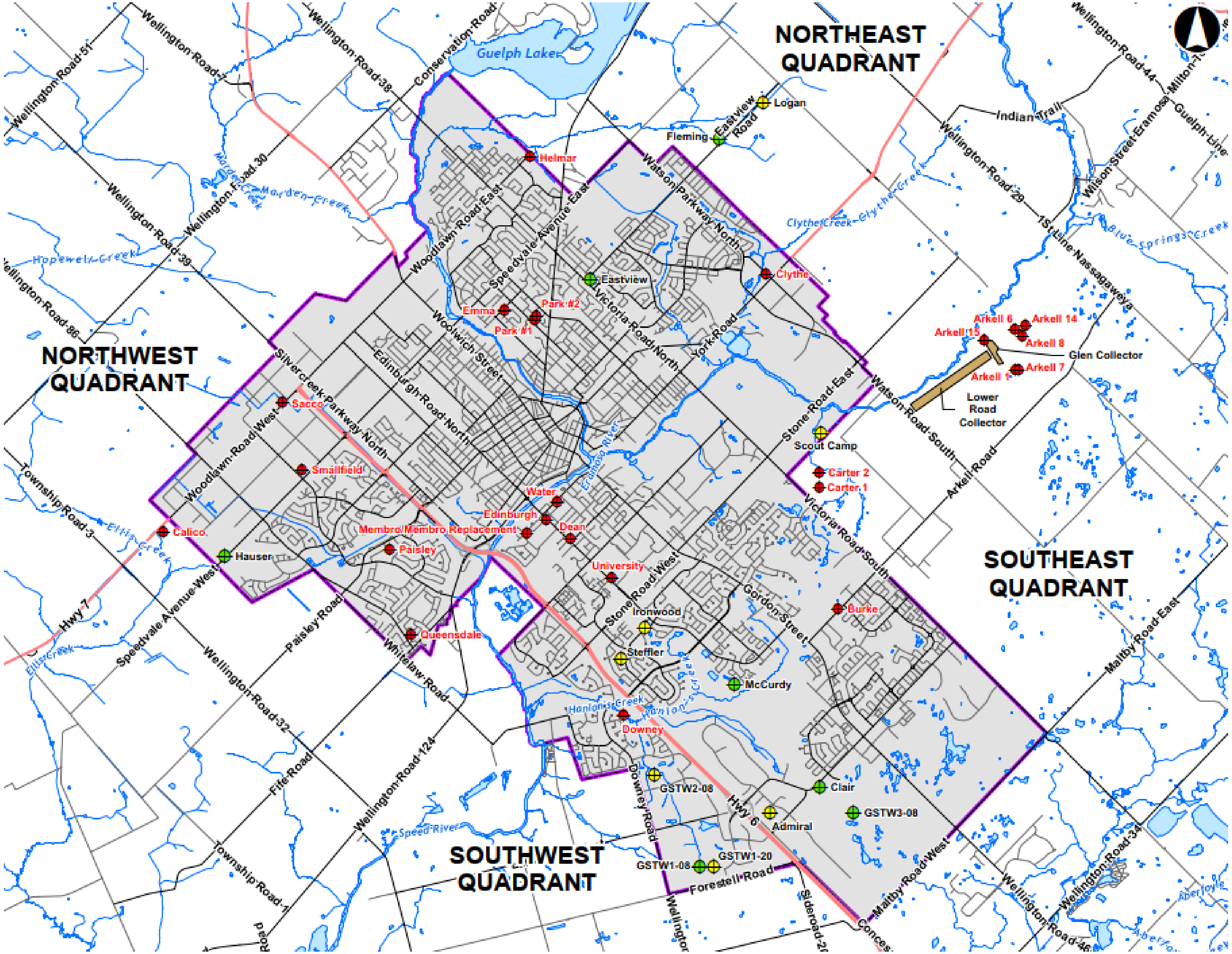
This task includes:

- Evaluation of the maximum capacity of each individual City well (how much each well can pump each day);
- The total sustainable capacity of the existing water supply system (how much can the entire system pump each day); and
- An assessment of the potential risks to the system (Security of Supply)

Overview of Guelph's Existing Water Supply System

- Reliance on groundwater to meet the City's water demands since 1879
- Guelph's water supply system includes production wells primarily installed in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system:
  - 25 production wells in the municipal supply system, with 21 wells in continuous operation - 4 wells offline due primarily to water quality concerns
  - Glen Collector captures shallow spring water in the Arkell Spring Grounds
  - Artificial recharge system: water is pumped from the Eramosa River to an infiltration pond/ trench – water infiltrates into the ground and some is captured by the collector system

Map of Guelph's Existing Water Supply System



Arkell Spring Grounds

Well Capacity Assessment – Summary

City Quadrant	2014 WSMP (m^3/day)	WSMP Update (m^3/day)	Net Change
SE	49,700	47,584	2,116 m^3/d reduction
SW	17,936	16,338	1,598 m^3/d reduction
NE	12,300	11,600	700 m^3/d reduction
NW	3,900	3,900	Unchanged
TOTAL	83,836	79,422	4,414 m^3/d reduction

- Glen Collector (SE) – capacity reduced to reflect available year-round flow
- Carter Wells (SE) – capacity reduced to balance groundwater pumping with ecosystem function
- Water Street Well Field (SW) – capacity reduced to reflect available flow with all wells pumping
- Other reductions reflect lower well performance (Helmar - NE)

Existing System Capacity vs. 2051 Demand

Demand/Capacity	2019	2051
Average Daily Demand (m^3/day)	47,015	68,306
Maximum Daily Demand (m^3/day)	58,441	91,530
Total Existing System Capacity (m^3/day)	79,422	79,422
Surplus/Deficit (m^3/day)	20,981	-12,108

- Existing system capacity has not been field-tested
- Pumping individual wells effects other wells in system, overall system function at maximum rates is uncertain
- Modelled steady-state capacity ~67,000 m^3/day
- Security of supply assessment completed to address risks and uncertainties in evaluation

Security of Supply Assessment

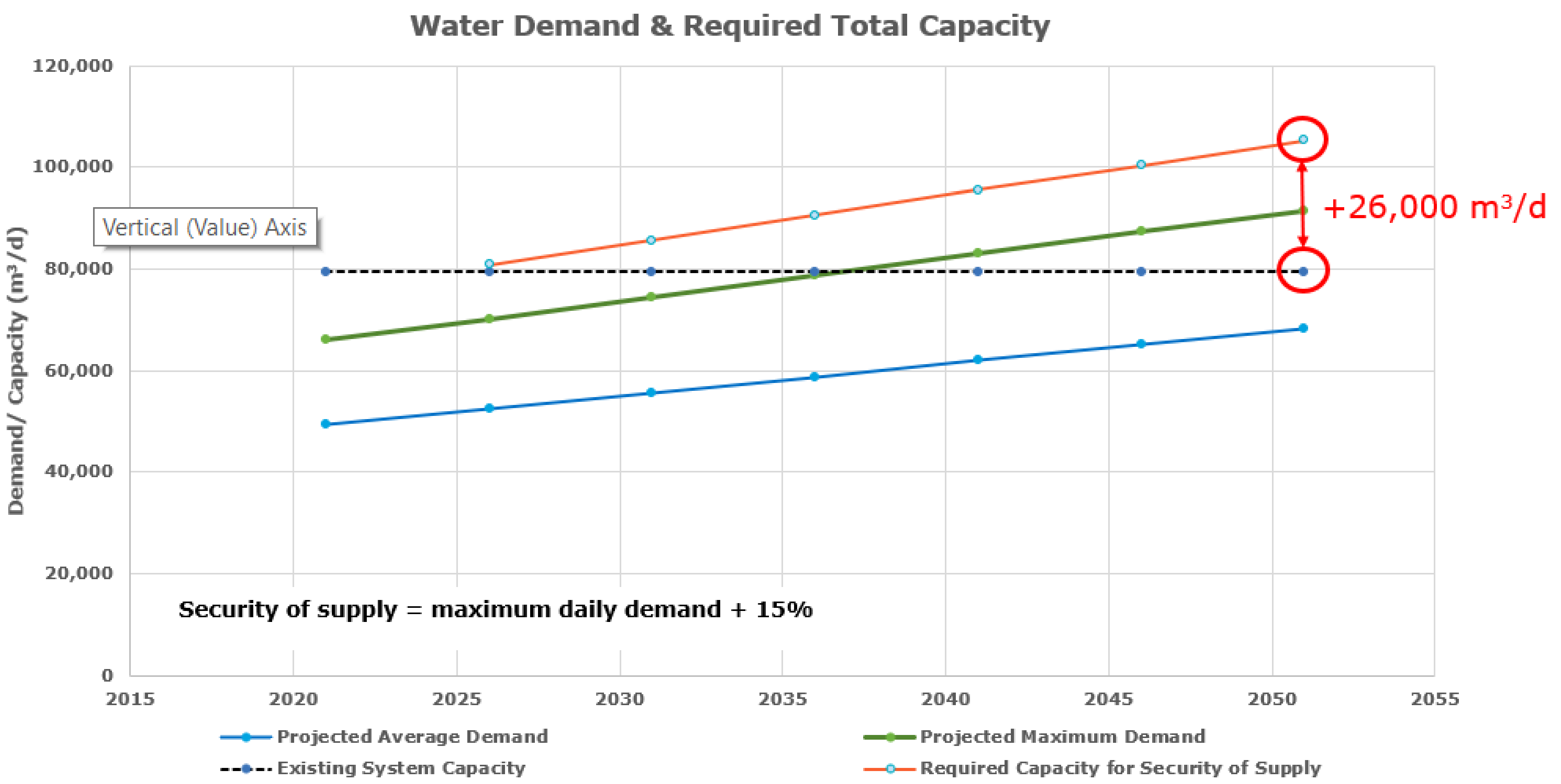
- Reviewed several risks to the City water supply:
  - Prolonged drought conditions
  - Contamination event
  - Loss of supply (well failure, damage, etc.)
  - Regulatory reduction in permitted pumping rate(s)
- Estimated reduction in capacity associated with each risk
- Evaluate amount of required "reserve" supply

Scenario	Capacity (m^3/day)	Capacity Reduction
Existing System Capacity	79,422	-
Prolonged Drought	71,477	10%
Contamination Event/ Loss of Well	71,422 to 78,022	2 to 10%
Reduction to Permitted Rate(s)	72,801 to 76,385	4 to 8%

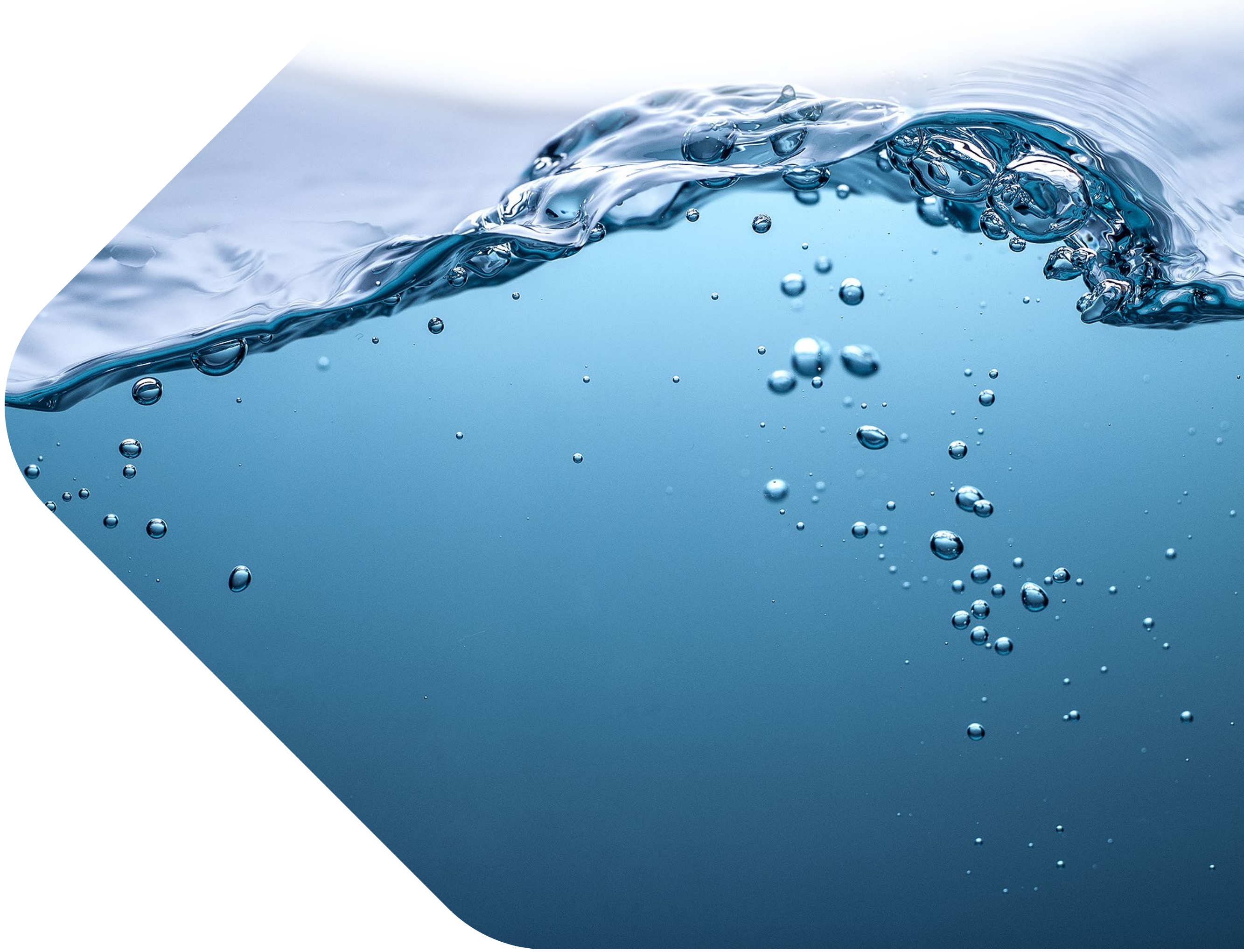
Additional System Risks

- Additional potential risks to the system were reviewed:
  - Drought combined with largest supply out of service
  - Regular maintenance/ mechanical failures combined with largest supply out of service
  - Distribution disruption/ damage
  - Specific contamination events (i.e. quarry, Eramosa River, contaminated sites, etc.)
- Most of the reviewed additional risks are currently managed by the City:
  - Demand management during drought conditions
  - Climate change models
  - Scheduling of maintenance
  - Response plan for watermain breaks
  - Source water protection
- Ultimately, 15% security of supply allowance was recommended

Required Capacity for Security of Supply



Questions or comments about Tasks 1-3?



Water Supply Master Plan Update

Task 4 – Water Supply Alternatives Assessment

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Alternatives Assessment

Assessment of proposed water supply alternatives under consideration:

1 - Water conservation and demand management/ water reuse

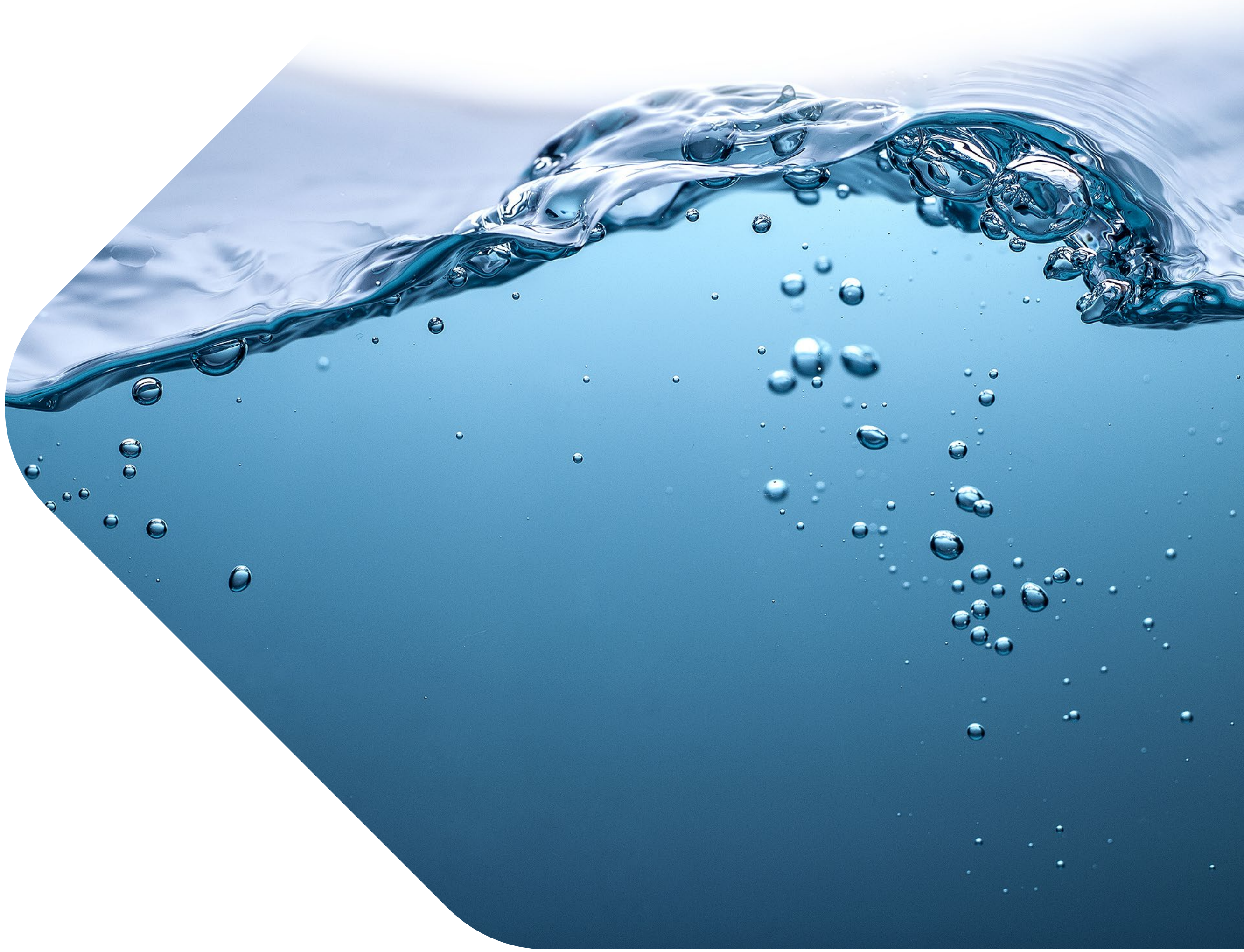
2 - Optimize and expand existing groundwater system

3 - Establish new surface water supply

4 - Limit growth/ do nothing

Water Supply Master Plan Update

Water Supply Alternatives – Water Conservation and Efficiency



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Conservation/ Efficiency Programming Scenarios

- Four scenarios to investigate future demand reduction and associated costs:
  - 1 – Static Residential and ICI per capita demands
  - 2 – Demand Reduction of 6.5% in 2051
  - 3 – Demand Reduction of 3.25% in 2051
  - 4 – Demand Reduction of 7.3% in 2051

Non-revenue Water

Economic Level of Leakage (ELL): point at which the cost of lost water (leakage) = costs of leakage prevention programs

Infrastructure leakage index (ILI) = Real Losses / Unavoidable Real Losses

- ILI=2.0 for Guelph in 2019
- Other jurisdictions (UK, Australia) have reported ELL when the ILI is below 3
- Results indicate that Guelph is near or at its ELL
- Recommended focus in future is to maintain the ILI, or improve where possible

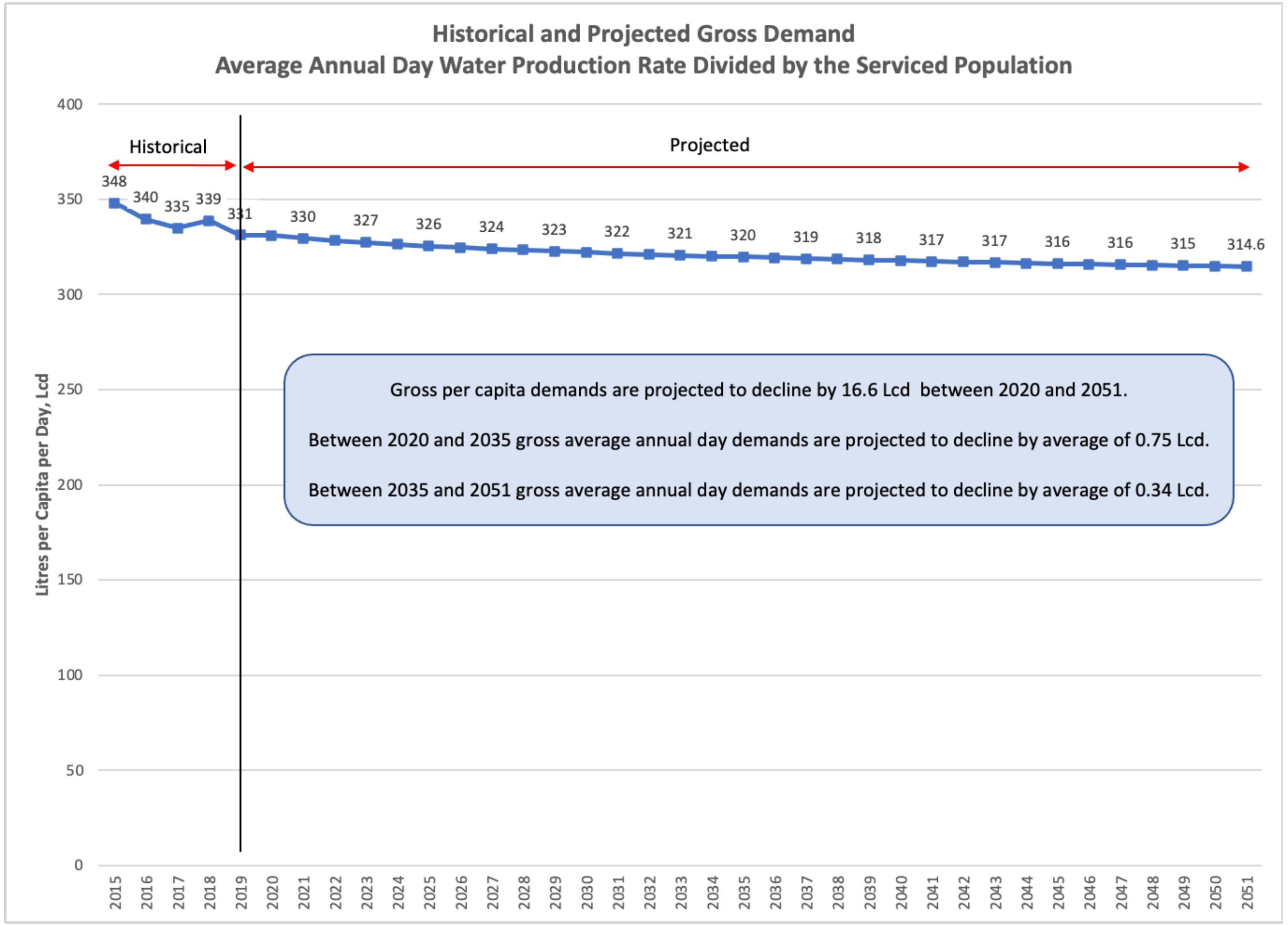
Scenario 1

- Assumes the City ceases non-mandatory programming
- Sets a baseline against which to compare scenarios
- Based on effort City has put into educating public, no resulting increase in demand is anticipated
- 2051 demands match Task 2 projections
- No cost associated with scenario

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	166.6	203,000	33,814
Employment	191.0	191.0	116,000	22,155
NRW	60.8	60.8	203,000	12,338
			Total	68,306

Scenario 2

- Continuation of current level of programming
- Decline in per capita demands has slowed over time
- Apply avg. rate of per capita demand decline observed from 2015-2019 as target for future decline
- Requires regular review of programs, replace those no longer effective
- Assume matching target reductions for residential and ICI



Scenario 2

- Results in 6.5% decline in 2051 demand
- Reduction of ~4,400 m^3/day vs. Scenario 1
- Associated cost estimate: $11.41 M or $2,578 m^3/day; $380,000/a operating costs

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338
			Total	63,882

Scenario 3

- Acknowledges that effective conservation programming becomes more challenging with success
- City may elect to focus programs on high water use customers if per capita demand trend continues to stabilize
- Approach would result in lower demand reduction at a lower cost to City
- Overall reduction of 3.25% in 2051 demand
- Reduction of ~2,200 m^3/day vs. Scenario 1
- Associated cost estimate: $4.73 M or $2,132 m^3/day; $158,000/a operating costs

Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	159.9	203,000	32,460
Employment	191.0	183.5	116,000	21,288
NRW	60.8	60.8	203,000	12,338
			Total	66,086

Scenario 4

- Addition of water reuse opportunities to Scenario 2 demand reductions
- Most aggressive option – highest demand reduction and program costs
- Review of water reuse options previously compiled
- Consideration of those most likely to reduce average daily demand (i.e. remove seasonal uses like irrigation)
- Total daily savings of 528 m^3/day estimated

