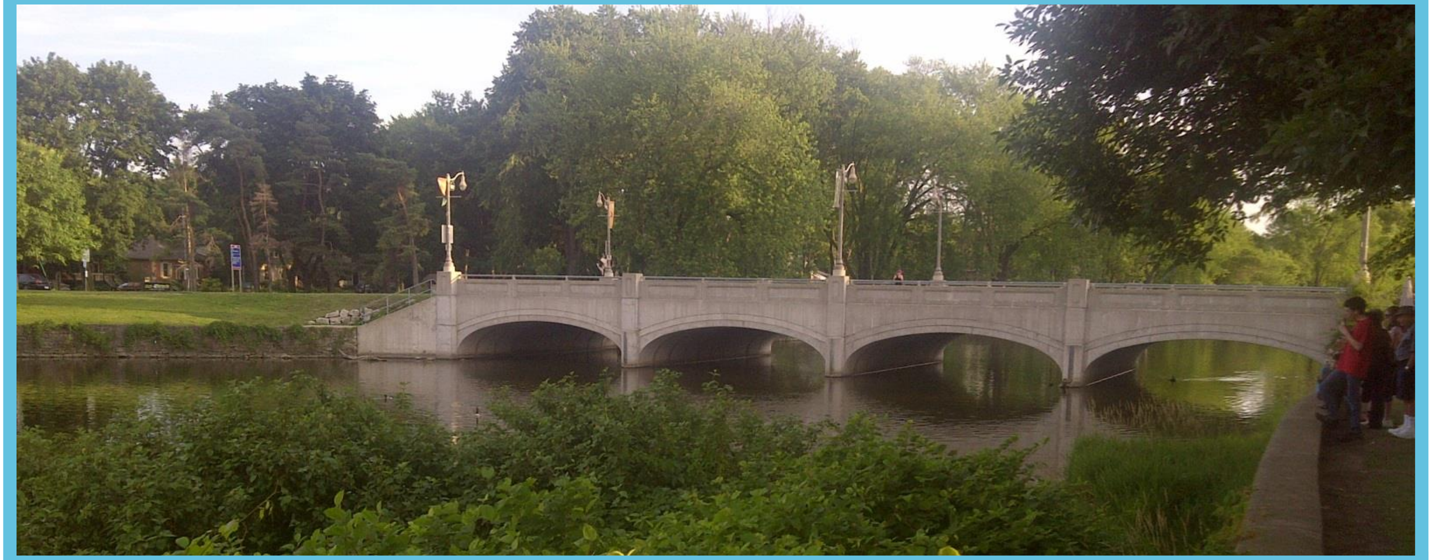
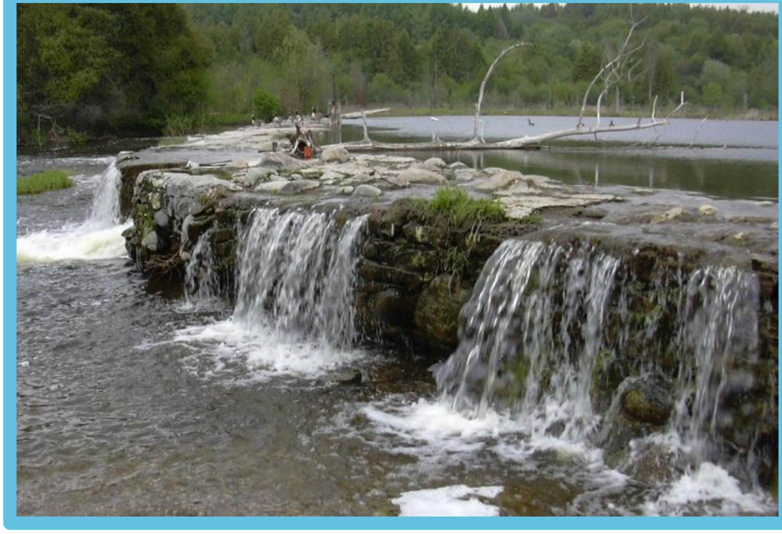
The Corporation of the City of Guelph

Water Supply Master Plan Update

(Draft Final Report)

May 2014





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Water

City of Guelph

Water Supply Master Plan Update
Draft Final Report

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AECOM: 2012-01-06

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
Draft	Dave Belanger, City of Guelph	23/May/2014	Draft Final Report issued 29/May/2014

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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 purpose of this WSMP update is to review and revise the 2007 WSMP to make it consistent with the current needs of the City, covering a 25 year period from 2013 to 2038. The WSMP update builds upon the work previously completed taking into account more recent studies and the work activities completed over the past six years. This update reviews the 2007 WSMP recommendations as well as examines 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 Purpose 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 Purpose Statement for the WSMP update was developed through communication with the public and stakeholders in the first round of consultation.

> *The City of Guelph is responsible for supplying clean, safe drinking water to its customers. The City has initiated an update to its Water Supply Master Plan (WSMP, 2007) that will define how we will continue to provide a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers over the next 25 years. The updated Master Plan will identify individual projects required to implement the master plan and prioritize these projects based on need.*
>
> *Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water. However, recent analysis confirms that the existing water supply system capacity will not meet future demands. Updating the WSMP is an opportunity to discuss with the community how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.*
>
> *When investigating existing and new water supply options, including water conservation strategies, we will consider water quality and quantity, economic factors, environmental concerns and 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.*

ES-3 Population/Water Demand Projections

ES-3.1 Population Projections

Population projections are required to determine future water supply requirements. The population projections presented herein combine non-residential and residential populations to develop a total 'equivalent' population. The equivalent population represents the projected residential population plus the additional population representative of

industrial, commercial and institutional (ICI) land use. This equivalent population forms the basis for developing existing and future water demands. Population growth projections to 2031 for the City are per the Official Plan, with details provided in the 2014 Development Charges Growth Forecast. In order to extend population projections beyond the current Official Plan planning period of 2031, City Planning staff provided forecasts of the Growth Plan from 2031 out to 2041. The population projections from 2013 to 2038 in five-year increments are presented in **Table ES-1**.

Table ES-1 Guelph Population Projections

Year	**Residential Population** (Including Census Undercount)*	**Equivalent Employment Population** (Excluding work at home and no fixed place of work)	**Total Equivalent Population****
2013	130,670	66,730	197,400
2018	143,480	73,874	217,354
2023	156,290	81,017	237,307
2028	168,190	90,340	258,530
2033	178,464	96,947	275,411
2038	186,299	99,480	285,779

* Census undercount is estimated at approximately 3.5%.
** Projection excludes lands designated Reserve Lands, and Open Space/Park within Clair-Maltby Secondary Plan Area; Projection also excludes students which would not be captured within the permanent population base.

2013 to 2031 Source: (Watson & Associates Economists Ltd., 2013) –1.6% to 2% growth per year
2032 to 2038 Source: (Ontario Ministry of Infrastructure, 2012), (City of Guelph - Planning, Building, Engineering and Environment - Todd Salter, 2013) – 0.7% to 0.9% growth per year

ES-3.2 Water Demand Projections

<u>Design Basis for Average Day Demands</u>

The basis for projecting demands from the residential and employment sectors, as well as non-revenue water, is to assume the status quo applied to population projections, i.e. representative of per capita demands without influence of future conservation or non-revenue water reduction 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.

Residential and Employment (ICI) consumption

The baseline demand for each of the residential and ICI sectors considered historical customer demand and analysis of recent trends over the past six years with consideration for whether the recent declines in per capita demands are sustainable for the purposes of projections. It was determined that the decrease in demand per capita in the residential sector is likely sustainable; whereas the decrease in the ICI sector may be partially attributed to economic factors. Therefore, the design rates in litres per capita per day (lcd) to apply to the future population were developed incorporating some contingency in the ICI unit rate:

- Residential – 180 litres per capita per day (lcd)
- Employment (ICI) – 286 lcd

These design values were applied to the projected populations from 2013 to 2038 to determine the future water demands for each sector assuming status quo in terms of water conservation efforts to date.

Non-Revenue Water (NRW)

The difference in water consumed by customers that is measured directly through utility billings and that which is pumped at water facilities to the water distribution system is classified as Non-Revenue Water (NRW). There are

three main categories of Non-Revenue Water (NRW): unbilled authorized consumption, apparent losses, and real losses. These all represent volumes of treated water for which the City does not receive revenue.

The average of the annual NRW volume for the period of 2006 to 2012 (5,550 m^3/d) was used as the basis for projecting future losses along with additional anticipated losses as a function of new watermains and connections for servicing future growth.

Projected Average Water Demands by Sector

Table ES-2 presents the projected average day water demand in 5-year increments from 2013 to 2038, based on the design per capita demands.

Table ES-2 Projected Average Day Water Demand (2013-2038)

Year	Population			Demand by Sector			NRW (m^3/d)	Average Water Demand (m^3/d)
	Resid.	Employ.	Total Equiv.	Resid.	Employ.	Total		
2013	130,670	66,730	197,400	23,536	19,059	42,595	5,658	48,253
2018	143,480	73,874	217,354	25,843	21,100	46,943	6,175	53,117
2023	156,290	81,017	237,307	28,150	23,140	51,290	6,691	57,982
2028	168,190	90,340	258,530	30,293	25,803	56,096	7,208	63,305
2033	178,464	96,947	275,411	32,144	27,690	59,834	7,628	67,462
2038	186,299	99,480	285,779	33,555	28,413	61,969	7,903	69,872

Design Basis for Maximum Day Demand

The Ministry of the Environment (MOE) Guidelines for the Design of Water Distribution Systems dictate that water supply systems be designed to satisfy the greater of the maximum day plus fire flow or peak rate (maximum hourly demand). Fire flows and peak flows are typically provided in storage within a distribution system; and therefore, the pumping capacity of the water supply system is designed to meet maximum day demands. Through review of historical average demands by sector, reasonable estimates can be developed for projecting future demands. Similarly, historical information regarding peak demands in recent years can be evaluated to determine a design maximum day factor (MDF) for projecting future maximum demands. The maximum day factor is calculated as the maximum day demand divided by average day demand during a given year.

With the success of water efficiency measures and the implementation of outside water use restrictions in Guelph, the actual maximum day factors for the period of 2008 to 2012 ranged between 1.19 and 1.41, with an average of 1.26. Based on a review of historical data through the previous WSMP and more recent years, it is reasonable to continue to use a maximum day factor of 1.35 for projecting future maximum water demands.

Another consideration in determining future water supply requirements is to provide an allowance for events which could impact the existing supply capacity. A review of potential risks to the City's existing water supply system was completed to consider possible scenarios which could result in supply reductions such as a period of drought, and contamination or mechanical issues resulting in a large supply well being off-line. It was determined that under these two scenarios, the total existing water supply capacity is reduced by approximately 10 to 15%. Therefore, it is suggested that the City adopt a maximum day factor of 1.5 for the purposes of projecting future water supply requirements, with the difference from the actual maximum day demand (at a MDF of 1.5) to provide additional contingency in the supply system.

Projected Total Water Supply Requirements

The design basis developed for each component making up the total water demand and supply requirement was applied to the 25 year period of this study in 5 year increments to develop future water demand projections and water supply requirements, as indicated in **Table ES-3** and **Figure ES-1**.

Table ES-3 Projected Total Water Supply Requirements (2013-2038)

Year	Total Average Day Demand (m^3/d)	Max Day Demand @ 1.35 MDF (m^3/d)	Water Supply Requirement @ 1.5 MDF (m^3/d)
2013	48,253	65,141	72,379
2018	53,117	71,708	79,676
2023	57,982	78,275	86,972
2028	63,305	85,461	94,957
2033	67,462	91,074	101,193
2038	69,872	94,327	104,808
Note: MDF = maximum day factor			

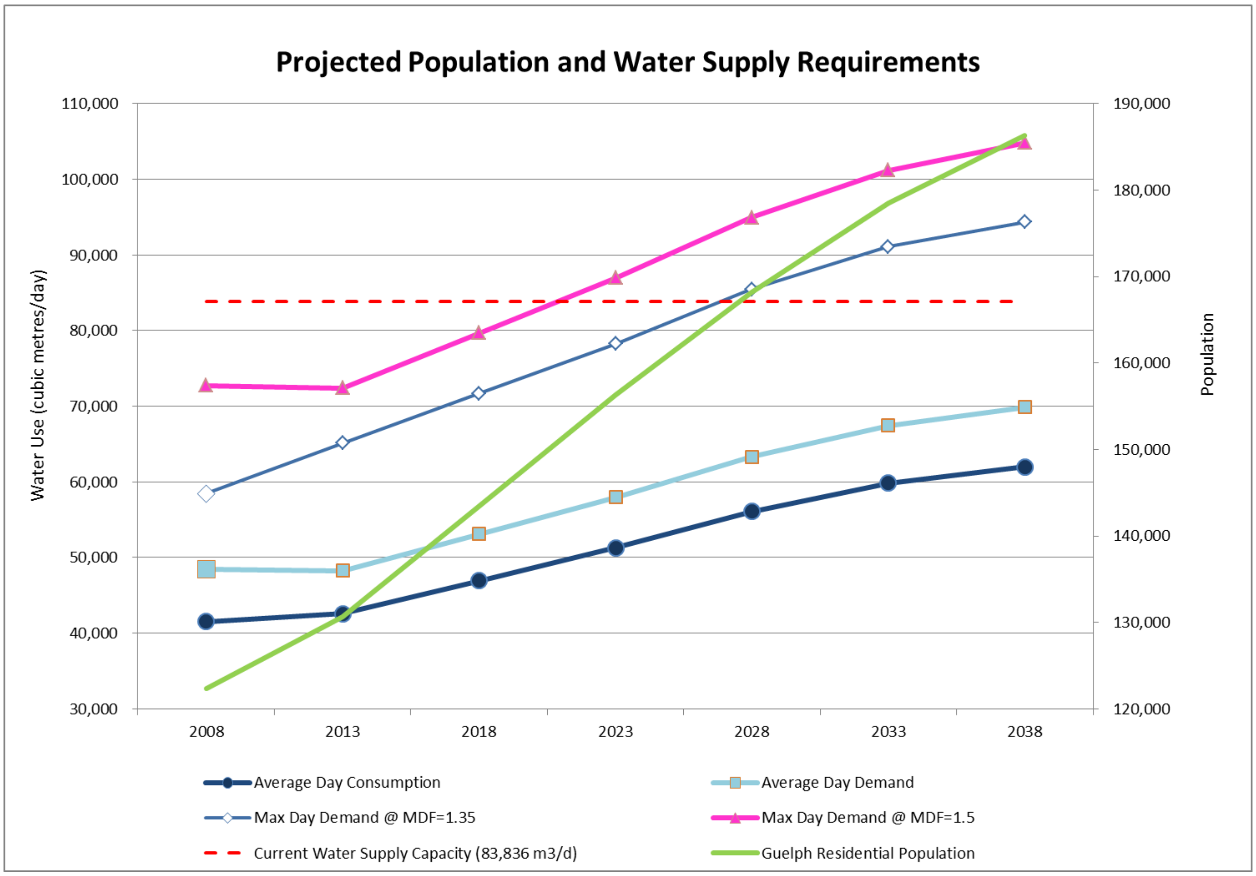

Figure ES-1 Projected Population and Water Supply Requirements

ES-4 Existing Water Supply System Capacity Assessment

The City of Guelph relies exclusively on groundwater to meet the City's residential and industrial, commercial and institutional (ICI) water demands. The City's groundwater supply system consists of 21 active wells constructed within overburden, shallow and deep bedrock aquifers and one active groundwater collection system (Arkell Infiltration Galleries - Glen Collector).

A detailed assessment of the existing maximum capacity of the existing water supply system was completed, which included determination of the maximum capacity of each individual well and to identify constraints to operating at the maximum; and assessment of the sustainable capacity of the existing water supply system (recognizing interference effects amongst the municipal wells). This review referenced the City of Guelph draft Tier Three Water Budget and Risk Assessment (Matrix Solutions Inc., 2013), herein referred to as the 'Tier Three Risk Assessment'. The objective of the Tier Three Risk Assessment is to evaluate the sustainability of the City's groundwater supply system from a quantity perspective, and to identify potential threats to that sustainability.

Evaluation of the existing system is completed with reference to the four quadrants of the City: Southeast, Southwest, Northeast and Northwest. Historical records (from 1997 through 2013) for each groundwater supply source and quadrant provided the daily pumping total, the monthly average of the daily production total, observed groundwater elevation and the permitted rate and maximum pumping elevations. Based on the review of groundwater pumping rate and groundwater elevation data, the capacity of each municipal groundwater supply source has been re-evaluated relative to the 2007 WSMP.

The total groundwater supply system capacity of the City's groundwater supply system was determined to be 83,836 m^3/day. This represents an increase of 8,836 m^3/day, relative to the available well capacity reported within the 2007 WSMP. The increase reflects additional permitted pumping from the new Arkell pumping wells (Arkell 14 and Arkell 15). It is noted that 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 continued pumping at the Dolime Quarry. Also taken into consideration are other physical constraints which potential limit the long term sustainable pumping rates of these supplies. A summary of the total water supply system capacity is indicated in the following table with comparison to the 2007 WSMP assessment.

Table ES-4 Existing Groundwater Supply System Capacity

Well Field	Well Name	Year Constructed	Permitted Rate (m^3/d)	2007 WSMP Well Capacity (m^3/d)	2014 WSMP Update Well Capacity (m^3/d)
	Arkell 1	1966	3,273	2,000	2,000
	Arkell 6	1963		6,500	
	Arkell 7	1963		6,500	
	Arkell 8	1963	28,800	6,500	28,800
SWQ	Arkell 14	2000		n/a	
	Arkell 15	2000		n/a	
	Burke	1966	6,546	6,500	6,500
	Carter 1	1962	7,855	5,500	5,500
	Carter 2	1962			
	Membro	1953	6,050	6,000	6,000
SEQ	Water Street	1953	3,400	2,700	2,700
	Dean	1958	2,300	1,500	1,500

Well Field	Well Name	Year	Permitted Rate	2007 WSMP Well	2014 WSMP Update Well
	University	1965	3,300	2,500	2,500
	Downey	1968	5,237	5,100	5,236
NEQ	Park 1	1937	10,300	8,000	8,000
	Park 2	1947			
	Emma	1931	3,100	2,800	2,800
	Helmar	1966	3,273	1,500	1,500
NWQ	Paisley	1952	3,200	1,400	1,400
	Calico	1976	5,237	1,100	1,400
	Queensdale	1970	5,237	2,000	1,100
Arkell Infiltration Galleries - Glen Collector			25,000	6,900	6,900
Total			**122,108**	**75,000**	**83,836**

ES-5 Water Supply Alternatives

The 2007 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. City Council provided direction in 2003 “That the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth”. This direction emphasizes the need for water supply to be sustainable. 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.

The utmost importance was placed on water conservation and as a result, the City of Guelph has become a renowned leader in water conservation and demand management in Canada. Council has made this a priority by setting a goal “to use less energy and water per capita than any comparable Canadian city” through its 2007 Strategic Plan and Community Energy Initiative. It is the aim of this update to establish success achieved to date, and to determine reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 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, impacts from pumping from aquifers may result in local impacts on the natural environment and also on private and municipal wells in close proximity. 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:

- Completed construction of new well facilities (Arkell 14 and 15) and commencement of the Arkell Adaptive Management Plan and Operational Testing Program;
- Completed Class Environmental Assessment (EA) for the existing Burke Well facility;
- Commenced Class EA for the Guelph Southwest Quadrant Water Supply (on-going) which includes evaluation of existing supplies in that quadrant as well as new test wells; and,
- Completed treatability assessments of municipal wells which were previously taken off line due to water quality issues: Clythe, Smallfield and Sacco Wells.

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, including the Guelph South Groundwater Supply Investigation.

The City also initiated the following regional studies and plans to ensure the protection and long term sustainability of the existing water supply system:

- The Guelph Tier Three Water Budget and Local Area Risk Assessment is being completed to evaluate the sustainability of the City's water supply system from a quantity perspective and to identify potential threats to that sustainability. This study and the Tier Three computer 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.
- The Guelph Drinking Water Source Protection Plan was developed within a watershed context to identify and evaluate potential quality threats to the municipal supply system. The City, through the Lake Erie Source Protection Authority and with other municipalities within the Grand River Watershed, have developed policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants.

The objective of the WSMP Update is to continue to ensure that the City can provide an adequate and sustainable supply of water to meet the current and future needs of all customers over the next 25 years. The water supply demand forecast indicates that under a "do nothing" scenario with continued growth, the City would require an additional capacity of 20,000 m^3/day to satisfy maximum day demand including an allowance for security of supply (approximately 10 to 15% of the total system capacity).

The following alternatives were 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.

ES-5.1 Water Conservation and Demand Management/Re-Use

The City of Guelph is known as one of the most proactive communities in Canada with respect to water conservation having implemented a wide variety of water conservation programs across all sectors since 1999. The City continues to implement water conservation programs to reduce demands within a Council approved cost-benefit framework that compares the cost to implement water reduction programs to the cost for developing new municipal water supplies, with consideration for the added benefits of also deferring wastewater treatment infrastructure and incurring energy savings.

Water Conservation Scenarios

In investigating future reduction scenarios and their associated costs, the City's water conservation staff reviewed the maximum potential of current programs, as well as potential for future additional programs. Five scenarios were developed; each consisting of a combination of possible water conservation and efficiency programs. Scenarios ranged from continuing with the current approved Water Conservation and Efficiency Strategy Update (WCESU) plan, to an aggressive scenario which considered all possibilities. The development of scenarios based on a number of possible initiatives was completed solely for the purpose of evaluating the cost and feasibility of various target reductions. The actual programs would be established through the next WCESU.

A summary of potential savings for each scenario is indicated in **Table ES-5**.

Table ES-5 Summary of Potential Savings for Each Scenario

Scenario	Total Potential Reduction in Average Day Demand (m^3/day)	Implementation Period	Direct Program Costs	Total O&M Costs	Total Program Cost for Period
Scenario 1	5,556	2014 to 2025	$5,685,930	$10,217,564	$15,903,500
Scenario 2	9,842	2014 to 2038	$43,767,600	$23,880,972	$67,648,600
Scenario 3	9,690	2014 to 2038	$24,597,600	$23,880,972	$48,478,600
Scenario 4	8,448	2014 to 2038	$23,097,600	$23,880,972	$46,978,600
Scenario 5	7,419	2014 to 2038	$22,553,100	$23,880,972	$46,434,100

The above water conservation 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. Further iterations of these scenarios were developed during the financial evaluation completed in developing the implementation plan**.**

Centralized Re-Use Alternative

The above scenarios do not include any programs related to Wastewater Reuse and Reclamation. Although pilot studies have been implemented for individual systems for grey water within the City, it is generally accepted that significant reductions from reclaim and re-use options will only be achieved through centralized facilities. Wastewater reclamation involves the treatment or processing of wastewater to make it suitable for reuse, with water reuse being the beneficial use of the treated water. Water reclamation and re-use has great potential to be an effective, efficient, sustainable way to meet water demands.

There are two options for centralized re-use or reclaimed water:

- Treatment to non-potable standards for landscaping irrigation and other non-potable uses through a dual plumbing system,
- Treatment to potable standards for use in the existing distribution system

Generally, due to the considerable challenges currently associated with the centralized re-use alternatives, these options are not implemented where there are alternative sources of fresh water as the costs of re-use options are prohibitive. However, as increasingly advanced treatment is required for wastewater to meet discharge requirements in future, these alternatives will become more attractive. In addition, it is expected that this eventuality will correspond to decreasing availability of local groundwater and surface water. While not considered as part of the conservation option in the 25 year study period, opportunities to incorporate reuse into future developments (e.g. purple pipe; dual plumbing systems) should be reviewed with a long term view to ensure its feasibility. It is recommended that this be considered when reviewing future expansion and treatment upgrades at the wastewater treatment facility.

ES-5.2 Expand Existing Groundwater Supply System

The approach undertaken in investigating opportunities for optimizing existing wells and developing new groundwater sources followed the direction provided through the consultation process in the 2007 WSMP. Public response indicated that the City should consider groundwater opportunities within the City boundaries prior to exploring outside the City. As noted in the 2007 WSMP, the development of new water supply sources in the Townships would require the concurrence of the Townships and the County of Wellington.

Furthermore, with use of the updated Tier Three computer model, the feasibility of higher pumping within the City is studied with respect to impacts on other supplies as well as potential environmental effects. The Tier Three Water Budget and Local Area Risk Assessment Study are referenced when seeking additional sources outside the City with consideration for available takings, and also known and anticipated impacts on the watersheds in close proximity. In general, although the Tier Three project is not yet completed, model-predicted impacts were found to be moderate for the south branch of Blue Springs Creek, Chilligo/Ellis Creek, and Hanlon Creek. Therefore, for the purposes of this WSMP Update, future groundwater supply sources investigated herein focussed preferentially on catchment areas along the Speed River and Mill Creek.

Each quadrant of the City has been studied extensively, with the City having completed monitoring and exploration programs in support of the existing operating wells and in reviewing feasibility of possible future sources. Of note is that the possible supply sources outside of the City boundaries considered in this WSMP update are limited to

approximately 5 km from the City's limits. This parameter was determined with consideration to limiting impacts on surrounding municipalities, as well as the practicality of connecting to the existing water distribution system. A general summary of potential new water supplies within each quadrant is provided as follows:

Southwest Quadrant (SWQ)

Following the recommendation in the 2007 WSMP, the City initiated a Class Environmental Assessment (EA) study to optimize existing and to develop new water supplies in the SWQ. This quadrant consists of the following existing operational wells: Downey, Membro, Water St., Dean and University Wells. It also includes the Edinburgh Well which was taken off-line due to water quality issues, and the Admiral Well which was initially developed for industrial use but not brought on line due to natural water quality issues. Through the Class EA study, two large diameter test wells (named 'Ironwood' and 'Steffler') were installed and tested over an extended period to determine potential capacity and to monitor the effects on other municipal and private wells, and surface water. Preliminary findings suggest that when the SWQ is considered as a whole, i.e. one wellfield, an additional taking of 4,500 m^3/day can be achieved. This rate is in addition to that established as a maximum day sustainable pump rate for the SWQ of 17,800 m^3/day. Therefore, a total objective for additional water supply from the SWQ of 4,500 m^3/day is available whether through one or two new municipal wells, or through a combination of new wells plus optimizing existing including reactivating existing wells off-line requiring treatment.

Southeast Quadrant (SEQ)

The SEQ consists primarily of the Arkell wellfield which includes Arkell 1, 6, 7, 8, 14 and 15 Wells, as well as the Glen Collector System, and the Carter Wells. The City is currently demonstrating the sustainability of operating the Arkell bedrock wellfield with extensive monitoring for three years through an Operational Testing Program; results to date have confirmed the existing capacity of the Arkell bedrock wellfield of 28,800 m^3/day and indicate no measureable impacts on the Blue Springs Creek watershed. A possible new source in the Arkell area is to reinstate the Lower Road Collection system which was taken off line due to regulated water quality concerns. It is anticipated that, although work is required to repair and construct the collector infrastructure, it would be acceptable to direct this water along with other wells and the Glen Collector to the aqueduct for ultraviolet irradiation (UV) disinfection at the Woods Pumping Station.

The City completed a Class EA study in 1994 investigating a new well supply near the Barber Scout Camp on Stone Road ('Scout Camp' Well) which was found to have naturally poor water quality.

Lastly, new potential water supply outside the City was reviewed using the Tier Three model. The hydrogeological conditions in the general area of Victoria and Maltby Roads suggest the possibility of a well with capacity of 4,000 to 6,000 m^3/day in this area, with consideration given to preventing potential impacts to Mill Creek.

Northeast Quadrant (NEQ)

Existing operating wells in the NEQ include the Park and Emma Wells, and the Helmar Well. The Clythe Well is a municipal supply that was taken offline due to natural water quality issues. A Class EA is currently underway which will consider treatment options for reconnecting this well to the distribution system.

The City has previously installed and tested wells in the area of Eastview Road and Watson Road, referred to as 'Logan' and 'Fleming' test wells, located outside the City in the Township of Guelph-Eramosa. The results suggest the potential for a new municipal supply in this area of 4,500 to 6,100 m^3/day.

Northwest Quadrant (NWQ)

Existing operational wells in the NWQ include the Paisley, Calico and Queensdale Wells. The City also has a test well referred to as the Hauser well with a proposed taking of 900 m^3/day.

Two municipal groundwater supply sources (Sacco and Smallfield Wells) are currently permitted for operation, however, remain inactive and off-line since the mid-1990s due to groundwater quality concerns. Smallfield Well groundwater consistently contained Trichloroethylene (TCE) concentrations that exceeded the Ontario Drinking Water Quality Standards (ODWQS) maximum acceptable concentration (MAC) of 5 µg/L. Sacco groundwater quality comprised of detectable levels of both TCE and Tetrachloroethylene (PCE), but consistently below the ODWQS MAC. The potential well capacities for Smallfield and Sacco Wells are 1,408 and 1,150 m^3/day respectively as concluded in the rehabilitation and performance assessment in 2008.

The Tier Three report suggested that the Ellis Creek Watershed may be under moderate stress, and therefore any new potential takings in the NWQ beyond the existing municipal active, off-line and test wells previously mentioned should to be located preferentially to avoid potential impacts to Ellis Creek. In modeling scenarios, a possible new well source was located closer to the Speed River at Sunny Acres Park where it was determined that an estimated 1,500 m^3/day may be available.

Beyond the City boundary, a potential new supply was considered in the general area of Conservation Road west of Highway 6. Through Tier Three modeling, a long term average pumping rate of 4,600 m^3/day could be supported which suggests the possibility of a well with a maximum day capacity of 6,200 m^3/day. It is anticipated that a well in this area would have good water quality.

Groundwater Alternatives

After reviewing existing and future well supplies on a quadrant basis and understanding operational and environmental constraints, the potential groundwater opportunities for expansion of the existing supply system are grouped into the following alternatives:

- Optimize existing operating municipal wells
- Restoration of existing off-line municipal wells
- Develop existing municipal test wells
- Install new wells inside City boundaries
- Install new wells outside City boundaries
- Install new ASR wells inside City to optimize excess Arkell Collector system volumes

Optimize Existing Operating Municipal Wells

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 to the well itself or the well system could be considered to improve the well performance, water quality and general security of the source. In general, 'optimizing' existing wells requires a review of operational and maintenance activities for the current facilities to ensure that the potential hydrogeological capacity can be achieved as required to meet peak demands.

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 6,000 m^3/day. The potential for increasing the capacity of the Downey well will be reviewed within the SWQ Class EA.

Restoration of Existing Off-line Municipal Wells

This alternative includes wells which have existing Permits to Take Water (PTTW) but the City has discontinued use due to concerns over existing issues with water quality, either elevated at present or a noted increasing trend. In general, these wells require upgrades for water quality treatment and to provide the required disinfection contact time. Most of these facilities will require completion of Class Environmental Assessment (EA) studies to establish

recommended treatment systems. The total increase in potential quantity available from these wells ranges from 8,000 to14,000 m^3/d. **Table ES-6** summarizes the capital cost estimates for implementation.

Table ES-6 Cost Estimate to Restore Existing Off-line Municipal Wells

	Clythe	Smallfield	Sacco	Edinburgh	Lower Road Collector	Admiral
Potential Capacity (m^3/d)	3,395	1,408	1,150	3,000	2,000	500
Total Cost	$4,809,000	$3,820,000	$4,135,000	$6,029,000	$9,161,000	$2,998,000
Cost per m^3/d	$1,400	$2,700	$3,600	$2,000	$4,600	$6,000

Develop Existing Municipal Test Wells

An extensive review and assessment of existing municipal test wells was undertaken to determine potential well yields and treatment requirements. Due to the information available from previous studies including pumping tests and water quality testing, there is more certainty regarding these alternatives in regards to location, potential yields and treatment requirements. The City can move more readily to the next steps including Class EA and treatability studies, should these be part of the recommended solution. The total increase in a potential quantity available from these wells is from 14,800 m^3/d (includes only 4,500 m^3/d from SWQ wells). **Table ES-7** summarizes the cost estimate for implementation.

Table ES-7 Cost Estimate to Develop Existing Municipal Test Wells

	NEQ Fleming/Logan	SEQ Scout Camp	SWQ Steffler	SWQ Ironwood	NWQ Hauser
Potential Capacity (m^3/d)	4,714	5,789	3,600	8,000	900
Total Cost	$4,735,000	$4,702,000	$3,252,000	$4,036,000	$3,691,000
Cost per m^3/d	$1,000	$800	$900	$500	$4,100

Develop New Wells Inside Existing City Boundary

Using the Tier Three groundwater flow model, analyses was completed to identify new potential groundwater supply source locations within the City. Due to interference effects amongst existing groundwater supply sources as well as new proposed supply sources (off-line wells and test wells), it is advised that additional new supplies within the remainder of the City are limited. For example, less than 10 metres of further groundwater level drawdown is available within the Gasport Formation in the northeast end of the City. In the northwest portion of the City, potential concerns are related to lower aquifer hydraulic conductivity and further stress of the Chilligo/Ellis Creek catchment area. Recognizing these constraints, only one new well inside the City is proposed located in or near Sunny Acres Park, located along Edinburgh Road approximately 600 metres north of the Speed River. The rationale for this location is its proximity to an area with high transmissivity within the Gasport aquifer. Due to the limited available drawdown at this location (approximately 7 m), the estimated capacity of a well in this area ranges from 1,000 m^3/day on an average basis to 1,500 m^3/day to meet maximum day demands. The cost estimate for implementation is $4,522,000, resulting in a cost per capacity of $3,015/m^3/day.

Install New Wells Outside City Boundaries

The Tier Three groundwater flow model was used to review potential for new water supply outside the City. Areas with potential for future groundwater supply sources were focused within Mill Creek (southeast of the City), Marsden Creek (north of the City) and Speed River (northeast of city) catchment areas. Groundwater modelling analysis concluded that additional groundwater supplies (ranging from 3,500 to 5,000 m^3/day on an average basis) can potentially be established within each of these respective areas, without significantly changing base flow rates encountered at the nearby watercourses. Two areas were evaluated including Guelph South (Victoria Road and

Maltby Road) and Guelph North (Conservation Road). The total increase in a potential quantity available from these wells is 11,500 m^3/d. **Table ES-8** summarizes the cost estimate for implementation of these two well supplies.

Table ES-8 Cost Estimate for Guelph South well and Guelph North well

	Guelph South	Guelph North
Potential Capacity (m^3/d)	5,281	6,291
Total Cost	$5,185,000	$5,289,000
Cost per m^3/day	$990	$840

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 which do not correspond to a period of corresponding demand. As a result, these flows cannot be considered as part of the maximum daily supply capacity. For the purposes of reviewing feasibility of an alternative that captures some of the excess flow available from these collector systems, it was assumed that an excess of 10,000 m^3/day would be available continuously for a period of 4 months. It is also assumed that the Lower Road Collector system is repaired and placed back online.

The advantage of this alternative is that a surface water treatment plant would not be required as it would be if water was taken directly from the Eramosa River. The additional seasonal volumes from the collector systems would be discharged to the aqueduct to combine with other Arkell wellfield supplies for disinfection at the Woods Pumping Station (PS). However, rather than shutting off the other Arkell wells while these high seasonal volumes are available, all will continue to be pumped and subsequently stored to recover as required to meet demands. The additional volume would be pumped into the distribution system and obtained similar to a large customer demand at two ASR wells for injection and storage in the aquifer. It is anticipated that the ASR wells would be located in the area of the Park and Emma wells where the high transmissivity would allow for optimization. It is assumed that two wells would be required, each capable of injection at 5,000 m^3/day. Based on the above assumption of 10,000 m^3/day over a four month period, this results in a potential supply capable of 3,300 m^3/day. The cost estimate for implementation is $9,954,000, resulting in a cost per capacity of $2,700/$m^3$/day.

ES-5.3 Establish New Local Surface Water Supply

Two possible local surface waters for assessment of volume available for taking water on a continuous or seasonal basis include the Speed River (at Guelph Lake) and the Eramosa River. Surface water must either be treated to provide a continuous flow into the distribution system, or alternatively, volumes of 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 recovery (ASR) system. 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 (ODWQS). 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 flows.

To evaluate potential quantity available through this alternative, the Grand River Conservation Authority (GRCA) was contacted for their expert opinion on this managed watershed. The GRCA undertook an evaluation of the Speed River (at Guelph Lake) and the Eramosa River (at Arkell) to determine the water volumes available throughout the

year, utilizing historical flow information and modeling tools. 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 in the rivers and minimizing potential environmental impacts of 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 required 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 – Municipal Base Taking
- maximum taking of 300 L/s – ASR option

The total increase in a potential quantity available from a surface water treatment and ASR system based on after-treatment flows is 25,825 m^3/d. 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. The costs and capacities shown are for two independent alternatives. **Table ES-9** summarizes the cost estimate for implementation of the surface water alternatives.

Table ES-9 Estimated Capital Costs to Develop Surface Water Alternatives

	Guelph Lake WTP	Guelph Lake WTP + ASR
Potential Capacity (m^3/d)	12,312	25,825
Total Cost	$36,708,000	$78,905,000
Cost per m^3/day	$3,471	$3,055

ES-6 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-10**.

Table ES-10 Evaluation Criteria Components Summary

Component	Criteria
Built Environment	• Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities • Effect on private and municipal wells
Natural Environmental	• Effect of construction and operation on aquatic and terrestrial species & habitat • Effect on surface water quantity and quality
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
Financial Considerations	• Estimated capital costs; capital cost per capacity • Estimated operation and maintenance costs • Life cycle cost (per volume produced)
Legal/Jurisdictional Considerations	• Location inside vs. outside of City boundaries
Technical Considerations	• Constructability

Component	Criteria
	• Potential productivity and reliability • Water treatment requirements • Approval requirements

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 alternative solutions and strategies based on significant advantages and disadvantages. The summary evaluation tables (in the full 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 in order to meet the water supply requirement to 2038. The alternatives are listed in **ES-11** in order of the priority as determined by the summary outputs:

Table ES-11 Summary of Evaluation Outputs

Alternative	Ranking	Comments
1A – Conservation & Demand Management	1	Strong public support for continued and enhanced water conservation; target reduction explored further through financial analysis
2B – Groundwater: Existing Municipal Off-line Wells	1	Support for optimizing water takings within the City; order of implementation to be determined by the City with consideration for regulatory, treatment, financial constraints
2C – Groundwater: Municipal Test Wells	1	
2D – Groundwater: New Well inside City	1	
2F – Arkell Collectors & ASR Wells	2	ASR alternative requires additional feasibility investigation with respect to Eramosa River PTTW optimization; water volumes available via collector systems; need to install ASR wells vs. changing existing well permits to allow for flexible takings
2E – Groundwater: New Wells outside City	2	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	3	While this alternative is not required to provide water supply within the 25 year study period, 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	3	
1B – Re-Use – Centralized	3	Potential of this alternative to be explored further; highly dependent on end use customer demand; integration and alignment with future WWTP treatment requirements
Limit Growth	4	This alternative does not meet the Study Problem Statement and contravenes the Official Plan
Do Nothing	4	This alternative does not meet the Study Problem Statement and contravenes the Official Plan

Figure ES-2 compares the implementation of all of the water supply alternatives to the water demand curve with and without conservation to 2038. It can be seen that with conservation, the groundwater options ranked first ('1') are sufficient to satisfy the demand in the study period.

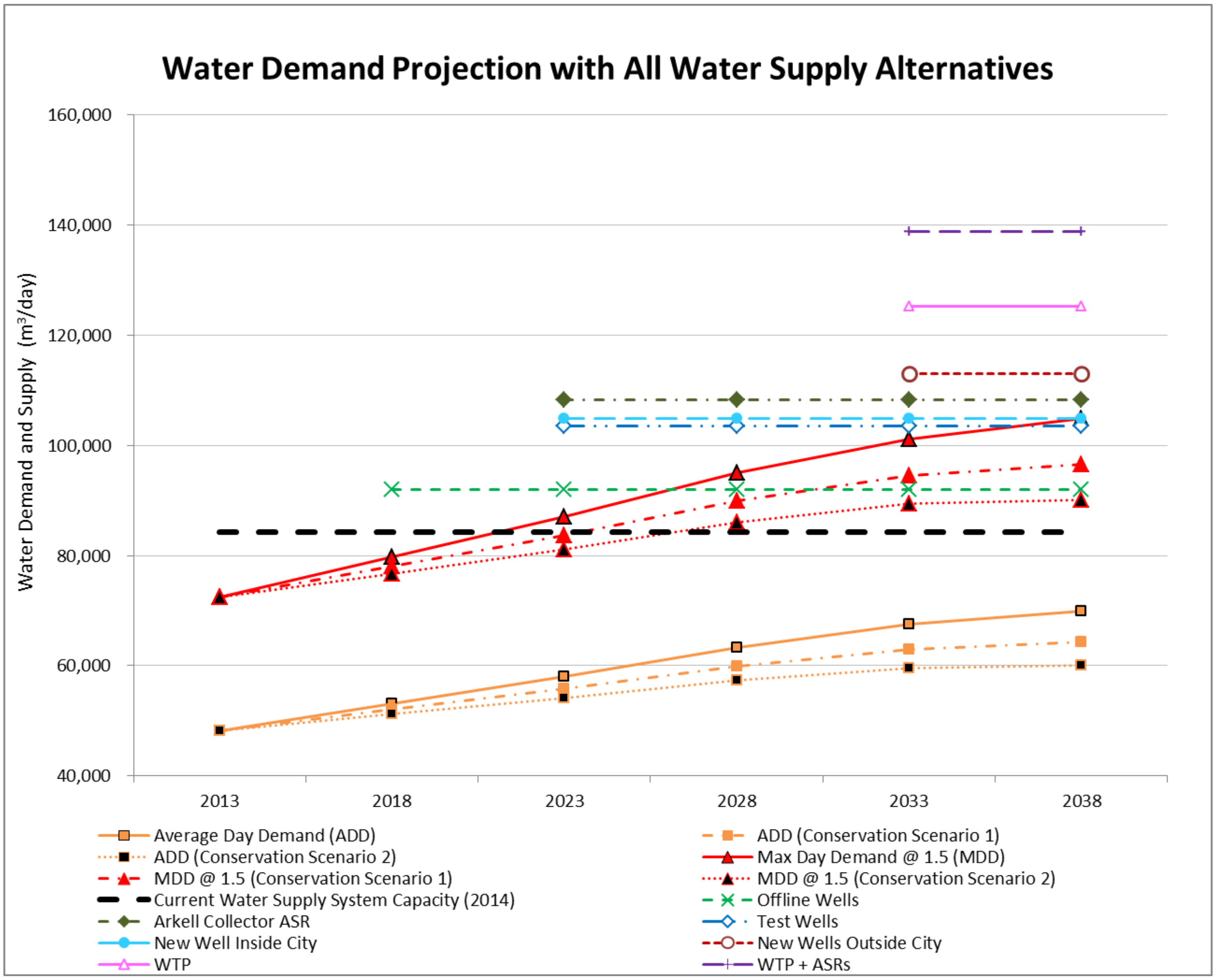

Figure ES-2 Water Demand Projection with All Water Supply Alternatives

ES-7 Public Consultation Plan/Outputs

Communications and consultation activities formed a key component of the process to develop the Guelph Water Supply Master Plan (WSMP). 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. With this in mind:

- **Pre-consultation Interviews** were held with select community members and prospective Community Liaison Committee members to understand perspectives related to water supply and to confirm community engagement needs.
- A **Community Liaison Committee** (CLC) was established to advise and provide feedback to the project team throughout the process;
- A **Municipal / Agency Workshop** provided crucial inputs from a government and approval agency perspective;

- Two public **Open Houses** were held during the course of the study, 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 four meetings of the Water Conservation and Efficiency Public Advisory Committee;
- Presentations were made at the Puslinch Township and the Guelph Eramosa Township Councils' meetings at their request; and,
- **Guelph Water User Survey**: Expectations of Service was completed in early 2014.

Figure ES-3 illustrates the communications and consultation activities undertaken as part of the EA process for the Guelph WSMP.

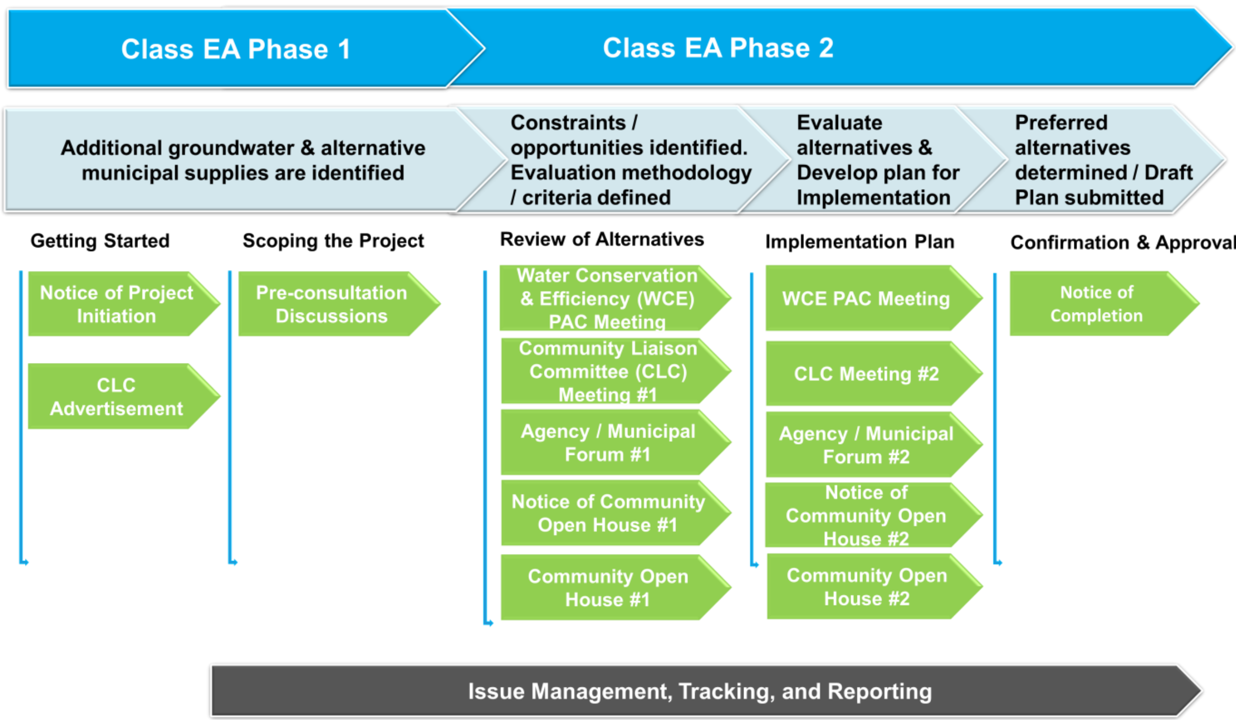

Figure ES-3 Consultation Process

Overall the public was pleased to be informed and to participate in this study. The main points of discussion at the Community Open Houses were water conservation programming, the impact of major water users on the water system, source water protection 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 of Guelph and the surrounding area.

The additional consultation offered and provided to the Townships at their request was also well received and provides 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. Township representatives raised concerns regarding source protection issues and potential constraints on land uses resulting from new water supplies.

ES-8 Implementation Recommendations

ES-8.1 Implementation Approach

Based on the evaluation outputs for each of the alternatives, a timeline and budget was to be established for implementation of the preferred alternative. This strategy included a financial analysis for determining the optimum conservation scenario when considered with the need for new water supply sources. This 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/ Surface Water + ASR wells – 10 year timeline
- The exception to the above is that the investigative phase for all of the test wells and inside-City groundwater options is scheduled to occur earlier 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.
- An assumed order of groundwater projects based on the following priorities:
  - water supply sources currently included in on-going Class EAs pursuant to recommendations from the 2007 WSMP: Southwest Quadrant (e.g. Ironwood test well); and Clythe Well
  - test well with high potential for large volume production and low anticipated treatment requirements (i.e. lower costs) – Logan test well
  - off-line wells - Sacco Well; Smallfield Well
  - upgrades to Lower Road Collector System – although at a higher per capacity cost, this must be done in advance of the Collector System/ASR well project
  - new well in City
  - test wells with lower certainties – Scout Camp test well; Hauser test well
  - Collector Systems & ASR wells – longer lead-in time to allow for feasibility review; also Lower Road Collector System would require upgrades prior to implementation.

  It is important to note that the assumptions made to the above prioritization 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.
- Provide a schedule for implementation such that supply is always greater than 90% to ensure sufficient capacity for proposed development commitment, and industrial/commercial applications, as well as to respond to large increases in demand by current customers. This flexibility is important to address growth needs or demands that do not follow the planned demand projection. This 90% trigger is not to be compared to the redundancy and security of supply allowance which is included in the design maximum day factor of 1.5.

ES-8.2 Recommended Water Conservation Strategy

A number of conservation scenarios were explored in order to establish the cost associated with varying combinations of possible programs. As discussed, five original scenarios were developed to represent a range of possible target reductions and associated costs. With reference to these five scenarios, three were included in the financial evaluation as shown in **Table ES-12**. Current WCESR Approved Programming represents Scenario 1; Maximum Water Conservation represents Scenario 2; and Enhanced Water Conservation is a variation on Scenarios 3 to 5 developed through a closer review of the overall costs and reductions. Under the Base Case without any spending on water conservation, natural savings in water demand are forecasted due to improving building standards (changes in 2014 Ontario Building Code), and consumer reaction to real increases in the price of

water. Each of the water conservation scenarios explored will delay the need to implement proposed projects for increasing the water supply, assuming that the conservation is successfully implemented to achieve the desired targets.

Table ES-12 Water Conservation Scenarios

	Timing	Reduction in Average Day Demand (m^3/d)	Total Program Cost (Non-Discounted)
Base Case	NA	990	–
Current WCESU Approved Programming	2014 to 2025	5,556	$5,685,930
Enhanced Water Conservation	2014 to 2038	9,147	$13,864,780
Maximum Water Conservation	2014 to 2038	9,842	$42,267,600

This analysis compares the forecasted impacts of different water conservation 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. Water conservation allows water supply projects to be delayed and/or avoided within the 25 year study period. This is because as increased water conservation is achieved, per capita demand is reduced, lowering overall water demand. If overall demand is lowered, the City's current water sources will meet demand for a longer period of time before more sources are needed to meet an increased overall demand.

The forecasted timing of proposed water supply projects under the different scenarios is presented in **Table ES-13.** The indicated year is when the new source is required to be on-line; as indicated earlier, there is a timeline for implementation including investigation, Class EA studies, design and construction prior to the year that the new supply is required.

Table ES-13 Timing of Proposed Water Supply Projects under Different Conservation Scenarios

Project No./ Order of Implementation	Project Name	Timing			
	Base Forecast	Base Case	Current WCESU Approved Programming	Enhanced Conservation	Maximum Conservation
Project 1	SWQ (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 No./ Order of Implementation	Project Name	Timing			
	Base Forecast	Base Case	Current WCESU Approved Programming	Enhanced Conservation	Maximum Conservation
Project 13	Guelph Lake WTP	2038	Post 2038	Post 2038	Post 2038
Project 14	Guelph Lake WTP and ASR wells in Northeast Quadrant	Post 2038	Post 2038	Post 2038	Post 2038

The timing of new water supply projects is dependent on the City's overall demand for water and is different under each of the four water conservation scenarios. This in turn impacts capital and operational spending. The capital spending on water supply projects is combined with the spending on water conservation to result in a net present value of cost for each of the four different water conservation scenarios, presented in **Table ES-14**.

Table ES-14 Present Value and Reduction in Average Day Demand for Conservation Scenarios

	Reduction in Average Day Demand (m^3/d)	Present Value (PV) Cost of System
Base Case	990	$78,260,000
Current WCESU Approved Programming	5,556	$58,696,000
Enhanced Water Conservation	9,147	$59,959,000
Maximum Water Conservation	9,842	$75,467,000

Based on the completed financial analysis, the Enhanced Water Conservation Scenario is recommended for implementation. This scenario will result in a target for reduction in average day demand of 9,150 m^3/d by 2038. Although the water conservation programs included in the Enhanced Water Conservation Scenario are not fully specified to allow for flexibility in subsequently determining the best strategy for achieving the water conservation target, it is important to note that rate reform is a key driver of water conservation in the enhanced scenario. If the City does not proceed with rate reform, it will likely be difficult to hit the specified water conservation target, which would consequently necessitate additional water supply projects within the study period to meet the required system capacity.

ES-8.3 Preferred Water Supply Alternative

The preferred water supply alternative consists of the Enhanced Water Conservation Scenario as well as Projects 1 through 8 listed as identified in **Table ES-15**. These are all groundwater projects included in the first ranked alternatives in the evaluation process, consisting of existing municipal off-line wells, existing municipal test wells, and a new well inside the City. A recommended implementation strategy for all required projects is provided in detail in the full report.

Table ES-15 Preferred Water Supply Alternatives

Alternative	Evaluation Ranking	Projects
1A – Conservation & Demand Management	1	Enhanced Water Conservation Scenario
2B – Groundwater: Existing Municipal Off-line Wells	1	1. Southwest Quadrant well (e.g. Ironwood test well) 2. Clythe Well 3. Logan test well 4. Sacco Well 5. Smallfield Well 6. Lower Road Collector System 7. Sunny Acre (new well inside City) 8. Scout Camp test well
2C – Groundwater: Municipal Test Wells	1	
2D – Groundwater: New Well inside City	1	

It will be important for the City to closely track the success of the water conservation 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. 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-8.4 Recommendations

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 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 supplies. As such, it is recommended that the City review its planning and approvals process for managing allocation of water supply capacity.

Future City policies addressing water supply may 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.
- 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.
- Develop a tracking system to closely monitor conservation successes and whether results are in-line with the forecasted demand for the preferred scenario.
- Consider time limits on development commitments such that water capacity is not 'held' for long periods of time.

- Determine a consultation and approval process for existing customers to request additional large volumes of water takings, to avoid sudden and unexpected increases in demand.
- 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.

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 expected to protect and improve the quality aspects of the existing water supply system. The following are recommendations to manage the maintenance of 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 restrict new private groundwater supply wells in the City as well as other areas where municipal water services are present.

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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. 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 with the exception of the Great Lakes Water Supply. One of the recommendations was that the WSMP be updated every five (5) years, and the project herein represents the first update to the 2007 WSMP.

The purpose of the WSMP update is to review and revise the 2007 WSMP to make it consistent with the current needs of the City. The update covers a 25 year period from 2013 to 2038. It applies to water supply only; however, references to other City studies including the Wastewater Treatment Master Plan (WWTMP) and Water and Wastewater Master Servicing Master Plan (W-WWMSMP) are relevant in terms of infrastructure planning co-ordination.

The WSMP update builds upon the work previously completed taking into account more recent studies and the work activities completed over the past six years. This update will review the 2007 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 2007 WSMP:

- Public consultation – complete the required consultation to collect and incorporate public and agency input in the update;
- Population and water demand projections – review potential population and industrial/ commercial/ institutional (ICI) growth and water demand 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,
- Water Supply Master Plan 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 of Guelph relies almost exclusively on groundwater to meet the municipality's residential, industrial, commercial and institutional (IC&I) 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 – public education and awareness programs, and conservation initiatives to promote the conservation of water by all (residential, IC&I), 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 the aquifer through extensive testing of existing municipal wells and the development of a groundwater 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 Environmental Assessment (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 taking 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 and unaccounted for water; 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 Water Supply Master Plan (WSMP) study in 2007. 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. City Council provided direction in 2003 "That the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth". This direction emphasizes the need for water supply to be sustainable. 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 proposed in the 2007 Plan but was considered to be unsustainable in the local context and City Council removed the pipeline alternative from the Plan. A Great Lakes pipeline alternative is not included in this Water Supply Master Plan Update.

The utmost importance was placed on water conservation and as a result, the City of Guelph has become a renowned leader in water conservation and demand management in Canada. Council has made this a priority by setting a goal "to use less energy and water per capita than any comparable Canadian city" through its 2007 Strategic Plan and Community Energy Initiative, respectively. It is the aim of this update to document success achieved to date, and to determine feasible reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 indicated that the City first examine groundwater supply opportunities within the City's boundaries in order to minimize potential impacts on its neighbors. Although groundwater flow does not respect geographic borders, impacts from pumping from aquifers may result in potential local impacts on the natural environment and also on private and municipal wells in close proximity. 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:

- Completed construction of new well facilities (Arkell 14 and 15) and commencement of the Arkell Adaptive Management Plan and Operational Testing Program;
- Completed Class Environmental Assessment (EA) for the existing Burke Well facility;
- Commenced Class EA for the Guelph Southwest Quadrant Water Supply (on-going) which includes evaluation of existing supplies in that quadrant as well as new test wells; and,
- Completed treatability assessments of municipal wells which were previously taken off line due to water quality issues: Clythe, Smallfield and Sacco Wells.

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, including the Guelph South Groundwater Supply Investigation.

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 Tier Three Water Budget and Local Area Risk Assessment is being 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., 2013). This study and the 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 capacity and environmental perspective. (Note: The Tier Three Project is scheduled to be completed in 2014.)

- The Guelph Drinking Water Source Protection Plan was developed within a watershed context to identify and evaluate potential threats to the municipal supply system. The City and other municipalities within the Grand River Watershed, through the Lake Erie Source Protection Authority, are currently developing policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants.

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 2001 Official Plan (December 2012 Consolidation) provides the rationale for protection policies and describes these as follows:

"4.3 Water Resources

The City is dependent upon water resources for supplying water for residents and businesses in the community, and for supporting diverse fish habitat as well as river and wetland ecosystems.

The City of Guelph obtains its potable water from the Arkell Spring Grounds, located in Puslinch Township as well as numerous municipal wells located within the City. The safety and security of the City's water resources is critical to a continued high quality of life for existing and future residents and businesses. The City recognizes the potential threat to surface and groundwater resources from possible deterioration of water quality and quantity.

Objectives

a) To provide a high quality water supply to meet the needs of residents and businesses, now and in the future through an emphasis on conservation, protection and sustainable development.

b) To promote water conservation and efficiency measures to sustain the City's valuable water resources.

c) To protect the quality and quantity of the City's surface and groundwater resources through municipal initiatives and community stewardship.

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

e) To utilize stormwater management to assist in regulating the quantity and quality of stormwater runoff to receiving natural watercourses, wetlands and recharge facilities.

Water Resource Protection and Conservation

4.3.1 The City will promote water protection and conservation through land use planning that maintains and enhances the aquatic ecosystems within and beyond the Municipality.

1. The City will work with other government agencies, municipalities and interested parties on integrated and coordinated water resource management. This management will enhance the existing water resources in and around the City, as a supply for the community's water consumption.

4.3.2 The City will require that all development proposals be considered in relation to their potential impacts on the quantity and quality of the City's water supply.

4.3.3 The City will implement a water supply master plan ***(this report)****, that identifies how growth on lands designated for urban use will be serviced. Implementation elements of this plan will include:*

a) Identifying current and future water demand and supply areas;

b) Investigating sources of long-term potable water supply; and identification of major water supply infrastructure improvements (including servicing capacity calculations) required to accommodate population growth as projected by this Plan;

c) Developing programs and policies to conserve water and to reduce requirements for additional water supply and water treatment.

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

4.3.5 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 of the community and to sustain the area's natural ecosystem.

4.3.6 The entire City area is considered to be a recharge area for public and private potable water supply. In order to protect this valuable water resource, the City will introduce conditions of development approval that:

a) Protect wetlands and other areas that make significant contributions to groundwater recharge;

b) Ensure that stormwater management systems protect water quality and quantity;

c) Prohibit the extraction of mineral aggregates in significant groundwater recharge areas;

d) Require all storage of liquid waste, petroleum, fuels, fertilizers and related chemicals be provided for in properly designed and engineered containment areas;

e) Require impact studies where proposed development has the potential to affect groundwater resources;

f) Restrict the placement of underground storage tanks;

g) Require that contaminated properties be restored to the appropriate condition in compliance with Ministry of Environment Guidelines;

h) 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 or other putrescible waste disposal facilities, asphalt and concrete batching plants, the storage or processing of chemical products, gasoline or oil depots and service stations, and vehicle salvage, maintenance and service yards.

4.3.7 The City will prepare a water resources protection strategy in consultation with the Province, adjacent municipalities, the Grand River Conservation Authority and the Guelph community. This strategy will include the following components:

a) Studies that define the location, nature and extent of potable water resources;

b) Identification and evaluation of potential threats (i.e., sources of contamination) to surface water and groundwater;

c) Policies and programs to manage, reduce or eliminate threats based on potential risk of contaminant sources;

d) A monitoring system to provide for the early detection of changes in water levels and water quality in the vicinity of municipally-owned wells and within the collector system;

e) Operational policies and contingency plans which will facilitate a quick response to natural or human-induced incidents (such as accidental releases of contaminants);

f) Policies and programs to consult with and inform the community about water resource protection issues; and

g) Amendments to this Plan to acknowledge sensitive groundwater and surface water areas.

4.3.8 The Arkell Springs, located to the southeast of the City in Puslinch Township, are the source of a significant portion of Guelph's water supply. A portion of the spring's recharge area is located within the City of Guelph, and is delineated on Schedule 2 as the "Arkell Springs Water Resource Protection Area."

a) The policies of this Plan, most notably policy 4.3.6 will be used to ensure that development activities within the "Arkell Springs Water Resource Protection Area" do not impair the quality and groundwater recharge capabilities of the "Protection Area."

b) In order to protect the future ability of the Arkell Springs to supply good quality and quantity water to Guelph, the City will work co-operatively with the upper and lower tier municipalities within Wellington County and Halton Region, to introduce water resource protection policies into their respective Official Plans to provide protection to the Arkell Springs recharging area".

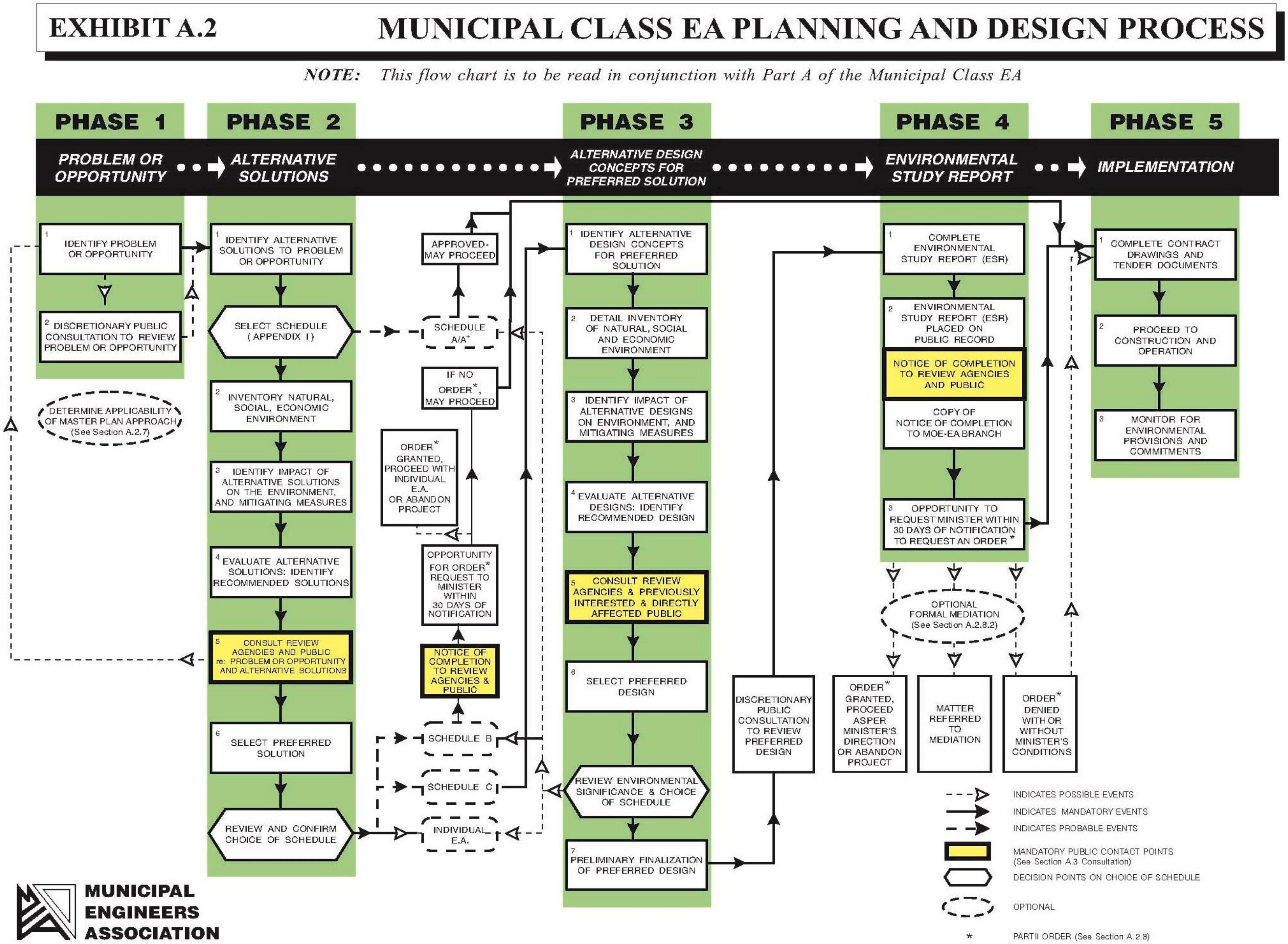
In addition to the City's policies, the Wellington County Official Plan contains some protection measures for the City's wells located in Puslinch and Guelph Eramosa Townships. The Arkell Spring Grounds is designated as a protection area with specific development constraints. The City is circulated by 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 (see **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.

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; and infrastructure master plans.



Source: (Municipal Engineers Association, 2011)

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

This Guelph Water Supply Master Plan update document was prepared at the conclusion of Phases 1 and 2 of the Municipal Class EA process. The Master Plan document will be made available for public comment prior to being approved by City Council. The Water Supply Master Plan update 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 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 Water Supply Master Plan will continue to be reviewed 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 Master Plan update approach are provided in **Table 1-1**.

Table 1-1 Master Plan Update Approach Overview

Task No.	Task Description
Task 1 Public Consultation	• Pre-consultation interviews • WSMP Community Liaison Committee (CLC) meetings (2) • Municipality / Agency workshops (2) • Community Open Houses (2) • Water Conservation and Efficiency Public Advisory Committee meetings (4) • Guelph Water User Expectations of Service Survey
Task 2 – Population and Water Demand Forecasts	• Develop population projections – residential and Industrial/Commercial/Institutional • Develop water demand projections
Task 3 – Existing Water Supply Capacity Assessment	• Update the assessment of existing well performance, maximum system capacity and minimize potential constraints for each supply source • Compare existing capacity with demand forecast
Task 4 – Water Supply Alternatives	• Demand management & conservation programs • Re-use • Groundwater sources inside city • Groundwater sources outside city • Local surface water supply • Limit growth/Do nothing
Task 5 – Water Supply Master Plan Update	• Evaluate alternatives • Develop Implementation Strategy • Complete WSMP Update Report

This report documents completion of each of the above tasks, commencing with development of the Master Plan Purpose Statement.

1.2.2 Purpose 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 Purpose 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 Purpose Statement for the City of Guelph Water Supply Master Plan Update was provided to the public for comment at the Community Liaison Committee, Municipality and Agency group workshop, and Community Open House in the fall of 2013. Suggestions provided by the public, agencies and municipalities were reviewed and incorporated in developing the final Purpose Statement:

> *The City of Guelph is responsible for supplying clean, safe drinking water to its customers. The City has initiated an update to its Water Supply Master Plan (WSMP, 2007) that will define how we will continue to provide a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers over the next 25 years. The updated Master Plan will identify individual projects required to implement the master plan and prioritize these projects based on need.*
>
> *Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water. However, recent analysis confirms that the existing water supply system capacity will not meet future demands. Updating the WSMP is an opportunity to discuss with the community how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.*
>
> *When investigating existing and new water supply options, including water conservation strategies, we will consider water quality and quantity, economic factors, environmental concerns and 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.*

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 of Guelph municipal boundaries. Furthermore, the update will define and factor in the role of water conservation/efficiency measures which can extend the life of existing supply capacity and defer the need for future water supply capacity.

2 STUDY AREA PROFILE

Background data were collected on existing regulatory, environmental, social and economic conditions in the study area. These existing conditions were used to characterize the study area and provide a basis for assessment and evaluation purposes for future water supply alternatives. The conditions are described as follows:

- 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 land owners.
- 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.
- 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 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 national 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, and 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 387-4). Through the regulation, the MOE 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 were presented and endorsed by 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 is now awaiting approval by the Ontario Ministry of the Environment. The Ontario Ministry of the Environment 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 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 will be addressed once additional water quantity studies have been completed.

- 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).

2.2 Natural Environment

2.2.1 Natural Heritage Systems

This section presents the area's 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
- City of Guelph Official Plan Amendment 42: Natural Heritage System

Other Documents

- City of Guelph Natural Heritage Strategy
- Grand River Conservation Authority website
- Natural Heritage Information Centre website
- Soil Survey of Wellington County
- Wellington County website Interactive Mapping

Tool

- Ministry of Natural Resources - Species at Risk Website – Species at Risk in Wellington County
- Atlas of the Breeding Birds of Ontario – Atlas Data Summary Squares 17NJ51, 17NJ52, 17NJ61 AND 17NJ62

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

The following describes the natural environment within the study area in a general sense. It is expected that more detailed review utilizing Wetland Evaluations, Environmental Significant Area Reports and Fisheries Information will be conducted further in individual Class EAs for the proposed undertakings. Further details along with the referenced extracts from Official Plan documents can be found in **Appendix A**.

City of Guelph

With a total coverage of approximately 18%, 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. The City of Guelph encompasses the following natural heritage features:

- 5 Subwatershed/Watershed Areas (partially or entirely – Eramosa-Speed River Watershed, Clythe Creek Subwatershed, Hanlon Creek Watershed, Torrance Creek Subwatershed, Mill Creek Subwatershed)
- 4 Environmentally Sensitive Areas (ESAs),
- 2 Areas of Natural and Scientific Interest (ANSIs),
- 8 Provincially Significant Wetlands (PSWs) Complexes (partially or entirely),
- 3 Locally Significant Wetlands (LSWs),
- The Speed, Eramosa, Hanlon, Torrance, Clythe and Ellis River/Creek Systems,
- Approximately 30 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, January 2012 consolidation).

Within and surrounding the City, more than 70 element occurrences of at risk species have been recorded. Those species which have been observed more recently (since 1990) include; least bittern (*Ixobrychus exilis*), Jefferson salamander (*Ambystoma jeffersonianum*), American chestnut (*Castanea dentata*), wavy-rayed lampmussel (*Lampsilis fasciola*), Williamson's emerald (*Somatochlora williamsoni*) 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 include areas containing wetlands, forested areas, wildlife habitat for terrestrial and aquatic species (including endangered and threatened species) significant areas of wetlands, habitats of endangered and threatened species, areas of natural and scientific interest, fish habitat, woodlands, environmental corridors, ecological linkages and wildlife habitat.

A copy of Schedule 1: Land Use Plan and Schedule 2: Natural Heritage Features and Development Constraints from the City Guelph's Official Plan 2001 December 2012 Consolidation, as well a copy of Schedule 1: Land Use Plan and Schedule 10: Natural Heritage Strategy Natural Heritage System from the Official Plan Amendment (OPA) 42 is provided in **Appendix A**.

It is noted that OPA 42 establishes a new Natural Heritage System as part of the Official Plan (Adopted by Guelph City Council - July 27, 2010; Approved by Minister of Municipal Affairs and Housing - Feb 22, 2011, and is currently under appeal before the Ontario Municipal Board). OPA 42 does not comprise part of the December 2012 OP Consolidation. OPA 42 includes revisions to the above referenced Schedules, which are also attached to Appendix A. OPA 42 also includes new policies regarding where and how public and private infrastructure is permitted in relation to the City's Natural Heritage System. Consideration should be given to the Current Official Plan Greenland's System mapping and policies, as well as regard for the mapping and policies of OPA 42 until such time that it is no longer under appeal.

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 from the construction of Guelph Lake Dam on the Speed River in 1974, occurs to the north.

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 thirty (30) species that have been designated as Endangered, Threatened or Special Concern under the provincial Endangered Species Act are known to occur within Wellington County. In addition to this, two (2) species that have been designated as Threatened or Special Concern by the Committee on the Status of Endangered Wildlife in Canada are also known to occur within Wellington County. A list of these species and their habitat preferences is included in **Appendix A**.

Natural heritage features are located throughout the County and include evaluated wetlands, earth science Areas of Scientific Interest, conservation areas and life science sites.

A copy of Appendix 1 "South Wellington Watershed Study Areas" and Appendix 3 "Provincially Significant Wetlands" can be found in **Appendix A**.

2.3 Social/Cultural and Built Environment

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

2.3.1 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. 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. 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 City's Official Plan update.

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).

2.3.2 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 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 his 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.

2.3.3 Education Programs

Various alternative solutions can provide the opportunity to be combined with water conservation 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.

2.4 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 2013 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.

2.5 Legal Jurisdiction

Legal jurisdictional issues were also considered given the potential impacts 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 impacts on agricultural operations and other land uses were also considered for water supply alternatives outside of the City.

2.6 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 on line 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/WATER DEMAND PROJECTIONS

3.1 Population Projections

This section presents the population projection design basis used for this Water Supply Master Plan Update. Additional details on the sources for these projections can be found in **Appendix B**.

Population projections are required to determine future water supply requirements. The population projections presented herein combine non-residential (employment excluding work at home and no fixed place of work) and residential (including census undercount) populations to develop a total 'equivalent' population. The equivalent population represents the projected residential population plus the additional population representative of industrial, commercial and institutional (ICI) land use. This equivalent population forms the basis for developing existing and future water demands. The advantage of this approach is that it accounts for changes in both the residential and non-residential sectors (i.e. any change in the proportion of each).

Population growth projections to 2031 for the City are per the Official Plan, with details provided in the 2014 Development Charges Growth Forecast. In order to extend population projections beyond the current Official Plan planning period of 2031, City Planning staff provided forecasts of the Growth Plan from 2031 out to 2041. The population projections from 2013 to 2038 in five-year increments are presented in **Table 3-1** and illustrated in **Figure 3-1**.

Table 3-1 Guelph Population Projections

Year	**Residential Population** (Including Census Undercount)*	**Equivalent Employment Population** (Excluding work at home and no fixed place of work)	**Total Equivalent Population****
2013	130,670	66,730	197,400
2018	143,480	73,874	217,354
2023	156,290	81,017	237,307
2028	168,190	90,340	258,530
2033	178,464	96,947	275,411
2038	186,299	99,480	285,779

* Census undercount is estimated at approximately 3.5%.
** Projection excludes lands designated Reserve Lands, and Open Space/Park within Clair-Maltby Secondary Plan Area; Projection also excludes students which would not be captured within the permanent population base.

2013 to 2031 Source: (Watson & Associates Economists Ltd., 2013) –1.6% to 2% growth per year
2032 to 2038 Source: (Ontario Ministry of Infrastructure, 2012), (City of Guelph - Planning, Building, Engineering and Environment - Todd Salter, 2013) – 0.7% to 0.9% growth per year

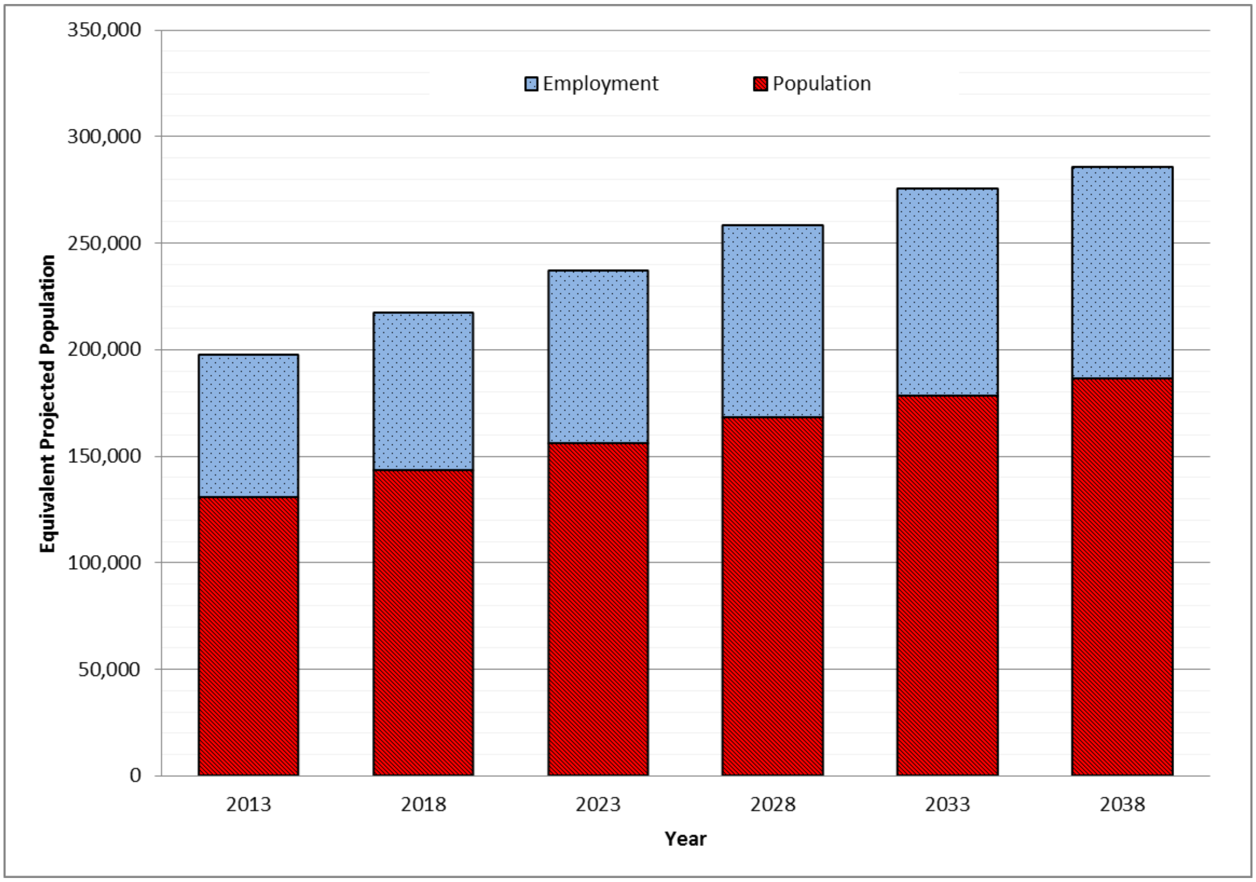


Figure 3-1 Guelph Projected Population Growth (2013-2038)

3.2 Water Demand Projections

This section presents the water demand projections design basis used for this Water Supply Master Plan Update. Additional details on the sources for these projections can be found in **Appendix B**.

3.2.1 Design Basis for Average Day Demands

3.2.1.1 Overall Approach by Sector

The basis for projecting demands from the residential and employment sectors, as well as non-revenue water, is to assume the status quo applied to population projections, i.e. representative of per capita demands without influence of future conservation or non-revenue water reduction efforts. This baseline will be used to measure the effect of potential future programs and their associated costs against the costs and efforts to provide new water supply.

3.2.1.2 Residential and Employment (ICI) consumption

Water billings data from 2006 to 2012 were provided and summarized by property codes which allowed them to be grouped by classification as follows:

- Land Use Pending/Other
- Residential
  - Low Density Residential
  - Medium Density Residential
  - High Density Residential
- Commercial
- Industrial
- Institutional

These were then combined and tabulated as residential, commercial, industrial and institutional sources. The City commissioned an independent detailed analysis of patterns underlying metered customer water demands through exploration of variables including season, land use, account size and area within the City (Fortin, 2014). This is important in considering whether observed recent trends are sustainable or possibly due to factors which may not continue. For example, the decline in commercial and industrial demands since 2006, as a percentage of average demand, is slightly higher than that observed for residential customers. Fortin has suggested that this may be partially attributed to the impact of the economic downturn since 2009. Several interesting observations and trends were noted:

- In general summer demand exceeds winter demand; exceptions noted include multi-residential and institutional customers when the class is viewed in its entirety; within each class this is variable;
- Variability in demand is smallest for residential customers and largest for industrial and institutional customers; however, within the residential customers there is large variability in use with 21% of the smallest customers using less than 25% of the water used by the largest 3% of customers;
- There are residential areas of the City with notably high excess summer use;
- There are also residential areas with high winter use relative to summer use which are likely student rentals with higher winter occupancy.

Statistical analysis of the trends in annual water consumption by customer class provides valuable insight into the factors influencing changes in demand to date, and whether these will continue to influence changes in future, including:

- A review of trends supports the observed overall downward trend in demand across all customer classes; this is influenced by the following factors:
  - Natural adoption of water efficient technologies with equipment replacement
  - Increased implementation of water efficient technologies due to demand management programs
  - Changes in level of economic activity affecting commercial and industrial customers
- The higher decline in commercial and industrial demands cannot continue indefinitely.

Further analysis was completed to determine what factors may be contributing to the decline in demand, specifically within the residential and multi-residential customers:

- The results indicate that the demand management programs such as rebate programs for washing machines and toilets have been effective in reducing residential and multi-residential demands
- Results from other demand management programs such as the humidifier replacement, grey water reuse and outdoor water use efficiency programs were inconclusive due to the small number of participants

Another independent commissioned review was completed to assess the success of Guelph's Water Conservation and Efficiency Program since 2006 (Gauley Associates Ltd., 2014). This report provides additional rationale for determining the effectiveness of water efficiency on short and long term demands,

through assessing direct, indirect and natural water savings for the residential and ICI sectors in terms of sustainability of each. The study defined each of these savings as follows:

- Direct water savings – savings directly attributable to the implementation of water efficiency measures or strategies
- Indirect water savings – savings achieved by the City's marketing and outreach programs resulting in improvements in water use behaviour or implementation of improvements independent of municipal incentives
- Natural water savings – savings achieved by City residents and businesses that are unrelated to the City's programs, e.g. market shifts towards use of higher efficiency washers and toilets.

It was concluded that it is unlikely that per capita water demands will continue to decline at the rate that was achieved since 2006 of approximately 3%/year. There was a strong correlation in the trendline describing residential demands over time which suggests that the savings incurred to date are sustainable.

This was not found to be the case for the ICI sector water demands which in general showed high variability from year to year. Demand trendlines for institutional and commercial customer classes are declining although with a poor correlation; the demand trendline for the industrial sector has increased since the economic downturn in 2008-9 with a very low correlation. This indicates that this trendline is not a good indicator of future demands.

Given these findings, the following approach was implemented for the demand forecasts in this update.

- Residential demands – all direct, indirect and natural water savings achieved to date are included in developing the base case for projecting future single family and residential demands.
- ICI demands – only the direct savings as measured through the City's implementation of the ICI Capacity Buy-Back program are included as sustainable savings in developing the base case for projecting future ICI demands.

Therefore, the baseline demand for each of these sectors was developed as follows:

- Residential – 180 lcd
- Employment (ICI) – 286 lcd

This compares to that actually found in 2012 of 180 and 247 lcd for residential and ICI employment respectively.

These design values were applied to the projected populations from 2013 to 2038 to determine the future water demands for each sector assuming status quo in terms of water conservation efforts to date.

3.2.1.3 Non-Revenue Water (NRW)

3.2.1.3.1 <u>Non-Revenue Water Definitions</u>

The difference in water consumed by customers that is measured directly through utility billings and that which is pumped at water facilities to the water distribution system is classified as Non-Revenue Water (NRW). The International Water Association (IWA) Non-Revenue Water Task Force has produced an international 'best practice' standard approach for water balance calculations and the estimation of non-revenue water. This best practice is also advocated by InfraGuide in their Best Practice "Water Use and Non-Revenue Water in Water Distribution Systems" and by the American Waterworks Association

(AWWA) through their Water Loss Control Committee. More and more utilities are turning to the IWA best practice for consistent and comparable results between utilities worldwide.

The IWA 'best practice' standard water balance is presented in **Figure 3-2**. As shown in this water balance, there are three main categories of Non-Revenue Water (NRW): unbilled authorized consumption, apparent losses, and real losses. These all represent volumes of treated water for which the City does not receive revenue. The standard water balance is calculated on an annual basis from the measured and estimated volumes for metered and unmetered water (revenue water) and water lost (non-revenue water). It should be noted that some cities in North America still refer to water loss as a percentage of unaccounted for water; however, the influence of changes in total consumption makes % losses a flawed performance measure. In addition, unaccounted for water is no longer an appropriate term (as after the water balance is completed, all types of water loss become "accounted for") and the correct term should be non-revenue water.

<table>
<tr><td rowspan="9">System Input Volume

(Allow for Known Errors)</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption Residential, Industrial, Commercial & Institutional Properties</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water - NRW</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Costumer Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Mains</td></tr>
<tr><td>Leakage on Reservoir Overflows</td></tr>
<tr><td>Leakage on Service Connections Up to Point of Customer Metering</td></tr>
</table>

Figure 3-2 IWA 'Best Practice' Standard Water Balance

The real water losses typically represent the greatest proportion of non-revenue water, i.e. the annual volumes lost from the distribution system through all types of leaks and bursts on mains and service connections, up to the point of customer metering. As identified in the Standard Water Balance in **Figure 3-2**, the International Water Association (IWA) defines two major categories of water loss: real losses and apparent losses.

<u>Real Losses</u>

Real losses occur when water physically escapes from the distribution system, and includes leakage and overflows prior to the point of end use. Real losses are also considered "physical losses". Leakage from mains and service connections are typically the most common form of real losses, and occur due to a number of factors such as poor installation, workmanship and materials, ground movement, the weather (freeze/thaw), excess pressure, corrosion, lack of scheduled maintenance, and overflows at reservoirs. The annual volume of real losses is made up of three components:

1) Background leakage – small undetectable leaks at joints and fittings;

2) Reported bursts – events with larger flows which cause problems and are reported to the water supplier; and
3) Unreported bursts – significant events that do not cause problems and can only be found by active leakage control.

It is interesting to note that the volume of water lost from background leakage and unreported bursts can be significantly greater than the volume lost from reported bursts, despite the often negligible flow rates. This is due to the influence of leakage run times on the leakage volume. This leads to an opportunity to reduce these losses through programs such as the City's Leak Detection & District Meter Area (DMA) program which identifies and addresses areas in the distribution system experiencing extraordinary water losses.

Apparent Losses

Apparent losses occur when customer use is not recorded, either through metering error, incorrect assumptions of un-metered use, or unauthorized consumption. Apparent losses are also considered "paper losses". Apparent losses of water can occur in three primary ways:

1) **Errors in water consumption measurement** occur when water meter readings are in error due to a variety of reasons, including meter reading error, meter wear over time, incorrect meter sizing, specification or installation, and lack of routine testing and maintenance.
2) **Errors in water accounting** may occur due to a variety of reasons, such as incorrect documentation of customers, or errors in meter reading, billing errors, or data analysis.
3) **Unauthorized consumption** occurs where users obtain the water service illegally and without payment.

3.2.1.3.2 Water Loss Performance Measures

The use of percentages, such as % unaccounted for water, as an indicator of water loss within a system is not a recommended practice as it does not allow for sensible comparison between systems with different demands and is not suitable for use as a target. The use of percentages also results in having to compare to a moving target for the utility as the % depends on consumption and production, which could vary with climatic conditions or water use patterns. A more common approach is to unitize the amount of water lost in a system by dividing it by the length of mains in the system, or by the number of service connections served by the system. The performance indicator "L/service connection/day" is considered the most reliable of the traditional performance indicators for all systems with service connection densities of >20/km. If the system has a service connection density <20/km, the preferred performance indicator is m^3/km/day.

The international best practice performance measure advocated by the IWA (and the AWWA) is the Infrastructure Leakage Index (ILI). The Infrastructure Leakage Index is the ratio of current annual real losses (CARL) to the unavoidable annual real losses (UARL), which measures how well the system is being managed for control of real losses. The ILI is a highly effective performance measure because it is:

- Based on a calculation that has been tested globally;
- Unit-less & based on real water loss;
- System specific – takes into account operating pressure, service connection length, pipe condition & meter location; and
- A measure that can be compared to an international data set.

The ILI performance measure is recommended for systems with more than 3,000 service connections.

The calculation is ILI = CARL / UARL
Where: CARL = Current Annual Real Losses (L/day) and
UARL = Unavoidable Annual Real Losses (L/day)

Any units can be used for CARL and UARL as long as they are the same for both, for example L/day or ML/year. The CARL is directly calculated from the water balance approach.

The UARL is a theoretical reference value developed by the IWA to represent the technical low limit of leakage that could be achieved under a proactive water loss reduction program using the best technology (e.g. speed of repairs, pressure management, pipe materials management, active leakage control etc.). The UARL equation was developed to allow for:

- background leakage;
- reported leaks and bursts;
- unreported leaks and bursts; and
- pressure/leakage rate relationships.

The calculation for UARL is system specific and takes into account the key variables that affect the amount of leakage in a distribution system including:

- Average operating pressure in metres (P);
- Total length of mains (Lm);
- Number of service connections (Nc);
- Total length of private pipe, i.e. service connection length from property line to meter (Lp); and
- Intermittent supply conditions (if system is pressurized for less than 24 hours per day).

Where UARL (L/day) = (18 x Lm + 0.8 x Nc + 25 x Lp) x P x % of time that the system is pressurized.

The UARL equation has been proven to be robust in diverse international situations and is the most reliable predictor yet of “how low could you go”.

An Infrastructure Leakage Index close to 1.0 may demonstrate that all aspects of a successful leakage management policy are being implemented by a water utility or that the distribution system is in excellent condition with very little water loss. Typically it will only be economical to achieve an ILI close to 1.0 if water is very expensive, scarce or both. Economic values of ILI typically lie in the range of 1.5 to 2.5 for most systems.

3.2.1.3.3 Projected Non-Revenue Water

The calculated non-revenue water per year is provided in **Table 3-2** for the period of 2006 to 2012. In a recent study (Gauley Associates Ltd., 2014) the decline in NRW from 2006 to 2012 was determined to be 3106 ML over that period. The City implemented a Pilot Leakage Program in 2011 (C3 Water Inc., 2014) which targeted the repair of leaks estimated at a total reduction in real losses of 1128 ML in 2011-12. Therefore it is anticipated that the total reduction in NRW of 3106 ML includes both real and apparent losses.

A review of the calculated NRW in **Table 3-2** indicates no clear trend over that period despite the above savings due to the pilot program. Therefore, the average of the annual NRW volume determined in the last 5 years (5,550 m^3/d) was used as the basis for the purpose of projecting future losses. This translates into an estimated 135 litres per service connection per day (based on 41,233 metered connections in 2013).

Table 3-2 Historical Non-Revenue Water

Year	Average Water Produced (m^3/d)	Average Water Consumed (m^3/d)	Non-Revenue Water (m^3/d)
2006	51,387	44,887	6,500
2007	51,005	44,157	6,848
2008	48,492	41,517	6,976
2009	46,607	40,618	5,989
2010	44,442	40,642	3,800
2011	45,578	40,267	5,311
2012	45,244	39,548	5,697
		5-year average	**5,554**

However, it is necessary to make allowances in this projection for the growth of the overall water supply system with increased population as the real water losses will increase with additional customers (connections) and water distribution main length. If no increase is applied to this base rate (i.e. assumed constant), this would result in a reduction in non-revenue water as a fraction of the overall production, which could imply that this reduction would occur without implementing water loss reduction programs. The City used the IWA software tool to provide a breakdown of NRW in 2012 as shown in **Figure 3-3** (data as ML per year).

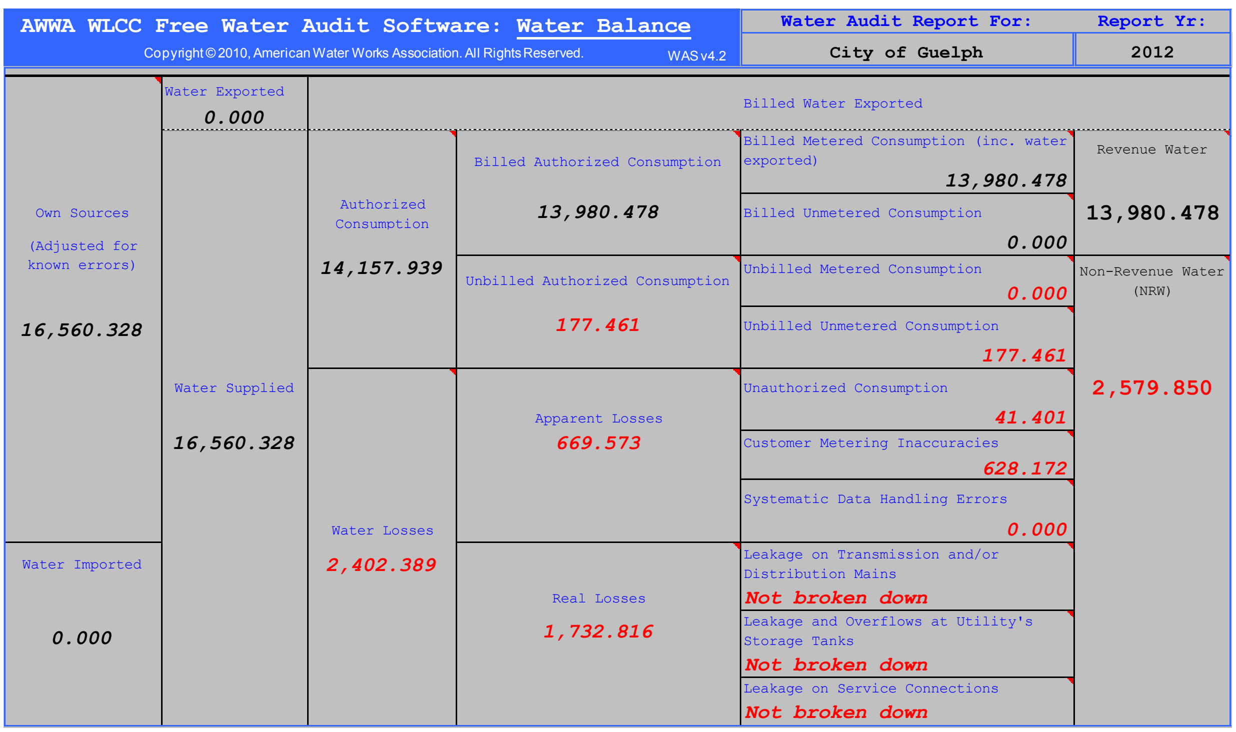


Figure 3-3 IWA Software Output

By increasing the inputs in the software with estimated watermain length and number of connections in 2031 and 2038, the outputs provide the increase in unavoidable real losses to reflect growth in the distribution system. The City has developed a detailed water distribution model that accounts for the 545 km of watermains making up the distribution system in 2012. As part of the Water-Wastewater System Servicing Master Plan, scenarios were developed to include servicing of future population which indicate that on average, additional 5km of watermains will be added to the distribution system each year. This information was used along with maintaining a constant ILI to develop a reasonable increase in water losses. Anticipated reductions through planned and proposed City initiatives will be considered as part of the demand management and water efficiency alternatives.

3.2.1.3.4 Projected Average Water Demands by Sector

Table 3-3 presents the projected average day water demand in 5-year increments from 2013 to 2038, based on the design per capita demands developed earlier. This assumes no further reductions as a result of further conservation initiatives.

Table 3-3 Projected Average Day Water Demand (2013-2038)

Year	Population			Demand by Sector			NRW (m^3/d)	Average Water Demand (m^3/d)
	Resid.	Employ.	Total Equiv.	Resid.	Employ.	Total		
2013	130,670	66,730	197,400	23,536	19,059	42,595	5,658	48,253
2018	143,480	73,874	217,354	25,843	21,100	46,943	6,175	53,117
2023	156,290	81,017	237,307	28,150	23,140	51,290	6,691	57,982
2028	168,190	90,340	258,530	30,293	25,803	56,096	7,208	63,305
2033	178,464	96,947	275,411	32,144	27,690	59,834	7,628	67,462
2038	186,299	99,480	285,779	33,555	28,413	61,969	7,903	69,872

3.2.2 Design Basis for Maximum Day Demand

3.2.2.1 Maximum Day Demand Projection

The MOE Guidelines for the Design of Water Distribution Systems dictate that water supply systems be designed to satisfy the greater of the maximum day plus fire flow or peak rate (maximum hourly demand). Fire flows and peak flows are typically provided in storage within a distribution system; and therefore, the pumping capacity of the water supply system is designed to meet maximum day demands.

Through review of historical average demands by sector, reasonable estimates can be developed for projecting future demands. Similarly, historical information regarding peak demands in recent years can be evaluated to determine a design maximum day factor for projecting future maximum demands. The maximum day factor is calculated as the maximum day demand divided by average day demand during a given year.

MOE Guidelines also provide recommended peaking factors for municipal water supply systems to be used in design where existing information may not exist. This table indicates that as population increases, the maximum day factors decrease, reflect a dampening of the diurnal demand curve for larger communities, with additional variety of water uses (i.e. industrial and commercial). For a community with

a population greater than 150,000, a maximum day factor of 1.50 is recommended. With the success of water efficiency measures and the implementation of outside water use restrictions in Guelph, the actual maximum day factors for the period of 2008 to 2012, ranged between 1.19 and 1.41, with an average of 1.26. Maximum day demands are also calculated in some municipalities as the average of the highest five or seven days of water usage experienced in an average demand year; this results in a maximum 'week' factor less than that based on an individual peak day. Based on historical data it is reasonable to adopt a maximum day factor of 1.35 for projecting future water demands.

3.2.2.2 Maximum Day Supply Projection

In the 2007 WSMP, a maximum day factor of 1.5 was proposed for the design of future water supply facilities in order to ensure a "firm capacity" sufficient to meet the actual future water supply demands based on maximum day requirements with a degree of conservatism to address uncertainties and risks such as contamination events, drought conditions and security of supply concerns.

Typically for municipalities with surface water supply systems, firm capacity is determined by the capacity without the largest piece of equipment or unit operation (for example, the largest pump or one of multiple modular unit processes out of service). However, this approach does not address "system" firm capacity. Neither is it applicable to a groundwater system with many sources. Firm capacity assessment of a water supply system is an exercise in risk assessment, such that a municipality will incorporate measures or strategies to minimize the risk of certain aspects of the system being off-line, and will accept a level of risk that a portion of the system will not be available due to maintenance, water quality issues or otherwise.

A review of potential risks to the City's water supply system was completed to consider possible scenarios which could result in short term and long term supply reductions such as infrastructure failures, largest well out of service, medium well out of service, etc. Also included was a general scenario where firm capacity was determined by applying an industry standard of 85% of existing capacity. For example, historically the Region of Waterloo has reportedly calculated firm capacity at 85% of current pumping capacity due to the large number of wells, and other municipalities with groundwater sources have adopted similar approaches.

This assessment allows the City to determine where there needs to be redundancy or emergency response procedures in place compared to what is acceptable in terms of capacity "downtime". This is the capacity that can be adopted as firm capacity; thereby not impacting the consumers' normal use of water. This can also be the capacity that may be off-line to undertake maintenance protocols or for system upgrades.

In developing the projected total water supply requirements, Golder & Associates were concurrently reviewing the capacity of the existing water supply system and exploring the impacts of potential risks to the total existing capacity. Two scenarios were reviewed in detail including one in which one of the City's largest well supply sources (i.e. Park wells) is out of service, and the other being a long term drought condition (refer to **Section 4.2**). It was determined that under these two scenarios, the total existing water supply is reduced by approximately 10 to 15%. Therefore, it is suggested that the City continues to apply an additional 15% to the average day demand, which results in a 10% increase to the maximum day factor of 1.35, to determine the future water supply requirements. This results in a 1.5 maximum day factor for the purposes of projecting future water supply requirements, with the difference in maximum day demand and the supply projection attributed to contingency in the supply system.

3.3 Projected Total Water Supply Requirements

The design basis developed for each component making up the total water demand and supply requirement, in Sections 4.1 and 4.2, was applied to the 25 year period of this study in 5 year increments to develop future water demand projections and water supply requirements, as indicated in **Table 3-4** and **Figure 3-4**.

Table 3-4 Projected Total Water Supply Requirements (2013-2038)

Year	Total Average Day Demand (m^3/d)	Max Day Demand @ 1.35 MDF (m^3/d)	Water Supply Requirement @ 1.5 MDF (m^3/d)
2013	48,253	65,141	72,379
2018	53,117	71,708	79,676
2023	57,982	78,275	86,972
2028	63,305	85,461	94,957
2033	67,462	91,074	101,193
2038	69,872	94,327	104,808
Note: MDF = maximum day factor			

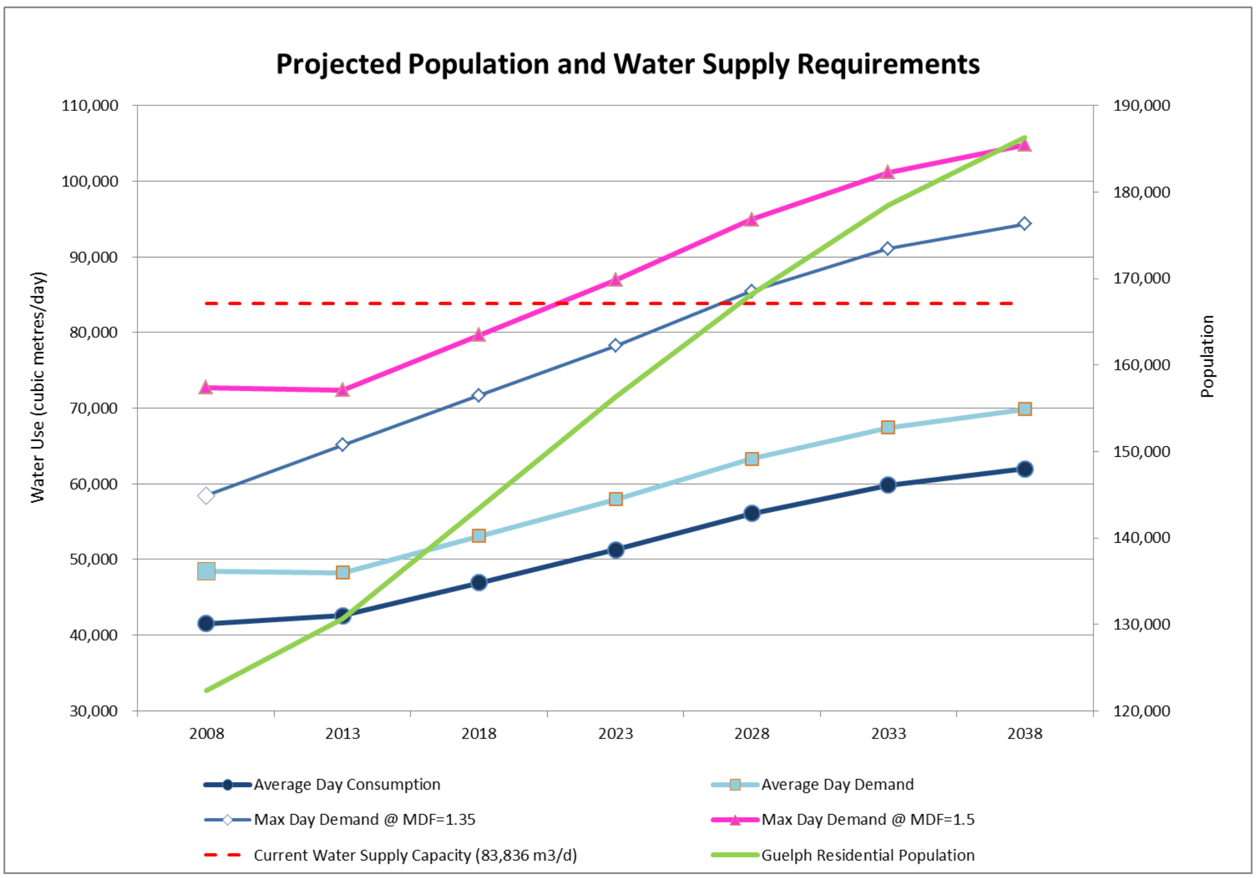


Figure 3-4 Projected Population and Water Supply Requirements

4 EXISTING WATER SUPPLY SYSTEM CAPACITY ASSESSMENT

The City of Guelph relies exclusively on groundwater to meet the City's residential and industrial, commercial and institutional (ICI) water demands. The City has utilized groundwater as its primary source of water supply since 1908. The City's groundwater supply system consists of 21 active wells constructed within overburden, shallow and deep bedrock aquifers and one active groundwater collection system (Arkell Infiltration Galleries - Glen Collector). The locations of these groundwater supply locations are shown in
Figure 4-1.

A Technical Memorandum (refer to **Appendix C**) was prepared to provide a detailed assessment of the existing maximum capacity of the existing water supply system, including the following:

- To define the maximum capacity of each individual well and to identify constraints to operating at the maximum;
- To define the sustainable capacity of the existing water supply system (recognizing interference effects amongst the municipal wells); and,
- To consider potential risks to the system operation (e.g., drought, supply sources off-line due to well contamination, etc.) and determine vulnerability in total existing supply capacity from a hydrogeological and operational perspective.

An important reference in this completing this update is the City of Guelph draft Tier Three Water Budget and Risk Assessment (Matrix Solutions Inc., 2013), herein referred to as the 'Tier Three Risk Assessment'. The objective of the Tier Three Risk Assessment is to evaluate the sustainability of the City's groundwater supply system from a quantity perspective, and to identify potential threats to that sustainability. The Tier Three Risk Assessment describes the hydrostratigraphic framework surrounding the City of Guelph; additional details are provided in **Appendix C**.

A brief discussion on the well capacity assessment for each groundwater supply source is provided in the following section organized into the four quadrants of the City: Southeast, Southwest, Northeast and Northwest.

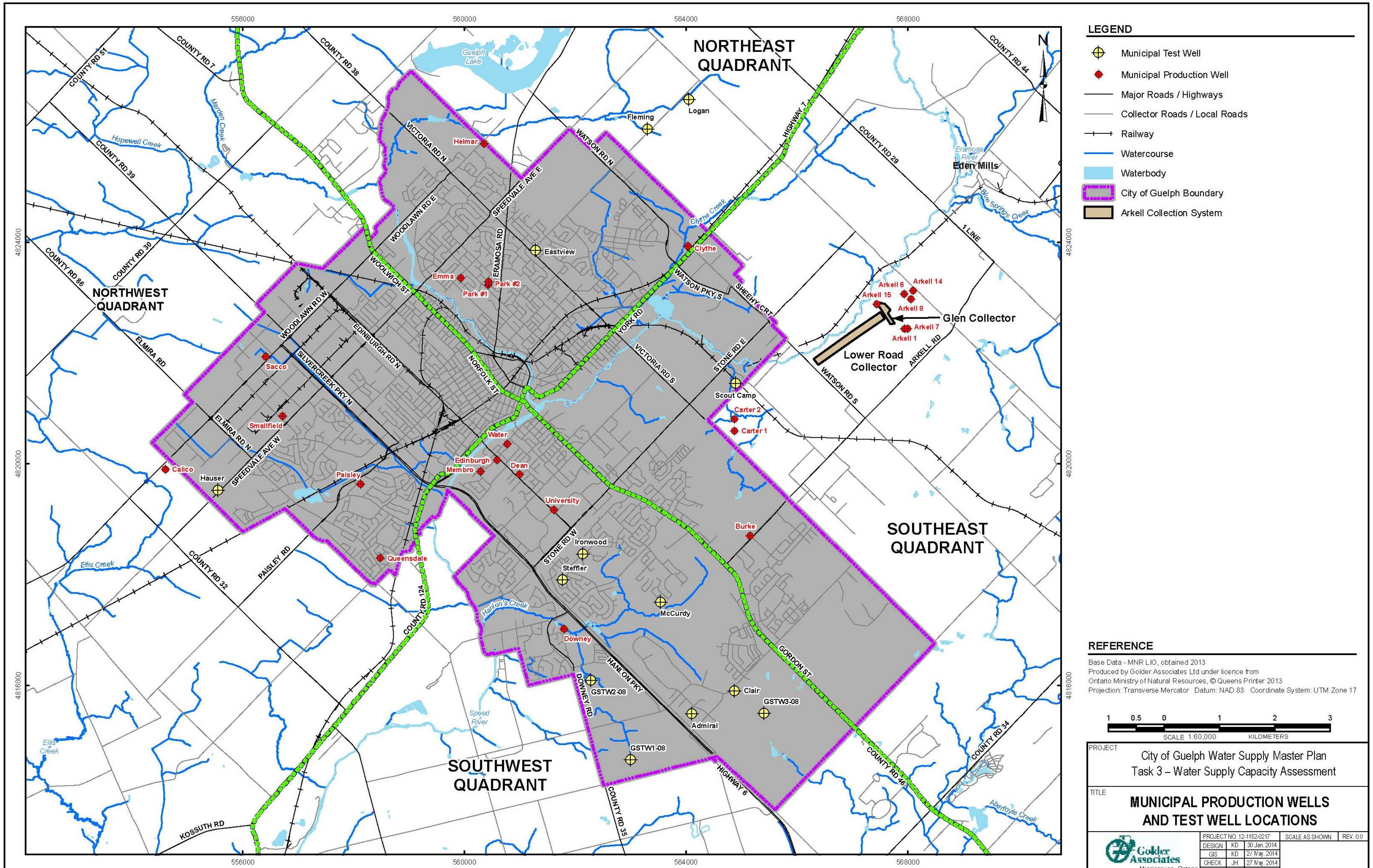


Figure 4-1 Existing Production Well and Test Well Locations

4.1 Assessment of Existing Well Capacities

Historical records (from 1997 through 2013) for each groundwater supply source and quadrant provided the daily pumping total, the monthly average of the daily production total, observed groundwater elevation and the permitted rate and maximum pumping elevations. Based on the review of groundwater pumping rate and groundwater elevation data, the capacity of each municipal groundwater supply source has been re-evaluated relative to the 2007 WSMP. This re-evaluation considered:

- Long term performance history;
- Recently demonstrated specific capacity; and
- Response to previous maintenance efforts.

The total groundwater supply system capacity of the City's groundwater supply system was determined to be 83,836 m^3/day. This represents an increase of 8,836 m^3/day, relative to the available well capacity reported within the 2007 WSMP. The increase reflects additional permitted pumping from the new Arkell pumping wells (Arkell 14 and Arkell 15). It is noted that 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 continued pumping at the Dolime Quarry. Also taken into consideration are other physical constraints which potential limit the long term sustainable pumping rates of these supplies.

A brief discussion on the well capacity assessment for each groundwater supply source is provided below by quadrant. Also included is a discussion on groundwater quality trends at each of the production well locations. Additional details including recommendations for upgrades and operational changes to ensure well capacity values are reported in the Task 3 Technical Memorandum in **Appendix C**.

4.1.1 Southeast Quadrant Capacity Assessment

The Southeast Quadrant (SEQ) provides the bulk of the City's groundwater supply, with high-yield production wells and groundwater collection systems with daily pumped volumes ranging from 20,000 to 40,000 m^3/day. The active productions wells/systems located within the SEQ are as follows:

- Arkell Wells 1, 6, 7, 8, 14, and 15
- Burke Well
- Carter Wells
- Arkell Spring Ground Collection Systems

It is noted that in 2012, the City initiated the Operational Testing Plan (OTP) for the Arkell bedrock production wells. The OTP requires pumping from the Arkell wells, near the permitted rates, over a 36 month period. Due to increased pumping from Arkell, the pumping rates from other quadrants have been reduced since January 2012.

Groundwater quality monitoring data for the SEQ show no significant changes from historical trends. Concentrations of key parameters (i.e., chloride, sodium, iron, manganese and nitrate) have remained consistent or have decreased with time. Since 2004, the concentration of nitrate in groundwater pumped from the Carter wells has gradually decreased from approximately 10 mg/L to less than 8 mg/L. If this trend continues, nitrate concentrations within the groundwater pumped from the Carters will cease to be of concern. These results indicate that volatile organic compounds (VOCs) have only been detected within Arkell 1, decreasing with respect to time to trace concentrations.

4.1.2 Southwest Quadrant Well Capacity Assessment

The following six production wells are located within the City's Southwest Quadrant (SWQ):

- Membro Well
- Dean Well
- Water Street Well
- University Well
- Downey Well
- Edinburgh Well (inactive)

These wells are completed within a highly transmissive zone of the Gasport Formation. Mutual interference is experienced from groundwater pumping amongst these production wells and with the nearby River Valley Developments (RVD) Quarry Site (the Dolime Quarry). The monthly average of the daily Quarry pumping rate, between July 2009 and January 2011, generally ranged from 6,000 to 7,000 m^3/day. Groundwater pumping rates at the Dolime Quarry are known to fluctuate in response to pumping rate changes at the City's production wells. The evaluation of existing SWQ wells' capacities assumes continued operation of the Dolime Quarry at current rates. It is noted that well capacities in this area may be increased at some point in the future, when the Dolime Quarry ceases to operate.

From 2001 through 2010, groundwater pumping from the Southwest Quadrant (SWQ) wells averaged approximately 11,500 m^3/day. Groundwater pumping from the Southwest Quadrant was reduced in 2012 in response to the commencement of the OTP. :

The City initiated a Class Environmental Assessment for optimization and development of new well capacity within the Southwest Quadrant in 2007, following the recommendation from the 2007 WSMP. The Class EA is currently on hold due to on-going litigation regarding the Dolime Quarry's Permit To Take Water.

Groundwater quality monitoring data show increasing concentrations of sodium and chloride within the Southwest Quadrant wells. The concentrations of these constituents are expected to continually increase over the long term. Best management source protection practices should be implemented to stabilize the concentration of these parameters within concentrations below the aesthetic objectives of the Ontario Drinking Water Quality Standards (ODWQS). Other constituents (i.e., iron, nitrate, manganese) are stable and within acceptable concentrations. Low concentrations of VOCs have been reported at Membro, Edinburgh and Water. While the concentrations of these constituents have been decreasing at Water (up to 2006), concentrations at Membro have remained stable with respect to time. The Trichloroethylene (TCE) concentration at Membro has remained consistent at approximately 2.5 μg/L (i.e., half the ODWQS value).

4.1.3 Northeast Quadrant Well Capacity Assessment

The following five production wells are located within the City's Northeast Quadrant (NEQ):

- Park Wells (Park 1 and Park 2)
- Emma Well
- Helmar Well
- Clythe Well (inactive)

These wells are completed within the Gasport Formation. From 2001 through 2013, groundwater pumping from the NEQ wells generally ranged from 6,000 to 9,000 m^3/day.

Groundwater quality monitoring data for NEQ Wells show elevated but stable concentrations of sodium and chloride. Similar to the Southwest Quadrant Wells, best management source protection practices should be undertaken to maintain the concentrations of chloride below the aesthetic objectives of the ODWQS. Occurrences of VOCs have been reported at the Emma and Park wells. At the Park wells, trace detections of VOCs were first encountered in 2012. At the Emma well, VOCs detections have been observed since 2006, with an increasing trend in concentrations between 2006 and 2009 when Emma was being pumped relatively consistently. The concentrations of these constituents have varied with respect to time.

4.1.4 Northwest Quadrant Well Capacity Assessment

The following five production wells are located within the City's Northwest Quadrant (NWQ):

- Paisley Well
- Queensdale Well
- Calico Well
- Smallfield Well (inactive)
- Sacco Well (inactive)

The combined pumping rate from the NWQ wells generally ranged from 2,000 to 4,000 m^3/day between 2003 and 2011. Since 2011, pumping has been reduced in response to the OTP. The active productions wells located within the NWQ are as follows:

Aside from elevated concentrations of iron within pumped groundwater from the Queensdale and Paisley wells, groundwater quality within the Northwest Quadrant wells remain well below Ontario Drinking Water Quality Standards.

4.2 System Capacity during Problematic Operating Conditions

As part of Task 3, the capacity of the Groundwater Supply System has been assessed for problematic operating conditions, such as drought and a potential contamination event. This section discusses the potential system capacity reduction that could be realized under the following problematic operating conditions:

- Drought Conditions
- Contamination Event, or
- Loss of Supply Source

4.2.1 System Capacity During Drought Conditions

As part of the City's Tier Three Risk Assessment (Matrix Solutions Inc., 2013), groundwater modelling analysis was undertaken to assess the capacity of the City's groundwater supply system under a 10-year drought condition and it determined that operation of the groundwater supply system at an average pumping rate of 73,500 m^3/day (to meet the same average demand in non-drought conditions for future conditions) could be sustained through a 10-year drought period. This was accomplished by adjusting some well pump rates higher to compensate for other wells where the aquifer levels dropped. For example, the Tier Three Risk Assessment concluded that drought conditions would significantly affect the operation of groundwater supply wells that predominantly draw from shallow aquifers (i.e., Glen Collector, Arkell 1, Burke, Carter 1, Carter 2) or groundwater supply wells that have limited available drawdown within the deep aquifers (i.e., Emma and Water). It is noted, however, that the Tier Three Assessment does not identify the maximum pumping rates that can be sustained from the deeper (confined wells) on a shorter term basis to meet maximum day requirements (during the drought period).

It is also noted that the Tier Three Risk Assessment included pumping from inactive municipal wells (Clythe, Sacco, Smallfield) as part of the above analysis. Applying the Tier Three Risk Assessment findings to active municipal wells, the sustainable long term average combined pumping rate from the active groundwater supply sources through a 10-year drought period is approximately 68,692 m^3/day. With review of available drawdown under drought conditions, shorter term higher pump rates of approximately 71,128 m^3/day are possible as long as the annual average is maintained at 68,692 m^3/day.

Table 4-1 summarizes the review of the constraints to the sustainable pumping capacity of the existing system as a function of drought conditions to the system from a hydrogeological perspective. As the Tier Three model reflects long term average pumping, it is also prudent to compare this and the estimated short term pumping capacity that can be realized from the existing wells for comparison to the current and future average day demand.

Table 4-1 System Capacity during Drought Conditions

Demand/Capacity	2013	2038
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (MDF of 1.35) (m^3/day)	64,100	94,300
Total Existing System Capacity (m^3/day)	83,836	
10 Year Drought Condition – long term average day (m^3/day)	68,692	
10 Year Drought Condition – short term max day (m^3/day)	71,128	
Surplus/Deficit (m^3/day)	7,028	(23,172)

This analysis suggests that under drought conditions there is a reduction of approximately 15% in available total existing system capacity as compared to non-drought conditions.

4.2.2 System Capacity During Contamination Event or Loss of Supply Source

Contamination events or unexpected loss of a supply source (i.e., long-term maintenance event) is an inherent potential risk. In order to quantify the potential effect of a contamination event or loss of supply source on the City's groundwater supply system, a desktop exercise was undertaken considering four potential scenarios: the loss of the highest-yield supply source within every quadrant where the capacity could not generally be made up by pumping nearby wells.

For these scenarios, groundwater supply wells presumed to be taken off-line are as follows:

Scenario 1: Loss of Burke Well - one of the largest producers in the Southeast Quadrant, with no neighbouring wells to make up the lost supply;

Scenario 2: Loss of Membro Well - the largest producer in the Southwest Quadrant, with limited capacity to recover the lost supply from Water Well;

Scenario 3: Loss of the Park Well - the largest producer in the Northeast Quadrant, with limited capacity to recover the lost supply from Emma Well; and

Scenario 4: Loss of Paisley Well - the largest producer in the Northwest Quadrant, where distance and poor well specific capacity limit any reasonable recovery of lost capacity at Queensdale and Calico Wells.

The results of this desktop exercise are summarized in **Table 4-2**. The minimum capacity of the groundwater supply system remains above 76,000 m^3/day during the loss of any single groundwater supply source. The above evaluation summarizes a review of the constraints to the sustainable pumping capacity of the existing system as a function of potential risks to the system from a hydrogeological perspective as well as an operational perspective. If a well supply source is not available for pumping due to contamination or other issues such as mechanical issues or well/facility failure, there is a resulting overall loss to the total system pumping capacity. The worst case scenario is the loss of the Park wells in the NE Quadrant which results in approximately a 10% reduction in available capacity (7,700 m^3/day). This reduction reflects the constraints related to the ability of the existing facilities to produce water rather than limitations of the aquifer.

Table 4-2 System Capacity during Contamination Event or Loss of Supply Source

Demand/Capacity	2013	2038
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (MDF of 1.35) (m^3/day)	64,100	94,300
Total Existing System Capacity (m^3/day)	83,836	
Total System Capacity with Loss of Supply (m^3/day)	75,800	
Surplus/Deficit (m^3/day)	11,700	(18,500)

The above summary documents the updated estimated total existing water supply system capacity under normal conditions, as well as under drought conditions and with loss of groundwater supply due to contamination or other causes. The results suggest that the total system capacity is vulnerable to a potential reduction in supply of approximately 10 to 15% under either of these risk scenarios. If considered in combination (i.e. occurring concurrently), this would be reduced even further.

Under each of the above conditions, the existing total capacity was compared to the current and projected future demands at a maximum day factor of 1.35 to determine future requirements. As noted, the baseline projection reflects current per capita demands and no future water conservation efforts, and therefore represents a very conservative scenario with respect to future supply requirements. By incorporating a firm capacity approach to reflect the risk assessment undertaken herein, a higher maximum day factor of 1.5 is recommended to incorporate the historical MDF of 1.35 and an added 10 to 15% in determining the total water supply system requirements.

4.3 Inactive Municipal Groundwater Supply Sources

Table 4-3 list the municipal groundwater supply sources currently permitted for operation, however, inactive or off-line since the 1990s due to groundwater quality concerns. These are addressed further in the discussion of water supply alternatives: Offline Municipal Wells.

Table 4-3 Inactive Groundwater Supply Sources

Well Field	Inactive Source Name	Inactive Since	Potential Capacity (m^3/d)	Issues
NEQ	Clythe Well	1997	3,395	Hydrogen sulphide
SWQ	Edinburgh Well	1998	3,000	TCE
NWQ	Sacco Well	Early 1990's	1,150	TCE and PCE
NWQ	Smallfield Well	Mid-1990's	1,408	TCE, other chlorinated organic compounds
SEQ	Lower Road Collector	Disconnected in October 2000	576 to 6,192	Poor condition

4.4 Summary of Existing Well System Capacity Assessment

Based on the record of groundwater quantity and quality monitoring data, the following conclusions and recommendations were developed as the baseline capacity assessment:

1) The total groundwater supply system capacity of the City's groundwater supply system is currently 83,836 m^3/day. This represents an increase of 8,836 m^3/day, relative to the available well capacity reported within the 2007 WSMP. The increase reflects additional permitted pumping from the new Arkell pumping wells (Arkell 14 and Arkell 15).
2) Groundwater quality within the Southeast Quadrant (the largest producing well field) is good, meeting all objectives of the ODWQS (except for manganese at the Burke Well). Nitrate concentrations at the Carter Wells have been steadily decreasing since 2004, indicating improved groundwater quality. Elevated sodium and chloride concentrations are reported in pumped groundwater from groundwater supply sources within the Southwest and Northeast Quadrants. While these concentrations have stabilized in the Northeast Quadrant, a steady increase remains on-going within the Southwest Quadrant. Source protection best management practices should be undertaken to stabilize these water quality trends within the Southwest Quadrant.
3) Capture of impacted groundwater will remain a concern at groundwater supply sources located in proximity to industrial areas (i.e., Park 1, Park 2, Emma, Membro and Water Wells). TCE concentrations at Water and Park Wells are low to trace (i.e., less than 0.5 μg/L) and do not appear to be increasing. At Membro and Emma Wells, however, TCE concentrations generally range from 2 to 3 μg/L. Variability of TCE concentrations at the Emma Well are a concern.
4) Several municipal production wells are cased into the top of bedrock and draw water from shallow and deep groundwater flow systems. Liner installation in key groundwater supply sources (i.e., where the Vinemount aquitard effectively separates the shallow and deep groundwater flow systems) could limit the potential of capturing impacted groundwater from a shallow flow system and possibly improve well performance. It is recognized that liner installations could adversely affect the production capacity of municipal supply wells. It is therefore recommended that performance testing be undertaken to confirm sustainable pumping rates prior to (i.e., packer testing) and following the installation of liners. Liner installations are recommended at six municipal supply well locations (Water, Dean, Downey, Paisley, Queensdale and Calico Wells).
5) At eight groundwater supply locations (Arkell 1, Burke, Water, Dean, University, Helmar, Paisley and Queensdale Wells), the recent (i.e., past eight years) performance history has not demonstrated an obvious capability to sustain the pumping capacity established by the 2007 WSMP. In the past, these wells have responded positively to rehabilitation. It is recommended that performance testing and rehabilitation (if needed) be undertaken to demonstrate that these wells can operate at their assigned capacity. Performance testing should consist of:

- Well step testing to allow for comparison with historical specific capacity results.
- Continuous operation at the assigned well capacity rate (over a period ranging from one week to one month). During the performance testing period, continuous monitoring of the pumping level within the well (and nearby monitoring well if possible) should be undertaken. If a reduction in well specific capacity is noted, consideration should be given to initiation of a well rehabilitation program.

6) As part of the Tier Three Risk Assessment, groundwater modelling has been undertaken to approximate the average sustainable capacity of the groundwater supply system under a 10-year drought condition. The modelling analysis concluded that groundwater pumping can be sustained during the 10-year drought condition if the groundwater supply system pumping rate is reduced to approximately 68,692 m^3/day from active groundwater supply sources. Further analysis of the Tier Three modelling results determined the maximum capacity of the groundwater supply wells on a shorter term basis to meet peaking demands. The maximum daily pumping rate (over the short term, during drought conditions) is estimated to be 71,128 m^3/day.
7) A desktop exercise has been undertaken to estimate the effect of a contamination event (i.e., loss of supply) on the total existing capacity of the groundwater supply system. Four scenarios were considered, where the highest producing source was taken off-line within each quadrant, respectively. In these scenarios, the capacity of the groundwater supply system remained above 76,000 m^3/day (approximately 10% less that the total available capacity).

Table 4-4 is provided as a summary to document the updated estimated total existing water supply system capacity under normal conditions, as well as under drought conditions and with loss of groundwater supply due to contamination or other causes. The results suggest that the total system capacity is vulnerable to a potential reduction in supply of approximately 10 to 15% under either of these risk scenarios. If considered in combination (i.e. occurring concurrently), this would be reduced even further. This provides support for the previous WSMP approach with respect to the design allowance of additional supply capacity for redundancy; for example, setting aside 10% of existing and future capacity. Under each of the above conditions, the existing total capacity was compared to the current and projected future demands at a maximum day factor of 1.35 to determine future requirements. As the baseline projection reflects current per capita demands and no future water conservation efforts, this represents a very conservative scenario with respect to future supply requirements. By incorporating a firm capacity approach to reflect the risk assessment undertaken herein, a higher maximum day factor of 1.5 is recommended to incorporate the historical MDF of 1.35 and an added 10 to 15% in determining the total water supply system requirements.

Table 4-4 Existing Groundwater Supply System Capacity Under Problematic Operating Conditions

Well Field	Well Name	Year Constructed	Permitted Rate (m^3/d)	2007 WSMP Well Capacity (m^3/d)	2014 WSMP Update Well Capacity (m^3/d)	Capacity Under Problematic Operating Conditions					
						Drought Conditions (m^3/d)		Loss of Groundwater Supply Source (m^3/d)			
						Max	Average	Scn. 1 (SE)	Scn. 2 (SW)	Scn. 3 (NE)	Scn. 4 (NW)
SWQ	Arkell 1	1966	3,273	2,000	2,000	1,400	1,400	2,000	2,000	2,000	2,000
	Arkell 6	1963	28,800	6,500	28,800	6,200	5,300	28,800	28,800	28,800	28,800
	Arkell 7	1963		6,500		5,800	5,300				
	Arkell 8	1963		6,500		5,000	4,900				
	Arkell 14	2000		n/a		4,500	4,400				
	Arkell 15	2000		n/a		4,500	4,400				
	Burke	1966	6,546	6,500	6,500	6,300	6,300	0	6,500	6,500	6,500
	Carter 1	1962	7,855	5,500	5,500	4,400	4,400	5,500	5,500	5,500	5,500
	Carter 2	1962									
SEQ	Membro	1953	6,050	6,000	6,000	5,500	4,300	6,000	0	6,000	6,000
	Water Street	1953	3,400	2,700	2,700	2,400	2,400	2,700	2,700	2,700	2,700
	Dean	1958	2,300	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
	University	1965	3,300	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
	Downey	1968	5,237	5,100	5,236	5,236	5,200	5,236	5,236	5,236	5,236
NEQ	Park 1	1937	10,300	8,000	8,000	7,200	6,900	8,000	8,000	0	8,000
	Park 2	1947									
	Emma	1931	3,100	2,800	2,800	2,400	2,400	2,800	2,800	3,100	2,800
	Helmar	1966	3,273	1,500	1,500	1,200	1,200	1,500	1,500	1,500	1,500
NWQ	Paisley	1952	3,200	1,400	1,400	1,000	1,000	1,400	1,400	1,400	0
	Calico	1976	5,237	1,100	1,400	1,100	1,100	1,400	1,400	1,400	1,400
	Queensdale	1970	5,237	2,000	1,100	1,100	2,000	1,100	1,100	1,100	1,100
Arkell Infiltration Galleries - Glen Collector			25,000	6,900	6,900	1,892	1,892	6,900	6,900	6,900	6,900
Total			**122,108**	**75,000**	**83,836**	**71,128**	**68,792**	**77,336**	**77,836**	**76,136**	**82,436**

5 WATER SUPPLY ALTERNATIVES

5.1 Introduction

During early public consultation events of the Water Supply Master Plan (WSMP) Update, the list of potential water supply alternatives from the 2007 WSMP was reviewed and revised to reflect work completed by the City in the interim, as well as new information. The following alternatives were carried forward for reconsideration:

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

A Technical Memorandum (refer to **Appendix D**) was prepared to provide details of the alternatives and the evaluation process.

Through the master plan study completed in 2007, the above 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. 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 fresh public and stakeholder input.

The 2007 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. City Council provided direction in 2003 "That the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth". This direction emphasizes the need for water supply to be sustainable. 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 proposed in the 2007 Plan but was considered to be unsustainable in the local context and City Council removed the pipeline alternative from the Plan. A Great Lakes pipeline alternative is not included in this Water Supply Master Plan Update.

The utmost importance was placed on water conservation and as a result, the City of Guelph has become a renowned leader in water conservation and demand management in Canada. Council has made this a priority by setting a goal "to use less energy and water per capita than any comparable Canadian city" through its 2007 Strategic Plan and Community Energy Initiative. It is the aim of this update to establish success achieved to date, and to determine reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 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, impacts from pumping from aquifers may result in local impacts on the natural environment and also on private and municipal wells in close proximity. 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:

- Completed construction of new well facilities (Arkell 14 and 15) and commencement of the Arkell Adaptive Management Plan and Operational Testing Program;
- Completed Class Environmental Assessment (EA) for the existing Burke Well facility;

- Commenced Class EA for the Guelph Southwest Quadrant Water Supply (on-going) which includes evaluation of existing supplies in that quadrant as well as new test wells; and,
- Completed treatability assessments of municipal wells which were previously taken off line due to water quality issues: Clythe, Smallfield and Sacco Wells.

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, including the Guelph South Groundwater Supply Investigation.

The City also initiated the following regional studies and plans to ensure the protection and long term sustainability of the existing water supply system:

- The Guelph Tier Three Water Budget and Local Area Risk Assessment is being completed to evaluate the sustainability of the City's water supply system from a quantity perspective and to identify potential threats to that sustainability. This study and the Tier Three computer 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 capacity and environmental perspective. (Note: The Tier Three Project is scheduled to be completed in 2014.)
- The Guelph Drinking Water Source Protection Plan was developed within a watershed context to identify and evaluate potential threats to the municipal supply system. The City, through the Lake Erie Source Protection Authority and with other municipalities within the Grand River Watershed, are currently developing policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants.

The objective of the WSMP Update is to continue to ensure that the City can provide an adequate and sustainable supply of water to meet the current and future needs of all customers over the next 25 years. The water supply demand forecast indicates that under a "do nothing" scenario with continued growth, the City would require an additional capacity of 20,000 m^3/day to satisfy maximum day demand including an allowance for security of supply (approximately 10 to 15% of the total system capacity).

Following the direction of the previous WSMP and incorporating the updates from 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.

1. Water conservation and demand management

It is anticipated that water conservation and demand management will continue to form part of the preferred water supply solution in the future. A number of scenarios are developed to consider the potential reductions associated with various combinations of initiatives at increasing cost in order to set a reasonable and publicly supported reduction target. The details of the 2009 Water Conservation and Efficiency Strategy, including the preferred initiatives to be implemented to reach proposed targets will be further developed in the next Water Conservation and Efficiency Strategy (WCES) update planned for late 2014. The water conservation alternative explores the following:

a. Potential of current water conservation programs
b. Potential of new initiatives
c. Centralized re-use opportunities

2. Groundwater sources inside and outside of the City

The groundwater supply alternatives considered in the 2007 WSMP are updated and re-organized to provide clarity between various stages of development of future potential supply sources. The following list represents all opportunities in the order of priority established in the original implementation plan.

a. Optimize existing municipal wells
b. Restore off-line municipal wells
c. Develop municipal test wells
d. Develop new wells inside the City
e. Develop new wells outside the City – a distance of 5 km from the City boundary was applied to meet the desire to maintain local sustainability

A computer-based, three-dimensional groundwater flow model, developed in the Tier Three Project was used to review the total sustainable capacity from a natural environment perspective for all of the above alternatives operating concurrently. However, recognizing that there is no guarantee that all of these possible supplies may be developed, an estimate of additional local groundwater was determined to provide an opinion on the potential available groundwater supply before causing unacceptable stress to local watersheds.

3. Local surface water sources

Local surface water sources 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 extracting additional water during periods of high flows for treatment and storage to be accessed as required by demands in other times of the year. Storage would be accomplished by pumping through wells into the same aquifers that Guelph currently draws its water from – a technology referred to as aquifer storage and recovery (ASR).

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 the Township of Guelph-Eramosa. 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.

4. Limit growth/ 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 growth/Do nothing alternatives.

The following sections provide additional details, discussion on potential impacts, and summary of estimated capital and lifecycle costs for each of the water supply alternatives. Additional details can be found in Technical Memorandum 3 in **Appendix D**.

5.2 Water Conservation and Demand Management/Re-Use

5.2.1 Approach

It is not the intent of this WSMP Update to revisit the program details of the City's Water Conservation and Efficiency Strategy Update (WCESU), but to develop conservation scenarios with varying levels of reduction in demand and corresponding implementation costs for equal comparison to other water supply alternatives. Through the 2007 WSMP, clear direction was provided by Guelph residents regarding the need for aggressive water conservation targets and the City has successfully moved ahead with the

WCESU implementation strategy. The objective of this update is to evaluate conservation scenarios in order to provide feasible recommendations for future programming.

Options for consideration range from 'do nothing', i.e. no future conservation efforts, to a 'soft path' approach which would incorporate a vision such as using the same total volume of water in future that is used today. In reality, while a 'do nothing' scenario would not incorporate further water conservation or demand management programs, natural savings would occur regardless as a function of changes in the 2014 Ontario Building Code which have mandated more efficient plumbing fixtures. Nevertheless, a do nothing water conservation scenario does not fit with Council's direction, in that the availability of local water supplies has a finite value which would result in no growth once this future limit has been reached. Nor would the City achieve its goal to "use less energy and water per capita than any comparable Canadian city".

The 'soft path' approach to water management, developed by the Polis Project for Ecological Governance, represents a fundamental shift from the traditional supply oriented approach (http://poliswaterproject.org/conservation). It recognizes the limitations of water as a resource, and focuses on water conservation and efficiency to ensure long term sustainability. This vision setting approach challenges a community to undertake a number of conservation practices across all sectors to achieve the future water demand target. This water soft path approach was piloted locally and documented in *The Soft Path Strategy for Fergus-Elora* (Maas & Porter-Bopp, 2011) wherein two possible targets were considered with reference to 2008 demands:

- a long term target of "Using the Same Water Tomorrow We Use Today" (i.e. Soft Path Scenario) which would require a reduction in maximum day demand (MDD) of 38% by 2028 and 51% by 2040; and,
- an interim target of avoiding infrastructure expansion which would require a reduction in MDD of 14% by 2028 and 17% by 2040.

The necessary reductions to achieve these targets were reviewed by sector to determine what water practices would be required.

The City of Guelph is known as one of the most proactive communities in Canada with respect to water conservation having implemented a wide variety of water conservation programs across all sectors since 1999. Comparison to similar Canadian cities that participate in the National Water and Wastewater Benchmarking Initiative (NWWBI) indicates that Guelph has already achieved low per capita residential consumption, as shown in **Figure 5-1**. The other communities are not identified here as information provided through the NWWBI is confidential.

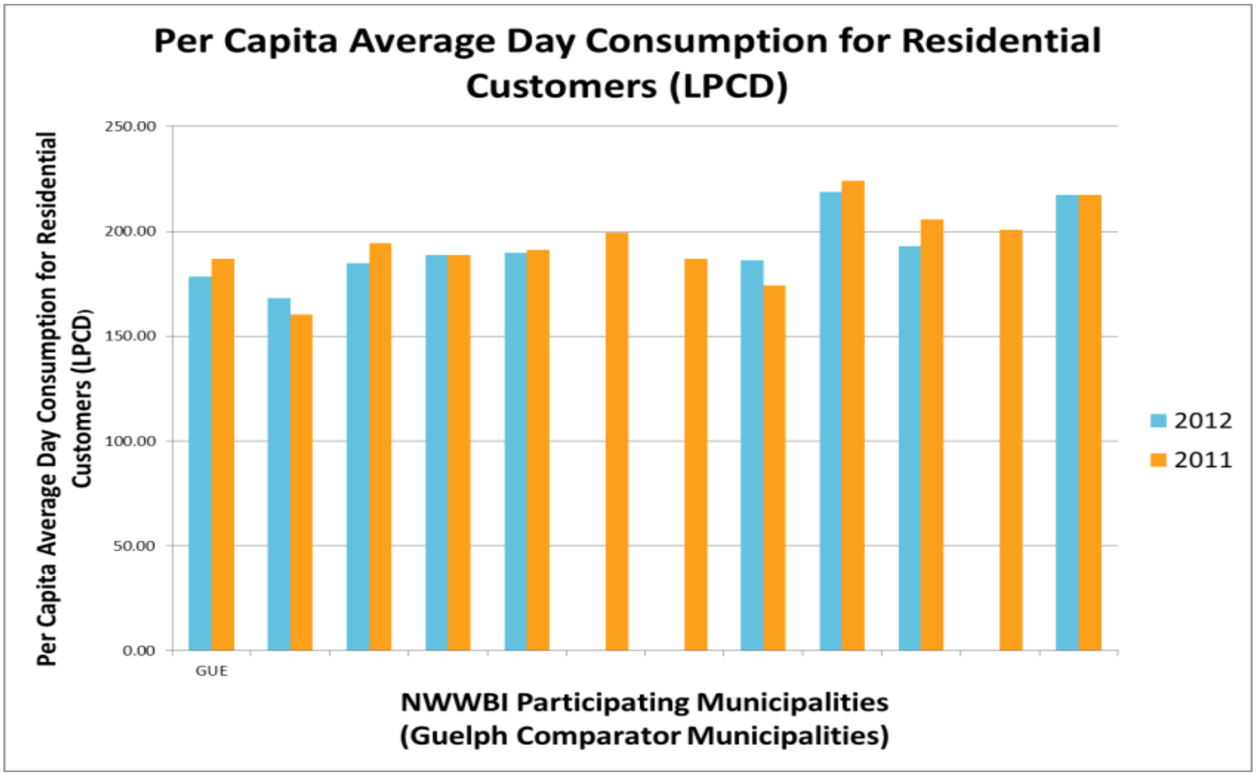


Figure 5-1 Comparison of Residential Per Capita Demand with Comparator Municipalities

Through its programs to date, the City is already well down the road to achieving success. With Council's 2003 mandate to establish a sustainable water supply to regulate future growth, the vision of local sustainability with respect to water supply has long been embraced by its residents. Future studies will establish how much of this local supply is achievable without impacting the natural environment, after which any future development will only be possible by reductions in demand and/or re-use options. These are presented herein for comparison to other supply options.

In the interim, the City continues to implement water conservation programs to reduce demands within a Council approved cost-benefit framework that compares the cost to implement water reduction programs to the cost for developing new municipal water supplies, with consideration for the added benefits of also deferring wastewater treatment infrastructure and incurring energy savings. With reference to the 2013 Water Services Annual and Summary Report (*http://guelph.ca/wp-content/uploads/Annual-Summary-Water-Services-Report-2013.pdf*), as of December 31, 2013, annual average day water production has decreased by 7,009 m^3/day (14 %) since 2006, with an estimated direct savings of 5,914 m^3/day attributed to community participation in the City's water conservation programs. However, similar to the increase in cost of water supply options which incorporate higher treatment systems, with decreasing demands it becomes more difficult and more costly to continue to effectively reduce demands further.

In investigating future reduction scenarios and their associated costs, the City's water conservation staff reviewed the maximum potential of current programs, as well as potential for future additional programs. Five scenarios were developed as follows, which consist of a combination of the programs listed in **Table 5-1**:

- Scenario 1 - Current WCESU Approved Programming, with implementation by 2025

- Scenario 2 - All Alternatives
- Scenario 3 - All Alternatives minus Pressure Management
- Scenario 4 - All Alternatives minus Pressure Management and Rate Reform
- Scenario 5 - All Alternatives minus Pressure Management, Rate Reform and potential Local Improvement Charges (LIC) Funded Programs

Table 5-1 Water Conservation Scenarios

Program Alternatives	Sector	Scenario				
		1	2	3	4	5
Current Retrofits Incentive Program Model - Single Family Toilets	RES	x	x	x	x	x
Current Retrofits Incentive Program Model - Multi Family Toilets	RES	x	x	x	x	x
Current Retrofits Incentive Program Model - Clothes Washers	RES	x	x	x	x	x
New Retrofit Incentive Program - Hot Water Recirculation	RES		x	x	x	x
New Retrofit Incentive Program - Water Softener	RES		x	x	x	x
New Retrofit Wholesale Program Model- Multi-res Toilets	RES		x	x	x	x
New Retrofit Wholesale Program Model- Multi-res Toilet Flapper	RES		x	x	x	x
New Retrofit LIC Program Model - Toilets	RES		x	x	x	
New Retrofit LIC Program Model - Hot Water Recirculation	RES		x	x	x	
New Retrofit LIC Program Model - Water Softener	RES		x	x	x	
Water Conservation Rates - Planning Rate Increase Response Guelph 2014 LRFP	RES	x				
Water Conservation Rates - Increasing Block Rate Implementation	RES		x	x		
Building Code Improvements	RES	x	x	x	x	x
Active Water Loss Management - DMAs	NRW	x	x	x	x	x
Advanced Water Loss Management - Pressure Management	NRW		x			
ICI Audits and Capital Retrofit Incentives	ICI	x	x	x	x	x
ICI Peak Demand Management - Cooling Tower/Chiller Retrofit Incentives	ICI		x	x	x	x
Home Audit and Retrofit Program	RES		x	x	x	x
Private Side Leak Reduction: Res Sector AMI Implementation	RES		x	x	x	x
Blue Built Home - New Home Water Efficiency Certification	RES	x	x	x	x	x

Notes:
RES – Residential
ICI – Industrial, Commercial and Institutional
DMA – District Metering Areas
NRW – Non-Revenue Water
AMI – Advanced Metering Infrastructure

It is noted that the first Scenario represents the continuation of the current Water Conservation and Efficiency Strategy until program implementation is in alignment with the term of the strategy and saturation of some program offerings, including the following:

- Current retrofit programs - residential toilets and clothes washers, ICI audits and capital incentives
- Blue Built Homes – New Home Water Efficiency Certification

- Active Water Loss Management – continuation of the District Metering Areas (DMAs) to monitor and address identified distribution system leaks
- Demand Elasticity – natural customer demand response to water rate increases
- Building Code improvements

Scenario 2 includes conservation and demand reduction strategies effectively implemented in North American communities currently which have been deemed to be applicable to the City of Guelph. In addition to the programs which make up Scenario 1, these also include the following:

- New Retrofit Incentive Program - hot water recirculation; water softeners,
- New Retrofit Wholesale Program Model- multi-res toilets and toilet flapper
- New Retrofit LIC Program Model – toilets; hot water recirculation; water softeners
- Water Conservation Rates - Increasing Block Rate Implementation
- Advanced Water Loss Management - Pressure Management
- ICI Peak Demand Management - Cooling Tower/Chiller Efficiency Retrofit Incentives
- Private Side Leak Reduction: Residential Sector AMI Implementation

Scenarios 3, 4 and 5 consist of versions of Scenario 2 without programs that have uncertain confidence of success for various reasons:

- Pressure Management – the uncertainty of implementing pressure management in Guelph's open pressure distribution system is complicated by multiple well supplies requiring unimpeded transmission is incorporated into the above assumptions and reflected in high costs to implement with minimal success.
- Rate Reform – while this would seem to be a reliable demand management program at minimal cost to implement, local community and political support would need to be attained.
- Local Improvement Charges (LIC) Funded Programs – programs subject to legal review of eligibility of water efficiency based retrofits following recent changes to the scope of Local Improvement Charges under the Municipal Act.

As indicated above, the development of scenarios based on a number of possible initiatives was completed solely for the purpose of evaluating the cost and feasibility of various target reductions. The actual programs would be established through the Water Conservation and Efficiency Strategy update, and may consider additional demand substitution opportunities not included here such as decentralized re-use/rainwater capture systems and bulk water treatment/ distribution systems. Centralized re-use options are discussed further in the following section.

The predicted reductions in demands for the initiatives included in each Scenario over the period of this study update include the following assumptions derived from a number of sources including the following:

- Alliance for Water Efficiency Calculator - 2012 City of Guelph Model
- Region of Waterloo Draft Water Efficiency Master Plan (2014)
- UBrock/Econnics Demand Preliminary Demand Elasticity Study (2013)
- AECOM Impact of Price Analysis Technical Memorandum (2014) Appendix B
- 2014 Ontario Building Code
- District Metering Areas Standard and City-wide Program Justification Technical Memorandum (C3 Water Inc., 2014) – Appendix D

A summary of potential savings for each scenario is indicated in **Table 5-2**.

Table 5-2 Summary of Potential Savings for Each Scenario

Scenario	Total Potential Savings* (m^3/day)	Implementation Period	Direct Program Costs	Total O&M Costs	Total Program Cost for Period	Capital Cost per m^3/day	LCC - Cost per m^3 avoided
Scenario 1	5,556	2014 to 2025	$5,685,930	$10,217,564	$15,903,494	$1,023	$0.65
Scenario 2	9,842	2014 to 2038	$43,767,600	$23,880,972	$67,648,572	$4,447	$0.75
Scenario 3	9,690	2014 to 2038	$24,597,600	$23,880,972	$48,478,572	$2,539	$0.55
Scenario 4	8,448	2014 to 2038	$23,097,600	$23,880,972	$46,978,572	$2,734	$0.61
Scenario 5	7,419	2014 to 2038	$22,553,100	$23,880,972	$46,434,072	$3,040	$0.69
* Reduction in Average Day Demand							

The above water conservation 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. Further iterations of these scenarios were developed during the financial evaluation discussed in **Section 8.**

It is also worth noting that there are additional financial benefits associated with reduced demand that are not included in the above analysis, such as the costs savings related to reduced wastewater treatment.

5.2.2 Centralized Re-Use Alternatives

The above scenarios do not include any programs related to Wastewater Reuse and Reclamation. Although pilot studies have been implemented for individual systems for grey water within the City, it is generally accepted that significant reductions from reclaim and re-use options will only be achieved through centralized facilities. The City of Guelph undertook a Residential Greywater Re-use Field Test in 2009 to assess the feasibility of large scale adoption of home-based greywater reuse technologies. This project provided significant insight into the challenges and opportunities associated with residential water reuse practices, including greywater reuse. More information on this study is available at http://guelph.ca/wp-content/uploads/GreywaterFieldTestReport.pdf.

Wastewater reclamation involves the treatment or processing of wastewater to make it suitable for reuse, with water reuse being the beneficial use of the treated water. Water reclamation and re-use has great potential to be an effective, efficient, sustainable way to meet water demands. While separate from water conservation, re-use/reclamation alternatives could be reviewed and implemented under the purview of the Water Conservation initiative through implementation or enforcement in new developments.

There are two options for centralized re-use or reclaimed water:
- Treatment to non-potable standards for landscaping irrigation and other non-potable uses through a dual plumbing system,
- Treatment to potable standards for use in the existing distribution system

Each of these options has considerable challenges. Reclaimed water is wastewater (sewage) that is treated to the required quality dictated by the end use. Potable treatment requirements are considerably more than non-potable, and are also typically more advanced than typical surface water treatment requirements. Non-potable treatment requirements are less extensive although still require high standards with respect to safety as the water may still come into public contact. However, the non-

potable option requires an independent recycled water system which conveys the treated non-potable water to end-uses such as irrigation or industrial cooling. In the City's Water and Wastewater System Optimization Master Plan, recommendations included installation of a 'purple pipe' for this application to be installed during upgrades to the York Trunk sewer and Wellington watermain installation. However, through the Class EA completed for this project, Council did not approve installation or a future easement allowance for the purple pipe due to current uncertainties with respect to future regulatory requirements and capital costs of this current unfunded/ un-established City utility. The rationale for not implementing this project at this time can be found in the York Trunk Sewer & Paisley Feedermain Municipal Class EA Tech Memo: Effluent Re-use System "Purple Pipe System" (Genivar, 2012).

Typically, communities that have implemented recycled water have more limited access to fresh water supplies. In the U.S. California and Florida have progressive reclaimed water programs for non-potable uses such as landscape irrigation with extensive recycle water systems. Using reclaimed water for non-potable uses reduces the demand for potable water. The cost of reclaimed water is typically higher than the cost to treat potable water; however, as fresh water supplies become limited, the cost ratios will change accordingly.

There is debate about possible health and environmental effects of reclaimed water use including pathogens. In general, treatment of reclaimed water to drinking water standards uses technologies such as reverse osmosis to ensure that pathogens, pharmaceutical chemicals and other trace chemicals (that would pass through standard treatment and filtering processes) are removed. Drinking water standards that were developed for natural ground water and surface water are not sufficient for identifying contaminants commonly present in reclaimed water.

As world populations require both more clean water and better ways to dispose of wastewater, it is anticipated that the demand for water reclamation will increase. Future success in water reuse will depend on whether this can be done without adverse effects on human health and the environment. Leading countries in the field of reclaimed water or non-potable use currently include Israel, Japan, Australia, U.S., Spain, and the United Kingdom. There are fewer countries providing potable water from reclaimed water; one example includes Singapore which has implemented reverse osmosis systems to produce potable 'NEWater' from reclaimed water; another example is South Korea. The ability to readily dispose of the treatment residuals (e.g. reverse osmosis concentrate or brine) to oceans, which can be 50% of the raw influent flow, provides a significant advantage from a cost perspective.

It is generally understood that to move these options forward, the regulatory framework must provide direction, and there must be increased public confidence in water reuse. For water reuse to grow as a feasible water supply option, a number of technical, environmental, and socioeconomic issues need to be addressed. These include:

- Integrating reuse into water resource planning and projections
- Determining the effects of water reuse on water quality
- Determining the effects on public and environmental health
- Improving public perception and gaining public acceptance
- Development of appropriate standards
- Economic feasibility of water reuse
- Justifying the intensive energy consumed to treat

The actual cost of a reclaim facility varies depending on the system-specific characteristics and configuration. As current potable water systems are based on servicing strategies for distribution systems that were often implemented decades ago, the cost of delivering reclaimed non-potable water supplies

often results in water that at least as expensive to provide as potable water alternatives, if not more. If reclaimed water rates are designed to provide full cost recovery then the average unit cost for reclaimed water will usually be higher than that of comparable potable water supply; however, the public typically views reclaimed it has having lower value, providing little incentive for reclaim water use. Therefore, it can be a challenge for effluent reclaim/reuse to find an end user (e.g. irrigation), preferable with a year-round need.

Generally, due to the considerable challenges associated with the centralized re-use alternatives, these options are not implemented where there are alternative sources of fresh water as the costs are prohibitive. However, as increasingly advanced treatment is required for wastewater to meet discharge requirements in future, these alternatives become more attractive. In addition, it is expected that this eventuality will correspond to decreasing availability of local groundwater and surface water. While not considered as part of the conservation option in the 25 year study period, opportunities to incorporate reuse into future developments (e.g. purple pipe; dual plumbing systems) should be reviewed with a long term view to ensure its feasibility. It is recommended that this be considered when reviewing future expansion and treatment upgrades at the wastewater treatment facility.

5.2.3 Water Conservation Summary

The impact of applying the range of proposed conservation scenarios to the predicted water demand over the 25 Master Plan update study period is demonstrated by applying the estimated reductions associated with Scenarios 1 (status quo) and 2 (high) to the average total demand in year 2038. This results in a change in the rate of change over time, which is duplicated when multiplied by the maximum day factor of 1.5.

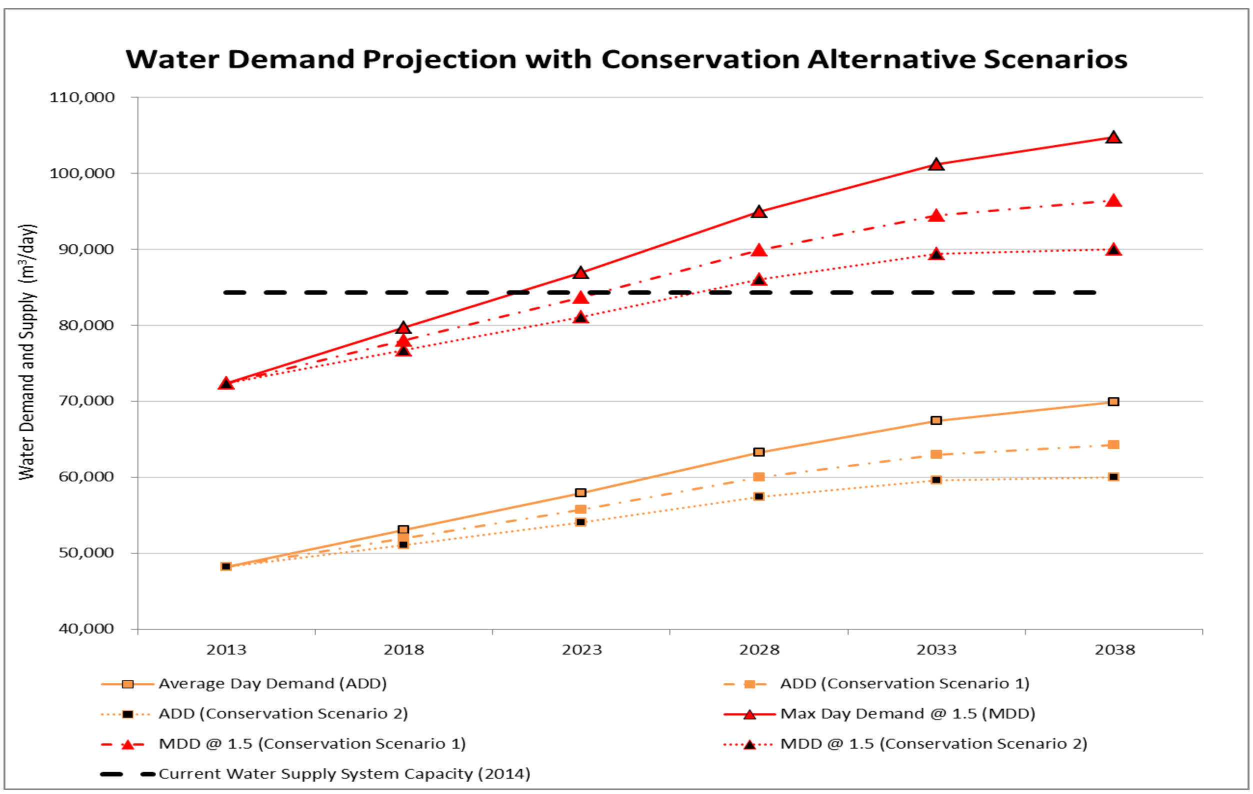


Figure 5-2 Water Demand Projection with Conservation Alternative Scenarios

In **Figure 5-2**, it is observed that the range in scenarios depicted provides a significant reduction in the future supply requirements. It is also of note that the costs presented on a per capacity basis only reference the average day demand reductions associated with each scenario. When compared to the water supply alternatives, this is not presenting an equal assessment.

5.3 Expand Existing Groundwater Supply System

The approach undertaken in investigating opportunities for optimizing existing wells and developing new groundwater sources followed the direction provided through the consultation process in the 2007 WSMP. Public response indicated that the City should consider groundwater opportunities within the City boundaries prior to exploring outside the City. This direction was reflected in the prioritization given to projects in the 2007 WSMP implementation plan. In updating the review of groundwater alternatives, this is factored into the approach. As noted in the 2007 WSMP, the development of new water supply sources in the Townships would require the concurrence of the Townships and the County of Wellington.

Furthermore, with use of the updated Tier Three model, the feasibility of higher pumping within the City is studied with respect to impacts on other supplies as well as potential environmental effects. The Tier Three Water Budget and Local Area Risk Assessment Study are referenced when seeking additional sources outside the City with consideration for available takings, and also known and anticipated impacts on the watersheds in close proximity. In general, although the Tier Three project is not yet completed, model-predicted impacts were found to be moderate for the south branch of Blue Springs Creek, Chilligo/Ellis Creek, and Hanlon Creek. Therefore, for the purposes of this WSMP Update, future groundwater supply sources investigated herein focussed on catchment areas along the Speed River and Mill Creek.

The Tier Three Assessment groundwater flow model is applicable to studying potential impacts from long-term average pumping to determine sustainable system pumping rates. Fluctuations in the pumping rate to meet minimum to maximum day demands are incorporated in these average rates. This translates to the required permitted capacity of any individual supply being rated at a capacity that meets the maximum day demand, and similarly, associated treatment and disinfection facilities must also be rated at the higher rate, recognizing that this will not be its average operating condition. The general approach in establishing water supply requirements is to assume that each facility must be able to pump at maximum day demand requirements. However, operational strategies could be developed to pump combinations of wells at higher rates on a continuous basis and others to meet peaking requirements in order to mitigate any potential environmental impacts.

Each quadrant of the City has been studied extensively, with the City undertaking monitoring and exploration programs in support of the existing operating wells and in reviewing feasibility of possible future sources. Of note is that the possible supply sources outside of the City boundaries considered in this WSMP update are limited to approximately 5 km from the City's limits. This parameter was initially determined with consideration to limiting impacts on surrounding municipalities, as well as the practicality of connecting to the existing water distribution system. However, if insufficient supply was available to satisfied projected 25 year demands, this distance would be revisited. The study period of the 2007 WSMP was 50 years and therefore, assessment of potential areas of new water supply extended beyond this perimeter.

A general summary of existing and potential new water supplies within each quadrant is provided below:

Southwest Quadrant (SWQ)

Following the recommendation in the 2007 WSMP, the City initiated a Class Environmental Assessment (EA) study to optimize existing and to develop new water supplies in the SWQ. This quadrant consists of the following existing operational wells: Downey, Membro, Water St., Dean and University Wells. It also includes the Edinburgh Well which was taken off-line due to water quality issues, and the Admiral Well which was initially developed for industrial use but not brought on line due to natural water quality issues. Through the Class EA study, two large diameter test wells (named 'Ironwood' and 'Steffler') were installed and tested over an extended period to determine potential capacity and to monitor the effects on other municipal and private wells, and surface water. Preliminary findings suggest that when the SWQ is considered as a whole, i.e. one wellfield, an additional taking of 4,500 m^3/day can be achieved. This volume is in addition to that established as a maximum day sustainable pump rate for the SWQ of 17,800 m^3/day.

Therefore, a total objective for additional water supply from the SWQ of 4,500 m^3/day is available whether through one or two new municipal wells alone, or through a combination of new wells plus optimizing existing including reactivating existing wells off-line requiring treatment. This is explored further in the alternatives discussion and evaluation.

There are no new water supplies recommended outside the City boundary in the SWQ area as part of this update.

Lastly it is prudent to reference the influence of the Dolime quarry dewatering operation on aquifer elevations. During the 25 year timeframe of this WSMP update, review of the available capacities in existing and proposed new wells in the SWQ assume continued operation of the quarry. If the dewatering rate at the quarry increases above the current average, there will be less water available for the SWQ municipal wells. It is acknowledged that once the quarry dewatering ceases, this will require re-evaluation, and therefore, alternatives which would exceed what is currently considered available additional capacity (4,500 m^3/day) may remain for future consideration.

Southeast Quadrant (SEQ)

The SEQ consists primarily of the Arkell wellfield which includes Arkell 1, 6, 7, 8, 14 and 15 Wells, as well as the Glen Collector System, and the Carter Wells. The City is currently demonstrating the sustainability of operating the Arkell bedrock wellfield with extensive monitoring for three years through an Operational Testing Program; results to date have confirmed the existing capacity of the Arkell bedrock wellfield of 28,800 m^3/day and indicate no measureable impacts on the Blue Springs Creek watershed. A possible new source in the Arkell area is to reinstate the Lower Road Collection system which was taken off line due to regulated water quality concerns. It is anticipated that, although work is required to repair and construct the collector infrastructure, it would be acceptable to direct this water along with other wells and the Glen Collector to the aqueduct for Ultra Violet (UV) disinfection at the Woods Pumping Station. A preliminary review of the Woods UV system indicates sufficient capacity excluding extreme peaks in flows from the collectors.

Also included in the SEQ is the Burke Well which has recently been reviewed through a Class EA study. Treatment is proposed for removal of iron and manganese at this facility, as well as optimization of pumping through coordination of the well pump and highlift pumping.

The City also completed a Class EA study in 1994 investigating a new well supply near the Barber Scout Camp on Stone Road (‘Scout Camp’ Well) which was found to have naturally poor water quality. This alternative is considered further in the following sections.

Lastly, new potential water supply outside the City was reviewed using the Tier Three model. The hydrogeological conditions in the general area of Victoria Road and Maltby suggest the possibility of a well with capacity of 4,000 to 6,000 m^3/day in this area, with consideration to preventing potential impacts to Mill Creek.

Northeast Quadrant (NEQ)

Existing operating wells in the NEQ include the Park and Emma Wells, and the Helmar Well. The Clythe Well is a municipal supply that was taken offline due to natural water quality issues. A Class EA is currently underway which will consider treatment options for reconnecting this well to the distribution system.

The City has previously installed and tested wells in the area of Eastview Road and Watson Road, referred to as ‘Logan’ and ‘Fleming’, located outside the City in the Township of Guelph-Eramosa. The results suggest a possible new municipal supply in this area of 4,500 to 6,100 m^3/day.

No additional supplies outside the City are considered in the NEQ as part of this update.

Northwest Quadrant (NWQ)

Existing operational wells in the NWQ include the Paisley, Calico and Queensdale Wells. The City also has a test well referred to as the Hauser well with a proposed taking of 900 m^3/day, which was included as a source to meet a future model run to 2031. The Tier Three report suggested that the Ellis Creek Watershed may be under moderate stress, and therefore any new potential takings in the NWQ beyond the wells previously mentioned should to be located preferentially to avoid potential impacts to Ellis Creek. In modeling work completed by Golder, a possible new well source was located closer to the Speed River at Sunny Acres Park where it was determined that an estimated 1,500 m^3/day may be available.

Two municipal groundwater supply sources (Sacco and Smallfield Wells) are currently permitted for operation, however, remain inactive and off-line since the mid-1990s due to groundwater quality concerns. Smallfield Well groundwater consistently contained Trichloroethylene (TCE) concentrations that exceeded the Ontario Drinking Water Quality Standards (ODWQS) maximum acceptable concentration (MAC) of 5 µg/L. Sacco groundwater quality comprised of detectable levels of both TCE and Tetrachloroethylene (PCE), but consistently below the ODWQS MAC. The potential well capacities for Smallfield and Sacco Wells are 1,408 and 1,150 m^3/day respectively as concluded in the rehabilitation and performance assessment in 2008.

Beyond the City boundary, a potential new supply was considered in the general area of Conservation Road west of Highway 6. Through Tier Three modeling, a long term average pumping rate of 4,600 m^3/day could be supported which suggests the possibility of a well with a maximum day capacity of 6,200 m^3/day. It is anticipated that a well in this area would have good water quality.

After reviewing existing and future well supplies on a quadrant basis and understanding operational and environmental constraints (refer to **Section** 4 for existing groundwater sources details), the potential groundwater opportunities for expansion of the existing supply system are grouped into the following alternatives following the prioritization approach of the 2007 WSMP:

- Optimize existing operating municipal wells
- Restoration of existing off-line municipal wells
- Develop existing municipal test wells
- Install new wells inside City boundaries
- Install new wells outside City boundaries
- Install new ASR wells inside City to optimize excess Arkell Collector system volumes

These are discussed in the following sections. Non-municipal groundwater supply sources are also mentioned for completeness as these represent potential future opportunities.

5.3.1 Non-Municipal Groundwater Supply Sources

A summary of non-municipal wells inside the City and in close proximity to the City is documented in Technical Memorandum 2 (refer to **Appendix C**), as their current operation impacts the available capacity of municipal wells (Golder Associates, 2014). Furthermore, should any of these wells be discontinued in future, this could present an opportunity to the City to either incorporate the well into the municipal system, or optimize existing municipal wells to increase production accordingly. Similarly, should any of these wells increase production; this could have a negative impact on the total municipal wells' capacity.

This opportunity is maintained for future consideration but is not included as an alternative under consideration in this WSMP update.

5.3.2 Optimize Existing Operating Municipal Wells

An extensive assessment of existing municipal production wells (shown in **Table 4-4**), was undertaken to determine sustainable concurrent water takings from all supplies, and to identify wells where upgrades and/or modifications to the well itself or the well system could be considered to improve the well performance, water quality and general security of the source. These findings are documented in Technical Memo 2 (refer to **Appendix C**) (Golder Associates, 2014). These takings are compared to previous testing results and to the assessment completed in the 2007 WSMP. In general, the overall total capacity is comparable to earlier estimates, with the new Arkell wells 14 and 15 (brought online in 2012) increasing the current available total system capacity.

An operations workshop was held with City Waterworks staff to explore potential constraints within existing facilities that could impede possible expansion or increase to the current capacity. Also discussed were operational challenges which could result in operating the well facility at a lesser capacity than possible. For example, this could include optimizing a well with a highlift pump operation such that capacity is not 'lost' due to operational limits. Another example is declining well performance over time which would suggest more frequent rehabilitation to ensure sustained ongoing capacity. A summary of the recommendations to optimize and maintain the existing wells' capacity is provided in **Table 5-3**.

Table 5-3 Summary of Recommendations to Optimize and Maintain Capacity at Existing Operating Wells

Quadrant	Existing Municipal Well Supply Facility	Max Pumping Capacity (m^3/d)	Recommendations from Water Services*
SE	Arkell 1	2,000	• Consider rehabilitation of the well as part of regular maintenance activities; Undertake performance testing after rehabilitation • Re-work discharge piping to not feed through Well 7 piping • New pump • Upgrade piping
SE	Arkell 6 Arkell 7 Arkell 8 Arkell 14 Arkell 15	28,800	• Pumps for Arkell 6, 7, and 8 need replacement • Consider rehabilitation of the well as part of regular maintenance activities • Valve and piping replacement • Start online monitoring for nitrate
SE	Burke	6,546	• Consider rehabilitation of the well as part of regular maintenance activities • Undertake performance testing after rehabilitation • Slated for New Treatment Plant, pressure performance test included in project • Needs to be programmed to operate off Clair Tower
SE	Carter 1 Carter 2	5,500	• Operate in conjunction with Arkell Wells • Consider online nitrate monitoring • Upgrade pipe and valves • New pumps and motors • Upgrade discharge piping
SW	Membro	6,000	• Replace pump and motor with VFD slave/operate high lift to well • Improvements to contact chamber or install UV system • Optimize well pump with highlift pumps to maximize total capacity • Upgrade valves and piping • Add treatment if required – consider UV/AOP at each well site or common treatment site in SWQ
SW	Water St	2,700	• Consider installation of a liner; • Performance testing following liner installation to confirm capacity • Install new pump and motor • Operate more consistently • Will be more utilized with proposed Wellington to Clair transmission main • Add treatment if required – consider UV/AOP at each well site or common treatment site in SWQ
SW	Dean	1,500	• Consider installation of a liner; Performance testing pre and post liner installation • Complete facility upgrade required • Add treatment if required – consider UV/AOP at each well site or common treatment site in SWQ
SW	University	2,500	• Consider rehabilitation of the well as part of regular maintenance activities; Performance testing following

Quadrant	Existing Municipal Well Supply Facility	Max Pumping Capacity (m^3/d)	Recommendations from Water Services*
			rehabilitation • New pump • Upgrade valve and piping
SW	Downey	6,000	• Replace and lower pump • Operate from Clair Tower • Replace valves and piping in time • Possible increase in PTTW to 6000 m^3/day is under review in SWQ Water Supply Class EA
NE	Park 1 Park 2	8,000	• Consider purchasing nearby property • Operate into Pressure Zone 2 and Zone 1 • Replace well pumps • Add more pumps for Zone 2
NE	Emma	3,100	• Performance testing while Park wells are operating at maximum capacity • Consider operating into Zone 2 • Replace pump • Consider common treatment (UV/AOP) at Park
NE	Helmar	1,200	• Add treatment for H_2S, and iron removal (not sequestration) • Undertake regular rehabilitation; Performance testing following rehabilitation • New pump/motor • Operate from Speedvale Tank • Residuals disposal/pump to sewer
NW	Paisley	1,400	• Consider rehabilitation of the well as part of regular maintenance activities; Performance testing following rehabilitation • Add new valving and piping • Pipe to cell 1 & 2 • Upgrade MCC at booster station (longer term need) • Iron treatment
NW	Queensdale	1,100	• Consider rehabilitation of the well as part of regular maintenance activities; Performance testing following rehabilitation • Add new valving, pump, piping, etc. • Possible expansion of property • Rework booster pump to coincide with well pump • Iron treatment necessary with residual disposal
NW	Calico	1,400	• Performance testing • New pump • Upgrade building foundation • Operate from Speedvale Tank • Upgrade access
Upgrades to well infrastructure are subject to budget approvals and maintenance priorities			

In general, ‘optimizing’ existing wells require a review of operational and maintenance activities for the current facilities to ensure that the potential hydrogeological capacity can be achieved as required to meet peak demands.

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 6,000 m^3/day. Based on preliminary outputs from the SWQ Water Supply Class EA Study, an estimated additional total capacity of 4,500 m^3/day is available from the SWQ without resulting in potential significant environmental effects. An increase to the PTTW at the Downey Well to pump more could form part of the preferred solution; however, this option would need to be combined with other SWQ options to achieve the potential available capacity of 4,500 m^3/day. If not included in the preferred short term solution, a future increase of the Downey well should be included in the consideration of future potential for the SWQ once the Dolime quarry dewatering operation ceases.

5.3.3 Restoration of Existing Off-line Municipal Wells

This alternative includes wells which have existing Permits to Take Water (PTTW) but the City has discontinued use due to concerns over existing issues with water quality, either elevated at present or a noted increasing trend. In general, these wells require upgrades for water quality treatment and to provide the required disinfection contact time. Most of these facilities will require completion of Class Environmental Assessment (EA) studies to establish recommended treatment systems. The locations of these wells are shown in
Figure 4-1. The potential for future operation of these wells is discussed below.

Southwest Quadrant

Edinburgh Well

The Edinburgh Well was drilled in 1953 and is located on the southeast corner of Water Street and Edinburgh Road. This well has been out of service since the early 1990's due to TCE detections within the pumped groundwater and interference with the Membro and Water Wells. Edinburgh Well is not currently equipped with a pump; however, it is permitted for operation at a maximum pumping rate of 3,000 m^3/day.

Admiral Well

The Admiral Well was drilled in 1999 and is located next to Sleeman Breweries Ltd. (Sleeman), off of Admiral Place. The capacity of Admiral Well is low, approximately 432 m^3/day. The City was permitted for non-municipal groundwater supply pumping from the Admiral Well with the intent to service Sleeman but the permit was recently changed to include municipal water supply. However, Admiral Well remains inactive due to elevated concentrations of sulphate in the pumped groundwater.