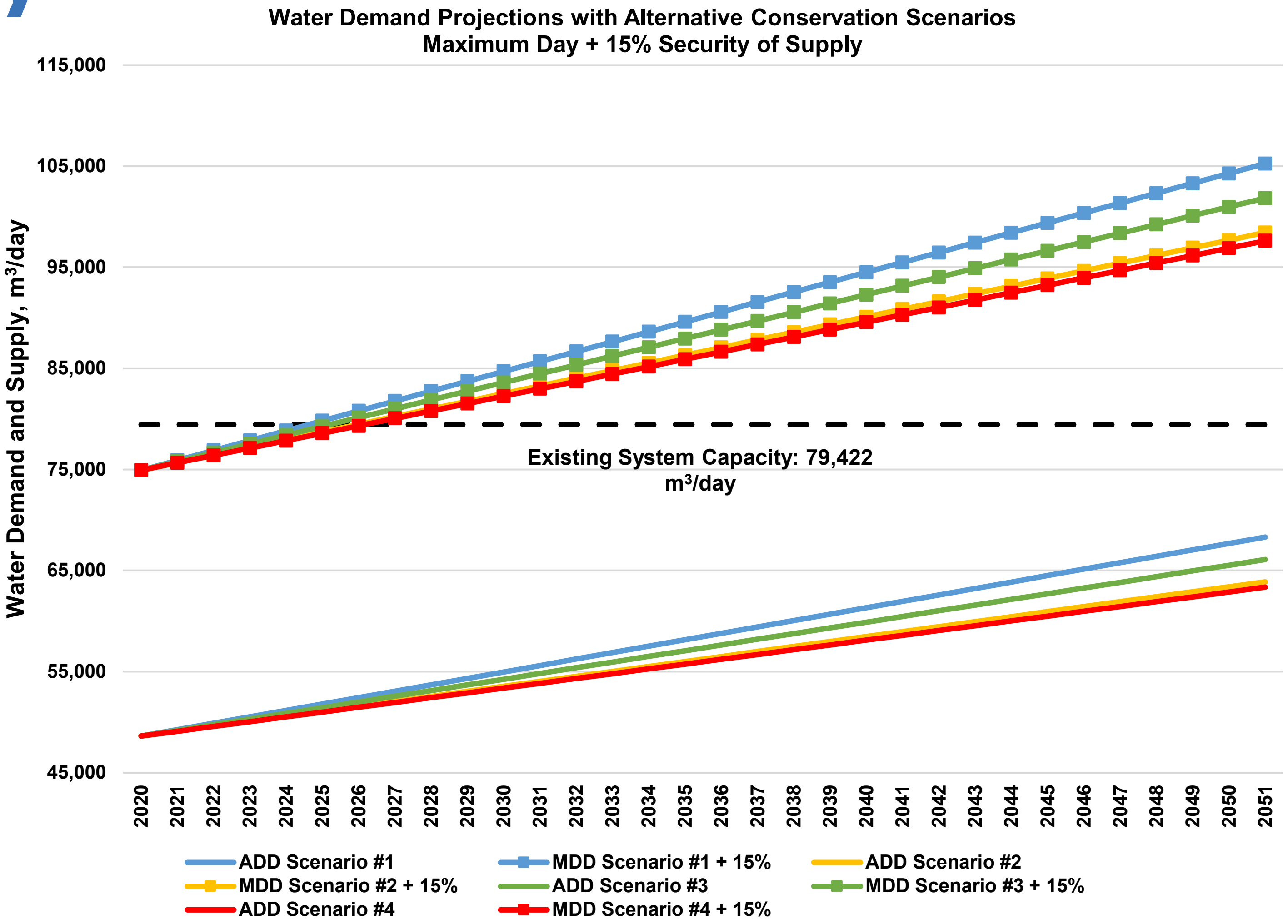
Measure	Annual Savings, m^3	Average Annual Day Savings, m^3/day
Street sweeping	3,175	8.7
Sewer flushing	11,223	30.7
Urban applications	168,168	460.7
Construction	10,160	27.8
Municipal irrigation	8,800	24.1
Golf course irrigation	147,000	402.7
Total	348,526	955
Total without Irrigation	192,736	528

Scenario 4

- Overall reduction of 7.3% in 2051 demand
- Reduction of ~4,900 m^3/day vs. Scenario 1
- Associated cost estimate: $15.04 M or $3,037 m^3/day; $586,000/a operating costs

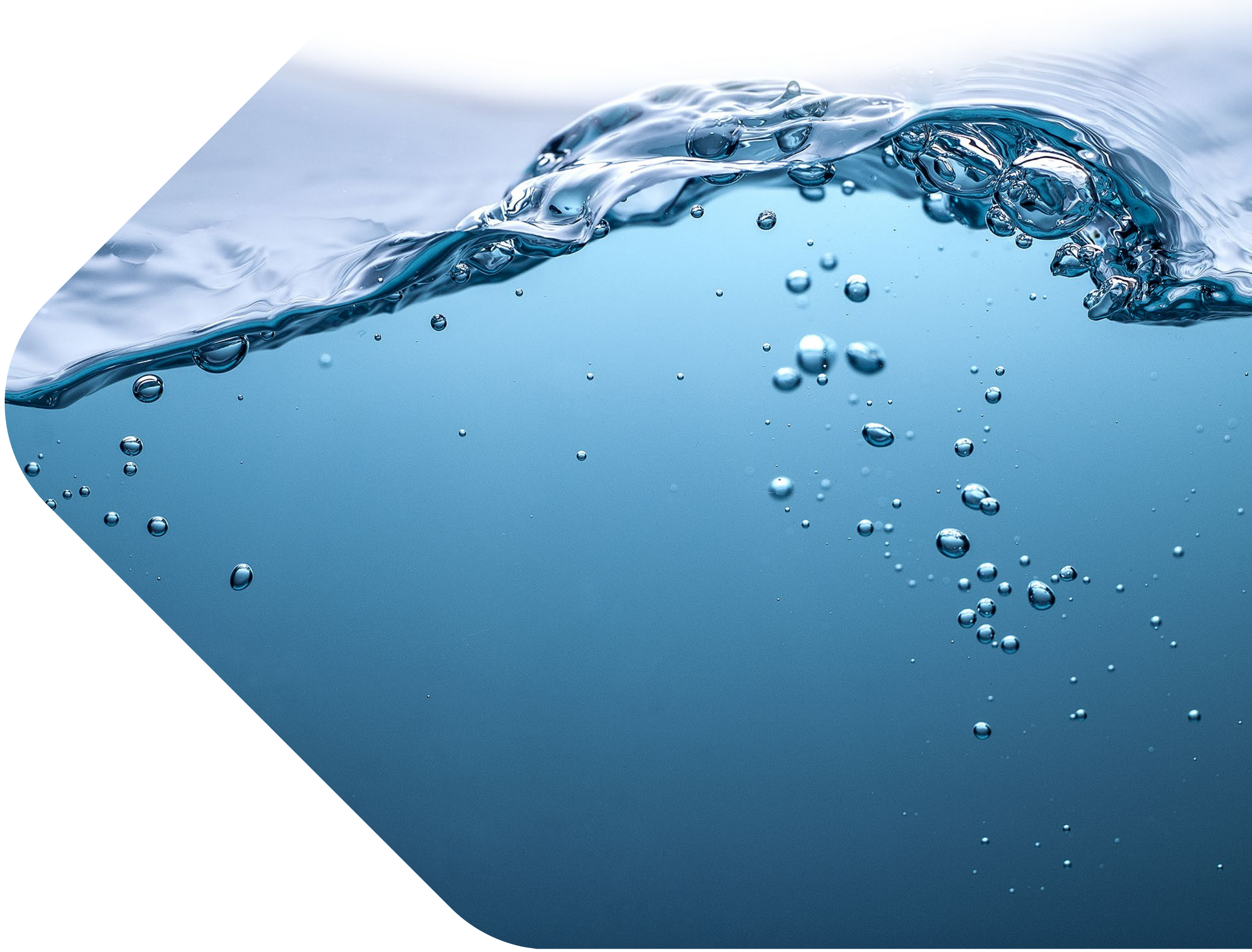
Sector	2020, Lcd	2051, Lcd	2051 Population	2051, m^3/day
Residential	166.6	153.4	203,000	31,140
Employment	191.0	175.9	116,000	20,404
NRW	60.8	60.8	203,000	12,338
			Total Potable	63,882
			Minus Estimated Water Reuse Savings	-528
			Total Potable Minus Reuse	63,354

Conservation/ Efficiency Programming Scenario Summary



Water Supply Master Plan Update

Water Supply Alternatives – Groundwater Sources



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Groundwater Alternatives

The potential opportunities for expansion of the existing groundwater supply system are grouped into the following alternatives:

- **Optimize** existing operating municipal sources
- **Restore** existing off-line municipal wells
- **Develop** existing municipal test wells
- **Install new wells inside** City boundaries (screened out through prelim. modelling)
- **Install new wells outside** City boundaries
- **Install new ASR wells** inside City to optimize excess Arkell Collector system volumes

Optimize existing operating municipal wells

- Reviewed optimization opportunities through historical well performance and discussions with Operations staff
- No significant additional capacity identified
- Recommendations:
  - Confirm capacity where uncertain (Arkell 1)
  - General maintenance, rehabilitation, replacement of equipment where required
  - Replace Calico well (same capacity anticipated)
  - Opportunity to increase Arkell recharge system within existing permit
- Review of previous recommendation to replace Glen Collector – screened out through preliminary modelling

Upgrades to Arkell Recharge System

Recharge System Modelling

- Three flow rates assessed: existing, 2x rate, 3x rate (all within existing permit)
- Max. flow rates increase; min. flow rates do not vary significantly between scenarios
- Field testing/ upgrades required to increase recharge
- Replacement of Lower Road Collector would improve system efficiency

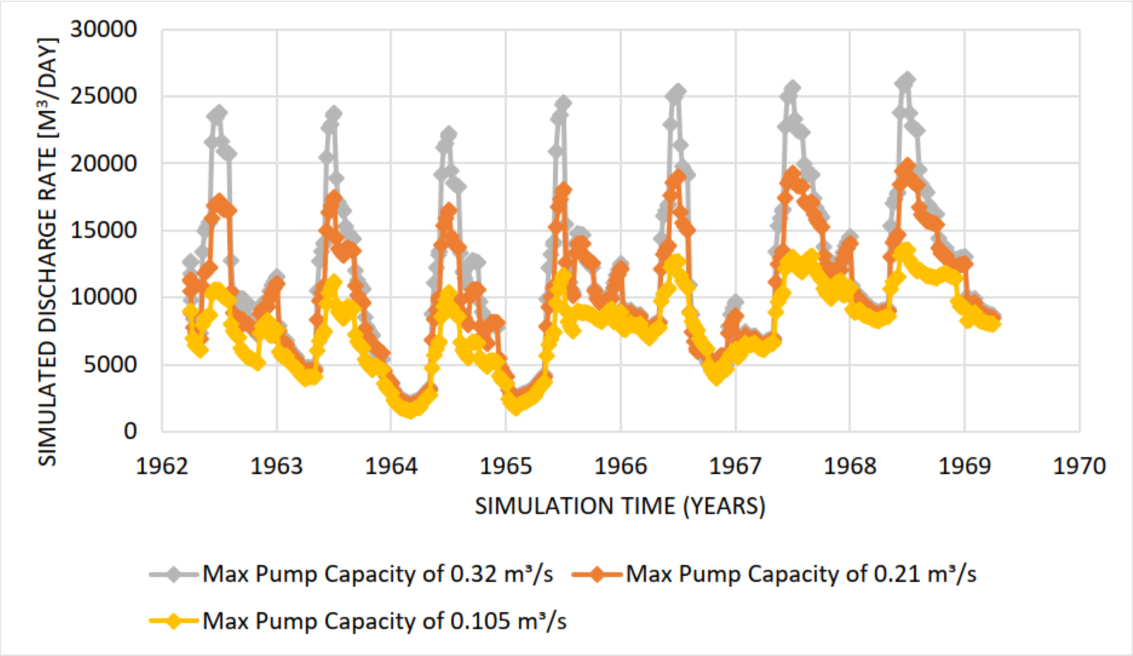
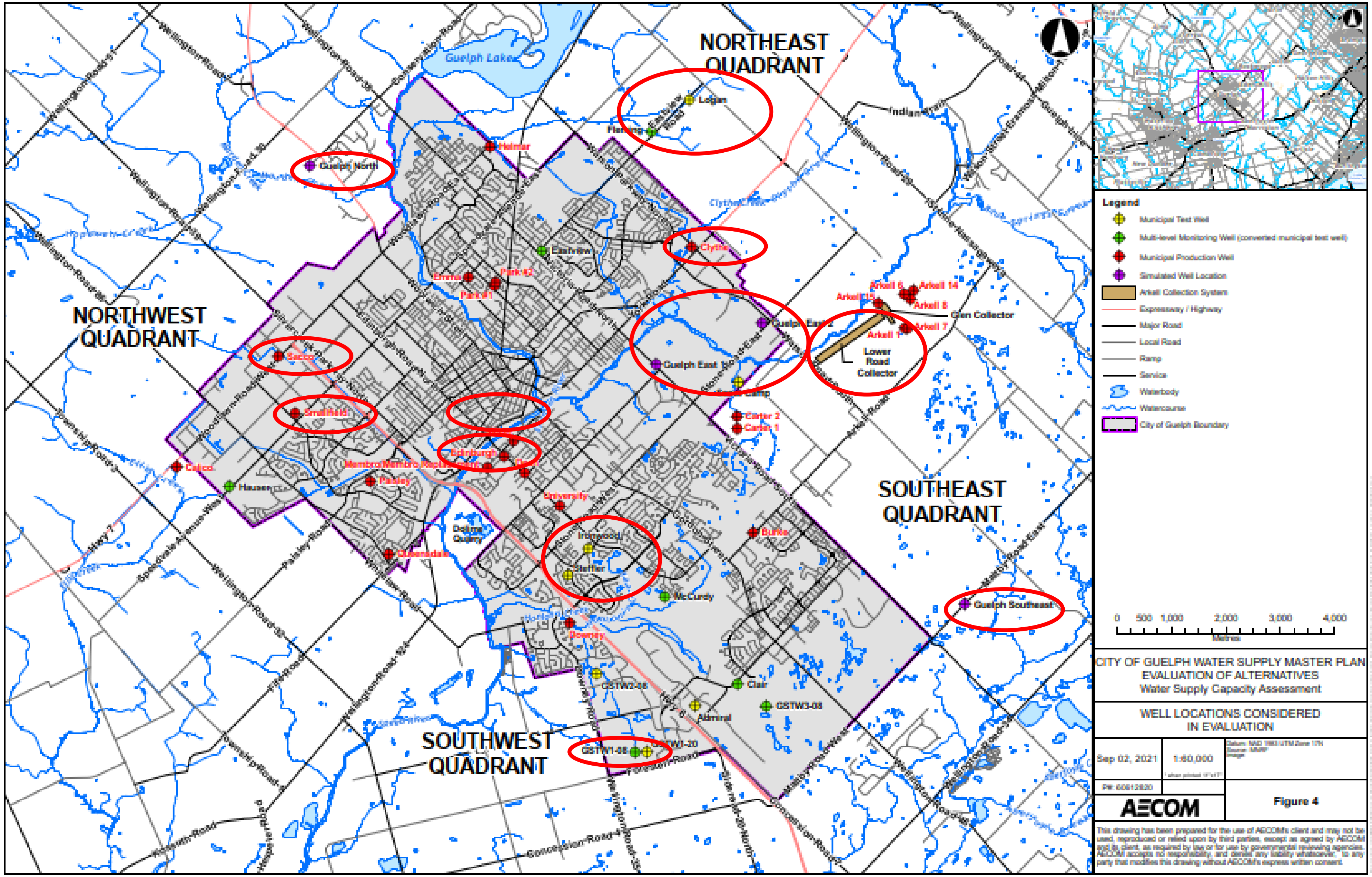


CHART 2 **Simulated Transient Glen Collector Discharge Under the Various Pump Capacity Scenarios**

Off-line/ New Sources



Restore existing off-line municipal wells

Quadrant	Well	Required Upgrades	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Northeast	Clythe	Well house upgrade; H2S, Fe&Mn treatment (EA complete)	1,180-3,400	$6.8M	$2,000
Northwest	Sacco/ Smallfield	wellhouse upgrade; VOC treatment	850-2,560	$13.1M	$5,100
Southeast	Lower Road Collector	new perforated pipe system & associated infrastructure	4,000	$14.67M	$3,700
		Total	**6,030**		

- Uncertainty about Clythe Creek requires additional field program to address as part of PTTW
- Sacco/ Smallfield alternative assumes combined treatment facility on Smallfield property; MECP correspondence: achieving clean up goals (i.e. ODWQS by 2051) is unlikely
- Full re-construction of Lower Road Collector anticipated; additional modelling recommended to optimize design; would benefit from recharge system upgrades
- Additional capacity in table represents modelled long-term average
- Costing developed for maximum capacity where existing data are available

Develop existing municipal test wells

Quadrant	Well	Required Infrastructure	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southwest	Guelph South	SWG EA/OTP; land acquisition; well house; connect to distribution	2,250-4,300	$5.3M	$1,200
Southwest	Ironwood/ Steffler	SWG EA/OTP; well house; disinfection; connect to distribution	2,250-8,000	$5.1 to 6.2M	$650 to 1,700
Northeast	Logan/ Fleming	new well; well house; connect to distribution	4,180-4,700	$10.1M	$2,150
Northwest	Hauser	new well; property in area; well house; connect to distribution	425-900	$6.6M	$7,300
Total			**9,105**		

- Modelled long-term average additional capacity of 4,500 m^3/day in SWQ (with active Dolime Quarry dewatering)
- Southwest Guelph EA initiated to assess additional water supply in SWQ in detail
- City has initiated project on Logan site to re-construct and test well

Assessment of Dolime Pond Level Management

- City has agreement in place to take over quarry water management
- Potential opportunity to increase municipal water supply while managing water quality concerns
- Maintain flow divide around quarry to isolate quarry water
- Quarry inflow ranges 8,000 – 11,000 m^3/day
- Managing quarry pond will allow for capture of additional water by surrounding wells or directly from quarry
- Modelling indicates 3,000 m^3/day of available capacity
- SWG Water Supply EA will assess available capacity, associated potential impacts and costs in detail

Assessment of Dolime Pond Level Management

Quadrant	Source	Required Infrastructure	Approximate Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southwest	Dolime	SWG EA/OTP; pumping station; WTP (if supply is direct from quarry); connect to distribution	3,000	$18.9M	$6,300

- SWG Class EA will assess optimal strategy for capturing available water
- Water quality assessment will determine treatment requirements
- Capture of quarry water would reduce current artificial discharge to Speed River – not relied upon for WWTP assimilative capacity
- Cost would be reduced if additional capacity is captured by surrounding wells

Install new wells outside City boundaries – Guelph North

- Approximate location - North of the City (western limit of Conservation Road; City does not currently own land here)
- Rationale - proximity to an area with high transmissivity within the Gasport aquifer and limited local groundwater usage
- Estimated available capacity – 2,935 m^3/day on an average basis
- Model output: >10% baseflow reduction to Marden Creek; near the Marden South PSW Complex
- Field study would assess potential for interference with G-E Township wells, private wells
- Fe&Mn treatment assumed as conservative cost assumption
- Estimated capital cost: \$12.8 M, \$4,375/m^3

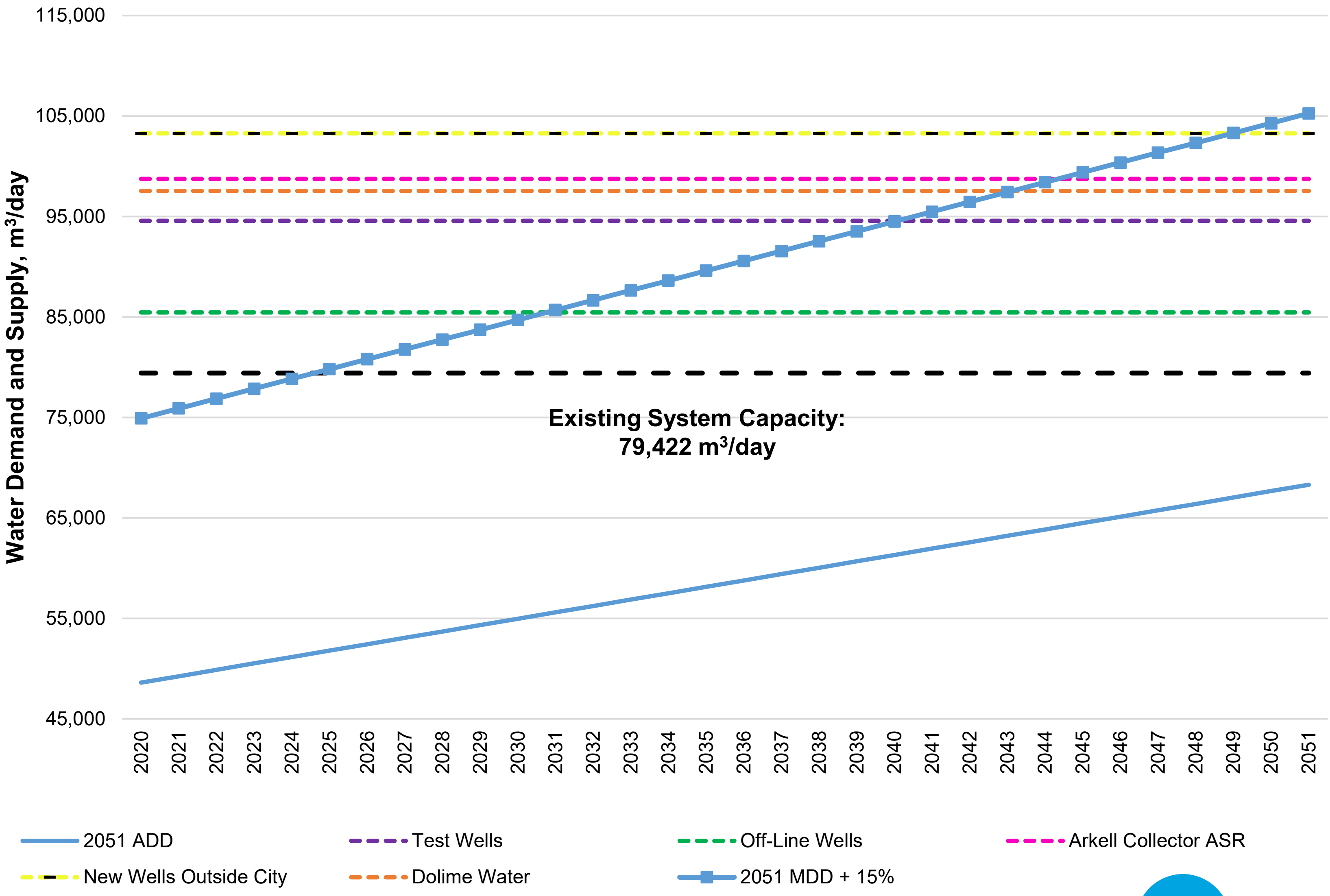
Install new wells outside City boundaries – Guelph Southeast

- Approximate location - southeast of the City (Maltby Rd. east of Victoria Road; City does not own land here)
- Rational - Proximity to area with high transmissivity within the Gasport aquifer and limited local groundwater usage
- Estimated available capacity – 1,600 m³/day on an average basis
- Model output: <10% baseflow reduction to Mill Creek; near Arkell Bog PSW Complex
- Field study would assess potential for interference with private wells
- Fe&Mn treatment assumed as conservative cost assumption
- Estimated capital cost: \$10.3 M, \$6,400/m³

Install new ASR wells inside City

- Will be discussed under surface water alternative section

Alternative #2 Summary



Water Supply Master Plan Update

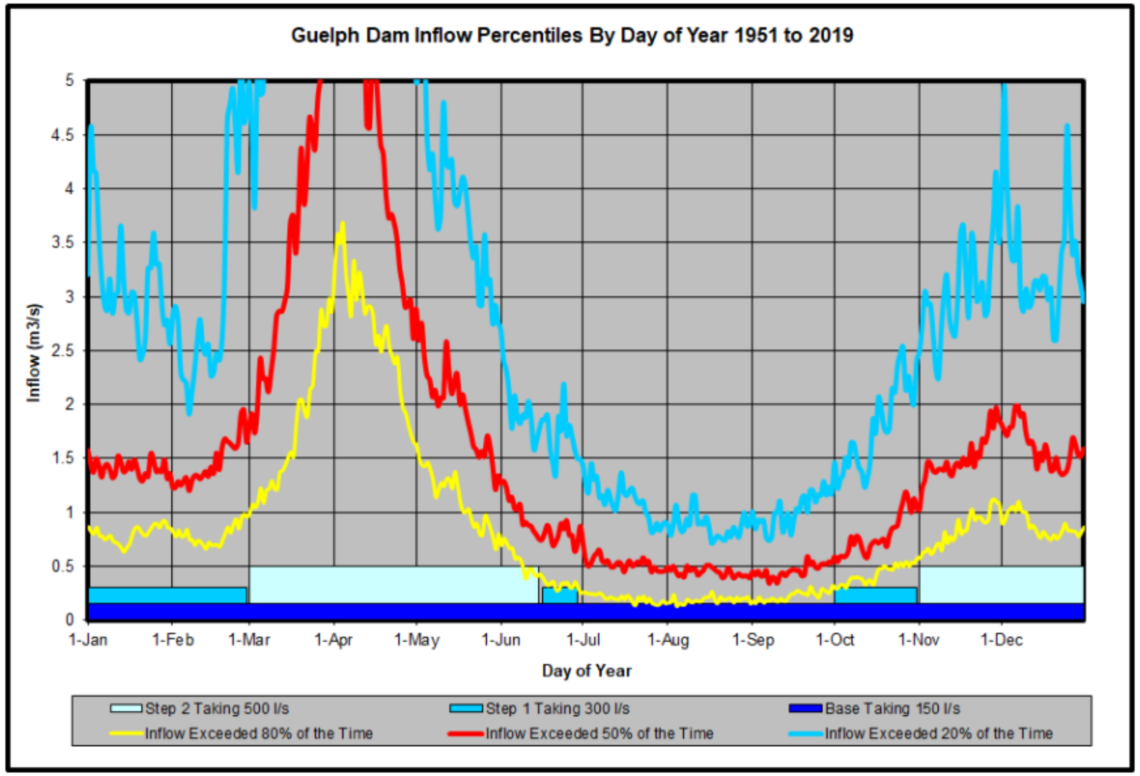
Surface Water Alternatives Assessment

September 14, 2021

New Surface Water Supply

- Two possible local surface water sources for water taking
  - Guelph Lake – upstream of the dam
  - Eramosa River – at Arkell
- Alternatives:
  - Treatment & direct continuous flow into the distribution system
  - Treatment & store in ASR wells; recovery as required
- New water treatment plant (WTP) required to fully treat the surface water to meet Ontario Drinking Water Quality Standards (ODWQS)
- Assumptions - conventional treatment with treatment for taste and odour on a seasonal basis, as required
- Wastewater treatment plant assimilative capacity study (underway) will be considered in evaluation

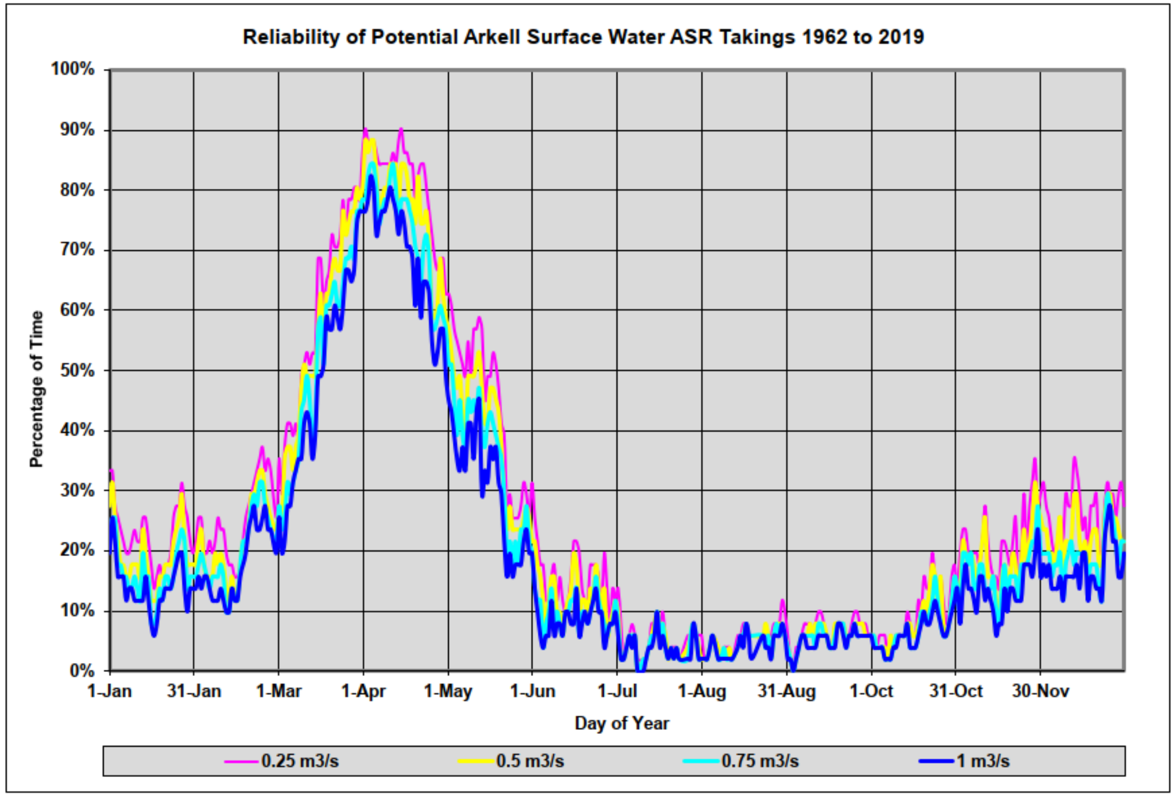
Surface Water – Guelph Lake



Guelph Lake Yield Analysis (GRCA):