Similar to discussion regarding the Downey Well, based on preliminary outputs from the SWQ Water Supply Class EA Study, an estimated additional total capacity of 4,500 m^3/day is available from the SWQ without resulting in potential significant environmental effects. Providing treatment and well facilities at Edinburgh and/or Admiral Wells could form part of the preferred solution but would not meet the potential capacity as stand-alone options. If through the SWQ Water Supply Class EA, the preferred short term solution is to provide all of the additional capacity in a new supply facility, future upgrades to the Edinburgh and/or Admiral Wells should be included in the consideration of future potential for the SWQ once the Dolime quarry dewatering operation ceases.

Southeast Quadrant

Lower Collector

The Lower Road Collection System extends along the lower slope of the Eramosa Valley wall, eastwards from Watson Road to the northern extent of the Glen Collector System in the Arkell Spring Grounds. It is comprised of 30 manholes and 26 collection galleries. Groundwater taking from the Lower Road collector is permitted by the Arkell Spring Grounds collector system PTTW. Due to the poor condition of the connections to the Lower Road Aqueduct and an elevated bacterial content from this collector system, the Lower Road Collector System was disconnected in October 2000. It does not currently provide water to the municipal distribution system.

Northeast Quadrant

Clythe Well

The Clythe Well was constructed in 1976 and is located adjacent to Clythe Creek, near the intersection of Highway 7 and Watson Road. The well is listed on the City's consolidated Certificate of Approval (CCOA) and the well is currently permitted for pumping up to 5,237 m^3/day. This well has been out of service for the last ten years due to poor natural water quality (hydrogen sulfide) and potential well interference issues. The concentration of hydrogen sulfide ranged from 0.1 to 0.31 mg/L and consistently exceeded the Ontario Drinking Water Quality Standard (ODWQS) Aesthetic Objective (AO) of 0.05 mg/L.

Northwest Quadrant

Sacco Well

The Sacco Well was drilled in 1952 and is permitted to pump at a rate of 1,633 m^3/day. Sacco groundwater quality is comprised of detectable levels of TCE, consistently ranging between 0.3 and 0.5 µg/L. Low level concentrations of PCE and 1,1-dichloroethylene were also detected in Sacco water quality samples. This well was removed from service in 1991 due to low level concentrations of TCE. Recent testing of the well water quality indicated low levels of volatile organic compounds but at concentrations that were less than the ODWQS Maximum Acceptable Concentration (MAC).

Smallfield Well

The Smallfield Well was drilled in 1966 and was brought into service in 1970. The well was removed from service in 1994 due to rising concentrations of TCE. Smallfield Well groundwater consistently contained TCE concentrations that exceeded the ODWQS MAC of 5 µg/L. In addition to TCE, other volatile organic compounds were detected in a recent pumping test. The concentration of chloride was also elevated during the pumping test. Based on the rehabilitation and performance assessment conducted in 2008, this well has a potential pumping capacity of 1,408 m^3/day.

Restoration of Existing Off-line Municipal Wells Summary

The total increase in potential quantity available from these wells ranges from 8,000 to14,000 m^3/d. **Table 5-4** summarizes the capital cost estimates for preliminary investigations, and design, land acquisition where required, construction of new wells and treatment systems, and approvals.

Table 5-4 Cost Estimate to Restore Existing Off-line Municipal Wells

Item ID	Item Description	Clythe	Smallfield	Sacco	Edinburgh	Lower Road Collector	Admiral
	Potential Capacity (m^3/d)	**3,395**	**1,408**	**1,150**	**3,000**	**2,000**	**500**
1	Preliminary Studies and Approvals	$200,000	$250,000	$300,000	$215,000	$200,000	$250,000
2	Land Acquisition	$300,000	$0	$300,000	$300,000	$0	$100,000
3	Well House/Collector Upgrades	$1,554,000	$1,347,500	$1,243,000	$2,392,500	$4,989,600	$841,500
4	Connection to Existing System	$0	$150,000	$150,000	$200,000	$500,000	$150,000
5	Disinfection System	$55,000	$75,000	$75,000	$55,000	$0	$60,000
6	Water Treatment System	$877,800	$550,000	$500,000	$582,000	$0	$460,000
	Subtotal	**$2,986,800**	**$2,372,500**	**$2,568,000**	**$3,744,500**	**$5,689,600**	**$1,861,500**
	Contractor Overhead (10%)	$298,680	$237,250	$256,800	$374,450	$568,960	$186,150
	Estimating Contingency (30%)	$896,040	$711,750	$770,400	$1,123,350	$1,706,880	$558,450
	Total	**$4,181,520**	**$3,321,500**	**$3,595,200**	**$5,242,300**	**$7,965,440**	**$2,606,100**
	Engineering and Construction Services (15%)	$627,228	$498,225	$539,280	$786,345	$1,194,816	$390,915
	Grand Total	**$4,809,000**	**$3,820,000**	**$4,135,000**	**$6,029,000**	**$9,161,000**	**$2,998,000**
	Cost per m^3/d	$1,416	$2,713	$3,595	$2,010	$4,580	$5,994

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 requirements. Test wells/observation wells for which modeling has indicated potential capacities are shown in
Figure 4-1. It is noted that these wells are in areas both within and outside the City's boundary. Fleming and Logan test wells are located immediately east of the City on Eastview Road in Guelph-Eramosa Township. Due to the information available from previous studies including pumping tests and water quality testing, there is more certainty regarding these alternatives in regards to location, potential yields and treatment requirements. The City can move more readily to the next steps including Class EA and treatability studies, should these be part of the recommended solution.

The municipal test wells being considered as feasible alternatives for future water supply include the following:

Southwest Quadrant

Steffler
Constructed in May 2008, the Steffler Well is capable of sustaining a pumping rate of 3,600 m^3/day (based on a 32-day constant rate test).

Ironwood
Constructed in June 2008, the Ironwood Well has demonstrated a capacity of greater than 8,000 m^3/day (based on a 32-day constant rate test).

The Ironwood well is carried forward in costing and for evaluation assuming the total pump capacity as shown, recognizing that only an additional total of 4,500 m^3/day can be provided from the SWQ wells. Therefore, the additional capacity in the Ironwood well would contribute to system redundancy.

Southeast Quadrant

Scout Camp

The Scout Camp Well was constructed in 1987 with a rated pumping capacity of 5,789 m^3/day. It was approved under the Municipal Class Environmental Approval process in 1994 but doesn't have a PTTW. The main concern regarding the operation of Scout Camp is the presence of elevated hydrogen sulfide within the pumped groundwater.

Northeast Quadrant

Fleming

The Fleming test well is located on the north side of Eastview Road, approximately 1 km east of Watson Road. Drilled in 1966, Fleming well could yield a pumping rate ranging from 1,700 to 2,200 m^3/day. Fleming was converted to a municipal monitoring well in 2008.

Logan

The Logan test well is located on the south side of Eastview road approximately 1.5 km east of Watson Road. Constructed in 1966, Logan well could yield more than 5,000 m^3/day.

Northwest Quadrant

Hauser

The Hauser Well was originally drilled in 1966 and has the potential yield of 916 m^3/day or less. Hauser test well is now converted into a municipal monitoring well.

Field investigations are required to determine if further pumping in close proximity to the Hauser well is sustainable as the Tier Three Assessment indicated the possibility of the Upper Chilligo/Ellis Creek being moderately stressed during pumping of existing groundwater supply wells.

Develop Existing Municipal Test Well Summary

The total increase in a potential quantity available from these wells is from 14,800 m^3/d (includes only 4,500 m^3/d from SWQ wells).

Table 5-5 summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells and treatment systems, and approvals.

Table 5-5 Cost Estimate to Develop Existing Municipal Test Wells

Item ID	Item Description	NEQ Fleming/Logan	SEQ Scout Camp	SWQ Steffler	SWQ Ironwood	NWQ Hauser
	Potential Capacity (m^3/d)	**4,714**	**5,789**	**3,600**	**8,000**	**900**
1	Preliminary Studies and Approvals	$380,000	$230,000	$70,000	$75,000	$240,000
2	Land Acquisition	$50,000	$0	$0	$0	$300,000
3	Site Works	$655,740	$700,000	$261,600	$343,000	$570,000
4	Concrete	$465,000	$100,000	$465,000	$465,000	$220,000
5	Masonry, Metal, Wood, etc.	$143,250	$60,000	$143,250	$143,250	$75,250
6	Finishes	$58,300	$75,000	$58,300	$58,300	$75,000
7	Equipment	$88,100	$100,000	$83,100	$107,600	$43,800
8	Mechanical	$215,000	$200,000	$209,500	$215,000	$180,000
9	Instrumentation & Electrical	$457,380	$450,000	$327,800	$457,380	$210,400
10	Connection to Existing System	$230,000	$350,000	$181,000	$390,000	$212,500
11	Water Treatment System	$0	$600,000	$0	$0	$0
12	Disinfection Systems	$198,000	$55,000	$220,000	$251,900	$165,000
	Subtotal	**$2,940,770**	**$2,920,000**	**$2,019,550**	**$2,506,430**	**$2,291,950**
	Contractor Overhead (10%)	$294,077	$292,000	$201,955	$250,643	$229,195
	Estimating Contingency (30%)	$882,231	$876,000	$605,865	$751,929	$687,585
	Total	**$4,117,078**	**$4,088,000**	**$2,827,370**	**$3,509,002**	**$3,208,730**
	Engineering and Construction Services (15%)	$617,562	$613,200	$424,106	$526,350	$481,310
	Grand Total	**$4,735,000**	**$4,702,000**	**$3,252,000**	**$4,036,000**	**$3,691,000**
	Cost per m^3/d	**$1,004**	**$812**	**$903**	**$504**	**$4,100**

5.3.5 Develop New Wells Inside Existing City Boundary

Using the Tier Three groundwater flow model, Golder completed modelling analyses to identify new potential groundwater supply source locations within the City. This modelling analysis followed on the conclusions of the Tier Three Water Budget and Risk Assessment, which recognized:

- A future average day groundwater pumping rate of 73,450 m^3/day from the existing groundwater supply system (including three wells that are currently inactive: Sacco, Smallfield and Clythe Wells). This value was derived from previous studies.
- Potential stresses that may be realized on surface water catchment areas located within the City, in response to groundwater supply pumping at the 2031 average rate of 73,450 m^3/day.

A preliminary conclusion of the Southwest Quadrant Groundwater Supply Class EA is that an additional 4,500 m^3/day can be pumped from existing groundwater supply test wells (i.e., Ironwood and Steffler Wells) while not adversely impacting surface flow conditions within Hanlon Creek and its associated

wetland. This conclusion presumes on-going pumping from the Guelph Dolime Quarry in the order of 5,000 to 7,000 m^3/day.

Due to interference effects amongst existing groundwater supply sources as well as new proposed supply sources (off-line wells and test wells), Golder has indicated that additional new supplies within the remainder of the City are limited. For example, less than 10 metres of further groundwater level drawdown is available within the Gasport Formation in the northeast end of the City. In the northwest portion of the City, potential concerns are related to lower aquifer hydraulic conductivity and further stress of the Chilligo/Ellis Creek catchment area.

Recognizing the constraints listed above, only one new well inside the City is proposed located in or near Sunny Acres Park, located along Edinburgh Road approximately 600 metres north of the Speed River. The rationale for this location is its proximity to an area with high transmissivity within the Gasport aquifer. Due to the limited available drawdown at this location (approximately 7 m), the estimated capacity of a well in this area ranges from 1,000 m^3/day on an average basis to 1,500 m^3/day to meet maximum day demands. Analytical data from monitoring wells in this area indicate good water quality. However, given the proximity to the wells south of the Speed River which have had water quality samples containing TCE, there is the possibility that water in this area may be impacted by the same source of contamination. In developing this alternative it is assumed that treatment for TCE may be a requirement.

Develop New Wells Inside Existing City Boundary Summary

The total capacity available from this well is assumed to be 1,500 m^3/d. The cost estimate for capital works for preliminary investigations, and design, land acquisition, construction of a new well and treatment system, and approvals is provided in **Table 5-6**.

Table 5-6 Cost Estimate to Install New Wells Inside City Boundary

Item ID	Item Description	Sunny Acre Well
	Potential Capacity (m^3/d)	**1,500**
1	Preliminary Studies and Approvals	$300,000
2	Land Acquisition	$300,000
3	Site Works	$570,000
4	Concrete	$220,000
5	Masonry, Metal, Wood, etc.	$75,250
6	Finishes	$75,000
7	Equipment	$43,800
8	Mechanical	$180,000
9	Instrumentation & Electrical	$215,400
10	Connection to Existing System	$204,000
11	Water Treatment System	$460,000
12	Disinfection Systems	$165,000
	Subtotal	**$2,808,450**
	Contractor Overhead (10%)	$280,450
	Estimating Contingency (30%)	$842,535
	Total	**$3,931,830**
	Engineering and Construction Services (15%)	$589,775
	Grand Total	**$4,522,000**
	Cost per m^3/d	**$3,015**

5.3.6 Install New Wells Outside City Boundaries

Similar to the evaluation of wells inside the City, Golder used the Tier Three groundwater flow model to complete modeling runs incorporating assumptions regarding potential areas of new water supply outside the City. For the purposes of evaluating cumulative environmental impacts from pumping, these scenarios included a future average daily pumping rate of 73,450 m^3/day, as discussed above. Areas with potential for future groundwater supply sources were selected based on optimal hydrogeological characteristics (high aquifer transmissivity and available drawdown) and conclusions stemming from the Tier Three Risk Assessment.

The Tier Three Risk Assessment concluded that the South Branch of Blue Springs Creek could be moderately stressed when operating at the average rate of 73,450 m^3/day although this conclusion was associated with a high level of model uncertainty and was contradicted by extensive monitoring data. No further groundwater development is recommended within this catchment area, until further field studies (as recommended by the Tier Three Risk Assessment) have concluded that new additional groundwater supply can be sustained. Similar to Blue Springs Creek, Irish Creek and Hanlon Creek could be moderately stressed if additional groundwater supply development (beyond the additional proposed capacity within the City's Southwest Quadrant Class EA) is realized.

Groundwater supply modelling analysis (outside the City) has therefore been focused for this WSMP Update within Mill Creek (southeast of the City), Marsden Creek (north of the City) and Speed River (northeast of city) catchment areas. Groundwater modelling analysis concluded that additional groundwater supply (ranging from 3,500 to 5,000 m^3/day) can potentially be established within each of these respective areas, without significantly changing base flow rates encountered at the nearby watercourses.

Two areas were evaluated including Guelph South (Victoria Road and Maltby Road) and Guelph North (Conservation Road):

Guelph South - Victoria Rd & Maltby Rd

Golder modelled groundwater pumping from a general test well area, located southeast of the City (east of Victoria Road, on Maltby Road) within the Mill Creek catchment area. The rationale for this location is its proximity to an area with high transmissivity within the Gasport aquifer and limited local groundwater usage (i.e., nearby golf course well operating at 7.6 L/s seasonally). The estimated available capacity of a modelled groundwater supply well in this general area is 3,900 m^3/day on an average basis; and 5,300 m^3/day to meet maximum day demands. Baseline reduction to surface water features is predominantly limited to Mill Creek. Good quality water is expected from this well which will only require disinfection.

Guelph North – Conservation Rd. W.

One model scenario considered groundwater pumping from a location north of the City (the western limit of Conservation Road). The rationale for this location is its proximity to an area with high transmissivity within the Gasport aquifer and limited local groundwater usage (i.e., three Guelph-Eramosa Township community wells with a combined permitted rate of 2,022 m^3/day). The estimated available capacity of a well in this area is 4,600 m^3/day on an average basis; and 6,200 m^3/day to meet maximum day demands. Baseline reduction to surface water features is predominantly limited to the Middle Speed River catchment. Good quality water is expected from this well which will only require disinfection.

Install New Wells Outside City Boundaries Summary

The total increase in a potential quantity available from these wells is 11,500 m^3/d.

Table 5-7 summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells and treatment systems, and approvals.

Table 5-7 Cost Estimate for Guelph South well and Guelph North well

Item ID	Item Description	Guelph South	Guelph North
	Potential Capacity (m^3/d)	**5,281**	**6,291**
1	Preliminary Studies and Approvals	$380,000	$380,000
2	Land Acquisition	$200,000	$200,000
3	Site Works	$643,000	$653,000
4	Concrete	$465,000	$465,000
5	Masonry, Metal, Wood, etc.	$143,250	$143,250
6	Finishes	$58,300	$58,300
7	Equipment	$88,100	$88,100
8	Mechanical	$215,000	$215,000
9	Instrumentation & Electrical	$457,380	$457,000
10	Connection to Existing System	$350,000	$350,000
11	Water Treatment System	$0	$0
12	Disinfection Systems	$220,000	$275,000
	Subtotal	**$3,220,030**	**$3,284,650**
	Contractor Overhead (10%)	$322,003	$328,465
	Estimating Contingency (30%)	$966,009	$985,395
	Total	**$4,508,042**	**$4,598,510**
	Engineering and Construction Services (15%)	$676,206	$689,777
	Grand Total	**$5,185,000**	**$5,289,000**
	Cost per m^3/day	**$982**	**$841**

5.3.7 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 spring which do not correspond to a period of corresponding demand. As a result, this water is either not made available to the distribution system and these flows cannot be considered as part of the maximum daily supply capacity. While the historical flow ranges from each of these collector systems has been documented, information was not made available on reliability of achieving target flow for any specified time. For the purposes of reviewing feasibility of an alternative that captures some of the excess flow available from these collector systems, it was assumed that an excess of 10,000 m^3/day would be available continuously for a period of 4 months (March to May). It is also assumed that the Lower Road Collector system is repaired and placed back online and the costs associated with that alternative are not included here.

The advantage of this alternative is that a surface water treatment plant would not be required as it would be if water was taken directly from the Eramosa River. The additional seasonal volumes from the collector systems would be discharged to the aqueduct to combine with other Arkell wellfield supplies for disinfection at the Woods PS through the UV system as they are currently. However, rather than shutting off the other Arkell wells while these high seasonal volumes are available, all will continue to be pumped and subsequently stored to recover as required to meet demands. A preliminary check on UV capacity indicates sufficient design capacity to accommodate these additional flows, but this would require verification. The additional volume would be pumped into the distribution system and obtained similar to a large customer demand at two ASR wells for injection and storage in the aquifer. It is anticipated that the ASR wells would be located in the area of the Park and Emma wells where the high transmissivity would allow for optimization. It is assumed that two wells would be required, each capable of injection at 5,000 m^3/day. Based on the above assumption of 10,000 m^3/day over a four month period, this results in a potential supply capable of 3,300 m^3/day.

Upon review, it seems contradictory that one would continue to pump from the deep Arkell wells during high collector flows, only to inject this water into the aquifer to recovery later; however, this approach reflects the current limitation of the current PTTWs. Should a change in the permitting system occur to allow for optimization on an annual water balance basis this ASR alternative would not be required; i.e. allow for increased pumping of water when required to balance water not pumped when not required (and hence already “stored” in the aquifer).

For more discussion on ASR as an option, refer to **Section 5.4.3.1** as part of the surface water and ASR alternative.

<u>Arkell Collector System ASR Wells Summary</u>

The total increase in a potential quantity available from these wells is 3,300 m^3/d. The cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells and disinfection systems, and approvals is summarized in **Table 5-8**.

Table 5-8 Cost Estimate to Install New Arkell Collector System ASR Wells

Item ID	Item Description	Arkell Collector System ASR Wells
	Potential Capacity (m^3/d)	**3,300**
1	Preliminary Studies and Approvals	$1,200,000
2	Land Acquisition/Easement	$100,000
3	ASR Well Construction (drilling and well house and appurtenances)	$4,111,000
4	Connect to Distribution System	$150,000
	Subtotal	**$5,561,000**
	Contractor Overhead (10%)	$556,100
	Estimating Contingency (30%)	$1,668,300
	Total	**$7,785,400**
	Engineering and Construction Services (15%)	$1,167,810
	Grand Total	**$8,954,000**
	Cost per m^3/d	**$2,713**

5.3.8 Groundwater Alternatives Summary

An estimated level of confidence was applied to each of the groundwater alternatives to reflect uncertainty with respect to available information regarding capacity and water quality, as well as other factors such as public acceptance and potential constraints due to its location outside the City boundary. The resulting totals of each are shown in **Figure 5-3**, indicating the ability of the groundwater alternatives to provide required water supply capacity to meet projected demand with and without conservation.

It is recognized that there are limitations on the amount of groundwater that can be pumped from the identified study area (i.e. within 5 km of the City's boundaries) without causing significant environmental effects. Golder completed an analysis utilizing the Tier Three model which suggests that the maximum groundwater supply within 5 km of the City limits represents a total average pumping rate of approximately 95,000 to 105,000 m^3/day, based on causing no greater than 10% and 20% reductions in non-stressed watershed base flows respectively. Assuming a total of 95,000 m^3/day is achievable on an average day basis, and allowing for somewhat higher peak pumping to accommodate maximum day demands of up to 15 to 20%, this provides a total water supply capacity of not more than 109,000 to 114,000 m^3/day. It can be seen from **Figure 5-3** that the total groundwater supply included in the alternatives in this update is within this maximum sustainable range, which suggests there may be no further opportunities without considering groundwater supplies further afield.

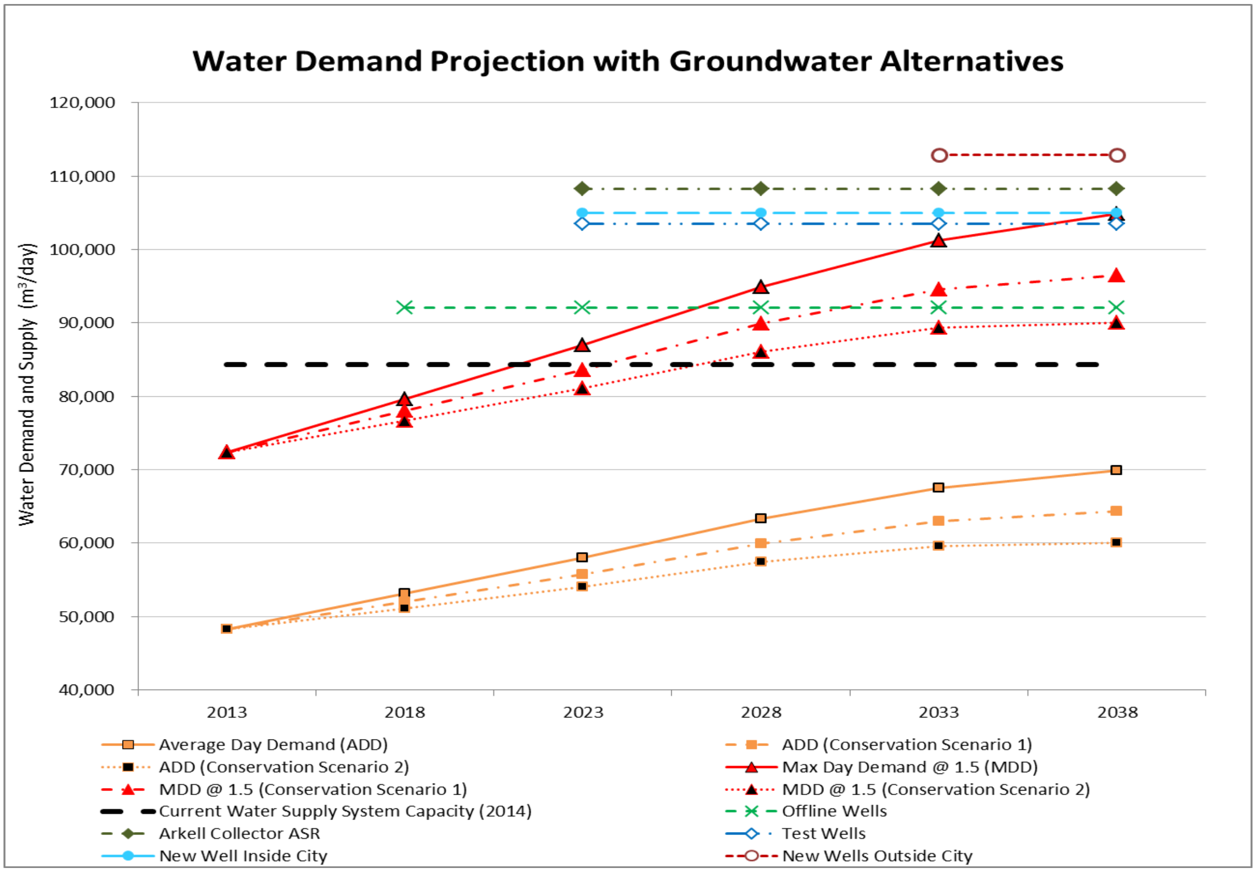


Figure 5-3 Water Demand Projection with Groundwater Alternatives

5.4 Establish New Local Surface Water Supply

During the completion of the 2007 WSMP, 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. Two possible local surface waters for assessment of volume available for taking water on a continuous or seasonal basis include the Speed River (at Guelph Lake) and the Eramosa River.

To contribute to the available supply capacity, surface water must either be treated to provide a continuous flow into the distribution system, or alternatively, volumes of water can be taken from the surface water when available, treated and stored underground in naturally occurring aquifers. This option is referred to as an aquifer storage 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.

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 (ODWQS). 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 flows.

To evaluate potential quantity available through this alternative, the Grand River Conservation Authority (GRCA) was contacted for their expert opinion on this managed watershed. Two possible sources and locations were investigated for water takings:

- Guelph Lake - downstream of the dam
- Eramosa River - at Arkell

The GRCA undertook an evaluation at both locations to determine the water volumes available throughout the year, utilizing historical flow information and modeling tools. The results of this evaluation are documented in **Appendix D**. Through this evaluation, a base level water taking was established which would be available year-round, while maintaining minimum river flows in the rivers and minimizing potential environmental impacts of reducing total river flows. The GRCA also reviewed historical records to establish 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 water treatment plant, such that it would be operating at three capacity levels each for a minimum period in any given year.

The following summarizes work conducted by the GRCA in aid of evaluating local surface water takings for the purpose of providing additional potable water supply to the City of Guelph. The original analysis completed for the 2007 WSMP was based on the 1951 to 2004 period of record; the updated analysis extends this period to the end of 2012. Following this is a discussion of how these are applied to the surface water treatment with and without ASR.

5.4.1 Guelph Lake Reservoir Yield Analysis

For the Guelph Lake analysis, based on preliminary analysis of reliability of river flow based on historical flow monitoring data provided by the GRCA, 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 assumed.

The stream inflow which is the supply to Guelph dam is not constant. It varies within the year and across years. Based on the taking scenario described above, a chart of the daily inflow probability into Guelph Dam for the 1950 to 2012 period was constructed which was used to determine which periods of the year were most likely to yield potential for taking 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 by **Figure 5-4** 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.

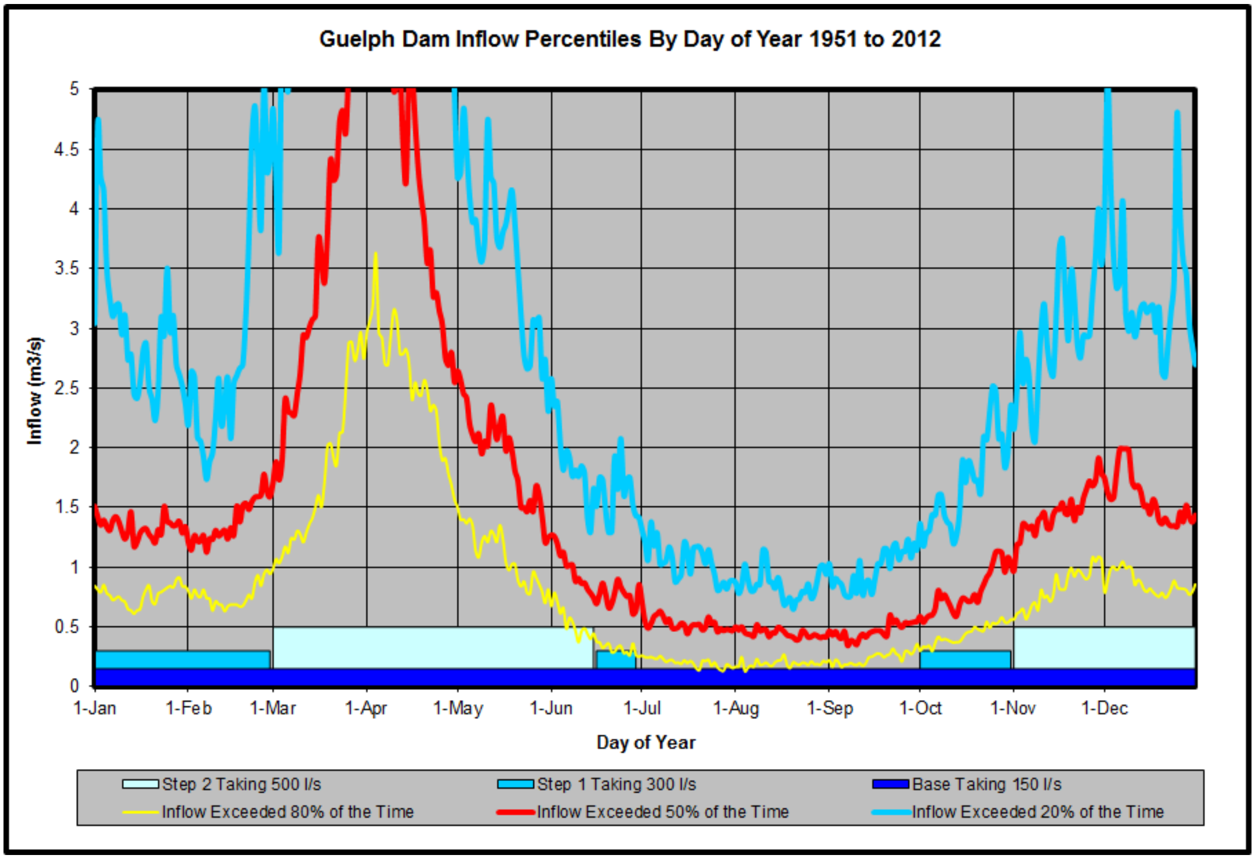


Figure 5-4 Step Takings Compared to River Flows

Based on the above, the reliability of stepped taking was modelled. The reservoir yield modeling assumed the Eramosa River taking at Arkell was maximized and that downstream low flow targets upstream of the Guelph sewage treatment plant were achieved 100% of the time. The results provided the reliability of ASR takings which closely follows the inflow reliability. Based on this analysis, and the reliability based on time, the step to 500 L/s was dismissed. It is not deemed practical to build a WTP plant for the incremental step to 500 L/s for months for which the reliability is high for possibly three months. Furthermore, through discussions regarding the hydrogeological conditions which govern the number of ASR wells required, this flow cannot be injected in a reasonable number of 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), and is summarized in **Table 5-9**.

Table 5-9 Calculation of Guelph Lake annual volume (for ASR)

Month	Days	Water Takings (L/s)		Volume from Guelph Reservoir			Estimated Demand* (m^3/month)	Flow minus Demand (m^3/mo)	Volume to ASR (m^3/mo)	Volume from ASR (m^3/mo)
		150	300	Total Volume (m^3/mo)	Base Volume (m^3/mo)	Vol > base (m^3/mo)				
		excess:	150							
Jan	31	401,760	401,760	803,520	401,760	401,760	596,916	206,604	206,604	
Feb	28	362,880	362,880	725,760	362,880	362,880	539,150	186,610	186,610	
Mar	31	401,760	401,760	803,520	401,760	401,760	667,142	136,378	136,378	
Apr	30	388,800	388,800	777,600	388,800	388,800	679,601	97,999	97,999	
May	31	401,760	401,760	803,520	401,760	401,760	702,254	101,266	101,266	
June	30	388,800	388,800	777,600	388,800	388,800	747,561	30,039	30,039	
July	31	401,760		401,760	401,760	0	842,705	-440,945		440,945
Aug	31	401,760		401,760	401,760	0	842,705	-440,945		440,945
Sept	30	388,800		388,800	388,800	0	747,561	-358,761		358,761
Oct	31	401,760	401,760	803,520	401,760	401,760	702,254	101,266	101,266	
Nov	30	388,800	388,800	777,600	388,800	388,800	611,641	165,959	165,959	
Dec	31	401,760	401,760	803,520	401,760	401,760	596,916	206,604	206,604	
Total	**365**	**4,730,400**	**3,538,080**	**8,268,480**	**4,730,400**	**3,538,080**	**8,276,409**	**-7,929**	**1,232,723**	**1,240,652**
Daily pump rate to distribution (m^3/day)				**22,653**	**12,960**	**9,693**	**22,675**	**-22**		
* assumed annual demand pattern to reflect seasonal fluctuations										

5.4.2 Eramosa River Yield Analysis

The permitted taking associated with the current Eramosa River PTTW (PTTW No. 6145-7L6LDC) water varies throughout the period of April 15 till November 15. GRCA completed the update to the reliability of takings based on the previous PTTW; whereas the new permit allows takings over the same period at approximately 50% higher rates subject to maintaining a minimum downstream flow in the Eramosa River and a minimum flow at the Speed River at the Guelph WWTP discharge location. It was assumed that the ASR taking would be confined to periods when stream flow exceeded the mean annual flow of 2.48 m^3/s after allowing for the prior PTTW which is indicated in the following figure. The reliability of the assumed ASR taking as determined by GRCA is summarized in **Figure 5-5**.

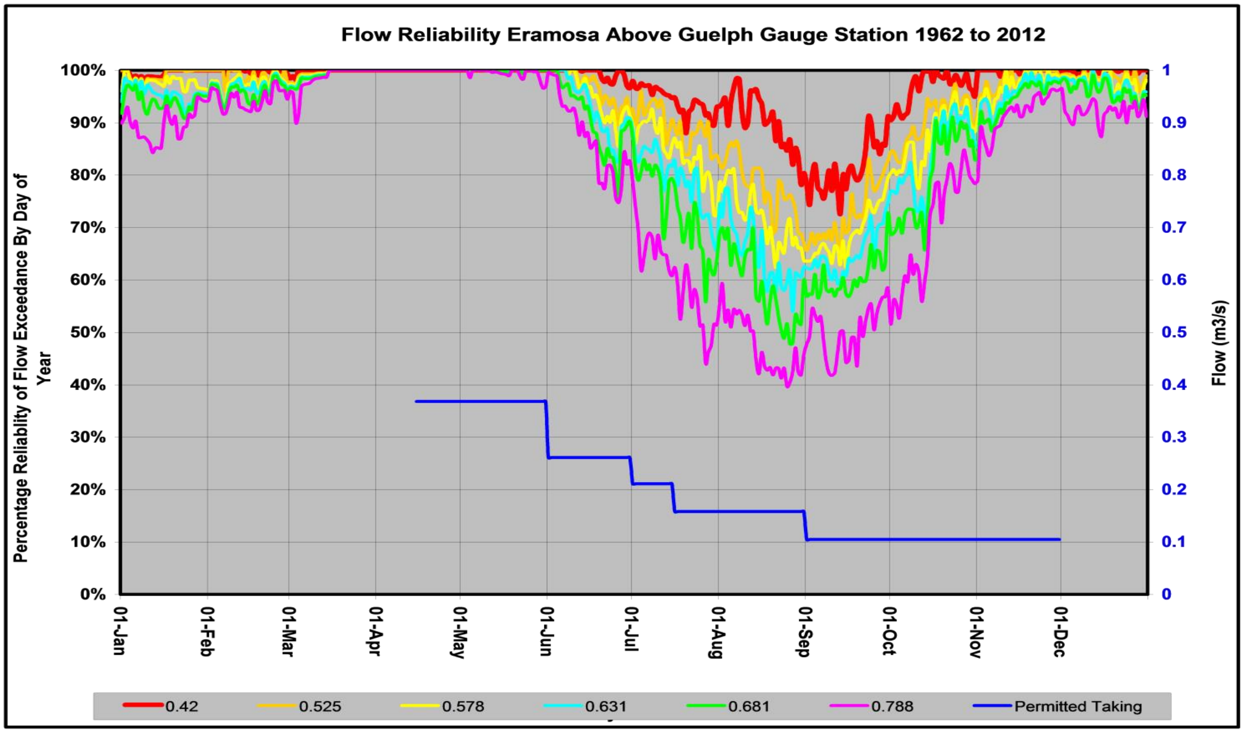


Figure 5-5 Flow Reliability – Permit to Take Water

A continuous flow is not available for providing a constant rate supply to the distribution system. Furthermore, there is very limited potential for significant increased takings beyond either the previous or existing Eramosa River PTTW at any time other than the spring period. Through further discussions with GRCA, it was agreed that it may be more prudent for the City to consider optimizing existing river takings through the current permit requirements. As the existing recharge system efficiently applies a natural in-situ filtration system, it is not practical to construct a separate surface water treatment system for the highly variable seasonal flows that may be available after the current PTTW for the recharge system. Therefore, the Surface Water and Surface Water ASR alternatives for Eramosa River are screened from further consideration.

5.4.3 Surface Water Treatment

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

- continuous taking of 150 L/s – Municipal 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 process units required would include:

- screening
- pretreatment (dissolved air flotation - DAF) with coagulant
- advanced oxidation (UV/H_2O_2 /ozone for taste and odour, organics etc.) and seasonal addition of powdered activated carbon (PAC)
- filtration (dual media) with allowance for granular activated carbon (GAC)
- chlorination
- residuals management (equalization, thickening, discharge to sewer)
- allowance for connection to ASR with re-chlorination

These treatment processes were selected to ensure water quality will meet current and anticipated future water quality limits. The proposed treatment train combines conventional processes with advanced treatment technologies. Advanced oxidation and seasonal addition of PAC, as well as filtration with GAC, will remove trace organic compounds from the water and ensure it is aesthetically acceptable (free of colour, taste and odour). Coagulation and filtration will remove most of the turbidity and a large proportion of bacteria, viruses and other (Giardia cysts and cryptosporidium). Post-chlorination further ensures pathogen destruction. 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 recharge. 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 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. Estimated costs for the surface water treatment options are provided in **Table 5-10**.

The total increase in a potential quantity available from a surface water treatment based on after treatment flows is 12,312 m^3/d (based on a continuous taking from Guelph Lake of 150 L/s).

5.4.3.1 Aquifer Storage Recovery

Aquifer Storage Recovery (ASR) 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). Recharge of the aquifer can be accomplished through injections wells, while recovery of the water is done through recovery wells. In many installations, wells are installed with dual purpose: injection and recovery, where the stored water is recovered from the same well, disinfected and then pumped to the distribution system to meet demands.

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

water treatment plant construction or expansion where capacity exceeds demand; the WTP could be operated to treat excess volumes to be stored in aquifers for future recovery.

Aquifer recharge technology has been demonstrated for many years in the U.S. and Europe. It has also been applied in the Region of Waterloo at the Mannheim WTP to maximize the supply capability of the Grand River which is subject to seasonal stream flow limitations, while minimizing downstream impacts. A similar approach is proposed for Guelph.

In concept, the ASR system would consist of a series of wells in a wellfield that would store treated water 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 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 surface water takings as well as appropriate areas to install wells to ensure optimal hydrogeological properties. Another important consideration is location of the system (including the water treatment plant, wells etc.) to ensure the most advantageous input into the distribution system from an operational perspective and to accommodate future growth and facilitate additional supply scenarios. However from a feasibility perspective, the Gasport Formation 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 is considered to be highly feasible for ASR.

Recommendations for further work include pilot testing; in order to plan and design a full-scale ASR facility; there is a need to evaluate site specific issues including water quality, geochemical reactions, aquifer hydraulics, recharge/ recovery capacity of individual wells, maximum feasible storage volume, maximum possible storage time, and treatment requirements.

This work is required to specifically address water quality issues including recharge water quality; soil and/or aquifer characteristics, recharge methodology, operational methods and microbial growth. It is necessary to study potential impacts of recharge water which could result in a decrease in ability to transmit water into aquifer storage due to clogging of aquifers. In addition, degradation of existing groundwater quality is possible due to introduction of dissolved salts or contaminants. Chemical interactions between recharge water and aquifer matrix and mixing with native groundwater can also produce detrimental geochemical reactions which can result in surface clogging or reduce 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 chemistry will establish a new equilibrium which can cause precipitation of minerals, and therefore lead to clogging of the aquifer and reduction in recharge rates; can also cause increases in concentrations of dissolved minerals to levels above drinking water limits. While there are considerable studies to confirm the feasibility of ASR with respect to water quality issues, the investigation process is well defined and there are many existing case studies that demonstrate the feasibility of ASR in a number of different geological and hydrogeological settings.

Environmental effects could reflect changes to groundwater quality along the flow paths of the injected water. Such changes could be negative as discussed above (i.e., precipitation of minerals within aquifer) or positive (i.e., dilution of impacted groundwater resulting from existing land use within urban areas). In many locations throughout the City, groundwater levels within the Gasport aquifer are significantly low

(i.e., more than 20 m below ground surface near municipal production wells in the Northeast Quadrant). Significant quantities of groundwater injection can therefore be undertaken within these areas without losses to surface water or affecting surface drainage conditions. The intent of ASR is that on an annual basis, the ASR facility represents zero net withdrawal – therefore, no decline in groundwater levels in the aquifer. Therefore, it is not anticipated that there will be any significant interference effects on existing groundwater users.

Areas to implement ASR injection:
From a hydrogeological perspective, ASR would be most effective in areas where there is high aquifer transmissivity and the potential to develop ASR wells with a corresponding high specific capacity. Areas where these conditions appear to occur in the City of Guelph included the vicinity of the Park and Emma production wells and in the vicinity of the production wells in the Southwest Quadrant (i.e. Membro). Selection of suitable recharge sites includes evaluation of local conditions and physical parameters that influence recharge rates etc. These include:

- Need to evaluate characteristics of subsurface material and aquifer: depth to water table, water quality, specific yield, soil/subsurface characteristics, storage availability,
- Nature of natural groundwater flow in area,
- Proximity to other wellfields and drawdown areas,
- Native groundwater quality,
- Proximity to distribution system and major watermains – i.e. costs to connect ASR wells to distribution system,
- Ability to locate surface water treatment plant,
- City owned property; access to or purchase of lands for construction of wells,
- Aquifer transmissivity,
- Environmental impacts of construction activities of pipelines/wells,
- Strategic placement in other well fields in service areas,
- Operational considerations: length of recharge/recovery cycles,
- Well design – recharge capacity ASR wells (recharge and recovery) can significantly reduce construction costs; designed and constructed with pumps and injection and discharge piping permanently installed.

An evaluation of the number of wells required for injection and recovery was completed by Golder (refer to **Appendix C**).

For the purposes of evaluating this option at this point (i.e. area requirements, number of wells and the cost model), two options were assumed:

- ASR system located at Guelph Lake
- ASR system located in area of Park and Emma Wells

Other assumptions include:

- Allowance for 6 to 15 injection/extraction wells for ultimate supply; the higher number wells are required if located at Guelph Lake.
- Cost for ASR system includes full treatment costs (i.e. includes treatment of the base municipal taking at 150 L/s)
- Approximately 4.5 km of pipeline to connect WTP discharge and/or ASR wells/High Lift Pumping Station to the City system
- 100% efficiency of ASR process.

Surface Water Treatment Summary

The total increase in a potential quantity available from a surface water treatment and ASR system based on after treatment flows is 25,825 m^3/d (based on a continuous taking from Guelph Lake of 150 L/s and a step taking of 300 L/s).

Table 5-10 summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition, construction of a WTP, and approvals.

Table 5-10 Capital Cost to Construct Surface Water Alternatives

Item ID	Item Description	Guelph Lake WTP	Guelph Lake WTP + ASR
1	Preliminary Testing	$250,000	$1,500,000
	WQ Analysis	$200,000	$235,000
	Approvals	$200,000	$352,000
2	Water Treatment Plant Intake	$1,000,000	$1,000,000
3	Water Treatment Plant	$14,450,000	$25,440,000
	Low lift pumping station		
	Screening		
	Pre-treatment (Dissolved Air Floatation with Coagulation)		
	Advanced Oxidation (UV/H_2O_2 for taste and odour, organics, etc.)		
	Powdered Activated Carbon (PAC) – seasonal addition		
	Filtration (dual media) with allowance for granular activated carbon (GAC)		
	Chlorination		
	Residues Management (equalization, thickening, discharge to sewer)		
	Allowance for connection to ASR with re-chlorination		
4	ASR well construction		$11,431,000
5	Land acquisition	$100,000	$1,318,000
6	Connect to distribution system	$6,600,000	$7,733,000
	Subtotal	**$22,800,000**	**$49,009,000**
	Contractor Overhead (10%)	$2,280,000	$4,900,900
	Estimating Contingency (30%)	$6,840,000	$14,702,700
	Total	**$31,920,000**	**$68,612,600**
	Engineering and Construction Services (15%)	$4,788,000	$10,291,890
	Grand Total	**$36,708,000**	**$78,905,000**

5.4.4 Surface Water Alternatives Summary

The estimated volume from surface water alternatives is applied to the demand projections with and without conservation in **Figure 5-6**.

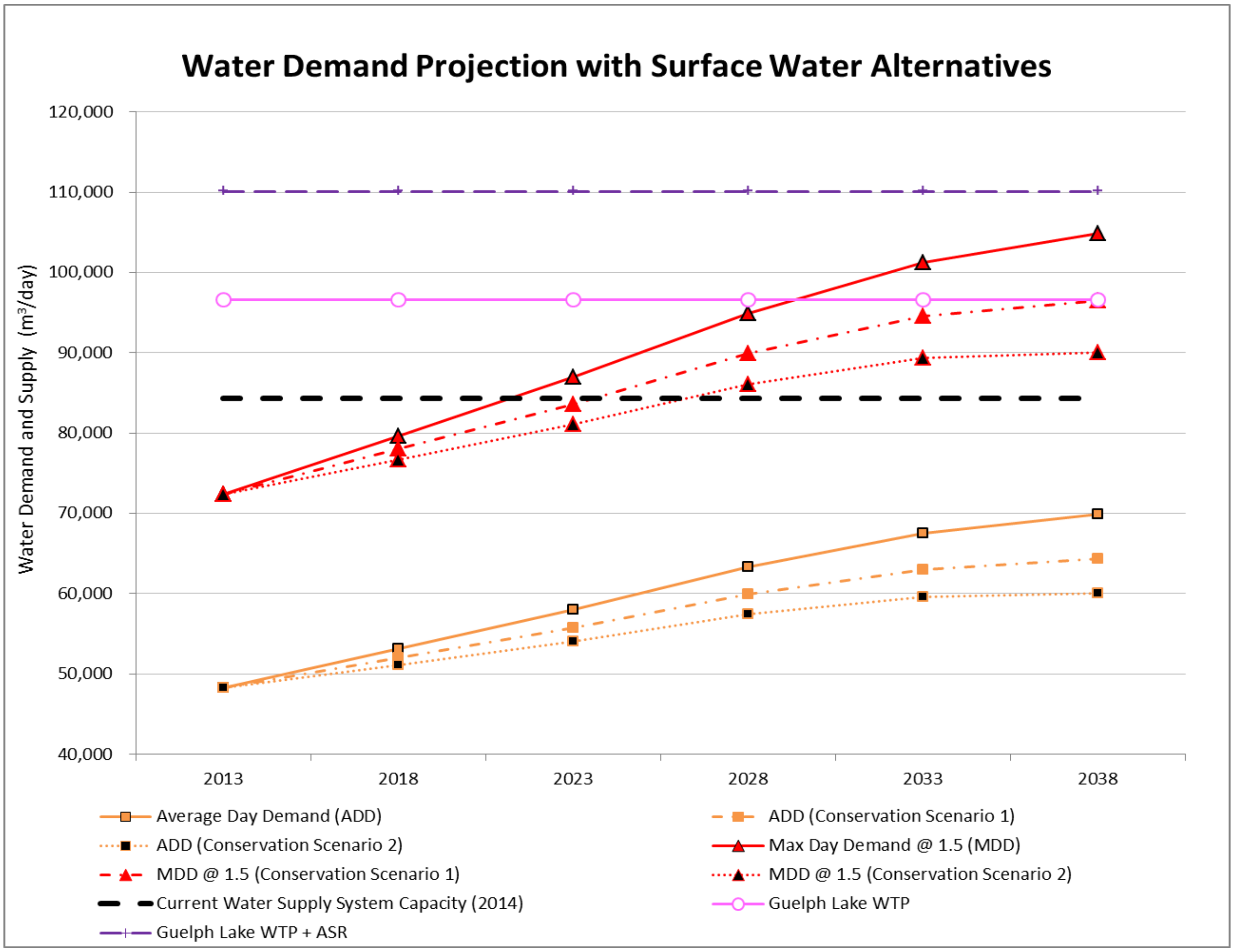


Figure 5-6 Water Demand Projection with Surface Water Alternatives

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 change to municipal planning documents which would not meet Provincial growth targets. This alternative does not meet the Purpose Statement for the project, and therefore, 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. This alternative does not meet the Purpose Statement for the project, and therefore, is not carried forward as part of the preferred alternative.

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, Public Advisory Committee and the general public in October 2014 (see **Section** 7). The proposed criteria and process were revised incorporating the comments received, and then confirmed via the Community Liaison Committee and Agency Municipality group through meetings in April 2014.

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
Built Environment	• Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities • Effect on private and municipal wells
Natural Environmental	• Effect of construction and operation on aquatic and terrestrial species & habitat • Effect on surface water quantity and quality
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
Financial Considerations	• Estimated capital costs; capital cost per capacity • Estimated operation and maintenance costs • Life cycle cost (per volume produced)
Legal/Jurisdictional Considerations	• Location inside vs. outside of City boundaries
Technical Considerations	• Constructability • Potential productivity and reliability • Water treatment requirements • Approval requirements

The above 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 being applied. Furthermore, these criteria and their indicators reflect input received from a very broad and diverse range of Master Plan Study participants. For example, during the Municipality and Agency group workshop, participants from the Townships expressed the need to have the impact of future Source Water Protection policies on the landowners in the vicinity of possible future wells located outside the

City. This was reviewed with additional emphasis following this discussion with the additional indicator added as a result of this discussion pertaining to the Townships' requirement to implement Source Water Protection requirements within their jurisdictions.

Table 6-2 Evaluation Criteria Indicators Summary

Component	Criteria	Indicator
Technical	Water Treatment	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*.
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 suggested 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 the following Tables (**Table 6-3** to **Table 6-8**) which include the comparison of each alternative relative to other alternatives. The tables were provided in draft format at the Community Liaison Committee meeting and Municipality Agency group workshop in April 2014, 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; however suggestion to proceed with conservative estimates of success
- Preference for groundwater over surface water
- Preference for groundwater that does not require treatment
- Strong recommendation to maximize water supply potential within the City's boundaries before going into Townships
- Questions regarding impacts on the surrounding land uses/owners from Source Water Protection policies on new wells and surface water taking
- Concern expressed about non-municipal sources regarding private takings competing with Guelph's municipally supplies, and how to control these takings
- Concern expressed regarding potential impact of historical industrial contamination on municipal supplies

In addition to the feedback from consultation events, the City undertook a public survey on water service expectations and the findings were generally similar to comments noted above.

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 potential impacts from this review are incorporated into the summary evaluation tables.

The summary comparison is shown in the form of a pie chart with all white having the most positive/lowest impact and all black having the most negative/highest impact. These ratings were then further considered with respect to application in the short-, mid- and long-terms 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 - Other

Category of Consideration	Conservation *(Status Quo)*	Conservation *(Enhanced)*	Re-Use	Limit Growth	Do Nothing
Technical Category	Most preferred for achieving reduction	Most preferred for achieving reduction	Advanced treatment and residuals management required Extensive approvals	Does not result in added capacity	Does not result in added capacity
Natural Environment Category	No impact	No impact	High potential impact from residuals management	No impact	No improvements to existing system; minimal impact
Built Environment Category	Minor changes to existing & planned building	Minor changes to existing & planned building	Moderate impact due to new infrastructure	High impact to planned growth (does not meet growth targets)	High impact to planned growth (does not meet growth targets)
Social/Cultural Environment Category	Contributes to meeting future demands; high public acceptance	Contributes to meeting future demands; higher public acceptance supporting increasing block rates 52% either agreed or strongly agreed with this approach, compared to 25% who disagreed or strongly disagreed.	Contributes to meeting future demands; low public acceptance	Does not meet growth targets	Does not meet growth targets
Legal/Jurisdictional Category	In City	In City	Potential impacts outside of City due to residuals management requirements	May drive growth to Township	May drive growth to Township
Financial Category	Moderate costs as compared to supply alternatives	Moderate to high costs as compared to supply alternatives	High to very high	Not evaluated; does not address problem statement	Not evaluated; does not address problem statement
Overall Results					

Least preferred → ***Most preferred***

Table 6-4 Assessment and Evaluation of Water Supply Alternatives - Other

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation *(Status Quo)*	Conservation *(increase)*	Re-Use	Limit Growth	Do Nothing
Technical Category		High potential for reductions	Moderate to high potential for reductions	Advanced WTP and residuals management required; extensive approvals	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	New infrastructure required by customer	New infrastructure required by customer	Re-use of reclaimed wastewater for non-potable use – requires new municipal distribution system and targeted customers with dedicated dual plumbing system Re-use of reclaimed wastewater for potable use – requires high tech WTP	Not applicable	Not applicable
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	Available capacity remaining for avoidance = 5600 m^3/d	Available capacity remaining for avoidance = 7400 to 9800 m^3/d	Quantity available = minimum WWTP flows	none	none
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 accordance with Source Water Protection standards of the *Clean Water Act*.	none	none	Advanced WTP required for public safety Significant residuals from treatment process	none	none
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 (Permit to Take Water, Environmental Compliance Approval/Drinking Water License); Grand River Conservation Authority (GRCA). Ability to respond in change in permitting requirements	none	none	Extensive approvals required for advanced WTP, new distribution piping, residuals management	Changes to Official Plan	Changes to Official Plan, as growth targets could not be met
Natural Environment Category		No impact to natural environment	No impact to natural impact	High impact	No impact	No impact
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	No impact	No impact	High impact – construction of new WTP at location of existing WWTP Significant residuals from treatment process	No impact	No impact

Category of Consideration / Evaluation Criteria	Indicator (*How the Evaluation Criteria was Applied*)	Conservation (*Status Quo*)	Conservation (*increase*)	Re-Use	Limit Growth	Do Nothing
	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.					
Effect on Surface Water Quantity & Quality	An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies (including those identified in the "Proximity to wetlands/streams" criteria used to assess the Potential Alternative Well Areas) due to: 1. Construction or operation; 2. Groundwater drawdown during operation of the well.	No impact	No impact	Reduction in WWTP effluent flows – residuals to be removed from site	No impact	No impact
Built Environment Category		Minor changes to existing and planned buildings	Minor changes to existing and planned buildings	Moderate impact due to new 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)	Changes in requirements for existing and future buildings	Changes in requirements for existing and future buildings	Allows for continued growth WTP at WWTP requires added property New distribution infrastructure for non-potable uses; extensive construction required for dual piping network	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	none	none	none	none	none
Social/Cultural Environment Category		Contributes to meeting future demands High public acceptance	Contributes to meeting future demands High public acceptance	Contributes to meeting future demands Low public acceptance	Will not meet growth targets Low 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 25 year demands	partial	partial	Partial to full	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 based on health and safety concerns	High High public acceptance	Very High Higher public acceptance as majority of survey respondents support an increase in conservation, including support for increasing block rates as a	Moderate – unlimited resource; but high reuse Low public acceptance	None Low public acceptance	None Low public acceptance

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Conservation ***(Status Quo)***	Conservation ***(increase)***	Re-Use	Limit Growth	Do Nothing
			pricing strategy as a measure to reduce demand. 52% either agreed or strongly agreed with this approach, compared to 25% who disagreed or strongly disagreed.			
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	none	none
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	none
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	none
Legal/Jurisdictional Category		In City	In City	Moderate impacts outside City	City would not meet targets driving growth to Townships	City would not meet targets 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	Potential impacts outside of City due to residuals management requirements	Lack of allowable growth in City will drive growth to Townships	Lack of allowable growth in City will drive growth to Townships
Financial Category		Moderate costs as compared to supply alternatives	Moderate to high costs as compared to supply alternatives	High to very high	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/d) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate	• Capital cost = $5.7 Million • Capital cost per capacity = $1000 per m^3/day of avoided capacity • Life cycle cost: $0.65 per m^3 avoided	• Capital cost = $22.6 to 43.8 Million • Capital cost per capacity = $2500 to $4500 per m^3/day of avoided capacity • Life cycle cost: $0.55 to $0.75 per m^3 avoided	Re-use of reclaimed wastewater for non-potable use – moderate to high capital and O&M cost Re-use of reclaimed wastewater for potable use – very high capital and O&M cost	• 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 Wells *(Clythe, Sacco, Smallfield, Lower Road)*	2C – Groundwater - Municipal Test Wells *(Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser)*	2D – Groundwater - New Well Inside City *(Sunny Acres)*	2E – Groundwater - New Wells Outside City *(Guelph North; Guelph South)*	2F - Arkell Collectors & ASR
Technical Category	High probability of success due to level of available information on existing municipal wells; More complexity to treatment requirements	High probability of success due to level of available information on existing test wells Better water quality	Moderate probability of success due to level of available information on nearby wells Possible TCE treatment required	High probability of success due to ideal hydrogeological conditions Good water quality expected	Moderate probability of success – need to confirm available recharge water surplus through optimization of Eramosa PTTW
Natural Environment Category	Sustainable pumping established historically; impacts known	Requires investigation at wells near or adjacent to natural heritage features	Proposed well area not near sensitive receptors	Requires investigation at wells near or adjacent to natural heritage features	Capturing excess collector system flows has minimal impacts to natural heritage features
Built Environment Category	Minimal disruption at existing well facilities; some sites require added land Existing Well Protection Areas (WPA)	Property acquisition required New WPA may impact current and future land use	Park land or new property acquisition in area New WPA may impact current and future land use	Property acquisition in areas outside City New WPAs may impact current and future land use in Townships	Property acquisition for ASR wells inside City. New WPA may impact current and future land use
Social/ Cultural Environment Category	Moderate ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated	Low ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated	Low ability to meet future demand Noise impacts to be mitigated
Legal/ Jurisdictional Category	No issues	Logan/Fleming well in Guelph Eramosa Township (GET)	No issues	Guelph North well in GET Guelph South well in Puslinch Township (PT)	Arkell collectors are part of existing Arkell wellfield system in PT ASR wells inside City
Financial Category	Low to moderate costs depending on well capacity	Lowest costs due to high capacity wells (except Hauser)	Moderate cost due to low capacity well	Low costs due to high capacity wells and assumed good water quality	Moderate cost
Overall Results					

Least preferred → ***Most preferred***

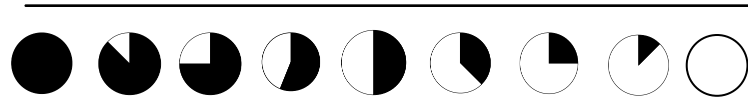


Table 6-6 Assessment and Evaluation of Water Supply Alternatives - Groundwater Sources

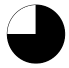
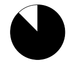
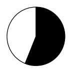
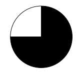
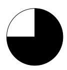
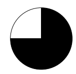
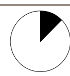
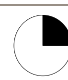
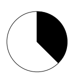
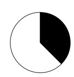
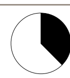
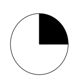
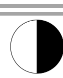
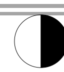
Category of Consideration / Evaluation Criteria	Indicator (*How the Evaluation Criteria was Applied*)	Existing Municipal Off-line Wells (*Clythe, Sacco, Smallfield, Lower Road*)	Municipal Test Wells (*Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser*)	New Well Inside City (*Sunny Acres*)	New Wells Outside City (*Guelph North – Conservation Rd. W.; Guelph South – Victoria& Maltby*)	Collector Systems ASR Wells (*Central*)
Technical Category		Highest potential due to level of available information regarding quantity, quality; existing facilities with connections to system	Moderate to High	Moderate to High	Moderate to High	Moderate
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	All off-line wells are existing facilities located in the City or in existing municipal well field grounds; improvements to existing infrastructure can be accommodated Connections to distribution system exist; close proximity to sanitary sewer where required Lower Road – major infrastructure upgrades required	Scout Camp – existing building and connection to the aqueduct; building would require expansion/upgrades for treatment systems; sanitary connection at Stone & Victoria Ironwood/Steffler – new facilities proposed in municipal parks; close proximity to distribution system and sanitary services Logan/Fleming – requires new well installation in area outside wetland; subject to investigation; just east of City boundary; close proximity to distribution system Hauser – in City; close proximity to distribution system and sanitary services	Sunny Acres – groundwater exploration required; Class EA to determine preferred location; in City provides proximity to existing watermains and sanitary	New areas located south and north of City – no existing infrastructure; would require connection to nearest large diameter watermain in City Land acquisition and utilities required	Reliant on upgrades to Lower Road collector system 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 (around Park & Emma) – requires land acquisition and/or locate in municipal parks Requires ASR well facilities for dechlorination and disinfection/ rechlorination systems
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	Clythe – known available quantity Sacco – known available quantity Smallfield – known available quantity Lower Road – seasonal variability; assumptions regarding base flows; potential for optimization	Scout Camp – available volume may be impacted by installation of liner Ironwood/Steffler – pumping tests indicate high volumes available; limited by possible Hanlon Creek impacts Logan/Fleming – unknown confined aquifer; subject to investigation Hauser – low volume available	Area of high transmissivity in Gasport aquifer Estimate volume limited by potential interference with other municipal wells in close proximity	Guelph North – area with high transmissivity in Gasport aquifer Guelph South - area with reasonably high transmissivity in Gasport aquifer	Reliability of excess flows during peak seasons to be confirmed; assumption of excess volumes of 10,000 m^3/day from both Glen and Lower Road Collectors for 4 months for feasibility assessment of ASR
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 accordance with Source Water Protection standards of the *Clean Water Act*.	Clythe – iron & manganese; H2S; existing wellhead protection area Sacco – TCE & PCE; existing wellhead protection area Smallfield – TCE & VOCs; existing wellhead protection area Lower Road – historical bacteria issues can be addressed through infrastructure upgrades and UV disinfection at Woods PS; located in existing wellhead protection area	Scout Camp – H2S (likely from lower aquifer - not addressed through liner) Ironwood/Steffler – good quality; Fe and Mn noted; treatment not anticipated subject to added testing Logan/Fleming – assumed good WQ; only disinfection required Hauser – assumed good WQ; only disinfection required	Sunny Acres – assumed good WQ in area based on nearby MWs; however, given proximity to Membro and Edinburgh with measured TCE, assumed treatment required WPAs to be considered for any new wells in the City	Guelph North – assumed good WQ; only disinfection required Guelph South - – assumed good WQ; only disinfection required WPAs to be developed for new wells outside City; potential impacts to existing uses (e.g. agricultural)	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 WPAs to be considered for any new ASR wells in the City
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 (Permit to Take Water, Environmental Compliance Approval/Drinking Water License); 3. Grand River Conservation Authority (GRCA).	All existing municipal off-line wells have current PTTWs Requirement for treatment to be studied in Schedule B Class EAs Amendments to City DWL Municipal permits required for new/expanded well facilities	All test wells require all approvals for new production wells, including: • Class EA – Schedule B • Municipal – City and Township of Guelph-Eramosa (Logan/Fleming) • PTTW	New municipal well requires hydrogeological investigation phase; all approvals for new production well, including: • Class EA – Schedule B • Municipal – City • PTTW	New municipal wells require hydrogeological investigation phase; all approvals for new production well, including: • Class EA – Schedule B • Municipal: • South: Township of Puslinch	New ASR wells require hydrogeological investigation phase; all approvals for new production wells, including: • Class EA • Municipal – City • PTTW

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Existing Municipal Off-line Wells *(Clythe, Sacco, Smallfield, Lower Road)*	Municipal Test Wells *(Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser)*	New Well Inside City *(Sunny Acres)*	New Wells Outside City *(Guelph North – Conservation Rd. W.; Guelph South – Victoria& Maltby)*	Collector Systems ASR Wells *(Central)*
	Ability to respond in change in permitting requirements	DWL amendment for Lower Road Collector system	• ECA/DWL • GRCA	• ECA/DWL • GRCA	• North: Township of Guelph-Eramosa • PTTW • ECA/DWL • GRCA	• ECA/DWL GRCA
Natural Environment Category		Existing municipal wells – sustainable pumping established historically with impacts within catchments accounted for	Test wells near or adjacent to natural heritage features must be investigated to confirm potential impacts resulting from reduction in surface water and wetland water levels	New well near or adjacent to natural heritage features must be investigated to confirm potential impacts resulting from reduction in surface water and wetland water levels	New wells near or adjacent to natural heritage features must be investigated to confirm potential impacts resulting from reduction in surface water and wetland water levels	Capturing excess collector system flows has minimal impacts to heritage features
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.	Clythe – close to Clythe Creek and Clythe Creek Non-provincially Significant Wetland Sacco & Smallfield – Speed River catchment; close proximity to Ellis/ Chillico Creek; near Marden South Non-Provincially Significant Wetland Complex Lower Road – near Eramosa River	Scout Camp – near Eramosa River Blue Springs Creek Provincially Significant Wetland Complex; Logan/Fleming – test wells are located near Guelph Northeast Provincially Significant Wetland Complex; new well required; Hauser – close proximity to Ellis/ Chillico Creek; near Ellis Creek Provincially Significant Wetland Complex	Sunny Acres – Location of new well within City not anticipated to impact aquatic or terrestrial species	Guelph North – near the Marden South Provincially Significant Wetland Complex; Guelph South - near Arkell Bog Provincially Significant Wetland Complex;	Potential impacts from construction of works within Arkell wellfield to be mitigated Location of new wells within City not anticipated to impact aquatic or terrestrial species
Effect on Surface Water Quantity & Quality	An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies (including those identified in the "Proximity to wetlands/streams" criteria used to assess the Potential Alternative Well Areas) due to: 1. Construction or operation; 2. Groundwater drawdown during operation of the well.	Existing PTTWs – flows already accounted for in Tier Three groundwater flow model and therefore, impacts to watersheds incorporated into combined takings	Scout Camp – moderate impacts to Eramosa River and Torrence Creek Ironwood/Steffler – pumping limited to avoid impacts to Hanlon Creek base flow Logan/Fleming – new well required; Speed River catchment; close to Speed R tributary; potential impact to SW; need more testing to demonstrate confined aquifer Hauser – close proximity to Ellis/ Chillico Creek;	Sunny Acres – in Speed River catchment area - minimal impact	Guelph North – moderate to high impacts to Marden Creek base flow due to minimal flow; very confined well Guelph South - in Mill Creek Catchment area; low impact to base flow	Excess flows from collector systems discharges to Eramosa River; excess flows proportional to seasonality of river flows so no reduction in base flows ASR wells in high conductivity areas – no impact
Built Environment Category		Disruption on neighbouring residents due to need for expansion to accommodate treatment requirements at Clythe, Sacco, Smallfield Existing WPAs	Property acquisition required in area of Logan/Fleming outside City; and Hauser inside City New WPAs may impact current and future land use	Property acquisition required in area of Sunny Acres inside City New WPAs may impact current and future land use	Property acquisition required in areas outside City; New WPAs may impact current and future land use	Property acquisition required for ASR wells inside City New WPAs may impact 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	Clythe – expansion of facility for treatment requires new property Sacco – expansion of facility for treatment requires new property Smallfield – sufficient area for expansion of facility for treatment Lower Road – no property required ; in existing WPA	Scout Camp – land available in vicinity for expansion if required; potentially from adjacent Barber scout camp; in Arkell wellfield area WPA Ironwood/Steffler – planned locations in municipal parks; potential disruption to park use; concern	Sunny Acres – land required in City or potential location in City park WPAs to be considered for any new wells in the City	Guelph North – land required; new WPA may impact current and future land use including agricultural Guelph South - – land required; new WPA may impact current and future land use including agricultural	New ASR wells in the City will require property – either private or park land. These wells will also result in new WPAs which may impact current and future uses.

Category of Consideration / Evaluation Criteria	**Indicator** *(How the Evaluation Criteria was Applied)*	**Existing Municipal Off-line Wells** *(Clythe, Sacco, Smallfield, Lower Road)*	**Municipal Test Wells** *(Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser)*	**New Well Inside City** *(Sunny Acres)*	**New Wells Outside City** *(Guelph North – Conservation Rd. W.; Guelph South – Victoria& Maltby)*	**Collector Systems ASR Wells** *(Central)*
	limited to existing and future agricultural operations and Environmental Protection Areas. 3. Effect on Property (ownership, size, and willingness of property owner)		regarding property value from adjacent residents; new WPAs to consider nearby existing land use Logan/Fleming – land required in Township for new well facility; new WPA may impact current and future agricultural operations Hauser – land required in City; new WPAs to consider nearby existing land			
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 wells – interference with other municipal wells already considered in establishing available capacity when system pumped at maximum rate	Test wells - available capacity at approximate well location in model considers potential interference with other municipal wells	Sunny Acres – available capacity at approximate well location in model considers potential interference with other municipal wells	Guelph North – potential impacts anticipated to municipal wells Guelph South - – minimal risk of impacts anticipated to private wells (golf course PTTWs); no risk to municipal wells	New ASR wells in the City require future investigations to review potential interference with municipal wells.
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	High ability to meet future demand; lower confidence in achieving all available capacity 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	High ability to meet future demand; lower confidence in achieving all potential capacity 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
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	Existing wells – total available maximum capacity of 7,732 m^3/d At confidence level of 100% Estimated Total Max Capacity = 7,732 m^3/d	Test wells – total available maximum capacity of 17,823m^3/d At confidence level of 70% Estimated Total Max Capacity = 12,674 m^3/d	New Wells inside the City – total available maximum capacity of 1,470 m^3/d At confidence level of 100% Estimated Total Max Capacity = 1,470m^3/d	New Wells outside the City – total available maximum capacity of 12,900 m^3/d At confidence level of 70% Estimated Total Max Capacity = 8,940 m^3/d	New ASR wells total - available maximum capacity of 1,671 m^3/d At confidence level of 100% Estimated Total Max Capacity = 1,671 m^3/d
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	Public will be educated regarding treatment requirements through Class EA; Water Use survey respondents' opinion was split regarding use of water requiring treatment for contaminants, with 42% finding this acceptable and 38% unacceptable. Clythe – moderate public acceptance due to treatment requirements for H2S; Sacco & Smallfield – low public acceptance due to treatment requirements for TCE, PCE, VOCs; Lower Road – high public acceptance based on good water quality	Public will be educated regarding new wells and treatment requirements through Class EA Scout Camp – moderate public acceptance due to H2S Ironwood/Steffler – high public acceptance based on good water quality Logan/Fleming – high public acceptance based on good water quality Hauser – high public acceptance based on good water quality	Public will be educated regarding new well and treatment requirements through Class EA Sunny Acres –public acceptance dependent on WQ; anticipate treatment for TCE	Public will be educated regarding new wells outside City through Class EA Guelph North –public acceptance based on good water quality; Township residents may oppose Guelph South –public acceptance based on good water quality; Township residents may oppose	Public will be educated regarding importance of groundwater through ASR well location communication High public acceptance based on good water quality

Category of Consideration / Evaluation Criteria	**Indicator** *(How the Evaluation Criteria was Applied)*	**Existing Municipal Off-line Wells** *(Clythe, Sacco, Smallfield, Lower Road)*	**Municipal Test Wells** *(Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser)*	**New Well Inside City** *(Sunny Acres)*	**New Wells Outside City** *(Guelph North – Conservation Rd. W.; Guelph South – Victoria& Maltby)*	**Collector Systems ASR Wells** *(Central)*
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 wells – construction of new treatment systems and expansion of well facility will have temporary effects Operations phase will have similar impacts to previous historical operation	Scout Camp – minimal impacts due to remote location Ironwood/Steffler – temporary impacts from construction to adjacent residents; operations phase noise and disruption to be mitigated through design considerations Logan/Fleming – to be determined for new location Hauser – temporary impacts from construction to adjacent residents; operations phase noise and disruption to be mitigated through design considerations	Sunny Acres – location 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 new locations; anticipate minimal impacts due to remote locations	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.
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
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 Township of Guelph-Eramosa	No jurisdictional issues	Guelph North well in Township of Guelph-Eramosa Guelph South well in Township of Puslinch	No jurisdictional issues
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 or wellfield	All proposed wells at test wells are inside City except new well in area of Fleming/Logan just east of City on Eastview Rd Within GET jurisdiction – impacts with respect to wellhead protection area	Proposed well inside City	Proposed wells outside City will require land for facilities and easements for utilities as well as consultation during Class EAs Within GET and PT jurisdictions – impacts with respect to wellhead protection areas	Proposed ASR wells are inside City.
Financial Category		Low to moderate costs depending on well capacity	Lowest costs due to high capacity wells (except Hauser)	Moderate costs due to low capacity well	Low costs due to high capacity wells and assumed no treatment	Very high costs due to seasonal availability & low average production year-round
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$/d) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate and capital plus O&M cost	• Capital cost = $31.2 Million • Capital cost per capacity = $1500 to $6100 per m^3/day of proposed capacity • Life cycle cost: $0.47 to $1.40 per m^3 produced	• Capital cost = $20.4 Million • Capital cost per capacity = $505 to $1004 per m^3/day of proposed capacity; ($4100/m3/d for Hauser) • Life cycle cost: $0.16 to $0.93 per m^3 produced	• Capital cost = $4.5 Million • Capital cost per capacity = $3100 per m^3/day of proposed capacity; • Life cycle cost: $0.70 per m^3 produced	• Capital cost = $10.5 Million • Capital cost per capacity = $841to $982 per m^3/day of proposed capacity; • Life cycle cost: $0.23 to $0.26 per m^3 produced	• Capital cost = $9.0 Million • Capital cost per capacity = $2700 per m^3/day of proposed capacity • Life cycle cost: $0.60 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
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 heritage features to be assessed and mitigated	 Impacts to natural heritage features to be assessed and mitigated
Built Environment Category	 Potential disruption to recreational use of Guelph Lake & Speed River. Potential impacts to agricultural operations from new Source Water intake protection zone	 Potential disruption to recreational use of Guelph Lake & Speed River. Potential impacts 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		

Least preferred → ***Most preferred***

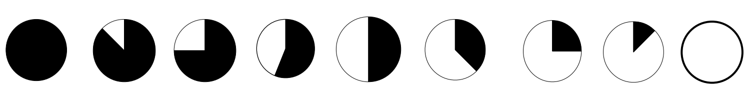


Table 6-8 Assessment and Evaluation of Water Supply Alternatives - Surface Water Source

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
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 150L/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 150L/s to 300 L/s for future ASR 2 options for locating ASR wells: 1. Injection wells in area of Guelph Lake + recovery wells around Park & Emma 2. Full ASR wells in Park & Emma area Use of existing municipal wells to maximize recovery to 100%
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	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) • Advanced Oxidation (UV/H2O2 for taste and odour, organics, etc.) • Powdered Activated Carbon (PAC) - seasonal addition • Filtration (dual media) with allowance for granular activated carbon (GAC) • Chlorination • Residues 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) • Advanced Oxidation (UV/H2O2 for taste and odour, organics, etc.) • Powdered Activated Carbon (PAC) - seasonal addition • Filtration (dual media) with allowance for granular activated carbon (GAC) • Chlorination • Residues 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
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 (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) ECA/DWL GRCA
Natural Environment Category		Impacts to natural heritage features to be assessed and mitigated	Impacts to natural heritage 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	Area affected includes Guelph Lake and its associated wetland and aquatic features, i.e. Guelph Northeast Provincially Significant Wetland and Speed River Impacts mitigated by keeping existing water capacity at base levels; however taking of surface water may impact 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	Area affected includes Guelph Lake and its associated wetland and aquatic features, i.e. Guelph Northeast Provincially Significant Wetland and Speed River Impacts mitigated by keeping existing water capacity at base levels; however taking of surface water may impact 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

Category of Consideration / Evaluation Criteria	Indicator *(How the Evaluation Criteria was Applied)*	Surface Water – Guelph Lake	Surface Water & ASR – Guelph Lake/City
	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.	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	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 ASR may result in fluctuations in groundwater levels ; potential impacts
Effect on Surface Water Quantity & Quality	An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies (including those identified in the "Proximity to wetlands/streams" criteria used to assess the Potential Alternative Well Areas) due to: 1. Construction or operation; 2. Groundwater drawdown during operation of the well.	Reduced water quantity; possible temperature impacts per above	Reduced water quantity; possible temperature impacts per above
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 intake protection zone.
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 impact 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 may impact existing and future agricultural use in area	Reduction in surface water flow and water levels could impact 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 and new WPAs for ASR wells may impact 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 (13,000 m^3/d) After WTP treatment losses – 12,300 m^3/d Provides significant source to partially meet future 25 year max day demand	Available takings of 150 to 300 L/s; provides maximum capacity of 27,200 m^3/d) After WTP treatment losses – 25,800 m^3/d Provides significant source to fully meet future 25 year 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
Effect on Cultural Heritage Landscapes and Built	An evaluation of effects on cultural heritage resources, based on:	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
Heritage Resources	1. Presence of cultural heritage landscapes; 2. Presence of built heritage resources.		
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
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 2 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 2 options for ASR include combination of ASR wells inside and outside City; or all wells inside City
Financial Category g		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/d) 3. Life Cycle Cost (20 year) – Cost per m^3 produced based on average pumping rate	• Capital cost = $42.7 Million • Capital cost per capacity = $3470 per m^3/day of proposed capacity • Life cycle cost: $0.88 per m^3 produced	• Capital cost = $78.9 Million • Capital cost per capacity = $3060 per m^3/day of proposed capacity) • Life cycle cost: $0.75 per m^3 produced

6.3 Environmental Assessment (EA) Evaluation Process Recommendations

The summary evaluation tables 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 in order to meet the water supply requirement to 2038.

The alternatives are listed in **Table 6-9** in order of the priority as determined by the summary outputs:

Table 6-9 Summary of Evaluation Outputs

Alternative	Ranking	Comments
1A – Conservation & Demand Management	1	Strong public support for continued and enhanced water conservation; target reduction explored further through financial analysis
2B – Groundwater: Existing Municipal Off-line Wells	1	Support for optimizing water takings within the City; order of implementation to be determined by the City with consideration for regulatory, treatment, financial constraints
2C – Groundwater: Municipal Test Wells	1	
2D – Groundwater: New Well inside City	1	
2F – Arkell Collectors & ASR Wells	2	ASR alternative requires additional feasibility investigation with respect to Eramosa River PTTW optimization; water volumes available via collector systems; need to install ASR wells vs. changing existing well permits to allow for flexible takings
2E – Groundwater: New Wells outside City	2	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	3	While this alternative is not required to provide water supply within the 25 year study period, 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	3	
1B – Re-Use – Centralized	3	Potential of this alternative to be explored further; highly dependent on end use customer demand; integration and alignment with future WWTP treatment requirements
Limit Growth	4	This alternative does not meet the Study Problem Statement and contravenes the Official Plan
Do Nothing	4	This alternative does not meet the Study Problem Statement and contravenes the Official Plan

Figure 6-1 compares the implementation of the above options to the water demand curve with and without conservation to 2038. It can be seen that with conservation, the groundwater options ranked first ('1') are sufficient to satisfy the demand in this timeframe.

Therefore the preferred alternative consists of proceeding with conservation programs and developing existing and new groundwater sources within the City to meet the projected water demand requirements to 2038. The order and priority of the individual well supplies within these groupings of supply options will be determined as the City moves through development of each. Recognizing the challenges with developing new water supplies, and the long timeline required for implementation, the City will continue to undertake the required investigations and preliminary studies to facilitate design and construction to

ensure that the water is available in order to meet demand. Furthermore, understanding that additional supplies consisting of those identified in the above table, will be required beyond 2028, it will be prudent for the City to track and update the demand and supply timeline to ensure that the necessary preliminary work commences at the appropriate time within this study period in order to have new supplies in place as required beyond 2038. This is discussed further in **Section** 8.4.

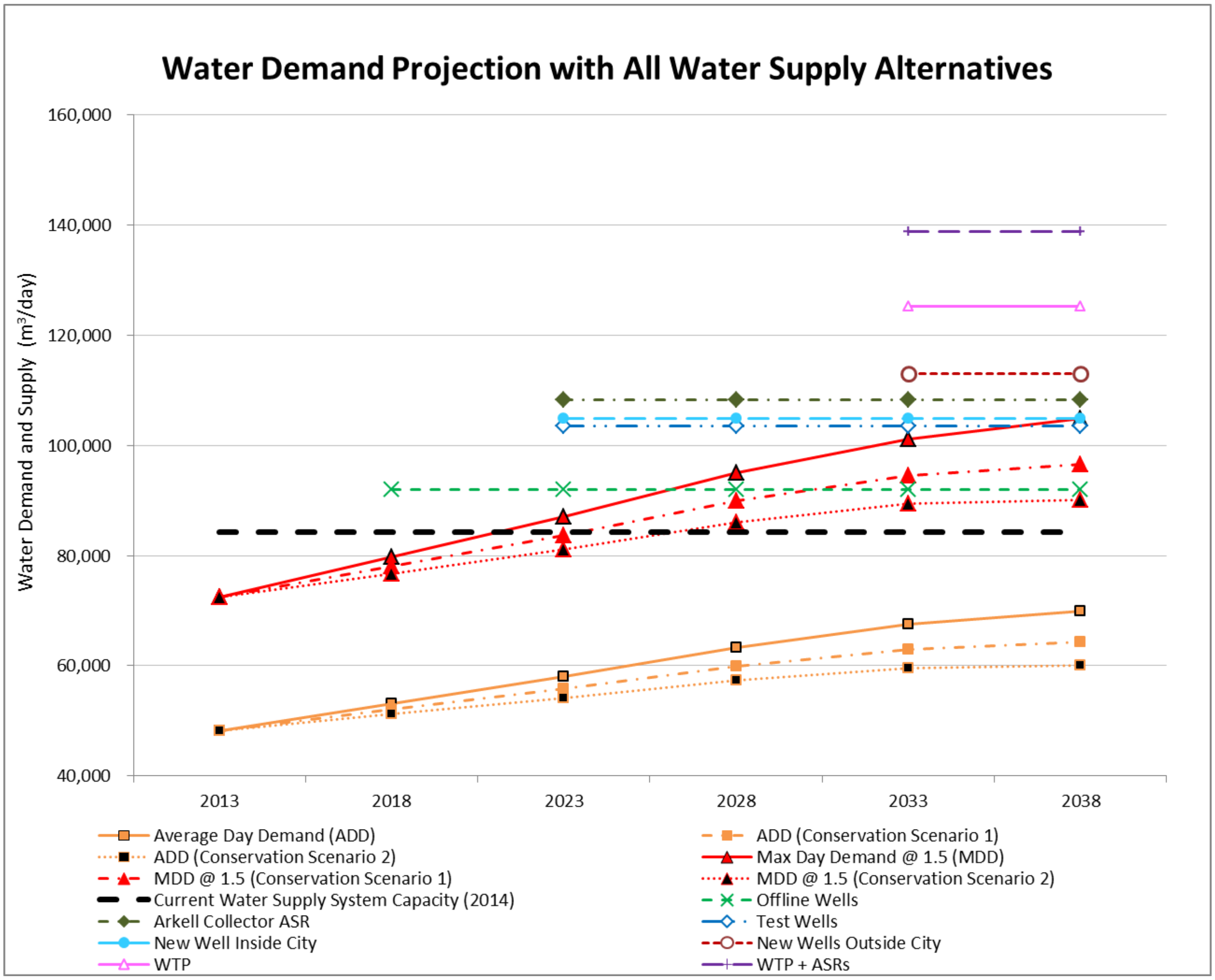


Figure 6-1 Water Demand Projection with All Water Supply Alternatives

7 PUBLIC CONSULTATION PLAN/OUTPUTS

Communications and consultation activities formed a key component of the process to develop the Guelph Water Supply Master Plan (WSMP). 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. With this in mind:

- **Pre-consultation Interviews** were held with select community members and prospective Community Liaison Committee members to understand perspectives related to water supply and to confirm community engagement needs.
- A **Community Liaison Committee** (CLC) was established to advise and provide feedback to the project team throughout the process;
- A **Municipal / Agency Workshop** provided crucial inputs from a government and approval agency perspective;
- Two public **Open Houses** were held during the course of the study, 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 four meetings of the Water Conservation and Efficiency Public Advisory Committee;
- Presentations were made at the Puslinch Township and the Guelph Eramosa Township Councils' meetings at their request; and,
- **Guelph Water User Survey**: Expectations of Service was completed in early 2014.

Figure 7-1 illustrates the communications and consultation activities undertaken as part of the EA process for the Guelph WSMP.

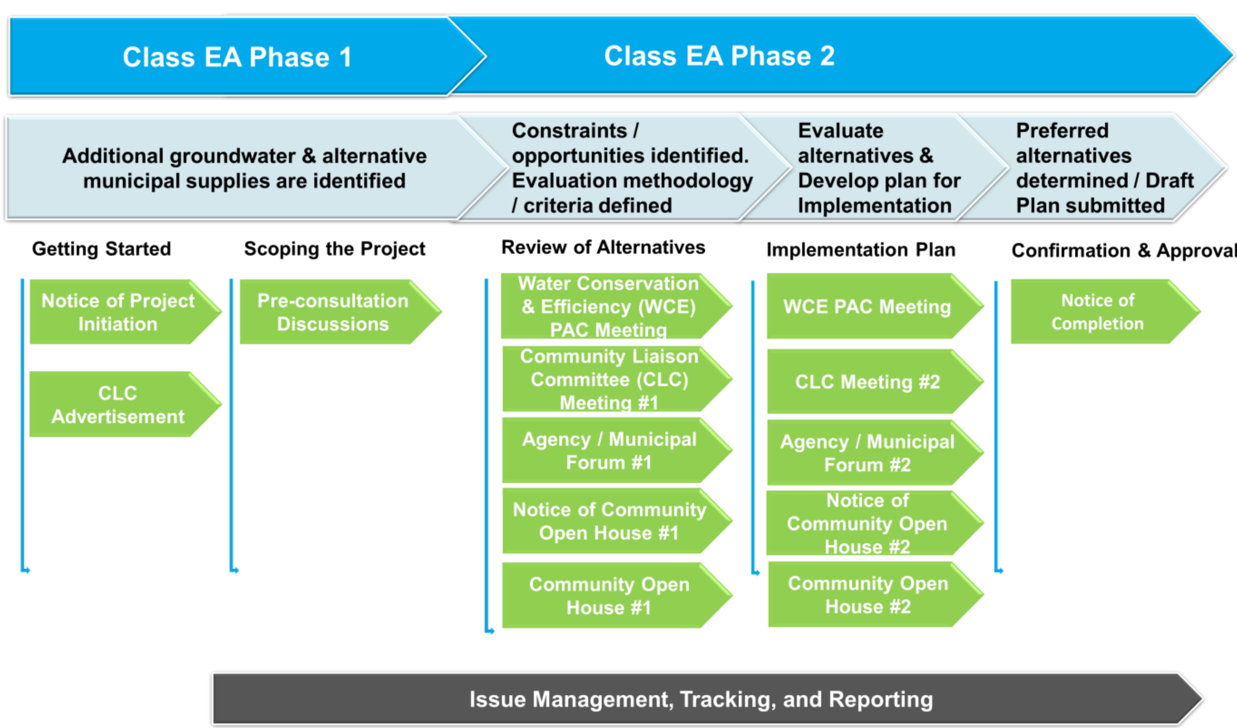


Figure 7-1 Consultation Process

A Technical Memorandum (refer to **Appendix E**) was prepared to summarize public consultation activities and feedback.

This update follows the requirements of a Municipal Class Environmental Assessment (Class EA). The updated Water Supply Master Plan identifies constraints and opportunities related to our existing water supply system. It also prioritizes a number of individual projects to increase the capacity of the existing water supply system. This section presents an overview of consultation for the Guelph Water Supply Master Plan Update and to document responses.

7.1 Notice of Commencement

One of the key objectives of the environmental planning process is to provide the public, interested parties and agencies with opportunities for meaningful input. To meet this objective, comprehensive public and agency notification was undertaken.

The Notice of Commencement for this project was advertised on May 16, 2013 in the following locations:

- Milton Canadian Champion, May 16, 2013
- Guelph Tribune, May 16, 2013
- Wellington-Advertiser, May 16, 2013
- City website: http://guelph.ca/plans-and-strategies/water-supply-master-plan/

The Notice of Commencement was also sent to the project mailing list, which included the following agencies and First Nations groups (**Table 7-1**):

Table 7-1 Agency, Municipality and First Nations Groups Receiving the Notice of Commencement

Agency	Contact/ Position
Ministry of Natural Resources	Mr. Mike Stone, Guelph District Planner
Ministry of Natural Resources	Mr. Ian Hagman, Guelph District Manager
Ministry of Natural Resources, Water Resources Section, Lands and Waters Branch	Ms. Paula Thompson, Senior Policy Advisor
Ministry of the Environment	Ms. Annamaria Cross, Manager Environmental Approvals Branch
Ministry of the Environment	Ms. Jane Glassco, District Manager, Guelph
Ministry of Agriculture, Food, and Rural Affairs, Environmental and Land Use Policy Unit	Ms. Carol Neumann, Rural Planner, Environmental Land Use Policy, Food and Environmental Policy Branch
Ministry of Agriculture, Food, and Rural Affairs	Mr. David Cooper, Manager, Environmental & Land Use Policy
Wellington-Dufferin-Guelph Health Unit	Mr. Shawn Zentner Program Manager, Health Protection Division
Wellington-Dufferin-Guelph Health Unit	Mr. Chuck Ferguson, Manager of Communications
Ministry of Municipal Affairs and Housing, Planning Services, Southwestern Municipal Services Office	Mr. Bruce Curtis, Manager Community Planning & Development
Ministry of Culture, Tourism and Recreation, Southwest Area Head Office	Chris Stack Added Sept. 6, 2013, Manager Southwest Area
Guelph / Eramosa Township	Ms. Janice Sheppard, CAO

Agency	Contact/ Position
County of Wellington	Mr. Scott Wilson, CAO
Township of Puslinch	Karen Landry, CAO
Town of Milton	Mr. Mario Belvedere
GRCA	Mr. Martin Keller, Source Protection Program Manager
Six Nations of the Grand River	Chief William Montour
Mississauga's of the New Credit First Nation	Chief Bryan LaForme
Aboriginal Affairs and Northern Development Canada	Consultation Unit

The Notice of Commencement identified the purpose of the Water Supply Master Plan study, project team contact information, and the many opportunities for public engagement as part of the Municipal Class Environmental Assessment process. The Notice of Commencement can be found in **Appendix E**.

7.2 Consultation Round #1

The first round of consultation occurred in September and October 2013. The purpose of the first round of consultation was to introduce the Water Supply Master Plan Update process and the proposed methodology, and the problem/opportunity statement which explains the anticipated need for additional water supply.

Activities during this period included:

- Community Liaison Committee Meeting #1
- Municipality/Agency Meeting #1
- Community Open House #1

7.2.1 Community Liaison Committee #1

7.2.1.1 Composition

A Community Liaison Committee (CLC) was established to help the project team understand what water supply issues are important to Guelph residents. The CLC also provided guidance on key aspects of the Guelph Water Supply Master Plan update, including:

- Objectives and scope of the Master Plan Update;
- Issues and opportunities to be addressed;
- Alternative solutions to be assessed;
- Evaluation method and criteria to be applied; and
- Preferred alternatives and implementation strategy.

The committee included 20 individuals, with membership drawn from a cross-section of the community to provide a broad and balanced perspective. **Table 7-2** identifies the individuals selected for the committee and their affiliation.

Table 7-2 Community Liaison Committee Composition

Business / Industry			
University of Guelph	1a	Bob Carter	Assoc. VP, Physical Resources
University of Guelph	1b (alternate)	Dan Maclachlan	Director, Design, Engineering and Construction
Chamber of Commerce	2	Janet Roy	Chair and CEO
Sleeman Breweries Ltd.	3a	Ed McCallum	Director of Brewing Development
Sleeman Breweries Ltd.	3b (alternate)	Dave Klaassen	National Director of Total Quality
Environment			
Water Conservation & Efficiency Advisory Committee	1	Mike Darmon	Chair
Wellington Water Watchers	2	Kim Gutt	Communications Director
Agriculture			
Wellington-Guelph Federation of Agriculture	1	Gordon Flewwelling	President
Land Development			
Guelph Wellington Developers' Association	1	Angela Kroetsch	
Guelph & District Homebuilders' Association	2	Glenn Anderson	
Community/Social			
Friends of Guelph	1	Ken Hammill	
River Systems Advisory Committee	2	Jeremy Shute	Chair
Academia			
University of Guelph	1	Brady Deaton	Assoc. Professor, Food, Ag. & Resource Economics
University of Guelph	2	Peter Chrisholm	School of Engineering
Community at Large (Guelph)			
Resident	1	Andrea Williams	
Resident	2	Steve Chomyc	
Region of Waterloo; prior head of water services	3	John Pawley	
Community at Large (Outside Guelph)			
Hydrogeologist	1	Bill Banks	
Puslinch Councilor	2	Wayne Stokley	Puslinch Township Councilor
Guelph-Eramosa Representative	3	Chris White	Mayor of Guelph-Eramosa Township

A notification letter was sent on August 1, 2013 to individual members of the Community Liaison Committee to confirm their participation.

7.2.1.2 Objectives and Format

The first Community Liaison Committee (CLC) meeting was held on September 17, 2013 at the City of Guelph's City Hall, from 7:00 pm to 9:30 pm. Fourteen members of the CLC were able to attend the first meeting, along with two members of the public. Eight members of the project team from AECOM and the City of Guelph were also present.

During the evening, presentations were delivered by Dave Belanger and Wayne Galliher of the City of Guelph, and Patty Quackenbush of AECOM. The meeting was facilitated by Avril Fisken of AECOM.

The CLC meeting #1 presentation covered the following topics:
- Welcome and Opening Remarks
- Water Supply Master Plan Update Overview
- Guelph's Current Water Supply System
- Progress Since the 2007 Water Supply Master Plan
- The 2013 Water Supply Master Plan Update
- Next Steps

A Discussion Guide was prepared and given to each of the participants. The guide included additional information about the project, as well as questions to encourage dialogue and feedback on areas of interest. The CLC meeting minutes and presentation can be found in **Appendix E.**

7.2.2 Municipality / Agency Workshop #1

7.2.2.1 Composition

The project team encouraged the participation of agencies and local municipalities in the Guelph Water Supply Master Plan process. A series of two workshops were held to provide regulatory agencies with information about study progress, and to answer questions and obtain initial feedback.

Meeting notifications / invitations were sent by email on September 6, 2013 to agency and municipality contacts who were expected to have a potential interest in the project. These included:
- Ministry of Natural Resources
- Ministry of the Environment
- Grand River Conservation Authority
- Township of Puslinch
- Township of Guelph Eramosa
- Town of Milton
- County of Wellington
- Wellington-Dufferin-Guelph Public Health
- Ministry of Tourism and Culture
- Ministry of Municipal Affairs and Housing

Individual's representatives who were unable to attend were encouraged to send an alternate in their place.

The first Municipality and Agency Workshop was held on September 19, 2013 at the City of Guelph City Hall from 1:00 pm to 5:00 pm. Thirteen representatives from local municipalities and agencies were present, including:

- Puslinch Township – 2 representatives
- Guelph-Eramosa Township – 2 representatives
- County of Wellington – 1 representative
- Grand River Conservation Authority – 1 representative
- Wellington-Dufferin-Guelph Public Health – 1 representative
- Ministry of the Environment – 6 representatives

Ten (10) City of Guelph staff and two Project Team members from AECOM were also present at the meeting to answer questions.

7.2.2.2 Objectives and Format

The Municipality and Agency Workshop was established to provide input from a government and agency perspective to ensure that the Water Supply Master Plan update meets related local and provincial By-laws and Acts, as well as Environmental Assessment and Approval requirements.

Participants were expected to provide guidance on key aspects of the Guelph Water Supply Master Plan Update, including:

- Objectives and scope of the Master Plan Update
- Issues and opportunities to be addressed
- Alternative solutions to be assessed
- Evaluation method and criteria to be applied
- Preferred alternatives and implementation strategy

The Municipality and Agency Workshop followed the same format as the CLC meeting. Dave Belanger and Wayne Galliher of the City of Guelph, and Patty Quackenbush of AECOM delivered presentations. Avril Fisken of AECOM facilitated the meeting.

The Municipality and Agency Workshop presentation covered the following topics:

- Welcome and Opening Remarks
- Water Supply Master Plan Update Overview
- Guelph's Current Water Supply System
- Progress Since the 2007 Water Supply Master Plan
- The 2013 Water Supply Master Plan Update
- Next Steps

The Municipality and Agency Workshop minutes and presentation can be found in **Appendix E.**

7.2.3 Community Open House #1

7.2.3.1 Notification and Timing

Community Open House #1 was held on October 10, 2013 to provide interested stakeholders with an opportunity to learn more about Guelph's water supply system, review project plans and to provide preliminary input on the Problem/Opportunity statement and methodology.

A notice was prepared for Community Open House #1 and advertised in the following locations:

- City website: September 21, 2013
- Milton Canadian Champion: Thursday September 26, 2013
- Guelph Tribune: Thursday September 26, 2013
- Wellington-Advertiser: Friday October 4, 2013 (one week later resulting from an oversight at the newspaper)
- Facebook: October 8, 2013
- Twitter: October 8, 2013 and October 10, 2013

The Community Open House notice was also distributed between September 26 to 27 2013 to the project mailing list which includes elected officials, agencies, aboriginal communities, interested residents, and the Community Liaison Committee (CLC) members.

- The Community Open House notice is included in **Appendix E.**

7.2.3.2 Objectives and Format

The Community Open House was designed to provide attendees with an opportunity to:

- Learn about the study scope and the need for an updated Water Supply Master Plan
- Review existing conditions
- Review and comment on conservation and infrastructure progress since the 2007 Water Supply Master Plan
- Ask questions and discuss the project with members of the project team

Participants were greeted and encouraged to sign the Open House Attendance Sheet on arrival. A Discussion Guide was provided with questions that could be answered and deposited in the comment box provided. The agenda for the Community Open House can be found in **Appendix E.**

Information was presented at the Community Open House using two methods:

1) **Display Panels** to aid the explanation of project progress and key issues in a relaxed atmosphere. The panels were placed around the room to explain existing conditions of Guelph's water supply, progress since the 2007 Water Supply Master Plan and finally the approach for the current update. Attendees could view the panels at their own pace or with a project team member.
2) A **presentation** was provided between 7:00-7:45 pm by Dave Belanger, Water Supply Program Manager at the City of Guelph, and Patty Quackenbush, AECOM Senior Project Engineer. The presentation walked participants through the display boards and explained key project details. Time to ask questions was provided.

The presentation and the displays presented at the Community Open House were posted to the City's website and are provided in **Appendix E**.

The Community Open House provided an opportunity for members of the public to view the display material and to discuss the project with City of Guelph staff and consultant representatives. Attendees were encouraged to discuss their comments or concerns with the project team members present and to provide written comments for the comment box.

7.2.3.3 *Participation and Comments*

Sixteen members of the general public attended the Community Open House. Of these, six individuals identified themselves as home builders or from related construction and engineering firms, four were from surrounding municipalities, one was from a non-governmental organization (NGO), and the remaining five were unaffiliated or residents. These affiliations suggest that this Water Supply Master Plan update has attracted a wide cross-section of individuals, but with a focus on individuals likely to have a primary interest in the plan's policy and infrastructure implications.

7.3 Consultation Round #2

The second round of consultation occurred in April 2014. The purpose of this consultation was to provide an estimation of water supply capacity compared to demand, results from the examination of existing conditions, and to present draft alternatives and preliminary evaluation results. Activities during this period included:

- Community Liaison Committee Meeting #2
- Municipality/Agency Meeting #2
- Community Open House #2

7.3.1 Community Liaison Committee Meeting #2

The second Community Liaison Committee (CLC) meeting was held on April 8, 2014 from 7:00 pm to 9:30 pm. The meeting provided CLC members with information contained in the three technical memoranda prepared for the Water Supply Master Plan update, covering the following topics:

- Technical Memo 1 – Population and Water Supply Demand Forecasts
- Technical Memo 2 – Existing Water Supply Capacity Assessment
- Technical Memo 3 – Review of Water Supply Alternatives

Based on feedback received from the first CLC meeting, participants were provided with a copy of the presentation materials and a document summarizing the technical memoranda to facilitate the review of materials prior to the meeting.

The meeting was attended by 11 CLC members, in addition to staff from the City of Guelph and AECOM. Following the meeting, CLC members who were unable to attend were sent a copy of the presentation and a discussion sheet to provide comments. No additional comments were received from CLC members during the one week additional feedback period.

7.3.2 Municipality/Agency Workshop #2

The second Municipality/Agency Workshop was held on April 7, 2014 from 1:00 pm to 4:15 pm. Fourteen representatives attended the meeting from agencies including the Ministry of the Environment, Grand River Conservation Authority, Wellington-Dufferin-Guelph Public Health, as well Guelph-Eramosa Township, The Township of Puslinch, and the County of Wellington.

The workshop provided participants with an overview of three technical memoranda:

- Technical Memo 1 – Population and Water Supply Demand Forecasts
- Technical Memo 2 – Existing Water Supply Capacity Assessment
- Technical Memo 3 – Review of Water Supply Alternatives

The meeting minutes for the Municipality and Agency Workshop #2 are found in **Appendix E**.

7.3.3 Community Open House #2

7.3.3.1 Notification and Timing

The Notice of a Community Open House #2 was advertised in local newspapers in Guelph and the surrounding area to provide information about the event, the date and location (i.e., April 29th at Guelph City Hall), and contact information for key Project Team members. The notice was also posted to the project website http://guelph.ca/plans-and-strategies/water-supply-master-plan/ and on the City of Guelph Twitter and Facebook pages. The Community Open House notice was published at least two weeks prior to the event, as per the following schedule:

- City website: April 10, 2014
- Milton Canadian Champion, Thursday April 10th and 24th, 2014
- Guelph Tribune, Thursday April 10th, 17th and 24th, 2014
- Wellington Advertiser, Friday April 11th and 25th, 2014

The City also posted COH information on social media sites including Facebook and Twitter.

The Community Open House notice was distributed on April 14, 2014 to the project mailing list which includes elected officials, agencies, aboriginal communities, interested residents, and the Community Liaison Committee (CLC) members.

The Community Open House notice is found in **Appendix E.**

7.3.3.2 Objectives and Format

The Community Open House #2 was designed to provide attendees with an opportunity to:

- Learn about the Water Supply Master Plan project;
- Obtain details about Guelph's existing water supply system;
- Understand population demand and the need for additional water supply;
- Learn about the various alternatives considered by the project team, including their costs, benefits and limitations;
- Review preliminary evaluation tables to provide feedback on whether stakeholders agree or disagree with the information presented;
- Speak to project team members about water supply issues and concerns

Participants were greeted and encouraged to sign the Open House #2 Attendance Sheet on arrival. A Discussion Guide was provided that included questions for answering and depositing in the Comment Box provided. The agenda for Community Open House #2 can be found in **Appendix E.**

Information was presented at the Community Open House using two methods:

1) **Display Panels** to aid the explanation of project progress and key issues in a relaxed atmosphere. The panels were placed around the room to explain existing conditions of the Guelph's water supply, water supply demands vs. Population growth, and information for reviewing the preliminary evaluation tables. Attendees could view the panels at their own pace or with a project team member.
2) A **presentation** was provided between 7:00-7:30 pm by Dave Belanger, Water Supply Program Manager at the City of Guelph, and Patty Quackenbush, AECOM Senior Project Manager. The

presentation reviewed information provided on the display boards and explained key project details. A Question and Answer period followed the presentation.

The presentation and the displays presented at the Community Open House are provided in **Appendix E**.

7.3.3.3 Participation and Comments

Twenty-three members of the general public attended the Community Open House, in addition to individuals from the project team and other staff from the City of Guelph.

7.4 Engagement of Surrounding Townships

The City of Guelph understands that ensuring a safe and sustainable water supply is also an important goal of its neighbours. Engagement with surrounding communities began at the outset of the Guelph Water Supply Master Plan update process in May 2013. As part of the Notice of Commencement sent on May 16, 2013, the project team contacted community leadership of Puslinch Township, Guelph-Eramosa Township and Wellington County to set up individual meetings. The meetings introduced participants to the project, sought initial input, and identified potential CLC members outside Guelph.

The Community Liaison Committee includes representatives of Guelph-Eramosa and Puslinch Townships, two of the closest neighbours to Guelph. The participation of Puslinch Township Councillor Wayne Stokley and Guelph-Eramosa Mayor Chris White provides a broader perspective on how water supply decisions may interest these communities.

7.4.1 Consultation Round #1

Local Township representatives attended the Municipality and Agency Workshop held on September 19, 2013 to introduce the project and areas of mutual interest with respect to the local water supply.

Follow up letters were sent to Puslinch Township on September 26, 2013 and Guelph-Eramosa Township on October 1, 2013 to notify residents about the community Open House, and to seek an opportunity to deliver a delegate presentation to each of the councils. Project team staff presented to Puslinch Township Council on October 2, 2013 and to Guelph-Eramosa Township Council on October 21, 2013. The meetings provided an overview of the presentation given at the Community Open House with the goal of obtaining input from the councils on the path ahead.

7.4.2 Consultation Round #2

During Consultation Round #2, Guelph-Eramosa Township and Puslinch Township representatives attended the Municipality/Agency Workshop on April 7, 2014 and the Community Open House on April 29, 2014.

As well, City of Guelph staff were invited to present project progress as delegates to the Guelph-Eramosa council meeting on May 5, 2014 and to the Puslinch Township council meeting on May 7, 2014.

A staff member from Center Wellington Township, who is also affiliated with Wellington County, asked to be added to the project mailing list on March 11, 2014, and subsequently attended the Municipality/Agency Workshop #2 and Community Open House #2.

Township Notification Letters and a response received from GET can be found in **Appendix E.**

7.5 Aboriginal Engagement

The City of Guelph recognizes the important relationship between the Crown and Aboriginal Communities in Canada. Section 35 of the Canadian Constitution affirms the Aboriginal Rights of Aboriginal people (First Nations, Inuit, and Métis) in Canada, and subsequent Supreme Court of Canada decisions have recognized that the Crown has a duty to consult and accommodate in matters where Aboriginal Rights or Treaty Rights may be infringed upon.

To seek input on this requirement, Notice of Commencement letters were sent on August 13, 2013 to Six Nations of the Grand River First Nation and the Mississauga's of the New Credit First Nation, two communities close to Guelph that may be interested in the project. The letters explained the project purpose, asked for information pertaining to Aboriginal Rights or Treaty Rights as it relates to the project, and provided contact information for more information.

The project team also sent a letter to the Aboriginal Affairs and Northern Development Canada (AANDC) and the Ministry of Aboriginal Affairs (MAA) to seek further clarification on other communities that should be provided with information about the project. AANDC replied on August 27, 2013 that the two communities already contacted were the two main Aboriginal groups that should be consulted if project impacts are expected within a 50 kilometres radius. As a Master Plan process, no project effects will occur due to the project within or beyond 50 kilometres.

On September 11, 2013, the Ontario Ministry of Aboriginal Affairs replied and identified a third group, the Haudenosaunee Confederacy Chiefs Council, as potentially requiring consultation. This group was added to the contact list and was included in subsequent notices.

The letters to Aboriginal communities and Aboriginal agencies are found in **Appendix E.** Representatives from each of the identified aboriginal communities have been included on the mailing list, and received information about the project including: the Notice of Commencement (mailed on August 13, 2014), Open House notification emails and the Notice of Completion.

No requests for information have been received from the aboriginal groups identified for this project.

7.6 Water Conservation and Efficiency Public Advisory Committee Meetings

Dave Belanger of the City of Guelph and Patty Quackenbush of AECOM delivered a presentation to and consulted with the City of Guelph Water Conservation and Efficiency Public Advisory Committee (WCEPAC) during its October 3, 2013 meeting. The meeting included the following topics:

- WSMP – Overview
- Guelph's Current Water Supply System
- City Updates – Since 2007 WSMP
- WSMP Update – Objectives / Scope of Work
- Next Steps
- Discussion

The meeting provided an opportunity to obtain feedback on the project following the first phase of public consultation, and to seek the opinion of committee members on how best to move forward with the project objectives. The minutes of this meeting are attached in **Appendix E**.

An update was also provided at the WCEPAC meeting held November 7, 2013 which focused on the proposed approach for development and review of water conservation alternatives. Additional updates and presentations were provided at meetings held on February 12, 2014 and April 3, 2014. At the last meeting, the presentation provided to the other groups in the second Round of consultation was reviewed with a focus on the water conservation scenarios.

All discussions and presentations provided at the WCEPAC meetings are posted on the City of Guelph website at:
http://guelph.ca/city-hall/council-and-committees/advisory-committees/water-conservation-and-efficiency-public-advisory-committee/

7.7 Guelph Water User Survey: Expectations of Service

The University of Toronto approached the City of Guelph in fall of 2013 to determine whether the City was willing to actively participate in facilitating a survey to Guelph residents regarding expectations of service as it relates to water. The timing of this request was such that it allowed the WSMP Update project team to provide input into the survey questions with the objective of gaining input into the update and feedback on the water supply alternatives being considered. The survey was carried out in early 2014 with preliminary results provided prior to completing the preliminary evaluation of alternatives, and therefore, public opinion on various alternatives and issues is captured in the evaluation comments.

The *Guelph Water Use Report (Oracle Poll Research, March 2014)* (**Appendix E**) provides a summary of the purpose, demographics of those responding, and responses to the survey questions asked. Among the 400 residential water users surveyed it was found that the awareness of Guelph water users is high, with the majority understanding the source of potable water and their estimated consumption. The report contains much information that will be of use to the City and Waterworks in communicating with City residents regarding water sources, use, rates and future programs. However, there are also some of the key findings that are of interest to the WSMP update are as follows:

- The current top water issues in order of priority are water scarcity, water quality, aging infrastructure and costs
- Most respondents try to conserve water and have focussed on installing efficient indoor devices and appliances, as well as reducing lawn watering
- In times of drought, priorities for potable water include indoor household use, wildlife and the natural environment, and municipal operations over other demands, with the majority of responders strongly agreeing that at such times landscaping uses should be restricted
- A strong majority of respondents support an increase in conservation
- The majority of respondents agree with the current water pricing structure but also support increasing block rates. Most disagreed with declining block rates and flat fees.
- There was general support for new groundwater sources within Guelph as well as outside of Guelph
- Responses related to acceptance of using water from contaminated sources are varied, with slightly stronger negative opinions
- Responses relating to the use of the Eramosa River or Speed River/Guelph Lake were mixed.

In this update, these findings were incorporated into the evaluation summary comments and considered when completing the comparative ranking of alternatives.

7.8 Correspondence Record

A Correspondence Record was established for this project for correspondence beyond notices and other information sent to a wide audience. All comments pertaining to the project, or requests for additional information were passed on to the project team or the appropriate person for a response.

A list of the correspondence and responses can be found in **Appendix E.**

7.9 Notice of Completion

On May 29, 2014, the Notice of Completion was sent to the project mailing list about the end of Phase I and II of the Guelph Water Supply Master Plan Update, and published in the following locations:

- City website,
- Milton Canadian Champion,
- Guelph Tribune, and,
- Wellington Advertiser,

In addition, the Notice of Completion was made available for the 30 day review period in hard copy in the following locations:

- City of Guelph Public Library (Main Branch)
- City of Guelph Water Services Department
- City of Guelph Clerk's Office

At the completion of the 30 day review period, if no additional comments are provided, the final report will be submitted the City of Guelph Council for approval. The Notice of Completion can be found in **Appendix O.**

7.10 Public Consultation Conclusion

Overall the public was pleased to be informed and to participate in this study. The main points of discussion at the Community Open Houses were water conservation programming, the impact of major water users on the water system, source water protection and water quality. The Community Open House format allowed participants to view the boards at their own pace, listen to the presentation by the project team, and to ask questions in a variety of forums.

The quality of questions and the engagement of those present was a positive indicator of the interest in water supply issues within the City of Guelph and the surrounding area. The Project team encouraged those present to email any follow up questions or comments they had to the Project team for answering or consideration.

The additional consultation offered and provided to the Townships at their request was also well received and provides 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. Township representatives raised concerns regarding source protection issues and potential constraints on land uses resulting from new water supplies.

8 IMPLEMENTATION RECOMMENDATIONS

8.1 Financial Evaluation Approach

Based on the evaluation outputs for each of the alternatives summarized in **Table 6-9**, a timeline and budget is established for implementing the preferred alternative. This strategy includes a financial analysis for determining the optimum conservation scenario as compared to the water supply alternatives.

This analysis also 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 all of the test wells and inside-City groundwater options is scheduled to occur in the next four years (2015-2018) 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, minimal budget is allocated in the short-term for additional modeling work to update and substantiate the estimated capacities and potential impacts related to these alternatives prior to the next WSMP update. Further investigation is budgeted in the mid-term.
- An assumed order of groundwater projects based on the following priorities:
    - water supply sources currently included in on-going Class EAs pursuant to recommendations from the 2007 WSMP: Southwest Quadrant (e.g. Ironwood test well); and Clythe Well
    - test well with high potential for large volume production and low anticipated treatment requirements (i.e. lower costs) – Logan test well
    - off-line wells - Sacco Well; Smallfield Well
    - upgrades to Lower Road Collector System – although at a higher per capacity cost, this must be done in advance of the Collector System/ASR well project
    - new well in City
    - test wells with lower certainties – Scout Camp test well; Hauser test well
    - Collector Systems & ASR wells – longer lead-in time to allow for feasibility review; also Lower Road Collector System would require upgrades prior to implementation.

  It is important to note that the assumptions made to the above prioritization 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 supply is always greater than 90% to ensure sufficient capacity for proposed development commitment, 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 not to be compared to the redundancy and security of supply allowance which is included in the design maximum day factor of 1.5. The additional 10 to 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 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.

Table 8-1 Assumed Order of Project Implementation

Order of implementation	Project Name	Project Type
Project 1	Southwest Quadrant (Ironwood test well)	Test Wells
Project 2	Clythe Well	Offline Wells
Project 3	Logan test well	Test Wells
Project 4	Sacco Well	Offline Wells
Project 5	Smallfield Well	Offline Wells
Project 6	Lower Road Collector	Offline Wells
Project 7	Sunny Acre	New Well Inside City
Project 8	Scout Camp test well	Test Wells
Project 9	Hauser test well	Test Wells
Project 10	Arkell Collector ASR Wells	Arkell Collector
Project 11	Guelph South	New Wells Outside City
Project 12	Guelph North	New Wells Outside City
Project 13	Guelph Lake WTP	Surface Water
Project 14	Guelph Lake WTP and ASR wells in Northeast Quadrant	Surface Water

8.2 Recommended Water Conservation Strategy

From a water supply planning perspective, water conservation delays the requirement to implement high cost water supply projects to meet demand. Although there are still several low cost opportunities for reducing per capita water demand, as Guelph continues with initiatives to incrementally reduce water usage, marginal costs will increase. In order to fully understand the trade-offs between demand management and the need for additional water supply, a full 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, a number of conservation scenarios were explored in order to establish the cost associated with varying bundles of possible programs. As discussed in **Section 5**, five original 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 $1.8 million/year, and reduce average day water demand by 990 m^3/d to 9,842 m^3/d. Each of the water conservation scenarios explored will delay the need to implement proposed projects for increasing the water supply, assuming that the conservation is successfully implemented to achieve the desired targets.

While most 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 scheduled sooner rather than later. This study looked at a range of possible water conservation scenarios which are described in detail in **Section 5.2**, four of which were reviewed in more detail through a financial analysis completed in **Appendix F**, as presented in **Table 8-2**.

Table 8-2 Water Conservation Scenarios

	Timing	Reduction in Average Day Demand (m^3/d)	Total Program Cost (Non-Discounted)
Base Case	NA	990	$ –
Current WCESU Approved Programming	2014 to 2025	5,556	$5,685,930
Enhanced Water Conservation	2014 to 2038	9,147	$13,864,780
Maximum Water Conservation	2014 to 2038	9,842	$42,267,600

Under the Base Case without any spending on water conservation, natural savings in water demand are forecasted due to improving building standards (changes in 2014 Ontario Building Code), and consumer reaction to real increases in the price of water. With reference to the five scenarios discussed in **Section 5**, Current WCESR Approved Programming represents Scenario 1; Maximum Water Conservation represents Scenario 2; and Enhanced Water Conservation is a variation on Scenarios 3 to 5 developed through a closer financial review of the overall costs and reductions. The current Water Conservation and Efficiency Strategy Update (WCESU) Approved Programming is a continuation of the program the City is currently implementing. Enhanced Water Conservation goes beyond the current approved programming and could include initiatives such as rate reform, new retrofit incentives, active water loss management, and other initiatives. Maximum Water Conservation looks at implementing all potential demand management options without consideration of the system cost.

This analysis compares the forecasted impacts of different water conservation 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 analysis does not look at the costs of any one water supply project on conservation scenario in isolation. Rather the analysis looks at the total combined system cost of all of the initiatives, giving consideration for timing of projects.

For each of the water conservation scenarios the following assumptions were made:
- Water conservation results in savings from the 2014 base water demand number.
- Full water conservation scenario savings are gradually achieved over the duration of the program.

Water conservation allows water supply projects to be delayed and/or avoided within the 25 year study period. This is because as increased water conservation is achieved, per capita demand is reduced, lowering overall water demand. If overall demand is lowered, the City's current water sources will meet demand for a longer period of time before more sources are needed to meet an increased overall demand. **Figure 8-1** shows the relationship between the availability of and demand for water supply for the Enhanced conservation scenario. The future system capacity incorporates new supply sources as required in the order found in **Table 8-1** to ensure that capacity exceeds 90% demand at all times.

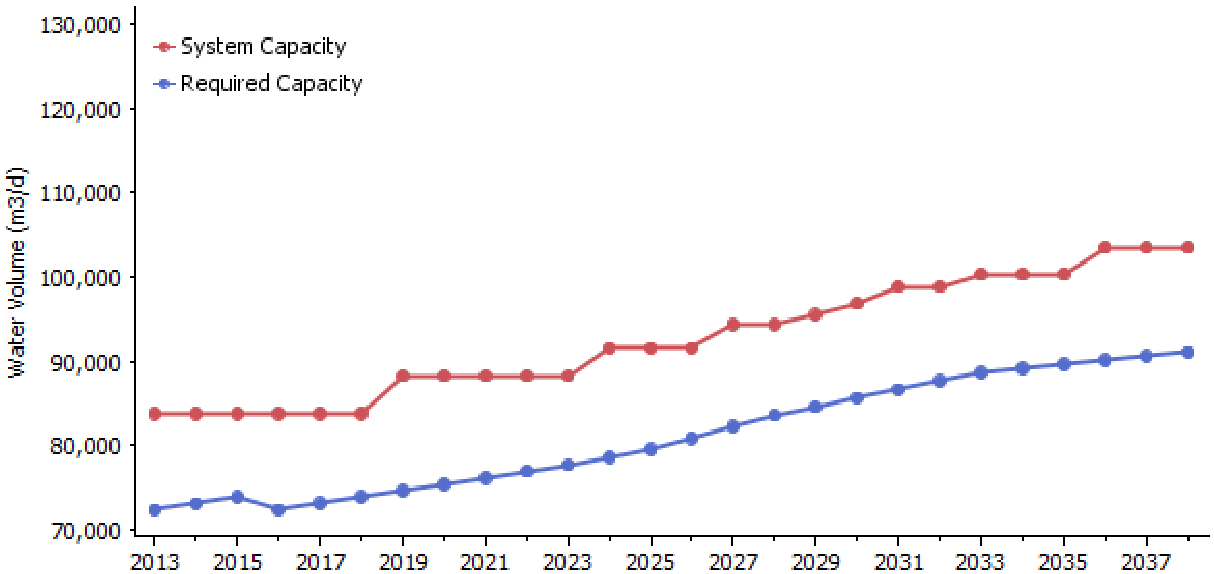


Figure 8-1. Water Supply and Required Capacity with Enhanced Conservation Scenario

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.

Table 8-3 Timing of Proposed Water Supply Projects under Different Conservation Scenarios

Project No.	Project Name	Timing			
	Base Forecast	Base Case	Current WCESU Approved Programming	Enhanced Conservation	Maximum Conservation
Project 1	SWQ (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 No.	Project Name	Timing			
	Base Forecast	Base Case	Current WCESU Approved Programming	Enhanced Conservation	Maximum Conservation
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 Northeast Quadrant	Post 2038	Post 2038	Post 2038	Post 2038

The schedule of when water supply projects come online is dependent on the City's overall demand for water and is different under each of the four water conservation scenarios. This in turn impacts capital and operational spending. The capital spending on water supply projects is combined with the spending on water conservation. This combined expenditure over time results in a specific net present value of cost for each of the four different water conservation scenarios and is presented in **Table 8-4**.

Table 8-4 Present Value and Reduction in Average Day Demand for Conservation Scenarios

	Reduction in Average Day Demand (m^3/d)	Present Value (PV) Cost of System
Base Case	990	$78,260,000
Current WCESU Approved Programming	5,556	$58,696,000
Enhanced Water Conservation	9,147	$59,959,000
Maximum Water Conservation	9,842	$75,467,000

This analysis considers four types of expenditure (abbreviations in parentheses are used in the following figures):

- Water Supply Capital Cost (Supply.Capx)
- Water Supply Operating Cost (Supply.Opx)
- Water Conservation Indirect Cost (Conservation.Indirect)
- Water Conservation Direct Cost (Conservation.Direct)

Water Supply Capital Cost is the spending on one-time investments to implement identified water supply projects. Water Supply Operating Costs are the annual costs incurred in the operation of the various water supply sources. Water Conservation Indirect Cost is the fixed annual base spending to maintain an

organization that can implement various water conservation initiatives. Water Conservation Direct Cost is the project specific spending targeted at reducing water demand.

The combined water supply and conservation cash flow for each of the above scenarios is provided in **Appendix F**. The Enhanced Water Conservation programming extends the WCESU program and continues to 2038. This is the conservation option that results in the lowest system costs. **Figure 8-2** shows the combined water supply and conservation cash flow.

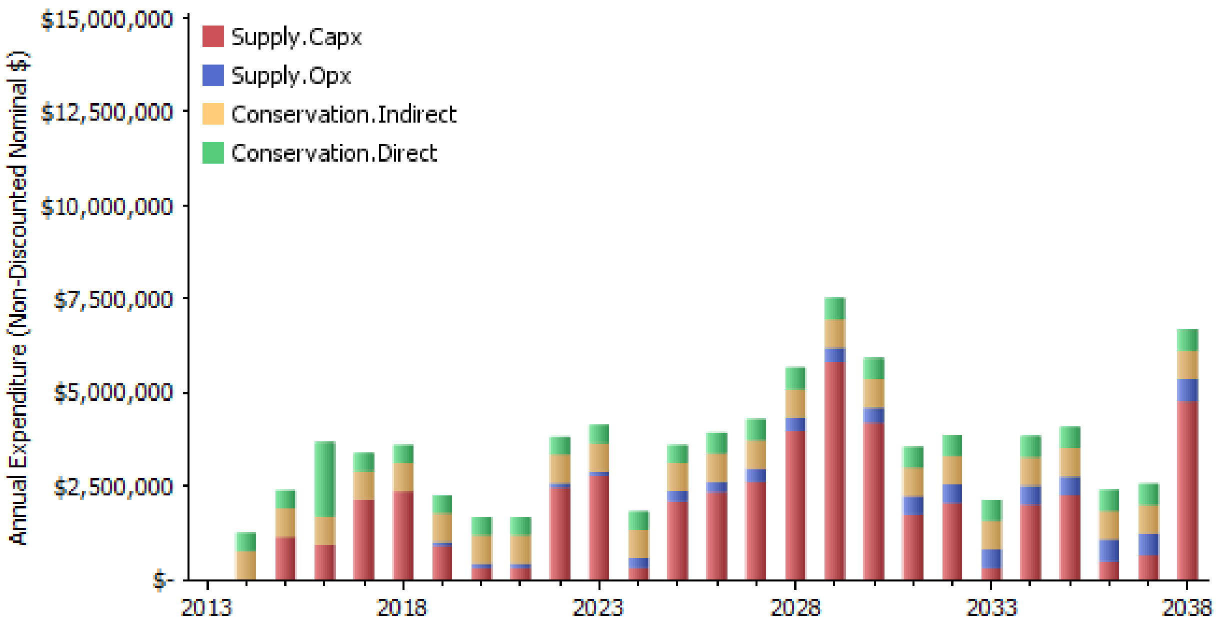


Figure 8-2 Incremental Spending on Water Supply from 2014–2038 – With Enhanced Water Conservation Program

Beyond the straight financial benefits from water conservation, there are additional ecological and other intangible benefits associated with reduced water demand. The following table shows the Net Present Value (NPV) of costs for each of the scenarios against the reduction in average water demand.

Table 8-5 NPV System Cost / m^3/d Reduction in Average Day Water Demand

	NPV System Cost / m^3 /day reduction in water demand
Base Case	$79,089
Current WCESU Approved Programming	$10,565
Enhanced Water Conservation	$6,555
Maximum Water Conservation	$7,668

Based on the above analysis AECOM recommends implementing the Enhanced Water Conservation Scenario. This scenario will result in a target for reduction in average day demand of 9,150 m^3/d by 2038. Although the water conservation programs included in the Enhanced Water Conservation Scenario are not fully specified, to allow for flexibility in subsequently determining the best strategy for achieving the

water conservation target, it is important to note that rate reform is a key driver of water conservation in the enhanced scenario. If the City does not proceed with rate reform as part of the enhanced scenario it will likely be difficult to hit the specified water conservation target, which would consequently necessitate additional water supply projects within the study period to meet the greater required system capacity.

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.

Considering the time value of money, delaying the currently identified phase III expansion of the wastewater treatment plant (2023 – 2031; $62.2 Million) by just one year could result in a NPV system cost savings of up to $1.5 million dollars.

8.3 Preferred Water Supply Alternative

The preferred water supply alternative consists of the Enhanced Water Conservation Scenario as well as Projects 1 through 8 listed as identified in **Table 8-6.** These are all groundwater projects included in the first ranked alternatives in the evaluation process, consisting of existing municipal off-line wells, existing municipal test wells, and a new well inside the City. .

Table 8-6 Preferred Water Supply Alternative

<table>
<tr><th>Alternative</th><th>Ranking</th><th>Projects</th></tr>
<tr><td>1A – Conservation & Demand Management</td><td>1</td><td>Enhanced Water Conservation Scenario</td></tr>
<tr><td>2B – Groundwater: Existing Municipal Off-line Wells</td><td>1</td><td rowspan="3">1. Southwest Quadrant well (e.g. Ironwood test well)
2. Clythe Well
3. Logan test well
4. Sacco Well
5. Smallfield Well
6. Lower Road Collector System
7. Sunny Acre (new well inside City)
8. Scout Camp test well</td></tr>
<tr><td>2C – Groundwater: Municipal Test Wells</td><td>1</td></tr>
<tr><td>2D – Groundwater: New Well inside City</td><td>1</td></tr>
</table>

8.3.1 Recommended Water Supply Alternative Implementation

The preferred alternative consists of proceeding with enhanced water conservation and demand management, and developing existing and new groundwater sources within the City to meet the projected water demand requirements to 2038. 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. The order of implementation of the groundwater projects was selected based on priorities which are subject to change with time to align with the City's priorities and other planned works. The order and timing of the individual well supplies within these groupings of supply options will be determined as the City moves through development of each. However, a general 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 fraction 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 (2015-2018) 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 recommended timeline developed for the recommended Enhanced Water Conservation scenario.

Table 8-7 illustrates the impact of the Enhanced Water Conservation scenario on the required project implementation schedule, along with total annual spending.

Table 8-7 Capital Cost Forecast – Enhanced Conservation Scenario

Project	1	2	3	4	5	6	7	8	9	10	11	12	Total Capital Cost for Water Supply Projects	Enhanced Water Conservation Program*		Total Budget
Year	Ironwood	Logan	Clythe	Smallfield	Sacco	Lower Collector	Sunny Acre	Scout Camp	Hauser	Arkell Collector ASR	Guelph South	Guelph North		Indirect**	Direct**	
2014	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$760,000	$473,828	$1,233,828
2015	$105,000	$670,000	$597,000	$0	$0	$0	$405,000	$0	$0	$0	$0	$0	$1,777,000	$760,000	$473,828	$3,010,828
2016	$264,000	$0	$0	$810,000	$350,000	$280,000	$405,000	$322,000	$0	$0	$0	$0	$2,431,000	$760,000	$1,973,828	$5,164,828
2017	$264,000	$0	$0	$0	$0	$0	$0	$0	$363,000	$603,333	$0	$0	$1,230,333	$760,000	$473,828	$2,464,161
2018	$1,701,500	$0	$0	$0	$0	$0	$0	$0	$363,000	$603,333	$79,200	$79,200	$2,826,233	$760,000	$473,828	$4,060,061
2019	$1,701,500	$0	$0	$0	$0	$0	$0	$0	$0	$603,333	$0	$0	$2,304,833	$760,000	$473,828	$3,538,661
2020	$0	$314,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$314,000	$760,000	$473,828	$1,547,828
2021	$0	$314,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$314,000	$760,000	$473,828	$1,547,828
2022	$0	$1,755,500	$0	$0	$0	$0	$0	$0	$0	$0	$712,800	$0	$2,468,300	$760,000	$473,828	$3,702,128
2023	$0	$1,755,500	$309,000	$0	$0	$0	$0	$0	$0	$0	$0	$712,800	$2,777,300	$760,000	$473,828	$4,011,128
2024	$0	$0	$309,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$309,000	$760,000	$473,828	$1,542,828
2025	$0	$0	$1,760,000	$270,000	$0	$0	$0	$0	$0	$0	$0	$0	$2,030,000	$760,000	$473,828	$3,263,828
2026	$0	$0	$1,760,000	$270,000	$250,000	$0	$0	$0	$0	$0	$0	$0	$2,280,000	$760,000	$556,571	$3,596,571
2027	$0	$0	$0	$1,392,500	$250,000	$598,000	$0	$0	$0	$0	$0	$0	$2,240,500	$760,000	$556,571	$3,557,071
2028	$0	$0	$0	$1,392,500	$1,485,000	$598,000	$0	$0	$0	$0	$0	$0	$3,475,500	$760,000	$556,571	$4,792,071
2029	$0	$0	$0	$0	$1,485,000	$3,842,500	$295,000	$0	$0	$0	$0	$0	$5,622,500	$760,000	$556,571	$6,939,071
2030	$0	$0	$0	$0	$0	$3,842,500	$295,000	$0	$0	$0	$0	$0	$4,137,500	$760,000	$556,571	$5,454,071
2031	$0	$0	$0	$0	$0	$0	$1,561,000	$0	$0	$0	$0	$0	$1,561,000	$760,000	$556,571	$2,877,571
2032	$0	$0	$0	$0	$0	$0	$1,561,000	$307,000	$0	$0	$0	$0	$1,868,000	$760,000	$556,571	$3,184,571
2033	$0	$0	$0	$0	$0	$0	$0	$307,000	$0	$0	$0	$0	$307,000	$760,000	$556,571	$1,623,571
2034	$0	$0	$0	$0	$0	$0	$0	$1,883,000	$0	$0	$0	$0	$1,883,000	$760,000	$556,571	$3,199,571
2035	$0	$0	$0	$0	$0	$0	$0	$1,883,000	$0	$389,333	$0	$0	$2,272,333	$760,000	$556,571	$3,588,904
2036	$0	$0	$0	$0	$0	$0	$0	$0	$241,000	$389,333	$0	$0	$630,333	$760,000	$556,571	$1,946,904
2037	$0	$0	$0	$0	$0	$0	$0	$0	$241,000	$389,333	$0	$0	$630,333	$760,000	$556,571	$1,946,904
2038	$0	$0	$0	$0	$0	$0	$0	$0	$1,241,500	$2,988,000	$0	$0	$4,229,500	$760,000	$556,571	$5,546,071

*** Conservation spending includes approved budgets already allocated to the City Water Conservation Program**
**** Conservation costs: Indirect – overhead costs; Direct – program costs**

It will be important for the City to closely track the success of the water conservation 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. 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 25 year study period although the water supply capacity is not required until outside the study period. This points to the need to look beyond 25 years to better understand potential future requirements to determine where preliminary work must take place in preparation for the following years. This is addressed further in the following section.

8.4 Future Water Supply Challenges and Opportunities (beyond 2038)

8.4.1 Beyond the Study Period (to 2041)

For the purpose of co-ordinating other City initiatives and determining budgetary requirements from 2013 to 2041 to align with the Province's Growth Plan for Greater Golden Horseshoe municipalities - Amendment 2, the population and water demand projections are extended based on the City planning information referenced in **Section 3**, as shown in **Figure 8-3**.

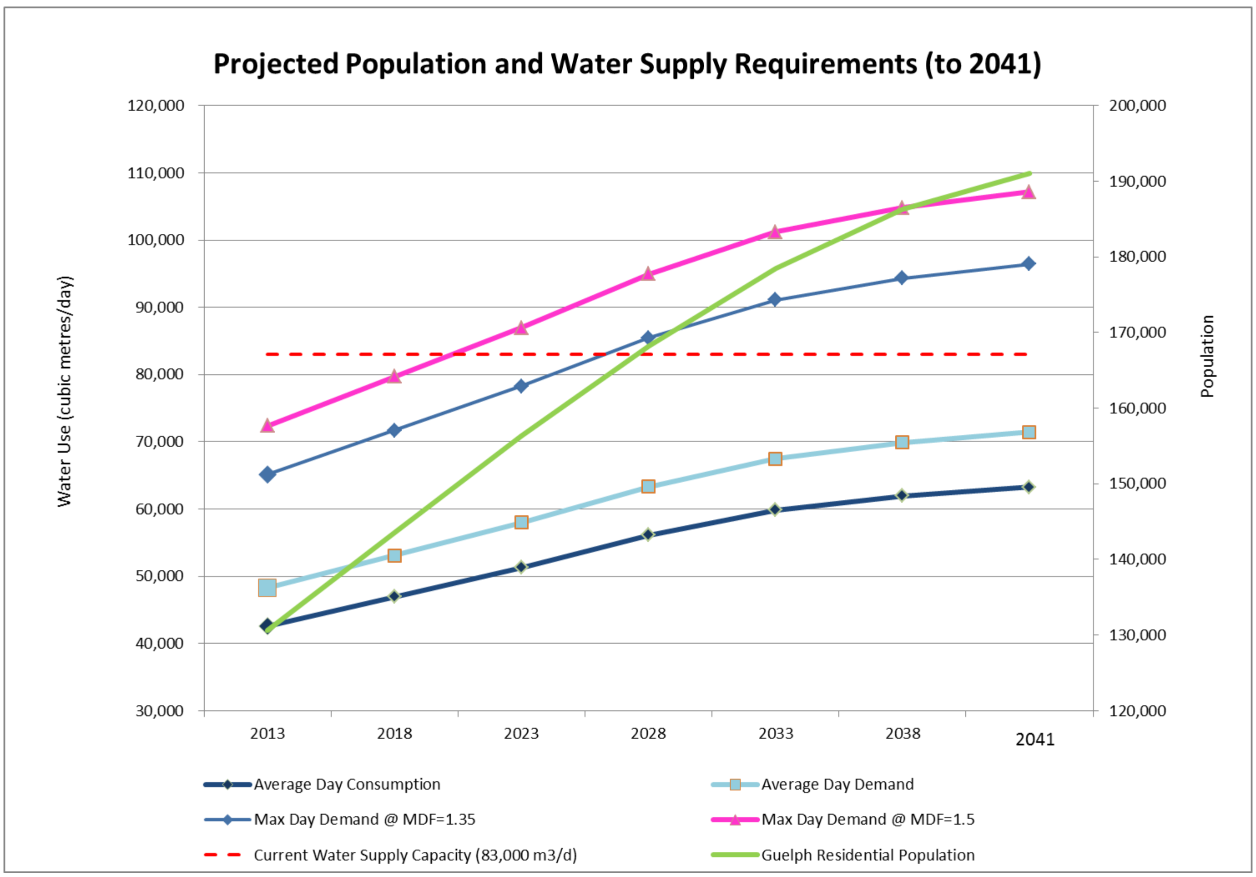


Figure 8-3 Projected Population and Water Supply Requirements to 2041

Figure 8-4 depicts the demand projections including the range in water conservation and demand management scenarios considered in this update, together with all possible future water alternatives.

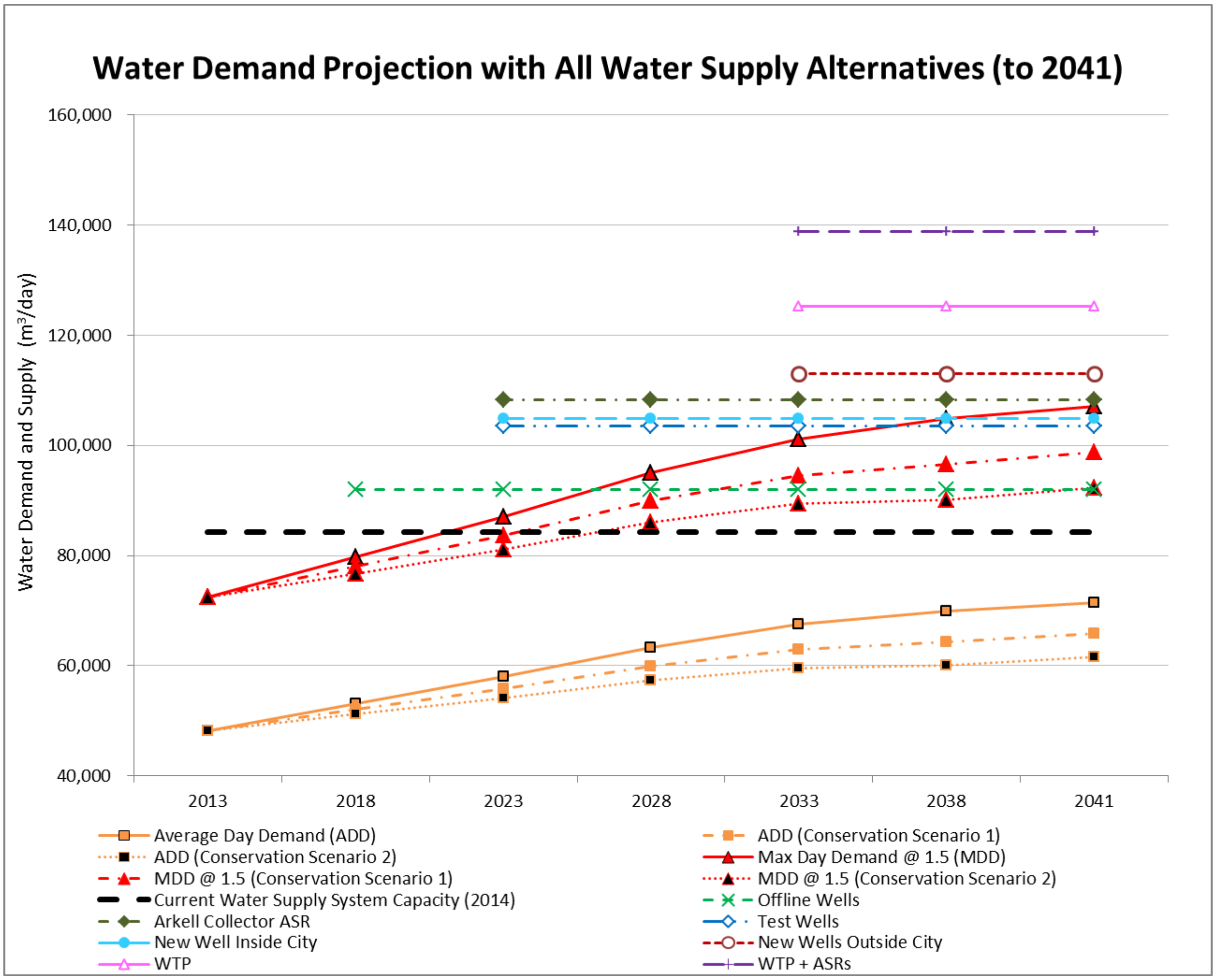


Figure 8-4 Water Demand Projection with All Water Supply Alternatives to 2041

8.4.2 Beyond the Study Period (to 2048)

In order to determine whether any of the water supply projects are required within the period of 2038 to 2041, one must also consider the ten year period following 2038, since even though new water supply may not be required in the additional three years, spending for long-term projects may commence within this timing. For years beyond 2041, the growth and demand projections are extrapolated by assuming a continued 0.9% increase based on growth between 2031 and 2041.

For the four different conservation scenarios, the following **Table 8-8** indicates the required timing of additional projects.

Table 8-8 Timing of Proposed Water Supply Projects Beyond the Study Period (2039-2048)

Project No.	Project Name	Timing			
		Base Case	Current WCESU Approved Programming	Enhanced Conservation	Maximum Conservation
Project 9	Hauser	2027	2033	2040	2041
Project 10	Arkell Collector ASR Wells	2028	2034	2040	2041
Project 11	Guelph South	2030	2038	2043	2045
Project 12	Guelph North	2034	2042	2047	Post 2048
Project 13	Guelph Lake WTP	2038	2045	Post 2048	Post 2048
Project 14	Guelph Lake WTP and ASR Wells in Northeast Quadrant	Post 2048	Post 2048	Post 2048	Post 2048

For the preferred Enhanced Water Conservation alternative, there are additional groundwater projects that will be required in years 2039 to 2041, as well as projects in the following five year period that will require preliminary studies and costs to occur commencing in 2039 to 2041 due to the lead in time. It is noted that the timeline for implementation of the Arkell collector ASR wells project is eight years to allow for long term monitoring and investigations.

8.5 Recommendations

8.5.1 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 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 supplies. As such, it is recommended that the City review its planning and approvals process for managing allocation of water supply capacity.

Future City policies addressing water supply may 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.

- Develop a tracking system to closely monitor conservation successes and whether results are in-line with the forecasted demand for the preferred scenario. 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.
- Determine a consultation and approval process for existing customers to request additional large volumes of water takings, to avoid sudden and unexpected increases in demand.
- 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.

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 expected to protect and improve the quality 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 restrict new private groundwater supply wells in the City as well as other areas where municipal water services are present.

8.6 Individual Project Implementation

Descriptions of the individual projects are included in **Table 8-9** to **Table 8-22**. 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 Enhanced Water Conservation scenario.

Table 8-9 Project 1 Existing Municipal Test Well – Well in Southwest Quadrant (Ironwood Well)

PROJECT SHEET			
PROJECT NAME:	SWQ: Development of Ironwood Well	PROJECT No.	1
LOCATION:	SWQ: Edinburgh Rd. S. & Ironwood Rd.; in municipal park		
RANKING:	1	IMPLEMENTATION YEAR(s):	2015-2019

DESCRIPTION

Ironwood Well: Drilled in 2008, 400 mm Ø casing

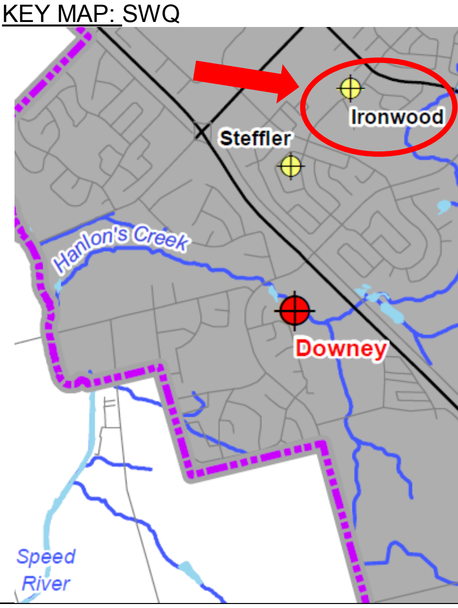
Sustainable Capacity: 8,000 m^3/d; preliminary SWQ Class EA evaluation suggests that only an additional 4500 m^3/day water taking from the SWQ can be achieved without impact to the natural environment; therefore any added capacity available through this supply facility would provide redundancy only.

Existing Approvals: Hydrogeological investigations were completed in this area prior to commencement of the SWQ Class EA which resulted in a test well completed close to the Hanlon Stone Road interchange. Large diameter test wells were installed and tested in the Ironwood-Edinburgh and Steffler Park areas. The Ironwood well showed the most promise with respect to potential production rates. Development of this well as a municipal facility is pending completion of the SWQ Class EA and identification as a preferred alternative.

Past Studies/Work: the SWQ Class EA commenced in 2008, completion is pending resolution of the Dolime Quarry issue; includes groundwater development study and 32 days constant rate pumping test in 2011

Environmental Constraints:
overall SWQ capacity can be increased by 4,500 m^3/d; therefore additional capacity provides redundancy only
pumping limited to avoid impacts to Hanlon Creek base flow

KEY MAP: SWQ



Required Studies:

- Complete SWQ Water Supply Schedule C Class EA; actual location(s) of new well supply subject to completion of EA and identification of preferred alternative; for the purposes of budgetary planning, cost estimates have been developed for a well at the Ironwood location
- Obtain Approvals
- Preliminary Design & Detailed Design

Water Quality Issues:

- Low concentrations of Fe & Mn; both were below ODWQS
- Treatment not required

Required Infrastructure:

- Well house and well pump, including sodium hypochlorite disinfection
- Connection to distribution system on Edinburgh Road
- Coordination with the W-WWSMP to incorporate additional reservoir storage and highlift pumping as required (costs not included here); Also included in other City MP are upgrades to the distribution system as part of the Zone 1 separation allowing for direct connection of this facility to Zone 1B on Kortright Road West. Optimization of this well due to its large proposed capacity will require a means to transmit the pumped water to the existing and future zones.

Required Approvals:

- Class EA – requires completion
- PTTW – a temporary permit was obtained for testing purposes. A well PTTW (or alternatively a wellfield permit for all wells in the SWQ) will be pursued following completion of the Class EA.
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits particularly due to the need for standby power.
- Municipal approvals – approval is required to construct the facility within the municipal park located north of Ironwood Road just west of Edinburgh Road South; additional accommodations may be required to facilitate the park location such as washroom facilities, equipment storage, etc. It is strongly recommended that upon completion of the SWQ Class EA, discussions are initiated with City Parks staff to discuss how to best integrate this well facility into the current or proposed park plans.
- The test well is in the south east corner near the parking lot.

Site Plan Approval and building permits would also be required from the City, as well as ESA for power.

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $4,036,000; Cost per m^3/day: $500

O&M Cost:

Annual O&M Cost = $111,250

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 8,000 m^3/d

Finished Water = 8,000 m^3/d

Total Water Produced in 20 years = 38,930,000 m^3

Life Cycle Cost per water produced = $0.16/$m^3$

ANTICIPATED EXPENDITURES

SWQ Ironwood

Phase \ Year	2015	2016	2017	2018	2019	Total
Preliminary Studies and Approvals	$105,000					**$105,000**
Land Acquisition	$0					**$0**
Design		$264,000	$264,000			**$528,000**
Construction				$1,701,500	$1,701,500	**$3,403,000**
Total	**$105,000**	**$264,000**	**$264,000**	**$1,701,500**	**$1,701,500**	**$4,036,000**

PROJECT NAME: SWQ: Development of Ironwood Well

PROJECT No.: 1

Table 8-10 Project 2 Existing Municipal Offline Well - Clythe Well

PROJECT SHEET			
PROJECT NAME:	Restoration of Clythe Well	PROJECT No.:	2
LOCATION:	NEQ: Adjacent to Clythe Creek, near intersection of Highway 7 & Watson Rd		
RANKING:	1	IMPLEMENTATION YEAR(s):	2015, 2020-2023

DESCRIPTION

Drilled in 1976, 305 mm Ø casing, not in operation for last 10 years
Permitted Capacity: 5,237 m^3/d;
Sustainable Capacity: 3,395 m^3/d
Past Studies/Work:

- In 2008, the City commissioned the rehabilitation and performance assessment of the Clythe Well (Stantec, 2008).

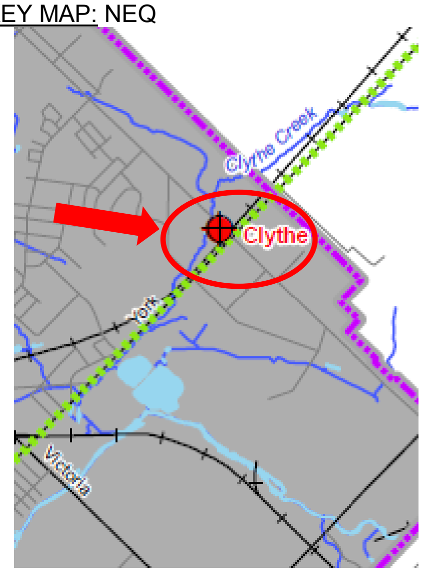
Existing Approvals: PTTW # 3240-62HPVV
Environmental Constraints: Close proximity to Clythe Creek
Required Studies:

- Class EA, Schedule C – new Water Treatment Plant
- Possible land acquisition
- Obtain Approvals
- Preliminary Design & Detailed Design

Water Quality Issues:

- Hydrogen sulfide concentration between 0.1 to 0.31 mg/L, above ODWQS AO of 0.05 mg/L
- Iron and manganese concentration caused by shallow groundwater infiltration

KEY MAP: NEQ



Required Infrastructure: Infrastructure for accommodating a treatment system for H_2S will be determined through the Class EA; it is anticipated that this will include:

- Existing well house upgrades or new well house
- Water treatment system (GAC and manganese dioxide filtration)
- Upgrades to existing reservoir and booster pumping station required
- Existing connection to distribution system
- Requires connection to the sanitary collection system for treatment residuals
- Land acquisition for expansion of facility

Required Approvals:

- Class EA, Schedule C
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits due to the need for increase in standby power.
- Municipal approvals – approval is required to construct the facility including Site Plan Approval and building permits from the City, as well as possible ESA permit for increased power requirements.

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $4,809,000 Cost per m^3/day: $1,500

O&M Cost:

Annual O&M Cost = $154,400

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 3,395 m^3/d

Finished Water = 3,225 m^3/d

Total Water Produced in 20 years = 15,696,200 m^3

Life Cycle Cost per water produced = $0.50/$m^3$

ANTICIPATED EXPENDITURES

Clythe

Phase \ Year	2015	2020	2021	2022	2023	Total
Preliminary Studies and Approvals	$280,000					**$280,000**
Land Acquisition	$390,000					**$390,000**
Design		$314,000	$314,000			**$628,000**
Construction				$1,755,500	$1,755,500	**$3,511,000**
Total	**$670,000**	**$314,000**	**$314,000**	**$1,755,500**	**$1,755,500**	**$4,809,000**

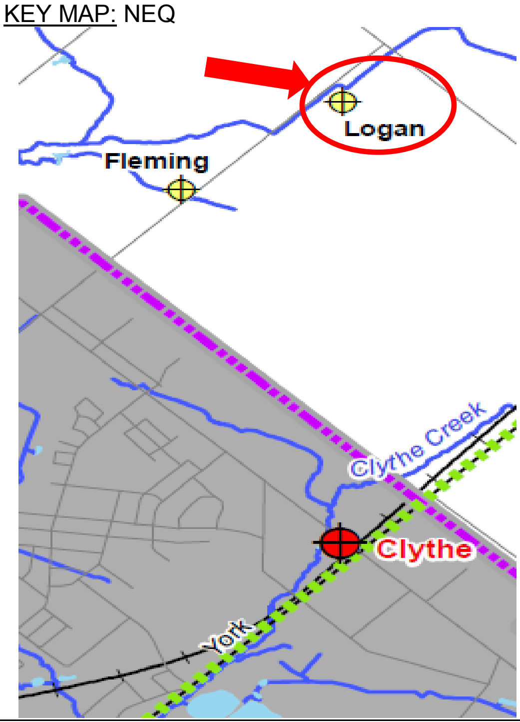
PROJECT NAME: Restoration of Clythe Well	PROJECT No.: 2

Table 8-11 Project 3 Existing Municipal Test Well - Logan Well

PROJECT SHEET					
PROJECT NAME:	Development of Well in area of Logan and Fleming Test Wells			PROJECT No.	3
LOCATION:	NEQ: Township of Guelph-Eramosa; Eastview Rd, East of Watson Rd				
RANKING:	1	IMPLEMENTATION YEAR(s):	2015, 2023-2026		

DESCRIPTION

KEY MAP: NEQ



New well required to replace existing test wells in new location

Sustainable Capacity: 4,700 m^3/d max pump rate (3,492 m^3/d average pumping rate)

Existing Approvals: None

Past Studies/Work: Hydrogeological investigations were completed in this area with installation of test wells at both Logan and Fleming. Part of Guelph Monitoring System Project in 2009 Groundwater pumping, as part of the City of Guelph Monitoring System Project (Golder, 2009) Fleming well has since been converted to a monitoring well.

Environmental Constraints:

- Dependent on determination of the presence or effectiveness of the Vinemount aquitard; investigations required to confirm confined aquifer
- Test well located near Guelph Northeast Provincially Significant Wetland Complex; new well required;

Required Studies:

Hydrogeological investigations and water quality monitoring: well logs suggests that the Eramosa Member is present from 17-33 m, however, this has not been confirmed through subsequent field investigation (i.e., geophysics or nearby coring). The degree of hydraulic connection between shallow and deeper groundwater flow systems within this area has not been established. The City should carry out further field investigations at the Logan well to determine the viability of establishing a groundwater supply source in this location

- Class EA – Schedule B: new well at a new municipal well site with no treatment anticipated; consultation with Guelph Eramosa Township
- Property acquisition
- Test Well installation and testing
- Obtain Approvals
- Preliminary Design & Detailed Design

Water Quality Issues:

- Treatment assumed not required; needs to be confirmed with additional water quality monitoring

Required Infrastructure:

- Well house and well pump, including sodium hypochlorite or UV disinfection
- Connection to distribution system on Eastview Road (assumed 200 m)

Required Approvals:

- Class EA – Schedule B
- PTTW – temporary permit for testing purposes. A well PTTW following completion of the Class EA.
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits particularly due to the need for standby power.

Municipal approvals – Township of Guelph-Eramosa approval is required to construct the facility including Site Plan Approval and building permits; approvals through local hydro provider for power.

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $4,735,000 Cost per m^3/day: $1,000

O&M Cost:

Annual O&M Cost = $92,150

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 4,714 m^3/d

Finished Water = 4,714 m^3/d

Total Water Produced in 20 years = 22,942,500 m^3

Life Cycle Cost per water produced = $0.29/$m^3$

ANTICIPATED EXPENDITURES

NEQ Fleming/Logan

Phase \ Year	2015	2023	2024	2025	2026	Total
Preliminary Studies and Approvals	$532,000					**$532,000**
Land Acquisition	$65,000					**$65,000**
Design		$309,000	$309,000			**$618,000**
Construction				$1,760,000	$1,760,000	**$3,520,000**
Total	**$597,000**	**$309,000**	**$309,000**	**$1,760,000**	**$1,760,000**	**$4,735,000**

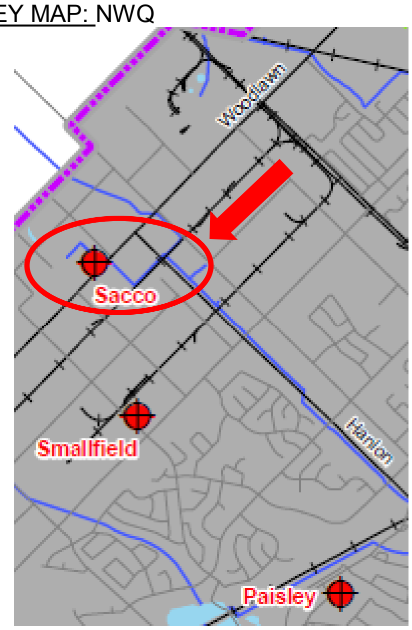
PROJECT NAME: Development of Well in area of Logan and Fleming Test Wells	PROJECT No.: 3

Table 8-12 Project 4 Existing Municipal Offline Well - Sacco Well

PROJECT SHEET			
PROJECT NAME:	Restoration of Sacco Well	PROJECT No.:	4
LOCATION:	NWQ: 348 Woodlawn Road		
RANKING:	1	IMPLEMENTATION YEAR(s):	2016, 2025-2026

DESCRIPTION

KEY MAP: NWQ



Drilled in 1952, 300 mm Ø casing, inactive since 1991

Permitted Capacity: 1,633 m^3/d

Sustainable Capacity: 1,150 m^3/d

Existing Approvals: The existing facility could be turned back on to provide potable water to the distribution system as it currently does not exceed ODWQS; water quality could be monitored to establish any trends.

Past Studies/Work: rehabilitation and performance assessment (Stantec, 2008)

Environmental Constraints:

- Speed River catchment;
- close proximity to Ellis/ Chilligo Creek;
- near Marden South Non-Provincially Significant Wetland Complex

Required Studies:

- Treatment Studies
- Class EA, Schedule C – Water Treatment Plant; could combine the EA and potential alternatives with the Smallfield well; volatile organics present at both wells would require similar treatment requirements; could also include one common facility for both wells located at Smallfield which would eliminate need for property acquisition at Sacco. This would require approximately 1.5 km of raw watermain.
- Preliminary Design and Detailed Design

Water Quality Issues:

- Detectable levels of TCE and PCE below ODWQS
- TCE concentration between 0.3 to 0.5 µg/L

Required Infrastructure:

- Well house upgrade/replacement for treatment; expansion
- Water treatment system
- New power supply

Required Approvals:

- Class EA, Schedule C
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits particularly due to the need for standby power.
- Municipal approvals – approval is required to reconstruct the facility including Site Plan Approval and building permits from the City, as well as possible ESA permit for increased power requirements

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $4,135,000; Cost per m^3/day: $3,670

O&M Cost:

Annual O&M Cost = $22,275

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 1,150 m^3/d

Finished Water = 1,127 m^3/d

Total Water Produced in 20 years = 5,484,700 m^3

Life Cycle Cost per water produced = $0.84/$m^3$

ANTICIPATED EXPENDITURES

Sacco

Phase \ Year	2016	2025	2026	2027	2028	Total
Preliminary Studies and Approvals	$420,000					**$420,000**
Land Acquisition	$390,000					**$390,000**
Design		$270,000	$270,000			**$540,000**
Construction				$1,392,500	$1,392,500	**$2,785,000**
Total	**$810,000**	**$270,000**	**$270,000**	**$1,392,500**	**$1,392,500**	**$4,135,000**

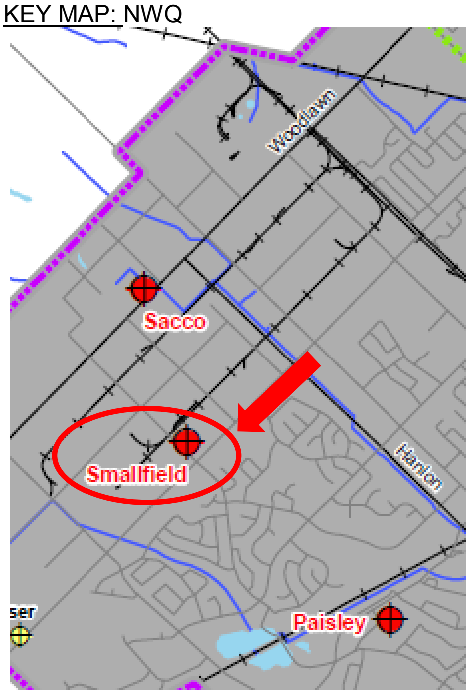
PROJECT NAME: Restoration of Sacco Well	PROJECT No.: 4

Table 8-13 Project 5 Existing Municipal Offline Well – Smallfield Well

PROJECT SHEET			
PROJECT NAME:	Restoration of Smallfield Well	PROJECT No.	5
LOCATION:	NWQ: 461 Speedvale Ave		
RANKING:	1	IMPLEMENTATION YEAR(s):	2016, 2026-2029

DESCRIPTION

KEY MAP: NWQ



Drilled in 1966, 300 mm Ø casing, inactive since 1993

Permitted Capacity: 1,964 m^3/d

Sustainable Capacity: 1,408 m^3/d

Existing Approvals: PTTW No. 2803-7CUXLT, renewed on November 24, 2008

Past Studies/Work: rehabilitation and performance assessment of the Smallfield Well (Stantec, 2008)

Environmental Constraints:

- Speed River catchment;
- close proximity to Ellis/ Chilligo Creek;
- near Marden South Non-Provincially Significant Wetland Complex

Required Studies:

- Treatment Studies
- Class EA, Schedule C – Water Treatment Plant; could combine the EA and potential alternatives with the Sacco well; volatile organics present at both wells would require similar treatment requirements; could also include one common facility for both wells located at Smallfield which would eliminate need for property acquisition at Sacco. This would require approximately 1.5 km of raw watermain.
- Preliminary Design and Detailed Design

Water Quality Issues:

- TCE concentration above ODWQS MAC of 5 µg/L
- Detectable concentration of 1,1,1-Trichloroethane & chloroform

Required Infrastructure:

- Well house upgrade/replacement for treatment; expansion
- Water treatment system (air stripping process)
- New power supply

Required Approvals:

- Class EA, Schedule C
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits particularly due to the need for standby power.

Municipal approvals – approval is required to reconstruct the facility including Site Plan Approval and building permits from the City, as well as possible ESA permit for increased power requirements

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $3,820,000; Cost per m^3/day: $2,768

O&M Cost:

Annual O&M Cost = $23,440

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 1,408 m^3/d

Finished Water = 1,380 m^3/d

Total Water Produced in 20 years = 6,715,200 m^3

Life Cycle Cost per water produced = $0.64/$m^3$

ANTICIPATED EXPENDITURES

Smallfield

Phase \ Year	2016	2026	2027	2028	2029	Total
Preliminary Studies and Approvals	$350,000					**$350,000**
Land Acquisition	$0					**$0**
Design		$250,000	$250,000			**$500,000**
Construction				$1,485,000	$1,485,000	**$2,970,000**
Total	**$350,000**	**$250,000**	**$250,000**	**$1,485,000**	**$1,485,000**	**$3,820,000**

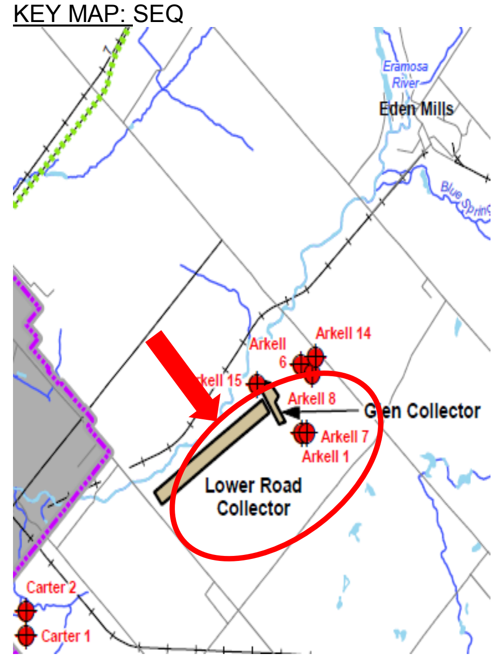
PROJECT NAME: Development of Smallfield Well	PROJECT No.: 5

Table 8-14 Project 6 Existing Municipal Offline Well –Lower Road Collector

PROJECT SHEET				
PROJECT NAME:	Restoration of Lower Road Collector System		PROJECT No.:	6
LOCATION:	SEQ: Lower slope of the Eramosa River valley wall, eastward from Watson Rd to the Northern extent of the Glen Collector System			
RANKING:	1	IMPLEMENTATION YEAR(s):	2016, 2027-2030	

DESCRIPTION

KEY MAP: SEQ



A collector system consisting of 30 manholes and 26 collection galleries, disconnected in 2000

Historical Production Rate: 600 to 6,000 m^3/d

Typical Collection Rate: 2,000 to 3,000 m^3/d

Existing Approvals: PTTW (included in Arkell Springs Grounds Collector groundwater taking)

Past Studies/Work: Aquifer Performance Evaluation Southeast Quadrant in 1998

Environmental Constraints: near Eramosa River, in Arkell well spring ground

Required Studies:

- Field Investigations: sufficient information should be gathered to determine whether reconstruction of the Lower Road is technically and financially feasible; this will include:
  - survey existing and surrounding area to determine future collector layout
  - flow monitoring/pump testing to establish potential capacities (substantiate historical volumes)
  - water quality monitoring
  - cost-benefit analysis
- Constructability plan – sufficient preliminary investigation is required to determine how to construct in the spring grounds with the existing flowing conditions; to include a geotechnical/ hydrogeological investigation for construction dewatering purposes
- Aqueduct condition and hydraulic assessment for additional flows; review of Woods UV system capacity
- Preliminary Design and Detailed Design

Water Quality Issues:

- Elevated bacterial content; may be treated via Woods UV system (capacity to be reviewed)
- Bypass when turbidity high (similar to Glen collector)

Required Infrastructure:

- Complete replacement of existing collector system:
- new HDPE perforated pipe & associated infrastructure
- Pumping system
- Connection to Valve Chamber 1 (near Arkell well 15) with turbidity control and bypass

Required Approvals:

- Drinking Water Permit/ License amendment

Cost Assumption:

- Lower collector system will produce minimum flow of 2,000 m^3/d; higher rates seasonally via recharge from Eramosa River PTTW
- Collector system will connect to the distribution system on the northern extent of the Glen Collector system
- 5 new manholes within the collector system will be installed
- Assumed 12 laterals are connected to each manhole, each 60 m in length
- 900 mm HDPE perforated pipe with filtration sock will be used

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $9,161,000; Cost per m^3/day: $4,581

O&M Cost:

Annual O&M Cost = $80,229

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 3,000 m^3/d

Finished Water = 2,000 m^3/d

Total Water Produced in 20 years = 9,735,000 m^3

Life Cycle Cost per water produced = $1.11/$m^3$

ANTICIPATED EXPENDITURES

Lower Road Collector

Phase \ Year	2016	2027	2028	2029	2030	Total
Preliminary Studies and Approvals	$280,000					**$280,000**
Land Acquisition	$0					**$0**
Design		$598,000	$598,000			**$1,196,000**
Construction				$3,842,500	$3,842,500	**$7,685,000**
Total	**$280,000**	**$598,000**	**$598,000**	**$3,842,500**	**$3,842,500**	**$9,161,000**

PROJECT NAME: Restoration of Lower Road Collector System

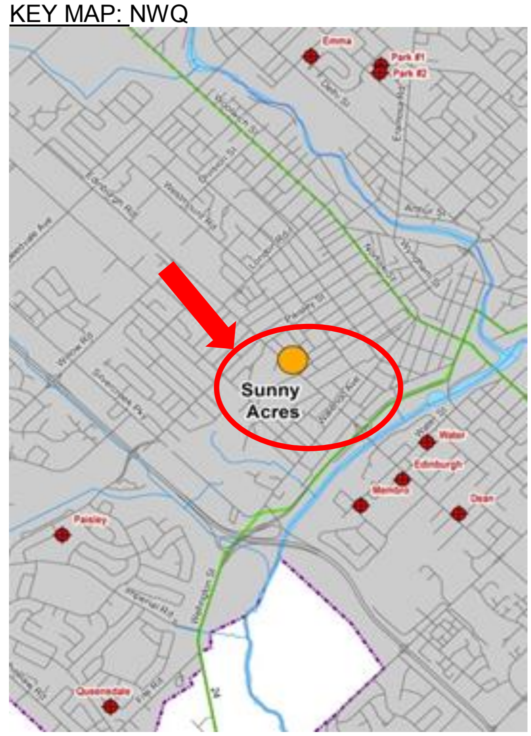
PROJECT No.: 6

Table 8-15 Project 7 New Well Inside City – Sunny Acre Well

PROJECT SHEET				
PROJECT NAME:	Development of Sunny Acre Well		PROJECT No.:	7
LOCATION:	NWQ: Central portion of the City (near Sunny Acre Park)			
RANKING:	1	IMPLEMENTATION YEAR(s):	2015-2016, 2029-2032	

DESCRIPTION

KEY MAP: NWQ



Recommended test well location inside the City based on groundwater modelling analysis undertaken by Golder

Sustainable Capacity: 1,500 m^3/d

Existing Approvals: None

Past Studies/Work:

- Tier Three Risk Assessment
- Groundwater modelling analysis by Golder, 2014

Environmental Constraints: Interference effects from existing groundwater supply wells in the vicinity

Required Studies:

- Hydrogeological investigation: test well, test pumping and water quality monitoring,
- Class EA, Schedule B or C – possible water treatment required
- Obtain Approvals
- Preliminary Design & Detailed Design

Water Quality Issues:

- nearby monitoring wells indicate good WQ;
- assumed treatment for TCE due to presence in municipal wells in vicinity (south of Speed River)

Required Infrastructure:

- Well house and associated infrastructure, including sodium hypochlorite or UV disinfection; possible TCE treatment
- If not located in City park, land acquisition would be required
- Connection to distribution system

Required Approvals:

- Class EA, Schedule B or C pending water quality monitoring
- PTTW – a temporary permit for testing purposes. A municipal well PTTW following completion of the Class EA.
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits particularly due to the need for standby power.
- Municipal approvals – approval is required to construct the facility within the municipal park; additional accommodations may be required to facilitate the park location such as washroom facilities, equipment storage, etc. It is strongly recommended that City Parks be consulted during the Class EA when locating the large diameter test well. Discussions may include how to best integrate this well facility into the current or proposed park plans.

Site Plan Approval and building permits would also be required from the City, as well as ESA for power.

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $4,522,000; Cost per m^3/day: $3,080

O&M Cost:

Annual O&M Cost = $25,070

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 1,500 m^3/d

Finished Water = 1,470 m^3/d

Total Water Produced in 20 years = 7,154,000 m^3

Life Cycle Cost per water produced = $0.70/$m^3$

ANTICIPATED EXPENDITURES

Sunny Acre Well

Phase \ Year	2015-2016	2029	2030	2031	2032	Total
Preliminary Studies and Approvals	$420,000					**$420,000**
Land Acquisition	$390,000					**$390,000**
Design		$295,000	$295,000			**$590,000**
Construction				$1,561,000	$1,561,000	**$3,122,000**
Total	**$810,000**	**$295,000**	**$295,000**	**$1,561,000**	**$1,561,000**	**$4,522,000**

PROJECT NAME:	Development of Sunny Acre Well	PROJECT No.:	7

Table 8-16 Project 8 Existing Municipal Test Well - Scout Camp Well

PROJECT SHEET			
PROJECT NAME:	Development of Scout Camp Well	PROJECT No.:	8
LOCATION:	SEQ: South of Stone Road and southwest of the Eramosa River (inside City)		
RANKING:		IMPLEMENTATION YEAR(s):	2016, 2032-2035

DESCRIPTION

Drilled in 1987

Sustainable Capacity: 5,789 m^3/d

Existing Approvals: None

Past Studies/Work:
- Water supply performance evaluation, 1993
- Class EA, 1994

Environmental Constraints:
- Groundwater inflow from the shallow groundwater flow system; can be addressed via liner installation - may reduce capacity
- near Eramosa River -Blue Springs Creek Provincially Significant Wetland Complex;
- potential moderate impacts to Eramosa River and Torrance Creek

Required Studies:
- Class EA, Schedule C – new water treatment plant
- Treatment study
- Performance test after liner installation
- Aqueduct condition and hydraulic assessment for additional flows; review of Woods UV system capacity
- Obtain Approvals
- Preliminary Design & Detailed Design

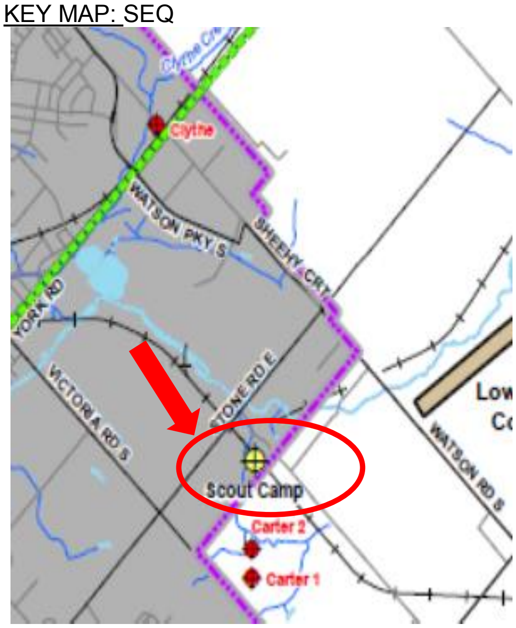
Water Quality Issues:
- Elevated hydrogen sulphide levels

Required Infrastructure:
- Well house upgrade/replacement and well pump, including water treatment system (air stripping system)
- Connection to distribution system on Stone Road
- sanitary connection to sewer system for treatment residuals

Required Approvals:
- Class EA, Schedule C
- PTTW
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits particularly due to the need for standby power.
- Municipal approvals – Site Plan Approval and building permits would also be required from the City, as well as ESA for power.

Cost Assumption
- Connection to closest sewer (Stone & Victoria) is required for disposal of waste
- 2% of the feed water is lost during the water treatment process
- Land acquisition is not required

KEY MAP: SEQ



COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $4,702,000; Cost per m^3/day: $830

O&M Cost:

Annual O&M Cost = $79,170

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 5,789 m^3/d
Finished Water = 5,673 m^3/d
Total Water Produced in 20 years = 27,610,000 m^3
Life Cycle Cost per water produced = $0.23/$m^3$

ANTICIPATED EXPENDITURES

SEQ Scout Camp

Phase \ Year	2016	2032	2033	2034	2035	Total
Preliminary Studies and Approvals	$322,000					**$322,000**
Land Acquisition	$0					**$0**
Design		$307,000	$307,000			**$614,000**
Construction				$1,883,000	$1,883,000	**$3,766,000**
Total	**$322,000**	**$307,000**	**$307,000**	**$1,883,000**	**$1,883,000**	**$4,702,000**

PROJECT NAME: Development of Scout Camp Well	PROJECT No.: 8

Table 8-17 Project 9 Existing Municipal Test Well - Hauser Well

PROJECT SHEET			
PROJECT NAME:	Development of Hauser Well	PROJECT No.:	9
LOCATION:	NWQ: On Speedvale Ave W.		
RANKING:	1	IMPLEMENTATION YEAR(s):	2017-2018, 2036-2039

DESCRIPTION

Drilled in 1966, 300 mm Ø casing; converted to monitoring well

Sustainable Capacity: 900 m^3/d

Existing Approvals: None

Past Studies/Work: Step Test in 1994

Environmental Constraints:

- close proximity to Ellis/ Chilligo Creek;
- near Ellis Creek Provincially Significant Wetland Complex

Required Studies:

- hydrogeological investigation - well installation and testing
- Water quality analysis
- Class EA, Schedule B or C
- Land acquisition
- Obtain Approvals
- Preliminary Design & Detailed Design

Water Quality Issues:

- Water quality information is not available; assumed good WQ

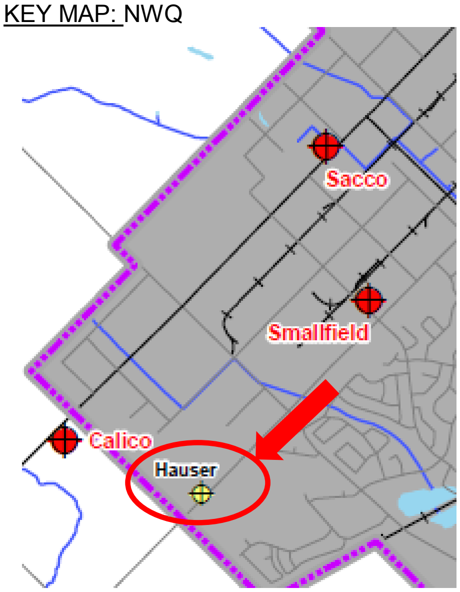
Required Infrastructure:

- Land acquisition
- Well house and well pump, including sodium hypochlorite or UV disinfection
- Connection to distribution system

Required Approvals:

- Class EA, Schedule B or C, pending water quality monitoring
- PTTW – a temporary permit for testing purposes. A well PTTW following completion of the Class EA.
- ECA/Drinking Water License – approvals from the MOE are required which would include process, air and noise permits particularly due to the need for standby power.
- Municipal approvals – Site Plan Approval and building permits would also be required from the City, as well as ESA for power.

KEY MAP: NWQ



COST ESTIMATE

Capital Cost:

Estimated Capital Cost: \$3,691,000; Cost per m^3/day: \$4,100

O&M Cost:

Annual O&M Cost = \$19,950

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 900 m^3/d

Finished Water = 900 m^3/d

Total Water Produced in 20 years = 4,380,000 m^3

Life Cycle Cost per water produced = \$0.93/m^3

ANTICIPATED EXPENDITURES

NWQ Hauser

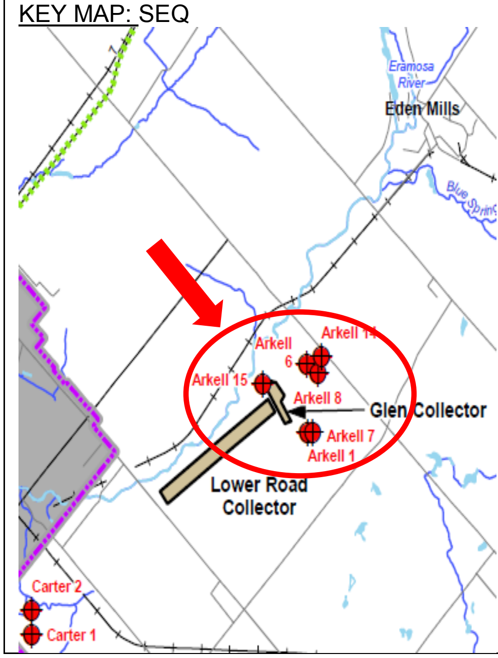
Phase \ Year	2017-2018	2036	2037	2038	2039	Total
Preliminary Studies and Approvals	$336,000					**$336,000**
Land Acquisition	$390,000					**$390,000**
Design		$241,000	$241,000			**$482,000**
Construction				$1,241,500	$1,241,500	**$2,483,000**
Total	**$726,000**	**$241,000**	**$241,000**	**$1,241,500**	**$1,241,500**	**$3,691,000**

PROJECT NAME: Development of Hauser Well	PROJECT No.: 9

Table 8-18 Project 10 Arkell Collectors & ASR

PROJECT SHEET			
PROJECT NAME:	Arkell Collector System with ASR Wells	PROJECT No.:	10
LOCATION:	Arkell Collector System seasonal flow & ASR wells in Northeast Quadrant		
RANKING:	2	IMPLEMENTATION YEAR(s):	2017-2019, 2035-2039
DESCRIPTION			

KEY MAP: SEQ



Transfer excess seasonal collector volumes to ASR wells

Surplus Capture Rate: Assume excess of 10,000 m^3/day for four months

Distribution Rate: Results in average capacity of 3,300 m^3/day

Existing Approvals: PTTW (under Arkell Springs Grounds Collector groundwater taking)

Past Studies/Work: Aquifer Performance Evaluation Southeast Quadrant in 1998

Environmental Constraints:
None

Required Studies:

- Field investigation
- Feasibility Studies
- Class EA for ASR Wells (potential C)
- Obtain Approvals
- Preliminary Design & Detailed Design

Water Quality Issues:

- Requires dechlorination prior to injection to ASR wells; disinfection upon recovery prior to distribution

Required Infrastructure:

- ASR wells with dechlorination and UV disinfection
- Connection to distribution water main
- Confirmation of capacity of Arkell Aqueduct including repairs to older section between Watson and Stone Road (as referenced in the W-WWSMP)
- Confirmation of Woods UV system capacity for seasonal flows
- Assumes Lower Road Collector system is constructed first
- Connections to distribution system

Required Approvals:

- Class EA, Schedule C (for ASR wells if MOE interprets as surface water treatment/ injection)
- PTTW for ASR wells; assuming working within existing Eramosa PTTW for optimization of collector systems
- ECA/DWL
- GRCA
- ECA/Drinking Water License – approvals from the MOE for ASR wells are required which would include process, air and noise permits particularly due to the need for standby power.
- Municipal approvals – Site plan approval, building permits and ESA approvals for new ASR wells.

Cost Assumption

- Reliability of excess flows during peak seasons is unknown; therefore, assumption of excess volumes of 10,000 m^3/day from both Glen and Lower Road Collectors for 4 months for feasibility assessment of ASR
- Assumes Lower collector system is restored (cost not included)
- Collected water will be treated at the Woods Station via UV disinfection
- Woods Station UV system has the capacity to disinfect extra 10,000 m^3/d water
- After UV treatment at Woods Station treated water will be injected in the new ASR wells
- Dechlorination required prior to ASR injection; disinfection is required after recovery prior to distribution
- 2 new ASR wells are required to inject 10,000 m^3/d water
- The ASR wells will be located in the NEQ in the vicinity of Park/Emma wells; minimal land acquisition costs (assume located in municipal park)

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $8,954,000; Cost per m^3/day: $2,680

O&M Cost:

Annual O&M Cost = $12,628

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 3,342 m^3/d

Finished Water = 3,342 m^3/d

Total Water Produced in 20 years = 16,267,000 m^3

Life Cycle Cost per water produced = $0.57/$m^3$

ANTICIPATED EXPENDITURES

Arkell Collector System ASR Wells

Phase \ Year	2017-2019	2035-2037	2038-2039	Total
Preliminary Studies and Approvals	$1,680,000			**$1,680,000**
Land Acquisition/Easement	$130,000			**$130,000**
Design		$1,168,000		**$1,168,000**
Construction			$5,976,000	**$5,976,000**
Total	**$1,810,000**	**$1,168,000**	**$5,976,000**	**$8,954,000**

PROJECT NAME: Arkell Collector System with ASR Wells | PROJECT No.: 10

Table 8-19 Project 11 New Well Outside City – Guelph South Well

PROJECT SHEET				
PROJECT NAME:	Development of Guelph South Well		PROJECT No.:	11
LOCATION:	Township of Puslinch, Southeast of the City, within the Mill Creek catchment area, East of Victoria Rd, on Maltby Rd			
RANKING:	2	IMPLEMENTATION YEAR(s):	2018, 2022, 2039-2042	

DESCRIPTION

Recommended test well location based on groundwater modelling analysis undertaken by Golder

Sustainable Capacity: 5,300 m^3/d max pump rate (3,900 m^3/d average pumping rate)

Existing Approvals: None

Water Quality Issues: Water quality information not available; assumed good WQ – only disinfection required

Environmental Constraints:

- Tier 3 model indicates minimal impact to Mill Creek; less than 5% reduction in baseflow
- Area near Arkell Bog Provincially Significant Wetland Complex

Past Studies/Work:

- Tier Three Risk Assessment
- Groundwater modelling analysis by Golder, 2014

Required Studies:

- Groundwater supply development study
- Water quality analysis
- Performance testing
- Class EA, Schedule B
- Land acquisition
- PTTW
- Preliminary Design and Detailed Design

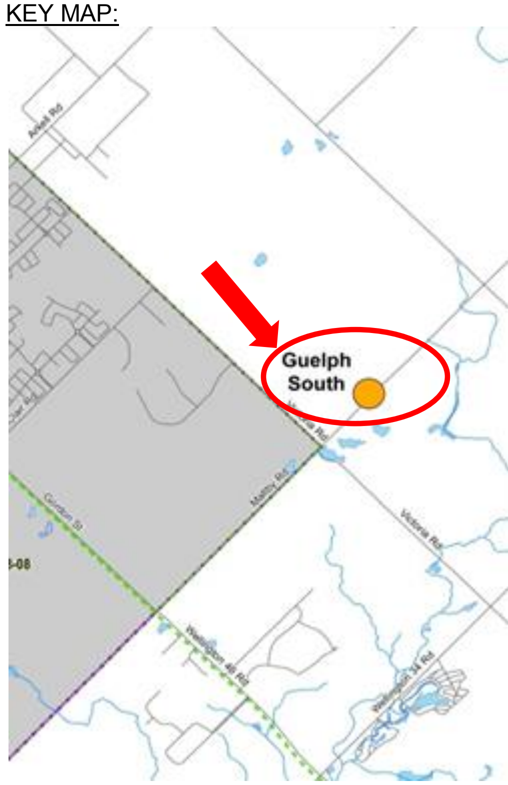
Required Infrastructure:

- Land acquisition
- New wellhouse and associated infrastructure

Connection to distribution system Required Approvals:

- PTTW
- Class EA
- ECA/DWP
- Municipal Approvals –Puslinch Township, ESA/local hydro for power supply

KEY MAP:



COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $5,185,000; Cost per m^3/day: $980

O&M Cost:

Annual O&M Cost = $80,230

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 5,281 m^3/d

Finished Water = 5,281 m^3/d

Total Water Produced in 20 years = 25,700,000 m^3

Life Cycle Cost per water produced = $0.26/$m^3$

ANTICIPATED EXPENDITURES

Guelph South

Phase \ Year	2018-2022	2039	2040	2041	2042	Total
Preliminary Studies and Approvals	$532,000					**$532,000**
Land Acquisition	$260,000					**$260,000**
Design		$339,000	$339,000			**$678,000**
Construction				$1,857,500	$1,857,500	**$3,715,000**
Total	**$792,000**	**$339,000**	**$339,000**	**$1,857,500**	**$1,857,500**	**$5,185,000**

PROJECT NAME: Development of Guelph South Well PROJECT No.: 11

Table 8-20 Project 12 New Well Outside City – Guelph North Well

PROJECT SHEET				
PROJECT NAME:	Development of Guelph North Well		PROJECT No.:	12
LOCATION:	Township of Guelph-Eramosa North of the City, the western limit of Conservation Rd			
RANKING:	2	IMPLEMENTATION YEAR(s):	2018, 2023, 2043-2046	

DESCRIPTION

Recommended test well area outside the City based on groundwater modelling analysis undertaken by Golder

Sustainable Capacity: 6,300 m^3/d max pump rate (4,660 m^3/d average pumping rate)

Existing Approvals: None

Water Quality Issues: Water quality information - not available; assumed good WQ – only disinfection required

Environmental Constraints:

- Marden Creek -moderate to high impact; reduction in baseflows due to low seasonal flows;
- potential impacts to municipal/private wells anticipated
- near the Marden South Provincially Significant Wetland Complex;

Past Studies/Work:

- Tier Three Risk Assessment
- Groundwater modelling analysis by Golder, 2014

Required Studies:

- Groundwater supply development study
- Water quality analysis
- Performance testing
- Class EA, Schedule B
- Land acquisition
- PTTW
- Preliminary Design and Detailed Design

Required Infrastructure:

- Land acquisition
- New wellhouse and associated infrastructure

Connection to distribution system Required Approvals:

- PTTW
- Class EA
- ECA/DWP
- Municipal Approvals –Puslinch Township, ESA/local hydro for power supply

KEY MAP: NWQ

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $5,289,000; Cost per m^3/day: $840

O&M Cost:

Annual O&M Cost = $92,900

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 6,291 m^3/d

Finished Water = 6,291 m^3/d

Total Water Produced in 20 years = 30,620,000 m^3

Life Cycle Cost per water produced = $0.23/$m^3$

ANTICIPATED EXPENDITURES

Guelph North

Phase \ Year	2018-2023	2043	2044	2045	2046	Total
Preliminary Studies and Approvals	$532,000					**$532,000**
Land Acquisition	$260,000					**$260,000**
Design		$345,000	$345,000			**$690,000**
Construction				$1,903,500	$1,903,500	**$3,807,000**
Total	**$792,000**	**$345,000**	**$345,000**	**$1,903,500**	**$1,903,500**	**$5,289,000**

PROJECT NAME:	Development of Guelph North Well	PROJECT No.:	12

Table 8-21 Project 13 Surface Water – Guelph Lake WTP

PROJECT SHEET				
PROJECT NAME:	Guelph Lake Water Treatment Plant		PROJECT No.:	13
LOCATION:	WTP at Guelph Lake or NE part of City			
RANKING:	3	IMPLEMENTATION YEAR(s):	Post 2038	

DESCRIPTION

Surface WTP consisting of conventional/advanced treatment and distribution pipeline

Available taking: 13,000 m^3/d (continuous annual base taking of 150 L/s)

Production Rate: 12,300 m^3/d

Existing Approvals: none

Required Approvals:

- Class EA – Schedule C
- Federal EA
- Municipal – City and Township
- MNR/MOE - PTTW (Surface Water); ECA/DWL
- GRCA

Water Quality Issues: High turbidity, colour, odour

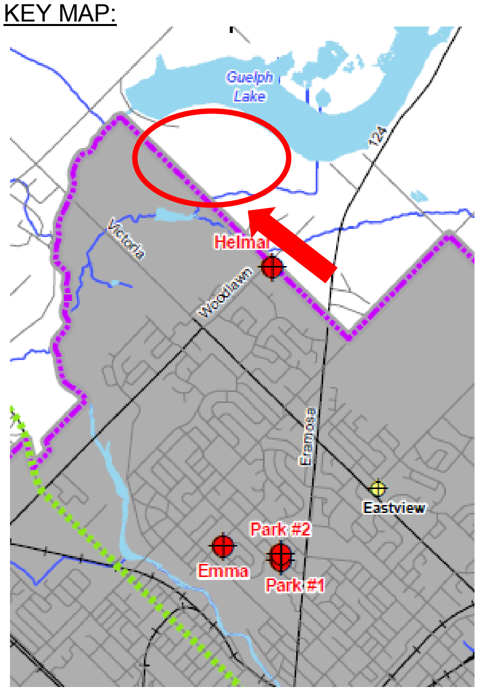
Environmental Constraints: Area affected includes Guelph Lake and its associated wetland and aquatic features

Past Studies/Work: GRCA review of water taking reliability

Required Studies:

- GRCA – more detailed review of water taking reliability; ecological assessment of reduced flow downstream
- Field investigations, environmental baseline/impact
- Feasibility Studies
- Siting of Intake - Bathymetry study – to establish water intake locations; Constructability and minimizing dam operation
- Treatment study – minimum 2 years to establish seasonal variations and treatment requirements
    - Treatment pilot project, if required
- Class EA – Schedule C (to include any Federal EA requirements)
- Land acquisition
- Preliminary Design and Detailed Design

KEY MAP:



Required Infrastructure:

- Water intake structure
- Surface water treatment plant & associated infrastructure:
    - Low lift pumping station
    - Screening
    - Pre-treatment (Dissolved Air Floatation with Coagulant)
    - Advanced Oxidation (UV/H_2O_2 for taste and odour, organics, etc.)
    - Powdered Activated Carbon (PAC) - seasonal addition
    - Filtration (dual media) with allowance for granular activated carbon (GAC)
    - Chlorination
    - Residues Management (equalization, thickening, discharge to sewer)
    - Allowance for connection to ASR with re-chlorination
- Connection to distribution water main

Cost Assumptions:

- Water treatment plant intake will be 13,000 m^3/d
- Water treatment plant will produce 12,300 m^3/d after 5% water loss through treatment
- Advanced oxidation with PAC/GAC filtration is used for water treatment to meet ODWQS drinking water criteria
- Land acquisition from GRCA; location in NE corner of Guelph or in Guelph Eramosa Township

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $42,738,000; Cost per m^3/day: $3,470

O&M Cost:

Annual O&M Cost = $490,543

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 12,960 m^3/d

Finished Water = 12,312 m^3/d

Total Water Produced in 20 years = 59,920,000 m^3

Life Cycle Cost per water produced = $0.88/$m^3$

ANTICIPATED EXPENDITURES

Guelph Lake WTP

Phase \ Year	Year 1 to Year 6	Year 7 to Year 8	Year 9 to Year 10	Total
Preliminary Studies and Approvals	$910,000			**$910,000**
Land Acquisition	$260,000			**$260,000**
Design		$4,788,000		**$4,788,000**
Construction			$30,750,000	**$30,750,000**
Total	**$1,170,000**	**$4,788,000**	**$30,750,000**	**$36,708,000**

PROJECT NAME: Guelph Lake Water Treatment Plant | PROJECT No.: 13

Table 8-22 Project 14 Surface Water – Guelph Lake WTP & ASR

PROJECT SHEET				
PROJECT NAME:	Guelph Lake Water Treatment Plant with ASR Wells		PROJECT No.:	14
LOCATION:	WTP at Guelph Lake/dam , ASR wells at NEQ in the vicinity of Park/Emma wells			
RANKING:	3	IMPLEMENTATION YEAR(s):	Post 2038	

DESCRIPTION

A surface water treatment plant consisting of conventional treatment and distribution pipelines, ASR wells

Intake Rate: 12,960 to 25,920 m^3/d

Distribution Rate: Up to 26,600 m^3/day

Existing Approvals: None

Required Approvals:
- Class EA – Schedule C
- Federal Class EA
- Municipal – City and Township
- MNR/MOE - PTTW (Surface Water); ECA/DWL
- GRCA

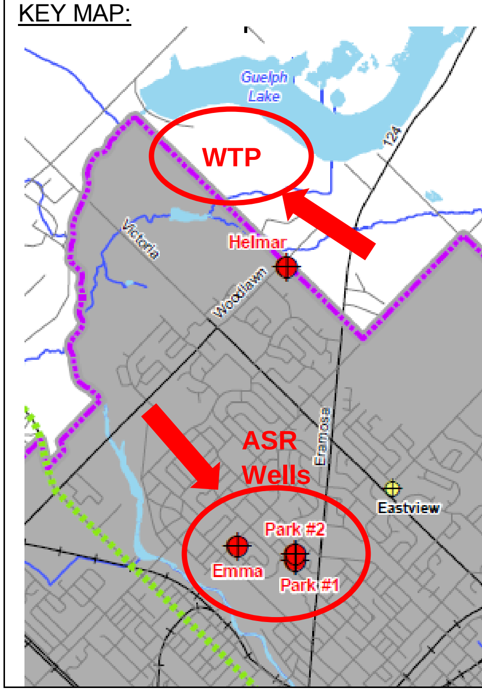
Water Quality Issues: High turbidity, colour, odour

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
- Preliminary Design and Detailed Design

KEY MAP:



Required Infrastructure:
- Water intake structure
- Surface water treatment plant & associated infrastructure:
  - Low lift pumping station
  - Screening
  - Pre-treatment (Dissolved Air Floatation with Coagulant)
  - Advanced Oxidation (UV/H_2O_2 for taste and odour, organics, etc.)
  - Powdered Activated Carbon (PAC) - seasonal addition
  - Filtration (dual media) with allowance for granular activated carbon (GAC)
  - Chlorination
  - Residues Management (equalization, thickening, discharge to sewer)
  - Allowance for connection to ASR with re-chlorination
- Connection to distribution water main

Additional ASR investigation:
- Geochemistry review – interaction of surface water and groundwater
- Geophysics review
- Model - Particle tracking

Cost Assumptions:
- 300 L/s of water will be extracted from Guelph lake for treatment on a daily basis except for summer months when the water intake will be 150 L/s
- The amount to be stored in the ASR wells equals 300 L/s less the system demand at that time
- The ASR wells will be located in the NEQ in the vicinity of Park/Emma/Helmar well
- Total number of ASR wells is 6 (only if located near Park/Emma/Helmar well); 15 if located near Guelph

Lake

- The aquifer can sustain the estimated withdrawal pumping rate over shorter durations
- ASR well efficiency is 100%
- Advanced oxidation with PAC/GAC filtration is used for water treatment to meet ODWQS drinking water criteria. 5% of the total feed water is lost during the treatment process

COST ESTIMATE

Capital Cost:

Estimated Capital Cost: $78,905,000; Cost per m^3/day: $3,060

O&M Cost:

Annual O&M Cost = $1,150,000

20-yr Life Cycle Cost:

Proposed Raw Water Capacity = 27,184 m^3/d

Finished Water = 27,184 m^3/d

Total Water Produced in 20 years = 136,610,000 m^3

Life Cycle Cost per water produced = $0.75/$m^3$

ANTICIPATED EXPENDITURES

Guelph Lake WTP + ASR

Phase \ Year	Year 1 to Year 6	Year 7 to Year 8	Year 9 to Year 10	Total
Preliminary Studies and Approvals	$2,922,000			**$2,922,000**
Land Acquisition	$458,000			**$458,000**
Design		$10,292,000		**$10,292,000**
Construction			$65,233,000	**$65,233,000**
Total	**$3,380,000**	**$10,292,000**	**$65,233,000**	**$78,905,000**

PROJECT NAME: Guelph Lake Water Treatment Plant with ASR Wells	PROJECT No.: 14

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Appendix A

Background Documentation
(Natural Heritage, OP reference)

AECOM

Appendix A

City of Guelph Water Supply Master Plan Update (Draft Final Report)

Background Documentation (Natural Environment Considerations)

Note: As per the Accessibility for Ontarians with Disabilities Act, this document is available in an alternate format by contacting Dave Belanger – City of Guelph (519-822-1260 Ext. 2186)

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Memorandum

To	Dave Belanger, City of Guelph	Page	1
CC	Patty Quackenbush, AECOM		
Subject	Natural Environment Considerations for Alternatives – Guelph Water Supply Master Plan Update Study		
From	Jillian deMan, AECOM		
Date	May 23, 2014	Project Number	60287843

1. INTRODUCTION

The City of Guelph is completing a water supply master plan update that is investigating a variety of water supply alternatives over the next 25-year planning horizon. Alternatives include water conservation and demand management, expansion of 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
- City of Guelph Official Plan Amendment Number 42: Natural Heritage System

Other Documents
- City of Guelph Natural Heritage Strategy
- Grand River Conservation Authority website
- Natural Heritage Information Centre website
- Soil Survey of Wellington County
- Wellington County website Interactive Mapping Tool
- Ministry of Natural Resources - Species at Risk Website – Species at Risk in Wellington County
- Atlas of the Breeding Birds of Ontario – Atlas Data Summary Squares 17NJ51, 17NJ52, 17NJ61 AND 17NJ62

It is noted that Official Plan Amendment (OPA) 42 which establishes a new Natural Heritage System as part of the Official Plan (Adopted by Guelph City Council – July 27, 2010; Approved by Minister of Municipal Affairs and Housing – Feb 22, 2011 and is currently under appeal before the Ontario Municipal Board). OPA 42 does not comprise part of the December 2012 Official Plan Consolidation. OPA 42

includes revisions to the above referenced Schedules, which are also attached to Appendices A and C. OPA 42 also includes new policies regarding where and how public private infrastructure is permitted in relation to the City's Natural Heritage System. Consideration should be given to the Current Official Plan Greenland's System mapping and policies, as well as regard for the mapping and policies of OPA 41 until such time that it is no longer under appeal.

2. NATURAL ENVIRONMENT

The various servicing alternatives are restricted to Wellington County (City of Guelph, Puslinch Township, Guelph/Eramosa Township).

The following describes the natural environment within the study area in a general sense. It is expected that more detailed review utilizing Wetland Evaluations, Environmental Significant Area Reports and Fisheries Information will be conducted further in individual Class EAs for the proposed undertakings.

2.1 City of Guelph

With a total coverage of approximately 18%, 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. The City of Guelph encompasses the following natural heritage features:

- 5 Subwatershed/Watershed Areas (partially or entirely – Eramosa-Speed River Watershed, Clythe Creek Subwatershed, Hanlon Creek Watershed, Torrance Creek Subwatershed, Mill Creek Subwatershed)
- 4 Environmentally Sensitive Areas (ESAs),
- 2 Areas of Natural and Scientific Interest (ANSIs),
- 8 Provincially Significant Wetlands (PSWs) Complexes (partially or entirely),
- 3 Locally Significant Wetlands (LSWs),
- The Speed, Eramosa, Hanlon, Torrance, Clythe and Ellis River Systems,
- Approximately 30 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, January 2012 consolidation).

Within and surrounding the City, more than 70 element occurrences of at risk species have been recorded. Those species which have been observed more recently (since 1990) include; least bittern (*Ixobrychus exilis*), Jefferson salamander (*Ambystoma jeffersonianum*), American chestnut (*Castanea dentata*), wavy-rayed lampmussel (*Lampsilis fasciola*), Williamson's emerald (*Somatochlora williamsoni*) 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 include areas containing wetlands, forested areas, wildlife habitat for terrestrial and aquatic species (including endangered and threatened species) significant areas of wetlands, habitats of endangered and threatened species, areas of natural and scientific interest, fish habitat, woodlands, environmental corridors, ecological linkages and wildlife habitat.

Attachment A presents a copy of Schedule 1: Land Use Plan and Schedule 2: Natural Heritage Features and Development Constraints from the City Guelph's Official Plan 2001 December 2012 Consolidation, as well a copy of Schedule 1: Land Use Plan and Schedule 10: Natural Heritage Strategy Natural Heritage System from the Official Plan Amendment 42.

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 from the construction of Guelph Lake Dam in 1974, occurs to the north.

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 thirty (30) species that have been designated as Endangered, Threatened or Special Concern under the provincial Endangered Species Act are known to occur within Wellington County. In addition to this, two (2) species that have been designated as Threatened or Special Concern by the Committee on the Status of Endangered Wildlife in Canada are 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 evaluated wetlands, earth science Areas of Scientific Interest, conservation areas and life science sites.

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 towards 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 1 presents the potential impacts of each alternative.

Table 1 Potential Impacts of Each Alternative

Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
Groundwater Sources			
Optimize Existing Wells Improvement of well performance to yield additional capacity	The existing well which can be optimized that are near or adjacent to natural heritage features include Downey Well (near Speed River Provincially Significant Wetland Complex).	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 through change of riparian/emergent and submergent 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 river and wetland systems within proximity of wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
Restoration of Existing Off-line Municipal Wells Wells have existing permits to take water but City has discontinued use due to concerns with water quality. Wells require upgrades for water quality	Those existing wells which require treatment that are near or adjacent to natural heritage features include the Arkell Lower Road Collector (near Eramosa River), Edinburgh Well (near Speed River), Clythe Creek Well (near Clythe Creek Non-provincially Significant Wetland and Clythe Creek) and Sacco Well (near Marden South Non-provincially Significant Wetland Complex) .	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 through change of riparian/emergent and submergent 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 river and wetland systems within proximity of wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
Develop Existing Municipal Test Wells Construction of wells at or near location of existing municipal test wells	The test wells that may be developed into municipal production wells that are near or adjacent to natural heritage features include Steffler & Ironwood; Scout Camp (near Eramosa River Bluesprings Creek Provincially Significant Wetland Complex); Fleming & Logan (near Guelph Northeast Provincially Significant Wetland Complex ; and Hauser (near Ellis Creek Provincially Significant Wetland Complex) .	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 through change of riparian/emergent and submergent 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 river and wetland systems within proximity of wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
New Wells Inside City Development of additional supplies using Tier 3 Model	In addition to locations of existing test wells, an area where a new well will potentially be installed is near Sunny Acres Park.	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;	Further Studies/ Class EAs should include the following tasks: - Conduct field investigations to determine existing conditions of aquatic/terrestrial habitat within river and wetland systems within proximity of wells; - Conduct field investigations to determine existing conditions of proposed sites for new wells - Obtain Wetland Evaluation Reports, Fisheries and Species at

Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
		- 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.	Risk information for wetlands and watercourses - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
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	Those areas where new wells will potentially be installed, include: Victoria (near the Arkell Bog Provincially Wetland Complex), Guelph North (near the Marden South Provincially Significant Wetland 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; - 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 river and wetland systems within proximity of wells; - Conduct field investigations to determine existing conditions of proposed sites for new wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing potential erosion impacts.
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 Provincially Significant Wetland 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 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; - 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.
Aquifer Storage Recovery (ASR)			
ASR Guelph Lake Storage of treated drinking water in underground aquifers near Guelph Lake during periods of water surplus and subsequent recovery of volume stored during periods of water shortage.	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 in the deep bedrock (i.e. injection mode) when the water was available from the treatment system. When water was required	The process of storage/recovery of surplus water in a given area in theory keeps the existing water capacity at base level. The following impacts might occur: - The potential for groundwater contamination (i.e. nutrient leaching) - Depending on the location of the wells, impacts towards 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; - Determination of Mitigation Measures specifically addressing potential erosion and groundwater impacts; - Preparation of detailed hydrologic studies to investigate existing annual hydrologic regimes;

Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
	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).		- Species at Risk Inventories targeting species sensitive to hydrologic changes; - Amphibian surveys within wetland communities; and - During recovery periods, ensure water capacity remains at determined existing conditions.
Other Water Source Alternatives			
Conservation/Demand Management – Non-Revenue Water	Natural heritage features not affected.	No impacts to natural heritage features anticipated.	No further recommendations required
Conservation/Demand Management – Pricing/Controls/Education	Natural heritage features not affected.	No impacts to natural heritage features anticipated.	No further recommendations required
Reuse – Dual System/Wastewater Reuse	Facility locations/ routing have not yet been determined. There is a potential that natural heritage areas might be affected.	Impacts would relate to facility construction and routing and include: - Sedimentation into adjacent watercourses/natural heritage areas during construction; - Compaction of soils from heavy machinery working adjacent to wetlands/woodlands disturbing root systems and soil pore spaces; - Damage to edge trees from heavy machinery working adjacent to wetlands/woodlands causing wounded trunks or limbs/roots to break, increasing possibility of disease; - Possible vegetation clearing; and - Noise and vibration disturbance to wildlife.	Further Studies/ Class EAs should include the following tasks: - Field investigations documenting existing conditions of natural heritage features ; - Aquatic habitat assessments of any watercourse crossings to determine appropriate crossing methods and construction timing; - Provision of more detailed Impact Assessment; - Determination of Mitigation Measures specifically addressing impacts related to construction; and - Species at Risk Inventories targeting species that might be present within proximity to construction.
Limit Growth	This option applies to the entire study area.	May result in natural heritage feature impacts due to densification.	No further recommendations required
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 negative affects towards the natural environment. These address all potential alternatives. More detailed measures should be determined during the Class EA/Detailed Design phase of this project once a preferred solution is selected.

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 impact this may potentially cause is disruption of riverine/lacustrine baseflow. All alternatives should ensure that base flow conditions are maintained at all times to minimize impacts towards 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 from 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 MNR), sediment control fencing and restoration of disturbed areas/habitat etc.

3) **Dewatering Impacts During Construction –** During construction, especially for the installation of the pipeline, 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.

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.

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.

5. REFERENCES

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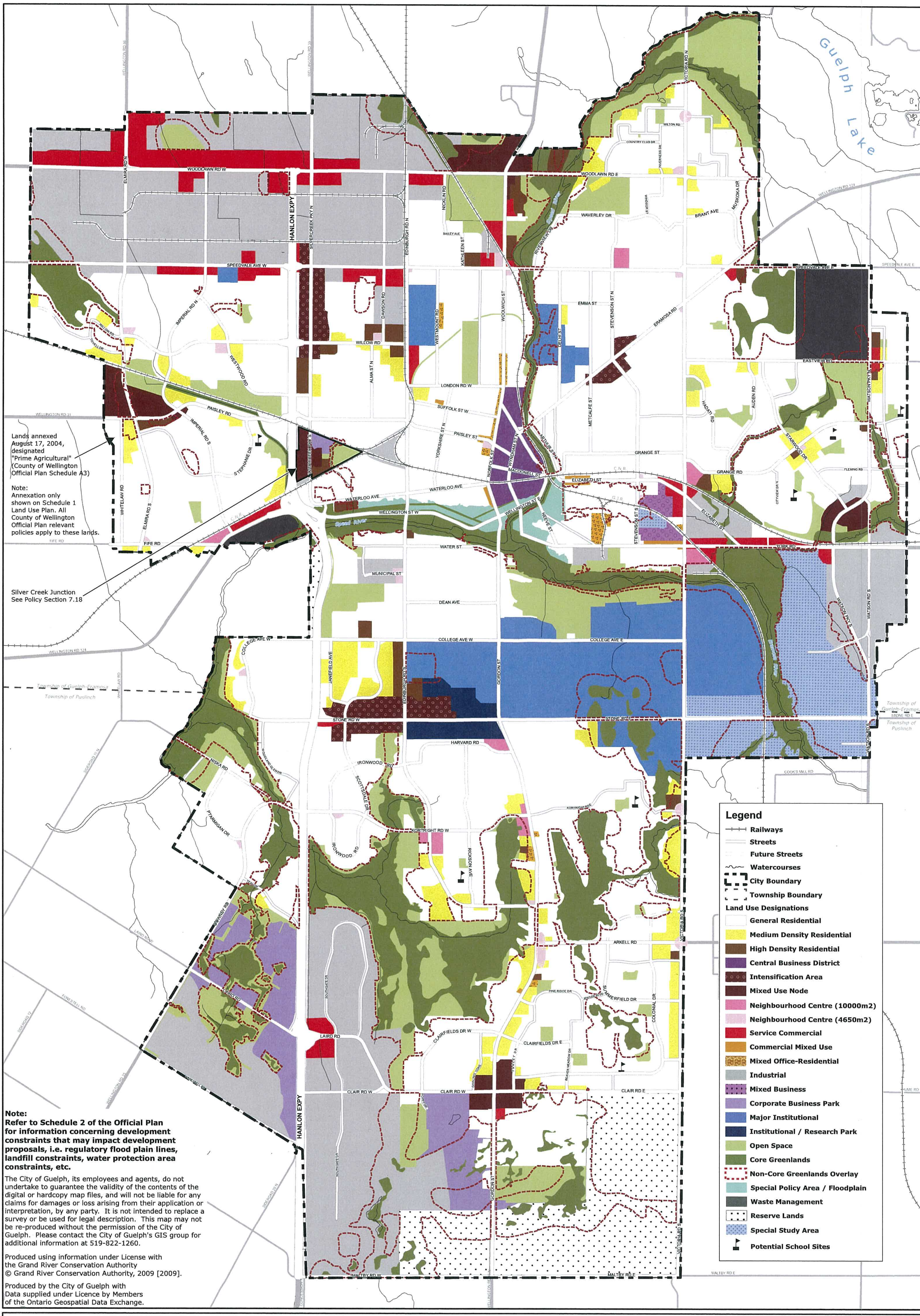
ATTACHMENT "A"

CITY OF GUELPH – SCHEDULE 1 "LAND USE PLAN" AND SCHEDULE 2 "NATURAL HERITAGE FEATURES AND DEVELOPMENT CONSTRAINTS" FROM OFFICIAL PLAN AND SCHEDULE 1 "LAND USE PLAN" AND SCHEDULE 10 "NATURAL HERITAGE STRATEGY NATURAL HERITAGE SYSTEM" FROM OFFICIAL PLAN AMENDMENT 42



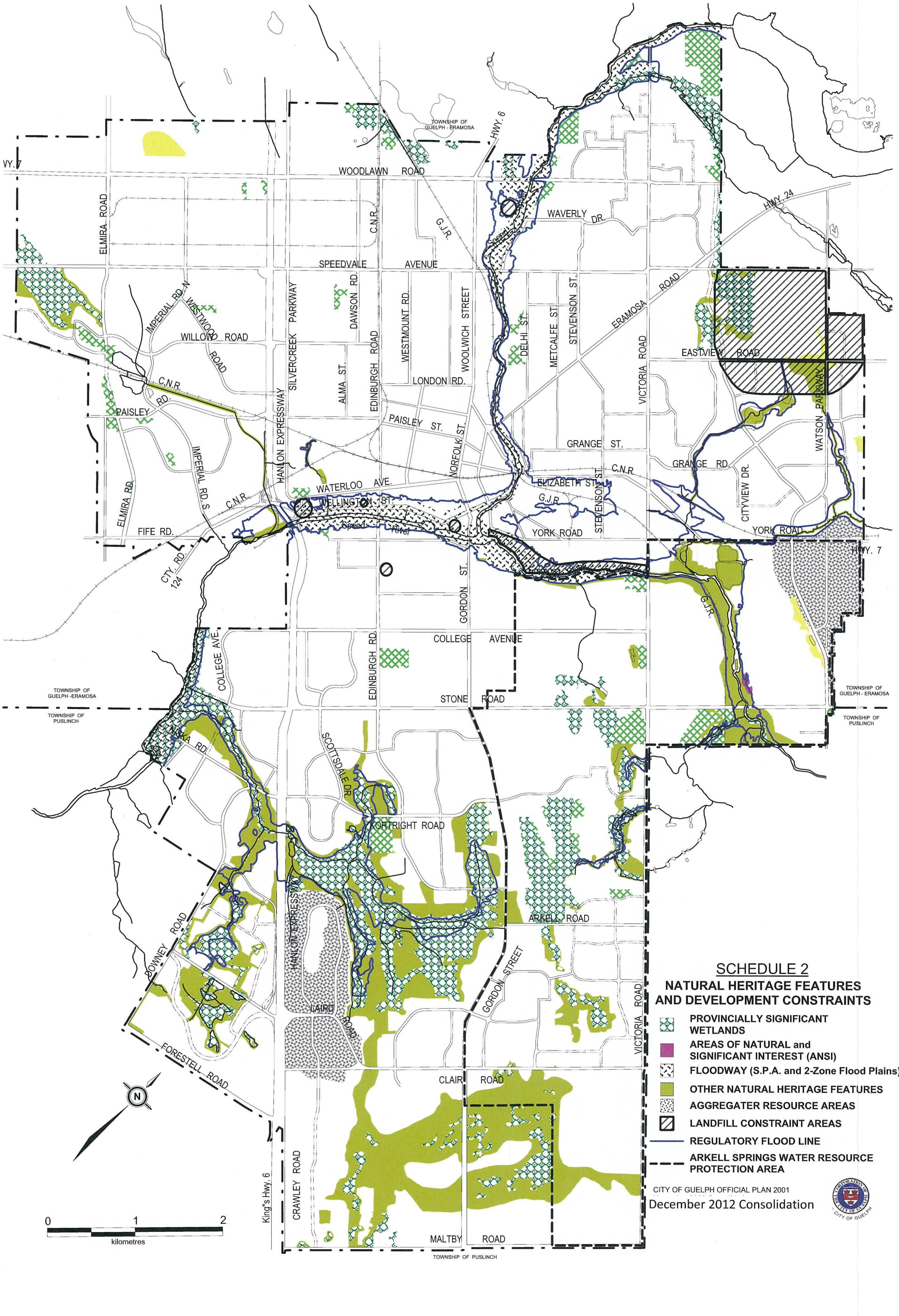
2001 Official Plan, December 2012 Consolidation

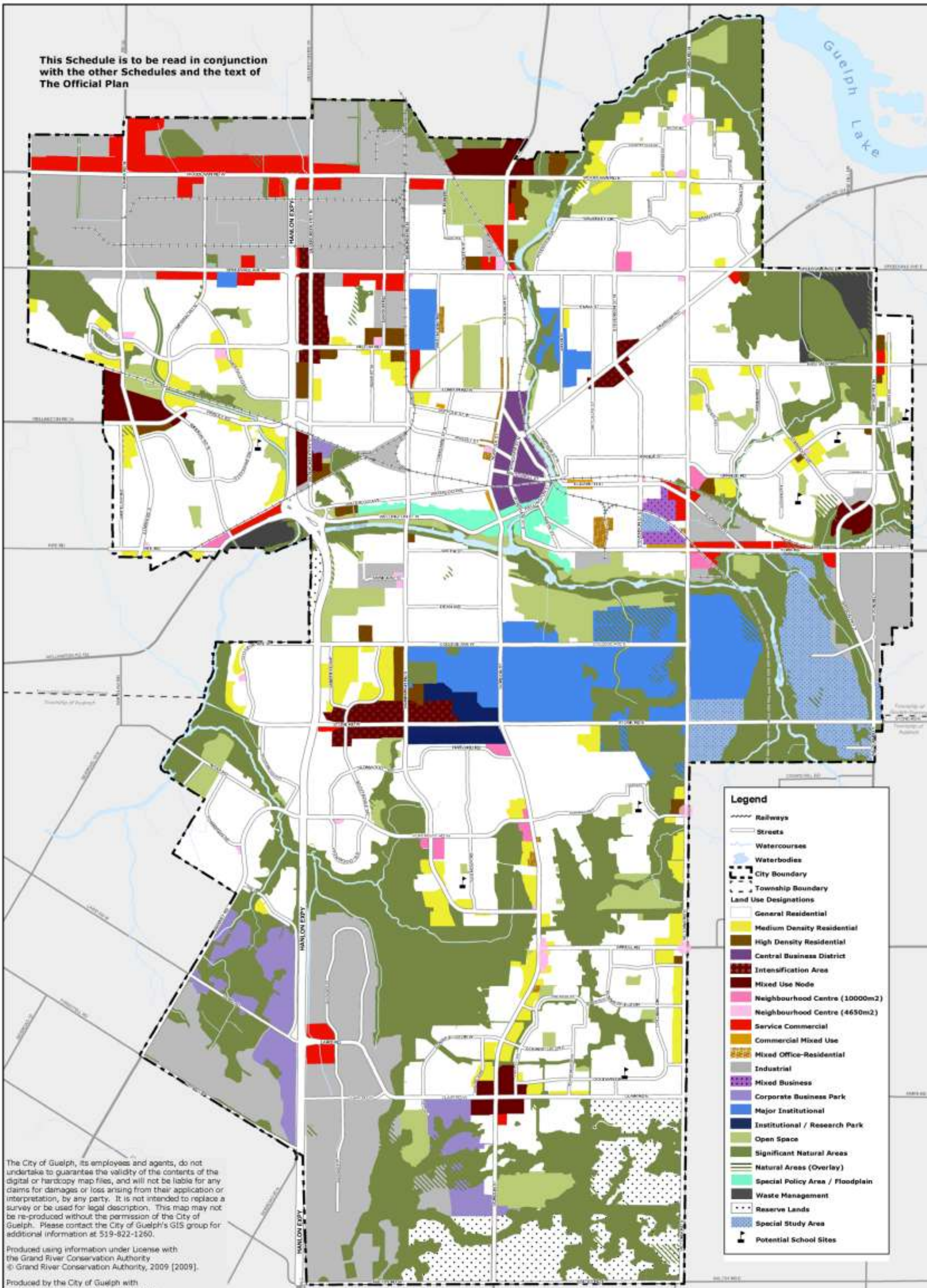
CITY OF GUELPH OFFICIAL PLAN

SCHEDULE 1: LAND USE PLAN

CITY OF Guelph
Making a Difference

Projection: NAD83 UTM Zone 17
Produced by the City of Guelph
Planning Services


SCHEDULE 2
NATURAL HERITAGE FEATURES
AND DEVELOPMENT CONSTRAINTS
PROVINCIALLY SIGNIFICANT WETLANDS
AREAS OF NATURAL and SIGNIFICANT INTEREST (ANSI)
FLOODWAY (S.P.A. and 2-Zone Flood Plains)
OTHER NATURAL HERITAGE FEATURES
AGGREGATER RESOURCE AREAS
LANDFILL CONSTRAINT AREAS
REGULATORY FLOOD LINE
ARKELL SPRINGS WATER RESOURCE PROTECTION AREA
CITY OF GUELPH OFFICIAL PLAN 2001
December 2012 Consolidation
0
1
2
kilometres
TOWNSHIP OF GUELPH - ERAMOSA
TOWNSHIP OF PUSLINCH
WOODLAWN ROAD
SPEEDVALE AVENUE
WILLOW ROAD
PAISLEY RD.
PAISLEY ST.
LONDON RD.
WATERLOO AVE.
WELLINGTON ST.
FIFE RD.
YORK ROAD
COLLEGE AVENUE
STONE ROAD
KORTRIGHT ROAD
ARKELL ROAD
CLAIR ROAD
MALTBY ROAD
FORESTELL ROAD
DOWNEY ROAD
CRAWLEY ROAD
LAIRD ROAD
GORDON STREET
VICTORIA ROAD
ELMIRA ROAD
HANLON EXPRESSWAY
SILVERCREEK PARKWAY
EDINBURGH ROAD
WOOLWICH STREET
EASTVIEW ROAD
WATSON PARKWAY
ERAMOSA ROAD
GRANGE ST.
GRANGE RD.
WAVERLY DR.
HWY. 6
HWY. 24
HWY. 7
King's Hwy. 6
C.N.R.
G.J.R.
Speed River



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1 0.5 0 1 KM

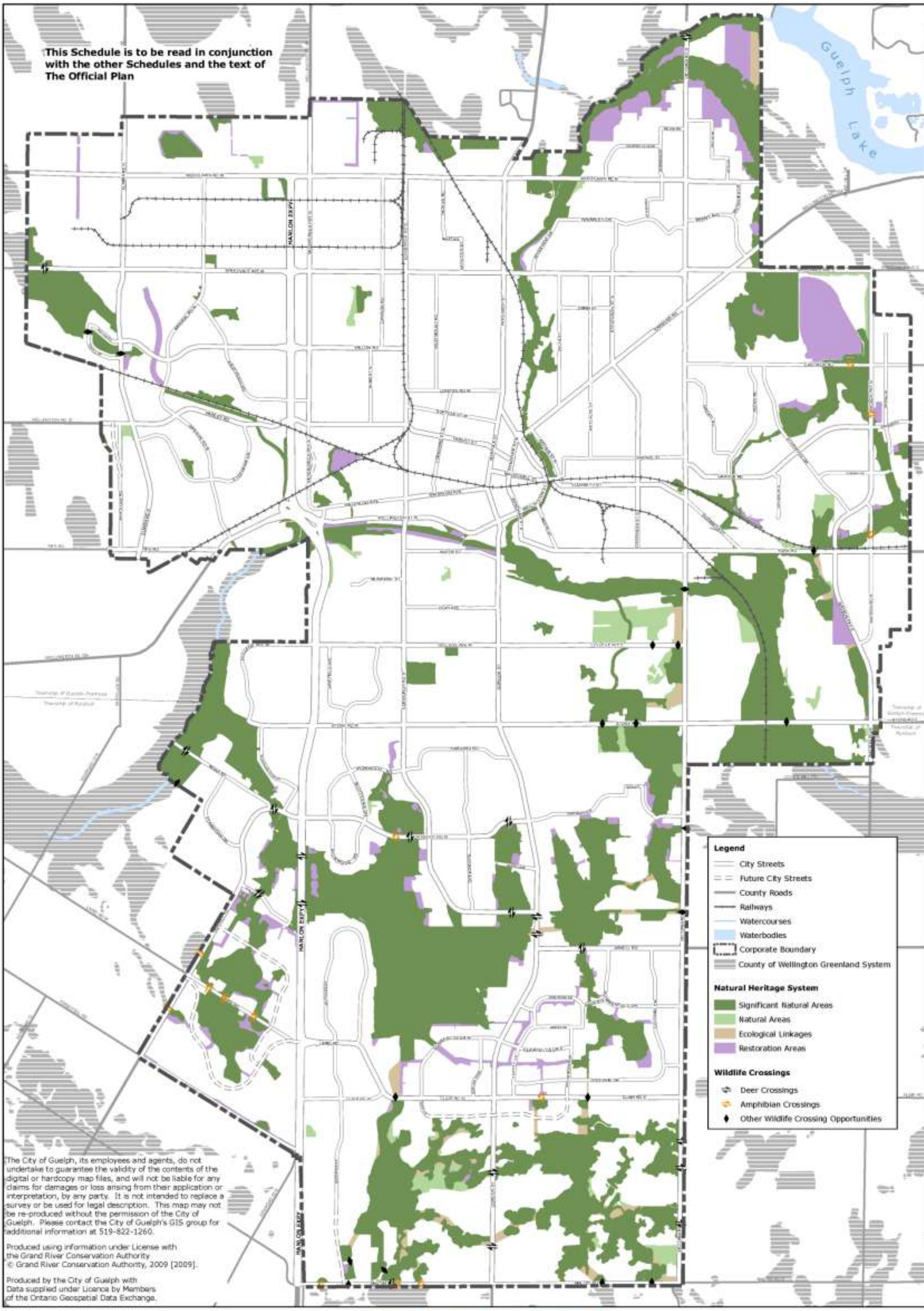
Projection: NAD83 UTM Zone 17
Produced by the City of Guelph
Community Design and Development Services, Planning Services
July 14, 2010

Official Plan Amendment 42

CITY OF GUELPH OFFICIAL PLAN

SCHEDULE 1: LAND USE PLAN

CITY OF Guelph
Making a Difference



Official Plan Amendment 42

CITY OF GUELPH OFFICIAL PLAN SCHEDULE 10: NATURAL HERITAGE STRATEGY

Natural Heritage System

N

1 0.5 0 1 KM

Projection: UTM 17N NAD83
Produced by the City of Guelph
Community Design and Development Services, Planning Services
July 14, 2010

CITY OF Guelph
Making a Difference

ATTACHMENT "B"

SPECIES AT RISK WITHIN WELLINGTON COUNTY

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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 assoicated 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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 30cm 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Amphibians	Jefferson Salamander *Ambystoma jeffersonianum*	END	THR 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Fish	Redside Dace *Clinostomus elongatus*	END	SC Schedule 3	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).	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Yellow-breasted Chat *Icteria virens*	END	SC 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Barn Swallow *Hirundo rustica*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
Fish	Black Redhorse *Moxostoma duquesnei*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Birds	Bobolink *Dolichonyx oryzivorus*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
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 nesitng habitat (i.e. chimnies).	he 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
Birds	Eastern Meadowlark *Sturnella magna*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
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 speice 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
Fish	Silver Shiner *Notropis photogenis*	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 follwoing ELC communities: OAO charachterized 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Molluscs	Wavy-rayed Lampmussel *Lampsilis fasciola*	THR	SC Schedule 1	SC	The Wavy-rayed Lampmussel is usually found in small to medium rivers with clear water. It lives in shallow riffle areas with clean gravel or sand bottoms. Like all mussels, this species filters water to find food, such as bacteria and algae. Mussel larvae are parasitic and must attach to a fish host, where they consume nutrients from the fish body until they transform into juvenile mussels and drop off. The Wavy-rayed Lampmussel's fish hosts are the Largemouth Bass and Smallmouth Bass. The presence of fish hosts is one of the key features for an area to support a healthy mussel population. This species can typically be associated with the following ELC communities: OAO characterized as small to medium rivers with clean water and riffles with gravel or sand substrates.	In Canada, the Wavy-rayed Lampmussel is found only in Ontario in the Grand, upper Thames, Maitland, and Ausable rivers, and the St. Clair River delta in Lake St. Clair. It has disappeared from Lake Erie, the Detroit River and most of Lake St. Clair, and may also be gone from the Sydenham River.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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 immediatly 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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
Birds	Common Nighthawk *Chordeiles minor*	SC	THR Schedule 1	THR	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 communitiesdes: SD, BB, RB, CUM, BO, FOM, FOC and FODwith 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Plants	Hart's-tongue Fern *Asplenium scolopendrium americanum*	SC	THR Schedule 1		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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Reptiles	Milksnake *Lampropeltis triangulum*	SC	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	The Northern Map Turtle's range extends from the Great Lakes region west to Oklahoma and Kansas, south to Louisiana and east to the Adirondack and 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Red-headed Woodpecker *Melanerpes erythrocephalus*	SC	THR Schedule 1	THR	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	Short-eared Owl *Asio flammeus*	SC	SC Scheudle 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 assoicated 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Wood Thrush *Hylocichla mustelina*	No Status	No Status	THR	The Wood Thrush can typically be found in the interior and along the edges of well-develoepd 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

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Birds	Eastern Wood-Pewee *Contopus virens*	No Status	No Status	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 follwoing 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

Glossary

EXP	ESA - Extripated - a species that no longer exists in the wild in Ontario but still occurs elsewhere. SARA - Extripated - a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
END	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.
THR	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.
SC	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 Stauts of Endangerd Wildlife in Canada - a committee of experts that assesses and designates which wild species are in some danger of disappearing from Canada.

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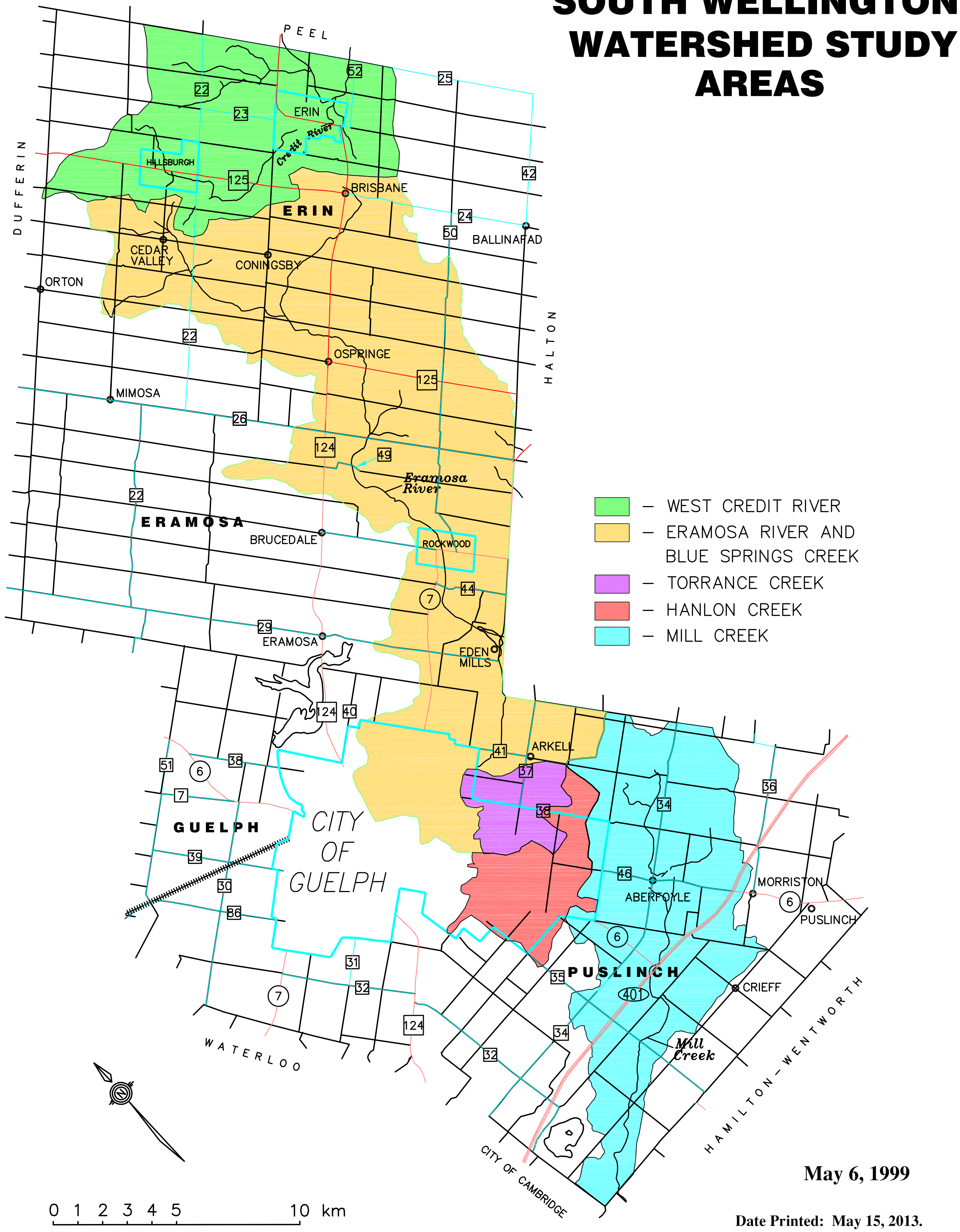
4 - McCarty, John P. 1996. Eastern Wood-Pewee (Contopus virens), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/245doi:10.2173/bna.245

ATTACHMENT "C"

WELLINGTON COUNTY – APPENDIX 1 "SOUTH WELLINGTON WATERSHED STUDY AREAS AND APPENDIX 3 "COUNTY OF WELLINGTON PROVINCIALLY SIGNIFICANT WETLANDS" FROM OFFICIAL PLAN

APPENDIX 1

SOUTH WELLINGTON WATERSHED STUDY AREAS

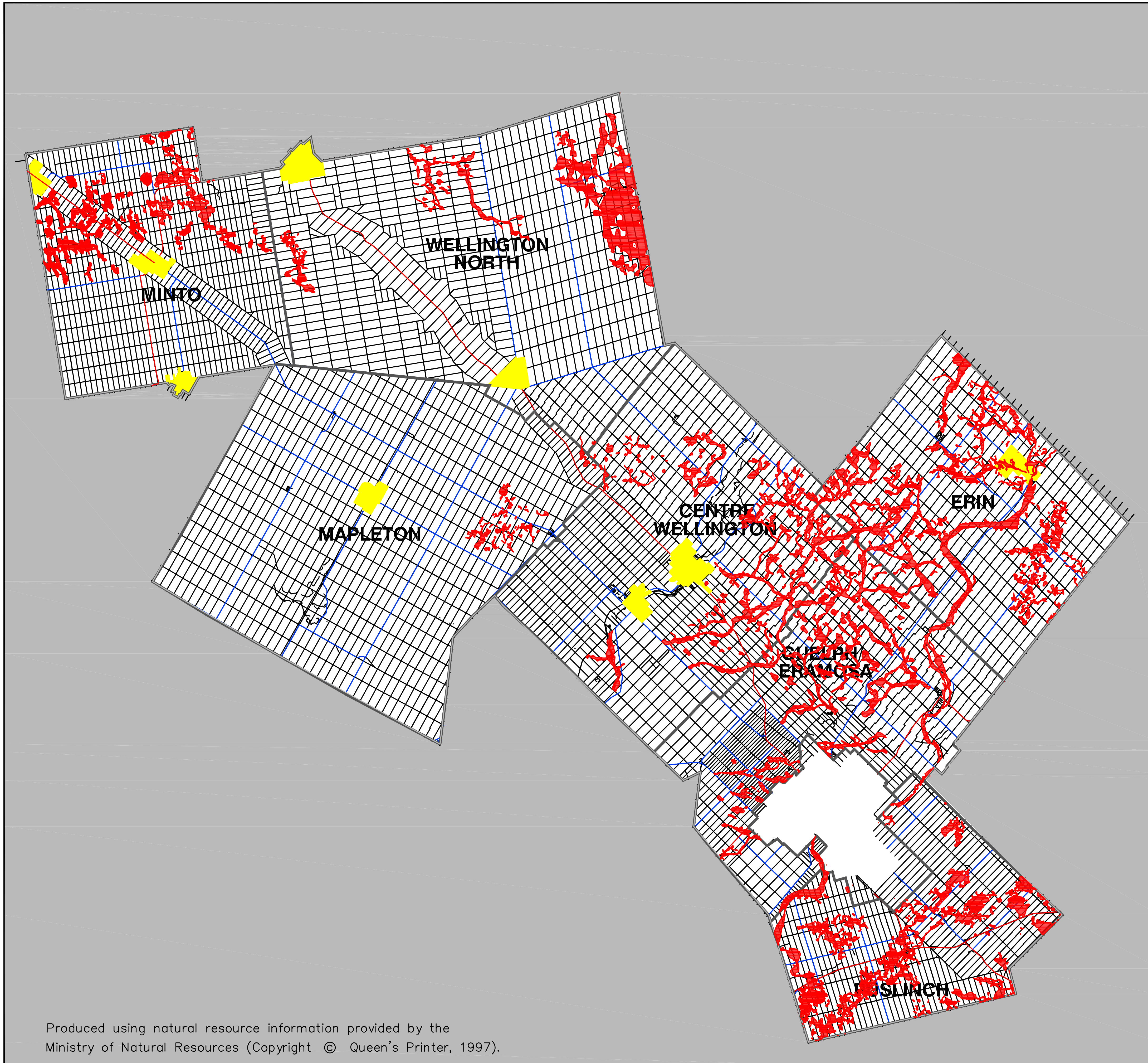


May 6, 1999

Date Printed: May 15, 2013.

APPENDIX 3

COUNTY OF WELLINGTON



Provincially Significant Wetlands (Class 1,2,3)

Scale:
0 2000 6000 12000 metres

May 6, 1999
Date Printed: May 15, 2013.

Appendix B

Technical Memorandum 1

Population and Water Supply Demand Forecasts

Appendix B

City of Guelph Water Supply Master Plan Update (Draft Final Report)

Technical Memorandum No. 1 - Population and Water Supply Demand Forecasts

City of Guelph

Water Supply Master Plan Update: Technical Memorandum No. 1 - Population and Water Supply Demand Forecasts (Draft Final)

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1. Introduction

AECOM has been retained by the City of Guelph to complete the Water Supply Master Plan Update. The intent of this memo is to provide background information and present population and water supply demand projections for the 25-year study period (i.e. to 2038).

2. Population Projections

Section 2.1 presents the population projections and sources of the projections up to year 2041. The population projection design basis used for this Water Supply Master Plan Update is presented in **Section 2.2**.

2.1 Summary of Population Projections

Population projections are required to determine future water supply requirements. The population projections presented herein combine non-residential (employment excluding work at home and no fixed place of work) and residential (including census undercount) populations to develop a total 'equivalent' population. The equivalent population represents the projected residential population plus the additional population representative of industrial, commercial and institutional (ICI) land use. This equivalent population forms the basis for developing existing and future water demands. The advantage of this approach is that it accounts for changes in both the residential and non-residential sectors (i.e. any change in the proportion of each).

Population growth projections for the City are per the Development Charge Background Study and are presented in **Table 2-1** (Watson & Associates Economists Ltd., 2013). The residential population includes census undercount, and the employment population excludes work at home and no fixed place of work. The Development Charges Growth Forecast estimates 1.6% to 2% growth per year until 2031.

Table 2-1: Residential and Employment Population Projections to 2031

Year	**Residential Population** (Including Census Undercount)*	**Equivalent Employment Population** (Excluding work at home and no fixed place of work)**	**Total Equivalent Population**
2013	130,670	66,730	197,400
2023	156,290	81,017	237,307
2031 / Buildout***	175,330	95,934	271,264

Source: **(Watson & Associates Economists Ltd., 2013)**
*From Schedule 1
**From Schedule 9B
*** Buildout refers to the residential and non-residential yield on all lands within the City's Municipal Corporate boundary including the Guelph Innovation District (GID), but excluding lands designated Reserve Lands and Open Space/Park land in the Clair-Maltby Secondary Plan Area.

Note: 1.6% to 2% growth per year.

In order to extend population projections beyond the current Official Plan planning period of 2031, an existing City Staff Report to City Council (Report Number 13-09, dated March 25, 2013) was referenced (City of Guelph - Planning, Building, Engineering and Environment - Todd Salter, 2013). To address growth to 2041, the City prepared this document to advise Council of the Proposed Amendment 2 to the

Growth Plan for the Greater Golden Horseshoe, 2006, and seek Council endorsement (City of Guelph - Planning, Building, Engineering and Environment - Todd Salter, 2013). The Proposed Amendment 2 to the Growth Plan for the Greater Golden Horseshoe, 2006, proposes an extension of the population and employment forecasts of the Growth Plan from 2031 out to 2041. For Guelph, Amendment 2 proposes the population forecast presented in **Table 2-2** (pending City's Council approval). The Amendment 2 to the Growth Plan for the Greater Golden Horseshoe estimates 0.7% to 0.8% growth per year beyond 2031.

Table 2-2: Growth Plan Amendment 2 Residential and Employment Population Projections to 2041

Year	Residential Population	Employment Population	Total Equivalent Population
2031	175,000	92,000	267,000
2036	183,000	97,000	280,000
2041	191,000	101,000	292,000
Source: **(Ontario Ministry of Infrastructure, 2012), (City of Guelph - Planning, Building, Engineering and Environment - Todd Salter, 2013)** Note: 0.7% to 0.8% growth per year.			

2.2 Design Basis for Population Projections

For the purposes of this Master Plan update, the City of Guelph Development Charges (DC) Growth Forecast (Watson & Associates Economists Ltd., 2013) is referenced to develop 2031 projections, and the Proposed Amendment 2 to the Growth Plan for the Greater Golden Horseshoe, 2006 is referenced to develop population projections from 2032 to 2038 (City of Guelph - Planning, Building, Engineering and Environment - Todd Salter, 2013). The population projections from 2013 to 2038 in five-year increments are presented in **Table 2-3** and illustrated in **Figure 2-1**.

Table 2-3: Guelph Population Projections

Year	**Residential Population** (Including Census Undercount)*	**Equivalent Employment Population** (Excluding work at home and no fixed place of work)	**Total Equivalent Population****	Notes
2013	130,670	66,730	197,400	1, 2*
2018	143,480	73,874	217,354	1, 2
2023	156,290	81,017	237,307	1, 2
2028	168,190	90,340	258,530	1, 2
2033	178,464	96,947	275,411	
2038	186,299	99,480	285,779	
* Census undercount is estimated at approximately 3.5%. ** Projection excludes lands designated Reserve Lands, and Open Space/Park within Clair-Maltby Secondary Plan Area; Projection also excludes students which would not be captured within the permanent population base.				

Year	**Residential Population** (Including Census Undercount)*	**Equivalent Employment Population** (Excluding work at home and no fixed place of work)	**Total Equivalent Population****	Notes
2013 to 2031 Source: **(Watson & Associates Economists Ltd., 2013)** –1.6% to 2% growth per year 2032 to 2038 Source: **(Ontario Ministry of Infrastructure, 2012), (City of Guelph - Planning, Building, Engineering and Environment - Todd Salter, 2013)** – 0.7% to 0.8% growth per year				

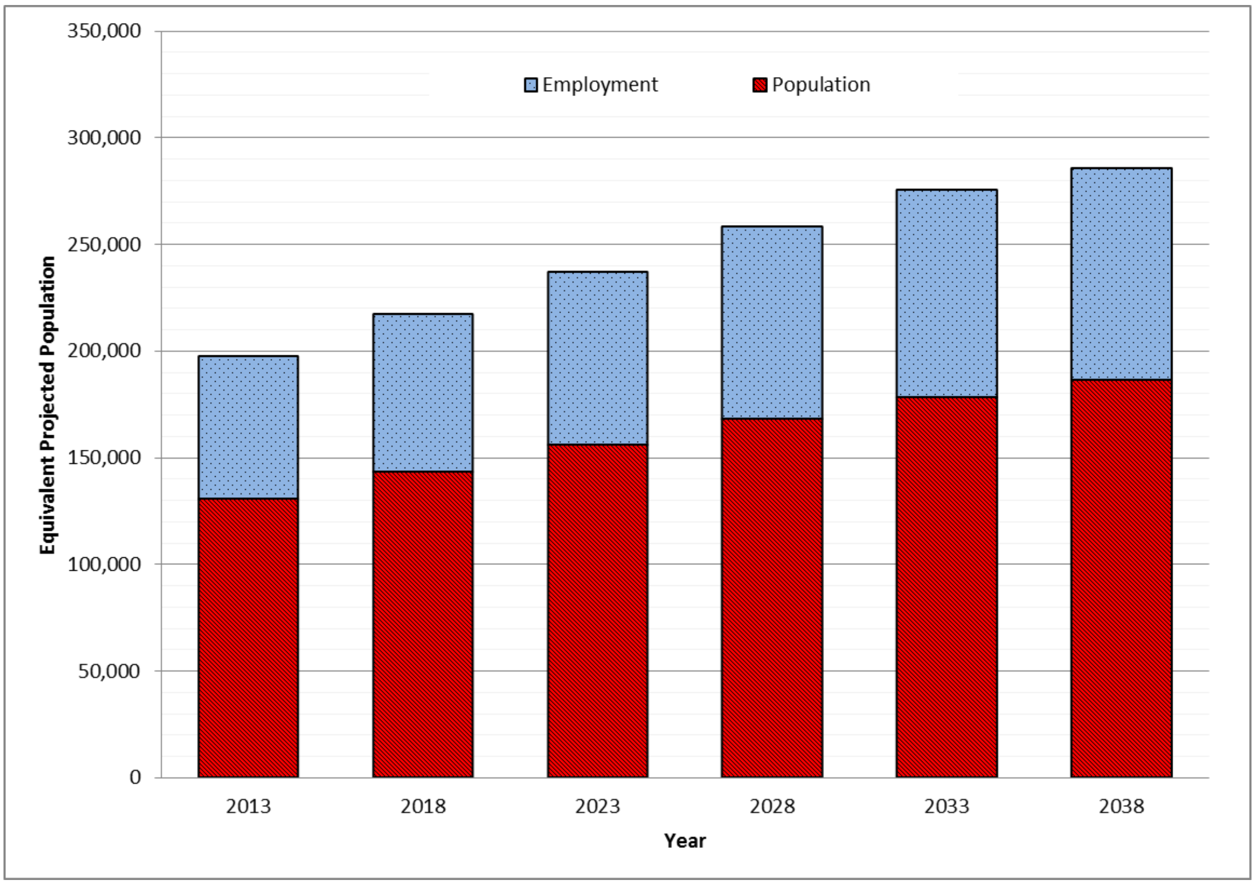

Figure 2-1: Guelph Projected Population Growth (2013-2038)

3. Historical Water Use

3.1 Overall Water Demand for Last Five Years

Figure 3-1 presents the reduction in historical average daily water production, and average daily water consumption during the last seven years (2006 to 2012), since completion of the last Water Supply Master Plan. Also shown for comparison in **Figure 3-1** is the steady increase in population.

Historical water production and demand data for the last five years (2008 to 2012) are presented in **Table 3-1**. Water production and demands on a per capita basis (for residential and equivalent population) is presented in **Figure 3-2**.

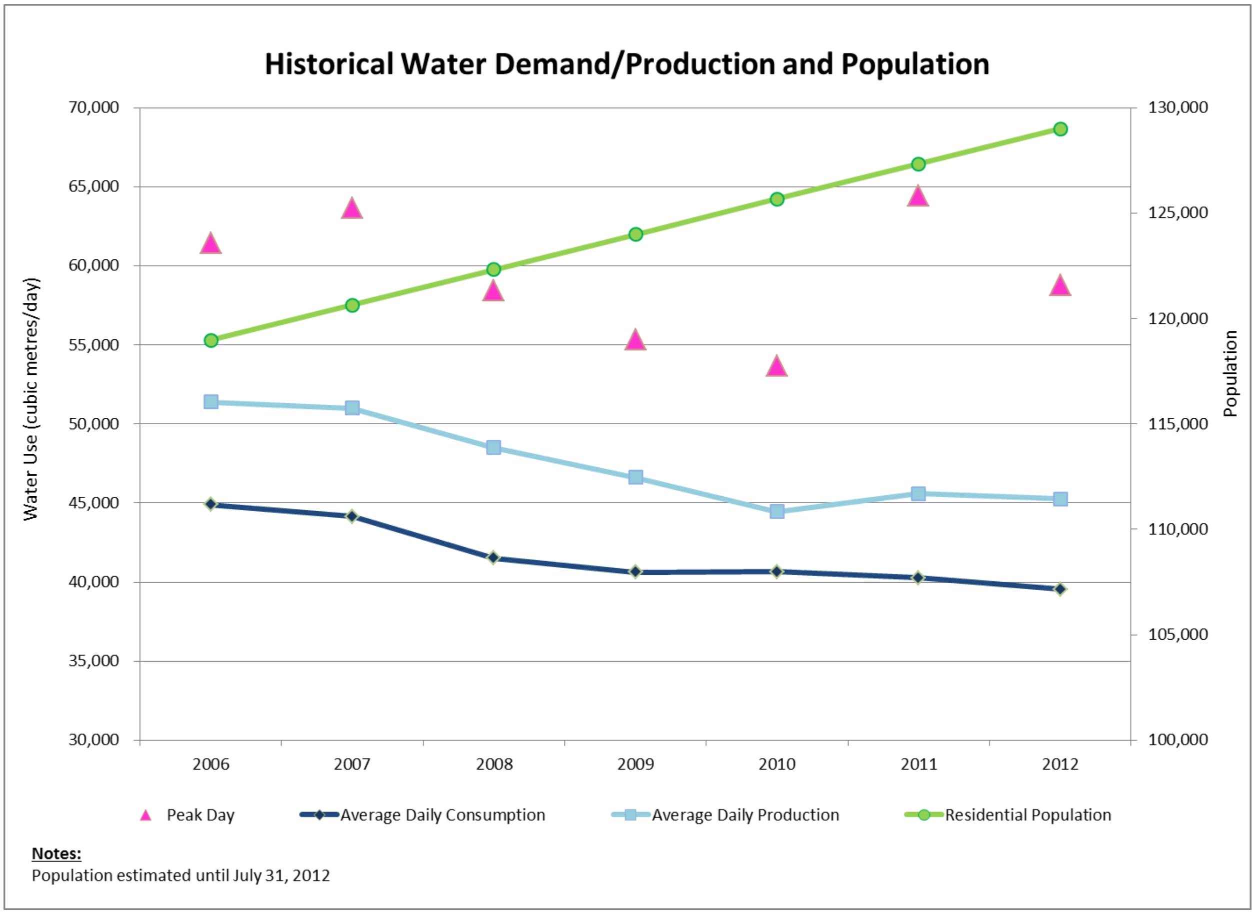

Figure 3-1: Historical Water Demand/Production and Population (2006 – 2012)

Table 3-1: Historical Water Production and Demand (2008 - 2012)

Year	Equivalent Population (estimate)	Average Daily Production (m^3/d)	Average Daily Consumption (m^3/d)	Non-Revenue Water (m^3/d)[1]	Total demand per capita (L/equiv. pop/day)	Peak Day Production (m^3/d)	Max Day Factor[2]
2008	186,279	48,492	41,517	6,976	260	58,440	1.21
2009	188,503	46,607	40,618	5,989	247	55,337	1.19
2010	190,727	44,442	40,642	3,800	233	53,691	1.21
2011	192,951	45,578	40,267	5,311	236	64,416	1.41
2012	195,176	45,244	39,548	5,697	232	58,764	1.30
Ave (2008-2012)		**46,073**	**40,518**	**5,554**	**242**	**58,130**	**1.26**

Notes:
Source: City of Guelph Waterworks
[1] Non Revenue Water = Production (m^3/d) - Consumption (m^3/d). Average daily production represents volume pumped from water supply facilities. Average daily consumption represents volume billed to customers on distribution system.
[2] Max day factor = Peak day production / average daily production

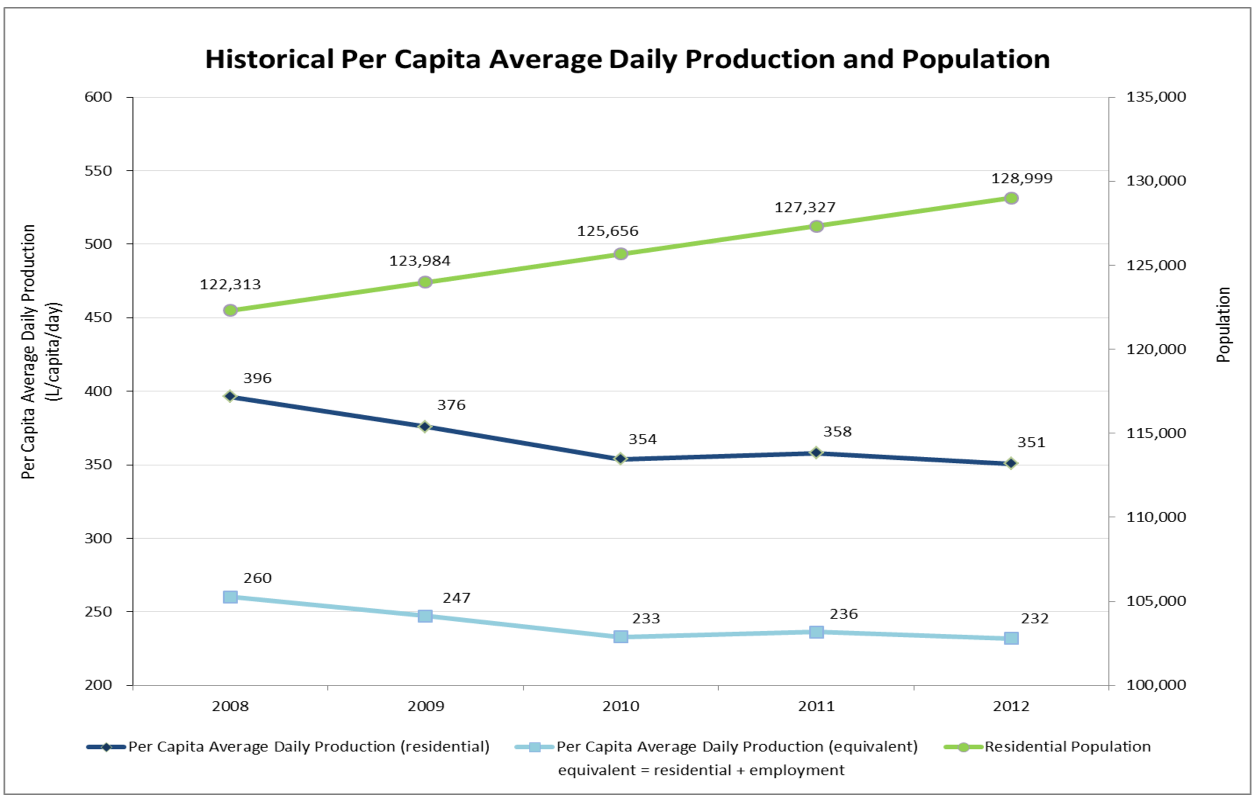

Figure 3-2: Per Capita Average Daily Production vs. Population (2008 – 2012)

The following observations can be noted from **Figure 3-1, Table 3-1**, and **Figure 3-2**:

- Although the equivalent population increases from 2008 to 2012, water consumption has declined. This declining trend in per capita consumption has been noted in most municipalities across Canada. This is partially attributed to water conservation measures implemented by the City. Water conservation measures details are presented in **Section 3.3**. Other contributing factors may include loss of industries and change in industry and other economic (recessionary) stresses influencing behavioural changes, etc.
- Non-revenue water represents approximately 12% of the total water produced, on average, from 2008 to 2012. Non-revenue water includes watermain breaks, exfiltration, water used for water main flushing, meter inaccuracies, fire flows, etc. This is described further in **Section 4.1.3**.
- The average per capita demand (from 2008 to 2012) based on equivalent population and residential population only, was 242 L/ca/d, and 367 L/ca/d, respectively, both including non-revenue water. In general, per capita consumption decreased from 2008 to 2012.
- The average maximum day factor from 2008 to 2012 was 1.26 ± 0.09, ranging from 1.19 to 1.41.

3.2 Review of Detailed Billing Data

The City of Guelph provided AECOM with the water consumption records based on billings data by sector from 2006 to 2012 sourced from its 2012 Water Intensity Mapping Exercise, as summarized in **Table 3-2** and **Figure 3-3** and **Figure 3-4**. The majority of demand is residential at an average of approximately 52% of the total demand.

Table 3-2: 2006-2012 Water Consumption Data by Sector

Sector	2006	2007	2008	2009	2010	2011	2012
Land Use Pending/Other (m^3)	97,511	87,892	78,705	71,981	104,139	118,788	98,241
Total Residential (m^3)	9,446,138	9,550,692	9,182,320	9,003,664	8,804,006	8,679,617	8,476,244
Commercial (m^3)	1,264,827	1,248,512	1,238,817	1,165,748	1,172,731	1,154,412	1,046,340
Industrial (m^3)	3,722,497	3,595,542	3,050,754	2,926,735	3,104,765	3,280,582	3,367,110
Institutional (m^3)	1,852,707	1,634,806	1,603,000	1,657,444	1,648,577	1,464,030	1,446,926
Non-revenue water (m^3)	2,372,658	6,163,790	2,546,059	2,186,165	1,387,040	1,938,450	2,079,225
TOTAL Pumped per year (m^3)	18,756,338	18,616,944	17,699,655	17,011,737	16,221,258	16,635,879	16,514,086
TOTAL Consumption per year (m^3)	16,383,680	12,453,154	15,153,596	14,825,572	14,834,218	14,697,429	14,434,860
Average Daily Consumption (m^3/d)	44,887	44,157	41,517	40,618	40,642	40,267	39,548

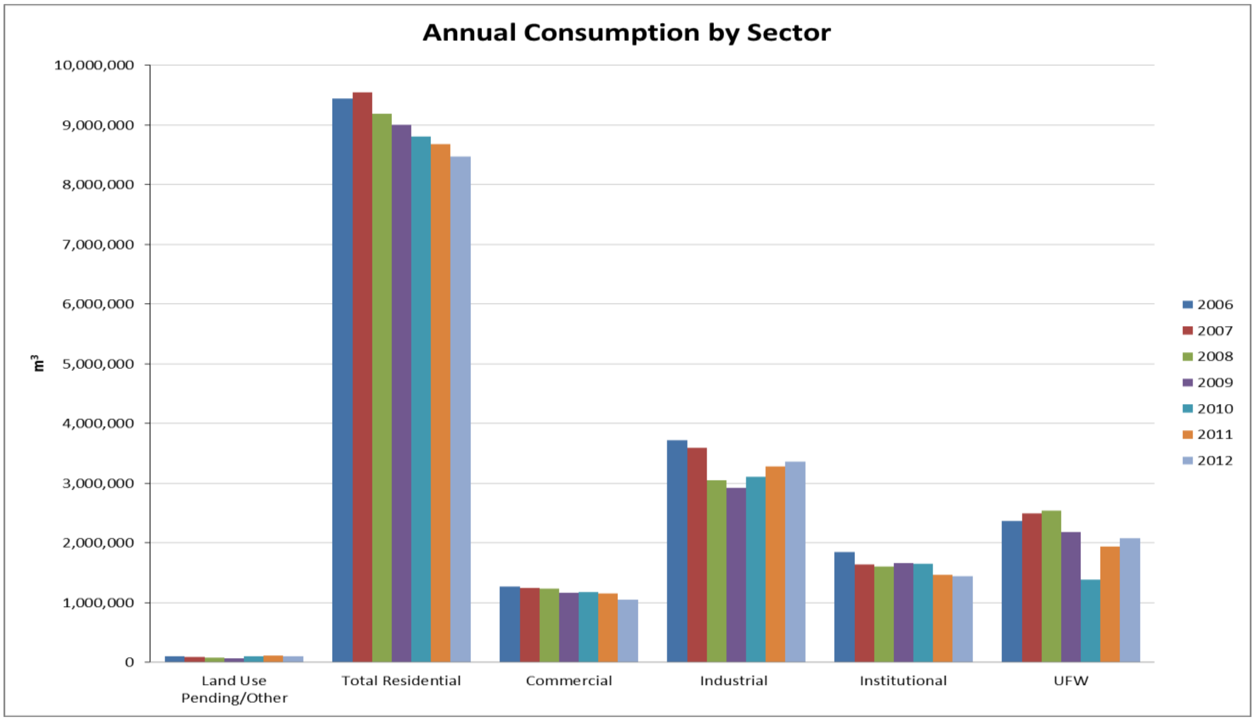

Figure 3-3: Water Demands by Sector (2006-2012)

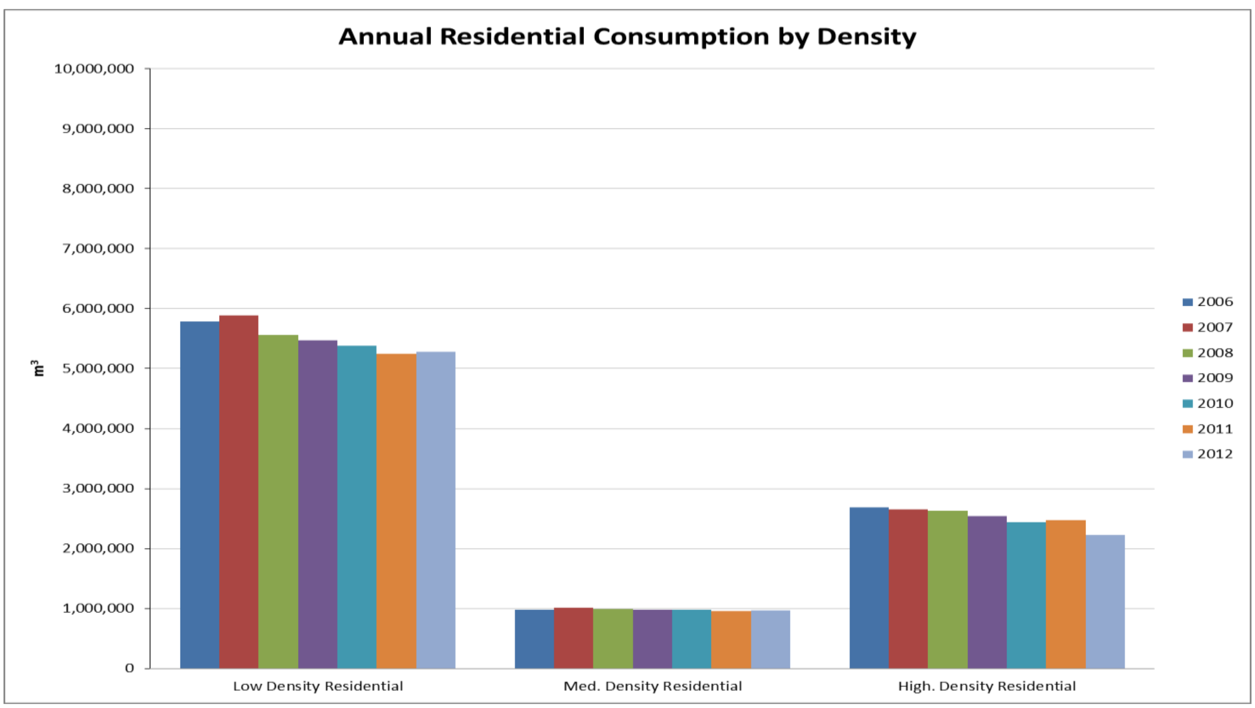

Figure 3-4: Residential Water Demands by Density (2006-2012)

3.3 Water Conservation

3.3.1 Historical Conservation Measures and Impact on Water Use

The City of Guelph has been implementing water conservation and efficiency for a number of years following the initiation of the Water Conservation and Efficiency Study (WC&E) in 1998. The latest version of the WC&E was finalized in 2009, as the 2009 Water Conservation and Efficiency Strategy Update (WCESU). The WCESU (Resource Management Strategies Inc., 2009) identified a number of recommendations which were implemented by the City, including the following:

- Rebates for low flow toilets, low water use washing machines, and water efficient central humidifiers;
- Rebates for grey water reuse systems;
- Rebates for rainwater harvesting systems;
- Rebates for watering timers;
- Educate residents on watering lawns and water efficient landscapes;
- Visit homes and installation of low flow showerheads and low flow kitchen aerators, and repair leaks;
- Outdoor water use restrictions;
- Public education and outreach;
- Complete ten (10) water audits per year and offer capacity buy-back rebates to facilities which implement some/all of the water saving recommendations;
- Complete water use audits on municipal buildings and implement water efficiency retrofits.

The Water Supply Master Plan completed in 2007 identified water conservation as a preferred short term source of water supply, with the following water reduction targets:

- 10% reduction (5,300 m^3/d) in 2006 total average day water use by 2010;
- 15% reduction (7,950 m^3/d) in 2006 total average day water use by 2017;
- 20% reduction (10,600 m^3/d) in 2006 total average day water use by 2025.

The key findings per the WCESU from the conservation measures implemented were as follows:

- In 2009, City was saving 409,895 m^3/yr (1,123 m^3/d) from measures implemented from 2003 to 2008;
- Water demand declined from 444 L/ca/d to 370 L/ca/d from 1999 to 2007;
- City has achieved an average of 883 m^3/d water savings from 2006 to 2009.

The WCESU identified the total potential water savings for the City, assuming a 100% participation rate in all conservation programs, of an additional 8,774 m^3/d by 2019, which is consistent with the 2007 Water Supply Master Plan goals above listed.

Table 3-3 presents the water production performance indicators from 1999 to 2012.

Table 3-3: Water Production Performance Indicator Summary 1999 to 2012

Year	Non-Peak Season Avg Day Production (m^3/day)	Peak Season Avg Day Prod (m^3/day)	Average Daily Production (m^3/day)	Peak Day (m^3/day)	Average Daily Consumption (m^3/day)	Guelph Residential Population
1999	50,013	55,074	52,329	71,590	45,263	101,857
2000	51,410	53,303	52,754	61,629	44,318	104,013
2001	53,580	57,198	55,290	73,744	44,927	106,170
2002	53,356	55,500	53,654	70,568	44,779	107,944
2003	52,297	52,782	51,945	65,647	43,481	109,718
2004	50,597	52,826	51,243	60,103	43,604	111,492
2005	50,621	55,146	52,579	67,975	43,708	113,266
2006	50,085	53,005	51,387	61,456	44,887	118,970
2007	49,448	53,163	51,005	63,652	44,157	120,641
2008	47,801	49,454	48,492	58,440	41,517	122,313
2009	46,426	46,859	46,607	55,337	40,618	123,984
2010	43,444	45,824	44,442	53,691	40,642	125,656
2011	43,608	48,308	45,578	64,416	40,267	127,327
2012	43,765	47,303	45,244	58,764	39,548	128,999
10 year difference (2003-2012)					-3,933 (-9%)	19,281 (17.6%)
5 year difference (2008-2012)					-1,969 (-4.7%)	6,686 (5.2%)
1 year difference (2011-2012)					-719 (-1.8%)	1,671 (1.3%)

The Royal Flush Rebate Program offers rebates of $75 to the home owner for the replacement of an old 20 litre or 13 litre toilet with a water efficient model, resulting of up to 110 litres of water saved per year. **Figure 3-5**, illustrates the Royal Flush Rebate Program savings.

The Smart Wash Washing Machine Rebate Program offers rebates $100 to the home owner for the replacement of an old, top loading washing machine with a new ENERGY STAR® qualified washing machine. **Figure 3-6** shows the Smart Wash Washing Machine Rebate Program savings.

The Floor Drain Retrofit Rebate Program offers rebates of $60 for the replacement of automatic floor drain priming devices with the City's approved waterless floor drain trap devices. **Figure 3-7** shows the Floor Drain Retrofit Rebate Program savings.

The Home Humidifier Rebate Program provides rebates of $30 and $70 for the installation of furnace-mounted humidifiers that uses no more than 50 litres of water per day down the drain. **Figure 3-8** shows the Home Humidifier Rebate Program savings.

The Blue Built Home Program certifies new homes that have water efficient fixtures and appliances that can reduce the utility bills in up to 54%. **Figure 3-9** shows the Blue Built Home Program savings.

Figure 3-5 to **Figure 3-9** show the savings obtained from the various water conservation programs described above and **Table 3-4** summarizes the water conservation program savings from 2006 to 2011.

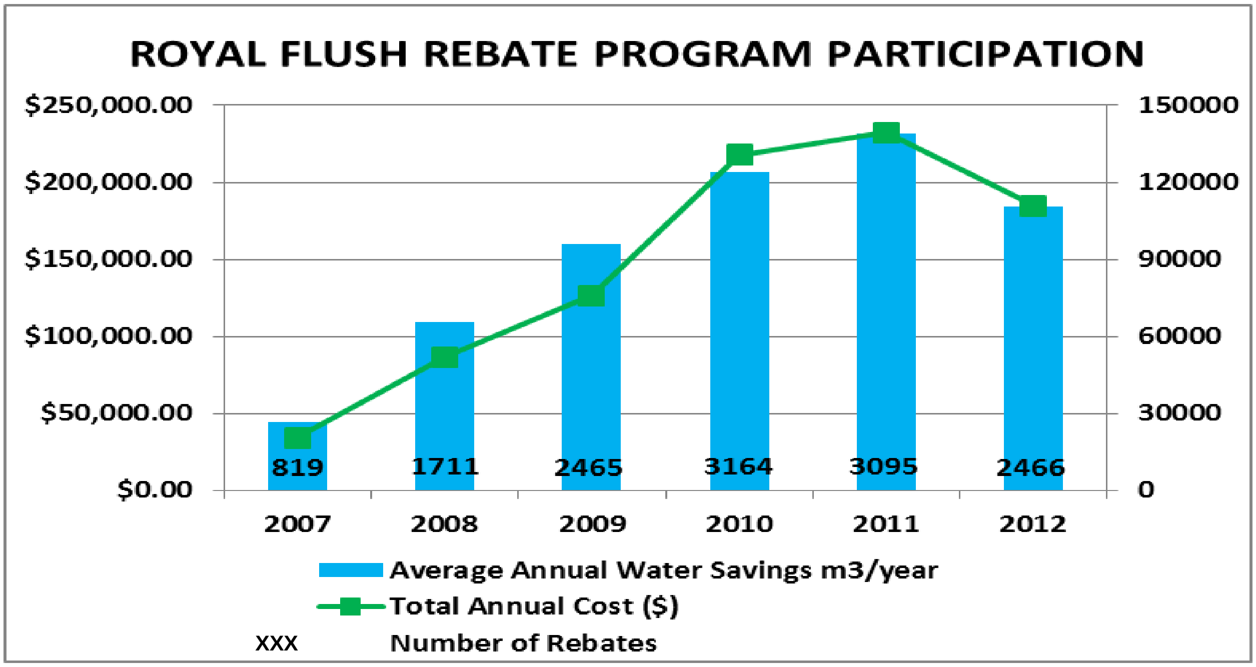

Figure 3-5: Water Conservation: Royal Flush Rebate Program Participation (2007-2012)

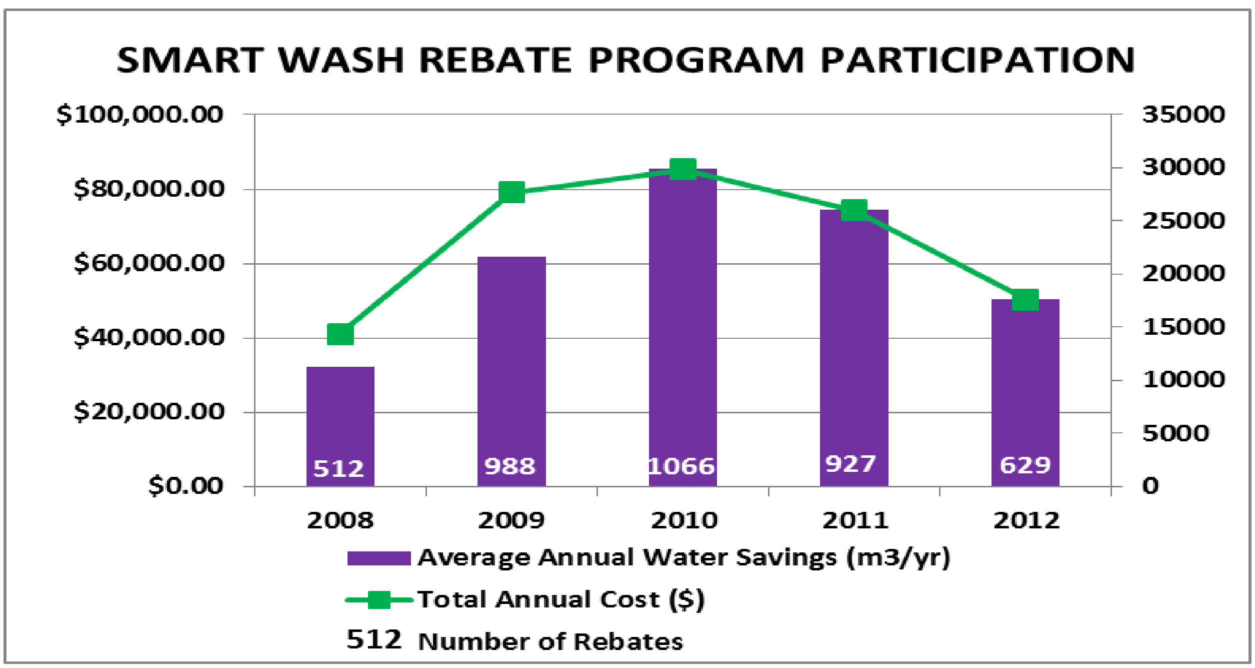

Figure 3-6: Water Conservation: Smart Wash Rebate Program Participation (2008-2012)

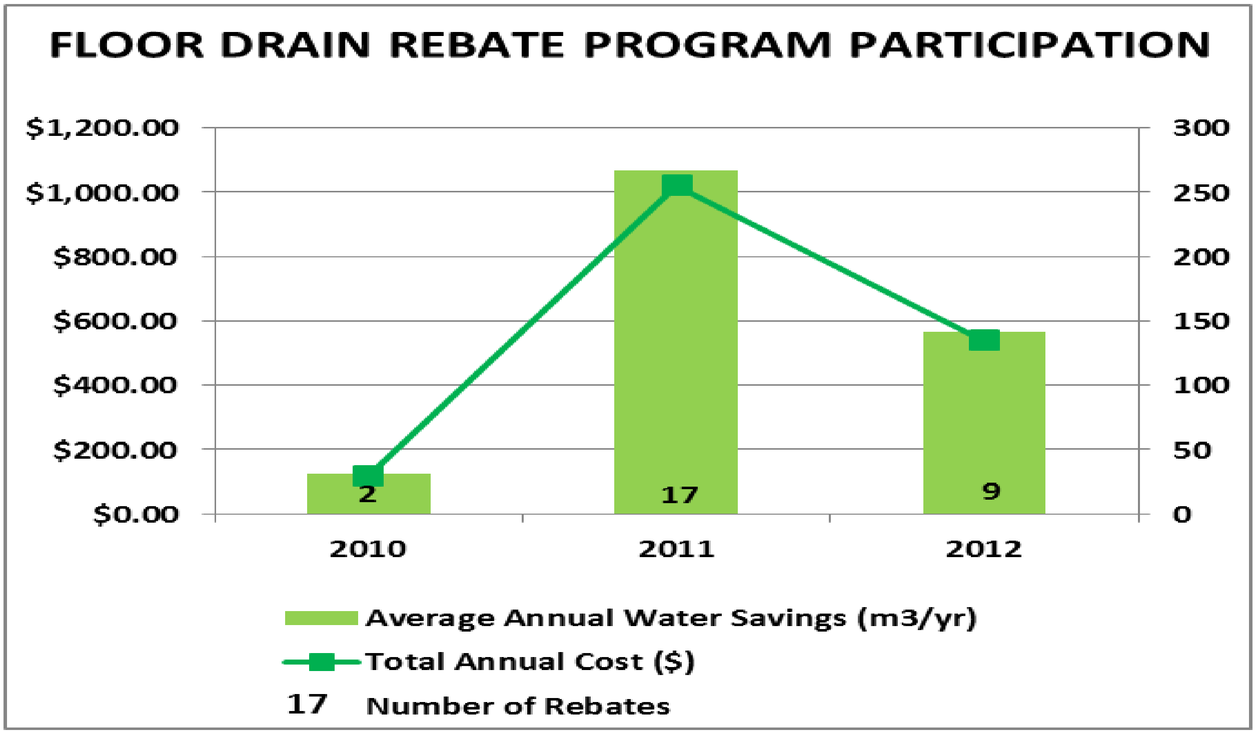

Figure 3-7: Water Conservation: Floor Drain Rebate Program Participation (2010-2012)

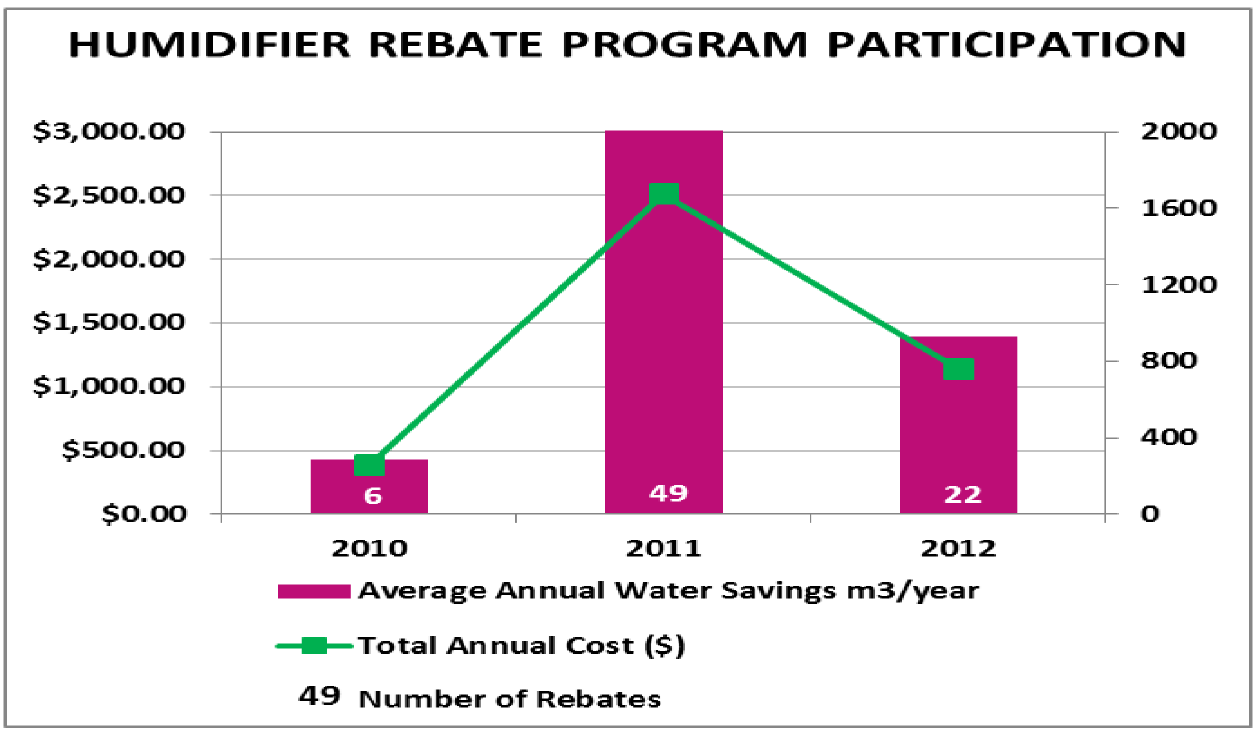

Figure 3-8: Water Conservation: Humidifier Rebate Program Participation (2010-2012)

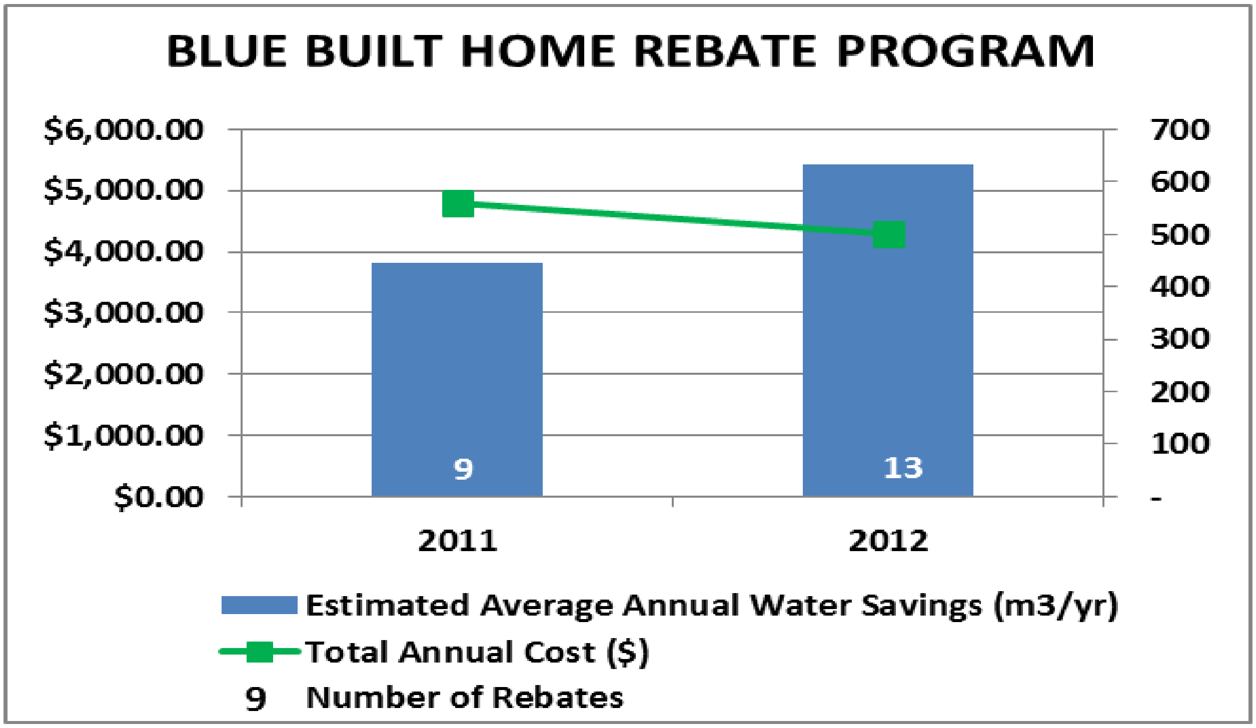

Figure 3-9: Water Conservation: Blue Built Home Rebate Program (2011-2012)

Table 3-4: Summary of Water Conservation Program Savings vs. Independent Demand Reductions: 2006 to 2011

Year	Average Day Production (m^3/avg.day)	Total Year to Year Production Reduction (m^3/avg.day)	Conservation Program Savings (m^3/avg.day)	Non Conservation Program Savings (m^3/avg.day)
2006	51,387	n/a	40	n/a
2007	51,005	382	384	-2
2008	48,492	2,513	420	2,093
2009	46,607	1,885	560	1,325
2010	44,442	2,166	522	1,644
2011	45,578	-1,136	1,817	-2,953
2012	45,244	334	1,096	-762
Total Reduction	**6,143**	**6,143**	**4,839**	**1,344**
% of Total Reduction		**100%**	**79%**	**22%**

It is noted that the annual water conservation savings and overall production demand reduction do not balance out in **Table 3-3** and **Table 3-4**. This is primarily attributed to the format by which conservation demand reductions are experienced (i.e. on a per participant or program initiative basis throughout the

year) and the nature of reporting (i.e. summarizing total average day reductions for all in-year initiatives regardless of date/timing by which reduction in demand was first experienced). However, given the overall period through which conservation savings versus production reductions are assessed, these year to year variances would be less significant in comparison to the bottom line.

Proposed Conservation Measures and Impact on Water Use**Figure 3-10** shows the estimated reduction in water demand based on conservation programs currently in place. The dark blue area shows the Water Conservation and Efficiency Strategy Update (WCESU) Savings Goals from 2007 to 2019, and the light blue area shows the actual savings between 2007 and 2012. The projected annual savings goal was developed by adding 1,279 m^3/day annually to the savings between 2010 and 2012, and adding 704.9 m^3/day annually to the savings between 2013 and 2019. It is noted that the goals have been mostly met during the first six years of the water conservation program implementation.

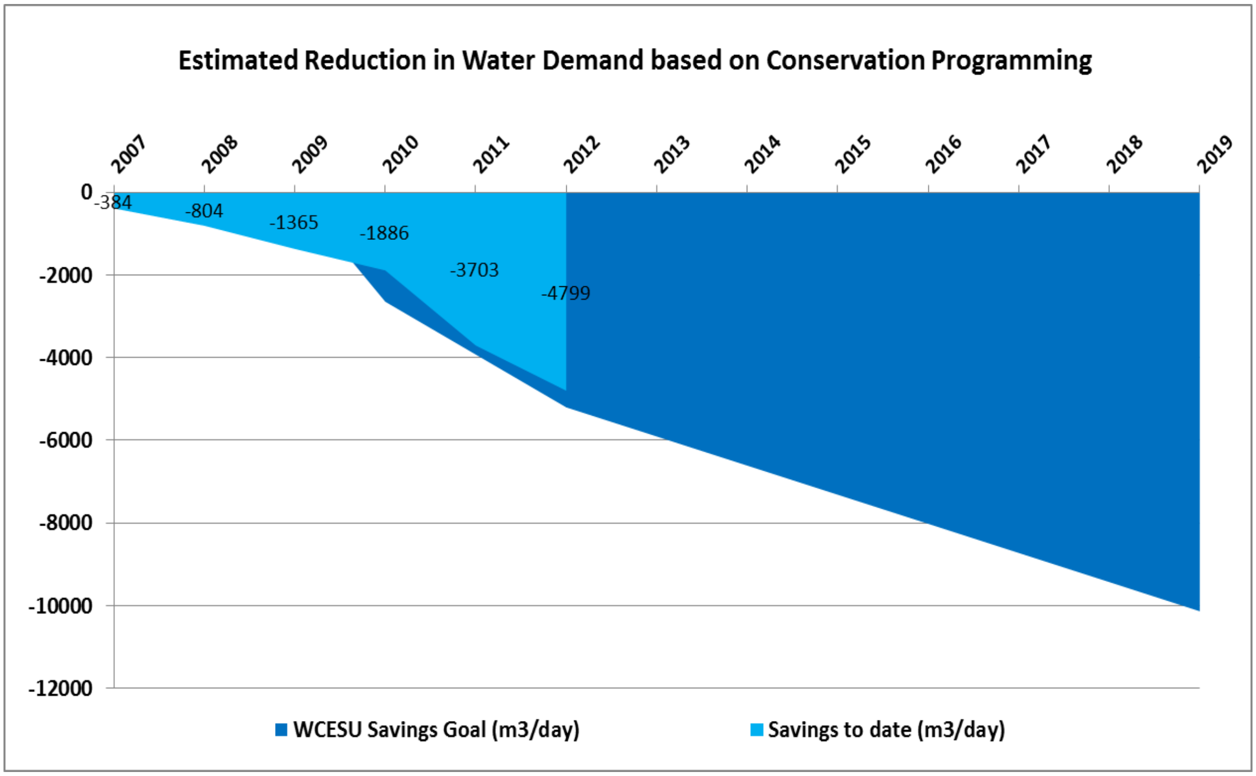

Figure 3-10: Water Conservation: Estimated Reduction in Water Demand (2007-2019)

4. Water Demand Projections

4.1 Design Basis for Average Day Demands

4.1.1 Overall approach by Sector

The basis for projecting demands from the residential and employment sectors, as well as non-revenue water, is to assume the status quo applied to population projections, i.e. representative of per capita demands without influence of future conservation or non-revenue water reduction efforts. This baseline will be used to measure the effect of potential future programs and their associated costs against the costs and efforts to provide new water supply.

4.1.2 Residential and Employment (ICI) consumption

Water billings data from 2006 to 2012 were provided and summarized by property codes which allowed them to be grouped by classification as follows:

- Land Use Pending/Other
- Residential
  - Low Density Residential
  - Medium Density Residential
  - High Density Residential
- Commercial
- Industrial
- Institutional

These were then combined and tabulated as residential, commercial, industrial and institutional sources. Additional efforts were undertaken by the City to allocate the billing records that fall within the ‘Land Use Pending/Other’ category so that they are appropriately captured within either the residential or ICI sectors for the purpose of projecting future demands. The approach taken was to assume that accounts with a total annual water consumption between 0 and 200 m^3 were residential accounts. In 2012, 41 out of 76 accounts (53.95%) fell within this range which accounted for 4360 m^3 annually (4% of the total annual volume). The remainder was assigned to ICI demand.

The City commissioned an independent detailed analysis of patterns underlying metered customer water demands through exploration of variables including season, land use, account size and area within the City (Fortin, 2014). This is important in considering whether observed recent trends are sustainable or possibly due to factors which may not continue. Several interesting observations and trends were noted:

- In general summer demand exceeds winter demand; exceptions noted include multi-residential and institutional customers when the class is viewed in its entirety; within each class this is variable
- Variability in demand is smallest for residential customers and largest for industrial and institutional customers; however, within the residential customers there is large variability in use with 21% of the smallest customers using less than 25% of the water used by the largest 3% of customers
- There are residential areas of the City with notably high excess summer use
- There are also residential areas with high winter use relative to summer use which are likely student rentals with higher winter occupancy

Statistical analysis of the trends in annual water consumption by customer class provides valuable insight into the factors influencing changes in demand to date, and whether these will continue to influence changes in future.

- A review of trends supports the observed overall downward trend in demand across all customer classes; this is influenced by the following factors:
  - Natural adoption of water efficient technologies with equipment replacement
  - Increased implementation of water efficient technologies due to demand management programs
  - Changes in level of economic activity affecting commercial and industrial customers
- The higher decline in commercial and industrial demands is at least partially attributed to the economic downturn, and it is believed that the recent annual decrease of 3% cannot continue indefinitely.

Further analysis was completed to determine what factors may be contributing to the decline in demand, specifically within the residential and multi-residential customers:

- The results indicate that the demand management programs such as rebate programs for washing machines and toilets have been effective in reducing residential and multi-residential demands
- Results from other demand management programs such as the humidifier replacement, grey water reuse and outdoor water use efficiency programs were inconclusive due to the small number of participants

Another independent commissioned review was completed to assess the success of Guelph's Water Conservation and Efficiency Program since 2006 (Gauley Associates Ltd., 2014). This report provides additional rationale for determining the effectiveness of water efficiency on short and long term demands, through assessing direct, indirect and natural water savings for the residential and ICI sectors in terms of sustainability of each. The study defined each of these savings as follows:

- Direct water savings – savings directly attributable to the implementation of water efficiency measures or strategies
- Indirect water savings – savings achieved by the City's marketing and outreach programs resulting in improvements in water use behaviour or implementation of improvements independent of municipal incentives
- Natural water savings – savings achieved by City residents and businesses that are unrelated to the City's programs, e.g. market shifts towards use of higher efficiency washers and toilets

It was concluded that it is unlikely that per capita water demands will continue to decline at the rate that was achieved since 2006. There was a strong correlation in the trendline describing residential demands over time which suggests that the savings incurred to date are sustainable.

This was not found to be the case for the ICI sector water demands which in general showed high variability from year to year. Demand trendlines for institutional and commercial customer classes are declining although with a poor correlation; the demand trendline for the industrial sector has increased since the economic downturn in 2008-9 with a very low correlation. This indicates that this trendline is not a good indicator of future demands.

Given these findings, the following approach was implemented for the demand forecasts in this update.

- Residential demands – all direct, indirect and natural water savings achieved to date are included in developing the base case for projecting future single family and residential demands.

- ICI demands – only the direct savings as measured through the City's implementation of the ICI Capacity Buy-Back program are included as sustainable savings in developing the base case for projecting future ICI demands.

Therefore, the baseline demand for each of these sectors was developed as follows:

- Residential – 180 lcd
- Employment (ICI) – 286 lcd

This compares to that actually found in 2012 of 180 and 247 lcd for residential and ICI employment respectively.

These design values were applied to the projected populations from 2013 to 2038 to determine the future water demands for each sector assuming status quo in terms of water conservation efforts to date.

4.1.3 Non-Revenue Water (NRW)

4.1.3.1 Non-Revenue Water Definitions

The difference in water consumed by customers that is measured directly through utility billings, and that which is pumped at water facilities to the water distribution system is classified as Non-Revenue Water (NRW). The International Water Association (IWA) Non-Revenue Water Task Force has produced an international 'best practice' standard approach for water balance calculations and the estimation of non-revenue water. This best practice is also advocated by InfraGuide in their Best Practice "Water Use and Non-Revenue Water in Water Distribution Systems" and by the American Waterworks Association (AWWA) through their Water Loss Control Committee. More and more utilities are turning to the IWA best practice for consistent and comparable results between utilities worldwide.

The IWA 'best practice' standard water balance is presented in **Figure 4-1**. As shown in this water balance, there are three main categories of Non-Revenue Water (NRW): unbilled authorized consumption, apparent losses, and real losses. The standard water balance is calculated on an annual basis from the measured and estimated volumes for metered and unmetered water (revenue water) and water lost (non-revenue water). It should be noted that some cities in North America still refer to water loss as a percentage of unaccounted for water; however, the influence of changes in total consumption makes % losses a flawed performance measure. In addition, unaccounted for water is no longer an appropriate term (as after the water balance is completed, all types of water loss become "accounted for") and the correct term should be non-revenue water. There are three main categories of non-revenue water (NRW): unbilled authorized consumption; apparent losses; and real losses. These all represent volumes of treated water for which the City does not receive revenue.

<table>
<tr><td rowspan="9">System Input Volume

(Allow for Known Errors)</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption Residential, Industrial, Commercial & Institutional Properties</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water - NRW</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Costumer Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Mains</td></tr>
<tr><td>Leakage on Reservoir Overflows</td></tr>
<tr><td>Leakage on Service Connections Up to Point of Customer Metering</td></tr>
</table>

Figure 4-1: IWA 'Best Practice' Standard Water Balance

The real water losses typically represent the greatest proportion of non-revenue water, i.e. the annual volumes lost from the distribution system through all types of leaks and bursts on mains and service connections, up to the point of customer metering. As identified in the Standard Water Balance in **Figure 4-1**, the International Water Association (IWA) defines two major categories of water loss: real losses and apparent losses.

4.1.3.1.1 Real Losses

Real losses occur when water physically escapes from the distribution system, and includes leakage and overflows prior to the point of end use. Real losses are also considered "physical losses". Leakage from mains and service connections are typically the most common form of real losses, and occur due to a number of factors such as poor installation, workmanship and materials, ground movement, the weather (freeze/thaw), excess pressure, corrosion, lack of scheduled maintenance, and overflows at reservoirs.

The annual volume of real losses is made up of three components:

1) Background leakage – small undetectable leaks at joints and fittings;
2) Reported bursts – events with larger flows which cause problems and are reported to the water supplier; and
3) Unreported bursts – significant events that do not cause problems and can only be found by active leakage control.

It is interesting to note that the volume of water lost from background leakage and unreported bursts can be significantly greater than the volume lost from reported bursts, despite the often negligible flow rates. This is due to the influence of leakage run times on the leakage volume. This leads to an opportunity to reduce these losses through programs such as the City's Leak Detection & District Meter Area (DMA)

program which identifies and addresses areas in the distribution system experiencing extraordinary water losses.

4.1.3.1.2 Apparent Losses

Apparent losses occur when customer use is not recorded, either through metering error, incorrect assumptions of un-metered use, or unauthorized consumption. Apparent losses are also considered "paper losses". Apparent losses of water can occur in three primary ways:

1) **Errors in water consumption measurement** occur when water meter readings are in error due to a variety of reasons, including meter reading error, meter wear over time, incorrect meter sizing, specification or installation, and lack of routine testing and maintenance.
2) **Errors in water accounting** may occur due to a variety of reasons, such as incorrect documentation of customers, or errors in meter reading, billing errors, or data analysis.
3) **Unauthorized consumption** occurs where users obtain the water service illegally and without payment.

4.1.3.2 Water Loss Performance Measures

The use of percentages, such as % unaccounted for water, as an indicator of water loss within a system is not a recommended practice as it does not allow for sensible comparison between systems with different demands and is not suitable for use as a target. The use of percentages also results in having to compare to a moving target for the utility as the % depends on consumption and production, which could vary with climatic conditions or water use patterns. A more common approach is to unitize the amount of water lost in a system by dividing it by the length of mains in the system, or by the number of service connections served by the system. The performance indicator "L/service connection/day" is considered the most reliable of the traditional performance indicators for all systems with service connection densities of >20/km. If the system has a service connection density <20/km, the preferred performance indicator is m^3/km/day.

The international best practice performance measure advocated by the IWA (and the AWWA) is the Infrastructure Leakage Index (ILI). The Infrastructure Leakage Index is the ratio of current annual real losses (CARL) to the unavoidable annual real losses (UARL), which measures how well the system is being managed for control of real losses. The ILI is a highly effective performance measure because it is:

- Based on a calculation that has been tested globally;
- Unit-less & based on real water loss;
- System specific – takes into account operating pressure, service connection length, pipe condition & meter location; and
- A measure that can be compared to an international data set.

The ILI performance measure is recommended for systems with more than 3,000 service connections.

The calculation is ILI = CARL / UARL

Where CARL = Current Annual Real Losses (L/day) and

UARL = Unavoidable Annual Real Losses (L/day)

Any units can be used for CARL and UARL as long as they are the same for both, for example L/day or ML/year. The CARL is directly calculated from the water balance approach.

The UARL is a theoretical reference value developed by the IWA to represent the technical low limit of leakage that could be achieved under a proactive water loss reduction program using the best technology (e.g. speed of repairs, pressure management, pipe materials management, active leakage control etc). The UARL equation was developed to allow for:

- background leakage;
- reported leaks and bursts;
- unreported leaks and bursts; and
- pressure/leakage rate relationships.

The calculation for UARL is system specific and takes into account the key variables that affect the amount of leakage in a distribution system including:

- Average operating pressure in metres (P);
- Total length of mains (Lm);
- Number of service connections (Nc);
- Total length of private pipe, i.e. service connection length from property line to meter (Lp); and
- Intermittent supply conditions (if system is pressurized for less than 24 hours per day).

Where UARL (L/day) = (18 x Lm + 0.8 x Nc + 25 x Lp) x P x % of time that the system is pressurized.

The UARL equation has been proven to be robust in diverse international situations and is the most reliable predictor yet of "how low could you go".

An Infrastructure Leakage Index close to 1.0 may demonstrate that all aspects of a successful leakage management policy are being implemented by a water utility or that the distribution system is in excellent condition with very little water loss. Typically it will only be economical to achieve an ILI close to 1.0 if water is very expensive, scarce or both. Economic values of ILI typically lie in the range of 1.5 to 2.5 for most systems.

4.1.3.3 Projected Non-Revenue Water

The calculated non-revenue water per year is provided in **Table 4-1** for the period of 2006 to 2012. In a recent study (Gauley Associates Ltd., 2014) the decline in NRW from 2006 to 2012 was determined to be 3106 ML over that period. The City implemented a Pilot Leakage Program in 2011 (C3 Water Inc., 2014) which targeted the repair of leaks estimated at a total reduction in real losses of 1128 ML in 2011-12. Therefore it is anticipated that the total reduction in NRW of 3106 ML includes both real and apparent losses.

A review of the calculated NRW in **Table 4-1** indicates no clear trend over that period despite the above savings due to the pilot program. Therefore, the average of the annual NRW volume determined in the last 5 years (5,550 m^3/d) was used as the basis for the purpose of projecting future losses.

Table 4-1: Historical Non-Revenue Water

Year	Average Water Produced (m^3/d)	Average Water Consumed (m^3/d)	Non-Revenue Water (m^3/d)
2006	51,387	44,887	6,500
2007	51,005	44,157	6,848
2008	48,492	41,517	6,976
2009	46,607	40,618	5,989
2010	44,442	40,642	3,800
2011	45,578	40,267	5,311
2012	45,244	39,548	5,697
		5-year average	5,554

However, it is necessary to make allowances in this projection for the growth of the overall water supply system with increased population as the real water losses will increase with additional customers (connections) and water distribution main length. If no increase is applied to this base rate (i.e. assumed constant), this would result in a reduction in non-revenue water as a fraction of the overall production, which could imply that this reduction would occur without implementing water loss reduction programs. The City used the IWA software tool to provide a breakdown of NRW in 2012 as shown in **Figure 4-2** (data as ML per year).

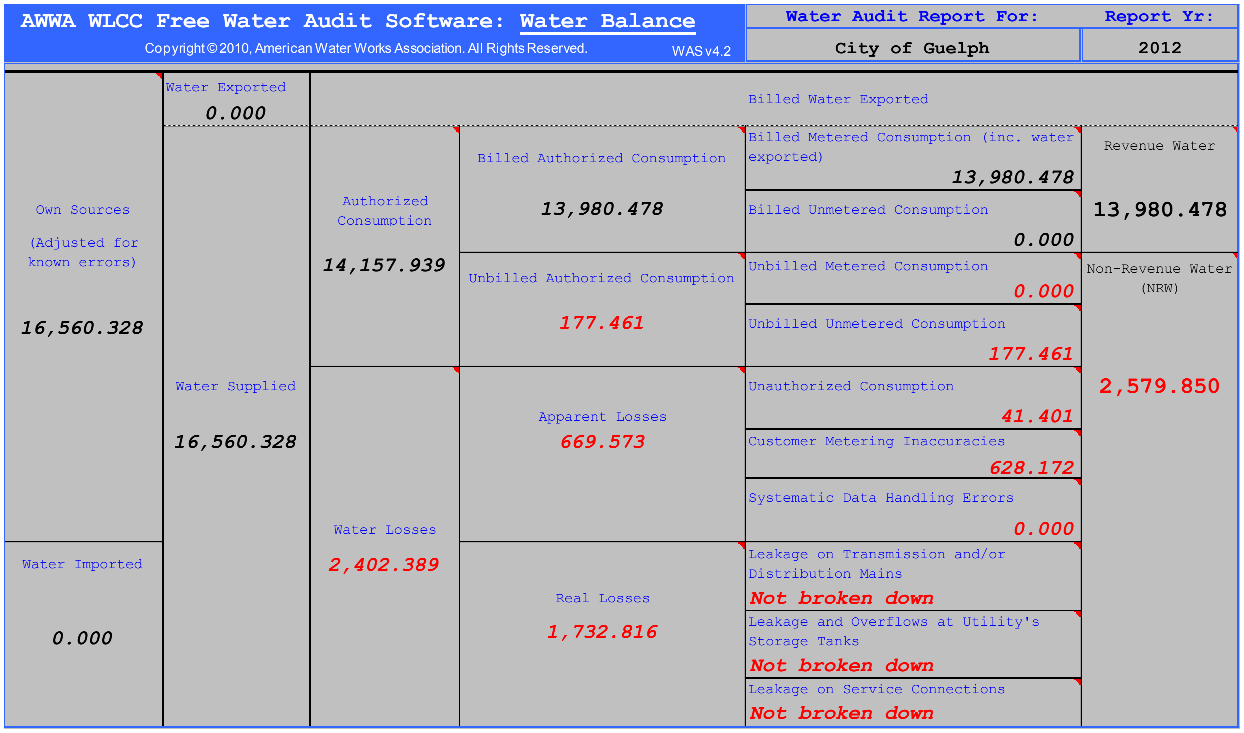

Figure 4-2: IWA Software Output

By increasing the inputs in the software with estimated watermain length and number of connections in 2031 and 2038, the outputs provide the increase in unavoidable real losses to reflect growth in the distribution system. The City has developed a detailed water distribution model that accounts for the 545 km of watermains making up the distribution system in 2012. As part of the Water-Wastewater System Optimization Master Plan, scenarios were developed to include servicing of future population which indicate that on average, additional 5km of watermains will be added to the distribution system each year. This information was used along with maintaining a constant ILI to develop a reasonable increase in water losses. Anticipated reductions through planned and proposed City initiatives will be considered as part of the demand management and water efficiency alternatives.

4.1.3.4 Projected Average Water Demands by Sector

Table 4-2 presents the projected average day water demand in 5-year increments from 2013 to 2038.

Table 4-2: Projected Average Day Water Demand (2013-2038)

Year	Population			Demand by Sector			NRW (m^3/d)	Average Water Demand (m^3/d)
	Resid.	Employ.	Total Equiv.	Resid.	Employ.	Total		
2013	130,670	66,730	197,400	23,536	19,059	42,595	5,658	48,253
2018	143,480	73,874	217,354	25,843	21,100	46,943	6,175	53,117
2023	156,290	81,017	237,307	28,150	23,140	51,290	6,691	57,982
2028	168,190	90,340	258,530	30,293	25,803	56,096	7,208	63,305
2033	178,464	96,947	275,411	32,144	27,690	59,834	7,628	67,462
2038	186,299	99,480	285,779	33,555	28,413	61,969	7,903	69,872

4.2 Design Basis for Water Demand and Supply Projections

4.2.1 Maximum Day Demand Projection

The MOE Guidelines for the Design of Water Distribution Systems dictate that water supply systems be designed to satisfy the greater of the maximum day plus fire flow or peak rate (maximum hourly demand). Fire flows and peak flows are typically provided in storage within a distribution system; and therefore, the pumping capacity of the water supply system is designed to meet maximum day demands.

Through review of historical average demands by sector, reasonable estimates can be developed for projecting future demands. Similarly, historical information regarding peak demands in recent years can be evaluated to determine a design maximum day factor for projecting future maximum demands. The maximum day factor is calculated as the maximum day demand divided by average day demand during a given year.

MOE Guidelines also provide recommended peaking factors for municipal water supply systems to be used in design where existing information may not exist. This table indicates that as population increases, the maximum day factors decrease, reflect a dampening of the diurnal demand curve for larger communities, with additional variety of water uses (i.e. industrial and commercial). For a community with a population greater than 150,000, a maximum day factor of 1.50 is recommended. With the success of water efficiency measures and the implementation of outside water use restrictions in Guelph, the actual maximum day factors for the period of 2008 to 2012, as indicated in Table 3-1, range between 1.19 and 1.41, with an average of 1.26. Maximum day demands are also calculated in some municipalities as the average of the highest five or seven days of water usage experienced in an average demand year; this results in a maximum 'week' factor less than that based on an individual peak day. Based on historical data it is reasonable to adopt a maximum day factor of 1.35 for projecting future water demands.

4.2.2 Maximum Day Supply Projection

In the 2007 WSMP, a maximum day factor of 1.5 was proposed for the design of future water supply facilities in order to ensure a “firm capacity” sufficient to meet the actual future water supply demands based on maximum day requirements with a degree of conservatism to address uncertainties and risks such as contamination events, climatic and drought conditions and security of supply concerns.

Typically for municipalities with surface water supply systems, firm capacity is determined by the capacity without the largest piece of equipment or unit operation (for example, the largest pump or one of multiple modular unit processes out of service). However, this approach does not address “system” firm capacity. Neither is it applicable to a groundwater system with many sources. Firm capacity assessment of a water supply system is an exercise in risk assessment and risk management, such that a municipality will incorporate measures or strategies to minimize the risk of certain aspects of the system being off-line, and will accept a level of risk that a portion of the system will not be available due to maintenance, water quality issues or otherwise.

A review of potential risks to the City’s water supply system was completed to consider possible scenarios which could result in short term and long term supply reductions such as infrastructure failures, largest well out of service, medium well out of service, etc. Also included was a general scenario where firm capacity was determined by applying an industry standard of 85% of existing capacity. For example, historically the Region of Waterloo has reportedly calculated firm capacity at 85% of current pumping capacity due to the large number of wells, and other municipalities with groundwater sources have adopted similar approaches.

This assessment allows the City to determine where there needs to be redundancy or emergency response procedures in place compared to what is acceptable in terms of capacity “downtime”. This is the capacity that can be adopted as a firm capacity; thereby not impacting the city’s normal use of water and not requiring an inordinate response. This can also be the capacity that can be off-line to undertake maintenance protocols or for system upgrades. It was determined that a scenario in which one of the City’s largest well supply sources (i.e. Park wells) is out of service, the total existing water supply is reduced by approximately 10%. Therefore, it is recommended that the City continue to apply an additional 10% to the maximum day factor of 1.35 to determine the future water supply requirements. This results in a 1.5 maximum day factor for the purposes of projecting future water supply requirements, with the difference in maximum day demand and the supply projection attributed to contingency in the supply system. .

4.3 Projected Total Water Supply Requirements

The design basis developed for each component making up the total water demand and supply requirement, in Sections 4.1 and 4.2, was applied to the 25 year period of this study in 5 year increments to develop future water demand projections and water supply requirements, as indicated in **Table 4-3** and **Figure 4-3**.

Table 4-3: Projected Total Water Supply Requirements (2013-2038)

Year	Total Average Day Demand (m^3/d)	Max Day Demand @ 1.35 MDF (m^3/d)	Water Supply Requirement @ 1.5 MDF (m^3/d)
2013	48,253	65,141	72,379
2018	53,117	71,708	79,676
2023	57,982	78,275	86,972
2028	63,305	85,461	94,957
2033	67,462	91,074	101,193
2038	69,872	94,327	104,808
Note: MDF = maximum day factor			

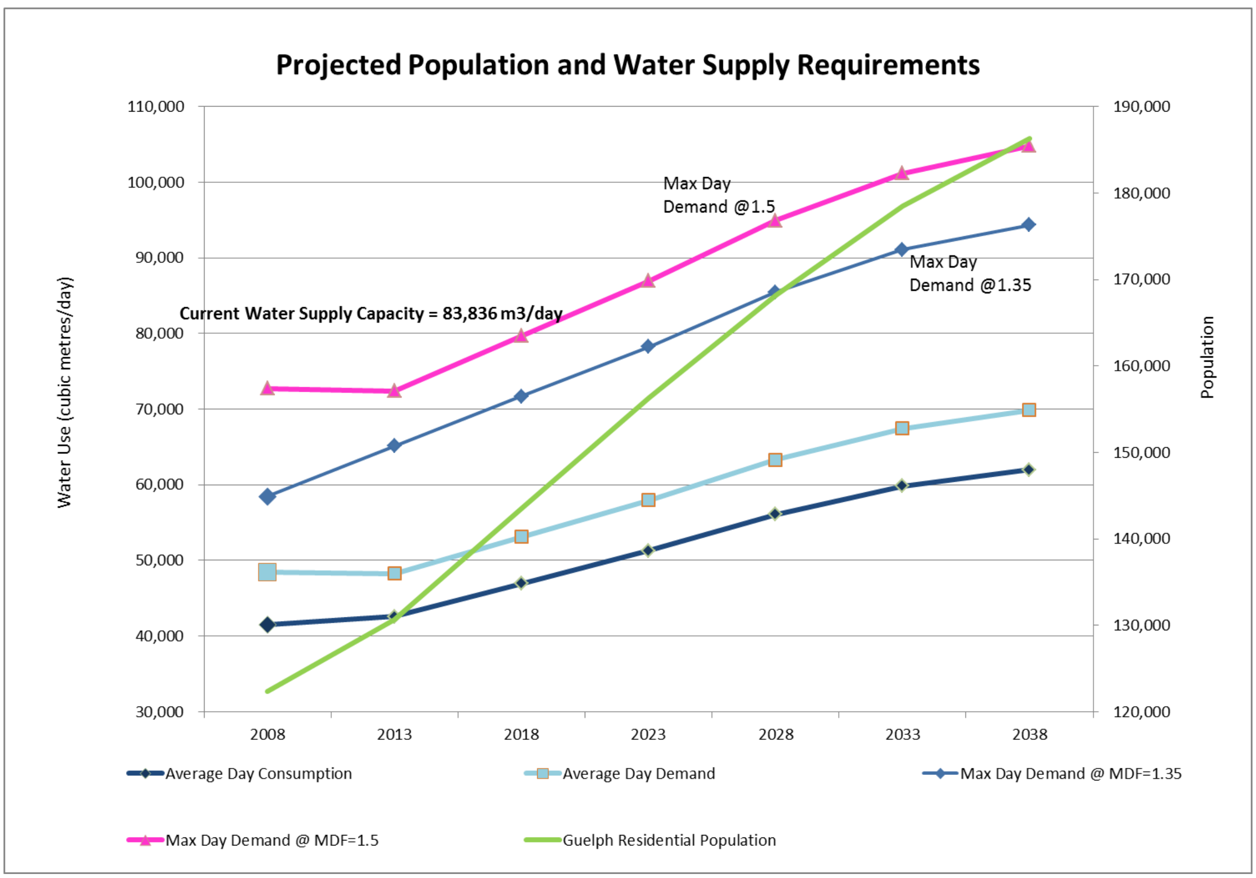

Figure 4-3: Projected Population and Water Supply Requirements

5. References

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Appendix C

Technical Memorandum 2

Existing Water Supply Capacity Assessment

Appendix C

City of Guelph Water Supply Master Plan Update (Draft Final Report)

Technical Memorandum No. 2 – Existing Water Supply Capacity Assessment

Note: As per the Accessibility for Ontarians with Disabilities Act, this document is available in an alternate format by contacting Dave Belanger – City of Guelph (519-822-1260 Ext. 2186)

TECHNICAL MEMORANDUM

DATE	March 4, 2014	**PROJECT No.**	12-1152-0217
TO	Dave Belanger City of Guelph		
CC	Patty Quackenbush, AECOM		
FROM	Stephen Di Biase, M.Sc., P.Geo.	**EMAIL**	stephen_dibiase@golder.com

CITY OF GUELPH WATER SUPPLY MASTER PLAN
TASK 3 – EXISTING WATER SUPPLY CAPACITY ASSESSMENT (DRAFT)

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. to carry out Task 3 (Water Supply Capacity) of the City of Guelph Water Supply Master Plan Update Terms of Reference (City of Guelph, 2012). The purpose of the Water Supply Capacity Assessment is to consider the following:.

- To define the maximum capacity of each individual well and to identify constraints to operating at the maximum;
- To define the sustainable capacity of the existing water supply system (recognizing interference effects amongst the municipal wells); and
- To consider potential risks to the system operation (e.g., drought, supply sources off-line due to well contamination, etc) and determine vulnerability in total existing supply capacity from a hydrogeological and operational perspective.

This technical memorandum (provided herein) is organized as follows:

Section 1: Provides a brief summary of the hydrostratigraphy surrounding the City of Guelph (herein referred to as 'the City').

Section 2: Reviews the construction details, quantity and quality of groundwater supply from existing (i.e., permitted) sources between 1997 through 2013. As part of this review, the capacity of the municipal groundwater supply sources is updated relative to the 2006 Water Supply Master Plan (WSMP).

Section 3: Discusses the sustainable capacity of the existing water supply system as a whole (recognizing interference effects), referencing outputs of the Tier 3 Risk Assessment model. In addition risks to the system are considered (e.g. drought, supply sources off-line due to well contamination, etc) to determine the available capacity of the City's groundwater supply system as a whole, under problematic conditions.

Section 4: Identifies City groundwater supply sources that were previously part of the City's groundwater supply system and are currently inactive.

Section 5: Summarizes the findings of the Task 3 assessment and provides conclusions and recommendations for consideration within the WSMP update.

Table 1 provides a summary of the information sources considered as part of this assessment. A key reference is the City of Guelph draft Tier Three Water Budget and Risk Assessment (Matrix, 2013), herein referred to as the 'Tier Three Risk Assessment'. The objective of the Tier Three Risk Assessment is to evaluate the sustainability of the City's groundwater supply system from a quantity perspective, and to identify potential threats to that sustainability.

1.0 REGIONAL HYDROSTRATIGRAPHY

The hydrostratigraphic framework surrounding the City of Guelph, as described by the Tier Three Risk Assessment, is briefly summarized on Figure 1. The conceptual hydrogeological model recognizes the following three principal aquifer zones: overburden aquifer; a deep overburden/shallow bedrock aquifer (comprised of Contact Aquifer and Guelph Formation); and a deep bedrock aquifer comprised of the Gasport Formation. Throughout much of this region, the shallow bedrock aquifer and deep bedrock aquifers are separated by a laterally extensive bedrock aquitard (Eramosa Formation). Where present and effective, the Eramosa Formation separates the shallow and deep aquifers into two distinct groundwater flow systems. Groundwater flow above the Eramosa Formation generally converges on surface water features. Groundwater flow below the Eramosa Formation generally reports to the City's groundwater supply wells in the area of the City.

2.0 WELL CAPACITY ASSESSMENT

The City's groundwater supply system consists of 24 wells constructed within overburden, shallow and deep bedrock aquifers and one active groundwater collection system (the Glen Collector). The locations of these groundwater supply locations are shown on Figure 2. These locations have been organized into the following four quadrants: Southeast, Southwest, Northeast and Northwest. Table 2 provides a summary of the construction details for each groundwater supply source. Maximum pumping levels (i.e., the lowest groundwater elevation within the pumping well that can sustain groundwater pumping) have been provided to Golder by City of Guelph Waterworks staff.

Recorded daily production totals (from 1997 through 2013) for each groundwater supply source and quadrant are provided on Figures 3 through 8. Each graph shows the daily pumping total (shown as solid hydrograph lines and reported in m^3/day) as well as the monthly average of the daily production total (shown as black diamonds and reported in m^3/day). For each groundwater supply source graph, observed groundwater elevation within the pumping wells (shown as circles) are reported as metres above sea level. Where applicable, these graphs also show the permitted rate and maximum pumping elevations for each groundwater supply well.

Based on the review of groundwater pumping rate and groundwater elevation data, the capacity of each municipal groundwater supply source has been re-evaluated relative to the 2006 WSMP and summarized in Table 3. This re-evaluation considered:

- Long term performance history;

- Recently demonstrated specific capacity; and
- Response to previous maintenance efforts.

A brief discussion on the well capacity assessment for each groundwater supply source is provided below. In some cases, Golder has made recommendations that performance testing, well rehabilitation, mechanical or operational changes be undertaken to confirm reported well capacity values. Table 4 provides a summary of the Golder recommendations relative to each municipal groundwater supply source.

Groundwater quality data, provided by the City of Guelph, are summarized on Figures 9 through 13 and compared to the Ontario Drinking Water Quality Standards (ODWQS). Figures 9 through 12 show key groundwater quality parameters (i.e., iron, manganese, nitrate, sodium, chloride) for each of the City's groundwater production wells. Volatile Organic Compounds (VOCs) have been reported in 10 of the City's 24 groundwater supply sources. VOC detections are summarized on Figure 13. A discussion on groundwater quality trends at each of the production well locations is included below.

2.1 Southeast Quadrant Capacity Assessment

The Southeast Quadrant provides the bulk of the City's groundwater supply, with high-yield production wells and groundwater collection systems. The bottom of Figure 4 shows the daily pumped volumes from the Southeast Quadrant groundwater supply sources, which has historically ranged from 20,000 to 40,000 m^3/day.

It is noted that in 2012, the City initiated the Operational Testing Plan (OTP) for the Arkell bedrock production wells. The OTP requires pumping from the Arkell wells, near the permitted rates, over a 42 month period. Due to increased pumping from Arkell, the pumping rates from other quadrants have been reduced since January 2012.

Arkell Well 1

Historically, in 2000 through 2002, Arkell 1 demonstrated the ability to continually pump at 2,000 m^3/day, however, since 2002, the pumping rate at Arkell 1 has gradually decreased, with no active pumping since 2011. In response to reduced pumping, groundwater elevation at Arkell 1 has increased from approximately 321 masl to approximately 324 masl. In 2008 and into the beginning of 2009, while Arkell 1 was pumped at a rate of approximately 800 m^3/day, the specific capacity of the well was about 270 m^3/day. During this period there was an additional 2 m of available drawdown, indicating a capacity of approximately 1,500 m^3/day. Rehabilitation followed by performance testing is therefore recommended to confirm the 2,000 m^3/day capacity specified for Arkell 1 in the 2006 WSMP.

Arkell Wells 6, 7, 8, 14 and 15

In 2001, Arkell 6, Arkell 7 and Arkell 8 each demonstrated the capability of pumping 8,000 m^3/day or greater for extensive periods of time (i.e., periods of 1 month or greater). Throughout most of 2011, groundwater pumping rates for these wells was approximately 6,000 m^3/day (representing a cumulative pumping rate of 18,000 m^3/day), while maintaining 5 to 10 m of available drawdown. These results indicate maximum well capacities of approximately 8,000 m^3/day for Arkell 6 and Arkell 7; and approximately 7,000 m^3/day for Arkell 8.

Arkell 14 and Arkell 15 became active in July 2011. In 2012, Arkell 14 was consistently pumped at 6,500 m^3/day while maintaining 1 m of available additional drawdown. During this same period, Arkell 15 was pumped at 6,500 m^3/day while maintaining 2 m of available drawdown. Collectively these results indicate that Arkell 14

and Arkell 15 can sustain pumping at approximately 7,000 m^3/day. It is noted that a liner was installed within Arkell 15 in late 2013.

The cumulative capacity of the Arkell wells is constrained by the Ontario Ministry of Environment Permit To Take Water at 28,800 m^3/day, which can be met from concurrent pumping by any four of the five bedrock wells.

Burke Well

Since 2005, a gradual decrease in the Burke Well pumping rate from about 6,000 m^3/day down to 4,000 m^3/day is noted. Further decreases in the pumping rate occurred at the commencement of the OTP. Based on the performance record, the specific capacity of the Burke well is interpreted to be about 400 m^3/day per m drawdown. It is therefore anticipated that the Burke well can sustain a pumping rate of 6,500 m^3/day, while maintaining pumping water levels above 313 masl. While there is no evidence indicating the Burke Well cannot sustain pumping at its permitted rate, it has been approximately 15 years since Burke was pumped at 6,500 m^3/day. The City should consider undertaking performance testing and / or rehabilitation to confirm the 6,500 m^3/day capacity specified for Burke 1 in the 2006 WSMP.

Carter Wells

The Carter Wells are completed within a shallow bedrock aquifer (within 21 m of ground surface) with a hydraulic connection to the overburden. Historically, the daily pumping rate for the Carter wells has been as high as 6,500 m^3/day, however, these wells are operated intermittently. The 2006 WSMP specified a capacity of 5,500 m^3/day for the Carter wells. Monthly averages of the daily production totals generally ranged from 2,000 to 4,000 m^3/day since 2005. Based on the review of operating data, the Carter wells have shown the capability of pumping as high as 6,000 m^3/day within a short term period (i.e. daily to weekly periods between 2005 and 2008). The City is currently undertaking performance testing (as part of the PTTW renewal) at these wells to confirm that pumping in excess of 5,500 m^3/day can be sustained over a longer period of time (i.e., months).

Arkell Spring Ground Collection Systems

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. Currently, the collector system is subdivided into two sub-systems, referred to as the Lower Road Collector System and the Glen Collector System.

The Lower Road Collection System is currently off-line and discussed within Section 4 below. The Glen Collector System is located within an erosional valley that has been cut southward from the Eramosa River through a thick deposit of outwash sands and gravels. This collector system includes 22 manholes and 3 accessible collector galleries. This system also includes a groundwater infiltration system, where water is taken from the Eramosa River and recharged through a pond and some of the water is captured by the Glen collector. The Glen Collector production record, with and without operation of the recharge system, is shown on Figure 4. While the recharge system is operating, groundwater capture from the Glen Collector generally ranges from 10,000 to 20,000 m^3/day. When the recharge system is inactive, groundwater capture from the Glen Collector generally ranges from 4,000 to 10,000 m^3/day. This review has found no technical basis to adjust the 2006 WSMP firm capacity assessment (of 6,900 m^3/day) for the Glen Collector System.

Southeast Quadrant Groundwater Quality

Groundwater quality monitoring data for the Southeast Quadrant, as summarized on Figures 9 and 13, show no significant changes from historical trends. Concentrations of key parameters (i.e., chloride, sodium, iron, manganese and nitrate) have remained consistent or have decreased with time. Since 2004, the concentration of nitrate in groundwater pumped from the Carter wells has gradually decreased from approximately 10 mg/L to less than 8 mg/L. If this trend continues, nitrate concentrations within the groundwater pumped from the Carters will cease to be of concern.

These results indicate that VOCs have only been detected within Arkell 1. As shown on Figure 14, the concentrations of cis 1,2 Dichloroethylene (DCE) and Tetrachloroethylene (PCE) within groundwater pumped from Arkel 1 have decreased with respect to time to trace concentrations.

2.2 Southwest Quadrant Well Capacity Assessment

A total of six production wells are located within the City's Southwest Quadrant (five active wells: Membro, Dean, Water, University, Downey, and one inactive well: Edinburgh). These wells are completed within a highly transmissive zone of the Gasport Formation. Mutual interference is experienced from groundwater pumping amongst these production wells and with the nearby River Valley Developments (RVD) Quarry Site (the Dolime Quarry). The monthly average of the daily Quarry pumping rate, between July 2009 and January 2011, generally ranged from 6,000 to 7,000 m^3/day. Groundwater pumping rates at the Dolime Quarry are known to fluctuate in response to pumping rate changes at the City's production wells. The evaluation of existing SWQ wells' capacities assumes continued operation of the Dolime Quarry at current rates. It is noted that well capacities in this area may be increased at some point in the future, when the Dolime Quarry ceases to operate.

Figure 5 shows the cumulative daily production totals of the Southwest Quadrant wells. From 2001 through 2010, groundwater pumping from the Southwest Quadrant wells averaged approximately 11,500 m^3/day. Groundwater pumping from the Southwest Quadrant was reduced in 2011 in response to the commencement of the OTP.

The City initiated a Class Environmental Assessment for optimization and development of new well capacity within the Southwest Quadrant in 2007, following the recommendation from the 2006 WSMP. The Class EA is currently on hold due to on-going litigation regarding the Dolime Quarry's Permit To Take Water.

Membro Well

Membro Well is permitted for a pumping rate of 6,050 m^3/day and has a maximum pumping level of 279 masl. The maximum pumping level within the Membro well is governed by the depth of a liner and pump motor, seated approximately 275 masl. The routine operation of Membro began in 2002, with pumping rates as high as 5,400 m^3/day resulting in a pumping water level of 283 to 287 masl. During this start-up period, the water elevation within the nearby Dolime Quarry pond was relatively high at approximately 292 masl. Since re-activation of the Quarry in 2005 (i.e., where the water elevation in the Quarry sump has been generallymaintained between 288.4 and 288.8 masl), the production rate of the Membro well has steadily decreased to approximately 4,000 m^3/day while maintaining a pumping water level of approximately 287 masl. In conjunction with the hydraulic responses observed at the Dolime Quarry from the Membro Shut-down events (Golder, 2006), it is evident that the production capacity of Membro will vary based on the interference (i.e., Dolime Quarry sump pumping rate and elevation).

Recent performance testing in 2013 confirmed that the Membro well can operate at its permitted rate for a short period of time. Therefore the capacity of the Membro well is still considered to be approximately 6,000 m^3/day.

Sustained pumping at the permitted rate, however, is unlikely while the Quarry sustains a pond/sump elevation below 289 masl.

Focused examination of the Membro well hydrograph indicates that pumping from the Membro well is significantly reduced for approximately 8 minutes every half-hour. As a result, the total daily production of Membro is generally 80% of the instantaneous pumping rate. Optimization of the well pumping with highlift pump operation to allow for continuous pumping from Membro would improve production.

Dean Well

Dean Well is currently permitted for a production rate of 2,300 m^3/day and has a maximum pumping water elevation of 277 masl. The maximum pumping water level is governed by the elevation of the top contact of the Gasport Formation. The normal pumping rate of Dean is approximately 1,275 m^3/day, which results in a pumping water level ranging from 285 to 295 masl. Based on its performance history, the specific capacity of the Dean well is interpreted to be about 60 m^3/day per m drawdown. It is therefore anticipated that the pumping rate of Dean can be sustained at 1,500 m^3/day, while a pumping water level above 277 masl.

The City should consider the installation of a liner within the Dean well to limit shallow groundwater inflow from the Guelph Formation. Groundwater inflow from the Guelph Formation is expected to be minor, and insignificant relative to groundwater inflow from the Gasport Formation. Performance testing should be undertaken prior to (i.e., using packers) and following the installation of the liner to confirm the capacity of the well remains at 1,500 m^3/day.

Water Street Well

Water Street Well is permitted for a production rate of 3,400 m^3/day. The maximum pumping level at Water is approximately 282 masl, which is governed by the base of the Goat Island Formation. From 2009 through 2011, Water operated at a pumping rate of approximately 2,200 m^3/day and demonstrated a specific capacity of approximately 125 m^3/day per m drawdown. These data indicate that Water should be capable of sustaining a pumping rate of 2,700 m^3/day, while maintaining a pumping elevation of 279 masl. Similar to the Membro well, the operation of Water is not continuous. Rate changes and shut-downs of Water are relatively frequent. Between 2005 and 2009, the routine pumping rate of Water was approximately 1,750 m^3/day, while the average daily production total was approximately 1,000 m^3. Furthermore, the City should consider the installation of a liner within the Water well to limit shallow groundwater inflow from the Guelph Formation. Performance testing should then be conducted to confirm that the capacity of the well remains at 2,700 m^3/day.

University Well

University Well is permitted for a production rate of 3,300 m^3/day. The University well is located approximately 250 m northwest of a groundwater supply well operated by the University of Guelph (UoG No. 4). Waterworks staff maintain the pumping level within the City's University Well at 285 masl or above, in order to minimize potential interference effects with UoG No. 4. There is a liner seated at 277 masl within the University Well. If interference issues were not a factor, the maximum pumping level could be consistent with the base of the liner (approximately 277 masl).

Poor well efficiency has historically been a constraint of the University Well performance. Between 1997 and 2001, the pumping rate ranged from 1,000 to 1,750 m^3/day. Rehabilitation of the University well in 2001 improved the production capacity of the well to allow for consistent pumping rate of 2,500 m^3/day through 2001 and 2002. Since 2003, the University well pumping rate has remained relatively consistent at approximately 1,750 m^3/day. In 2011, the pumping rate at University was increased to 2,200 m^3/day over a two-month period

until the commencement of the OTP in the fall of 2011. Based on its performance history in 2009, the specific capacity of this well is interpreted to be about 90 m^3/day per m drawdown. If the pumping level within is allowed to be drawn down to the base of the liner, the University well appears capable of sustaining the 2006 WSMP capacity of 2,500 m^3/day. Therefore, no changes have been recommended to the 2006 WSMP caoacity assessment value.

It is noted that when the maximum pumping level at the University well is constrained to an elevation of 285 m, the sustainable pumping rate of the University well is likely to be approximately 2,100 m^3/day. The University well has responded positively to past rehabilitation events. Regular rehabilitation could improve the efficiency of the University Well, allowing it to sustain a pumping rate of 2,500 m^3/day while maintaining a pumping elevation of 285 m.

Downey Well

Downey Well is permitted for a production rate of 5,236 m^3/day and has a maximum pumping water level of 283 masl that is governed by the top of the Gasport Formation. Downey has historically been operated at a pumping rate ranging from 4,000 to 5,000 m^3/day, while maintaining over 10 m of available drawdown. The Downey well is fully capable of pumping in excess of the permitted rate of 5,236 m^3/day. As a result, the capacity of Downey should be increased from 5,100 m^3/day (as reported within the 2006 WSMP) to the permitted rate of 5,236 m^3/day.

Based on the specific capacity (approximately 230 m^3/day per m drawdown) and available drawdown (approximately 10 to 12 m), it is expected that the pumping rate of Downey can be increased to 6,000 m^3/day, while still maintaining pumping water levels above the top of the Gasport Formation (approximately 280 masl). This would require an amendment to the Downey PTTW, which will be addressed in evaluation of alternatives under expansion of existing wells, with reference to the wellfield approach being undertaken as part of the Southwest Quadrant Water Supply Class Environmental Assessment.

Southwest Quadrant Groundwater Quality

Groundwater quality monitoring data summarized on Figure 10 show increasing concentrations of sodium and chloride within the Southwest Quadrant wells. The concentrations of these constituents are expected to continually increase over the long term. Best management source protection practices should be implemented to stabilize the concentration of these parameters within concentrations below the aesthetic objectives of the Ontario Drinking Water Standards. Other constituents (i.e., iron, nitrate, manganese) are stable and within acceptable concentrations.

Low concentrations of Trichloroethylene (TCE), Tetrachloroethylene (PCE) and 1,2-Dichloroethane (DCE) have been reported at Membro, Edinburgh and Water. While the concentrations of these constituents have been decreasing at Water (up to 2006), concentrations at Membro have remained stable with respect to time. The TCE concentration at Membro has remained consistent at approximately 2.5 μg/L (i.e., half the ODWQS standard).

2.3 Northeast Quadrant Well Capacity Assessment

A total of five production wells are located within the City's Northeast Quadrant (active wells: Park 1, Park 2, Emma, Helmar, and inactive well: Clythe). These wells are completed within the Gasport Formation. Figure 7 shows the cumulative daily production totals of the Northeast Quadrant wells. From 2001 through 2013, groundwater pumping from the Northeast Quadrant wells generally ranged from 6,000 to 9,000 m^3/day.

Park Wells (Park 1 and Park 2)

The Park Wells are permitted for a rate of 10,300 m^3/day. The maximum pumping elevation in these wells is 284 masl. Monthly average production totals from the Park wells have a broad range, generally between 2,000 to 7,000 m^3/day since 1997. Based on a consistent pumping rate of about 5,000 m^3/day during 2005 through 2007, the specific capacity of the Park wells is interpreted to be about 250 m^3/day per m of drawdown. It is therefore anticipated that the pumping rate of the Park wells can be increased to 8,000 m^3/day, while still maintaining pumping water levels above the maximum pumping level of 284 masl. As recently as February 2013, the Park wells demonstrated the capability of sustaining an average monthly production total of 8,000 m^3/day. As such, there are no changes recommended to the 2006 WSMP well capacity estimate for the Park wells.

Emma Well

The Emma Well is permitted for a groundwater pumping rate of 3,100 m^3/day and has a maximum pumping elevation of 290.7 masl. In 2001, a 200 mm diameter liner was installed to a depth of 42.7 m (286 masl) to eliminate groundwater inflow from above the Eramosa Member. From 2011 through 2012, the Emma well was consistently pumping at 2,800 m^3/day, with about 7 m of available drawdown. The capacity of the Emma well, 2,800 m^3/day as established by the 2006 WSMP, is confirmed by its recent performance record. As there is mutual interference between Emma and the Park Wells, combined performance testing at Emma and Park is recommended to confirm that Emma can sustain its capacity while the Park wells are operating at their maximum capacity.

Helmar Well

The Helmar Well is permitted for a groundwater pumping rate of 3,273 m^3/day. A 200 mm liner was installed to 27.4 m (318 masl) in 1999. Since 2001, the daily pumping rate for Helmar has remained below 1,000 m^3/day. Well plugging (i.e., chemical bio-fouling) is an issue associated with the operation of this well. Based on recent performance history, the specific capacity of this well is about 50 m^3/day per m of drawdown. Currently the water levels in the Helmar well are close to the maximum pumping levels and there is no additional available drawdown to increase the capacity of this well beyond 900 m^3/day. It is recommended that regular rehabilitation, followed by performance testing, be undertaken to confirm the 2006 WSMP capacity of 1,500 m^3/day. Without further rehabilitation or maintenance, it is unlikely Helmar can sustain a pumping rate above 1,200 m^3/day.

Northeast Quadrant Groundwater Quality

Groundwater quality monitoring data for Northeast Quadrant Wells is summarized on Figure 11. Concentrations of sodium and chloride are elevated (i.e., chloride concentration is 225 mg/L from the Park wells), however appear to be stable. Similar to the Southwest Quadrant Wells, best management source protection practices should be undertaken to maintain the concentrations of chloride below the aesthetic objectives of the Ontario Drinking Water Standards.

As shown on Figure 13, occurrences of TCE, PCE and DCE have been reported at the Emma and Park wells. At the Park wells, trace detections (i.e., less than 1 μg/L TCE and DCE) were first encountered in 2012. Due to the limited record of TCE and DCE occurrences, no water quality trend can currently be interpreted.

At the Emma well, TCE, PCE and DCE detections have been observed since 2006, with an increasing trend in TCE concentrations between 2006 and 2009 when Emma was being pumped relatively consistently. As shown on Figure 13, the concentrations of these constituents have varied with respect to time. TCE concentrations, for example, have ranged from approximately 1.0 to 3.4 μg/L. It is noted that spikes of these contaminant concentrations occurred during periods of well inactivity or low pumping rate (i.e., winter 2011 and 2013).

2.4 Northwest Quadrant Well Capacity Assessment

A total of five production wells are located within the City's Northwest Quadrant (active wells: Paisley, Queensdale, Calico, and inactive wells: Smallfield and Sacco). As shown on Figure 7, the combined pumping rate of these wells generally ranged from 2,000 to 4,000 m^3/day between 2003 and 2011. Since 2011, pumping has been reduced in response to the OTP.

Paisley Well

The Paisley Well is permitted at a rate of 3,200 m^3/day and represents an open borehole across the Guelph and Gasport aquifers. Since 2000, the Paisley well has generally operated at a pumping rate ranging from 1,000 m^3/day to 1,400 m^3/day. In 2002, rehabilitation was undertaken at the Paisley well to reduce well plugging from iron and nuisance organisms, increasing the well capacity to 1,400 m^3/day. In 2013, while pumping at a rate of approximately 1,050 m^3/day, only 3 m of available drawdown was remaining within the Paisley well. The specific capacity was approximately 55 m^3/day per m of drawdown in 2013, indicating a capacity of approximately 1,215 m^3/day.

Recognizing the Paisley well performance responded positively to rehabilitation in 2002, it is expected that the 2006 WSMP capacity for Paisley (1,400 m^3/day) can be achieved with regular rehabilitation. Following rehabilitation, performance testing should be undertaken to prove Paisley can sustain a capacity of 1,400 m^3/day.

Queensdale Well

The Queensdale Well is permitted at a rate of 5,237 m^3/day and has a maximum pumping elevation of 275.6 masl. Similar to the Paisley well, Queensdale represents an open borehole across the Guelph and Gasport aquifers. Between 2005 and 2009, the production rate at Queensdale declined from 1,200 to 800 m^3/day. In 2007 when Queensdale was pumping at rate of 1,100 m^3/day, the maximum pumping elevation of 277 masl was consistently observed (i.e., no available additional drawdown). Since 2009, Queensdale has frequently been inactive.

The Queensdale pumping rate decline (2005 – 2009) generally coincides with increasing pumping from the Do-Lime Quarry. It may be realized that operation at the 2006 WSMP capacity (2,000 m3/day) is not possible while Quarry pumping (at or above 7,000 m^3/day) remains on-going. It is therefore recommended that the capacity of the Queensdale well be reduced to 1,100 m^3/day unless well rehabilitation and performance testing can demonstrate otherwise.

Calico Well

The Calico Well is permitted at 5,237 m^3/day and has a maximum pumping elevation of 291 masl. Since 2005, Calico has been pumped fairly consistently at rates ranging from 700 to 1,000 m^3/day. As part of the 2006 WSMP, Calico was assigned a capacity of 1,100 m^3/day. Based on the performance record of Calico, the specific capacity of the Calico well is interpreted to be about 65 m^3/day per m drawdown. With about 15 m of available drawdown, the capacity of this well could be increased by about 300 m^3/day to a total of 1,400 m^3/day. Performance testing could be undertaken at the Calico Well to confirm if it could sustain a higher rate of pumping.

Northwest Quadrant Groundwater Quality

Groundwater quality monitoring data for Northwest Quadrant Wells is summarized on Figure 12. Aside from elevated concentrations of iron within pumped groundwater from the Queensdale and Paisley wells, groundwater quality within the Northwest Quadrant wells remain well below Ontario Drinking Water Quality Standards.

As shown on Figure 13, a single trace occurrence of TCE was reported within the Paisley well in December 2010. No repeated occurrences of TCE have been detected within groundwater pumped from Paisley.

2.5 Summary of Groundwater Supply System Capacity

Based on the assessment provided above, the updated capacity of the City's groundwater supply sources is summarized in Table 3. The total system capacity of the City's existing active groundwater well supply system is interpreted to be 83,836 m^3/day. It is noted that 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 continued pumping at the Do-Lime Quarry. Also taken into consideration are other physical constraints which potential limit the long term sustainable pumping rates of these supplies.

As this total system capacity is the basis for the City's groundwater supply system which is required to provide the City's maximum daily requirements, it is compared to the current and future projected supply needs. The maximum daily demand is calculated as the average daily demand on an annual basis times a maximum day factor (MDF) of 1.35, which was the proposed design value in Technical Memorandum No. 1 (AECOM, 2014) to reflect historical peaks in previous years. Furthermore, it is noted that the future average and maximum day demand provided here for comparison to the existing capacity consist of the baseline projections which assumes that there are no further reductions through water efficiency and conservation.

Demand/Capacity	2013	2038
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (MDF of 1.35) (m^3/day)	64,100	94,300
Total Existing System Capacity (m^3/day)	83,836	
Surplus/Deficit (m^3/day)	19,736	(10,464)

The above comparison of the City's existing water supply system capacity to current and future water supply provides a simple measure of the possible future shortfall 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.

3.0 SYSTEM CAPACITY DURING PROBLEMATIC OPERATING CONDITIONS

As part of Task 3, the capacity of the Groundwater Supply System has been assessed for problematic operating conditions, such as drought and a potential contamination event. This section discusses the potential system capacity reduction that could be realized under these problematic operating conditions.

3.1 System Capacity During Drought Conditions

As part of the City's Tier Three Risk Assessment (Matrix, 2013), groundwater modelling analysis has been undertaken to assess the capacity of the City's groundwater supply system under drought conditions.

The Tier Three groundwater flow model (Scenario H) was run with reduced groundwater recharge to simulate a 10-year drought condition. Through an iterative process, the Tier Three modelling analysis determined that operation of the groundwater supply system at an average pumping rate of 73,500 m^3/day (to meet the same average demand in non-drought conditions for future conditions) could be sustained through the 10-year drought period. This was accomplished by adjusting some well pump rates higher to compensate for other wells where the aquifer levels dropped. For example, the Tier Three Risk Assessment concluded that drought conditions would significantly affect the operation of groundwater supply wells that predominantly draw from shallow aquifers (i.e., Glen Collector, Arkell 1, Burke, Carter 1, Carter 2) or groundwater supply wells that have limited available drawdown within the deep aquifers (i.e., Emma and Water). It is noted, however, that the Tier Three Assessment does not identify the maximum pumping rates that can be sustained from the deeper (confined wells) on a shorter term basis to meet maximum day requirements (during the drought period).

It is also noted that the Tier Three Risk Assessment included pumping from inactive municipal wells (Clythe, Sacco, Smallfield) as part of the above analysis. Applying the Tier Three Risk Assessment findings to active municipal wells, the sustainable long term average combined pumping rate from the active groundwater supply sources through a 10-year drought period is approximately 68,692 m^3/day (as per the rate schedule shown in Table 5). With review of available drawdown under drought conditions in Figure 5-6 of the Tier Three Assessment report, it is estimated that under these conditions, shorter term higher pump rates of approximately 71,128 m^3/day are possible as long as the annual average is maintained at 68,692 m^3/day.

Table 3 provides a summary of the average pumping rates simulated within the 10-year drought analysis (Scenario H), as well as estimates of higher short-term pump rates to meet peaking demands. These pumping rates are compared to the well capacity estimates reported within Table 2.

The above evaluation summarizes a review of the constraints to the sustainable pumping capacity of the existing system as a function of drought conditions to the system from a hydrogeological perspective. As the Tier Three model reflects long term average pumping, it is also prudent to compare this and the estimated short term pumping capacity that can be realized from the existing wells for comparison to the current and future average day demand.

Demand/Capacity	**2013**	**2038**
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (MDF of 1.35) (m^3/day)	64,100	94,300
Total Existing System Capacity (m^3/day)	83,836	
10 Year Drought Condition – long term average day (m^3/day)	68,692	
10 Year Drought Condition – short term max day (m^3/day)	71,128	
Surplus/Deficit (m^3/day)	7,028	(23,172)

This analysis suggests that under drought conditions there is a reduction of approximately 15% in available total existing system capacity as compared to non-drought conditions.

3.2 System Capacity During Contamination Event or Loss of Supply Source

Contamination events or unexpected loss of a supply source (i.e., long-term maintenance event) is an inherent potential risk. In order to quantify the potential effect of a contamination event or loss of supply source on the City's groundwater supply system, a desktop exercise was undertaken. This exercise considered four potential scenarios: the loss of the highest-yield supply source within every quadrant where the capacity could not generally be made up by pumping nearby wells. For these scenarios, groundwater supply wells presumed to be taken off-line are as follows:

Scenario 1: Loss of Burke - one of the largest producers in the Southeast Quadrant, with no neighbouring wells to make up the lost supply;

Scenario 2: Loss of Membro - the largest producer in the Southwest Quadrant, with limited capacity to recover the lost supply from Water;

Scenario 3: Loss of the Park wells - the largest producer in the Northeast Quadrant, with limited capacity to recover the lost supply from Emma; and

Scenario 4: Loss of Paisley - the largest producer in the Northwest Quadrant, where distance and poor well specific capacity limit any reasonable recovery of lost capacity at Queensland and Calico.

The results of this desktop exercise are provided within Table 5. The minimum capacity of the groundwater supply system remains above 76,000 m^3/day during the loss of any single groundwater supply source.

The above evaluation summarizes a review of the constraints to the sustainable pumping capacity of the existing system as a function of potential risks to the system from a hydrogeological perspective as well as an operational perspective. If a well supply source is not available for pumping due to contamination or other issues such as mechanical issues or well/facility failure, there is a resulting overall loss to the total system pumping capacity. The worst case scenario is the loss of the Park wells in the NE Quadrant which results in approximately a 10% reduction in available capacity (7,700 m^3/day), This reduction reflects the constraints related to the ability of the existing facilities to produce water rather than limitations of the aquifer.

Demand/Capacity	2013	2038
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (MDF of 1.35) (m^3/day)	64,100	94,300
Total Existing System Capacity (m^3/day)	83,836	
Total System Capacity with Loss of Supply (m^3/day)	75,800	
Surplus/Deficit (m^3/day)	11,700	(18,500)

4.0 INACTIVE MUNICIPAL GROUNDWATER SUPPLY SOURCES

Five municipal groundwater supply sources (Clythe, Edinburgh, Sacco, Smallfield, and the Lower Road Collector) are currently permitted for operation, however, remain inactive or off-line since the 1990s due to groundwater quality concerns. A sixth source, the Admiral Well, was developed for dedicated industrial use but

not implemented due to groundwater quality issues. The potential for future operation of these wells will be discussed under consideration of future supply alternatives in the WSMP update. However, provided herein is a brief summary of the established capacity of these permitted groundwater supply sources.

Clythe Well

The Clythe well has been inactive since 1997, when a liner installation and rehabilitation were recommended to mitigate water quality issues (hydrogen sulphide). The Clythe Well Rehabilitation and Assessment report (Stantec, 2008) indicates a potential capacity of 3,395 m^3/day for Clythe.

Edinburgh Well

The Edinburgh well has been inactive since 1998, due to TCE detections within the pumped groundwater. Edinburgh is not currently equipped with a pump, however, is permitted for operation at a maximum pumping rate of 3,000 m^3/day.