- Modelling results indicate that there is a potential for proposed stepped taking: 150 L/s and 300 L/s
- 500 L/s step dismissed for two reasons:
  - not practical to build a WTP for three months
  - flow cannot be injected in a reasonable number of ASR wells
- ASR alternative assumes base taking of 150 L/s with increase to 300 L/s for nine months of the year

Surface Water – Eramosa



Eramosa River Yield Analysis (GRCA)

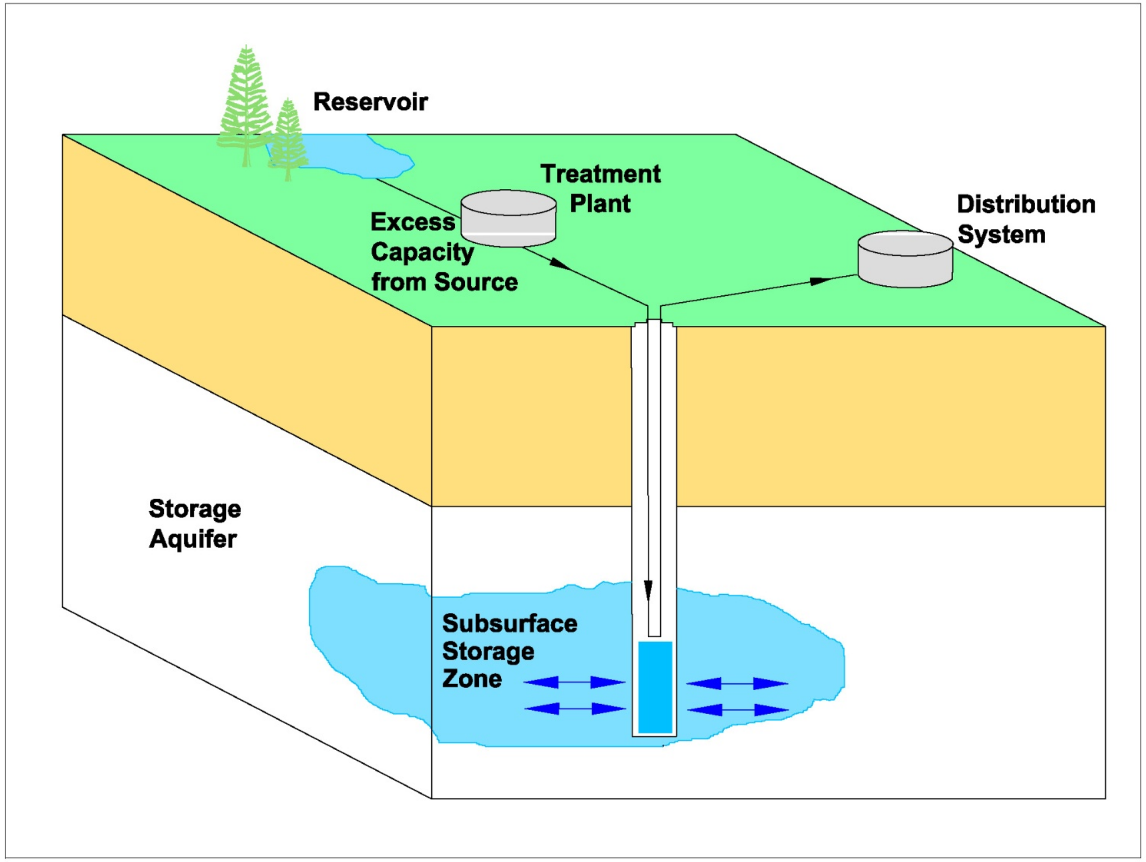
- Continuous flow not available for providing a constant rate supply to the distribution system
- Very limited potential for significant increased takings beyond the existing Arkell PTTW at any time other than the spring period

Summary – Guelph Lake

Location	**WTP at Guelph Lake or NE part of City**
Description	Surface WTP consisting of conventional/ advanced treatment and distribution pipeline
Intake Rate (m^3/d)	12,960 (continuous annual base taking of 150 L/s)
Distribution Rate (m^3/d)	12,300
Existing Approvals	None
Required Approvals	• Class EA – Schedule C • Municipal – City and Township • MNRF/ MECP - PTTW (Surface Water) • ECA/ DWL • GRCA
Water Quality Issues	High turbidity, colour, odour
Environmental Constraints	Area affected includes Guelph Lake and its associated wetland and aquatic features
Past Studies/Work	GRCA review of water taking reliability
Required Studies	• Field investigations; environmental baseline/ impact • Feasibility Studies • Treatment study • Class EA
Required Infrastructure	• Water intake structure • Surface water treatment plant & associated infrastructure • Connection to distribution water main
Estimated Capital Cost	$ 51,322,000
Cost per m^3/day	$3,960

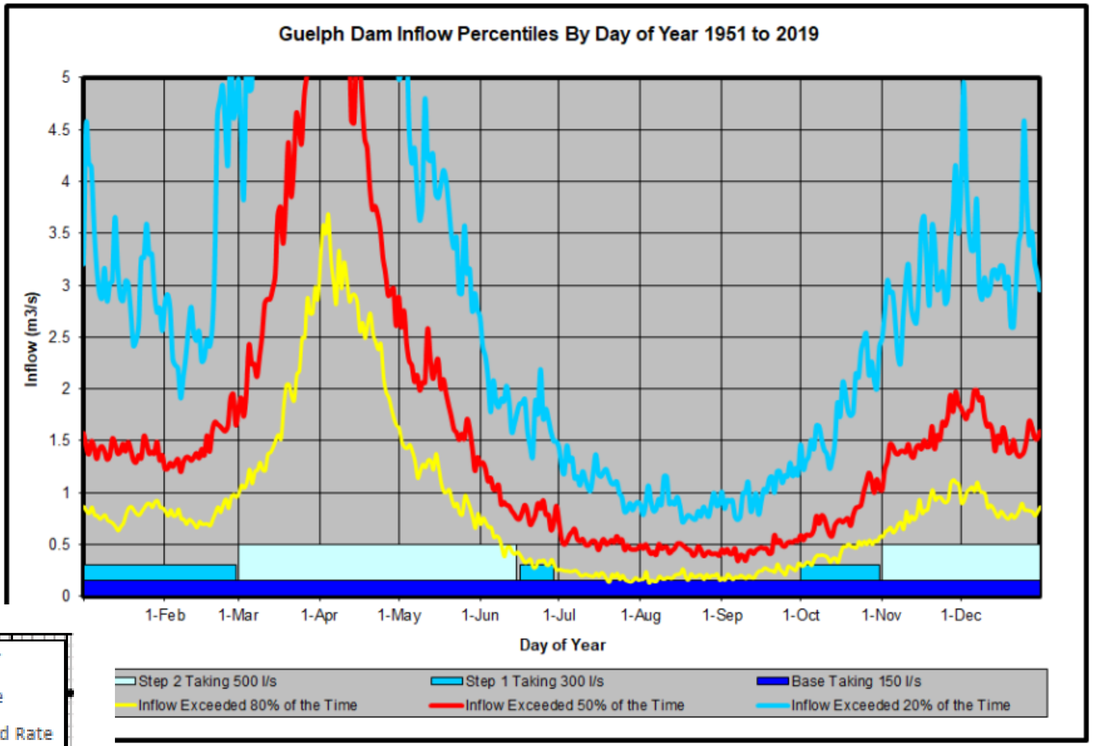
Install new ASR wells inside City

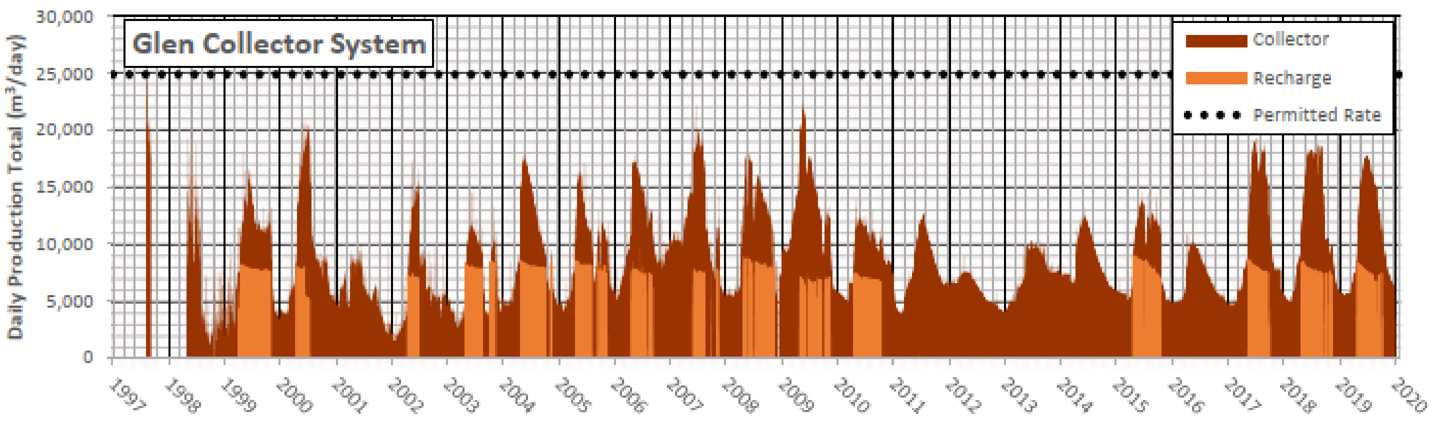
- **Aquifer Storage and Recovery (ASR)** - re-injection of potable water back into an aquifer for later recovery and use



Aquifer Storage and Recovery

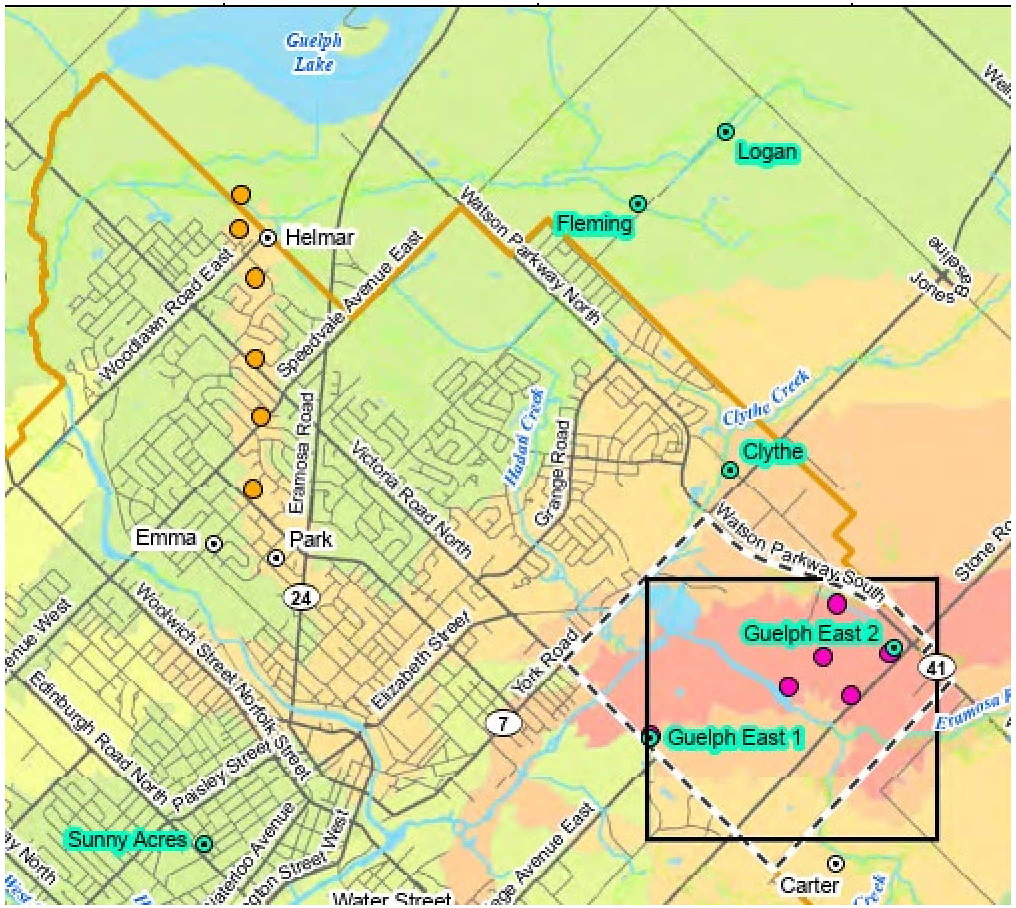
- Two potential sources: Guelph Lake following future potential WTP plant construction; Arkell collector system
- Estimated annual excess volume: Arkell – 451,000 m^3; Guelph Lake – 941,000 m^3





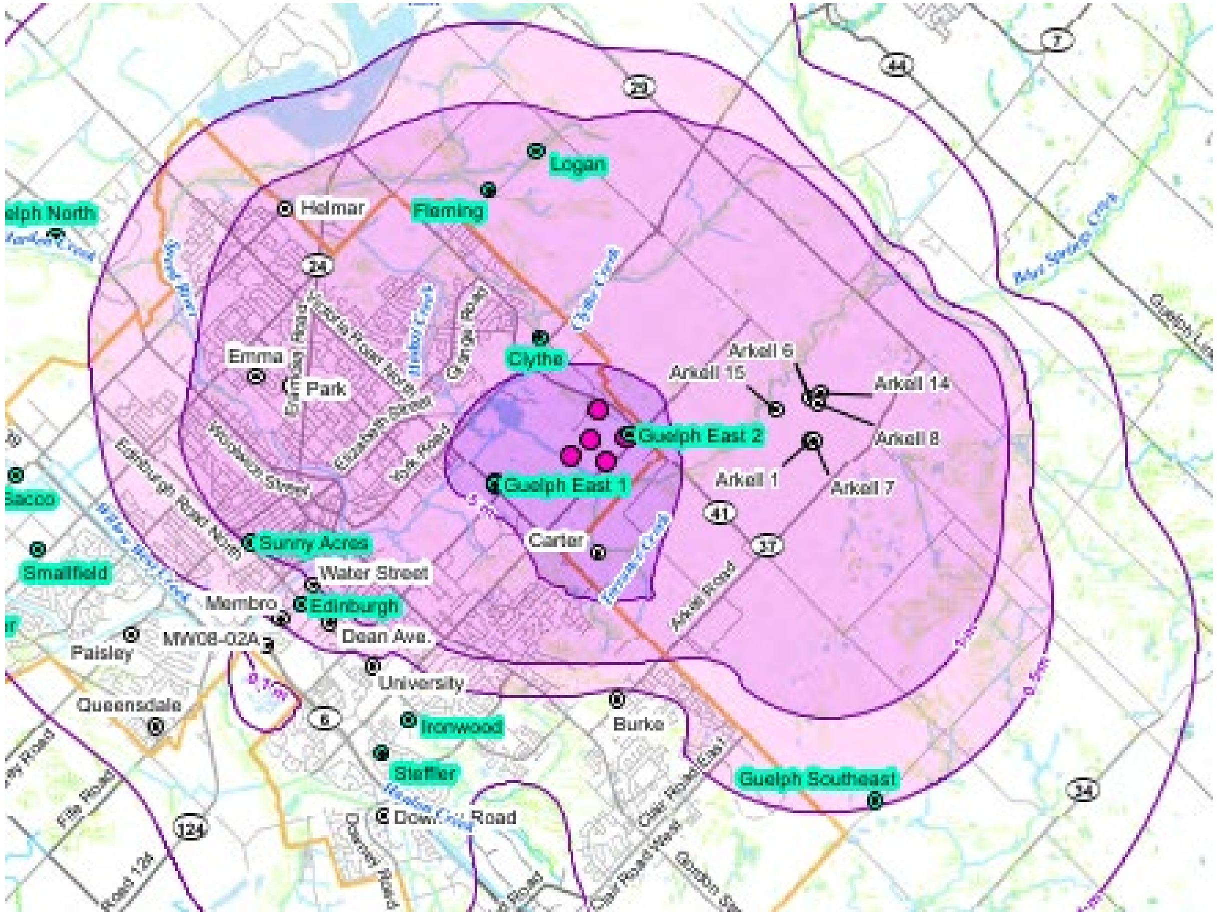
Aquifer Storage and Recovery

- Two injection locations assessed: NE Guelph – between Helmar and Emma/Park wells; East Guelph in area of simulated production wells
- All ASR wells simulated as injection and extraction
- Impact assessment:
  - Sustainability of surrounding production wells
  - Water level elevation during injection
  - Changes to stream baseflow



Aquifer Storage and Recovery

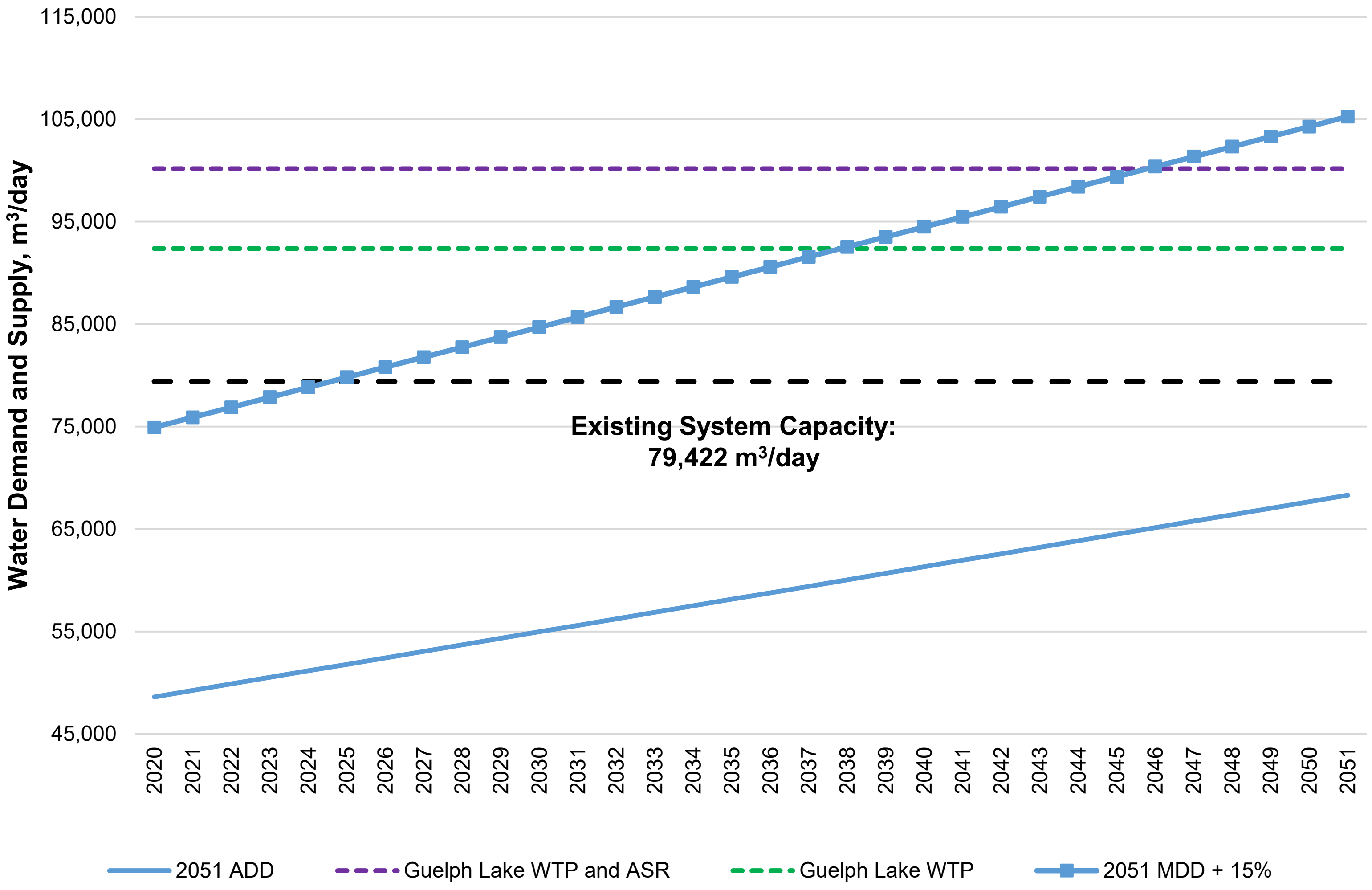
- Results:
  - Model predicts large area of injection influence (area of water level increase)
  - Extraction of 60% of injection volume to maintain function of existing wells
- Interpretation:
  - Efficiency of ASR well field approach with injection/ extraction wells below target
  - System would have to be optimized in City to utilize production wells for recovery
  - Focus on areas of existing wells, core of City to minimize influence beyond boundary
- Arkell ASR cost: \$25.3M; \$21,600/m^3
- Further study required to evaluate optimized system, fewer ASR wells and increased recovery efficiency will reduce cost



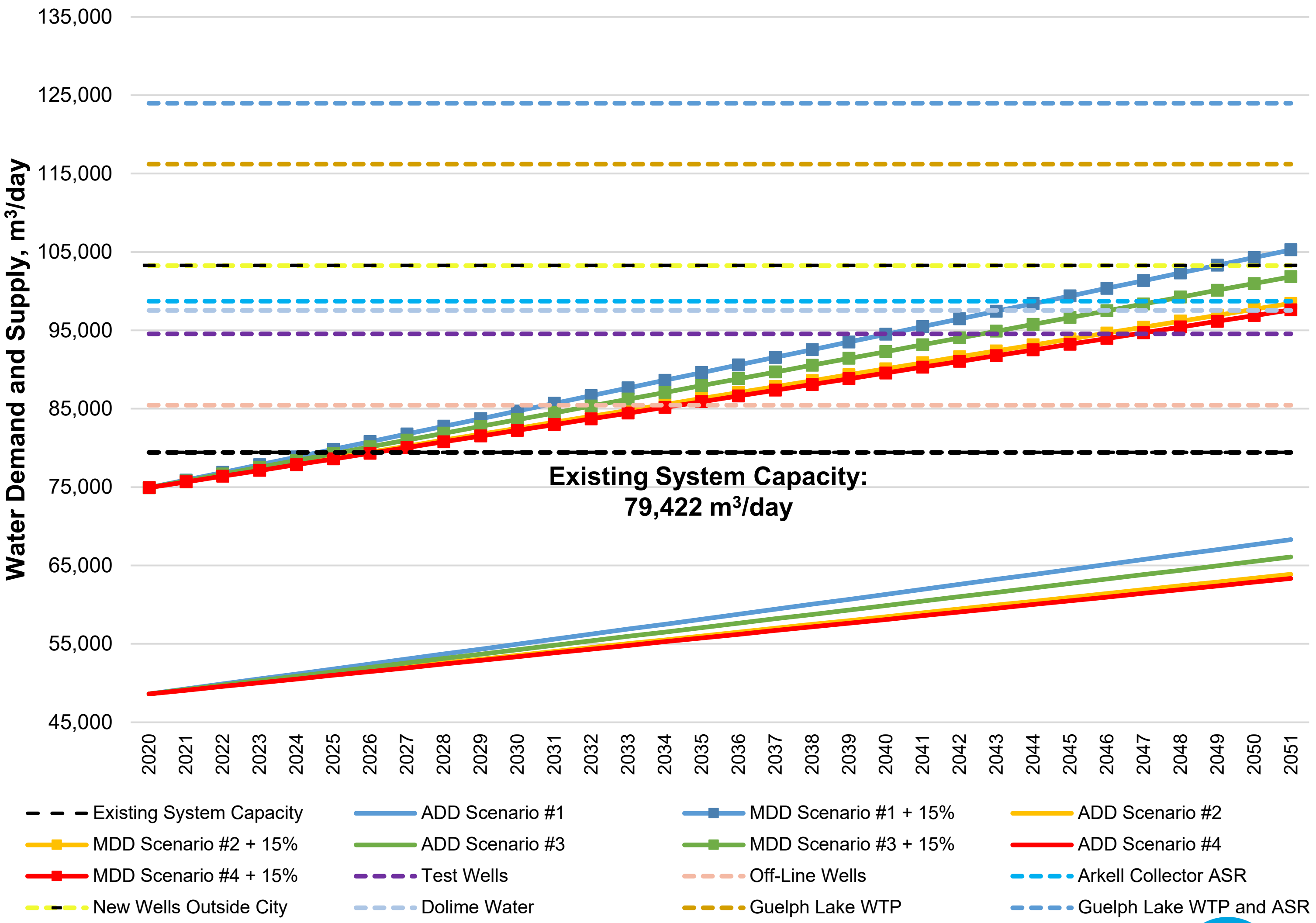
Summary – Guelph Lake + ASR

Location	**WTP at Guelph Lake/dam, ASR wells at NEQ in the vicinity of Park/Emma wells**
Description	A surface water treatment plant consisting of conventional treatment and distribution pipelines, ASR wells
Intake Rate (m^3/d)	12,960 – 25,920
Distribution Rate (m^3/d)	Up to 25,825 m^3/day (subject to ASR optimization)
Existing Approvals	None
Required Approvals	• Class EA – Schedule C • Municipal – City and Township • MNR/MECP - PTTW (Surface Water/ Groundwater); • ECA/DWL • GRCA
Water Quality Issues	High turbidity, colour, odour
Environmental Constraints	Area affected includes Guelph Lake and its associated wetland and aquatic features
Past Studies/Work	GRCA review of water taking reliability
Required Studies	• Field investigations; environmental baseline/ impact • Feasibility Studies • Treatment study • Class EA
Required Infrastructure	• Water intake structure • Surface water treatment plant & associated infrastructure • Connection to distribution water main; ASR well facilities
Estimated Capital Cost	$ 57,283,000
Cost per m^3/day	$4,420

Alternative #3 Summary



All Water Supply Alternatives Summary



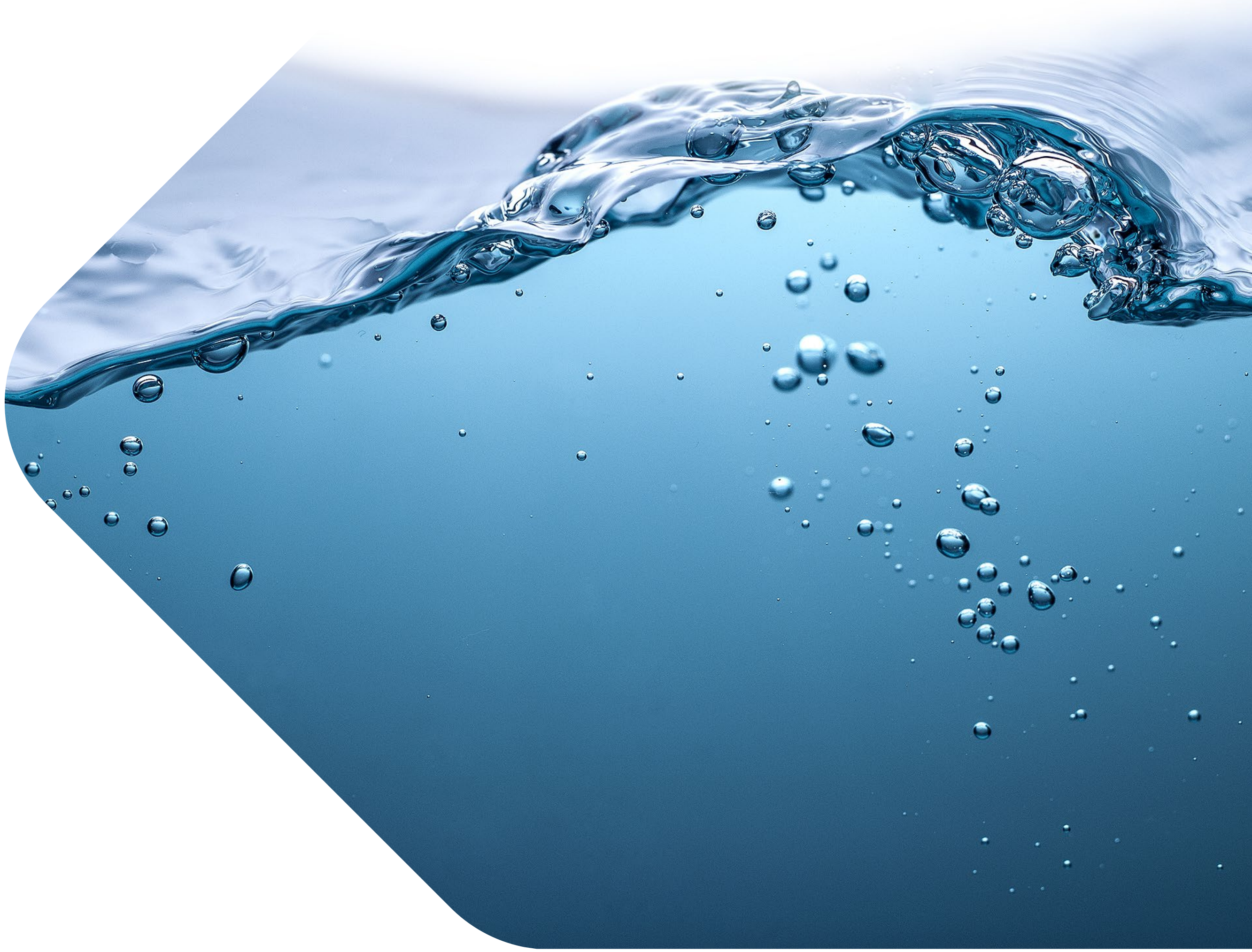
Other Alternatives

Limit Growth / Do Nothing

- Represents what would likely occur if none of the alternative solutions were implemented
- Reduction in future water supply needs by limiting the extent, density, type and/or location of future residential, industrial, commercial and institutional growth in the City below levels identified in recent planning studies
- Implementation of this alternative would require change to municipal planning documents which would not meet Provincial growth targets
- Will have a significant impact on the growth potential for the City.