Smallfield and Sacco Wells

The Smallfield Well has been inactive since the early 1990’s due to high concentrations of TCE in excess of the ODWQS within the pumped groundwater. The Sacco Well was shut-down in the mid-1990s due to its proximity to the Smallfield area and concerns regarding water quality degradation with continued pumping. In 2008, rehabilitation of the Sacco and Smallfield wells was undertaken as part of a well rehabilitation and hydrogeological assessment program (Stantec, 2009).

The Stantec (2009) assessment concluded that the sustainable well capacity for Smallfield is 1,408 m^3/day. Smallfield groundwater consistently contained TCE concentrations that exceeded the ODWQS MAC of 5 µg/L. In addition to TCE, other solvent products with detectable concentrations included 1,1,1-Trichloroethane and chloroform. Low level concentrations of some transformation products for these solvents were also detected. In addition, 1,4-Dioxane was detected at concentrations ranging from 18 µg/L to 33 µg/L and the concentration of chloride remained elevated throughout the testing (160 to 320 mg/L).

For Sacco, the Stantec (2009) assessment concluded a sustainable well capacity of 1,150 m^3/day. Sacco groundwater quality comprised of detectable levels of both TCE and PCE, but consistently below the ODWQS MAC.

Lower Road Collector

The Lower Road Collection System extends along the lower slope of the Eramosa Valley wall, eastwards from Watson Road to the northern extent of the Glen Collector System. It is comprised of 30 manholes and 26 collection galleries. Due to the poor condition of the connections to the Lower Road Aqueduct and an elevated bacterial content from this collector system, the Lower Road Collector System was disconnected in October 2000. It no longer provides water to the municipal distribution system.

During the operation of the Lower Road collector, production totals were known to range from 576 m^3/day to 6,192 m^3/day, with a typical collection rate ranging from approximately 2,000 m^3/day to 3,000 m^3/day. Groundwater taking from the Lower Road collector is still permitted by the Arkell Spring Grounds collector system PTTW.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The performance record (1997 through 2013) of the 22 (active) City groundwater supply sources have been reviewed and compared to the 2006 WSMP report. Based on the record of groundwater quantity and quality monitoring data, the following conclusions and recommendations are respectfully submitted:

1) The total groundwater supply system capacity of the City's groundwater supply system is currently 83,836 m^3/day. This represents an increase of 8,836 m^3/day, relative to the available well capacity reported within the 2006 WSMP. The increase reflects additional permitted pumping from the new Arkell pumping wells (Arkell 14 and Arkell 15).

2) Groundwater quality within the Southeast Quadrant (the largest producing well field) is good, meeting all objectives of the ODWQS (except for manganese at the Burke well). Nitrate concentrations at the Carter wells have been steadily decreasing since 2004, indicating improved groundwater quality. Elevated sodium and chloride concentrations are reported in pumped groundwater from groundwater supply sources within the Southwest and Northeast Quadrants. While these concentrations have stabilized in the Northeast Quadrant, a steady increase remains on-going within the Southwest Quadrant. Source protection best management practices should be undertaken to stabilize these water quality trends within the Southwest Quadrant.

   Capture of impacted groundwater will remain a concern at groundwater supply sources located in proximity to industrial areas (i.e., Park 1, Park 2, Emma, Membro and Water). TCE concentrations at Water and Park are low to trace (i.e., less than 0.5 μg/L) and do not appear to be increasing. At Membro and Emma, however, TCE concentrations generally range from 2 to 3 μg/L. Variability of TCE concentrations at Emma are a concern.

3) Several municipal production wells are cased into the top of bedrock and draw water from shallow and deep groundwater flow systems. Liner installation in key groundwater supply sources (i.e., where the Vinemount aquitard effectively separates the shallow and deep groundwater flow systems) could limit the potential of capturing impacted groundwater from a shallow flow system and possibly improve well performance. Liner installations at the Paisley well, for example, could limit cascading of water and iron precipitation that is known to promote bio-fouling of the well. It is recognized that liner installations could adversely affect the production capacity of municipal supply wells. It is therefore recommended that performance testing be undertaken to confirm sustainable pumping rates prior to (i.e., packer testing) and following the installation of liners. As summarized within Table 4, liner installations are recommended at six municipal supply well locations (Water, Dean, Downey, Paisley, Queensdale, Calico).

4) At eight groundwater supply locations (Arkell 1, Burke, Water, Dean, University, Helmar, Paisley, Queensdale), the recent (i.e., past 8 years) performance history has not demonstrated an obvious capability to sustain the pumping capacity established by the 2006 WSMP. In the past, these wells have responded positively to rehabilitation. As noted in Table 4, it is recommended that performance testing and rehabilitation (if needed) be undertaken to demonstrate that these wells can operate at their assigned capacity. Performance testing should consist of:

- Well step testing to allow for comparison with historical specific capacity results.
- Continuous operation at the assigned well capacity rate (over a period ranging from one week to one month). During the performance testing period, continuous monitoring of the pumping level within the well

(and nearby monitoring well if possible) should be undertaken. If a reduction in well specific capacity is noted, consideration should be given to initiation of a well rehabilitation program.

5) As part of the Tier Three Risk Assessment, groundwater modelling has been undertaken to approximate the average sustainable capacity of the groundwater supply system under a 10-year drought condition. The modelling analysis concluded that groundwater pumping can be sustained during the 10-year drought condition if the groundwater supply system pumping rate is reduced to approximately 68,692 m^3/day from active groundwater supply sources. Further analysis of the Tier Three modelling results determined the maximum capacity of the groundwater supply wells on a shorter term basis to meet peaking demands. The maximum daily pumping rate (over the short term, during drought conditions) is estimated to be 71,128 m^3/day.

6) A desktop exercise has been undertaken to estimate the effect of a contamination event (i.e., loss of supply) on the total existing capacity of the groundwater supply system. Four scenarios were considered, where the highest producing source was taken off-line within each quadrant, respectively. In these scenarios, the capacity of the groundwater supply system remained above 76,000 m^3/day (approximately 10% less that the total available capacity).

Table 5 is provided as a summary to document the updated estimated total existing water supply system capacity under normal conditions, as well as under drought conditions and with loss of groundwater supply due to contamination or other causes. The results suggest that the total system capacity is vulnerable to a potential reduction in supply of approximately 10 to 15% under either of these risk scenarios. If considered in combination (i.e. occurring concurrently), this would be reduced even further. This provides support for the previous WSMP approach with respect to the design allowance of additional supply capacity for redundancy; for example, setting aside 10% of existing and future capacity.

Under each of the above conditions, the existing total capacity was compared to the current and projected future demands at a maximum day factor of 1.35 to determine future requirements. As noted in Section 3, the baseline projection reflects current per capita demands and no future water conservation efforts, and therefore represents a very conservative scenario with respect to future supply requirements. By incorporating a firm capacity approach to reflect the risk assessment undertaken herein, a higher maximum day factor of 1.5 is recommended to incorporate the historical MDF of 1.35 and an added 10 to 15% in determining the total water supply system requirements.

6.0 CLOSURE

We trust that this draft technical memorandum meets your current needs. If you require any further clarification, please contact the undersigned.

Stephen Di Biase
Associate, Senior Hydrogeologist

JLH/SMD/wlm

Attachments: Table 1: References
Table 2: Municipal Water Supply Wells – Construction Details
Table 3: Water Supply Capacity Assessment Update
Table 4: Summary of Recommendations
Table 5: Groundwater Supply Capacity Under Problematic Operating Conditions

Figure 1: Conceptual Hydrogeological Model
Figure 2: Municipal Production Well and Test Well Locations
Figure 3: Southeast Quadrant Wells Daily Pumped Volumes and Groundwater Elevations
Figure 4: Southeast Quadrant Wells Daily Pumped Volumes and Groundwater Elevations
Figure 5: Southwest Quadrant Wells Daily Pumped Volumes and Groundwater Elevations
Figure 6: Southwest Quadrant Wells Daily Pumped Volumes and Groundwater Elevations
Figure 7: Northeast Quadrant Wells Daily Pumped Volumes and Groundwater Elevations
Figure 8: Northwest Quadrant Wells Daily Pumped Volumes and Groundwater Elevations
Figure 9: Southeast Quadrant Wells Inorganic Water Quality
Figure 10: Southwest Quadrant Wells Inorganic Water Quality
Figure 11: Northeast Quadrant Wells Inorganic Water Quality
Figure 12: Northwest Quadrant Wells Inorganic Water Quality
Figure 13: Volatile Organic Compounds

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TABLES

TABLE 1
References
City of Guelph Water Supply Master Plan Update

Report Title	Reference
Arkell Spring Grounds Hydrogeologic Study - Final Report	AECOM, 2009
Guelph Tier 3 Water Budget and Local Area Risk Assessment Groundwater Flow Model Report	AquaResource, 2012
Resource Evaluation Summary	City of Guelph, 1999
City of Guelph - 2006 Water Supply Master Plan	Earth Tech, 2006
Clythe and Helmar Treatability Assessment Report	Gamsby and Mannerow, 2010
Arkell Spring Grounds Groundwater Supply Investigation	Gartner Lee, 2003
Guelph-Puslinch Groundwater Study	Golder, 2006
Guelph Southwest Quadrant Water Supply Class Environmental Assessment – Hydrogeological and Natural Environment Report	Golder, 2011
Guelph Tier 3 Water Budget and Local Area Risk Assessment - Appendix A: Characterization Report	Golder, 2011
Groundwater Resources Study - City of Guelph Northeast Quadrant	Jagger Hims Limited, 1995
Groundwater Resources Study - City of Guelph Northwest Quadrant	Jagger Hims Limited, 1998
Groundwater Resources Study - City of Guelph Southeast Quadrant	Jagger Hims Limited, 1998
Groundwater Resources Study - City of Guelph Southwest Quadrant	Jagger Hims Limited, 1998
Sacco Well Assessment	Lotowater, 2009
Tier Three Water Budget and Local Area Risk Assessment	Matrix., 2013
Arkell Spring Grounds – Hydrogeological Study in Support of a Caisson Collector System	Stantec, 2006
Clythe Well Rehabilitation and Assessment	Stantec, 2008
Guelph South Groundwater Supply Investigation	Stantec, 2009
Smallfield and Sacco Production Wells – Well Rehabilitation and Hydrogeological Assessment	Stantec, 2009
2011 Annual Monitoring Report - Arkell Adaptive Management Plan	Stantec, 2011
Arkell Adaptive Management Plan and Operational Testing Program – 2011 Annual Monitoring Report	Stantec, 2012

TABLE 2
Municipal Water Supply Wells - Construction Details
City of Guelph Water Supply Master Plan Update

Well Field	Well	Year Constructed	Pump House Floor Elevation	Well Pump Base Plate	Casing Diameter	Casing Depth[1]	Depth of Liner[1]	Liner Diameter	Depth to Pump Suction	Depth to Water Bearing Zone[2]	Maximum Pumping Level[3]		Well Depth	Permitted Rate
			(masl)	(masl)	(mm)	(m)	(m)	(mm)	(m)	(m)	(m)	(masl)	(m)	(m^3/day)
Southeast Quadrant	Arkell 1	1966	330.2	330.7	300.7	9.6	-	-	13.7	9.6	10.7	320.0	14.2	3,273
	Arkell 6	1963	330.3	330.8	305	11.0	-	-	33.2	32.3	30.2	300.6	43.0	28,800
	Arkell 7	1963	330.2	330.8	360	23.8	-	-	31.0	38.2	28.0	302.8	41.2	
	Arkell 8	1963	332.4	333.0	305	12.5	-	-	30.5	37.4	27.5	305.5	42.1	
	Arkell 14	2000	333.6	334.3	387	27.4	-	-	31.7	26.8	29.7	304.6	40.5	
	Arkell 15	2000	319.6	320.4	387	14.6	23.4		15.4	24.0	12.4	308.0	30.5	
	Burke	1966	335.6	336.2	300	21.7	-	-	26.0	26.1	23.0	313.2	79.6	6,546
	Carter 1	1962	324.6	325.0	250	4.6	10.1	200	11.4	11.0	8.4	316.6	20.6	7,855
	Carter 2	1962	324.6	325.0	250	7.3	-	-	12.1		9.1	315.9	20.4	
Southwest Quadrant	Membro	1953	315.6	316.0	254	7.0	41.1	200	38.5	36.3	35.5	280.5	73.8	6,050
	Water Street	1953	314.5	315.3	305	6.4	-	-	39.6	32.0	36.6	278.7	60.1	3,400
	Dean	1958	323.3	323.8	330	12.5	-	-	49.5	34.3	46.5	277.3	57.6	2,300
	University	1965	329.5	330.0	254	25.9	52.5	200	56.5	48.0	44.7 [4]	285.3 [4]	64.8	3,300
	Downey	1968	317.4	318.0	305	14.9	-	-	40.8	37.5	37.8	280.2	74.7	5,237
Northeast Quadrant	Park 1	1937	328.3	328.7	508	12.4	43.7	400	47.3	45.7	44.3	284.4	54.7	10,300
	Park 2	1947	328.3	328.7	508	8.2	42.4	400	47.3	42.8	44.3	284.4	48.2	
	Emma	1931	329.3	329.9	457	6.4	43.3	200	41.0	21.7	38.0	291.9	46.0	3,100
	Helmar	1966	344.5	345.2	305	10.1	27.4	200	48.2	61.3	45.2	300.0	77.7	3,273
Northwest Quadrant	Paisley	1952	322.2	322.6	305	6.6	33.2	250	33.1	46.0	30.1	292.5	80.2	3,200
	Calico	1976	324.1	324.8	305	18.0	-		36.6	20.4	33.6	291.2	61.9	5,237
	Queensdale	1970	325.9	326.4	254	9.9	-		52.1	41.0	49.1	277.3	70.2	5,237
Arkell Infiltration Galleries - Glen Collector														25,000

Notes: 1) Depths are relative to pump house floor elevation.
2) Taken from Table G5, Appendix A of Tier 3 Report (Golder, 2011).
3) Maximum pumping level provided by the City of Guelph staff. Unless otherwise noted this level is set at 3 m above Well Pump Base Plate.
4) The maximum pumping level for the University Well is based on interference with private well at the University of Guelph, otherwise it would be 53.5 m (276 masl).

TABLE 3
Water Supply Capacity Assessment Update
City of Guelph Water Supply Master Plan Update

Well Field	Well	WSMP (2006) (m³/day)	WSMP UPDATE (m³/day)	Update
Southeast Quadrant	Arkell 1	2,000	2,000	unchanged
	Arkell 6	6,500	28,800	Revised based on Arkell Spring Grounds Water Supply Class Environmental Assessment
	Arkell 7	6,500		
	Arkell 8	6,500		
	Arkell 14	N/A		
	Arkell 15	N/A		
	Burke	6,500	6,500	unchanged
	Carter 1	5,500	5,500	unchanged
	Carter 2			unchanged
Southwest Quadrant	Membro	6,000	6,000	unchanged
	Water Street	2,700	2,700	unchanged
	Dean	1,500	1,500	unchanged
	University	2,500	2,500	unchanged
	Downey	5,100	5,236	increased 136 m^3/day
Northeast Quadrant	Park 1	8,000	8,000	unchanged
	Park 2			
	Emma	2,800	2,800	unchanged
	Helmar	1,500	1,500	unchanged
Northwest Quadrant	Paisley	1,400	1,400	unchanged
	Calico	1,100	1,400	increased 300 m^3/day
	Queensdale	2,000	1,100	decreased 900 m^3/day
Arkell Infiltration Galleries - Glen Collector		6,900	6,900	unchanged
	Total	**75,000**	**83,836**	

TABLE 4
Summary of Recommendations
City of Guelph Water Supply Master Plan Update

Well Field	Well	Recommended Action			
		Liner	Performance Testing	Rehabilitation	Modifications to Engineering
Southeast Quadrant	Arkell 1		✓	✓	
	Arkell 6				
	Arkell 7				
	Arkell 8				
	Arkell 14				
	Arkell 15				
	Burke		✓	✓	
	Carter 1		✓		
	Carter 2		✓		
Southwest Quadrant	Membro				Highlift Pump Operation
	Water Street	✓	✓		Highlift Pump Operation
	Dean	✓	✓		
	University		✓	✓	
	Downey				
Northeast Quadrant	Park 1				
	Park 2				
	Emma		✓		
	Helmar		✓	✓	
Northwest Quadrant	Paisley		✓	✓	
	Calico		✓		
	Queensdale		✓		

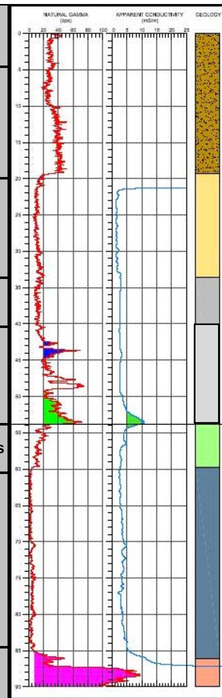
TABLE 5
Groundwater Supply Capacity Under Problematic Operating Conditions
City of Guelph Water Supply Master Plan Update

Well Field	Well	Permitted Rate	WSMP (2006)	WSMP UPDATE	Drought Conditions		Loss of Groundwater Supply Source Scenario			
					Max	Average[1]	Scn. 1 (SE)	Scn. 2 (SW)	Scn. 3 (NE)	Scn. 4 (NW)
		(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)
Southeast Quadrant	Arkell 1	3,273	2,000	2,000	1,400	1,400	2,000	2,000	2,000	2,000
	Arkell 6		6,500		6,200	5,300				
	Arkell 7		6,500		5,800	5,300				
	Arkell 8	28,800	6,500	28,800	5,000	4,900	28,800	28,800	28,800	28,800
	Arkell 14		N/A		4,500	4,400				
	Arkell 15		N/A		4,500	4,400				
	Burke	6,546	6,500	6,500	6,300	6,300	0	6,500	6,500	6,500
	Carter 1	7,855	5,500	5,500	4,400	4,400	5,500	5,500	5,500	5,500
	Carter 2									
Southwest Quadrant	Membro	6,050	6,000	6,000	5,500	4,300	6,000	0	6,000	6,000
	Water Street	3,400	2,700	2,700	2,400	2,400	2,700	2,700	2,700	2,700
	Dean	2,300	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
	University	3,300	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
	Downey	5,237	5,100	5,236	5,236	5,200	5,236	5,236	5,236	5,236
Northeast Quadrant	Park 1	10,300	8,000	8,000	7,200	6,900	8,000	8,000	0	8,000
	Park 2									
	Emma	3,100	2,800	2,800	2,400	2,400	2,800	2,800	3,100	2,800
	Helmar	3,273	1,500	1,500	1,200	1,200	1,500	1,500	1,500	1,500
Northwest Quadrant	Paisley	3,200	1,400	1,400	1,000	1,000	1,400	1,400	1,400	0
	Calico	5,237	1,100	1,400	1,100	1,100	1,400	1,400	1,400	1,400
	Queensdale	5,237	2,000	1,100	1,100	2,000	1,100	1,100	1,100	1,100
Glen Collector		25,000	6,900	6,900	1,892	1,892	6,900	6,900	6,900	6,900
	Total:	**122,108**	**75,000**	**83,836**	**71,128**	**68,792**	**77,336**	**77,836**	**76,136**	**82,436**

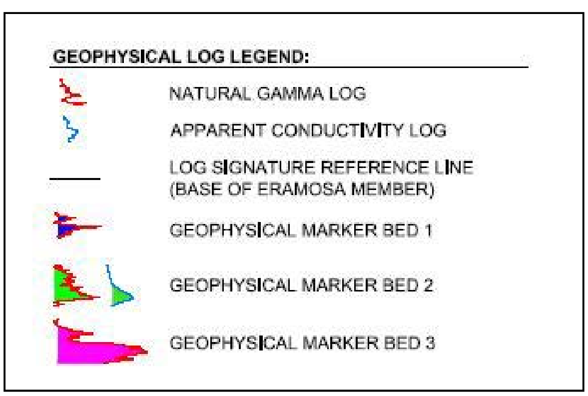
Note: [1] - Flow rates specified for Scenario H of Tier Three Water Budget and Local Area Risk Assessment (Drought Conditions)

FIGURES

Formation / Member	
Overburden	
Guelph Formation	
Eramosa Formation	Stone Road / Reformatory Quarry
	Vinemount
Goat Island Formation	Ancaster / Niagara Falls
Gasport Formation	Gothic Hill
Cabot Head / Reynales Formation	



Conceptual Model Layer	Aquifer/Aquitard	Thickness (m)	FEFLOW Numerical Model Layers
Upper Sand and Gravel	Aquifer	Variable, up to 71	Layers 1 to 2
Till	Aquifer/Aquitard	Variable, up to 72	Layer 3
Contact Aquifer	Aquifer	Variable, up to 7	Layer 4
Guelph Formation	Aquifer	Variable, up to 62	Layer 5
Eramosa - Reformatory Quarry	Aquitard	Variable, up to 48	Layer 6
Eramosa - Vinemount		Variable, up to 18	Layers 7 to 9
Goat Island	Aquifer/Aquitard	Variable, up to 50	Layer 10
Upper Gasport	Aquifer	Variable, up to 68	Layer 11
Middle Gasport	Aquifer	Variable, up to 12	Layer 12
Lower Gasport	Aquifer	Variable, up to 26	Layer 13
Cabot Head	Aquitard	Variable, up to 100	Layer 14
Underlying Impermeable Bedrock	**Aquitard**		**Base of Model**

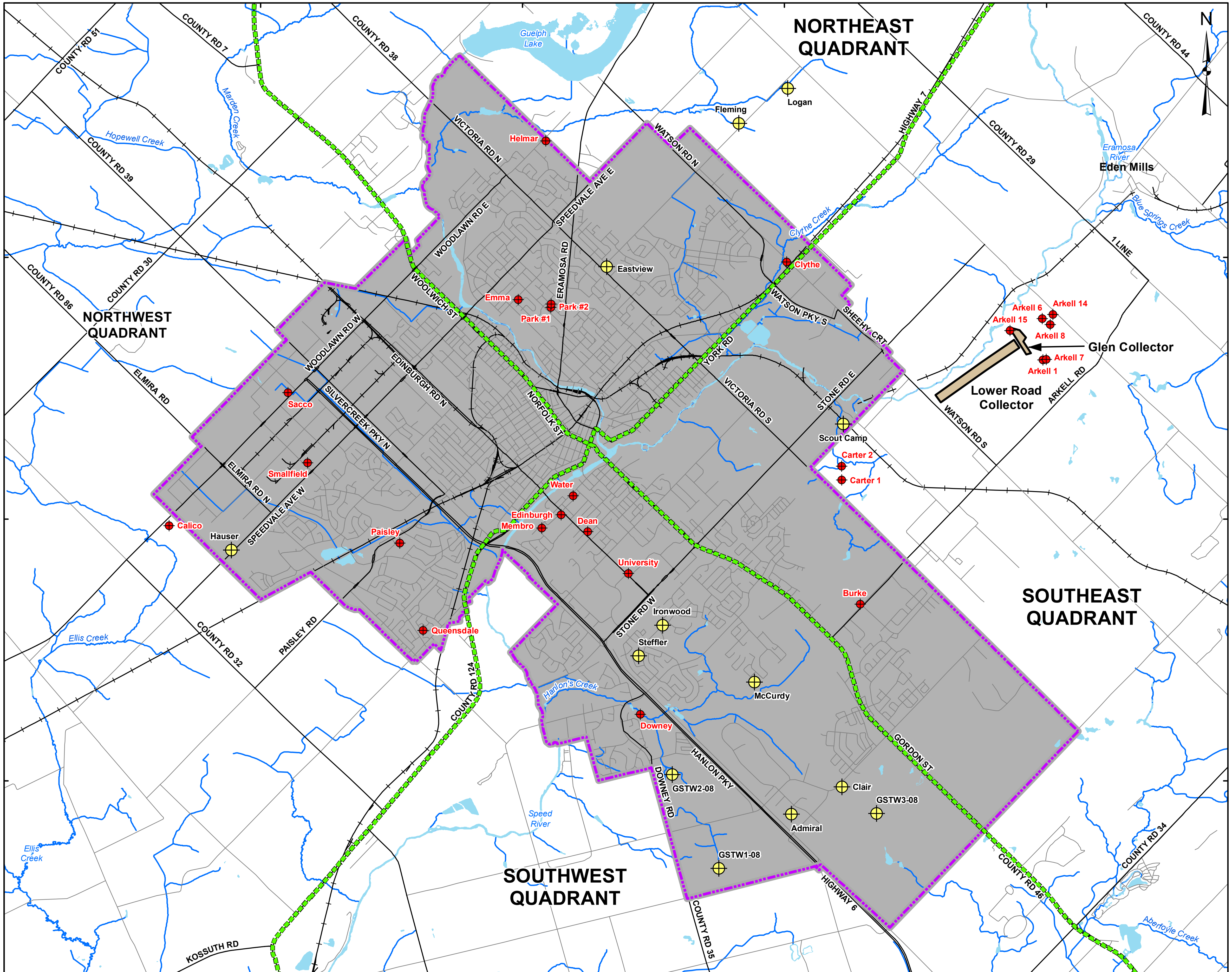


TITLE

Regional Stratigraphic Section
Conceptual Hydrogeological Model

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	July 2011	FIGURE: 1	
GIS	BR	July 2011		
CHECK	SMD	Jan 2014		
REVIEW	SMD	Jan 2014		



LEGEND

- Municipal Test Well
- Municipal Production Well
- Major Roads / Highways
- Collector Roads / Local Roads
- Railway
- Watercourse
- Waterbody
- City of Guelph Boundary
- Arkell Collection System

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

1 0.5 0 1 2 3
SCALE 1:60,000 KILOMETERS

PROJECT

City of Guelph Water Supply Master Plan
Task 3 – Water Supply Capacity Assessment

TITLE

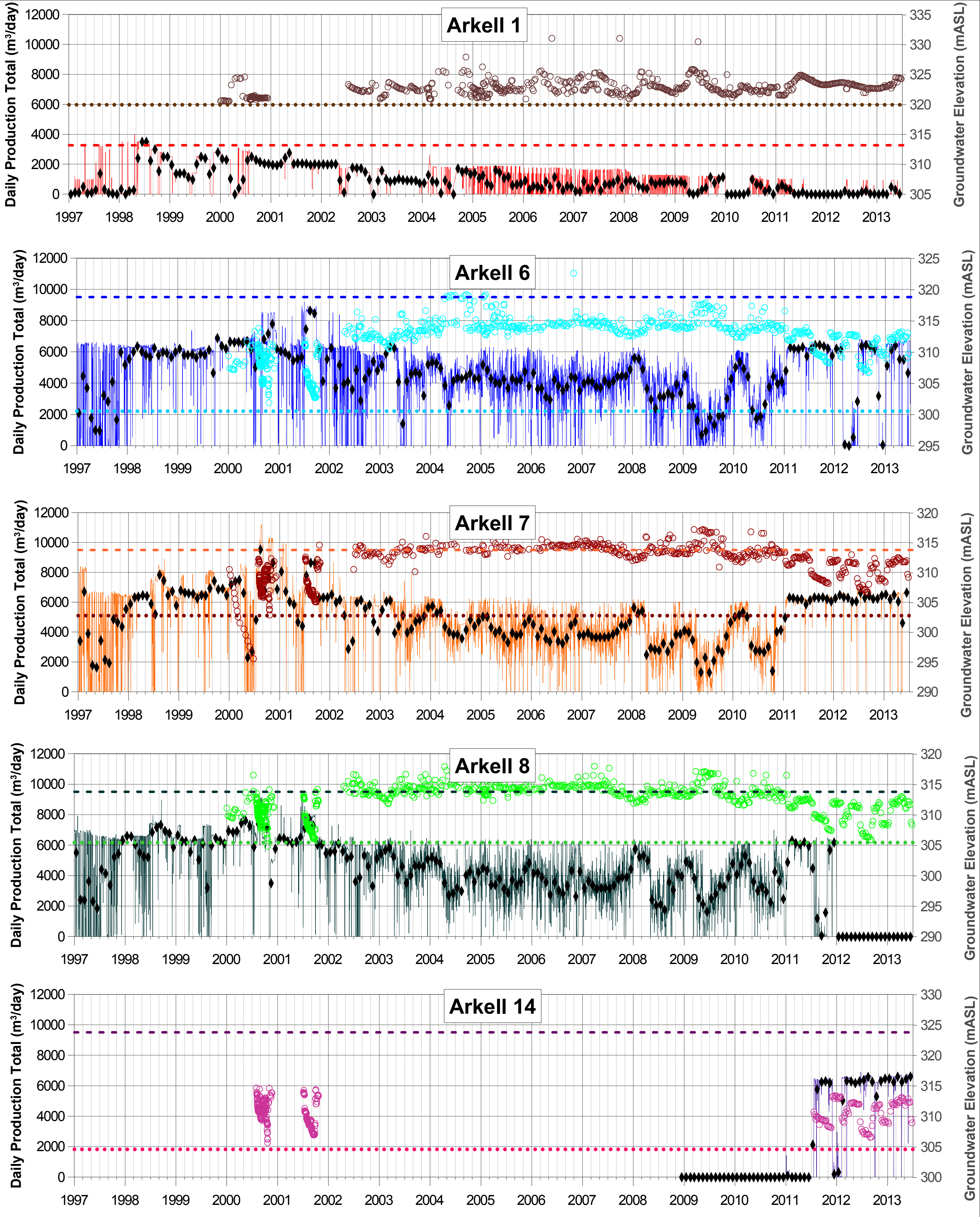
MUNICIPAL PRODUCTION WELLS AND TEST WELL LOCATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0217			SCALE AS SHOWN	REV. 0.0
DESIGN	KD	30 Jan. 2014		
GIS	KD	27 May. 2014		
CHECK	JH	27 May. 2014		
REVIEW	SMD	27 May. 2014		

FIGURE: 2

G:\Projects\2012\12-1152-0217_City_of_Guelph_Water_Supply\GIS\MXDs\Reporting\Tech_Memo\Well_Locations.mxd

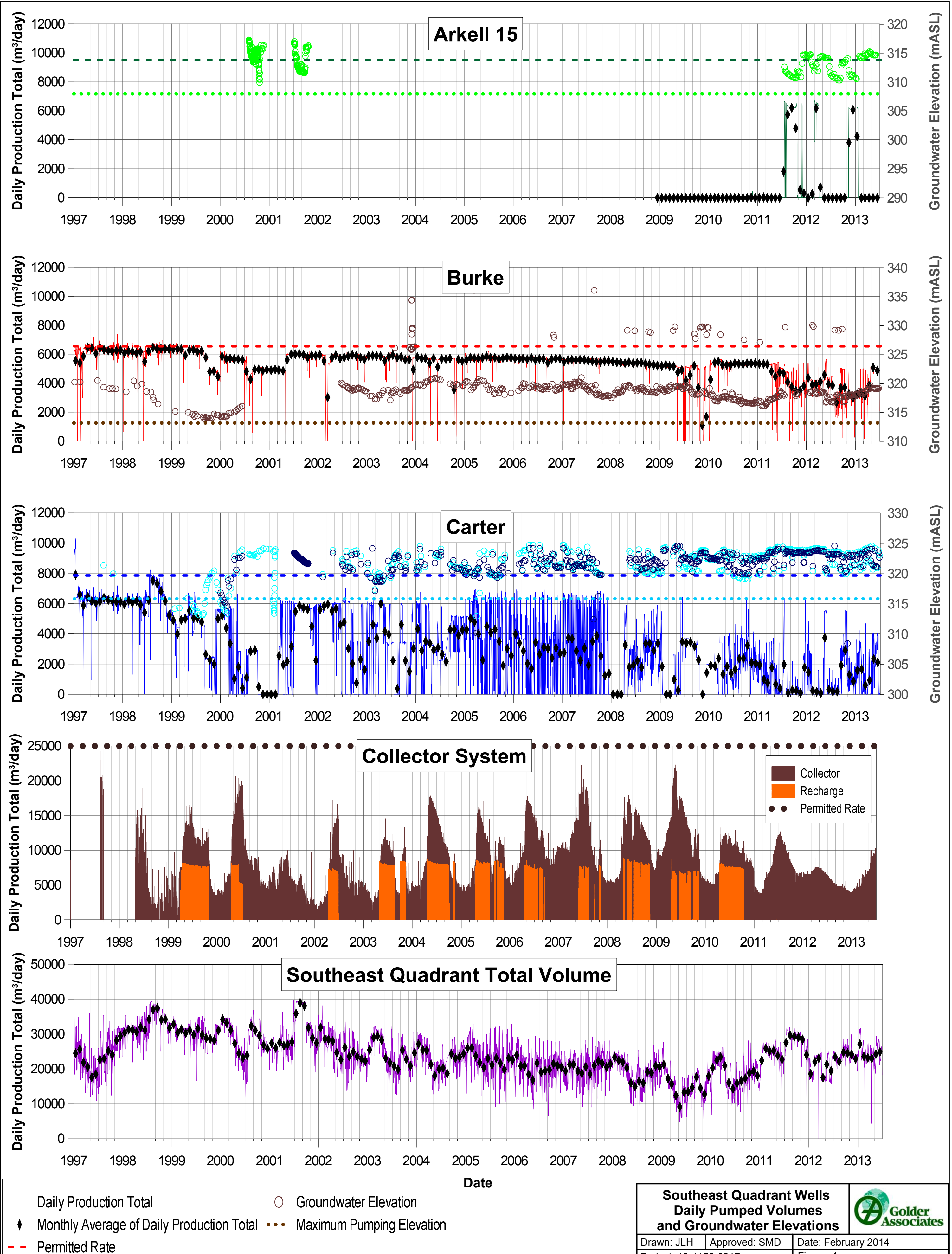


Daily Production Total
Monthly Average of Daily Production Total
Permitted Rate
Groundwater Elevation
Maximum Pumping Elevation

Southeast Quadrant Wells Daily Pumped Volumes and Groundwater Elevations

Golder Associates

Drawn: JLH	Approved: SMD	Date: February 2014
Project: 12-1152-0217		Figure: 3



Southeast Quadrant Wells Daily Pumped Volumes and Groundwater Elevations

Drawn: JLH	Approved: SMD
Project: 12-1152-0217	
Date: February 2014	Figure: 4

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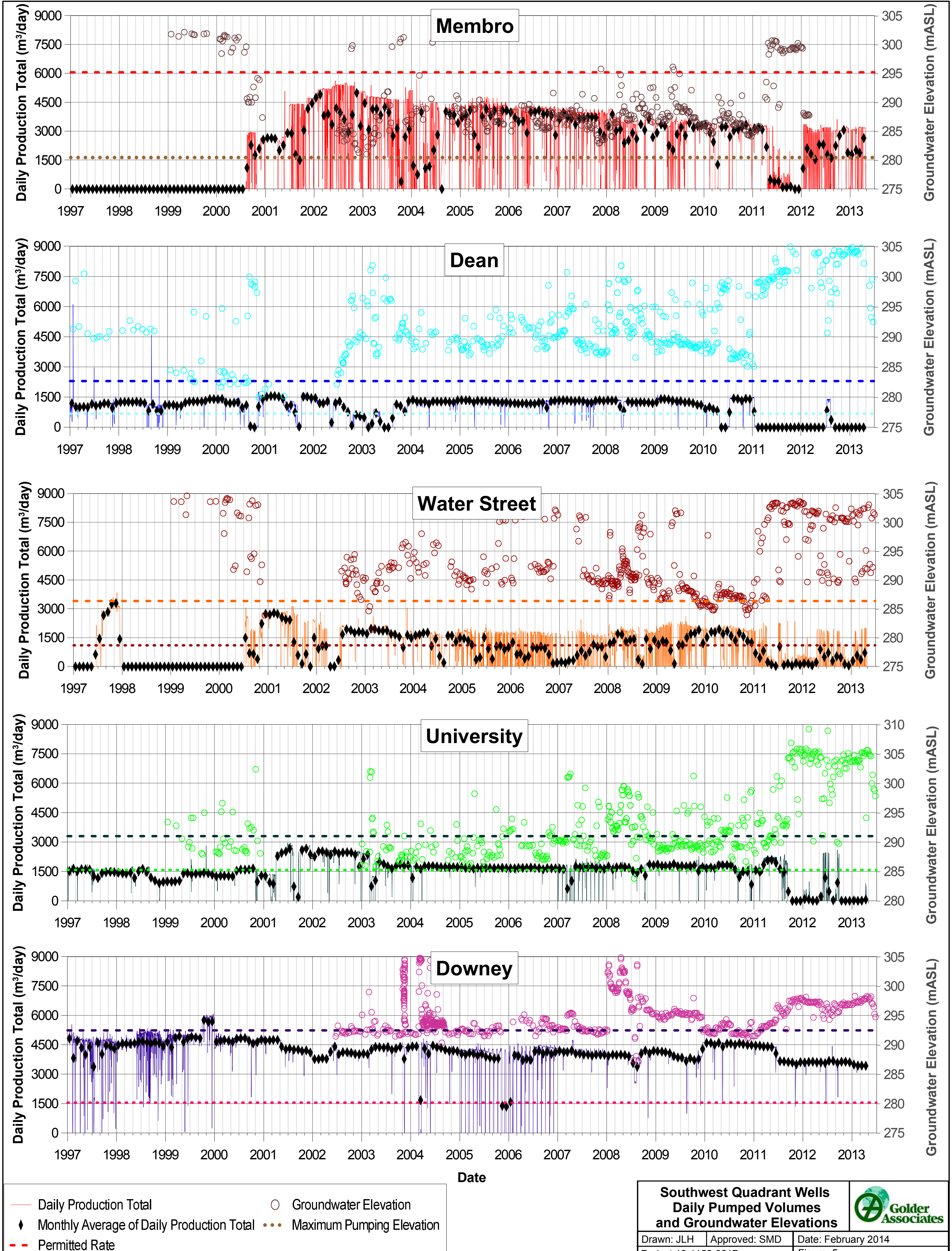
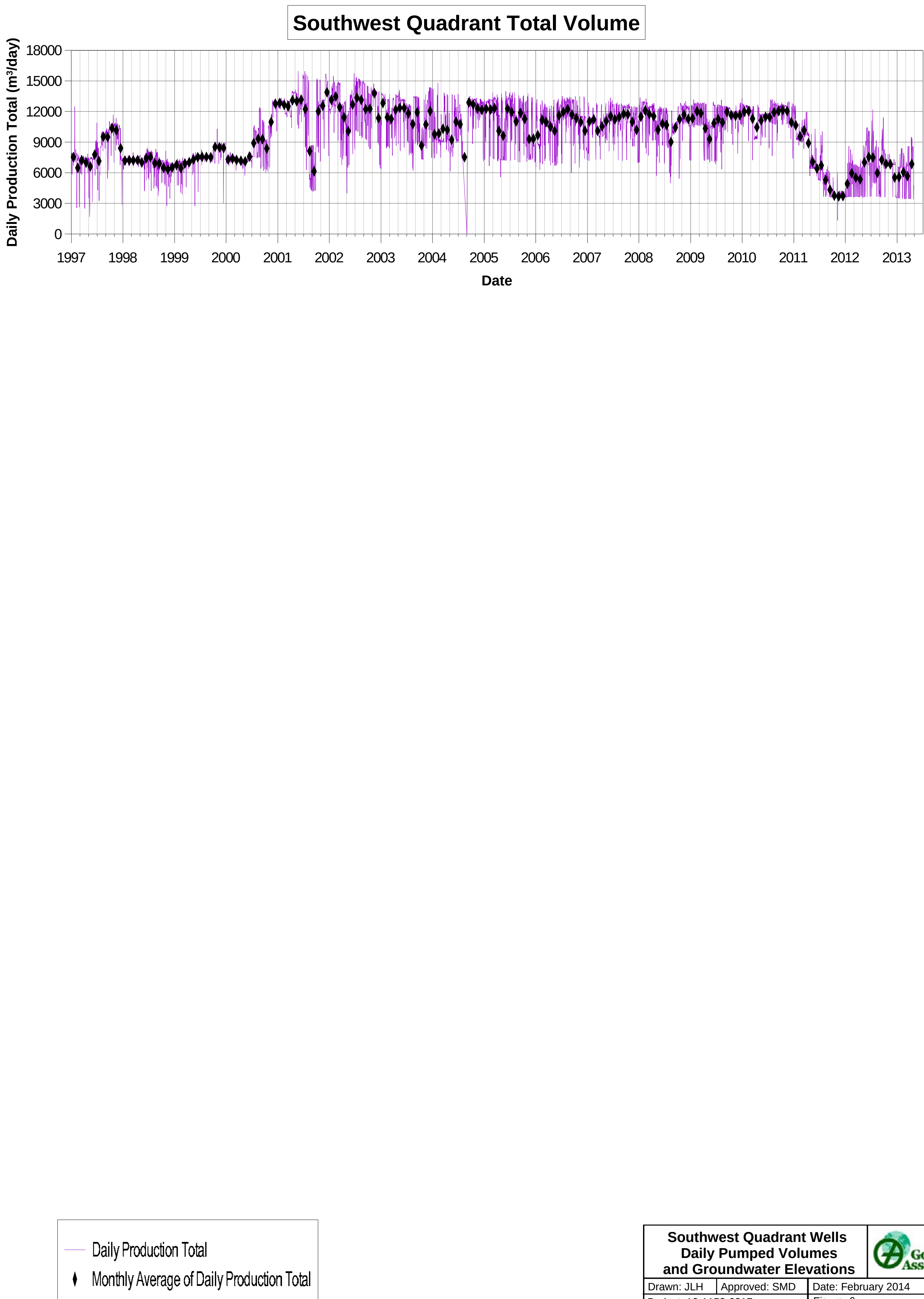


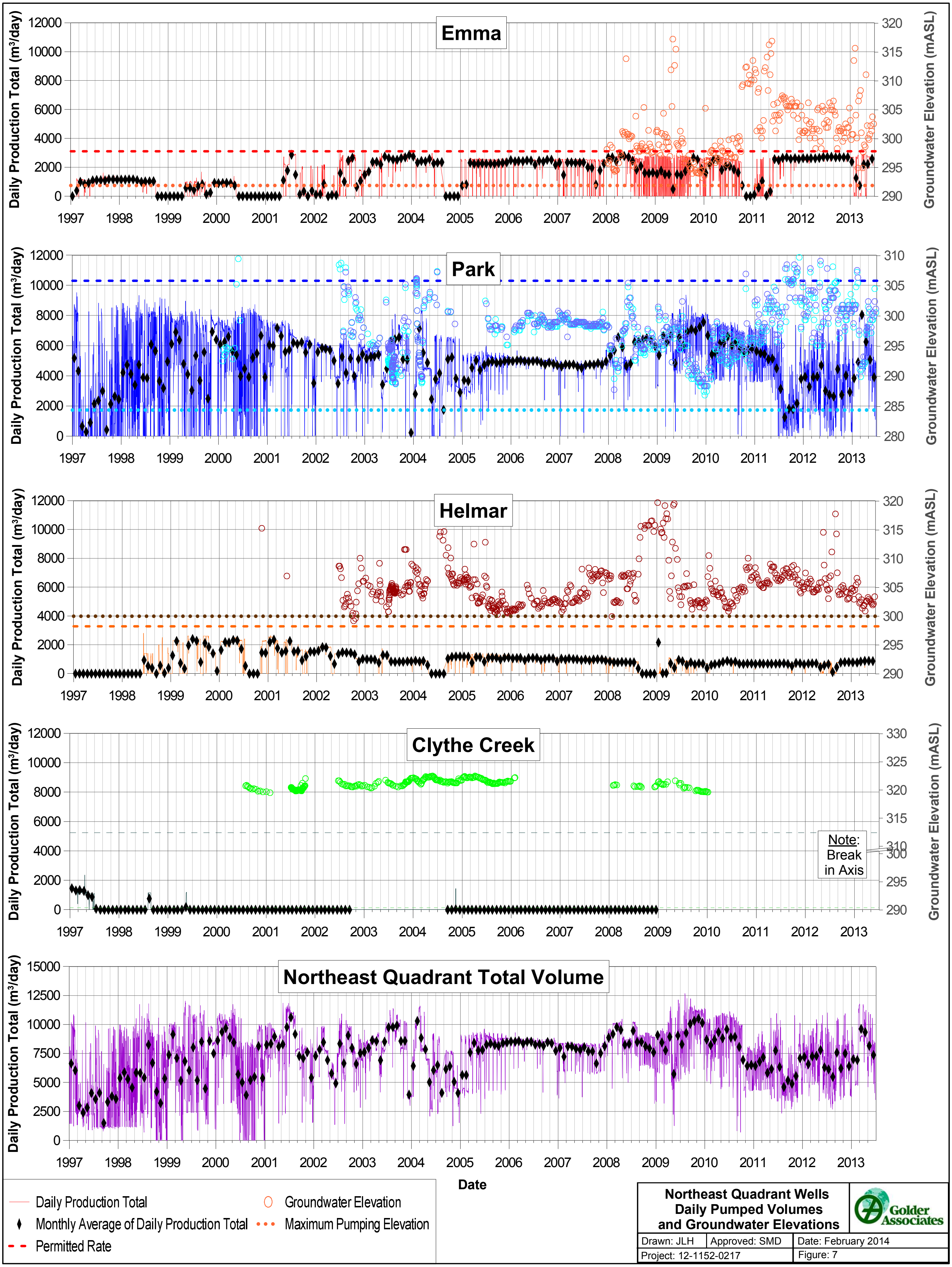
Southwest Quadrant Wells Daily Pumped Volumes and Groundwater Elevations

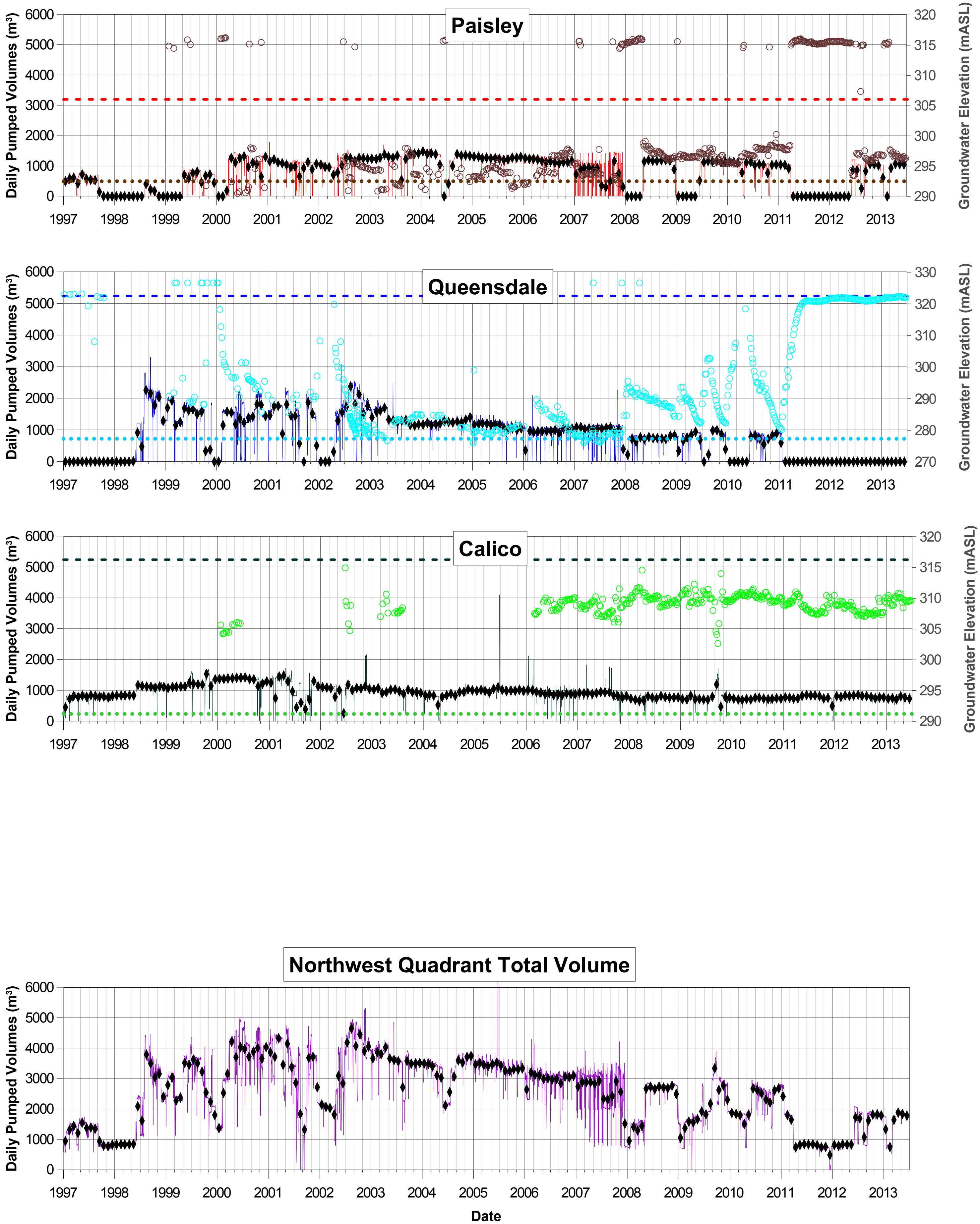
Golder Associates

Drawn: JLH	Approved: SMD	Date: February 2014
Project:12-1152-0217		Figure: 5



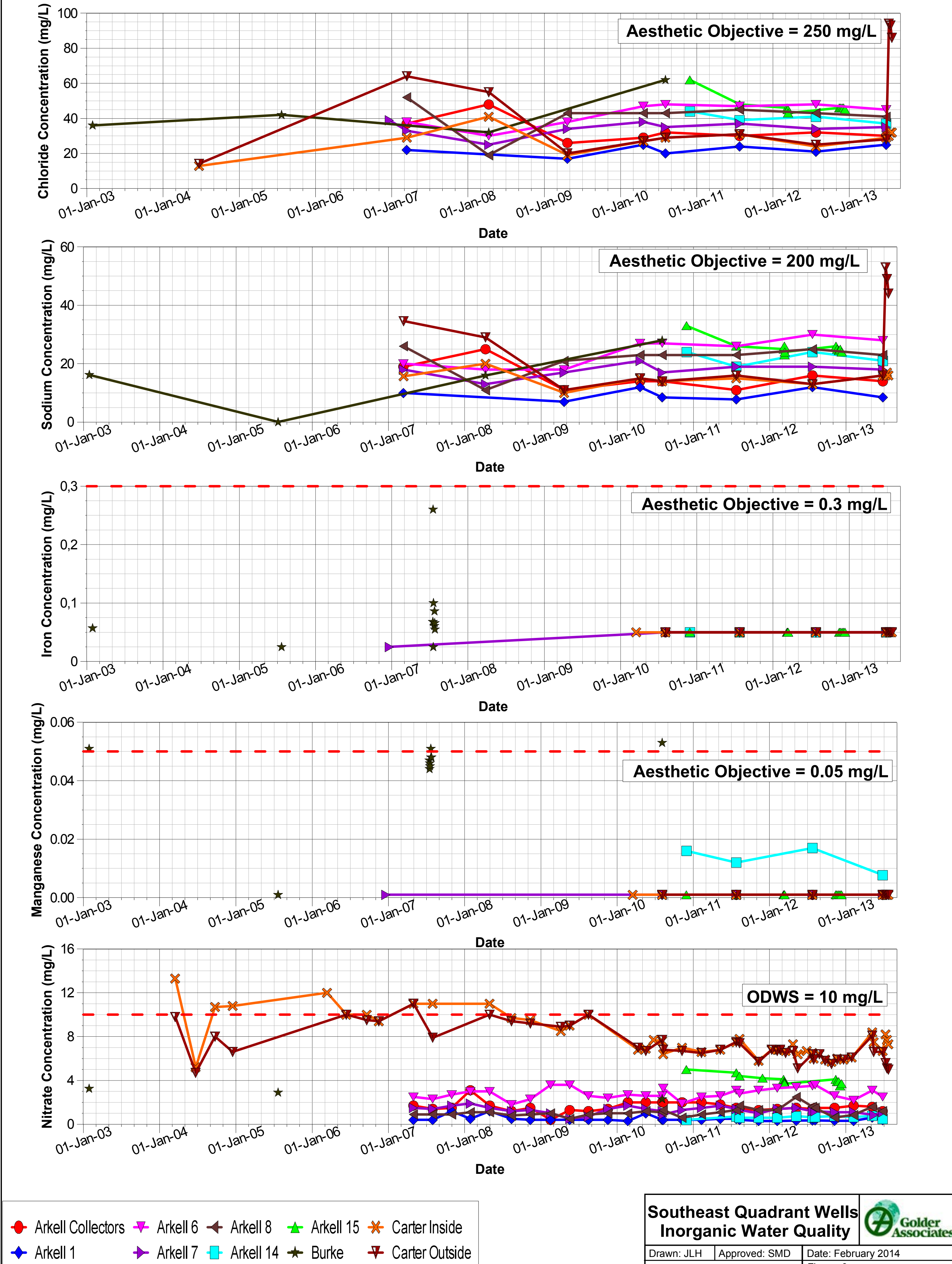
Southwest Quadrant Wells Daily Pumped Volumes and Groundwater Elevations		Golder Associates
Drawn: JLH	Approved: SMD	Date: February 2014
Project: 12-1152-0217		Figure: 6


Emma
Park
Helmar
Clythe Creek
Northeast Quadrant Total Volume
Daily Production Total (m³/day)
Groundwater Elevation (mASL)
Note: Break in Axis
Date
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Daily Production Total
Monthly Average of Daily Production Total
Permitted Rate
Groundwater Elevation
Maximum Pumping Elevation
Northeast Quadrant Wells Daily Pumped Volumes and Groundwater Elevations
Golder Associates
Drawn: JLH
Approved: SMD
Date: February 2014
Project: 12-1152-0217
Figure: 7



Daily Production Total
Monthly Average of Daily Production Total
Permitted Rate
Groundwater Elevation
Maximum Pumping Elevation

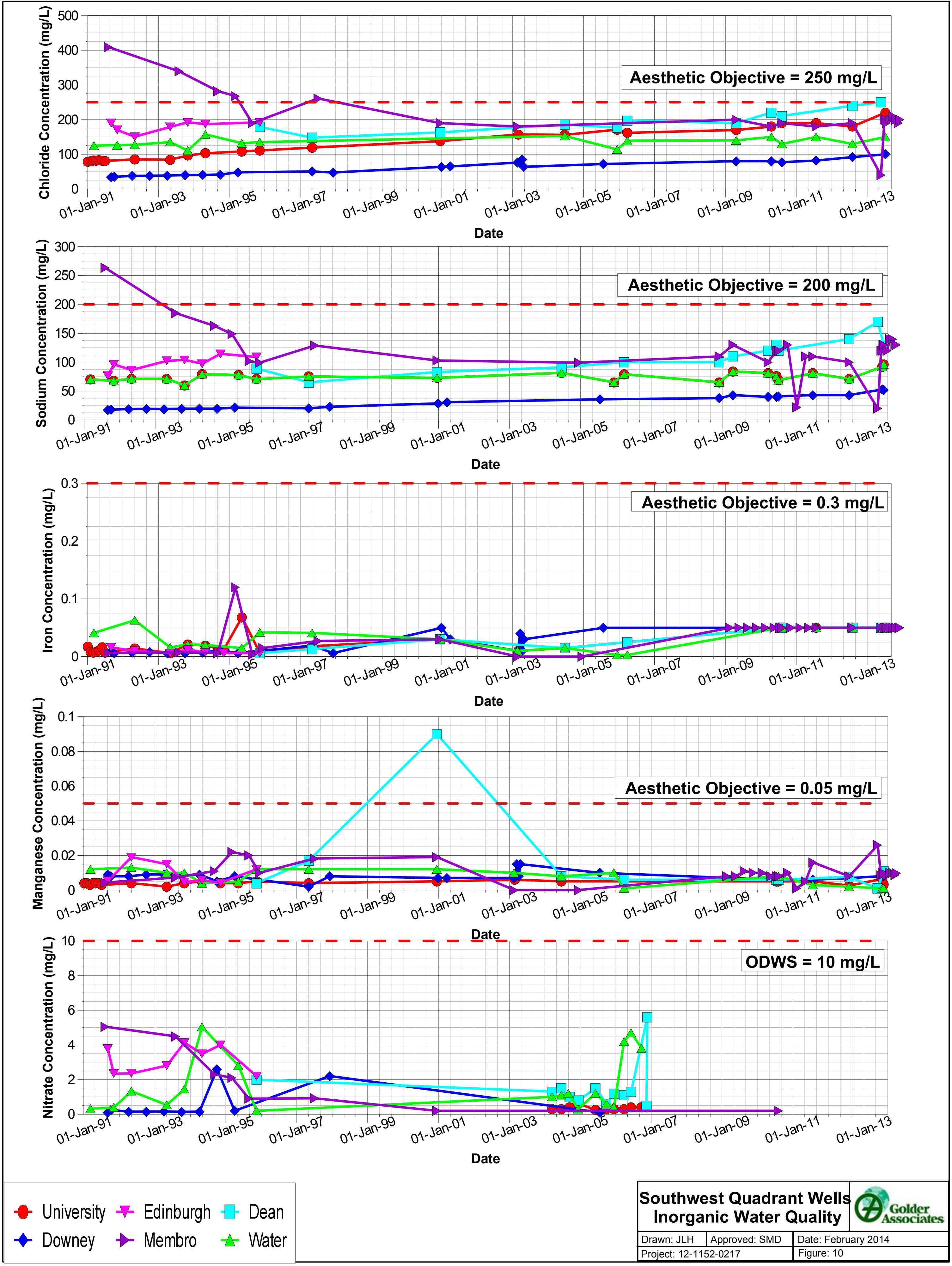
Northwest Quadrant Wells Daily Pumped Volumes and Groundwater Elevations		Golder Associates
Drawn: JLH	Approved: SMD	Date: February 2014
Project: 12-1152-0217		Figure: 8



Southeast Quadrant Wells Inorganic Water Quality

Golder Associates

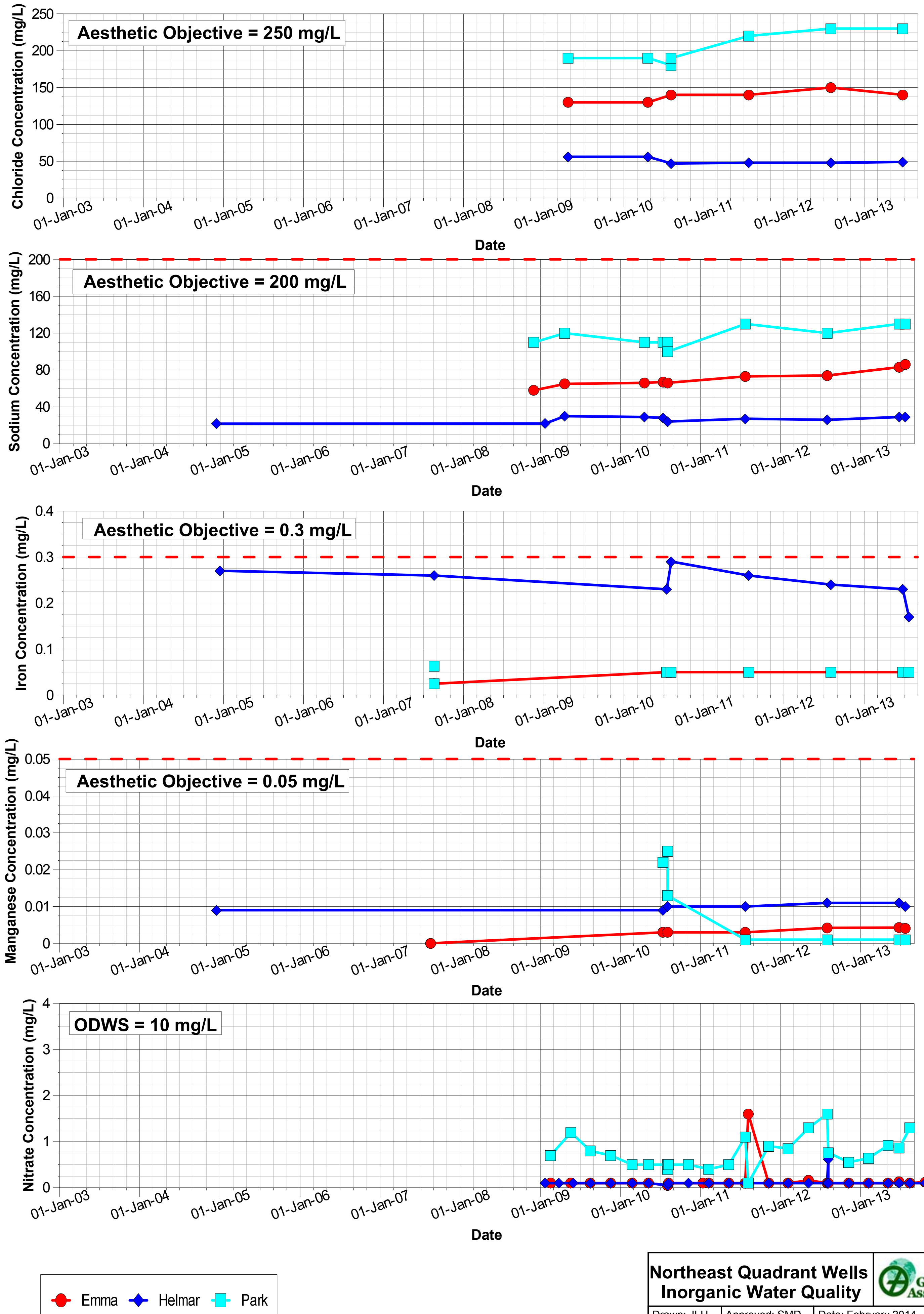
Drawn: JLH	Approved: SMD	Date: February 2014	
Project: 12-1152-0217		Figure: 9	



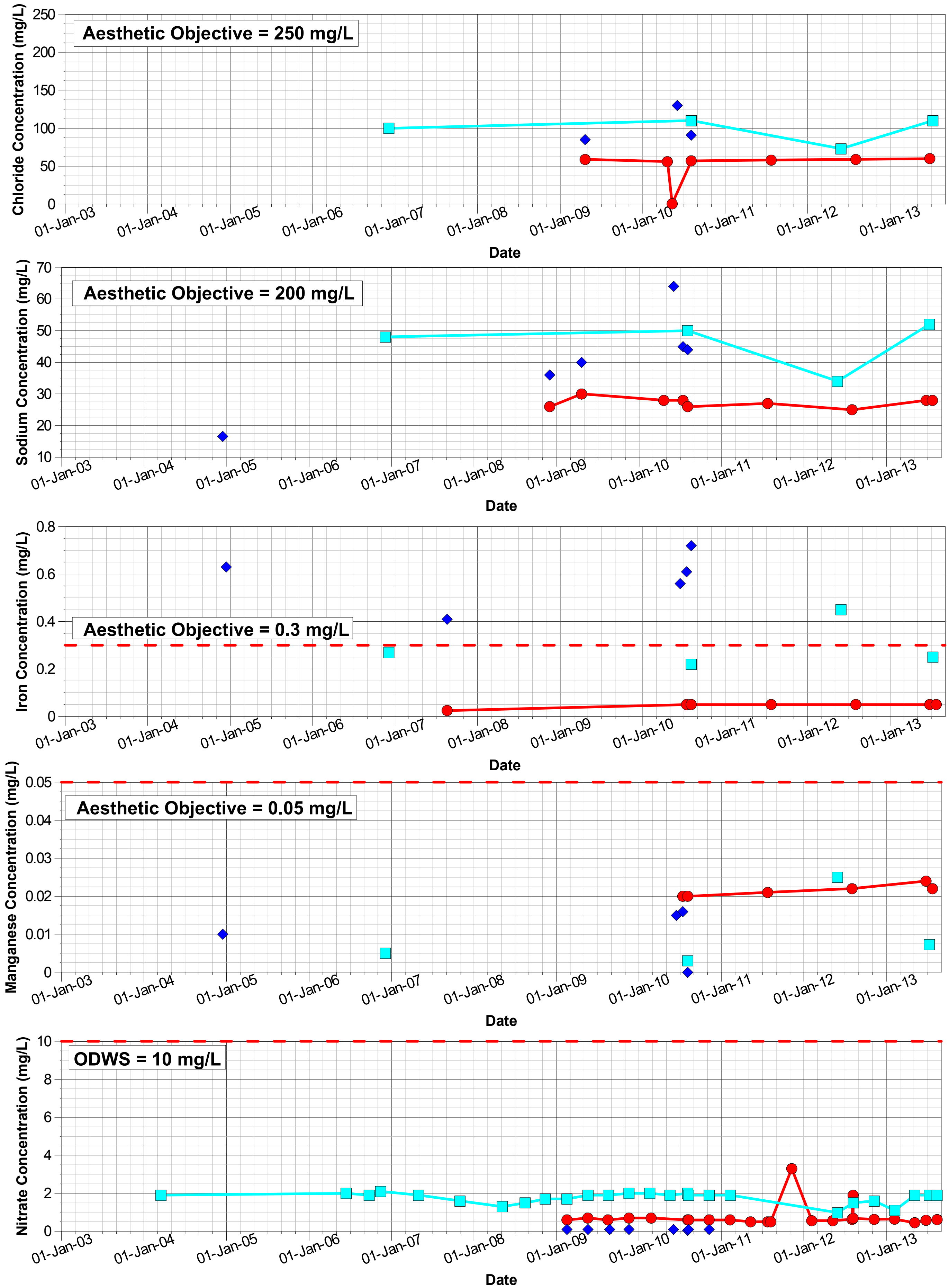
Southwest Quadrant Wells
Inorganic Water Quality

Golder Associates

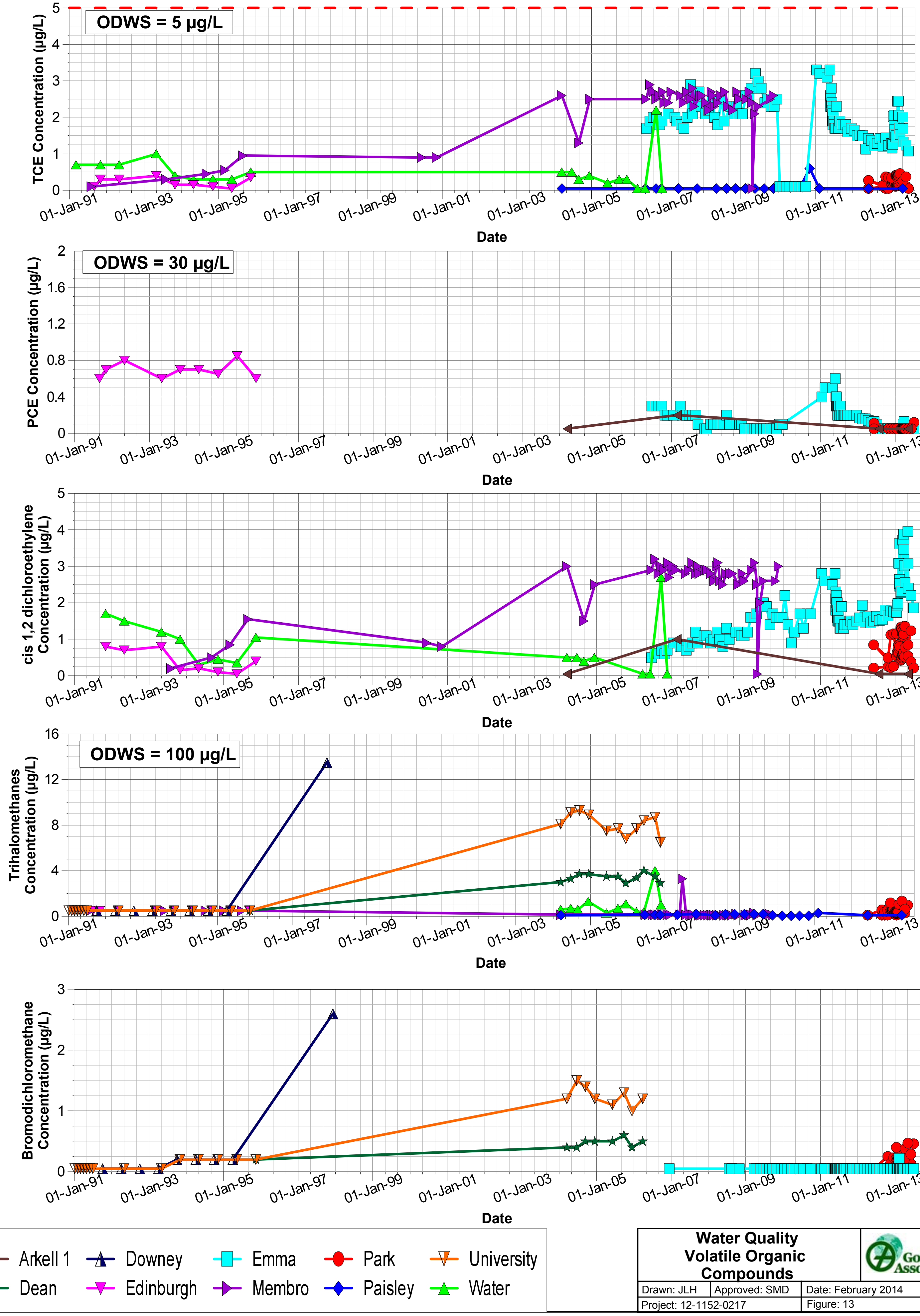
Drawn: JLH	Approved: SMD	Date: February 2014
Project: 12-1152-0217		Figure: 10



Northeast Quadrant Wells Inorganic Water Quality		Golder Associates
Drawn: JLH	Approved: SMD	Date: February 2014
Project: 12-1152-0217		Figure: 11



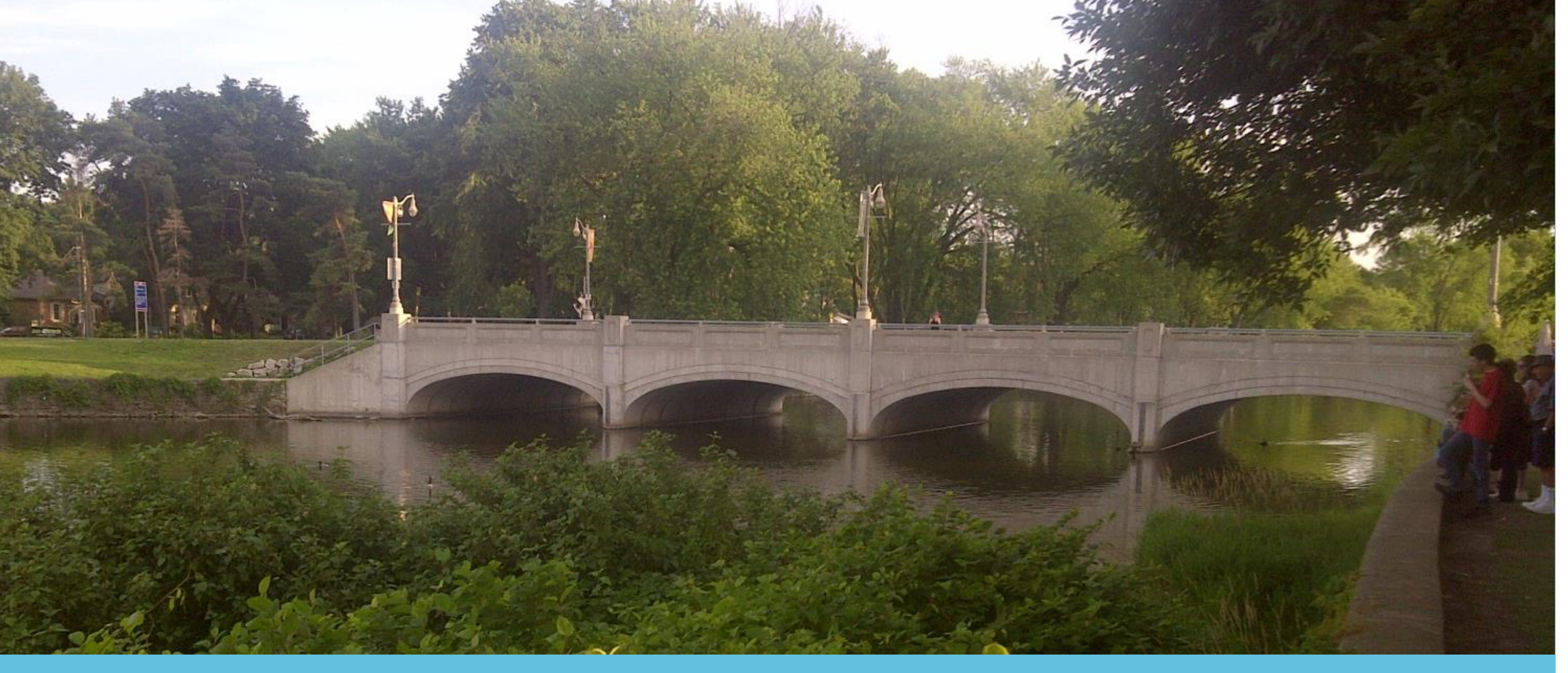
Northwest Quadrant Wells Inorganic Water Quality		Golder Associates
Drawn: JLH	Approved: SMD	Date: February 2014
Project: 12-1152-0217		Figure:12



Water Quality Volatile Organic Compounds		Golder Associates
Drawn: JLH	Approved: SMD	Date: February 2014
Project: 12-1152-0217		Figure: 13

Appendix D

Technical Memorandum 3
Review of Water Supply Alternatives



AECOM

Appendix D

City of Guelph Water Supply Master Plan Update (Draft Final Report)

Technical Memorandum No. 3 – Review of Water Supply Alternatives

Note: As per the Accessibility for Ontarians with Disabilities Act, this document is available in an alternate format by contacting Dave Belanger – City of Guelph (519-822-1260 Ext. 2186)

City of Guelph

Water Supply Master Plan Update Technical Memorandum No. 3: Water Supply Alternatives (Draft Final)

Prepared by:

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Kitchener, ON, Canada N2P 0A4 519.650.3424 fax
www.aecom.com

Project Number:

60287843

Date:

May, 2014

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- 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
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AECOM: 2012-01-06

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Appendix A. Assessing Effectiveness of Water Efficiency Strategy by Gauley Associates Ltd.
Appendix B. Utilizing Water Price Elasticity of Demand as an Instrument of Conservation by AECOM
Appendix C. District Metering Area Standard and City-wide Program Justification Technical Memorandum by C3 Water
Appendix D. Assessment of Groundwater Sources Inside/Outside the City (Draft) by Golder Associates
Appendix E. City of Guelph Long-term Water Supply Memorandum (Draft) by Grand River Conservation Authority
Appendix F. Memorandum on ASR Background Modelling (Draft) by Golder Associates
Appendix G. Natural Environment Considerations for Alternatives by AECOM

1. Water Supply Alternatives

1.1 Introduction

During early public consultation events of the Water Supply Master Plan (WSMP) Update, the list of potential water supply alternatives from the 2007 WSMP was reviewed and revised to reflect work completed by the City in the interim, as well as new information. The following alternatives were developed for consideration:

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

Through the master plan study completed in 2007, the above 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. 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 fresh public and stakeholder input.

The 2007 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. City Council provided direction in 2003 “That the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth”. This direction emphasizes the need for water supply to be sustainable. 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 proposed in the 2007 Plan but was considered to be unsustainable in the local context and City Council removed the pipeline alternative from the Plan. A Great Lakes pipeline alternative is <u>not</u> included in this Water Supply Master Plan Update.

The utmost importance was placed on water conservation and as a result, the City of Guelph has become a renowned leader in water conservation and demand management in Canada. Council has made this a priority by setting a goal “to use less energy and water per capita than any comparable Canadian city”. It is the aim of this update to document success achieved to date, and to determine reduction strategies and goals moving forward for comparison to other water supply alternatives.

Public feedback in 2007 demanded that the City first examine groundwater supply opportunities within the City’s boundaries in order to minimize potential impacts on its neighbors. Although groundwater flow does not respect geographic borders, impacts from pumping from aquifers result in potential local impacts on the natural environment and also on private and municipal wells in close proximity. 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:

- Completed construction of new well facilities (Arkell 14 and 15) and commencement of the Arkell Adaptive Management Plan and Operational Testing Program;
- Completed Class Environmental Assessment (EA) for the existing Burke Well facility;
- Commenced Class EA for the Guelph Southwest Quadrant Water Supply (on-going) which includes evaluation of existing supplies in that quadrant as well as new test wells; and,
- Completed treatability assessments of municipal wells which were previously taken off line due to water quality issues: Clythe, Smallfield and Sacco Wells.

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, including the Guelph South Groundwater Supply Investigation.

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 Tier 3 Water Budget and Local Area Risk Assessment is being 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., 2013). This study and the Tier 3 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 capacity and environmental perspective. (Note: The Tier 3 Project is scheduled to be completed in 2014.)
- The Guelph Drinking Water Source Protection Plan was developed within a watershed context to identify and evaluate potential threats to the municipal supply system. The City and other municipalities within the Grand River Watershed, through the Lake Erie Source Protection Authority, are currently developing policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants.

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 25 years. The water supply demand forecast and the existing water supply system capacity were determined in Technical Memoranda 1 and 2 respectively, concluding that under a "do nothing" scenario with continued growth, the City would require an additional capacity of 20,000 m^3/day to satisfy maximum day demand including an allowance for security of supply (approximately 10 to 15% of the total system capacity).

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.

1. Water conservation and demand management

It is anticipated that water conservation and demand management will continue to form part of the preferred water supply solution in the future. A number of 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. The details of the water conservation and efficiency strategy, including the preferred initiatives to be implemented to reach proposed targets will be further developed in the next Water Conservation and Efficiency Strategy (WCES) update. The water conservation scenarios explore the following:

a. Potential reduction through current water conservation program
b. Potential reduction through new initiatives
c. Costs associated with the above initiatives

Centralized re-use opportunities are also explored as a separate alternative for potable and non-potable consumption.

2. Groundwater sources inside and outside of the City

The groundwater supply alternatives considered in the 2007 WSMP are updated and re-organized to provide clarity between various stages of development of future potential supply sources. The following list represents all opportunities in the order of priority established in the original implementation plan.

a. Optimize existing municipal wells

b. Restore off-line municipal wells
c. Develop municipal test wells
d. Develop new wells inside the City
e. Develop new wells outside the City – a distance of 5 km from the City boundary was applied to meet the desire to maintain local sustainability

A computer-based, three- dimensional groundwater flow model, developed in the Tier 3 Project was used to review the total sustainable capacity from a natural environment perspective for all of the above alternatives operating concurrently. However, recognizing that there is no guarantee that all of these possible supplies may be developed, an estimate of additional local groundwater was determined to provide an opinion on the potential available groundwater supply before causing unacceptable stress to local watersheds.

In addition to the above sources, existing non-municipal wells are documented 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. <u>Local surface water sources</u>

Local surface water sources 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 extracting additional water during periods of high flows for treatment and storage to be accessed as required by demands in other times of the year. Storage would be accomplished by pumping through wells into the same aquifers that Guelph currently draws its water from – a technology referred to as aquifer storage and recovery (ASR).

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 the Township of Guelph-Eramosa. 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.

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 following:

4. <u>Limit community growth</u>; and,
5. <u>Do nothing.</u>

The following sections provide additional details, discussion on potential impacts, and summary of estimated capital and lifecycle costs for each of the water supply alternatives. Studies completed in development of the alternatives are appended. Lastly, a comparative evaluation is completed to provide recommendations regarding inclusion in the overall total solution with prioritization of each to include in a final implementation strategy.

1.2 Water Conservation and Demand Management/Reuse

1.2.1 Background

The City of Guelph has been actively implementing water conservation and efficiency programs and initiatives since completion of the *Water Conservation and Efficiency Study* (WCES) in 1999. Through the 2007 WSMP, water conservation was recognized as a preferred short term source of water supply. Recommendations included enhanced water conservation and efficiency, mitigation of distribution system water losses, and education/policy/rate based reviews. Sustainable growth potential in the City was contingent upon the success of aggressive water

conservation and efficiency programs to be implemented concurrently with optimization of the existing water supply system and the development of new groundwater supply sources. City Council approved the short and mid-term WSMP recommendations that included demand reduction through conservation, and also endorsed a goal through the City of Guelph 2007 Strategic Plan and Community Energy Plan to "use less energy and water per capita than any comparable Canadian city".

In the 2007 WSMP, the targets as set out in the original WCES (1999) were updated to the following:

- 10% reduction by 2010 (8,000 m^3/day)
- 15% reduction by 2017 (12,000 m^3/day)
- 20% reduction by 2025 (16,000 m^3/day)

The volumes calculated are based on the stated reductions to per capita consumption rates and applied to the future populations in the given years compared to the baseline projections at current demands.

In the 2007 WSMP, the intent was that these reductions would be applied to the future projected demands in the timeframes noted (based on current per capita consumption applied to predict future population). The challenge with measuring success of this strategy is that with updates to demand projections, the measured reductions are compared to a moving target.

In 2009 the City completed the Water Conservation and Efficiency Strategy Update (WCESU) which incorporated the targets set out in the 2007 WSMP by applying them to the total 2006 average day water use as follows:

- 10% reduction by 2010, based on 2006 average day water use (5,300 m^3/day)
- 15% reduction by 2017, based on 2006 average day water use (7,950 m^3/day)
- 20% reduction by 2025, based on 2006 average day water use (10,600 m^3/day)

This results in more aggressive targets than originally outlined in the WSMP as it assumes volume reductions directly from the 2006 demands.

The goal of the WCESU was to identify preferred programs, policy and resource alternatives to meet these goals over the planning period (2010 – 2019). These included the following 2009 recommendations:

Single Family Detached Residential Indoor Measures

- Provide rebates to residents who replace inefficient 13L toilets and install ultra-low flow toilets, high efficiency toilets or dual flush toilets.
- Provide rebates to residents who purchase and install water efficient clothes washers, water efficient central humidifiers and floor drain covers.
- Provide rebates to residents who install a grey water reuse system.
- Provide rebates to residents who install a rain water harvesting system.
- Visit homes and install free of charge low flow showerheads, low flow kitchen aerators and repair any water leaks while there.

Single Family Detached Residential Summer Demand Measures

- Provide rebates to residents who purchase and install watering timers.
- Visit homes and educate residents on how to maintain their lawns and water less and how to convert their properties to water efficient landscapes.
- Provide rebates or subsidized pricing for residents who purchase a rain barrel or larger water storage unit.

Multi-Family Residential Indoor Measures

- Provide rebates to building owners who purchase and install ultra-low flow toilets, high efficiency toilets or dual flush toilets.
- Provide rebates to building owners who purchase and install a water efficient clothes washer in their laundry rooms.
- Visit apartments and install free of charge low flow showerheads, low flow kitchen aerators and repair any water leaks while there.

Residential New Development Indoor Measures

- Provide rebates to builders who proactively purchase and install approved high efficiency toilets or dual flush toilets, low flow showerheads and low flow kitchen faucets at the time of new home construction.
- Provide rebates to builders who purchase and install water efficient clothes washers, water efficient central humidifiers and floor drain covers at the time of new home construction.
- Provide rebates to builders who install a grey water reuse system at the time of new home construction.
- Provide rebates to builders who install a rain water harvesting system at the time of new home construction.

Residential New Development Summer Demand Measures

- Provide rebates to builders who install watering timers.
- Provide rebates to builders who install water efficient landscapes as part of new home construction.

Industrial/Commercial/Institutional Measures

- Provide rebates to facilities who replace inefficient 13L toilets with ultra-low flow toilets, high efficiency toilets or dual flush toilets.
- Provide rebates to local businesses who purchase and install a water efficient clothes washer in their operations.
- Visit commercial kitchens and install free of charge low flow pre-rinse spray valves.
- Complete ten comprehensive water audits per year and offer a capacity buy-back rebate to any facility that implements all or some of the water saving recommendations.

Municipal Measures

- Design and implement five (5) district meter areas per year for three years. Locate, quantify and repair the leakage within the water distribution system.
- Complete Property Water Use Audits of existing municipal buildings and implement water efficiency retrofits and public demonstration projects.

Public Education

- Distribution of booklets, leaflets, and fact sheets at home shows and community and environmental events.
- Distribution of a water efficiency bulletin in the water bills.
- Displays at home shows, fairs and community events.
- Newspaper articles and advertisements.
- Develop and maintain a website to educate the public on water efficiency.
- Provide workshops and seminars to the public on water saving techniques both inside and outside the home.
- Provide water efficient demonstration gardens for the public to visit and learn.

Youth Education

- Develop and deliver a water efficiency education program based on the Ontario curriculum requirements.

- Continue annual participation in the Waterloo Wellington Children's Groundwater Festival.

Policy Based Recommendations (requiring Council approval)

- That the time based average day water reduction goals of the City's Water Supply Master Plan be formally endorsed as;
  - 10% reduction (5,300 m^3/day) by 2010, based on 2006 average day water use;
  - 15% reduction (7,950 m^3/day) by 2017, based on 2006 average day water use, and;
  - 20% reduction (10,600 m^3/day) by 2025, based on 2006 average day water use;
- That the City adopt a water reduction philosophy of maintaining average day water production below the 2006 value (53,000 m^3/day) for a 5 year period (2014).
- That the City of Guelph continue operation of the City's Outside Water Use Program in efforts to reduce impacts of Peak Seasonal Demands.
- That the City form a long standing Water Conservation and Efficiency Advisory Committee for purpose of ongoing public consultation throughout the implementation of the 2009 Water Conservation and Efficiency Strategy Update with an appropriate mandate and charter to be developed for the Committee.
- That the City in partnership with the Region of Waterloo continue performance testing research of home water softener technologies and promote through a public educational program technology performance results and related environmental benefits of preferred technologies.
- That the City's Wastewater Effluent Re-use dedicated pipe project, commonly referred to as the "Purple Pipe" project, and Class Environmental Assessment, as approved by Council through the 2008 Guelph Water/Wastewater Master Servicing Plan, evaluate the further potential for a communal wastewater effluent reuse system and design practices for customer serving of the effluent reuse source.
- That the City undertake a feasibility study to evaluate the best practices for multi-unit residential water metering and private servicing condition assessment requirements for current bulk metered multi-unit residential customers.
- That the City's Strategic Urban Forest Management Plan and the Natural Heritage Strategy define the appropriate means for protection and preservation of the City's urban forest in recognition of water conservation and storm water management benefits provided by the urban canopy.
- That staff undertake the immediate development of an enhanced public education water conservation program in 2009 subject to the availability of program funding.
- That staff initiate water loss mitigation activities in 2009 as outlined in the City's Water Loss Mitigation Strategy and investigate the potential for improved water pressure management in distribution system.
- That the City's Waterworks Department undertakes a pilot study as part of the City's 2009 Water Loss Mitigation Strategy to evaluate the local implementation of Automated Metering Infrastructure (AMI) for customer water metering.
- That the City's Water/Wastewater Rate Review define customer billing policies for properties possessing Rain Water Harvesting Systems.
- That staff pursue external funding sources, and key partnerships, throughout implementation of the Water Conservation and Efficiency Strategy Update program recommendations.
- That Guelph's Water Conservation and Efficiency Programs be extended to customers located outside the Guelph Municipal boundary whom are individually metered by the City.

This strategy identified achievable versus potential water savings with comparison to the overall targets and predicted that the goals as identified above were attainable. The City will update the current WCESU on a regular basis to track progress and ensure programs are cost effective.

1.2.2 Approach

It is not the intent of this WSMP Update to revisit the program details of the WCESU, but to develop conservation scenarios with varying levels of reduction in demand and corresponding implementation costs for comparison to other water supply alternatives. Through the 2007 WSMP, clear direction was provided by Guelph residents regarding the need for aggressive water conservation targets and the City has successfully moved ahead with the WCESU implementation strategy. The objective of this update is to evaluate conservation scenarios in order to provide recommendations for future programming.

Success of the water conservation and efficiency measures implemented to date are documented in Technical Memorandum 1 which describes the direct water savings associated with individual programs. A review of current initiatives was also completed in January 2014 (Gauley Associates Ltd., 2014) which accounted for reductions in residential, industrial, commercial and institutional sectors from 2006 to 2012 in terms of natural, direct and indirect savings by comparison to future projections based on 2006 per capita demands, attached in **Appendix A**. This study provides input into developing future alternatives strategies for conservation programs.

Options for consideration range from 'do nothing', i.e. no future conservation efforts, to a 'soft path' approach which would incorporate a vision such as using the same total volume of water in future that is used today. In reality, while a 'do nothing' scenario would not incorporate further water conservation or demand management programs, natural savings would occur regardless as a function of changes in the 2014 Ontario Building Code which have mandated more efficient plumbing fixtures. Nevertheless, a do nothing water conservation scenario does not fit with Council's direction, in that the availability of local water supplies has a finite value which would result in no growth once this future limit has been reached. Nor would the City achieve its goal to "use less energy and water per capita than any comparable Canadian city".

The 'soft path' approach to water management represents a fundamental shift from the traditional supply oriented approach (http://poliswaterproject.org/conservation). It recognizes the limitations of water as a resource, and focuses on water conservation and efficiency to ensure long term sustainability. This vision setting approach challenges a community to undertake a number of conservation practices across all sectors to achieve the future water demand target. This water soft path approach was piloted locally and documented in *The Soft Path Strategy for Fergus-Elora* (Mass & Porter-Bopp, 2011) wherein two possible targets were considered with reference to 2008 demands:

- a long term target of "Using the Same Water Tomorrow We Use Today" (i.e. Soft Path Scenario) which would require a reduction in maximum day demand (MDD) of 38% by 2028 and 51% by 2040; and,
- an interim target of avoiding infrastructure expansion which would require a reduction in MDD of 14% by 2028 and 17% by 2040.

The necessary reductions to achieve these targets were reviewed by sector to determine what water practices would be required.

The City of Guelph is known as one of the most proactive communities in Canada with respect to water conservation having implemented a wide variety of water conservation programs across all sectors since 1999. Comparison to other similar Canadian cities included in the National Water and Wastewater Benchmarking Initiative (NWWBI) indicates that Guelph has already achieved low per capita residential consumption, as shown in **Figure 1** Comparison of Residential Per Capita Demand with Comparator Municipalities

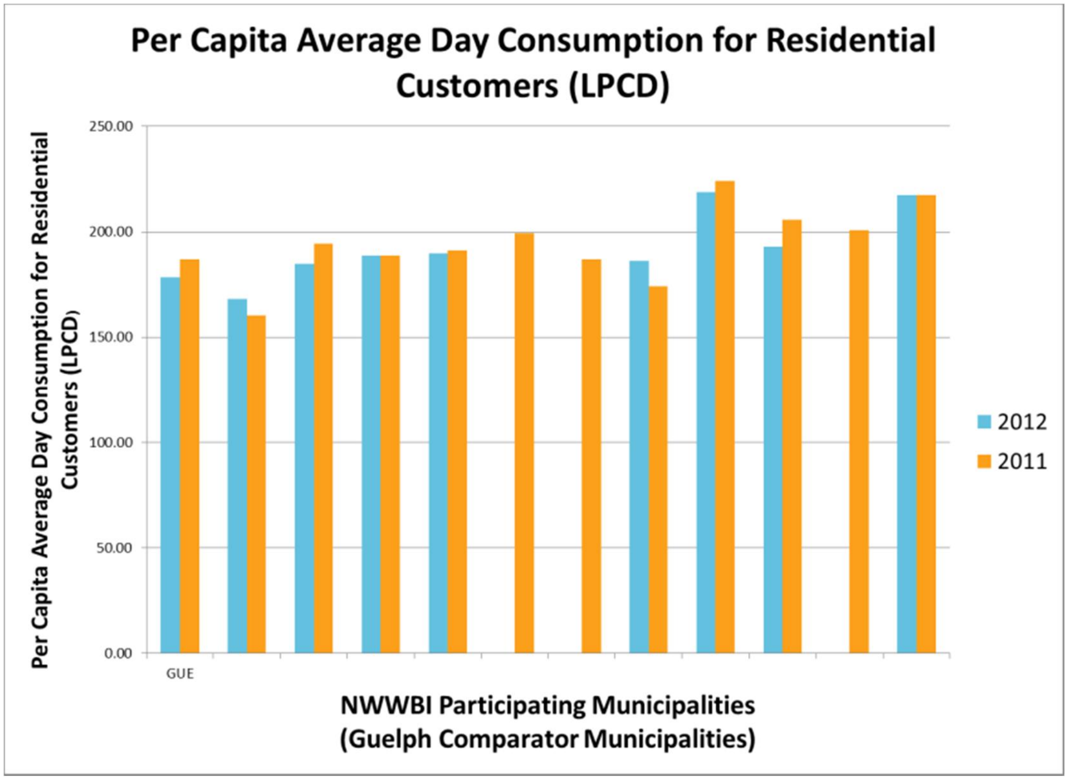


Figure 1 Comparison of Residential Per Capita Demand with Comparator Municipalities

Through its programs to date, the City is already well down the road to achieving success. With Council's 2003 mandate to establish a sustainable water supply to regulate future growth, the vision of local sustainability with respect to water supply has long been embraced by its residents. Future studies will establish how much of this local supply is achievable without impacting the natural environment, after which any future development will only be possible by reductions in demand and/or re-use options. These are presented herein for comparison to other supply options.

In the interim, the City continues to implement water conservation programs to reduce demands within a Council approved cost-benefit framework that is compares the cost to implement water reduction programs to the cost for developing new municipal water supplies, with consideration for the added benefits of also deferring wastewater treatment infrastructure and incurring energy savings. However, similar to the increase in cost of water supply options which incorporate higher treatment systems, with decreasing demands it becomes more difficult and more costly to continue to effectively reduce demands further.

In investigating future reduction scenarios and their associated costs, the City's water conservation staff reviewed the maximum potential of current programs, as well as potential for future additional programs. Five scenarios were developed as follows, which consist of a combination of the programs listed in **Table 1**:

- Scenario 1 - Current WCESU Approved Programming, with implementation by 2025
- Scenario 2 - All Alternatives
- Scenario 3 - All Alternatives minus Pressure Management
- Scenario 4 - All Alternatives minus Pressure Management and Rate Reform
- Scenario 5 - All Alternatives minus Pressure Management, Rate Reform and potential Local Improvement Charges (LIC) Funded Programs

Table 1 Water Conservation Scenarios

Program Alternatives	Sector	Scenario				
		1	2	3	4	5
Current Retrofits Incentive Program Model - Single Family Toilets	RES	x	x	x	x	x
Current Retrofits Incentive Program Model - Multi Family Toilets	RES	x	x	x	x	x
Current Retrofits Incentive Program Model - Clothes Washers	RES	x	x	x	x	x
New Retrofit Incentive Program - Hot Water Recirculation	RES		x	x	x	x
New Retrofit Incentive Program - Water Softener	RES		x	x	x	x
New Retrofit Wholesale Program Model- Multi-res Toilets	RES		x	x	x	x
New Retrofit Wholesale Program Model- Multi-res Toilet Flapper	RES		x	x	x	x
New Retrofit LIC Program Model - Toilets	RES		x	x	x	
New Retrofit LIC Program Model - Hot Water Recirculation	RES		x	x	x	
New Retrofit LIC Program Model - Water Softener	RES		x	x	x	
Water Conservation Rates - Planning Rate Increase Response Guelph 2014 LRFP	RES	x				
Water Conservation Rates - Increasing Block Rate Implementation	RES		x	x		
Building Code Improvements	RES	x	x	x	x	x
Active Water Loss Management - DMAs	NRW	x	x	x	x	x
Advanced Water Loss Management - Pressure Management	NRW		x			
ICI Audits and Capital Retrofit Incentives	ICI	x	x	x	x	x
ICI Peak Demand Management - Cooling Tower/Chiller Retrofit Incentives	ICI		x	x	x	x
Home Audit and Retrofit Program	RES		x	x	x	x
Private Side Leak Reduction: Res Sector AMI Implementation	RES		x	x	x	x
Blue Built Home - New Home Water Efficiency Certification	RES	x	x	x	x	x

Notes:

RES – Residential

ICI – Industrial, Commercial and Institutional

DMA – District Metering Areas

NRW – Non-Revenue Water

AMI – Automated Metering Infrastructure

It is noted that the first Scenario represents the continuation of the current Water Conservation and Efficiency Strategy until program implementation is in alignment with the term of the strategy and saturation of some program offerings, including the following:

- Current retrofit programs - residential toilets and clothes washers, ICI audits and capital incentives
- Blue Built Homes – New Home Water Efficiency Certification
- Active Water Loss Management – continuation of the District Metering Areas (DMAs) to monitor and address identified distribution system leaks
- Demand Elasticity – natural customer demand response to water rate increases
- Building Code improvements

Scenario 2 includes conservation and demand reduction strategies effectively implemented in North American communities currently which have been deemed to be applicable to the City of Guelph. In addition to the programs which make up Scenario 1, these also include the following:

- New Retrofit Incentive Program - hot water recirculation; water softeners,

- New Retrofit Wholesale Program Model- multi-res toilets and toilet flapper
- New Retrofit LIC Program Model – toilets; hot water recirculation; water softeners
- Water Conservation Rates - Increasing Block Rate Implementation
- Advanced Water Loss Management - Pressure Management
- ICI Peak Demand Management - Cooling Tower/Chiller Efficiency Retrofit Incentives
- Private Side Leak Reduction: Residential Sector AMI Implementation

Scenarios 3, 4 and 5 consist of versions of Scenario 2 without programs that have uncertain confidence of success for various reasons:

- Pressure Management – the uncertainty of implementing pressure management in Guelph's open pressure distribution system complicated by multiple well supplies requiring unimpeded transmission is incorporated into the above assumptions and reflected in high costs to implement with minimal success.
- Rate Reform – while this would seem to be a reliable demand management program at minimal cost to implement, local community and political support would need to be attained.
- Local Improvement Charges (LIC) Funded Programs – programs subject to legal review of eligibility of water efficiency based retrofits following recent changes to the scope of Local Improvement Charges under the Municipal Act.

As indicated above, the development of scenarios based on a number of possible initiatives was completed solely for the purpose of evaluating the cost and feasibility of various target reductions. The actual programs would be established through the Water Conservation and Efficiency Strategy update, and may consider additional opportunities not included here such as decentralized re-use/rainwater capture systems and bulk water treatment/ distribution systems. Centralized re-use options are discussed further in the following section.

The predicted reductions in demands for the initiatives included in each Scenario over the period of this study update include the following assumptions derived from a number of sources including the following:

- Alliance for Water Efficiency Calculator - 2012 City of Guelph Model
- Region of Waterloo Draft Water Efficiency Master Plan (2013)
- UBrock/Econnics Demand Preliminary Demand Elasticity Study (2013)
- AECOM Impact of Price Analysis Technical Memorandum (2014) Appendix B
- 2014 Ontario Building Code
- District Metering Areas Standard and City-wide Program Justification Technical Memorandum (C3 Water Inc., 2014) – Appendix D

A summary of potential savings for each scenario is indicated in **Table 2**.

Table 2 Summary of Potential Savings for Each Scenario

Scenario	Total Potential Savings (m^3/day)	Implementation Period	Direct Program Costs	Total O&M Costs	Total Program Cost for Period	Capital Cost per m^3/day	LCC - Cost per m^3 avoided
Scenario 1	5,556	2014 to 2025	$5,685,930	$10,217,564	$15,903,494	$1,023	$0.65
Scenario 2	9,842	2014 to 2038	$43,767,600	$23,880,972	$67,648,572	$4,447	$0.75
Scenario 3	9,690	2014 to 2038	$24,597,600	$23,880,972	$48,478,572	$2,539	$0.55
Scenario 4	8,448	2014 to 2038	$23,097,600	$23,880,972	$46,978,572	$2,734	$0.61
Scenario 5	7,419	2014 to 2038	$22,553,100	$23,880,972	$46,434,072	$3,040	$0.69

1.2.3 Centralized Re-Use Alternatives

The above scenarios do not include any programs related to Wastewater Reuse and Reclamation. Although pilot studies have been implemented for individual systems for grey water with City funding, it is generally accepted that significant reductions from reclaim and re-use options will only be achieved through centralized facilities. Wastewater reclamation involves the treatment or processing of wastewater to make it reusable and water reuse is the beneficial use of the treated water. Water reclamation and reuse has great potential to be an effective, efficient, sustainable way to meet water demands. While separate from water conservation, reuse/reclamation alternatives could be reviewed and implemented under the purview of the Water Conservation initiative through implementation or enforcement in new developments.

There are two options for centralized re- use or reclaimed water:

- Treatment to non-potable standards for landscaping irrigation and other non-potable uses through a dual plumbing system,
- Treatment to potable standards for use in the distribution system

Each of these options has considerable challenges. Reclaimed water is wastewater (sewage) that is treated to the required quality dictated by the end use. Potable treatment requirements are considerably more than non-potable, and are also typically more advanced than typical surface water treatment requirements. Non-potable treatment requirements are less extensive although still require high standards with respect to safety as the water may still come into public contact. However, the non-potable option requires an independent recycled water system which conveys the treated non-potable water to end-uses such as irrigation or industrial cooling. In the City's Water and Wastewater System Optimization Master Plan, recommendations included installation of a 'purple pipe' for this application to be installed during upgrades to the York Trunk sewer and Wellington watermain installation. However, through the Class EA completed for this project, Council did not approve installation or a future easement allowance for the purple pipe due to current uncertainties with respect to future regulatory requirements and capital costs of this current unfunded/ un-established City utility. The rationale for not implementing this project at this time can be found in the York Trunk Sewer & Paisley Feedermain Municipal Class EA Tech Memo: Effluent Re-use System "Purple Pipe System" (Genivar, 2012).

Typically, communities that have implemented recycled water have more limited access to fresh water supplies. In the U.S. California and Florida have progressive reclaimed water programs for non-potable uses such as landscape irrigation with extensive recycle water systems. Using reclaimed water for non-potable uses reduces the demand for potable water. The cost of reclaimed water is typically higher than the cost to treat potable water; however, as fresh water supplies become limited, the cost ratios will change accordingly.

There is debate about possible health and environmental effects of reclaimed water use including pathogens. In general, treatment of reclaimed water to drinking water standards uses technologies such as reverse osmosis to ensure that pathogens, pharmaceutical chemicals and other trace chemicals (that would pass through standard treatment and filtering processes) are removed. Drinking water standards that were developed for natural ground water and surface water are not sufficient for identifying contaminants in reclaimed water.

As world populations require both more clean water and better ways to dispose of wastewater, it is anticipated that the demand for water reclamation will increase. Future success in water reuse will depend on whether this can be done without adverse effects on human health and the environment. Leading countries in the field of reclaimed water or non-potable use currently include Israel, Japan, Australia, U.S., Spain, and the United Kingdom. There are fewer countries providing potable water from reclaimed water; one example includes Singapore which has implemented reverse osmosis systems to produce potable 'NEWater' from reclaimed water; another example is South Korea. The

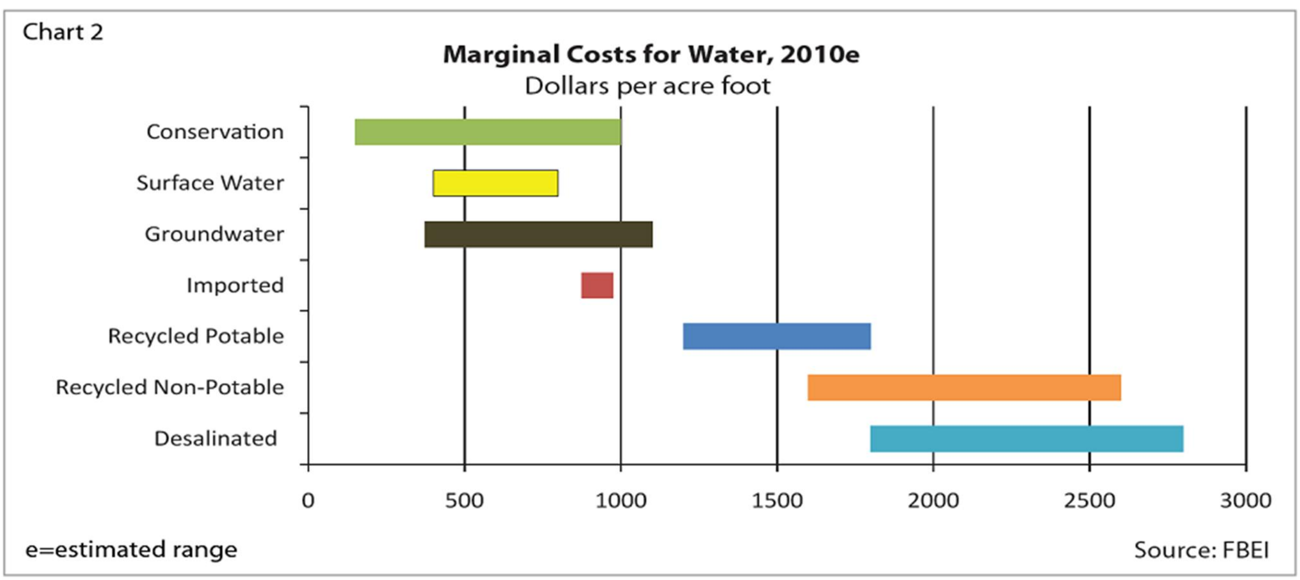
ability to readily dispose of the treatment residuals to the sea, which can be 50% of the raw influent flow, provides a significant advantage from a cost perspective.

It is generally understood that to move these options forward, the regulatory framework must provide direction, and there must be increased public confidence in water reuse. For water reuse to grow as a feasible water supply option, a number of technical, environmental, and socioeconomic issues need to be addressed. These include:

- Integrating reuse into water resource planning and projections
- Determining the effects of water reuse on water quality
- Determining the effects on public and environmental health
- Improving public perception and gaining public acceptance
- Development of appropriate standards
- Economic feasibility of water reuse
- Justifying the intensive energy consumed to treat

The actual cost of a reclaim facility varies depending on the system-specific characteristics and configuration. As current potable water systems are based on investments in distribution systems that were often made decades ago, the cost of delivering reclaimed non-potable water supplies often results in water that at least as expensive to provide as potable water alternatives, if not more. If reclaimed water rates are designed to provide full cost recovery then the average unit cost for reclaimed water will usually be higher than that of comparable potable water supply; however, the public typically views reclaimed it has having lower value, providing little incentive for reclaim water use. Therefore, it can be a challenge for effluent reclaim/reuse to find an end user (e.g. irrigation), preferable with a year-round need.

A study completed to review possible water supply options for the City of San Diego provided comparative cost estimates between various sources (Fermanian Business & Economic Institute, 2010), as shown in **Figure 2**. Note that the conversion from acre foot to m^3 is 1233.5. The ranges of costs shown in this table for surface water and groundwater options are comparable to those being reviewed for Guelph within this study.



Source: (Fermanian Business & Economic Institute, 2010)

Figure 2 Cost Comparison for San Diego Water Source Options

Generally, due to the considerable challenges associated with the centralized re-use alternatives, these options are not implemented where there are alternative sources of fresh water as the costs are prohibitive. However, as

increasingly advanced treatment is required for wastewater to meet discharge requirements in future, these alternatives become more attractive. In addition, it is expected that this eventuality will correspond to decreasing availability of local groundwater and surface water. While not considered as part of the conservation option in the 25 year study period, opportunities to incorporate reuse into future developments (e.g. purple pipe; dual plumbing systems) should be reviewed with a long term view to ensure its feasibility.

1.2.4 Water Conservation Summary

The impact of applying the range of proposed conservation scenarios to the predicted water demand over the 25 Master Plan update study period is demonstrated by applying the estimated reductions associated with Scenarios 1 (status quo) and 2 (high) to the average total demand in year 2038. This results in a change in the rate of change over time, which is duplicated when multiplied by the maximum day factor of 1.5.

In **Figure 3**, it is observed that the range in scenarios depicted provides a significant reduction in the future supply requirements. It is also of note that the costs presented on a per capacity basis only reference the average day demand reductions associated with each scenario. When compared to the water supply alternatives, this is not presenting an equal assessment.

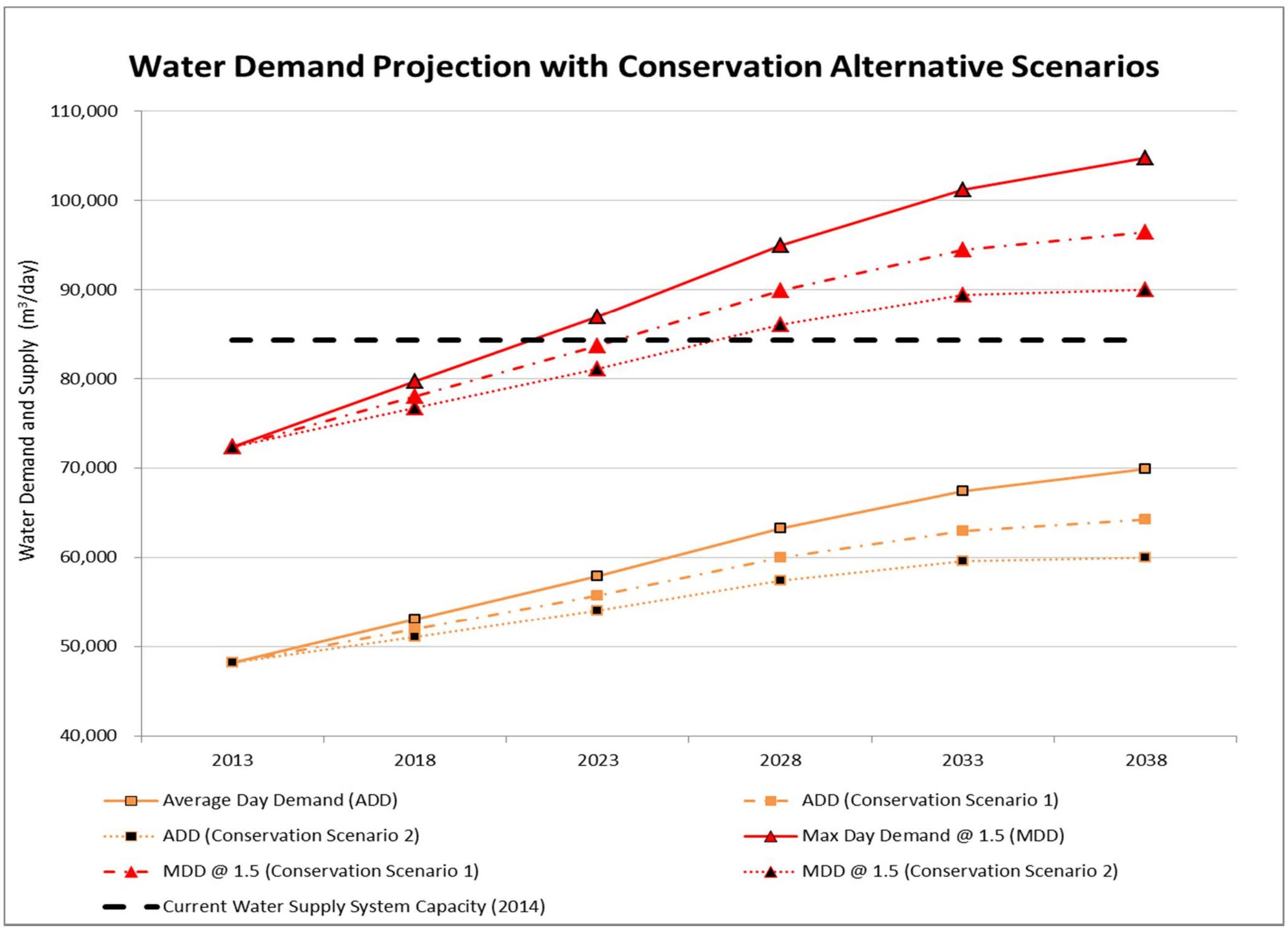


Figure 3 Water Demand Projection with Conservation Alternative Scenarios

1.3 Expand Existing Groundwater System

The City's groundwater supply system consists of 24 wells constructed within overburden, shallow and deep bedrock aquifers and one active groundwater collection system (the Glen Collector). The locations of these groundwater supplies as organized in four quadrants: Southeast, Southwest, Northeast and Northwest are shown on **Figure 4**.

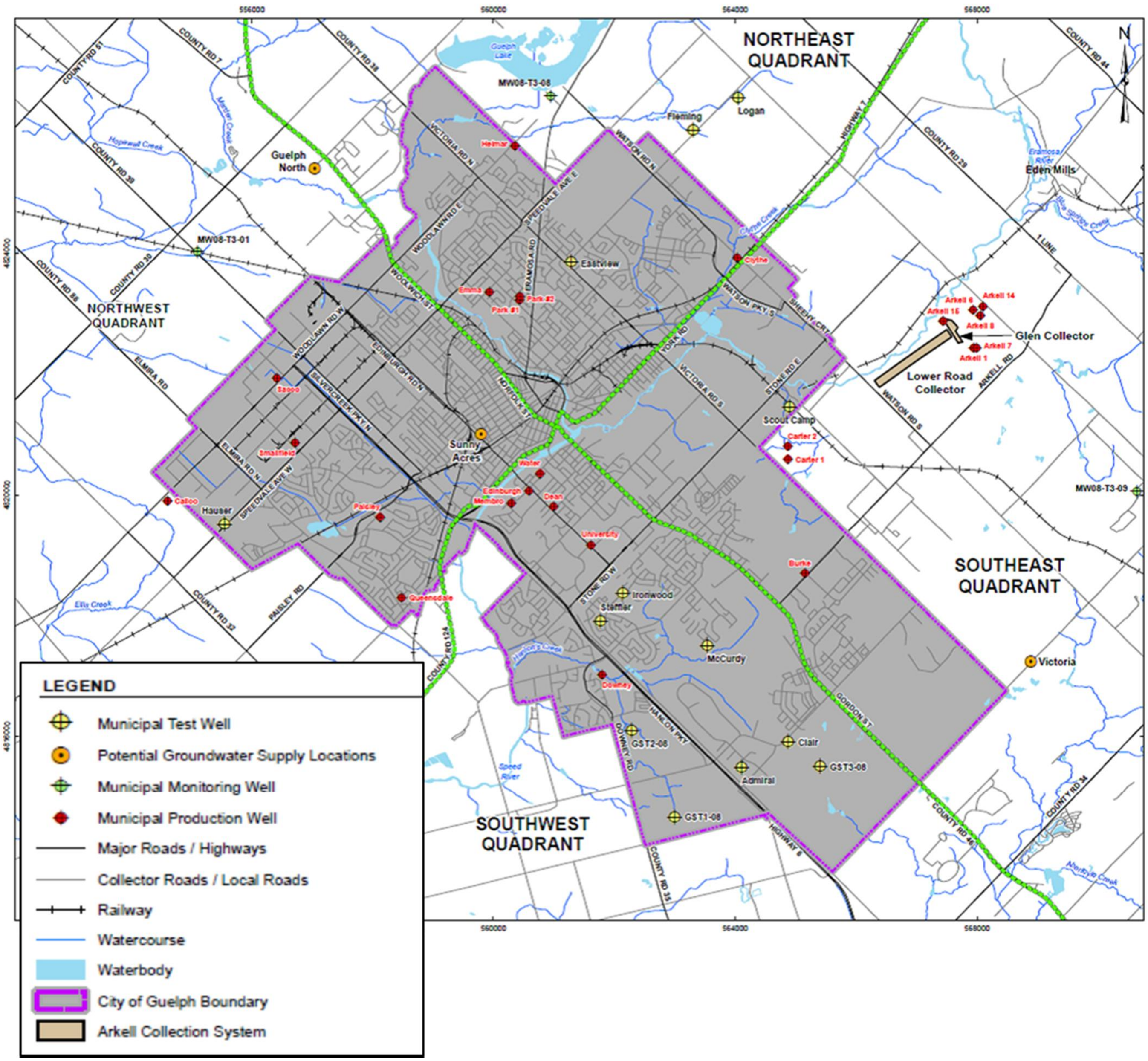
The approach undertaken in investigating opportunities for optimizing existing wells and developing new groundwater sources followed the direction provided through the consultation process in the 2007 WSMP. Public response clearly indicated that the City should consider groundwater opportunities within the City boundaries prior to exploring outside. This direction was reflected in the prioritization given to projects in the 2007 WSMP implementation plan. In updating the review of groundwater alternatives, this is factored into the approach. As noted in the 2007 WSMP, the development of new water supply sources in the Townships would require the concurrence of the Townships and the County of Wellington.

Furthermore, with use of the updated Tier 3 model, the feasibility of higher pumping within the City is studied with respect to impacts on other supplies as well as potential environmental effects. The Tier Three Water Budget and Local Area Risk Assessment Study is referenced when seeking additional sources outside the City with consideration for available takings, and also known and anticipated impacts on the watersheds in close proximity. In general, model-predicted impacts were found to be potentially significant for the south branch of Blue Springs Creek and Chilligo/Ellis Creek, and moderate for Hanlon Creek. Therefore, for the purposes of the WSMP Update, future groundwater supply sources investigated herein focussed on catchment areas along the Speed River and Mill Creek.

The Tier Three Assessment groundwater flow model is applicable to studying potential impacts from long-term average pumping to determine sustainable system pumping rates. Fluctuations in the pumping rate to meet minimum to maximum day demands are incorporated in these average rates. This translates to the required permitted capacity of any individual supply being rated at a capacity that meets the maximum day demand, and similarly, associated treatment and disinfection facilities must also be rated at the higher rate, recognizing that this will not be its average operating condition. The general approach in establishing water supply requirements is to assume that each facility must be able to pump at maximum day demand requirements. However, operational strategies could be developed to pump combinations of wells at higher rates on a continuous basis and others to meet peaking requirements in order to mitigate any potential environmental impacts.

Each quadrant of the City has been studied extensively, with the City undertaking monitoring and exploration programs in support of the existing operating wells and in reviewing feasibility of possible future sources. Of note is that the possible supply sources outside of the City boundaries considered in this WSMP update are limited to approximately 5 km from the City's limits. This parameter was initially determined with consideration to limiting impacts on surrounding municipalities, as well as the practicality of connecting to the existing water distribution system. However, if insufficient supply was available to satisfy projected 25 year demands, this distance would be revisited. It is noted that the study period of the 2007 WSMP was 50 years and therefore, assessment of potential areas of new water supply extended beyond this perimeter.

In comparison to the 2007 WSMP, there were other potential supply sources which were included in the review of alternatives (e.g. McCurdy Well, Eastview Well, Clair Well), which have since been converted to monitoring well nests. The reasoning for these is provided in the attached **Appendix D**.



Source: (Golder Associates, 2014)

Figure 4 Location of Groundwater Supply Wells

A general summary of existing and potential new water supplies within each quadrant is provided below:

Southwest Quadrant (SWQ)

Following the recommendation in the 2007 WSMP, the City initiated a Class Environmental Assessment (EA) study to optimize existing wells and to develop new water supplies in the SWQ. This quadrant consists of the following existing operational wells: Downey, Membro, Water St., Dean and University. It also includes the Edinburgh Well which was taken off-line due to water quality issues, and the Admiral Well which was initially developed for industrial use but not brought on line due to natural water quality issues. Through the Class EA study, two large diameter test wells (named 'Ironwood' and 'Steffler') were installed and tested over an extended period to determine potential capacity and to monitor the effects on other municipal and private wells, and surface water. Preliminary findings

suggest that when the SWQ is considered as a whole, i.e. one wellfield, an additional taking of 4,500 m^3/day can be achieved. This volume is in addition to that established as a maximum day sustainable pump rate for the SWQ of 17,800 m^3/day.

Therefore, a total objective for additional water supply from the SWQ of 4,500 m^3/day is available through new municipal wells (i.e., Ironwood, Steffler, GSTW1-08) alone, or through a combination of new wells plus optimizing existing including reactivating existing wells off-line requiring treatment. This is explored further in the alternatives discussion and evaluation.

There are no new water supplies recommended outside the City boundary in the SWQ area, recognizing the potential impacts to Hanlon Creek and Irish Creek watersheds, as reported within the Draft Southwest Quadrant Hydrogeological and Natural Environment Report (In Progress, Golder). Any proposed new City supplies would need to consider proposed Region of Waterloo wells in this vicinity for predicted cumulative impacts.

Lastly it is prudent to reference the influence of the Dolime quarry dewatering operation on aquifer water level elevations. During the 25 year timeframe of this WSMP update, review of the available capacities in existing and proposed new wells in the SWQ assume continued operation of the quarry. If the dewatering rate at the quarry increases above the current average, there will be less water available for the SWQ municipal wells. It is acknowledged that once the quarry dewatering ceases, this will require re-evaluation, and therefore, alternatives which would exceed what is currently considered available additional capacity (4,500 m^3/day) may remain for future consideration.

Southeast Quadrant (SEQ)

The SEQ consists primarily of the Arkell wellfield which includes Arkell 1, 6, 7, 8, 14 and 15 wells, as well as the Glen collector system, the Carter wells. The City is currently demonstrating the sustainability of operating the Arkell system with extensive monitoring for 3 years through an Operational Testing Program; results to date have confirmed the existing capacity of the Arkell bedrock wellfield of 28,800 m^3/day and indicate no measureable impacts on the Blue Springs Creek watershed. A possible new source in the Arkell area is to reinstate the Lower Road Collection system which was taken off line due to regulated water quality concerns. It is anticipated that, although work is required to repair and construct the collector infrastructure, it would be acceptable to direct this water along with other wells and the Glen Collector water to the aqueduct for Ultra Violet (UV) disinfection at the Woods Pumping Station. A preliminary review of the Woods UV system indicates sufficient capacity excluding extreme peaks in flows from the collector systems.

Also included in the SEQ is the Burke well which has recently been reviewed through a Class EA study. Treatment is proposed for removal of iron and manganese at this facility, as well as optimization of pumping through coordination of the well pump and highlift pumping.

The City completed a Class EA study in 1994 investigating a new well supply near the Barber Scout Camp on Stone Road (‘Scout Camp’ Well) which was found to have naturally poor water quality. This alternative is considered further in the following sections.

Lastly, new potential water supply outside the City was reviewed using the Tier Three model. The hydrogeological conditions in the general area of Victoria Road and Maltby suggest the possibility of a well with capacity of 4,000 to 6,000 m^3/day in this area, with consideration to potential impacts to Mill Creek.

Northeast Quadrant (NEQ)

Existing operating wells in the NEQ include the Park and Emma Wells, and the Helmar Well. The Clythe Well is a municipal supply that was taken offline due to natural water quality issues. A Class EA is currently underway which will consider treatment options for reconnecting this well to the distribution system.

The City has previously installed and tested wells in the area of Eastview Road and Watson Road, referred to as 'Logan' and 'Fleming', located outside the City in the Township of Guelph-Eramosa. The results suggest a possible new municipal supply in this area of 4,500 to 6,100 m^3/day.

No additional supplies outside the City are considered in the NEQ.

Northwest Quadrant (NWQ)

Existing operational wells in the NWQ include the Paisley, Calico and Queensdale Wells. The City also has a test well referred to as the Hauser well with a proposed taking of 900 m^3/day, which was included as a source to meet a future model run to 2031. The Tier 3 report suggested that the Ellis Creek Watershed may be under stress, and therefore any new potential takings in the NWQ beyond the wells previously mentioned should to be located to avoid potential impacts to Ellis Creek. Through groundwater modeling, it was determined that a possible new well source may be located closer to the Speed River at Sunny Acres Park where it was determined that an estimated 1,500 m^3/day may be available.

Two municipal groundwater supply sources (Sacco and Smallfield) are currently permitted for operation; however, these remain inactive and off-line since the mid-1990s due to groundwater quality concerns. Smallfield groundwater consistently contained Trichloroethylene (TCE) concentrations that exceeded the Ontario Drinking Water Quality Standards (ODWQS) maximum acceptable concentration (MAC) of 5 µg/L. Sacco groundwater quality indicated detectable levels of both TCE and Tetrachloroethylene (PCE) that remained consistently below the ODWQS MAC. The potential well capacities for Smallfield and Sacco are 1,408 and 1,150 m^3/day respectively as concluded in the rehabilitation and performance assessment in 2008.

Beyond the City boundary, a potential new supply was considered in the general area of Conservation Road west of Highway 6. Through Tier 3 modeling, a long term average pumping rate of 4,600 m^3/day could be supported which suggests the possibility of a well with a maximum day capacity of 6,200 m^3/day. It is anticipated that a well in this area would have good water quality.

Approach

After reviewing existing and future well supplies on a quadrant basis and understanding operational and environmental constraints, the potential groundwater opportunities for expansion of the existing supply system are grouped into the following alternatives following the prioritization approach of the 2007 WSMP:

- Optimize existing operating municipal wells
- Restoration of existing off-line municipal wells
- Develop existing municipal test wells
- Install new wells inside City boundaries
- Install new wells outside City boundaries
- Install new ASR wells inside City to optimize excess Arkell Collector system volumes

These are discussed in the following sections. Non-municipal groundwater supply sources are also mentioned for completeness as these represent potential future opportunities.

1.3.1 Non-Municipal Groundwater Supply Sources

A summary of non-municipal wells inside the City and in close proximity to the City is documented in Tech Memo 2 (Task 3), as their current operation impacts the available capacity of municipal wells (Golder Associates, 2014). Furthermore, should any of these wells be discontinued in future, this could present an opportunity to the City to either incorporate the well into the municipal system, or optimize existing municipal wells to increase production accordingly. Similarly, should any of these wells increase production; this could have a negative impact on the total municipal wells' capacity.

This opportunity is maintained for future consideration but is not included as an alternative under consideration in this WSMP update.

1.3.2 Optimize Existing Operating Municipal Wells

An extensive assessment of existing municipal production wells (shown in **Figure 4**), was undertaken to determine sustainable concurrent water takings from all supplies, and to identify wells where upgrades and/or modifications to the well itself or the well system could be considered to improve the well performance, water quality and general security of the source. These findings are documented in Tech Memo 2 (Task 3) (Golder Associates, 2014). These takings are compared to previous testing results and to the assessment completed in the 2007 WSMP. In general, the overall total capacity is comparable to earlier estimates, with the new Arkell wells 14 and 15 (brought online in 2012) increasing the current available total system capacity.

An operations workshop was held with City Waterworks staff to explore potential constraints within existing facilities that could impede possible expansion or increase to the current capacity. Also discussed were operational challenges which could result in operating the well facility at a lesser capacity than possible. For example, this could include optimizing a well with a highlift pump operation such that capacity is not 'lost' due to operational limits. Another example is declining well performance over time which would suggest more frequent rehabilitation to ensure sustained ongoing capacity. A summary of the recommendations to optimize and maintain the existing wells' capacity is provided in **Table 3**.

Table 3 Summary of Recommendations to Optimize and Maintain Capacity at Existing Operating Wells

Quadrant	Existing Municipal Well Supply Facility	Max Pumping Capacity (m^3/d)	Recommendations from Water Services*
SE	Arkell 1	2,000	• Rehabilitate well; Undertake performance testing after rehabilitation • Re-work discharge piping to not feed through Well 7 piping • New pump • Upgrade piping
SE	Arkell 6 Arkell 7 Arkell 8 Arkell 14 Arkell 15	28,800	• Pumps for Arkell 6, 7, and 8 need replacement • All wells need rehabilitation • Valve and piping replacement • Start online monitoring for nitrate
SE	Burke	6,546	• Rehabilitate well • Undertake performance testing after rehabilitation • Slated for New Treatment Plant, pressure performance test included in project • Needs to be programmed to operate off Clair Tower

Quadrant	Existing Municipal Well Supply Facility	Max Pumping Capacity (m^3/d)	Recommendations from Water Services*
SE	Carter 1 Carter 2	5,500	• Operate in conjunction with Arkell Wells • Provide online nitrate monitoring • Upgrade pipe and valves • New pumps and motors • Upgrade discharge piping
SW	Membro	6,000	• Replace pump and motor with VFD slave/operate high lift to well • Improvements to contact chamber or install UV system • Optimize well pump with highlift pumps to maximize total capacity • Upgrade valves and piping • Add treatment if required – consider UV/AOP at each well site or common treatment site in SWQ
SW	Water St	2,700	• Install liner; • Performance testing following liner installation to confirm capacity • Install new pump and motor • Operate more consistently • Will be more utilized with proposed Wellington to Clair transmission main • Add treatment if required – consider UV/AOP at each well site or common treatment site in SWQ
SW	Dean	1,500	• Liner installation; Performance testing pre and post liner installation • Complete facility upgrade required • Add treatment if required – consider UV/AOP at each well site or common treatment site in SWQ
SW	University	2,500	• Rehabilitation required; Performance testing following rehabilitation • New pump • Upgrade valve and piping
SW	Downey	6,000	• Replace and lower pump • Operate from Clair Tower • Replace valves and piping in time • Possible increase in PTTW to 6000 m^3/day is under review in SWQ Water Supply Class EA
NE	Park 1 Park 2	8,000	• Consider purchasing nearby property • Operate into Pressure Zone 2 and Zone 1 • Replace well pumps • Add more pumps for Zone 2
NE	Emma	3,100	• Performance testing while Park wells are operating at maximum capacity • Consider operating into Zone 2 • Replace pump • Consider common treatment (UV/AOP) at Park
NE	Helmar	1,200	• Add treatment for H_2S, and iron removal (not sequestration) • Undertake regular rehabilitation; Performance testing following rehabilitation • New pump/motor • Operate from Speedvale Tank • Residuals disposal/pump to sewer
NW	Paisley	1,400	• Rehabilitate well; Performance testing following rehabilitation • Add new valving and piping

Quadrant	Existing Municipal Well Supply Facility	Max Pumping Capacity (m^3/d)	Recommendations from Water Services*
			• Pipe to cell 1 & 2 • Upgrade MCC at booster station (longer term need) • Iron treatment
NW	Queensdale	1,100	• Rehabilitate well; Performance testing following rehabilitation • Add new valving, pump, piping, etc. • Undertake performance testing after rehabilitation • Possible expansion of property • Rework booster pump to coincide with well pump • Iron treatment necessary with residual disposal
NW	Calico	1,400	• Performance testing • New pump • Upgrade building foundation • Operate from Speedvale Tank • Upgrade access
*Upgrades to well infrastructure are subject to budget approvals and maintenance priorities			

In general, 'optimizing' existing wells require a review of operational and maintenance activities for the current facilities to ensure that the potential hydrogeological capacity can be achieved as required to meet peak demands. 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 6,000 m^3/day. Based on preliminary outputs from the SWQ Water Supply Class EA Study, an estimated additional total capacity of 4,500 m^3/day is available from the SWQ without resulting in potential environmental effects. An increase to the PTTW at the Downey Well to pump more could form part of the preferred solution; however, this option would need to be combined with other SWQ options to achieve the potential available capacity of 4500 m^3/day. If not included in the preferred short term solution, a future increase of the Downey well should be included in the consideration of future potential for the SWQ once the Dolime quarry dewatering operation ceases.

1.3.3 Restoration of Existing Off-line Municipal Wells

This alternative includes wells which have existing PTTW but the City has discontinued use due to concerns over existing issues with water quality, either elevated at present or a noted increasing trend. In general, these wells require upgrades for water quality treatment and to provide the required disinfection contact time. Most of these facilities will require completion of Class EA studies to establish recommended treatment systems. The potential for future operation of these wells is discussed below, followed by their project sheets.

Southwest Quadrant

Edinburgh Well

The Edinburgh Well was drilled in 1953 and is located on the southeast corner of Water Street and Edinburgh Road. This well has been out of service since the early 1990's due to TCE detections within the pumped groundwater and interference with the Membro and Water wells. Edinburgh is not currently equipped with a pump; however, it is permitted for operation at a maximum pumping rate of 3,000 m^3/day.

Admiral Well

The Admiral Well was drilled in 1999 and is located next to Sleeman Breweries Ltd. (Sleeman), off of Admiral Place. The capacity of Admiral is low, approximately 432 m^3/day. The City was permitted for non-municipal groundwater supply pumping from the Admiral Well with the intent to service Sleeman but the permit was recently changed to

include municipal water supply. However, Admiral remains inactive due to elevated concentrations of sulphate in the pumped groundwater.

Similar to discussion on the Downey well, based on preliminary outputs from the SWQ Water Supply Class EA Study, an estimated additional total capacity of 4,500 m^3/day is available from the SWQ without resulting in potential environmental effects. Providing treatment and well facilities at Edinburgh and/or Admiral could form part of the preferred solution but would not meet the potential capacity as stand-alone options. If through the SWQ Water Supply Class EA, the preferred short term solution is to provide all of the additional capacity in a new supply facility, future upgrades to the Edinburgh and/or Admiral wells should be included in the consideration of future potential for the SWQ once the Dolime quarry dewatering operation ceases.

Southeast Quadrant

Lower Collector

The Lower Road Collection System extends along the lower slope of the Eramosa Valley wall, eastwards from Watson Road to the northern extent of the Glen Collector System in the Arkell Spring Grounds. It is comprised of 30 manholes and 26 collection galleries. Groundwater taking from the Lower Road collector is permitted by the Arkell Spring Grounds collector system PTTW. Due to the poor condition of the connections to the Lower Road Aqueduct and an elevated bacterial content from this collector system, the Lower Road Collector System was disconnected in October 2000. It does not currently provide water to the municipal distribution system.

Northeast Quadrant

Clythe Well

The Clythe Well was constructed in 1976 and is located adjacent to Clythe Creek, near the intersection of Highway 7 and Watson Road. The well is listed on the City's consolidated Certificate of Approval (CCOA) and the well is currently permitted for pumping up to 5,237 m^3/day. This well has been out of service for the last ten years due to poor water quality (hydrogen sulfide) and potential well interference issues. The concentration of hydrogen sulfide ranged from 0.1 to 0.31 mg/L and consistently exceeded the Ontario Drinking Water Quality Standard (ODWQS) Aesthetic Objective (AO) of 0.05 mg/L.

Northwest Quadrant

Sacco Well

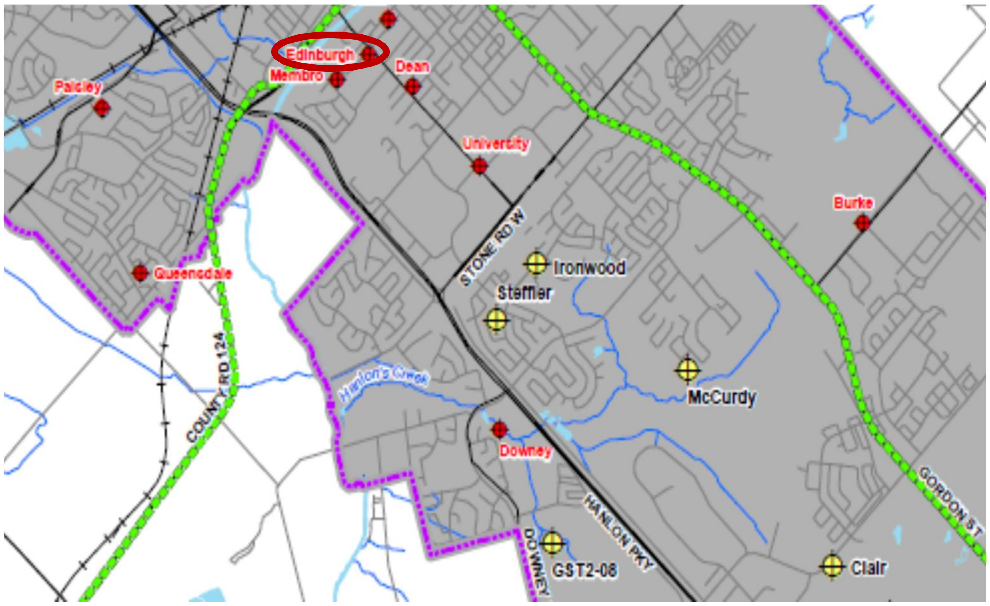
The Sacco Well was drilled in 1952 and is permitted to pump at a rate of 1,633 m^3/day. Sacco groundwater quality is comprised of detectable levels of TCE, consistently ranging between 0.3 and 0.5 µg/L. Low level concentrations of PCE and 1,1-dichloroethylene were also detected in Sacco water quality samples. This well was removed from service in 1991 due to low level concentrations of TCE.

Smallfield Well

The Smallfield Well was drilled in 1966 and was brought into service in 1970. The well was removed from service in 1994 due to rising concentrations of TCE. Smallfield Well groundwater consistently contained TCE concentrations that exceeded the ODWQS Maximum Acceptable Concentration (MAC) of 5 µg/L. In addition to TCE, other volatile organic compounds were detected in a recent pumping test. The concentration of chloride was also elevated during the pumping test. Based on the rehabilitation and performance assessment conducted in 2008, this well has a potential pumping capacity of 1,408 m^3/day.

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Edinburgh Well



Location	SE corner of Water St and Edinburgh Rd
Description	Drilled in 1953, has 300 mm dia casing, out of service since early 1990s
Permitted Pump Rate (m^3/d)	3,000
Sustainable Capacity (m^3/d)	1,200
Existing Approvals	PTTW
Required Approvals	Class EA
Water Quality Issues	Historical TCE detection in groundwater
Environmental Constraints	Interference from nearby wells (Water, Membro, Dean) and Dolime quarry
Past Studies/Work	Diagnostic step testing in 1995
Required Studies	• Performance Test • Treatment Studies • Class EA; Design & Construction
Required Infrastructure	• Water Treatment System • Well house upgrade/expansion
Estimated Capital Cost	$ 6,029,000
Cost per m^3/day	$ 2,010

Item	Description	Units	Quantity	Unit Price	Total
0	***Preliminary Studies and Approvals***				
0.1	Treatment Studies	L.S.	1	$165,000	$165,000
0.2	PTTW Approval	L.S.	1	$50,000	$50,000
	Subtotal	**Preliminary Studies and Approvals**			**$215,000**
1	***Land Acquisition***				
1.1	Purchase Land	L.S.	1	$300,000	$300,000
	Subtotal	**Land Acquisition**			**$300,000**
2	***Well House Upgrades***				
2.1	Demolish existing building	L.S.	1	$50,000	$50,000
2.2	Site Works	L.S.	1	$100,000	$100,000
2.3	New Building	L.S.	1	$950,000	$950,000
2.4	Servicing (power, w & ww)	L.S.	1	$200,000	$200,000
2.5	Mechanical (pumps & piping)	L.S.	2	$125,000	$250,000
2.6	Instrumentation & Control	L.S.	1	$175,000	$175,000
2.7	Install liner	L.S.	1	$50,000	$50,000
2.8	Electrical	L.S.	1	$4000,000	$400,000
	Subtotal	**Well House Upgrades**			**$2,392,500**
3	***Distribution System Connect***				
3.1	Pipe to Road	L.S.	1	200,000	$200,000
	Subtotal	**Distribution System Connect**			**$200,000**
4	***Disinfection System - NaOCl***				
4.1	Sodium hypochlorite system	L.S.	1	55,000	$55,000
	Subtotal	**Disinfection System - NaOCl**			**$55,000**
5	***Water Treatment System***				
5.1	UV AOP System for TCE removal	L.S.	1	582,000	$582,000
	Subtotal	**Water Treatment System**			**$485,000**
	SUBTOTAL				**$3,744,500**
	Contractor overhead and profit on SubTotal (10%)				$374,450
	Estimating Contingencies on Sub Total (30%)				$1,123,350
	TOTAL				**$5,242,300**
	Engineering Design and Construction Services on Total (15%)				$786,345
	GRAND TOTAL				**$6,029,000**

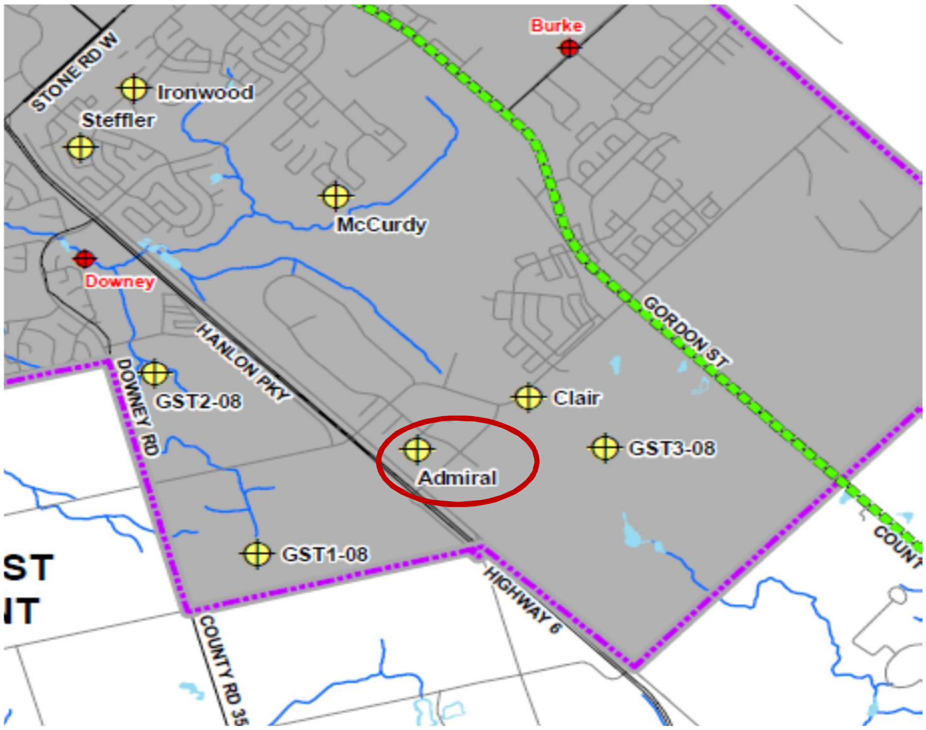
Cost Assumption

- Assume well can produce 1,200 m^3/d water
- Well water will be treated to meet ODWQS MAC of 5 µg/L for TCE with UV/AOP.

Edinburgh Well

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Admiral Well



Location	Next to Sleeman Breweries off of Admiral Place
Description	200 mm dia casing, developed as non-municipal well
Permitted Pump Rate (m^3/d)	452
Sustainable Capacity (m^3/d)	452
Existing Approvals	PTTW
Required Approvals	Class EA
Water Quality Issues	Elevated sulphate levels
Environmental Constraints	Interference from nearby wells (Water, Membro, Dean) and Do-Lime quarry
Past Studies/Work	-
Required Studies	• Performance Test • Treatment Studies • Class EA; Design & Construction
Required Infrastructure	• Water Treatment System • Well house upgrade/expansion
Estimated Capital Cost	$ 2,998,000
Cost per m^3/day	$ 6,630

Item	Description	Units	Quantity	Unit Price	Total
0	***Preliminary Studies and Approvals***				
0.1	Treatment Studies	L.S.	1	$100,000	$100,000
0.2	Class EA	L.S.	1	$150,000	$150,000
	Subtotal	**Preliminary Studies and Approvals**			**$250,000**
1	***Land Acquisition***				
1.1	Purchase Land	L.S.	1	$100,000	$100,000
	Subtotal	**Land Acquisition**			**$100,000**
2	***Well House Upgrades***				
2.1	Servicing (power, w & ww)	L.S.	1	$60,000	$60,000
2.2	Mechanical (pumps & piping)	L.S.	1	$80,000	$80,000
2.3	Instrumentation & Control	L.S.	1	$75,000	$75,000
2.4	Electrical	L.S.	1	$100,000	$100,000
2.5	Building upgrade	L.S.	1	$250,000	$250,000
2.6	Site Work	L.S.	1	$200,000	$200,000
	Subtotal	**Well House Upgrades**			**$841,500**
3	***Distribution System Connect***				
3.1	Pipe to Road	L.S.	1	150,000	$150,000
	Subtotal	**Distribution System Connect**			**$150,000**
4	***Disinfection System - UV***				
4.1	UV system	L.S.	1	60,000	$60,000
	Subtotal	**Disinfection System - UV**			**$60,000**
5	***Water Treatment System***				
5.1	Treatment for H2S removal	L.S.	1	460,000	$460,000
	Subtotal	**Water Treatment System**			**$460,000**
	SUBTOTAL				**$1,861,500**
	Contractor overhead and profit on SubTotal (10%)				$186,150
	Estimating Contingencies on Sub Total (30%)				$558,450
	TOTAL				**$2,606,100**
	Engineering Design and Construction Services on Total (15%)				$390,915
	GRAND TOTAL				**$2,998,000**

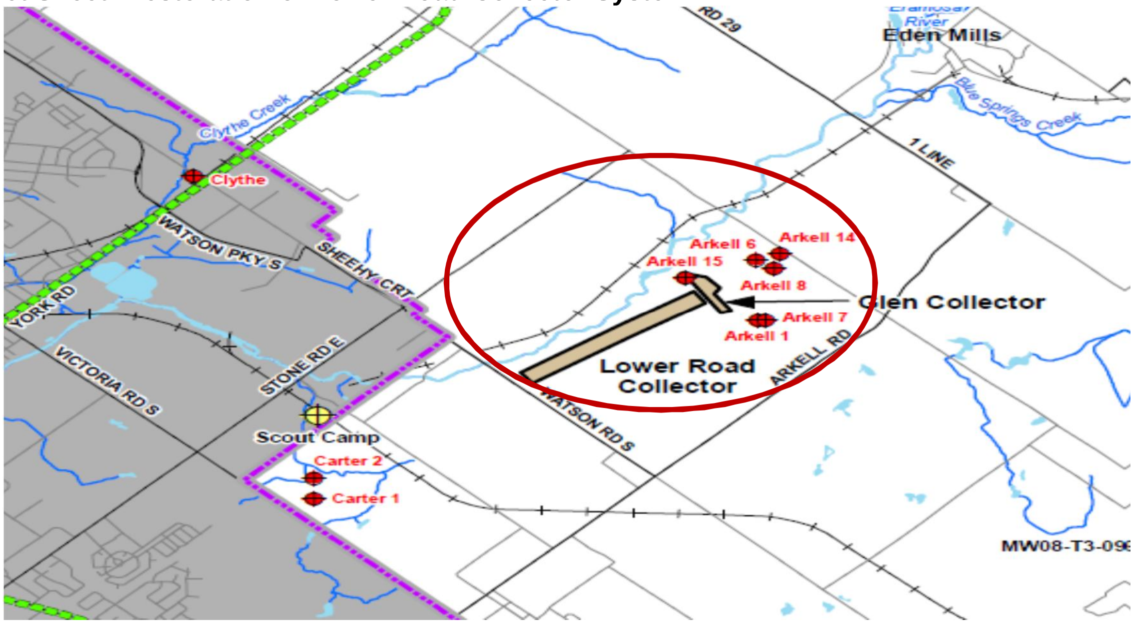
Cost Assumption

- Assume well can produce 452 m^3/d water
- Well water will be treated with air stripping system to achieve ODWQS AO of 0.05 mg/L for H_2S

Admiral Well

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Lower Road Collector System



Location	Lower slope of the Eramosa valley wall, eastward from Watson Rd to the Northern extent of the Glen Collector System
Description	A collector system consisting of 30 manholes and 26 collection galleries, disconnected in 2000
Historical Production Rate (m^3/d)	600-6000
Typical Collection Rate (m^3/d)	2,000-3,000
Existing Approvals	PTTW (under Arkell Springs Grounds Collector groundwater taking)
Required Approvals	DWP update
Water Quality Issues	Elevated bacterial content; may be treated via Woods UV system Bypass when turbidity high (similar to Glen collector)
Environmental Constraints	Near Eramosa River; in Arkell well spring-ground
Past Studies/Work	Aquifer Performance Evaluation Southeast Quadrant, 1998
Required Studies	• Field investigation • Design & construction
Required Infrastructure	• New HDPE perforated pipe & associated infrastructure
Estimated Capital Cost	$ 9,161,000
Cost per m^3/day	$ 4,581
O&M Cost	$80,229
Life Cycle Cost	$1.11/$m^3$ of water produced

Item	Description	Units	Quantity	Unit Price	Total
0	***Preliminary Studies and Approvals***				
0.1	Field Investigation	L.S.	1	$100,000	$100,000
0.2	Feasibility study	L.S.	1	$100,000	$100,000
	Subtotal	**Preliminary Studies and Approvals**			**$200,000**
1	***Collection System Upgrades***				
1.1	Decommissioning existing system	L.S.	1	$350,000	$350,000
1.2	Cleaning, restoration of site	L.S.	1	$250,000	$250,000
1.3	New HDPE perforated pipe with filtration sock and coupling, buoyancy etc (installed)	m	1600	$656	$1,050,000
1.4	New manholes	each	5	$20,000	$100,000
1.5	Horizontal Lateral	m	3600	$269	$970,000
1.6	Tie into Aqueduct	L.S.	1	$150,000	$150,000
1.7	Isolation valve chamber	L.S.	1	$50,000	$50,000
1.8	New pumps	each	5	$125,000	$625,000
1.9	Electrical	L.S.	1	$250,000	$250,000
1.10	I & C	L.S.	1	$200,000	$200,000
1.11	Structural work	L.S.	1	$300,000	$300,000
1.12	Pipe disinfection, flushing, cleaning	L.S.	1	$25,000	$25,000
1.13	Misc (5% of the above)	L.S.	1	$216,000	$216,000
	Subtotal	**Collection System Upgrades**			**$4,931,850**
2	***Distribution System Connect***				
2.1	Pipe to the northern extent of Glen (overflow/outlet)	L.S.	1	$500,000	$500,000
	Subtotal	**Distribution System Connect**			**$500,000**
	SUBTOTAL				**$5,689,600**
	Contractor overhead and profit on SubTotal (10%)				$568,960
	Estimating Contingencies on Sub Total (30%)				$1,706,880
	TOTAL				**$7,965,440**
	Engineering Design and Construction Services on Total (15%)				$1,194,816
	GRAND TOTAL				**$9,161,000**

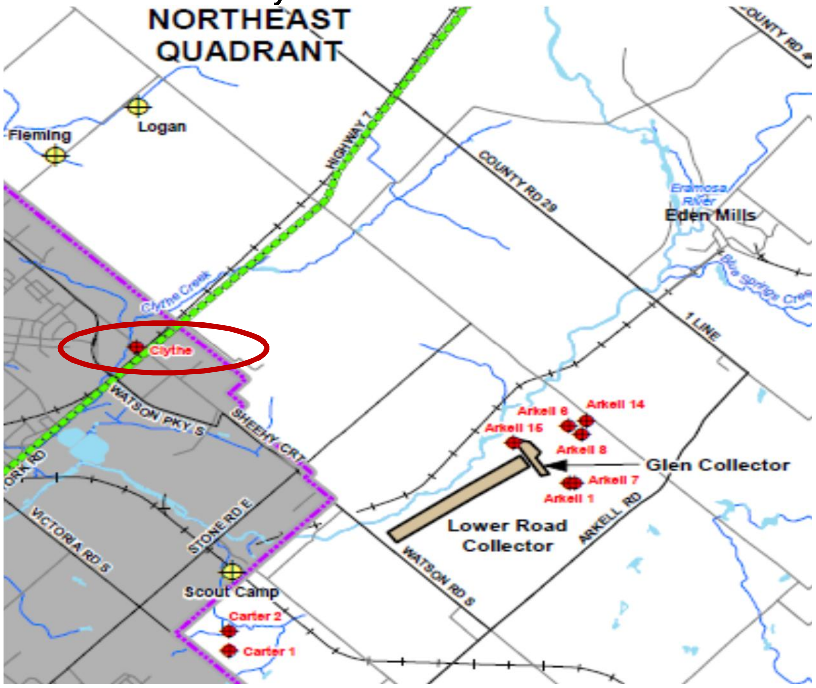
Cost Assumption

- Lower collector system will produce 2,000 m^3/d
- Collector system will connect to the distribution system on the northern extent of the Glen collector system
- 5 new manholes within the collector system will be installed
- Assumed 12 laterals are connected to each manhole, each 60 m in length
- 900 mm HDPE perforated pipe with filtration sock will be used

Arkell Lower Collector System

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Clythe Well



Location	Adjacent to Clythe Creek, near intersection of Highway 7 & Watson Rd
Description	Drilled in 1976, has 305 mm dia casing, not in operation for last 10 years
Permitted Pump Rate (m^3/d)	5,237
Potential Capacity (m^3/d)	3,395
Existing Approvals	PTTW
Required Approvals	• Class EA Schedule B • Amendment to City DWL
Water Quality Issues	• Hydrogen sulfide concentration between 0.1 to 0.31 mg/L, above ODWQS AO of 0.05 mg/L • Iron and manganese concentration caused by shallow groundwater infiltration
Environmental Constraints	Close to Clythe Creek
Past Studies/Work	Rehabilitation and Performance Assessment in 2008
Required Studies	Water treatment studies
Required Infrastructure	• Water Treatment System • Existing well house upgrades
Estimated Capital Cost	$ 4,809,000
Cost per m^3/day	$ 1,500

Annual O&M Cost	$ 154,400
Life Cycle Cost	$0.50/m^3 of water produced

Item	Description	Units	Quantity	Unit Price	Total
0	Preliminary Studies and Approvals				
0.1	Treatment Studies	L.S.	1	$200,000	$200,000
Subtotal		Preliminary Studies and Approvals			$200,000
1	Land Acquisition				
1.1	Purchase Land	L.S.	1	$300,000	$300,000
Subtotal		Land Acquisition			$300,000
2	Well House Upgrades				
2.1	Building expansion	m2	45	$4,000	$180,000
2.2	Modification to the existing pump house	L.S.	1	$100,000	$100,000
2.3	Servicing (power, w & ww)	L.S.	1	$200,000	$200,000
2.4	Mechanical (pumps & piping)	L.S.	1	$400,000	$400,000
2.5	Instrumentation & Control	L.S.	1	$200,000	$200,000
2.6	Electrical	L.S.	1	$200,000	$200,000
2.7	Site work	L.S.	1	$150,000	$150,000
2.8	Install Liner	L.S.	1	$50,000	$50,000
Subtotal		Well House Upgrades			$1,554,000
3	Disinfection System - NaOCl				
3.1	Sodium hypochlorite system	L.S.	1	55,000	$55,000
Subtotal		Disinfection System - NaOCl			$55,000
3	Water Treatment System				
3.1	Manganese dioxide filtration package	L.S.	1	423,500	$423,500
3.2	GAC package	L.S.	1	308,000	$308,000
Subtotal		Water Treatment System			$878,000
SUBTOTAL					$2,986,000
	Contractor overhead and profit on SubTotal (10%)				$298,000
	Estimating Contingencies on Sub Total (30%)				$896,000
TOTAL					$4,181,520
	Engineering Design and Construction Services on Total (15%)				$627,228
GRAND TOTAL					$4,809,000

Cost Assumption

- Existing connection to the distribution system
- Expansion of facility for treatment requires new property
- Well water will be treated with GAC and manganese dioxide filtration to achieve ODWQS AO of 0.05 mg/L for H_2S, 0.05 mg/L for manganese and 0.3 mg/L for iron

Clythe Well

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Sacco Well

Location	348 Woodlawn Road
Description	Drilled in 1952, has 300 mm dia casing, inactive since 1991
Permitted Pump Rate (m^3/d)	1,633
Sustainable Capacity (m^3/d)	1,150
Existing Approvals	PTTW
Required Approvals	Class EA Design and Construction
Water Quality Issues	• Detectable levels of TCE and PCE below ODWQS • TCE concentration between 0.3 to 0.5 µg/L
Environmental Constraints	Speed River catchment; close proximity to Ellis/ Chillico Creek; near Marden South Non-Provincially Significant Wetland Complex
Past Studies/Work	Rehabilitation and Performance Assessment in 2008
Required Studies	• Water treatment studies • Design and Construction
Required Infrastructure	• Land acquisition of adjacent property • Well house upgrade • Water Treatment System
Estimated Capital Cost	$ 4,135,000
Cost per m^3/day	$ 3,600

O&M Cost	$22,275
Life Cycle Cost	$0.84/m^3 of water produced

Item	Description	Units	Quantity	Unit Price	Total
0	***Preliminary Studies and Approvals***				
0.1	Treatment Studies	L.S.	1	$100,000	$100,000
0.2	Class EA	L.S.	1	$200,000	$200,000
	Subtotal	**Preliminary Studies and Approvals**			**$300,000**
1	***Land Acquisition***				
1.1	Purchase Land	L.S.	1	$300,000	$300,000
	Subtotal	**Land Acquisition**			**$300,000**
2	***Well House Upgrades***				
2.1	Servicing (power, w & ww)	L.S.	1	$80,000	$80,000
2.2	Mechanical (pumps & piping)	L.S.	1	$125,000	$125,000
2.3	Instrumentation & Control	L.S.	1	$75,000	$75,000
2.4	Electrical	L.S.	1	$200,000	$200,000
2.5	Building upgrade	L.S.	1	$200,000	$200,000
2.6	Site Work	L.S.	1	$400,000	$400,000
2.7	Install liner	L.S.	1	$ 50,000	$ 50,000
	Subtotal	**Well House Upgrades**			**$1,243,000**
3	***Distribution System Connect***				
3.1	Pipe to Road	L.S.	1	150,000	$150,000
	Subtotal	**Distribution System Connect**			**$150,000**
4	***Disinfection System - UV***				
4.1	UV system	L.S.	1	75,000	$75,000
	Subtotal	**Disinfection System - UV**			**$75,000**
5	***Water Treatment System***				
5.1	Treatment for TCE removal	L.S.	1	500,000	$500,000
	Subtotal	**Water Treatment System**			**$500,000**
	SUBTOTAL				**$2,568,000**
	Contractor overhead and profit on Subtotal (10%)				$256,800
	Estimating Contingencies on Sub Total (30%)				$770,400
	TOTAL				**$3,595,,200**
	Engineering Design and Construction Services on Total (15%)				$539,280
	GRAND TOTAL				**$4,135,000**

Cost Assumption

- Distance of the WTP to the nearby watermain is 200 m
- Well water will be treated to achieve ODWQS MAC of 5 µg/L for TCE

Sacco Well

Alternative: Restoration of Existing Off-line Municipal Wells

Project Sheet: Restoration of Smallfield Well

Location	461 Speedvale Av
Description	Drilled in 1966, has 300 mm dia casing, inactive since 1993
Permitted Pump Rate (m^3/d)	1,964
Sustainable Capacity (m^3/d)	1,408
Existing Approvals	PTTW
Required Approvals	Class EA
Water Quality Issues	• TCE concentration above ODWQS MAC of 5 µg/L • Detectable concentration of 1,1,1-Trichloroethane & chloroform
Environmental Constraints	Speed River catchment; close proximity to Ellis/ Chillico Creek; near Marden South Non-Provincially Significant Wetland Complex
Past Studies/Work	Rehabilitation and Performance Assessment in 2008
Required Studies	• Performance Test • Treatment Studies • Class EA; Design & Construction
Required Infrastructure	• Land acquisition of adjacent property • Well house upgrade • Water Treatment System
Estimated Capital Cost	$ 3,820,000
Cost per m^3/day	$ 2,710

O&M Cost	$23,440
Life Cycle Cost	$0.64/m^3 of water produced

Item	Description	Units	Quantity	Unit Price	Total
0	***Preliminary Studies and Approvals***				
0.1	Treatment Studies	L.S.	1	$100,000	$100,000
0.2	Class EA	L.S.	1	$150,000	$150,000
Subtotal	**Preliminary Studies and Approvals**				**$250,000**
1	***Land Acquisition***				
1.1	Purchase Land	L.S.	0	$0	$0
Subtotal	**Land Acquisition**				**$0**
2	***Well House Upgrades***				
2.1	Servicing (power, w & ww)	L.S.	1	$125,000	$125,000
1. 2.2	2. Mechanical (pumps & piping)	3. L.S.	4. 1	5. $125,000	6. $125,000
2.3	Instrumentation & Control	L.S.	1	$75,000	$75,000
2.4	Electrical	L.S.	1	$150,000	$150,000
2.5	Site Work	L.S.	1	$400,000	$400,000
2.6	Install Liner	L.S.	1	$50,000	$50,000
2.7	Building upgrade	L.S.	1	$250,000	$250,000
Subtotal	**Well House Upgrades**				**$1,347,500**
3	***Distribution System Connect***				
3.1	Pipe to Road	L.S.	1	150,000	$150,000
Subtotal	**Distribution System Connect**				**$150,000**
4	***Disinfection System - UV***				
4.1	UV system	L.S.	1	75,000	$75,000
Subtotal	**Disinfection System - UV**				**$75,000**
5	***Water Treatment System***				
5.1	Treatment for TCE removal	L.S.	1	550,000	$550,000
Subtotal	**Water Treatment System**				**$550,000**
	SUBTOTAL				**$2,372,500**
	Contractor overhead and profit on SubTotal (10%)				$237,250
	Estimating Contingencies on Sub Total (30%)				$711,750
	TOTAL				**$3,321,500**
	Engineering Design and Construction Services on Total (15%)				$498,225
	GRAND TOTAL				**$3,820,000**

Cost Assumption

- Distance of the WTP to the nearby watermain is 200 m
- Well water will be treated to achieve ODWQS MAC of 5 µg/L for TCE with air stripping process

Smallfield Well

Summary

The total increase in a potential quantity available from these wells ranges from 8,000 to14,000 m^3/d. The assumptions and requirements for providing treatment and upgrades to all of the above are documented in the above project sheets.

Table 4 summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells and treatment systems, and approvals. In addition to the capital costs, the operating and maintenance costs were also estimated including labour, maintenance and energy costs.

Table 4 Summary of the Existing Off-line Municipal Wells Requiring Restoration

Item ID	Item Description	Clythe	Smallfield	Sacco	Edingburgh	Lower Road Collector	Admiral
	Potential Capacity (m^3/d)	**3,395**	**1,408**	**1,150**	**3,000**	**600-6,100**	**500**
1	Preliminary Studies and Approvals	$200,000	$250,000	$300,000	$215,000	$200,000	$250,000
2	Land Acquisition	$300,000	$0	$300,000	$300,000	$0	$100,000
3	Well House/Collector Upgrades	$1,554,000	$1,347,500	$1,243,000	$2,392,500	$4,989,600	$841,500
4	Connection to Existing System	$0	$150,000	$150,000	$200,000	$500,000	$150,000
5	Disinfection System	$55,000	$75,000	$75,000	$55,000	$0	$60,000
6	Water Treatment System	$877,800	$550,000	$500,000	$582,000	$0	$460,000
	Subtotal	**$2,986,800**	**$2,372,500**	**$2,568,000**	**$3,744,500**	**$5,689,600**	**$1,861,500**
	Contractor Overhead (10%)	$298,680	$237,250	$256,800	$374,450	$568,960	$186,150
	Estimating Contingency (30%)	$896,040	$711,750	$770,400	$1,123,350	$1,706,880	$558,450
	Total	**$4,181,520**	**$3,321,500**	**$3,595,200**	**$5,242,300**	**$7,965,440**	**$2,606,100**
	Engineering and Construction Services (15%)	$627,228	$498,225	$539,280	$786,345	$1,194,816	$390,915
	Grand Total	**$4,809,000**	**$3,820,000**	**$4,135,000**	**$6,029,000**	**$9,161,000**	**$2,998,000**

1.3.4 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 requirements. Test wells/observation wells for which modeling has indicated potential capacities are shown in

Figure 4. It is noted that these wells are in areas both within and outside the City's boundary. Fleming and Logan test wells are located immediately east of the City on Eastview Road. Due to the information available from previous studies including pumping tests and water quality testing, there is more certainty regarding these alternatives in regards to location, potential yields and treatment requirements. The City can move more readily to the next steps including Class EA and treatability studies, should these be part of the recommended solution.

The municipal test wells being considered as feasible alternatives for future water supply include the following:

Southwest Quadrant

Steffler

Constructed in May 2008, the Steffler well is capable of sustaining a pumping rate of 3,600 m^3/day (based on a 32-day constant rate test).

Ironwood

Constructed in June 2008, the Ironwood well has demonstrated a capacity of greater than 8,000 m^3/day (based on a 32-day constant rate test).

Both of the above wells are carried forward in costing and for evaluation assuming the total pump capacity as shown, recognizing that only an additional 4,500 m^3/day can be provided from the SWQ wells. Therefore, the additional capacity in these wells would contribute to system redundancy.

Southeast Quadrant

Scout Camp

The Scout Camp Well was constructed in 1987 with a rated pumping capacity of 5,789 m^3/day. It was approved under the Municipal Class Environmental Approval process in 1994 but doesn't have a PTTW. The main concern regarding the operation of Scout Camp is the presence of elevated hydrogen sulfide within the pumped groundwater.

Northeast Quadrant

Fleming

The Fleming test well is located on the north side of Eastview Road, approximately 1 km east of Watson Road. Drilled in 1966, Fleming well could yield a pumping rate ranging from 1,700 to 2,200 m^3/day. Fleming was converted to a municipal monitoring well in 2008.

Logan

The Logan test well is located on the south side of Eastview road approximately 1.5 km east of Watson Road. Constructed in 1966, Logan well could yield more than 5,000 m^3/day.

Northwest Quadrant

Hauser

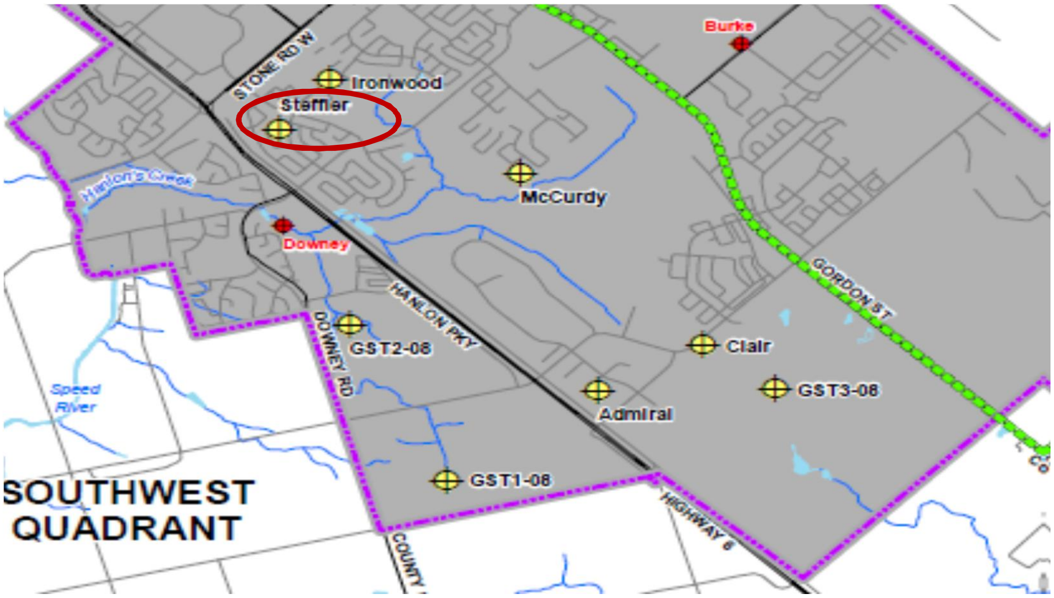
The Hauser Well was originally drilled in 1966 and has the potential yield of 916 m^3/day or less. Hauser test well is now converted into a municipal monitoring well.

A high degree of field investigation is required to determine if further pumping in close proximity to the Hauser well is sustainable as the Tier Three Assessment indicated the possibility of the Upper Chilligo/Ellis Creek being significantly stressed during pumping of existing groundwater supply wells.

Project sheets for the wells above are presented as follows.

Alternative: Develop Existing Municipal Test Wells

Project Sheet: Develop Steffler Well



Location	At Steffler Drive & Ironwood Road; in Steffler municipal park;
Description	Constructed in May 2008 with a 400 mm diameter casing
Sustainable Capacity (m^3/d)	3,600
Existing Approvals	None
Required Approvals	• PTTW • Class EA • Municipal approvals
Water Quality Issues	• Low concentrations of Fe & Mn; does not require treatment
Environmental Constraints	• Overall SWQ capacity can be increased by 4,500 m^3/d; therefore additional capacity provides redundancy only • pumping limited to avoid impacts to Hanlon Creek baseflow
Past Studies/Work	Class EA initiated; includes groundwater development study and 32 days constant rate pumping test, 2011
Required Studies	• Complete SWQ Water Supply Class EA • Design & Construction
Required Infrastructure	• Connection to distribution system • Well house
Estimated Capital Cost	$ 3,252,000
Cost per $m^{3/}$day	$ 900

	Cost Item	Steffler Well
1	Preliminary Studies and Approvals	$ 70,000
2	Land Acquisition	-
3	Site Works	$ 261,600
4	Concrete	$ 465,000
5	Masonry, Metal, Wood etc	$ 143,250
6	Finishes	$ 58,300
7	Equipment	$ 116,100
8	Mechanical	$ 209,500
9	Instrumentation & Electrical	$ 327,800
10	Distribution System Connect	$ 181,000
11	Water Treatment System	-
12	Disinfection Systems	$ 220,000
Subtotal		**$2,019,550**
Contractor Overhead (10%)		$ 202,255
Estimating Contingency (30%)		$ 606,765
Total		**$ 2,827,370**
Engineering and Construction Service (15%)		$424,736
Grand Total		**$3,252,000**

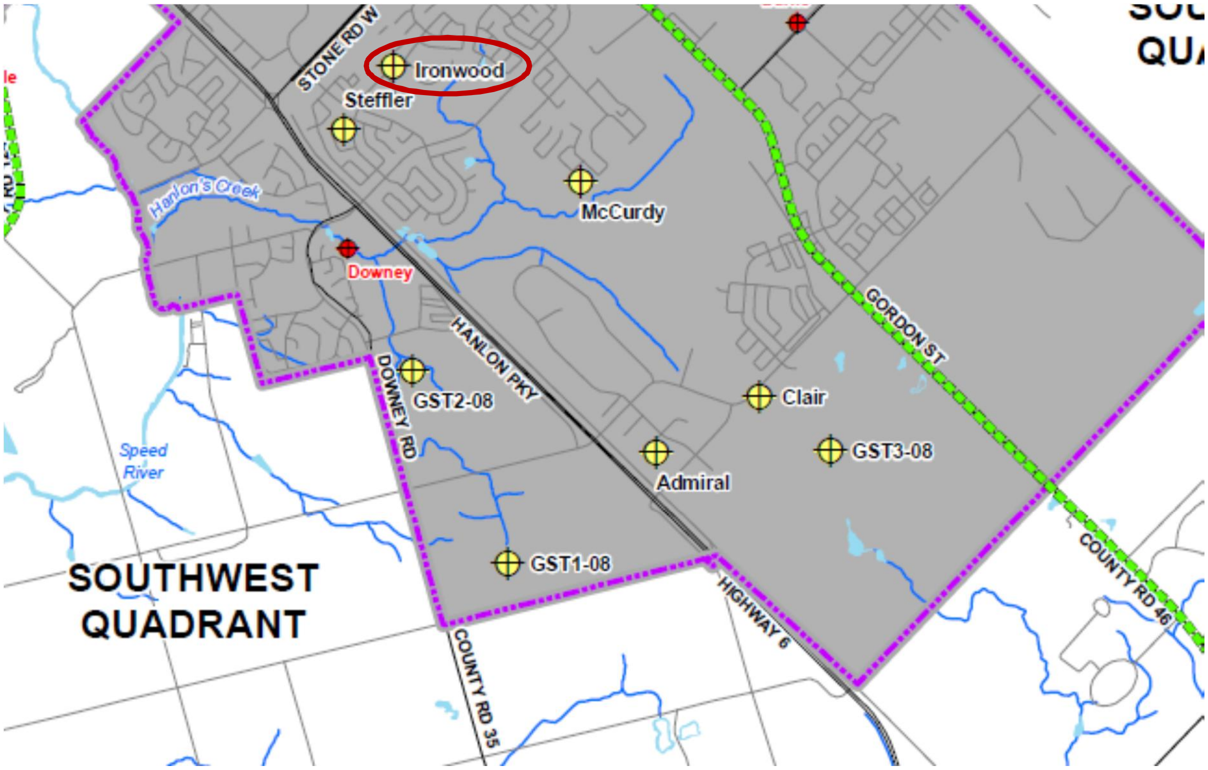
Cost Assumption

- Well water is good quality and only requires disinfection
- Land acquisition is not required
- Distance to the nearest watermain is 160 m

Steffler Well

Alternative: Develop Municipal Test Wells

Project Sheet: Development of Ironwood Well



Location	Edinburgh Rd. S. & Ironwood Rd.; in municipal park
Description	Constructed in 2008, has 400 mm dia casing
Sustainable Capacity (m^3/d)	8,000
Existing Approvals	None
Required Approvals	• PTTW • Class EA • Municipal approvals
Water Quality Issues	• Low concentrations of Fe & Mn; does not require treatment
Environmental Constraints	Overall SWQ capacity can be increased by 4,500 m^3/d; therefore additional capacity provides redundancy only pumping limited to avoid impacts to Hanlon Creek baseflow
Past Studies/Work	Class EA initiated; includes groundwater development study and 32 days constant rate pumping test, 2011
Required Studies	• Complete SWQ Water Supply Class EA • Design & Construction
Required Infrastructure	• Connection to distribution system • Well house and reservoir
Estimated Capital Cost	$ 4,036,000
Cost per m^3/day	$ 510

Annual O&M	$111,250
Life Cycle Cost	$0.16/m^3 of water produced

	Cost Item	Ironwood Well
1	Preliminary Studies and Approvals	$ 75,000
2	Land Acquisition	-
3	Site Works	$ 343,000
4	Concrete	$ 465,000
5	Masonry, Metal, Wood etc	$ 143,250
6	Finishes	$ 58,300
7	Equipment	$ 107,600
8	Mechanical	$ 215,000
9	Instrumentation & Electrical	$ 457,380
10	Connection to existing system	$ 390,000
11	Water Treatment System	-
12	Disinfection Systems	$ 251,900
Subtotal		**$ 2,506,430**
Contractor Overhead (10%)		$ 250,646
Estimating Contingency (30%)		$ 751,929
Total		**$ 3,509,002**
Engineering and Construction Service (15%)		$ 526,350
Grand Total		**$ 4,036,000**

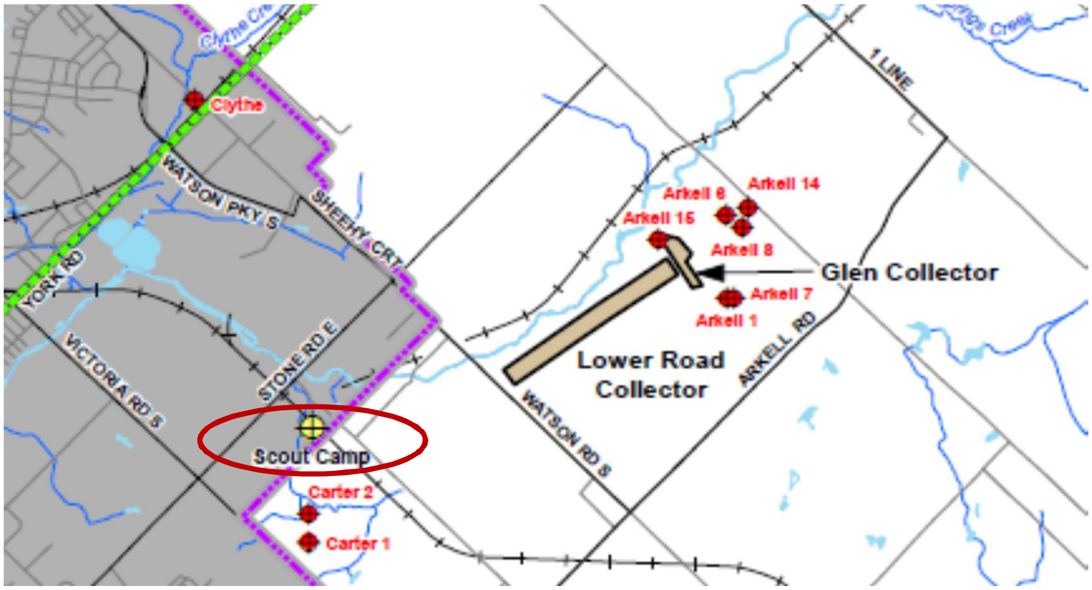
Cost Assumption

- Well water is good quality and will only require disinfection
- Land acquisition is not required

Ironwood Well

Alternative: Develop Municipal Test Wells

Project Sheet: Development of Scout Camp Well



Location	South of Stone Road and southwest of the Eramosa River (inside City)
Description	Drilled in 1987
Sustainable Capacity (m^3/d)	5,789
Existing Approvals	None
Required Approvals	• PTTW • Class EA
Water Quality Issues	• Elevated hydrogen sulphide levels
Environmental Constraints	• Groundwater inflow from the shallow groundwater flow system; can be addressed via liner installation -may reduce capacity • near Eramosa River Blue Springs Creek Provincially Significant Wetland Complex; • moderate impacts to Eramosa River and Torrence Creek
Past Studies/Work	• Water supply performance evaluation, 1993 • Class EA, 1994 (expired)
Required Studies	• Treatment study • Performance test after liner installation
Required Infrastructure	• Water treatment system • Waste connection to sewer system • Well house upgrade
Estimated Capital Cost	$ 4,702,000
Cost per m^3/day	$ 830

Annual O&M Cost	$79,170
Life Cycle Cost	$0.23/m^3 of water produced

	Cost Item	Scout Camp Well
1	Preliminary Studies and Approvals	$230,000
2	Land Acquisition	-
3	Site Works	$770,000
4	Concrete	$100,000
5	Masonry, Metal, Wood etc	$60,000
6	Finishes	$75,000
7	Equipment	$100,0000
8	Mechanical	$200,000
9	Instrumentation & Electrical	$450,000
10	Sewer System Connect	$350,000
11	Water Treatment System	$600,000
12	Disinfection Systems	$55,000
Subtotal		**$ 2,920,000**
Contractor Overhead (10%)		$ 292,000
Estimating Contingency (30%)		$ 876,000
Total		**$ 4,088,000**
Engineering and Construction Service (15%)		$ 613,200
Grand Total		**$ 4,702,000**

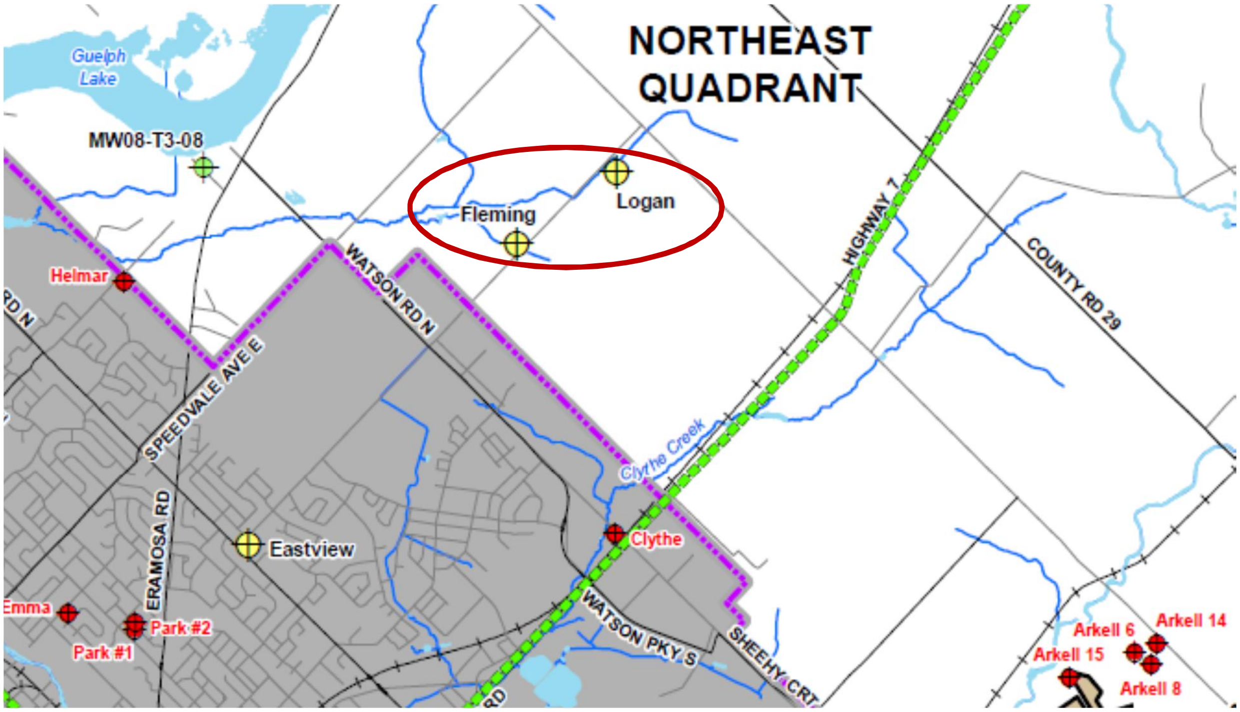
Cost Assumption

- Connection to nearby sewer is required for disposal of waste
- Water will be treated via air stripping system to remove H_2S to accepted aesthetic objective of ≤0.05 mg/L
- 2% of the feed water is lost during the water treatment process
- Land acquisition is not required

Scout Camp Well

Alternative: Develop Municipal Test Wells

Project Sheet: Development of Well in area of Logan and Fleming Test Well



Location	Township of Guelph-Eramosa Eastview Rd, East of Watson Road
Description	• Logan - Drilled in 1966, has 300 mm dia casing • Fleming – drilled in 1996, has 300 mm dia casing
Sustainable Capacity (m^3/d)	4,700 m^3/d max pump rate (3,492 m^3/d average pumping rate)
Existing Approvals	None
Required Approvals	• PTTW, Class EA • Municipal – Township of Guelph-Eramosa
Water Quality Issues	None
Environmental Constraints	• test well are located near Guelph Northeast Provincially Significant Wetland Complex; new well required; • investigations required to confirm confined aquifer
Past Studies/Work	Part of Guelph Monitoring System Project, 2009
Required Studies	• Groundwater supply development study • Water quality analysis • Performance testing • Class EA; PTTW; Design & Construction
Required Infrastructure	• Property acquisition • Connection to distribution system • Well house
Estimated Capital Cost	$ 4,735,000
Cost per m^3/day	$ 1,000

Annual O&M Cost	$92,150
Life cycle cost	$0.29/$m^3$ of water produced

	Cost Item	Logan/Fleming Well
1	Preliminary Studies and Approvals	$ 380,000
2	Land Acquisition	$ 50,000
3	Site Works	$ 655,740
4	Concrete	$ 465,000
5	Masonry, Metal, Wood etc	$ 143,250
6	Finishes	$ 58,300
7	Equipment	$ 88,100
8	Mechanical	$ 215,000
9	Instrumentation & Electrical	$ 457,380
10	Distribution System Connect	$ 230,000
11	Water Treatment System	-
12	Disinfection Systems	$ 198,100
Subtotal		**$ 2,940,770**
Contractor Overhead (10%)		$ 294,077
Estimating Contingency (30%)		$ 882,231
Total		**$ 4,117,078**
Engineering and Construction Service (15%)		$ 617,562
Grand Total		**$ 4,735,000**

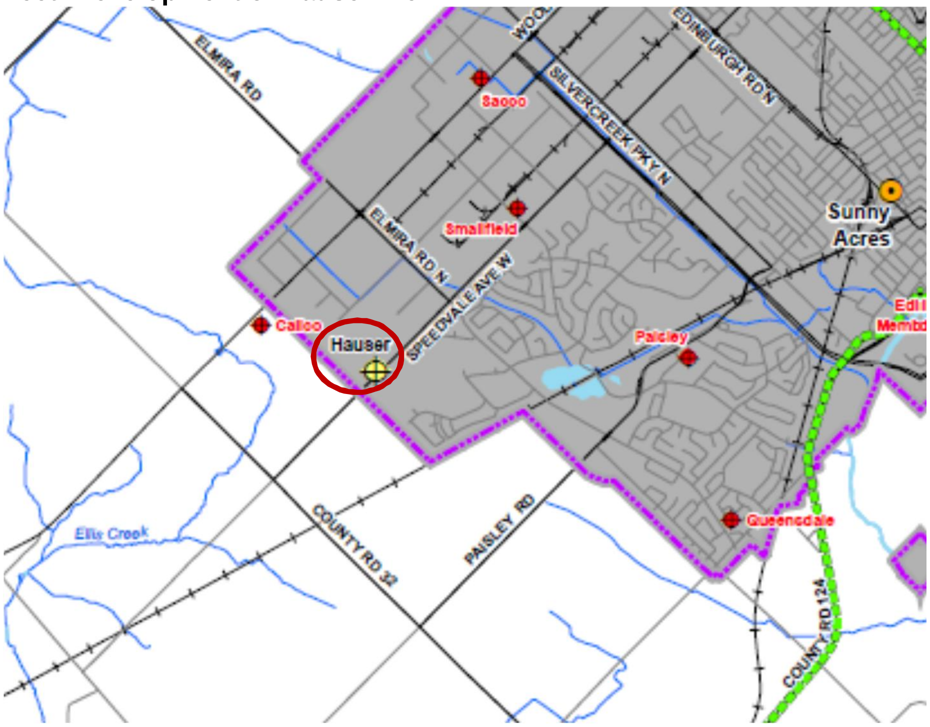
Cost Assumption

- Well water is good quality and will only require disinfection
- Maximum of 4700 m^3/d water can be drawn from this location
- Distance to nearest watermain is 200 m

Logan/Fleming Well

Alternative: Develop Municipal Test Wells

Project Sheet: Development of Hauser Well



Location	On Speedvale Av W.
Description	Drilled in 1966, has 300 mm dia casing
Sustainable Capacity (m^3/d)	900
Existing Approvals	None
Required Approvals	• PTTW • Class EA
Water Quality Issues	Water quality info is not available; assumed good WQ
Environmental Constraints	close proximity to Ellis/ Chillico Creek; near Ellis Creek Provincially Significant Wetland Complex
Past Studies/Work	Step Test, 1994
Required Studies	• Well installation and testing • Water quality analysis • Class EA; Design & Construction
Required Infrastructure	• Property acquisition • New Well • Connection to distribution system • Well house
Estimated Capital Cost	$ 3,691,000
Cost per m^3/day	$ 4,100

Annual O&M Cost	$19,950
Life Cycle Cost	$0.93/$m^3$ of water produced

	Cost Item	Hauser Well
1	Preliminary Studies and Approvals	$ 240,000
2	Land Acquisition	$ 300,000
3	Site Works	$ 570,000
4	Concrete	$ 220,000
5	Masonry, Metal, Wood etc	$ 75,250
6	Finishes	$ 75,000
7	Equipment	$ 43,800
8	Mechanical	$ 180,000
9	Instrumentation & Electrical	$ 210,000
10	Connection to existing system	$ 2112,500
11	Water Treatment System	-
12	Disinfection Systems	$ 165,000
Subtotal		**$ 2,291,950**
Contractor Overhead (10%)		$ 229, 195
Estimating Contingency (30%)		$ 687,585
Total		**$ 3,208,730**
Engineering and Construction Service (15%)		$ 481,310
Grand Total		**$ 3,691,000**

Cost Assumption

- Well water is good quality and will only require disinfection
- Maximum of 900 m^3/d water can be drawn from this location

Hauser Well

Summary

The total increase in a potential quantity available from these wells is from 14,800 m^3/d (includes only 4,500 m^3/d from SWQ wells). The assumptions and requirements for providing well facilities for all of the above are documented in the above project sheets.

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

Table 5 Cost Estimate to Develop Existing Municipal Test Wells

Item ID	Item Description	NEQ Fleming/Logan	SEQ Scout Camp	SWQ Steffler	SWQ Ironwood	NWQ Hauser
	Potential Capacity (average) (m^3/d)	**4,714**	**5,789**	**3,600**	**8,000**	**900**
1	Preliminary Studies and Approvals	$380,000	$230,000	$70,000	$75,000	$240,000
2	Land Acquisition	$50,000	$0	$0	$0	$300,000
3	Site Works	$655,740	$700,000	$261,600	$343,000	$570,000
4	Concrete	$465,000	$100,000	$465,000	$465,000	$220,000
5	Masonry, Metal, Wood, etc.	$143,250	$60,000	$143,250	$143,250	$75,250
6	Finishes	$58,300	$75,000	$58,300	$58,300	$75,000
7	Equipment	$88,100	$100,000	$83,100	$107,600	$43,800
8	Mechanical	$215,000	$200,000	$209,500	$215,000	$180,000
9	Instrumentation & Electrical	$457,380	$450,000	$327,800	$457,380	$210,400
10	Connection to Existing System	$230,000	$350,000	$181,000	$390,000	$212,500
11	Water Treatment System	$0	$600,000	$0	$0	$0
12	Disinfection Systems	$198,000	$55,000	$220,000	$251,900	$165,000
	Subtotal	**$2,940,770**	**$2,920,000**	**$2,019,550**	**$2,506,430**	**$2,291,950**
	Contractor Overhead (10%)	$294,077	$292,000	$201,955	$250,643	$229,195
	Estimating Contingency (30%)	$882,231	$876,000	$605,865	$751,929	$687,585
	Total	**$4,117,078**	**$4,088,000**	**$2,827,370**	**$3,509,002**	**$3,208,730**
	Engineering and Construction Services (15%)	$617,562	$613,200	$424,106	$526,350	$481,310
	Grand Total	**$4,735,000**	**$4,702,000**	**$3,252,000**	**$4,036,000**	**$3,691,000**

1.3.5 Develop New Wells Inside Existing City Boundary

While the reporting of the Tier Three Assessment (Matrix Solutions Inc., 2013) is subject to revision prior to finalizing the report in 2014, key findings identified within the draft report are as follows:

- The increased groundwater pumping could reduce groundwater base flow to the following catchment areas by 10% or more:
  - Torrance Creek (41%);
  - Chilligo/Ellis Creek at Wellington Road 32 (33%);
  - Blue Springs Creek South Branch at 28th Side Road (31%);
  - Hanlon Creek South Tributary at Highway 6 (15%); and
  - Hanlon Creek at Waterfowl Park (13%).

- Recognizing a high degree of uncertainty in the model predictions, and, in the case of Blue Springs Creek, extensive monitoring data that contradicts the model results, predicted impacts are significant for the South Branch of Blue Springs Creek and Chilligo/Ellis Creek and moderate for Hanlon Creek.

Based on the preliminary conclusions provided above, it is recognized that future groundwater supply development should preferentially consider catchment areas that are less likely to be significantly stressed. Modelling of future groundwater supply sources as part of the WSMP update have therefore focused on catchment areas along the Speed River and Mill Creek.

A preliminary conclusion of the Southwest Quadrant Groundwater Supply Class EA is that an additional 4,500 m^3/day can be pumped from existing groundwater supply test wells (i.e., Ironwood and Steffler) while not adversely impacting surface flow conditions within Hanlon Creek and its associated wetland. This conclusion presumes on-going pumping from the Guelph Dolime Quarry in the order of 5,000 to 7,000 m^3/day.

Due to interference effects amongst existing groundwater supply sources, Golder has indicated that additional new supplies within the remainder of the City are limited. For example, less than 10 m of further groundwater level drawdown is available within the Gasport Formation in the northeast end of the City. In the northwest portion of the City, potential concerns are related to lower aquifer hydraulic conductivity and further stress of the Chilligo/Ellis Creek catchment area.

Recognizing the constraints listed above, only one new well inside the City is proposed. One model scenario includes an additional well supply located in or near Sunny Acres Park, located along Edinburgh Road approximately 600 metres north of the Speed River. The rationale for this location is its proximity to an area with high transmissivity within the Gasport aquifer. Due to the limited available drawdown at this location (approximately 7 m), the estimated capacity of a well in this area ranges from 1,000 m^3/day on an average basis to 1,500 m^3/day to meet maximum day demands. Analytical data from monitoring wells in this area indicate good water quality. However, given the proximity to the wells south of the Speed River which have had water quality samples containing TCE, there is the possibility that water in this area may be impacted by the same source of contamination. In developing this alternative it is assumed that treatment for TCE may be a requirement.

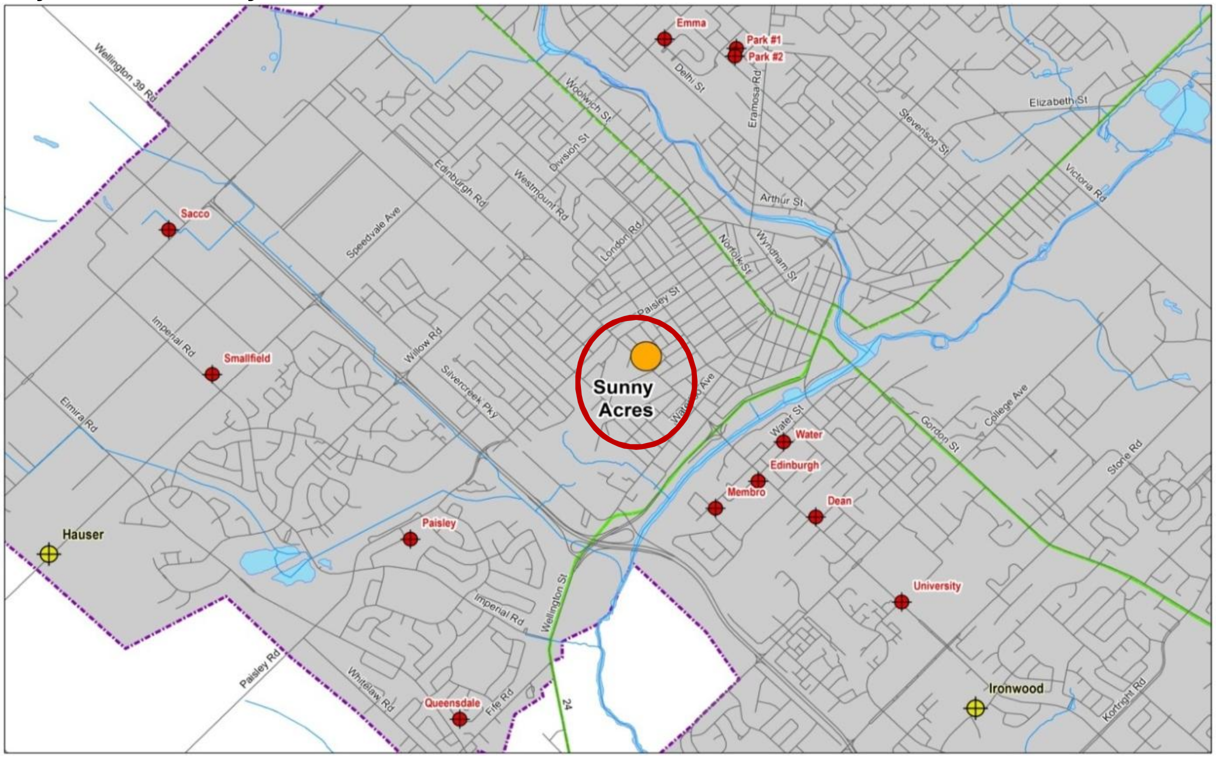
Summary

The total capacity available from this well is assumed to be 1,500 m^3/d. The assumptions and requirements for providing a well facility in this area are documented in the project sheet below.

The following project sheet also summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition, construction of new wells and treatment systems, and approvals. In addition to the capital cost, the operating and maintenance costs were also estimated including labour, maintenance and energy costs.

Alternative: Install New Wells Inside City Boundary

Project Sheet: Sunny Acre Well



Location	Central portion of the City (near Sunny Acre Park)
Description	Recommended test well location inside the City based on groundwater modelling analysis undertaken by Golder
Sustainable Capacity (m^3/d)	1,500
Existing Approvals	None
Required Approvals	• PTTW • Class EA
Water Quality Issues	Nearby MWs indicate good WQ; assumed treatment for TCE due to presence in municipal wells in area
Environmental Constraints	Interference effects from existing groundwater supply wells in the vicinity
Past Studies/Work	• Tier Three Risk Assessment • Groundwater modelling analysis by Golder, 2014
Required Studies	• Groundwater supply development study • Water quality analysis • Performance testing • Class EA; PTTW; Design & Construction
Required Infrastructure	• Land acquisition • Water treatment system • New wellhouse and associated infrastructure • Connection to distribution system
Estimated Capital Cost	$ 4,522,000
Cost per m^3/day	$ 3,020

Annual O&M Cost	$25,070
Life Cycle Cost	$0.70/$m^3$ of water produced

	Cost Item	Sunny Acre Well
1	Preliminary Studies and Approvals	$ 300,000
2	Land Acquisition	$ 300,000
3	Site Works	$ 570,000
4	Concrete	$ 220,000
5	Masonry, Metal, Wood etc	$ 75,250
6	Finishes	$ 75,000
7	Equipment	$ 43,800
8	Mechanical	$ 180,000
9	Instrumentation & Electrical	$ 215,400
10	System Connection	$ 204,000
11	Water Treatment System	-
12	Disinfection Systems	$ 165,000
Subtotal		**$ 2,808,450**
Contractor Overhead (10%)		$ 280,845
Estimating Contingency (30%)		$ 842, 535
Total		**$ 3,931, 830**
Engineering and Construction Service (15%)		$ 589, 775
Grand Total		**$ 4,522,000**

Cost Assumption

- Well water will be of reasonable quality and will only require treatment for TCE and disinfection
- Maximum of 1,500 m^3/d water can be drawn from this location

Sunny Acre Well

1.3.6 Install New Wells Outside City Boundaries

Similar to the evaluation of wells inside the City, Golder used the Tier 3 groundwater flow model to complete modeling runs incorporating assumptions regarding potential areas of new water supply outside the City. For the purposes of evaluating cumulative environmental impacts from pumping, these scenarios included a future average daily pumping rate of 73,450 m^3/day, as discussed above. Areas with potential for future groundwater supply sources were selected based on optimal hydrogeological characteristics (high aquifer transmissivity and available drawdown) and conclusions stemming from the Tier Three Risk Assessment.

The Tier Three Assessment concluded that the South Branch of Blue Springs Creek could be significantly stressed when operating at the average rate of 73,450 m^3/day although this conclusion was associated with a high level of model uncertainty and was contradicted by extensive monitoring data. No further groundwater development is recommended within this catchment area, until further field studies (as recommended by the Tier Three Assessment) have concluded that new additional groundwater supply can be sustained. Similar to Blue Springs

Creek, Irish Creek and Hanlon Creek could be significantly stressed if additional groundwater supply development (beyond the additional proposed capacity within the City's Southwest Quadrant Class EA) is realized.

Groundwater supply modelling analysis (outside the City) has therefore been focused within Mill Creek (southeast of the City), Marsden Creek (north of the City) and Speed River (northeast of city) catchment areas. Groundwater modelling analysis concluded that additional groundwater supply (ranging from 3,500 to 5,000 m^3/day) can potentially be established within each of these respective areas, without significantly changing baseflow rates encountered at the nearby water courses.

Two areas were evaluated including Victoria and Guelph North:

Guelph South - Victoria Rd & Maltby Rd

Golder modelled groundwater pumping from a general test well area, located southeast of the City (east of the Victoria Road, on Maltby Road) within the Mill Creek catchment area. The rationale for this location is its proximity to an area with high transmissivity within the Gasport aquifer and limited local groundwater usage (i.e., nearby golf course well operating at 7.6 L/s seasonally). The estimated available capacity of a modelled groundwater supply well in this general area is 3,900 m^3/day on an average basis; and 5,300 m^3/day to meet maximum day demands. Baseline reduction to surface water features is predominantly limited to Mill Creek. Good quality water is expected from this well which will only require disinfection.

Guelph North – Conservation Rd. W.

One model scenario considered groundwater pumping from a location north of the City (the western limit of Conservation Road). The rationale for this location is its proximity to an area with high transmissivity within the Gasport aquifer and limited local groundwater usage (i.e., three Guelph-Eramosa Township community wells with a combined permitted rate of 2,022 m^3/day). The estimated available capacity of a well in this area is 4,600 m^3/day on an average basis; and 6,200 m^3/day to meet maximum day demands. Baseline reduction to surface water features is predominantly limited to the Middle Speed River catchment. Good quality water is expected from this well which will only require disinfection.

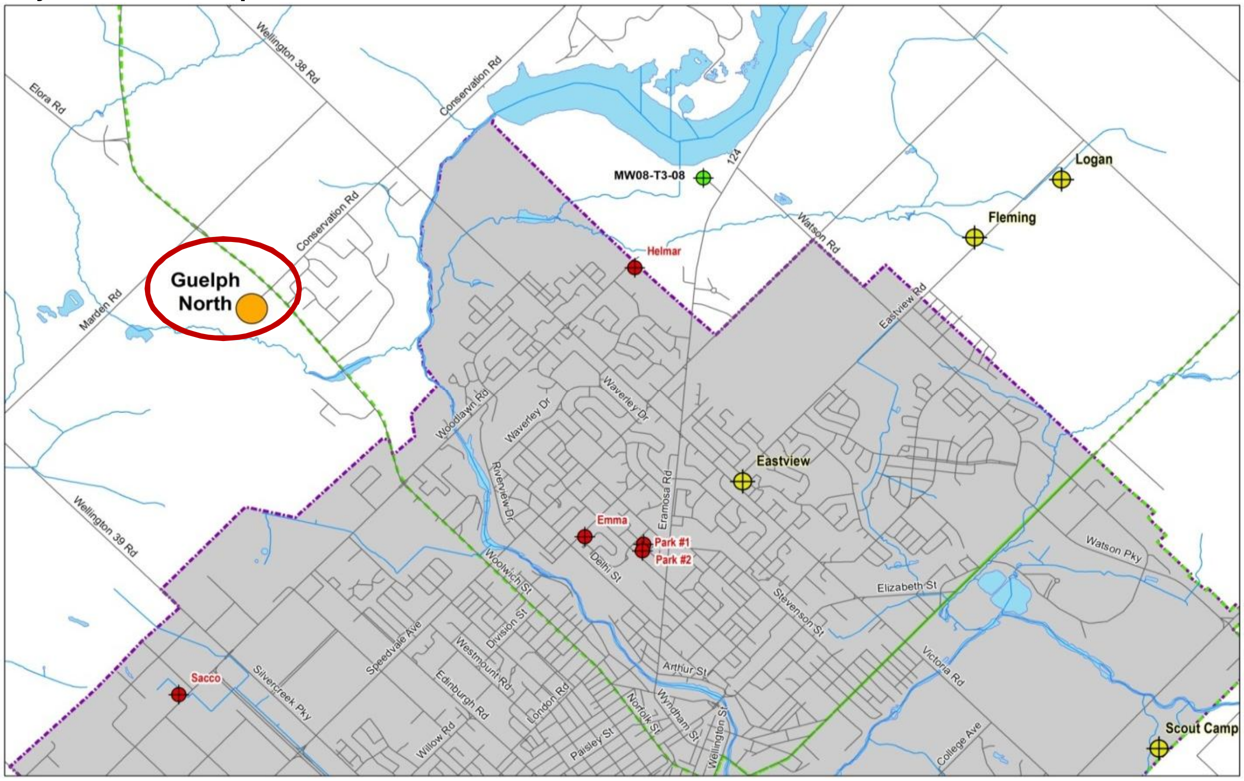
<u>Summary</u>

The total increase in a potential quantity available from these wells is 11,500 m^3/d. The assumptions and requirements for providing well facilities for the above are documented in the following project sheets.

Table 6 summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells and treatment systems, and approvals. In addition to the capital costs, the operating and maintenance costs were also estimated including labour, maintenance and energy costs.

Alternative: Install New Wells Outside City Boundary

Project Sheet: Guelph North – Conservation Road



Location	Township of Guelph-Eramosa North of the City, the western limit of Conservation Rd
Description	Recommended test well area outside the City based on groundwater modelling analysis undertaken by Golder
Sustainable Capacity (m^3/d)	6,300 m^3/d max pump rate (4,660 m^3/d average pumping rate)
Existing Approvals	None
Required Approvals	• PTTW • Class EA
Water Quality Issues	Water quality information - not available; assumed good WQ – only disinfection required
Environmental Constraints	Marden Creek -moderate to high impact; reduction in baseflows due to low seasonal flows; potential impacts to municipal/private wells anticipated near the Marden South Provincially Significant Wetland Complex;
Past Studies/Work	• Tier Three Risk Assessment • Groundwater modelling analysis by Golder, 2014
Required Studies	• Groundwater supply development study • Water quality analysis • Performance testing • Class EA; PTTW; Design & Construction
Required Infrastructure	• Land acquisition • New wellhouse and associated infrastructure • Connection to distribution system
Estimated Capital Cost	$ 5,289,000
Cost per m^3/day	$ 840

Annual O&M	$92,000
Life Cycle Cost	$0.23/ m^3 of water produced

	Cost Item	Guelph N Well
1	Preliminary Studies and Approvals	$ 380,000
2	Land Acquisition	$ 200,000
3	Site Works	$ 653,000
4	Concrete	$465,000
5	Masonry, Metal, Wood etc	$ 143,200
6	Finishes	$ 58,300
7	Equipment	$ 88,100
8	Mechanical	$ 215,000
9	Instrumentation & Electrical	$ 457,380
10	System Connection	$ 350,000
11	Water Treatment System	-
12	Disinfection Systems	$ 275,000
Subtotal		**$ 3,85,030**
Contractor Overhead (10%)		$ 328,503
Estimating Contingency (30%)		$ 985, 509
Total		**$ 4,599,042**
Engineering and Construction Service (15%)		$ 689,856
Grand Total		**$ 5,289,000**

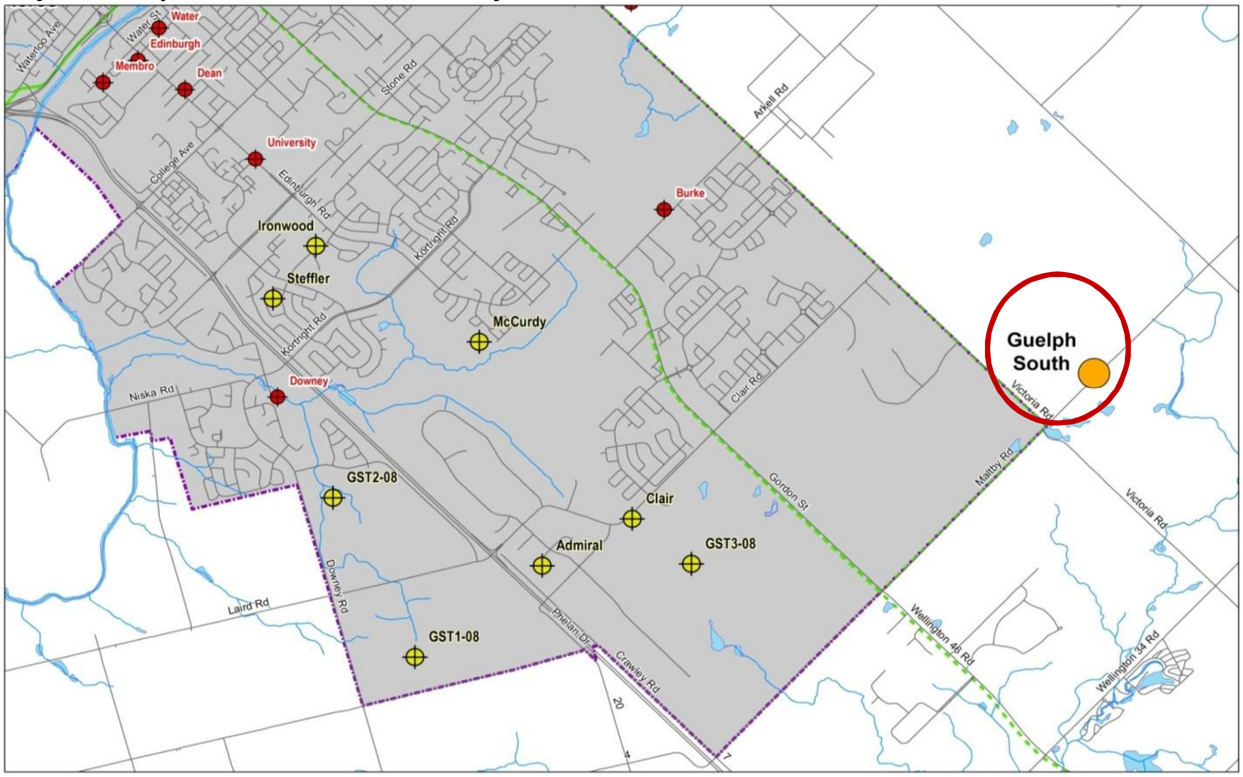
Cost Assumption

- Well water will be of good quality and will only require disinfection
- Maximum of 6,900 m^3/d water can be drawn from this location

Guelph North – Conservation Road

Alternative: Install New Wells Outside City Boundary

Project: Guelph South: Victoria & Maltby



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 undertaken by Golder
Sustainable Capacity (m^3/d)	5,300 m^3/d max pumprate (3,900 m^3/d average pumping rate)
Existing Approvals	None
Required Approvals	• PTTW • Class EA • ECA/DWP
Water Quality Issues	Water quality information not available; assumed good WQ – only disinfection required
Environmental Constraints	• Tier 3 model indicates minimal impact to Mill Creek; less than 5% reduction in baseflow • Area near Arkell Bog Provincially Significant Wetland Complex
Past Studies/Work	• Tier Three Risk Assement • Groundwater modelling analysis by Golder, 2014
Required Studies	• Groundwater supply development study • Water quality analysis • Performance testing • Class EA; PTTW; Design & Construction
Required Infrastructure	• Land acquisition; new wellhouse and associated infrastructure • Connection to distribution system
Estimated Capital Cost	$ 5,185,000
Cost per m^3/day	$980

Annual O&M	$80,230
Life Cycle Cost	$0.26/ m^3 of water produced

	Cost Item	Guelph S Well
1	Preliminary Studies and Approvals	$ 380,000
2	Land Acquisition	$ 200,000
3	Site Works	$ 643,000
4	Concrete	$ 465,000
5	Masonry, Metal, Wood etc	$ 143,250
6	Finishes	$ 58,300
7	Equipment	$ 88,100
8	Mechanical	$ 215,000
9	Instrumentation & Electrical	$ 457,380
10	System Connection	$ 350,000
11	Water Treatment System	-
12	Disinfection Systems	$ 220,000
Subtotal		**$ 3,220,030**
Contractor Overhead (10%)		$ 322,033
Estimating Contingency (30%)		$ 966,009
Total		**$ 4,508,042**
Engineering and Construction Service (15%)		$ 676,206
Grand Total		**$ 5,185,000**

Cost Assumption

- Well water will be of good quality and will only require disinfection
- Maximum of 5,300 m^3/d water can be drawn from this location

Guelph South: Victoria & Maltby

Table 6 Cost Estimate for Guelph South well and Guelph North well

Item ID	Item Description	Guelph South	Guelph North	Total
	Potential Capacity (average) (m^3/d)	**5,281**	**6,291**	**11,572**
1	Preliminary Studies and Approvals	$380,000	$380,000	
2	Land Acquisition	$200,000	$200,000	
3	Site Works	$643,000	$653,000	
4	Concrete	$465,000	$465,000	
5	Masonry, Metal, Wood, etc.	$143,250	$143,250	
6	Finishes	$58,300	$58,300	
7	Equipment	$88,100	$88,100	
8	Mechanical	$215,000	$215,000	
9	Instrumentation & Electrical	$457,380	$457,000	
10	Connection to Existing System	$350,000	$350,000	
11	Water Treatment System	$0	$0	
12	Disinfection Systems	$220,000	$275,000	
	Subtotal	**$3,220,030**	**$3,285,030**	**$6,505,060**
	Contractor Overhead (10%)	$322,003	$328,503	
	Estimating Contingency (30%)	$966,009	$985,509	
	Total	**$4,508,042**	**$4,599,042**	**$9,107,084**
	Engineering and Construction Services (15%)	$676,206	$689,856	
	Grand Total	**$5,185,000**	**$5,289,000**	**$10,474,000**

1.3.7 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 spring which do not correspond to a period of corresponding demand. As a result, this water is either not made available to the distribution system and these flows cannot be considered as part of the maximum daily supply capacity. While the historical flow ranges from each of these collector systems has been documented, information was not made available on reliability of achieving target flow for any specified time. For the purposes of reviewing feasibility of an alternative that captures some of the excess flow available from these collector systems, it was assumed that an excess of 10,000 m^3/day would be available continuously for a period of 4 months (March to May). It is also assumed that the Lower Road Collector system is repaired and placed back online and the costs associated with that alternative are not included here.

The advantage of this alternative is that a surface water treatment plant would not be required as it would be if water was taken directly from the Eramosa River. The additional seasonal volumes from the collector systems would be discharged to the aqueduct to combine with other Arkell wellfield supplies for disinfection at the Woods PS through the UV system as they are currently. However, rather than shutting off the other Arkell wells while these high seasonal volumes are available, all will continue to be pumped and subsequently stored to recover as required to meet demands. A preliminary check on UV capacity indicates sufficient design capacity to accommodate these additional flows, but this would require verification. The additional volume would be pumped into the distribution system and obtained similar to a large customer demand at two ASR wells for injection and storage in the aquifer. It is anticipated that the ASR wells would be located in the area of the Park and Emma wells where the high transmissivity would allow for optimization. It is assumed that two wells would be required, each capable of injection

at 5,000 m^3/day. Based on the above assumption of 10,000 m^3/day over a four month period, this results in a potential supply capable of 3,300 m^3/day.

Upon review, it seems contradictory that one would continue to pump from the deep Arkell wells during high collector flows, only to inject this water into the aquifer to recovery later; however, this approach reflects the current limitation of the current PTTWs. Should a change in the permitting system occur to allow for optimization on an annual water balance basis this ASR alternative would not be required; i.e. allow for increased pumping of water when required to balance water not pumped when not required (and hence already "stored" in the aquifer).

For more discussion on ASR as an option, refer to **Section 1.4.4.1** as part of the surface water and ASR alternative.

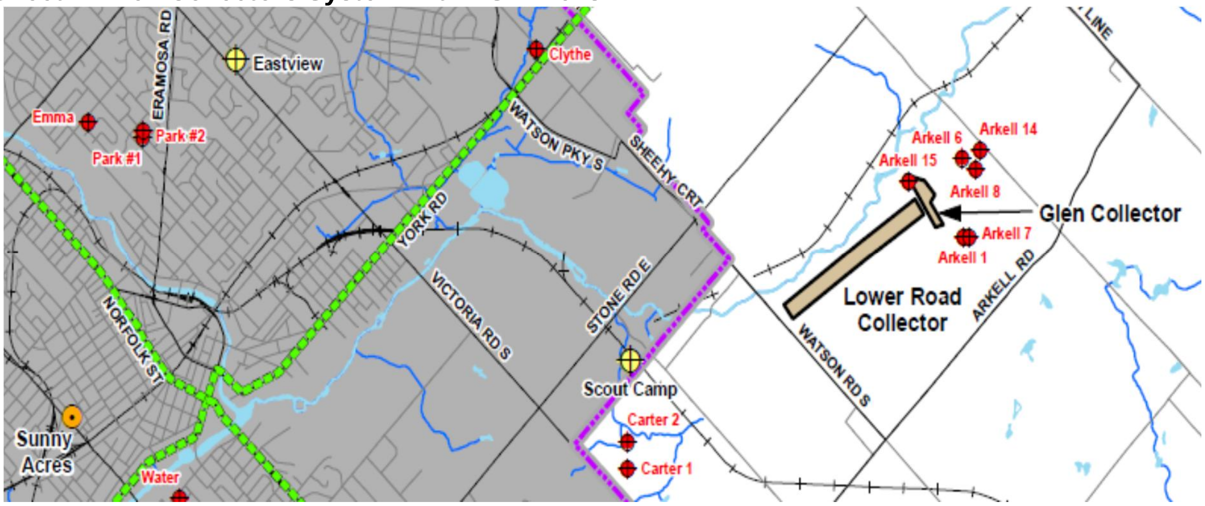
Summary

The total increase in a potential quantity available from these wells is 3,300 m^3/d. The assumptions and requirements for providing well facilities for the above are documented in the project sheet below.

The following project sheet also summarizes the cost estimate for capital works for preliminary investigations, and design, land acquisition where required, construction of new wells and disinfection systems, and approvals. In addition to the capital costs, the operating and maintenance costs were also estimated including labour, maintenance and energy costs.

Alternative: New Groundwater Supply

Project Sheet : Arkell Collectors System with ASR Wells



Location	Arkell Collector Systems excess flow & ASR wells in Central Guelph
Description	Transfer excess seasonal collector volumes to ASR wells
Capture Rate (m^3/d)	Assume excess of 10,000 m^3/day for four months
Distribution Rate (m^3/d)	Results in average capacity of 3,300 m^3/day
Existing Approvals	PTTW (under Arkell Springs Grounds Collector groundwater taking)
Required Approvals	• Class EA (for ASR wells) • Municipal – City • PTTW • ECA/DWL • GRCA
Water Quality Issues	Requires dechlorination prior to injection to ASR wells; disinfection upon recovery prior to distribution
Environmental Constraints	none
Past Studies/Work	Aquifer Performance Evaluation Southeast Quadrant, 1998
Required Studies	• Field investigation • Feasibility Studies • Class EA, design
Required Infrastructure	• ASR wells with dechlorination and UV disinfection • Connection to distribution water main
Estimated Capital Cost	$ 8,954,000
Cost per m^3/day	$ 2,700
Annual O&M Cost	$12,628
Life Cycle Cost	$0.57/$m^3$ of water produced

Item No.	Item Description		Total Cost
1	Preliminary exploration/testing		$1,000,000
	Approvals - PTTW; Class EA		$200,000
3	ASR Well construction		
	Well installation (drilling)		$1,000,000
	Well house, pumps, header, process piping, etc.		$2,811,000
4	Land Acquisition		$100,000
5	Disinfection		$300,000
6	Connect to distribution system		$150,000
		SUBTOTAL	**$5,561,000**
Contractor overhead and profit on SubTotal		*10%*	$556,100
Estimating Contingencies on Sub Total		*30%*	$1,668,300
		TOTAL	**$7,785,400**
Engineering Design and Construction Services on Total		*15%*	$1,167,810
		GRAND TOTAL	**$8,954,000**

Cost Assumption

- Reliability of excess flows during peak seasons is unknown; therefore, assumption of excess volumes of 10,000 m^3/day from both Glen and Lower Road Collectors for 4 months for feasibility assessment of ASR
- Assumes Lower collector system is restored (cost not included above)
- Collected water will be treated at the Woods Station via UV disinfection
- Woods Station UV system has the capacity to disinfect extra 10,000 m^3/d water
- After UV treatment at Woods Station treated water will be injected in the new ASR wells
- Dechlorination required prior to ASR injection; disinfection is required after recovery prior to distribution
- 2 new ASR wells are required to injects 10,000 m^3/d water
- The ASR wells will be located in the NEQ in the vicinity of Park/Emma wells; minimal land acquisition costs (assume located in municipal park)

Arkell Collectors System with ASR Wells

1.3.8 Groundwater Alternatives Summary

An estimatedlevel of confidence was applied to each of the groundwater alternatives to reflect uncertainty with respect to available information regarding capacity and water quality, as well as other factors such as public acceptance and potential constraints due to its location outside the City boundary. The resulting totals of each are shown in **Figure 5**, indicating the ability of the groundwater alternatives to provide required water supply capacity to meet projected demand with and without conservation.

It is recognized that there are limitations on the amount of groundwater that can be pumped from the identified study area (i.e. within 5 km of the City's boundaries) without causing environmental effects. Golder completed an analysis utilizing the Tier 3 model which suggests that the maximum groundwater supply within 5 km of the City limits represents a total average pumping rate of approximately 95,000 to 105,000 m^3/day, based on causing no greater than 10% and 20% reductions in non-stressed watershed baseflows respectively. Assuming a total of 95,000 m^3/day is achievable on an average day basis, and allowing for somewhat higher peak pumping to accommodate maximum day demands of up to 15 to 20%, this provides a total water supply capacity of not more than 109,000 to 114,000 m^3/day. It can be seen from **Figure 5** that the total groundwater supply included in the alternatives included in this update is within this maximum sustainable range, which suggests there may be no further opportunities without considering groundwater supplies further afield.

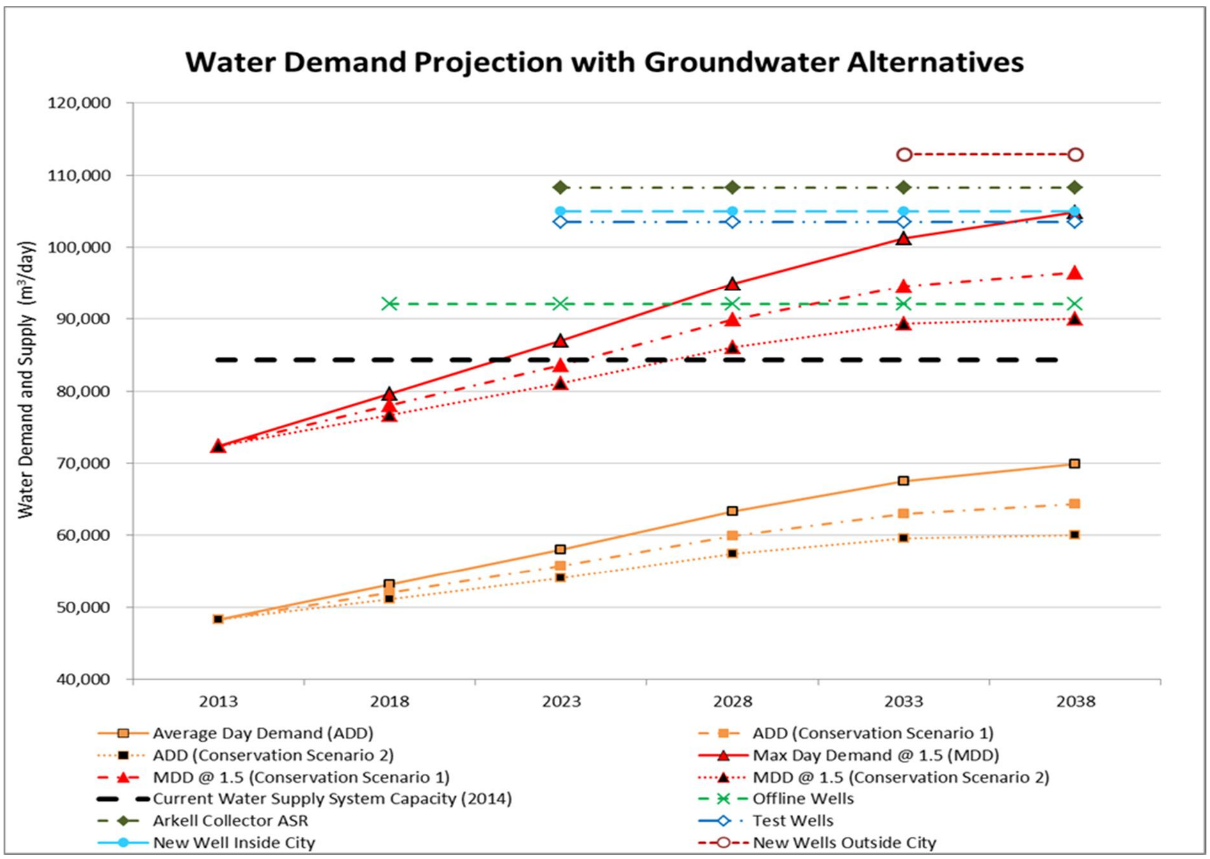


Figure 5 Water Demand Projection with Groundwater Alternatives

1.4 Establish New Surface Water Supply

During the completion of the 2007 WSMP, 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. Two possible local surface waters for assessment of volume available for taking water on a continuous or seasonal basis include the Speed River (at Guelph Lake) and the Eramosa River.

To contribute to the available supply capacity, surface water must either be treated to provide a continuous flow into the distribution system, or alternatively, volumes of water can be taken from the surface water when available, treated and stored underground in naturally occurring aquifers. This option is referred to as an aquifer storage 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.

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 (ODWQS). 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 flows.

To evaluate potential quantity available through this alternative, the Grand River Conservation Authority (GRCA) was contacted for their expert opinion on this managed watershed. Two possible sources and locations were investigated for water takings:

- Guelph Lake - downstream of the dam
- Eramosa River - at Arkell

The GRCA undertook an evaluation at both locations to determine the water volumes available throughout the year at locations, utilizing historical flow information and modeling tools. The results of this evaluation are documented in a memo contained in **Appendix E**. Through this evaluation, a base level water taking was established which would be available year-round, while maintaining minimum river flows in the rivers and minimizing potential environmental impacts of reducing total river flows. The GRCA also reviewed historical records to establish 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 water treatment plant, such that it would be operating at three capacity levels each for a minimum period in any given year.

The following summarizes work conducted by the GRCA in aid of evaluating local surface water takings for the purpose of providing additional potable water supply to the City of Guelph. The original analysis completed for the 2007 WSMP was based on the 1951 to 2004 period of record; the updated analysis extends this period to the end of 2012. Following this is a discussion of how these are applied to the surface water treatment with and without ASR.

1.4.1 Guelph Lake Reservoir Yield Analysis

For the Guelph Lake analysis, based on preliminary analysis of reliability of river flow based on historical flow monitoring data provided by the GRCA, 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) was assumed as follows:

For the period of a year:

- 100 days @ 150 L/s
- 100 days @ 300 L/s (assumed based reliability at 200 L/s 99% of the time)
- 164 days @ 500 L/s (based on reliability reported of 44%)

The above scenario required modeling and consideration of a two-step ASR taking of 300 L/s and 500 L/s respectively. The reliability indicated was taken from the long term reliability and applied on an annual basis; this was used as a starting basis to construct a stepped taking scenario.

The stream inflow which is the supply to Guelph dam is not constant. It varies within the year and across years. Based on the taking scenario described above, a chart of the daily inflow probability into Guelph Dam for the 1950 to 2012 period was constructed which was used to determine which periods of the year were most likely to yield potential for taking 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 by **Figure 6** 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.

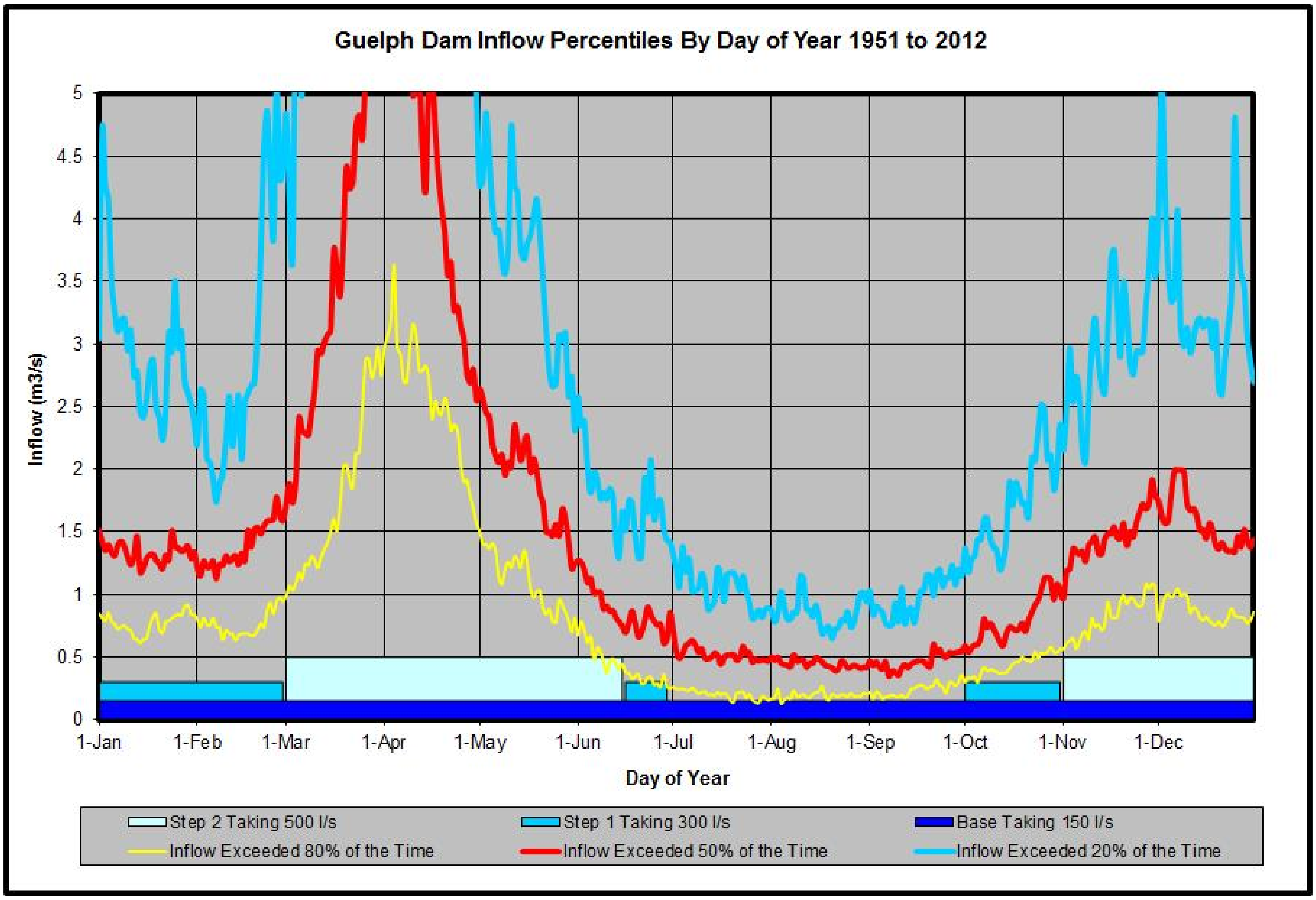


Figure 6 Step Takings Compared to River Flows

Figure 6 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 July and October through December period of the year. During the summer period only the base taking 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 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 the 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.

Based on the above, the reliability of stepped taking was modelled. The reservoir yield modeling assumed the Eramosa Arkell taking was maximized and that downstream low flow targets upstream of the Guelph sewage treatment plant were achieved 100% of the time. The results provided the reliability of ASR takings which closely follows the inflow reliability. The results are provided in detail in the supporting technical memo. In summary, the results indicated that there is a potential for the proposed stepped taking, as indicated in **Table 7**.

Table 7 Reliability of a Step ASR Taking from Guelph Dam 1951 to 2012

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
500 l/s per second taking													
Total Number of Occurrences (days)	1,275	1,111	1,332	1,689	1,471	574	192	123	321	630	771	1,212	10,701
Total Days Period of Record	1,922	1,752	1,922	1,860	1,922	1,860	1,922	1,922	1,860	1,922	1,860	1,922	22,646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	17%	33%	41%	63%	47%
Reliability Based on Occurrence	77%	77%	94%	97%	94%	69%	27%	16%	24%	40%	52%	73%	98%
500 l/s per second or greater taking													
Total Number of Occurrences (days)	1,703	1,576	1,786	1,801	1,745	1,468	192	123	1,114	1,345	1,482	1,663	15,998
Total Days Period of Record	1,922	1,752	1,922	1,860	1,922	1,860	1,922	1,922	1,860	1,922	1,860	1,922	22,646
Reliability Based on Time	89%	90%	93%	97%	91%	79%	10%	6%	60%	70%	80%	87%	71%
Reliability Based on Occurrence	90%	92%	98%	98%	97%	89%	27%	16%	66%	77%	90%	89%	100%
500 l/s per second or greater taking													
Total Number of Occurrences (days)	1,867	1,723	1,917	1,852	1,890	1,841	1,912	1,884	1,837	1,894	1,801	1,860	22,278
Total Days Period of Record	1,922	1,752	1,922	1,860	1,922	1,860	1,922	1,922	1,860	1,922	1,860	1,922	22,646
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	98%	99%	99%	97%	97%	98%
Reliability Based on Occurrence	98%	98%	100%	100%	98%	100%	100%	100%	100%	100%	100%	98%	100%

Based on this analysis, and the reliability based on time, the step to 500 L/s was dismissed. It is not deemed practical to build a WTP plant for the incremental step to 500 L/s for months for which the reliability is high for possibly three months. Furthermore, through discussions regarding the hydrogeological conditions which govern the ASR wells, this flow cannot be injected in a reasonable number of 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), and is summarized in **Table 8**.

Table 8 Calculation of Guelph Lake annual volume (for ASR)

Month	Days	Water Takings (L/s)		Volume from Guelph Reservoir			Estimated Demand* (m3/month)	Flow minus Demand (m3/month)	Volume to ASR (m3/month)	Volume from ASR (m3/month)
		150	300	Total Volume (m^3/mon)	Base Volume (m^3/mon)	Vol > base (m^3/mon)				
		excess:	150							
Jan	31	401,760	401,760	803,520	401,760	401,760	596,916	206,604	206,604	
Feb	28	362,880	362,880	725,760	362,880	362,880	539,150	186,610	186,610	
Mar	31	401,760	401,760	803,520	401,760	401,760	667,142	136,378	136,378	
Apr	30	388,800	388,800	777,600	388,800	388,800	679,601	97,999	97,999	
May	31	401,760	401,760	803,520	401,760	401,760	702,254	101,266	101,266	
June	30	388,800	388,800	777,600	388,800	388,800	747,561	30,039	30,039	
July	31	401,760		401,760	401,760	0	842,705	-440,945		440,945
Aug	31	401,760		401,760	401,760	0	842,705	-440,945		440,945
Sept	30	388,800		388,800	388,800	0	747,561	-358,761		358,761
Oct	31	401,760	401,760	803,520	401,760	401,760	702,254	101,266	101,266	
Nov	30	388,800	388,800	777,600	388,800	388,800	611,641	165,959	165,959	
Dec	31	401,760	401,760	803,520	401,760	401,760	596,916	206,604	206,604	
Total	**365**	**4,730,400**	**3,538,080**	**8,268,480**	**4,730,400**	**3,538,080**	**8,276,409**	**-7,929**	**1,232,723**	**1,240,652**
Daily pump rate to distribution (m^3/day)				**22,653**	**12,960**	**9,693**	**22,675**	**-22**		
* assumed annual demand pattern to reflect seasonal fluctuations										

1.4.2 Eramosa River Yield Analysis

Flow Reliability of the Existing Permit to Take Water

The flow reliability of the existing permit to take water at the Arkell site is illustrated in **Figure 7**.

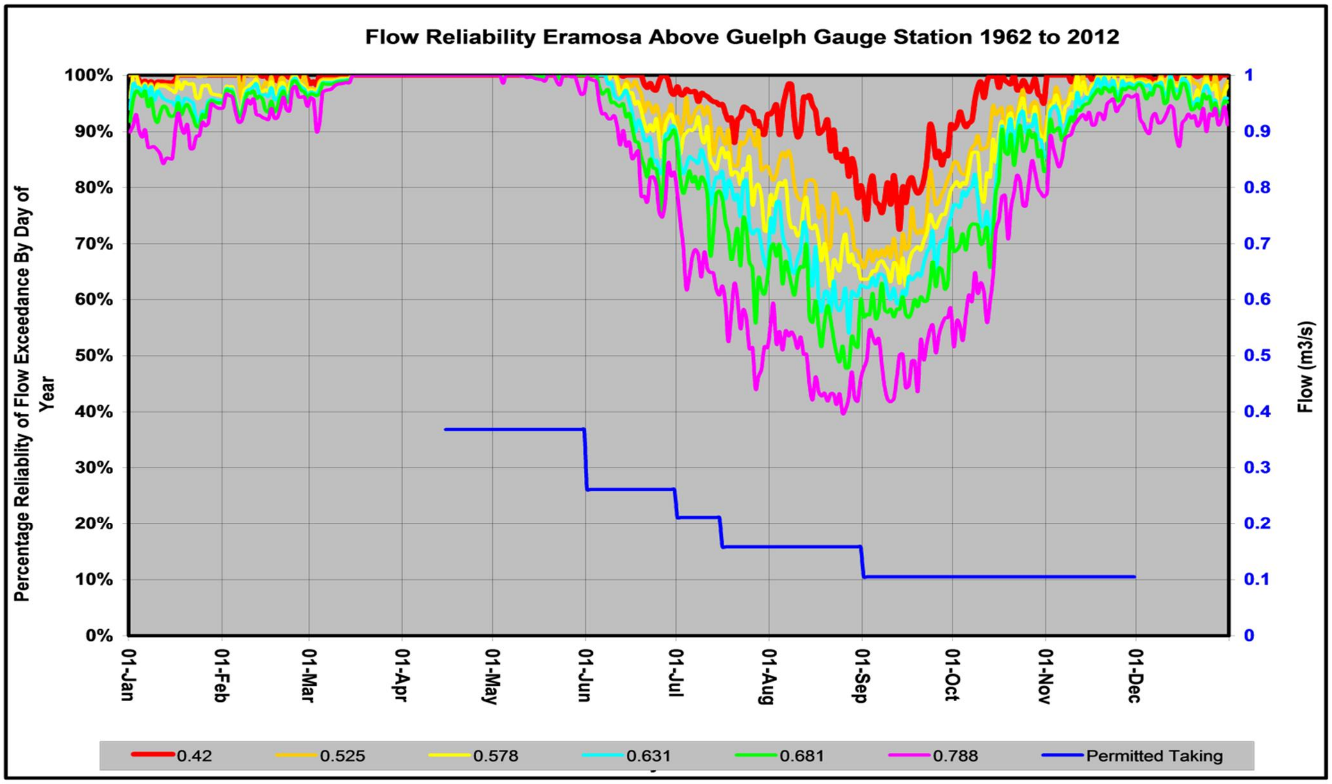


Figure 7 Flow Reliability – Existing Permit to Take Water

The permitted taking associated with this Permit to Take Water (PTTW) varies throughout the period of April 15 till December 1 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 2012. This chart illustrates the probability on any given day of the flow exceeding the indicated value.

Currently the City is limited by infrastructure to a taking of 100 L/s. The reliabilities in the attached chart have not been adjusted for historical takings by the City. These are solely based on observed river flow downstream of the City of Guelph taking at the Eramosa River above the Guelph gauge. A further refinement would be to analyze the naturalized daily flow time series and simulate the taking in the Permit to Take Water described in **Table 9**.

Table 9 Arkell Surface Water Permit to Take Water Conditions

Eramosa at Watson Road Flow Availability Statistics Based on Naturalized Daily Flows													
Description	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**April to Nov**
Eramosa River at Watson Flow Statistics for Flow Equaling or Exceeding 0.42 m^3/s													
Total Number of Occurrences (days)	1,569	1,433	1,578	1,530	1,581	1,524	1,507	1,472	1,334	1,538	1,525	1,568	12,011
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	99%	99%	100%	100%	100%	100%	95%	93%	87%	97%	100%	99%	97%
Reliability Based on Occurrence	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%	100%	100%
Eramosa River at Watson Flow Statistics for Flow Equaling or Exceeding 0.525 m^3/s													

Total Number of Occurrences (days)	1,563	1,428	1,566	1,530	1,581	1,487	1,442	1,303	1,150	1,450	1,505	1,552	11,448
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	99%	99%	99%	100%	100%	97%	91%	82%	75%	92%	98%	98%	92%
Reliability Based on Occurrence	100%	100%	100%	100%	100%	100%	98%	100%	94%	100%	100%	100%	100%
Eramosa River at Watson Flow Statistics for Flow Equaling or Exceeding 0.578 m^3/s													
Total Number of Occurrences (days)	1,540	1,413	1,564	1,530	1,580	1,470	1,392	1,216	1,100	1,403	1,486	1,535	11,177
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	97%	98%	99%	100%	100%	96%	88%	77%	72%	89%	97%	97%	90%
Reliability Based on Occurrence	100%	100%	100%	100%	100%	100%	98%	100%	97%	100%	100%	100%	100%
Eramosa River at Watson Flow Statistics for Flow Equaling or Exceeding 0.631 m^3/s													
Total Number of Occurrences (days)	1,507	1,386	1,563	1,530	1,579	1,455	1,330	1,133	1,046	1,346	1,458	1,520	10,877
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	95%	96%	99%	100%	100%	95%	84%	72%	68%	85%	95%	96%	87%
Reliability Based on Occurrence	100%	100%	100%	100%	100%	100%	96%	96%	90%	100%	100%	100%	100%
Eramosa River at Watson Flow Statistics for Flow Equaling or Exceeding 0.681 m^3/s													
Total Number of Occurrences (days)	1,481	1,373	1,563	1,530	1,577	1,434	1,254	1,033	987	1,297	1,435	1,508	10,547
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	94%	95%	99%	100%	100%	94%	79%	65%	65%	82%	94%	95%	85%
Reliability Based on Occurrence	100%	100%	100%	100%	100%	100%	96%	96%	90%	100%	100%	100%	100%
Eramosa River at Watson Flow Statistics for Flow Equaling or Exceeding 0.788 m^3/s													
Total Number of Occurrences (days)	1,407	1,350	1,552	1,530	1,564	1,366	1,058	847	828	1,150	1,394	1,452	9,737
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	89%	94%	98%	100%	99%	89%	67%	54%	54%	73%	91%	92%	78%
Reliability Based on Occurrence	100%	100%	100%	100%	100%	100%	96%	92%	86%	98%	100%	100%	100%

Results in **Table 10** indicate that there is 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. This supports optimizing the recharge system and collector systems to maximize the potential for this seasonal volume.

Table 10 Summary of Eramosa River at Watson Road Flow Static Related to City of Arkell PTTW

Time Frame of Permitted Taking	Permitted Daily Volume m^3	Daily Volume Expressed as rate (m^3/s)	Eramosa River Flow Condition (m^3/s)	Edinburgh Road Flow Condition (m^3/s)	Required Flow In the River to Support Given Taking (m^3/s)
April 15 to May 31	1540	0.368	> 0.42	> 0.85	0.788
June 1 to June 30	1100	0.261	> 0.42	> 0.85	0.681
July 1 to July 15	880	0.211	> 0.42	> 0.85	0.631
July 16 to Aug. 31	660	0.158	> 0.42	> 0.85	0.578
Sept. 1 to Nov. 31	440	0.105	> 0.42	> 0.85	0.525

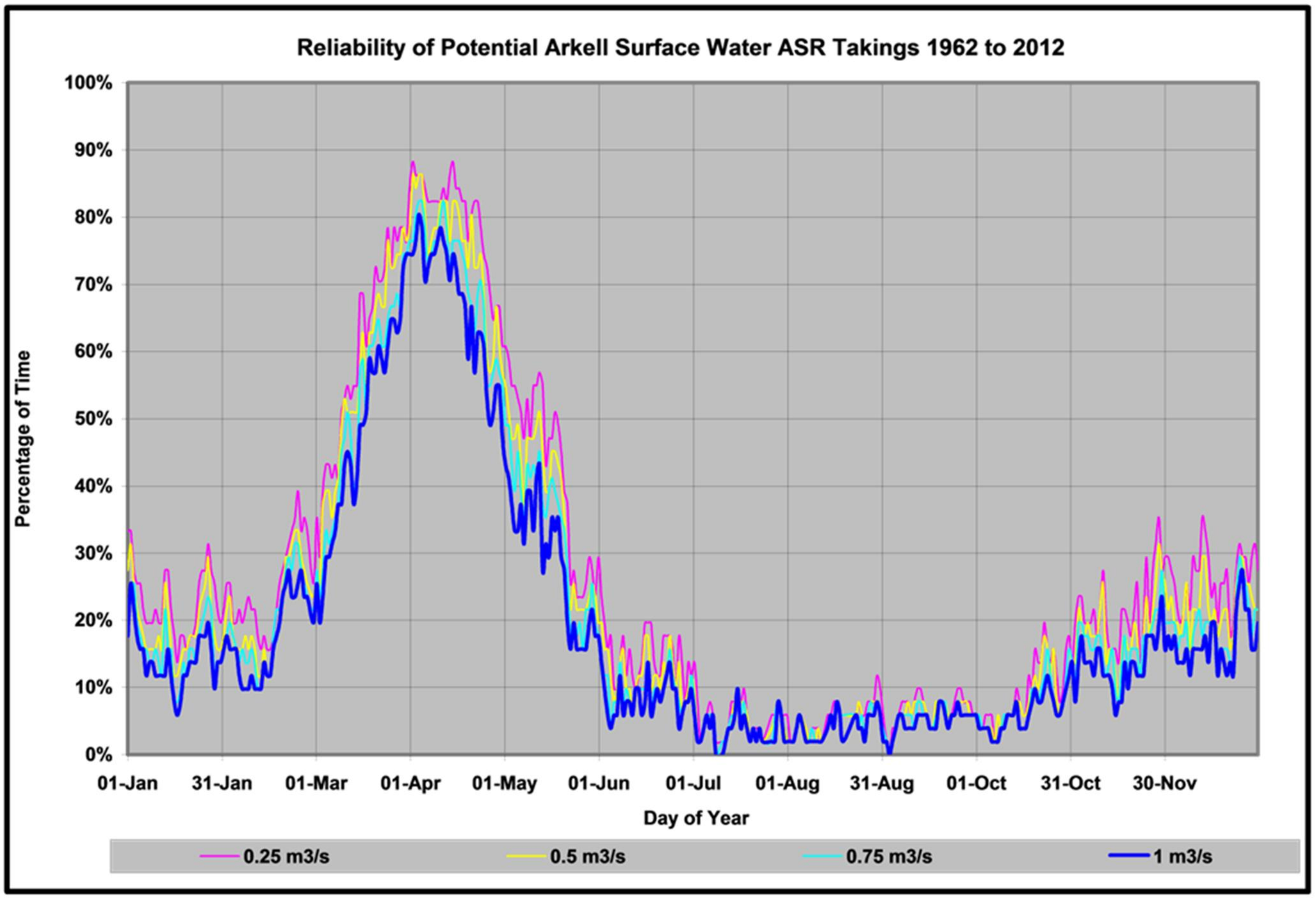


Figure 8 Potential ASR Ttaking Reliability Statistics (Increased Taking Beyond Existing Arkell PTTW)

Potential Arkell ASR Taking

An ASR taking at the Eramosa River would be confined to periods when stream flow exceeded the mean annual flow of 2.48 m^3/s. The restricted ASR taking corresponding to the mean annual stream flow is summarized in **Table 11**. The reliability of the assumed ASR taking is summarized in **Figure 8**.

Table 11 Flow and Corresponding ASR Taking

Mean Annual Flow (m^3/s)	Assumed ASR Taking (m^3/s)
Between 2.5 and 2.75	No taking
Between 2.75 and 3.00	0.25
Between 3.00 and 3.25	0.50
Between 3.25 and 3.50	0.75
Above 3.50	1.00

As shown in **Figure 8**, a continuous flow is not available for providing a constant rate supply to the distribution system. Furthermore, there is very limited potential for significant increased takings beyond the existing Arkell PTTW at any time other than the spring period. Through further discussions with GRCA, it was agreed that it may be more prudent for the City to consider optimizing existing river takings through the current permit requirements. As the existing recharge system efficiently applies a natural in-situ filtration system, it is not practical to construct a separate surface water treatment system for the highly variable seasonal flows that may be available after the current PTTW for the recharge system.

Therefore, the Surface Water and Surface Water ASR alternatives for Eramosa River are screened from further consideration.

1.4.3 Environmental Flow Considerations

Potential impacts to the flow regime were analyzed for the two reaches reviewed initially are discussed in **Appendix E**. In summary, simulated flow data for the Speed River below Guelph site was analyzed to scope the impacts of water takings for the reach downstream of the Guelph wastewater treatment plant (WWTP). The results indicate that the takings are in the normal range of variability. At this scoping level, the results suggest that there should not be a significant impact to environmental flow requirements. Impacts would have to be investigated in more detail if the ASR option is pursued.

Parish Geomorphic was contracted during the initial evaluation completed in 2006 to determine the geomorphic thresholds for the reach downstream of the Guelph WWTP. It is noted that this evaluation considered water takings of 500 L/s for several months of the year, which is greater than that currently assumed in the proposed updated alternative. Discussion with GRCA indicated that the general conclusions remain relevant. The geomorphic thresholds are used to infer the sediment transport flow thresholds that flush the river reach, flush the riffles and inundate the floodplain. The investigation completed in 2006 indicated a couple of significant points:

- The reach downstream of the Guelph WWTP is composed of a backwater and a (bedrock) riffle reach. The riffle reach would be more sensitive to changes in low flows and is likely acting as a recovery reach that helps the river recover from impacts associated with the Guelph WWTP effluent. The thresholds estimated by Parish indicate the bedrock reach flow thresholds are well above the low flow range because it is a bedrock controlled reach. Therefore the implications of the proposed ASR and Arkell takings should have little impact from a sediment transport perspective.
- Based on the more conservative river takings, during the winter months the low flow target is 1.1 m^3/s, therefore there may be occasions when the D50 threshold would not be achieved. Analysis of the base case indicates the D50 threshold would not be achieved 4.6% of the time and under the ASR condition it may not be met 6.9% of the time. This is not likely to be significant, slight adjustments to the taking scenario or operating strategy of Guelph Dam could likely address this impact.

In summary, from a scoping perspective implications to environmental flow requirements should not discount further consideration of these alternatives. More detailed analysis of the environmental impacts would be included in the further studies and investigations regarding feasibility of the surface water alternatives.

1.4.4 Surface Water Treatment

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

- continuous taking of 150 L/s – Municipal 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 process units required would include:

- screening
- pretreatment (dissolved air flotation - DAF) with coagulant

- advanced oxidation (UV/H_2O_2 /ozone for taste and odour, organics etc.) and seasonal addition of powdered activated carbon (PAC)
- filtration (dual media) with allowance for granular activated carbon (GAC)
- chlorination
- residuals management (equalization, thickening, discharge to sewer)
- allowance for connection to ASR with re-chlorination

These treatment processes were selected to ensure water quality will meet current and anticipated future water quality limits. The proposed treatment train combines conventional processes with advanced treatment technologies. Advanced oxidation and seasonal addition of PAC, as well as filtration with GAC, will remove trace organic compounds from the water and ensure it is aesthetically acceptable (free of colour, taste and odour). Coagulation and filtration will remove most of the turbidity and a large proportion of bacteria, viruses and other (Giardia cysts and cryptosporidia). Post-chlorination further ensures pathogen destruction. 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 recharge. 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 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. Estimated costs for the surface water treatment options are provided in the table below.

Summary

The total increase in a potential quantity available from a surface water treatment based on after treatment flows is 12,312 m^3/d (based on a continuous taking from Guelph Lake of 150 L/s). The assumptions and requirements for providing a WTP at Guelph Lake are documented in the attached project sheets.

Alternative: Surface Water Supply

Project: 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
Available Taking (m^3/d))	13,000 (continuous annual base taking of 150 L/s)
Production Rate (m^3/d)	12,300
Existing Approvals	none
Required Approvals	• Class EA – Schedule C • Federal Class EA • Municipal – City and Township • MNR/MOE - 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	$ 42,738,000
Cost per m^3/ day	$3,470
Annual O&M Cost	$490,543

Life Cycle Cost	$0.88/m^3 of water produced

Item No.	Item Description		Total Cost
1	Preliminary testing		$ 293,000
	WQ analysis		$ 235,000
	Approvals		$ 235,000
2	Water treatment plant intake		$ 1,000,000
3	Water treatment plant		$ 16,931,000
	Low lift pumping station Screening Pre-treatment (Dissolved Air Floatation with Coagulant) Advanced Oxidation (UV/H_2O_2 for taste and odour, organics, etc.) Powdered Activated Carbon (PAC) - seasonal addition Filtration (dual media) with allowance for granular activated carbon (GAC) Chlorination Residues Management (equalization, thickening, discharge to sewer) Allowance for connection to ASR with re-chlorination		
4	Land acquisition		$ 118,000
5	Connect to distribution system		$ 7,733,000
SUBTOTAL			**$26,545,000**
Contractor overhead and profit on SubTotal		*10%*	$2,654,500
Estimating Contingencies on Sub Total		*30%*	$7,963,500
TOTAL			**$37,163,000**
Engineering Design and Construction Services on Total		*15%*	$5,574,450
GRAND TOTAL			**$42,738,000**

Cost Assumption

- Water treatment plant intake will be 13,000 m^3/d
- Water treatment plant will produce 12,300 m^3/d after 5% water loss through treatment
- Advanced oxidation with PAC/GAC filtration is used for water treatment to meet ODWQS drinking water criteria
- Land acquisition from GRCA; location in NE corner of Guelph or in Guelph Eramosa Township

Guelph Lake Water Treatment Plant

1.4.4.1 Aquifer Storage Recovery

Aquifer Storage Recovery (ASR) 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). Recharge of the aquifer can be accomplished through injections wells, while recovery of the water is done through recovery wells. In many installations, wells are installed with dual purpose: injection and recovery, where the stored water is recovered from the same well, disinfected and then pumped to the distribution system to meet demands.

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 water treatment plant construction or expansion where capacity exceeds demand; the WTP could be operated to treat excess volumes to be stored in aquifers for future recovery. Aquifer recharge technology has been demonstrated for many years in the U.S. and Europe. It has also been 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. A similar approach is proposed for Guelph.

In concept, the ASR system would consist of a series of wells in a wellfield that would store treated water 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 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 surface water takings as well as appropriate areas to install wells to ensure optimal hydrogeological properties. Another important consideration is location of the system (including the water treatment plant, wells etc.) to ensure the most advantageous input into the distribution system from an operational perspective and to accommodate future growth and facilitate additional supply scenarios. However from a feasibility perspective, the Gasport Formation 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 is considered to be highly feasible for ASR.

Recommendations for further work include pilot testing; in order to plan and design a full-scale ASR facility; there is a need to evaluate site specific issues including water quality, geochemical reactions, aquifer hydraulics, recharge/ recovery capacity of individual wells, maximum feasible storage volume, maximum possible storage time, and treatment requirements.

This work is required to specifically address water quality issues including recharge water quality; soil and/or aquifer characteristics, recharge methodology, operational methods and microbial growth. It is necessary to study potential impacts of recharge water which could result in a decrease in ability to transmit water into aquifer storage due to clogging of aquifers. In addition, degradation of existing groundwater quality is possible due to introduction of dissolved salts or contaminants. Chemical interactions between recharge water and aquifer matrix and mixing with native groundwater can also produce detrimental geochemical reactions which can result in surface clogging or reduce 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 chemistry will establish a new equilibrium which can cause precipitation of minerals, and therefore lead to

clogging of the aquifer and reduction in recharge rates; can also cause increases in concentrations of dissolved minerals to levels above drinking water limits. While there are considerable studies to confirm the feasibility of ASR with respect to water quality issues, the investigation process is well defined and there are many existing case studies that demonstrate the feasibility of ASR in a number of different geological and hydrogeological settings.

Environmental effects could reflect changes to groundwater quality along the flowpaths of the injected water. Such changes could be negative as discussed above (i.e., precipitation of minerals within aquifer) or positive (i.e., dilution of impacted groundwater resulting from existing land use within urban areas). In many locations throughout the City, groundwater levels within the Gasport aquifer are significantly low (i.e., more than 20 m below ground surface near municipal production wells in the Northeast Quadrant). Significant quantities of groundwater injection can therefore be undertaken within these areas without losses to surface water or affecting surface drainage conditions. The intent of ASR is that on an annual basis, the ASR facility represents zero net withdrawal – therefore, no decline in groundwater levels in aquifer. Therefore, it is not anticipated that there will be any significant interference effects on existing groundwater users.

Areas to implement ASR injection:

From a hydrogeological perspective, ASR would be most effective in areas where there is high aquifer transmissivity and the potential to develop ASR wells with a corresponding high specific capacity. Areas where these conditions appear to occur in the City of Guelph included the vicinity of the Park and Emma production wells and in the vicinity of the production wells in the Southwest Quadrant (i.e. Membro). Selection of suitable recharge sites includes evaluation of local conditions and physical parameters that influence recharge rates etc. These include:

- Need to evaluate characteristics of subsurface material and aquifer: depth to water table, water quality, specific yield, soil/subsurface characteristics, storage availability,
- Nature of natural groundwater flow in area,
- Proximity to other wellfields and drawdown areas,
- Native groundwater quality,
- Proximity to distribution system and major watermains – i.e. costs to connect ASR wells to distribution system,
- Ability to locate surface water treatment plant,
- City owned property; access to or purchase of lands for construction of wells,
- Aquifer transmissivity,
- Environmental impacts of construction activities of pipelines/wells,
- Strategic placement in other well fields in service areas,
- Operational considerations: length of recharge/recovery cycles,
- Well design – recharge capacity ASR wells (recharge and recovery) can significantly reduce construction costs; designed and constructed with pumps and injection and discharge piping permanently installed.

An evaluation of the number of wells required for injection and recovery was completed by Golder (**Appendix F**).

For the purposes of evaluating this option at this point (i.e. area requirements, number of wells and the cost model), two options were assumed:

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

Other assumptions include:

- Allowance for 6 - 15 injection/extraction wells for ultimate supply; more wells are required if located at Guelph Lake.
- Cost for ASR system includes full treatment costs (i.e. includes treatment of the base municipal taking at 150 L/s)
- Approximately 4.5km of pipeline to connect WTP discharge and/or ASR wells/High Lift Pumping Station to the City system
- 100% efficiency of ASR process.

Alternative: Surface Water Supply & Aquifer Storage Recovery Wells

Project: Guelph Lake Water Treatment Plant with ASR Wells

Location	WTP at Guelph Lake/dam , ASR wells at NEQ in the vicinity of Park/Emma wells (alternative – wells in vicinity of Guelph Lake)
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 26,600 m^3/day
Existing Approvals	PTTW
Required Approvals	• Class EA – Schedule C • Federal Class EA • Municipal – City and Township • MNR/MOE - 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	$ 78,905,000
Cost per m^3/day	$ 3,060
Annual O&M Cost	$1,150,000
Life Cycle Cost	$0.75/$m^3$ of water produced

Item No.	Item Description		Total Cost
1	Preliminary exploration/testing		$1,500,000
	WQ analysis		$235,000
	Approvals - PTTW; Class EA		$352,000
2	Water treatment plant intake		$1,000,000
3	Water treatment plant (max water taking capacity)		$25,440,000
	Low lift pumping station		
	Screening		
	Pre-treatment (Dissolved Air Floatation with Coagulant)		
	Advanced Oxidation (UV/H_2O_2 for taste and odour, organics, etc.)		
	Powdered Activated Carbon (PAC) - seasonal addition		
	Filtration (dual media) with allowance for granular activated carbon (GAC)		
	Chlorination		
	Residues Management (equalization, thickening, discharge to sewer)		
	Allowance for connection to ASR with re-chlorination		
3	ASR Well construction		
	Well installation (drilling)		$3,000,000
	Well house, pumps, header, process piping, etc.		$8,431,000
5	Land acquisition		
	For WTP		$118,000
	For ASRs		$1,200,000
6	Connect to distribution system		$7,733,000
	SUBTOTAL		**$49,009,000**
	Contractor overhead and profit on SubTotal	*10%*	$4,900,900
	Estimating Contingencies on Sub Total	*30%*	$14,702,700
	TOTAL		**$68,612,600**
	Engineering Design and Construction Services on Total	*15%*	$10,291,890
	GRAND TOTAL		**$78,905,000**

Cost Assumption

- 300 L/s of water will be extracted from Guelph lake for treatment on a daily basis except for summer months when the water intake will be 150 L/s
- The amount to be stored in the ASR wells equals 300 L/s less the system demand at that time
- The ASR wells will be located in the NEQ in the vicinity of Park/Emma/Helmar well
- Total number of ASR wells is 6 (only if located near Park/Emma/Helmar well); 15 if located near Guelph Lake
- The aquifer can sustain the estimated withdrawal pumping rate over shorter durations
- ASR well efficiency is 100%
- Advanced oxidation with PAC/GAC filtration is used for water treatment to meet ODWQS drinking water criteria
- 5% of the total feed water is lost during the treatment process

Guelph Lake Water Treatment Plant with ASR Wells

Summary

The total increase in a potential quantity available from a surface water treatment and ASR system based on after treatment flows is 25,825 m^3/d (based on a continuous taking from Guelph Lake of 150 L/s and a step taking of 300 L/s). The assumptions and requirements for providing a WTP at Guelph Lake and two ASR options are documented in the above project sheet.

Table 12 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.

Table 12 Capital Cost to Construct Surface Water Alternatives

Item ID	Item Description	Guelph Lake WTP	Guelph Lake WTP + ASR
1	Preliminary Testing	$250,000	$1,500,000
	WQ Analysis	$200,000	$235,000
	Approvals	$200,000	$352,000
2	Water Treatment Plant Intake	$1,000,000	$1,000,000
3	Water Treatment Plant	$14,450,000	$25,440,000
	Low lift pumping station		
	Screening		
	Pre-treatment (Dissolved Air Floatation with Coagulation)		
	Advanced Oxidation (UV/H_2O_2 for taste and odour, organics, etc.)		
	Powdered Activated Carbon (PAC) – seasonal addition		
	Filtration (dual media) with allowance for granular activated carbon (GAC)		
	Chlorination		
	Residues Management (equalization, thickening, discharge to sewer)		
	Allowance for connection to ASR with re-chlorination		
4	ASR well construction		$11,431,000
5	Land acquisition	$100,000	$1,318,000
6	Connect to distribution system	$6,600,000	$7,733,000
	Subtotal	**$22,800,000**	**$49,009,000**
	Contractor Overhead (10%)	$2,280,000	$4,900,900
	Estimating Contingency (30%)	$6,840,000	$14,702,700
	Total	**$31,920,000**	**$68,612,600**
	Engineering and Construction Services (15%)	$4,788,000	$10,291,890
	Grand Total	**$36,708,000**	**$78,905,000**

1.4.5 Surface Water Alternatives Summary

The estimated volume from groundwater and surface water alternatives is applied to the demand projections with and without conservation in **Figure 9** and **Figure 10**. **Figure 9** indicates the ability of the surface water alternatives to provide required water supply capacity to meet projected demand excluding any additional groundwater

alternatives; **Figure 10** assumes that all groundwater alternatives are first constructed and that surface water alternatives are implemented subsequently to meet demands beyond 25 years. It is prudent to consider this possibility within this study period as the required studies and investigations for the surface water alternatives would need to be initiated years in advance of implementation.

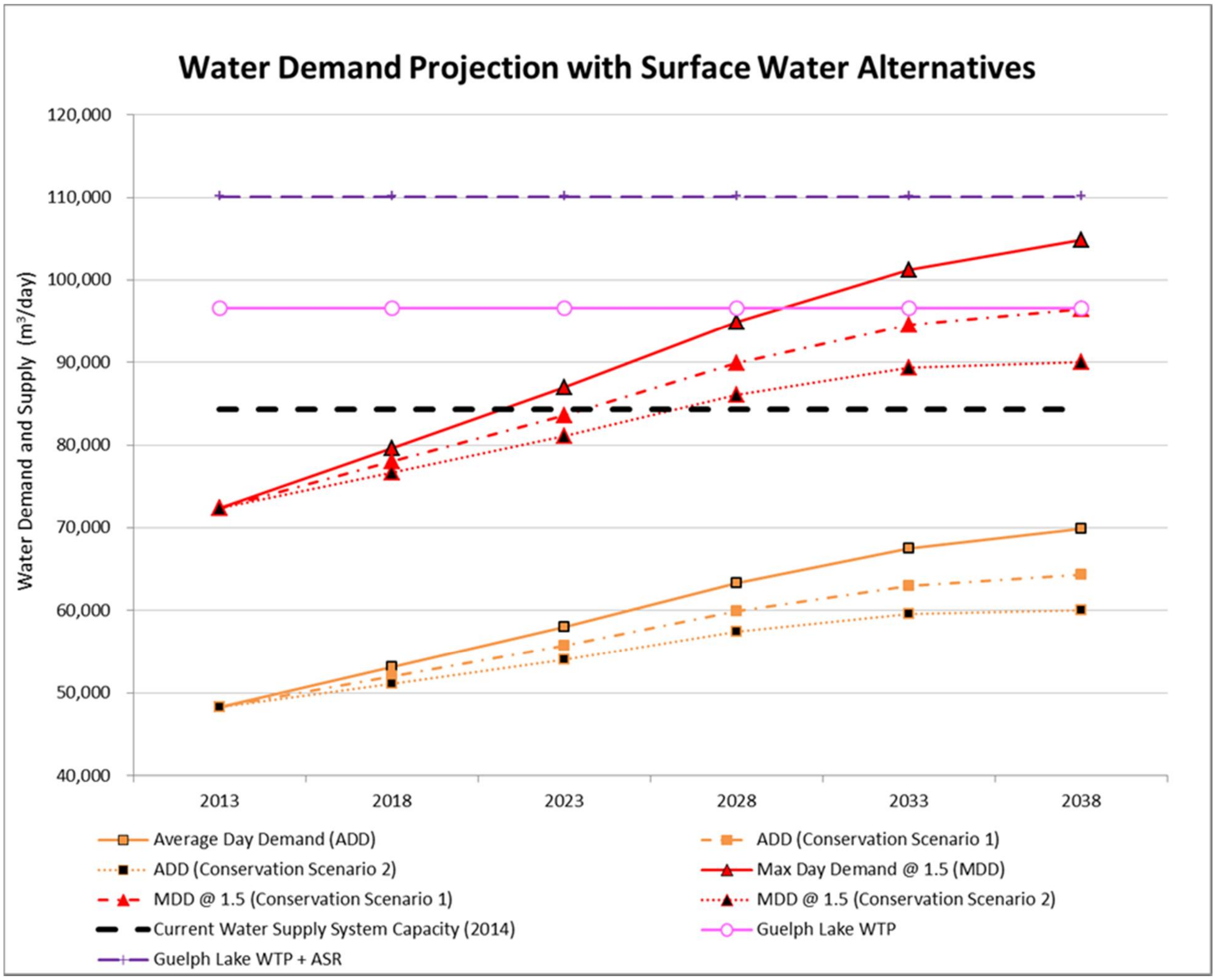


Figure 9 Water Demand Projections with Surface Water Alternatives

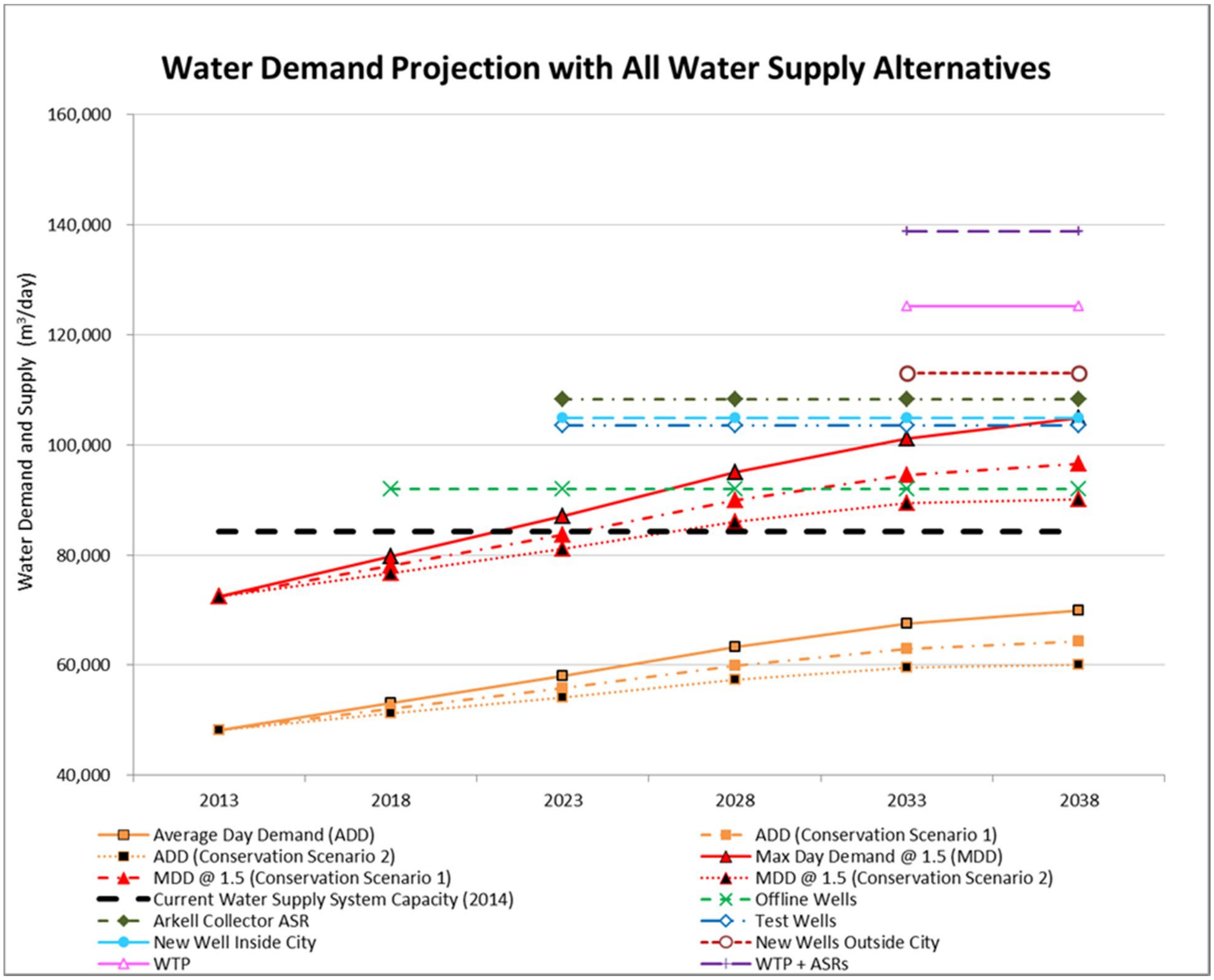


Figure 10 Water Demand Projection with All Water Supply Alternatives

1.5 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 change to municipal planning documents which would not meet Provincial growth targets. This alternative does not meet the Purpose Statement for the project, and therefore, is not carried forward as part of the preferred alternative.

1.6 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.

2. Preliminary Evaluation of Alternatives

Each potential alternative is to be assessed using a consistent approach and evaluation criteria. The suggested evaluation will be qualitative – not a numerical ranking system – and will consider the suitability of alternative solutions and strategies based on significant advantages and disadvantages. Comparisons and trade-offs will be made between alternatives and will form the rationale for the identification of the preferred solution or water supply strategy.

Preliminary evaluation tables were developed to include the comparison of each alternative relative to other alternatives. The summary comparison was shown in the form of a pie chart with all white having the most positive/lowest impact and all black having the most negative/highest impact.

These draft evaluation tables were presented to the public in the Community Liaison Committee meeting #2, the Agency and Municipality workshop #2, a Water Conservation and Efficiency Public Advisory Committee meeting and at the Community Open House #2 meeting, to solicit comments and feedback. The final versions of the tables are to be provided in the WSMP update report.

Natural Environment Considerations for Alternatives is provided in **Appendix G**.

3. References

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Appendix A

Guelph Water Supply Master Plan Update
TM3: Water Supply Alternatives (Draft Final)

Assessing Effectiveness of Water Efficiency Strategy

By Gauley Associates Ltd.

CITY OF GUELPH

Assessing Effectiveness of Water Efficiency Strategy

Final Report

January 22, 2014

Gauley Associates Ltd.: Bill Gauley, P.Eng., Principal

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1. INTRODUCTION

The analysis documented in this report has been completed to assess the success of Guelph's *Water Conservation and Efficiency Program* for the years 2006 – 2012. Specifically, this report is intended to:

- verify the water savings achieved by the various water efficiency measures implemented by the City during this period,
- assess contribution of "direct" water savings (i.e., savings *directly* attributable to the implementation of water efficiency measures), "indirect" water savings (i.e., savings achieved by the City's marketing and outreach programs), and "natural" water savings (i.e., savings achieved by City residents and businesses that are unrelated to the City's *Water Conservation and Efficiency Program)*,
- estimate the overall financial value of the *Water Conservation and Efficiency Program* to the City,
- estimate the probable impact of water reuse measures (e.g., rainwater harvesting and greywater reuse) on total system demands, and
- estimate effects of water efficiency on short-term and long-term demands.

Guelph, one of the largest cities in Canada completely dependent on groundwater, has a long history of environmental stewardship and leadership dating back to the development of their 1999 *Water Conservation and Efficiency Study*. While many municipalities claim to pursue a leadership role, Guelph's commitment to leadership is clearly stated in their 2007 *Community Energy Plan* and 2007 *Strategic Plan*. Both of these documents explicitly state the goal of Guelph to use less water and energy on a per capita basis than any comparable Canadian city.

As changes are happening very quickly in the field of water efficiency, it is prudent for municipalities to conduct periodic assessments of the effectiveness of their long-term water efficiency strategies. This report represents the results of the most recent assessment.

2. DATA SOURCE

The data used for this study includes customer water billing data, population data, program participation data on a measure-by-measure basis, program cost data, and various reports provided by the City, as well as relative web-based info, etc.

3. TREATMENT OF DATA

Customer water billing data were provided on a monthly or bimonthly basis. These data were aggregated into average annual day demands, average summer day demands, and average winter (i.e., indoor) day demands on a year-by-year basis.

Customer billing records that showed no water demand for the billing cycle (or negative demands) were not included in the analysis[1].

4. RANGE IN CUSTOMER BILLING DATA

The residential customer water billing data included demands that ranged from extremely small (equivalent to only a couple of litres per capita per day, Lcd) to extremely large (equivalent to more than 3,000 Lcd). Table 1 in the November 2013 *Mining Guelph's Customer Water Meter Data* Report by Mike Fortin illustrates that 10% of the City's total residential water demand is used by 23% of the residential customers with the lowest demands consume, yet another 10% of the demand is used by only 3% of residential customers with the highest demands.

Most of the billing data demands were more 'typical'. For example, 90% of residential customer demands during the final six months of 2012 were between 4 Lcd and 395 Lcd. Figure 1 illustrates the wide range in average daily single-family home per capita demands for this period. It can be seen in Figure 1 that while most of the demands are less than 500 litres per capita per day (Lcd), a very few "outlier" demands are greater than 1,000 Lcd (with one account having demands greater than 9,000 Lcd). Note that the 'per capita' water demand analysis was based on each home having 3.0 persons. Since the actual number of persons per home (pph) can vary significantly, per capita demand values for individual accounts can be misleading (either much higher or much lower than the true value). For this reason, most of the analysis contained in this report is based on *average* per capita demand values using large data sets to help mitigate the effects of both large and small outliers.

Figure 2 illustrates the much smaller range in demand per account values of all but the top 5% of per account demands. The shape of the demand range curve in Figure 2, which represents 95% of single-family residential accounts, is much more indicative of a 'normal distribution' of demands without extreme *high demand* outliers. While Figure 1 and Figure 2 are examples of demands for the final six months of 2012, the same type of demand range occurs throughout the customer billing database.

[1] Negative customer water demands were only observed in 2012 billing data.

While the age and efficiency of water-using fixtures and appliance used by residential customers can vary somewhat, as can the number of persons living in each home, water demands in the single-family customer sector are far more consistent and predictable than those in the multi-family and ICI customer sectors. For this reason, a significant portion of the data analysis contained in this report is related to average water demands observed in the single-family customer sector. Of course, an evaluation of the trends observed in overall production data and total customer consumption data is also included in this report.

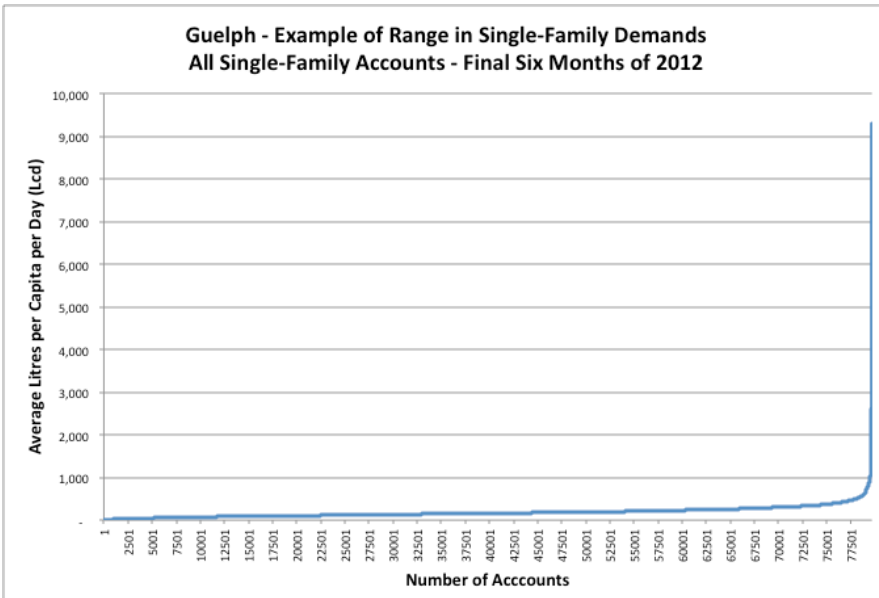

Figure 1

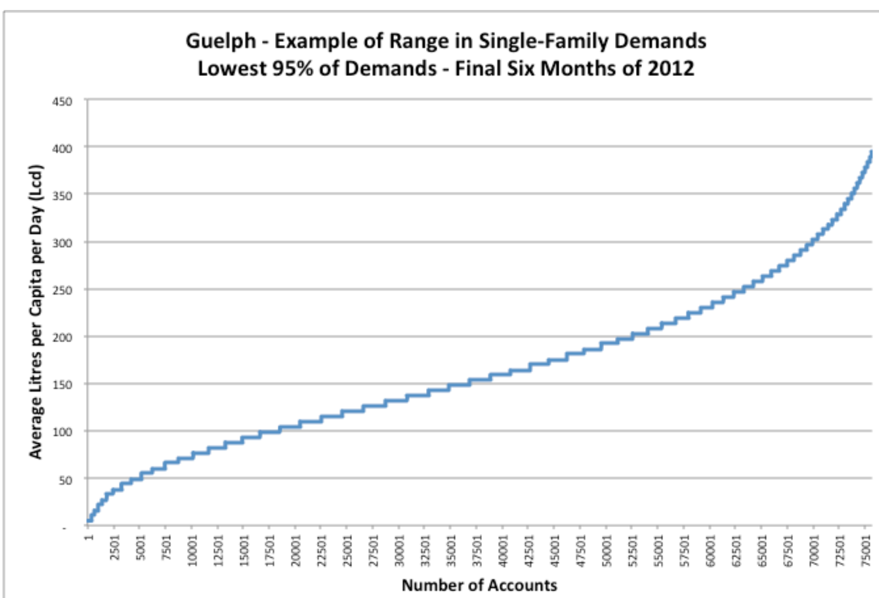

Figure 2

5. RESULTS OF THE ANALYSIS

5.1 Demand Trends

The primary focus of the analysis outlined in this report is from 2006 to 2012 (full data for 2013 not being available at the time of writing).

It is understood that per capita water demands have been generally declining in virtually every municipality in North America for approximately the last decade[2] - primarily because of the market shift towards the use of high-efficiency clothes washers and toilets. The water savings related to this market shift is referred to as "natural" savings, whereas any water savings in excess of this natural savings and resulting from the implementation of a water efficiency program or strategy is referred to as either "direct" savings (e.g., physical improvements made to customer fixtures or appliances specifically because of incentives offered by the municipality, or improvements made to the physical systems operated by the municipality) or "indirect" savings (e.g., improvements in water use behavior or the implementation of physical improvements independently of municipal incentives).

The first step in analyzing the water savings achieved by Guelph's Water Efficiency Water Conservation and Efficiency Study is to determine the total reduction in water demands (i.e., the total water savings) during the study period including all three elements of savings – direct savings, indirect savings, and natural savings.

5.2 Water Production / Water Demand

The water savings achieved in Guelph between 2006 and 2012 can be calculated using population, water production, and water demand data. The calculation assumes that the relationship between large-water-using industrial, commercial, or institutional (ICI) customers and the total City population has remained relatively constant during this time (i.e., that there has not been a significant influx of large ICI customers into or out of the City during this time).

Table 1 and Figure 3 illustrate population values, water production values, and water demand between 2006 and 2012. While the City's population increased by approximately 9,210 persons (about 8.0%) during this time, total water production fell by about 6,143 m^3 per day (about 12.0%). Note that production values are presented as million litres per day (MLd) and litres per capita per day (Lcd).

[2] *Insights into Declining Single Family Residential Water Demands*, June 2012, Aquacraft Inc.

Table 1: Population, Water Production, and Water Demand Values

Year	Population	Production MLd	Production Lcd	Demand MLd	Demand Lcd
2006	115,040	51.4	447	43.6	379
2007	116,766	51.0	437	43.2	370
2008	118,491	48.5	409	40.4	341
2009	120,491	46.6	387	39.1	324
2010	121,093	44.4	367	38.7	319
2011	123,000	45.6	371	39.4	321
2012	124,250	45.2	364	38.3	308

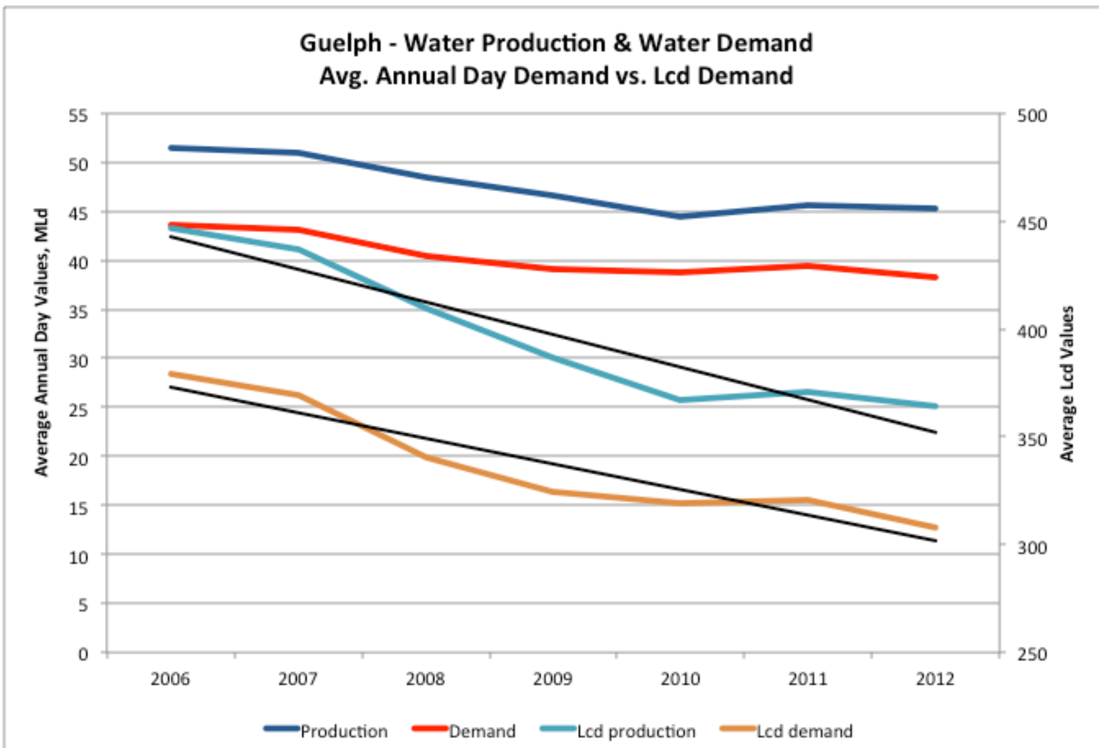

Figure 2

Water production and demand values naturally fluctuate slightly from year to year based on variables such as local weather conditions. As such, it is useful to look at the overall *trend* in these values vs. the actual values for individual years. Table 2 presents the trends in the Lcd values based on a linear regression analysis of the 2006 to 2012 values. The average reduction in water *production* during this period, based on this trend, is 15.1 Lcd per year. The average reduction in water *demands* during this period is 11.9 Lcd per year.

- **Average Decline in <u>Production</u> 2006-12: 15.1 Lcd**
- **Average Decline in <u>Demand</u> 2006-12: 11.9 Lcd**

Table 2: Total Water Production & Trend in Production Lcd Values

Year	Production Lcd	Production Trend Lcd	Demand Lcd	Demand Trend Lcd
2006	447	443	379	373
2007	437	428	370	361
2008	409	412	341	349
2009	387	397	324	337
2010	367	382	319	326
2011	371	367	321	314
2012	364	352	308	302
Annual Reduction - Trend Values		**15.1**	-	**11.9**

5.3 Production Water Savings

Historically, water production in most municipalities increases or decreases more or less in concert with changes in population. In Guelph, however, water production has declined both in real terms and in per capita terms since 2006, even though population has increased by approximately 8.0%. Whereas total production declined by 6,143 m^3/day or 12.0% between 2006 and 2012, this value does not include the impact of the growing population. The true overall water savings achieved during this period is calculated as the difference between the volume of water that *was* produced between 2006 and 2012 (based on the trend in production values) and the volume of water that *would have been* produced if the gross per capita water demand had remained constant at the 2006 *trend* value of 443 Lcd. Table 3 illustrates the water savings achieved on an annual basis as well as the total volume of water saved between 2006 and 2012 of 14,200 million litres (ML). Figure 4 illustrates the growth in population, the trend of actual production values, and the projected production values if gross per capita demands had remained at the 2006 *trend* value of 443 Lcd.

Table 3: Actual vs. Projected Production – Annual and Cumulative Savings

Year	Actual Production (trend) MLd	Projected Values at 443 Lcd MLd	Annual Savings ML	Cumulative Savings ML
2006	50.9	51.0	0	0
2007	49.9	51.7	656	656
2008	48.9	52.5	1,320	1,975
2009	47.9	53.4	2,007	3,982
2010	46.3	53.6	2,685	6,667
2011	45.2	54.5	3,406	10,073
2012	43.7	55.0	4,127	**14,200**

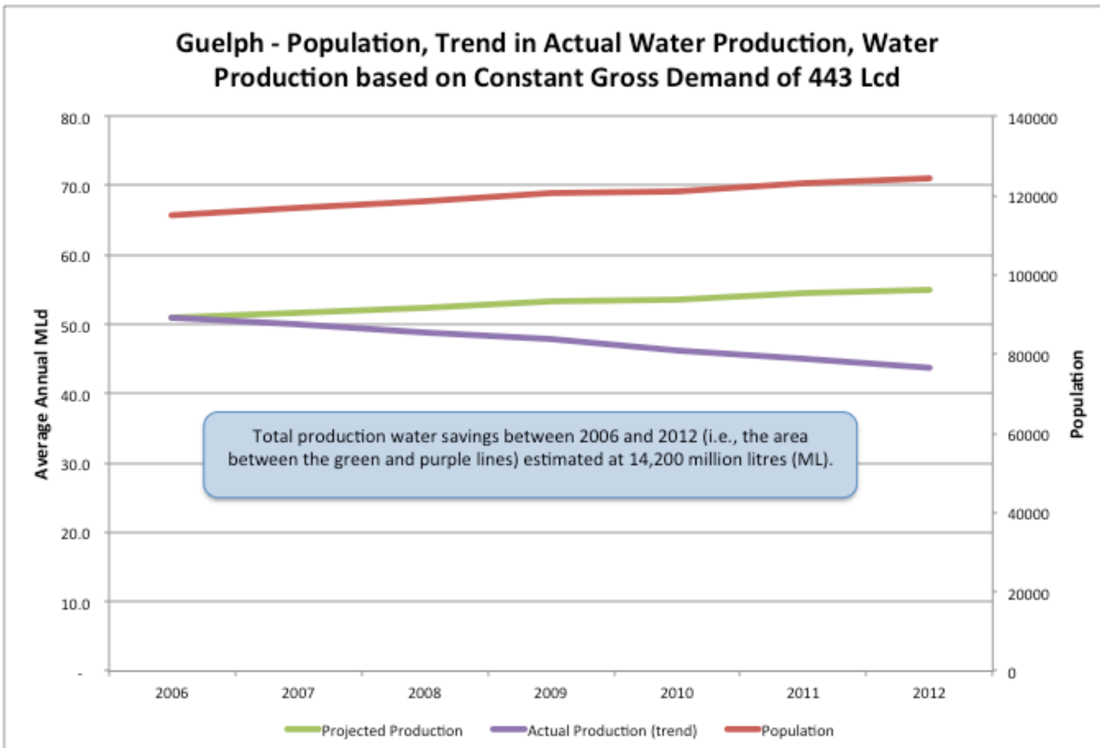

Figure 4

5.4 Demand Water Savings

While Guelph's water *production* values declined between 2006 and 2012, most of this reduction was due to lower water *demands*. Water *demands* have also declined both in real terms and in per capita terms since 2006 even though population has increased by about 8.0%. Whereas total demand has declined by 5,447 m^3/day or 12.5% between 2006 and 2012, this value does not include the impact of the growing population. The true overall water savings achieved during this period is calculated as the difference between the *actual* volume of water demands between 2006 and 2012 (based on the trend) and the *projected* volume of water demands if the gross per capita water demand remained constant at the 2006 trend value of 373 Lcd. Table 4 illustrates the water savings achieved on an annual basis as well as the total water saved between 2006 and 2012 of 11,094 million litres (ML). Figure 5 illustrates the growth in population, the trend of actual demand values, and the projected demand values if gross per capita demands had remained at their 2006 value of 373 Lcd.

Table 4: Actual vs. Projected Demand – Annual and Cumulative Savings

Year	Actual Production (trend) MLd	Projected Values at 373 Lcd MLd	Annual Savings ML	Cumulative Savings ML
2006	42.9	42.9	0	0
2007	42.2	43.6	506	506
2008	41.4	44.2	1,027	1,533
2009	40.7	44.9	1,566	3,099
2010	39.4	45.2	2,099	5,198
2011	38.6	45.9	2,665	7,863
2012	37.5	46.3	3,231	**11,094**

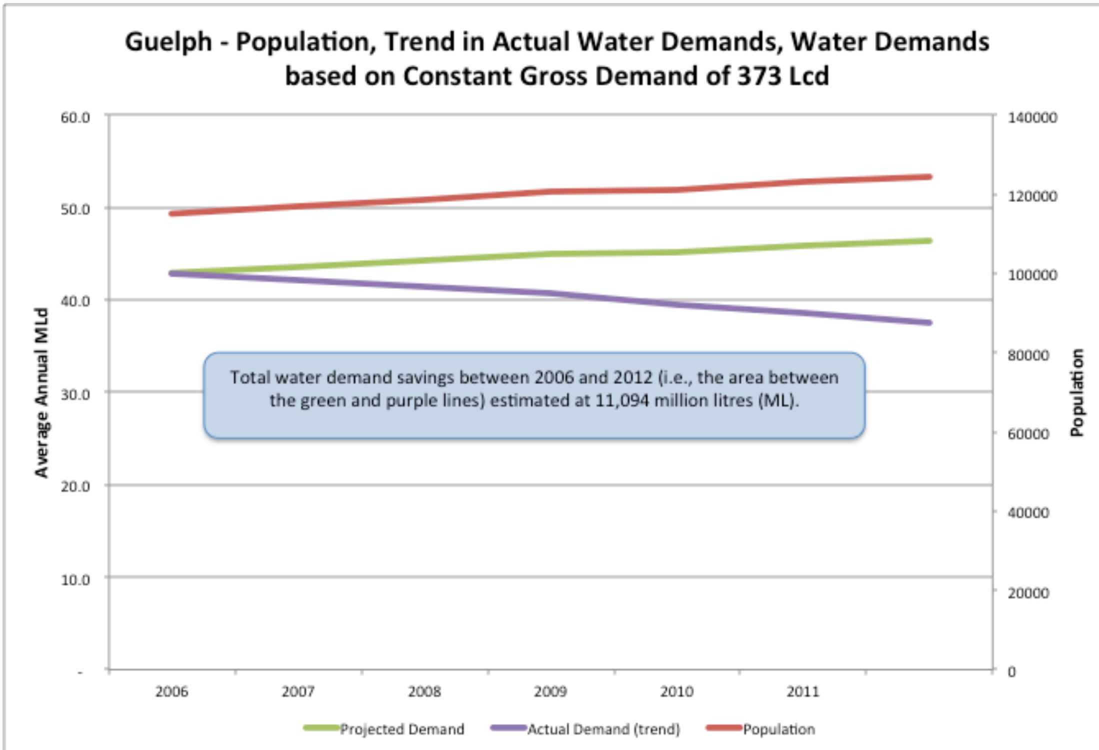

Figure 5

5.5 Non-Revenue Water

As illustrated in the previous sections, most of the reduction in total water production has been the result of a reduction in consumption (demands). The difference between *production* savings and *demand* savings is related to changes in non-revenue water (NRW).

- Decline in Production (2006–2012) = 14,200 ML
- Decline in Demand (2006–2012) = 11,094ML
- Decline in NRW (2006–2012) = 3,106 ML

The reduction in NRW could be a reduction in real loss (leakage) and / or a reduction in apparent water loss. The City implemented a *Pilot Leakage Reduction Program* beginning in 2011. This program resulted in the repair of a number of leaks. The volume of water saved by repairing leaks in 2011 has been estimated as approximately 478 ML. An additional 172 ML of leak reduction was achieved by Guelph's program in 2012. Assuming that the leakage savings achieved in 2011 was sustained in 2012, the total volume of leakage reduction assigned to the Pilot Program between 2006 and 2012 would be 1,128 ML (i.e., 478 ML in both 2011 and 2012, plus 172 ML in 2012). It is important to remember that water system leaks can occur at any

time – as some leaks are repaired, other leaks can form[3]. It is also probable that a number of leaks were identified and repaired by City staff outside the scope of the Pilot Program. That said, with a total decline in NRW of approximately 3,106 ML between 2006 and 2012, and an estimated reduction in real losses of about 1,128 ML during the same time, it appears likely that the total NRW reduction experienced by Guelph includes components related to *both* real and apparent losses.

- **Reduction in NRW (2006 – 2012): 3,106 ML**

5.6 Industrial, Commercial, Institutional Savings

The November 2013 report *Mining Guelph's Customer Water Meter Data Report*[4] contained information regarding the number of accounts in the industrial, commercial, and institutional (ICI) customer sectors, along with the average water use per customer per month. Table 5 presents the trend in average daily water demand per ICI sector and the number of accounts in each ICI customer sector based on the assumption that the ratio of accounts-to-population has remained relatively constant during the years 2006 through 2012.

Table 5: Number of ICI Accounts and Daily Demand Trends per Sector

	Industrial		Commercial		Institutional	
Year	# accounts	m^3/day	# accounts	m^3/day	# accounts	m^3/day
2006	383	10,667	805	4,002	156	5,278
2007	389	10,319	817	3,909	158	4,871
2008	395	8,656	829	3,653	160	4,844
2009	401	8,686	843	3,487	163	5,127
2010	403	9,374	847	3,694	164	5,035
2011	410	10,068	860	3,922	166	4,629
2012	414	10,546	869	3,773	168	4,780

Based on a proportional number of ICI customers vs. total population, average demands in the ICI customer sectors has declined from approximately 173.5 Lcd in 2006 to about 153.7 Lcd in 2012 – a reduction of about 19.8 Lcd in 6 years, or an average decline of about 3.3 Lcd per year. This savings can be described as an average reduction of 0.74 Lcd per year in the Commercial sector, 1.32 Lcd in the industrial sector, and 1.23 in the Institutional sector.

[3] Note that this calculation does not include leakage savings achieved prior to 2011 or after 2012.
[4] Prepared by Mike Fortin

As can be seen in Figure 6, ICI water demands vary from year to year - especially industrial demands. While the R^2 value[5] of the demand trendlines for the institutional and commercial customer classes is relatively low, average per customer water demands in these sectors are clearly declining. The average per customer water demand in the industrial customer sector, however, has actually increased since the economic downturn in 2008-2009. The R^2 value for the trend in industrial sector water demands is *extremely* low (only 0.10), indicating that this trendline is not a good indicator of future demands. It is likely that the improvement in the economy since 2008 was largely responsible for the increase in average water demands in the industrial customer sector as companies have "ramped up" production.

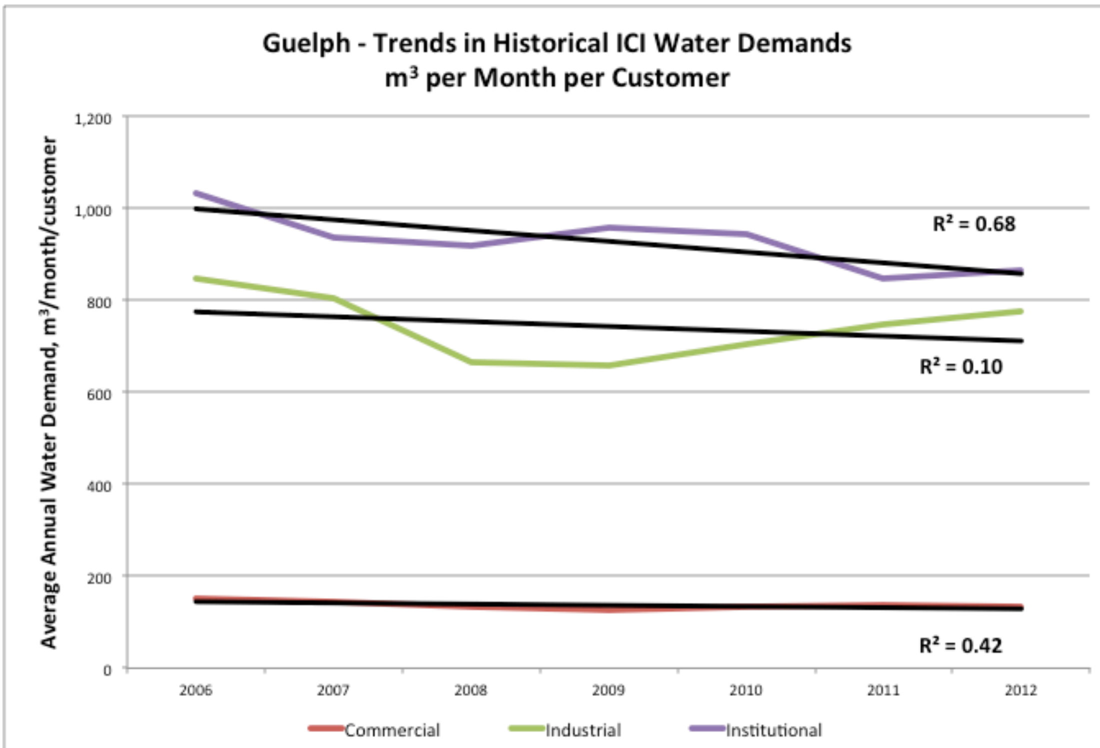

Figure 6

An analysis was completed to estimate the volume of water savings achieved in the ICI customer sectors. The analysis compared *actual* demands in the industrial, commercial, and institutional sectors to the *projected* demands in each sector if the average per customer water demand had remained at 2006 levels. Table 6 and Figure 7 illustrate the results of this analysis.

[5] The R^2 value indicates how well the trendline represents the actual data set. A high R^2 value indicates a good fit. A value of 1.0 indicates a perfect fit.

Based on this analysis, the total volume of water savings in the ICI customer sectors between 2006 and 2012 is approximately 2,621 ML. The actual volume of water savings achieved by Guelph's ICI Capacity Buy-Back (CBB) Program, assuming that participating facilities maintain their achieved water savings in subsequent years[6], is 1,565 ML.

As such, the total savings in the ICI customer sector between 2006 and 2012 is approximately 1,056 ML greater than the volume of water directly achieved by the City's Capacity Buy-Back program. This type of "natural" savings is anticipated as at least some existing ICI facilities would be expected to implement efficiency measures without participating in the City's program and newly constructed ICI facilities would be expected to employ equipment and processes that are relatively efficient compared to existing stock. It is assumed for the sake of analysis that the total non-direct savings of 1,056 ML in the ICI customer sector is split evenly between indirect and natural savings, i.e., 528 ML of indirect savings and 528 ML of natural savings.

Table 6: Estimated Savings in ICI Customer Sectors

Year	Industrial		Commercial		Institutional	
	Actual Trend ML/Year	**Projected ML/Year**	**Actual Trend ML/Year**	**Projected ML/Year**	**Actual Trend ML/Year**	**Projected ML/Year**
2006	3,568	3,568	1,400	1,400	1,866	1,866
2007	3,572	3,622	1,395	1,421	1,849	1,894
2008	3,575	3,675	1,390	1,442	1,831	1,922
2009	3,584	3,737	1,387	1,466	1,816	1,954
2010	3,551	3,756	1,368	1,473	1,779	1,964
2011	3,555	3,815	1,362	1,497	1,760	1,995
2012	3,538	3,854	1,349	1,512	1,731	2,015
Totals	**24,943**	**26,027**	**9,651**	**10,210**	**12,633**	**13,611**
-	Savings	1,084	Savings	559	Savings	978
					Total Savings 2007 - 2012	**2,621**

[6] For example, that the approximately 114 ML of water savings achieved by the City's 2007 Capacity Buy-Back Program is sustained is subsequent years.

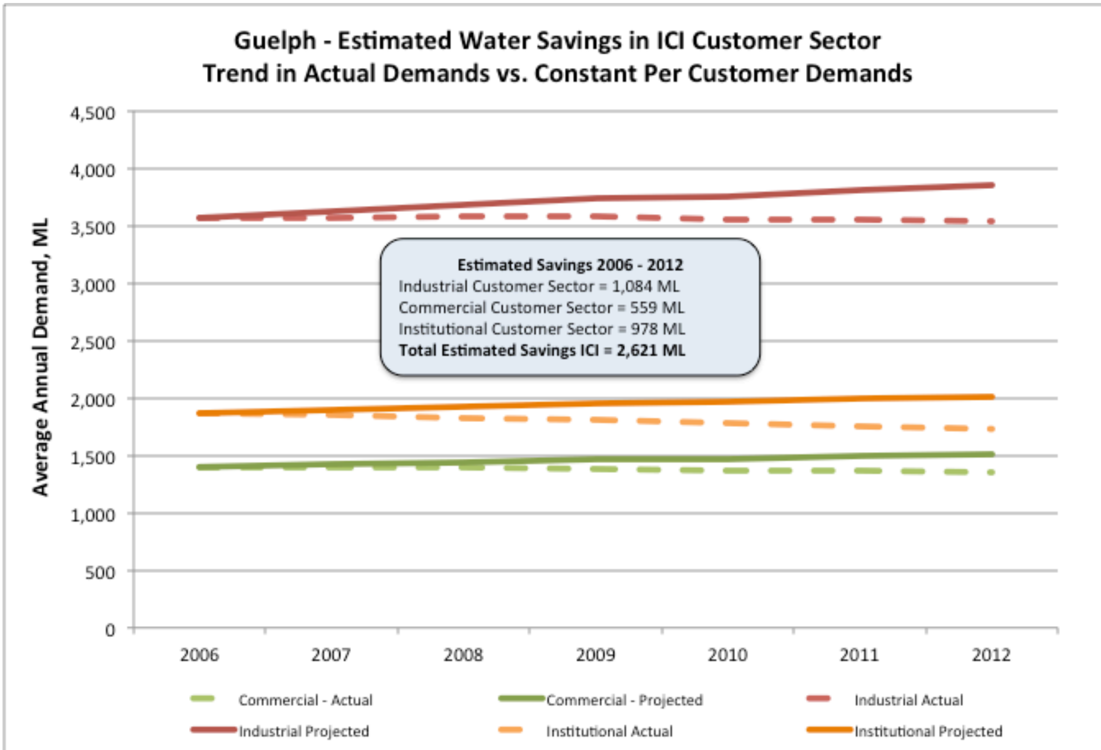

Figure 7

- Total Savings in ICI sector (2007-2012) = 2,621 ML
- Direct Savings (2007-2012) = 1,565 ML
- Indirect Savings (2007-2012) = 528 ML
- Natural Savings (2007-2012) = 528 ML

5.7 Single-Family Savings - Indoors

Figure 8 illustrates average daily water demands in the single-family home customer sector on a month-by-month basis from 2006 to 2012. Note that, although summer demands are largely dependent on local weather conditions, winter (indoor) demands appear to be declining each year in a relatively uniform manner.

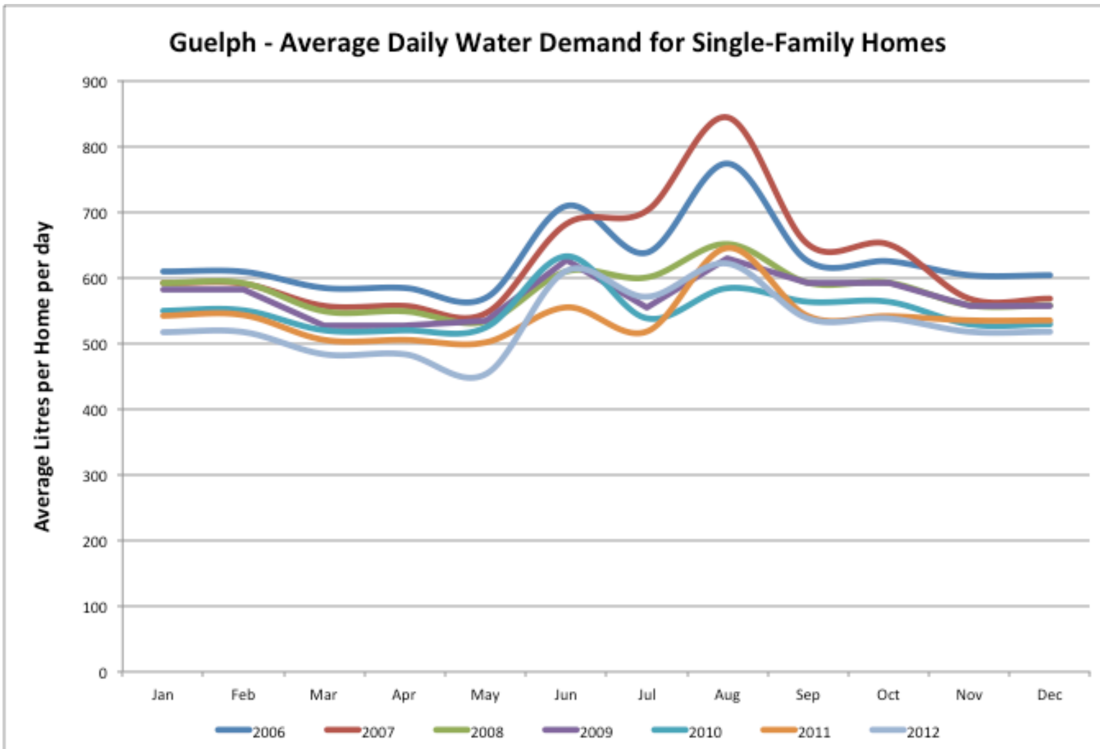

Figure 8

Figure 9 presents the historical single-family water demand data as average annual day demands per single-family home. It can be seen that the average decline in indoor (winter) single-family demands is very linear; in fact, the R^2 value of the trendline describing these demands is very high at 0.95 (an R^2 value of 1.0 indicates a perfect relationship). The average rate of demand decline during this period is 13.7 litres per day per home per year. Note that the difference between per home summer and winter water demands is minimal between 2008 and 2011 (inclusive), indicating relatively little irrigation occurred during these years. Summer demands (i.e., irrigation) increased slightly in 2012 likely due to local weather conditions.

Based on an average occupancy rate of 3.0 persons per single-family home, the reduction in household demands equates to 4.6 litres per capita per day (Lcd) per year between 2006 and 2012, see Figure 10.

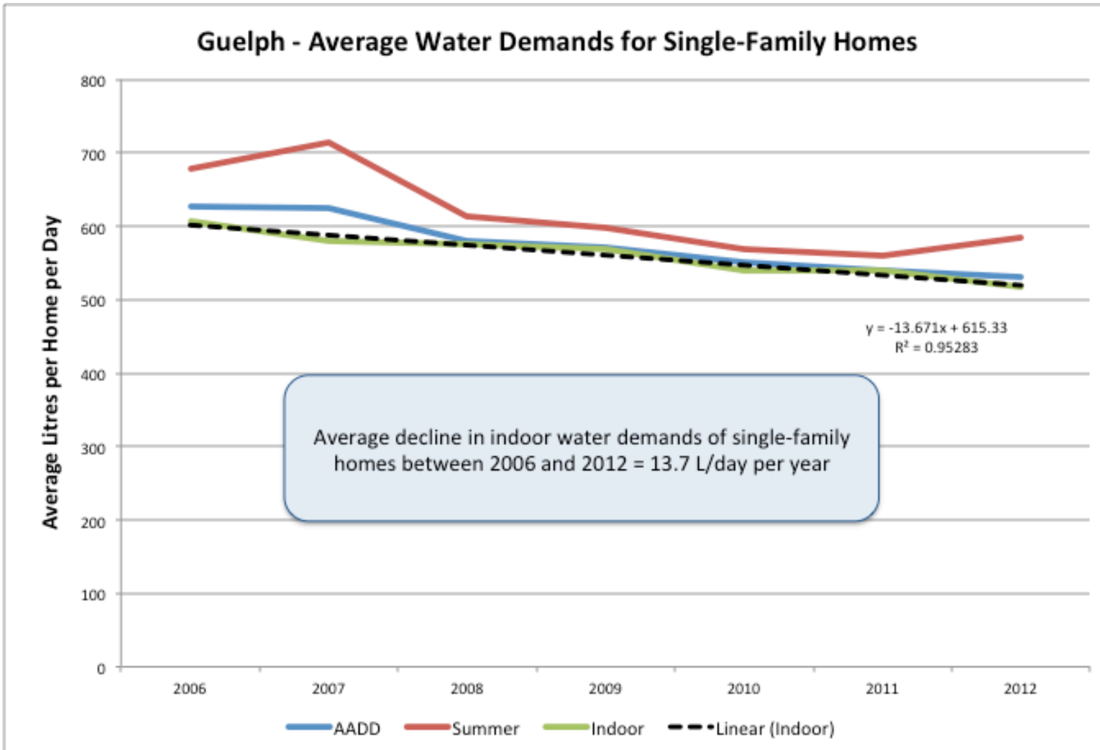

Figure 9

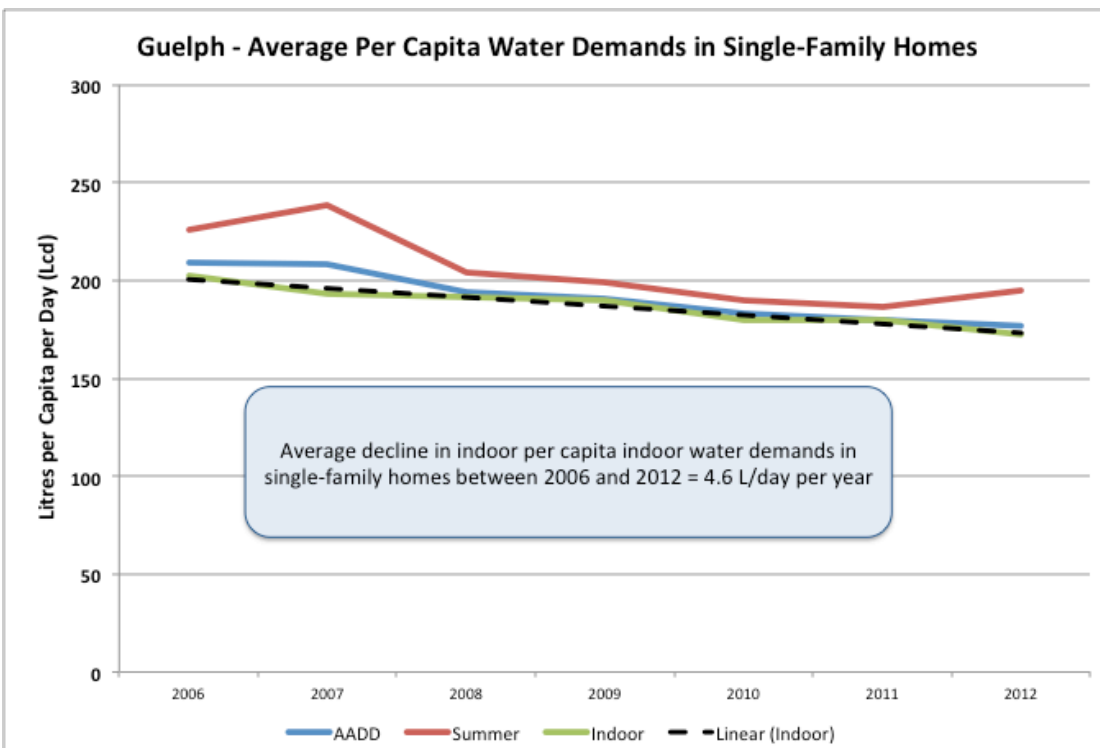

Figure 10

The serviced population of Guelph (i.e., the number of persons serviced by the municipal water supply system) in 2012 was currently approximately 124,250 persons. Approximately 75% of the serviced population lives in what would be considered single-family (S-F) homes; the remaining 25% live in multi-family (M-F) buildings. Approximate population values for the years 2006 through 2012 are provided in Table 7. Table 8 identifies the approximate number of serviced single-family homes based on an average occupancy rate of 3.0 persons per home.

Table 7: Historical Population Values

Year	Population	Single-Family Population	Multi-Family Population
2006	115,040	86,280	28,760
2007	116,766	87,575	29,192
2008	118,491	88,868	29,623
2009	120,491	90,368	30,123
2010	121,093	90,820	30,273
2011	123,000	92,250	30,750
2012	124,250	93,188	31,063

Table 8: Historical Number of Serviced Single-Family Homes

Year	Serviced S-F Population	Approx. # of Serviced S-F Homes
2006	86,280	28,760
2007	87,575	29,192
2008	88,868	29,623
2009	90,368	30,123
2010	90,820	30,273
2011	92,250	30,750
2012	93,188	31,063

Table 9 illustrates actual demands in the single-family sector based on the historical trend vs. projected demands in this sector had indoor and average annual per demands remained at the 2006 level of 200.5 Lcd. The total volume of indoor savings in Guelph's single-family customer sector between 2006 and 2012 is estimated as 3,184 ML. A significant portion of this savings is directly related to the implementation by the City of a number of single-family water efficiency measures, including: toilet rebate, clothes washer rebate, humidifier rebate, waterless floor drain rebate, and development of the Blue Built Home program. Assuming that the savings achieved by each of these measures is sustained, the total direct water savings in this customer sector between 2006 and 2012 is 2,040 ML, or about 64% of the total savings achieved. Assuming the split between indirect and natural savings in the single-family sector are similar, the total of 1,144 ML non-direct savings would be divided as approximately 572 ML (18%) indirect savings and 572 ML (18%) natural savings that were not impacted by the City's programs.

Table 9: Trend in Actual Single-Family Indoor Water Demands vs. No Savings Scenario

Year	Serviced S-F Population	Indoor Lcd (trend)	ML / Year (trend)	ML / Year at 200.5 Lcd
2006	86,280	200.5	6,314	6,314
2007	87,575	196.0	6,265	6,409
2008	88,868	191.4	6,208	6,504
2009	90,368	186.9	6,165	6,613
2010	90,820	182.3	6,043	6,646
2011	92,250	177.8	5,987	6,751
2012	93,188	173.2	5,891	6,820
		Total Demands, ML	**42,874**	**46,057**
		Total Savings, ML	**3,184**	

5.8 Single-Family Savings - Outdoors

When average annual demands are evaluated, the total water savings in the single-family sector between 2006 and 2012, including both indoor and outdoor demands, is approximately 4,133 ML. Table 10 illustrates actual demands in the single-family sector based on the historical trend vs. projected demands in this sector had average annual day demands remained at the 2006 level of 209.4 Lcd.

Table 10: Trend in Actual Single-Family Indoor Water Demands vs. No Savings Scenario

Year	Serviced S-F Population	AADD Lcd (trend)	ML / Year (trend)	ML / Year At 209.4 Lcd
2006	86,280	209.4	6,593	6,593
2007	87,575	203.5	6,504	6,692
2008	88,868	197.6	6,408	6,791
2009	90,368	191.7	6,322	6,906
2010	90,820	185.8	6,158	6,940
2011	92,250	179.9	6,057	7,050
2012	93,188	174.0	5,918	7,121
		Total Demands, ML	**43,960**	**48,093**
		Total Savings, ML	**4,133**	

The reduction in water demands specifically related to outdoor water use in the single-family sector can be determined by subtracting the indoor savings from the overall average annual savings values in this sector, i.e., the total outdoor savings during this period is:

Total Savings of 4,133 ML – Indoor Savings of 3,184 ML = 949 ML Savings Outdoor

The City of Guelph implements two significant programs that focus on reducing outdoor water demands, as follows:

- Healthy Landscapes Visits: A landscape specialist conducts a complimentary 30-minute site audit of participant's property and provides tips and recommendations regarding how to create low-maintenance, water efficient lawns and gardens.
- Outside Water Use Program (OWUP): This program was created in 2002 in response to the Ontario Low Water Response Plan and to conserve Guelph's groundwater supply and protect against the impact of drought during the hot, dry summer months. The Program has three levels that affect residential outside water use. These levels are triggered by dry weather and local watershed conditions: Level 0 Blue (careful water use), Level 1 Yellow (reduce outside water use), and Level 2 Red (stop non-essential outdoor water use). It is estimated that about 95% of Guelph residents recognize and follow the OWUP levels each summer.

Of course, the volume of outdoor water demand varies on a year-to-year basis depending largely on local weather conditions. Largely because of the variable nature of outdoor water demands, it is not known what portion of the outdoor water savings that has been achieved in Guelph is related to the Healthy Landscape Visits program or the OWUP, or how much is occurring naturally. As such, to be conservative, the total savings of 949 ML has been allocated equally between direct, indirect, and natural savings.

- **Direct Outdoor Savings = 316.3 ML**
- **Indirect Outdoor Savings = 316.3 ML**
- **Natural Outdoor Savings = 316.3 ML**

5.9 Multi-Family Demands

It is difficult to accurately quantify changes in water demands in the multi-family residential customer sector because of the significant number of variables involved for each customer, e.g., number of suites in the building, average number of persons per suite, volume of water used beyond the apartment suites, etc. That said, Table 1 and Table 2 in the report *Mining Guelph's Customer Water Meter Data* (Dec. 2013, M. Fortin) identifies a total of 1,604 multi-residential accounts in 2012 and the average water demand per multi-residential account from 2006 to 2012.

Table 11 below compares total and annual water demands for the multi-family customer sector based on the demand trend between 2006 and 2012 vs. the total and annual demands if the average water demand *per account* had remained at the 2006 level of 6.7 m^3/day. As can be

seen in Table 11, the total water savings in the multi-residential customer sector between 2006 and 2012 is approximately 2,878 ML. Figure 11 illustrates these demands graphically.

As part of the City's water efficiency strategy, fixture replacement projects were implemented in select multi-residential buildings during 2009 and 2010, resulting in water savings of approximately 35 m^3/day in each year. If, as expected, these savings are sustained in subsequent years, the total water savings achieved by these fixture replacements is approximately 89 ML[7].

Based on these results, it appears that only a small percentage (i.e., 89 ML of 2,878 ML or 3.1%) of total water savings in the multi-family sector has been achieved as a direct result of a City program. It is assumed for the sake of analysis that the level of indirect savings achieved in the multi-family customer sector is similar to the level of direct savings, i.e., 89 ML. As such, most of the savings achieved in this customer sector – 2,700 ML or 94% - is projected to be naturally occurring savings.

Table 11: Trend in ICI Water Demands vs. No Savings Scenario

Year	Number of Accounts	ML/Year (Trend)	ML/Year at 6.7 m^3/day/account
2006	1,485	3,639	3,639
2007	1,507	3,562	3,693
2008	1,530	3,482	3,748
2009	1,555	3,405	3,811
2010	1,563	3,286	3,830
2011	1,588	3,199	3,891
2012	1,604	3,092	3,930
	Totals	**23,665 ML**	**26,543 ML**
		Total Savings 2007 - 2012	**2,878ML**

[7] Calculated as 35 m3/day x 4 years plus 35 m3/day x 3 years = 89,425 m3 = 89 ML

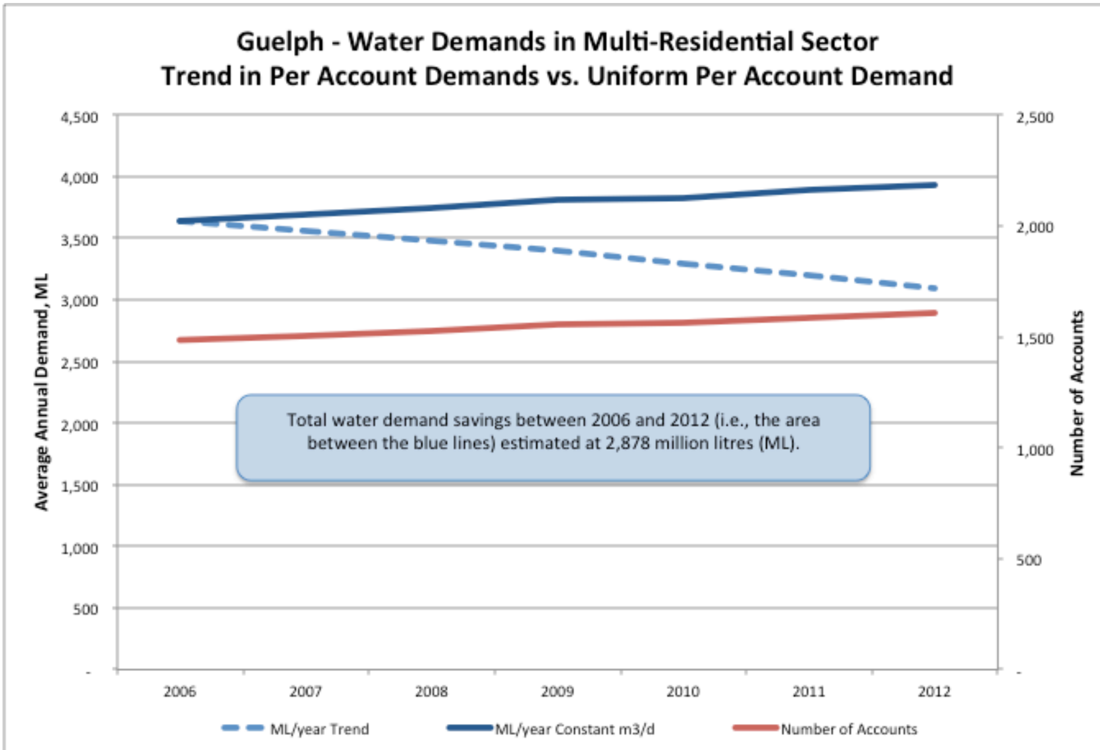

Figure 11

5.10 Summary of Water Savings

The analysis described in this report identifies a total system water savings of 14,200 ML between 2006 and 2012. Figure 12 on the following page illustrates the delineation of water savings as identified in the previous sections of this report.

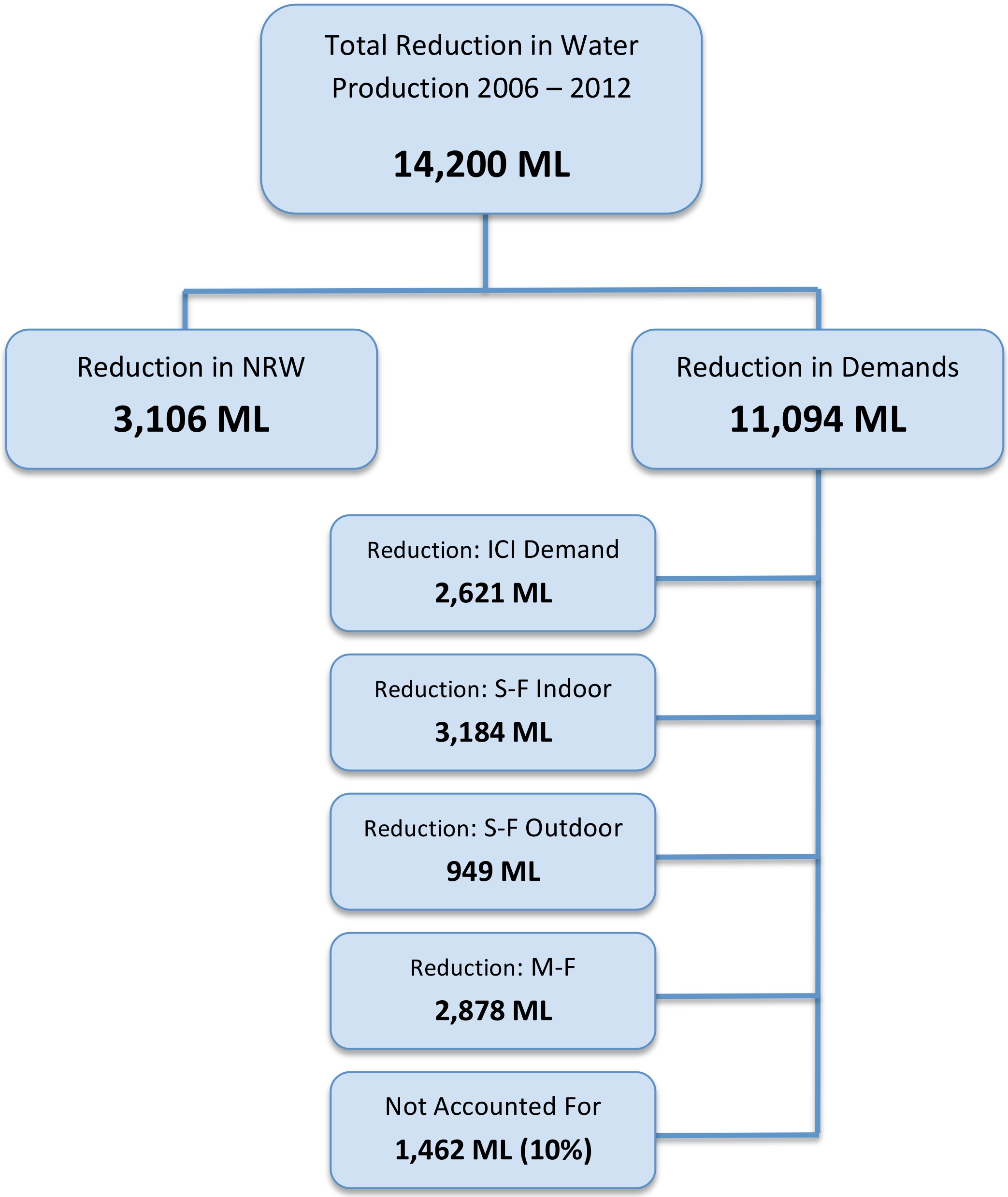

Figure 3

The savings in each sector is made up of direct savings, i.e., savings that were achieved as a direct result of the implementation of a City program (such as a toilet rebate), indirect savings, i.e., savings that were achieved indirectly by a City program (such as a consumer outreach or education program), and savings that were achieved naturally, without any influence from a City program (such as a customer that is unaware of the City's programs installing a new and efficient product). The total savings, direct savings, and estimated indirect and natural savings values for each sector are outlined in Table 12 below.

Table 12: Distribution of Water Savings 2007 - 2012

Sector	Total Savings ML	Direct Savings ML	Indirect Savings ML	Natural Savings ML
Non-Revenue Water	3,106	3,106	0	0
Industrial, Commercial, Institutional	2,621	1,565	528	528
Single-Family (indoor)	3,184	1,938	623	623
Single-Family (outdoor)	949	316	316	316
Multi-Family (AADD)	2,878	89	89	2,700
Not Accounted For[8]	1,462	487	487	487
Totals[9]	14,200 (100%)	7,501 (53%)	2,043 (14%)	4,654 (33%)

6. VALUE OF WATER SAVINGS TO CITY OF GUELPH

6.1 Capital Savings

Between 2006 and 2012 the City of Guelph spent approximately $5.6 million on their water efficiency strategy. This cost included all program development costs, staff costs, and program rebates.

If gross per capita water demands had remained at the 2006 level of 447 Lcd, the average 2012 daily water production in the City would have reached 55.5 MLd because of the growth in population. Because of the decline in per capita demands, however, actual water production in 2012 was only 45.2 MLd, i.e., 10.3 MLd lower than the projected value.

Since 67% of the total production savings is considered either directly or indirectly related to the City's water efficiency strategy[10], the savings achieved by the City's programs is approximately 6.9 MLd (i.e., 67% of 10.3 MLd) or about 6,900 m^3/day. The City estimates that expanding their water supply system to meet growing demands would cost about $4,000 per m^3 of average day production. As such, a savings of 6,900 m^3/day of water production has a capital cost value of about $27.6 million (i.e., $4,000/$m^3$/day x 6,900 m^3/day).

[8] Water savings that have not been accounted for in this analysis have been divided evenly between direct, indirect, and natural savings.
[9] Totals may not add exactly because of rounding.
[10] 53% Direct Savings, 14% Indirect Savings

As stated earlier, the actual cost of implementing Guelph's water efficiency programs between 2006 and 2012 was about $5.6 million. Therefore, the benefit to the City is approximately $22.0 million, or a benefit to cost ratio of about 5:1.

Net Capital Savings: $27.6 million - $5.6 million = $22.0 million

6.2 Operational Savings

The total water savings achieved by the City between 2006 and 2012 is approximately 14,200,000 m^3. It has been estimated that about 67% of this savings, or about 9,514,000 m^3, is either directly or indirectly the result of the City's water efficiency strategy. Based on an approximate cost for electricity and chemical of $0.10 per m^3 (based on values for Toronto and Peel Region), the total operational savings achieved by the City's water efficiency strategy over this period is approximately $951,400.

9,514,000 m^3 x $0.10/$m^3$ = $951,400

6.3 Environmental Saving

While the City of Guelph has clearly identified a high level of water efficiency as one of its key objectives, it has not yet attempted to quantify the *environmental value* associated with using less water. Since no City-specific value is available, the following assessment uses a value derived from work completed by Lawrence Berkeley National Laboratory (LBL) for the California Urban Water Conservation Council (CUWCC). In 2006 LBL prepared a report called *Valuing the Environmental Benefits of Urban Water Conservation*[11]. The purpose of the project was to conduct research and develop a model that would assist water utilities to calculate the environmental benefits associated with implementation of water efficiency programs. The LBL model acknowledges that "this type of environmental valuation is still relatively new, and there are numerous complications, ambiguities, data gaps and differences of opinion that make the construction of a definitive methodology problematic.[12]" LBL completed a number of model runs using different parameters during the beta testing phase of their methodology. While the environmental value outcome of the model runs varied depending on the input data used, the average value was approximately $50 per acre-foot of water savings. This value equates to a savings of approximately $0.04 per m^3 of water savings. This value will be used to estimate the approximate environmental savings achieved by the City's water efficiency programs.

9,514,000 m^3 x $0.04/$m^3$ = $380,560

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[11] Project sponsored by United States Bureau of Reclamation and U.S. Environmental Protection Agency.
[12] Valuing the Environmental Benefits of Urban Water Conservation, CUWCC, March 27, 2006.

6.4 Societal Saving

Unlike financial indicators and, to a lesser degree, environmental indicators, social impacts are not easy to identify and measure. In fact, there seems to be little agreement about how agencies should define or assess their social impact, and no single tool or methodology exists to quantify social benefits.

The two greatest social benefits associated with water efficiency to the City of Guelph are:

1. Ensuring high quality potable water is available and affordable to all customers.
2. Allowing more customers to be serviced within City's current water budget.

While improved water efficiency will lead to more affordable water rates and possibly an increase in economic development within the City, it is difficult to assign a dollar value to these social benefits. While the benefits related to maintaining affordable water rates and fostering economic development might be considered even *more valuable* to the City than the associated environmental benefits, it is recommended that a conservative value of $0.04 per m^3 of water savings be used, the same value used to assess environmental benefits.

$$\mathbf{9{,}514{,}000\ m^3 \times \$0.04/m^3 = \$380{,}560}$$

7. PROBABLE IMPACT OF WATER RE-USE

Water re-use projects are expected to have a negligible impact on Guelph's overall water demands over the short term because of the relatively long payback periods associated with implementing, operating, and maintaining these types of systems in a community where potable water is readily available. Many smaller systems, the type designed for use by single-family homes, have payback periods that far exceed the life-cycle of the system itself.

Even over the long-term, the potential for water reuse systems to reduce overall water demands will remain relatively small unless they can be cost-effectively installed and operated in larger non-residential facilities.

8. FUTURE DEMANDS

It is unlikely that per capita water demands in the City of Guelph will continue to decline at the same rate that was achieved between 2006 in 2012, i.e., production values declining at an average of 15.1 Lcd per year and demand values declining at an average of 11.9 Lcd per year during this period. As illustrated in Figure 3, the annual reduction in per capita production and demand values was lower between 2010 and 2012 than from 2006 to 2010. Of course,

production and demand values cannot continue to decline indefinitely and Guelph already boasts some of the lowest per capita water demands in the Country.

There is some agreement in the industry that indoor residential will eventually ‘level off’ at approximately 140 to 150 Lcd as existing older and inefficient plumbing fixtures and appliances are replaced with newer efficiency models. As such, it is expected that indoor residential demands in Guelph will continue to decline from their existing level of about 170 Lcd to between 140 and 150 Lcd, although this reduction may be at a lower rate than the current rate of about 4.6 Lcd per year.

While per capita water demands are expected to continue to decline in the near future, Guelph’s serviced population continues to increase and, as such, total annual production and demand values may be expected to remain at approximately the current levels or perhaps to decline very slightly over the next few years. Of course, unexpected changes in non-residential demands, especially in industrial demands (which have increased since the economic downturn of 2008), will affect overall water production and demand values.

9. SUMMARY

The City of Guelph saved approximately 14,200 ML in water production between 2006 and 2012. It is estimated that approximately 67% of this savings is either directly or indirectly a result of the City's water efficiency strategy and programs[13]. The following table (Table 12 in this report) delineates the areas of water savings.

Distribution of Water Savings 2006 - 2012

Sector	Total Savings ML	Direct Savings ML	Indirect Savings ML	Natural Savings ML
Non-Revenue Water	3,106	3,106	0	0
Industrial, Commercial, Institutional	2,621	1,565	528	528
Single-Family (indoor)	3,184	1,938	623	623
Single-Family (outdoor)	949	316	316	316
Multi-Family (AADD)	2,878	89	89	2,700
Not Accounted For[14]	1,462	487	487	487
Totals[15]	14,200 (100%)	7,501 (53%)	2,043 (14%)	4,654 (33%)

Water production values in 2012 were approximately 10.3 MLd lower than they would have been had gross per capita water demands remained at the 2006 level. As stated above, it is estimated that about 67% of this savings – about 6.9 MLd - is either directly or indirectly related to the City's programs. Based on an estimated cost to expand water production works of \$4,000 per m^3 of average day supply, reducing water production requirements by 6.9 MLd would save the City \$27.6 million. Because the City only spent a total of approximately \$5.6 million on water efficiency efforts during this period, the total savings to the City is about \$22.0 million and the City benefitted by approximately \$5 for every dollar they spent on their programs.

In addition to the capital savings, it is estimated that the City saved approximately \$951,400 in electrical and chemical costs during this period, reduced environmental degradation by drawing lower volumes of water by about \$380,560, and added about \$380,560 in societal benefits to the City.

[13] Approximately 53% direct savings, 14% indirect savings, and 33% natural savings.
[14] Water savings that have not been accounted for in this analysis have been divided evenly between direct, indirect, and natural savings.
[15] Totals may not add exactly because of rounding.

It is anticipated that overall water production values will remain relatively constant over the next several years or even to continue to decline slightly as Guelph continues to implement both proven water efficiency strategies as well as innovative pilot studies.

Guelph has some of the lowest per capita water demands in North America and these demands are anticipated to continue to decline for several more years. As such, the City appears to be on track to achieve its goal of using less water on a per capita basis than any comparable Canadian city.

Based on the results expressed in this report, it appears that the City of Guelph's water efficiency strategy has not only been a technical success but also a financial success as well. The cost savings achieved by the City's programs can be used to finance further water efficiency endeavours as well as to help keep future rate increases to a minimum.

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Appendix B

Guelph Water Supply Master Plan Update
TM3: Water Supply Alternatives (Draft Final)

Utilizing Water Price Elasticity of Demand as an Instrument of Conservation

By AECOM

City of Guelph

Utilizing Water Price Elasticity of Demand as an Instrument of Conservation

Prepared by:

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Project Number:

60287843

Date:

March, 2014

Statement of Qualifications and Limitations

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1. Background

The City of Guelph 2009 Water Conservation and Efficiency Strategy Update stated the goal of becoming the national leader in municipal water conservation in Canada (City of Guelph, 2009). To achieve this goal The City of Guelph has already taken several significant actions, and plans to achieve a 15% per capita reduction in water usage by 2017. In order to truly maximize water conservation multiple strategies, programs and initiatives are needed to work in harmony to achieve a sustainable reduction in per capita water usage.

One strategy not currently employed by The City of Guelph is utilizing water price elasticity of demand as an instrument of conservation. Economists have long recognized price as an effective tool for shifting consumer demand, and this theory can be applied to a municipal water distribution system. Price elasticity of demand is a foundational economic theory which examines how demand will be impacted with certain changes to price. Utilizing water price elasticity of demand as an instrument of conservation has the potential to contribute the City's goal of sustainably reducing per capital water usage. This study estimates the potential impact of different pricing strategies as tools of water conservation.

2. Price Elasticity and Water Demand

Price elasticity of demand is a fundamental economic observation which describes that as the price of a commodity increases, the overall commodity volume demanded will typically decrease. This also applies to situations where the price of a commodity is declining, and the volume demanded will typically increase. A commodity is considered “elastic” if the change in price stimulates an even greater change in demand. Contrarily, if the same change in price stimulates a smaller change in demand, it is considered an “inelastic” commodity. Price elasticity of demand is a relatively simple and general economic theory and can therefore be applied to a wide variety of situations.

Primary resources (raw materials) behave in the most predictable fashion and are therefore good commodities to apply the theory of price elasticity of demand to. As water is a primary resource, the theory of price elasticity of demand can be applied in an accurate, meaningful and effective manner. All Guelph residents use water and would be impacted by a change in the price of water. For this reason, applying the theory of price elasticity of demand to the City of Guelph’s water prices forecasts how the use of water will change with changes in water prices.

It is predicted that as water prices increase, the overall demand on water will decease to some extent. However, it is also predicted that many City water user who are already using a minimal amount of water will have inelastic water demand. To better understand the relationship between water price and demand, the City commissioned a Conservation-Oriented Pricing Analysis for City of Guelph, which looked at using water pricing as a conservation tool (econics, 2013).

The Conservation-Oriented Pricing Analysis for City of Guelph found that water price can be effectively implemented as a conservation tool. However, the report identified that using this tool is much more complicated than simply increasing water prices as there are several factors which impact the price elasticity of water. Income is a foundational predictor of consumer behavior and income was determined to be a major determinate of price elasticity. **Table 2-1** presents the specific price elasticities calculated for various household income levels.

Table 2-1 Water Price Elasticity of Demand by Household Income

Household Income Range	Elasticity
0 – 30k	0
30k - 60k	-0.06
60k - 70k	-0.25
70k - 80k	-0.48
80k - 90k	-0.68
90k+	-0.89

(Renzetti, 2013)

This study combines the City’s price elasticity data with demand data to forecast the potential impacts of different water pricing scenarios.

3. Mapping Price Elasticity to Connection

The City of Guelph has month by month water usage data for each connection in the City. For this study we analyzed 2011 data (Fortin, 2013) to determine total annual consumption and monthly consumption in 2011 for each water connection. As we had only bi-monthly data for some connections, we averaged the total consumption reported with the prior month with no consumption data to develop a monthly consumption.

The next process was to map water price elasticities to individual connections (households). The first step is to determine the household income distribution for The City of Guelph, which is presented below in **Table 3-1**. The exact distribution of household income for the City of Guelph is not available and Guelph's household income distribution was developed by applying the Ontario household income distribution.

Table 3-1 City of Guelph Household Income Distribution

Household Income Range	Estimated % of Population
0 - 30k	11.03%
30k - 60k	24.13%
60k - 70k	7.77%
70k - 80k	7.40%
80k - 90k	6.87%
90k +	42.80%

(Statistics Canada, 2013)

With the City of Guelph's household income distribution estimated, the next step is to map household water consumption (by segment) to; percentage of Guelph population, percentage of municipal water demanded, and average annual water consumption. This information is presented below in **Table 3-2**.

Table 3-2 Percentage of Guelph Population, Percentage of Water Demanded, and Average Annual Consumption by Water Consumption Segment

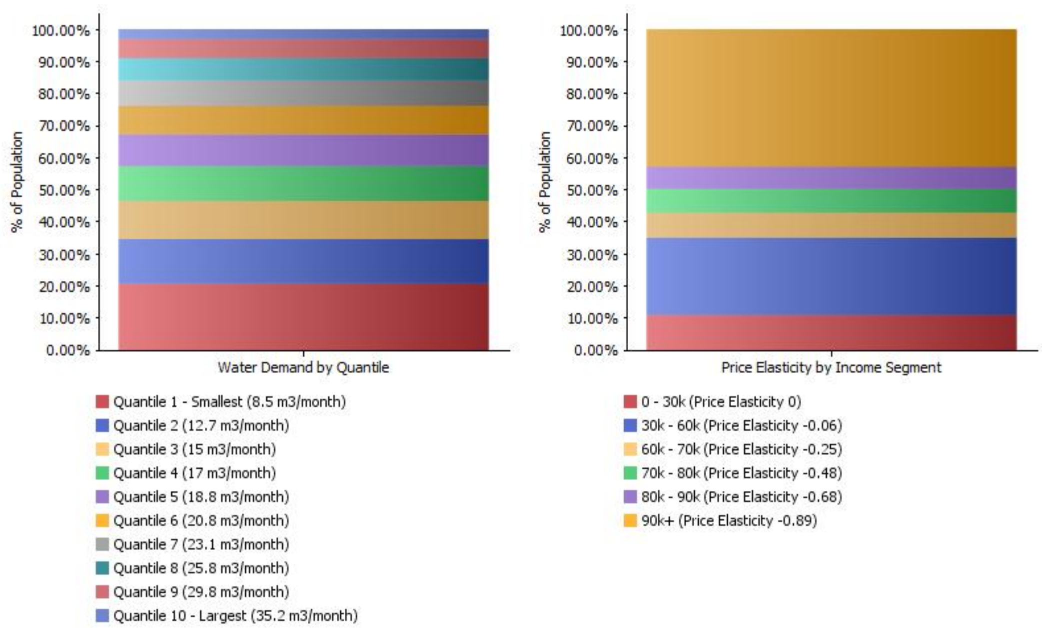
	% of Population	% of Total City Demand	Annual Average Monthly Consumption (m^3 / connection / mo)
Segment 1 - Smallest	21%	10%	8.50
Segment 2	14%	10%	12.70
Segment 3	12%	10%	15.00
Segment 4	11%	10%	17.00
Segment 5	10%	10%	18.80
Segment 6	9%	10%	20.80
Segment 7	8%	10%	23.10
Segment 8	7%	10%	25.80
Segment 9	6%	10%	29.80
Segment 10 - Largest	3%	10%	35.20

(Fortin, 2013)

We then made the assumption that the segmentation of water demand followed the same distribution of water price elasticities by income segment presented in Conservation-Oriented Pricing Analysis for City of Guelph (Renzetti,

2013). **Figure 3-1** illustrates the relationship between water consumption by segment and water price elasticity of demand.

Figure 3-1 Water Demand by Segment and Price Elasticity of Demand by Income Segment



Using this information we are able to map water demand segment with estimated water price elasticity and average annual demand. This information is presented below in **Table 3-3.**

Table 3-3 Estimated Percentage of Guelph Population, Estimated Water Price Elasticity of Demand and Average Annual Demand by Water Consumption Segment

	Estimated % of Population	Estimated Elasticity	Annual Average Monthly Demand (m3/mos)
Segment 1 - Smallest	20.79%	-0.03	8.50
Segment 2	13.86%	-0.06	12.70
Segment 3	11.88%	-0.31	15.00
Segment 4	10.89%	-0.61	17.00
Segment 5	9.90%	-0.89	18.80
Segment 6	8.91%	-0.89	20.80
Segment 7	7.92%	-0.89	23.10
Segment 8	6.93%	-0.89	25.80
Segment 9	5.94%	-0.89	29.80
Segment 10 - Largest	2.97%	-0.89	35.20

With this information now analyzed and organized, it is possible to analyze the impacts of various pricing scenarios.

4. Analysis of Pricing Scenarios

In order to determine the impact and effectiveness of utilizing water price as an instrument for conservation the next step is to develop different pricing structures and analyze their impacts on water demand. For this study we looked at four different pricing structures, and their impacts on water demand. The four pricing structures are presented below in **Table 4-1**.

Table 4-1 Pricing Structures Analyzed

Pricing Structure	Details of Structure
No Increase	No nominal increase in price
Planned Increase	• An increase of 5.7% across the board for all levels of consumption • reflective of the identified costs in Conservation-Oriented Pricing Analysis for City of Guelph (econics, 2013)
Summer Block Pricing	• An increase of 5.7% across the board for all levels of consumption in the non-summer months • A tiered increase based on consumption during the summer months (June – September) o 0 – 18 m^3 / month = 5.7% increase o 18 – 22 m^3 / month = 15.7% increase o +22m^3 / month = 25.7% increase
Year-Round Block Pricing	• A tiered increase based on consumption for all months o 0 – 18 m^3 / month = 5.7% increase o 18 – 22 m^3 / month = 15.7% increase o +22m^3 / month = 25.7% increase

Table 4-2 shows the percentage price increase for each water consumption block with regard to each pricing structure and season.