Water Supply Master Plan Update

Preliminary Evaluation of Alternatives



September 14, 2021

Water Supply Master Plan
guelph.ca/WSMP

City of Guelph Making a Difference

AECOM

Evaluation Summary Tables

We’d Like Your Input…

Are there additional factors that should considered in the evaluation? Is there anything you would evaluate differently or change?

Should any alternatives be prioritized differently? Why?

We'd Like Your Input…

Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; off-line sources; ASR; wells outside the City; surface water.

What advice do you have for presenting this information at the upcoming virtual Open House?

Next Steps

September 14, 2021

Next Steps

- Incorporate/ consider feedback from this workshop
- Prepare meeting summary and circulate to attendees
- Additional communications with First Nation communities
- Refine assessment/ evaluation based on feedback received
- Additional Community Engagement
  - Community Liaison Group Meeting #3 –September 21st
  - Community Open House #2 – September 28th

Thank You!

Visit our website: guelph.ca/WSMP

Water Supply Master Plan Agency and Municipalities Workshop #2 – Summary

Date and Time of Meeting: September 14, 2021, 1:00pm – 4:00pm

Location: Virtual teleconference using Microsoft Teams

Overview

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP), from 2014, to define how we will continue to access a sustainable supply of water — to meet residential, industrial, commercial and institutional demands — to the year 2051. Reviewing our existing water supply system is an opportunity to discuss with Guelph and surrounding communities how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Part of our WSMP update includes two (2) workshops to bring agencies and municipalities together, providing a forum to discuss plans for the 2021 WSMP update and to gather input. The purpose of this meeting was to:

- Provide an update on the technical work completed to date
- Review and get feedback on the Draft Evaluation of Alternatives

The format of the workshop included a presentation and opportunities for discussion and questions.

Attendance

The following participants were present:

Organization	Name
GoodLabs Studio	Donald McGillivray
Ministry of the Environment, Conservation and Parks	Corrine Taylor

Organization	Name
Ministry of the Environment, Conservation and Parks	Joan Del Villar Cuicas
Ministry of the Environment, Conservation and Parks	Lisa Williamson
Ministry of the Environment, Conservation and Parks	Pamela Grande
Ministry of Natural Resources and Forestry	Ian Thornton
Township of Puslinch	Stan Denhoed
Wellington Source Water Protection	Emily Vandermeulen
Wellington Source Water Protection	Kyle Davis
City of Guelph	Dave Belanger
City of Guelph	Emily Stahl
City of Guelph	Heather Yates
City of Guelph	Mari MacNeil
City of Guelph	Scott Cousins
City of Guelph	Wayne Galliher
AECOM	Alicia Evans

Organization	Name
AECOM	Matthew Alexander
AECOM	Tracey McKenna

Meeting Format

The meeting was conducted virtually on September 14, 2021 from 1:00pm – 4:00pm. Dave Belanger (City of Guelph) opened with a Statement of Territorial Acknowledgement and spoke to the lapse of time since the first agency and municipality workshop (pre-COVID-19). Dave also referenced the change in the planning horizon timeline from 2041 to 2051 and the importance of exploring whether the population targets in this new timeline can be met while still maintaining sustainable groundwater supply. Alicia Evans (AECOM) provided an overview of the meeting and asked attendees to introduce themselves. Attendees were provided with a copy of the presentation and the preliminary evaluation matrix in advance. The presentation was delivered by Matthew Alexander (AECOM). Alicia Evans (AECOM) facilitated the discussions and Dave Belanger (City of Guelph) and Matthew Alexander (AECOM) responded to questions during discussions.

The main sections of the presentation included:

- Review of WSMP objectives
- Overview of major WSMP tasks
- Major task overview and progress update
    - Summary of consultation conducted to-date
    - Review of population targets and water supply demand forecasts
    - Review of existing water supply capacity assessment
    - Review of technical assessment of alternatives to-date
- Review of the preliminary evaluation of alternatives
- Next steps

Attendees shared their questions/ comments with the group and had the opportunity to respond to discussion questions related to the content provided in the presentation.

The discussion captured throughout the meeting is summarized in the sections that follow. Questions are noted with a "Q", answers with "A", comments with a "C" and responses with an "R". Answers were provided by Matthew Alexander (AECOM) and Dave Belanger (City of Guelph).

It is recommended to review the discussion below alongside the presentation; notes are provided under applicable sections below when the presenter added additional details that are not captured in the presentation.

Matt presented the "Water Supply Master Plan 2021 Update". Please see attached for more details.

Project Objectives and Major Tasks

An overview of objectives including where and how the City gets safe and reliable water to the year 2051; the water supply demand forecast; water supply sources to supplement the existing supply; and short-term, mid-term and long-term water supply options.

Task 1 – Public Consultation To-Date

An overview of results and feedback from the first round of public consultation was provided. Consultation included Indigenous Engagement, Community Liaison Group meetings, Agency and Municipality workshops, and Community Open Houses. It was also noted that the Phase 1 Engagement Summary Report is available online and contains more detailed information than what is presented.

Task 2 – Population and Water Supply Demand Forecasts

A summary of task 2 – population and water supply demand forecasts – was provided, including population projections changing to 2051 instead of 2041, a review of historical water supply demand, the design basis for projecting future water supply demand and projected water supply demands.

Task 3 – Existing Water Supply Capacity Assessment

A summary of task 3 – existing water supply capacity assessment – was provided, including an overview of Guelph's existing water supply system, how the 2021 system capacity compares to 2051 demand projections, a security of supply assessment, additional system risks and required capacity for security of supply.

Additional context for slide 25's well capacity assessment table to explain where reductions in capacity were identified relative to 2014:

- The existing capacity within the southeast quadrant was reduced to reflect the capacity that is available year-round. The Glen collector system captures the highest flow during the artificial recharge period and the lowest flow when artificial recharge does not occur. As the timing of the maximum demand is variable in Guelph and cannot be precisely known, the City needs to be prepared to supply the maximum demand any day of the year. Therefore the capacity of the Glen Collector was reduced to reflect the minimum reliable flow available from this system

- Within the southwest quadrant, the Water Street well field includes four active wells that experience mutual interference. The cumulative capacity for these four wells was reduced to reflect the maximum reliable flow that can be pumped from the well field simultaneously.

- The full system has not been tested at the identified existing capacity – it is not feasible to do so. There is confidence in the number based on the available performance records but there are uncertainties in how the system would perform under maximum system-wide conditions.

Task 4 – Water Supply Alternatives Assessment

A summary of task 4 – the assessment of proposed water supply alternatives – was provided. Alternatives include:

- water conservation, efficiency and demand management,
- optimizing and expanding the existing groundwater system,
- establishing a new surface water supply, and
- limiting growth / doing nothing.

Water Conservation, Efficiency and Demand Management

A description of the analysis completed to evaluate non-revenue water and the fact that the City is currently at or near the Economic Level of Leakage. Therefore, the conservation, efficiency and demand management scenarios include a static non-revenue water value.

As part of the water conservation, efficiency and demand management alternative, four scenarios were established to evaluate potential future demand reduction and associated costs.

1. Scenario One: Static Demands
   i. Baseline scenario where City ceases non-mandatory programming and therefore does not achieve demand reduction. There is no cost associated with this scenario.
2. Scenario Two: Demand Reduction of 6.5% by 2051
   i. Continue current level of effort in programming, with routine program review to replace ones that are no longer effective or have matured. Assumes similar level of demand reduction to that achieved by the City between 2015 and 2019.
3. Scenario Three: Demand Reduction of 3.25% by 2051
   i. Implementation of effective conservation programming makes reduction more challenging with success. This scenario assumes that programming is scaled back in response to a slowing demand reduction trend, with a switch in focus to less efficient and higher demand customers. Lower demand reduction at a lower cost to the City.
4. Scenario Four: Demand Reduction of 7.3% by 2051
   i. Scenario Two with additional water reuse opportunities. Most aggressive approach with highest demand reduction and highest estimated cost.

Groundwater Sources

The following groundwater alternatives were discussed in detail:

- *Optimize existing operating municipal sources*: review of existing municipal sources to identify any that could potentially contribute additional capacity. The Downey well was identified as a possibility but would have to be considered alongside other existing and potential new sources in southwest Guelph.
- *Restore existing off-line municipal sources*: evaluated the possibility of restoring the Clythe, Sacco, and Smallfield wells and the Lower Road Collector.

- *Develop existing municipal test wells*: considered three test wells in southwest Guelph (Ironwood, Steffler, Guelph South) and the Dolime Quarry, one test well in northwest Guelph (Hauser) and two test wells in Northeast Guelph (Logan and Fleming).
- *Install new wells inside City boundaries*: evaluated one well location in the City included within the 2014 WSMP; however, the location was screened out through preliminary modelling.
- *Install new wells outside City boundaries*: considered one potential well location north of Guelph within Guelph-Eramosa Township and one potential well location south of Guelph in Puslinch Township.
- *Install new ASR wells inside City*: Aquifer Storage and Recovery (ASR) system to collect excess water from the Arkell Collectors, treat to potable standards and inject into the deep aquifer for later recovery and use.

Surface Water Alternatives Assessment

- Review the Guelph Lake and Arkell collector system as potential sources for aquifer storage and recovery systems to capitalize on peak flow.

Preliminary Evaluation of Alternatives

A summary of the evaluation tables was presented for the Water Supply Alternatives including Conservation / Limit Growth / Do Nothing (Table 4-3), Groundwater Sources (Table 4-5), and Surface Water Sources (Table 4-7).

For each table the alternatives were evaluated using the following criteria: Effect on Indigenous values, culture and Traditional use for First Nations, Métis, and Inuit Peoples, Technical (ability to achieve demand and reduction), Natural Environment, Built Environment, Social / Cultural Environment, Legal / Jurisdictional, and Financial.

For Conservation, Limit Growth, Do Nothing (Table 4-3)

The most favourable alternatives for the short-term strategy is to maintain the current level of effort (Scenario 2), for the medium-term strategy a focus on high demand customers was identified (Scenario 3) and add in additional water reuse programming (Scenario 4). The least favourable alternatives are the baseline of cease conservation, efficiency and demand management programs, limit growth and do nothing.

For Groundwater (Table 4-5)

Each of the five alternatives are preferred with various limitations

1. For leveraging the existing municipal off-line sources, additional investigation and work would be required. In addition, the uncertainties regarding remediation of contamination affecting the Smallfield Well and the Sacco Well, to a lesser extent, mean that returning these wells to service may not be feasible prior to 2051;
2. For municipal test wells, Class EA studies would need to be conducted to confirm feasibility and evaluate potential impacts;
3. for the Dolime Quarry, the Southwest Guelph Water Supply Class EA would confirm the feasibility of managing the quarry water supply and capturing water currently dewatered and discharged to the Speed River;
4. for the Arkell Collectors and Aquifer Storage and Recovery, modelling and hydrogeological studies would be needed to assess efficiency and confirm infrastructure and costs,
5. and for New Wells Outside the City, communicating with Townships regarding project feasibility, followed by groundwater field investigation to assesses feasibility and impact.

For the Surface Water Source (Table 4-7)

Both alternatives are preferred as part of the overall solution. Guelph Lake Wastewater Treatment Plant (WTP) is undergoing preliminary treatability studies and ecological impact investigations. Guelph Lake WTP and ASR requires addition modelling and hydrogeological studies to assess efficiency.

Questions and Answers: Preliminary Evaluation of Alternatives

- Q1: Will there be wells in the Clair Maltby area in the southeast? If not, why was the area not considered?
- A1: Wells will not be put in this area. In the past the Clair Maltby area was considered but based on a review of the geology and existing water supply wells in that area there was not good aquifer materials. In addition, the area could have a lot of environmental impacts, so it was screened out.

- Q2: Can you confirm assimilative capacity of the Speed River not depending on Dolime Quarry discharge water?
- A2: Assimilative capacity studies do not consider the Dolime Quarry water. Assimilative capacity is considered based on the upstream flow, not the flow downstream of the plant, so there must be a certain flow past the wastewater treatment plant to assimilate the effluent from the plant. There is an on-going study to update the assimilative capacity, and we expect to see a final report shortly.
- Q3: The City has maximized internal sources and there's limited potential for increase. It's likely city boundary or exterior sites will be considered as alternatives to make up the water supply. How are legal and jurisdictional rights of the Townships including land use restrictions, water use restrictions, and employment opportunities (both current and future) being factored into the Environmental Assessment? How do we navigate so that Townships are not restricted, or unfairly compensated as a result of the source water protection restrictions associated with the Municipal Water Supply plan?
- A3: The City has targeted sources within city limits as the primary source for the required water supply. In the future, there is going to be a lot of consultation and engagement so that all can benefit, and we can achieve our mandated growth targets. We will also be working with the Townships to review land restriction policies to ensure that the Townships are fairly compensated and resourced accordingly when planning potential wells. We're also trying to develop the resource as a whole, to understand where water supply might be available and where it might have the least amount of impact.
- Q4: How can community members outside of Guelph be properly consulted to evaluate water supply sources outside of the City?
- A4: Public perception varies depending on what's in the news. If the media picks it up there will certainly be more influence over the public perception and there may be additional push back.
- Q5: How can Townships to respond or be involved with the WSMP?
- A5: A letter would work. If you get it to a member of the project team, we will consider the feedback and record it. In the past we've made offers to

come and talk to Township councils, and we're open to honouring those offers.

- C1: Public acceptance changes depending on the amount of personal impact. The greater the impact, the less likely the public is to be accepting. In addition, if there is media focus on the topic, the public is more likely to react and have some push back.

Next Steps and Adjournment

Participants were invited to reach out to Dave Belanger (City of Guelph) and Matthew Alexander (AECOM) if they had any questions, comments or concerns about the technical information presented.

Next steps in the project include incorporating and considering feedback from this meeting, preparing a meeting summary to circulate to attendees, additional communications with First Nation communities, refining assessment / evaluation based on feedback received.

Upcoming engagement opportunities include:

- Community Liaison Group Meeting #3 – September 21st, 2021
- Community Open House #2 – September 29th, 2021

The meeting was adjourned at 4:00 pm.

Appendix H

Indigenous Engagement

- Mississaugas of the Credit First Nation meeting briefing note
- Mississaugas of the Credit First Nation meeting briefing note - Questions
- Mississaugas of the Credit First Nation meeting presentation
- Mississaugas of the Credit First Nation meeting minutes
- Haudenosaunee Confederacy Chiefs Council Letter
- Six Nations of the Grand River meeting #1 minutes
- Six Nations of the Grand River meeting #2 minutes

Briefing Note

Water Supply Master Plan Update

October 6, 2021

Summary
The 2021 Water Supply Master Plan (WSMP) (https://guelph.ca/plans-and-strategies/water-supply-master-plan/) for the City of Guelph is intended to update the 2014 WSMP. Guelph Water Services have followed the same approach used in the past, consistent with the provincial Municipal Class Environmental Assessment (EA) process and the direction from City Council in 2003: "That the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth". The WSMP update considers the provincial population growth forecasts to 2051 and develops water supply demand forecasts to meet growth for the planning horizon. The demand forecasts are compared to the City's existing water supply capacity under several security of supply scenarios. Deficits – the difference between the demand forecast and the existing supply capacity for average day and maximum day demand – are addressed through the development of a master plan of projects to bring on new water supply capacity, as it is needed through to 2051. Details are provided below.

Guelph's Existing Water Supply System

Guelph's water supply is groundwater based. We have 21 existing water supply wells, which draw water primarily from a deep bedrock aquifer, called the Gasport Formation. The City also has a shallow groundwater collector system in the Arkell Spring Grounds to the east of the City that draws groundwater from soil overlying the bedrock (called shallow overburden deposits) adjacent to the Eramosa River. From mid-April to mid-November, the shallow groundwater collector system can be supplemented with water from the Eramosa River that is pumped into an infiltration pond and trench that recharges into the shallow overburden deposits. Groundwater from the Arkell Spring Grounds is piped into the City through gravity drainage in an aqueduct. Guelph's current (2020) water supply demand is approximately 45,000 cubic metres per day (m^3/day or 45,000,000 L/day). Our current maximum day demand is approximately 60,000 m^3/day.

Population and Water Demand Forecasts

Population and employment growth rates were based on 2051 residential and employment populations of 203,000 and 116,000 persons, respectively, as per Ontario's *A Place to Grow Growth Plan* for the Greater Golden Horseshoe. Based on Guelph's historical water demand, average residential demand and average employment demand were estimated as 167 and 191 Litres per person per day respectively. The City's Water Efficiency Strategy has been highly successful to date; however, we are at the point in which we do not expect to see the average daily residential demand continue to be significantly lowered year over year. For this reason, to calculate the 2051 water demands, the current average residential demand (167 L/person) and employment demand (191 L/person) were used to determine a total estimated 2051 average day demand of approximately 68,300 m^3/day and a maximum day demand of approximately 91,500 m^3/day. The City will continue its Water Efficiency programming, including education and outreach, rebate incentives for water reduction technology, and research into new programmes aimed at furthering reductions (see - https://guelph.ca/plans-and-strategies/water-efficiency-strategy/).

Existing Water Supply Capacity

An assessment was conducted at each of the City's individual groundwater supply sources (i.e., 21 existing water supply wells and the shallow groundwater collector system) to identify constraints to operating at the maximum and sustainable capacity of the overall water supply system. The assessment also considered "security of supply" scenarios such as drought/climate change and loss of supply source(s) to ensure that, under extreme events, the water supply system was capable of meeting the 2051 supply demand. The assessment determined the existing supply capacity is approximately 79,000 m^3/day with a range between 65,000 to 79,000 m^3/day when accounting for drought conditions or loss of supply source(s). The difference between the existing supply capacity and the 2051 demand (i.e., the water supply deficit) is approximately 3,000 m^3/day for average day demand and 26,000 m^3/day for maximum day demand. The water supply deficit is the amount of new water supply capacity that will be required to meet the provincial growth targets to 2051. In addition, the City proposes to reserve an additional 15% of water capacity for security of supply to accommodate maintenance, unplanned service interruptions, drought or a contamination event.

Example – Municipal Wellhouse (Arkell 15)

Example – Wellhouse interior

Water Supply Alternatives

Based on the water supply deficit, the WSMP Update will develop sustainable water supply alternatives for consideration. The evaluation is in progress; however, the potential 2021 water supply alternatives are similar to the groundwater alternatives proposed in the 2014 WSMP. The Water Efficiency Strategy remains a high priority alternative and we strongly support the City's water conservation and efficiency programs to maintain our low water supply demand and to defer the need for new supply sources. Specifically, focusing efforts on demand and water loss management and system optimization driven by the highest water consumers (i.e., the Industrial/Commercial/Institutional sectors) provide the greatest potential. As in 2014, the WSMP has assessed potential groundwater sources inside the City or on City-owned property. The Clythe Well (3,400 m^3/day), an existing well taken offline due to water quality issues, is scheduled to be returned to service with treatment in 2023. The Ironwood and Steffler Test Wells (~6,000 m^3/day) are potential new supply alternatives subject to the proposed operational testing program for Pond Level Management of the Dolime Quarry pond. Additional potential, high priority sources are located in the Hanlon Creek Business Park (Guelph South Test Well -~4,300 m^3/day) in the southwest and the City-owned Logan property (Logan Test Well -~4,700 m^3/day) to the east of the City. All potential new groundwater sources inside or outside of the City have the potential to cause environmental impacts to surface water systems in and around the City. Following Council approval of the WSMP, future projects will be conducted as individual Class EA's to solicit public engagement and assess potential environmental impacts and sustainability concerns. The WSMP and potential water supply projects are updated every five years approximately.

Engagement Approach

To date, the City has pursued Indigenous engagement for this Master Plan with potentially interested First Nations as per the procedure prescribed in the Municipal Class EA process. The City did not receive any responses through these initial channels. We are therefore appreciative of the Mississaugas of the Credit First Nation's (MCFN) indication of interest via other work streams. We welcome the ability to engage on the WSMP to obtain your input, and to listen to any concerns or ideas. Moving forward, we would welcome MCFN's feedback on how best to continue engagement over the course of this project.

The WSMP Update is also being conducted under a public engagement plan consistent with Guelph's Community Engagement Framework (https://guelph.ca/plans-and-strategies/community-engagement-framework/). The current plan consists of a Community Liaison Group, multi-agency and community workshops, public information centres and online and social media engagement. Phase 1 engagement has been completed and Phase 2 engagement will be completed this fall to present the results of the project. The draft WSMP Update Report will be presented to Guelph City Council in late 2021.

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Briefing Note

Response to questions related to the City of Guelph's conservation and efficiency programs

October 6, 2021

Summary

The City of Guelph wishes to provide responses to the questions asked by the Mississaugas of the Credit First Nation regarding efforts to date related to water conservation and efficiency programs.

Key facts

Since 1999, the City of Guelph has made water conservation and efficiency a priority while meeting the Provincial population growth targets; ensuring the sustainable use of the water supply required to meet the needs of the growing community.

The 2016 Water Efficiency Strategy (https://guelph.ca/plans-and-strategies/water-efficiency-strategy/) recommends programs, pilots and research – that both directly and indirectly – help residents, businesses and the municipality use water wisely – this document also outlined the reduction in water use gained by the community by participating in the City's programs.

The City estimates that between 2003 and 2020 previous and present water conservation programs have resulted in a cumulative reduction of 6,379,166 m^3 of water. The cumulative daily reduction during the same time period is estimated at 17,477 m^3/day.

Spokesperson

Heather Yates, Supervisor, Environmental Programs
Environmental Services
519-822-1260 extension 2831
heather.yates@guelph.ca

Background

- Since 1999 the City of Guelph has made water conservation and efficiency a priority while meeting the Provincial population growth targets; ensuring the sustainable use of the water supply required to meet the needs of the growing community.
- The Water Efficiency Strategy evaluates past programs and water savings achieved since the 2009 Water Conservation and Efficiency Strategy Update and projects proposed programs currently being undertaken to save water.

Questions and answers

What incentives does the City make available to encourage our residents to conserve water?

The City administers several programs that target residential water conservation. The following programs focus on at least one of the following conservation options; installation of reuse systems (greywater/rainwater harvesting), upgrade or retrofit of high efficiency fixtures and appliances (low water usage), implementation of technology to find leaks or inform residents on specific water usage (audits and sub-metering) and lastly public engagement and education that focuses on water conservation options such as implementing drought resistant landscaping:

eMERGE Home Tune-Up – emergeguelph.ca

Blue Built Home Rebate and Certification Program – bluebuilthome.ca

Multi-residential Water Audit – guelph.ca/living/environment/water/rebates/multi-residential-water-audit-program/

Residential Water Sub-meter Rebate – https://guelph.ca/living/environment/water/rebates/sub-water-meter-rebate-program/

Healthy Landscape Program Visits – guelph.ca/healthylandscapes

Royal Flush Toilet Rebate Program – guelph.ca/royalflush

Outside Water Use Bylaw and Program –guelph.ca/living/house-and-home/lawn-and-garden/outdoor-water-use-and-restrictions-in-guelph/

Public and Youth Outreach, Engagement and Education (outlined in the Water Efficiency Strategy) - guelph.ca/plans-and-strategies/water-efficiency-strategy/

The specific details of these programs are available on the City's website. Direct program links, where available, are included above.