Table 4-2 Percentage Water Price Increases per Water Consumption Bock and Pricing Structure

	No Increase		Planned Increase		Summer Block Pricing		Year-Round Block Pricing	
	Summer (Jun - Sep)	Other	Summer (Jun - Sep)	Other	Summer (Jun - Sep)	Other	Summer (Jun - Sep)	Other
Block 1	0.00%	0.00%	5.70%	5.70%	5.70%	5.70%	5.70%	5.70%
Block 2	0.00%	0.00%	5.70%	5.70%	15.70%	5.70%	15.70%	15.70%
Block 3	0.00%	0.00%	5.70%	5.70%	25.70%	5.70%	25.70%	25.70%

With possible pricing structures now developed, the next step is to estimate the impact to water demand for each pricing structure and water consumption block. For each connection the estimated pricing impact of the four pricing scenarios was calculated on a month-by-month basis. The corresponding reduction in demand was subsequently

calculated, allowing us to forecast changes in overall demand based on pricing variables. **Table 4-3** summarizes these findings.

Table 4-3 Summary of Impacts to Water Volume Demanded by Pricing Scenario

	Change in Demand (m3)	Change in Demand (%)	Revised Total Demand
No Increase	125,924.08	1.46%	8,759,877.08
Planned Increase	(200,333.77)	-2.32%	8,433,619.23
Summer Block Pricing	(541,014.82)	-6.27%	8,092,938.18
Year-Round Block Pricing	(1,106,713.68)	-12.82%	7,527,239.32

5. Conclusions

In conclusion, different pricing strategies can result in reductions to water demand. As can be seen in **Table 4-3** if there is to be no planned increases to Guelph municipal water prices, there will be a 1.46% increase in water consumption. In contrast, each of the block pricing strategies which involved some form of rate increases saw reductions in water demand ranging from 6.3% - 12.8%.

As with any economic or financial model there is a risk that actual impacts of price changes on water demand will vary from the forecasted impacts in this report. Sources of variation include; changes in the conservation programs available to households from the time the study was completed, time from when the elasticities were calculated to when the pricing shocks are completed, and different seasonal elasticities. With regard to variation due to different seasonal elasticities, it should be noted that the report completed for Guelph shows one average annual elasticity, and research shows that there is likely seasonal variation in water price elasticities (Klaiber, 2010).

Regardless of potential variation, we believe that implementing a Year-Round Block Rate Water Pricing Strategy will contribute to the City of Guelph's Water Conservation Initiatives. Several local municipalities have already implemented Block Rate Water Pricing Strategies including East Gwillimbury (Regional Municipality of York) and Township of King (Township of King, 2013).

Increasing the public awareness of water consumption and conservation and the economic impact of a Block Rate Water Price Strategy will enhance conservation. Utilizing price elasticity of demand as an instrument of conservation can help the City of Guelph achieve their vision of becoming the leader of water conservation in Canada.

6. Important Considerations When Using Price as an Instrument of Conservation

It is important to recognize that a municipal water system is designed to be sustainably self-funding, meaning overall the service is not to run an ongoing financial surplus or deficit. It is therefore important to note that before a Block Rate System is to be implemented, a study would need to be conducted into the potential impacts to revenues and costs of the water distribution system.

In addition, it is important to note that the impact of each pricing strategy is significantly impacted depending on where the consumption blocks are set. Therefore, further analysis could be done to determine the ideal configuring of the consumption and pricing structure.

It should be noted that the report completed for Guelph shows one average annual elasticity, and our research shows that there is likely seasonal variation in water price elasticities (Klaiber, 2010). Further analysis could therefore be conducted to determine seasonal water price elasticities which would allow for more accurate forecasting of impacts.

Another source of possible error lays in the fact the data on price elasticity is based on income segment, not annual household demand. Therefore water price elasticity by water consumption had to be estimated, and with estimations comes the possibility of error. To create more accurate forecasts, a study could be launched analyzing water price elasticity of demand by water consumption.

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Appendix C

Guelph Water Supply Master Plan Update
TM3: Water Supply Alternatives (Draft Final)

District Metering Area Standard and Citywide Program Justification Technical Memorandum

By C3 Water

TECHNICAL MEMORANDUM

To:	**Wayne Galliher**	Company:	**City of Guelph, Waterworks Division**
From:	**Dennis Mutti**	Our File:	**75-41-1012**
Cc:		Date:	**January 21, 2014**

Subject: **Guelph Water District Metering Area (DMA) Standard and City-Wide Program Justification Technical Memorandum**

CITY OF GUELPH
WATER SERVICES DIVISION

DISTRICT METERING AREA (DMA) STANDARD AND CITY-WIDE PROGRAM JUSTIFICATION TECHNICAL MEMORANDUM

C3 WATER INC.

January 21, 2014

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1.0 EXECUTIVE SUMMARY

The City of Guelph Water Services Division has developed a standard approach to the implementation of District Metering Areas (DMA's) and the technology used to monitor their performance. This development has been significantly supported through the Province of Ontario's Showcasing Water Innovation program and a specific project awarded to the Water Services Division. It is also based on a thorough understanding of industry best practices and trends.

The Water Services city-wide DMA program and standard approach to implementing a DMA and associated monitoring systems is discussed and presented in this Technical Memorandum (TM). A key element in determining the cost of the program is the estimated number of flow meters required per DMA. For planning purposes a number of 2.5 has been used, but it is anticipated that an actual number of two (2) will be achieved. This represents an estimating safety factor of 25%.

A cost benefit analysis of the program is also presented. This assesses the value of the program represented by the deferral of capital spending on new water supply and distribution infrastructure achieved through the reduction of lost water in the distribution system. This represents a one-time benefit to the City and development community.

A five (5) year capital investment of $3.36 Million, or $2,184 per m^3/day of average day water supply in the city-wide DMA program, has the potential to result in up to $4.15 Million, or $2,702 per m^3/day of average day water supply of deferred capital spending on new water supply and distribution infrastructure. Should the number of flow meters per DMA during actual implementation be two (2) rather than 2.5, then the capital investment will be reduced to $2.67 Million, or $1,747 per m3/day of average day capacity.

Water Services has developed a DMA implementation strategy which has the potential to produce a very significant return on investment of development charge related capital as per the following table.

Internal Rate of Return (IRR) Comparison

Years to Implement the DMA Program Fully	IRR (2.5 flow meters per DMA)	IRR (2.0 flow meters per DMA)
5	24%	54%

It is recommended that the City continue funding the DMA program through the collection of development charges and implement the full city-wide DMA program in a five (5) year timeframe.

2.0 INTRODUCTION AND BACKGROUND

The City of Guelph Waterworks division began investigating methods to reduce water loss in 2006, with the possibility of establishing district metering areas (DMA's) to measure, control and reduce distribution system water loss in 2012. A pilot installation of a DMA flow meter was completed in 2012 by City staff. The installation works well to this day, but requires labour intensive manual data collection and processing.

In a parallel undertaking, the City of Guelph was awarded a project under the Ministry of the Environment's (MOE) Showcasing Water Innovation (SWI) Program in February 2012. This program provided a matching funding through a competitive process up to $1 Million for projects that best exemplified the Provinces Program Objectives:

- Take an integrated and sustainable approach to solve water management challenges.
- Use new and innovative approaches and technologies.
- Produce results that can easily be used by other communities.
- Create partnerships that highlight the benefits of collaboration.

While there are many activities which have been undertaken through this project, the main goals of this project from the City's perspective were as follows:

- Implementation of a permanent distribution operational tool, which is also used to transfer real time operational data into the City's hydraulic modelling software enabling on-line calibration and much more accurate predictions of the impact of capital improvements and operational changes within the potable water supply and distribution system.
- Optimized power consumption in the supply and distribution of potable water with a specific target of 10% reduction, which is an equivalent of 1.3 million kWHr annually, or 337,000 kg of CO_2 emissions. Depending on how much off-peak load shifting can be achieved in conjunction with this initiative, this will be the equivalent of $100K to $200K of annual operational savings.
- Reduction of water loss in the distribution of potable water to the end user of 2%. This works out to an annual volume of 325 ML/Yr, or 55,000 kg of CO_2 emissions. Perhaps more important than the financial savings this relates to in terms of reduced supply and distribution costs, this quantity represents "found water" and defers the need for capital intensive implementation of new water supplies. This becomes critical for a City such as Guelph which has adopted a policy to grow responsibly, relying on a limited number of future potential water supply solutions which are available locally.

The SWI project goals are being realized through an assessment of capital improvements and operational practices which are first demonstrated using the City's well-calibrated hydraulic modelling software. Improvements are then implemented, and performance is measured. In fact field trials with respect to the main performance goals identified above are planned for 2014. The SWI project wraps up with final reporting in March of 2015.

While all of the SWI project goals dove-tail very well with the City's on-going Water Efficiency Program, the focus of this Technical Memo (TM) is to assess the long-term value represented by the reduction of water loss program, and in particular the implementation of development charge funded DMA's. Note that a total of six (6) fully automated DMA's including eleven (11) new DMA flow meter installations are being implemented through the SWI project. These

are being implemented outside of the development charge funded budget, with the Province of Ontario contributing 50 cents for every dollar which the City spends.

Note that the SWI project was completed in a collaborative manor with the Water Division providing a significant number of in-kind work hours. There were many working on the team and you will find this team referenced throughout the document. A number of the findings of this tech memo were a result of the collaborative effort of the SWI project team. Specifically with respect to the DMA flow meter implementation project, Water Division staff participated throughout the design, tender, construction management and commissioning process. In fact, Water Division staff were responsible for managing the contract for the implementation of the DMA flow meter installation.

This TM presents:

- The proposed design standard for DMAs and associated monitoring systems. This was established through a combination of industry best practices review and experience gained through the SWI project.
- The City of Guelph Water Division's proposed long-term plan for DMA implementation.
- The proposed development charge funded capital spending plan to implement the DMA program.
- A cost-benefit analysis of the DMA implementation program.

This TM references:

- Appendix A – DMA Areas Flow Meter Sizing TM, CH2M Hill
- Appendix B – Review of City Wide DMA Program, Kingsley Blease Consulting
- Appendix C – DMA Flow Meter Chamber and Boulevard Box Drawings

3.0 CITY OF GUELPH DMA DESIGN STANDARDS

Elements of the standard DMA design approach used by the City of Guelph Water Division are discussed as follows:

1. DMA Design Standard Summary.
    a. Detailed Design Criteria For Establishing a DMA
    b. DMA Instrumentation
2. Detailed DMA Design Criteria Discussion.
    a. Flow instrumentation
        i. Number of Flow Meters Per DMA
        ii. Type
        iii. Flow Element Direct Buried versus Installation in a Chamber
        iv. Flow Transmitter
            1. Communication and integration
            2. Location of installation
            3. Power supply
    b. Pressure instrumentation
    c. Other instrumentation

3.1 DMA Design Standard Summary

The following is a summary of approach that the City of Guelph Water Division utilized in implementing DMA's through the SWI project. This serves as an initial DMA design standard. It is recommended that the Water Services Division set up a governance procedure to keep this and other standards relevant and current in the face of changing technology and approaches.

3.1.1 Design Criteria for Establishing a DMA

Work through the SWI project established the following Guelph Water Division specific criteria for establishing a DMA:

1. DMA's will not contain critical users currently defined to include hospitals, the Provincial Data Centre, and Designated Industrial Users.
2. Typically, there will be a minimum of 1000 connections and a maximum of 2500 connections within a DMA.
3. The number of valves which must be closed to implement the DMA will be kept to a minimum.
4. The number of flow meters used in the DMA will be kept at a minimum. However, prior to implementation detailed hydraulic modelling using the City's up to date and calibrated hydraulic model will be used to simulate the operational performance of a proposed DMA with the proposed number of flow meters and specific flow meter sizes as follows:
    a. Modelling will use an interval time of 5-minutes and result in a balanced maximum day scenario.
    b. The DMA will maintain a minimum of 25 psi pressure at all nodes within a DMA during fire flow scenarios modelled at each hydrant in the DMA.
    c. The DMA will maintain a minimum of 40 psi pressure at all nodes with a DMA during the maximum day scenario.

Blease' report (Appendix B) also recommends that field testing be completed for each DMA prior to implementation to confirm model results.

3.1.2 DMA Instrumentation

The exact number of flow meters required for a given DMA will be established using the criteria presented in section 2.2.1.1 below. For planning purposes, water services is carrying an average of 2.5 flow meters per DMA.

At present no other instrumentation is being specified. However, the application of pressure instrumentation and on-line leak detection equipment is being researched and developed through the SWI project and may be considered in the future. These enhancements to DMA instrumentation would be considered operational improvements and would not impact the cost of development funded capital improvements.

DMA flow meter installations are intended to be permanent, long-term assets.

Flow meters shall be magnetic flow meters. The specific make and model shall be ABB/Elster Aquamaster. ABB/Elster software shall be used to collect and store flow meter data via a cellular modem.

The flow element shall be manufactured to the IP68/NEMA6P standard and shall be installed in a buried pre-cast chamber with the flow transmitter located in a remote boulevard box. Refer to Appendices C and D for standard drawings and specifications.

The transmitter shall communicate via wireless technology, the current standard being GSM cellular technology to a cellular modem to vendor software which is capable of being mined by the Guelph Water Division SCADA application to provide 1-minute data.

Essential elements of the design standard are:

- The standard chamber size shown in Appendix C may be reduced when desired by the City. The overall distance to the nearest non-straight through or diameter modifying fitting or isolation valve is maintained at five (5) and three (3) pipe diameters up and downstream of the flow element, respectively. Depending on which of the three available flow element bores are used, there may be an opportunity to look at this on a case by case basis and reduce this distance.
- The flow element will be connected to piping using flanges. Flanges will be supported using appropriately designed supports which keep the element a minimum of 750 mm and a maximum of 900 mm above the floor of the chamber. The specific intent is to keep the element out of groundwater which may penetrate the chamber.
- The flow element will be properly grounded as per manufacturer's recommendations, including using grounding rings and a specifically installed metallic grounding rod where non-metallic pipe is used in the chamber and/or in contact with the ground outside of the chamber.
- The flow element will be able to be isolated through the closing of two valves located within close proximity of the upstream and downstream side of the element. Where existing valves are not available install new MJ-style gate valves. Closing these valves shall not impact any other distribution system services. When necessary valves closed to establish the DMA may be opened temporarily while servicing occurs.
- The chamber will contain a sump for dewatering via a portable sump pump. It is intended that dewatering be a part of regular DMA flow meter maintenance.
- Two (2) conduits will connect the flow element chamber with the remote flow transmitter box, one for flow transmitter and other future potential instrumentation cabling and the other for a future potential power supply cabling. A fish wire shall be installed in each conduit.
- The person access opening and maintenance access opening will be centred lengthwise on the flow element to facilitate servicing.

- Prior to finalizing the location of the flow transmitter, GSM cellular signal strength at ground level at the proposed location of the boulevard box shall be demonstrated as acceptable.
- The transmitter and battery power supply suitable for three (3) years of operation at one (1) minute data capture and fifteen (15) minute data transmission.
- The transmitter and battery shall be mounted on shelf made of water resistant material, in a non-metallic boulevard box, Synertech S118BC12FA. The shelf shall be mounted to the wall of the boulevard box such that it is below ground level but is at the maximum height permitted by the equipment to provide maximum clearance from groundwater which may penetrate the box.

3.2 Detailed DMA Design Criteria Discussion

3.2.1 Flow Instrumentation

Historically, flow instrumentation provides the key measurement used in DMA monitoring, namely flow across (into or out of) the DMA boundary.

3.2.1.1 Number of Flow Meters per DMA

Blease' review of four (4) projects in Ontario and Atlantic Canada totaling twenty-three (23) DMA's pegs the average number of flow meters per DMA at 1.24. Through the SWI program the City used its detailed and well-calibrated hydraulic model to assess the issue and size flow meters in accordance with the Criteria for Establishing a DMA noted above. The table in Appendix A identifies that 12 flow meters were required for 6 DMA's to be implemented. The optional DMA was not implemented. It is recognized that each utility is unique and the rationale for the higher number in Guelph is two-fold:

- Guelph's water supply system is somewhat unique in Ontario, perhaps similar in nature only to that of Waterloo Region. The majority of its supply is derived from groundwater sources. As such there are a large number of water supplies distributed throughout the distribution system. There are thirteen (13) unique water supplies if the supplies feeding the F.M. Woods WTP are counted as a point sources for the purposes of this discussion. The majority of surface water based systems in the Province which have one (1) or two (2) point sources. For example, Toronto has four (4) point sources supplying water to a population of 2.8 million people. Guelph's much higher ratio of supply number to population results in more complexity associated with the establishment and control of DMAs.
- Guelph Water has a very detailed and well-calibrated hydraulic model. Most municipalities have not developed their hydraulic model to the same level of detail and accuracy. As a result the Water Division is better able to assess the true operational impact of establishing DMAs on the end user and ensure safe and reliable potable water supply through all operating conditions.

3.2.1.2 Type

When trying to resolve measurements that may result in a Water Loss Reduction of less than five (5) %, it is important that the DMA flow meter assembly provide at a level of accuracy that makes such a finding meaningful. Magnetic flow meters are typically utilized given their high level of accuracy and repeatability. The magnetic flow meter requires the least amount of clearance to upstream and downstream flow modifiers (fittings, valves, taps, etc.) making it relatively easy to install. The magnetic flow meter also offers the lowest head loss profile. Less head loss results in lower pumping costs. ((Talk about the full bore option)).

3.2.1.3 Direct Buried Flow Element versus Flow Element Chamber Installation

While direct buried flow element installations are less capital intensive, the City's Water Division reviewed this issue and found that installation of the flow element in an underground chamber, elevated from the bottom of the chamber to avoid submergence represented more long-term value and would result in improved public perception of the project. The following is the rationale:

- Many flow element manufacturers claim that their flow elements can be direct buried. When this claim is made manufacturers typically build their product to the IP68/NEMA6P standard. Within the standard there are thirteen (13) different types of performance specification. Careful review of each type highlights that in each case only a "degree of protection against the ingress of water" is offered. In no case is it intended that the flow element be submerged in water for prolonged periods of time. In the City's experience most installations will be subjected to significant periods of submergence. This is particularly true during winter and spring thaws which occur on an annual basis. The cost and public disruption associated with excavating and replacing or removing and repairing the flow element, potentially on an annual basis, far outweighs the initial capital cost benefit of a direct buried flow meter.
- A flow element built to the above noted standard was installed on the Glen Collector system in 2007. The flow element failed permanently approximately within one week of installation. Upon review the supplier and manufacturer indicated that although the device was manufactured to the NEMA6P standard it was not intended for submerged service. The installation area is notorious for having high groundwater levels.
- There will be a need to visit the chamber installations on a regular basis to inspect and remove ground water inflow to the chamber to prevent it from rising to an unacceptable level. Water Division staff will need to visit the installations on a regular basis regardless to check the flow meter calibration.

3.2.1.4 Flow Transmitter

There are three key elements to review with respect to flow transmitter selection;

- Mode of communications and integration into Water Services data management system.
- Location of the transmitter.
- Transmitter power supply.

3.2.1.4.1 Communications and Integration

The trend in the industry is to utilize cellular technology to transmit the flow meter signal into a central data storage system. There are a number of reasons for this including;

- The reliance on existing wireless network hardware rather than building an independent network.
- The low on-going operating cost of cellular service plans for this application versus the more capital intensive implementation of a hard-wired solution which would include;
  - A power supply and new hydro service.
  - A remote processing unit (RPU).
  - Hardwired input/output signals.
  - A temperature controlled above ground enclosure with a UPS battery to provide continuous power through a power outage.

The flow meters specified for this project utilize GSM cellular wireless to communicate with a cellular modem which then stores the data in a SQL database via proprietary software supplied by the flow meter manufacturer. From here the data is integrated into SCADA and pushed into other business intelligence software.

3.2.1.4.2 Location of the Installation

In order to facilitate cellular wireless communications, the transmitter must be installed in a location which is capable of receiving and sending a cellular transmission. A buried chamber is not suitable. Hence the transmitter is mounted remotely from the flow element. The transmitter is capable of being installed anywhere within a distance to which the 800 foot allowable transmitter cable will reach. Ideally the transmitter should be located as close as possible to the flow element to minimize construction impacts and interference with numerous other buried services which are located in the boulevard. Given that it is the transmitter which receives routine inspection and calibration servicing, easy and safe access to the transmitter is key. As such the transmitter is located in the boulevard in a vault or boulevard box.

The material of construction of the boulevard box is critical and must not be metallic such that a cellular signal can pass through the box. In the SWI project, the boulevard boxes were designed to be installed with their lids flush with the ground, as per the detail provided in Appendix C. It was felt that not having an above ground component would result in a design that is less vulnerable to vandalism, unintended damage from snow removal equipment or a car accident. Through commissioning, this solution has proven to work well from a data transfer stand-point, with no issues regarding lost communications to date.

3.2.1.4.3 Power Supply

Three power supply options were reviewed; battery, hydro service, solar power. The hydro service was eliminated due to the cost associated with initial installation and the on-going cost of managing a large number of hydro accounts as each installation would require its own service. The main concern regarding a solar power approach was above ground infrastructure being exposed to vandalism or accidental damage. Battery power was selected. Battery technology has greatly progressed in recent years, and the batteries specified for the installation are expected to last three (3) years prior to requiring replacement. It should be noted as well that external packs are also available for future installations which will extend the replacement timeline further.

3.2.2 Pressure Instrumentation

There is a trend towards using pressure instrumentation to monitor DMA performance. In fact the flow transmitters specified are also capable of connecting to a pressure instrument should this be desired in the future. Also, the City has invested in unique technology through the SWI project which resulted in the commercialization of a product which places the pressure element and transmitter in a dry-barrel fire hydrant. This device also uses cellular wireless technology for data transmission, and is integrated with the Water Division's SCADA system and hydraulic model. More importantly it is mobile. Water Services can co-locate the technology with a DMA flow meter on a trial basis to determine if there is a benefit to utilizing pressure as an additional DMA monitoring parameter. At present the DMA design standard does not include pressure monitoring equipment.

3.2.3 Other Instrumentation

While not yet adopted industry-wide, many water utilities are also investigating the implementation of leak identification technology in association with their DMAs to further enhance the water loss reduction potential of these systems through enhanced monitoring and reduced mean-time to identification of leak location and repair. The City's water division is also investigating these technologies through on-going work under the SWI project and a recently awarded Ontario Centre of Excellence (OCE) and National Science and Engineering Research (NSERC) in conjunction with the University of Waterloo. At present, the DMA design standard does not include pressure monitoring equipment.

4.0 CITY OF GUELPH LONG-TERM PLAN FOR DMA IMPLEMENTATION AND EXPECTED BENEFIT

The Blease report (Appendix B) uses industry best practices and conceptual knowledge of the operation of the City of Guelph's water supply and distribution system to identify twenty-six (26) potential DMA's for implementation. The report provides a map showing the proposed DMA boundaries. Accounting for the six (6) DMA's implemented through the SWI project, Water Services plans on implementing a total of twenty (20) additional DMA's comprising of an estimated fifty (50) additional flow meter installations.

It is important to note that the actual number of flow meters installed per DMA in the SWI project was two (2). The Blease report estimates that this number may be reduced to 1.8 flow meters per DMA. While it is hoped that this level of efficiency can be achieved, along with some of the other efficiencies discussed in this report, the 2.5 flow meter per DMA number is used for planning purposes. The technical memo prepared by Sam Ziemann of CH2M Hill Ltd., Appendix A, presents the detailed DMA design which justifies the actual final number of flow meters used. As discussed in section 2, a detailed review of each proposed DMA will be required to confirm that the design criteria are met.

Based on the Water Services Division's experience in implementing the first six (6) DMA's in 2013 a five (5) year implementation period is recommended as manageable for the proposed city-wide DMA program. The tendered cost of each DMA flow meter installation was $60,000, in 2013 Canadian dollars. Engineering and project management costs are more difficult to estimate as a great deal of the engineering, contract management and integration work was completed by Water Services staff through the SWI project in order to meet in-kind contribution requirements required as a part of this project. An allowance of twelve (12) % is recommended for engineering, project and contract management and system integration. The recommended budget for the proposed city-wide DMA program is therefore $3.36 Million.

The Blease report estimates that water loss reductions as a result of implementing the city-wide DMA program will be 3.4% of the total water supplied to the City. The 2012 average day demand for the City of Guelph was 45,244 m^3/day. The expected benefit as a result of implementing the program will be a reduction in water supply of 1,538 m^3/day on the average day. As per the Blease report, it is expected that this benefit will be realized within a year of specific DMA implementation.

Reducing the average day water supply demand through reducing water loss is equivalent to deferring the requirement for new water supply infrastructure to be built and commissioned. This is a direct, one-time cost benefit to the City and the development community if the cost of implementing the DMA program is less than that of building new water supply

5.0 COST BENEFIT ANALYSIS OF THE DMA IMPLEMENTATION PROGRAM

5.1 Financial Justification of the City-Wide DMA Program

As noted in section 4, the implementation of the city-wide DMA program is recommended over a five (5) year period. The total cost of the program will be $3.36 Million and is expected to result in a deferral of 1,538 m3/day of new water supply infrastructure for average day supply. The cost of this benefit is therefore estimated to be **$2,184 per m3/day of average day supply**.

The City of Guelph Water Supply Master Plan (2007) estimates the price of the development of new water supplies by category of supply. The plan also identifies how much of each type of supply is available and will be required to carry the City through the planning period. Thus, it is possible to develop a weighted average for the cost of the development of new water supply in general. The details are as follows:

- In city new groundwater supply, $791 per m^3/day of average day supply with 59,017 m^3/day available.
- Outside of city new groundwater supply, $1,786 per m^3/day of average day supply with 22,032 m^3/day available.
- Local surface water supply, $3,042 per m^3/day of average day supply with 27,123 m^3/day available.
- The weighted average cost of new water supply is **$1,558 per m^3/day of average day supply**.

The Arkell Wells is a new outside of city water supply that has recently been developed and brought on-line. Staff have indicated that the actual cost associated with bringing this source on-line was $2,250 m^3/day of average day capacity. It is prudent to factor this actual cost into the weighted average discussed above to reflect real conditions encountered versus the planning estimate. In doing so, the revised weighted average cost to develop a new water supply is **$1,652 per m^3/day of average day capacity**.

The Water Supply Master Plan considers only the cost to develop the new water supply. The cost to develop the infrastructure required to bring the water supply into the distribution system, such that it can be conveyed to the end user is captured in the Water and Wastewater Servicing Plan (2008). There are three (3) key projects listed in this plan for implementation in the first five (5) year window, identifying new and upgraded infrastructure requirements to bring the proposed new water supplies into the distribution system. The details of these projects are as follows:

- Project WI2, Improvements to Address Scout Camp Capacity Restrictions. $2.00 Million.
- Project WI4, New Infrastructure to Connect and Manage New In-City Groundwater Supplies within the southwest quadrant of the City. $1.26 Million.
- Project WI5, New Infrastructure to Connect and Manage New In-City Groundwater Supplies within the southwest quadrant of the City. $1.46 Million.

The total new water supply capacity identified in the Water Supply Master Plan for this five (5) year window is approximately 4,500 m^3/day of average day supply. The cost of additional infrastructure required to accommodate new water supplies is therefore $1,050 m^3/day of average day supply.

The total cost, therefore, to implement new water supply is **$2,702 per m^3/day of average water day supply**. This is significantly more than the cost of the city-wide DMA program estimated to be **$2,184 per m^3/day of average day supply**. Should the actual number of flow meters per DMA be closer to two (2) as seen in the SWI project, then the program cost will drop to **$1,787 per m^3/day of average day supply**.

In the following analysis it was assumed that the DMA flow meter chambers and water loss reduction benefits are realized equally in successive years. The following table provides a comparison of the internal rate of return (IRR) that the City would realize on its investment in the proposed number of DMA's funded through development

charges compared to the estimated benefit realized through the deferral of new water supply and distribution capital spending.

Table 1
Internal Rate of Return (IRR) Comparison

Years to Implement the DMA Program Fully	IRR (2.5 flow meters per DMA)	IRR (2.0 flow meters per DMA)
5	24%	54%

It should be noted that there will be additional O&M cost savings realized through the deferral of additional capital infrastructure amounting to roughly \$40/(m^3/day) on an annual basis, based on data provided in the Water Supply Master Plan. While this amount is significant it will be partially off-set by the additional DMA infrastructure O&M cost and is funded through water rates not development charges. The O&M cost is not, therefore, factored into the evaluation.

In addition to the cost of the city-wide DMA program, there will be the cost of pipe repairs and/or main replacements as leaks are identified and located. This additional cost is one that the City would need to bear as a normal cost of asset renewal, which is a normal cost of doing business. This cost is also rate funded and is not, therefore, factored into the evaluation.

5.2 Other Benefits

The Blease report quotes AWWA M36, Water Audits and Loss Control Programs (AWWA, 2009) and the IWA Water Audit as documents describing industry best practice. This document and procedure provides an excellent starting point to managing and reducing water loss. Additional benefits also identified in these documents and in the Blease report include:

- The early identification of water main leaks allowing them to be fixed before they become full-scale water main breaks. This then also enables the repair to be scheduled to occur at a time when it is less costly to effect, and less inconvenient to the end user. With a main break, the repair must typically be effected immediately upon discovery.
- Reduced liability associated with water main breaks.

Through the SWI project the City of Guelph has been able to evolve its understanding of what can be achieved through the automation of DMA monitoring. This understanding extends to other distribution system real-time data that is being collected. The industry trend is undeniably towards full integration of DMA instrumentation into the Supervisory Control and Data Acquisition (SCADA) system. This allows the data to be collected with significantly less effort and to be easily accessed by other Business Intelligence (BI) software resulting in:

- The establishment of real-time night flow baselines through daily reporting. This reporting will supplement the calculation of legitimate night time flows to aid in identifying problems within a DMA.
- With the ability to compare real-time flows throughout the system with automated meter reading (AMR) systems, automate the water audit process and make it more of a real-time process.
- Reporting systems such that summary reports can be prepared for management for ready documentation of issues and ultimately used to establish a key metric, expected versus measured and reported usage within the DMA.

- Greatly simplify monitoring of and reporting on any field work used to pin-point leaks within a DMA.
- With baselines established, develop on-line control software such that unusual conditions deviating from the baseline can be alarmed, greatly reducing response times.
- Additional real time information. When combined with that information already collected (reservoir levels, production flows, distribution flows and pressures) this data can be used for the on-line calibration of the hydraulic modelling software to assess the impact of proposed capital improvements to the water supply and distribution system which result in the development of a system Master Plan (MP) and Capital Improvement Program (CIP). As a result, the CIP becomes more realistic and accurate.

APPENDIX A

DISTRICT METERING AREAS FLOW METER SIZING

SAM ZIEMANN, P. ENG.
CH2M HILL LTD.

District Metered Areas Flow Meter Sizing

PREPARED FOR: City of Guelph

COPY TO: John Michalofsky

PREPARED BY: CH2M HILL

DATE: July 3, 2013

PROJECT NUMBER: 437617

Introduction

This technical memorandum provides a summary of the recommended flow meter sizing to be installed in seven district metered areas (DMAs) within the City of Guelph's water system. Appropriate flow meter sizes were selected based on achieving a flow measurement accuracy of ±0.5 percent under typical flow ranges and the maximum and minimum flows that were predicted for each flow meter.

The flow ranges and maximum/minimum flows were determined from hydraulic model simulations using the City of Guelph's calibrated model dated November 28, 2011, with Infowater software. The hydraulic simulations were run under average and maximum day demand scenarios, and included available fire flows (steady state) and extended period fire flow simulations under a maximum day demand scenario. The size of fires tested in the model was based on the type of construction within each DMA. To verify modeling results field fire flow testing should be completed. The recommended flow meter sizes are summarized in Table 1 and results for each DMA are discussed in the following section.

TABLE 1
Recommended Flow Meter Sizes

DMA	Meter ID	Location	Pipe Diameter (mm)	Pipe Material	Flow Meter Size (mm)
1	1-1	In front of 47 Meyer Dr	250	Cast Iron	250
	1-2	Victoria Rd N near Grange St	200	Ductile Iron	200
	1-3	Eramosa Rd near Meyer Dr	150	Cast Iron	150
3	3-1	South of 310 Metcalfe St	200	Cast Iron	200
7	*7-1 (installed)*	*Woodland Glen Dr south of Stone Rd*	300	Hyprotec	*250*
	7-2	Collegiate Av W at Hanlon Rd	200	Cast Iron	200
9	9-1	In front of 274 Ironwood Rd	200	Ductile Iron	200
	9-2	In front of 46 Ironwood Rd	200	Ductile Iron	200
10	10-1	In front of 3 Youngman Dr	200	Ductile Iron	200
	10-2	Between valve & hydrant in front of 102 Rickson Av	150	Ductile Iron	150
	10-3	East of 34 Harvard Rd & plaza entrance	200	Ductile Iron	200
11	11-1	North of hydrant at 188 Clairfields Dr W	300	Polyethylene	300
	11-2	In front of 4 Clairfields Dr W	300	Polyethylene	300

Results

DMA 1

DMA#1 includes 3 proposed flow meters. The first flow meter is located on Meyer Drive,the second near Victoria Road and Grange Street. Results from the available fire flow simulation for the DMA are shown in Figure A.1. An area of high elevation in the northwest portion of DMA 1 (near John F. Ross Collegiate and Vocational Institute) resulted in lower than ideal (<50 L/s) available fire flows at several junction points, due to high elevations and a 150 mm diameter main on Meyer Drive supplying this area.

To improve fire flows in the area a third flow meter on the 150 mm diameter main on Meyer Drive at Lincoln Crescent was tested in the model and an available fire flow simulation was run for the DMA (results are shown in Figure A.2). Available fire flows were improved from 43 L/s to 74 L/s due to the increased supply capacity, and therefore a third flow meter is recommended.

Average and maximum day demand flows for the individual flow meters in the DMA are shown in Figure B.1 (Meter 1-1) and Figure B.2 (Meter 1-2). Table 2 provides a summary of the typical flow range, and Max fire flows through each flow meter in DMA 1 based on the average and maximum day simulations and extended period fire flow simulation.

As the minimum fire flows are narrowly met in the DMA, it is recommended that the flowmeters be installed at the same diameter as the existing watermain to limit the amount of headloss through the fittings and maintain the hydraulic capacity of the watermains and ensure no hindrance to any swabbing done in the area.

TABLE 2
Summary of Flow Meters in DMA 1

DMA	Meter ID	Pipe ID	Location	Flow (L/s)		Size (mm)	
				Typical Range	Max Fire Flow	Pipe	Flow Meter
1	1-1	P-2530	In front of 47 Meyer Dr	-7 to 8	36	250	250
	1-2	P-925	Victoria Rd N near Grange St	-4 to 10	57	200	200
	1-3	*WLNE101815*	*Eramosa Rd near Meyer Dr*			*150*	*150*

DMA 3

DMA#3 includes a single flow meter located on Metcalfe Street near Speedvale. Results from the available fire flow simulation for the DMA are shown in Figure A.3. The available fire flows were less than ideal (<50 L/s) in two areas: the southwest part of the DMA, on Kitchener Avenue, and an area surrounding the intersection of Waverly Drive and Knightswood Boulevard.

An available fire flow simulation was run which excluded Riverview Drive from the DMA (results not shown), however this did not result in significant improvement in the available fire flows in the DMA. An available fire flow simulation was run which included a second flow meter on the 300 mm diameter main on Knightswood Drive at Speedvale Avenue East (results are shown in Figure A.4). Available fire flows were improved due to the increased supply into the east side of the DMA, however, rather than add a second flow meter in this DMA, it is recommended to only isolate this DMA for one week, as eventually the DMA will be converted to the upper zone and a second meter will be potentially installed along Waverly Drive.

Average and maximum day demand for the flow meter in the DMA are shown in Figure B.3 (Meter 3-1). Table 3 provides a summary of the typical flow range and maximum fire flows through each flow meter in the DMA based on the average and maximum day demand simulations and extended period fire flow simulation.

As the minimum fire flows are narrowly met in the DMA, it is recommended that the flowmeter be installed at the same diameter as the existing watermain to limit the amount of headloss through the fittings and maintain the hydraulic capacity of the watermains.

TABLE 3
Summary of Flow Meters in DMA 3

DMA	Meter ID	Pipe ID	Location	Flow (L/s)		Size (mm)	
				Typical Range	Max Fire Flow	Pipe	Flow Meter
3	3-1	P-1243	South of 310 Metcalfe St	1 to 7	63	200	200

DMA 7

DMA#7 has a flow meter on Woodland Glen Drive and a second flow meter is proposed on College Avenue east of Hanlon Road. Results from the available fire flow simulation for the DMA are shown in Figure A.5. The available fire flows at all but four junction points within the DMA were acceptable (≥50 L/s). The available fire flows at these four junction points ranged from 40 to 47 L/s and were located on deadends.

Average and maximum day demand flows for the individual flow meters in DMA 7 are shown in Figure B.4 (Meter 7-1) and Figure B.5 (Meter 7-2). Table 4 provides a summary of the typical flow range, minimum, and maximum flows through each flow meter in DMA 7 based on the average and maximum day demand simulations and extended period fire flow simulation.

Although the minimum fire flows are met within the DMA there is not a As the available fire flows meet the expected fire flows of the DMA but are not significant, it is recommended that the flowmeters be installed at the same diameter as the existing watermain to limit the amount of headloss through the fittings and maintain the hydraulic capacity of the watermains.

As the minimum fire flows are met in the DMA, it is recommended that the flowmeters be installed at the same diameter as the existing watermain to limit the amount of headloss through the fittings and maintain the hydraulic capacity of the watermains.

It should be noted that a school (Mary Phelan Catholic School) exists on Bishop Crescent near Flanders with an available fire flow of approximately 80 L/s.

TABLE 4
Summary of Flow Meters in DMA 7

DMA	Meter ID	Pipe ID	Location	Flow (L/s)		Size (mm)	
				Typical Range	Max Fire Flow	Pipe	Flow Meter
7	*7-1*	*P-2872*	*Woodland Glen Dr south of Stone Rd (installed)*	-2 to 10	93	*300*	300
	7-2	P-3455	Collegiate Av W at Hanlon Rd	-4 to 10	43	200	200

DMA 9

DMA#9 proposes a flow meter on Ironwood Road near Kortright Road and a second flowmeter on Ironwood Road near Edinburgh Road. Results from the available fire flow simulation for the DMA are shown in Figure A.6. The available fire flows at all points within the DMA were generally were very good.

Average and maximum day flows for the individual flow meters in the DMA are shown in Figure B.6 (Meter 9-1) and Figure B.7 (Meter 9-2). Table 5 provides a summary of the typical flow range and maximum fire flows through

each flow meter in the DMA based on the average and maximum day simulations and extended period fire flow simulation.

As a school exists in the DMA, it is recommended that the flowmeters be installed at the same diameter as the existing watermain to limit the amount of headloss through the fittings and maintain the hydraulic capacity of the watermains.

TABLE 5
Summary of Flow Meters in DMA 9

DMA	Meter ID	Pipe ID	Location	Flow (L/s)		Size (mm)	
				Typical Range	Max Fire flow	Pipe	Flow Meter
9	9-1	P-1036	In front of 274 Ironwood Rd	-6 to 11	215	200	200
	9-2	P-1061	In front of 46 Ironwood Rd	-4 to 14	88	200	200

DMA 10

DMA#10 proposes three flow meters at Youngman Drive and Edinburgh Road, Rickson Avenue and Kortright Road, and Harvard and Gordon. Results from the available fire flow simulation for DMA 10 are shown in Figure A.7. The available fire flows at all but seven points within the DMA were acceptable (≥50 L/s) with those points being on deadends.

Average and maximum day demand flows for the individual flow meters in the DMA are shown in Figure B.8 (Meter 10-1), Figure B.9 (Meter 10-2), and Figure B.10 (Meter 10-3). Table 6 provides a summary of the typical flow range and maximum flows through each flow meter in the DMA based on the average and maximum day simulations and extended period fire flow simulation.

As two schools exist in the DMA, it is recommended that the flowmeters be installed at the same diameter as the existing watermain to limit the amount of headloss through the fittings and maintain the hydraulic capacity of the watermains.

TABLE 6
Summary of Flow Meters in DMA 10

DMA	Meter ID	Pipe ID	Location	Flow (L/s)		Size (mm)	
				Typical Range	Max Fire flow	Pipe	Flow Meter
10	10-1	P-1068	In front of 3 Youngman Dr	-7 to 3	96	200	200
	10-2	P-207	Between valve & hydrant in front of 102 Rickson Av	-1 to 5	53	150	150
	10-3	P-1103	East of 34 Harvard Rd & plaza entrance	0 to 11	37	200	200

DMA 11

DMA#11 includes two flowmeters. The first flow meter is located on Clairfields Road near Clair Road and the second on Clairfields Road near Gordon Road. Results from the available fire flow simulation for the DMA are shown in Figure A.8. The available fire flows at all points within the DMA were very good (≥100 L/s). This is due to the proximity of the DMA to the trunk watermains on Gordon Road and Clair Road as well as the proximity to the Clair Elevated Tank.

Average and maximum day demand flows for the individual flow meters in the DMA are shown in Figure B.11 (Meter 11-1) and Figure B.12 (Meter 11-2). Table 7 provides a summary of the typical flow range and maximum

fire flows through each flow meter in the DMA based on the average and maximum day simulations and extended period fire flow simulation.

The location of the DMA suggests that a significant amount of water passes through the DMA to fill the Clair Elevated tank or water comes from the Clair Elevated Tank to service areas during high demands. Although the flowmeter diameter size could be decreased to a 250mm it is suggested that both flowmeters be maintained at 300mm to maintain the hydraulic capacity of the system.

TABLE 7
Summary of Flow Meters in DMA 11

DMA	Meter ID	Pipe ID	Location	Flow (L/s)		Size (mm)	
				Typical Range	Max Fire flow	Pipe	Flow Meter
11	11-1	P-89	North of hydrant at 188 Clairfields Dr W	-30 to 25	247	300	300
	11-2	WLNE104033	In front of 4 Clairfields Dr W	-10 to 40	173	300	300

APPENDIX A

Available Fire Flows

FIGURE A.1

Available Fire Flows in DMA 1 (Two Flow Meters)

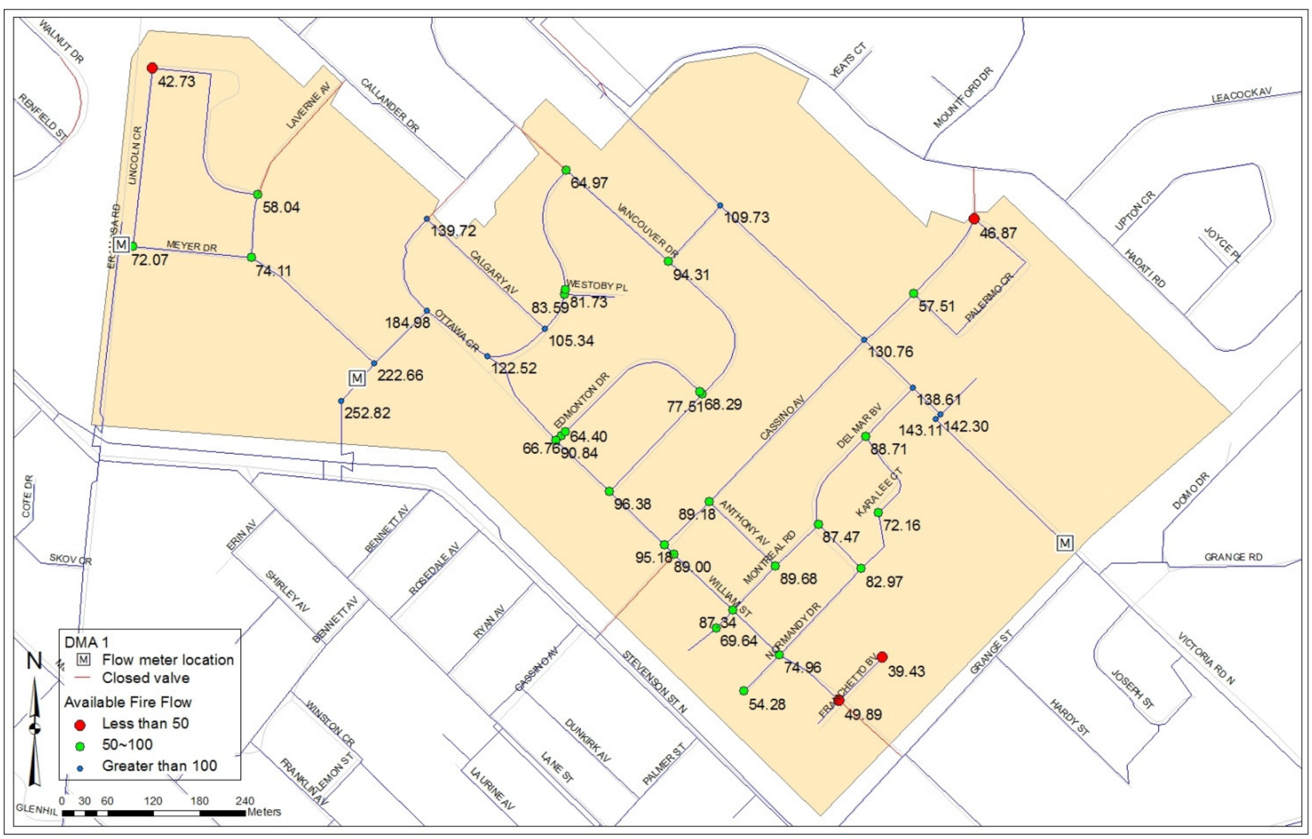

FIGURE A.2

Available Fire Flows in DMA 1 (Three Flow Meters)

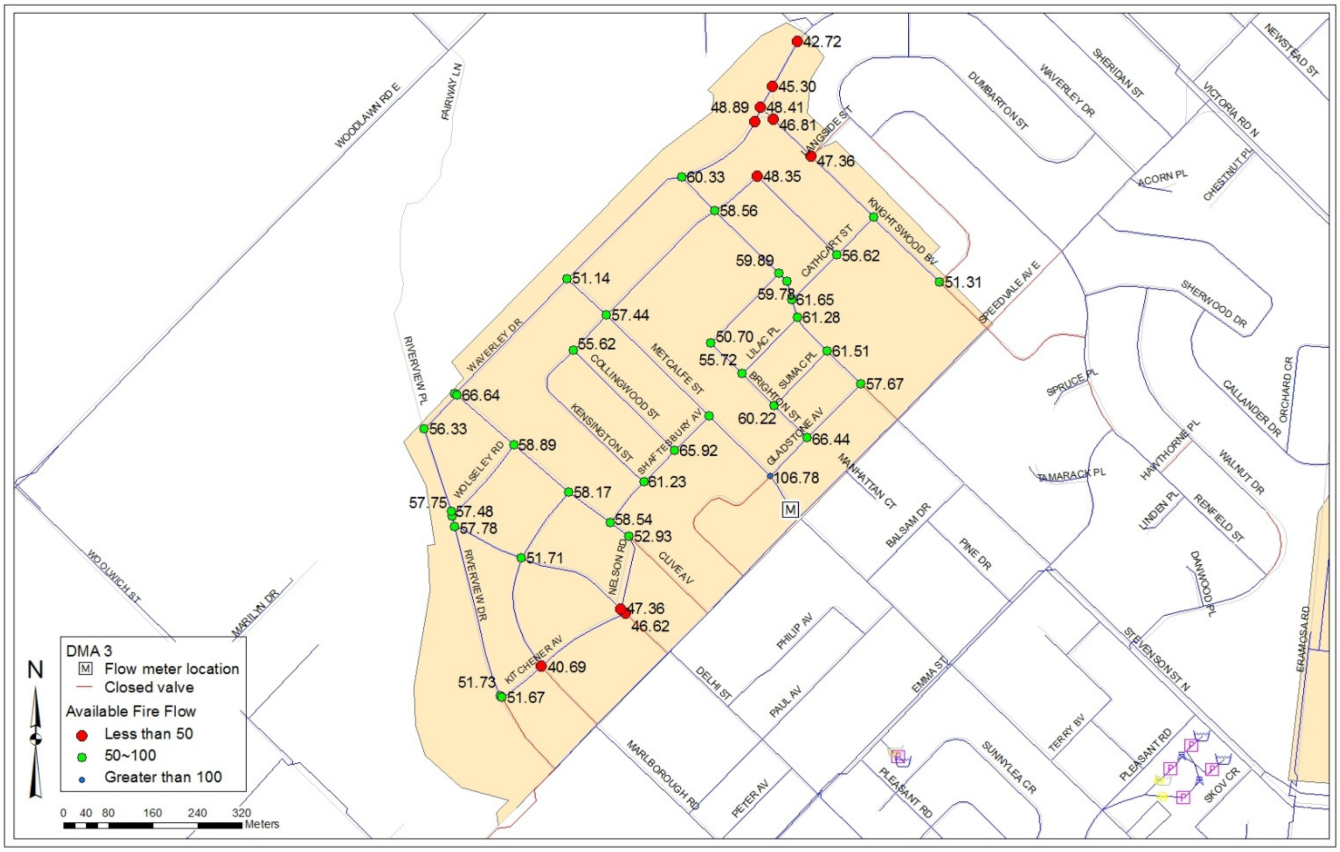

FIGURE A.3

Available Fire Flows in DMA 3 (One Flow Meter)

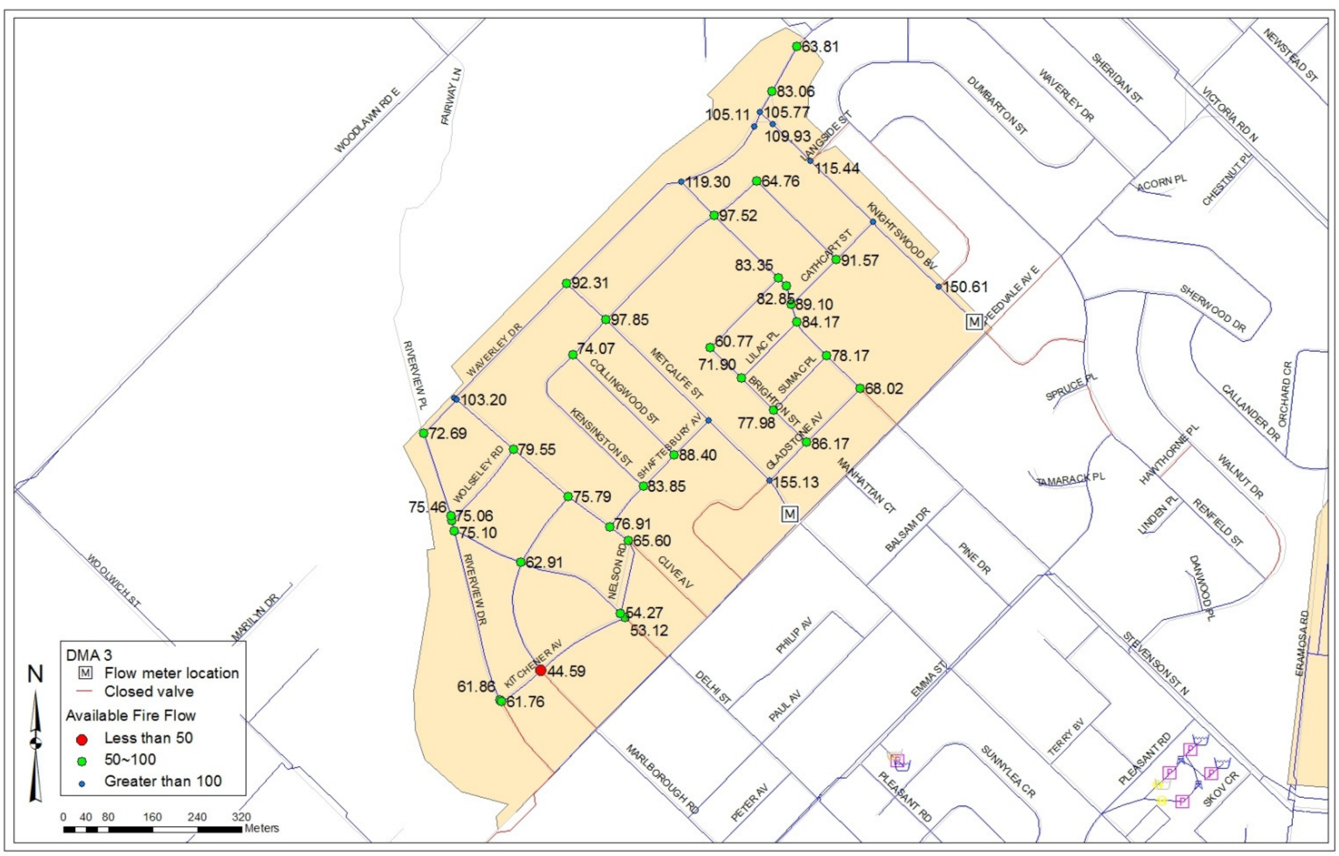

FIGURE A.4

Available Fire Flows in DMA 3 (Two Flow Meters)

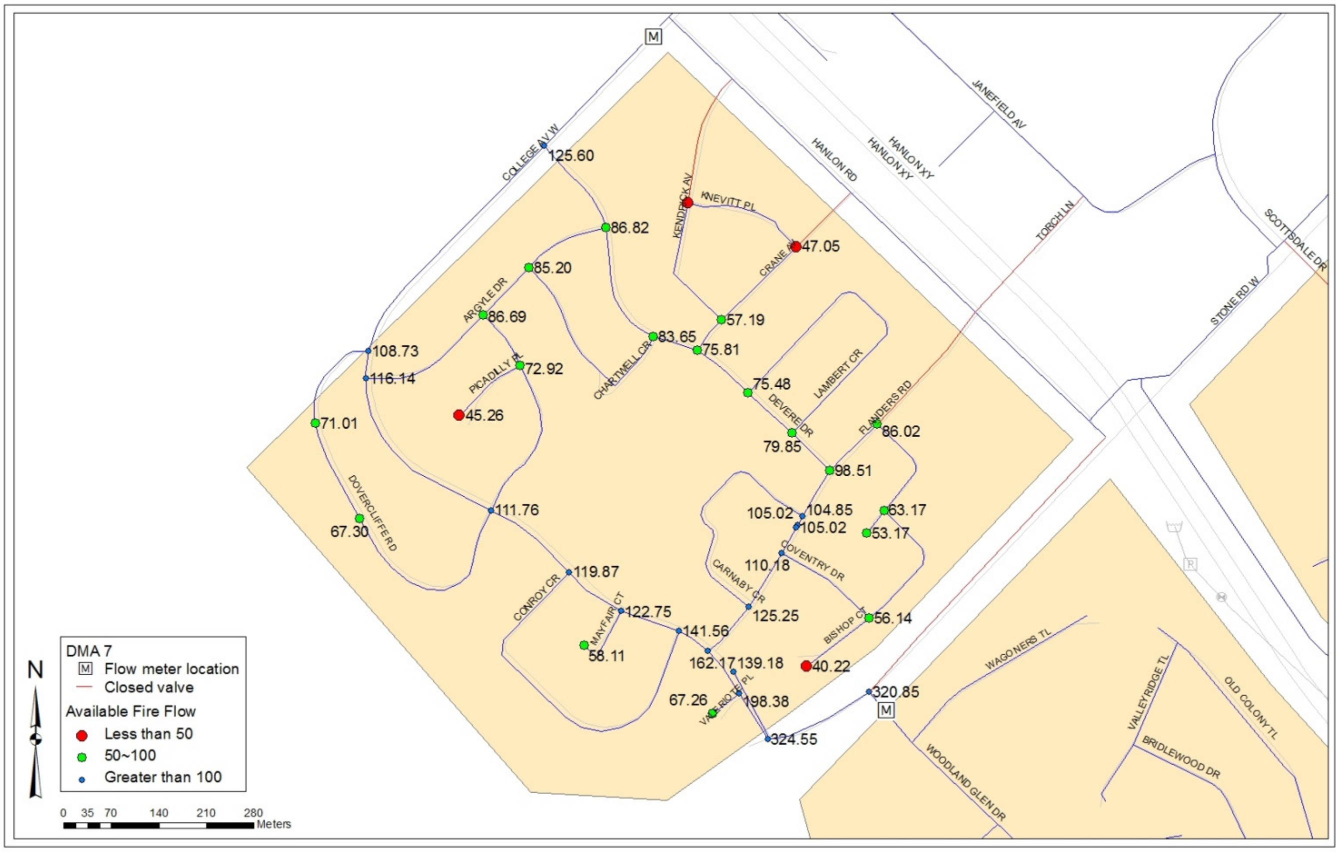

FIGURE A.5

Available Fire Flows in DMA 7 (Two Flow Meters)

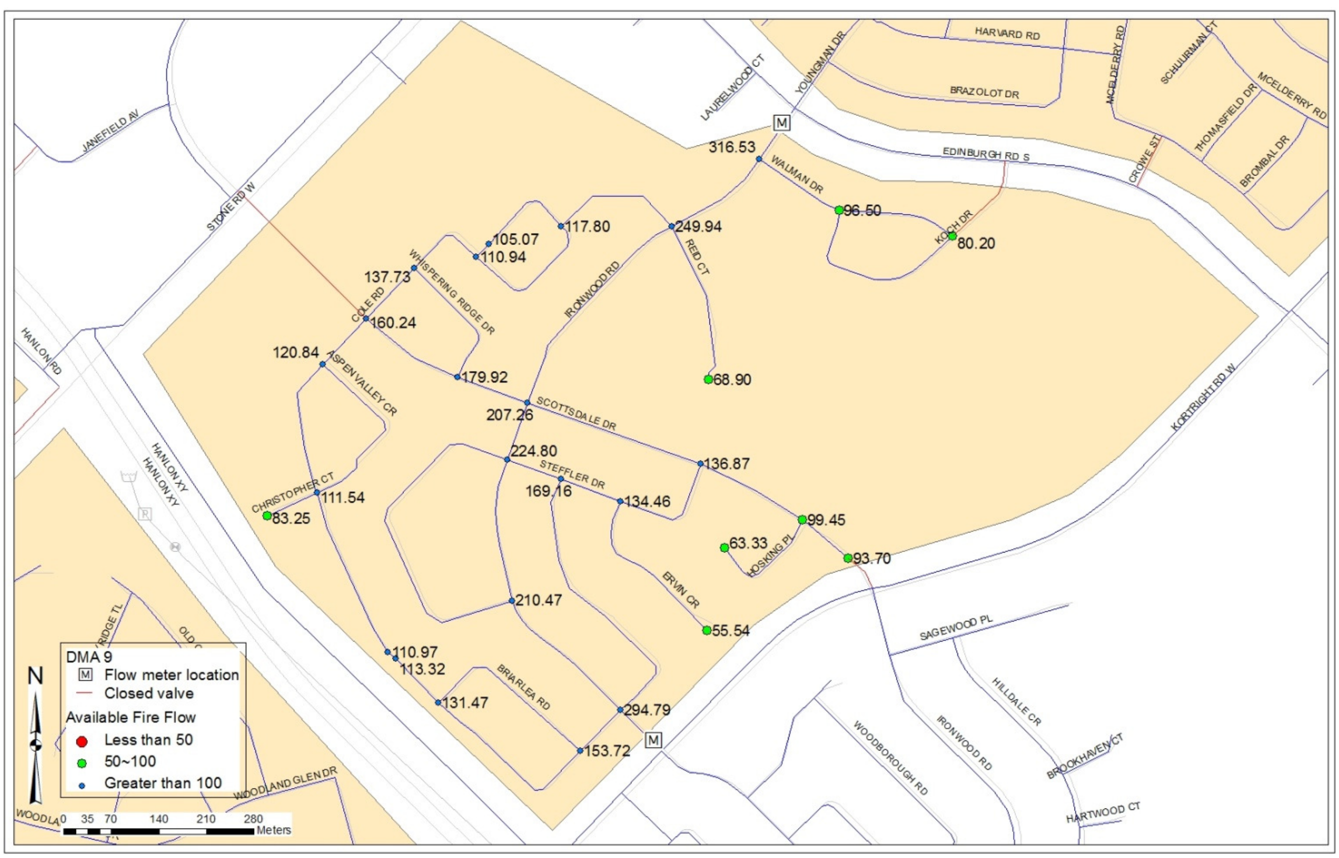

FIGURE A.6

Available Fire Flows in DMA 9 (Two Flow Meters)

FIGURE A.7

Available Fire Flows in DMA 10 (Three Flow Meters)

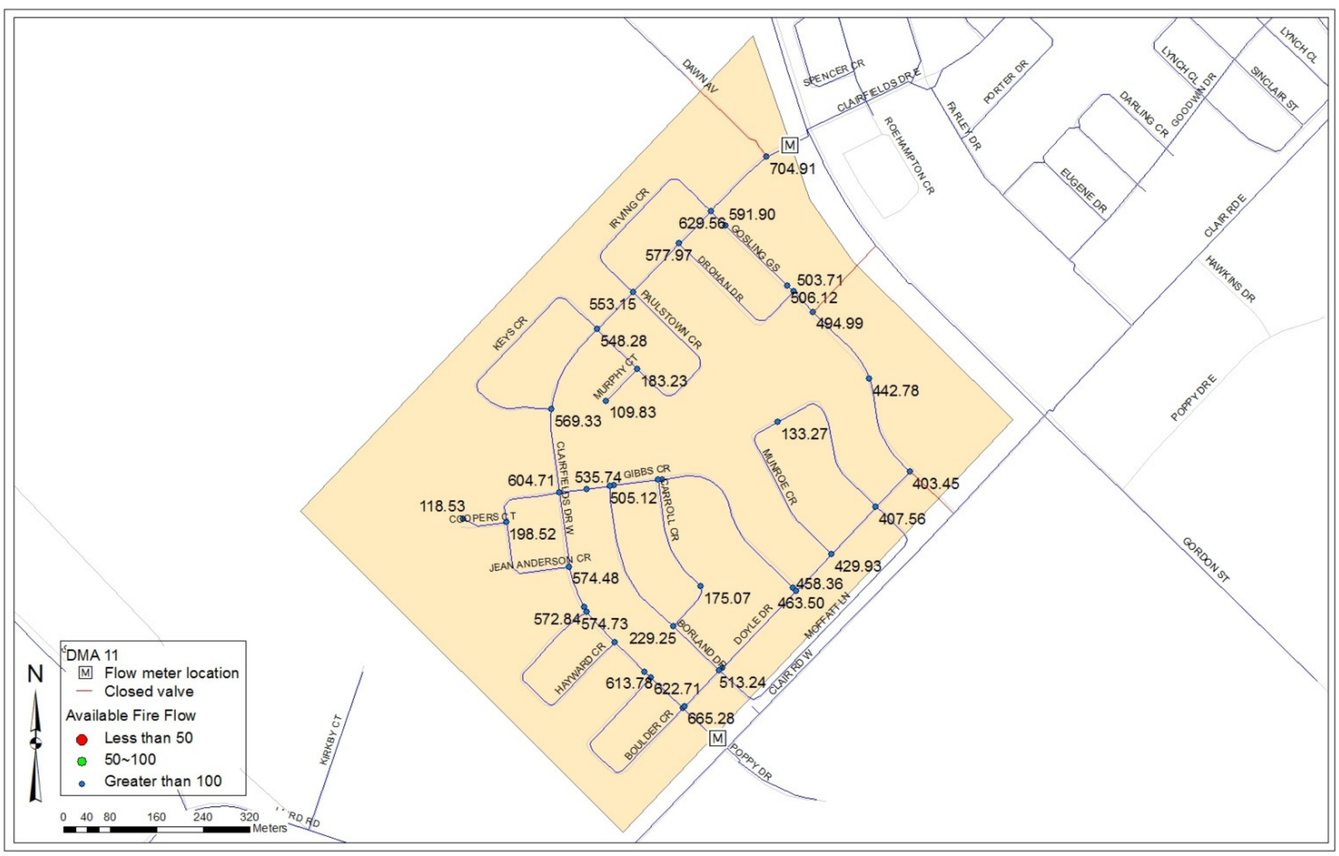

FIGURE A.8

Available Fire Flows in DMA 11 (Two Flow Meters)

APPENDIX B

Average and Maximum Day Demand Flows

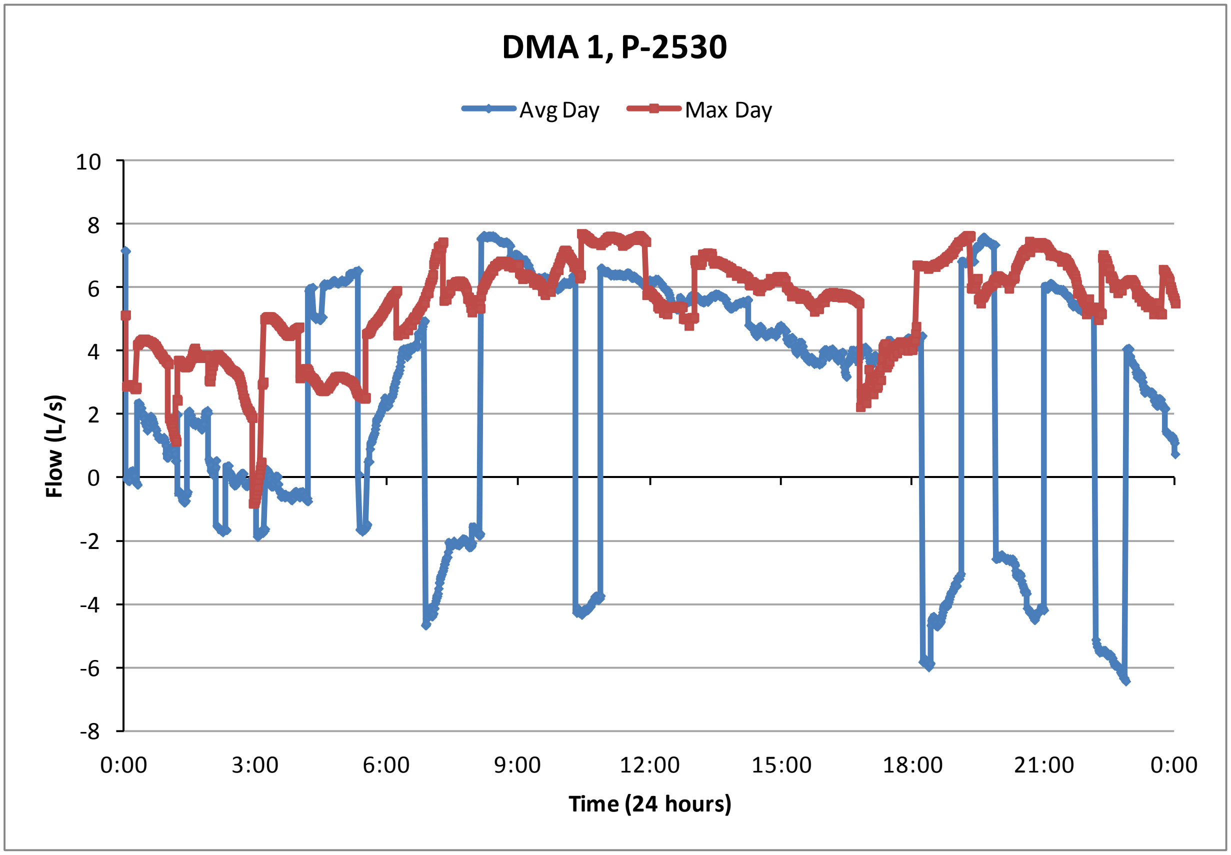

FIGURE B.1
Average and Maximum Day Demand Flows, Flow Meter 1-1 (P-2530, DMA 1)

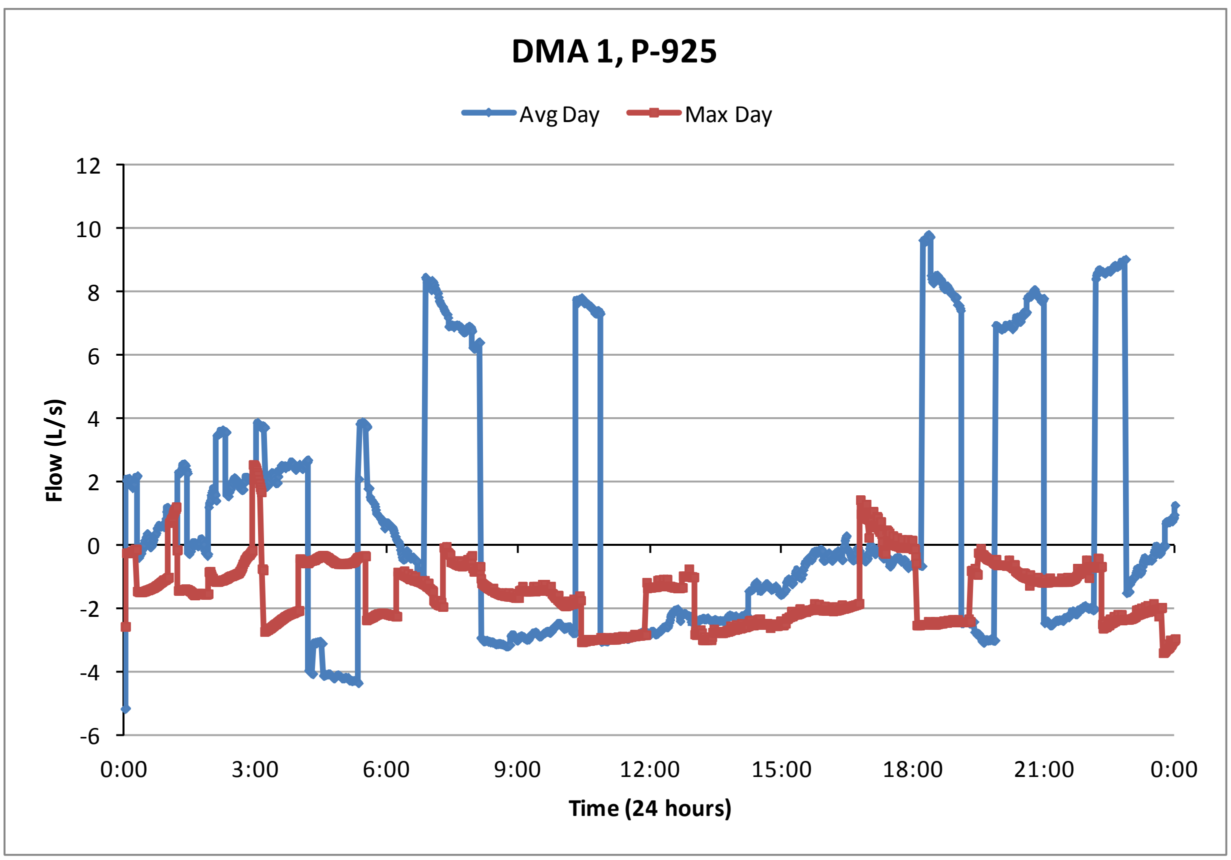

FIGURE B.2
Average and Maximum Day Demand Flows, Flow Meter 1-2 (P-925, DMA 1)

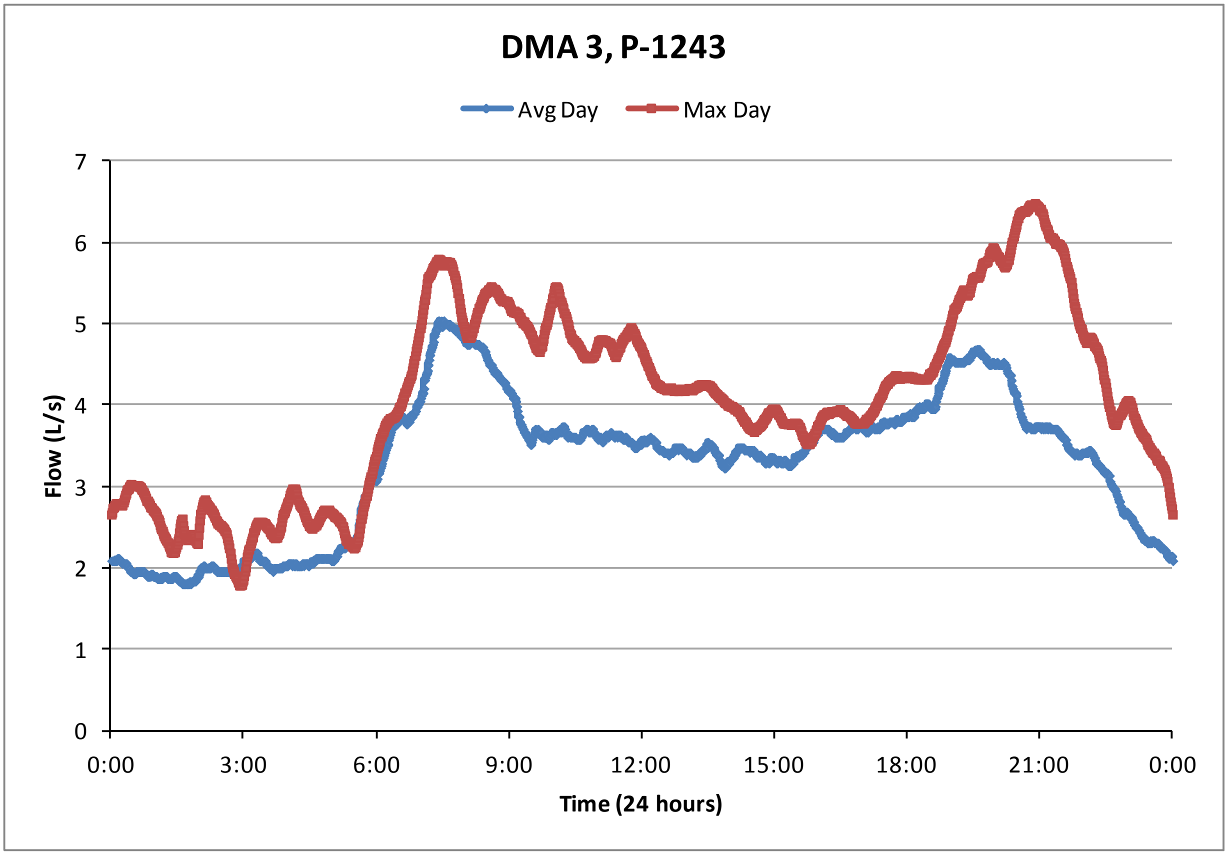

FIGURE B.3
Average and Maximum Day Demand Flows, Flow Meter 3-1 (P-1243, DMA 3)

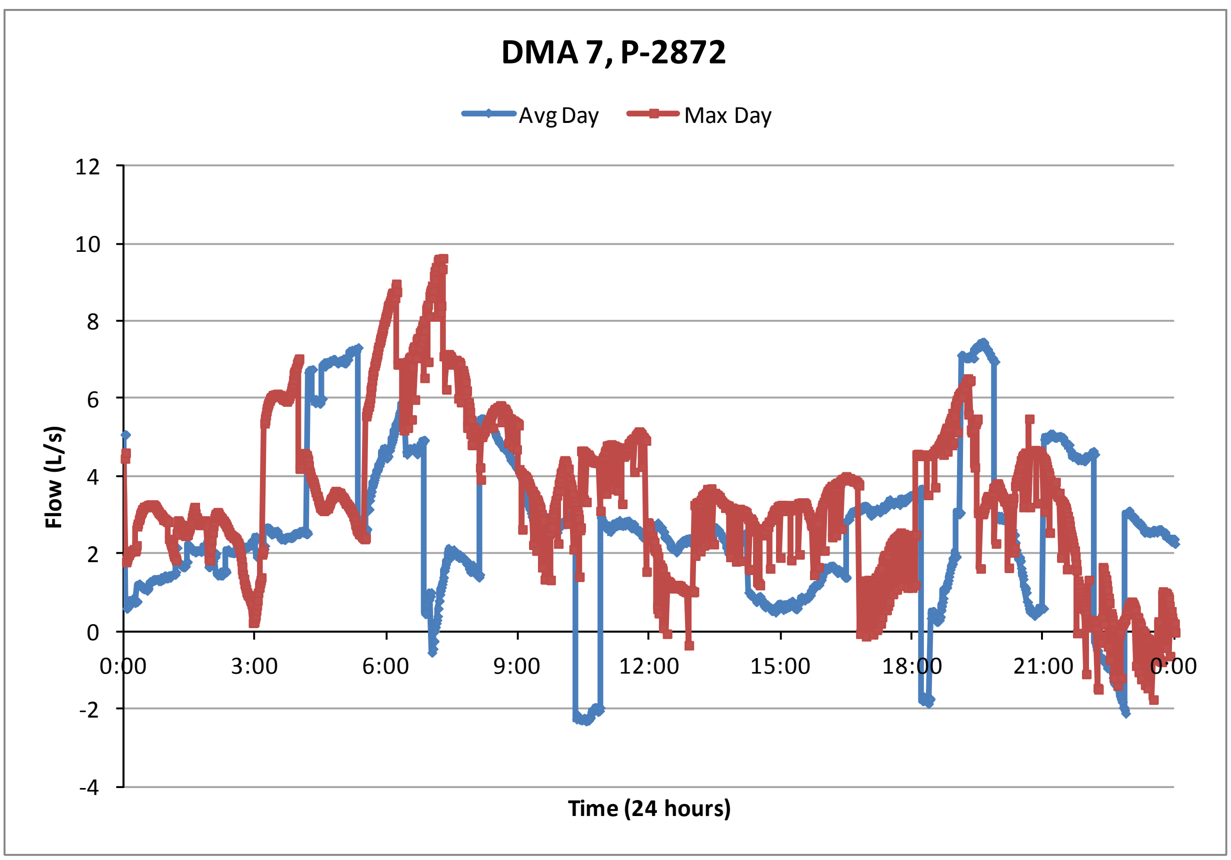

FIGURE B.4
Average and Maximum Day Demand Flows, Flow Meter 7-1 (P-2872, DMA 7)

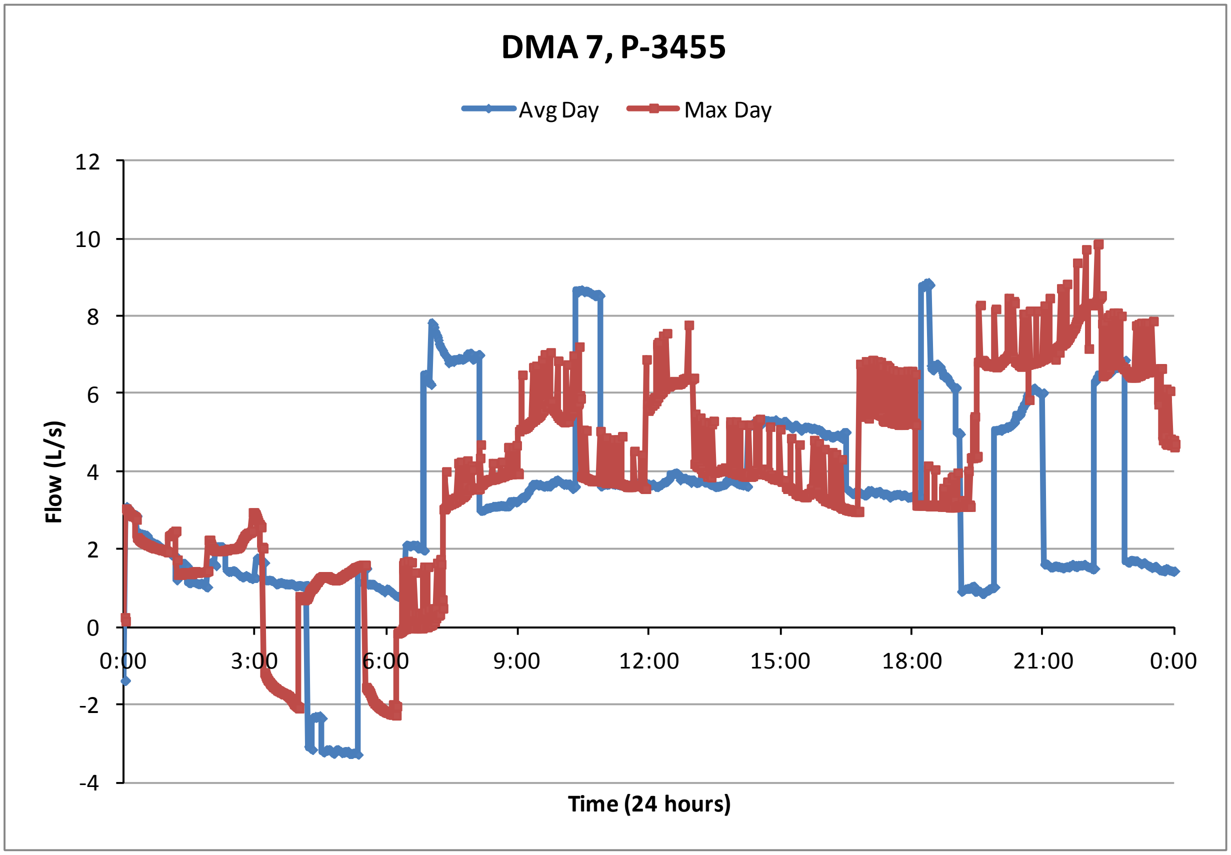

FIGURE B.5
Average and Maximum Day Demand Flows, Flow Meter 7-2 (P-3455, DMA 7)

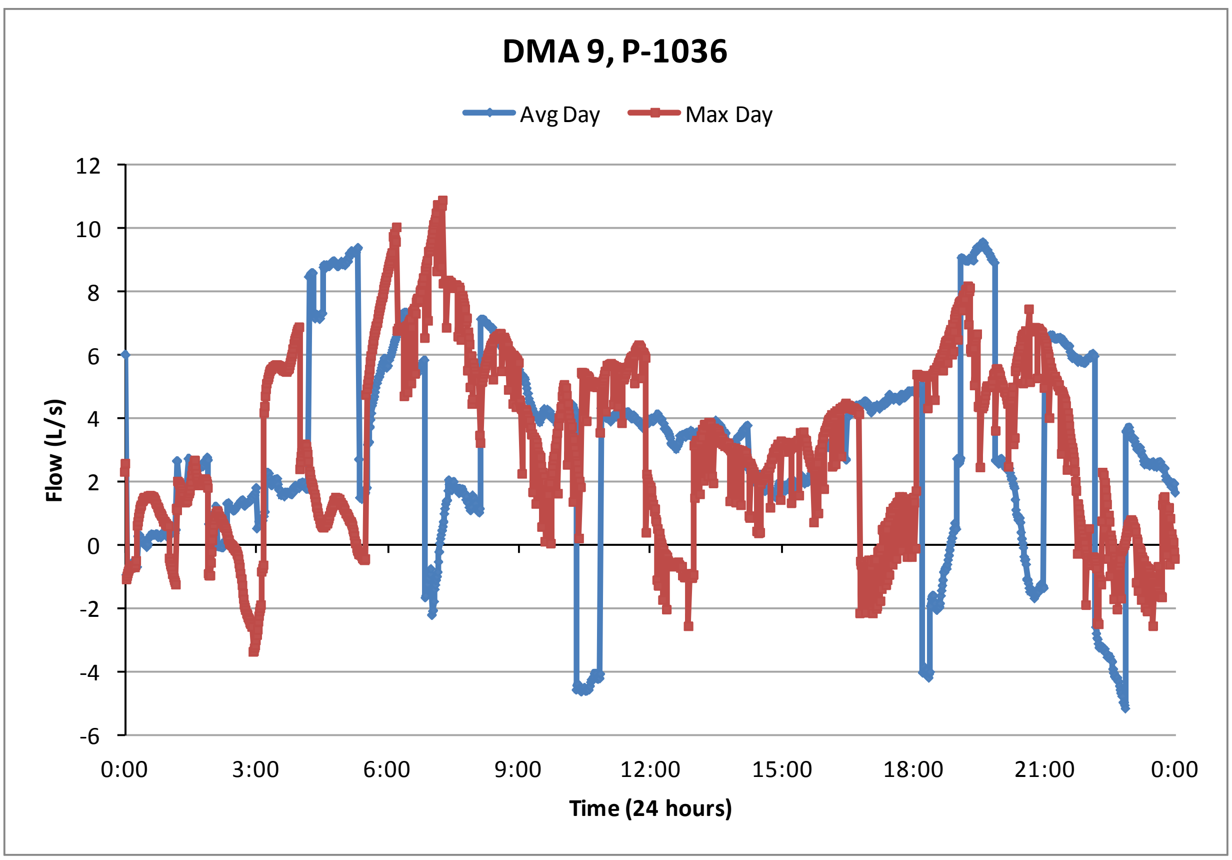

FIGURE B.6
Average and Maximum Day Demand Flows, Flow Meter 9-1 (P-1036, DMA 9)

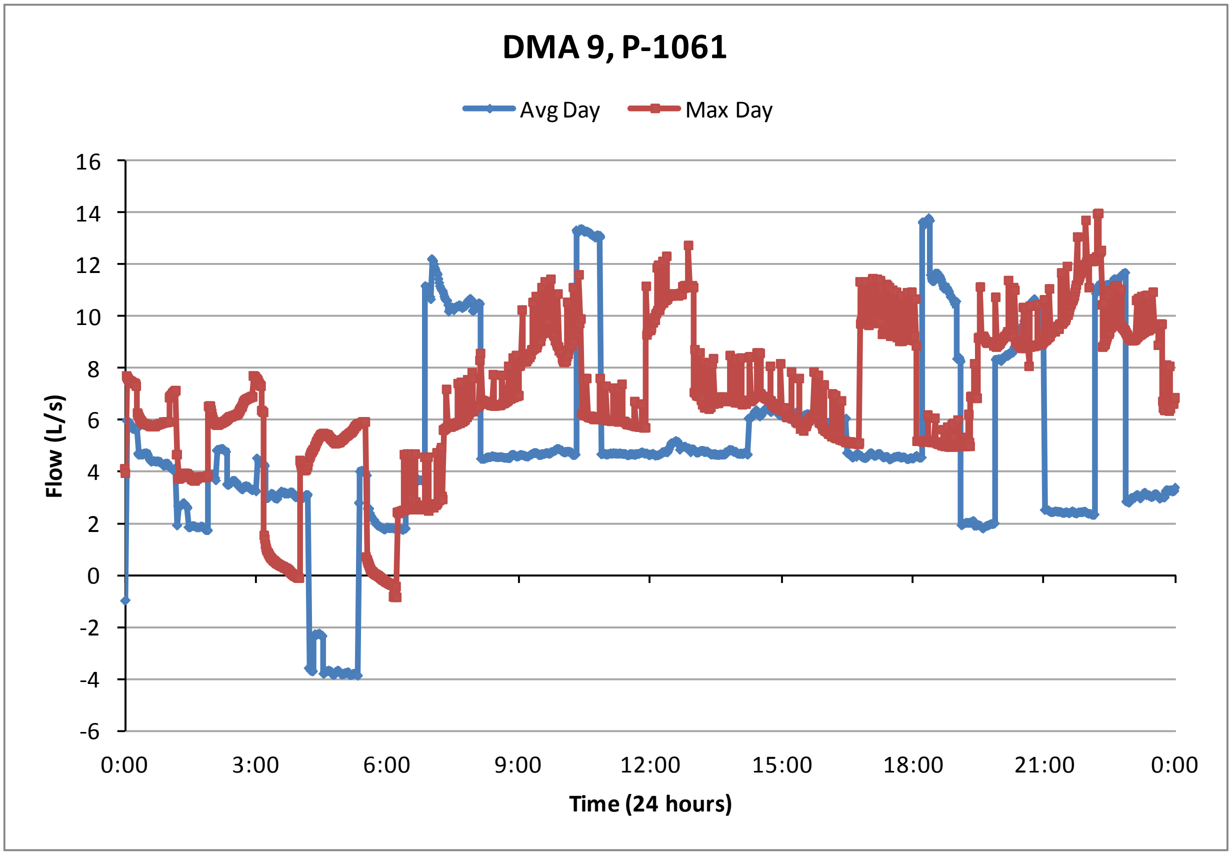

FIGURE B.7
Average and Maximum Day Demand Flows, Flow Meter 9-2 (P-1061, DMA 9)

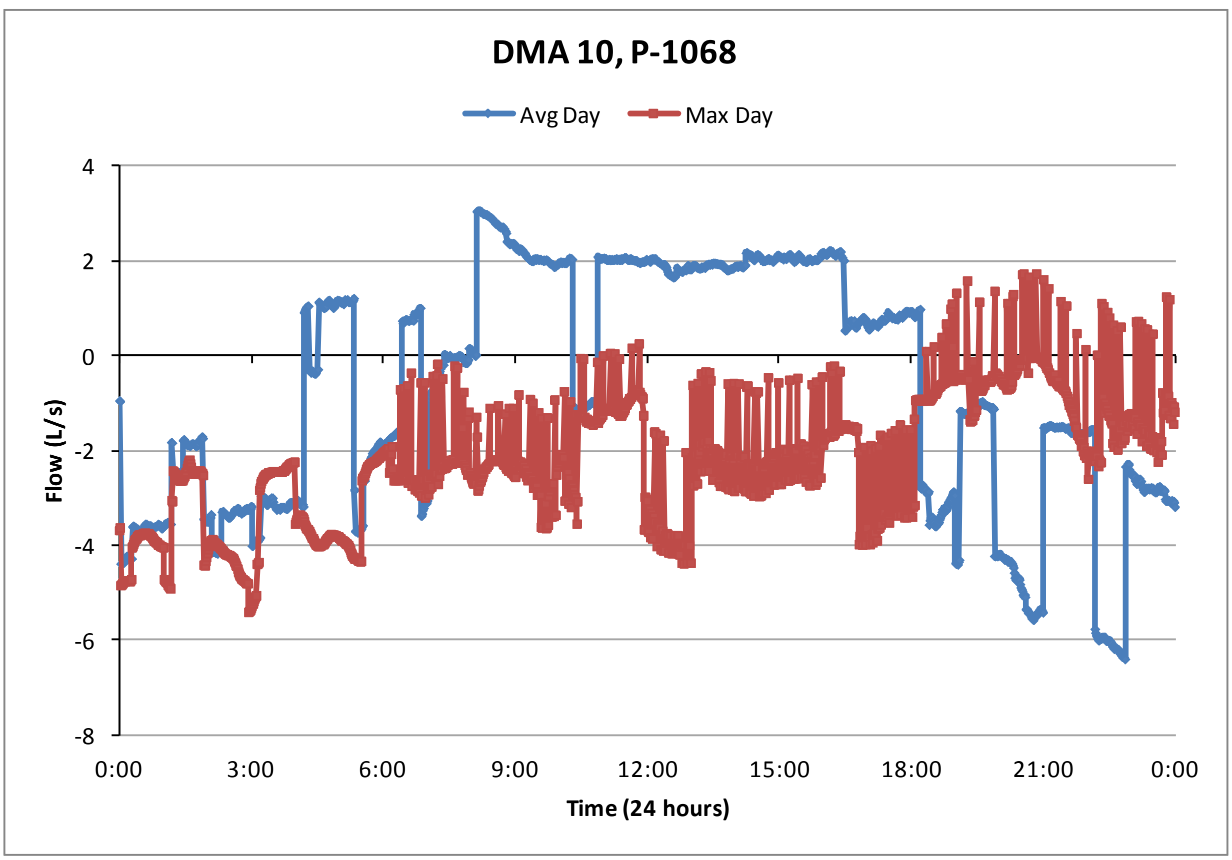

FIGURE B.8
Average and Maximum Day Demand Flows, Flow Meter 10-1 (P-1068, DMA 10)

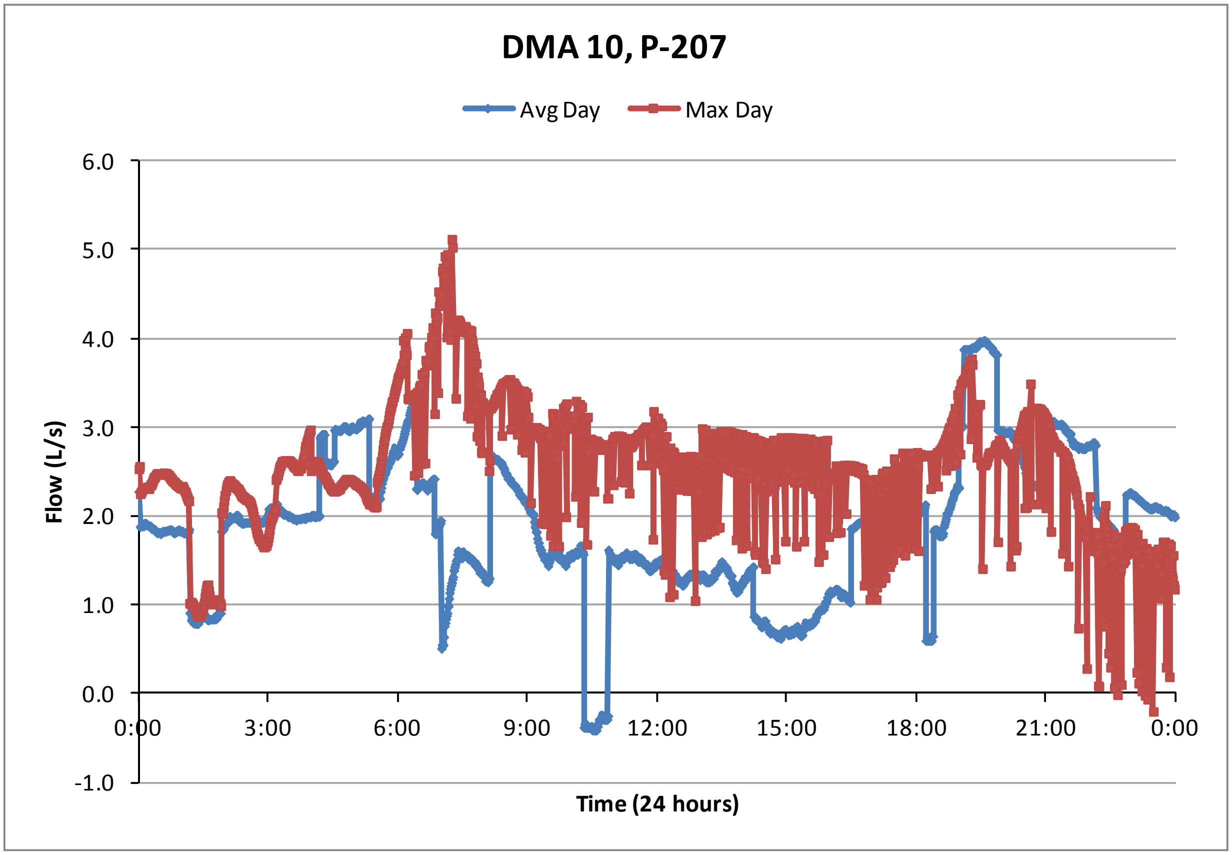

FIGURE B.9

Average and Maximum Day Demand Flows, Flow Meter 10-2 (P-207, DMA 10)

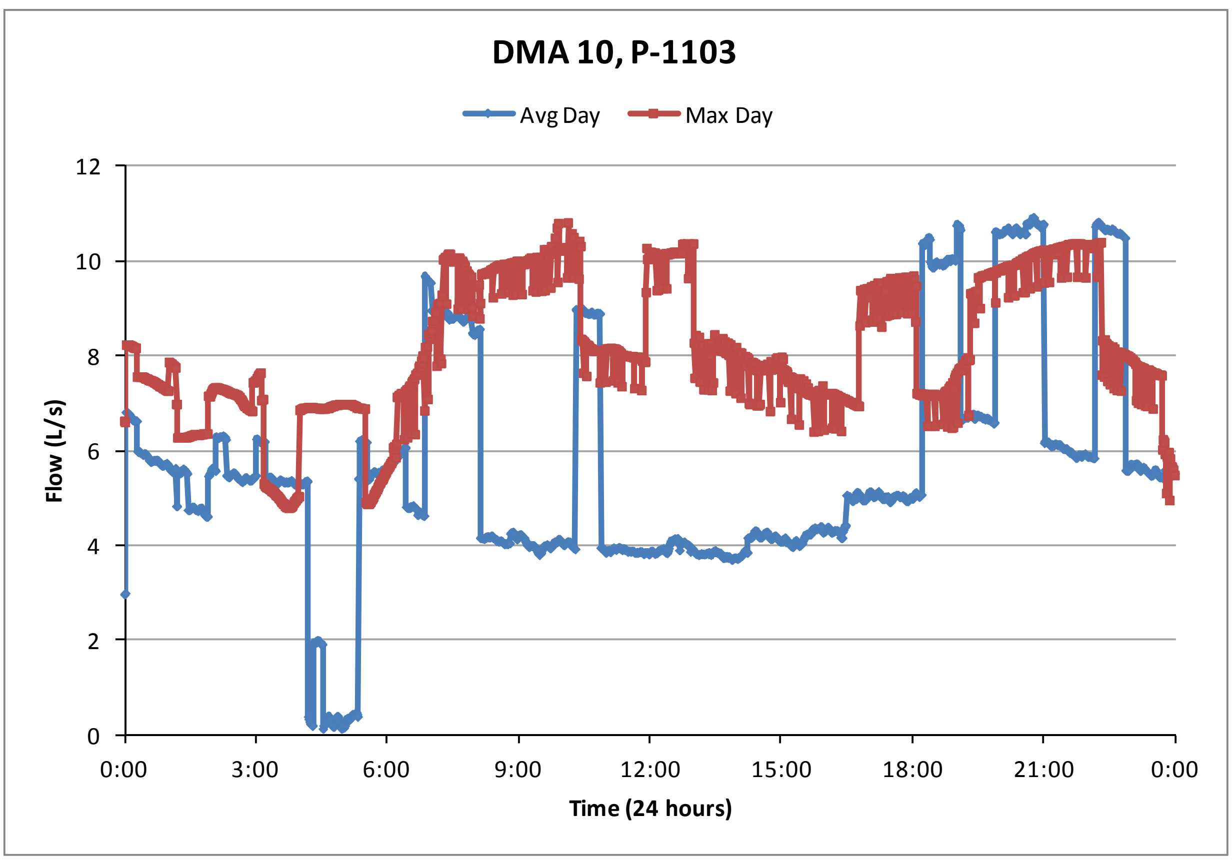

FIGURE B.10

Average and Maximum Day Demand Flows, Flow Meter 10-3 (P-1103, DMA 10)

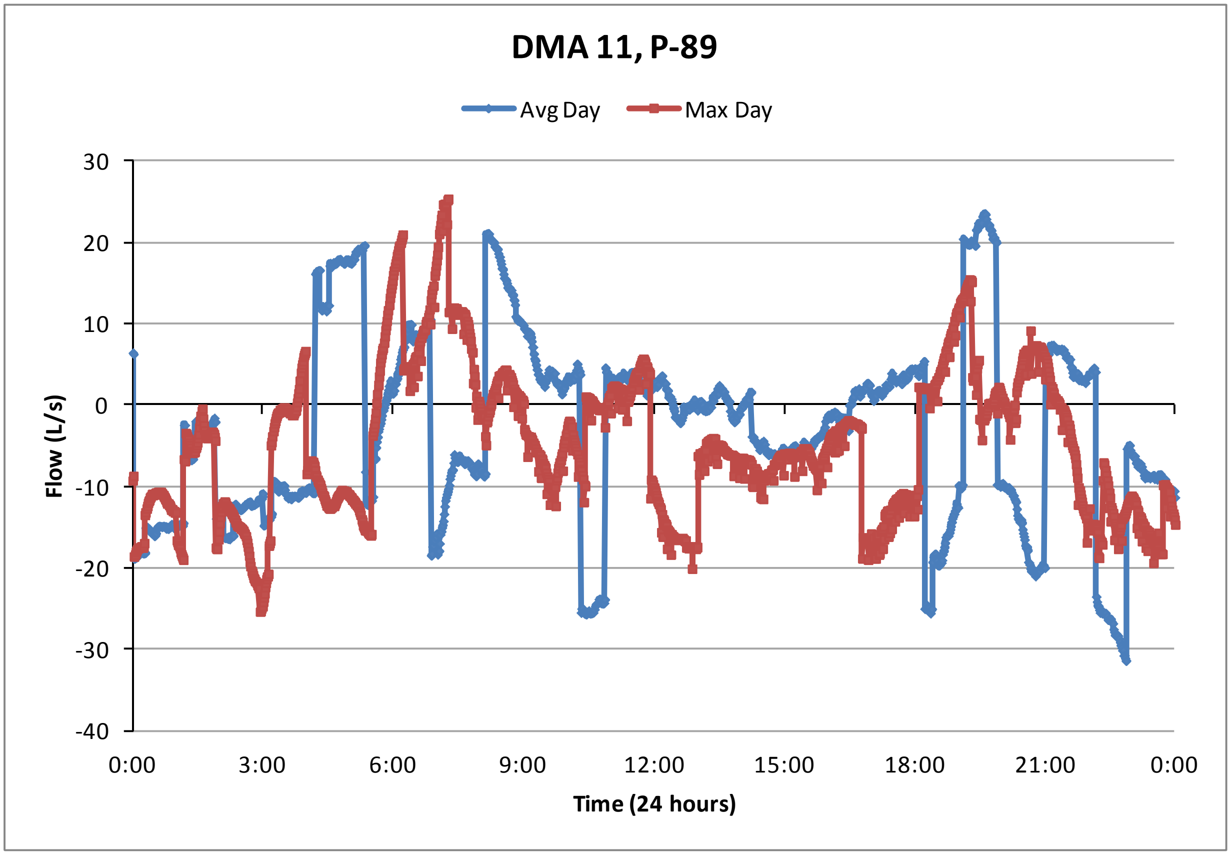

FIGURE B.11
Average and Maximum Day Demand Flows, Flow Meter 11-1 (P-89, DMA 11)

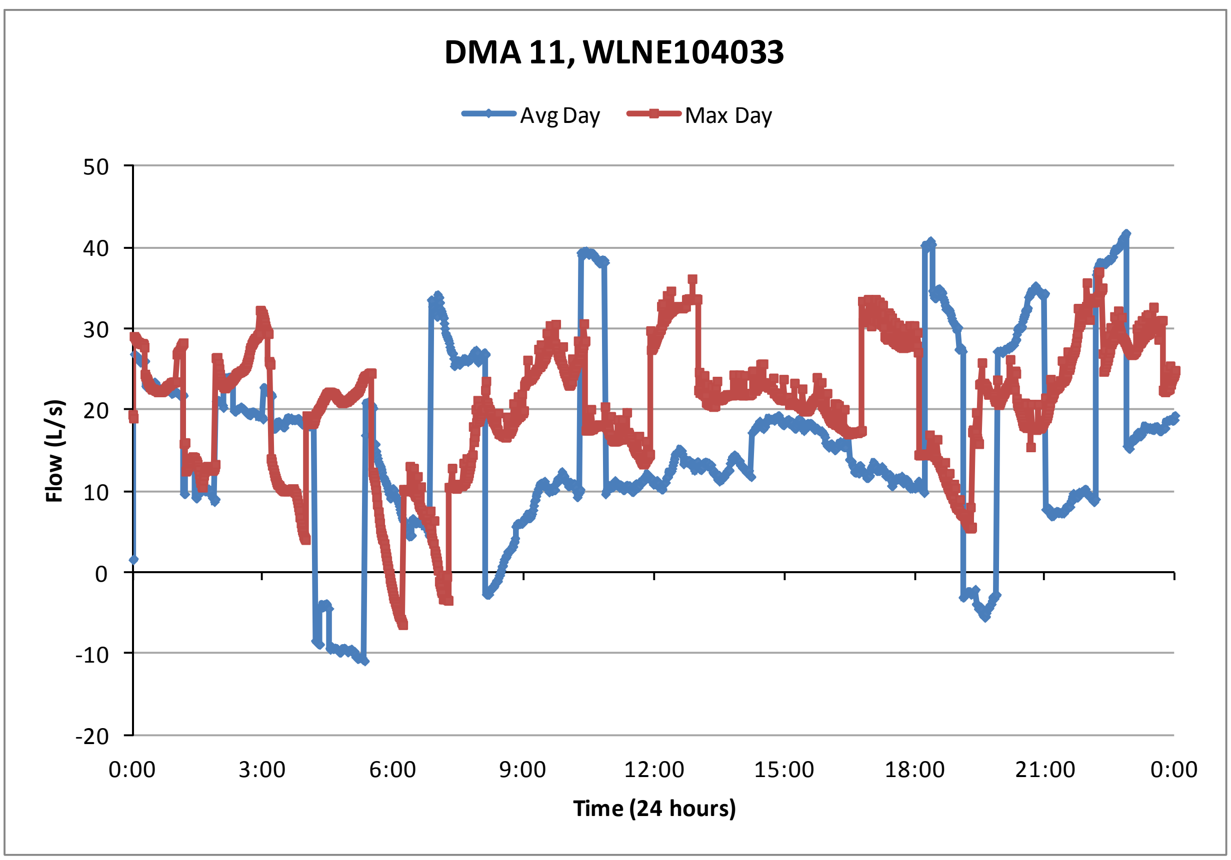

FIGURE B.12
Average and Maximum Day Demand Flows, Flow Meter 11-2 (WLNE104033, DMA 11)

APPENDIX B

REVIEW OF CITY WIDE DMA PROGRAM

KINGSLEY BLEASE
KINGSLEY BLEASE CONSULTING

CITY OF GUELPH

Water Loss Management Program

Review of City Wide District Meter Area Program

Draft Report

January 20, 2014

Kingsley Blease Consulting

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YELLOW – Dennis Mutti Report

Appendix A	**Drawing of Potential City Wide District Meter Areas**
Appendix B	**Spreadsheet of Potential City Wide District Meter Areas**

1.0 Introduction

Overview

The AWWA Manual M36 (Water Audits and Loss Control Programs), recommends the operation of District Meter Areas (DMAs) for ongoing water loss management. In Addition, M36 recommends completing an International Water Association (IWA) Water Audit and Water Balance. Both DMAs and the IWA Water Audit are considered to be North American Best Management Practice (BMP), for water loss control. The City of Guelph has been developing DMAs since 2010, and had been completing IWA Water Audit's since 2006.

District Meter Areas will enable The City of Guelph to find individual leaks in the water distribution system. This is effectively achieved by measuring the flow at night into the DMA, and then comparing this flow with the Legitimate Night Flow (LNF). LNF is a calculation of background losses from watermains, customer services, valves and hydrants, plus customer night time use.

The benefit of the flow based DMA approach is that not only does potential leakage get identified, but the approximate volume of the leakage is known. In order to establish what is an 'abnormally high flow" into the DMA, a software analysis is completed to calculate the "Legitimate Night Flow", or the flow at night that is expected. Once these flow levels have been established, they can be used as screens to alert the operations staff that water loss is increasing

The potential leakage in each DMA is the difference between the measured night flow, and the Legitimate Night Flow. For some DMAs, that difference may be small, suggesting that there is little leakage in that DMA. However, because this will be the first time the DMAs are operated, it is likely that many will have potential recoverable leakage.

In order to find the "General Area of the Leakage", which is a smaller area within the DMA, generally a few streets, the most effective technique is to complete Step Testing at night. This involves closing small sections of the DMA for a few minutes, and watching the DMA flowmeter to see the reduction in flow. For steps with relatively large drops in flow, that is where there is potential leakage. Other methods, including the use acoustic listening devices put on valves ("noise logger"), can also be used to find the "General Area of Leakage". Leaks can then be found, or "Pinpointed" in these areas, using acoustic listening devices and leak noise correlators.

For each DMA, once the leaks have been repaired, and the measured night flow reduced close to the Legitimate Night Flow, the DMA 'Entry" and "Exit" levels can be set. The "Entry" level is the measured night flow reached when the DMA should be operated, as there is leakage to be found. The "Exit" level is the measured night flow that is close to the Legitimate Night Flow, when leakage has been reduced to economic levels.

It is also likely, that there will be multiple leaks in some DMAs, so the process is continued, until the DMA reaches the "Economic Level of Leakage", when the effort expended to find and repair the leakage is greater than the value of the leaks - effectively the "Exit" level.

Because of the age of the infrastructure (mains and services) in downtown areas, it is likely that there is leakage in this area. Typically, because of the complexity of the water distribution system, and large number of major water users, consuming water at night, operation of DMAs is difficult in these areas. However, there are a number of techniques that can be used in these areas, which include intensive leak sounding, or use of noise loggers (some of which can correlate, or pinpoint a leak).

City of Guelph Water Loss Management Activity

The City of Guelph has been completing IWA Water Audits and Water Balances since 2006. In relation to DMAs, in 2010 Kingsley Blease Consulting provided an outline of twelve potential District Meter Areas (DMAs), from which some could be developed for a pilot program. The pilot would enable the City to see the costs and benefits associated with operating the DMAs, to reduce water loss.

Since that time, the City of Guelph has been in the process of implementing a number of DMAs, and it is understood that one was commissioned and operated to find leaks (DMA No 7) last Fall (2012). For five other DMAs (Nos 1,3,9,10 and 11), flowmeters have been installed and commissioned in early November.

The flowmeters have been installed in concrete chambers, and cost estimates are currently being prepared for the future development of DMAs across other parts of the City. It is understood that these costs are based on an average of 2.5 flowmeters per DMA, at an approximate cost of $60,000 per flowmeter and chamber. It is further understood that the water savings from the water loss program have to satisfy the criteria of $4,000 per m3, related to Development Charges

The City retained Kingsley Blease Consulting in early November, 2013, to provide an estimate of potential water savings from the District Meter Area Program. Kingsley offered to also

provide commentary on the City's program, compared to other current Municipal District Meter Area programs.

In order to complete the task, an examination was made of the number, size and attributes of the DMAs the City is in the process of commissioning, to make an estimate of the number across the City. Because of the challenges of maintaining necessary servicing requirements through isolating feeds of water in the downtown area, it is not practical to develop DMAs there. An estimate was therefore made of how much of the City can be operated as DMAs. In addition, commentary is provided on a water loss reduction program in the downtown, and other areas not included in the DMA program, to proactively reduce and sustain water loss within the City of Guelph.

2.0 Review of Currently Developed District Meter Areas

The City of Guelph has developed six DMAs, to the stage that one was operated last fall, and the remaining five have the flowmeters installed, ready to operate the DMAs. From the data sent by the City, the characteristics of the preliminary DMAs are shown in the following table:

DMA	Length of Mains (m)	Number of Services	Metered	No of Flowmeters
1	7,676	665	Yes	3
2	20,139	1,655		
3	8,706	605	Yes	1
4	5,775	1,051		
5	8,460	1,040		
6	11,462	658		
7	8,668	908	Yes	1
8	24,232	1,452		
9	7,724	1,053	Yes	2
10	10,811	1,077	Yes	3
11	7,440	1,003	Yes	2
12	9,413	1,153		
				for six DMAs
Totals	130,506	12,320		12

As discussed, it is not practical to provide DMAs for every area, so a desktop design of DMAs across the whole City of Guelph was performed. A total of 26 were developed, and the length of watermain and number of customer meters (which is close to the number of services), is shown in the following table:

DMA	Length of Mains	Flow meters installed	No of meters (approx no of services)
	m		no
1	7,676	Yes	665
2	20,139		1,655
3	8,706	Yes	605
4	5,775		1,051
5	8,460		1,040
6	11,462		658
7	8,668	Yes	908
8	24,232		1,452
9	7,724	Yes	1,053
10	10,811	Yes	1,077
11	7,440	Yes	1,003
12	9,413		1,153
13	16,465		288
14	12,608		1,821
15	14,761		1,557
16	12,114		624
17	13,445		1,427
18	16,706		2,080
19	9,238		687
20	30,194		2,917
21	9,705		753
22	7,810		1,205
23	26,275		3,769
24	4,058		442
25	12,815		938
26	8,276		747
Totals	**324,976**		**31,575**

The following table summarises the breakdown of watermains and services in the DMAs

Lengths of Watermain and Number of Services					
	Watermain			**Services**	
	m	percentage		No	percentage
In DMAs	324,980	60%	In DMAs	31,575	78%
Not in DMAs	214,220	40%	Not in DMAs	9,028	22%
Total	539,200		Total	40,603	

3.0 Comparison with Recent District Meter Areas in Other Municipalities

Kingsley Blease has been designing and implementing DMAs for many municipalities over the years, mostly in Ontario and the Atlantic Provinces. A summary of the characteristics of four recent DMA projects, which are typical, is shown in the table below.

Municipality 2011 and 2012	No of DMAs	Average Per DMA Km Main	No of Services	No of Flowmeters
A - Atlantic	9	15.6	1,121	1
B - Ontario	5	22.6	1,443	1.2
C - Ontario	5	22.8	2,072	1.5
D - Atlantic	4	26.5	1,201	1.25
Average of 4 Municipalities		**21.9**	**1,459**	**1.24**

A preliminary design has been made for a program of City Wide DMAs in Guelph, which is described in the following sections of this report. The number of DMAs is 26, with the characteristics shown in the following table:

Guelph	No of DMAs	Average Per DMA Km Main	No of Services	No of Flowmeters
	26	**12.5**	**1,214**	**1.8**

It can be seen by reference to the above tables, that the City of Guelph's DMAs are slightly smaller compared to typical DMAs, and the number of flowmeters higher. It is acknowledged, however, that each municipality is unique, in terms of its water distribution system, and design and operating criteria. However it was thought to be useful to make the City aware of the general characteristic of DMAs.

It was necessary to establish the size of the City of Guelph DMAs, as the estimated water savings in this report are based on experience from other projects, whose DMAs are slightly larger. The estimated savings for each of the City of Guelph DMAs will be less than averages from other areas, and the number of DMAs will be greater.

4.0 City of Guelph, Potential City Wide District Meter Area Program

The next stage of the process was to develop potential DMAs across the whole City. This was completed as a "desk top" exercise, where potential DMA boundaries and flowmeter locations were developed using drawings of the water distribution system. A drawing of these potential DMAs is attached as **Appendix A**, and the flowmeter locations and boundary valves are provided in the spreadsheet in **Appendix B.**

A total of 26 potential DMAs were developed, as shown in the following tables:

<u>Summary of Flowmeters and Boundary Valves to Close</u>

DMA	DMA	DMA Flowmeters - Watermain Diameter (mm)							Closed
No	Name	150	200	250	300	400	450	500	Valves
1		1		2					3
2			1	1					12
3			1						7
4				1					2
5			1		1				5
6		2							4
7			1		1				3
8					1				5
9			2						3
10		1	2						2
11					2				2
12					1	1			2
13				1	1				3
14			1	1					3
15				2					3
16					1	1			7
17			2						4
18					2				6
19				1	1				4
20								1	0
21				1	1				2
22					1				2
23				1	1				12
24			1						2
25			1	1					10
26			1						2

Summary of Watermain Material in DMAs

DMA No	DMA Name	Pipe Material			
		CI	DI	HYP	PVC
1		■			
2		■			■
3		■			■
4		■	■	■	
5					■
6		■			■
7		■			
8				■	■
9			■	■	
10		■	■		
11					■
12				■	■
13			■		■
14		■	■		
15		■			■
16		■			■
17		■			■
18					■
19		■			
20			■	■	■
21			■	■	■
22				■	■
23					■
24		■	■		
25		■			■
26		■			■

<u>Summary of DMA Characteristics</u>

Number of Flowmeters by Watermain Diameter								
4	14	12	14	2	0	1	47	Total Number of Meters
150	200	250	300	400	450	500	26	Number of DMAs
Watermain Diameter (mm)							1.8	Av Meters Per DMA
							110	Total Number of Closed Valves
							26	Number of DMAs
							4.2	Av Closed Valves Per DMA

<u>Next Stages to Develop DMAs Further</u>

Listed below are the next series of stages to develop the DMAs further:

- Review DMAs with operations staff, including confirming the boundary valve locations
- Complete site inspections of DMA flowmeter and boundary valve locations
- Simulate DMA operation with the Hydraulic model
- Prepare individual DMA drawings
- Complete site testing to prove DMAs at “tight”, with water only being supplied through the proposed flowmeter locations. Complete pressure data logging and fire flow testing, with DMAs “open” (boundary valves open), and DMAs “closed”(with boundary valves closed, and water supplied through watermains at proposed DMA flowmeter locations)
- Install DMA flowmeters

After all these stages are complete, the DMAs will be ready to operate for the first time.

5.0 Estimate of Potential Water Savings

The estimate of potential water savings was made from two directions. Firstly using the results of the 2012 IWA water audit, which identified the level of leakage, in the form of Current Annual Real Losses (CARL) – the "Top Down" approach. Secondly, using average water savings from DMAs over recent years – the "Bottom Up" approach.

The water savings fall into two categories. The first category is the leaks that are found and repaired the first time the DMA is operated. The second category of water loss savings, is associated with the ongoing operation of the DMAs, which effectively is the prevention of increases in water loss from new leaks that develop as time goes on.

Initial Operation - "Top Down" Potential Water Savings, from IWA Water Audit

First the water loss reduction from the initial operation of the DMAs will be dealt with by looking at the 2012 IWA data. The following table summarises that audit results:

Base Data - 2012 IWA Balance			
	m3 per Year	m3 per Day	Perecentage of Volume Supplied
Volume Water Supplied	16,560,000	45,370	
Authorised consumption	13,980,000	38,301	84.4%
Apparent Losses	670,000	1,836	4.0%
Current Annual Real Loss (CARL)	1,733,000	4,748	10.5%
Unavoidable Annual Real Loss (UARL)	805,000	2,205	4.9%
CARL minus UARL	**928,000**	**2,542**	**5.6%**

The available water leakage to be targeted is the Current Annual Real Loss (CARL) minus the Unavoidable Annual Real Loss (UARL) – this is 2,542 m3 per day, as seen in the table above. Using a target of reducing the difference between CARL and UARL by 60%, the table below shows that to be 1,525 m3 per day.

Potential Real Loss Reduction, With Active Leak Detection Program (DMAs)				
	m3 per Year	m3 per Day	Perecentage of CARL minus UARL	Percentage of Volume Supplied
Projected Real Loss Reduction	556,800	1,525	60%	3.4%
	per M3	per Year		
Variable Cost of Real Loss (CARL)	$0.069	$120,097		
Variable Cost Saving from DMA Program		$38,586		

Initial Operation - "Bottom Up" Water Savings from DMA Estimates

Second the potential water savings from individual DMAs was considered. Kingsley Blease developed a water loss management program for the Ontario Government in 2009, which including developing estimates of Province wide DMAs. An estimate potential water savings per DMA of 115 m3 per day, was used in the Ontario study.

Based on this work and recent projects, the table below demonstrates the potential water savings for the City of Guelph. A value of 42 litres per minute (lpm), or 60 m3 per day has been estimated, to reflect the savings from the smaller DMAs in the City, and taking into account the IWA Water Audit results

Potential Water Savings - 26 DMAs		
Estimated water saving per DMA, based on recent pilots	42	lpm
	60	m3 per day (KB used 115 m3 per day for Ontario strategy)
Total estimated water saving, City Wide DMAs (42)	1,092	lpm
	1,572	m3 per day
Total volume of water supplied in 2012	45,616	m3 per day
Potential water savings as percentage of water supplied	3.4%	

Ongoing Operation of District Meter Areas

Once the DMAs have been operated for the first time, and leaks found and repaired, the DMAs can then be operated on an ongoing basis, where the objective is to find leaks before they surface and become larger leaks. This is effectively a method of preventing further increases in leakage, once the DMAs have been operated for the first time.

Additional Benefits of DMA Operation

There are a number of additional benefits to the City of Guelph for development and ongoing operation of DMAs across the City, which include:

- Leaks that are identified in DMAs are repaired in normal hours, and not as emergency work
- Third party damage claims against the City are reduced, because leaks are found and fixed, before they become main breaks
- There are environmental benefits as a result of less pumping of treated water into the distribution system. These environmental benefits are from less hydro and chemical use. Reduced hydro provides the environmental benefit of CO2 reduction from less hydro generation
- Flow and pressure data gathered during the proving and ongoing operation of the DMAs, provides excellent information to calibrate the City's hydraulic model

6.0 Commentary on Estimated Costs to Develop, then Operate Program

The tasks to set up and operate the DMAs have been developed by the City of Guelph, as they are in the process of commissioning six DMAs. Those costs would have included:

- Proving the validity of the DMAs on site, and via hydraulic model runs. The site testing normally includes fire flow tests and pressure logging for 7 days on the "open system", then repeating the process with the DMA boundary valves closed. The results of the "open" and "closed" DMA operation are compared, to confirm the DMA satisfies demand and fire flows
- Proving the DMA is 'tight", with flow only through the DMA flowmeter location
- Installation of DMA flowmeters
- Operate DMA, and compare measured night flow with "expected", or "Legitimate Night Flow"
- For DMAs with high measured nigh flow complete leak detection, which is often a two stage process. First find the 'general area of the leak", by step testing or the use of noise loggers. Second "pinpoint the leak" using acoustic methods of leak noise correlators and listening devices
- Repair identified leak quickly and well
- Check DMA measured night flow, to confirm that it has been reduced close to 'Legitimate Night Flow". In not, repeat the process, as often DMAs have multiple leaks, and one leak can mask another

One cost that will have a great influence on the cost benefit of the program is the cost of the DMA flowmeters. A broad analysis was completed to compare the flowmeter costs based on the six DMAs developed by the City of Guelph, and typical flowmeter costs in other municipalities. The results are shown in the following tables, which the Guelph can use with their existing criteria to develop a City wide program.

Estimated Individual DMA Flowmeter Costs					
Flowmeter	Estimated Cost	DMA Cost Based on Number of Flowmeters Per DMA			
Construction	Per Flowmeter	1.25	1.5	2.0	2.5
In Chamber	$60,000	$75,000	$90,000	$120,000	$150,000
Buried Sensor	$20,000	$25,000	$30,000	$40,000	$50,000

Estimated City Wide DMA Flowmeter Program Costs, Based on 26 DMAs Range of Costs			
Flowmeter	26 DMAs		
Construction	1.5 Flowmeters	2.0 Flowmeters	2.5 lowmeters
In Chamber	$2,340,000	$3,120,000	$3,900,000
Buried Sensor	$780,000	$1,040,000	$1,300,000

Over the last few years, generally municipalities have been using Aquamaster flowmeters for their DMAs, and in many cases have been burying the flow sensor, and locating the transmitter at the surface, often well away from the flow sensor in the boulevard. Generally the transmitter has been located in a sturdy box, and an example is shown below.

7.0 Areas Not Included as District Meter Areas

For the downtown area, and also parts of the water distribution system that cannot be included in DMAs, there are a number of techniques to find leaks, which include:

Intensive Acoustic Leak Detection

Intensive acoustic leak detection involves sounding all hydrants, all valves on the distribution system, and selective curb stops. It is most effective when completed at night, as this is the time when customer water use is at a minimum normally, and background noise from traffic and other causes is also at a minimum.

Noise loggers

This involves placing noise loggers on valves in the distribution system, and leaving them for a few days, and they will pick up any leak noises (at night), if they are present. The noise loggers typically turn on for two hours, normally between 2 am and 4 am, every night. After two or three nights, if leaks are present in the area, they will be identified by the noise logger. The leaks will still have to be found, or pinpointed, using acoustic devices

There are also correlating noise loggers now on the market, that can pinpoint a leak at the same time, so these should be considered as well.

Trunk Mains

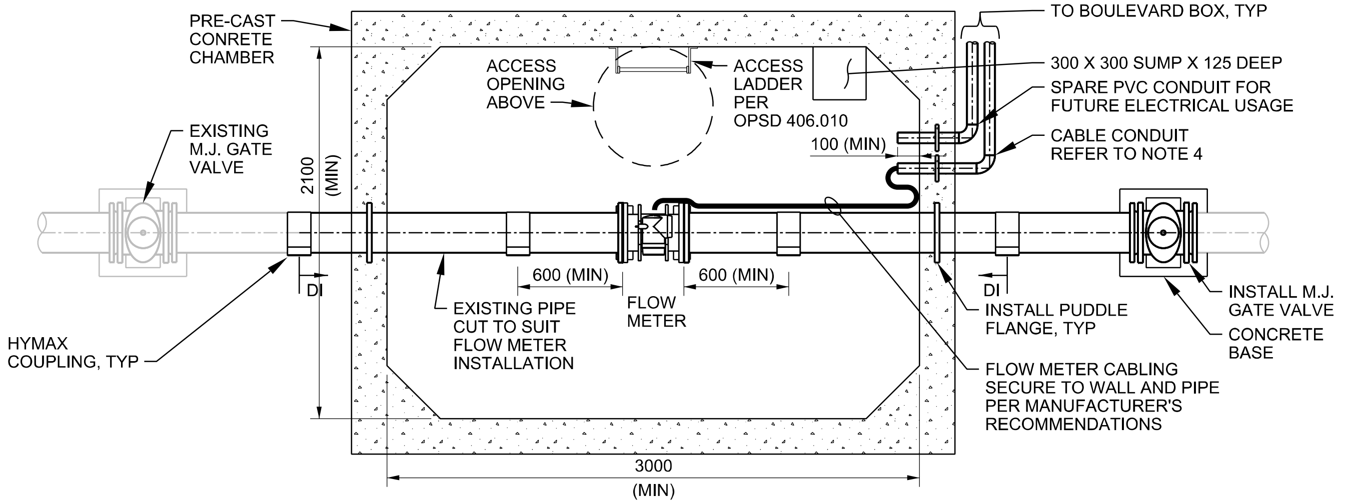
There are a number of techniques available to find leaks on trunk mains, which are the large diameter mains that transfer water across the City. These techniques are typically expensive, compared to leak detection methods on the smaller water distribution mains, and include:

- Devices that are put into the trunk mains, and travel along the pipe to detect any leakage. The two most common devices area "SmartBall", and "Sahara", both from Pure Technologies. Smartball is a free swimming ball that travels inside the large diameter main, and uses acoustic methods to detect leaks. Sahahra also travels inside large diameter mains and uses acoustic methods to detect leaks, but is tethered on a line.
- For prestressed concrete large diameter mains, there are electromagnetic testing techniques, and wire break monitoring using acoustic fibre optics available.

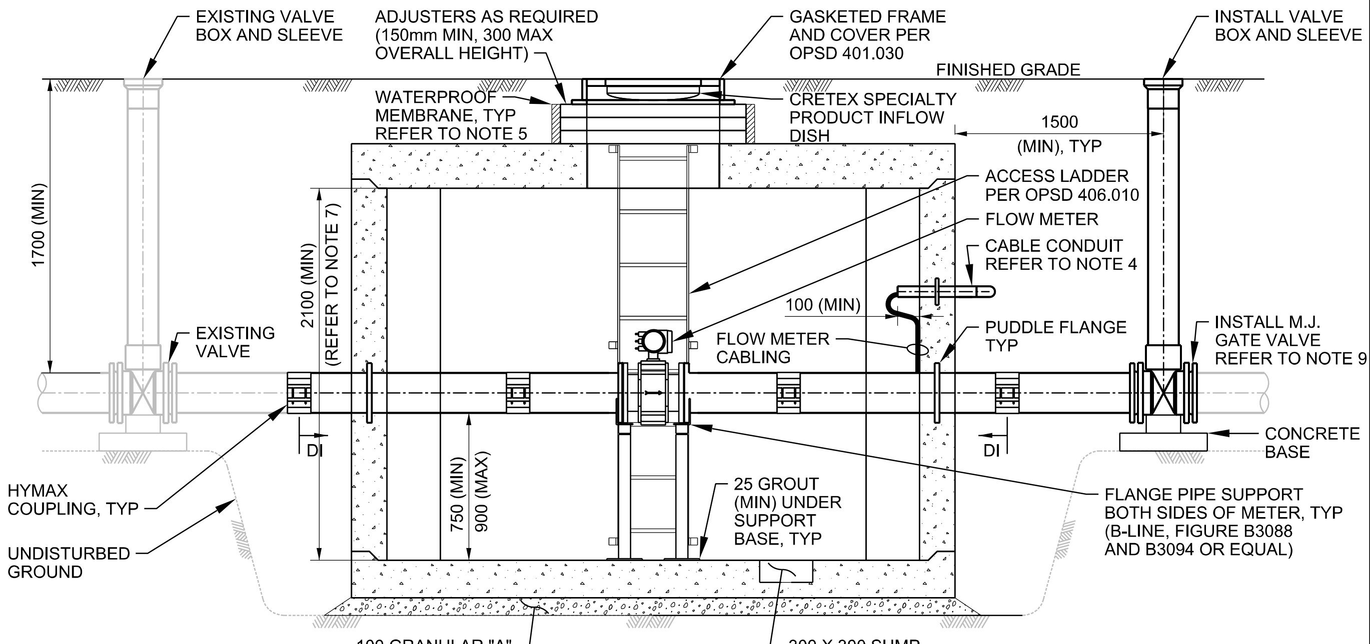
Draft Report Prepared by:
Kingsley Blease, P.Eng., January 20, 2014

APPENDIX C

DMA FLOW METER CHAMBER AND BOULEVARD BOX DRAWINGS



PLAN



SECTION

NOTES:

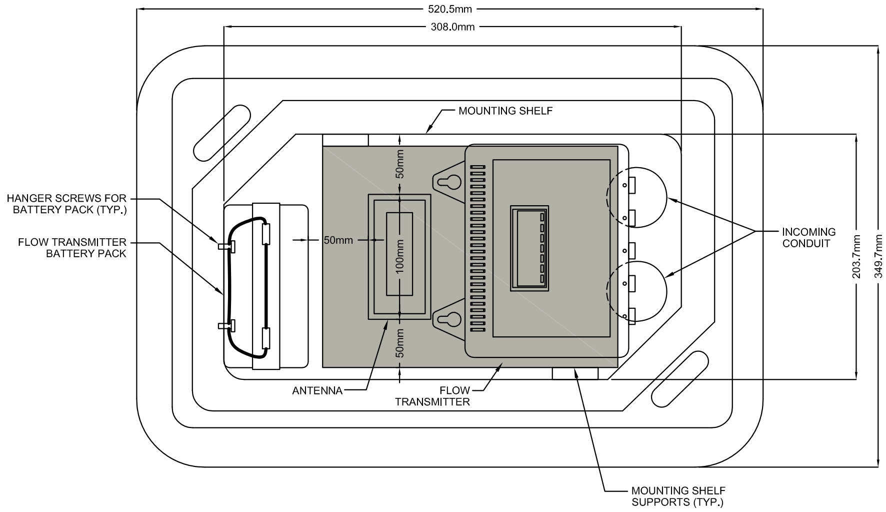
1. ALL MEASUREMENTS ARE NOMINAL AND IN MILLIMETRES (mm).
2. ALL EXTERNAL VALVES, FITTINGS, METAL PIPING AND MECHANICAL RESTRAINTS TO BE COMPLETELY PROTECTED WITH DENSO PASTE, DENSO MASTIC AND DENSO TAPE (OR APPROVED EQUAL), PER MANUFACTURER'S RECOMMENDATIONS.
3. ALL INTERNAL VALVES, FITTINGS AND MECHANICAL RESTRAINTS TO BE WRAPPED BY THE CITY AFTER INSTALLATION.
4. 50mm ROBROY CONDUIT, NYLON FISH LINE, SHALL BE INSTALLED FROM METER FLOW TUBE TO NEARBY BOULEVARD BOX HOUSING METER'S REMOTE TRANSMITTER. PROVIDE SECOND CONDUIT (PVC), WITH FISH LINE FOR FUTURE POWER SUPPLY CABLES.
5. WATERPROOF MEMBRANE TO BE "MEL-ROL" BY W.R. MEADOWS OF MILTON, ONTARIO, OR APPROVED EQUAL. EXTEND COMPLETELY AROUND RISER SECTION JOINTS WITH A MINIMUM 300mm WIDE STRIP.
6. PIPING BETWEEN HYMAX COUPLINGS EXTERIOR TO CHAMBER SHALL BE DUCTILE IRON (DI).
7. REFER TO CONTRACT SPECIFICATIONS FOR TABLE SPECIFYING INDIVIDUAL CHAMBER HEIGHT.
8. REFER TO CONTRACT SPECIFICATIONS FOR FLOW METER GROUNDING DETAILS.
9. REFER TO CONTRACT SPECIFICATION FOR ISOLATION VALVE REQUIREMENTS. CONTRACTOR TO SUPPLY AND INSTALL VALVE ACCORDINGLY.
10. PRECAST CONCRETE CHAMBER TO BE SUPPLIED BY A MANUFACTURER CERTIFIED BY THE CANADIAN STANDARD ASSOCIATION ACCORDING TO CSA A234, "PRECAST CONCRETE MATERIALS AND CONSTRUCTION/QUALIFICATION CODE FOR ARCHITECTURAL AND STRUCTURAL PRECAST CONCRETE PRODUCTS". CHAMBER TO BE DESIGNED FOR H-20 LOADING.

CITY OF Guelph

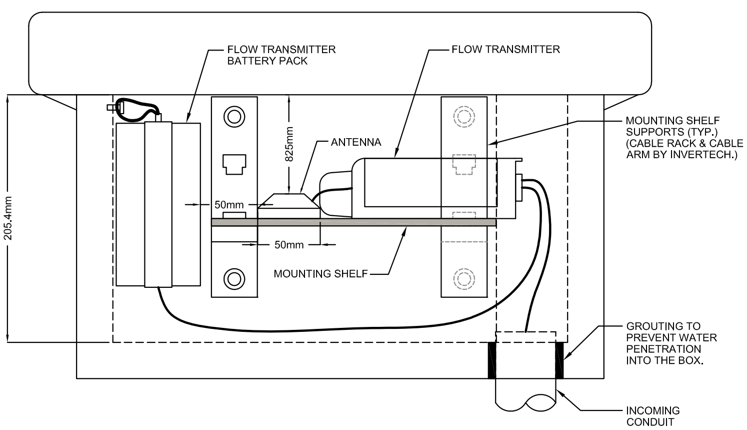
ENGINEERING SERVICES

TYPICAL FLOW METER CHAMBER FOR 100mm TO 400mm PIPE

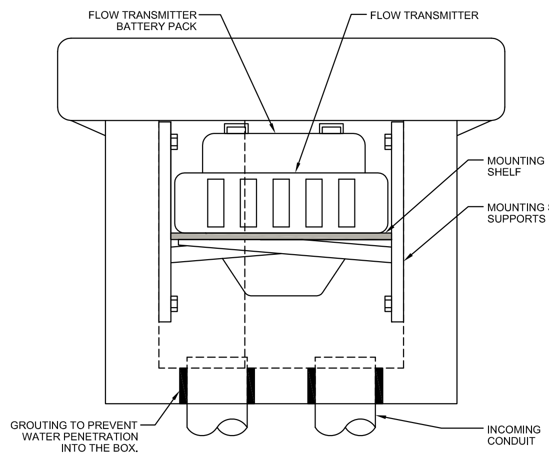
DATE DRAWN :	DRAWN BY :
MAY, 2013	CH2M HILL
SCALE :	DRAWING No. :
NTS	XXXX



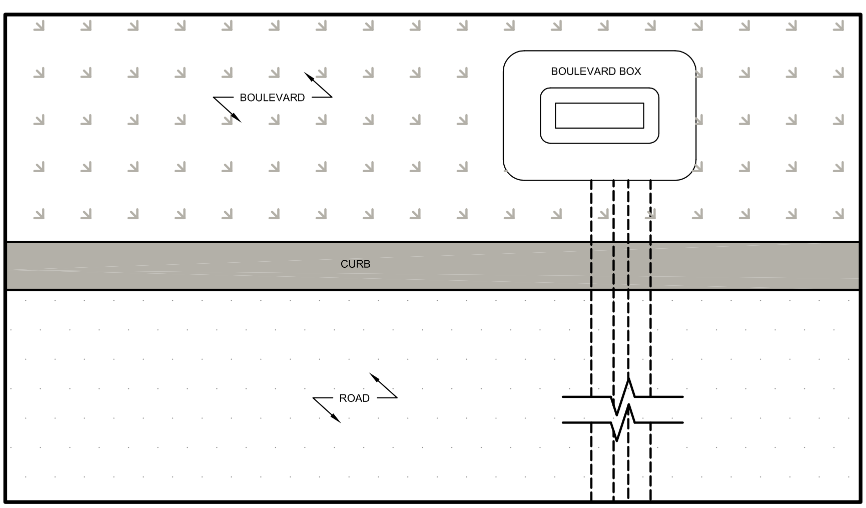
BOULEVARD BOX - TOP VIEW



BOULEVARD BOX - SIDE VIEW



BOULEVARD BOX - END VIEW



BOULEVARD BOX - LAYOUT PLAN

NOTES:

1. ALL MEASUREMENTS ARE NOMINAL AND IN MILLIMETRES (mm).
2. 50mm ROBROY CONDUIT, NYLON FISH LINE, SHALL BE INSTALLED FROM METER FLOW TUBE TO NEARBY BOULEVARD BOX HOUSING METER'S REMOTE TRANSMITTER. PROVIDE SECOND CONDUIT (PVC), WITH FISH LINE FOR FUTURE POWER SUPPLY CABLES.
3. FLOW METER, TRANSMITTER, ANTENNA AND BATTERY PACK WILL BE ISSUED BY THE CITY TO THE CONTRACTOR FOR INSTALLATION. THE CONTRACTOR IS TO SUPPLY AND INSTALL BOULEVARD BOX - SYNERTECH S1118BC12FA BY OLD CASTLE PRECAST AS WELL AS ALL ASSOCIATED ACCESSORIES AND HARDWARE.
4. MOUNTING SHELF SUPPORT (CABLE RACK\CABLE ARM) IS TO BE SUPPLIED AND INSTALLED BY BOULEVARD (JUNCTION) BOX SUPPLIER. THE CONTRACTOR IS TO SEAL ALL BOX PENETRATION POINTS TO PREVENT WATER FROM GETTING INTO THE BOX.

CITY OF Guelph ENGINEERING SERVICES	TYPICAL BOULEVARD BOX INSTALLED WITH FLOW METER TRANSMITTER	DATE DRAWN : JUNE 2013	DRAWN BY : ERAMOSA
		SCALE : NTS	DRAWING No. : XXXX

Appendix D

Guelph Water Supply Master Plan Update
TM3: Water Supply Alternatives (Draft Final)

Assessment of Groundwater Sources Inside/Outside the City (Draft)

By Golder Associates

TECHNICAL MEMORANDUM

DATE March 14, 2014 **PROJECT No.** 12-1152-0217

TO Dave Belanger
City of Guelph

CC Patty Quackenbush, AECOM

FROM Stephen Di Biase, M.Sc., P.Geo. **EMAIL** stephen_dibiase@golder.com

CITY OF GUELPH WATER SUPPLY MASTER PLAN
TASK 4B - ASSESSMENT OF GROUNDWATER SOURCES INSIDE/OUTSIDE THE CITY (DRAFT)

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. to carry out Task 4B (Assessment of Groundwater Sources Inside/Outside the City) of the City of Guelph Water Supply Master Plan Update Terms of Reference (City of Guelph, 2012). The purpose of this task is to identify potential areas for additional groundwater supply both inside and outside the City and assess the potential yield and environmental effects from future groundwater pumping within these areas.

This technical memorandum herein should be read in conjunction with Golder's Task 3 – Well Capacity Assessment technical memorandum (dated February 22, 2013), which has been prepared in support of the Water Supply Master Plan (WSMP) Update. The Task 3 technical memorandum provides a detailed discussion regarding:

- Sources of information considered as part of the hydrogeological reporting supporting the WSMP Update;
- Hydrostratigraphy of the area surrounding the City of Guelph; and
- The range of capacities available from the existing groundwater supply system.

From the evaluation completed in Task 3, it was determined that the existing operating wells have the capability to provide a maximum day pumping capacity of 84,300 m^3/day.

In accordance with the Ontario Clean Water Act, the City of Guelph initiated a Tier Three Water Budget and Local Area Risk Assessment (herein referred to as the 'Tier Three Assessment') in 2008. The draft Tier Three assessment (Matrix, 2013) concluded through a computer modeling exercise, that the existing municipal supply system can sustain a long term pumping rate of 73,450 m^3/day with current and allocated pumping rates under average and drought conditions to meet estimated 2031 demands determined through its Water Conservation and Efficiency Strategy Update or WC&ES (Resource Management Strategies Inc. 2009). The Tier Three Assessment identified, where respect to baseflow reductions, potential for moderate impacts within Hanlon Creek and significant impacts within the South Branch of Blue Springs Creek and Upper Chilligo/Ellis Creek. It is duly noted that the Tier Three Assessment recognizes a high degree of uncertainty with respect to the potential impacts and has made recommendations to verifying its modelled simulations. It is also noted that

interpretation and conclusions provided within the draft Tier Three Assessment may be revised when finalized in 2014.

From this starting point, the WSMP update can investigate possible options for future groundwater supply under various operating scenarios; for example:

- all existing and future wells operating to meet the 2038 average demand, and capable of increasing the pumping rate to meet peak day demands, or,
- operating existing wells at rates determined to be sustainable, and providing added peaking requirements through new supplies.

Using the Tier Three Assessment groundwater flow model, the future sustainable pumping capacity can be assessed by locating new potential groundwater supply sources in areas that are not stressed by existing groundwater takings.

This technical memorandum (provided herein) is organized as follows:

Section 1: Identifies existing municipal groundwater supply wells that are currently inactive, and wells that have been developed but not brought on-line; however, potentially available for future operation.

Section 2: Describes groundwater supply potential at existing municipal test well locations.

Section 3: Summarizes non-municipal groundwater supply sources in proximity to the City, for which current and future operation may affect available municipal groundwater takings.

Section 4: Presents groundwater modelling results for future potential groundwater supply sources inside and outside the City.

Section 5: Summarizes the findings of the Task 4B assessment and provides recommendations for consideration within the WSMP update.

1.0 INACTIVE MUNICIPAL GROUNDWATER SUPPLY SOURCES

The locations of the City's 24 existing groundwater supply wells are shown in red on Figure 1. Five municipal groundwater supply sources (Clythe, Edinburgh, Sacco, Smallfield, and the Lower Road Collector) are currently permitted for operation, however, remain inactive or off-line, some since the 1990s, due to natural or man-made groundwater quality concerns. The sixth source is the Admiral Well which was developed for dedicated industrial use but not implemented due to natural groundwater quality issues. The potential for future operation of these wells is discussed below.

Clythe Well

The Clythe Well was constructed in 1976 and is located adjacent to Clythe Creek, near the intersection of Highway 7 and Watson Road. The well is a 305 mm diameter casing extending to a depth of 9.1 m below ground surface (bgs) and open bedrock borehole to a depth of 64 m bgs. In 1999, the well was retrofitted with a 200 mm diameter liner that was installed to a depth of 26.8 m (IWS, 1999). The purpose of lining the well was to reduce the concentration of iron and manganese that was thought to be caused by shallow groundwater entering the well (Braun, 1999). The well was tested after the liner installation and it was recommended the well be equipped with a pump capable of 1,987 m^3/day. The well is currently permitted for pumping up to 5,237 m^3/day

(PTTW # 3240-62HPVV), however, is not included within the City's Drinking Water License. It has been reported that the well was shut down due to elevated concentrations of hydrogen sulphide and has not been operated for more than ten years. The well is currently physically disconnected from the distribution system. In 2008, the City commissioned the rehabilitation and performance assessment of the Clythe Well (Stantec, 2008), which concluded a potential capacity of 3,395 m^3/day. Groundwater quality concerns were predominantly limited to hydrogen sulfide. The concentration of hydrogen sulfide ranged from 0.1 to 0.31 mg/L, consistently exceeded the ODWQS Aesthetic Objective (AO) of 0.05 mg/L.

Smallfield Well

The Smallfield Well was drilled in 1966 and is located at 461 Speedvale Avenue in the City of Guelph. The well is a 300 mm diameter casing extending to a depth of 5.2 m bgs and open bedrock borehole to a depth of 102 m bgs. The well was brought into service in 1970 and when operating, the well pumped at rates of 1,296 m^3/day to 1,900 m^3/day up until 1993 when the well was removed from service due to rising concentrations of trichloroethylene (TCE). At the time, Smallfield groundwater contained TCE concentrations that exceeded the current Ontario Drinking Water Quality Standard (ODWQS) Maximum Acceptable Concentration (MAC) of 5 µg/L. In addition to TCE, other volatile organic compounds with detectable concentrations included 1,1,1-trichloroethane and chloroform. Low level concentrations of some transformation products for these solvents were also detected. In addition, 1,4-dioxane was detected at concentrations ranging from 18 µg/L to 33 µg/L and the concentration of chloride remained elevated throughout the testing (160 to 320 mg/L).

Smallfield has an active PTTW (PTTW No. 2803-7CUXLT), which was renewed on November 24, 2008. In 2008, the City commissioned the rehabilitation and performance assessment of the Smallfield Well (Stantec, 2008), which concluded a potential capacity of 1,408 m^3/day. Performance testing results indicate that installation of a liner to a depth of 65 m would not adversely affect the quantity of water available from the Smallfield Well.

Sacco Well

The Sacco Well was drilled in 1952 and is located at 348 Woodlawn Road in the City of Guelph. The well is a 330 mm diameter casing extending to a depth of 5.8 m bgs and open bedrock borehole to a depth of 95.7 m bgs. The well is permitted to pump at a rate of 1,633 m^3/day under PTTW No. 01-P-2088. In 1991 the Sacco Well was removed from service due to low level concentrations of TCE and concerns that poor groundwater quality in the area of the Smallfield Well may migrate to the Sacco Well under pumping conditions.

In 2008, the City commissioned the rehabilitation and performance assessment of the Sacco well (Stantec, 2008), which concluded a potential capacity of 1,150 m^3/day. Sacco groundwater quality comprised of detectable levels of TCE but less than the MAC, consistently ranging between 0.3 and 0.5 µg/L. Low level concentrations of tetrachloroethylene (PCE) and 1,1-dichloroethylene were also detected in the Sacco water quality samples but less than the applicable ODWQS. Performance testing results indicate that installation of a liner to a depth of 54 m would not adversely affect the quantity of water available from the Sacco Well.

Edinburgh Well

The Edinburgh Well was drilled in 1953 and is located on the southwest corner of Water Street and Edinburgh Road. The well is a 300 mm diameter casing extending to a depth of 7.6 m bgs and open bedrock borehole to a depth of 68.9 m bgs. Edinburgh has been out of service since the early 1990s due to TCE detections within the

pumped groundwater. Edinburgh is not currently equipped with a pump, however, it is permitted (PTTW No. 0I-P-2090) for operation at a maximum pumping rate of 3,000 m^3/day.

Based on the performance history and diagnostic step testing results of the Edinburgh well in 1995 (Jagger Hims Ltd., 1998), the optimized pumping rate of Edinburgh is interpreted to be approximately 1,750 m^3/day, while maintaining a minimum pumping elevation of 282 masl (i.e., base of Goat Island Formation). Considering the proximity to nearby pumping (i.e., Membro, Water, Dean, Dolime Quarry) the typical pumping rate of Edinburgh may be as low as 1,200 m^3/day due to interference. The installation of a liner to a depth of 275 masl and lowering the pump intake to 280 masl, could possibly improve groundwater quality pumped from Edinburgh.

Admiral Well

The Admiral Well was drilled in 1999 and is located next to Sleeman Breweries Ltd. (Sleeman's), off of Admiral Place. The well is a 200 mm diameter casing extending to a depth of 30 m bgs and open bedrock borehole to a depth of 101.8 m bgs. Admiral is equipped with a 150 mm diameter liner that extends to a depth of 45 m bgs. The capacity of Admiral is low, approximately 432 m^3/day. The City is permitted (PTTW No.1065-5VFQ9K) for industrial groundwater supply pumping from the Admiral Well. The City had intended to service Sleeman's with groundwater supply from the Admiral Well. However, Admiral remains inactive due to elevated concentrations of sulphate in the pumped groundwater. The City has made an application to amend the Admiral PTTW, changing its purpose industrial to water supply (municipal).

Lower Road Collector

The Lower Road Collection System extends along the lower slope of the Eramosa Valley wall, eastwards from Watson Road to the northern extent of the Glen Collector System in the Arkell Spring Grounds. It is comprised of 30 manholes and 26 collection galleries. Due to the poor condition of the connections to the Lower Road Aqueduct and elevated bacterial content from this collector system and changes to the regulatory requirements for municipal water supply systems, the Lower Road Collector System was disconnected in October 2000. It no longer provides water to the municipal supply system.

During the operation of the Lower Road Collector, production totals were known to range from 576 m^3/day to 6,192 m^3/day, with a typical collection rate ranging from approximately 2,000 m^3/day to 3,000 m^3/day. Groundwater taking from the Lower Road Collector is included in the Arkell Spring Grounds collector system PTTW.

1.1 Potential Supply from Inactive Municipal Groundwater Supply Sources

The cumulative total supply available from the six inactive groundwater supply sources ranges from approximately 8,253 to 14,303 m^3/day, as summarized below.

Inactive Municipal Groundwater Supply Source	Range of Potential Pumping Rate (m^3/day)
Clythe	3,395
Sacco	1,408
Smallfield	1,150
Edinburgh	1,200 – 1,750
Lower Road Collector	600 – 6,100
Admiral	500
Total	**8,253 to 14,303**

Inactivity of these permitted municipal sources is directly related to the quality of the groundwater supply. As part of the WSMP update, future operation of these groundwater supply sources can be considered in conjunction with associated treatment upgrades.

Within the Southwest Quadrant, aquifer dewatering at the Dolime Quarry represents a pumping rate of approximately 6,000 to 7,000 m^3/day (as observed from between July 2009 and January 2011). Due to interference effects, limited groundwater supply potential currently exists at the Edinburgh Well. However, following the cessation of Quarry pumping at some time in the future, increased groundwater pumping from Membro and Edinburgh could be undertaken to optimize groundwater pumping from the Southwest Quadrant.

2.0 POTENTIAL SUPPLY FROM EXISTING MUNICIPAL TEST WELLS

The City owns 13 groundwater supply test wells, which are shown in yellow on Figure 1. Of these thirteen test wells (listed below), only one test well (Scout Camp Well) had a Class Environmental Assessment (Class EA) study completed for development as a municipal groundwater supply. None of the 13 test wells are permitted for operation through an Ontario Ministry of Environment PTTW. This Section (Section 2) discusses the potential to develop additional groundwater supply (organized by quadrant) from future operation of production wells at these existing municipal test wells.

2.1 Municipal Test Wells within the Southeast Quadrant

A single test well (Scout Camp) is located within the City's Southeast Quadrant.

Scout Camp Well

The Scout Camp Well was constructed in 1987 and consists of a 300 mm nominal diameter casing extending to a depth of 7.6 m. The well depth is approximately 48 m, with significant producing zones at 12.5 – 15 m (60% of flow) and 32 - 34 m (40% of flow). The Southeast Quadrant Report (Jagger Hims Ltd., 1998) indicates a rated pumping capacity of 4,580 m^3/day. Development of this well as a municipal production well was studied through the Municipal Class EA process in 1994. The City has not applied for a PTTW for this well. The main concern regarding the operation of Scout Camp is the presence of elevated hydrogen sulfide within the pumped groundwater. The 2006 WSMP indicated that these issues could be mitigated with the installation of a liner to limit groundwater inflow from the shallow groundwater flow system, however, this could significantly reduce the

capacity of Scout Camp. Further investigation would be required to determine the capacity of Scout Camp following liner installation. In-situ or conventional treatment methods could be considered to address the hydrogen sulfide concentrations. There may also be well interference effects associated with pumping of this well due to the proximity of domestic wells in the area.

2.2 Municipal Test Wells within the Southwest Quadrant

A total of seven municipal test wells are located within the City's Southwest Quadrant (Steffler, Ironwood, GSTW1-08, GSTW2-08, GSTW3-08, McCurdy and Clair). A municipal class environmental assessment to develop additional groundwater supplies within the City's Southwest Quadrant is on-going. A draft technical report prepared by Golder (2011) concluded that municipal groundwater pumping within the City's Southwest Quadrant could be increased to 22,300 m^3/day (approximately 4,500 m^3/day above the existing well field capacity) while the Dolime Quarry continues to operate and without adversely affecting surface water features or terrestrial habitat within Hanlon Creek and surrounding watersheds. This increase in groundwater pumping can be carried out from any combination of the Steffler, Ironwood or GSTW1-08, which demonstrated good groundwater quality and high potential yields (i.e., approximately 3,600 m^3/day or greater from each source).

Hydrogeological investigations determined low aquifer transmissivity (i.e., poor well yields) at Clair, GSTW2-08 and GSTW3-08. Sustainable groundwater pumping from McCurdy is inconclusive based on the proximity to Hanlon Creek and results of the Guelph South Hydrogeological Investigation (Stantec, 2009).

Steffler Well

The Steffler well was constructed in May 2008 with a 400 mm diameter casing advanced through the bedrock into the upper Gasport Formation to a depth of 60.5 m bgs. A 375 mm diameter open hole was drilled through the Gasport Formation to a depth of 82.3 m bgs. Based on 32-day constant rate test, the Steffler Well was shown to sustain a pumping rate of 3,600 m^3/day (Golder, 2011).

Ironwood Well

The Ironwood Well was constructed in June 2008 with a 400 mm diameter casing advanced through the bedrock into the upper Gasport Formation to a depth of 51.8 m bgs. A 375 mm diameter open hole was drilled through the Gasport Formation to a depth of 78.9 m bgs. Based on 32-day constant rate test, the Ironwood Well demonstrated a capacity of greater than of 8,000 m^3/day (Golder, 2011).

GSTW1-08 Test Well

GSTW1-08, a 203 mm diameter test well, was installed and tested in 2008. The well is drilled to a depth of 91.4 m bgs, with casing seated at a depth of 28.8 m bgs. Based on constant rate testing in 2009 at a rate of 3,200 m^3/day, it was determined that the well has a specific capacity of 346 m^3/day per m of drawdown. Most of the pumped groundwater form this well was sourced from the Gasport Formation and is connected to the highly transmissive section of the Gasport Formation that is encountered at other Southwest Quadrant wells (Membro, Downey, Ironwood, University). The Guelph South Hydrogeological Investigation (Stantec, 2009) concluded that GSTW1-08 is capable of producing up to 5,615 m^3/day, with a maximum theoretical yield of about 5,010 m^3/day if pumped at the same time as the Downey and the Steffler and Ironwood Wells.

GSTW2-08 Test Well

GSTW2-08, a 203 mm diameter test well was installed and tested in 2008. Its casing extends down to 17.1 m bgs with a total depth of 85.3 m bgs. Most of water flowing into this well originates from a highly fractured

Guelph Formation with limited production capacity in Gasport Formation. Step testing at this well indicated a specific capacity of less than 150 m^3/day per m drawdown. The Guelph South Hydrogeological Investigation, concluded that GSTW2-08 is unlikely to be capable of producing sufficient water to meet the needs of a municipal supply well (Stantec, 2009).

GSTW3-08 Test Well

GSTW1-08 was also installed and tested in 2008. This 203 mm test well has casing to a depth of 38.3 m bgs and is open to a depth of 103.6 m bgs. This well is a poor producer and the Guelph South Hydrogeological Investigation recommended that this well be abandoned due to insufficient supply potential (Stantec, 2009).

McCurdy Well and GSTW4-08 Test Well

The McCurdy test well (MOE No. 67-2434) was drilled in 1967 and has a 305 mm diameter casing set at a depth of 13.3 m bgs and a total depth of 78 m bgs. The Southwest Quadrant Report (Jagger Hims Ltd., 1998) indicates that the well yield is unlikely to exceed 1,469 m^3/day without interference effects on the Hanlon Creek watershed. The peaking yield was estimated at 5,789 m^3/day, subject to monitoring. In 2008, a 152 mm diameter test well (GSTW4-08) was drilled near the McCurdy Well. It has a casing set to 12.8 m bgs and is an open hole down to a depth of 77.8 m bgs. Pumping tests in 2008 and 2009 indicated hydraulic connection between the overburden, Guelph and Gasport Formations in this area and that this site is not hydraulically connected to the main water producing zone within the Gasport Formation. The Guelph South Hydrogeological Investigation recommended abandoning GSTW4-08 (Stantec, 2009).

Clair Well

The Clair Well was drilled and tested in 1967 (MOE No. 67-932) with a 160 mm diameter casing set to a depth of 19.5 m bgs and an open hole down to 82.3 m bgs. Performance testing as part of the City of Guelph monitoring system project (Golder, 2009) determined the specific capacity of the Clair Well was only 25 m^3/day per m drawdown and concluded that the site was not viable for groundwater supply development.

2.3 Municipal Test Wells within the Northeast Quadrant

Three municipal test wells are located within the Northeast Quadrant (Eastview, Fleming and Logan).

Eastview Well

The Eastview Well is located approximately 1.3 km east of the Park wells and represents a historical groundwater supply source operating predominantly between 1960 and 1970. The well had been out of service since 1988 and was converted to a municipal monitoring well in 2008. Proximity to the landfill, well plugging and water quality (iron, turbidity) were problematic issues associated with the use of this well for municipal supply. Performance testing as part of the City of Guelph monitoring system project (Golder, 2009) determined that the potential yield at this location is on the order of 1,700 to 2,600 m^3/day. Further groundwater supply development within this area is not recommended due to proximity to the Park and Emma wells.

Fleming Well

The Fleming test well is located on the north side of Eastview Road, approximately 1 km east of Watson Road. Fleming was drilled in 1966 and represents a 300 mm casing to a depth of 20 m and open borehole to a depth of 67 m. Groundwater pumping, as part of the City of Guelph Monitoring System Project (Golder, 2009), determined Fleming could yield a pumping rate ranging from 1,700 to 2,200 m^3/day. In 2008, Fleming was

converted to a municipal monitoring well. However, further groundwater supply development is recommended in proximity to Fleming and nearby Logan.

Logan Well

The Logan test well is located on the south side of Eastview Road approximately 1.5 km east of Watson Road. The well was constructed in 1966, with a 300 mm casing to approximately 9 m bgs and borehole depth of approximately 74 m bgs. The drillers' log suggests that the Eramosa Member is present from 17-33 m, however, has not been confirmed through subsequent field investigation (i.e., geophysics or nearby coring). The potential yield of Logan is greater than 5,000 m^3/day, however, the degree of hydraulic connection between shallow and deeper groundwater flow systems within this area has not be established. The City should carry out further field investigations at the Logan well to determine the presence or effectiveness of the Vinemount aquitard and viability of establishing a groundwater supply source in this location.

2.4 Municipal Test Wells within the Northwest Quadrant

A single test well (Hauser Well) is located within the City's Northwest Quadrant.

Hauser Well

The Hauser Well was originally drilled in 1966 and had a 300 mm diameter casing to a depth of 11.6 m bgs and is an open hole through the bedrock to 96 m bgs. A step test in 1994 indicated that the potential yield of Hauser is 916 m^3/day or less. This test well was converted into a municipal monitoring well in 2008. Therefore a new test well would need to be installed for further groundwater supply investigation within this area.

The Tier Three Assessment indicated the possibility that the Upper Chilligo/Ellis Creek could be significantly stressed during pumping of existing groundwater supply wells. A high degree of field investigation will therefore be required to determine if further pumping in proximity to the Hauser Well is sustainable.

2.5 Summary of Groundwater Supply Potential from Municipal Test Wells

Additional groundwater supply potential from municipal test wells, as reported by hydrogeological studies or interpreted by well performance testing results, is approximately 15,000 m^3/day or greater. This additional supply potential is summarized (by quadrant) below.

Quadrant	Groundwater Supply Sources	Approximate Additional Groundwater Supply Development Potential (m^3/day)
Southeast	Scout Camp	4,580
Southwest	Ironwood, Steffler, GSTW1-08	4,500
Northeast	Logan, Fleming	4,500
Northwest	Hauser	900
	Total	**14,480**

Further exploration or investigation should be undertaken to develop potential groundwater supply sources identified within the Northeast quadrant and Northwest quadrants (outside the Upper Chilligo/Ellis Creek catchment area). Completion of Class EAs and acquiring PTTWs are required for municipal test wells within the Southwest and Southeast Quadrants.

3.0 NON-MUNICIPAL GROUNDWATER SUPPLY SOURCES

In additional to municipal groundwater supply wells, there are a large number of MOE permitted water takers both inside the City and in close proximity to the City. Table 1, taken from Tier Three Assessment (Matrix, 2008), summarizes non-municipal permitted rates and consumptive demands by water use sector as their current operation impacts the available capacity of municipal wells. Should any of these wells be discontinued in future, this could present an opportunity to the City to either incorporate the well into the municipal system, or optimize existing municipal wells to increase production accordingly. Similarly, should any of these wells increase production, this could have a negative impact on the total municipal wells' capacity.

The maximum permitted use for these non-municipal water wells totals 369,505 m^3/day while the estimated consumptive water demand for the area is 64,767 m^3/day (Matrix, 2008). Permits for pits and quarries account for 52% of total permitted takings and the largest consumptive demand of all non-municipal sources.

4.0 GROUNDWATER MODELLING ANALYSES FOR FUTURE GROUNDWATER SUPPLY SOURCES

As part of the Tier Three Risk Assessment (Matrix, 2013), the following activities were undertaken:

- Application of an interactive surface water and groundwater flow model to help assess the sustainability of the municipal groundwater supply sources; and
- Conducting a Groundwater Stress Assessment, to characterize the stress on surface water features relating to existing and future groundwater supply pumping.

In support of the WSMP update, Golder utilized the Tier Three groundwater flow model (Matrix, 2013) to assess the potential for developing additional groundwater supplies for the City's groundwater supply system. This Section (Section 4), presents the findings of Golder's groundwater modelling analysis.

4.1 Review of Key Conclusions from the Tier Three Risk Assessment

As part of the City's Tier Three Risk Assessment (Matrix, 2013), groundwater modelling analysis was undertaken to assess the potential effects associated with increasing the City's groundwater pumping from the actual 2008 demand (47,682 m^3/day, as per Table 2 attached) to the estimated 2031 average daily demand at the time of that study (approximately 73,500 m^3/day, as per Table 2 attached). It is noted that the groundwater modelling analysis presumes future pumping from municipal groundwater supply sources that are currently inactive (Clythe, Sacco and Smallfield). While the reporting of the Tier Three Assessment (Matrix, 2013) is subject to revision prior to finalization of the report in 2014, key findings identified within the draft report are as follows:

- The increased groundwater pumping could reduce groundwater base flow to the following catchment areas by 10% or more:
  - Torrence Creek (41%);
  - Chilligo/Ellis Creek at Wellington Road 32 (33%);
  - Blue Springs Creek South Branch at 28th Side Road (31%);
  - Hanlon Creek South Tributary at Highway 6 (15%); and

- Hanlon Creek at Waterfowl Park (13%).

- Recognizing a high degree of uncertainty, predicted impacts are significant for the South Branch of Blue Springs Creek and Chilligo/Ellis Creek and moderate for Hanlon Creek.

Based on the conclusions provided above, it is recognized that future groundwater supply development should preferentially consider catchment areas that are less likely to be significantly stressed. Modelling of future groundwater supply sources as part of the WSMP update have therefore focused on catchment areas along the Speed River and Mill Creek.

4.2 Modelling of Future Groundwater Supply Sources

Groundwater modelling analyses undertaken by Golder as part of the WSMP update (and discussed herein) builds on the findings of the Tier Three Assessment. Golder's modelling analyses presumes steady-state groundwater pumping from the municipal groundwater supply system at 73,450 m^3/day, as per the 2031 rate schedule shown on Table 2. (Note that the projected 2038 average day water supply requirement determined through the WSMP Update is approximately 70,000 m^3/day). Six modelling scenarios (Scenario 1 through Scenario 6) have been developed, simulating groundwater pumping in addition to 73,450 m^3/day 'baseline' rate.

Based on the characterization provided within Section 2, future groundwater supply sources and modelling scenarios have been considered within a 5 km radius of the City limits. The description and results of these modelling analyses are provided below. Note that these areas were incorporated for the purposes of determining potential environmental impacts of increased takings at estimated pumping rates. For locations where there is not an existing test well, the modelled locations are hypothetical and are intended to represent general areas rather than specific locations. Review of actual locations and priorities will consider all available groundwater alternatives in determining the preferred options for future water supply sources. The general locations of the future modeled groundwater supply sources are shown on Figure 1.

Modelling Scenario No.	Modelled Groundwater Supply Source	Basis for Consideration
1	**Guelph East** – Logan Well	■ Positive performance testing results, as discussed within Section 2. ■ Located within Speed River catchment area.
2	**Guelph Southwest** - Ironwood Well	■ Positive performance testing results and limited environmental effects, as discussed within Southwest Quadrant Class Environmental Assessment report (Golder, 2011).
3	**Guelph Southeast** – Hypothetical well on Maltby Road, east of Victoria Road	■ Hypothetical location located southeast of City, within the Mill Creek catchment area. ■ Limited groundwater usage locally. ■ Nearby municipal monitoring well (MW08-T3-09) and MOE water well records indicate reasonably high transmissivity within Gasport aquifer.
4	**Guelph North** – Hypothetical well on Conservation Road W.	■ Hypothetitcal location located north of City, within Speed River catchment area. ■ Limited groundwater usage locally. ■ Located in proximity to an area where high transmissivity is encountered within the Gasport aquifer.

Modelling Scenario No.	Modelled Groundwater Supply Source	Basis for Consideration
5	**Guelph Central** – Sunny Acres Park	■ Hypothetical location located within City, approximately 600 m north of Speed River. ■ Located in proximity to an area where high transmissivity is encountered within Gasport aquifer.
6	Concurrent pumping from all future sources listed above.	

For the modelling scenarios identified above, the groundwater pumping rates from simulated groundwater supply sources were established as follows:

- Where test wells or performance testing information is not available (i.e., Scenarios 3, 4 and 5), a specified head boundary condition was assigned at the base of the Middle Gasport. The corresponding head was set to be equivalent to the elevation of the Upper Gasport.

- It is noted that the Logan performance test (July, 1993) indicated a potential capacity of 5,000 m^3/day. However, the Tier Three groundwater flow model cannot sustain a pumping rate beyond 1,150 m^3/day from the middle Gasport due the specified hydraulic conductivity value of the middle Gasport layer. To achieve a target pumping rate of 3,000 m^3/day for the Logan well, which is considered reasonable based on performance testing, two specified head boundary conditions (~ 500 m apart) were assigned at the base of the Middle Gasport (the corresponding head was set to be equivalent to the elevation of the Upper Gasport).

- Where test well information exists (i.e., Ironwood), a well boundary condition was applied with a specified pumping rate, based on performance testing results. These well boundary conditions were assigned in the Middle Gasport.

Table 3 provides a summary of the Tier 3 model parameters that were specified for the pumping rate evaluation at each of the simulated test well locations.

Within the Tier Three groundwater flow model, water courses were generally simulated as constant head boundaries, allowing recharge from, or discharge to, these features depending on simulated groundwater elevations in the vicinity of the water course. Ensuring the net simulated discharge (i.e., baseflow) at water courses is consistent with field observations was a key component of the model calibration process. Baseflow estimates from a wide variety of locations and sources exist within the model area. These data reflect ranges from long term Water Survey of Canada gauge stations (provided by GRCA); short to medium term gauging stations (provided by GRCA); and spot flow measurements carried out as part of the Tier Three and SWQ field studies (Golder, 2011).

Table 4 provides the simulated groundwater base flow rates within surface water courses, while existing municipal wells are operating at a baseline pumping rate of 73,500 m^3/day (as per the 2031 rate schedule shown on Table 2). These groundwater base flow rates are therefore referred to as ‘baseline’ within Table 4. As part of the groundwater flow modelling analysis provided herein, groundwater base flow reduction to local surface water courses (in response to pumping from the modelled groundwater supply sources) has been undertaken. These reductions (for each scenario) are summarized on Table 4, as flow rate reductions (in L/s) and percentage reduction relative to the baseline simulated base flow rates.

4.3 Modelling Results

Modelling results for Scenarios 1 through 6 are summarized below. For all scenarios, the simulated environmental effects (i.e., groundwater level drawdown and surface water base flow reductions) are related to the modelled pumping from the new test well sources only. As noted in Section 4.2 above, the model scenarios presume a baseline pumping rate of 73,500 m^3/day, as per the 2031 rate schedule shown on Table 2.

Groundwater baseflow rates in local surface water courses, associated with the baseline pumping rate, are provided in Table 4.

Recognizing that the Tier Three model was developed as a regional scale model and (in some areas) does not reflect local variability in the hydrostratigraphy, the results of these simulations and the estimation of potential impacts should be considered as a cursory indicator. Any modelling results should be confirmed through field study analysis.

Scenario 1 – Guelph Northeast (Logan Well)

Scenario 1 considered groundwater pumping from the area surrounding the Logan Well. Using two wells, a groundwater pumping rate of 3,492 m^3/day was sustained from the middle Gasport. The lateral extent of groundwater drawdown within the Gasport and Guelph Formations are shown on Figures 3 and 4, respectively. The depth and lateral extent of groundwater drawdown within both these Formations are relatively consistent, generally ranging from approximately 10 m in proximity to the test wells to approximately 1 m at a distance of 3 km from the production wells. This consistency amongst the drawdown is presumed to reflect the absence of the Vinemount aquitard locally within Tier Three model. Base flow reductions predicted by the model are predominantly constrained to the Speed River catchment area, however, potential reductions are noted within Clythe Creek, Marden Creek and Eramosa River.

Based on the these modelling results, it is recommended that further field studies be undertaken in proximity to the Logan Well. These studies should focus on:

- Determination of the transmissivity of the Gasport Formation in proximity to Logan; and
- Characterization of the Vinemount aquitard over a broad area surrounding Logan.

Scenario 2 – Guelph Southwest (Ironwood Well)

Scenario 2 simulated groundwater pumping from the Ironwood Well at 4,500 m^3/day. As shown on Figure 5, simulated groundwater drawdown in the Gasport Formation predominantly extends in a north-south direction along a highly transmissive zone within the Gasport Formation. Along the long axis of the drawdown cone, groundwater level drawdown ranges from approximately 12 m in proximity to Ironwood to approximately 2 m at a distance of 6 km.

Simulated groundwater drawdown in the Guelph Formation, as shown on Figure 6, is relatively minor (i.e., generally less than 0.5 m) regionally. In general, groundwater drawdown in the Guelph Formation is simulated to be 10% of the drawdown simulated within the Gasport Formation. These results reflect the low hydraulic conductivity of the Vinemount aquitard which is laterally extensive within the southwest Quadrant. Base flow reductions within surface water courses throughout the Ironwood zone of influence are simulated to be minor.

Scenario 3 – Guelph Southeast (Maltby Rd., east of Victoria Rd.)

Scenario 3 considered groundwater pumping from a hypothetical test well location, southeast of the City (east of the Victoria Road, on Maltby Road). The model simulation suggests a pumping rate of approximately 3,900 m^3/day can be sustained from this location. Groundwater drawdown in the Gasport Formation (as shown on Figure 7) is laterally extensive, ranging from approximately 14 m in proximity to the simulated pumping well to approximately 1 m at a radial distance of 4 km. Groundwater level drawdown within the Guelph Formation (as shown on Figure 8) is simulated to be less than 0.5 m in proximity to the pumping well. The limited hydraulic response within the Guelph Formation is interpreted to reflect the low hydraulic conductivity and lateral extent of the Vinemount aquitard within this area. Base flow reduction to surface water features is predominantly limited to Mill Creek, with a minor effect on the eastern limit of the Hanlon Creek catchment (referred to as Hall's Pond on Figure 2).

In general, the modelling results are positive (i.e., high potential yields from aquifer and limited base flow reduction at nearby surface water courses). Field study investigation is recommended within this area to identify confirm groundwater supply viability.

Scenario 4 – Guelph North (Conservation Drive)

Scenario 4 considered groundwater pumping from a hypothetical test well location, north of the City (the western limit of Conservation Road). The model simulation suggests a pumping rate of approximately 4,600 m^3/day can be sustained from this location. Groundwater drawdown in the Gasport Formation (as shown on Figure 9) is laterally extensive, ranging from approximately 14 m in proximity to the simulated pumping well to approximately 1 m at a radial distance of 4 km. Groundwater drawdown in the overlying Guelph Formation (as shown on Figure 10) is generally simulated to be less than 1 m. Minor base flow reductions are simulated within the middle Speed River and Hopewell Creek catchment areas. Potential base flow reductions within Marden Creek could be significant.

In general, the modelling results are positive from the Guelph North location. Field study investigation is recommended to assess sustainable groundwater supply viability while maintaining aquatic habitat and surface water flow conditions within Marden Creek.

Scenario 5 – Guelph Central (Sunny Acres Park)

Scenario 5 simulated groundwater pumping from a hypothetical test well location in the central portion of the City (Sunny Acres Park). While the hydraulic conductivity of the Gasport Formation is high in this area, there is limited available drawdown (approximately 7 m) resulting from the baseline pumping rate of 73,500 m^3/day. The model simulation suggests a pumping rate of approximately 1,500 m^3/day can be sustained from this location. Groundwater drawdown in the Gasport Formation (as shown on Figure 11) extends for a radial distance of approximately 1.5 km. Groundwater drawdown in the overlying Guelph Formation (as shown on Figure 12) is approximately 1 m or less, focused in proximity to the simulated pumping well. Base flow reduction to surface water features is predominantly limited to the Speed River catchment.