What is the City doing to conserve water in our own facilities?

The City has completed upgrades and retrofits across its own facilities to improve water use on an ongoing basis. Since 2013 the estimated total savings for these projects is 119 m^3/day. Some past projects include splash pad recirculation systems, pool heat recovery system, toilet, and faucet aerator upgrades.

In 2014, the Guelph Transit Bus Wash Rainwater Harvesting project was completed which demonstrates that rainwater is a resource and can help reduce water usage. After the first four months of operation, 120,000 litres of rainwater was captured which offset one third of the municipal water normally required for the final rinse. More efficient spray nozzles also helped reduce approximately 1.9 million litres worth of municipal water at an estimated cost of $6,225 annually.

Furthermore, every five to seven years, the City completes water use reviews on all City owned facilities, to ensure leaks are addressed and recommendations for water-using fixtures, systems and processes are completed.

With respect to ensuring water infrastructure optimization, the City has administered an active leak detection program of its water mains throughout the City since 2011. The City inspects the entire distribution system (pipes, valves, hydrants, etc.) annually and when a leak is confirmed the City repairs it to prevent further water loss. Since program initiation the City estimates that the average daily volume of servicing capacity reclaimed through locating and fixing these leaks is 404 m^3/day. Water loss management factors into the update of the Water Supply Master Plan, as well.

What is the City doing to encourage water conservation in local industry?

The City administers the Water Smart Business program that specifically targets industrial, commercial and institutional (ICI) water customers to save water and money. The City helps cover the cost of water audits, calculates a payback period, and may offer financial incentives to support water saving technology investments. Two recent projects have resulted in process water use improvements resulting in a 360 m3/day saved, and an annual utility cost savings of approximately $276,168. The City provided one-time financial incentives totaling $99,796 to assist the implementation of these two projects.

For more information on the Water Smart Business program, including case studies, please visit guelph.ca/watersmart

Prepared by

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Water Supply Master Plan Update

Mississaugas of the Credit First Nations Meeting

October 6, 2021

Water Supply Master Plan Update

Update of the 2014 WSMP – consistent with Guelph City Council 2003 direction "that the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth"

Five parts of the WSMP:

- How much water do we have now?
- How much water do we need in the future?
- What are the water supply alternatives?
- What is the plan for new supply?
- How are we engaging on the WSMP Update?

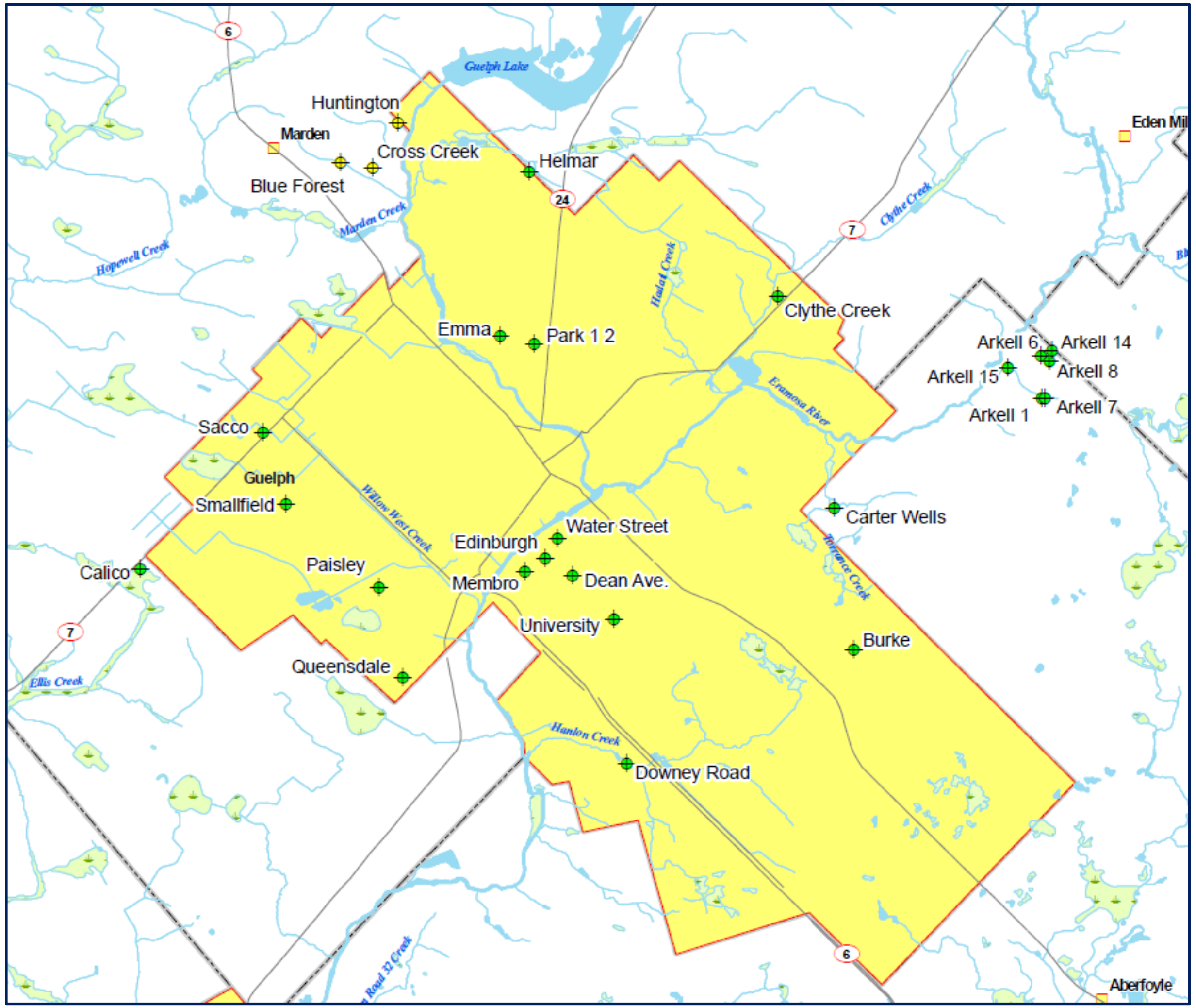
Overview of Our Existing System

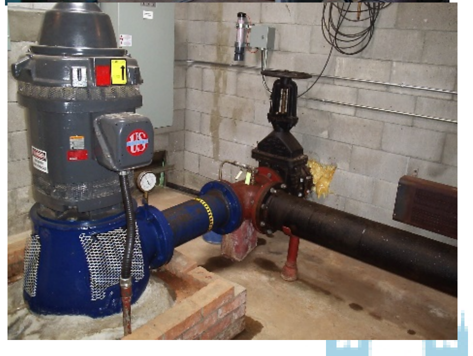
Groundwater-based water supply since 1879

Water supply system - production wells in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system:

- 21 wells in continuous operation - 4 wells offline due primarily to water quality concerns
- A shallow groundwater collector system that collects spring water in the Arkell Spring Grounds
- Eramosa River Intake and Recharge system (seasonal): river water pumped to an infiltration pond and trench provides water to the collector system; subject to river flow conditions

Overview of Our Existing System – Existing Supply Sources





Overview of Our Existing System – Arkell Spring Grounds

How much water do we have now?

Water supply capacity:

- "Normal" conditions: 79,422 m^3/day
- Drought conditions: 65,447 m^3/day
- Loss of source: 73,437 to 76,200 m^3/day
- Regulatory approvals: 73,300 to 77,200 m^3/day

For planning purposes:

- 65,447 to 79,422 m^3/day

Current water supply demand:

- Average day – 45,000 m^3/day
- Maximum day – 61,000 m^3/day

How much water do we need in the future?

Provincial Places to Grow projections to 2051

Guelph 2051 population:

- Residential – 203,000
- Employment – 116,000

Per person water demand:

- Residential – 167 Litres per day
- Employment – 191 L/day

2051 Water demand:

- Average day – 68,300 m^3/day
- Maximum day – 91,500 m^3/day

Water supply deficit:

- Average day – ~3,000 m^3/day
- Maximum day – ~26,000 m^3/day

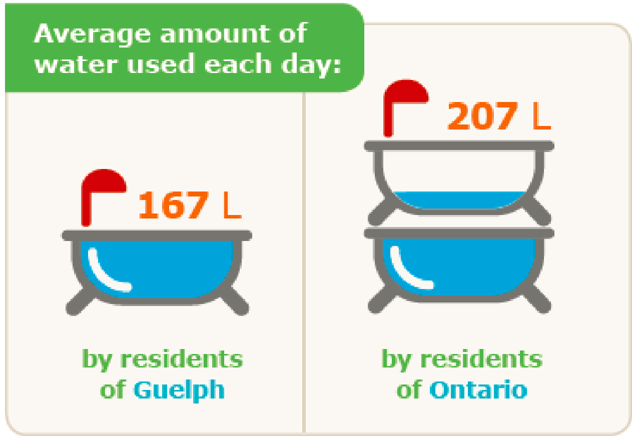
What are the water supply alternatives?

Water Efficiency Strategy

- Most important component of the WSMP
- Guelph is a leader in water conservation
- Reductions of 11,500 m^3/day (2014 – 2020)
- Additional details on WES provided separately

Short-term Alternatives – Steffler/Ironwood, Guelph South, Logan Test Wells, plus Dolime Quarry

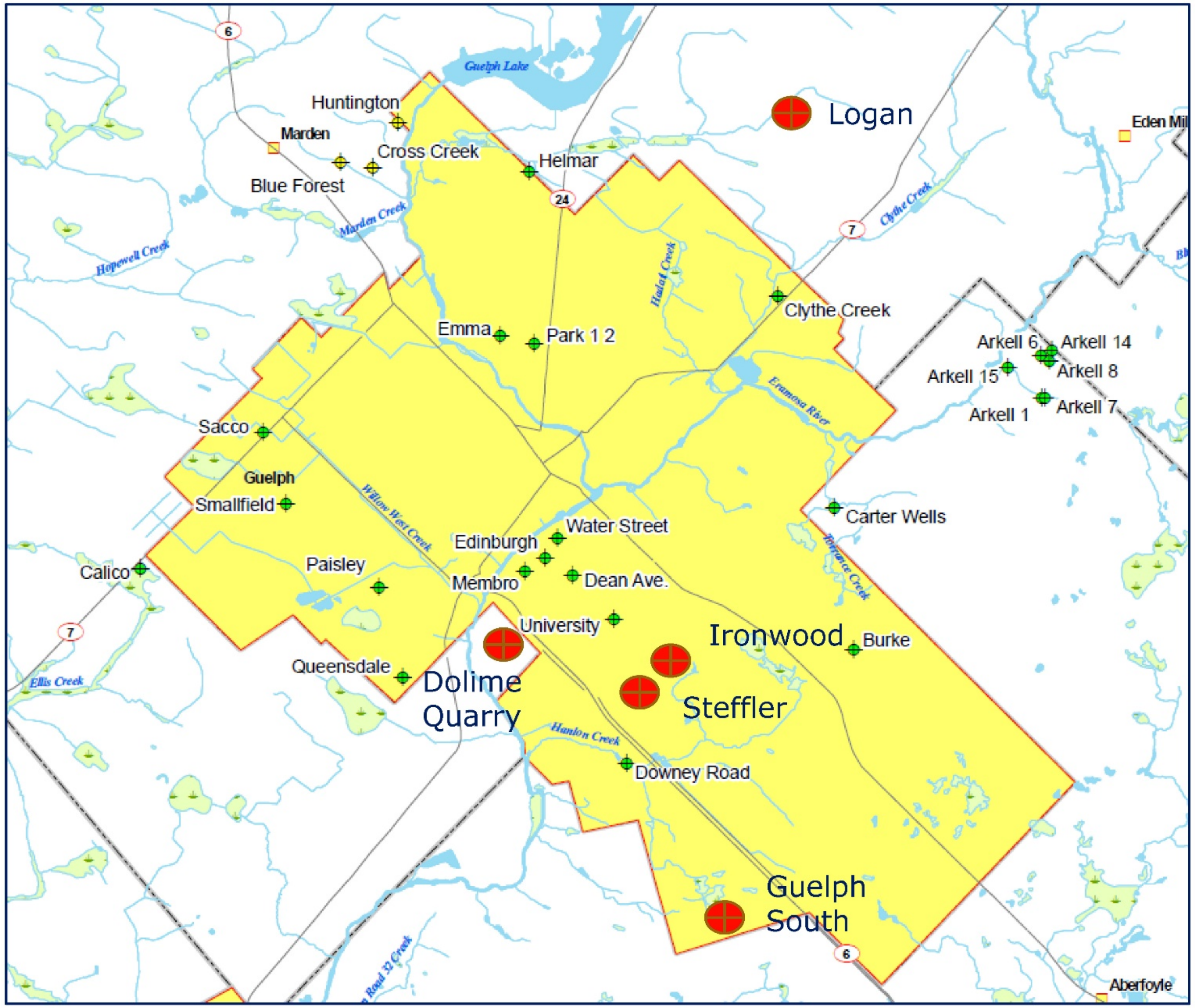
Other new sources inside/outside the City (long-term)



Plan for new supply:

- New supply projects - Class EA process to evaluate environmental, social, and economic impacts (such as impacts to surface water systems and sustainability) in and around the City
- Draft Water Supply Master Plan Update Report to be presented to Council in late 2021
- Update WSMP every 5 years approximately

New Supply - Test Wells




© The Groundwater Foundation

How are we engaging on the WSMP?

Guelph Community Engagement Framework

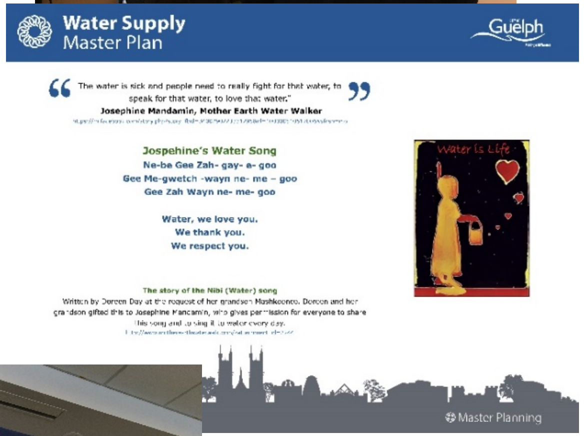
Community engagement plan:

- 3 Community Liaison Group meetings
- 2 Multi-agency workshops
- 2 Public information centres
- Online and social media engagement
- Completion of Community Engagement – Fall, 2021

Indigenous Engagement: How would Mississaugas of the Credit First Nations like to be engaged on this Master Plan?

Project web page – https://guelph.ca/plans-and-strategies/water-supply-master-plan/

Have your say Guelph - https://www.haveyoursay.guelph.ca/water-related-master-plans



Questions?

Comments?

Thank you!

Meeting Minutes

City of Guelph and Mississaugas of the Credit First Nation Environmental Water Master Plans Meeting

City of Guelph and Mississaugas of the Credit First Nation Environmental Water Master Plans Meeting

Mississaugas of the Credit First Nation

Date: Wednesday, October 6, 2021
Location: WebEX
Time: 10:00 a.m.
Hosts: City of Guelph: Leslie Muñoz, Scott Cousins, Wayne Galliher, Dave Belanger, Jennifer Rose, Kelly Guthrie, Heather Yates, Tim Robertson, Emily Stahl, Marina Grassi, Bibiana Bartokova
Attendees: Mississaugas of the Credit First Nation: Fawn Sault, Hilary Chamberlin

Meeting Minutes

Leslie oversaw everyone's introductions, thanked the representatives of the Mississaugas of the Credit First Nation for their willingness to meet.

1. **Overview of the Wastewater Treatment & Biosolids Management Master Plan**

Tim began the presentation by introducing the item for discussion, the Wastewater Treatment & Bio-solids Management Master Plan. He also described the roles of Environmental Services and Wastewater Services at the City of Guelph.

- Environmental Services: Stewards and professionals deliver reliable services to the community, while sustaining Guelph's finite resources for future generations with care for the environment.
- Wastewater services: provides Guelph with innovative service, while meeting current and future environmental needs.

Tim stated that the current Wastewater Treatment and Bio-Solids Management Master Plan is a combination of two existing master plans:

- 2009 Wastewater Treatment Master Plan
- 2006 Bio-solids Management Master Plan

The current Wastewater Treatment and Bio-solids Management Master Plan is expected to be reviewed and updated every 5 years.

Tim introduced the goals of the Master Plan. The Master Plan shall ensure that the City's wastewater is managed in a way that is sustainable and protects the environment and waterways. The Master Plan is expected to support the needs of the City up to 2051, given anticipated population growth to 203,000 residents and the associated impacts of this growth on the existing system.

Tim discussed the current existing conditions of the City's wastewater treatment and biosolids management system. The current system supports a flow rate of 64 MLD and its next expansion is approved through the latest EA update for up to 73.3 MLD. Tim stated that the Grand River Conservation Authority has recognized the City of Guelph with the Silver Level Award for successfully meeting water quality discharge targets below what is regulated by the facilities Environmental Compliance Approval The City is proud of it's bio-solids management. Tim explained that and the City is currently diverting 100% of this waste stream from landfill. Biolsolids are being beneficially reused through a Canadian Food Inspection Agency approved grade fertilizer.

Tim provided a Wastewater Treatment & Biosolids Management Master Plan progress update. The City initiated the Wastewater Treatment & Biosolids Management Master Plan in January 2020 which has a 2051 planning horizon. The Master Plan includes recommendations and identifies actions to address population growth and maintain environmental health.

Tim stated that the health of the Speed River is important to City of Guelph. As a result, the City has conducted a study on the Speed River to further understand how to best maintain the health of the waterway. The information provided through this study shall be worked into the final report of the Wastewater Treatment & Biosolids Management Master Plan.

Tim mentioned that it has been determined that there is adequate space for future expansion needs regarding wastewater treatment and biosolids management at the existing location.

Tim shared the next steps of the master plan. A Final Report shall be completed and reviewed. The report shall include findings from the studies as well as a prioritized project list and an implementation plan. Alternate technologies to support high quality discharge shall be included in the plan. This work will be presented to Council in December 2021.

Following approval of the plan, the following will occur:

- Policy and program recommendations shall be carried out,
- Existing wastewater infrastructure shall be maintained,
- Infrastructure shall be built and updated; and the
- Health of the Speed river and the environment shall be maintained and protected.

Tim concluded the presentation by asking the attendees if they had any questions regarding the content that was shown in the Wastewater Treatment & Bio-solids Management Master Plan Update presentation. No questions were asked by Fawn, Hilary or the hosts.

Leslie added a final comment stating that the City is currently developing a funding application for Infrastructure Canada's Disaster Mitigation and Adaptation Fund (DMAF) to secure federal dollars for upgrades to the existing wastewater treatment facility. It was mentioned that the upgrades shall further help protect the rivers and environment within the City of Guelph. Leslie offered to send a high-level description of the application to Fawn, which Fawn accepted.

2. Overview of the Water Supply Master Plan Update

Dave started the presentation by introducing the Water Supply Master Update. Dave stated that the current Water Supply Master Plan Update is an update of the existing 2014 Water Supply Master Plan. The current master plan has a focus on sustainable water supply for future growth in the City of Guelph. The Master plan's goals are to address the following questions:

- How much water do we have?
- How much water do we need in the future?
- What are the water supply alternatives?
- What is the plan for new supply?
- How are we engaging on the WSMP Update?

Dave continued the presentation with an overview of the existing system in Guelph. Dave spoke to the fact that the City is a groundwater-based community and its system includes 21 wells within the Guelph-Gasport Bedrock Aquifer, a shallow groundwater collector system and the Eramosa Rive Intake (seasonal). In addition, Dave explained that out of the 21 production wells, 4 are currently offline.

Dave proceeded to show a map of Guelph which displayed the existing system including the well locations as well as other water supply sources. The next map he showed was of the Arkell Spring Grounds where he described the Glen Collector system and the Eramosa River recharge system. Any water that is not picked up by the system is returned to the watercourse. He then proceeded to explain that the aqueduct on the site uses gravity to send water to the F.M. Woods station, which is used to service the City of Guelph.

Dave addressed the various water supply conditions including normal, drought, loss of source and regulatory approval scenarios. Currently under normal conditions the City has 79,422 m^3/day, a value that is expected to decrease under the other conditions and scenarios. For planning purposes, the City uses a range of 65,447 to 79,422 m^3/day, which is determined by anticipated drought conditions for the minimum value and normal conditions for the maximum value. Dave stated that the City wants to make sure that they always have enough water supply available to meet the demand.

Dave described that the current water supply demand is based on average daily demand and maximum daily demand. The average daily demand in 2020 was approximately 45,000 m^3/day and the maximum daily demand was 61,000 m^3/day. It was mentioned that the maximum demand is 34-35% higher than the average, but due to the success of City of Guelph water conservation programs, the maximum value continues to be lower than typical rates.

Dave continued by explaining the provincial growth projection to 2051 and how much water the City of Guelph will require to sustain this growth. The population is expected to increase to 203,000 people and 116,000 jobs by this timeframe. Given this anticipated population growth and an estimated demand of 167 L/day and 191

L/day for residential and employment respectively, the estimated 2051 water supply demand would be approximately 68,300 m^3/day. The Water Supply Master Plan is expected to address this increasing requirement for water.

Dave introduced the Water Efficiency Strategy as the most important component of the Water Supply Master Plan. The water efficiency strategy is used to promote water conservation and has already resulted in reductions of 11,500 m^3/day between 2014 and 2020. Dave further explained that due to the Water Efficiency Strategy, water demand in Guelph has remained relatively flat.

The identification of additional water supply is part of the master plan update and Dave explained both the short term and long term solutions. Short term solutions including using the Dolime Quarry, Steffler/Ironwood, Guelph South and Logan test wells, while long terms solutions would involve finding additional supply sources both inside and outside of the City. Dave showed a map which displayed the locations of the supply test wells.

Dave then spoke to the plan for the new supply. It was stated that the Master Plan is a collection of water supply projects and, for each project, the City would conduct a Class Environmental Assessment to evaluate potential impacts. A draft Water Supply Master Plan Update report shall be presented to Council on December 15th, 2021. The Water Supply Master Plan is expected to be updated approximately every five years.

Dave provided some information on how the City is engaging on the Water Supply Master Plan. Dave listed the following, which is aligned to Guelph's Community Engagement Framework:

- 3 community liaison group meetings
- 2 multi-agency/municipality workshops
- 2 public information centers
- Online and social media engagement
- Completion of community engagement (Fall 2021 Wrap Up)
- Looking for discussions with the Mississaugas of the Credit First Nations

3. Water Supply Master Plan Update Discussion

To conclude Dave asked if there were any further questions regarding the presentation.

Leslie added a final comment stating that there is currently another grant application under development by the City for Infrastructure Canada's DMAF program for funding to upgrade the F.M. Woods station. A description of this project will be sent along with the description of the Wastewater facility upgrades project. Both Leslie and Dave confirmed that the proposed work solely involves upgrades to the existing asset and will not be breaking new ground. MCFN did not raise any issues.

Fawn asked: when the City is planning for growth, how does the City plan the growth around the areas that they are trying to protect? How does the City factor in impermeable surfaces in their plan? To address this question Dave stated these factors are a part of the City's Source Protection Plan. The Source Protection Plan has been developed to maintain recharge as Guelph relies on groundwater. This means that every land development project has to maintain the same amount of water recharge post-development when compared to pre-development. To support Dave's response Leslie stated that the Planning Services team at the City works closely with Water Services to ensure factors like this are considered in the development approval process and in the official plan review process. Scott added further that there are pre-development and post-development requirements as well as best management practices for mitigation strategies.

Fawn asked: when the City speaks about water usage does that include agriculture? To respond to the question, Dave stated that water usage only speaks to water that is taken out of the City's distribution system and includes water lost or that didn't make it for usage as a result of leaks. He said there are no significant agricultural areas within the City of Guelph. Agriculture is still taken into consideration when referring to how much water is available. The City uses a 3-D groundwater flow model as a part of the Source Protection and water budget studies that includes details from surrounding areas. The model gets updated regularly.

Fawn also asked about Nestle. Dave responded by stating that Blue Triton, which took over Nestle, is still at its location but they are downgradient from the City. The plant is still within the City's Well Head Protection Area for water quantity. Blue Triton is closely monitored to assure they have reliable data. Fawn asked to have Blue Triton's contact information and Dave said he could provide that to Fawn (Dave sent contact information to Fawn on October 8).

4. Next Steps

Leslie asked Fawn how she and the Mississaugas of the Credit First Nations would like to continue to be engaged. Leslie explained that there are some tight timelines due to the council meeting scheduled in December, but that the Master Plans will continue to be reviewed every 5 years.

Fawn stated that she is okay with receiving updates on a yearly basis, but specified that she would like the Mississaugas of the Credit First Nations to be involved and contacted whenever there is a field study, breaking ground, or new infrastructure being put in place. Upgrades and internal process do not require the involvement of the Mississaugas of the Credit First Nation. Yearly updates should include where the City is at and where they are going regarding the Master Plans.

To address Fawn's comments, Dave stated that each individual project goes through a municipal Class Environmental Assessment and he would like to engage with the Mississaugas of the Credit First Nation at each project.

Heather then stated that the City will be developing a strategy on expanded water stewardship and conservation in the year ahead, indicating the MCFN may have an interest in this work. Fawn asked to be kept in the loop.

Leslie concluded the meeting by thanking the Fawn and Hilary for joining the discussion as well as all the hosts, presenters and participants.

October 18, 2021

Haudenosaunee Confederacy Chiefs Council
2634 6th Line Road, RR#2Ohsweken, Ontario
N0A 1M0

Dear Haudenosaunee Confederacy Chiefs Council,

RE: Guelph Water Supply Master Plan Update – Virtual Meeting

It has been some time since we discussed the City of Guelph Water Supply Master Plan Update. Our last correspondence was in June 2020. As a reminder, the goal of the Water Supply Master Plan Update is to review our water supply sources and identify priorities, including sustainable municipal supply options, from now until 2051. Our work for the Project continues, including our desire to engage with Haudenosaunee Confederacy Chiefs Council, the public and those who may be impacted and/or interested in the project. For more information, you can visit our webpage or stay involved with our engagement page.

If Haudenosaunee Confederacy Chiefs Council is interested, we would like to offer a virtual project meeting for yourself and other members of Haudenosaunee Confederacy Chiefs Council consultation team. The intent of this meeting would be to re-introduce the project, gain any input and insight your community may have related to water supply in Guelph and answer any questions you may have.

If you are interested in meeting, please reply at the contact information below with a preferred date and time. We can set up the meeting using Microsoft Teams or another preferred meeting platform. Also, you are welcome to share any questions or concerns that you may have in advance so we can address them in our meeting.

If you have any questions, comments or concerns related to the Water Supply Master Plan or would like to meet virtually to discuss the project, please do not hesitate to contact me at dave.belanger@guelph.ca or (519) 822-1260 ext. 2186 or AECOM's Project Manager, Matthew Alexander, at matthew.alexander@aecom.com or (226) 821-4906.

Please note that we will also follow up by phone to confirm receipt of this letter and see if you have any questions or comments.

Sincerely,

D Belanger

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager
Water Services
Infrastructure, Development and Enterprise
City of Guelph
T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

Meeting Minutes

Wastewater Treatment and Biosolids Management & Water Supply Master Plans Indigenous Engagement Meeting
Six Nations of the Grand River

Date: Monday, July 12, 2021
Location: Microsoft Teams
Time: 11:00 a.m.
Hosts: City of Guelph: Leslie Muñoz, Scott Cousins, Wayne Galliher, Dave Belanger, Kelly Guthrie, Marina Grassi, Tim Robertson, Michael Lanc
Attendees: Six Nations of Grand River: Lonny Bomberry, Robbin Vanstone, Bethany Wakefield, Peter Graham, Taylor Hill, Tanya Hill-Montour, Phil Montour

Meeting Minutes
Leslie oversaw everyone's introductions, thanked the representatives of the Six Nations of the Grand River for their willingness to meet, and acknowledged that Six Nations has expressed water as an area of particular interest.

1. **Brief overview of Wastewater Treatment & Biosolids Management MP**

Tim begins a presentation overviewing the updates to the City's Wastewater Treatment and Biosolids Management Master Plan.

Tim explained the City treats wastewater domestic and commercial wastewater before discharging it to the Speed River.

The Wastewater Treatment & Biosolids Management MP connects to two mandates:

1. Environmental Services: Stewards and professionals deliver reliable services to the community, while sustaining Guelph's finite resources for future generations with care for the environment.
2. Wastewater services: provides Guelph with innovative service, while meeting current and future environmental needs.

Tim shared the goal of this Master Plan, stating that it is to ensure Guelph's wastewater is managed in a way that is sustainable and protective of our waterways and environment. It aims to meet Guelph's needs moving toward 2051, considering the City's population growth and advancing technologies.

Tim offered the context of this Master Plan update, stating it is updating two previously separate Master Plans. This single Master Plan will be updated every five years.

The current average flow of the WWTP is approximately 53,000 m^3/d. The WWTP uses Anammox, a biological process that treats 80% of the ammonia in the facility.

Tim shared the WWTP has received recognition from the Grand River Conservation Authorities Award program through a Silver level award.

Tim detailed the existing conditions of biosolids management. For the past several years, the facility has diverted 100% of biosolids from the landfill. All biosolids are either processed on site or sent to the Lystek facility in Dundalk and then applied as a CFIA approved fertilizer, recycling potassium, phosphorus, and nitrogen back into the environment.

Tim provided a progress update on the Master Plan. In January 2020, the City initiated the Wastewater Treatment and Biosolids Management update, which identifies recommendations for a proposed roadmap for future capital investment. To manage growth and environment health, an investment in current technologies and infrastructure is necessary.

Bethany asked about the safety of the fertilizer coming out of the plant. Tim stated he would address this at the end of the presentation.

Tim stated "The health of the Speed River is important to all of us". In 1996, a desktop ACS study was conducted to determine the conditions of the Speed River. The study recommended the plant expand to 73,300 m^3/d. In 2020-21 a thorough assimilative capacity of the river study is coming to a close to better understand the current conditions of the river and verify possible future effluent discharge limits.

Tim addressed the future needs of the WTTP. The current site has adequate space for future expansion needs. The alternatives and the evaluation process were communicated to the community and the public through website updates and a virtual public open house.

The next steps for the Master Plan were shared. The final report for the ACS will be reviewed, with an implementation plan based on the findings to be prepared. The City plans to incorporate alternate technologies in the WTTP. The Master Plan update will be presented to Council on December 6, 2021.

Tim stated that following approval, the city will:

- initiate the implementation of the strategy identified in the Master Plan,
- carry out policy and program recommendations,
- maintain existing wastewater infrastructure,
- build new infrastructure
- Continue to strive for the best quality effluent in order to protect the Speed River and surrounding environment

Tim concluded the presentation and asked if Six Nations had any questions or comments.

2. Discussion of Wastewater Treatment & Biosolids Management MP

Feedback on Master Plan:
Tim addressed Bethany's earlier question regarding the safety of the fertilizer. Tim stated that it meets CFIA fertilizer requirements. It is 15% solid and is applied subsurface to reduce runoff, allowing the nutrients to go back into the land.

Bethany asked if there is any contamination of the biosolid product. Tim stated that it is sent to the CFIA for testing, and it meets their standards.

Bethany stated that biosolids are allowed in agriculture, only in small amounts, because they contaminate. She asked how this is dealt with. Tim stated that the biosolids are stabilized through anaerobic digestion and then undergo thermal hydrolysis through the Lystek process producing a pathogen free product to apply to land. This land application step is contracted out to ensure it is responsibly applied to land, and is CFIA approved. Bethany asked Tim if he could share the documents detailing the technology involved, as well as the list of CFIA standards. Tim stated the City would send them after the meeting.

Peter asked about the anticipated discharge limits in the future, and what the planned technologies and processes are. Tim stated that when flow rates increase, it is expected that the allowable concentration limits will have to go down so that the overall loading to the river is not negatively impacted. Among other parameters, the regulated overall limit of ammonia released to the river will decrease.

Additional concerns or issues:
Lonny asked how old the WTTP is. Tim stated that the plant was initially built in 1903, with infrastructure renewals occurring over time. The newest renewals occurred in 2002. The MP is not aiming to build a new plant but looking to enhance the existing plant to recognize the full potential of existing infrastructure.
Lonny asked if the facility gets overrun in extreme flooding. Tim stated that in extreme scenarios the tertiary level of treatment utilized at the plant ensures that the final effluent is still very good. The primary and secondary systems with disinfection and dechlorination continue to function under worse case scenarios of very high flow rates.

3. Brief Overview of Water Supply Master Plan

Dave began a presentation overviewing the City's Water Supply Master Plan.

Dave provided an update of the Water Supply Master Plan. The City is currently updating the 2014 Water Supply Master Plan, which is an update to the 2007 Master Plan.

The focus of the Water Supply Master Plan is to establish a sustainable water supply to regulate future growth.

The Water Supply Master Plan aims to address five questions/concerns:

- How much water do we have now?
- How much water do we need in the future?
- What are the water supply alternatives?
- What is the plan for new supply?
- How are we engaging on the WSMP Update?

Dave shared an overview of the City's existing water supply system. Guelph has a groundwater-based water supply, with production wells in the Guelph-Gasport bedrock aquifer and the Arkell Spring Grounds collector system. There are 21 wells in continuous operation, with 4 wells currently offline due to water quality concerns. The Eramosa River Intake and Recharge system is seasonal, pumping river water to an infiltration pond, and a trench provides water to the collector system.

Dave shared a map identifying the locations of the water supply wells in Guelph. The Arkell Spring Grounds is located outside of the City; a photo of its notable features were displayed.

Dave addressed the City's water demand levels. For planning purposes, the City measures this by taking anticipated drought conditions and anticipated normal conditions and creating a range, which is 65,447 to 79,422 m^3/day.

The City has determined approximately how much water Guelph will need in the future using the Provincial Places to Grow projection up to 2051. Assuming Guelph reaches a population of 203, 000 people and 116,000 jobs in 2051, and uses 68,300 m^3/day, the City will be at a deficit of ~3,000 m^3/day. The Water supply Master Plan aims to make up this deficit.

Dave shared the City's water supply alternative. The Water Efficiency Strategy is the most important component of the Water Supply Master Plan, reducing approximately 11,500 m^3/day of water usage from 2014 to 2020. New test wells have been created as a near-term solution, with the acquisition of other water sources inside/outside the City is a long-term solution.

The draft Water Supply Master Plan Update Report will be presented to Council in late 2021, and the WSMP will be updated every 5 years.

Dave shared a map identifying the locations of the City's new supply test wells.

Dave provided a number of ways the City has engaged on the Water Supply Master Plan. The City completed Phase One of engagement, which included multi-agency workshops, the formation of public information centers, and online and social media engagement. Phase Two of engagement will begin in Fall of 2021, as COVID has set back engagement progress. Dave also asked Six Nations to consider how they would like to be engaged on the WSMP in the future.

Dave concluded the presentation and asked Six Nations if they had any questions or issues to bring up.

4. Discussion of Water Supply Master Plan

Feedback on Master Plan:
Bethany asked if the water from the aquifer is being completely replaced or if it is net depletion. Dave stated that the City only takes a small fraction of water from the aquifer, making it sustainable. The City recognizes that outtake will increase while supply will remain the same, and will look to manage this.

Bethany stated that as of 2013, 44% of water in Guelph is industrial, asking if there is any way to lower this. Wayne stated that the City has had a buyback program since 2012 with significant success.

Bethany expressed concern about the aquifer and the necessity to have permeable services to save source water.

Bethany also asked how the water budget was derived. Dave stated it is the product of a 7-8 year study, examining inputs and future growth scenarios.

Additional concerns or issues:
Lonny asks whether the wells go into rock, and how deep they go into the ground. Dave stated that the wells go to bedrock below the city, 60-70 meters at their deepest. They are in a confined bedrock aquifer, protected from surface contamination. Lonny asked how contamination occurred. Dave stated that groundwater is sometimes contaminated as a result of nearby industrial sites.

Bethany stated that there is a good opportunity for water services to get their planning aligned, as there is currently a lot of water wasted. Technologies that could save water are not being used and future projects should be required to use them to better save water. Dave stated that City programs are comprehensive and that the City does have water/wastewater saving initiatives. Wayne added that in household trials of new technologies in 2011, challenges included high price points for technologies, requirement for a tech-savvy owner, and the inability to enforce via the local building code. Bethany asked if it would be more efficient to implement these on a neighborhood level instead of the individual level. Wayne stated that there are no construction standards to regulate this.

Bethany expressed concern that the City is only looking at what affects us rather than what effects everything. It is important to protect plants that use the aquifers as well. Dave stated that the city shares this concern. Bethany asked if these considerations were added to the current budget and whether Six Nations can have access to the water budget studies. Dave stated that it is available online and the City can send it to Six Nations. Leslie added that the City often advocates to the province on issues of water quality.

Bethany recommended the City reopen the investigation into water technologies. Leslie stated that the city is bound to the building code and must follow the province. The City can incentivize but never force partners to comply.

5. Next Steps

Leslie stated that both Water Master Plans are to be reviewed and sent to Council in Q4 of 2021, and asked Six Nations what they want engagement to look like leading up to this. Robbin stated that Six Nations will want to see what the City is proposing to Council and want the option to add any last minute comments/requests. Six Nations would like to see the final drafts before they are sent to Council.

Bethany stated that it would be beneficial for Six Nations to be involved in the actual planning and development of the Master Plans.

Leslie stated that after the City gets approval for the Master Plans, implementation is next. Leslie stated that the City would be happy to engage again. Marina added that continuous engagement makes sense.

Leslie stated that they will compile the requested documents and send them to Bethany. They will also ensure Six Nations sees the MP drafts before they are sent to Council. The City will connect with Six Nations again at the implementation phase.

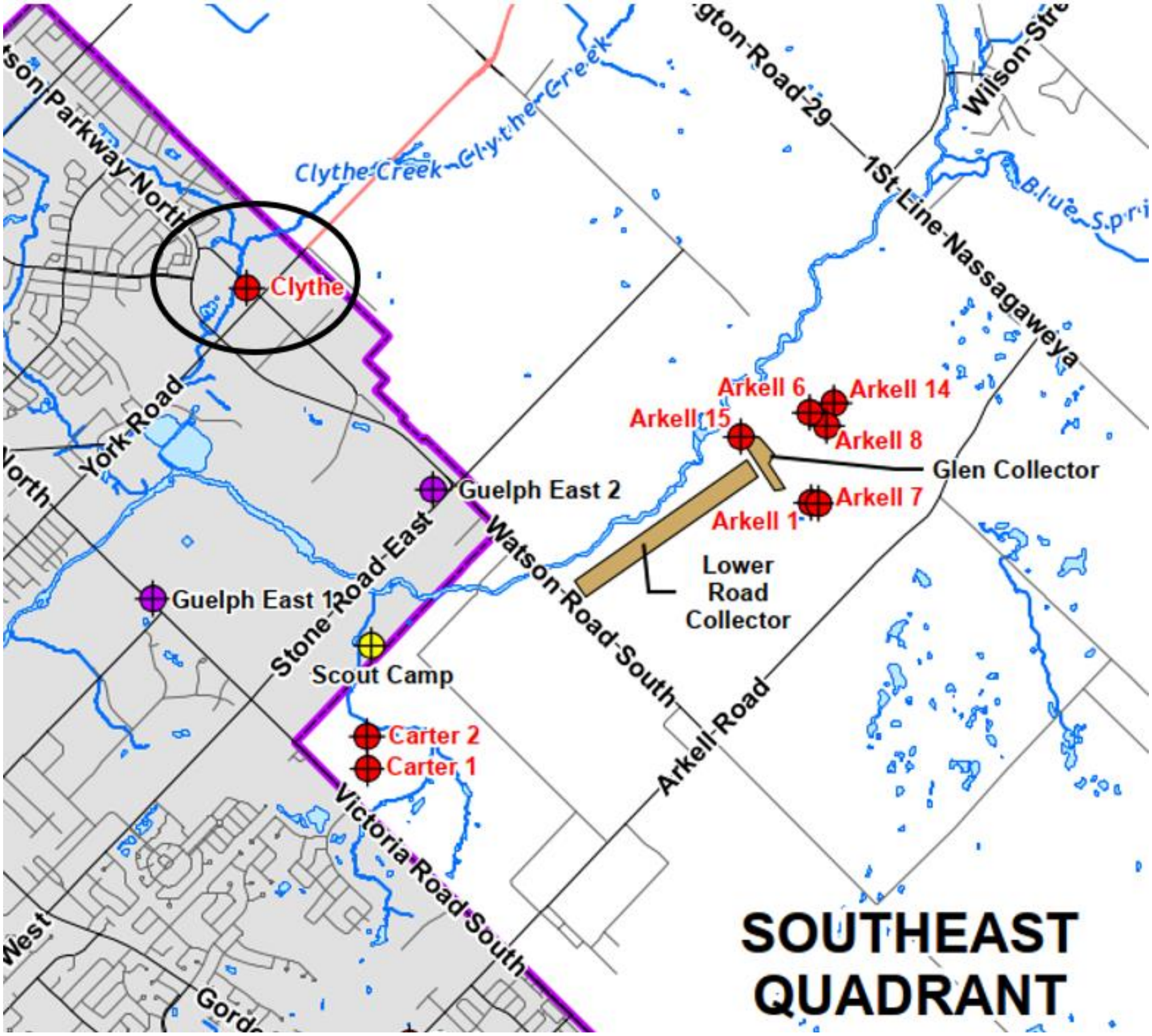
Leslie concluded the meeting by stating that Dolime quarry is a priority for the City, and the city appreciates Six Nations taking the meeting to learn about the details and possibly support the City.

Appendix G

Project Sheets for Preferred Alternatives

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Clythe Well

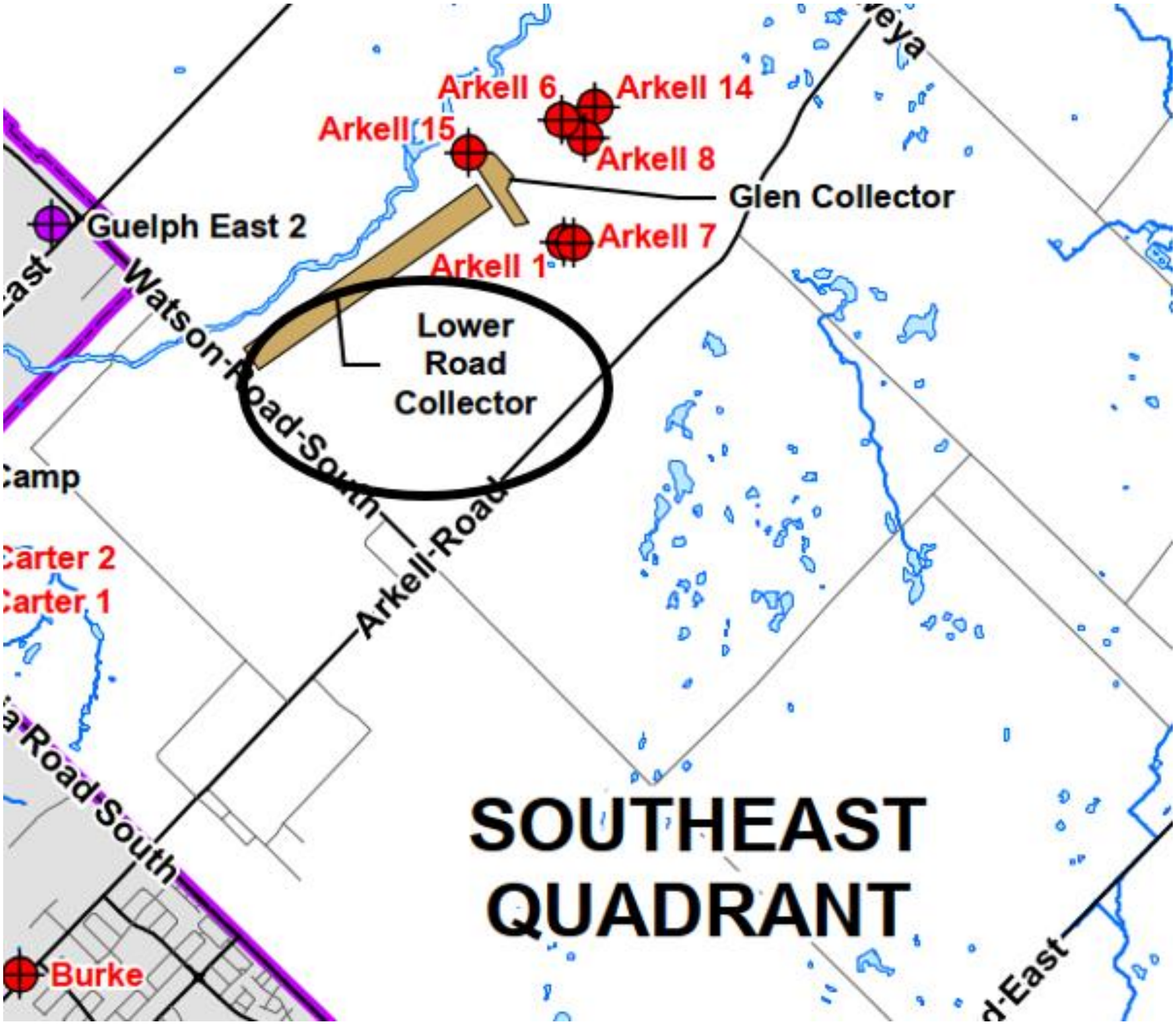


Project Component	Project Details
Location	■ Adjacent to Clythe Creek, near intersection of Highway 7 and Watson Road
Description	■ Drilled in 1976, has 305 mm dia. casing, offline since 1999
Permitted Pump Rate	■ 3,395 m^3/d
Sustainable Capacity	■ 1,180 m^3/d per modelling assessment (considered to be a conservative value); field testing has shown 3,370 to be locally sustainable

Project Component	Project Details
Existing Approvals	■ Permit To Take Water (PTTW)
Required Approvals	■ Amendment to City Drinking Water License (DWL)
Water Quality Issues	■ Hydrogen sulfide, iron and manganese
Environmental Constraints	■ Close to Clythe Creek and Clythe Creek Provincially Significant Wetland (PSW) ■ Potential impacts to features assessed as part of Ministry of the Environment, Conservation and Parks (MECP) PTTW approval process ■ City collecting additional data to build on understanding of the potential for interaction between the well and natural environment
Past Studies/Work	■ Rehabilitation and Performance Assessment in 2008 ■ Schedule B Class Environmental Assessment (EA) for Water Treatment Plant (WTP) completed in 2018 (identified strategy for water quality treatment requirements) ■ Land acquisition of property across road to accommodate new WTP
Required Studies	■ Additional monitoring data noted above
Required Infrastructure	■ Water Treatment System ■ Well house upgrades
Estimated Capital Cost	■ $6,781,000 (for WTP with design capacity of 3,370 m^3/d)
Cost per m^3/day	■ $2,012 (at 3,370 m^3/d; field tested rate)
Annual Operations & Maintenance (O&M) Cost	■ $100,000
Life Cycle Cost	■ $0.56/$m^3$ of water produced
Implementation Timeline	■ Two year design and construction period

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Arkell Lower Road Collector System

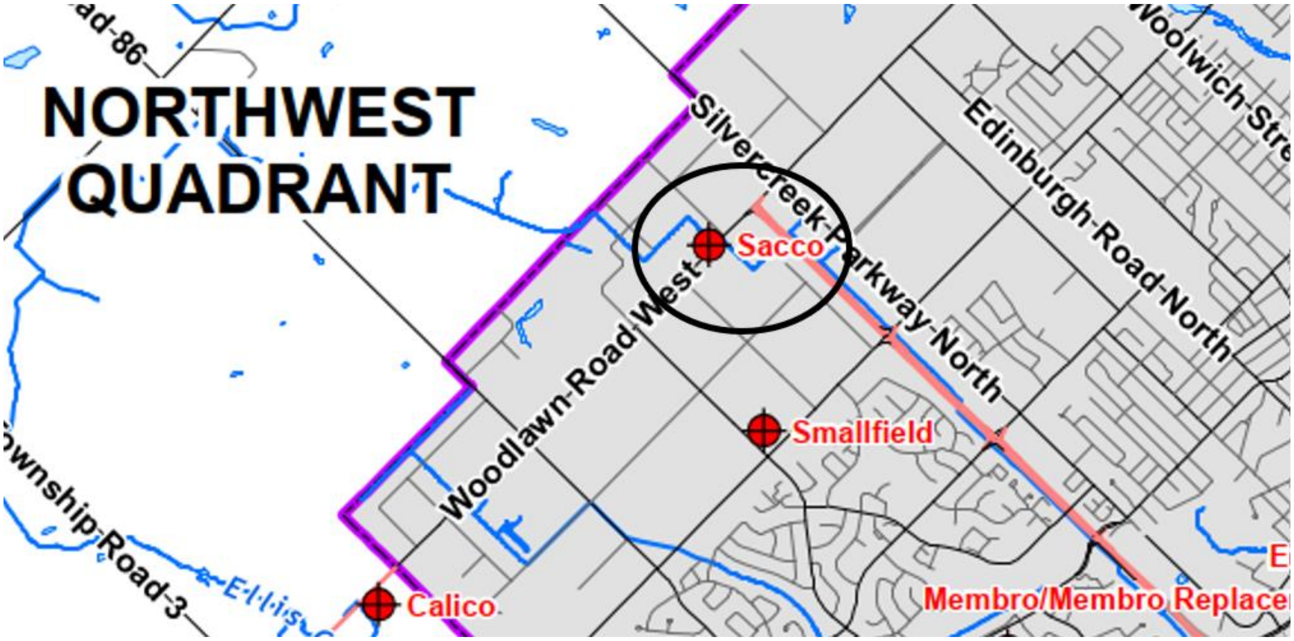


Project Component	Project Details
Location	■ Lower slope of the Eramosa valley wall (Arkell Spring Grounds), east of Watson Road
Description	■ A collector system consisting of 30 manholes and 26 collection galleries, disconnected in 2000
Historical Production Rate	■ 600 to 6,000 m^3/d
Sustainable Capacity	■ Modelling assessment indicates that collector replacement could add 4,000 m^3/d to the combined minimum collector volume (i.e., total for Lower Road and existing Glen Collector)

Project Component	Project Details
Existing Approvals	■ PTTW (under Arkell Springs Grounds Collector groundwater taking)
Required Approvals	■ DWL amendment ■ Possible Class EA Schedule B, with consideration for potential environmental impacts
Water Quality Issues	■ Elevated bacterial content; would be treated via Woods Ultraviolet (UV) system (review of updated Groundwater Under Direct Influence of Surface Water Terms of Reference [GUDI TOR] required, when available) ■ Separate connection to valve chamber with bypass when turbidity high (similar to Glen collector)
Environmental Constraints	■ Near Eramosa River and Eramosa River Blue Springs Creek PSW – system previously permitted, no PTTW increase required, potential impacts assessed and permitted previously (updated ecological assessment required) ■ Near Arkell well field
Past Studies/Work	■ Aquifer Performance Evaluation Southeast Quadrant, 1998 ■ Review of Collector Rehabilitation/Replacement Options, 2004 ■ 2014 WSMP Update
Required Studies	■ Field investigation ■ Arkell artificial recharge system improvement study ■ Design & Construction
Required Infrastructure	■ New HDPE perforated pipe & associated infrastructure
Estimated Capital Cost	■ $13,874,000
Cost per m³/day	■ $3,469 (at 4,000 m^3/day)
Annual O&M Cost	■ $125,000
Life Cycle Cost	■ $0.84/$m^3$ of water produced
Implementation Timeline	■ Feasibility study (field and modelling investigation); artificial recharge system upgrades – estimated 4 year period ■ Class EA – estimated one to two years ■ Design and construction – estimated four years

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Sacco Well

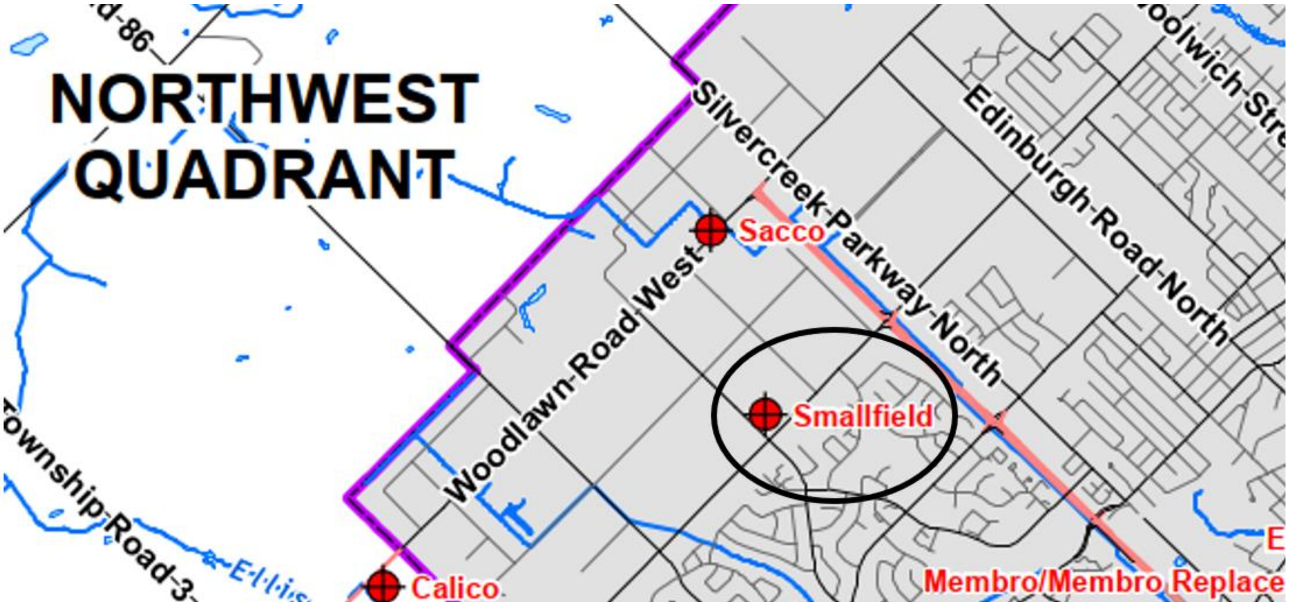


Project Component	Project Details
Location	■ 348 Woodlawn Road
Description	■ Drilled in 1952, has 300 mm dia. casing, inactive since 1991
Permitted Pumping Rate	■ 1,640 m^3/d
Sustainable Capacity	■ 425 m^3/d per modelling assessment (a portion of 1,275 m^3/day available within the City's Northwest Quadrant [NWQ]); field testing has demonstrated local sustainability up to 1,150 m^3/d
Existing Approvals	■ PTTW
Required Approvals	■ Class EA (Schedule B) ■ Amendment to City DWL
Water Quality Issues	■ Detectable levels of Trichloroethylene (TCE), Tetrachloroethylene (PCE) and 1,1-dichloroethylene below Ontario Drinking Water Quality Standards (ODWQS)
Environmental Constraints	■ Speed River catchment, close proximity to Ellis/ Chilligo Creek, near Marden South PSW Complex ■ Permitted source, potential impacts accounted for in assessment completed for PTTW application ■ Pumping could induce movement of contaminants within aquifer
Past Studies/Work	■ Rehabilitation and Performance Assessment in 2008 ■ Sacco Return to Service Options in 2014