Based on the modelling results, limited groundwater supply potential is available within this area due to interference effects from existing groundwater supply wells. These results high-light the challenge to developing new groundwater supply within the City as a result of interference effects from existing municipal wells.

Scenario 6 – Concurrent Pumping from All Simulated Locations

Scenario 6 considered groundwater pumping from all simulated well locations concurrently. The total cumulative average pumping rate (in addition to the baseline 73,500 m^3/day) is 18,025 m^3/day. Since these simulated wells are scattered over a broad area, there is a broad groundwater drawdown footprint within the Gasport Formation (as shown on Figure 13). Except in the vicinity of the Logan well, groundwater drawdown in the Guelph Formation is generally limited to less than 1 m in the vicinity of the simulated test well locations (as shown on Figure 14).

According to the Water Budget & Water Quantity Risk Assessment Guide (MOE & MNR, 2011), the Ontario Government has introduced the use of thresholds by which to assess reductions in groundwater discharge to coldwater streams. A risk level of moderate is assigned when groundwater baseflow is reduced by 10% to 20%. Therefore, for the purpose of identifying additional groundwater supply, this assessment (provided herein) has considered surface water base flow reductions ranging between 10 and 20% relative to the base flows simulated while operating municipal groundwater supply pumping at the baseline 73,500 m^3/day. As shown on Table 4, the reduction in groundwater base flow to most surface water courses is less than 20%. More significant reductions are simulated at Marden Creek and Clythe Creek, which reflect water courses with low base flow rates and smaller catchment areas. As part of environmental assessments considering future municipal groundwater supply sources considered in Scenarios 1 through 5, comprehensive field investigations should be undertaken to characterize and assess potential effects at Marden Creek and Clythe Creek.

5.0 CONCLUSIONS AND RECOMMENDATIONS

As part of Task 4B of the WSMP Update, an assessment of existing inactive wells and groundwater supply test well locations (both inside and outside the City) has been undertaken, as well as potential future locations outside the City. Within the WSMP update, each of these will be considered and prioritized for development into future municipal water supply facilities. Conclusions and recommendations developed from Task 4B are as follows:

1) The City owns six inactive groundwater supply sources that are currently permitted for use as part of the municipal groundwater supply system. These groundwater supply sources (Clythe, Sacco, Smallfield, Edinburgh, Lower Road Collector and Admiral), which represent a combined groundwater supply rate ranging from 8,253 to 14,303 m^3/day, are currently inactive due to raw water quality concerns. As part of the alternatives evaluation of the WSMP update, future operation of these groundwater supply sources should be considered in conjunction with associated treatment options.

   Due to interference effects from on-going groundwater pumping at the Dolime Quarry, limited groundwater pumping capacity is expected from the Edinburgh well. Following cessation of Quarry pumping, however, the Edinburgh well can be relied on to optimize groundwater pumping within the Southwest Quadrant.

2) The City owns thirteen municipal groundwater supply test wells that are not permitted for use as part of the municipal groundwater supply system. Six of the thirteen municipal test wells (Ironwood, Steffler, GSTW1-08, Logan, Fleming and Hauser) have demonstrated reasonably positive performance testing results and should be considered for use as future municipal groundwater supply sources. Simply stated, this would require completing a Class EA and acquiring a PTTW for each location.

   A Class EA was completed in 1994 for the Scout Camp Test Well; however, future use of this well may be constrained by the elevated concentrations of hydrogen sulphide and potential well interference effects.

The combined pumping rate of these groundwater supply test wells is approximately 15,689 m^3/day. Therefore, permitting and commissioning of these groundwater supply test wells should be considered as part of the alternatives evaluation of the WSMP update.

3) Review of existing test well details and modelling analyses using the groundwater flow model developed for the City of Guelph Tier Three Assessment suggest that additional groundwater supply is available in each quadrant of the City (within 5 km of the City limits) as follows:

- Guelph Northeast - Logan well – approximately 3,500 m^3/day;
- Guelph Northwest – Hauser – approximately 900 m^3/day
- Guelph Southwest – Edinburgh, Ironwood, Steffler, and GSTW1-08 wells - approximately 4,500 m^3/day;
- Guelph Southeast – Recommended test well location – approximately 4,000 m^3/day;
- Guelph North – Recommended test well location – approximately 4,500 m^3/day; and
- Guelph Central - Recommended test well location – approximately 1,500 m^3/day.

The collective pumping total from these potential locations reflect an additional 18,900 m^3/day of groundwater supply. Except for the Southwest Quadrant (where an environmental assessment is currently in progress), field study investigations should be undertaken to demonstrate the additional groundwater supply that may be available from these locations. Environmental concerns (i.e., potential reduction in groundwater base flow to surface water courses) are noted within Marden Creek, Chilligo/Ellis Creek and Clythe Creek catchment areas.

4) Groundwater flow modelling analyses indicate that cumulative average groundwater pumping at 92,400 m^3/day (representing a 2031 average day pumping rate of 73,500 m^3/day (which includes offline wells) from existing municipal wells and 18,900 m^3/day from future wells) could reduce base flow rates of local surface water courses within the limits recommended by the MOE. These analyses also indicate significant interference effects occurring amongst groundwater supply wells located within the City.

Additional groundwater supply development, beyond a collective average groundwater pumping rate of 92,400 m^3/day, must therefore be constrained to catchment areas that can tolerate further base flow reductions. Presuming that base flow reductions must remain within a 10 to 20% range, these catchment areas are remaining groundwater supply development potential are limited to:

- Lower Speed River catchment area – approximately 1,500 to 5,000 m^3/day;
- Upper Mill Creek – approximately 2,000 to 5,500 m^3/day;
- Hopewell Creek - approximately 500 to 2,500 m^3/day;

Following from the above, the maximum additional groundwater supply development within 5 km of the City limits (beyond an average day collective pumping rate of 91,525 m^3/day) could range from 4,000 to 13,000 m^3/day. This would represent a total average pumping rate of approximately 95,000 to 105,000 m^3/day.

Recognizing the interference effects and stresses anticipated within surface water catchments in proximity to the City, it is recommended that the City focus on developing groundwater supply further afield (i.e.,

within Cox Creek catchment area or further upstream within the Eramosa River watershed) if groundwater pumping in addition of 95,000 to 105,000 m^3/day is required.

6.0 CLOSURE

We trust that this draft technical memorandum meets your current needs. If you require any further clarification, please contact the undersigned.

Stephen Di Biase
Associate, Senior Hydrogeologist

JLH/SMD/wlm

Attachments:
Table 1: Non-Municipal Water Sources
Table 2: Existing and Predicted City of Guelph Water Demand
Table 3: Summary of Tier 3 Model Parameters
Table 4: Resulting Baseflow Estimates

Figure 1: Municipal Production Well and Test Well Locations
Figure 2: Location of Surface Water Catchment Areas
Figure 3: Modelling Scenario 1 – Drawdown in Gasport Formation
Figure 4: Modelling Scenario 1 – Drawdown in Guelph Formation
Figure 5: Modelling Scenario 2 – Drawdown in Gasport Formation
Figure 6: Modelling Scenario 2 – Drawdown in Guelph Formation
Figure 7: Modelling Scenario 3 – Drawdown in Gasport Formation
Figure 8: Modelling Scenario 3 – Drawdown in Guelph Formation
Figure 9: Modelling Scenario 4 – Drawdown in Gasport Formation
Figure 10: Modelling Scenario 4 – Drawdown in Guelph Formation
Figure 11: Modelling Scenario 5 – Drawdown in Gasport Formation
Figure 12: Modelling Scenario 5 – Drawdown in Guelph Formation
Figure 13: Modelling Scenario 6 – Drawdown in Gasport Formation
Figure 14: Modelling Scenario 6 – Drawdown in Guelph Formation

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TABLES

TABLE 1
Non-Municipal Groundwater Supply Sources

Specific Purpose	Max Permitted Rate (m^3/day)	Percentage of Total Permitted Takings	Consumptive Demand (m^3/day)	Difference (Max Permitted - Consumptive) (m^3/day)
Pits and Quarries	191,710	52	20,356	171,354
Aggregate Washing	82,716	22	3,124	79,592
Aquaculture	18,200	5	16,708	1,492
Golf Course Irrigation	17,913	5	3,068	14,845
Communal	10,893	3	5,512	5,381
Other-Industrial	10,246	3	4,472	5,774
Other - Agricultural	5,894	2	610	5,284
Field and Pasture Crops	5,475	1	415	5,060
Bottled Water	5,057	1	3,093	1,964
Sod Farm	4,696	1	239	4,457
Groundwater	2,183	1	1,853	330
Other - Water Supply	2,178	1	267	1,911
Fish Ponds	1,962	1	2	1,960
Campgrounds	1,785	0	448	1,337
Food Processing	1,760	0	311	1,449
Other - Remediation	1,483	0	960	523
Mall / Business	1,316	0	1,316	0
Other - Dewatering	899	0	213	686
Heat Pumps	885	0	821	64
Nursery	601	0	85	516
Brewing and Soft Drinks	553	0	0	553
Manufacturing	529	0	529	0
Other - Institutional	137	0	137	0
Cooling Water	110	0	53	57
Construction	100	0	8	92
Schools	100	0	83	17
Other - Commercial	64	0	52	12
Irrigation	60	0	32	28
Total	**369,505**	**100**	**64,767**	**304,738**

TABLE 2
Existing and Predicted City of Guelph Water Demand

Municipal Groundwater Supply Source	Existing Pumping Rates (Average 2008) (m^3/day)	2031 Average Daily Demand (m^3/day)
Arkell 1	730	1,400
Arkell 14	0	3,300
Arkell 15	0	3,300
Arkell 6	3,774	4,900
Arkell 7	3,689	4,900
Arkell 8	3,694	4,900
Burke	5,385	6,000
Calico	748	1,100
Carter Wells	2,004	4,000
Clythe Creek	0	2,200
Dean Ave.	1,215	1,500
Downey Rd.	3,940	5,100
Emma	2,273	2,100
Helmar	500	1,100
Membro	3,036	4,200
Paisley	762	800
Park 1 & 2	5,897	6,400
Queensdale	702	2,000
Sacco	0	1,150
Smallfield	0	1,400
University	1,648	2,500
Water Street	1,184	2,300
Total (Wells)	**41,182**	**66,550**
Glen Collector	6,500	6,900
Total Allocated:	**47,682**	**73,450**

TABLE 3
Summary of Tier 3 Model Parameters

Model Parameters	Scenario 1		Scenario 2	Scenario 3	Scenario 4	Scenario 5
	Logan Municipal Test Well 1	Logan Municipal Test Well 2	Ironwood Municipal Test Well	Victoria Test Well	Guelph North Test Well	Sunny Acres Test Well
Resulting Pumping Rate (m^3/day)	1,447	2,045	4,500	3,912	4,660	1,461
Head Set at Base of Middle Gasport (masl)	308.6	308.1		283.4	289.8	284.8
Initial Head at Top of Middle Gasport (masl)	330.2	333.6		324.4	333.0	297.5
Goat Island Top Elevation (masl)	316.9	311.3		290.3	299.6	292.3
Goat Island Hydraulic Conductivity (m/s)	5.00E-06	5.00E-06		5.00E-06	5.00E-06	5.00E-06
Upper Gasport Top Elevation (masl)	308.6	308.1		283.4	289.8	284.8
Upper Gasport Hydraulic Conductivity (m/s)	2.00E-06	2.00E-06		2.00E-06	2.00E-06	2.00E-06
Middle Gasport Top Elevation (masl)	296.8	298.7		279.1	273.6	266.6
Middle Gasport Hydraulic Conductivity (m/s)	8.00E-05	8.00E-05		8.00E-05	8.00E-05	7.50E-05
Lower Gasport Top Elevation (masl)	284.8	286.9		266.8	261.6	254.6
Lower Gasport Hydraulic Conductivity (m/s)	2.00E-06	2.00E-06		2.00E-06	2.00E-06	2.00E-06

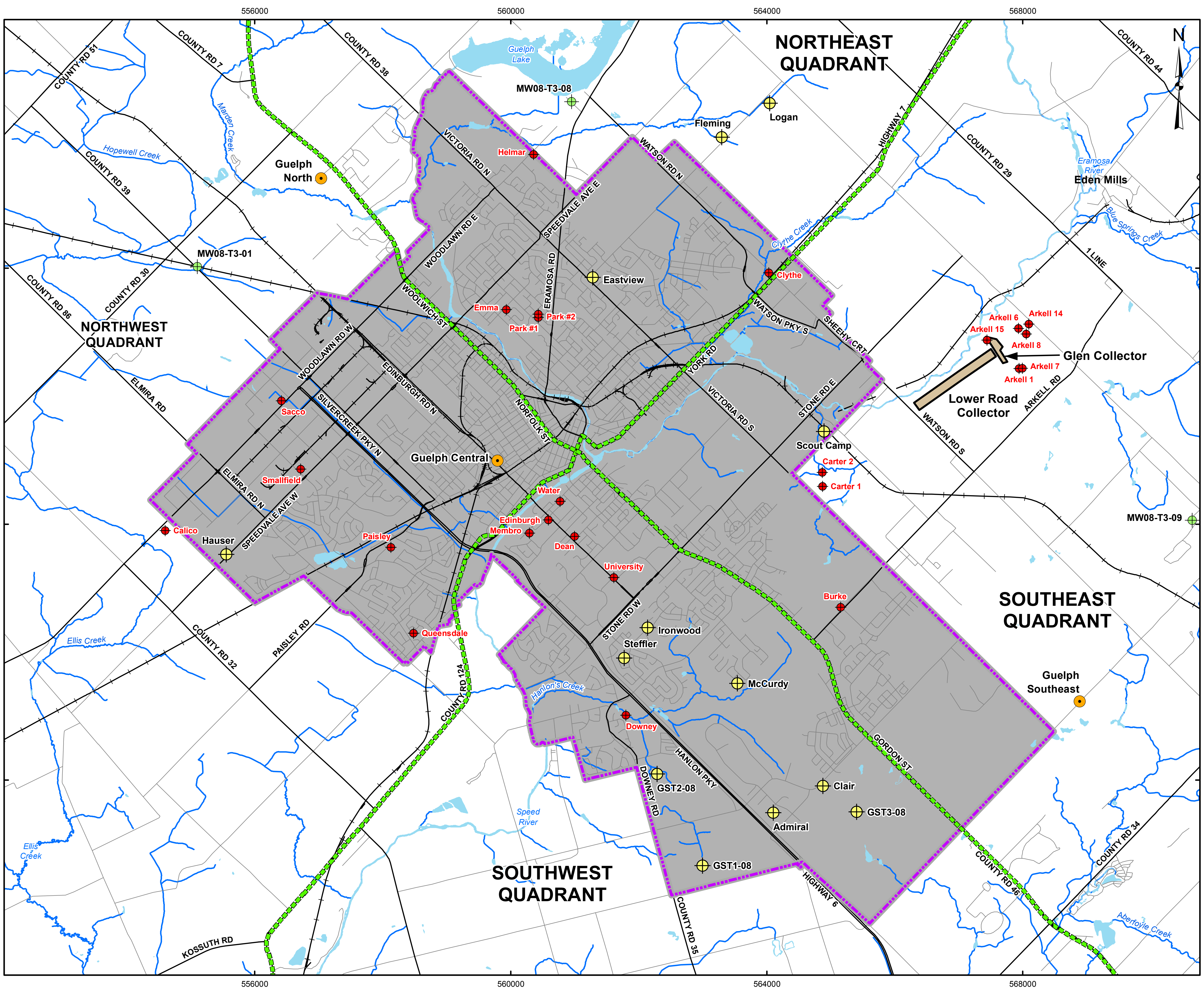
NOTE: The resulting pumping rate for Scenario 6 is the total of the first five scenarios which is 18,025 m^3/day.

TABLE 4
Resulting Baseflow Estimates

Sub-Watershed	Baseline* (L/s)	Reduction in Baseflow											
		Scenario 1 Guelph Northeast		Scenario 2 Guelph Southwest		Scenario 3 Guelph Southeast		Scenario 4 Guelph North		Scenario 5 Guelph Central		Scenario 6 All Wells	
		L/s	%	L/s	%	L/s	%	L/s	%	L/s	%	L/s	%
Marden Creek at Speed River	44	42	4	44	0	44	0	32	27	44	0	30	32
Hanlon Creek at Speed River	42	42	0	38	10	40	5	42	0	42	0	34	19
Hopewell Creek at Grand River	198	198	0	198	0	198	0	187	6	198	0	186	6
Upper Mill Creek at GRCA Station 2GAC19	438	438	0	436	0	418	5	438	0	438	0	415	5
Clythe Creek at Eramosa River	8	5	38	8	0	8	0	8	0	8	0	4	50
Irish Creek at Townline Road	51	51	0	47	8	50	2	51	0	51	0	44	14
Chilligo/Ellis Creek at Grand River	189	189	0	188	1	186	2	189	0	189	0	184	3
Lower Eramosa River at Speed River	88	85	3	87	1	87	1	88	0	88	0	79	10
Middle Speed River at Eramosa River	281	264	6	278	1	280	0	256	9	279	1	236	16
Lower Speed River at Grand River	348	348	0	342	2	348	0	347	< 1	346	1	338	3

NOTE: * - 'Baseline' represents the simulated cummulative groundwater baseflow reporting to the base of the catchment area.
- Scenario 6 represents the cummulative total groundwater pumping rate simulated within Scenarios 1 through 5, which is 18,025 m^3/day.

FIGURES



LEGEND

- Municipal Test Well
- Simulated Groundwater Supply Locations
- Municipal Monitoring Well
- Municipal Production Well
- Major Roads / Highways
- Collector Roads / Local Roads
- Railway
- Watercourse
- Waterbody
- City of Guelph Boundary
- Arkell Collection System

DRAFT

REFERENCE

Base Data - MNR LIO, obtained 2013
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

1 0.5 0 1 2 3
SCALE 1:60,000 KILOMETERS

PROJECT
City of Guelph Water Supply Master Plan
Task 4b – Potential Water Sources inside / outside City

TITLE
MUNICIPAL PRODUCTION WELLS AND TEST WELL LOCATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0217			SCALE AS SHOWN	REV. 0.0
DESIGN	KD	30 Jan. 2014		
GIS	KD	27 Feb. 2014		
CHECK	JH	27 Feb. 2014		
REVIEW	SMD	27 Feb. 2014		

FIGURE: 1

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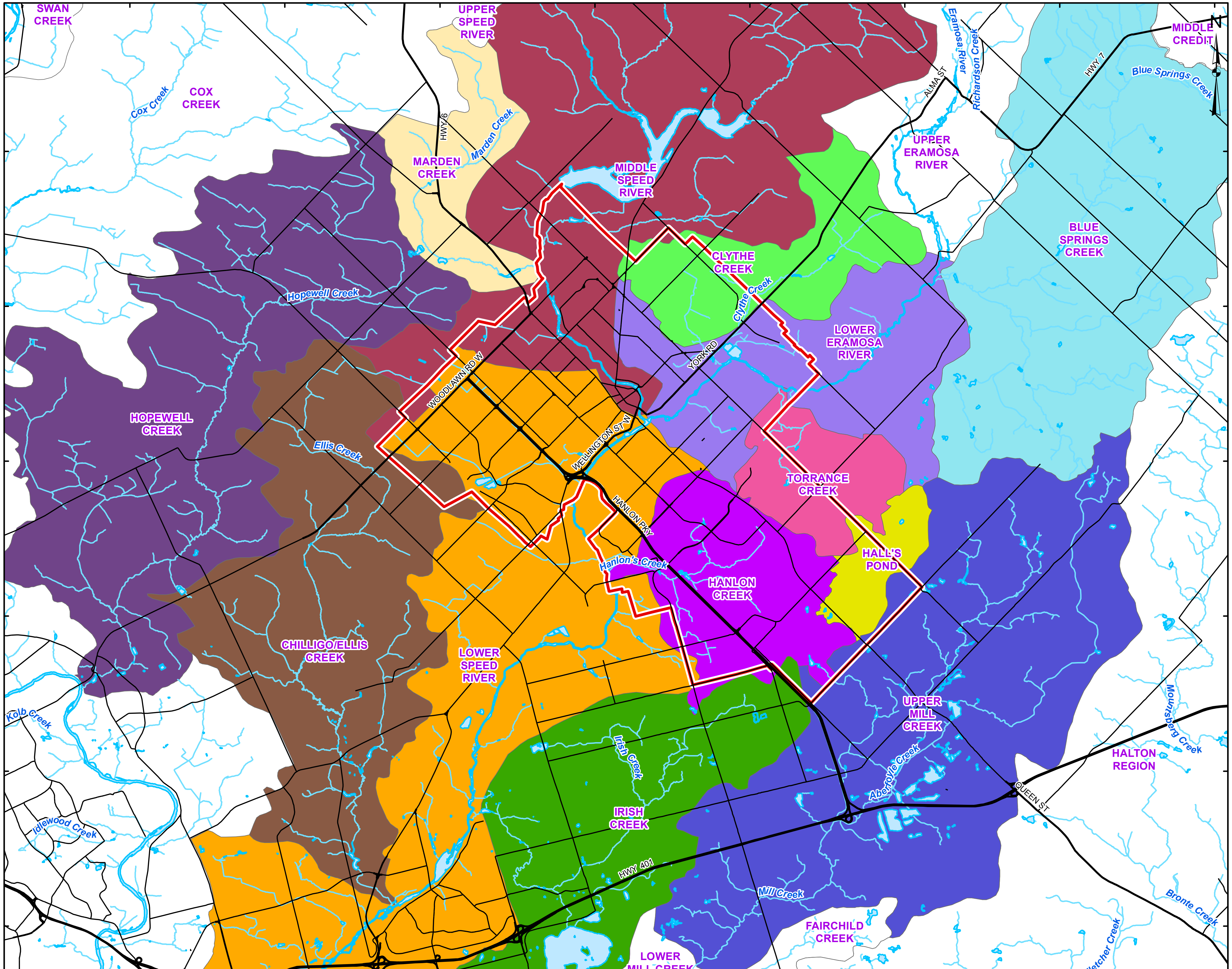

LEGEND

- Highway
- Major Road
- Watercourse
- Waterbody
- Guelph City Limit

Subwatersheds

- Clythe Creek Subwatershed
- Hall's Pond Subwatershed
- Upper Mill Creek Subwatershed
- Hanlon Creek Subwatershed
- Irish Creek Subwatershed
- Lower Speed River Subwatershed
- Torrance Creek Subwatershed
- Chilligo/Ellis Creek Subwatershed
- Middle Speed River Subwatershed
- Lower Eramosa River Subwatershed
- Blue Springs Creek Subwatershed
- Marden Creek Subwatershed
- Hopewell Creek Subwatershed

DRAFT

REFERENCE

Base Data - MNR NRVIS, PWS's MNR LIO data, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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SCALE 1:100,000 KILOMETERS

PROJECT
City of Guelph Water Supply Master Plan
Task 4b – Potential Water Sources inside / outside City

TITLE
LOCATION OF SUBWATERSHEDS

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0217			SCALE AS SHOWN	REV. 0.0
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GIS	KD	14 Mar. 2014		
CHECK	SMD	14 Mar. 2014		
REVIEW	SMD	14 Mar. 2014		

FIGURE: 2

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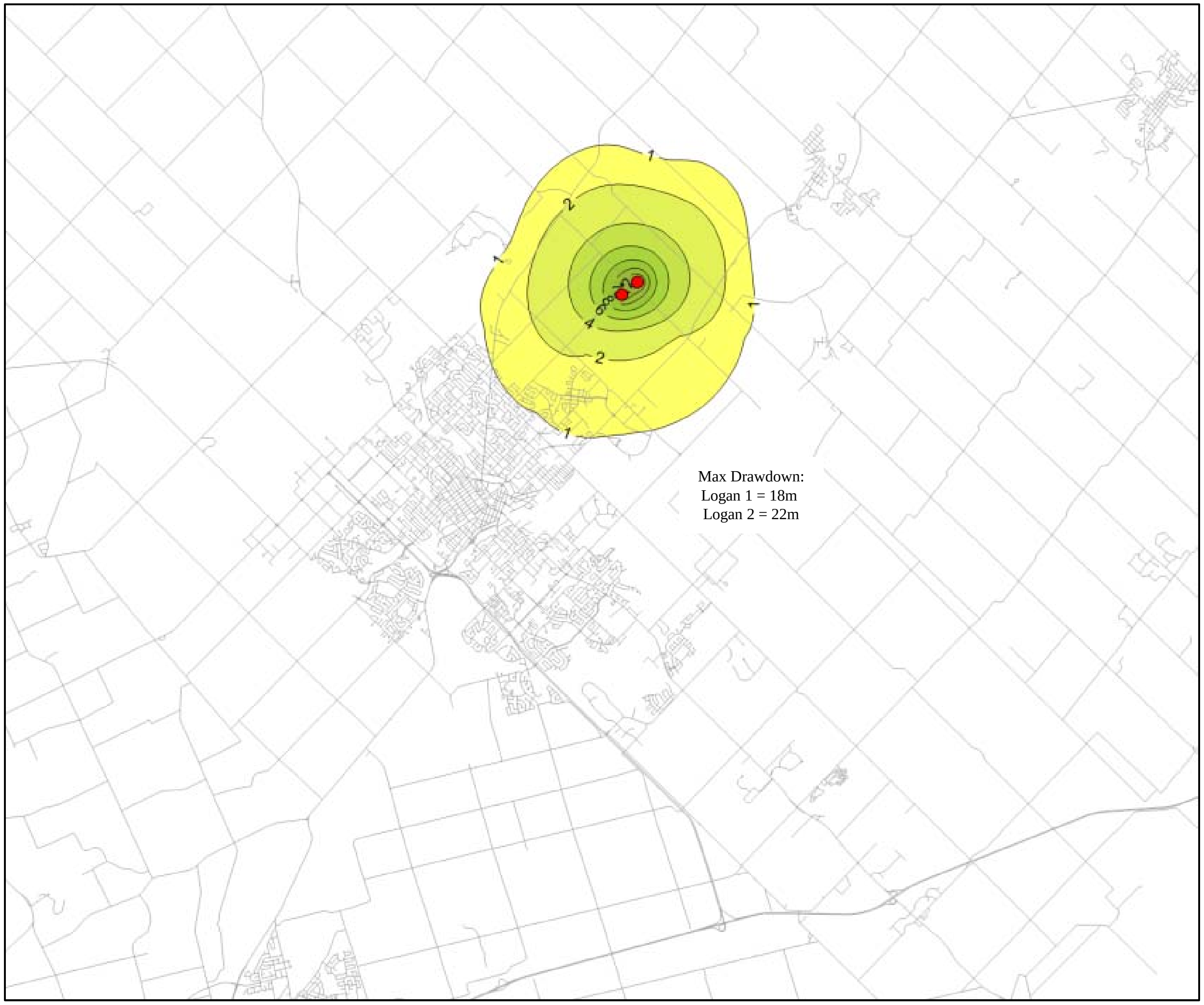

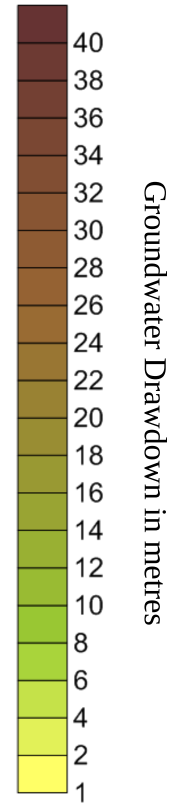

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Notes:

- Pumping Rate from Logan Municipal Test Wells = 3,492 m^3/day.
- 2 metre contour intervals; minimum contour interval of 1 metre.
- ● - Location of Logan Municipal Test Wells.

PROJECT
City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 1
Drawdown in Gasport Formation

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
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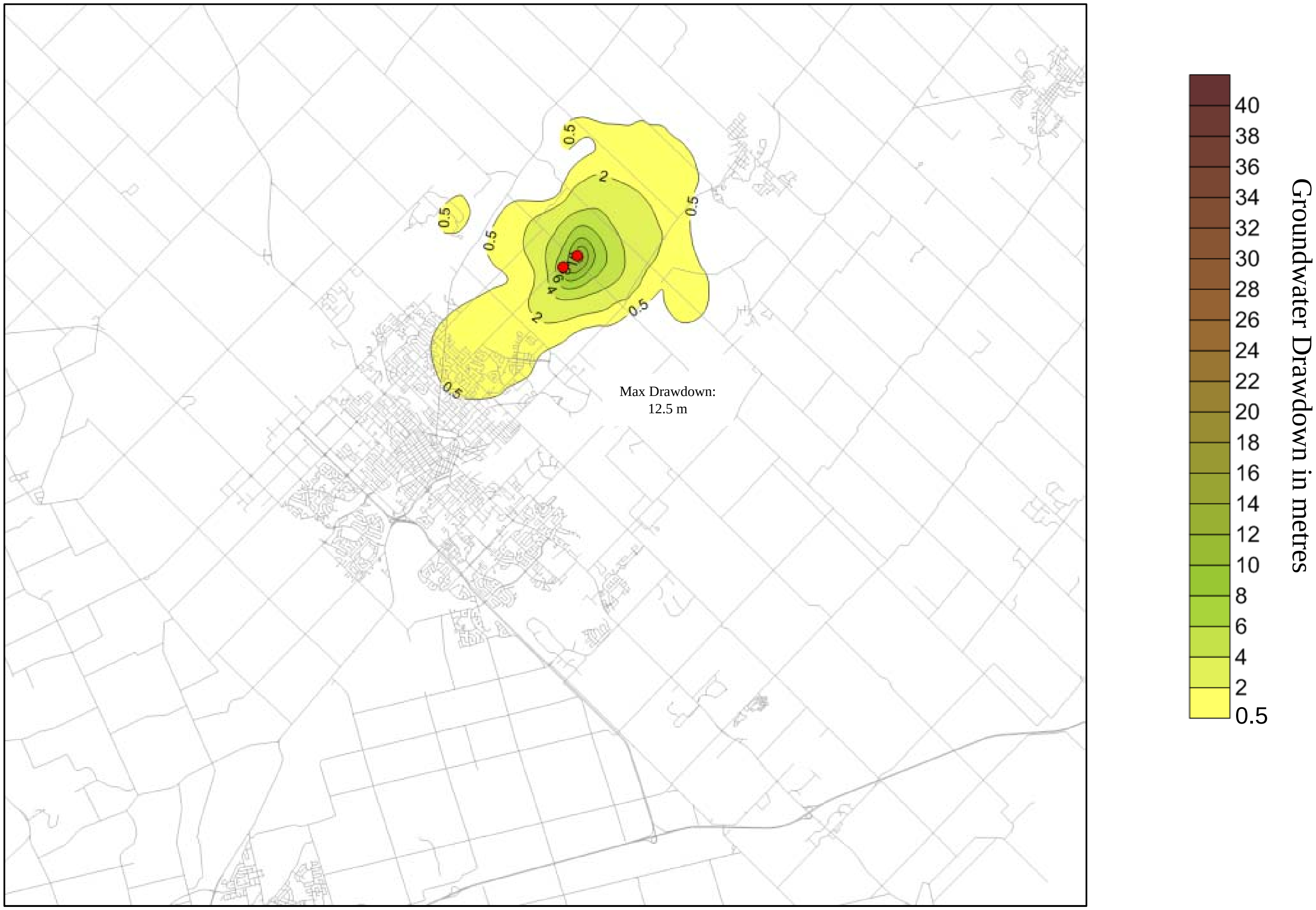
GIS				
CHECK				
REVIEW				



DRAFT

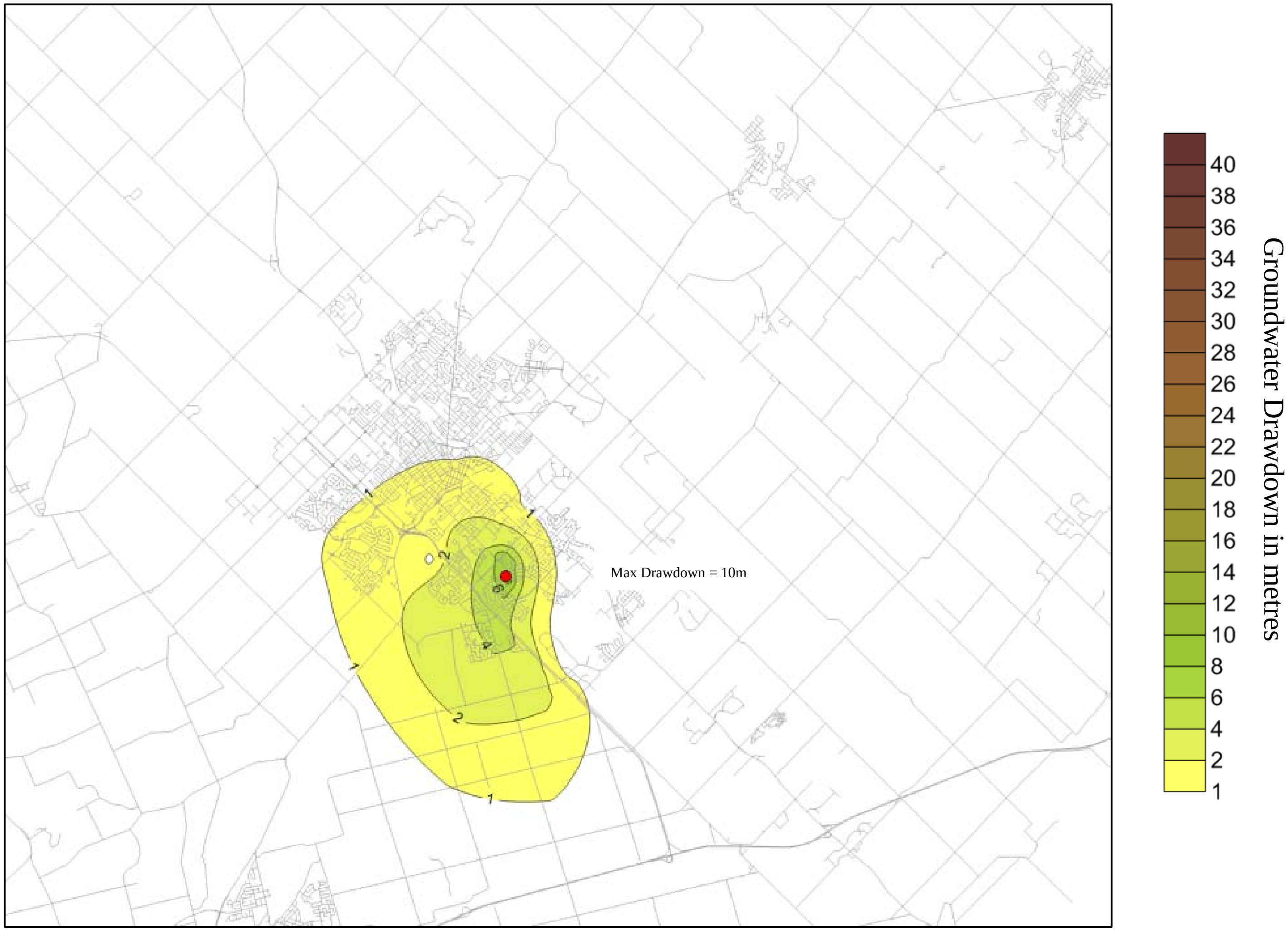
Notes:

- Pumping Rate from Logan Municipal Test Wells = 3,492 m^3/day.
- 2 metre contour intervals; minimum contour interval of 0.5 metre.
- ● - Location of Logan Municipal Test Wells.

PROJECT	City of Guelph Water Supply Master Plan Task 4B – Potential Water Sources Inside/Outside City
TITLE	**Modelling Scenario 1** **Drawdown in Guelph Formation**

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
DESIGN			**FIGURE: 4**	
GIS				
CHECK				
REVIEW				



DRAFT

Notes:

- Pumping Rate from Ironwood Municipal Test Well = 4,500 m^3/day.
- - 2 metre contour intervals; minimum contour interval of 1 metre.
- ● - Location of Ironwood Municipal Test Well.

PROJECT

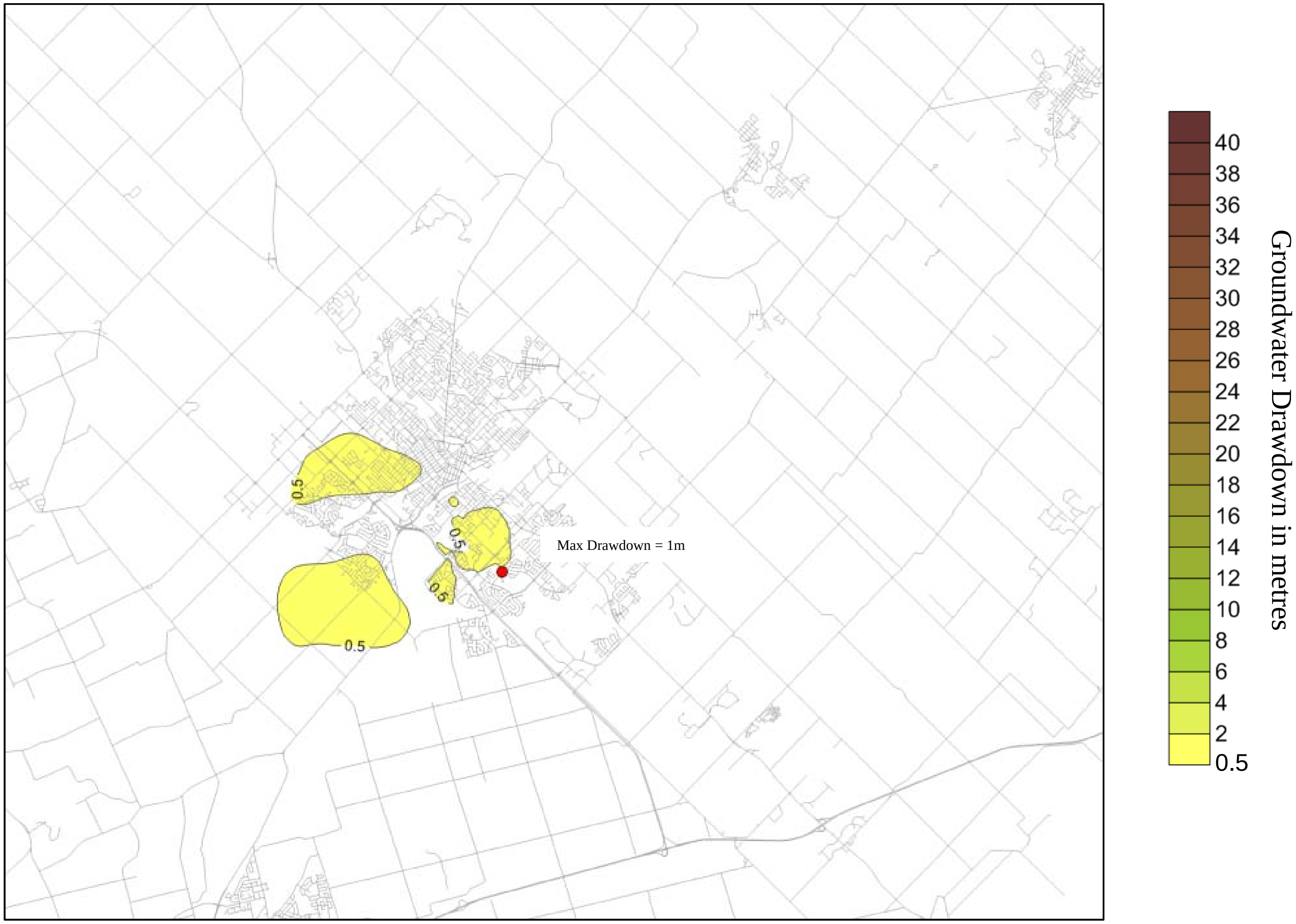
City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE

Modelling Scenario 2
Drawdown in Gasport Formation

Golder Associates

PROJECT No. 12-1152-0217		SCALE AS SHOWN	REV. 0
DESIGN		**FIGURE: 5**	
GIS			
CHECK			
REVIEW			



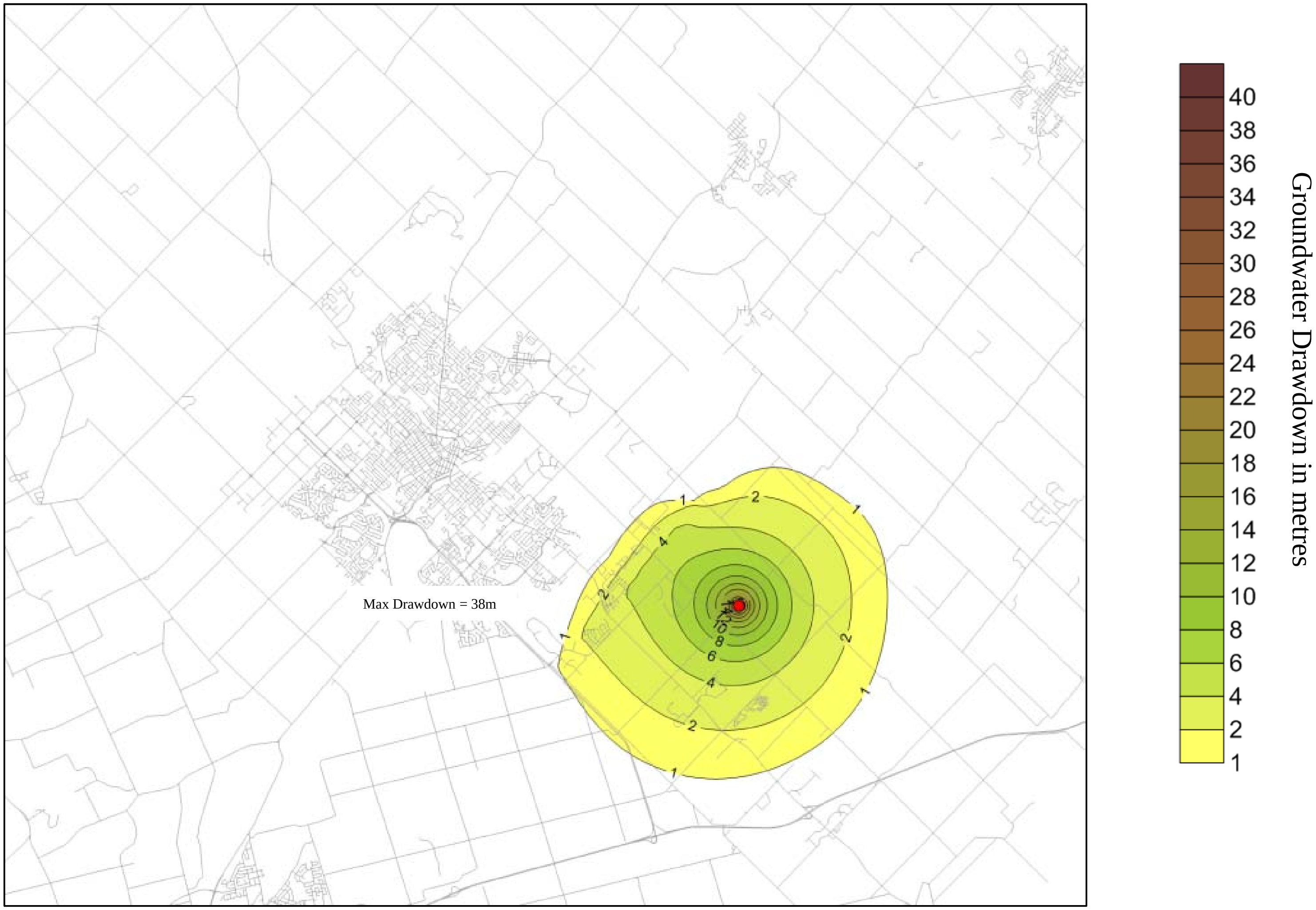
DRAFT

Notes:

- Pumping Rate from Ironwood Municipal Test Well = 4,500 m^3/day.
- 2 metre contour intervals; minimum contour interval of 0.5 metre.
- ● - Location of Ironwood Municipal Test Well.

PROJECT	City of Guelph Water Supply Master Plan Task 4B – Potential Water Sources Inside/Outside City
TITLE	**Modelling Scenario 2** **Drawdown in Guelph Formation**

Golder Associates	PROJECT No. 12-1152-0217	SCALE AS SHOWN	REV. 0
	DESIGN	**FIGURE: 6**	
	GIS		
	CHECK		
	REVIEW		



DRAFT

Notes:

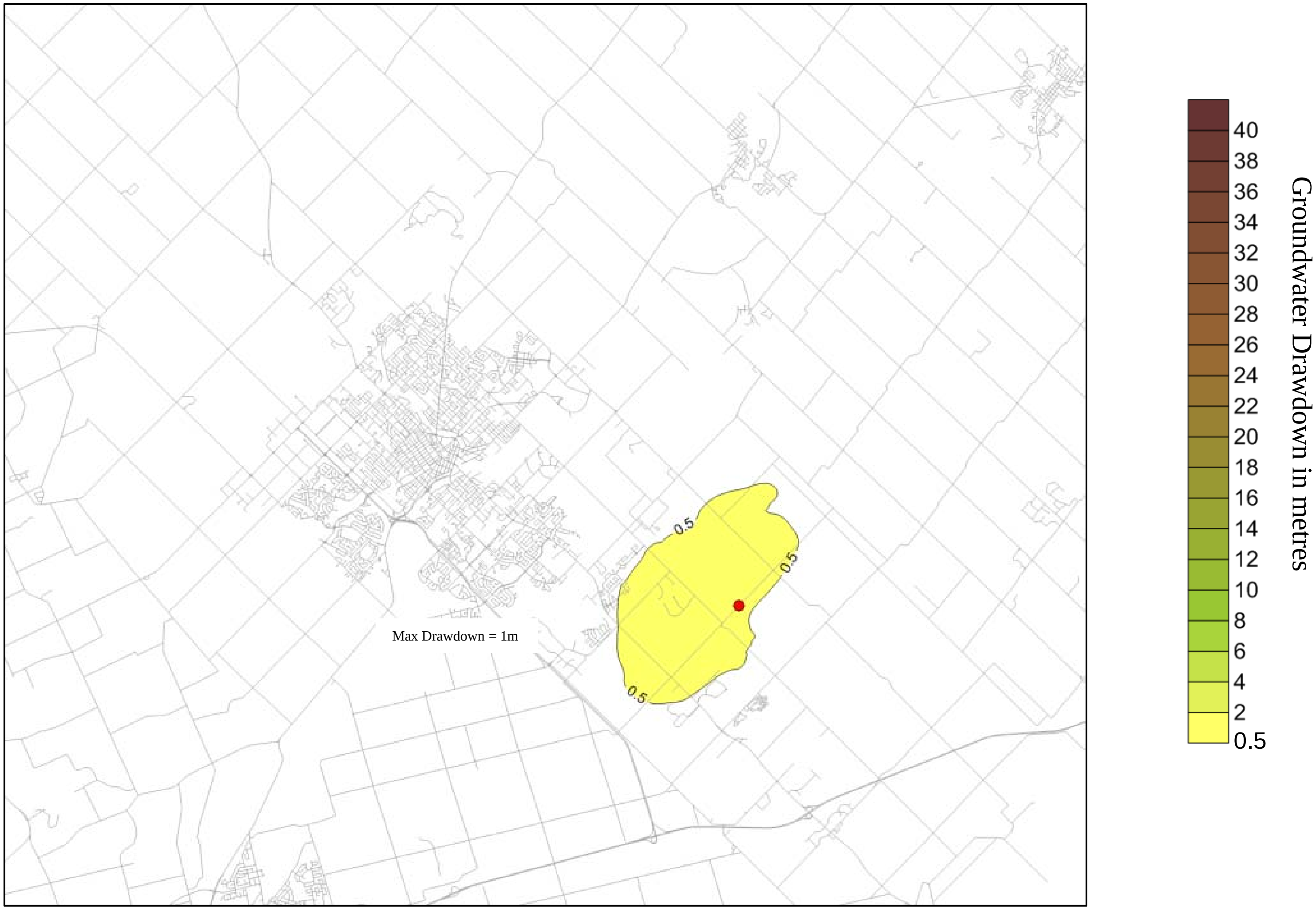
- Pumping Rate from Victoria Test Well = 3,912 m^3/day.
- 2 metre contour intervals; minimum contour interval of 1 metre.
- ● - Location of Victoria Test Well.

PROJECT
City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 3
Drawdown in Gasport Formation

Golder Associates

PROJECT No. 12-1152-0217		SCALE AS SHOWN	REV. 0
DESIGN		**FIGURE: 7**	
GIS			
CHECK			
REVIEW			



DRAFT

Notes:

- Pumping Rate from Victoria Test Well = 3,912 m^3/day.
- 2 metre contour intervals; minimum contour interval of 0.5 metre.
- ● - Location of Victoria Test Well.

PROJECT
City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 3
Drawdown in Guelph Formation

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
DESIGN			**FIGURE: 8**	
GIS				
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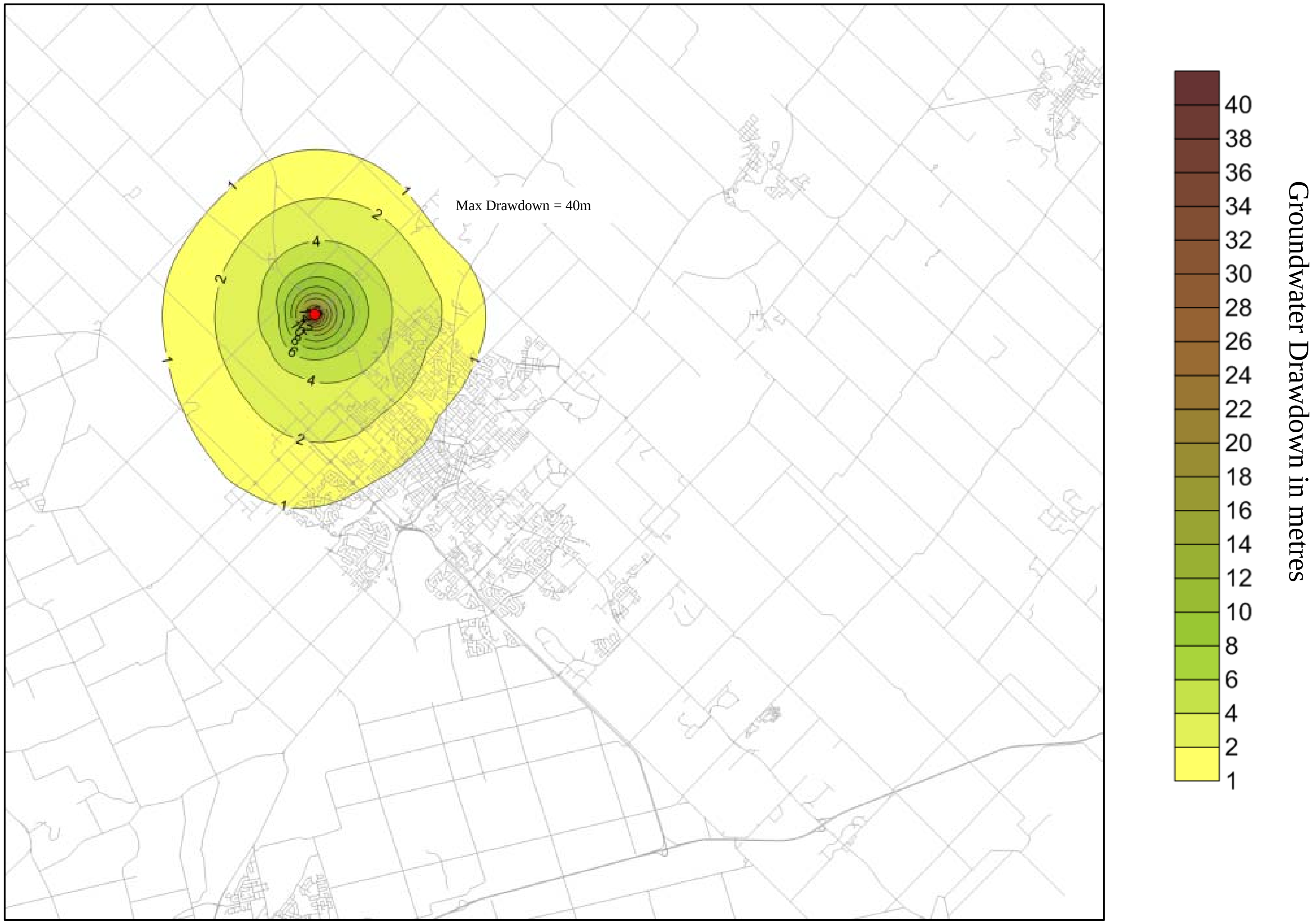
REVIEW				



DRAFT

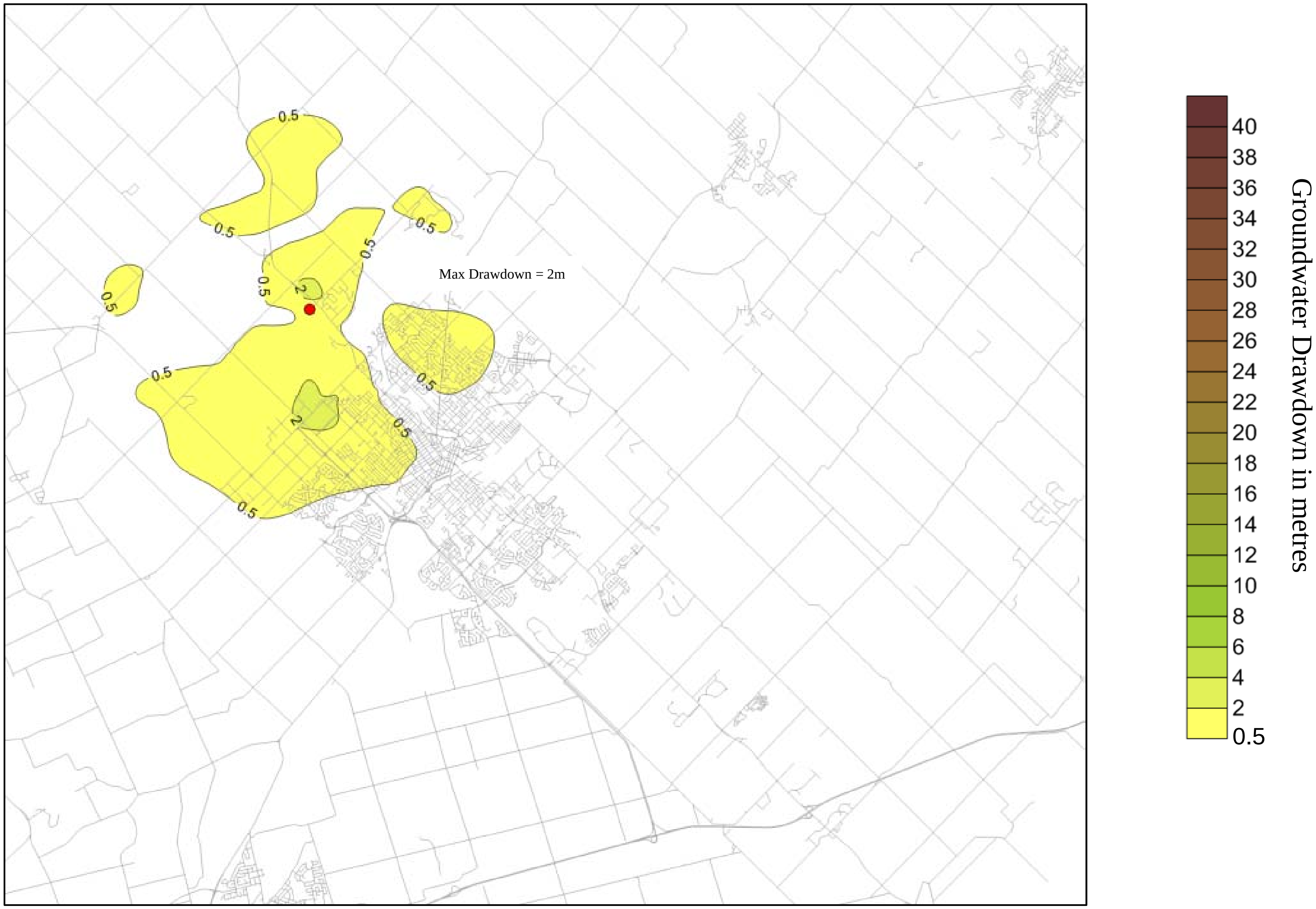
PROJECT
City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 4
Drawdown in Gasport Formation

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
DESIGN			**FIGURE: 9**	
GIS				
CHECK				
REVIEW				

Notes:
- Pumping Rate from Guelph North Test Well = 4,660 m^3/day.
- 2 metre contour intervals; minimum contour interval of 1 metre.
- ● - Location of Guelph North Test Well.



DRAFT

Notes:

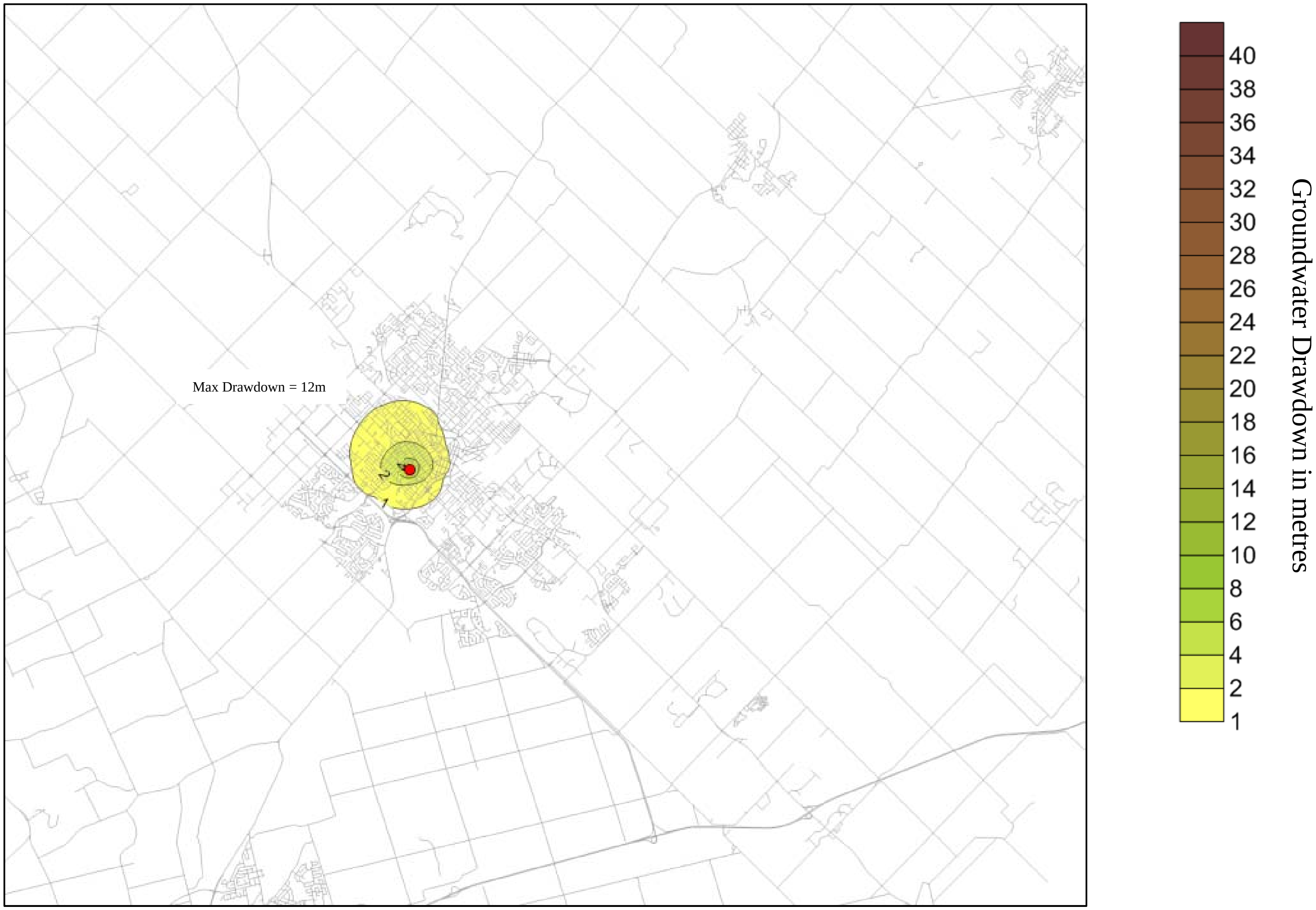
- Pumping Rate from Guelph North Test Well = 4,660 m^3/day.
- 2 metre contour intervals; minimum contour interval of 0.5 metre.
- ● - Location of Guelph North Test Well.

PROJECT City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 4
Drawdown in Guelph Formation

Golder Associates

PROJECT No. 12-1152-0217		SCALE AS SHOWN	REV. 0
DESIGN			
GIS		**FIGURE: 10**	
CHECK			
REVIEW			



DRAFT

Notes:

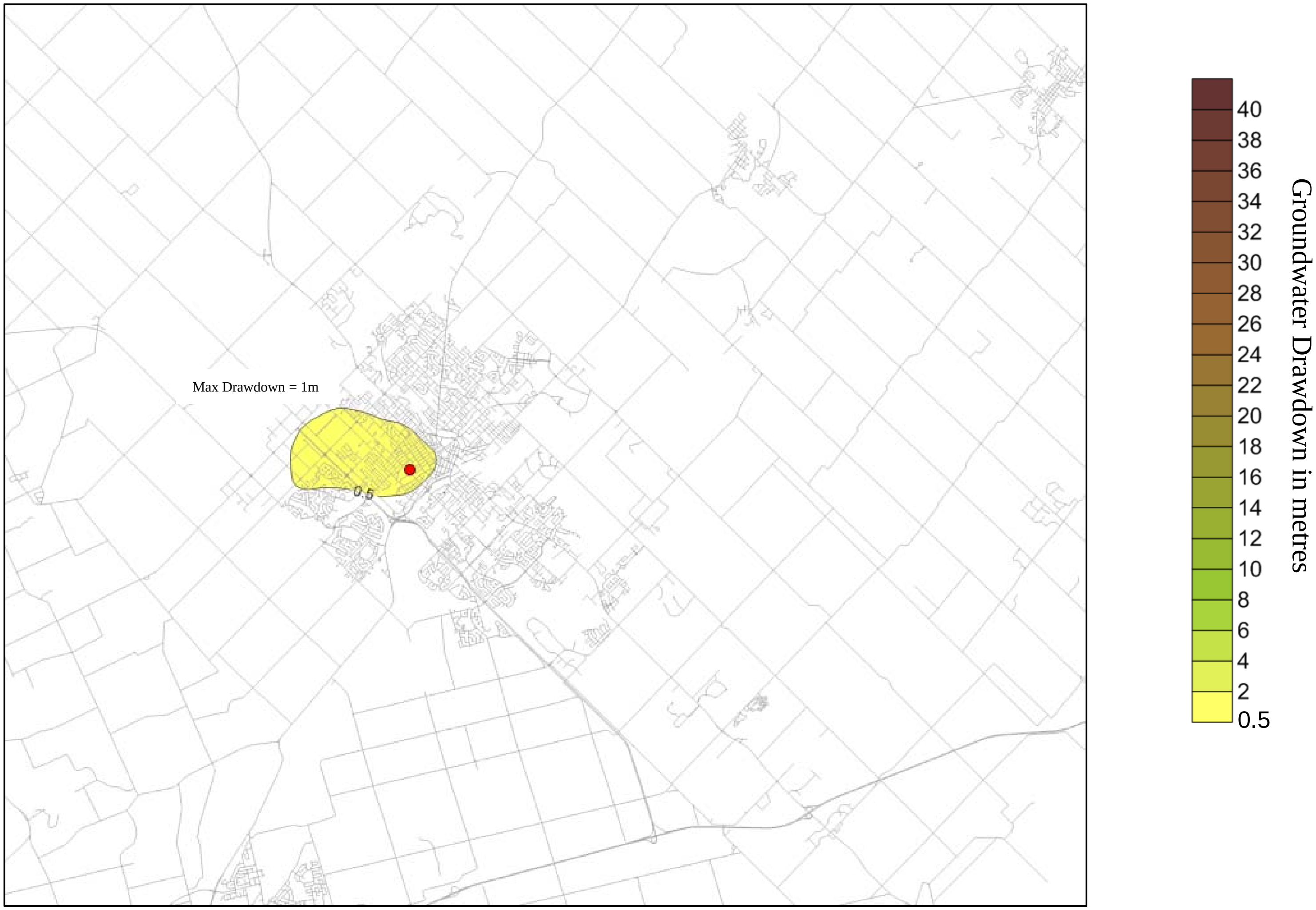
- Pumping Rate from Sunny Acres Test Well = 1,461 m^3/day.
- 2 metre contour intervals; minimum contour interval of 1 metre.
- ● - Location of Sunny Acres Test Well.

PROJECT City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 5
Drawdown in Gasport Formation

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
DESIGN			**FIGURE: 11**	
GIS				
CHECK				
REVIEW				



DRAFT

Notes:

- Pumping Rate from Sunny Acres Test Well = 1,461 m^3/day.
- 2 metre contour intervals; minimum contour interval of 0.5 metre.
- ● - Location of Sunny Acres Test Well.

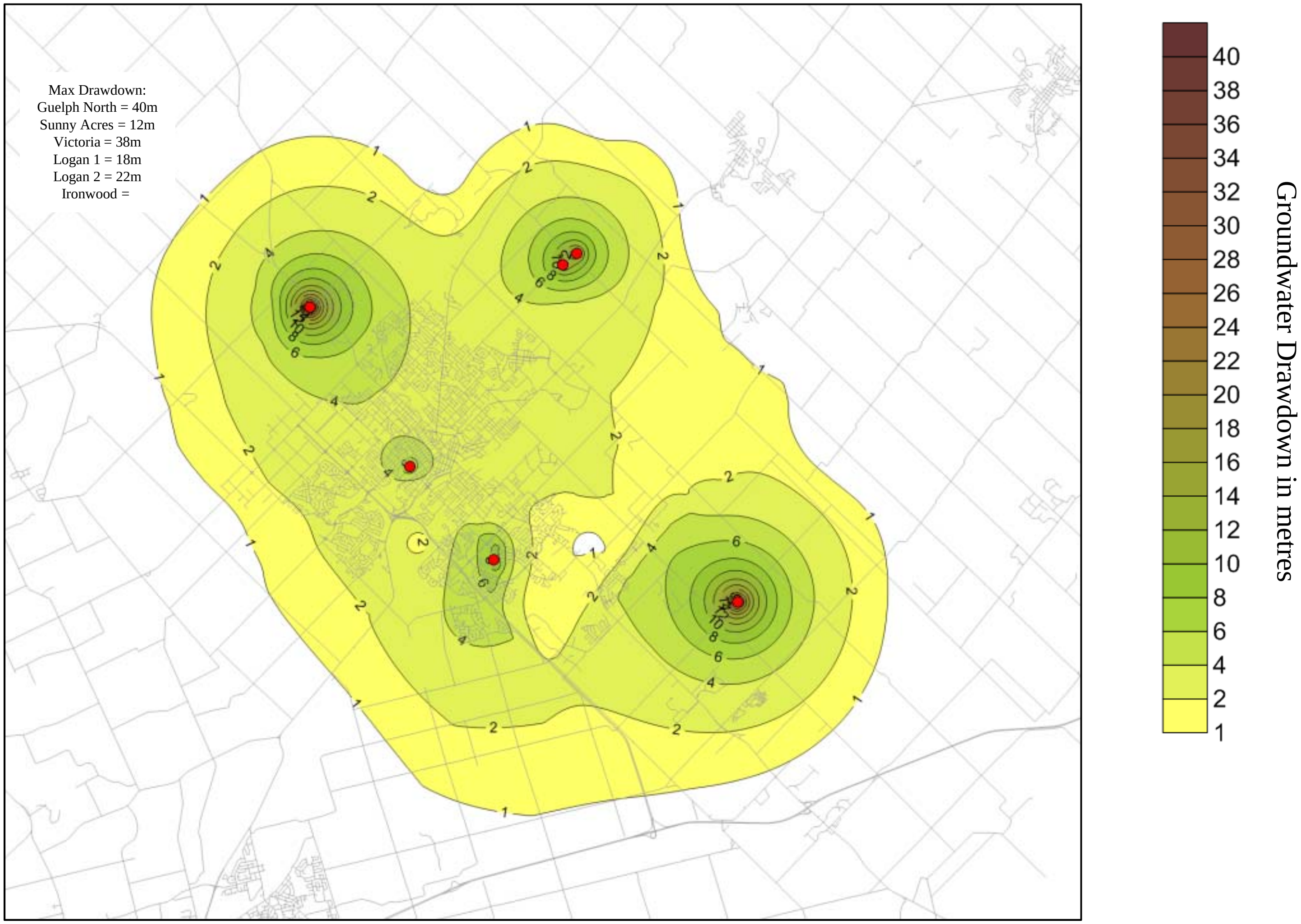
PROJECT City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE

Modelling Scenario 5
Drawdown in Guelph Formation

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
DESIGN			**FIGURE: 12**	
GIS				
CHECK				
REVIEW				



DRAFT

Notes:

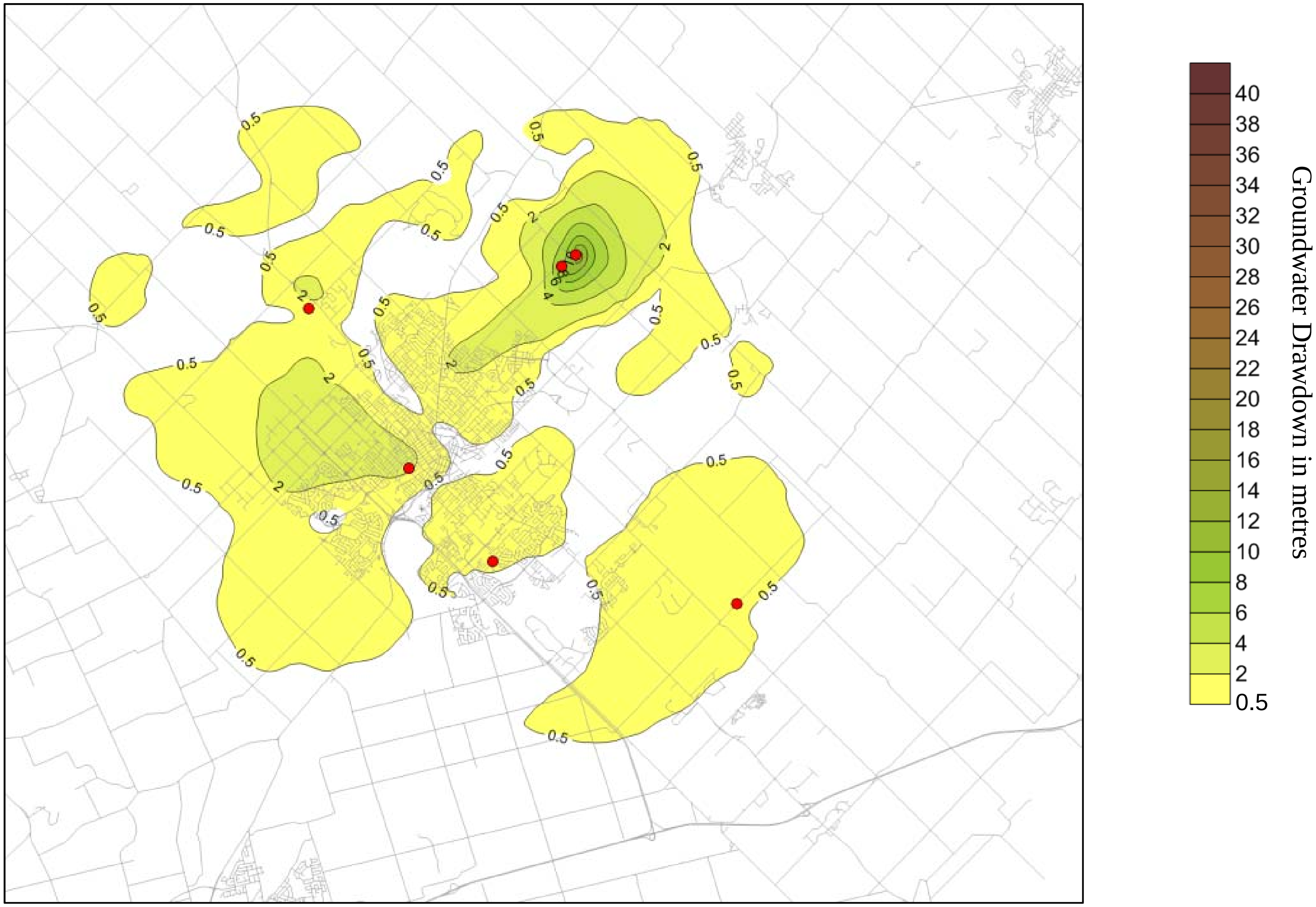
- Pumping Rate from All Test Well s= 13,525 m^3/day.
- 2 metre contour intervals; minimum contour interval of 1 metre.
- ● - Location of All Test Wells.

PROJECT
City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 6
Drawdown in Gasport Formation

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
DESIGN			**FIGURE: 13**	
GIS				
CHECK				
REVIEW				



DRAFT

Notes:

- Pumping Rate from All Test Well s= 13,525 m^3/day.
- 2 metre contour intervals; minimum contour interval of 0.5 metre.
- ● - Location of All Test Wells.

PROJECT
City of Guelph Water Supply Master Plan
Task 4B – Potential Water Sources Inside/Outside City

TITLE
Modelling Scenario 6
Drawdown in Guelph Formation

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 0
DESIGN			**FIGURE: 14**	
GIS				
CHECK				
REVIEW				

Appendix E

Guelph Water Supply Master Plan Update
TM3: Water Supply Alternatives (Draft Final)

City of Guelph Long-term Water Supply Memorandum (Draft)

By Grand River Conservation Authority

February 25, 2014 (Draft)

MEMO

TO: Patty Quackenbush, AECOM
Joe Gemin, AECOM
Dave Belanger, City of Guelph

FROM: Dwight Boyd, Grand River Conservation Authority

RE: City of Guelph Long-Term Water Supply

The purpose of this memo is to update the surface water taking analysis previously completed in 2005. The previous analysis investigated surface water taking alternatives for a taking from Guelph Dam located on the Speed River and the Arkell site located on the Eramosa River. The original analysis was based on the 1951 to 2004 period of record, the updated analysis extends this period to the end of 2012.

Guelph Dam Reservoir Yield Analysis

A sensitivity analysis was completed to analyze the impacts of takings on the reliability of filling Guelph Dam, on water elevations in Guelph Dam and on downstream low flow targets. The period of record analyzed included 1951 to 2012. Only partial record is available for 1950 therefore it was not analyzed although the time series is started on May 1st 1950.

The Guelph Dam analysis used the following assumptions;

1. 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. The 1 m^3/s maximum taking is an assumed cut off value. It is assumed there is an upper limit to the size of plant the City would consider to process intermittent takings. Also, the 1 m^3/s value is in a range that a taking of this magnitude would not significantly affect the higher flow regime from an environmental flow perspective.

2. The 1 m^3/s maximum taking is an assumed cut off value. It is assumed there is an upper limit to the size of plant the City would consider to process intermittent takings. Scenarios that consider a maximum taking of 0.5 m^3/s were also considered to examine the implications of the size of this taking on reliability. The 1 m^3/s maximum taking is small enough that an intermittent taking of this magnitude would not significantly affect the down high flow regime from an environmental flow perspective.

3. The discharge from the dam was set as the greater of the following:
    a. Minimum required discharge (0.57 m^3/s) or inflow
    b. The hydro turbine discharge at the given lake elevation
    c. 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 m^3/s from September 30th to May 30th.
    d. The uncontrolled slot discharge plus the turbine discharge
    e. The turbine discharge, uncontrolled slot discharge and any required flood discharge required to stabilize levels in Guelph Dam.

    Discharge to meet downstream flow targets was not constrained unless the lake ran dry. This condition did on occur in the period of record considered. The hydro turbine is operated as long as it is above the minimum lake elevation required to allow the turbine to operate, 342.1 metres.

4. After all the above conditions were met and the Guelph Lake elevation is above the lower operating range of the rule curve a range of base municipal taking was considered which included 0.15, 0.2, 0.25 and 0.3 m^3/s. A range of taking was examined to investigate the how the size of the base taking affected the reliability of this taking being available.

5. During the previous analysis completed in 2005, a sensitivity analysis was completed to determine the range of potential municipal takings. The range of municipal takings considered in the sensitivity analysis included 0.075, 0.1, 0.15, 0.2, 0.3 and 0.4 m^3/s takings respectively. After reviewing results a taking of 0.15 m^3/s was selected. A taking of this magnitude can be accommodated while being able to maintain downstream low flow targets and filling of Guelph Dam.

    A modified lower rule curve was developed assuming the 0.15 m3/s municipal taking. The lower operating rule curve for Guelph Dam was modified after analyzing the 1951 to 2004 time series. The lower operating range was modified so that the downstream low flow target at the Edinburgh Road gauge could be met with 100% reliability assuming the existing Arkell surface water taking 0.1 m3/s.

    The reservoir operation was analyzed using the modified lower rule curve and the assumed taking of 0.15 m^3/s. The 0.15 m^3/s taking was allowed as long as the reservoir elevation exceeded the lower rule curve limited. Analysis of the 1951 to 2012 period confirms a taking of 0.15 m^3/s can be accommodated with the exception of periods in 1963, 1964, 1999, 2007 and 2012. (See Appendix A.)

6. The impacts of the Arkell surface water taking were analyzed by modifying the local daily flow time series between the Guelph Dam and Edinburgh Road gauge station. The local flow time series is the series of daily flows that contribute to the Speed River Edinburgh Road gauge station downstream of Guelph Dam. This flow series represents the flows that would be present at the Speed River Edinburgh Road gauge station exclusive of contributions from Guelph Dam. The

Eramosa River contributes to this reach and is reflected in this time series. Three separate local flow time series were created to simulate the following three surface water taking conditions at Arkell

a. the existing Arkell surface water taking
b. abandonment of the Arkell surface water taking
c. maximizing the Arkell taking to the limits in the existing permit to take water.

Simulating the Arkell Surface Water Taking

7. Peter Bussatto at the City of Guelph was consulted in 2005 with respect to when the current Arkell surface water taking began. Peter reviewed records and indicated the current surface water taking appears to have begun when the existing dam was installed in 1974. The existing Arkell taking is limited to 100 l/s by existing infrastructure. Based on this information the existing Eramosa above Guelph gauge daily flow data was modified to add the Arkell taking to 100 l/s back onto the Eramosa Daily 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. This allowed a naturalized Eramosa Above Guelph flow series to be created, exclusive of the Arkell recharge taking.

8. The difference between the naturalized flow series and the existing flows series for the period of 1974 onward was used to adjust the local daily flow time series to simulate a condition assuming the Arkell surface water taking was abandoned.

9. Next 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 indicated in Table 9 presented later in this memo. 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.

10. 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.

Simulating at Stepped ASR Taking From Guelph Dam

After initial modelling 2005 the consultant requested a stepped taking be investigated with the following average taking durations over the course of a year.

Of 365 days per year:

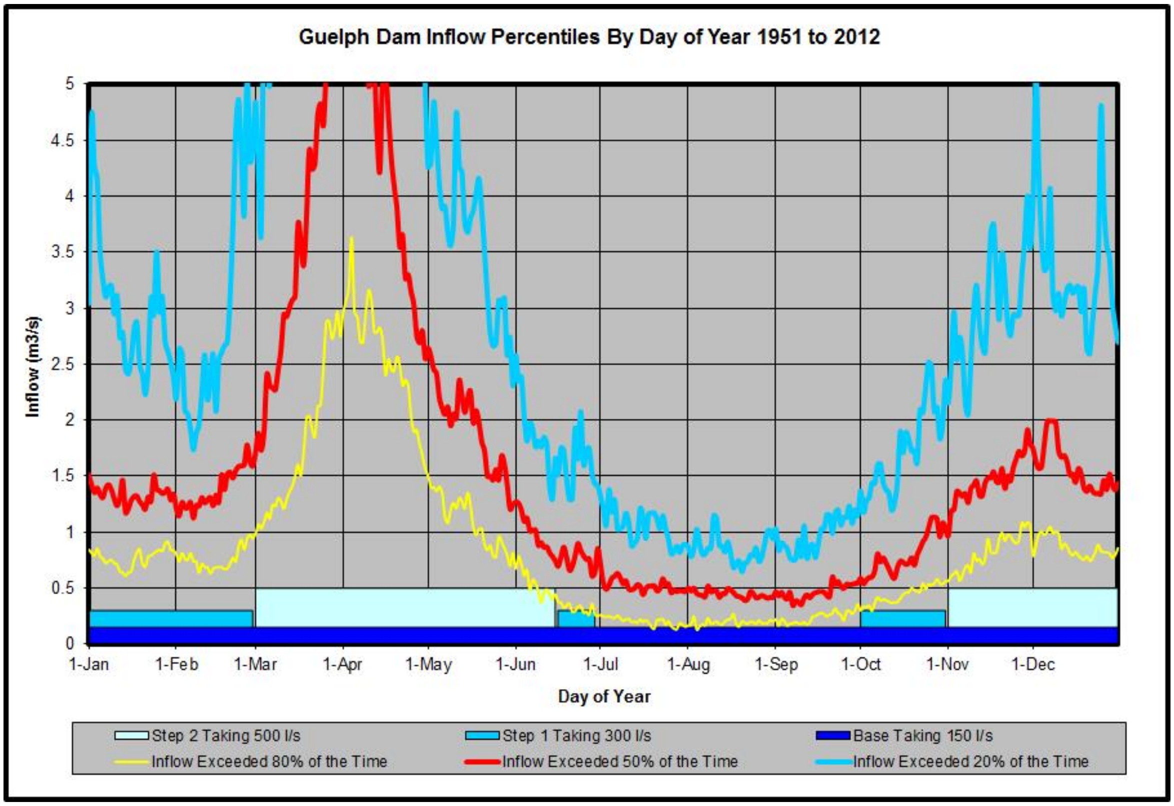
- ***100 days @ 150 L/s***
- ***100 days @ 300 L/s (assumed based reliability at 200 L/s 99% of the time)***
- ***164 days @ 500 L/s (based on reliability reported of 44%)***

The reservoir yield model was revised and the following rules used to model this taking.

11. The stream inflow to Guelph Dam is not constant. It varies within the year and across years. Figure 1 presents a chart illustrating the daily inflow probability into Guelph Dam for the 1950 to 2012 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.

12. 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 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 the 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



<u>Simulated Taking Scenarios</u>

In all 19 taking scenarios were simulated. In all five taking scenarios were simulated for Guelph Dam combined with three taking scenarios for Arkell, including status quo, abandonment and maximization of the existing Arkell permit to take water. This accounted for the first fifteen scenarios. Analysis of the first fifteen scenarios provides the basis for the sensitivity to a constant municipal base taking.

The final four scenarios analyzed a stepped municipal base taking and ASR taking of 0.3 m^3/s and 0.5 m^3/s for a range of four base municipal takings of 0.15, 0.2, 0.25 and 0.30 m^3/s. Analysis of scenarios 16 through 19 provides the basis for the sensitivity to a constant municipal base taking.

The results of the simulating the above scenarios are presented by table 2 to 4.

Table 1 Guelph Dam Municipal Base and ASR Taking Scenario Summary

Scenario	Guelph Dam			Arkell
	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

Table 2 Reliability of Municipal Taking For Various Taking Scenarios

Scenario	Guelph Dam			Arkell	Total Number of Days Base Taking Not 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	55	1	0	4	32	8	8	27	10	5	38	63	251
Scenario 2	150	500	n/a	Existing	55	0	0	4	31	7	5	16	3	1	36	61	219
Scenario 3	200	500	n/a	Existing	56	29	2	6	32	23	16	40	33	24	78	71	410
Scenario 4	250	500	n/a	Existing	56	48	14	11	33	32	29	54	76	52	88	75	568
Scenario 5	300	500	n/a	Existing	67	70	23	13	36	42	37	72	136	81	90	80	747
Scenario 6	150	1000	n/a	Abandon	55	1	0	3	32	1	8	27	7	1	27	53	215
Scenario 7	150	500	n/a	Abandon	55	0	0	3	31	1	5	16	3	0	24	45	183
Scenario 8	200	500	n/a	Abandon	56	29	2	6	32	18	16	40	20	13	64	71	367
Scenario 9	250	500	n/a	Abandon	56	48	10	10	33	32	29	50	51	37	87	76	519
Scenario 10	300	500	n/a	Abandon	67	68	23	13	36	42	36	64	122	68	89	78	706
Scenario 11	150	1000	n/a	Maximized	55	29	4	4	32	9	13	40	22	23	55	61	347
Scenario 12	150	500	n/a	Maximized	55	29	4	3	31	9	7	33	18	18	53	59	319
Scenario 13	200	500	n/a	Maximized	56	37	5	9	32	23	22	49	49	52	79	74	487
Scenario 14	250	500	n/a	Maximized	57	50	15	12	34	37	33	64	119	80	89	85	675
Scenario 15	300	500	n/a	Maximized	72	76	24	14	37	45	41	102	169	93	89	85	847
Scenario 16	150	500	300	Maximized	55	29	5	8	32	19	10	38	23	28	59	62	368
Scenario 17	200	500	300	Maximized	56	43	5	9	33	28	24	52	59	57	83	77	526
Scenario 18	250	500	300	Maximized	60	50	17	12	34	38	33	68	127	81	89	85	694
Scenario 19	300	500	300	Maximized	72	76	24	14	37	45	41	102	169	93	89	85	847

Scenario	Guelph Dam			Arkell	Maximum Number of Days Base Taking Not Available in Given Year or Month												
	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	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	17	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	13	29	31	80
Scenario 9	250	500	n/a	Abandon	31	29	6	6	31	28	15	29	23	23	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	23	28	31	71
Scenario 12	150	500	n/a	Maximized	31	29	4	3	31	9	5	24	12	18	28	31	67
Scenario 13	200	500	n/a	Maximized	31	29	5	5	31	23	12	28	24	31	30	31	96
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	26	29	31	79
Scenario 17	200	500	300	Maximized	31	29	5	5	31	28	12	28	26	31	30	31	102
Scenario 18	250	500	300	Maximized	31	29	11	7	31	29	18	31	30	31	30	31	121
Scenario 19	300	500	300	Maximized	31	29	18	8	31	30	22	31	30	31	30	31	137

Scenario	Guelph Dam			Arkell	Reliability Based On Time Of Municipal 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	97%	100%	100%	100%	98%	100%	100%	99%	99%	100%	98%	97%	99%
Scenario 2	150	500	n/a	Existing	97%	100%	100%	100%	98%	100%	100%	99%	100%	100%	98%	97%	99%
Scenario 3	200	500	n/a	Existing	97%	98%	100%	100%	98%	99%	99%	98%	98%	99%	96%	96%	98%
Scenario 4	250	500	n/a	Existing	97%	97%	99%	99%	98%	98%	98%	97%	96%	97%	95%	96%	97%
Scenario 5	300	500	n/a	Existing	97%	96%	99%	99%	98%	98%	98%	96%	93%	96%	95%	96%	97%
Scenario 6	150	1000	n/a	Abandon	97%	100%	100%	100%	98%	100%	100%	99%	100%	100%	99%	97%	99%
Scenario 7	150	500	n/a	Abandon	97%	100%	100%	100%	98%	100%	100%	99%	100%	100%	99%	98%	99%
Scenario 8	200	500	n/a	Abandon	97%	98%	100%	100%	98%	99%	99%	98%	99%	99%	97%	96%	98%
Scenario 9	250	500	n/a	Abandon	97%	97%	99%	99%	98%	98%	98%	97%	97%	98%	95%	96%	98%
Scenario 10	300	500	n/a	Abandon	97%	96%	99%	99%	98%	98%	98%	97%	93%	96%	95%	96%	97%
Scenario 11	150	1000	n/a	Maximized	97%	98%	100%	100%	98%	100%	99%	98%	99%	99%	97%	97%	98%
Scenario 12	150	500	n/a	Maximized	97%	98%	100%	100%	98%	100%	100%	98%	99%	99%	97%	97%	99%
Scenario 13	200	500	n/a	Maximized	97%	98%	100%	100%	98%	99%	99%	97%	97%	97%	96%	96%	98%
Scenario 14	250	500	n/a	Maximized	97%	97%	99%	99%	98%	98%	98%	97%	94%	96%	95%	96%	97%
Scenario 15	300	500	n/a	Maximized	96%	96%	99%	99%	98%	98%	98%	95%	91%	95%	95%	96%	96%
Scenario 16	150	500	300	Maximized	97%	98%	100%	100%	98%	99%	99%	98%	99%	99%	97%	97%	98%
Scenario 17	200	500	300	Maximized	97%	98%	100%	100%	98%	98%	99%	97%	97%	97%	96%	96%	98%
Scenario 18	250	500	300	Maximized	97%	97%	99%	99%	98%	98%	98%	96%	93%	96%	95%	96%	97%
Scenario 19	300	500	300	Maximized	96%	96%	99%	99%	98%	98%	98%	95%	91%	95%	95%	96%	96%

Scenario	Guelph Dam			Arkell	Reliability Based On Occurance Of Municipal 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	97%	98%	100%	98%	97%	98%	98%	97%	97%	98%	97%	95%	89%
Scenario 2	150	500	n/a	Existing	97%	100%	100%	98%	98%	98%	98%	97%	98%	98%	97%	95%	89%
Scenario 3	200	500	n/a	Existing	97%	97%	98%	97%	97%	98%	97%	97%	95%	97%	95%	95%	87%
Scenario 4	250	500	n/a	Existing	97%	97%	97%	97%	95%	97%	97%	95%	92%	95%	95%	95%	84%
Scenario 5	300	500	n/a	Existing	95%	95%	97%	97%	95%	97%	95%	92%	90%	94%	95%	95%	82%
Scenario 6	150	1000	n/a	Abandon	97%	98%	100%	98%	97%	98%	98%	97%	98%	98%	98%	95%	89%
Scenario 7	150	500	n/a	Abandon	97%	100%	100%	98%	98%	98%	98%	97%	98%	100%	98%	95%	89%
Scenario 8	200	500	n/a	Abandon	97%	97%	98%	97%	97%	98%	97%	97%	95%	98%	95%	95%	87%
Scenario 9	250	500	n/a	Abandon	97%	97%	97%	97%	95%	97%	97%	97%	94%	95%	95%	95%	84%
Scenario 10	300	500	n/a	Abandon	95%	95%	97%	97%	95%	97%	95%	94%	90%	94%	95%	95%	82%
Scenario 11	150	1000	n/a	Maximized	97%	98%	98%	97%	97%	98%	97%	97%	97%	98%	95%	95%	89%
Scenario 12	150	500	n/a	Maximized	97%	98%	98%	98%	98%	98%	97%	97%	97%	98%	97%	95%	89%
Scenario 13	200	500	n/a	Maximized	97%	97%	98%	97%	97%	98%	97%	97%	94%	95%	95%	95%	85%
Scenario 14	250	500	n/a	Maximized	95%	97%	97%	97%	95%	97%	97%	94%	89%	94%	95%	95%	82%
Scenario 15	300	500	n/a	Maximized	95%	95%	97%	97%	95%	97%	95%	90%	89%	90%	95%	95%	82%
Scenario 16	150	500	300	Maximized	97%	98%	98%	97%	97%	98%	97%	97%	97%	97%	95%	95%	89%
Scenario 17	200	500	300	Maximized	97%	97%	98%	97%	95%	98%	97%	97%	92%	95%	95%	95%	84%
Scenario 18	250	500	300	Maximized	95%	97%	97%	97%	95%	97%	97%	92%	89%	94%	95%	95%	82%
Scenario 19	300	500	300	Maximized	95%	95%	97%	97%	95%	97%	95%	90%	89%	90%	95%	95%	82%

Table 3 Reliability of ASR Taking Above Base Municipal Taking Scenarios

Scenario	Guelph Dam			Arkell	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	18	15	20	26	19	7	2	2	5	10	12	19	155
Scenario 2	150	500	n/a	Existing	25	21	25	31	28	11	4	2	6	13	16	25	208
Scenario 3	200	500	n/a	Existing	24	21	25	31	27	11	4	2	6	12	15	23	202
Scenario 4	250	500	n/a	Existing	23	20	25	31	27	11	4	2	6	11	14	22	197
Scenario 5	300	500	n/a	Existing	23	20	24	31	27	11	3	2	5	10	14	21	192
Scenario 6	150	1000	n/a	Abandon	20	18	23	30	22	8	2	2	6	11	14	21	178
Scenario 7	150	500	n/a	Abandon	25	21	25	31	28	11	4	2	7	13	16	25	209
Scenario 8	200	500	n/a	Abandon	24	21	25	31	27	11	4	2	6	13	15	23	203
Scenario 9	250	500	n/a	Abandon	24	21	25	31	27	11	4	2	6	11	14	23	197
Scenario 10	300	500	n/a	Abandon	23	20	24	31	27	11	3	2	5	10	14	21	192
Scenario 11	150	1000	n/a	Maximized	20	18	23	30	22	8	2	2	6	11	14	21	177
Scenario 12	150	500	n/a	Maximized	25	21	25	31	28	11	4	2	6	13	16	24	207
Scenario 13	200	500	n/a	Maximized	24	21	25	31	27	11	4	2	6	12	15	23	201
Scenario 14	250	500	n/a	Maximized	23	20	25	31	27	11	4	2	6	11	14	22	196
Scenario 15	300	500	n/a	Maximized	22	20	24	31	27	11	3	2	5	10	14	21	191
Scenario 16	150	500	300	Maximized	32	29	33	33	32	27	4	2	21	25	27	31	296
Scenario 17	200	500	300	Maximized	31	29	33	33	32	27	4	2	19	23	26	31	291
Scenario 18	250	500	300	Maximized	31	29	33	33	32	27	3	2	18	21	25	30	284
Scenario 19	300	500	300	Maximized	22	20	24	31	27	11	3	2	5	10	14	21	191

Scenario	Guelph Dam			Arkell	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	0
Scenario 2	150	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0
Scenario 7	150	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0
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	6	0	0
Scenario 18	250	500	300	Maximized	0	0	0	0	0	1	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			Arkell	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	57%	54%	64%	88%	63%	23%	7%	5%	16%	32%	41%	60%	42%
Scenario 2	150	500	n/a	Existing	70%	65%	71%	91%	78%	33%	10%	7%	19%	37%	46%	69%	50%
Scenario 3	200	500	n/a	Existing	68%	64%	71%	91%	77%	32%	10%	6%	17%	35%	43%	65%	48%
Scenario 4	250	500	n/a	Existing	66%	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Scenario 5	300	500	n/a	Existing	63%	62%	68%	91%	76%	31%	9%	5%	15%	29%	40%	60%	46%
Scenario 6	150	1000	n/a	Abandon	57%	54%	64%	88%	63%	23%	7%	5%	17%	32%	41%	60%	43%
Scenario 7	150	500	n/a	Abandon	70%	65%	71%	91%	78%	33%	10%	7%	19%	38%	47%	69%	50%
Scenario 8	200	500	n/a	Abandon	68%	64%	71%	91%	77%	32%	10%	6%	17%	35%	44%	66%	48%
Scenario 9	250	500	n/a	Abandon	66%	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Scenario 10	300	500	n/a	Abandon	64%	62%	68%	91%	76%	31%	9%	5%	16%	29%	40%	60%	46%
Scenario 11	150	1000	n/a	Maximized	57%	54%	64%	88%	63%	23%	7%	5%	16%	31%	40%	59%	42%
Scenario 12	150	500	n/a	Maximized	70%	65%	71%	91%	78%	33%	10%	7%	19%	37%	45%	68%	49%
Scenario 13	200	500	n/a	Maximized	67%	64%	70%	91%	77%	32%	10%	6%	17%	34%	43%	65%	48%
Scenario 14	250	500	n/a	Maximized	66%	63%	69%	91%	77%	31%	10%	6%	16%	31%	40%	62%	47%
Scenario 15	300	500	n/a	Maximized	63%	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%
Scenario 16	150	500	300	Maximized	89%	90%	93%	97%	91%	79%	10%	6%	60%	70%	80%	87%	71%
Scenario 17	200	500	300	Maximized	88%	89%	92%	97%	90%	79%	10%	6%	56%	65%	77%	86%	69%
Scenario 18	250	500	300	Maximized	87%	88%	91%	97%	90%	78%	10%	6%	52%	59%	73%	84%	68%
Scenario 19	300	500	300	Maximized	63%	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%

Scenario	Guelph Dam			Arkell	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	81%	77%	92%	97%	94%	60%	24%	15%	26%	45%	61%	76%	100%
Scenario 2	150	500	n/a	Existing	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	76%	100%
Scenario 3	200	500	n/a	Existing	81%	79%	94%	97%	94%	71%	29%	15%	24%	44%	61%	74%	98%
Scenario 4	250	500	n/a	Existing	77%	77%	94%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%
Scenario 5	300	500	n/a	Existing	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	71%	98%
Scenario 6	150	1000	n/a	Abandon	81%	77%	92%	97%	94%	60%	24%	15%	27%	45%	61%	77%	100%
Scenario 7	150	500	n/a	Abandon	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	77%	100%
Scenario 8	200	500	n/a	Abandon	81%	79%	94%	97%	94%	71%	29%	15%	26%	44%	61%	74%	98%
Scenario 9	250	500	n/a	Abandon	79%	77%	94%	97%	94%	69%	27%	15%	23%	40%	50%	73%	98%
Scenario 10	300	500	n/a	Abandon	74%	76%	92%	97%	94%	68%	26%	11%	23%	40%	47%	71%	98%
Scenario 11	150	1000	n/a	Maximized	81%	77%	92%	97%	92%	60%	24%	15%	27%	45%	61%	76%	98%
Scenario 12	150	500	n/a	Maximized	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	61%	76%	100%
Scenario 13	200	500	n/a	Maximized	81%	79%	94%	97%	94%	71%	29%	15%	24%	42%	55%	74%	98%
Scenario 14	250	500	n/a	Maximized	77%	77%	92%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%
Scenario 15	300	500	n/a	Maximized	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%
Scenario 16	150	500	300	Maximized	90%	92%	98%	98%	97%	89%	27%	16%	66%	77%	90%	89%	100%
Scenario 17	200	500	300	Maximized	90%	92%	98%	98%	97%	89%	26%	15%	63%	73%	87%	89%	100%
Scenario 18	250	500	300	Maximized	89%	92%	98%	98%	97%	87%	26%	13%	58%	65%	85%	89%	100%
Scenario 19	300	500	300	Maximized	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%

Table 4 Reliability of Full ASR Taking Being Available

Scenario	Guelph Dam			Arkell	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	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	18	23	30	22	8	2	2	6	11	14	21	178
Scenario 2	150	500	n/a	Existing	21	25	31	28	11	4	2	6	13	16	25	208
Scenario 3	200	500	n/a	Existing	21	25	31	27	11	4	2	6	12	15	23	202
Scenario 4	250	500	n/a	Existing	20	25	31	27	11	4	2	6	11	14	22	197
Scenario 5	300	500	n/a	Existing	20	24	31	27	11	3	2	5	10	14	21	192
Scenario 6	150	1000	n/a	Abandon	18	23	30	22	8	2	2	6	11	14	21	178
Scenario 7	150	500	n/a	Abandon	21	25	31	28	11	4	2	7	13	16	25	209
Scenario 8	200	500	n/a	Abandon	21	25	31	27	11	4	2	6	13	15	23	203
Scenario 9	250	500	n/a	Abandon	21	25	31	27	11	4	2	6	11	14	23	197
Scenario 10	300	500	n/a	Abandon	20	24	31	27	11	3	2	5	10	14	21	192
Scenario 11	150	1000	n/a	Maximized	18	23	30	22	8	2	2	6	11	14	21	177
Scenario 12	150	500	n/a	Maximized	21	25	31	28	11	4	2	6	13	16	24	207
Scenario 13	200	500	n/a	Maximized	21	25	31	27	11	4	2	6	12	15	23	201
Scenario 14	250	500	n/a	Maximized	20	25	31	27	11	4	2	6	11	14	22	196
Scenario 15	300	500	n/a	Maximized	20	24	31	27	11	3	2	5	10	14	21	191
Scenario 16	150	500	300	Maximized	21	25	31	27	11	4	2	6	12	14	22	198
Scenario 17	200	500	300	Maximized	20	24	31	27	11	4	2	6	11	14	22	196
Scenario 18	250	500	300	Maximized	20	24	31	27	11	3	2	6	11	14	21	193
Scenario 19	300	500	300	Maximized	20	24	31	27	11	3	2	5	10	14	21	191

Scenario	Guelph Dam			Arkell	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	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
Scenario 2	150	500	n/a	Existing	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 3	200	500	n/a	Existing	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
Scenario 5	300	500	n/a	Existing	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
Scenario 7	150	500	n/a	Abandon	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 8	200	500	n/a	Abandon	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
Scenario 10	300	500	n/a	Abandon	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
Scenario 12	150	500	n/a	Maximized	0	0	0	0	0	0	0	0	0	0	0	0
Scenario 13	200	500	n/a	Maximized	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
Scenario 15	300	500	n/a	Maximized	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
Scenario 17	200	500	300	Maximized	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
Scenario 19	300	500	300	Maximized	0	0	0	0	0	0	0	0	0	0	0	0

Scenario	Guelph Dam			Arkell	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	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	54%	64%	88%	63%	23%	7%	5%	16%	32%	41%	60%	42%
Scenario 2	150	500	n/a	Existing	65%	71%	91%	78%	33%	10%	7%	19%	37%	46%	69%	50%
Scenario 3	200	500	n/a	Existing	64%	71%	91%	77%	32%	10%	6%	17%	35%	43%	65%	48%
Scenario 4	250	500	n/a	Existing	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Scenario 5	300	500	n/a	Existing	62%	68%	91%	76%	31%	9%	5%	15%	29%	40%	60%	46%
Scenario 6	150	1000	n/a	Abandon	54%	64%	88%	63%	23%	7%	5%	17%	32%	41%	60%	43%
Scenario 7	150	500	n/a	Abandon	65%	71%	91%	78%	33%	10%	7%	19%	38%	47%	69%	50%
Scenario 8	200	500	n/a	Abandon	64%	71%	91%	77%	32%	10%	6%	17%	35%	44%	66%	48%
Scenario 9	250	500	n/a	Abandon	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Scenario 10	300	500	n/a	Abandon	62%	68%	91%	76%	31%	9%	5%	16%	29%	40%	60%	46%
Scenario 11	150	1000	n/a	Maximized	54%	64%	88%	63%	23%	7%	5%	16%	31%	40%	59%	42%
Scenario 12	150	500	n/a	Maximized	65%	71%	91%	78%	33%	10%	7%	19%	37%	45%	68%	49%
Scenario 13	200	500	n/a	Maximized	64%	70%	91%	77%	32%	10%	6%	17%	34%	43%	65%	48%
Scenario 14	250	500	n/a	Maximized	63%	69%	91%	77%	31%	10%	6%	16%	31%	40%	62%	47%
Scenario 15	300	500	n/a	Maximized	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%
Scenario 16	150	500	300	Maximized	63%	69%	91%	77%	31%	10%	6%	17%	33%	41%	63%	47%
Scenario 17	200	500	300	Maximized	63%	69%	91%	77%	31%	10%	6%	17%	32%	40%	62%	47%
Scenario 18	250	500	300	Maximized	62%	68%	91%	76%	31%	10%	6%	16%	30%	40%	60%	46%
Scenario 19	300	500	300	Maximized	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%

Scenario	Guelph Dam			Arkell	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	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Scenario 1	150	1000	n/a	Existing	77%	92%	97%	94%	60%	24%	15%	26%	45%	61%	76%	100%
Scenario 2	150	500	n/a	Existing	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	76%	100%
Scenario 3	200	500	n/a	Existing	79%	94%	97%	94%	71%	29%	15%	24%	44%	61%	74%	98%
Scenario 4	250	500	n/a	Existing	77%	94%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%
Scenario 5	300	500	n/a	Existing	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	71%	98%
Scenario 6	150	1000	n/a	Abandon	77%	92%	97%	94%	60%	24%	15%	27%	45%	61%	77%	100%
Scenario 7	150	500	n/a	Abandon	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	77%	100%
Scenario 8	200	500	n/a	Abandon	79%	94%	97%	94%	71%	29%	15%	26%	44%	61%	74%	98%
Scenario 9	250	500	n/a	Abandon	77%	94%	97%	94%	69%	27%	15%	23%	40%	50%	73%	98%
Scenario 10	300	500	n/a	Abandon	76%	92%	97%	94%	68%	26%	11%	23%	40%	47%	71%	98%
Scenario 11	150	1000	n/a	Maximized	77%	92%	97%	92%	60%	24%	15%	27%	45%	61%	76%	98%
Scenario 12	150	500	n/a	Maximized	79%	94%	97%	95%	73%	31%	16%	27%	47%	61%	76%	100%
Scenario 13	200	500	n/a	Maximized	79%	94%	97%	94%	71%	29%	15%	24%	42%	55%	74%	98%
Scenario 14	250	500	n/a	Maximized	77%	92%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%
Scenario 15	300	500	n/a	Maximized	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%
Scenario 16	150	500	300	Maximized	77%	94%	97%	94%	69%	27%	16%	24%	40%	52%	73%	98%
Scenario 17	200	500	300	Maximized	77%	94%	97%	94%	69%	26%	15%	23%	40%	48%	73%	98%
Scenario 18	250	500	300	Maximized	76%	92%	97%	94%	68%	26%	13%	23%	40%	47%	71%	98%
Scenario 19	300	500	300	Maximized	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%

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 m3/s and 0.5 m3/s appears to be the most realistic taking option. Assuming Eramosa Arkell taking was maximized and that downstream low flow targets upstream of the Guelph sewage treatment plant were achieved 100% of the time. The results of the reservoir modeling are summarized in table 5.

Table 5 Reliability of a Step ASR Taking from Guelph Dam 1951 to 2012

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)	1,275	1,111	1,332	1,689	1,471	574	192	123	321	630	771	1,212	10,701
Total Days Period of Record	1,922	1,752	1,922	1,860	1,922	1,860	1,922	1,922	1,860	1,922	1,860	1,922	22,646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	17%	33%	41%	63%	47%
Reliability Based on Occurrance	77%	77%	94%	97%	94%	69%	27%	16%	24%	40%	52%	73%	98%
300 l/s per second or greater taking													
Total Number of Occurrances (days)	1,703	1,576	1,786	1,801	1,745	1,468	192	123	1,114	1,345	1,482	1,663	15,998
Total Days Period of Record	1,922	1,752	1,922	1,860	1,922	1,860	1,922	1,922	1,860	1,922	1,860	1,922	22,646
Reliability Based on Time	89%	90%	93%	97%	91%	79%	10%	6%	60%	70%	80%	87%	71%
Reliability Based on Occurrance	90%	92%	98%	98%	97%	89%	27%	16%	66%	77%	90%	89%	100%
150 l/s per second or greater taking													
Total Number of Occurrances (days)	1,867	1,723	1,917	1,852	1,890	1,841	1,912	1,884	1,837	1,894	1,801	1,860	22,278
Total Days Period of Record	1,922	1,752	1,922	1,860	1,922	1,860	1,922	1,922	1,860	1,922	1,860	1,922	22,646
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	98%	99%	99%	97%	97%	98%
Reliability Based on Occurrance	98%	98%	100%	100%	98%	100%	100%	100%	100%	100%	100%	98%	100%

The above table illustrates 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.

Tables 2 through 4 reflect the taking reliability for individual years and months. The taking scenario is also presented by posters 1 and 2 attached which illustrate the municipal takings and lake elevations for each year of the simulation from 1951 to 2004.

The results indicated there is a potential for a stepped taking.

Table 6 Reliability of 500 l/s ASR Taking From Guelph Dam 1951 to 2004

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
Max	31	29	31	30	31	30	28	30	30	31	30	31	311
Average	24	21	25	31	27	11	4	2	6	12	14	22	198
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Number of Occurrances (days)	1275	1111	1332	1689	1471	574	192	123	321	630	771	1212	10701
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	17%	33%	41%	63%	47%
Reliability Based on Occurrance	77%	77%	94%	97%	94%	69%	27%	16%	24%	40%	52%	73%	98%

Table 7 Reliability of 300 l/s ASR Taking From Guelph Dam 1951 to 2004

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**350**
Average	**32**	**29**	**33**	**33**	**32**	**27**	**4**	**2**	**21**	**25**	**27**	**31**	**296**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1703	1576	1786	1801	1745	1468	192	123	1114	1345	1482	1663	15998
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	89%	90%	93%	97%	91%	79%	10%	6%	60%	70%	80%	87%	71%
Reliability Based on Occurrance	90%	92%	98%	98%	97%	89%	27%	16%	66%	77%	90%	89%	100%

Table 8 Reliability of 150 l/s ASR Taking From Guelph Dam 1951 to 2004

Scenario 16 Number of Days Taking Exceeds Base Taking													
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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**366**
Average	**30**	**28**	**31**	**30**	**30**	**30**	**31**	**30**	**30**	**31**	**29**	**30**	**359**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1867	1723	1917	1852	1890	1841	1912	1884	1837	1894	1801	1860	22278
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	98%	99%	99%	97%	97%	98%
Reliability Based on Occurrance	98%	98%	100%	100%	98%	100%	100%	100%	100%	100%	100%	98%	100%

Flow Reliability of the Existing Permit to Take Water

Figure 2 illustrates the flow reliability of the existing permit to take water at the Arkell site. The permitted taking associated with this permit to take water 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 2012. This chart illustrates the probability on any given day of the flow exceeding the indicated value.

Figure 2 Flow Reliability – Existing Permit to Take Water

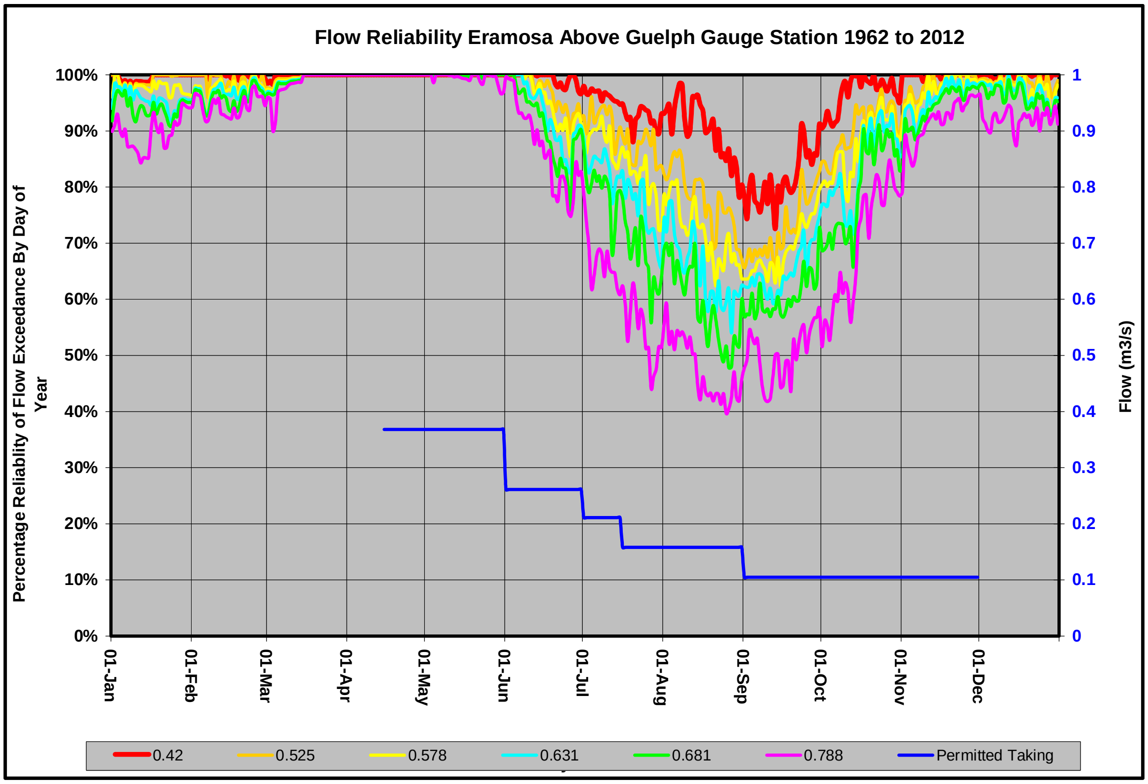


Table 9 Arkell Surface Water Permit to Take Water Conditions

Time Frame of Permitted Taking	Permitted Daily Volume M^3	Daily Volume Expressed as rate (m^3/s)	Eramosa River Flow Condition (m^3/s)	Edinburgh Road Flow Condition (m^3/s)	Required Flow In the River to Support Given Taking (m3/s)
April 15 to May 31	1540	0.368	> 0.42	> 0.85	0.788
June 1 to June 30	1100	0.261	> 0.42	> 0.85	0.681
July 1 to July 15	880	0.211	> 0.42	> 0.85	0.631
July 16 to Aug. 31	660	0.158	> 0.42	> 0.85	0.578
Sept. 1 to Nov. 31	440	0.105	> 0.42	> 0.85	0.525

Currently the City is limited by infrastructure to a taking of 100 l/s. The reliabilities in the attached chart have not been adjusted for historical takings by the City. These are solely based on observed river flow downstream of the City of Guelph taking at the Eramosa above Guelph gauge. A further refinement would be to analyze the naturalized daily flow time series and simulate the taking in the Permit to Take Water described in Table 9

Tables 10 to 16 summarize the number of days in a given month and year the river flow exceeds the required flow to support the given taking. These communicate the reliability of the existing permitted taking at Arkell.

The combination of information in figure 2 and tables 10 thru 16 offer a basis for assessing the reliability of the source bound by the existing permit to take water conditions.

Results in table 10 indicate there is 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.

Table 10 Summary of Eramosa River at Watson Road Flow Statistic Related to City of Arkell Permit to Take Water

Eramosa at Watson Road Flow Availablilty Statistics Based on Naturalized Daily Flows													
Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	April to Novembt
Eramosa River at Watson Flow Statiscs for Flows Equalling or Exceeding 0.42 m^3/s													
Total Number of Occurrances (days)	1,569	1,433	1,578	1,530	1,581	1,524	1,507	1,472	1,334	1,538	1,525	1,568	12,011
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	99%	99%	100%	100%	100%	100%	95%	93%	87%	97%	100%	99%	97%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%	100%	100%
Eramosa River at Watson Flow Statiscs for Flows Equalling or Exceeding 0.525 m^3/s													
Total Number of Occurrances (days)	1,563	1,428	1,566	1,530	1,581	1,487	1,442	1,303	1,150	1,450	1,505	1,552	11,448
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	99%	99%	99%	100%	100%	97%	91%	82%	75%	92%	98%	98%	92%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	94%	100%	100%	100%	100%
Eramosa River at Watson Flow Statiscs for Flows Equalling or Exceeding 0.578 m^3/s													
Total Number of Occurrances (days)	1,540	1,413	1,564	1,530	1,580	1,470	1,392	1,216	1,100	1,403	1,486	1,535	11,177
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	97%	98%	99%	100%	100%	96%	88%	77%	72%	89%	97%	97%	90%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	94%	100%	100%	100%	100%
Eramosa River at Watson Flow Statiscs for Flows Equalling or Exceeding 0.631 m^3/s													
Total Number of Occurrances (days)	1,507	1,386	1,563	1,530	1,579	1,455	1,330	1,133	1,046	1,346	1,458	1,520	10,877
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	95%	96%	99%	100%	100%	95%	84%	72%	68%	85%	95%	96%	87%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	96%	96%	90%	100%	100%	100%	100%
Eramosa River at Watson Flow Statiscs for Flows Equalling or Exceeding 0.681 m^3/s													
Total Number of Occurrances (days)	1,481	1,373	1,563	1,530	1,577	1,434	1,254	1,033	987	1,297	1,435	1,508	10,547
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	94%	95%	99%	100%	100%	94%	79%	65%	65%	82%	94%	95%	85%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	96%	96%	90%	100%	100%	100%	100%
Eramosa River at Watson Flow Statiscs for Flows Equalling or Exceeding 0.788 m^3/s													
Total Number of Occurrances (days)	1,407	1,350	1,552	1,530	1,564	1,366	1,058	847	828	1,150	1,394	1,452	9,737
Total Days Period of Record	1,581	1,441	1,581	1,530	1,581	1,530	1,581	1,581	1,530	1,581	1,530	1,581	12,444
Reliability Based on Time	89%	94%	98%	100%	99%	89%	67%	54%	54%	73%	91%	92%	78%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	96%	92%	86%	98%	100%	100%	100%

Table 11 Day Flows Exceed 0.42 m^3/s

Eramosa Above Guelph Days Flow Exceeds 0.42 (m3/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	25	31	30	31	30	31	238
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	17	6	31	30	31	206
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	17	10	30	30	31	209
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		12	20	31	30	31	184
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	15	7	6	19	25	18	182
Total Number of Occurrances (days)	1569	1433	1578	1530	1581	1524	1507	1472	1334	1538	1525	1568	12011
Total Days Period of Record	1581	1441	1581	1530	1581	1530	1581	1581	1530	1581	1530	1581	12444
Reliability Based on Time	99%	99%	100%	100%	100%	100%	95%	93%	87%	97%	100%	99%	97%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	100%	100%	100%	100%	100%

Table 12 Day Flows Exceed 0.525 m^3/s

Eramosa Above Guelph Days Flow Exceeds 0.525 (m3/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		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		21	30	31	174
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		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		7	7	19	30	31	149
Max	31	28	31	30	31	30	31	31	30	31	30	31	244
Average	31	28	31	30	31	29	29	26	24	28	30	30	224
Min	18	17	19	30	31	17	12	3	3	8	14	12	149
Total Number of Occurrances (days)	1563	1428	1566	1530	1581	1487	1442	1303	1150	1450	1505	1552	11448
Total Days Period of Record	1581	1441	1581	1530	1581	1530	1581	1581	1530	1581	1530	1581	12444
Reliability Based on Time	99%	99%	99%	100%	100%	97%	91%	82%	75%	92%	98%	98%	92%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	94%	100%	100%	100%	100%

Table 13 Day Flows Exceed 0.578 m^3/s

Eramosa Above Guelph Days Flow Exceeds 0.578 (m3/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	28	31	30	31	30	31	226
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		14	30	31	182
1970	31	28	31	30	31	30	31	24	30	31	30	31	237
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	25	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	30	28	31	30	31	30	31	29	27	31	30	31	239
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	21	8		9	23	30	152
1999	18	28	31	30	31	19	11	1	7	25	29	27	153
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	24	28	30	31	235
2005	31	28	31	30	31	30	29	14	27	31	30	31	222
2006	31	28	31	30	31	30	31	25	28	31	30	31	236
2007	31	28	31	30	31	30	29	17		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		6	4	18	30	31	139
Max	31	28	31	30	31	30	31	31	30	31	30	31	244
Average	30	28	31	30	31	29	28	24	23	28	29	30	219
Min	18	12	17	30	30	15	6	1	2	6	10	9	139
Total Number of Occurrances (days)	1540	1413	1564	1530	1580	1470	1392	1216	1100	1403	1486	1535	11177
Total Days Period of Record	1581	1441	1581	1530	1581	1530	1581	1581	1530	1581	1530	1581	12444
Reliability Based on Time	97%	98%	99%	100%	100%	96%	88%	77%	72%	89%	97%	97%	90%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	98%	100%	94%	100%	100%	100%	100%

Table 14 Day Flows Exceed 0.631 m^3/s

Eramosa Above Guelph Days Flow Exceeds 0.631 (m3/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		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		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	29	24	30	30	31	235
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	12	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	29	30	31	30	31	242
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		21	29	11	165
1990	28	28	31	30	31	30	31	28	18	31	30	31	229
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		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		3	14	25	133
1999	18	28	31	30	31	16	11		5	21	29	26	143
2000	30	10	31	30	31	30	31	31	30	30	29	31	242
2001	31	28	31	30	31	30	25		9	26	30	31	181
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	18	10		5	17	31	140
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		6	3	18	30	31	137
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	30	27	31	30	31	29	27	23	23	26	29	30	213
Min	12	10	17	30	30	13	6	3	2	3	9	9	127
Total Number of Occurrances (days)	1507	1386	1563	1530	1579	1455	1330	1133	1046	1346	1458	1520	10877
Total Days Period of Record	1581	1441	1581	1530	1581	1530	1581	1581	1530	1581	1530	1581	12444
Reliability Based on Time	95%	96%	99%	100%	100%	95%	84%	72%	68%	85%	95%	96%	87%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	96%	96%	90%	100%	100%	100%	100%

Table 15 Day Flows Exceed 0.681 m^3/s

Eramosa Above Guelph Days Flow Exceeds 0.681 (m3/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		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		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	21	19	31	30	31	221
1988	31	29	31	30	31	17	10	9	16	30	30	31	173
1989	31	28	31	30	31	30	12	6		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	28	24		25	30	31	197
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		2	8	23	120
1999	17	28	31	30	29	14	9		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		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	3		2	13	31	119
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		5	2	18	30	31	133
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	29	27	31	30	31	28	26	21	21	25	28	30	207
Min	9	6	17	30	29	9	5	2	1	2	7	7	119
Total Number of Occurrances (days)	1481	1373	1563	1530	1577	1434	1254	1033	987	1297	1435	1508	10547
Total Days Period of Record	1581	1441	1581	1530	1581	1530	1581	1581	1530	1581	1530	1581	12444
Reliability Based on Time	94%	95%	99%	100%	100%	94%	79%	65%	65%	82%	94%	95%	85%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	96%	96%	90%	100%	100%	100%	100%

Table 16 Day Flows Exceed 0.788 m^3/s

Eramosa Above Guelph Days Flow Exceeds 0.788 (m3/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		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				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		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	30	31	30	31	227
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	25	31	30	31	30	31	238
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	7	2		11	27	4	138
1990	20	28	31	30	31	29	23	17	6	31	30	31	197
1991	31	28	31	30	31	27	21	20	4	26	19	31	178
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		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	26	193
1998	28	28	31	30	31	26	12	6		2	4	10	111
1999	16	28	31	30	23	10	7		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		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			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		4		17	30	31	121
Max	31	29	31	30	31	30	31	31	30	31	30	31	244
Average	28	26	30	30	31	27	22	18	19	23	27	28	191
Min	4	5	17	30	23	7	4	1	1	1	4	3	104
Total Number of Occurrances (days)	1407	1350	1552	1530	1564	1366	1058	847	828	1150	1394	1452	9737
Total Days Period of Record	1581	1441	1581	1530	1581	1530	1581	1581	1530	1581	1530	1581	12444
Reliability Based on Time	89%	94%	98%	100%	99%	89%	67%	54%	54%	73%	91%	92%	78%
Reliability Based on Occurrance	100%	100%	100%	100%	100%	100%	96%	92%	86%	98%	100%	100%	100%

Potential Arkell ASR Taking

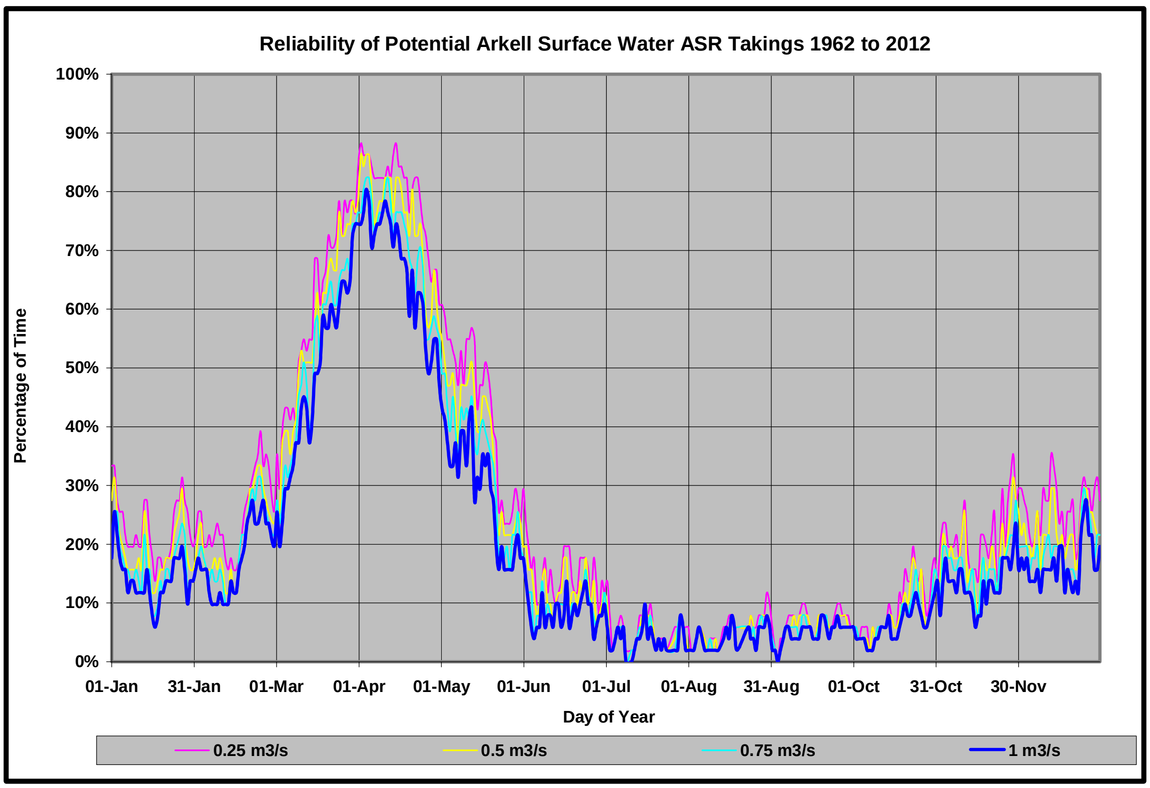
A potential ASR Taking was examined at Arkell using the following assumptions.

The ASR taking would be confined to periods when stream flow exceeded the mean annual flow of 2.48 m3/s. The ASR taking would be restricted to the following

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

The reliability of the above ASR taking is summarized by figure 3 and illustrated by the poster which presents the potential base municipal and ASR taking using the above assumption

Figure 3 Potential ASR Taking Reliability Statistics
Increased Taking Beyond Existing Arkell Permit to Take Water



Other than the spring period, there is limited potential for an increased ASR taking beyond the existing Arkell permit to take water.

Environmental Flow Considerations

Potential impacts to the flow regime were analyzed in two reaches. These included the Eramosa River reach immediately downstream of the Arkell taking and the reach downstream of the Guelph sewage treatment plant between Road 32 and Niska Road.

At this scoping level the Indicators of Hydrologic Alteration (IHA) and Range of Variability Approach (RVA) were applied to diagnoses impacts to the flow regime and potentially environmental habitat. The IHA and RVA have been developed by the US Nature Conservancy; these approaches examine 33 parameters to diagnose potential environmental impacts. More information regarding these methods can be found on the nature conservancy website at http://www.freshwaters.org.

The IHA and RVA methods are diagnostic tools that allow the user to determine specific aspects of flow regime being altered. This information can be used to consider implications to environmental flow requirements. The parameters considered by the IHA software are summarized in Table 17. These parameters were analyzed for each reach.

Below Guelph Reach IHA-RVA-Geomorphic Analysis

Simulated flow data for the Speed River below Guelph site was analyzed using the IHA and RVA software to scope the impacts for the reach downstream of the Guelph sewage treatment plant. The gauge station is located at Edinburgh Road upstream of the STP discharge point; therefore the Guelph STP discharge and flows from the Northwest storm drain and Hanlon Creek would also contribute to the reach downstream of the STP.

The base case conditions (existing condition) were modeled as 1950 to 2003 water year. The ASR taking conditions is simulated as 2010 to 2067 water year. Both are simulated conditions. The ASR taking condition assumes the stepped taking condition from Guelph dam and a base taking of 150 l/s. It also assumes the Eramosa taking is maximized. Analyzing the Below Guelph Reach simulated the impacts of both takings.

Selected results from the IHA model are presented by Figures 4 thru 7. Figure 4 presented the daily flow series analyzed as described in the above. Figure 6 presents the monthly alteration. Results in figure 4 indicate the impacts of the proposed taking are well within the range of monthly variability. The greatest monthly impacts are expected in the late fall, winter and spring months.

Figure 6 presents a summary of the greatest variation in the various IHA parameters. Results in this plot indicate the greatest alteration to the flow regime occurs in the lower RVA category, lower third of the flow regime to the following parameters:

Table 17 Summary of parameters used in the IHA software

IHA Statistics Group	Hydrologic Parameters	Ecosystem Influences
Group 1 Parameters		
Magnitude of monthly water conditions	Mean value for each calendar month	• Habitat availability for aquatic organisms • Soil moisture availability for plants • Availability of water for terrestrial animals • Availability of food/cover for fur-bearing mammals • Reliability of water supplies for terrestrial animals • Access by predators to nesting sites • Influences water temperature, oxygen levels, photosynthesis in water column
Group 2 Parameters		
Magnitude and duration of annual extreme water conditions	Annual 1-day minima	• Balance of competitive, ruderal, and stress- tolerant organisms
	Annual minima, 3-day means	• Creation of sites for plant colonization
	Annual minima, 7-day means	• Structuring of aquatic ecosystems by abiotic vs. biotic factors
	Annual minima, 30-day means	• Structuring of river channel morphology and physical habitat conditions
	Annual minima, 90-day means	• Soil moisture stress in plants
	Annual 1-day maxima	• Dehydration in animals
	Annual maxima, 3-day means	• Anaerobic stress in plants
	Annual maxima, 7-day means	• Volume of nutrient exchanges between rivers and floodplains
	Annual maxima, 30-day means	• Duration of stressful conditions such as low oxygen and concentrated chemicals in aquatic environments
	Annual maxima, 90-day means	• Distribution of plant communities in lakes, ponds, floodplains
	Number of zero-flow days (zero flow)	• Duration of high flows for waste disposal, aeration of spawning beds in channel sediments
	7-day minimum flow/mean for year (base flow)	

IHA Statistics Group	Hydrologic Parameters	Ecosystem Influences
Group 3 Parameters		
Timing of annual extreme water conditions	Julian date of each annual 1-day maximum	• Compatibility with life cycles of organisms • Predictability/avoidability of stress for organisms
	Julian date of each annual 1-day minimum	• Access to special habitats during reproduction or to avoid predation • Spawning cues for migratory fish • Evolution of life history strategies, behavioral mechanisms
Group 4 Parameters		
Frequency and duration of high and low pulses	Number of low pulses within each year	• Frequency and magnitude of soil moisture stress for plants • Frequency and duration of anaerobic stress for plants
	Mean duration of low pulses within each year	• Availability of floodplain habitats for aquatic organisms • Nutrient and organic matter exchanges between river and floodplain
	Number of high pulses within each year	• Soil mineral availability • Access for waterbirds to feeding, resting, reproduction sites
	Mean duration of high pulses within each year	• Influences bedload transport, channel sediment textures, and duration of substrate disturbance (high pulses)
Group 5 Parameters		
Rate and frequency of water condition changes	Means of all positive differences between consecutive daily values	• Drought stress on plants (falling levels)
	Means of all positive differences between consecutive daily values	• Entrapment of organisms on islands, floodplains (rising levels)
	Number of hydrological reversals	• Desiccation stress on low-mobility streamedge (varial zone) organisms

Figure 4 Simulated Base Case (Existing Condition) and ASR Taking Daily Flow Series

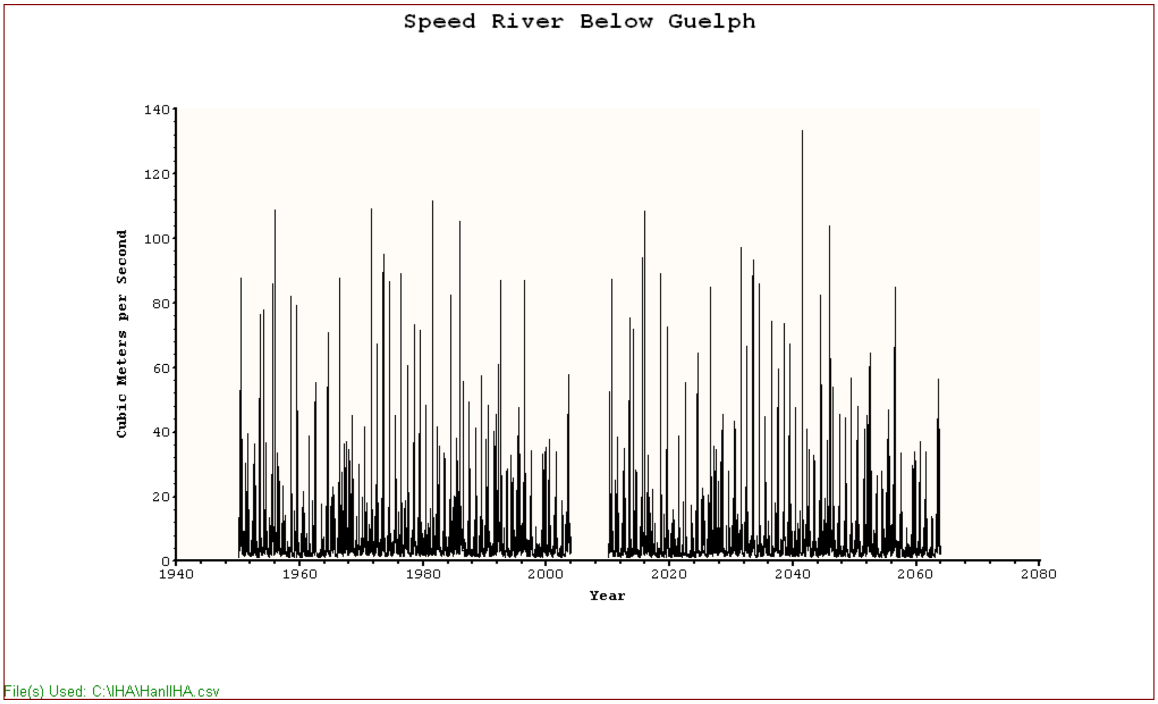


Figure 5 IHA Monthly Flow Alteration Plot

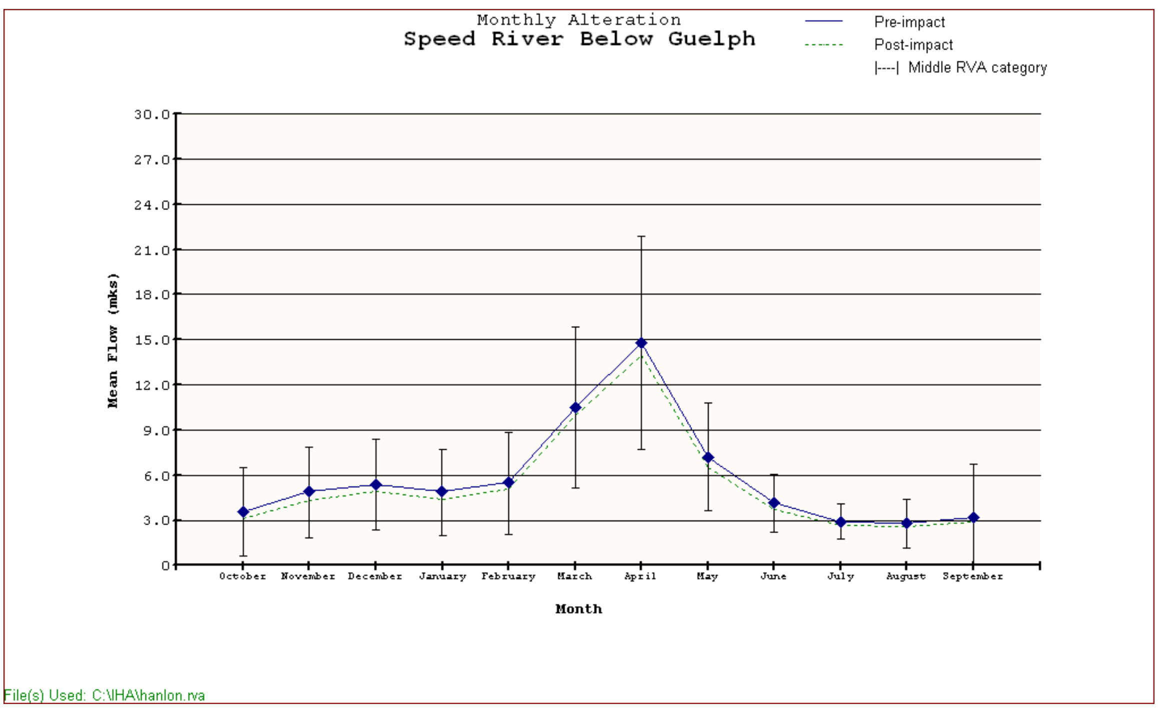


Figure 6 IHA Greatest Alterations

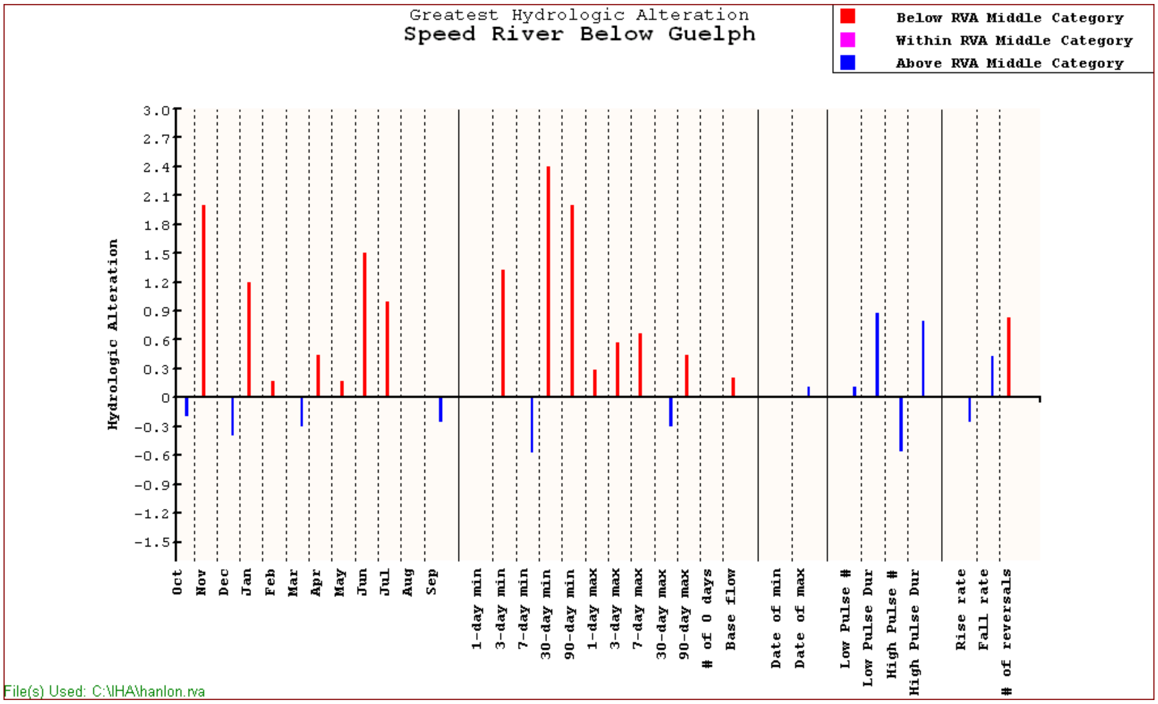
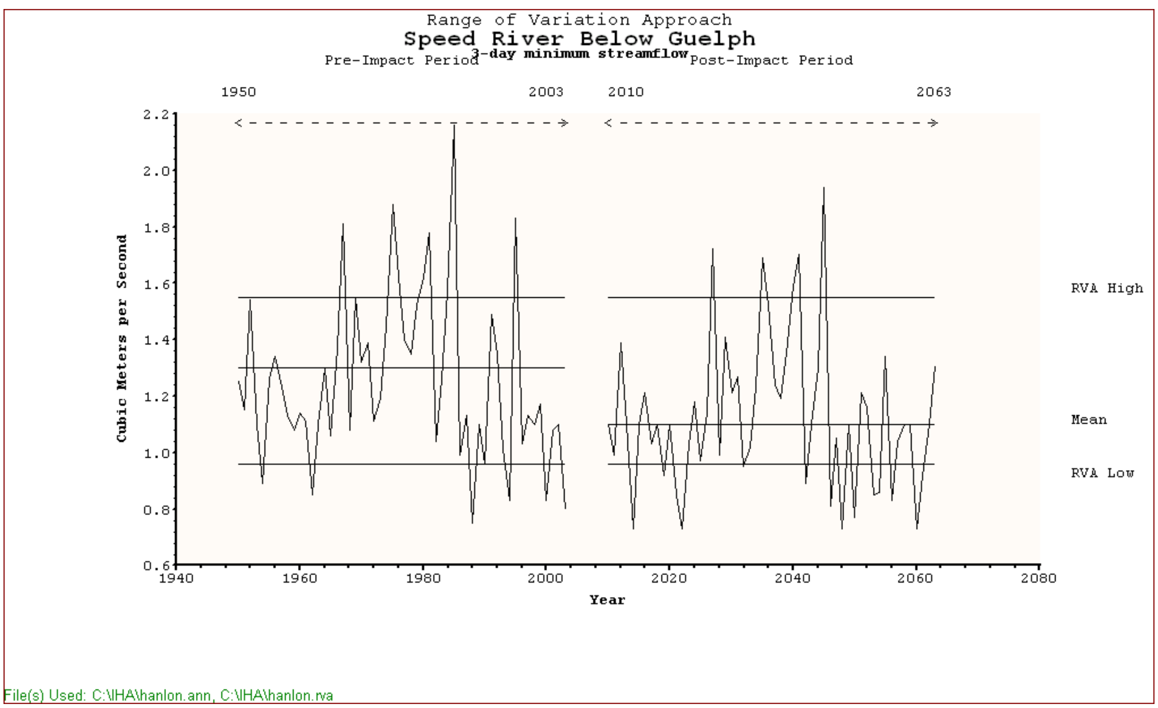


Figure 7 IHA 3-Day Minimum Comparison



November, January, June, July Monthly Flows and 3-Day Minimums, 30-Day Minimum, 90-Day Minimum flows.

The results point to couple of implications of the proposed ASR taking from Guelph Dam. The impacts to the 3-Day, 30-Day and 90-Day minimum flows primarily result from the late fall and winter takings. The reservoir yield model is operating to the minimum downstream low flow target of 1.1 m^3/s and excess water is being drawn out of the reservoir to support the ASR taking. This results in lower minimum flows during the late fall and winter months. The summer low flows are generally not affected.

The above explanation also applies to the November and January monthly flows. The changes in the June and July monthly flows primarily result from the ASR taking excess water from Guelph Dam that would have discharge through the high flow slots later into the season.

The takings are in the normal range of variability. At this scoping level, the results are suggesting there should not be a significant impact to environmental flow requirements. Impacts would have to be investigated in more detail if the ASR option is pursued.

Parish Geomorphic was contracted to determine the geomorphic thresholds for the reach downstream of the Guelph STP. The geomorphic thresholds are used to infer the sediment transport flow thresholds that flush the river reach, flush the riffles and inundate the floodplain. The Parish investigated yielded the following results;

Bedrock Reach (PARISH Transects 2-9):

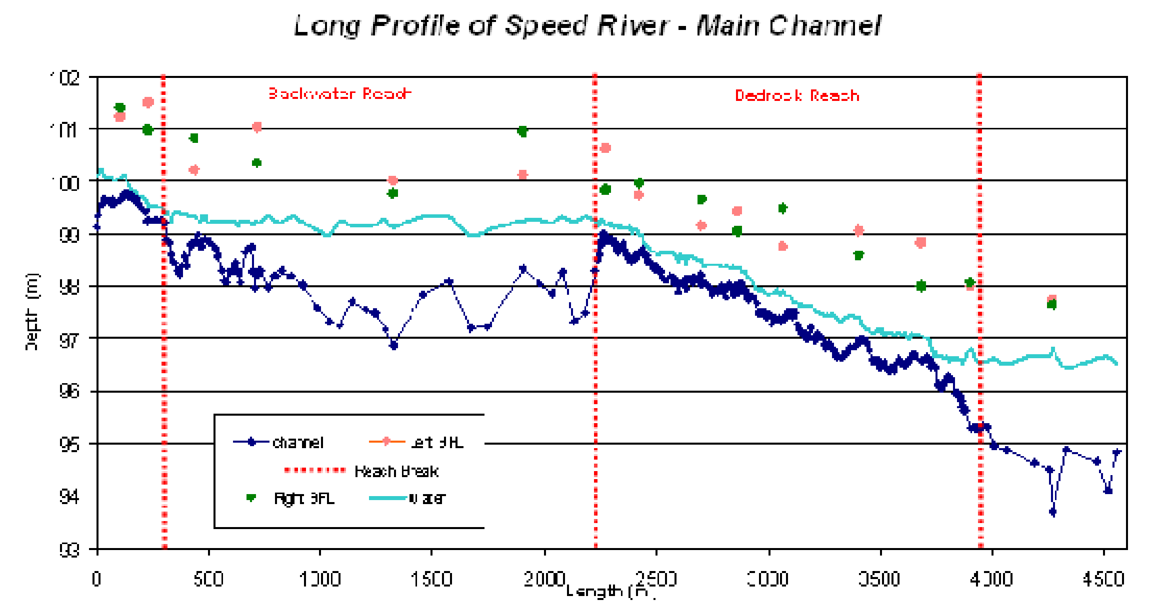
Residual Pool Threshold (low flow): Critical depth = 0.12 m; Velocity = 0.30 m/s; Discharge = **0.57 m3/s**
D50 Mobilizing Threshold: Critical depth = 0.73 m; Velocity = 0.65 m/s; Discharge = **25.6 m3/s**
Bankfull Conditions: Ave depth = 0.94 m; Velocity = 0.97 m/s; Discharge = **63.9 m3/s**
Hiding Threshold (flushing flow): Critical depth = 1.06 m; Velocity = 1.39 m/s; Discharge = **56.0 m3/s**

Backwater Reach (PARISH Transects 10-13):

Residual Pool Threshold (low flow): Critical depth = 0.10 m; Velocity = 0.21 m/s; Discharge = **0.34 m3/s**
D50 Mobilizing Threshold: Critical depth = 0.27 m; Velocity = 0.33 m/s; Discharge = **2.23 m3/s**
Bankfull Conditions: Ave depth = 1.13 m; Velocity = 0.82 m/s; Discharge = **37.6 m3/s**
Hiding Threshold (flushing flow): Critical depth = 1.0 m; Velocity = 1.43 m/s; Discharge = **63.9 m3/s**

The Parish investigation indicates a couple of significant points. First the reach downstream of the Guelph STP is composed of a backwater and a (bedrock) riffle reach. The riffle reach would be more sensitive to changes in lowflows and is likely acting as a recovery reach that helps the river recover from impacts associated with the Guelph STP effluent. The thresholds estimated by Parish indicate the bedrock reach flow thresholds are well above the lowflow range because it is a bedrock controlled reach. Therefore the implications of the proposed ASR and Arkell takings should have little impact to this reach from a sediment transport perspective.

The backwater reach contains finer material that moves or flushes at much lower flows. The combination of the summer low flow target and the Guelph STP discharge along with other discharges to the lower Speed reach would maintain the flow in the river above the D50 flushing threshold of 2.23 m^3/s estimated by Parish. During the winter months the low flow target is 1.1 m^3/s therefore there may be occasions when the D50 threshold would not be achieved. Analysis of the base case indicates the D50 threshold would not be achieved 4.6% of the time and under the ASR condition it may not be met 6.9% of the time. This is not likely to be significant, slight adjustments to the taking scenario or operating strategy of Guelph Dam could likely address this impact.



In summary from a scoping perspective implications to environmental flow requirements should not discount further consideration of these alternatives. More detailed analysis of the environmental impacts should be included in the next stage of assessment.

Poster 3 attached presents the results of the IHA analysis.

Maximizing Eramosa Arkell Taking

The Eramosa Arkell taking was analyzed as part of the instream flow study completed by GRCA for the Ministry of the Environment through Conservation Ontario. Results of the analysis completed suggest maximizing the taking would fall within the range of natural variability however it would be close to the maximum range of natural variability. Again at this scoping level this alternative should be carried forward and the potential impact investigated in more detail at the next stage. Details of the analysis of the Arkell surface water taking may be found in the report prepared for the Ministry of the Environment.

Appendix A – Base Municipal Taking Reliability Summaries for Various Scenarios

Scenario #1

Municipal Taking of:	0.15 m3/s
ASR Taking of:	1.0 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0 m3/s

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
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	38	63	251
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	100%	100%	100%	98%	100%	100%	99%	99%	100%	98%	97%	99%
Reliability Based on Occurrance	97%	98%	100%	98%	97%	98%	98%	97%	97%	98%	97%	95%	89%

Scenario #2

Municipal Taking of:	0.15 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0 m3/s

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
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	36	61	219
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	100%	100%	100%	98%	100%	100%	99%	100%	100%	98%	97%	99%
Reliability Based on Occurrance	97%	100%	100%	98%	98%	98%	98%	97%	98%	98%	97%	95%	89%

Scenario #3

Municipal Taking of:	0.2 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**25**	**2**	**5**	**31**	**23**	**10**	**21**	**13**	**17**	**29**	**31**	**96**
Total Number of Occurrances (days)	56	29	2	6	32	23	16	40	33	24	78	71	410
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	98%	98%	99%	96%	96%	98%
Reliability Based on Occurrance	97%	97%	98%	97%	97%	98%	97%	97%	95%	97%	95%	95%	87%

Scenario #4

Municipal Taking of:	0.25 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0 m3/s

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
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	54	76	52	88	75	568
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	97%	99%	99%	98%	98%	98%	97%	96%	97%	95%	96%	97%
Reliability Based on Occurrance	97%	97%	97%	97%	95%	97%	97%	95%	92%	95%	95%	95%	84%

Scenario #5

Municipal Taking of: 0.3 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0 m3/s

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
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	72	136	81	90	80	747
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	96%	99%	99%	98%	98%	98%	96%	93%	96%	95%	96%	97%
Reliability Based on Occurrance	95%	95%	97%	97%	95%	97%	95%	92%	90%	94%	95%	95%	82%

Scenario #6

Municipal Taking of: 0.15 m3/s
ASR Taking of: 1.0 m3/s
Arkell Taking: Arkrell Taking Abandon
Step 1 ASR Taking 0 m3/s

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
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	27	53	215
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	100%	100%	100%	98%	100%	100%	99%	100%	100%	99%	97%	99%
Reliability Based on Occurrance	97%	98%	100%	98%	97%	98%	98%	97%	98%	98%	98%	95%	89%

Scenario #7

Municipal Taking of:	0.15 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Taking Abandon
Step 1 ASR Taking	0 m3/s

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
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	24	45	183
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	100%	100%	100%	98%	100%	100%	99%	100%	100%	99%	98%	99%
Reliability Based on Occurrance	97%	100%	100%	98%	98%	98%	98%	97%	98%	100%	98%	95%	89%

Scenario #8

Municipal Taking of: 0.2 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Taking Abandon
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**25**	**2**	**5**	**31**	**18**	**10**	**21**	**11**	**13**	**29**	**31**	**80**
Total Number of Occurrances (days)	56	29	2	6	32	18	16	40	20	13	64	71	367
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	98%	99%	99%	97%	96%	98%
Reliability Based on Occurrance	97%	97%	98%	97%	97%	98%	97%	97%	95%	98%	95%	95%	87%

Scenario #9

Municipal Taking of: 0.25 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Taking Abandon
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**6**	**6**	**31**	**28**	**15**	**29**	**23**	**23**	**29**	**31**	**107**
Total Number of Occurrances (days)	56	48	10	10	33	32	29	50	51	37	87	76	519
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	97%	99%	99%	98%	98%	98%	97%	97%	98%	95%	96%	98%
Reliability Based on Occurance	97%	97%	97%	97%	95%	97%	97%	97%	94%	95%	95%	95%	84%

Scenario #10

Municipal Taking of:	0.3 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Maximized
Step 1 ASR Taking	0 m3/s

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
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	64	122	68	89	78	706
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	96%	99%	99%	98%	98%	98%	97%	93%	96%	95%	96%	97%
Reliability Based on Occurrance	95%	95%	97%	97%	95%	97%	95%	94%	90%	94%	95%	95%	82%

Scenario #11

Municipal Taking of: 0.15 m3/s
ASR Taking of: 1.0 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**4**	**3**	**31**	**9**	**8**	**26**	**15**	**23**	**28**	**31**	**71**
Total Number of Occurrances (days)	55	29	4	4	32	9	13	40	22	23	55	61	347
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	100%	99%	98%	99%	99%	97%	97%	98%
Reliability Based on Occurrance	97%	98%	98%	97%	97%	98%	97%	97%	97%	98%	95%	95%	89%

Scenario #12

Municipal Taking of: 0.15 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**4**	**3**	**31**	**9**	**5**	**24**	**12**	**18**	**28**	**31**	**67**
Total Number of Occurrances (days)	55	29	4	3	31	9	7	33	18	18	53	59	319
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	100%	100%	98%	99%	99%	97%	97%	99%
Reliability Based on Occurrance	97%	98%	98%	98%	98%	98%	97%	97%	97%	98%	97%	95%	89%

Scenario #13

Municipal Taking of:	0.2 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Maximized
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**5**	**5**	**31**	**23**	**12**	**28**	**24**	**31**	**30**	**31**	**96**
Total Number of Occurrances (days)	56	37	5	9	32	23	22	49	49	52	79	74	487
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	97%	97%	97%	96%	96%	98%
Reliability Based on Occurrance	97%	97%	98%	97%	97%	98%	97%	97%	94%	95%	95%	95%	85%

Scenario #14

Municipal Taking of: 0.25 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
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	64	119	80	89	85	675
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	97%	99%	99%	98%	98%	98%	97%	94%	96%	95%	96%	97%
Reliability Based on Occurrance	95%	97%	97%	97%	95%	97%	97%	94%	89%	94%	95%	95%	82%

Scenario #15

Municipal Taking of: 0.3 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
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	41	102	169	93	89	85	847
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	96%	96%	99%	99%	98%	98%	98%	95%	91%	95%	95%	96%	96%
Reliability Based on Occurrance	95%	95%	97%	97%	95%	97%	95%	90%	89%	90%	95%	95%	82%

Scenario #16 Municipal Taking of: 0.15 m3/s

ASR Taking of: 0.5 m3/s

Arkell Taking: Existing 0.1 m3/s

Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**5**	**5**	**31**	**19**	**8**	**25**	**16**	**26**	**29**	**31**	**79**
Total Number of Occurrances (days)	55	29	5	8	32	19	10	38	23	28	59	62	368
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	99%	99%	98%	99%	99%	97%	97%	98%
Reliability Based on Occurrance	97%	98%	98%	97%	97%	98%	97%	97%	97%	97%	95%	95%	89%

Scenario #17

Municipal Taking of: 0.15 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**5**	**5**	**31**	**28**	**12**	**28**	**26**	**31**	**30**	**31**	**102**
Total Number of Occurrances (days)	56	43	5	9	33	28	24	52	59	57	83	77	526
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	98%	100%	100%	98%	98%	99%	97%	97%	97%	96%	96%	98%
Reliability Based on Occurrance	97%	97%	98%	97%	95%	98%	97%	97%	92%	95%	95%	95%	84%

Scenario #18

Municipal Taking of:	0.15 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0.3 m3/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
Max	**31**	**29**	**11**	**7**	**31**	**29**	**18**	**31**	**30**	**31**	**30**	**31**	**121**
Total Number of Occurrances (days)	60	50	17	12	34	38	33	68	127	81	89	85	694
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	97%	97%	99%	99%	98%	98%	98%	96%	93%	96%	95%	96%	97%
Reliability Based on Occurrance	95%	97%	97%	97%	95%	97%	97%	92%	89%	94%	95%	95%	82%

Scenario #19

Municipal Taking of: 0.15 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0.3 m3/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
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	41	102	169	93	89	85	847
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	96%	96%	99%	99%	98%	98%	98%	95%	91%	95%	95%	96%	96%
Reliability Based on Occurrance	95%	95%	97%	97%	95%	97%	95%	90%	89%	90%	95%	95%	82%

Appendix B – Reliability of Available Taking Exceeding Base Municipal Taking

Scenario #1

Municipal Taking of:	0.15 m3/s
ASR Taking of:	1.0 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**286**
Average	**18**	**15**	**20**	**26**	**19**	**7**	**2**	**2**	**5**	**10**	**12**	**19**	**155**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1095	947	1237	1642	1207	426	129	103	306	607	760	1153	9612
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	57%	54%	64%	88%	63%	23%	7%	5%	16%	32%	41%	60%	42%
Reliability Based on Occurrance	81%	77%	92%	97%	94%	60%	24%	15%	26%	45%	61%	76%	100%

Scenario #2

Municipal Taking of:	0.15 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**311**
Average	**25**	**21**	**25**	**31**	**28**	**11**	**4**	**2**	**6**	**13**	**16**	**25**	**208**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1340	1145	1373	1698	1494	609	200	126	347	720	863	1327	11242
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	70%	65%	71%	91%	78%	33%	10%	7%	19%	37%	46%	69%	50%
Reliability Based on Occurrance	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	76%	100%

Scenario #3

Municipal Taking of: 0.2 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**12**	**15**	**23**	**202**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1302	1124	1357	1695	1484	598	195	118	321	671	808	1257	10930
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	68%	64%	71%	91%	77%	32%	10%	6%	17%	35%	43%	65%	48%
Reliability Based on Occurrance	81%	79%	94%	97%	94%	71%	29%	15%	24%	44%	61%	74%	98%

Scenario #4

Municipal Taking of: 0.25 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**310**
Average	**23**	**20**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**11**	**14**	**22**	**197**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1267	1106	1329	1689	1476	582	190	110	305	607	762	1208	10631
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Reliability Based on Occurrance	77%	77%	94%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%

Scenario #5

Municipal Taking of: 0.3 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**23**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**192**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1219	1088	1310	1684	1468	569	182	102	288	548	736	1149	10343
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	63%	62%	68%	91%	76%	31%	9%	5%	15%	29%	40%	60%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	71%	98%

Scenario #6

Municipal Taking of:	0.15 m3/s
ASR Taking of:	1.0 m3/s
Arkell Taking:	Arkrell Taking Abandon
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**286**
Average	**20**	**18**	**23**	**30**	**22**	**8**	**2**	**2**	**6**	**11**	**14**	**21**	**178**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1097	948	1238	1642	1207	426	129	103	310	610	765	1156	9631
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	57%	54%	64%	88%	63%	23%	7%	5%	17%	32%	41%	60%	43%
Reliability Based on Occurrance	81%	77%	92%	97%	94%	60%	24%	15%	27%	45%	61%	77%	100%

Scenario #7

Municipal Taking of: 0.15 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Taking Abandon
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**313**
Average	**25**	**21**	**25**	**31**	**28**	**11**	**4**	**2**	**7**	**13**	**16**	**25**	**209**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1347	1146	1374	1698	1494	609	200	126	357	724	872	1334	11281
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	70%	65%	71%	91%	78%	33%	10%	7%	19%	38%	47%	69%	50%
Reliability Based on Occurrance	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	77%	100%

Scenario #8

Municipal Taking of: 0.2 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Taking Abandon
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**13**	**15**	**23**	**203**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1306	1126	1358	1695	1484	598	195	118	323	676	818	1265	10962
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	68%	64%	71%	91%	77%	32%	10%	6%	17%	35%	44%	66%	48%
Reliability Based on Occurrance	81%	79%	94%	97%	94%	71%	29%	15%	26%	44%	61%	74%	98%

Scenario #9

Municipal Taking of:	0.25 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Taking Abandon
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**310**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**11**	**14**	**23**	**197**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1276	1107	1333	1689	1476	582	190	110	305	616	765	1215	10664
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Reliability Based on Occurrance	79%	77%	94%	97%	94%	69%	27%	15%	23%	40%	50%	73%	98%

Scenario #10

Municipal Taking of: 0.3 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**23**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**192**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1223	1090	1311	1684	1468	569	182	102	289	564	741	1156	10379
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	64%	62%	68%	91%	76%	31%	9%	5%	16%	29%	40%	60%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	23%	40%	47%	71%	98%

Scenario #11

Municipal Taking of: 0.15 m3/s

ASR Taking of: 1.0 m3/s

Arkell Taking: Arkrell Maximized

Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**286**
Average	**20**	**18**	**23**	**30**	**22**	**8**	**2**	**2**	**6**	**11**	**14**	**21**	**177**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1093	947	1236	1642	1205	426	129	103	305	598	743	1143	9570
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	57%	54%	64%	88%	63%	23%	7%	5%	16%	31%	40%	59%	42%
Reliability Based on Occurrance	81%	77%	92%	97%	92%	60%	24%	15%	27%	45%	61%	76%	98%

Scenario #12

Municipal Taking of:	0.15 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Maximized
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**311**
Average	**25**	**21**	**25**	**31**	**28**	**11**	**4**	**2**	**6**	**13**	**16**	**24**	**207**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1338	1144	1372	1698	1490	609	200	126	349	706	841	1313	11186
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	70%	65%	71%	91%	78%	33%	10%	7%	19%	37%	45%	68%	49%
Reliability Based on Occurrance	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	61%	76%	100%

Scenario #13

Municipal Taking of: 0.2 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**12**	**15**	**23**	**201**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1296	1124	1354	1695	1484	598	195	118	321	653	795	1247	10880
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	67%	64%	70%	91%	77%	32%	10%	6%	17%	34%	43%	65%	48%
Reliability Based on Occurrance	81%	79%	94%	97%	94%	71%	29%	15%	24%	42%	55%	74%	98%

Scenario #14

Municipal Taking of: 0.25 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**310**
Average	**23**	**20**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**11**	**14**	**22**	**196**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1263	1103	1326	1689	1476	582	190	110	304	602	750	1193	10588
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	16%	31%	40%	62%	47%
Reliability Based on Occurrance	77%	77%	92%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%

Scenario #15

Municipal Taking of: 0.3 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**22**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**191**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1207	1087	1310	1684	1468	569	182	102	288	547	729	1136	10309
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	63%	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%

Scenario #16 Municipal Taking of: 0.15 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**350**
Average	**32**	**29**	**33**	**33**	**32**	**27**	**4**	**2**	**21**	**25**	**27**	**31**	**296**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1703	1576	1786	1801	1745	1468	192	123	1114	1345	1482	1663	15998
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	89%	90%	93%	97%	91%	79%	10%	6%	60%	70%	80%	87%	71%
Reliability Based on Occurrance	90%	92%	98%	98%	97%	89%	27%	16%	66%	77%	90%	89%	100%

Scenario #17 Municipal Taking of: 0.2 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**349**
Average	**31**	**29**	**33**	**33**	**32**	**27**	**4**	**2**	**19**	**23**	**26**	**31**	**291**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**0**
Total Number of Occurrances (days)	1693	1562	1766	1800	1738	1462	189	116	1037	1245	1424	1656	15688
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	88%	89%	92%	97%	90%	79%	10%	6%	56%	65%	77%	86%	69%
Reliability Based on Occurrance	90%	92%	98%	98%	97%	89%	26%	15%	63%	73%	87%	89%	100%

Scenario #18 Municipal Taking of: 0.25 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**347**
Average	**31**	**29**	**33**	**33**	**32**	**27**	**3**	**2**	**18**	**21**	**25**	**30**	**284**
Min	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1674	1549	1757	1798	1722	1457	186	109	966	1143	1351	1624	15336
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	87%	88%	91%	97%	90%	78%	10%	6%	52%	59%	73%	84%	68%
Reliability Based on Occurrance	89%	92%	98%	98%	97%	87%	26%	13%	58%	65%	85%	89%	100%

Scenario #19 Municipal Taking of: 0.30 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**22**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**191**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1207	1087	1310	1684	1468	569	182	102	288	547	729	1136	10309
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	63%	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%

Appendix C – Reliability of Available Base Municipal and ASR Taking Equaling Assumed Maximum ASR Taking

Scenario #1

Municipal Taking of: 0.15 m3/s
ASR Taking of: 1.0 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**286**
Average	**20**	**18**	**23**	**30**	**22**	**8**	**2**	**2**	**6**	**11**	**14**	**21**	**178**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1095	947	1237	1642	1207	426	129	103	306	607	760	1153	9612
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	57%	54%	64%	88%	63%	23%	7%	5%	16%	32%	41%	60%	42%
Reliability Based on Occurrance	81%	77%	92%	97%	94%	60%	24%	15%	26%	45%	61%	76%	100%

Scenario #2

Municipal Taking of:	0.15 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Existing 0.1 m3/s
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**311**
Average	**25**	**21**	**25**	**31**	**28**	**11**	**4**	**2**	**6**	**13**	**16**	**25**	**208**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1340	1145	1373	1698	1494	609	200	126	347	720	863	1327	11242
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	70%	65%	71%	91%	78%	33%	10%	7%	19%	37%	46%	69%	50%
Reliability Based on Occurrance	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	76%	100%

Scenario #3

Municipal Taking of: 0.2 m3/s

ASR Taking of: 0.5 m3/s

Arkell Taking: Existing 0.1 m3/s

Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**12**	**15**	**23**	**202**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1302	1124	1357	1695	1484	598	195	118	321	671	808	1257	10930
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	68%	64%	71%	91%	77%	32%	10%	6%	17%	35%	43%	65%	48%
Reliability Based on Occurrance	81%	79%	94%	97%	94%	71%	29%	15%	24%	44%	61%	74%	98%

Scenario #4

Municipal Taking of: 0.25 m3/s

ASR Taking of: 0.5 m3/s

Arkell Taking: Existing 0.1 m3/s

Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**310**
Average	**23**	**20**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**11**	**14**	**22**	**197**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1267	1106	1329	1689	1476	582	190	110	305	607	762	1208	10631
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Reliability Based on Occurrance	77%	77%	94%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%

Scenario #5

Municipal Taking of: 0.3 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Existing 0.1 m3/s
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**23**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**192**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1219	1088	1310	1684	1468	569	182	102	288	548	736	1149	10343
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	63%	62%	68%	91%	76%	31%	9%	5%	15%	29%	40%	60%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	71%	98%

Scenario #6

Municipal Taking of: 0.15 m3/s
ASR Taking of: 1.0 m3/s
Arkell Taking: Arkrell Taking Abandon
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**286**
Average	**20**	**18**	**23**	**30**	**22**	**8**	**2**	**2**	**6**	**11**	**14**	**21**	**178**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1097	948	1238	1642	1207	426	129	103	310	610	765	1156	9631
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	57%	54%	64%	88%	63%	23%	7%	5%	17%	32%	41%	60%	43%
Reliability Based on Occurrance	81%	77%	92%	97%	94%	60%	24%	15%	27%	45%	61%	77%	100%

Scenario #7

Municipal Taking of:	0.15 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Taking Abandon
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**313**
Average	**25**	**21**	**25**	**31**	**28**	**11**	**4**	**2**	**7**	**13**	**16**	**25**	**209**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1347	1146	1374	1698	1494	609	200	126	357	724	872	1334	11281
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	70%	65%	71%	91%	78%	33%	10%	7%	19%	38%	47%	69%	50%
Reliability Based on Occurrance	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	63%	77%	100%

Scenario #8

Municipal Taking of: 0.2 m3/s

ASR Taking of: 0.5 m3/s

Arkell Taking: Arkrell Taking Abandon

Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**13**	**15**	**23**	**203**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1306	1126	1358	1695	1484	598	195	118	323	676	818	1265	10962
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	68%	64%	71%	91%	77%	32%	10%	6%	17%	35%	44%	66%	48%
Reliability Based on Occurrance	81%	79%	94%	97%	94%	71%	29%	15%	26%	44%	61%	74%	98%

Scenario #9

Municipal Taking of:	0.25 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Taking Abandon
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**310**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**11**	**14**	**23**	**197**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1276	1107	1333	1689	1476	582	190	110	305	616	765	1215	10664
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	16%	32%	41%	63%	47%
Reliability Based on Occurrance	79%	77%	94%	97%	94%	69%	27%	15%	23%	40%	50%	73%	98%

Scenario #10

Municipal Taking of:	0.3 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Maximized
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**23**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**192**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1223	1090	1311	1684	1468	569	182	102	289	564	741	1156	10379
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	64%	62%	68%	91%	76%	31%	9%	5%	16%	29%	40%	60%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	23%	40%	47%	71%	98%

Scenario #11

Municipal Taking of: 0.15 m3/s
ASR Taking of: 1.0 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**21**	**27**	**30**	**31**	**30**	**31**	**286**
Average	**20**	**18**	**23**	**30**	**22**	**8**	**2**	**2**	**6**	**11**	**14**	**21**	**177**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1093	947	1236	1642	1205	426	129	103	305	598	743	1143	9570
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	57%	54%	64%	88%	63%	23%	7%	5%	16%	31%	40%	59%	42%
Reliability Based on Occurrance	81%	77%	92%	97%	92%	60%	24%	15%	27%	45%	61%	76%	98%

Scenario #12

Municipal Taking of: 0.15 m3/s

ASR Taking of: 0.5 m3/s

Arkell Taking: Arkrell Maximized

Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**31**	**30**	**31**	**30**	**31**	**311**
Average	**25**	**21**	**25**	**31**	**28**	**11**	**4**	**2**	**6**	**13**	**16**	**24**	**207**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1338	1144	1372	1698	1490	609	200	126	349	706	841	1313	11186
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	70%	65%	71%	91%	78%	33%	10%	7%	19%	37%	45%	68%	49%
Reliability Based on Occurrance	82%	79%	94%	97%	95%	73%	31%	16%	27%	47%	61%	76%	100%

Scenario #13

Municipal Taking of:	0.2 m3/s
ASR Taking of:	0.5 m3/s
Arkell Taking:	Arkrell Maximized
Step 1 ASR Taking	0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**12**	**15**	**23**	**201**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1296	1124	1354	1695	1484	598	195	118	321	653	795	1247	10880
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	67%	64%	70%	91%	77%	32%	10%	6%	17%	34%	43%	65%	48%
Reliability Based on Occurrance	81%	79%	94%	97%	94%	71%	29%	15%	24%	42%	55%	74%	98%

Scenario #14

Municipal Taking of: 0.25 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**310**
Average	**23**	**20**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**11**	**14**	**22**	**196**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1263	1103	1326	1689	1476	582	190	110	304	602	750	1193	10588
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	16%	31%	40%	62%	47%
Reliability Based on Occurrance	77%	77%	92%	97%	94%	69%	27%	15%	23%	40%	48%	71%	98%

Scenario #15

Municipal Taking of: 0.3 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Arkrell Maximized
Step 1 ASR Taking 0 m3/s

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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**22**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**191**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1207	1087	1310	1684	1468	569	182	102	288	547	729	1136	10309
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	63%	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%

Scenario #16

Municipal Taking of: 0.15 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Maximized to Existing PTTW
Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**24**	**21**	**25**	**31**	**27**	**11**	**4**	**2**	**6**	**12**	**14**	**22**	**198**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1275	1111	1332	1689	1471	574	192	123	321	630	771	1212	10701
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	66%	63%	69%	91%	77%	31%	10%	6%	17%	33%	41%	63%	47%
Reliability Based on Occurrance	77%	77%	94%	97%	94%	69%	27%	16%	24%	40%	52%	73%	98%

Scenario #17

Municipal Taking of: 0.20 m3/s

ASR Taking of: 0.5 m3/s

Arkell Taking: Maximized to Existing PTTW

Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**30**	**30**	**31**	**30**	**31**	**311**
Average	**23**	**20**	**24**	**31**	**27**	**11**	**4**	**2**	**6**	**11**	**14**	**22**	**196**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1258	1100	1321	1686	1471	573	189	116	308	606	752	1186	10566
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	65%	63%	69%	91%	77%	31%	10%	6%	17%	32%	40%	62%	47%
Reliability Based on Occurrance	77%	77%	94%	97%	94%	69%	26%	15%	23%	40%	48%	73%	98%

Scenario #18

Municipal Taking of: 0.25 m3/s

ASR Taking of: 0.5 m3/s

Arkell Taking: Maximized to Existing PTTW

Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**310**
Average	**23**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**6**	**11**	**14**	**21**	**193**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1231	1092	1312	1685	1470	570	186	109	299	578	740	1160	10432
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	64%	62%	68%	91%	76%	31%	10%	6%	16%	30%	40%	60%	46%
Reliability Based on Occurrance	76%	76%	92%	97%	94%	68%	26%	13%	23%	40%	47%	71%	98%

Scenario #19

Municipal Taking of: 0.30 m3/s
ASR Taking of: 0.5 m3/s
Arkell Taking: Maximized to Existing PTTW
Step 1 ASR Taking 0.3 m3/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
Max	**31**	**29**	**31**	**30**	**31**	**30**	**28**	**29**	**30**	**31**	**30**	**31**	**309**
Average	**22**	**20**	**24**	**31**	**27**	**11**	**3**	**2**	**5**	**10**	**14**	**21**	**191**
Min	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Number of Occurrances (days)	1207	1087	1310	1684	1468	569	182	102	288	547	729	1136	10309
Total Days Period of Record	1922	1752	1922	1860	1922	1860	1922	1922	1860	1922	1860	1922	22646
Reliability Based on Time	63%	62%	68%	91%	76%	31%	9%	5%	15%	28%	39%	59%	46%
Reliability Based on Occurrance	74%	76%	92%	97%	94%	68%	26%	11%	21%	40%	47%	69%	98%

Appendix F

Guelph Water Supply Master Plan Update
TM3: Water Supply Alternatives (Draft Final)

Memorandum on ASR Background Modelling (Draft)

By Golder Associates

TECHNICAL MEMORANDUM

DATE May 14, 2014 **PROJECT No.** 12-1152-0217

TO Patty Quackenbush, P.Eng.
AECOM Canada Ltd.