Project Component	Project Details
Required Studies	■ MECP enforced contaminant source remediation ■ Water treatment study ■ GUDI assessment and well rehabilitation ■ Design and Construction
Required Infrastructure	■ Submersible pump, electrical panel and raw watermain for transmission to Smallfield site for treatment ■ Water Treatment System (Smallfield site)
Estimated Capital Cost	■ $13,116,000 (combined cost for Sacco and Smallfield wells)
Cost per m^3/day	■ $5,127 (at 1,150 m^3/day)
Annual O&M Cost	■ $99,000
Life Cycle Cost	■ $1.24/$m^3$ of water produced
Implementation Timeline	■ Timeline uncertain due to lack of active remediation or timeline to implement remediation

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Smallfield Well

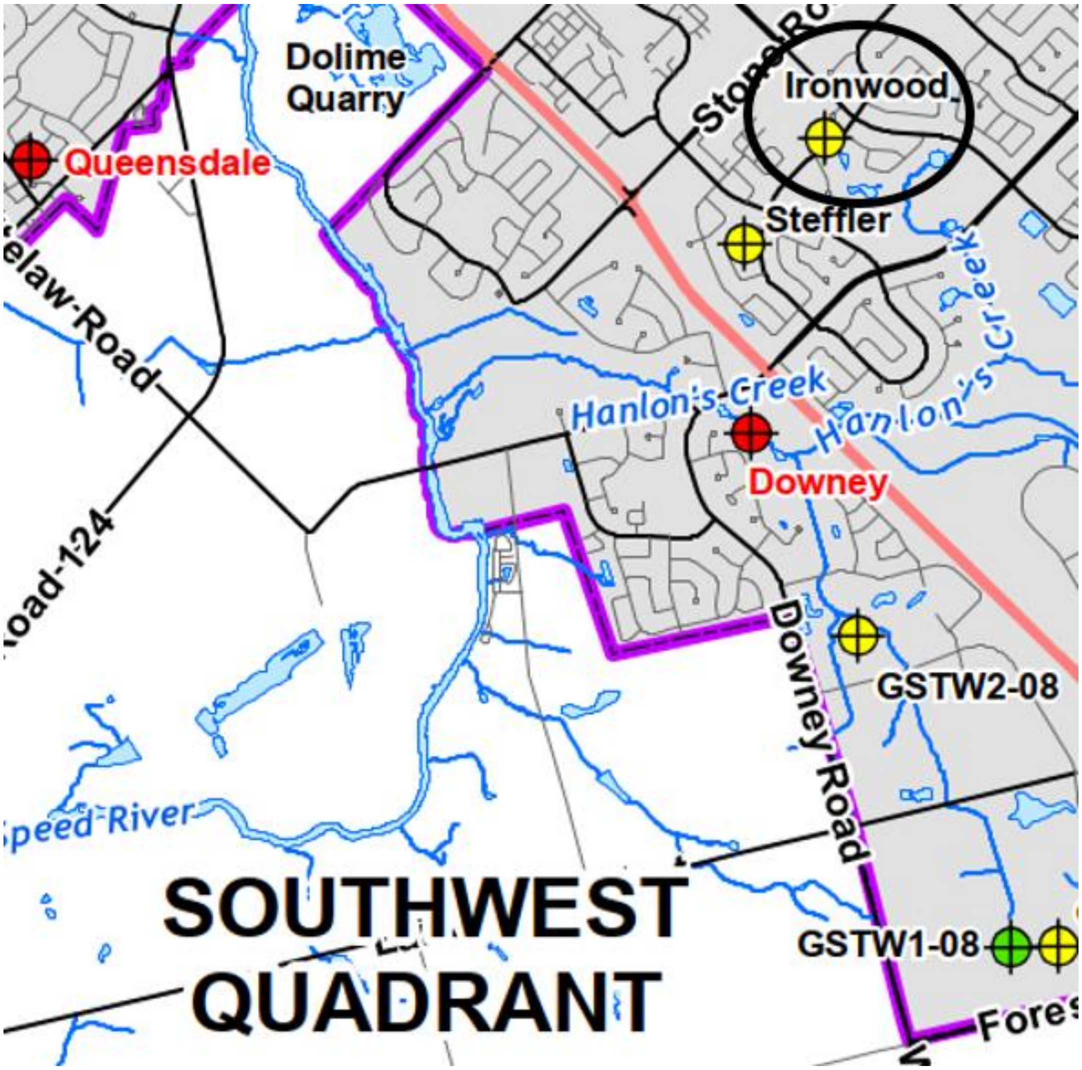


Project Component	Project Details
Location	■ 461 Speedvale Avenue
Description	■ Drilled in 1966, has 300 mm dia. casing, inactive since 1993
Permitted Pumping Rate	■ 1,964 m^3/d
Sustainable Capacity	■ 425 m^3/d per modelling assessment (a portion of 1,275 m^3/day available within the City's NWQ); field testing has demonstrated local sustainability up to 1,408 m^3/d
Existing Approvals	■ PTTW
Required Approvals	■ Amendment to City DWL ■ Class EA (Schedule B)
Water Quality Issues	■ TCE concentration above ODWQS Maximum Acceptable Concentration (MAC) of 5 µg/L, PCE, 1,1-dichloroethylene and 1,4-dioxane below MAC, detectable levels of 1,1,1-Trichloroethane/ dioxin and furans, chloride above ODWQS Aesthetic Objective of 250 mg/L. ■ High concentrations of similar contaminants are known to exist in groundwater on adjacent properties.
Environmental Constraints	■ Speed River catchment, close proximity to Ellis/ Chilligo Creek, near Marden South PSW Complex ■ Permitted source, potential impacts accounted for in assessment completed for PTTW application

Project Component	Project Details
	■ Pumping would induce movement of contaminants within aquifer
Past Studies/Work	■ Rehabilitation and Performance Assessment in 2008 ■ Sacco Return to Service Options in 2014
Required Studies	■ MECP enforced contaminant source remediation ■ Performance Test ■ Treatment Studies ■ Class EA; Design & Construction
Required Infrastructure	■ Well house upgrade ■ Water Treatment System
Estimated Capital Cost	■ $13,116,000 (combined cost for Sacco and Smallfield wells)
Cost per m^3/day	■ $5,127 (at 1,408 m^3/day)
Annual O&M Cost	■ $99,000
Life Cycle Cost	■ $1.24/$m^3$ of water produced
Implementation Timeline	■ Timeline uncertain due to lack of active remediation or timeline to implement remediation

Alternative: Develop Existing Municipal Test Wells

Project Sheet: Development of Ironwood Well

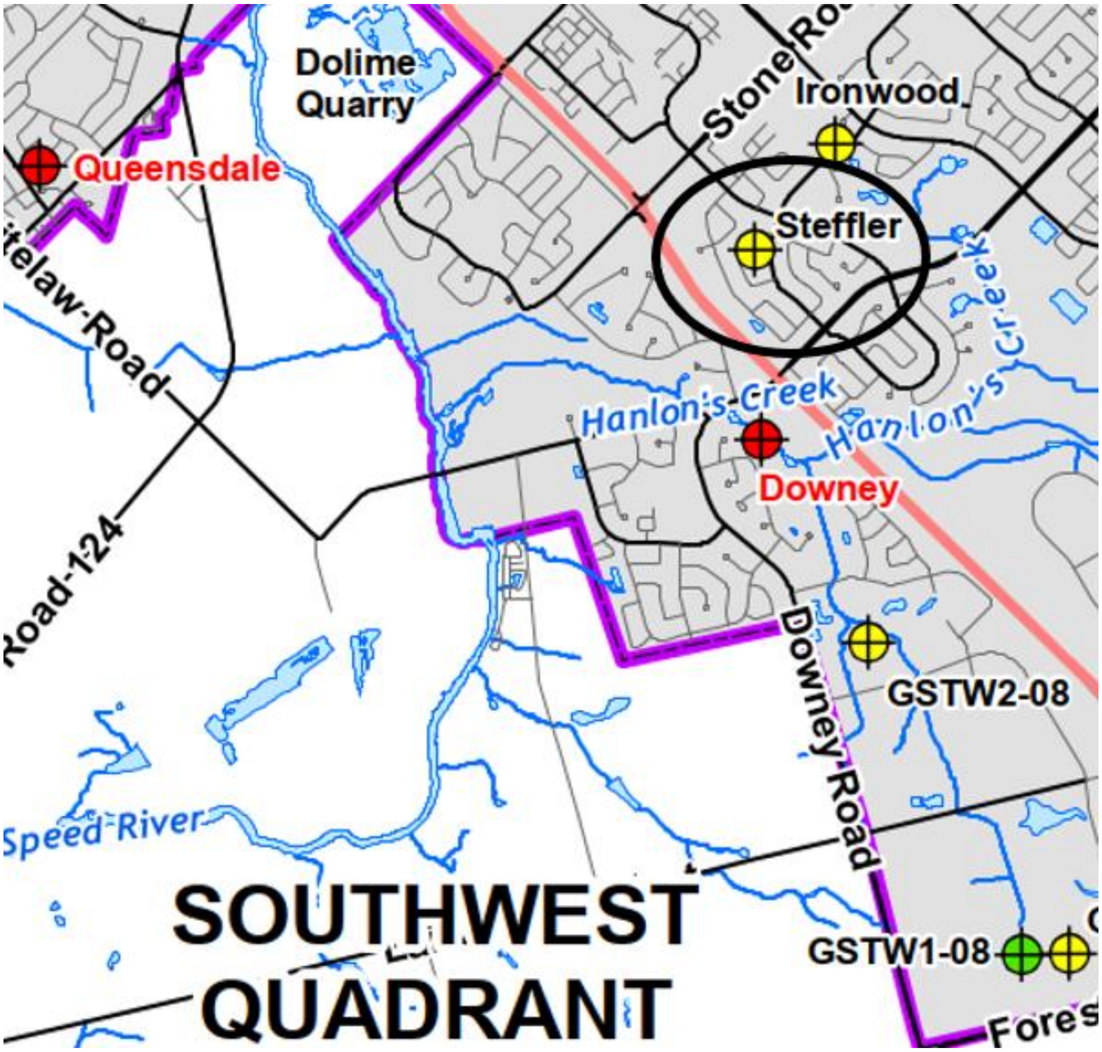


Project Component	Project Details
Location	■ Edinburgh Road South & Ironwood Road; in University Village municipal park
Description	■ Constructed in 2008, has 400 mm dia. casing
Sustainable Capacity	■ 2,250 m^3/d per modelling assessment; a portion of 4,500 m^3/day available within the City's Southwest Quadrant (SWQ) with active quarry dewatering; it is anticipated that either the Ironwood or Steffler well would be developed; capacity of Ironwood well estimated to be 8,000 m^3/day in 2008 SWQ Class EA
Existing Approvals	■ None

Project Component	Project Details
Required Approvals	■ PTTW ■ Amendment to City DWL ■ Class EA (initiated in 2021) ■ Municipal approvals
Water Quality Issues	■ During pumping test (2008 Class EA), antimony reported above ODWQS, result assumed to be spurious - to be confirmed through EA
Environmental Constraints	■ Modelling indicates that overall SWQ steady-state capacity can be increased by 4,500 m^3/d; therefore additional capacity provides redundancy ■ Pumping may be limited to avoid impacts to Hanlon Creek baseflow; uncertainty related to potential baseflow impacts to Irish Creek ■ Southwest Guelph Water Supply Class EA (ongoing) to evaluate potential impacts to natural environment through Operational Testing Program
Past Studies/Work	■ SWQ Class EA put on hold in 2010, included groundwater development study and 32 day constant rate pumping test; new EA initiated in 2021
Required Studies	■ Complete Water Supply Class EA (ongoing) ■ Design & Construction
Required Infrastructure	■ Connection to distribution system ■ Well house
Estimated Capital Cost	■ $5,125,000
Cost per m^3/day	■ $640 (at 8,000 m^3/day)
Annual O&M	■ $111,000
Life Cycle Cost	■ $0.19/$m^3$ of water produced
Implementation Timeline	■ Class EA (ongoing) – 5 years ■ Design and construction – estimated 2 years

Alternative: Develop Existing Municipal Test Wells

Project Sheet: Development of Steffler Well

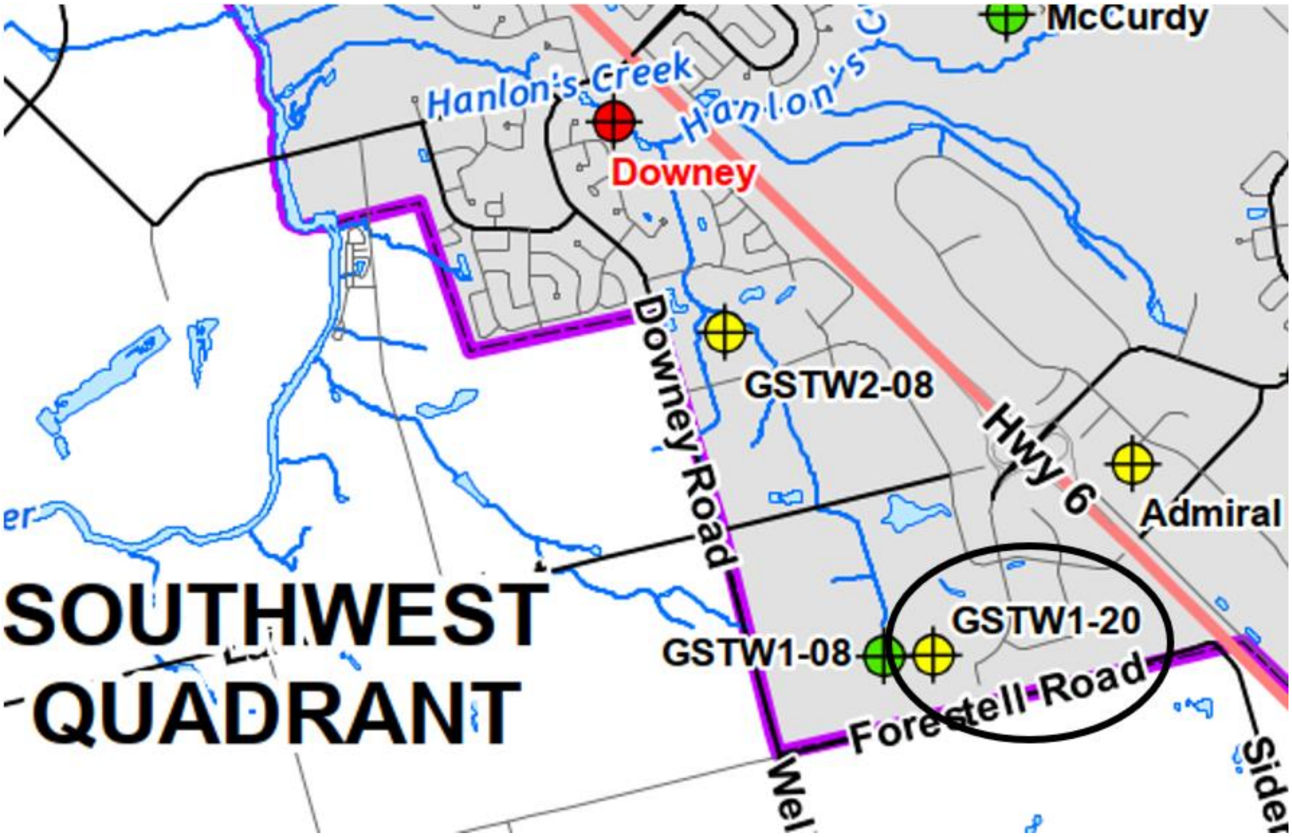


Project Component	Project Details
Location	■ At Steffler Drive and Ironwood Road; in Steffler municipal park
Description	■ Constructed in May 2008 with a 400 mm dia. casing
Sustainable Capacity	■ 2,250 m^3/d per modelling assessment; a portion of 4,500 m^3/day available within the City's SWQ with active quarry dewatering; it is anticipated that either the Steffler or Ironwood well would be developed; capacity of Steffler well estimated to be 3,600 m^3/day in 2008 SWQ Class EA
Existing Approvals	■ None

Project Component	Project Details
Required Approvals	■ PTTW ■ Amendment to City DWL ■ Class EA (initiated in 2021) ■ Municipal approvals
Water Quality Issues	■ During pumping test (2008 Class EA), antimony reported above ODWQS, result assumed to be spurious to be confirmed through EA
Environmental Constraints	■ Modelling indicates that overall SWQ steady-state capacity can be increased by 4,500 m^3/d; therefore additional capacity provides redundancy ■ Pumping may be limited to avoid impacts to Hanlon Creek baseflow; uncertainty related to potential baseflow impacts to Irish Creek ■ Southwest Guelph Water Supply Class EA to evaluate potential impacts to natural environment through Operational Testing Program
Past Studies/Work	■ Class EA put on hold in 2010, included groundwater development study and 32 day constant rate pumping test; new EA initiated in 2021
Required Studies	■ Complete Water Supply Class EA (ongoing) ■ Design & Construction
Required Infrastructure	■ Connection to distribution system ■ Well house
Estimated Capital Cost	■ $6,194,000
Cost per m^3/day	■ $1,721 (at 3,600 m^3/day)
Annual O&M	■ $106,000
Life Cycle Cost	■ $0.47/$m^3$ of water produced
Implementation Timeline	■ Class EA (ongoing) – 5 years ■ Design and construction – estimated 2 years

Alternative: Develop Existing Municipal Test Wells

Project Sheet: Development of Guelph South Test Well (GSTW1-20)

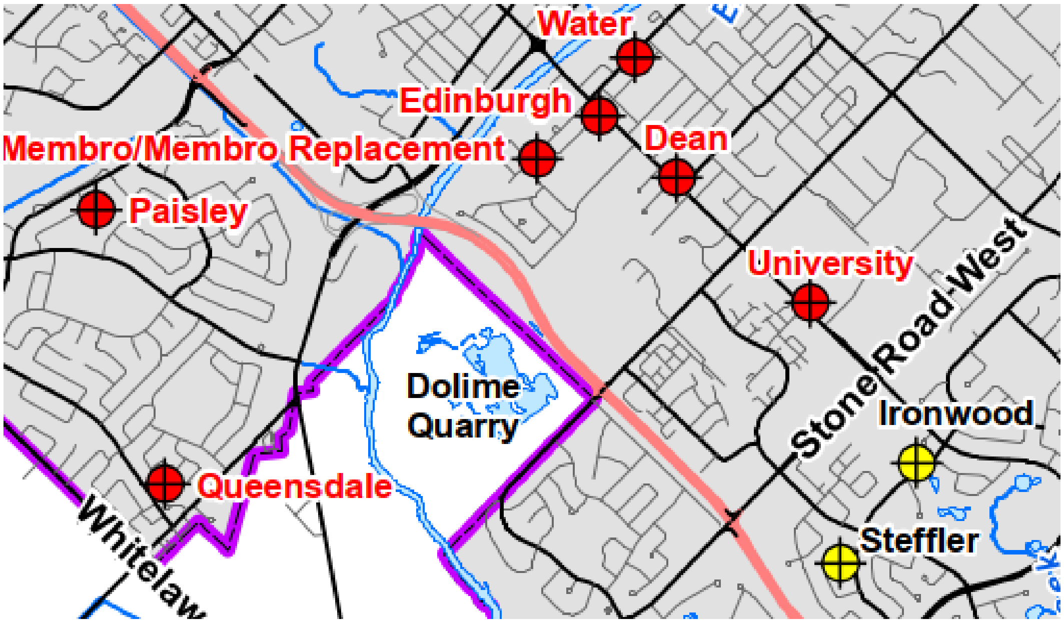


Project Component	Project Details
Location	■ Forestell Road; on municipal property
Description	■ Constructed in 2020, has 356 mm dia. casing
Sustainable Capacity	■ 2,250 m^3/d per modelling assessment; a portion of 4,500 m^3/day available within the City's SWQ with active quarry dewatering; field testing has demonstrated local sustainability up to 4,320 m^3/d
Existing Approvals	■ None
Required Approvals	■ PTTW ■ Amendment to City DWL ■ Class EA (initiated in 2021) ■ Municipal approvals
Water Quality Issues	■ No issues, standard disinfection required

Project Component	Project Details
Environmental Constraints	■ Modelling indicates that overall SWQ steady-state capacity can be increased by 4,500 m^3/d; therefore additional well capacity provides redundancy ■ Pumping may be limited to avoid impacts to Hanlon Creek baseflow; uncertainty related to potential baseflow impacts to Irish Creek ■ Southwest Guelph Water Supply Class EA to evaluate potential impacts to natural environment through Operational Testing Program
Past Studies/Work	■ Guelph South Groundwater Supply Investigation (on-going) included 30 day pumping test; new EA in 2021
Required Studies	■ Complete Water Supply Class EA (ongoing) ■ Design & Construction
Required Infrastructure	■ Connection to distribution system ■ Well house
Estimated Capital Cost	■ $4,800,000
Cost per m^3/day	■ $1,111 (at 4,320 m^3/day)
Annual O&M	■ $109,000
Life Cycle Cost	■ $0.33/$m^3$ of water produced
Implementation Timeline	■ Class EA (ongoing) – 5 years ■ Design and construction – estimated 2 years

Alternative: Develop Existing Municipal Test Wells

Project Sheet: Dolime Quarry Site Pumping Station and Water Treatment Plant

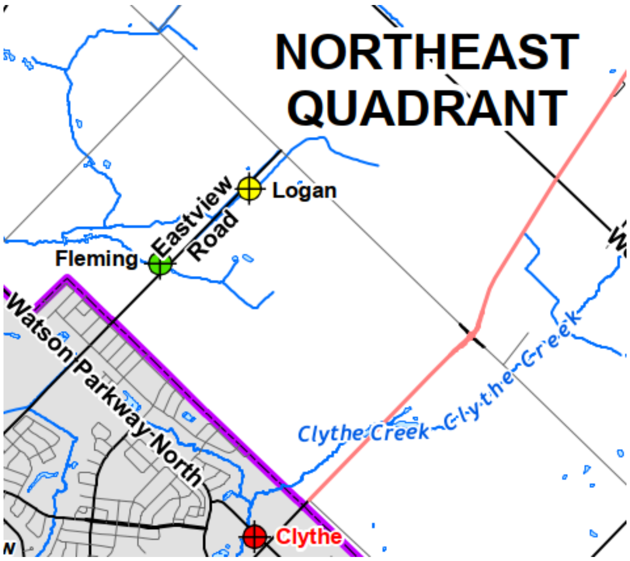


Project Component	Project Details
Location	■ Western portion of the City (currently within Guelph-Eramosa Township); to be moved into City, subject to provincial approval
Description	■ Capture of groundwater under the proposed Pond Level Management (PLM) strategy (PLM is a required source protection measure for existing and future wells), water capture via existing production wells and municipal test wells and/or directly from quarry
Sustainable Capacity	■ 1,000 – 3,000 m^3/d
Existing Approvals	■ Plan to bring Dolime property within the City boundary and pursue the PLM strategy has been approved by City Council, Wellington County Council and Guelph-Eramosa Township Council ■ Agreement in place with quarry owners (River Valley Developments)
Required Approvals	■ Province of Ontario to review City request for boundary change (annexation) ■ Class EA – Schedule B or C (subject to: preferred strategy [groundwater capture surrounding quarry or pump direct from quarry pond], water quality testing and characterization of source against GUDI TOR) ■ Municipal – City

Project Component	Project Details
	■ MECP - PTTW; Environmental Compliance Approval (ECA)/ DWL ■ Grand River Conservation Authority (GRCA)
Water Quality Issues	■ Limited data are available; water quality assumed to be similar to Gasport Formation groundwater
Environmental Constraints	■ Existing taking, effect on groundwater levels known; WWTP ECA evaluates required dilution for plant discharge assuming no discharge from quarry (i.e., discharge from the site is not a necessary component of the river dilution capacity)
Past Studies/Work	■ Extensive previous work completed at Dolime Quarry by City and quarry owners ■ Technical work completed to assess quarry risk to water resource
Required Studies	■ Water quality analysis, treatment study ■ Operational Testing Program to evaluate PLM strategy ■ Class EA (initiated in 2021; per above EA schedule to be confirmed); PTTW (transfer dewatering operations to the City) ■ Design & Construction
Required Infrastructure	■ Land acquisition (per agreement with quarry owners) ■ Permanent pumping station for PLM strategy ■ River discharge outfall ■ Water treatment system and associated infrastructure (for direct supply from quarry) ■ Connection to distribution system
Estimated Capital Cost	■ $18,976,440 (for quarry pond supply); $3,300,000 for pumping station
Cost per m^3/day	■ $6,325 (at 3,000 m^3/day)
Annual O&M Cost	■ $521,000 (for quarry pond supply)
Life Cycle Cost	■ $1.71/$m^3$ of water produced
Implementation Timeline	■ Class EA (ongoing) – 5 years ■ Design and construction (pumping station) – estimated 2 years ■ Design and construction (pumping station) – estimated 4 years

Alternative: Develop Existing Municipal Test Wells

Project Sheet: Develop well in the area of Logan and Fleming Test Wells

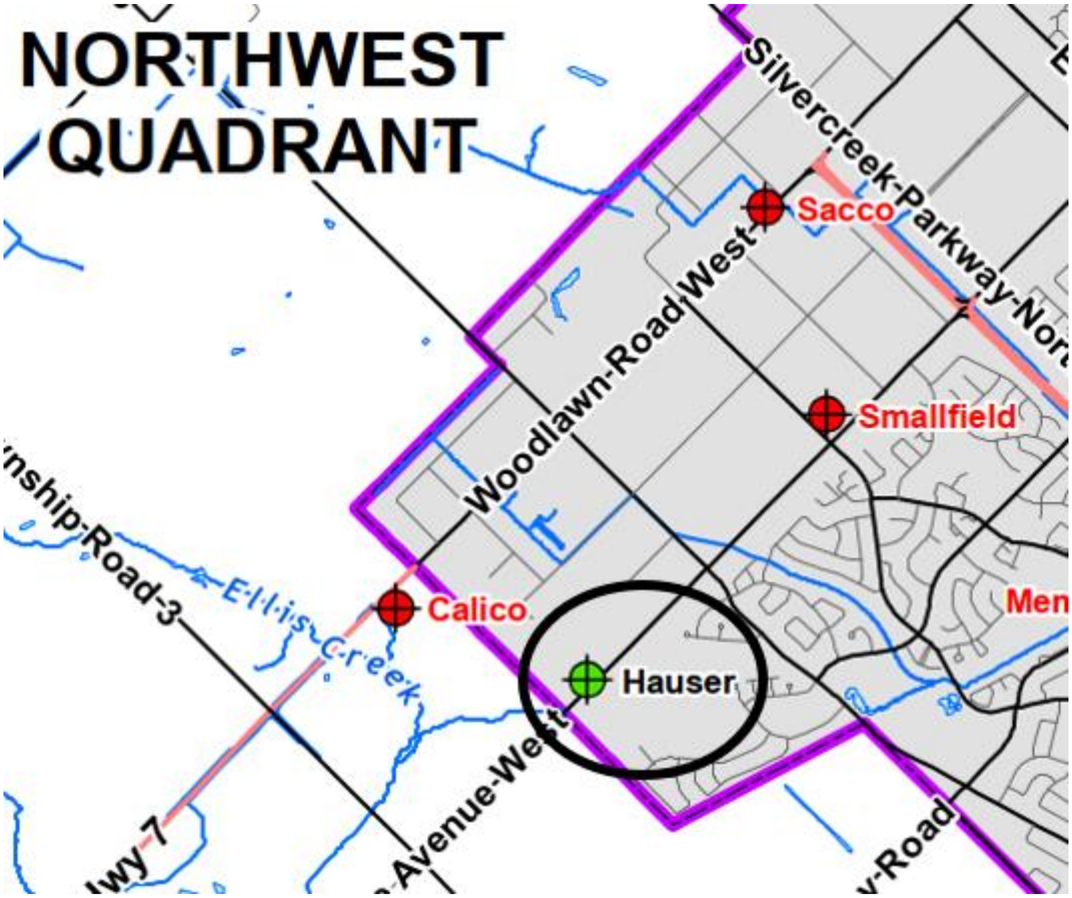


Project Component	Project Details
Location	■ Township of Guelph-Eramosa ■ Eastview Rd, east of Watson Road
Description	■ Logan Test Well - drilled in 1966, has 300 mm dia. Casing (to be reconstructed by City in 2021/2022) ■ Fleming Test Well – drilled in 1996, has 300 mm dia. casing (has been converted to multi-level monitoring well)
Sustainable Capacity	■ 4,180 m^3/d per modelling results
Existing Approvals	■ None
Required Approvals	■ PTTW ■ Amendment to City DWL ■ Class EA ■ Municipal – Township of Guelph-Eramosa ■ GRCA
Water Quality Issues	■ High quality groundwater within deep aquifer to be targeted ■ Fe reported at 0.27 mg/L (below ODWQS)
Environmental Constraints	■ Test wells are located near Guelph Northeast PSW Complex ■ Well modifications required (being completed in 2021/2022) ■ Associated investigations will assess confined nature of aquifer ■ Potential impacts to municipal/ private wells due to rural location

Project Component	Project Details
Past Studies/Work	■ Logan Well Assessment, 2020 ■ Part of Guelph Monitoring System Project, 2009
Required Studies	■ Well reconstruction and testing (including assessment of interaction with private wells and natural environment) ■ Water quality analysis ■ Class EA; PTTW ■ Design & Construction
Required Infrastructure	■ Connection to distribution system ■ Well house ■ Assumes City proceeds with developing Logan site; land acquisition may be required to develop Fleming site
Estimated Capital Cost	■ $10,103,000
Cost per m^3/day	■ $2,150 (at 4,180 m^3/day)
Annual O&M Cost	■ $126,000
Life Cycle Cost	■ $0.55/$m^3$ of water produced
Implementation Timeline	■ Feasibility study (field and modelling investigation) – estimated 2 year period ■ Class EA – estimated one to two years ■ Design and construction – estimated four years

Alternative: Develop Municipal Test Wells

Project Sheet: Develop Hauser Well

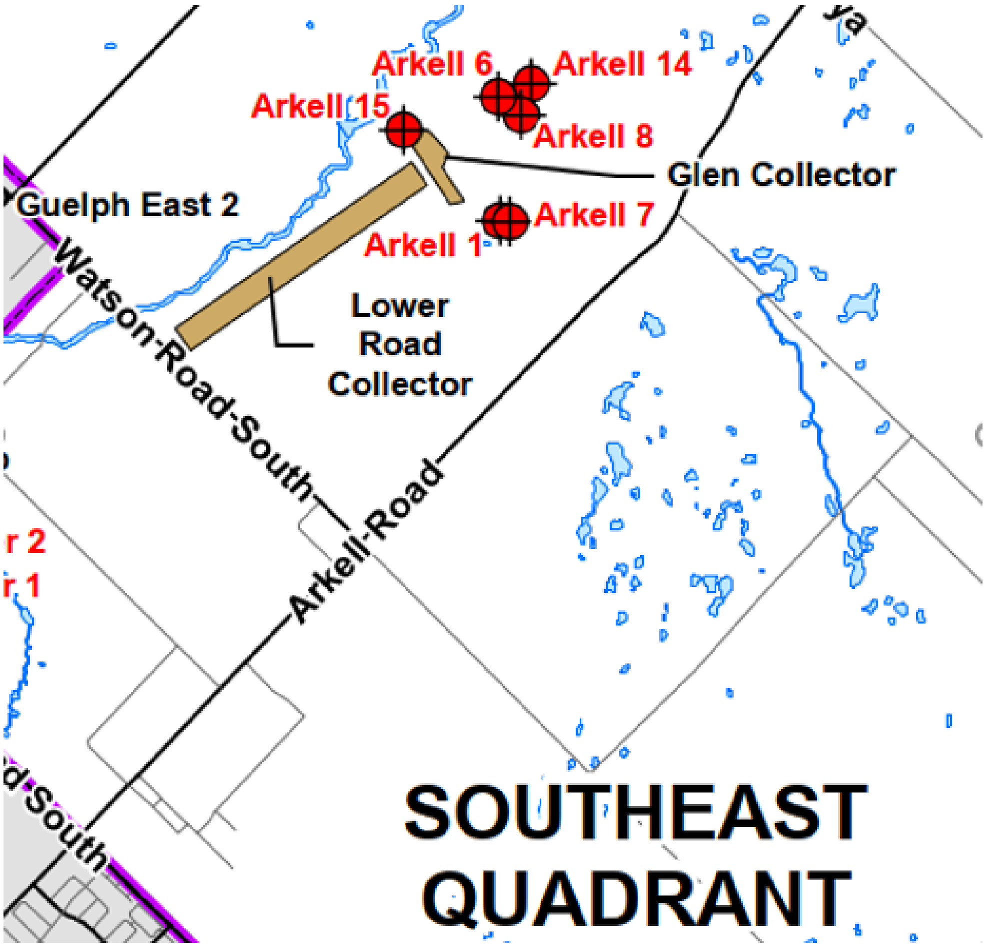


Project Component	Project Details
Location	■ On Speedvale Avenue West, near western City limit
Description	■ Drilled in 1966, has 300 mm dia. casing (has been converted to multi-level monitoring well)
Sustainable Capacity	■ 425 m^3/d per modelling assessment; a portion of 1,275 m^3/d available within the City's NWQ; local sustainable capacity estimated at 900 m^3/day in previous testing
Existing Approvals	■ None
Required Approvals	■ PTTW ■ Amendment to City DWL ■ Class EA ■ Municipal – City of Guelph
Water Quality Issues	■ Water quality info is not available; known issues in NWQ (e.g., Smallfield well)

Project Component	Project Details
Environmental Constraints	■ Close proximity to Ellis/ Chilligo Creek ■ Near Ellis Creek Provincially Significant Wetland Complex
Past Studies/Work	■ Step Test, 1994
Required Studies	■ NWQ water quality assessment (modelling study with potential field component) ■ Well installation and testing ■ Water quality analysis ■ Class EA and PTTW ■ Design & Construction
Required Infrastructure	■ New well ■ Connection to distribution system ■ Well house
Estimated Capital Cost	■ $5,832,000
Cost per m^3/day	■ $6,480 (at 900 m^3/day)
Annual O&M Cost	■ $96,000
Life Cycle Cost	■ $1.86/$m^3$ of water produced
Implementation Timeline	■ NWQ water quality assessment (modelling study with potential field component) – estimated one to two year period ■ Class EA – estimated one to two years ■ Design and construction – estimated four years

Alternative: New Groundwater Supply

Project Sheet: Arkell Collectors System with ASR Wells

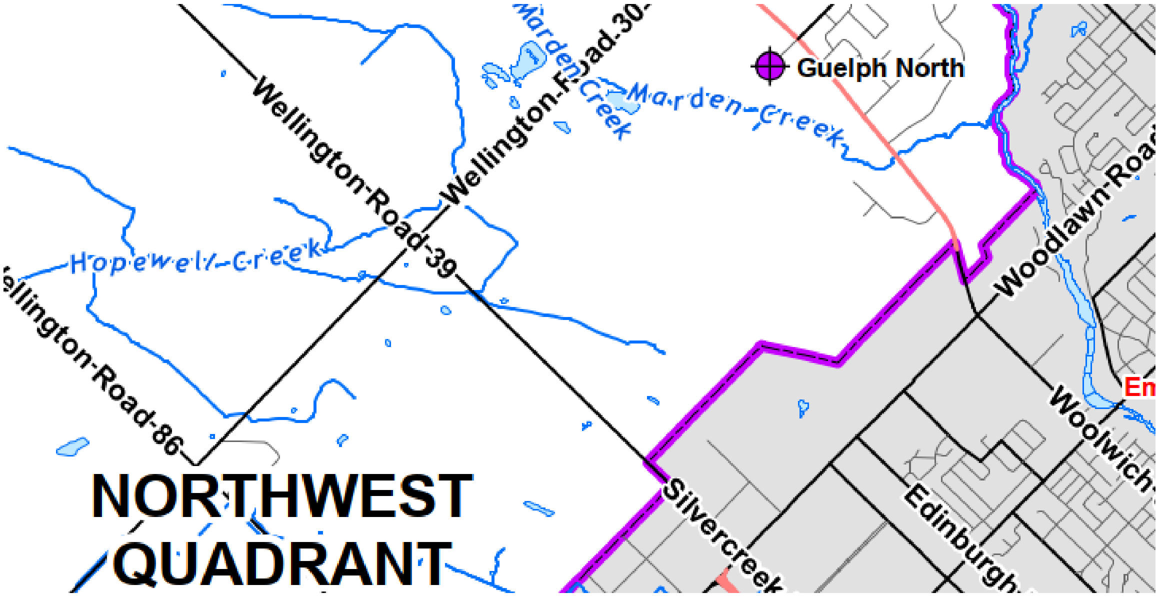


Project Component	Project Details
Location	■ Arkell Collector Systems excess flow & ASR wells within City
Description	■ Transfer excess seasonal collector volumes to ASR wells
Capture Rate (m^3/mo.)	■ 451,000 m^3/mo. from April to June
Distribution Rate (m^3/d)	■ 1,170 m^3/d per modelling assessment; additional capacity potentially available through optimization
Existing Approvals	■ PTTW (under Arkell Spring Grounds Collector groundwater taking)
Required Approvals	■ Class EA (for ASR wells) ■ Municipal – City ■ PTTW (for ASR wells) ■ ECA ■ DWL amendment ■ GRCA (for any wells in a regulated area)

Project Component	Project Details
Water Quality Issues	■ Requires dechlorination prior to injection; disinfection upon recovery prior to distribution
Environmental Constraints	■ Potential impacts of Arkell Collectors previously evaluated in assessment for existing PTTW approval ■ Environmental conditions at locations of ASR would be evaluated through Class EA; with optimization, impacts not anticipated
Past Studies/Work	■ Aquifer Performance Evaluation Southeast Quadrant, 1998 ■ Review of Collector Rehabilitation/Replacement Options, 2004 ■ 2014 WSMP Update
Required Studies	■ Feasibility/ Optimization Studies (field and modelling components) ■ Well installation and testing ■ Water quality analysis ■ Class EA and PTTW ■ Design & construction
Required Infrastructure	■ ASR wells with dechlorination and disinfection ■ Connection to distribution water main
Estimated Capital Cost	■ $25,284,000
Cost per m^3/day	■ $21,610 (at 1,170 m^3/day)
Annual O&M Cost	■ $99,000
Life Cycle Cost	■ $4.79/m^3 of water produced
Implementation Timeline	■ Feasibility/ Optimization Studies (field and modelling components) – estimated one to two years ■ Land acquisition, following above study ■ Class EA – estimated one to two years ■ Design and construction – estimated four to five years

Alternative: Install New Wells Outside City Boundary

Project Sheet: Guelph North

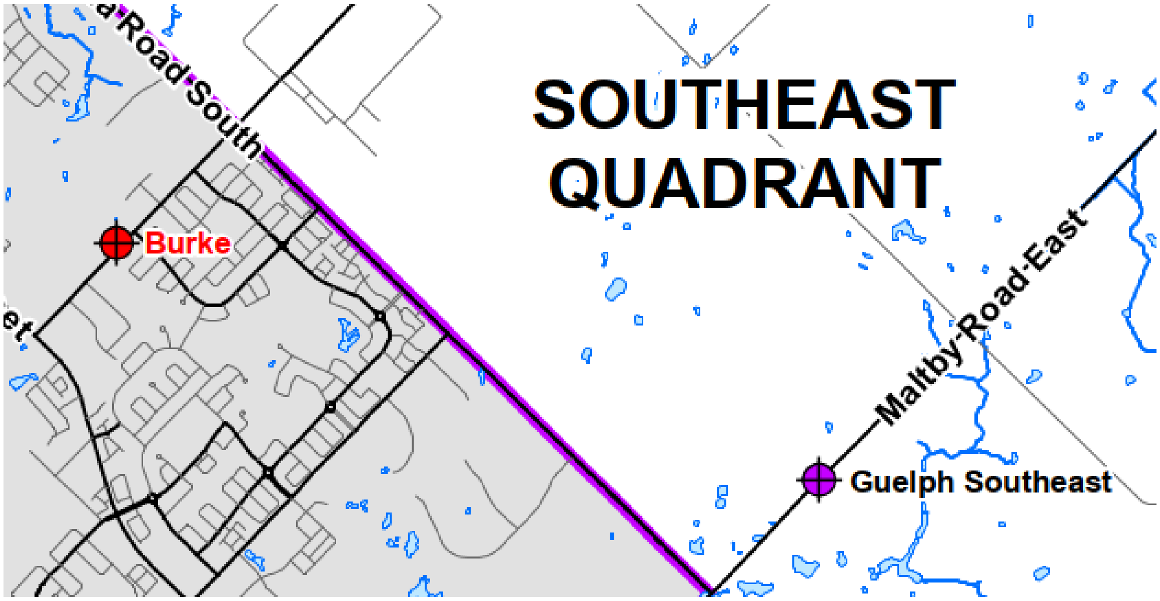


Project Component	Project Details
Location	■ Township of Guelph-Eramosa ■ North of the City, the western limit of Conservation Road (this is the approximate modelled location; City does not own land in area)
Description	■ Recommended test well area outside the City based on groundwater modelling analysis
Sustainable Capacity	■ 2,935 m^3/d per modelling assessment
Existing Approvals	■ None
Required Approvals	■ Municipal: Township of Guelph-Eramosa ■ PTTW ■ Class EA ■ ECA ■ DWL amendment ■ GRCA (depending on proximity to regulated area)
Water Quality Issues	■ Water quality information not available; assume Fe & Mn treatment, disinfection
Environmental Constraints	■ Marden Creek - moderate reduction in baseflows per modelling assessment ■ Near the Marden South PSW Complex ■ Potential impacts to municipal/ private wells anticipated due to rural location

Project Component	Project Details
Past Studies/Work	■ Tier Three Risk Assessment
Required Studies	■ Groundwater supply development study ■ Well installation and testing ■ Water quality analysis ■ Class EA and PTTW ■ Design & Construction
Required Infrastructure	■ Land acquisition ■ New well house and associated infrastructure ■ Connection to distribution system
Estimated Capital Cost	■ $12,841,000
Cost per m^3/day	■ $4,375 (at 2,935 m^3/d)
Annual O&M Cost	■ $111,000
Life Cycle Cost	■ $1.11/m^3 of water produced
Implementation Timeline	■ Groundwater supply development study – estimated one to two years ■ Land acquisition, following above study ■ Class EA – estimated one to two years ■ Design and construction – estimated four years

Alternative: Install New Wells Outside City Boundary

Project Sheet: Guelph Southeast

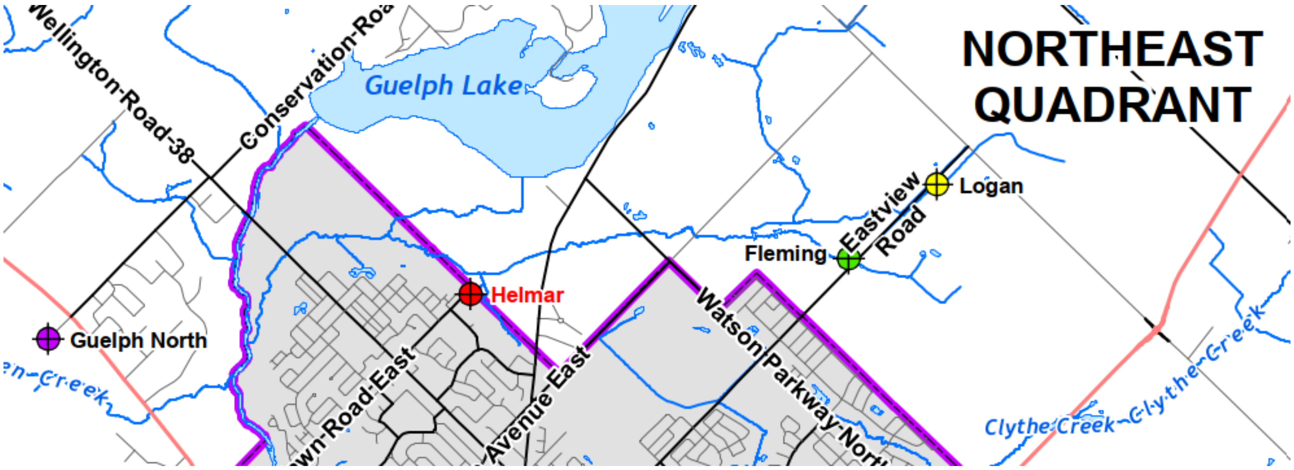


Project Component	Project Details
Location	■ Township of Puslinch, Southeast of the City, within the Mill Creek catchment area, East of Victoria Rd, on Maltby Rd
Description	■ Recommended test well location based on groundwater modelling analysis
Sustainable Capacity	■ 1,600 m^3/d per modelling assessment
Existing Approvals	■ None
Required Approvals	■ Municipal: Township of Puslinch ■ PTTW ■ Class EA ■ ECA ■ DWL amendment ■ GRCA (depending on proximity to regulated area)
Water Quality Issues	■ Water quality information not available; assume Fe & Mn treatment, disinfection
Environmental Constraints	■ Modelling assessment indicates minimal impact to Mill Creek; less than 5% reduction in baseflow ■ Potential impacts to municipal/ private wells due to rural location ■ Area near Arkell Bog and Mill Creek Puslinch PSW Complexes
Past Studies/Work	■ Tier Three Study

Project Component	Project Details
Required Studies	■ Groundwater supply development study ■ Well installation and testing ■ Water quality analysis ■ Class EA and PTTW ■ Design & construction
Required Infrastructure	■ Land acquisition ■ New well house and associated infrastructure ■ Connection to distribution system
Estimated Capital Cost	■ $6,862,000
Cost per m3/day	■ $4,289 (at 1,600 m^3/d)
Annual O&M Cost	■ $109,000
Life Cycle Cost	■ $1.22/$m^3$ of water produced
Implementation Timeline	■ Groundwater supply development study – estimated one to two years ■ Land acquisition, following above study ■ Class EA – estimated one to two years ■ Design and construction – estimated four years

Alternative: Surface Water Supply

Project Sheet: Guelph Lake Water Treatment Plant

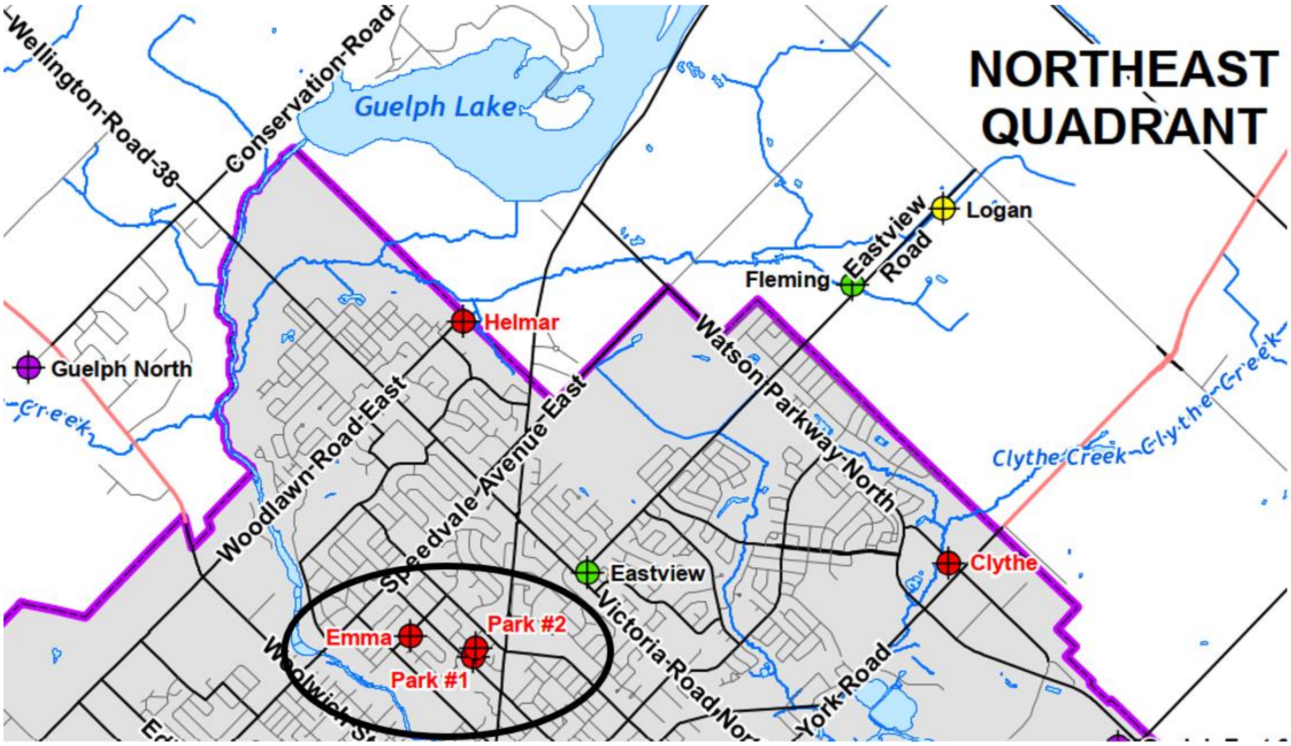


Project Component	Project Details
Location	■ WTP at Guelph Lake or NE part of City
Description	■ Surface WTP consisting of conventional/ advanced treatment and distribution pipeline
Capture Rate	■ 12,960 m^3/d (continuous annual base taking of 150 L/s)
Distribution Rate	■ 12,300 m^3/d
Existing Approvals	■ None
Required Approvals	■ Class EA – Schedule C ■ Municipal – City and Township ■ MNRF/ MECP - PTTW (Surface Water) ■ ECA ■ DWL amendment ■ GRCA
Water Quality Issues	■ High turbidity, colour, odour
Environmental Constraints	■ Area affected includes Guelph Lake and its associated wetland and aquatic features ■ GRCA analysis includes downstream minimum flow requirements, required storage within lake
Past Studies/Work	■ GRCA review of water taking reliability
Required Studies	■ Field investigations; environmental baseline/ impact ■ Feasibility Studies ■ Treatment study ■ Class EA – Schedule C ■ Property acquisition ■ Design & construction

Project Component	Project Details
Required Infrastructure	■ Water intake structure ■ Surface water treatment plant & associated infrastructure ■ Connection to distribution water main
Estimated Capital Cost	■ $51,322,000
Cost per m^3/day	■ $4,168 (at 12,960 m^3/d)
Annual O&M Cost	■ $900,000
Life Cycle Cost	■ $1.16/$m^3$ of water produced
Implementation Timeline	■ Field investigations, feasibility study – one to two years ■ Land acquisition, following above study ■ Class EA – estimated two years ■ Design and construction – estimated four years

Alternative: Surface Water Supply & Aquifer Storage Recovery Wells

Project Sheet: Guelph Lake Water Treatment Plant with ASR Wells



Project Component	Project Details
Location	■ WTP at Guelph Lake/dam, ASR wells in NEQ in the vicinity of Park/Emma wells
Description	■ A surface water treatment plant consisting of conventional treatment and distribution pipelines, ASR wells
Intake Rate	■ 12,960 – 25,920 m^3/d
Distribution Rate	■ Up to 25,825 m^3/d
Existing Approvals	■ PTTW (SW PTTW would exist at time of ASR project)
Required Approvals	■ Class EA – Schedule C ■ Municipal – City and Township ■ PTTW (Surface Water/ Groundwater); ■ ECA ■ DWL amendment ■ GRCA
Water Quality Issues	■ High turbidity, colour, odour

Project Component	Project Details
Environmental Constraints	■ Area affected includes Guelph Lake and its associated wetland and aquatic features ■ GRCA analysis includes downstream minimum flow requirements, required storage within lake
Past Studies/Work	■ GRCA review of water taking reliability
Required Studies	■ Field investigations; environmental baseline/ impact ■ Feasibility Studies ■ Treatment study ■ Class EA
Required Infrastructure	■ Water intake structure ■ Surface water treatment plant & associated infrastructure ■ ASR wells ■ Connection to distribution water main
Estimated Capital Cost	■ $57,283,000
Cost per m^3/day	■ $4,239 (cost for additional flow, total of 25,800 m^3/day)
Annual O&M Cost	■ $1,290,000
Life Cycle Cost	■ $0.75/$m^3$ of water produced
Implementation Timeline	■ Field investigations, feasibility study (ASR optimization) – one to two years ■ Land acquisition for ASR wells, following above study ■ Class EA – estimated two years ■ Design and construction – estimated two to four years