CC Greg Padusenko

FROM Jennifer Hancox
John Petrie
Blythe Reiha

EMAIL Jennifer_Hancox@golder.com;
John_Petrie@golder.com;
Blythe_Reiha@golder.com

CONCEPTUAL AQUIFER STORAGE (ASR) SCENARIOS - MODELLING RESULTS GUELPH (DRAFT)

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. (AECOM) to model conceptual Aquifer Storage Recovery (ASR) scenarios in support of the update to the Water Supply Master Plan (WSMP) for the City of Guelph (the City). The purpose of this task was to use the City's existing FEFLOW groundwater flow model (developed by Matrix Solutions Inc. [Matrix] as part of the Tier Three Water Budget and Local Area Risk Assessment [Matrix, 2013]) to evaluate the viability, from a hydrogeological perspective, of two conceptual ASR scenarios. The conceptual ASR systems were to be located in the Northeast Quadrant (NEQ) of the City to take advantage of a source of water from Guelph Lake.

This technical memorandum comprises an appendix to AECOM's Task 4 – Water Supply Alternatives Technical Memorandum #3 (dated May 3, 2014), which has been prepared in support of the City's WSMP Update.

1.0 INTRODUCTION

ASR comprises of the storage of treated drinking water in aquifers (recharge) during periods of water surplus (i.e., when capacity exceeds demand) and subsequent recovery of this stored water during periods of high water demand (i.e., when demand exceeds existing capacity). Recharge of the aquifer can be accomplished through injection wells, while recovery of the water is completed through recovery wells. In many ASR systems, the wells serve a dual purpose function of both injection and recovery of treated water.

With respect to the City, the Gasport Formation would be the most effective aquifer for an ASR system as it is a regionally confined bedrock aquifer with areas of high transmissivity. The City obtains much of its municipal water supply from wells completed in the Gasport Aquifer. Groundwater in the Gasport Formation generally flows from north to south through the City although flow directions are controlled locally by the operation of numerous municipal supply wells and groundwater levels have been lowered considerably from pre-pumping levels. Guelph Lake would serve as the water source for a water treatment plant (WTP) to provide treated water for injection and storage in an ASR system.

This technical memorandum is organized as follows: Section 2 summarizes the predictive modelling approach; Section 3 presents the modelling results; while Section 4 summarizes the general findings of the numerical modelling.

2.0 PREDICTIVE MODELLING APPROACH

Golder applied the existing Tier Three FEFLOW groundwater model (Matrix, 2013) to evaluate well layouts for two conceptual ASR systems. The two scenarios considered were developed jointly with AECOM to provide the basis for evaluating the concept of an ASR system. AECOM provided an analysis of the monthly volumes available for the ASR system. These monthly volumes were averaged over each of the injection and extraction periods for the purpose of the modelling exercise. These conceptual scenarios are described as follows:

- **Scenario 1**: Six ASR wells located in the highly transmissive portion of the Gasport Formation in the NEQ. Groundwater levels in this aquifer have been lowered by municipal pumping such that the injected water could be readily captured at the existing Park and Emma municipal wells (comprised of the Park 1 and 2 wells and the Emma well and hereinafter referred to as the Park & Emma wells). Figure 1 illustrates the distribution of the highly transmissive portion of the aquifer in the NEQ between the Helmar and the Park & Emma Wells.
- **Scenario 2**: 15 ASR wells located in the northeast corner of the City in the vicinity of Guelph Lake. The aquifer characteristics are less favourable in the vicinity of Guelph Lake, hence the need for a greater number of ASR wells to inject and recover the same volume of water.

The modelling approach was as follows:

- The model was run under transient conditions;
- Injection and extraction rates were distributed equally amongst all of the ASR wells;
- ASR wells continuously injected at a combined rate of 4,515 m^3/day, into the Middle Gasport Formation, from October through June (273 days). This is the period of greatest water surplus (on an average annual basis);
- Pumping was optimized at a combined rate of 13,500 m^3/day for 92 days from July through September. This is a period of greatest water demand (on an average-annual basis); and,
- ASR well locations for each scenario were selected through an iterative process by:
  - Ensuring that simulated groundwater elevations did not exceed ground surface (at the end of injection);
  - Ensuring that simulated groundwater elevations did not drop below the top of the Middle Gasport Formation (i.e., verified that extraction rates in this area were sustainable); and,
  - Completing forward-particle tracking around the ASR wells during injection to support the percent capture efficiency of the extraction well operation.

Figures 2 and 8 illustrate the final well layouts for Scenarios 1 and 2, respectively. Table 1 includes the total injection and extraction pumping schedule, which is applicable to both scenarios. Each ASR well serves the dual purpose of injection and pumping (recovery) of treated water and the system is assumed to be operating 100% of the time.

Table 1: Injection and Pumping Schedules for ASR Scenarios

Month	Days	Total Injection Rate (m^3/day)	Total Extraction Rate (m^3/day)
January	31	4,515	
February	28	4,515	
March	31	4,515	
April	30	4,515	
May	31	4,515	
June	30	4,515	
July	31		13,500
August	31		13,500
September	30		13,500
October	31	4,515	
November	30	4,515	
December	31	4,515	
	Total (m^3)	**1,232,595**	**1,242,000**

3.0 MODELLING RESULTS

Results of the Scenario 1 simulation are presented in Figures 2 through 7, while the results of the Scenario 2 simulation are presented in Figures 8 through 13. For each scenario, figures include the following:

- Simulated Heads Prior to Injection;
- Simulated Heads After 273 Days of Injection;
- Simulated Head Difference: Prior to and After Injection;
- Simulated Heads After 92 Days of Extraction;
- Simulated Head Difference: Prior to Injection and After Extraction; and,
- Particle Tracking Results.

3.1 Scenario 1

The well configuration for Scenario 1 is illustrated on Figure 2 with six wells spaced evenly between Helmar and the Park & Emma wells. Groundwater elevations in the Gasport Formation prior to injection ranged from 330 to 290 masl. After injection, simulated groundwater heads (Figure 3) remained below ground surface, rising to elevations of 335 to 310 masl. The rise in groundwater elevation was as high as 15 m around the ASR wells (Figure 4). After extraction, the simulated groundwater heads (Figure 5) remained above the top of the Middle Gasport Formation (so the aquifer remained under confined conditions) with elevations ranging from 320 to 285 masl. In order to maintain a sustainable rate for this ASR configuration during extraction, the combined pumping rate from the Park wells was reduced from 6,400 m^3/day to 3,200 m^3/day thereby allowing the simulated groundwater heads, in this vicinity, to remain above the top of the Middle Gasport Formation. As shown in Figure 6, relative to pre-injection levels, groundwater levels were lowered about 5 m at the Emma well to greater than 30 m at the Helmar well at the end of the simulated extraction in this Scenario. The Helmar and Park & Emma wells captured most of the injected water (Figure 7). The particle tracking results (Figure 7)

indicate that approximately 82% of the injected water was recovered at the extraction wells after 92 days of extraction. The percent capture of injected water could be increased with a longer extraction period, optimizing the location of the ASR wells and modifying the pumping rates at nearby municipal wells.

3.2 Scenario 2

The well configuration for Scenario 2 (Figure 8) included a series of 11 ASR wells placed along the northern boundary of the City (southwest of Guelph Lake) and four ASR wells placed between Helmar and the Park & Emma wells. Groundwater elevations in the Gasport Formation prior to injection ranged from 340 to 290 masl. During this scenario, simulated groundwater heads remained below ground surface after injection (ranging in elevation from 340 to 300 masl) (Figure 9). As is illustrated on Figure 10, after injection, simulated groundwater elevations increased as much as 12 m at the northern most ASR wells to about 3 m in the vicinity of the Park & Emma wells. After extraction, the simulated groundwater heads remained above the top of the Middle Gasport Formation (ranging in elevation from 320 to 290 masl) (Figure 11). As shown on Figure 12, after extraction, the simulated groundwater heads were 35 m lower relative to pre-injection elevations at the northern ASR wells to approximately 5 m lower at the Park & Emma wells. After 92 days of pumping, the particle tracking results (Figure 13) show that approximately 53% of the injected water was recovered. The percent capture of injected water could be increased with a longer extraction period, optimizing the location of the ASR wells and modifying the pumping rates at nearby municipal wells.

4.0 SUMMARY

The results of these two modelling scenarios indicate that a conceptual ASR system located in the NEQ of the City of Guelph is viable from a hydrogeological perspective. Simulated groundwater heads remain below ground surface during injection and are not drawn below the top of the Middle Gasport Formation during extraction. In order to capture a greater percentage of the injected water and increase the efficiency of an ASR system, an optimization study (i.e., injection / extraction rates and duration, well locations) would be required. From a hydrogeological perspective, design planning for an ASR system must be support by extensive field investigations and supporting analyses.

5.0 REFERENCES

AECOM Canada Ltd. (AECOM), 2014. Water Supply Master Plan Update. Technical Memorandum No. 3: Water Supply Alternatives. May 2014.

Matrix Solutions Inc. (Matrix), 2013. The Tier Three Water Budget and Local Area Risk Assessment. Report prepared for the City of Guelph. May 2013.

6.0 CLOSURE

We trust that this technical memorandum meets your current needs. If you require any further clarification, please contact the undersigned.

Jennifer Hancox, M.Sc., P.Geo.
Hydrogeologist

John Petrie, M.Sc., P.Geo.
Principal, Senior Hydrogeologist

Blythe Reiha, M.A.Sc., P.Eng.
Environmental Engineer

JLH/BR/JMP/

Attachments:
Figure 1: Horizontal Hydraulic Conductivity Distribution in the Middle Gasport
Figure 2: Scenario 1 – Simulated Heads in Middle Gasport Prior to Injection
Figure 3: Scenario 1 – Simulated Heads in Middle Gasport After 273 Days of Injection
Figure 4: Scenario 1 – Simulated Head Difference: Prior to and After Injection
Figure 5: Scenario 1 – Simulated Heads in Middle Gasport After 92 Days of Extraction
Figure 6: Scenario 1 – Simulated Head Difference: Prior to Injection and After Extraction
Figure 7: Scenario 1 – Particle Tracking Results
Figure 8: Scenario 2 – Simulated Heads in Middle Gasport Prior to Injection
Figure 9: Scenario 2 – Simulated Heads in Middle Gasport After 273 Days of Injection
Figure 10: Scenario 2 – Simulated Head Difference: Prior to and After Injection
Figure 11: Scenario 2 – Simulated Heads in Middle Gasport After 92 Days of Extraction
Figure 12: Scenario 2 – Simulated Head Difference: Prior to Injection and After Extraction
Figure 13: Scenario 2 – Particle Tracking Results

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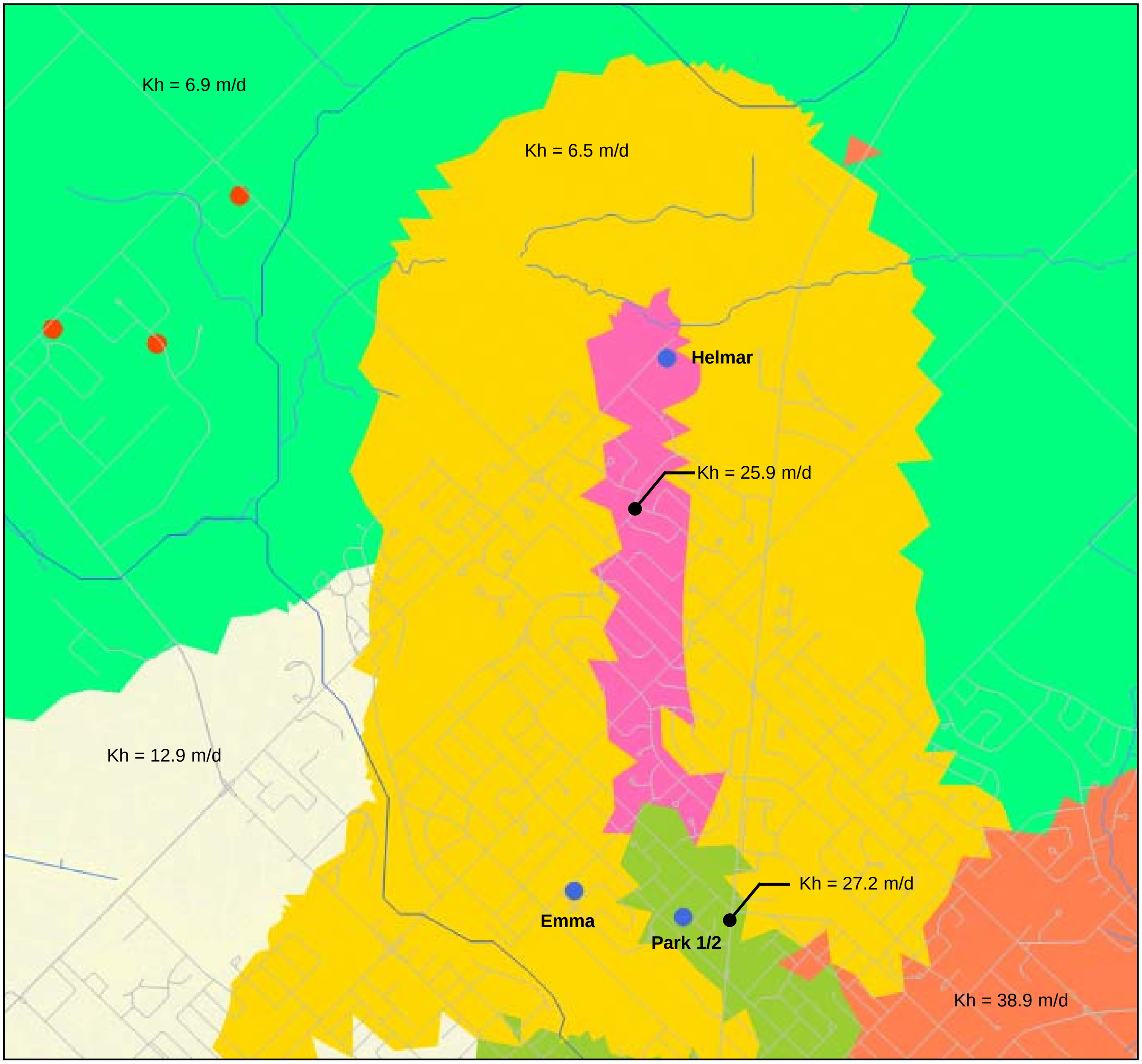

LEGEND

- Water Features
- Guelph Municipal Well
- Other Municipal Water Supply Well

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **HORIZONTAL HYDRAULIC CONDUCTIVITY DISTRIBUTION IN THE MIDDLE GASPORT**

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 1**	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

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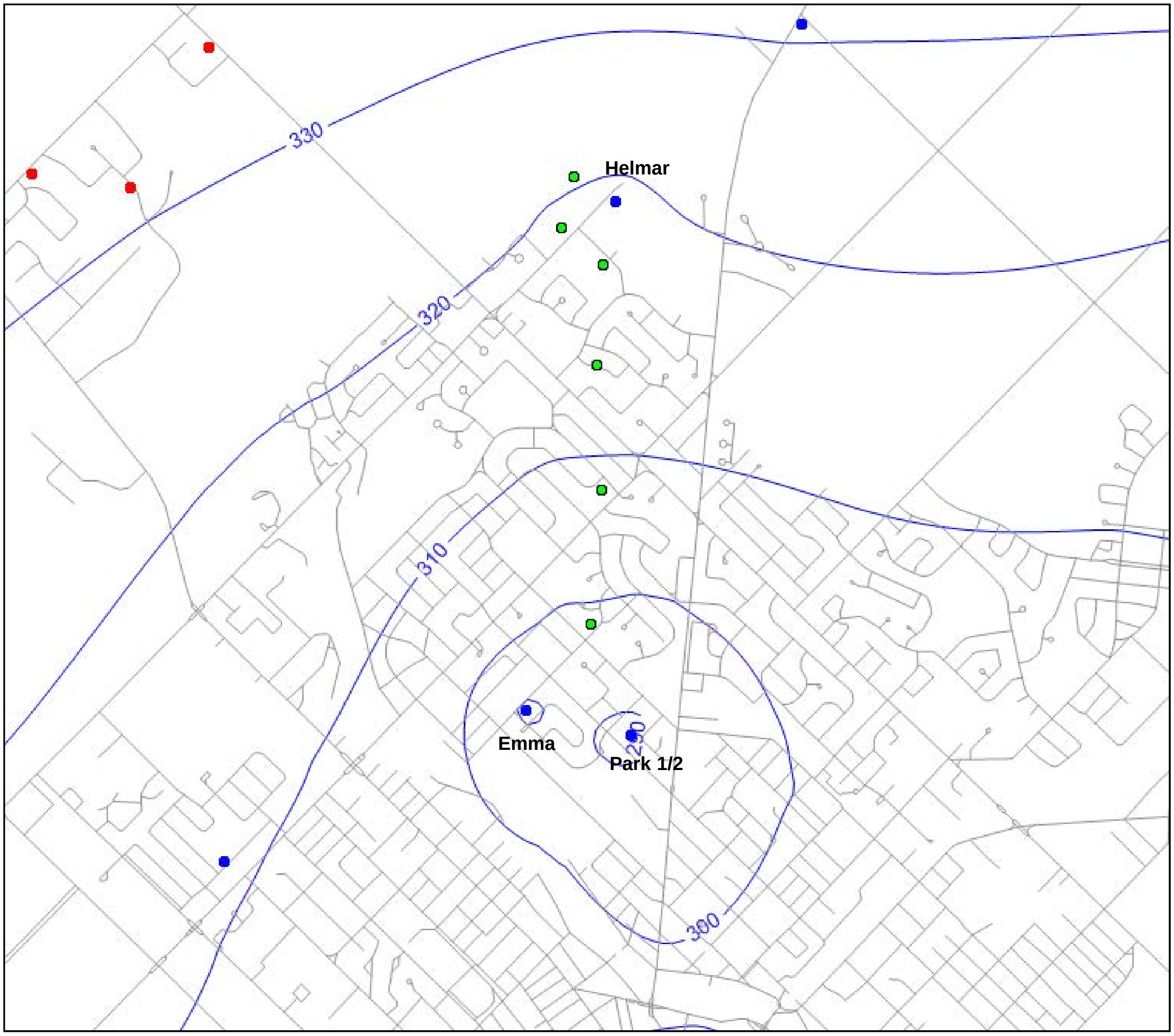


Notes:

6 ASR Wells

Injection per well = 752.5 m^3/d for 273 days

Extraction per well = 2,250 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

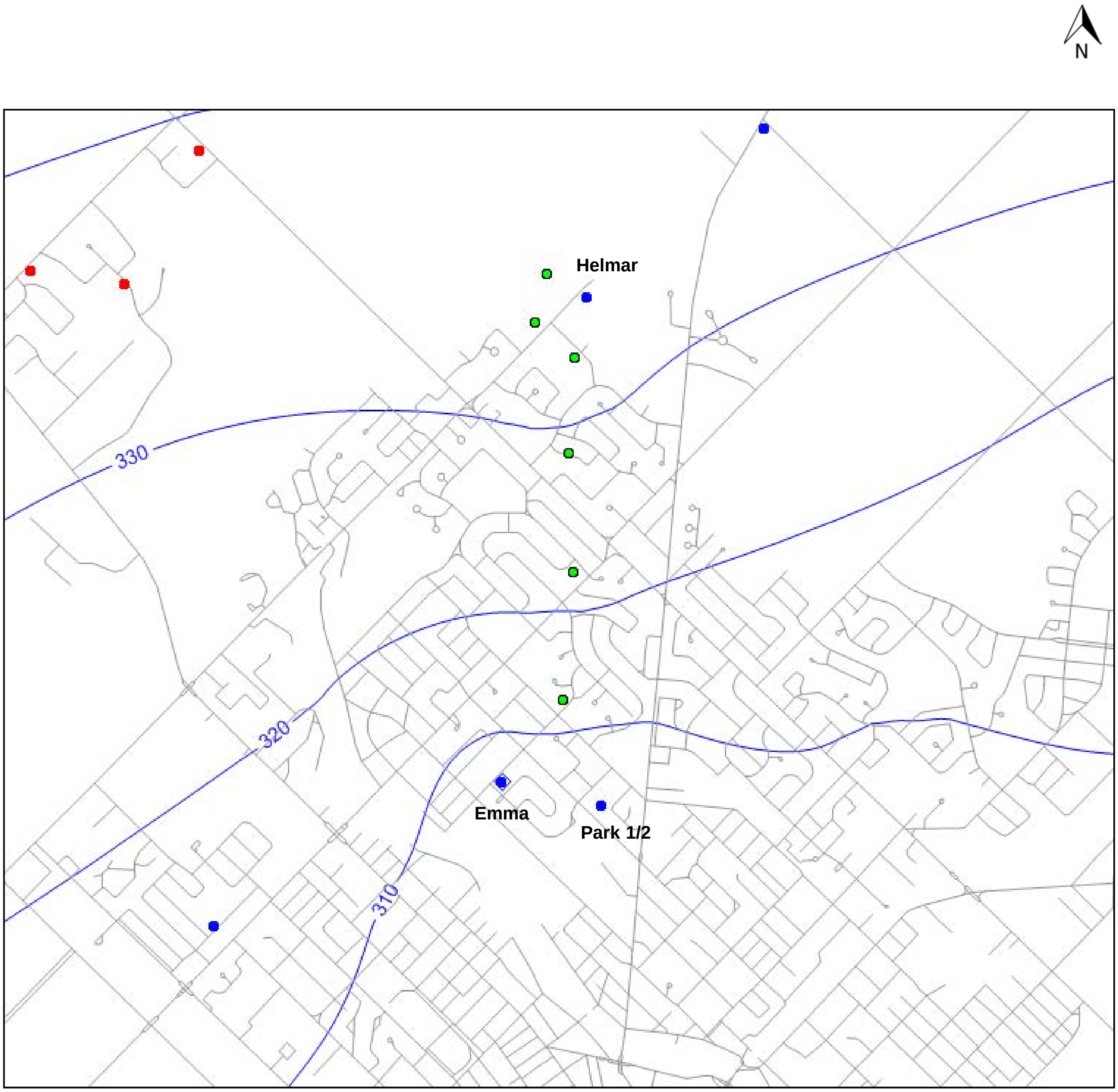
DRAFT

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 1 SIMULATED HEADS IN MIDDLE GASPORT PRIOR TO INJECTION**

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 2**	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		



Notes:

6 ASR Wells
Injection per well = 752.5 m^3/d for 273 days
Extraction per well = 2,250 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

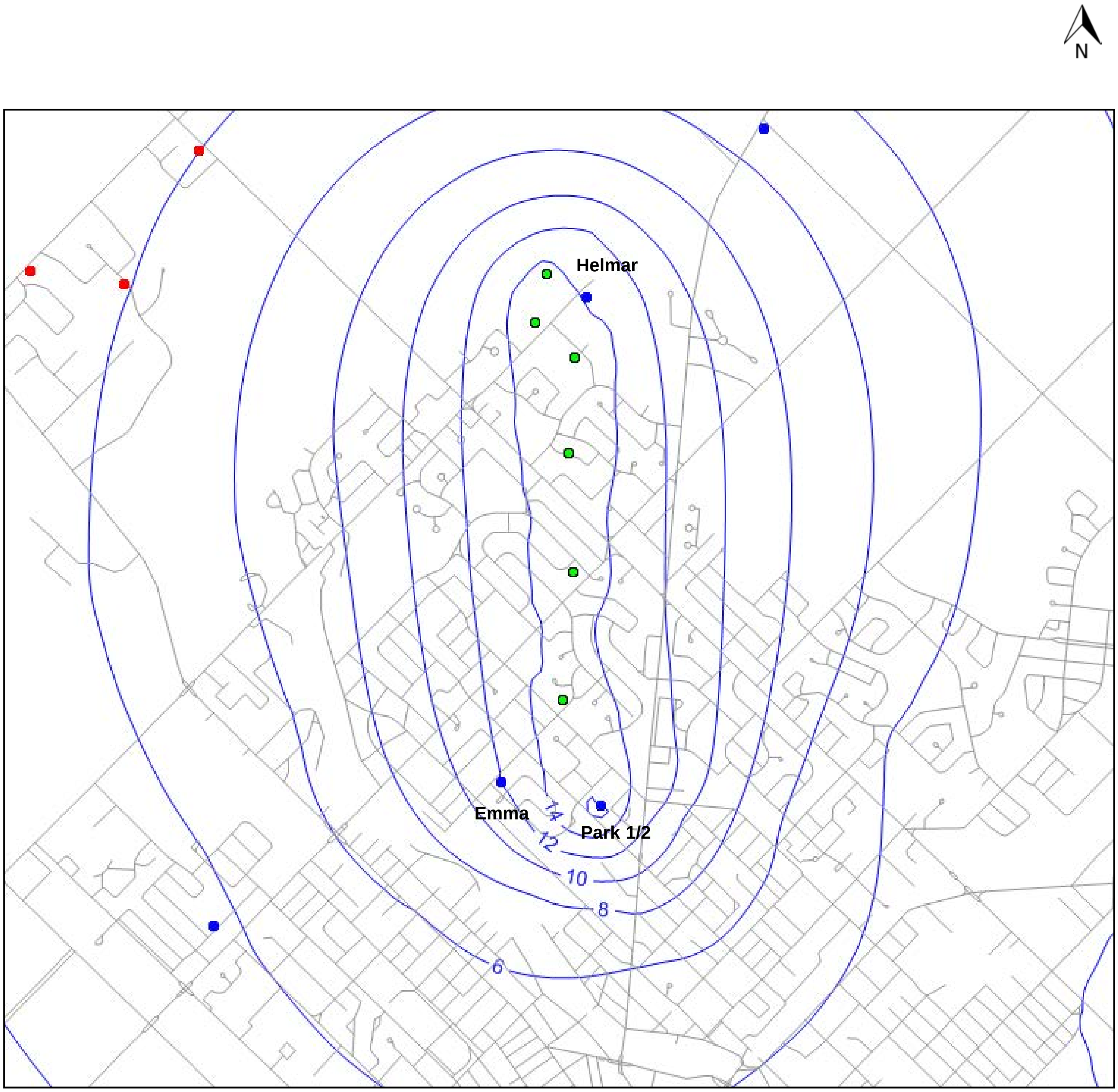
PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 1**
SIMULATED HEADS IN MIDDLE GASPORT AFTER 273 DAYS OF INJECTION

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 3**	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

Golder Associates

DRAFT



Notes:

6 ASR Wells
Injection per well = 752.5 m^3/d for 273 days
Extraction per well = 2,250 m^3/d for 92 days

LEGEND

- 2 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

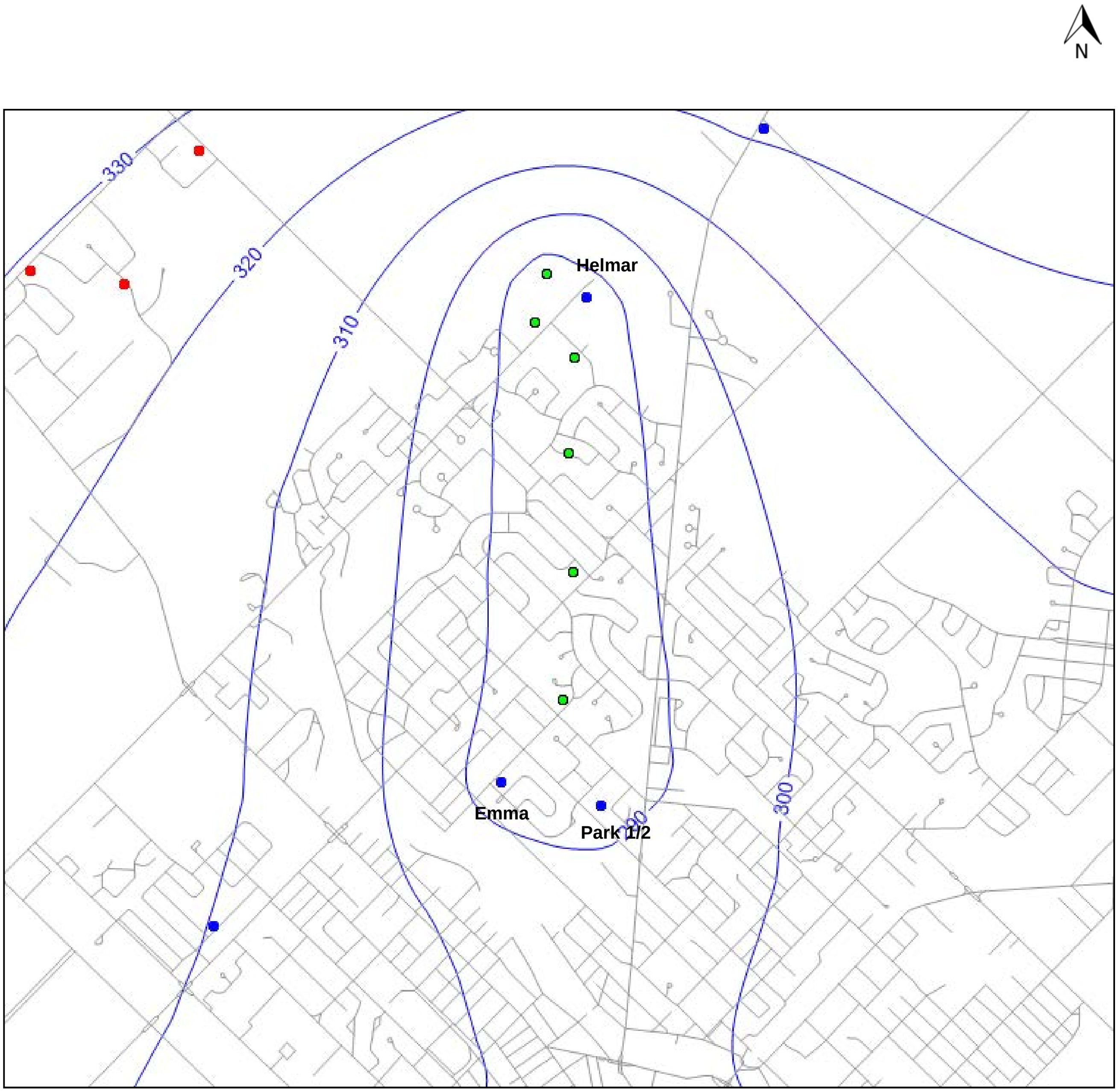
PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE
SCENARIO 1
SIMULATED HEAD DIFFERENCE: PRIOR TO AND AFTER INJECTION

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	FIGURE 4	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

DRAFT



Notes:

6 ASR Wells

Injection per well = 752.5 m^3/d for 273 days

Extraction per well = 2,250 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 1 SIMULATED HEADS IN MIDDLE GASPORT AFTER 92 DAYS OF EXTRACTION**

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 5**	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

Golder Associates

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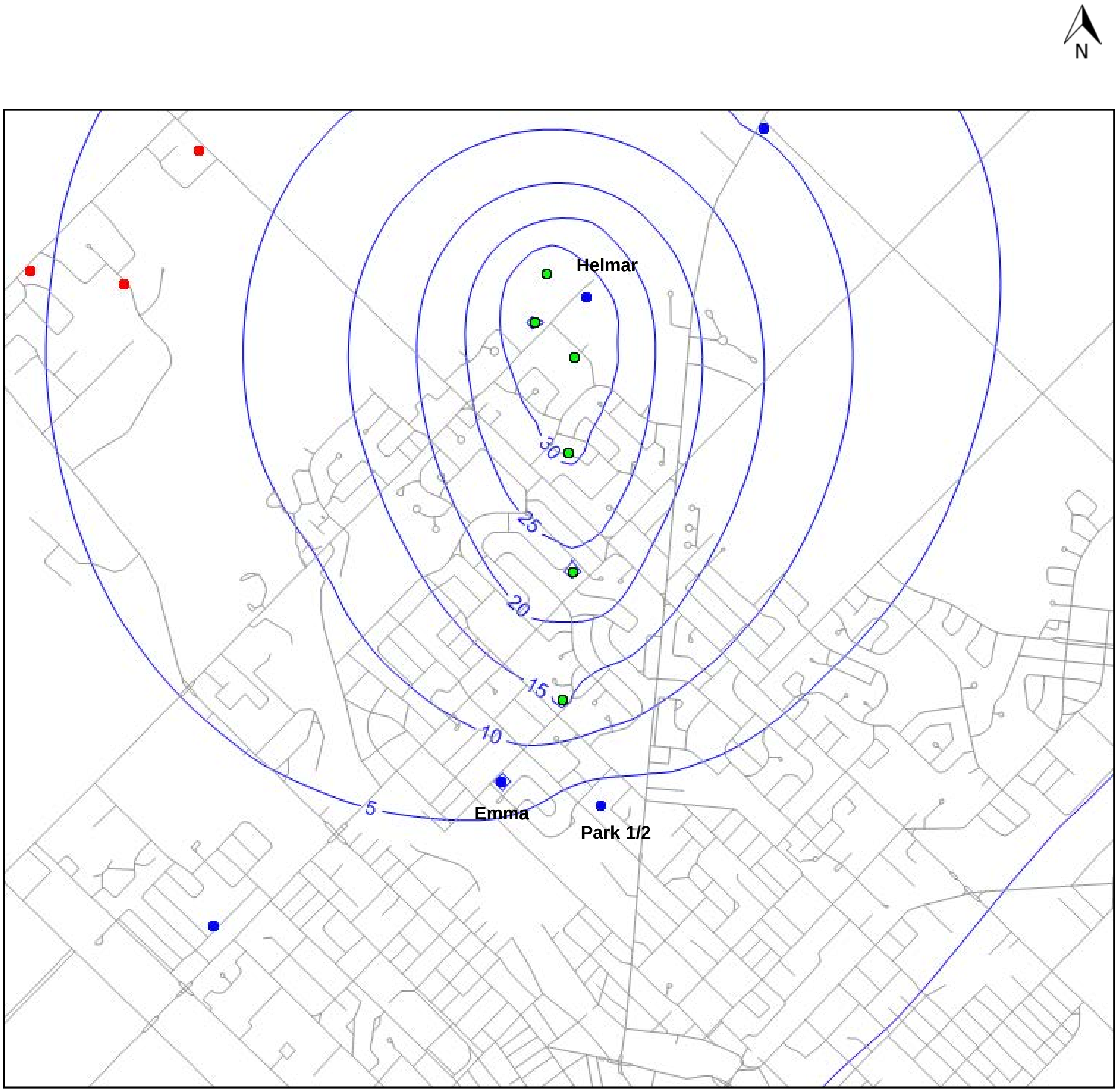

Notes:

6 ASR Wells
Injection per well = 752.5 m^3/d for 273 days
Extraction per well = 2,250 m^3/d for 92 days

LEGEND

- 5 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 1**
SIMULATED HEAD DIFFERENCE: PRIOR TO INJECTION AND AFTER EXTRACTION

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	FIGURE 6	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

Golder Associates

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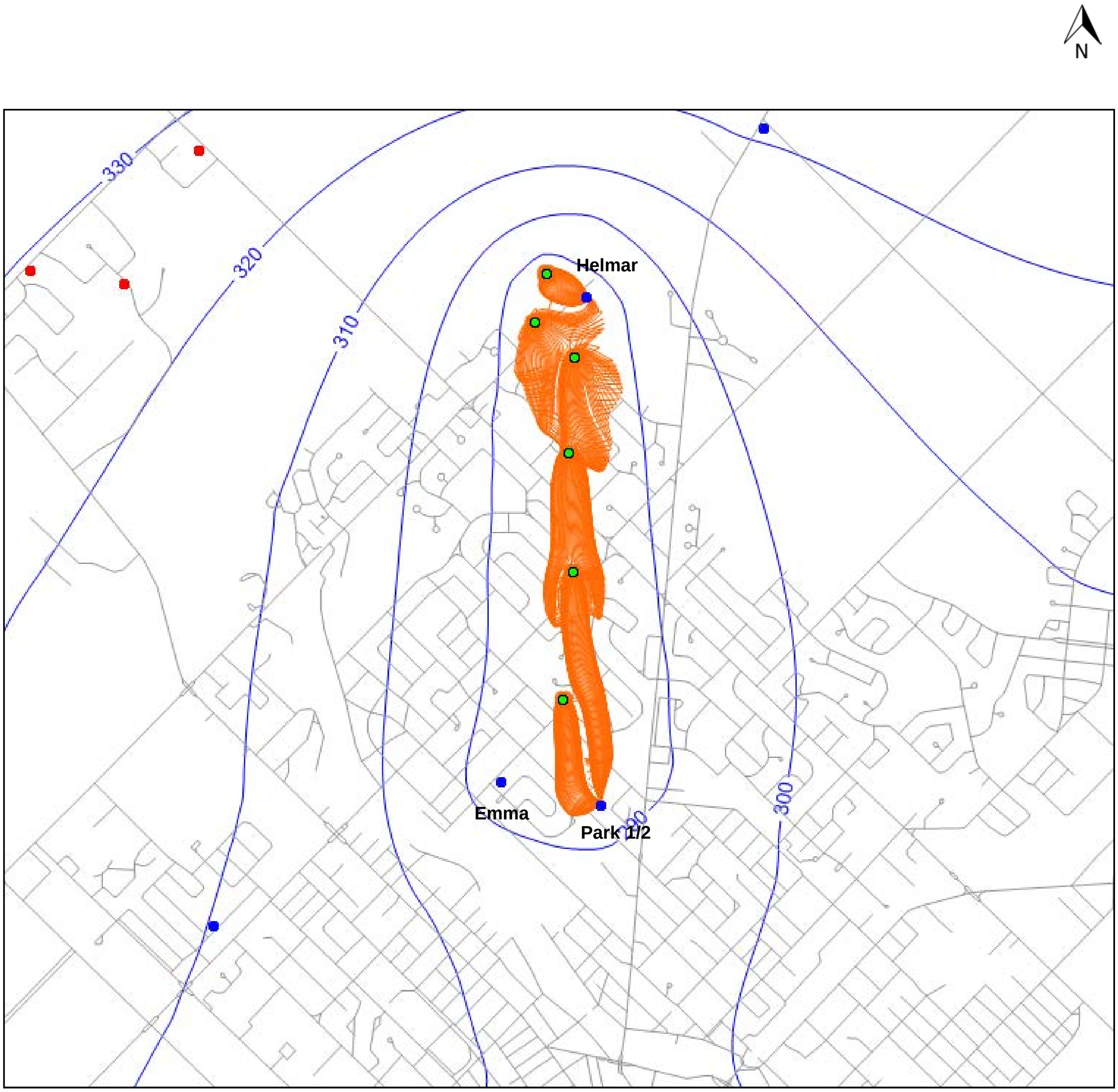


Notes:

6 ASR Wells
Injection per well = 752.5 m^3/d for 273 days
Extraction per well = 2,250 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well
- Forward Particle Tracking

DRAFT

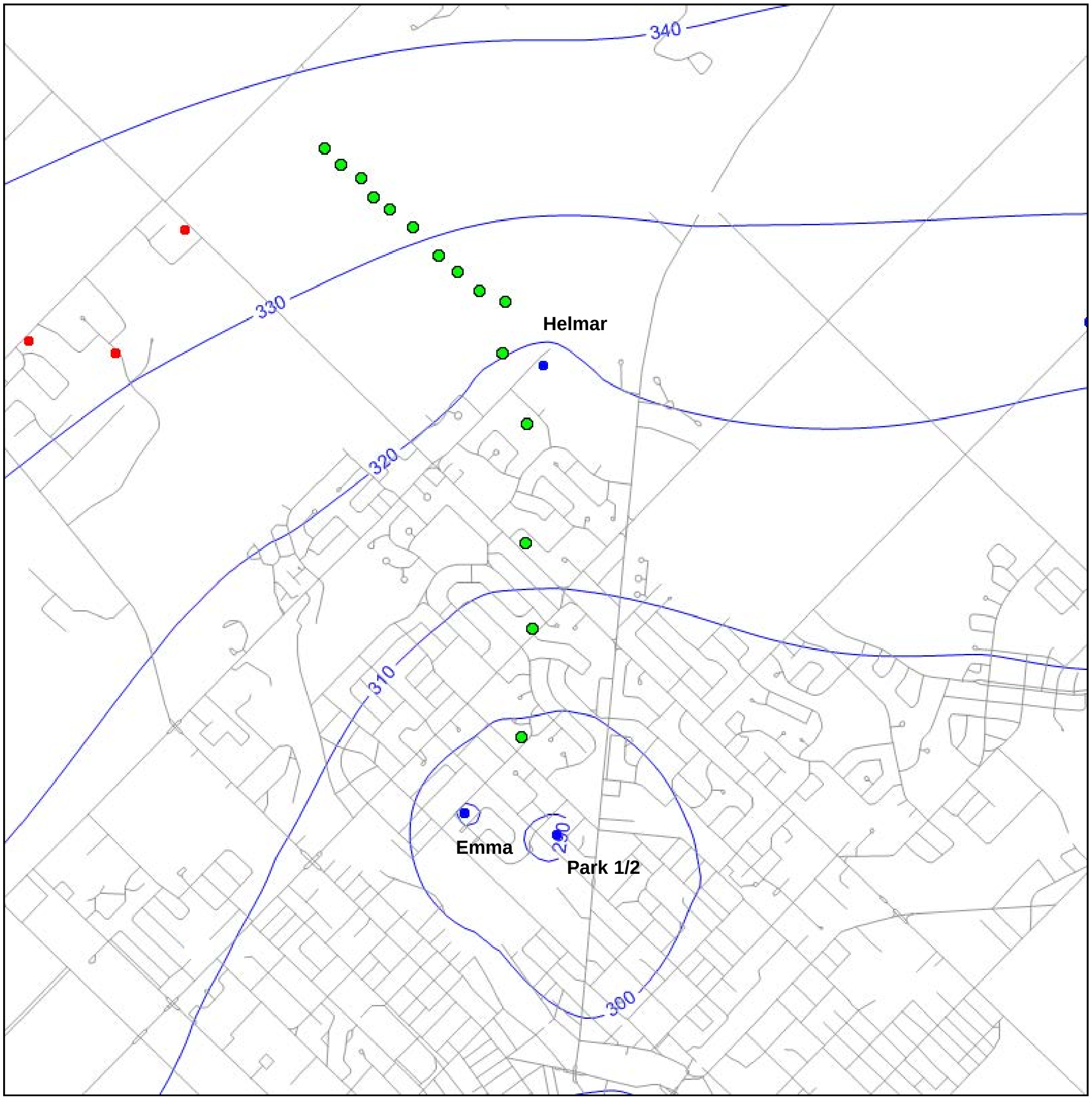
PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE

SCENARIO 1
PARTICLE TRACKING RESULTS

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	FIGURE 7	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		



Notes:

15 ASR Wells
Injection per well = 301 m^3/d for 273 days
Extraction per well = 900 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

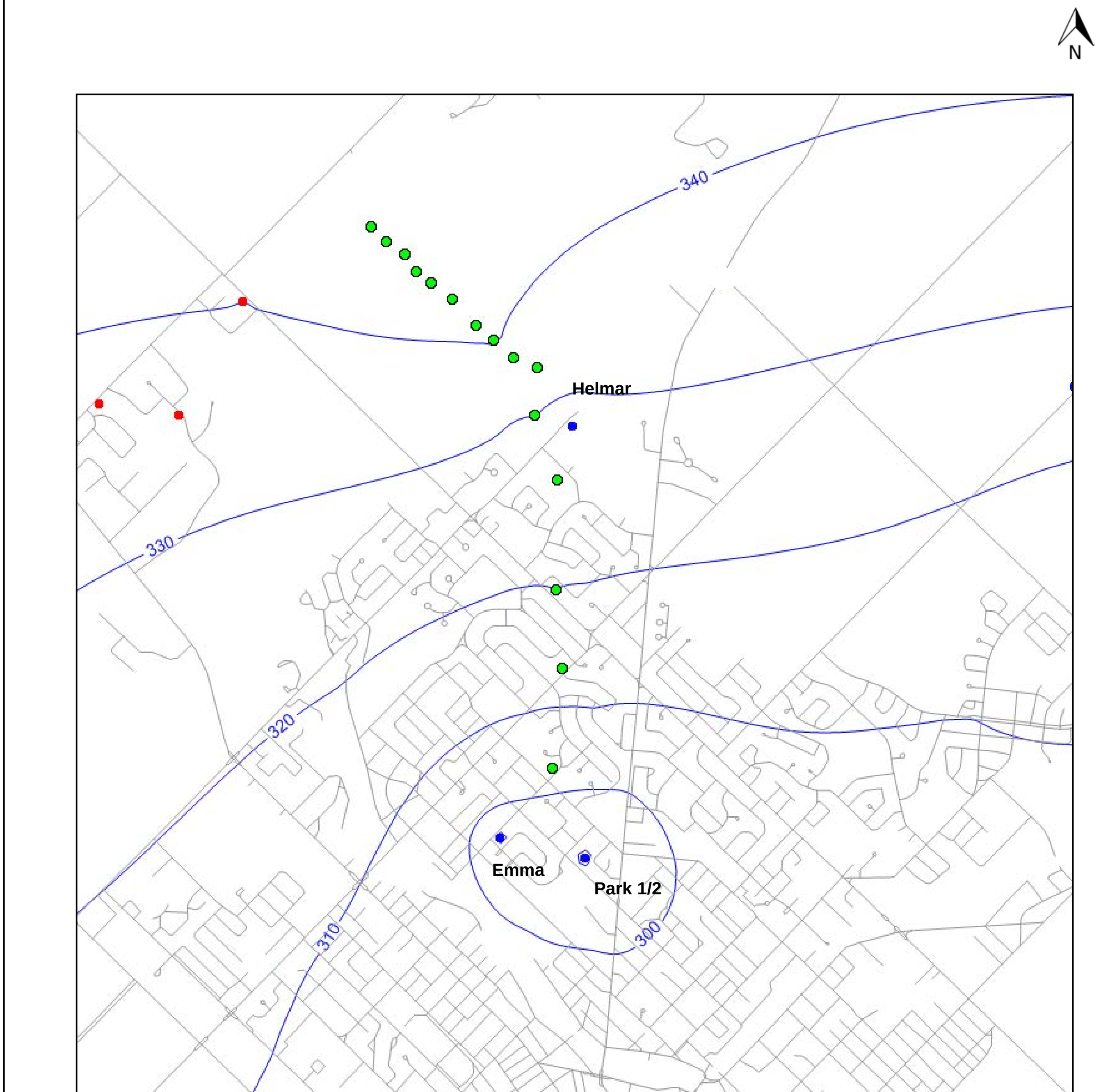
PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 2 SIMULATED HEADS IN MIDDLE GASPORT PRIOR TO INJECTION**

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 8**	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

DRAFT



Notes:

15 ASR Wells
Injection per well = 301 m^3/d for 273 days
Extraction per well = 900 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

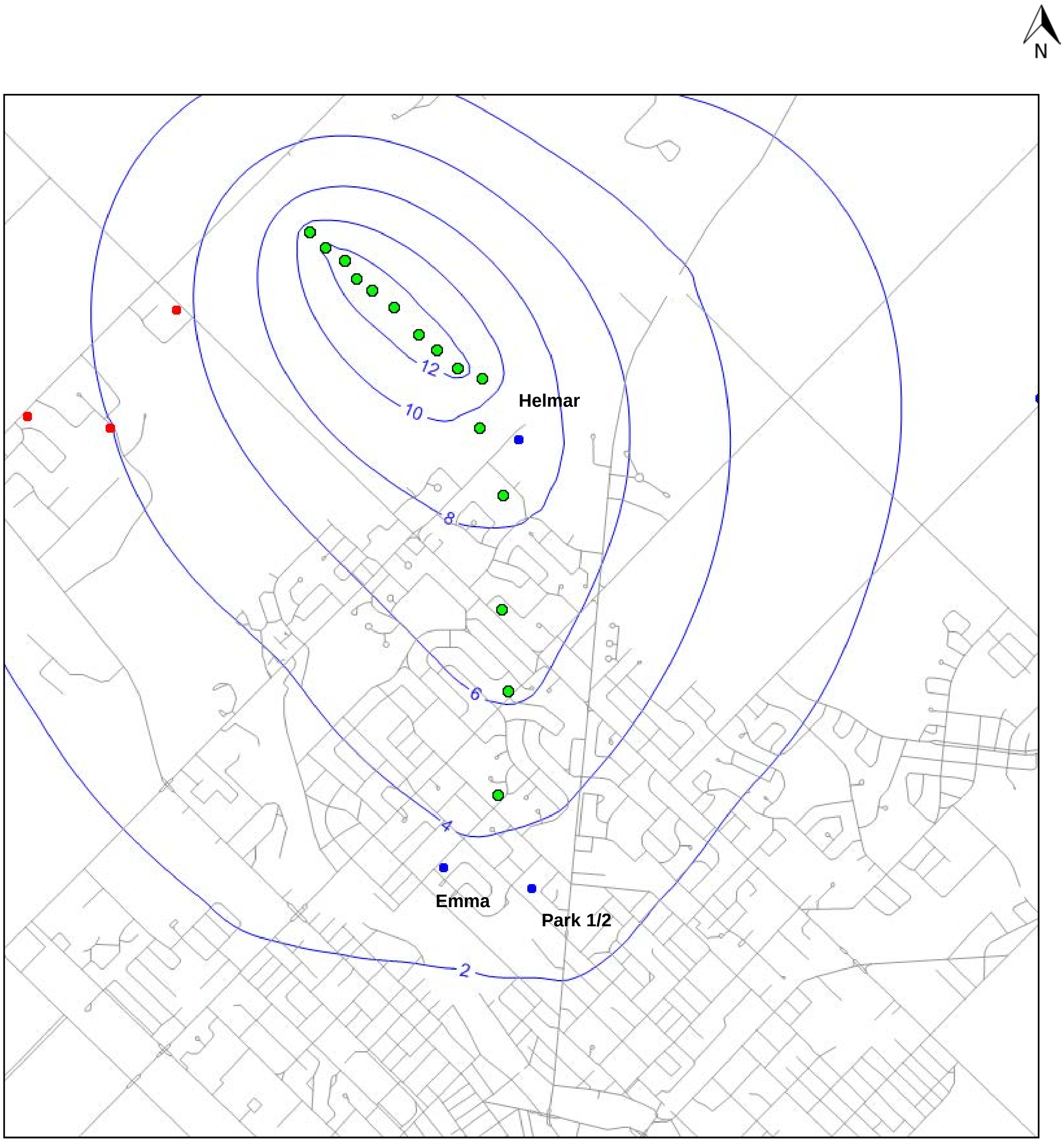
DRAFT

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 2**
SIMULATED HEADS IN MIDDLE GASPORT AFTER 273 DAYS OF INJECTION

Golder Associates

PROJECT No. 12-1152-0217		SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 9**
GIS	BR	MAY 2014	
CHECK	JH	MAY 2014	
REVIEW	JP	MAY 2014	



Notes:

15 ASR Wells
Injection per well = 301 m^3/d for 273 days
Extraction per well = 900 m^3/d for 92 days

LEGEND

- 2 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

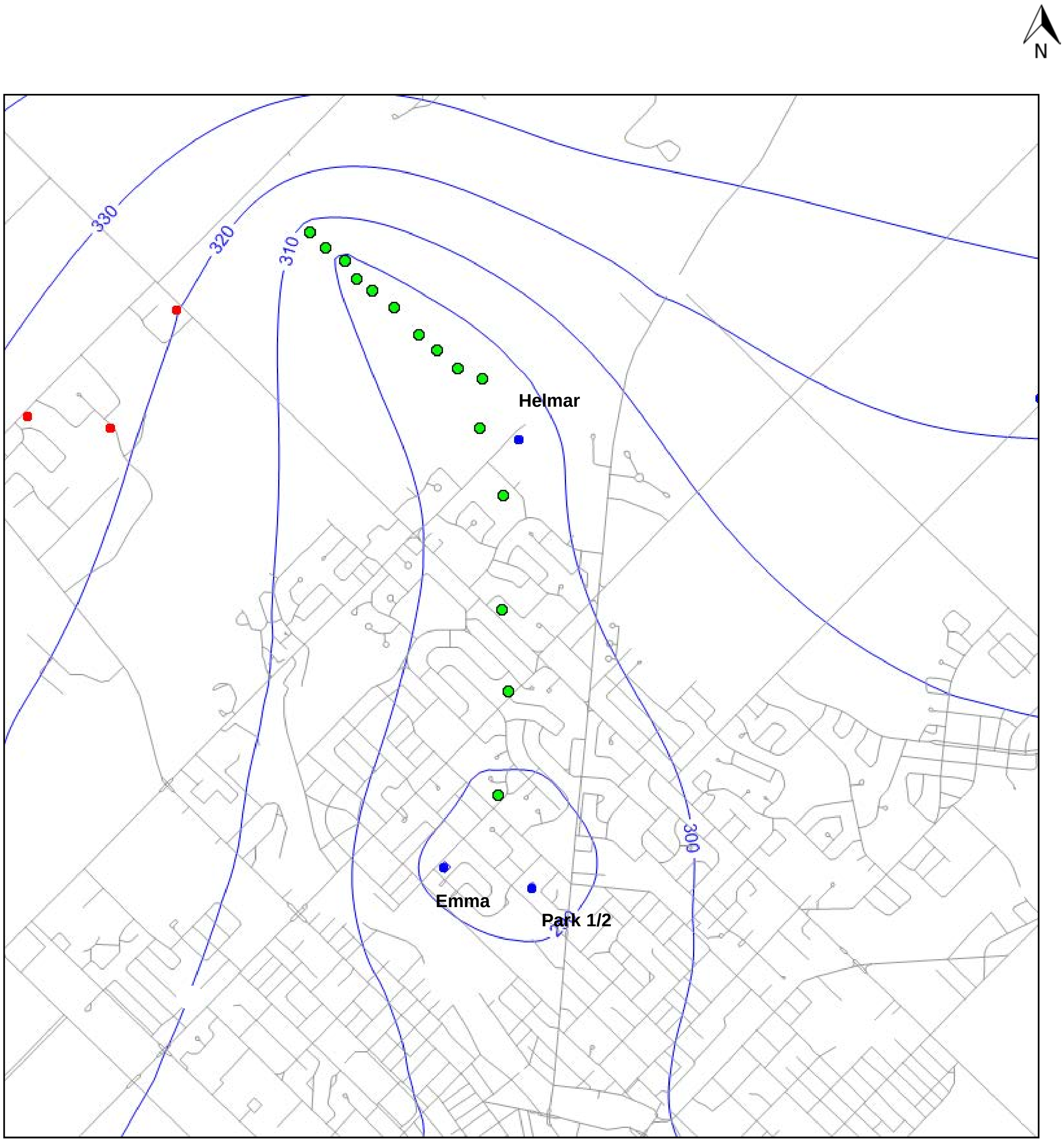
DRAFT

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 2 SIMULATED HEAD DIFFERENCE: PRIOR TO AND AFTER INJECTION**

Golder Associates

PROJECT No. 12-1152-0217		SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 10**
GIS	BR	MAY 2014	
CHECK	JH	MAY 2014	
REVIEW	JP	MAY 2014	



Notes:

15 ASR Wells
Injection per well = 301 m^3/d for 273 days
Extraction per well = 900 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE
SCENARIO 2
SIMULATED HEADS IN MIDDLE GASPORT AFTER 92 DAYS OF EXTRACTION

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	FIGURE 11	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

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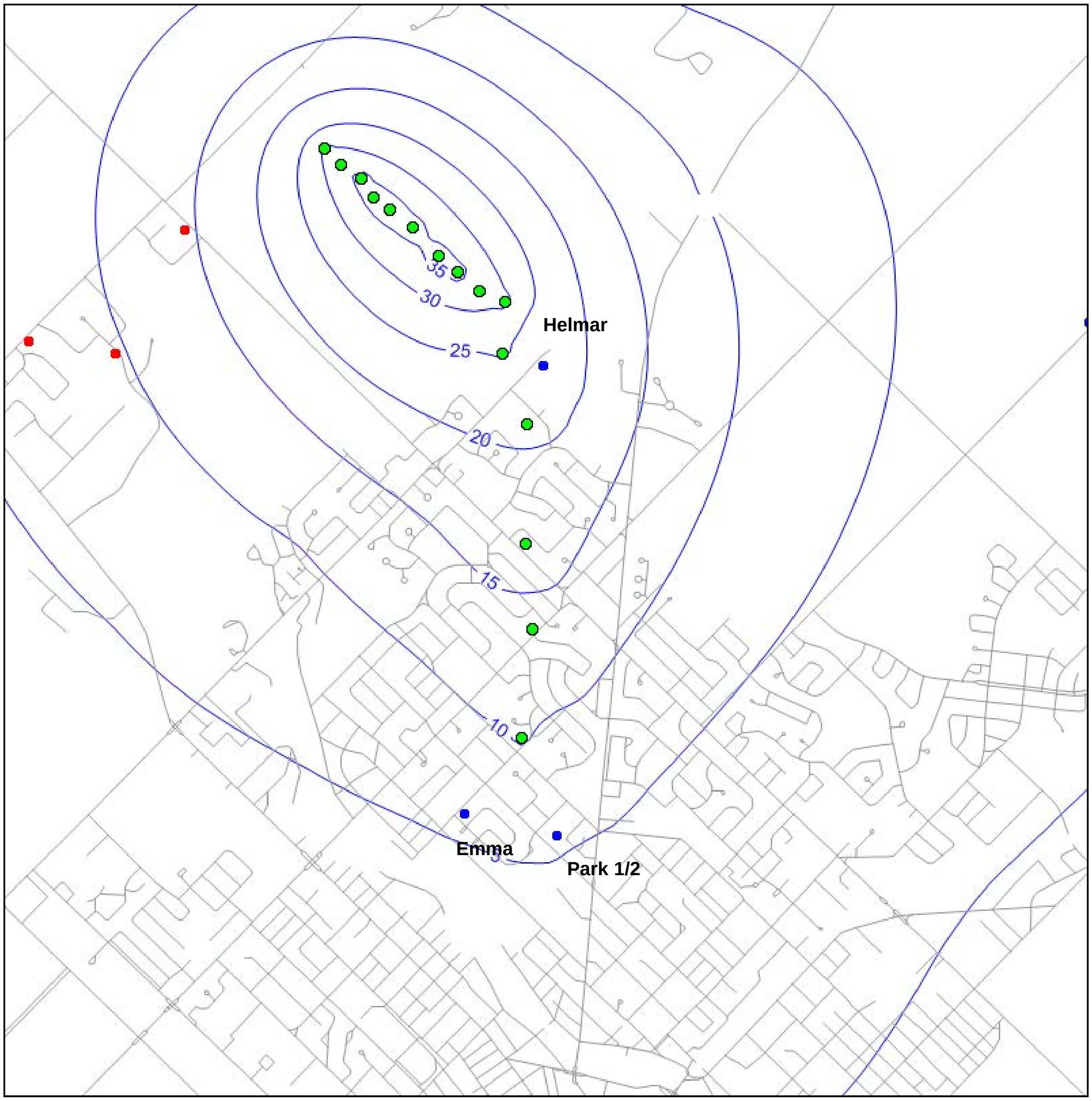

Notes:

15 ASR Wells
Injection per well = 301 m^3/d for 273 days
Extraction per well = 900 m^3/d for 92 days

LEGEND

- 5 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well

DRAFT

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE **SCENARIO 2**
SIMULATED HEAD DIFFERENCE:
PRIOR TO INJECTION AND AFTER EXTRACTION

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 12**	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

Golder Associates

Notes:

15 ASR Wells

Injection per well = 301 m^3/d for 273 days

Extraction per well = 900 m^3/d for 92 days

LEGEND

- 10 m groundwater contour intervals
- ASR Wells
- Guelph Municipal Well
- Other Municipal Water Supply Well
- Forward Particle Tracking

DRAFT

PROJECT AQUIFER STORAGE RECOVERY (ASR) GROUNDWATER MODELLING RESULTS: CITY OF GUELPH

TITLE

SCENARIO 2
PARTICLE TRACKING RESULTS

Golder Associates

PROJECT No. 12-1152-0217			SCALE AS SHOWN	REV. 1
DESIGN	BR	MAY 2014	**FIGURE 13**	
GIS	BR	MAY 2014		
CHECK	JH	MAY 2014		
REVIEW	JP	MAY 2014		

AECOM

Appendix G

Guelph Water Supply Master Plan Update
TM3: Water Supply Alternatives (Draft Final)

Natural Environmental Considerations for Alternatives

By AECOM

AECOM

AECOM
50 Sportsworld Crossing Road, Suite 290 519.650.5313 tel
Kitchener, ON, Canada N2P 0A4 519.650.3424 fax
www.aecom.com

Memorandum

To	Dave Belanger, City of Guelph	Page	1
CC	Patty Quackenbush, AECOM		
Subject	Natural Environment Considerations for Alternatives – Guelph Water Supply Master Plan Update Study		
From	Jillian deMan, AECOM		
Date	May 23, 2014	Project Number	60287843

1. INTRODUCTION

The City of Guelph is completing a water supply master plan update that is investigating a variety of water supply alternatives over the next 25-year planning horizon. Alternatives include water conservation and demand management, expansion of 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
- City of Guelph Official Plan Amendment Number 42: Natural Heritage System

Other Documents
- City of Guelph Natural Heritage Strategy
- Grand River Conservation Authority website
- Natural Heritage Information Centre website
- Soil Survey of Wellington County
- Wellington County website Interactive Mapping Tool
- Ministry of Natural Resources - Species at Risk Website – Species at Risk in Wellington County
- Atlas of the Breeding Birds of Ontario – Atlas Data Summary Squares 17NJ51, 17NJ52, 17NJ61 AND 17NJ62

It is noted that Official Plan Amendment (OPA) 42 which establishes a new Natural Heritage System as part of the Official Plan (Adopted by Guelph City Council – July 27, 2010; Approved by Minister of Municipal Affairs and Housing – Feb 22, 2011 and is currently under appeal before the Ontario Municipal Board). OPA 42 does not comprise part of the December 2012 Official Plan Consolidation. OPA 42

includes revisions to the above referenced Schedules, which are also attached to Appendices A and C. OPA 42 also includes new policies regarding where and how public private infrastructure is permitted in relation to the City's Natural Heritage System. Consideration should be given to the Current Official Plan Greenland's System mapping and policies, as well as regard for the mapping and policies of OPA 41 until such time that it is no longer under appeal.

2. NATURAL ENVIRONMENT

The various servicing alternatives are restricted to Wellington County (City of Guelph, Puslinch Township, Guelph/Eramosa Township).

The following describes the natural environment within the study area in a general sense. It is expected that more detailed review utilizing Wetland Evaluations, Environmental Significant Area Reports and Fisheries Information will be conducted further in individual Class EAs for the proposed undertakings.

2.1 City of Guelph

With a total coverage of approximately 18%, 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. The City of Guelph encompasses the following natural heritage features:

- 5 Subwatershed/Watershed Areas (partially or entirely – Eramosa-Speed River Watershed, Clythe Creek Subwatershed, Hanlon Creek Watershed, Torrance Creek Subwatershed, Mill Creek Subwatershed)
- 4 Environmentally Sensitive Areas (ESAs),
- 2 Areas of Natural and Scientific Interest (ANSIs),
- 8 Provincially Significant Wetlands (PSWs) Complexes (partially or entirely),
- 3 Locally Significant Wetlands (LSWs),
- The Speed, Eramosa, Hanlon, Torrance, Clythe and Ellis River Systems,
- Approximately 30 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, January 2012 consolidation).

Within and surrounding the City, more than 70 element occurrences of at risk species have been recorded. Those species which have been observed more recently (since 1990) include; least bittern (*Ixobrychus exilis*), Jefferson salamander (*Ambystoma jeffersonianum*), American chestnut (*Castanea dentata*), wavy-rayed lampmussel (*Lampsilis fasciola*), Williamson's emerald (*Somatochlora williamsoni*) 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 include areas containing wetlands, forested areas, wildlife habitat for terrestrial and aquatic species (including endangered and threatened species) significant areas of wetlands, habitats of endangered and threatened species, areas of natural and scientific interest, fish habitat, woodlands, environmental corridors, ecological linkages and wildlife habitat.

Attachment A presents a copy of Schedule 1: Land Use Plan and Schedule 2: Natural Heritage Features and Development Constraints from the City Guelph's Official Plan 2001 December 2012 Consolidation, as well a copy of Schedule 1: Land Use Plan and Schedule 10: Natural Heritage Strategy Natural Heritage System from the Official Plan Amendment 42.

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 from the construction of Guelph Lake Dam in 1974, occurs to the north.

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 thirty (30) species that have been designated as Endangered, Threatened or Special Concern under the provincial Endangered Species Act are known to occur within Wellington County. In addition to this, two (2) species that have been designated as Threatened or Special Concern by the Committee on the Status of Endangered Wildlife in Canada are 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 evaluated wetlands, earth science Areas of Scientific Interest, conservation areas and life science sites.

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 towards 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 1 presents the potential impacts of each alternative.

Table 1 Potential Impacts of Each Alternative

Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
Groundwater Sources			
Optimize Existing Wells Improvement of well performance to yield additional capacity	The existing well which can be optimized that are near or adjacent to natural heritage features include Downey Well (near Speed River Provincially Significant Wetland Complex).	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 through change of riparian/emergent and submergent 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 river and wetland systems within proximity of wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
Restoration of Existing Off-line Municipal Wells Wells have existing permits to take water but City has discontinued use due to concerns with water quality. Wells require upgrades for water quality	Those existing wells which require treatment that are near or adjacent to natural heritage features include the Arkell Lower Road Collector (near Eramosa River), Edinburgh Well (near Speed River), Clythe Creek Well (near Clythe Creek Non-provincially Significant Wetland and Clythe Creek) and Sacco Well (near Marden South Non-provincially Significant Wetland Complex) .	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 through change of riparian/emergent and submergent 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 river and wetland systems within proximity of wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
Develop Existing Municipal Test Wells Construction of wells at or near location of existing municipal test wells	The test wells that may be developed into municipal production wells that are near or adjacent to natural heritage features include Steffler & Ironwood; Scout Camp (near Eramosa River Bluesprings Creek Provincially Significant Wetland Complex); Fleming & Logan (near Guelph Northeast Provincially Significant Wetland Complex ; and Hauser (near Ellis Creek Provincially Significant Wetland Complex) .	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 through change of riparian/emergent and submergent 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 river and wetland systems within proximity of wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
New Wells Inside City Development of additional supplies using Tier 3 Model	In addition to locations of existing test wells, an area where a new well will potentially be installed is near Sunny Acres Park.	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;	Further Studies/ Class EAs should include the following tasks: - Conduct field investigations to determine existing conditions of aquatic/terrestrial habitat within river and wetland systems within proximity of wells; - Conduct field investigations to determine existing conditions of proposed sites for new wells - Obtain Wetland Evaluation Reports, Fisheries and Species at

Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
		- 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.	Risk information for wetlands and watercourses - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing groundwater impacts.
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	Those areas where new wells will potentially be installed, include: Victoria (near the Arkell Bog Provincially Wetland Complex), Guelph North (near the Marden South Provincially Significant Wetland 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; - 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 river and wetland systems within proximity of wells; - Conduct field investigations to determine existing conditions of proposed sites for new wells; - Obtain Wetland Evaluation Reports, Fisheries and Species at Risk information for wetlands and watercourses; - Provision of more detailed Impact Assessment; and - Determination of Mitigation Measures specifically addressing potential erosion impacts.
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 Provincially Significant Wetland 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 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; - 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.
Aquifer Storage Recovery (ASR)			
ASR Guelph Lake Storage of treated drinking water in underground aquifers near Guelph Lake during periods of water surplus and subsequent recovery of volume stored during periods of water shortage.	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 in the deep bedrock (i.e. injection mode) when the water was available from the treatment system. When water was required	The process of storage/recovery of surplus water in a given area in theory keeps the existing water capacity at base level. The following impacts might occur: - The potential for groundwater contamination (i.e. nutrient leaching) - Depending on the location of the wells, impacts towards 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; - Determination of Mitigation Measures specifically addressing potential erosion and groundwater impacts; - Preparation of detailed hydrologic studies to investigate existing annual hydrologic regimes;

Alternative	Potentially Affected Natural Heritage Features	Potential Impacts	Recommendations/Notes
	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).		- Species at Risk Inventories targeting species sensitive to hydrologic changes; - Amphibian surveys within wetland communities; and - During recovery periods, ensure water capacity remains at determined existing conditions.
Other Water Source Alternatives			
Conservation/Demand Management – Non-Revenue Water	Natural heritage features not affected.	No impacts to natural heritage features anticipated.	No further recommendations required
Conservation/Demand Management – Pricing/Controls/Education	Natural heritage features not affected.	No impacts to natural heritage features anticipated.	No further recommendations required
Reuse – Dual System/Wastewater Reuse	Facility locations/ routing have not yet been determined. There is a potential that natural heritage areas might be affected.	Impacts would relate to facility construction and routing and include: - Sedimentation into adjacent watercourses/natural heritage areas during construction; - Compaction of soils from heavy machinery working adjacent to wetlands/woodlands disturbing root systems and soil pore spaces; - Damage to edge trees from heavy machinery working adjacent to wetlands/woodlands causing wounded trunks or limbs/roots to break, increasing possibility of disease; - Possible vegetation clearing; and - Noise and vibration disturbance to wildlife.	Further Studies/ Class EAs should include the following tasks: - Field investigations documenting existing conditions of natural heritage features ; - Aquatic habitat assessments of any watercourse crossings to determine appropriate crossing methods and construction timing; - Provision of more detailed Impact Assessment; - Determination of Mitigation Measures specifically addressing impacts related to construction; and - Species at Risk Inventories targeting species that might be present within proximity to construction.
Limit Growth	This option applies to the entire study area.	May result in natural heritage feature impacts due to densification.	No further recommendations required
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 negative affects towards the natural environment. These address all potential alternatives. More detailed measures should be determined during the Class EA/Detailed Design phase of this project once a preferred solution is selected.

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 impact this may potentially cause is disruption of riverine/lacustrine baseflow. All alternatives should ensure that base flow conditions are maintained at all times to minimize impacts towards 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 from 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 MNR), sediment control fencing and restoration of disturbed areas/habitat etc.

3) **Dewatering Impacts During Construction –** During construction, especially for the installation of the pipeline, 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.

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.

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.

5. REFERENCES

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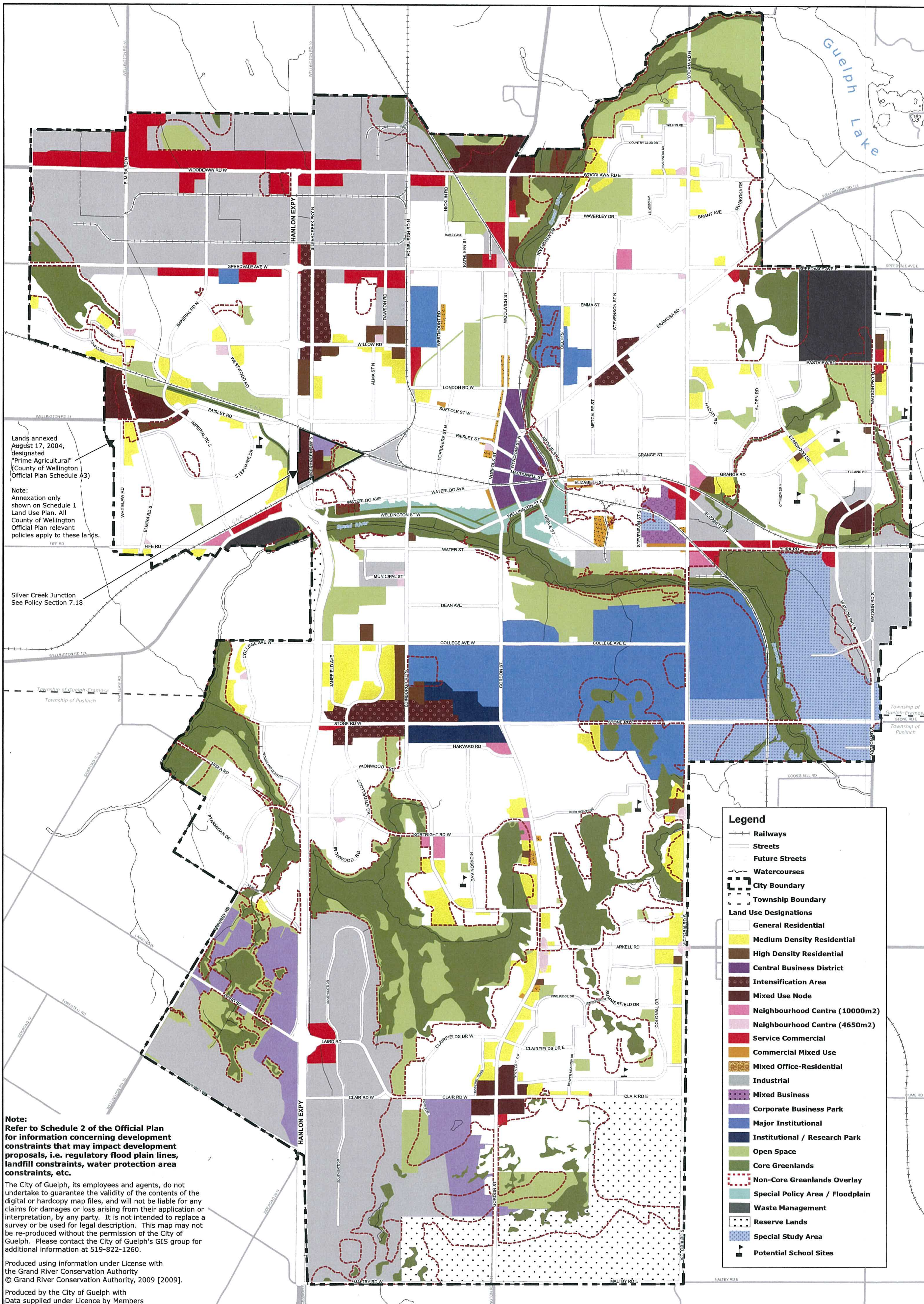
ATTACHMENT "A"

CITY OF GUELPH – SCHEDULE 1 "LAND USE PLAN" AND SCHEDULE 2 "NATURAL HERITAGE FEATURES AND DEVELOPMENT CONSTRAINTS" FROM OFFICIAL PLAN AND SCHEDULE 1 "LAND USE PLAN" AND SCHEDULE 10 "NATURAL HERITAGE STRATEGY NATURAL HERITAGE SYSTEM" FROM OFFICIAL PLAN AMENDMENT 42



Note:
Refer to Schedule 2 of the Official Plan for information concerning development constraints that may impact development proposals, i.e. regulatory flood plain lines, landfill constraints, water protection area constraints, etc.

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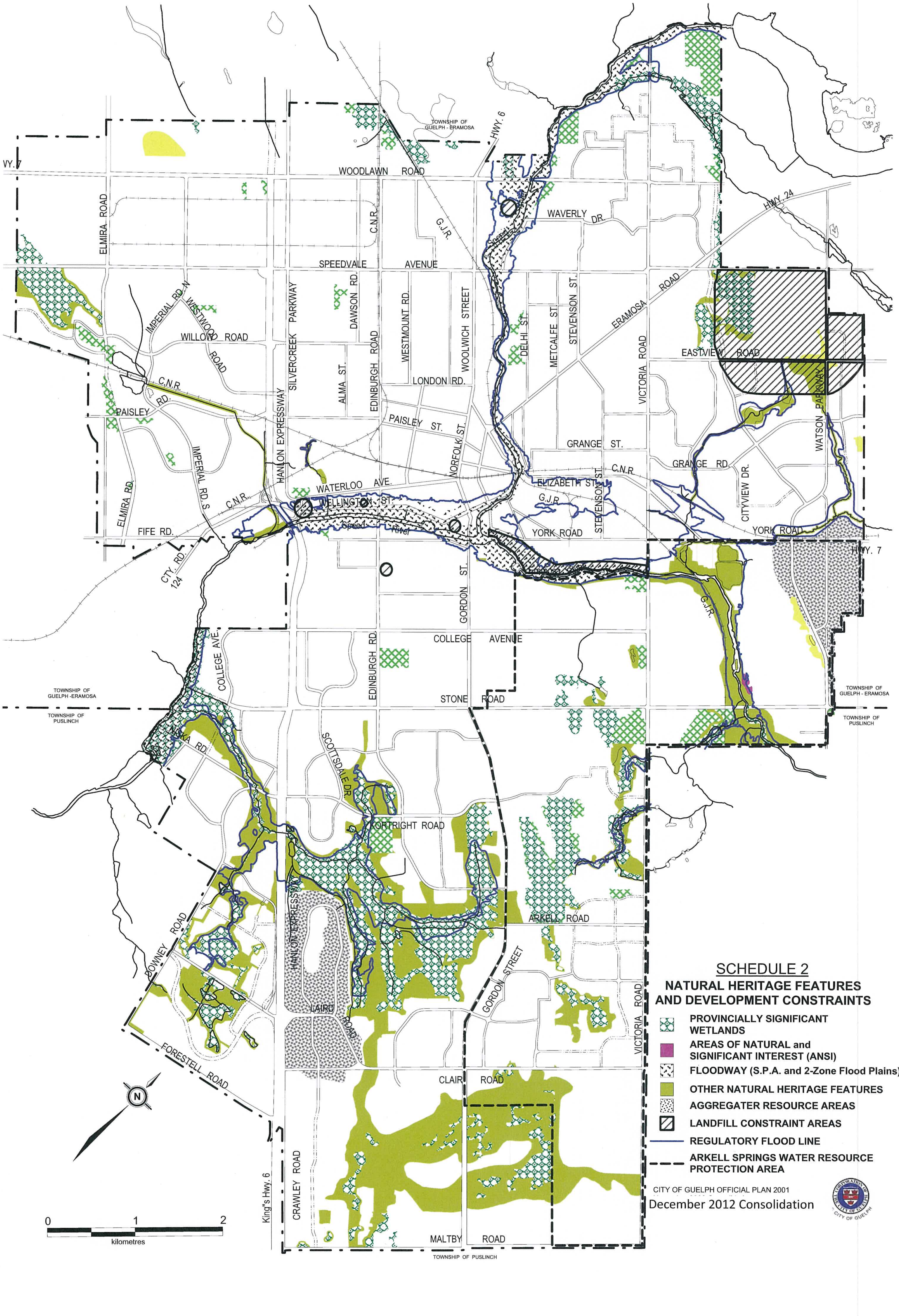
2001 Official Plan, December 2012 Consolidation

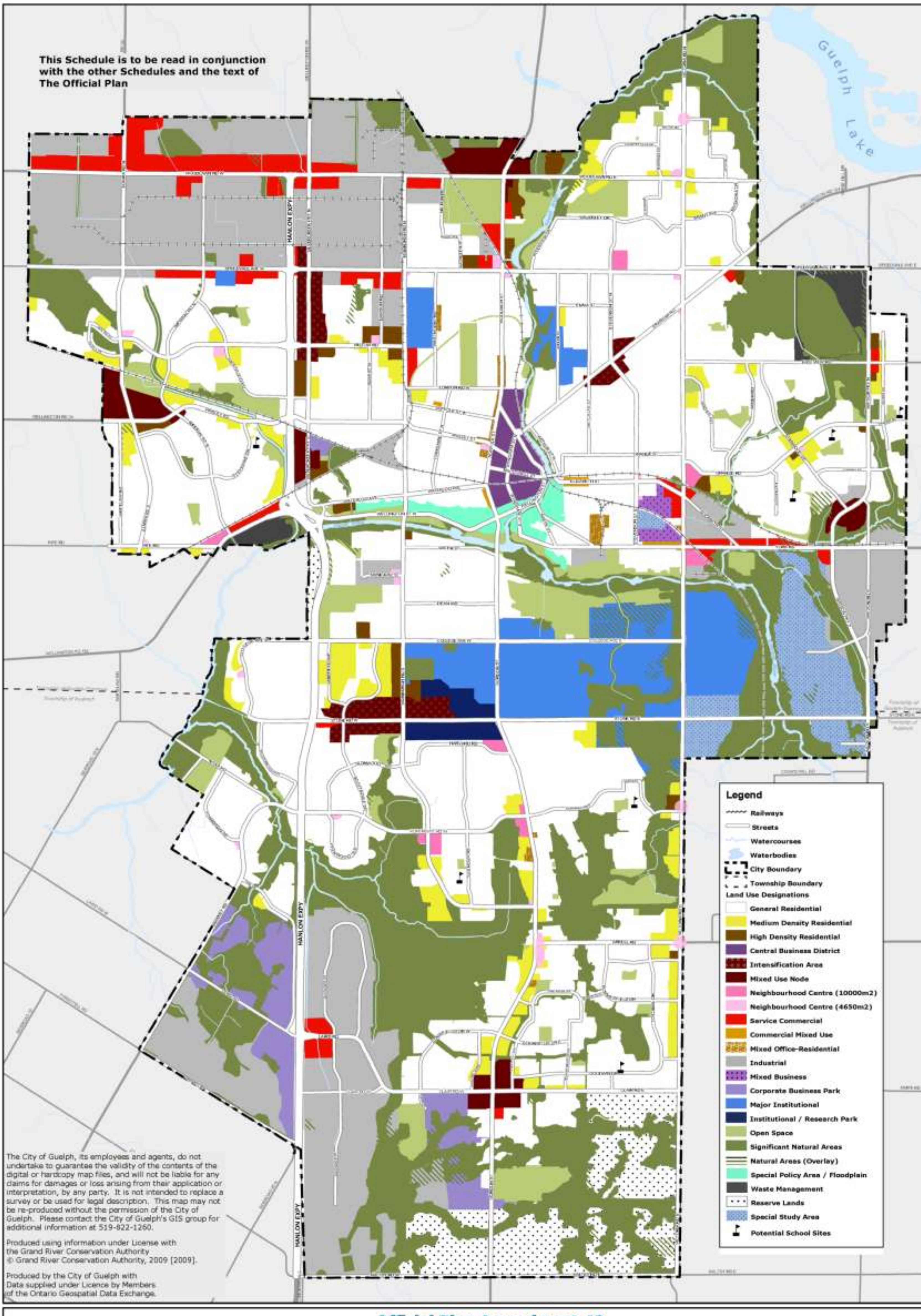
CITY OF GUELPH OFFICIAL PLAN

SCHEDULE 1: LAND USE PLAN

CITY OF Guelph
Making a Difference

Projection: NAD83 UTM Zone 17
Produced by the City of Guelph
Planning Services


SCHEDULE 2
NATURAL HERITAGE FEATURES AND DEVELOPMENT CONSTRAINTS
PROVINCIALLY SIGNIFICANT WETLANDS
AREAS OF NATURAL and SIGNIFICANT INTEREST (ANSI)
FLOODWAY (S.P.A. and 2-Zone Flood Plains)
OTHER NATURAL HERITAGE FEATURES
AGGREGATER RESOURCE AREAS
LANDFILL CONSTRAINT AREAS
REGULATORY FLOOD LINE
ARKELL SPRINGS WATER RESOURCE PROTECTION AREA
CITY OF GUELPH OFFICIAL PLAN 2001
December 2012 Consolidation
0
1
2
kilometres
N
TOWNSHIP OF GUELPH - ERAMOSA
TOWNSHIP OF PUSLINCH
WOODLAWN ROAD
SPEEDVALE AVENUE
WILLOW ROAD
PAISLEY RD.
PAISLEY ST.
LONDON RD.
WATERLOO AVE.
WELLINGTON ST.
FIFE RD.
YORK ROAD
COLLEGE AVENUE
STONE ROAD
KORTRIGHT ROAD
ARKELL ROAD
CLAIR ROAD
MALTBY ROAD
ELMIRA ROAD
HANLON EXPRESSWAY
SILVERCREEK PARKWAY
EDINBURGH ROAD
GORDON STREET
VICTORIA ROAD
WATSON PARKWAY
ERAMOSA ROAD
EASTVIEW ROAD
GRANGE ST.
GRANGE RD.
WAVERLY DR.
HWY. 6
HWY. 7
HWY. 24
CRAWLEY ROAD
DOWNEY ROAD
FORESTELL ROAD
LAIRD ROAD
SCOTTSDALE DR.
King's Hwy. 6
CITY OF GUELPH



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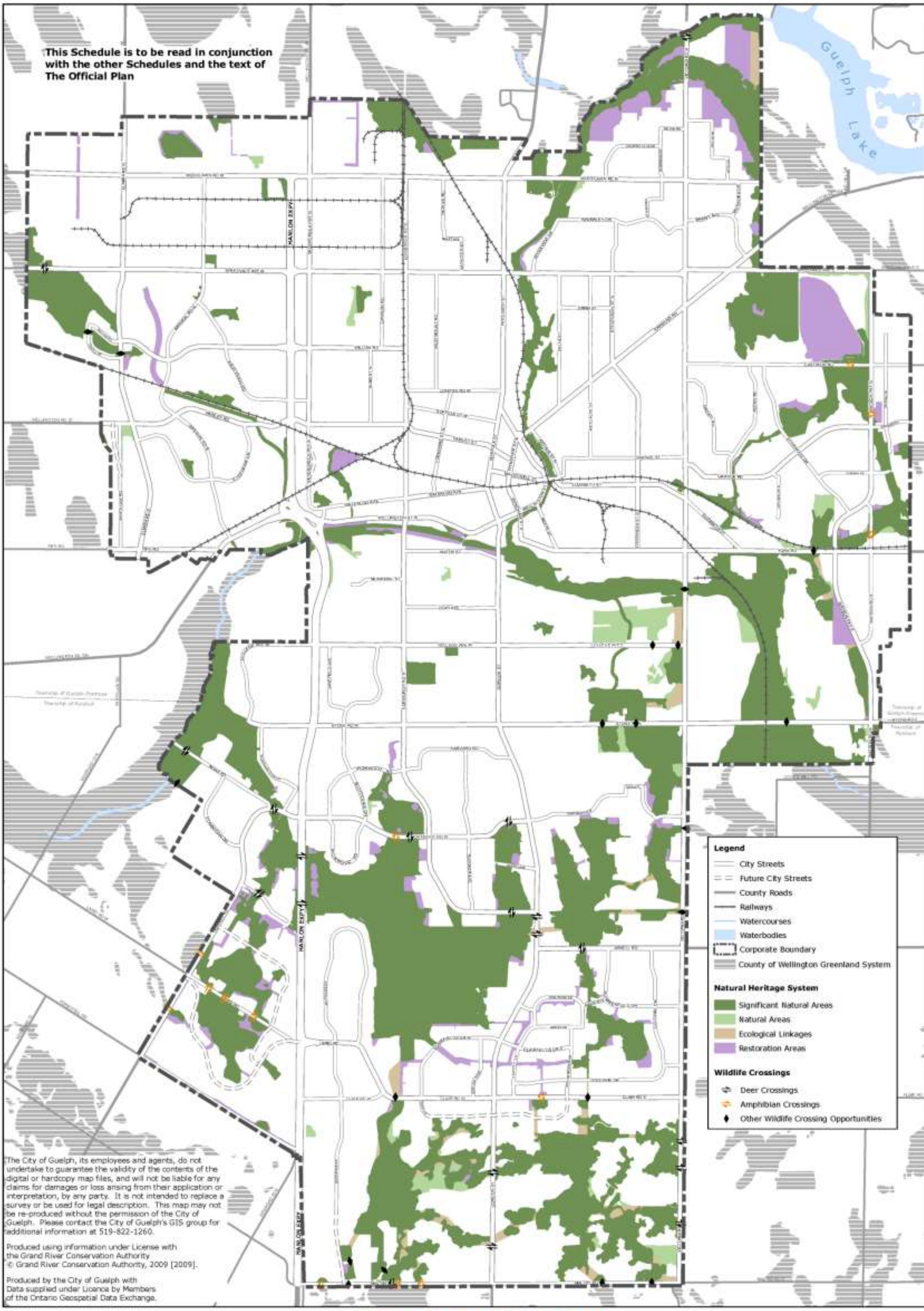
Projection: NAD83 UTM Zone 17
Produced by the City of Guelph
Community Design and Development Services, Planning Services
July 14, 2010

Official Plan Amendment 42

CITY OF GUELPH OFFICIAL PLAN

SCHEDULE 1: LAND USE PLAN

CITY OF Guelph
Making a Difference



Official Plan Amendment 42

CITY OF GUELPH OFFICIAL PLAN SCHEDULE 10: NATURAL HERITAGE STRATEGY

Natural Heritage System

N

1 0.5 0 1 KM

Projection: UTM 17N NAD83
Produced by the City of Guelph
Community Design and Development Services, Planning Services
July 14, 2010

CITY OF Guelph
Making a Difference

ATTACHMENT "B"

SPECIES AT RISK WITHIN WELLINGTON COUNTY

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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 assoicated 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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 30cm 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Amphibians	Jefferson Salamander *Ambystoma jeffersonianum*	END	THR 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Fish	Redside Dace *Clinostomus elongatus*	END	SC Schedule 3	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).	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Yellow-breasted Chat *Icteria virens*	END	SC 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Barn Swallow *Hirundo rustica*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
Fish	Black Redhorse *Moxostoma duquesnei*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Birds	Bobolink *Dolichonyx oryzivorus*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
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 nesitng habitat (i.e. chimnies).	he 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
Birds	Eastern Meadowlark *Sturnella magna*	THR	No Status	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
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 speice 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website Ontario Breeding Bird Atlas Wellington Squares 17NJ51, 17NJ52, 17NJ61, 17NJ62 Species List
Fish	Silver Shiner *Notropis photogenis*	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 follwoing ELC communities: OAO charachterized 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Molluscs	Wavy-rayed Lampmussel *Lampsilis fasciola*	THR	SC Schedule 1	SC	The Wavy-rayed Lampmussel is usually found in small to medium rivers with clear water. It lives in shallow riffle areas with clean gravel or sand bottoms. Like all mussels, this species filters water to find food, such as bacteria and algae. Mussel larvae are parasitic and must attach to a fish host, where they consume nutrients from the fish body until they transform into juvenile mussels and drop off. The Wavy-rayed Lampmussel's fish hosts are the Largemouth Bass and Smallmouth Bass. The presence of fish hosts is one of the key features for an area to support a healthy mussel population. This species can typically be associated with the following ELC communities: OAO characterized as small to medium rivers with clean water and riffles with gravel or sand substrates.	In Canada, the Wavy-rayed Lampmussel is found only in Ontario in the Grand, upper Thames, Maitland, and Ausable rivers, and the St. Clair River delta in Lake St. Clair. It has disappeared from Lake Erie, the Detroit River and most of Lake St. Clair, and may also be gone from the Sydenham River.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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 immediatly 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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
Birds	Common Nighthawk *Chordeiles minor*	SC	THR Schedule 1	THR	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 communitiesdes: SD, BB, RB, CUM, BO, FOM, FOC and FODwith 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Plants	Hart's-tongue Fern *Asplenium scolopendrium americanum*	SC	THR Schedule 1		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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Reptiles	Milksnake *Lampropeltis triangulum*	SC	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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	The Northern Map Turtle's range extends from the Great Lakes region west to Oklahoma and Kansas, south to Louisiana and east to the Adirondack and 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Red-headed Woodpecker *Melanerpes erythrocephalus*	SC	THR Schedule 1	THR	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	Short-eared Owl *Asio flammeus*	SC	SC Scheudle 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 assoicated 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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
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.	Wellington Region Speices at Risk - Ministry of Natural Resources Species at Risk Website
Birds	Wood Thrush *Hylocichla mustelina*	No Status	No Status	THR	The Wood Thrush can typically be found in the interior and along the edges of well-develoepd 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

Taxonomy	Species	ESA Status	SARA Status	COSEWIC Status	Preferred Habitat[1, 2]	Known Species Range[1, 2]	Source Identifying Species Record
Birds	Eastern Wood-Pewee *Contopus virens*	No Status	No Status	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 follwoing 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

Glossary

EXP	ESA - Extripated - a species that no longer exists in the wild in Ontario but still occurs elsewhere. SARA - Extripated - a wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
END	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.
THR	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.
SC	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 Stauts of Endangerd 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.
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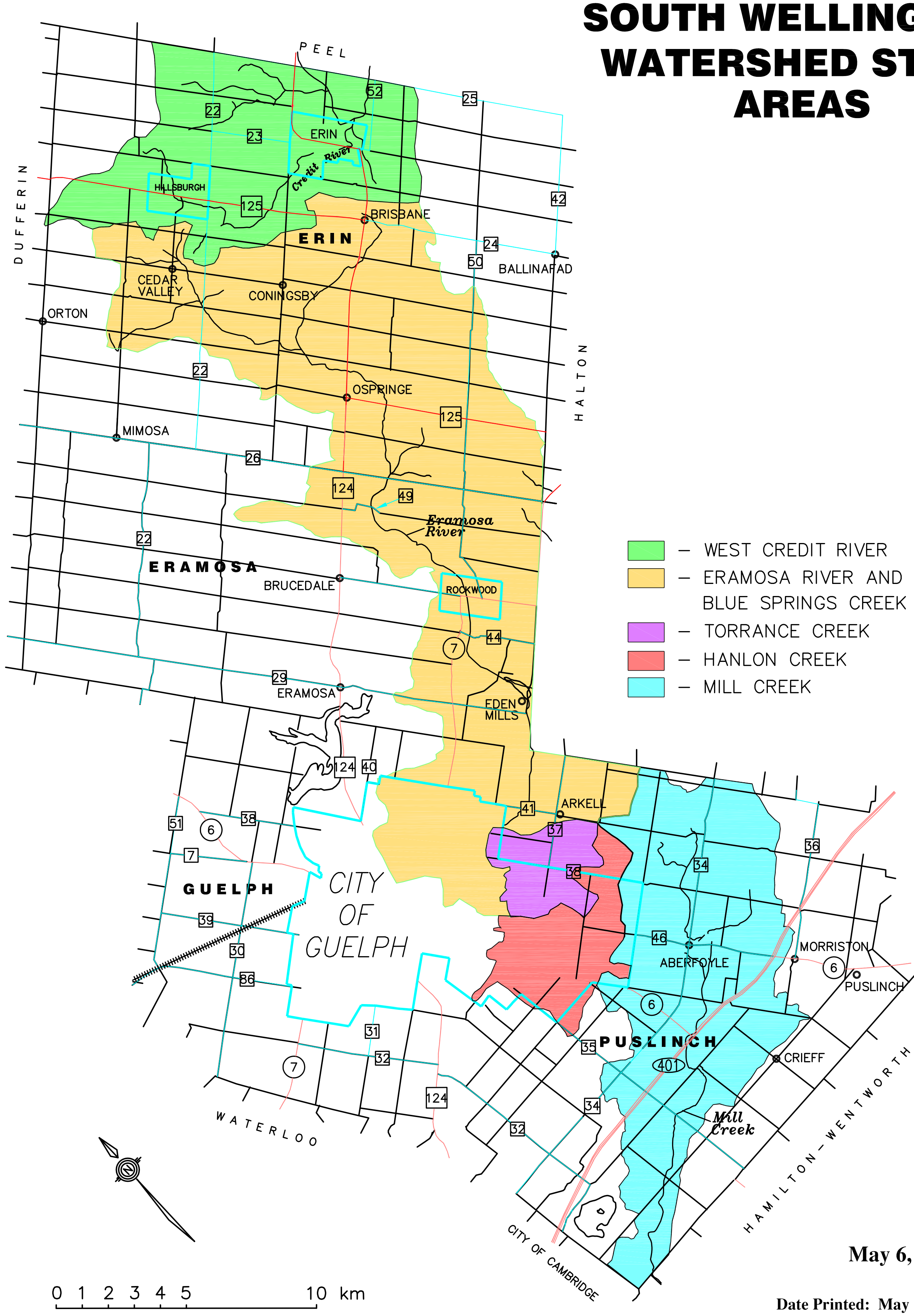
ATTACHMENT "C"

WELLINGTON COUNTY – APPENDIX 1 "SOUTH WELLINGTON WATERSHED STUDY AREAS AND APPENDIX 3 "COUNTY OF WELLINGTON PROVINCIALLY SIGNIFICANT WETLANDS" FROM OFFICIAL PLAN

APPENDIX 1

SOUTH WELLINGTON WATERSHED STUDY AREAS

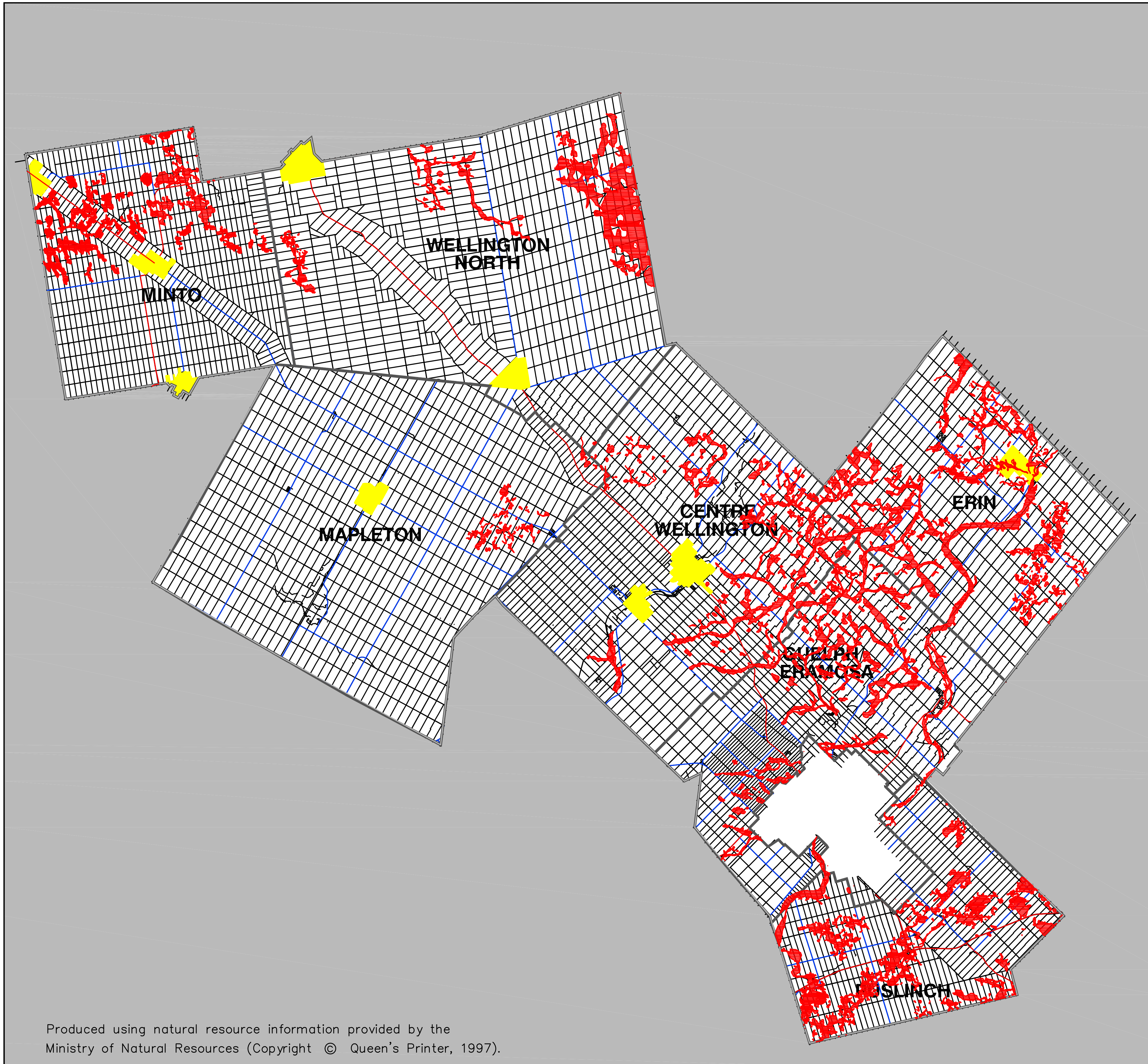


May 6, 1999

Date Printed: May 15, 2013.

APPENDIX 3

COUNTY OF WELLINGTON



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Provincially Significant Wetlands (Class 1,2,3)

Scale:

0 2000 6000 12000 metres

May 6, 1999

Date Printed: May 15, 2013.

Appendix E

Technical Memorandum
Public Consultation Memo

AECOM

Appendix E

City of Guelph Water Supply Master Plan Update (Draft Final Report)

Technical Memorandum – Public Consultation Summary

Note: As per the Accessibility for Ontarians with Disabilities Act, this document is available in an alternate format by contacting Dave Belanger – City of Guelph (519-822-1260 Ext. 2186)

City of Guelph

Water Supply Master Plan Update
Consultation Summary Report (Draft Final)

Prepared by:

AECOM
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Project Number:

60287843

Date:

May, 2014

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- may be based on information provided to Consultant 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
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Appendix M. Notice of Completion

1. Introduction

The City of Guelph initiated a Class Environmental Assessment (EA) Study in May 2013 to update the Water Supply Master Plan. The Water Supply Master Plan is a comprehensive assessment to define how the City will continue to access a sustainable supply of water—to meet residential, industrial, commercial and institutional demands—over the next 25 years. Reviewing Guelph's 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.

This update follows the requirements of a Municipal Class Environmental Assessment (Class EA). The updated Water Supply Master Plan identifies constraints and opportunities related to our existing water supply system. It also prioritizes a number of individual projects to increase the capacity of the existing water supply system.

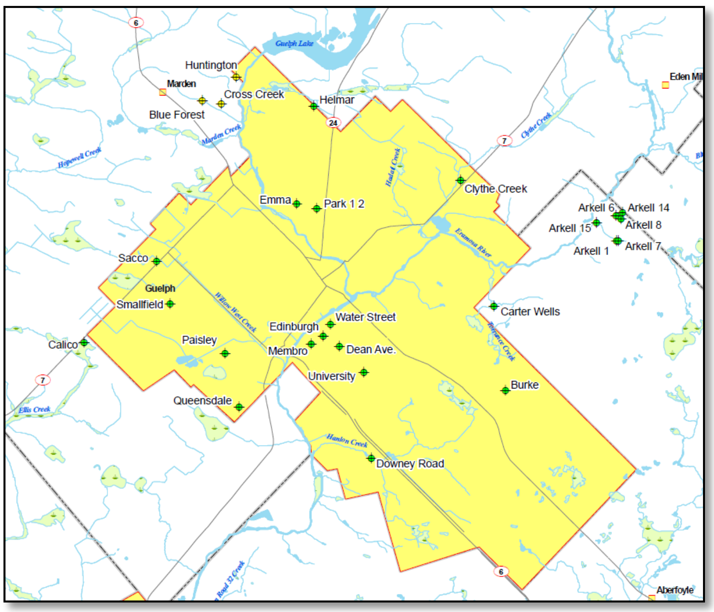

Figure 1. Study Area

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. With this in mind:

- **Pre-consultation Interviews** were held with select community members and prospective Community Liaison Committee members to understand perspectives related to water supply and to confirm community engagement needs.
- A **Community Liaison Committee** (CLC) was established to advise and provide feedback to the project team throughout the process;
- A **Municipal / Agency Workshop** provided crucial inputs from a government and approval agency perspective;
- Two public **Open Houses** were held during the course of the study, 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 four meetings of the Water Conservation and Efficiency Public Advisory Committee;

- Presentations were made at the Puslinch Township and the Guelph Eramosa Township Councils' meetings at their request; and,
- **Guelph Water User Survey**: Expectations of Service was completed in early 2014.

The purpose of this report is to present an overview of consultation for the Guelph Water Supply Master Plan Update and to document responses.

2. Notice of Commencement

One of the key objectives of the environmental planning process is to provide the public, interested parties and agencies with opportunities for meaningful input. To meet this objective, comprehensive public and agency notification was undertaken.

The Notice of Commencement for this project was advertised on May 16, 2013 in the following locations:

- Milton Canadian Champion, May 16, 2013
- Guelph Tribune, May 16, 2013
- Wellington-Advertiser, May 16, 2013
- City website: http://guelph.ca/plans-and-strategies/water-supply-master-plan/

The Notice of Commencement was also sent to the project mailing list, which included the following agencies and First Nations groups:

Table 1 – Agency, Municipality and First Nations Groups Receiving the Notice of Commencement

Agency	Contact/ Position
Ministry of Natural Resources	Mr. Mike Stone, Guelph District Planner
Ministry of Natural Resources	Mr. Ian Hagman, Guelph District Manager
Ministry of Natural Resources, Water Resources Section, Lands and Waters Branch	Ms. Paula Thompson, Senior Policy Advisor
Ministry of the Environment	Ms. Annamaria Cross, Manager Environmental Approvals Branch
Ministry of the Environment	Ms. Jane Glassco, District Manager, Guelph
Ministry of Agriculture, Food, and Rural Affairs, Environmental and Land Use Policy Unit	Ms. Carol Neumann, Rural Planner, Environmental Land Use Policy, Food and Environmental Policy Branch
Ministry of Agriculture, Food, and Rural Affairs	Mr. David Cooper, Manager, Environmental & Land Use Policy
Wellington-Dufferin-Guelph Health Unit	Mr. Shawn Zentner Program Manager, Health Protection Division
Wellington-Dufferin-Guelph Health Unit	Mr. Chuck Ferguson, Manager of Communications
Ministry of Municipal Affairs and Housing, Planning Services, Southwestern Municipal Services Office	Mr. Bruce Curtis, Manager Community Planning & Development
Ministry of Culture, Tourism and Recreation, Southwest Area Head Office	Chris Stack Added Sept. 6, 2013, Manager Southwest Area
Guelph / Eramosa Township	Ms. Janice Sheppard, CAO
County of Wellington	Mr. Scott Wilson, CAO
Township of Puslinch	Karen Landry, CAO
Town of Milton	Mr. Mario Belvedere
GRCA	Mr. Martin Keller, Source Protection Program Manager
Six Nations of the Grand River	Chief William Montour

Mississauga's of the New Credit First Nation	Chief Bryan LaForme
Aboriginal Affairs and Northern Development Canada	Consultation Unit

The Notice of Commencement identified the purpose of the Water Supply Master Plan study, project team contact information, and the many opportunities for public engagement as part of the Municipal Class Environmental Assessment process. The Notice of Commencement can be found in **Appendix A**.

3. Consultation Round #1

The first round of consultation occurred in September and October 2013. The purpose of the first round of consultation was to introduce the Water Supply Master Plan Update process and the proposed methodology, and the problem/opportunity statement which explains the anticipated need for additional water supply.
Activities during this period included:

- Community Liaison Committee Meeting #1
- Municipality/Agency Meeting #1
- Community Open House #1

3.1 COMMUNITY LIAISON COMMITTEE #1

3.1.1 Composition

A Community Liaison Committee (CLC) was established to help the project team understand what water supply issues are important to Guelph residents. The CLC also provided guidance on key aspects of the Guelph Water Supply Master Plan update, including:

- Objectives and scope of the Master Plan Update;
- Issues and opportunities to be addressed;
- Alternative solutions to be assessed;
- Evaluation method and criteria to be applied; and
- Preferred alternatives and implementation strategy.

The committee included 20 individuals, with membership drawn from a cross-section of the community to provide a broad and balanced perspective. **Table 2** identifies the individuals selected for the committee and their affiliation.

Table 2 – Community Liaison Committee Composition

Business / Industry			
University of Guelph	1a	Bob Carter	Assoc. VP, Physical Resources
University of Guelph	1b (alternate)	Dan Maclachlan	Director, Design, Engineering and Construction
Chamber of Commerce	2	Janet Roy	Chair and CEO
Sleeman Breweries Ltd.	3a	Ed McCallum	Director of Brewing Development
Sleeman Breweries Ltd.	3b (alternate)	Dave Klaassen	National Director of Total Quality
Environment			

Water Conservation & Efficiency Advisory Committee	1	Mike Darmon	Chair
Wellington Water Watchers	2	Kim Gutt	Communications Director
Agriculture			
Wellington-Guelph Federation of Agriculture	1	Gordon Flewwelling	President
Land Development			
Guelph Wellington Developers' Association	1	Angela Kroetsch	
Guelph & District Homebuilders' Association	2	Glenn Anderson	
Community/Social			
Friends of Guelph	1	Ken Hammill	
River Systems Advisory Committee	2	Jeremy Shute	Chair
Academia			
University of Guelph	1	Brady Deaton	Assoc. Professor, Food, Ag. & Resource Economics
University of Guelph	2	Peter Chrisholm	School of Engineering
Community at Large (Guelph)			
Resident	1	Andrea Williams	
Resident	2	Steve Chomyc	
Region of Waterloo; prior head of water services	3	John Pawley	
Community at Large (Outside Guelph)			
Hydrogeologist	1	Bill Banks	
Puslinch Councillor	2	Wayne Stokley	Puslinch Township Councillor
Guelph-Eramosa Representative	3	Chris White	Mayor of Guelph-Eramosa Township

A notification letter was sent on August 1, 2013 to individual members of the Community Liaison Committee to confirm their participation.

3.1.2 Objectives and Format

The first Community Liaison Committee (CLC) meeting was held on September 17, 2013 at the City of Guelph's City Hall from 7:00 pm to 9:30 pm. Fourteen members of the CLC were able to attend the first meeting, along with two members of the public. Eight members of the project team from AECOM and the City of Guelph were also present.

During the evening, presentations were delivered by Dave Belanger and Wayne Galliher of the City of Guelph, and Patty Quackenbush of AECOM. The meeting was facilitated by Avril Fisken of AECOM.

The CLC meeting #1 presentation covered the following topics:

- Welcome and Opening Remarks
- Water Supply Master Plan Update Overview

- Guelph's Current Water Supply System
- Progress Since the 2007 Water Supply Master Plan
- The 2013 Water Supply Master Plan Update
- Next Steps

A Discussion Guide was prepared and given to each of the participants. The guide included additional information about the project, as well as questions to encourage dialogue and feedback on areas of interest. The CLC meeting minutes and presentation can be found in **Appendix B.**

3.1.3 Discussion Guide Comments Received

The participants were encouraged to provide verbal comments about the project, and also to complete questions found at the end of the Discussion Guides for submission after the meeting. Three sets of Discussion Guide questions were returned.

Based on feedback received, participants were comfortable with the current level of water supply service provided by the City, and urged staff to take more action to conserve and manage existing water sources. Participants also supported existing conservation programming, and suggested new ways to save water. Concerns were expressed about how the City of Guelph's water conservation message can be perceived given the emphasis on growth and development. Concerns were also expressed about major water users and other Industrial, Commercial and Institutional (ICI) users, as well as the uneven pricing system which favours industries that increase Guelph's water needs. Other comments identified issues such as higher runoff due to new subdivision developments, a lack of support for a Great Lakes pipeline, and environmental contamination.

The answers have been combined in **Table 3** to show the diversity of opinions received:

Table 3 - Summary of Discussion Guide Submissions – Community Liaison Committee Meeting #1

Q: Are you comfortable with the level of service (water supply) currently provided by the City of Guelph?
A: Yes, as a residential user. A: The information on the capacity daily consumption and related conservation initiatives is great, and I am comfortable with the related level of services. From the street, the public tells me there is an apparent disconnect between Council pushing growth, but telling existing residents to use less water. A: Yes, though access to public taps could be improved. More water fountains in parks, and a map to public taps should be made available online and at City Hall. That way people can plan picnics, runs, etc. This also helps displaced youth and homeless.
Q: Do you feel the City's current water conservation goals are adequate? Are there additional goals that you feel should be considered?
A: Water conservation goals should increase with increased population growth. Technology advances will provide a resource for increasing conservation goals. So far, ICI capacity buyback program appears to have more of a financial incentive package than residential rebate programs. A: Excellent and probably more to come. A: Conservation can best be encouraged through effective public education initiatives, which can be carried out by the city in cooperation with special interest groups, NGO's, schools and other organizations. In the past, the City has supported water efficient gardening education, and this has potential for furthering conservation. We must

give more thought to new industrial uses. For example, Nestle came to the City and argued that it would create jobs and was good for business, when in reality this industry is largely automated. Now Nestle is taking advantage of us and our tax payers must pay for new infrastructure as well as for municipal recycling programs to deal with their silly bottles.
Q: Do you believe the City should consider establishing water use goals for new growth (e.g., Attracting industries that require less water or conservation-oriented new residential developments)?
A: Should [have] focus incentive programs to new builds in both residential and ICI sectors. Are retrofits as efficient as new builds? More marketing and promotion of the programs. A: No. A: Definitely, new industries and construction of residential housing should employ state of the art water conservation technologies, and new industries should both be evaluated for their water needs and required tax payers pay the cost of expanding water resources to meet their needs.
Q: How much water (i.e., percent of existing supply capacity) do you believe should be considered as "back-up" to ensure security of supply?
A: Stated in presentation that Guelph only uses a percentage of recharge capability. We should be using less than the recharge rate so that the initial total groundwater volume [could] be considered "back-up" A: This (firm capacity) must be provided by the project team. A: 20%
Q: Are the Objectives and Purpose Statement adequate for this WSMP update? Are there additional objectives that you feel should be considered?
A: Look at the relationship between population and water supply, examine whether to share the costs of waste loading on the speed river.
Q: Are there existing activities/ programs that you would like to see continued or prioritized?
A: ICI capacity buyback program, however I feel that their payback period is shorter than expected. Purple pipe research and planning studies. A: Yes. Conservation programs linked to cost effectiveness. A: Encouragement of urban agriculture using harvested rain water as a measure to recharge aquifers.
Q: Are there new approaches or alternatives that we should consider to improve or expand our water supply system?
A: "Purple Pipe program." Wastewater re-use. A: Enlarge the scope of the study beyond the city limits of Guelph to use conservancy system.
Q: Do you have concerns regarding any of the alternatives presented? Should any of these not be considered through the Water Supply Master Plan update?
A: We would not want to include a pipeline to Lake Erie as an option for meeting Guelph's current and projected water needs. The pipeline could be avoided entirely if local industries were charged a realistic rate for their water (which would require updating a provincial system) or there should be a clause in business agreements where they assume responsibility for replenishing water as quickly as the natural rate. We need more incentives for industry to conserve and restore.

Q: Are there changes (i.e., additions or deletions) that should be considered for the Scope of Work; to improve the recommendations resulting from the Water Supply Master Plan update?
A: Consider implications of population and water supply forecast will lead to possible choices for scope of work.
Q: Should water supply sources inside the City be prioritized over those outside the City boundaries?
A: Water inside the city should be prioritized. Promote the mentality of sustainability. Going outside the city limits weakens Guelph's perception by "the world" of being green. A: Yes, we should steward and protect our internal sources of water, rather than access water resources from outside. This has both financial implications (the transport of water from outside resources) and control concerns – (Other government bodies could control or deny access to outside water resources).
Q: Are there pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan?
A: New development programs should be a pressing issue due to window of action. A: Council should have technical staff to focus on technical issues and Council should guide policy issues. A: The failure of large industrial water users to pay the real costs of supplying their needs, especially as those needs require the city to increase water taking to meet industry's needs. Taxpayers will be responsible for paying for new infrastructure when water becomes scarce, yet most of them don't know this. Also, we could have more public education about the difficulty/infeasibility of removing many chemicals from our water supply. We need to help people understand that everything that is put in the sink/toilet ends up in the ecosystem and that small changes can affect whole ecosystem health. Prevent dumping of medicines and cleaning agents into water. Education is needed about rising levels of estrogen being found in freshwater and impeding the ability of important amphibians to reproduce, for example.
Q: Do you have a preferred approach for expanding our water supply capacity? If so, what and why?
A: Deep well development within the city limit. Decontaminating offline wells. Treating manganese/sulphur wells. A: Yes, rainwater harvesting and recharging of aquifers, further conservation efforts (e.g., Permeable pavement and other features built into building codes for any new developments or upgrades).
Q: Would you be comfortable obtaining water from sources that required treatment to remove contaminants (i.e., natural or industrial)? (Assumes that all regulatory standards are met after treatment)
A: Yes, as technology advances, our ability to meet water standards for drinking water may be met at a reasonable cost. A: Not at all – who would want to drink from Lake Erie, no matter how much it is treated? Furthermore, the Great Lakes are at all-time low levels. We are just moving the problem around. Conservation should be built into all building codes – grey water recycling, rain water harvesting, permeable pavement, landscaping restrictions, must become common place regardless of where our water source is.
Q: 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?
A: Unfortunately, the City is already moving down the path to environmental degradation by allowing prime farm land to be converted to subdivisions. While farming allows the recharging of aquifers naturally, subdivisions vastly increase the discharge of rain water into storm sewers, creeks and rivers, and this water is lost to the areas from which Guelph harvests water. The current level of degradation is already unacceptable. Water scarcity will cause violent conflict and illness in our lifetimes, and will be exacerbated by climate change which at this point is irreversible. Given the current uncertainty of future weather patterns, we should be doing everything we can to

protect our current water supply and do more with less.
Q: Any additional feedback or ideas?
A: N/A.

3.1.4 CLC Comment Card Responses

At the end of the meeting, CLC members were encouraged to provide their feedback on the meeting's effectiveness using the Comment Cards provided. Eleven of the 14 participants submitted comments, providing an overall positive evaluation of the project team. Project team members were highly rated for their responsiveness, and for encouraging of feedback and answering of questions.

Feedback on the session was mixed, with some seeking more information, while others felt that too much information was provided. An additional comment about the timeframe and scope of the project was also noted. Based on this feedback, the project team, during the next round of consultations, provided presentation materials prior to the CLC and Municipality/Agency meetings to give the participants time to review related documents prior to the sessions.

Comments and ratings received are included in **Table 4** below:

Table 4 - Summary of Comment Card Submissions – Community Liaison Committee Meeting #1

Comment Card Questions	Answers
Please let us know your thoughts on tonight's meeting. We welcome your feedback.	• Learned a great deal from the presentations and printed materials. • Well done. • Need more information • Great
Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?	Yes: 7 No: 0 No answer: 2 Both: 1 (yes for top level, but no, need more).
Did you feel encouraged to provide feedback?	Yes: 8 No: 0 No answer: 2
Did you get answers to your questions?	Yes: 7 No: 1 No answer: 2 Reason for answering "no": • Time constraints, lots of information to gather and questions to answer. • Generally, but some of my questions were out of context.
Were our staff forthcoming with their answers and knowledgeable in their area of expertise?	Yes: 9 No answer: 2
Overall, how would you rate this Open House?	Poor: 0 Fair: 2 Good: 7 Excellent:

Comment Card Questions	Answers
	No answer: 2
Please let us know what you would like to discuss at our next Community Liaison Committee Meeting?	• The meeting was good for educating community members, less effective for eliciting answers to your 17 questions. Perhaps you will get these answers/opinions through our written comments. Perhaps encourage people to read materials and submit comments online for next meeting. • Budget • Demand to 2031 • Are we looking beyond 2031? Yes, later in the meeting we had agreement with Rockwood which put a lid on growth. Still there? How do we educate public? • More information regarding new potential water supply areas: surface, shallow aquifer? • Perhaps a microphone for soft speaking presenters • More information (detailed) should be provided in advance. I'd like to learn a bit more about how water rates are set. • Groundwater supply developments adjacent to townships • Confirmation from township representatives on this.

3.2 MUNICIPALITY / AGENCY WORKSHOP #1

3.2.1 Composition

The project team encouraged the participation of agencies and local municipalities in the Guelph Water Supply Master Plan process. A series of two workshops were held to provide regulatory agencies with information about study progress, and to answer questions and obtain initial feedback.

Meeting notifications / invitations were sent by email on September 6, 2013 to agency and municipality contacts who were expected to have a potential interest in the project. These included:

- Ministry of Natural Resources
- Ministry of the Environment
- Grand River Conservation Authority
- Township of Puslinch
- Township of Guelph Eramosa
- Town of Milton
- County of Wellington
- Wellington-Dufferin-Guelph Public Health
- Ministry of Tourism and Culture
- Ministry of Municipal Affairs and Housing

Individuals representatives who were unable to attend were encouraged to send an alternate in their place.
The first Municipality and Agency Workshop was held on September 19, 2013 at the City of Guelph City Hall from 1:00 pm to 5:00 pm. Thirteen representatives from local municipalities and agencies were present, including:

- Puslinch Township – 2 representatives
- Guelph-Eramosa Township – 2 representatives

- County of Wellington – 1 representative
- Grand River Conservation Authority – 1 representative
- Wellington-Dufferin-Guelph Public Health – 1 representative
- Ministry of the Environment – 6 representatives

Ten (10) City of Guelph staff and two Project Team members from AECOM were also present at the meeting to answer questions.

3.2.2 Objectives and Format

The Municipality and Agency Workshop was established to provide input from a government and agency perspective to ensure that the Water Supply Master Plan update meets related local and provincial By-laws and Acts, as well as Environmental Assessment and Approval requirements.

Participants were expected to provide guidance on key aspects of the Guelph Water Supply Master Plan Update, including:

- Objectives and scope of the Master Plan Update
- Issues and opportunities to be addressed
- Alternative solutions to be assessed
- Evaluation method and criteria to be applied
- Preferred alternatives and implementation strategy

The Municipality and Agency Workshop followed the same format as the CLC meeting. Dave Belanger and Wayne Galliher of the City of Guelph, and Patty Quackenbush of AECOM delivered presentations. Avril Fisken of AECOM facilitated the meeting.

The Municipality and Agency Workshop presentation covered the following topics:

- Welcome and Opening Remarks
- Water Supply Master Plan Update Overview
- Guelph's Current Water Supply System
- Progress Since the 2007 Water Supply Master Plan
- The 2013 Water Supply Master Plan Update
- Next Steps

The Municipality and Agency Workshop minutes and presentation can be found in **Appendix C.**

3.2.3 Discussion Guide Comments Received

Discussion Guides were provided to participants at the Municipality and Agency Workshop that contained questions to prompt discussion during the meeting. Participants had the option of filling out the question section of the Guide and providing them to the Project Team after the meeting. No discussion guide questions were returned.

3.2.4 Municipality and Agency Comment Card Responses

Participants at the Municipality and Agency Workshop were encouraged to complete comment cards about the meeting format, the topics covered, and whether answers were received to questions. Five forms were completed by

participants, and one individual provided comments by email. Most respondents had a positive experience, with participants receiving answers from knowledgeable staff and feeling encouraged to provide feedback. Response explanations suggested that additional notification time and a review period prior to the meeting would help gain higher quality feedback. This feedback was acted on during the second round of consultation.

Table 5 summarizes the comments and ratings received:

Table 5 - Summary of Comment Card Submissions - Municipality and Agency Meeting #1

Comment Card Questions	Answers
Please let us know your thoughts on tonight's meeting. We welcome your feedback.	• None received.
Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?	Yes: 5 No: 0 Both: 1 Explanation for "both": Public Health's level of knowledge of existing system and 2007 plan is limited, so a more detailed overview provided ahead of the meeting may allow participants to provide more useful feedback during the meeting. However, info presented was excellent and is very much appreciated. Comment: Yes, but as I stated there are some considerable concerns about the planning aspects for wellhead protection and costs associated with any project being entirely assumed by Guelph. 1 cent a litre works for me. This equals 160/year.
Did you feel encouraged to provide feedback?	Yes: 6 No: 0 Comments: 1) However, as noted above, could use additional time to process info so feedback provided is valid and useful. 2) Yes again but if the "pipe" is off the table maybe others areas might be too.
Did you get answers to your questions?	Yes: 4 No: 1 No answer: 1 Comment: Not always but follow-up is required for some.
Were our staff forthcoming with their answers and knowledgeable in their area of expertise?	Yes: 6 No: 0

Comment Card Questions	Answers
	Comment: Yes, but the person at the end of the table that drew the circle to outline the advantages of combined network of supplies didn't get the consideration that he should have. This looks like a promising long term solution to some issues.
Overall, how would you rate this Open House?	Poor: 0 Fair: 0 Good: 5 Excellent: 1 Comment: Good, first session common ground for information base set up. I also asked for a copy of the attendance list and the .ppt presentation as the slides were too small to see in some cases. **(Note: This individual was met with on October 2, 2013 during which time slides were presented).**
Please let us know what you would like to discuss at our next Community Liaison Committee Meeting?	Public Health will provide feedback to questions posted by email as soon as possible. Public Health will also consider discussion and submit later by email. Also, earlier notice of meetings would be helpful.

3.3 COMMUNITY OPEN HOUSE #1

3.3.1 Notification and Timing

Community Open House #1 was held on October 10, 2013 to provide interested stakeholders with an opportunity to learn more about Guelph's water supply system, review project plans and to provide preliminary input on the Problem/Opportunity statement and methodology.

A notice was prepared for Community Open House #1 and advertised in the following locations:

- City website: September 21, 2013
- Milton Canadian Champion: Thursday September 26, 2013
- Guelph Tribune: Thursday September 26, 2013
- Wellington-Advertiser: Friday October 4, 2013 (one week later resulting from an oversight at the newspaper)
- Facebook: October 8, 2013
- Twitter: October 8, 2013 and October 10, 2013

The Community Open House notice was also distributed between September 26 to 27 2013 to the project mailing list which includes elected officials, agencies, aboriginal communities, interested residents, and the Community Liaison Committee (CLC) members.

The Community Open House notice is included in **Appendix D.**

3.3.2 Objectives and Format

The Community Open House was designed to provide attendees with an opportunity to:

- Learn about the study scope and the need for an updated Water Supply Master Plan
- Review existing conditions
- Review and comment on conservation and infrastructure progress since the 2007 Water Supply Master Plan
- Ask questions and discuss the project with members of the project team

Participants were greeted and encouraged to sign the Open House Attendance Sheet on arrival. A Discussion Guide was provided with questions that could be answered and deposited in the comment box provided. The agenda for the Community Open House can be found in **Appendix E.**

Information was presented at the Community Open House using two methods:

1. **Display Panels** to aid the explanation of project progress and key issues in a relaxed atmosphere. The panels were placed around the room to explain existing conditions of Guelph's water supply, progress since the 2007 Water Supply Master Plan and finally the approach for the current update. Attendees could view the panels at their own pace or with a project team member.

2. A **presentation** was provided between 7:00-7:45 pm by Dave Belanger, Water Supply Program Manager at the City of Guelph, and Patty Quackenbush, AECOM Senior Project Engineer. The presentation walked participants through the display boards and explained key project details. Time to ask questions was provided.

The presentation and the displays presented at the Community Open House were posted to the City's website and are provided in **Appendix F**.

The Community Open House provided an opportunity for members of the public to view the display material and to discuss the project with City of Guelph staff and consultant representatives. Attendees were encouraged to discuss their comments or concerns with the project team members present and to provide written comments for the comment box.

3.3.3 Participation and Comments

Sixteen members of the general public attended the Community Open House. Of these, six individuals identified themselves as home builders or from related construction and engineering firms, four were from surrounding municipalities, one was from a non-governmental organization (NGO), and the remaining five were unaffiliated or residents. These affiliations suggest that this Water Supply Master Plan update has attracted a wide cross-section of individuals, but with a focus on individuals likely to have a primary interest in the plan's policy and infrastructure implications.

The following sections provide a summary of both verbal and written comments received following the Community Open House.

3.3.3.1 Open House Presentation

The Community Open House included a presentation by Dave Belanger of the City of Guelph and Patty Quackenbush of AECOM. Questions were encouraged from the audience throughout the presentation. A summary of questions and answers are provided in **Table 6**:

Table 6 - Summary of Discussion at the Community Open House #1

Q: Are we going to touch on overall limits on water in the aquifer?
A: Our water supply is currently sustainable since we are using only a small percentage of the available water. Along with snow melt, the precipitation keeps recharging the aquifer.
Q: How does this project affect the Dolime Quarry?
A: The City of Guelph is working with the Ministry of the Environment to meet its requirements and regulations to ensure the City's water supply is protected. If there was to be an impact, it would when the quarry shut-down. The project does not address individual aggregate pits.
Q: How does road salt affect the water supply?
A: Guelph has observed some increased sodium chloride in some of the municipal wells. The City is looking at policies and procedures to manage this issue. Levels of sodium and chloride are not currently high enough, but we are seeing enough of a trend to continue watching it closely. Possible actions could include wet application of sand using beet juice, or other activities to reduce impacts.
Q: What is the status of the water system infrastructure with respect to leakage?
A: The City of Guelph does have leakage. There are programs to address the leaks, and large leaks have been addressed. Guelph has 10%-12% leakage in the municipal system, which is around the industry average. Guelph will be looking at comprehensive programs to fix leaks.
Q: How significant is water supply contamination in Guelph?
A: The Smallfield well has significant contamination. It is located near an area with high contamination due to existing and past industrial operations. The City of Guelph is working closely with the Ministry of the Environment and property owners to address the contamination issue. It is a long process, and there are no overnight solutions.
Q: In your assumptions that the water supply will stay the same, and are you taking into account global warming? Less precipitation or more precipitation?
A: Yes. The Tier 3 program is essentially a groundwater/ surface water modeling exercise. The model is able to account for more precipitation and more runoff. The program also will model certain drought conditions to ensure that the water supply is sustainable. Climate change will likely see the same amount of precipitation, but higher intensity rain events. We are taking those factors into account.
Q: What is the water cost in Guelph compared to other similar municipalities?
A: The City of Guelph rate is approximately $2.90 per cubic meter. The City is middle of the pack compared to other similar municipalities based on a comparison of 26 municipalities. The comparison will be released by the City in the next few days on the Guelph website.
Q: What is the effect of water softeners downstream?
A: One of the options that may be considered is more improvements to site-based softener technologies at water treatment plants.
Q: How does new growth in the Hanlon Parkway and Clair Road impact Guelph's wastewater treatment capacity?
A: New developments are examined at the City through the economic development group. They evaluate each development on a case by case basis to determine what services the Institutional, Commercial, and Industrial (ICI) sector developments will need. Guelph also looks at existing information regarding the demand of similar developments. In recent years the City of Guelph has been more supportive of companies that will have a dry approach – those that can provide employment but less demand on resources such as water.
Q: What are the three top water users in Guelph?
A: Guelph monitors major water users on a regular basis, however specific billing information cannot be shared since it is proprietary.

3.3.3.2 Open House Comment Cards

Comments cards were placed in multiple locations throughout the room, including near the welcome table and on the central table in the Council Chambers. One comment card was received with the following questions answered:

- Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update? **Yes.**
- Did you feel encouraged to provide feedback? **Yes.**
- Did you get answers to your questions? **Yes.**
- Were our staff forthcoming with their answers and knowledgeable in their area of expertise? **Yes.**
- Overall, how would you rate this workshop? **Excellent.**

No written comments were provided on the Open House Comment Card. The comment card is included in **Appendix D.**

3.3.3.3 Discussion Guide Questions

Individuals attending the Community Open House received Discussion Guides containing questions and were encouraged to provide answers. Two sets of completed Discussion Guide questions were returned from the Community Open House (**Table 7**).

Table 7 – Discussion Guide Question Submissions – Community Open House #1

Q: Are you comfortable with the level of service (water supply) currently provided by the City of Guelph?
A: Yes. A: Yes, because its groundwater sourced vs. somewhere like Waterloo Region.
Q: Do you feel the City's current water conservation goals are adequate? Are there additional goals that you feel should be considered?
A: They are good, but how will "Places to Grow" affect this plan? A: Yes, the best conservation is by a fee basis vs. incentive for water conservation.
Q: Do you believe the City should consider establishing water use goals for new growth (e.g., attracting industries that require less water, or conservation-oriented new residential developments)?
A: Definitely! Would like to see more efforts to conserve in condo towers. A: No. Some heavy water users are large high paying employers e.g. Sleeman Breweries, Wellington Breweries.
Q: Is the Problem/Opportunity Statement adequate for the WSMP update? Are there any changes (i.e., additions or deletions) that you feel should be considered?
A: Since Province has dictated population growth, then that portion is out of our hands and so we must concentrate on conservation and adding to supply of water. A: Yes
Q: Are there existing activities/ programs that you would like to see continued or prioritized?
A: More enforcement/education for "water levels" program. A: Low and medium density housing in the growth community.
Q: Are there new approaches or alternatives that we should consider to improve or expand our water

supply system?
A: Continue to remove red-tape surrounding grey water systems and retrofitting. A: No.
Q: Are the evaluation criteria suitable for this study? Is there anything you would like to add or change?
A: No.
Q: Are there pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan?
A: High mineral content.
Q: Do you have concerns regarding any of the alternatives presented? Should any of these not be considered through the Water Supply Master Plan update?
A: No alternatives?
Q: Are there other water supply alternatives that should be considered by the project team?
A: No.
Q: Should water supply sources inside the City be prioritized over those outside the City boundaries?
A: No. Go to the water.

4. Consultation Round #2

The second round of consultation occurred in April 2014. The purpose of this consultation was to provide an estimation of water supply capacity compared to demand, results from the examination of existing conditions, and to present draft alternatives and preliminary evaluation results. Activities during this period included:

- Community Liaison Committee Meeting #2
- Municipality/Agency Meeting #2
- Community Open House #2

4.1 COMMUNITY LIAISON COMMITTEE MEETING #2

The second Community Liaison Committee (CLC) meeting was held on April 8, 2014 from 7:00 pm to 9:30 pm. The meeting provided CLC members with information contained in the three technical memoranda prepared for the Water Supply Master Plan update, covering the following topics:

- Technical Memo 1 – Population and Water Supply Demand Forecasts
- Technical Memo 2 – Existing Water Supply Capacity Assessment
- Technical Memo 3 – Review of Water Supply Alternatives

Based on feedback received from the first CLC meeting, participants were provided with a copy of the presentation materials and a document summarizing the technical memoranda to facilitate the review of materials prior to the meeting.

The meeting was attended by 11 CLC members, in addition to staff from the City of Guelph and AECOM. Following the meeting, CLC members who were unable to attend were sent a copy of the presentation and a discussion sheet to provide comments. No additional comments were received from CLC members during the one week additional feedback period.

Table 8 - Summary of Discussion at Community Liaison Committee Meeting #2

Q: Average demand appears to go down in 2013, but the previous slide shows a projected increase in demand? Please explain.
A: The forecast does not include conservation measures so that a status quo can be established to allow conservation measures to be added as alternatives to establish required water system capacity at various levels of reduction.
Q: Did you account for expected student populations at Guelph (University of Guelph/ Conestoga College) in the demand forecast?
A: A follow-up response from Planning indicates that the Census includes some but not all students depending on whether they declare Guelph as their place of residence. Additional students are captured in the undercount.
Q: What figure was used to look at Watson & Associates population projections?
A: The project team was given a year by year breakdown for residential and employment for the population forecast to 2031. Beyond 2031, forecasts relied on an internal planning memo with projections to 2041. The team had to interpolate to get to 2038.
Q: Referencing the deficit and surplus values, are they existing capacities or maximum capacities?
A: Water supply systems are always designed to service maximum day demand, with additional redundancy to allow for potential shortfalls (e.g., plants go off line, contamination issues)
Q: Do shortfalls always require new wells, or can surplus be purchased as a commodity?
A: Temporary demand reductions to address shortfalls could be put in for a short term only.
Q: Is there an option to buy back water, which would restrict the amount of water that could be available, similar to an energy system?
A: This is not a concept that is easily applied to the City. The City currently encourages major water consumers to adopt conservation initiatives which ultimately frees up capacity. For industries with their own water supply under a Permit to Take Water (PTTW), the City could explore potentially seeking to take over permits or excess capacity when these permit holders no longer require the capacity. This proposal is included in the WSMP as non-municipal sources.
Q: Are there some conservation scenarios that are more favoured than others at this point?
A: The scenarios provide a range of demand reduction opportunities with associated costs; each requires further review and determination of public acceptance.
Q: Have you looked at ranking the conservation scenarios?
A: At this point, the scenarios have been developed to allow comparison of different levels of reductions and associated costs. These will be compared to other water supply alternatives during a financial evaluation.
Q: Have you looked at recycled water for the Aquifer Storage Recovery system?
A: We have only considered treated surface water in the ASR alternative. There are some regulatory concerns and public perception issues with using re-use water for the ASR. Wastewater would need to be treated to potable water quality before being injected in an ASR system.
Q: What is the status of the "purple pipe" option considered in the 2007 Water Supply Master Plan?
A: The York Trunk Sewer Class Environmental Assessment reviewed the capital cost and feasibility for implementing a purple pipe in the same corridor as the York trunk sewer from the WWTP to a new business park. There were challenges because it would be a utility without year-round customers. There were also regulatory issues. A technical memorandum was developed that is available on-line. If there was a customer willing to take volume all year long, it may expedite this option. The City would only be a seasonal user.
Q: What would be the cost of putting in a trial purple pipe?
A: The cost for dual piping in the distribution system is very expensive, particularly in developed areas. Opportunities for implementation will be highest in new areas where dual piping could be installed initially.
Q: Guelph North Potential Well: What is the potential for industrial contamination in this area?
A: Potential contamination from surrounding industries would be investigated during class **environmental**

assessments; to be undertaken **on a project specific basis.**	
Q: Has there been any thought to water storage behind the Guelph dam?	
A: The project team worked with the Grand River Conservation Authority to determine the reliable availability of water from the Speed River just upstream of the Guelph dam for both surface water options (continuous and ASR).	

Following the presentation and associated questions, participants were asked to divide into three groups to examine the evaluation tables provided in the Technical memorandum document and to discuss the following 5 questions:

1. Do you have any comments or suggestions regarding the criteria or indicators used?
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?
4. Do you have any feedback on any other aspects of the presentation?
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?

The minutes and presentation for CLC Meeting #2 can be found in **Appendix B.**

Table 9 presents a list of questions and answers recorded during discussion

Table 9 – Evaluation of Alternatives Group Responses – Community Liaison Committee #2

Questions	Group 1 Responses	Group 2 Responses	Group 3 Responses
1. Do you have any comments or suggestions regarding the criteria or indicators used?	• Insufficient time to digest during the time allowed in the meeting	• No response.	• Apply a sustainability factor to each category • Consider impacts on adjacent land owners across multiple categories
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.	• Public acceptance – Stay the course on groundwater	• Quality is important to residents: taste, hardness • ASR systems may be unknown to residents – may need additional explanations • Reuse of water may have trouble getting public acceptance due to perceptions of dirty water – may take additional education	• Re-use and treatment of existing wells will require public education • Use of wells outside City limits requires additional consultation • Optimize resources within city vs. outside city
3. Should any alternatives be ranked differently? Why? Will the suggested change	• No response.	• Conservation seemed to be rated high, but there is a risk that behaviours could change over time. Should only allow for	• No response.

alter the alternative overall priority rating?		more conservative scenario; i.e. lower target.	
4. Do you have any feedback on any other aspects of the presentation?	• Population projections require more explanation	• Group 2 liked the graphs, but they could be larger.	• Need additional explanation of charts to show increasing trends vs. decreasing trends
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?	• No response.	• Presentation at the public open house should be at least 15-20 minutes • Simplify the contents of the presentation • Cost will be the bottom line • Explain the problem/opportunity statement	• Explain acronyms, definitions, terminology • Use layman's terms • Break down charts into smaller pieces •

4.1.1 Comment Cards

Comment cards were provided to participants to encourage feedback on the presentation and level of detail. While some participants identified that the material was highly technical, respondents typically were positive about the level of detail and the willingness to answer questions. Respondents also noted that project staff were forthcoming with answers to specific questions asked during breakout sessions.

Table 10 presents a summary of the comment card responses from Community Liaison Committee #2:

Table 10 –Comment Card Submissions– Community Liaison Committee #2

Comment Card Questions	Answers
1. Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?	Yes: 3 No: 0 No answer given: 1 Comments: 1) I got information in the breakout session, but the content was over my head. 2) Water quality is key.
2. Did you feel encouraged to provide feedback?	Yes: 4 No: 0 Comment: none
3. Did you get answers to your questions?	Yes: 4 No: 0 Comment: during breakout session.

Comment Card Questions	Answers
4. Were our staff forthcoming with their answers and knowledgeable in their area of expertise?	Yes: 4 No: 0 Comment: none
5. Overall, how would you rate this meeting?	Poor: 0 Fair: 0 Good: 2 Excellent: 2 Comment: none
6. Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?	Comment: Greatly appreciate the info beforehand. Excellent presentations! Write out acronyms. Next meeting to measure progress. 6 months to 1 year?

4.2 MUNICIPALITY/AGENCY WORKSHOP #2

The second Municipality/Agency Workshop was held on April 7, 2014 from 1:00 pm to 4:15 pm. Fourteen representatives attended the meeting from agencies including the Ministry of the Environment, Grand River Conservation Authority, Wellington-Dufferin-Guelph Public Health, as well Guelph-Eramosa Township, The Township of Puslinch, and the County of Wellington.

The workshop provided participants with an overview of three technical memoranda:

- Technical Memo 1 – Population and Water Supply Demand Forecasts
- Technical Memo 2 – Existing Water Supply Capacity Assessment
- Technical Memo 3 – Review of Water Supply Alternatives

The meeting minutes for the Municipality and Agency Workshop #2 are found in **Appendix C**.

Table 11 presents an extract of the questions asked to the project team during the workshop presentation, and a summary of responses:

Table 11 –Summary of Discussion at the Municipality/ Agency Workshop #2

Q: What is the maximum population in the City of Guelph boundary?
A: The "Places to Grow" estimate is 175,000 in 2031. Official planning includes lands for development beyond 2031, but numbers are not assigned yet.
Q: Is this study going to generate more capacity than is needed, or require additional land?
A: The intent of this study to determine the capacity required to meet the needs of the projected population. It does not address land requirements for growth.
Q: For re-use of water, is the objection due to technology, or a psychological barrier to using water from previous uses?
A: Generally people prefer groundwater and surface water sources to re-use options. Re-use requires more advanced water treatment processes to achieve potable water quality.
Q: What communities were Guelph compared to when assessing conservation efforts?
A: We cannot publish the names of other municipalities participating in the National Water-Wastewater Benchmarking Initiative due to confidentiality. In previous City documentation and presentations to Council, the

annual budgets show comparison communities for reviewing water rates. Council wants to be a leading conservation community.
Q: Why are the Logan/Fleming wells identified together?
A: The combination of the two sites refers to two municipal test wells in an area where a future municipal production well could be located based on preliminary hydrogeological investigations.
Q: How big would the general area be around the potential new well site locations indicated in the Townships?
A: The indicated location is only a general area. The potential areas were identified where there would be less potential impacts to nearby watercourses. Areas are approximate and used for evaluation of area groundwater potential and would be reviewed further in a groundwater investigation study.
Q: Are land acquisition costs included in cost estimates for new wells?
A: Yes, land acquisition is included except where we are confident that location in a park is feasible. This would be subject to discussion with the City's Parks and Recreation department.
Q: Is there a cost upset limit for alternatives?
A: No. Cost estimates are developed for all alternatives; financial impact is one of several factors considered in evaluation.
Q: If there is a fairly large subdivision/development near Guelph, would there be impacts?
A: Potential impacts would be taken into consideration in the Class Environmental Assessment for any project resulting from the Water Supply Master Plan Update. For any proposed new water takings, existing and proposed developments that will require potable water would also be taken into consideration when evaluating potential impacts.
Q: At what point will you develop well protection areas?
A: Guelph will be developing policies under the Source Water Protection regulations. The actual well protection areas will be determined through modeling. Land use restrictions within the protection zones will be identified as part of these studies.
Q: Who picks up the potential costs of additional wells?
A: It would be unreasonable to ask Township residents to pick up additional costs for a City municipal well. With reference to source water protection and wellhead protection areas, the City will continue its discussions with neighbouring communities.
Comment: New wells may create a new dynamic between the City of Guelph and the Townships.
A: This comment has been noted.
Comment: Township residents want to make sure they aren't picking up unreasonable costs or to businesses in the area.
A: A dialogue will be in place with Townships on this issue.
Comment: Township development plans should be considered as part of the evaluation of alternatives.
A: This comment has been noted.
Q: Has Aquifer Storage and Recovery (ASR) been done in other areas?
A: Yes. It is used in the United States and closer to home in the Region of Waterloo. It has been around for 20 years. It requires good geology, but works well since it gets around the issue of seasonal variation and allows for some banking of water.

Participants were asked to divide into two groups to examine the evaluation tables provided in the Technical memorandum document and to answer the following 5 questions:

1. Do you have any comments or suggestions regarding the criteria or indicators used?
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?
4. Do you have any feedback on any other aspects of the presentation?
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?

Table 12 presents a list of responses received:

Table 12 – Evaluation of Alternatives Group Responses – Municipality/Agency Workshop #2

Questions	Group 1 Responses	Group 2 Responses
1. Do you have any comments or suggestions regarding the criteria or indicators used?	• Difficult to comment due to uncertainty related to source protection • Wellhead areas need to be added	• Assessment: why was it qualitative?
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.	• Aquifer Storage and Recovery – the option may be foreign to some members of the public	• The impact to individual wells, limitations and considerations should be identified. • Guelph residents are concerned about costs going up, while consumption is going down. This should generate better feedback from the public.
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?	• Use of options within the city boundaries first – The Township options should be the last resort	• Information on these wells should be obtained from the Townships
4. Do you have any feedback on any other aspects of the presentation?	• No response.	• Use more graphics – logical graphics such as trees, dollar signs to make the categories stand out. • The graph should show costs currently compared to 5 years ago. • Litres per person should be spelled out • Provide an understanding of what other jurisdictions higher than Guelph are doing to

		achieve conservation targets • Look at other measures to compare ICI sector businesses.
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?	• The public meeting should answer the question "why is this necessary and important?" • Potential cost implications – it is hard to quantify	• Make sure the public understands why it was not quantitative • Pros, cons, costs, etc. should be boiled down for the public • Costs to the individual ratepayers – when phased in, who pays?

4.2.1 Discussion Recording Sheet

A Discussion Recording sheet was available for individuals unable to stay for the group session, but who wished to leave comments. One sheet was provided to the project team:

Table 13 – Evaluation of Alternatives Additional Response –Municipality/ Agency Workshop #2

Question	Answer
1. Do you have any comments or suggestions regarding the criteria or indicators used?	• Difficult to comment since I don't know the extent of new Well Head Protection Areas (WHPAs) / vulnerability score. • Add Well-Head Protection Areas (WHPAs) to legal/ jurisdictional categories.
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment wells inside vs. outside the city; surface water.	• Can conservation go further? • Upfront about residential: 50% • What is important to public? Conservation. • Changes in demography in future • Why is this necessary? • Explain ASR more generally. • Increase in water rates in Guelph vs. Mississauga • Clearer explanation of quantity per option • Sustainable water taking from a quantity?
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?	• How to incorporate potential costs due to Source Protection impacts to properties • Selling people on using treated wells (TCE) • Township water is last resort • Proof that City has tried all options • Better data needed on costs and impacts • Need to adjust scoring for Table 2 – Existing off-line wells. Municipal test wells to reflect higher cost to Townships for those wells (because on boundary or in Township)
4. Do you have any feedback on any other aspects of	• No comment recorded.

the presentation?	
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?	• Criteria not understandable to general public • Reduce number and complexity of slides

4.2.2 Comment Cards

Table 14 provides a summary of the comment cards received from the second Municipality/Agency Workshop:

Table 14 –Comment Card Submissions– Municipality/Agency Workshop #2

Comment Card Questions	Answers
Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?	Yes: 2 No: 0 Comment: A lot of info to absorb.
Did you feel encouraged to provide feedback?	Yes: 2 No: 0
Did you get answers to your questions?	Yes 2: No: 0
Were our staff forthcoming with their answers and knowledgeable in their area of expertise?	Yes: 2 No: 0 Comment: Splendid presentation.
Overall, how would you rate this meeting?	Poor: 0 Fair: 0 Good: 1 Excellent: 1 Comment: Great Lakes pipeline completely ignored. I don't like the idea of drinking pee, especially mine!
Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?	No comments.

4.3 COMMUNITY OPEN HOUSE #2

4.3.1 Notification and Timing

The Notice of a Community Open House #2 was advertised in local newspapers in Guelph and the surrounding area to provide information about the event, the date and location (i.e., April 29th at Guelph City Hall), and contact information for key Project Team members. The notice was also posted to the project website http://guelph.ca/plans-and-strategies/water-supply-master-plan/ and on the City of Guelph Twitter and Facebook pages. The Community Open House notice was published at least two weeks prior to the event, as per the following schedule:

- City website: April 10, 2014

- Milton Canadian Champion, Thursday April 10th and 24th, 2014
- Guelph Tribune, Thursday April 10th, 17th and 24th, 2014
- Wellington Advertiser, Friday April 11th and 25th, 2014
- The City also posted COH information on social media sites including Facebook and Twitter.

The Community Open House notice was distributed on April 14, 2014 to the project mailing list which includes elected officials, agencies, aboriginal communities, interested residents, and the Community Liaison Committee (CLC) members.

The Community Open House notice is found in **Appendix D.**

4.3.2 Objectives and Format

The Community Open House #2 was designed to provide attendees with an opportunity to:

- Learn about the Water Supply Master Plan project;
- Obtain details about Guelph's existing water supply system;
- Understand population demand and the need for additional water supply;
- Learn about the various alternatives considered by the project team, including their costs, benefits and limitations;
- Review preliminary evaluation tables to provide feedback on whether stakeholders agree or disagree with the information presented;
- Speak to project team members about water supply issues and concerns

Participants were greeted and encouraged to sign the Open House #2 Attendance Sheet on arrival. A Discussion Guide was provided that included questions for answering and depositing in the Comment Box provided. The agenda for Community Open House #2 can be found in **Appendix E.**

Information was presented at the Community Open House using two methods:

1. **Display Panels** to aid the explanation of project progress and key issues in a relaxed atmosphere. The panels were placed around the room to explain existing conditions of the Guelph's water supply, water supply demands vs. Population growth, and information for reviewing the preliminary evaluation tables. Attendees could view the panels at their own pace or with a project team member.

2. A **presentation** was provided between 7:00-7:30 pm by Dave Belanger, Water Supply Program Manager at the City of Guelph, and Patty Quackenbush, AECOM Senior Project Manager. The presentation reviewed information provided on the display boards and explained key project details. A Question and Answer period followed the presentation.

The presentation and the displays presented at the Community Open House are provided in **Appendix H**.

4.3.3 Participation and Comments

Twenty-three members of the general public attended the Community Open House, in addition to individuals from the project team and other staff from the City of Guelph.

The following is a summary of both verbal and written comments received following the Community Open House.

4.3.3.1 Presentation

The Community Open House presentation by Dave Belanger and Patty Quackenbush was followed by a Question & Answer session for the audience. **Table 15** summarizes the questions asked and the answers given:

Table 15 - Summary of Discussion at the Community Open House #2 Session

Q: Where would “limit population growth” be on the evaluation? Why has this not been considered as solution? When will Guelph say no to new growth?
A: The “limit population growth” alternative does not address the problem/opportunity statement. Growth targets are not set by this Master Plan – it is a decision for Council through the Official Plan process. The WSMP update is meant to identify alternatives to meet the water supply needs of the projected growth.
Q: Do we know the groundwater takings needed for dealing with contaminated sites and have these been accounted for?
A: All water takings, municipal and non-municipal, are included in the computer model. These water takings are considered in the Tier 3 modeling when evaluating impacts associated with new supplies. From the City’s perspective, it is better to have water takings to deal with site contamination than to have these contaminants migrating towards municipal supplies. MOE is working to address contamination issues.
Comment: A resident said that the Farquhar Street site hasn’t been cleaned up yet. The resident wants more clean up at the contaminated sites.
A: Comment noted.
Q: Where in the WSMP is Source Water Protection considered for existing wells?
A: This is an ongoing process. In February 2013 source water protection policies were sent to the Ministry of the Environment, and Guelph is waiting on approval of these policies. Source protection will protect existing wells from contamination.
Q: Who is responsible for Source Water Protection for wells outside City boundaries?
A: Under Source Water Protection regulations, wells are the responsibility of the municipality in which they exist.
Q: Can you explain the storage tanks shown on the slide about the Arkell Springs Aquifer Storage and Recovery (ASR) slide? Are they reservoirs tanks?
A: The storage tanks pictured are just a schematic to explain the ASR concept, and not the actual configuration.
Q: Follow Up: It would be a great idea to have reservoir tanks filled above ground and holding tanks for emergency. They could store water for a period of time. Has this been considered?
A: The City of Guelph has above-ground reservoirs and in-ground reservoirs to store water for peak and fire flows, but these represent small storage capacity compared to what we need; perhaps half a day of capacity. Storage tanks are expensive. An ASR system can store a greater volume at a lesser cost by taking advantage of the natural geotechnical/hydrogeological conditions.
Q: Sewage treatment requires lots of water. Is the water required for sewage treatment modeled into the Water Supply Master Plan update?
A: Yes, Grand River Conservation Authority ensured that the base flow required in the Speed River for assimilative capacity at the Guelph WWTP is included in their analysis; also included is an preliminary evaluation of environmental impacts from various levels of water takings. The surface water alternatives will require further investigations and studies which would be undertaken as part of a Class Environmental Assessments.
Q: Cryptosporidium – How does the water supply system deal with this?
A: Surface water would be required to go through a water treatment process, which includes addressing the Cryptosporidium issue.
Q: Do ultra violet (UV) systems work to get rid of all contaminants?
A: Surface water treatment facilities have used UV and filtration systems successfully for years to achieve Ontario Drinking Water Quality Standards for potable water.

4.3.3.2 Open House Comment Cards

Comments cards were placed in multiple locations in the room, including near the welcome table and on the central table in the Council Chambers. Two comment cards were received with the following questions answered:

- Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update? Yes, Yes
- Did you feel encouraged to provide feedback? Yes, Yes
- Did you get answers to your questions? Yes, Yes
- Were our staff forthcoming with their answers and knowledgeable in their area of expertise? Yes, Yes
- Overall, how would you rate this workshop? Excellent, Excellent

One written response was provided at the end of the Open House stating “Good job AECOM and COG (City of Guelph) staff. The comment card is included in **Appendix G.**

4.3.3.3 Handout Question Sheet

Individuals attending the Community Open House were provided with a handout with questions, and participants were encouraged to deposit them in the Comment Box. No completed questions were returned for the Open House #2.

5. Engagement of Surrounding Townships

The City of Guelph understands that ensuring a safe and sustainable water supply is also an important goal of its neighbours. Engagement with surrounding communities began at the outset of the Guelph Water Supply Master Plan update process in May 2013. As part of the Notice of Commencement sent on May 16, 2013, the project team contacted community leadership of Puslinch Township, Guelph-Eramosa Township and Wellington County to set up individual meetings. The meetings introduced participants to the project, sought initial input, and identified potential CLC members outside Guelph.

The Community Liaison Committee includes representatives of Guelph-Eramosa and Puslinch Townships, two of the closest neighbours to Guelph. The participation of Puslinch Township Councillor Wayne Stokley and Guelph-Eramosa Mayor Chris White provides a broader perspective on how water supply decisions may interest these communities.

5.1 Consultation Round #1

Local Township representatives attended the Municipality and Agency Workshop held on September 19, 2013 to introduce the project and areas of mutual interest with respect to the local water supply.

Follow up letters were sent to Puslinch Township on September 26, 2013 and Guelph-Eramosa Township on October 1, 2013 to notify residents about the community Open House, and to seek an opportunity to deliver a delegate presentation to each of the councils. Project team staff presented to Puslinch Township Council on October 2, 2013 and to Guelph-Eramosa Township Council on October 21, 2013. The meetings provided an overview of the presentation given at the Community Open House with the goal of obtaining input from the councils on the path ahead.

5.2 Consultation Round #2

During Consultation Round #2, Guelph-Eramosa Township and Puslinch Township representatives attended the Municipality/Agency Workshop on April 7, 2014 and the Community Open House on April 29, 2014.

As well, City of Guelph staff were invited to present project progress as delegates to the Guelph-Eramosa council meeting on May 5, 2014 and to the Puslinch Township council meeting on May 7, 2014.

A staff member from Center Wellington Township, who is also affiliated with Wellington County, asked to be added to the project mailing list on March 11, 2014, and subsequently attended the Municipality/Agency Workshop #2 and Community Open House #2.

Township Notification Letters and a response received from GET can be found in **Appendix I.**

6. Aboriginal Engagement

The City of Guelph recognizes the important relationship between the Crown and Aboriginal Communities in Canada. Section 35 of the Canadian Constitution affirms the Aboriginal Rights of Aboriginal people (First Nations, Inuit, and Métis) in Canada, and subsequent Supreme Court of Canada decisions have recognized that the Crown has a duty to consult and accommodate in matters where Aboriginal Rights or Treaty Rights may be infringed upon.

To seek input on this requirement, Notice of Commencement letters were sent on August 13, 2013 to Six Nations of the Grand River First Nation and the Mississauga's of the New Credit First Nation, two communities close to Guelph that may be interested in the project. The letters explained the project purpose, asked for information pertaining to Aboriginal Rights or Treaty Rights as it relates to the project, and provided contact information for more information.

The project team also sent a letter to the Aboriginal Affairs and Northern Development Canada (AANDC) and the Ministry of Aboriginal Affairs (MAA) to seek further clarification on other communities that should be provided with information about the project. AANDC replied on August 27, 2013 that the two communities already contacted were the two main Aboriginal groups that should be consulted if project impacts are expected within a 50 kilometres radius. As a Master Plan process, no project effects will occur due to the project within or beyond 50 kilometres.

On September 11, 2013, the Ontario Ministry of Aboriginal Affairs replied and identified a third group, the Haudenosaunee Confederacy Chiefs Council, as potentially requiring consultation. This group was added to the contact list and was included in subsequent notices.

The letters to Aboriginal communities and Aboriginal agencies are found in **Appendix J.** Representatives from each of the identified aboriginal communities have been included on the mailing list, and received information about the project including: the Notice of Commencement (mailed on August 13, 2014), Open House notification emails and will be sent the Notice of Completion.

No requests for information have been received from the aboriginal groups identified for this project.

7. Water Conservation and Efficiency Public Advisory Committee Meetings

Dave Belanger of the City of Guelph and Patty Quackenbush of AECOM delivered a presentation to and consulted with the City of Guelph Water Conservation and Efficiency Public Advisory Committee (WCEPAC) during its October 3, 2013 meeting. The meeting included the following topics:

- WSMP – Overview
- Guelph's Current Water Supply System
- City Updates – Since 2007 WSMP
- WSMP Update – Objectives / Scope of Work
- Next Steps
- Discussion

The meeting provided an opportunity to obtain feedback on the project following the first phase of public consultation, and to seek the opinion of committee members on how best to move forward with the project objectives.

An update was also provided at the WCEPAC meeting held November 7, 2013 which focused on the proposed approach for development and review of water conservation alternatives. Additional updates and presentations were provided at meetings held on February 12, 2014 and April 3, 2014. At the last meeting, the presentation provided to the other groups in the second Round of consultation was reviewed with a focus on the water conservation scenarios.

All discussions and presentations provided at the WCEPAC meetings are posted on the City of Guelph website at: http://guelph.ca/city-hall/council-and-committees/advisory-committees/water-conservation-and-efficiency-public-advisory-committee/

8. Guelph Water User Survey: Expectations of Service

The University of Toronto approached the City of Guelph in fall of 2013 to determine whether the City was willing to actively participate in facilitating a survey to Guelph residents regarding expectations of service as it relates to water. The timing of this request was such that it allowed the WSMP Update project team to provide input into the survey questions with the objective of gaining input into the update and feedback on the water supply alternatives being considered. The survey was carried out in early 2014 with preliminary results provided prior to completing the preliminary evaluation of alternatives, and therefore, public opinion on various alternatives and issues is captured in the evaluation comments.

The report: *Guelph Water User Survey Expectations of Service Findings (May 2014)* provides a summary of the purpose, demographics of those responding, and responses to the survey questions asked. Among the 400 residential water users surveyed it was found that the awareness of Guelph water users is high, with the majority understanding the source of potable water and their estimated consumption. The report contains much information that will be of use to the City and Waterworks in communicating with City residents regarding water sources, use, rates and future programs. However, there are also some of the key findings that are of interest to the WSMP update are as follows:

- The current top water issues in order of priority are water scarcity, water quality, aging infrastructure and costs
- Most respondents try to conserve water and have focussed on installing efficient indoor devices and appliances, as well as reducing lawn watering

- In times of drought, priorities for potable water include indoor household use, wildlife and the natural environment, and municipal operations over other demands, with the majority of responders strongly agreeing that at such times landscaping uses should be restricted
- A strong majority of respondents support an increase in conservation
- The majority of respondents agree with the current water pricing structure but also support increasing block rates. Most disagreed with declining block rates and flat fees.
- There was general support for new groundwater sources within Guelph as well as outside of Guelph
- Responses related to acceptance of using water from contaminated sources are varied, with slightly stronger negative opinions
- Responses relating to the use of the Eramosa River or Speed River/Guelph Lake were mixed.

In this update, these findings were incorporated into the evaluation summary comments and considered when completing the comparative ranking of alternatives.

9. Correspondence Record

A Correspondence Record was established for this project for correspondence beyond notices and other information sent to a wide audience. All comments pertaining to the project, or requests for additional information were passed on to the project team or the appropriate person for a response.

A list of the correspondence and responses can be found in **Appendix L.**

10. Notice of Completion

On May 29, 2014, the Notice of Completion was sent to the project mailing list about the end of Phase I and II of the Guelph Water Supply Master Plan Update and published in the following locations:

- City website,
- Milton Canadian Champion,
- Guelph Tribune, and
- Wellington Advertiser

In addition, the Notice of Completion was made available for the 30 day review period in hard copy in the following locations:

- City of Guelph Public Library (Main Branch)
- City of Guelph Water Services Department
- City of Guelph Clerk's Office

At the completion of the 30 day review period, if no additional comments are provided, the final report will be submitted the City of Guelph Council for approval.

The Notice of Completion can be found in **Appendix M.**

11. Conclusion

Overall the public was pleased to be informed and to participate in this study. The main points of discussion at the Community Open Houses were water conservation programming, the impact of major water users on the water system, source water protection, and water quality. The Community Open House format allowed participants to view the boards at their own pace, listen to the presentation by the project team, and to ask questions in a variety of forums.

The quality of questions and the engagement of those present was a positive indicator of the interest in water supply issues within the City of Guelph and the surrounding area. The Project team encouraged those present to email any follow up questions or comments they had to the Project team for answering or consideration.

The additional consultation offered and provided to the Townships at their request was also well received and provides 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. Township representatives raised concerns regarding source protection issues and potential constraints on land uses resulting from new water supplies.

City of Guelph

Water Supply Master Plan Update
Consultation Summary Report (Draft Final)

Appendices

Prepared by:

AECOM
215 – 55 Wyndham Street North   519 763 7783 tel
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www.aecom.com

Project Number:

60287843

Date:

May, 2014

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CITY OF GUELPH NOTICE

Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan to define how we will continue to access a sustainable supply of water—for residential and industrial use—over the next 25 years.

Reviewing our existing water supply system is an opportunity to discuss with the community 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.

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, 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 Ministry of the Environment.

In Guelph we depend mostly on groundwater for our water supply so we know it makes sense to use our water wisely. Conservation and demand management will be as important during this Master Plan Update as they were during the 2007 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 per capita water use by nine per cent—meaning that we now use about 20 per cent less water in Guelph than the average person in Ontario.

Our review will follow 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.

Join the conversation

We understand that good planning involves the community and we want to hear from you! Here are a few ways you can get involved in the process:

- **Attend our Community Forums and let us know what you think.** Dates for these meetings will be publicized in this newspaper, provided through direct mail and posted on the City's website at **guelph.ca/water**.
- **Read about our progress.** Project information will be posted online at **guelph.ca/water**.
- **Join our mailing list.** Send us your name and how you would like to be contacted (i.e., email or mail) so we can keep you informed.
- **Follow the conversation on the City of Guelph's Twitter and Facebook pages.**

To find out more about the Water Supply Master Plan Update or to get involved, contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T **519-822-1260 x 2186**
E **dave.belanger@guelph.ca**

Patty Quackenbush
Senior Project Engineer
AECOM
T **519-650-8691**
E **patty.quackenbush@aecom.com**

CITY OF Guelph
Making a Difference

August 13, 2013

Ministry of Culture, Tourism and Recreation, Southwest Area Head Office
Mr. Ken Carter, Manager Southwest Area
30 Duke Street West, Suite 405
Kitchener ON
N2H 3W5

Dear Mr. Ken Carter:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

Our review will follow the requirements of a Municipal Class Environmental Assessment (Class EA) to identify constraints and opportunities related to our existing water supply system. We'll also evaluate and prioritize a number of individual projects to increase the capacity of our system. Some individual projects recommended in our Master Plan update – such as those that might have an environmental impact – will require individual approvals before we proceed with implementation. These projects will also follow the Class EA process.

There will be many opportunities for input on the update. **Two Community Open Houses** are planned to provide residents and other stakeholders with an opportunity to learn more about our water supply system and services, and to provide their thoughts on how Guelph can best maintain a sustainable water supply. A **Community Liaison Committee (CLC)** will provide guidance on key aspects of the Master Plan update and the Class EA.

Two meetings will also be held to bring agencies and municipal officials together, providing a forum to discuss plans for the updated Guelph WSMP and to gather input. We are tentatively scheduling our first meeting for mid to late September 2013 and are interested in hearing from you regarding your availability; please indicate your interest in attending and any scheduling constraints by emailing David Kielstra at david.kielstra@aecom.com. We will follow up closer to the planned session date with a formal invite and a proposed agenda.

If you have any questions prior to the planned meetings, please contact either Patty Quackenbush at (519) 650-8691, or myself at (519) 822-1260 x 2186. We would be happy to hear from you.

Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Wellington-Dufferin-Guelph Health Unit
Mr. Chuck Ferguson, Manager of Communications
474 Wellington Road #18,
Suite 100, RR#1
Fergus Ontario

Dear Mr. Chuck Ferguson:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

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E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

Letterhead

August 13, 2013

Ministry of the Environment
Ms. Jane Glassco, District Manager, Guelph
1 Stone Road W,4th Floor
Guelph, Ontario
N1G 4Y2

Dear Ms. Jane Glassco:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

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Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

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E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Ministry of Natural Resources, Water Resources Section, Lands and Waters Branch
Ms. Paula Thompson. Senior Policy Advisor
300 Water Street
P.O. Box 7000
Peterborough ON
K9J 8 M5

Dear Ms. Paula Thompson:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

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CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Ministry of Natural Resources
Mr. Mike Stone, Guelph District Planner
1 Stone Road West
Guelph, Ontario
N1G 4Y2

Dear Mr. Mike Stone:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

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There will be many opportunities for input on the update. **Two Community Open Houses** are planned to provide residents and other stakeholders with an opportunity to learn more about our water supply system and services, and to provide their thoughts on how Guelph can best maintain a sustainable water supply. A **Community Liaison Committee (CLC)** will provide guidance on key aspects of the Master Plan update and the Class EA.

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If you have any questions prior to the planned meetings, please contact either Patty Quackenbush at (519) 650-8691, or myself at (519) 822-1260 x 2186. We would be happy to hear from you.

Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

Letterhead

August 13, 2013

Ministry of Municipal Affairs and Housing, Planning Services, Southwestern Municipal Services Office
Mr. Bruce Curtis, Manager, Community Planning & Development
659 Exeter Road, 2nd Floor
London ON
N6E 1L3

Dear Mr. Bruce Curtis:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

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Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Ministry of Agriculture, Food, and Rural Affairs
Mr. David Cooper, Manager, Environmental & Land Use Policy
1 Stone Road W, 3rd Floor
Guelph, Ontario
N1G 4Y2

Dear Mr. David Cooper:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

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CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Ministry of Agriculture, Food, and Rural Affairs, Environmental and Land Use Policy Unit
Ms. Carol Neumann, Rural Planner, Environmental Land Use Policy, Food and Environmental Policy Branch
6484 Wellington Road 7, Unit 10
Elora Ontario
N0B 1S0

Dear Ms. Carol Neumann:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

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CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Lake Erie Source Protection Committee
c/o GRCA
Mr. Martin Keller, Program Manager
400 Clyde Road, P.O. Box 729
Cambridge
N1R 5W6

Dear Mr. Martin Keller:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

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August 13, 2013

Wellington-Dufferin-Guelph Health Unit
Mr. Chuck Ferguson, Manager of Communications
474 Wellington Road #18,
Suite 100, RR#1
Fergus Ontario

Dear Mr. Chuck Ferguson:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

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APPENDIX B: COMMUNITY LIAISON COMMITTEE MEETING MINUTES AND PRESENTATION

Community Liaison Committee Meeting #1 Minutes

Date of Meeting	September 17, 2013	7:00pm	60287843
Project Name	City of Guelph – Water Supply Master Plan Update 2013		
Location	Guelph City Hall, Meeting Room C		
Regarding	CLC Meeting #1		
Attendees	**CLC Members:** Angela Kroetsch, Bill Banks, Ken Hammill, John Pawley, Brady Deaton, Andrea Williams, Peter Chisholm, Wayne Stokley, Janet Roy, Steve Chomyc, Ludwig Batista, Michael Shook, Glenn Anderson, Bob Carter **Public:** Jim Yardley, David Parker **City of Guelph:** Dave Belanger, Wayne Galliher, Arun Hindupur, Peter Busatto, Brian Pett **AECOM:** Avril Fisken, Patricia Quackenbush, Jacob Stemeroff		
Distribution	Attendees		
Minutes Prepared By	Jacob Stemeroff		

PLEASE NOTE: **If this report does not agree with your records of the meeting, or if there are any omissions, please advise, otherwise we will assume the contents to be correct.**

Agenda

- Welcoming & Opening Remarks
- Water Supply Master Plan Update – Overview
- Guelph's Current Water Supply System
- Progress since 2007 WSMP
- 2013 Water Supply Master Plan Update
- Work Underway
- Assessing Alternatives
- Next Steps

* Presentation reviewed at CLC is appended.

Action Required

Action	Responsible	Accountable	Date Required
Committee members requested additional background information regarding the 2007 WSMP and related studies, including the quadrant studies from the 2007 plan. Project team to post relevant information to the project website, and provide	Dave Belanger / Laura Mousseau	Dave Belanger	For Next Meeting

Action	Responsible	Accountable	Date Required
members with details about information available. The index should include the study name, a brief description, and relevance to the WSMP (e.g., water supply capacity).			
Provide an estimate of water use by sector, such as Residential & ICI (institutional, commercial and industrial)	Patty Quackenbush	Dave Belanger	For Next Meeting
Provide an estimation of how water rates affect demand	Patty Quackenbush / Wayne Galliher	Dave Belanger	For Next Meeting
Provide additional information on the capacity of individual existing sources	Patty Quackenbush	Dave Belanger	For Next Meeting
Provide information on environmental impacts of proposed alternatives	Patty Quackenbush	Dave Belanger	For Next Meeting

Minutes

Welcoming and Opening Remarks

Information Reviewed

- Meeting objectives
- Roundtable introduction of CLC members and project team
- Role of CLC

Discussion Highlights

CLC member roles were discussed. Members are expected to provide guidance on key aspects of the Master Plan and the Class EA, including:

- Objectives and scope of the Master Plan Update
- Issues and opportunities to be addressed
- Alternative solutions to be assessed
- Evaluation method and criteria to be applied
- Preferred alternatives and implementation strategy

A brief overview identified the CLC members and their affiliation, including business and industry, environment groups, agriculture, community and social groups, academia, Guelph residents, and residents from the Townships of Puslinch and Guelph/Eramosa.

Water Supply Master Plan Update Overview

Information Reviewed

- Process for updating the Water Supply Master Plan
- Master planning process

Discussion Highlights

The Master Plan update will follow the requirements of a Municipal Class Environmental Assessment. Individual projects identified as part of the Guelph Water Supply Master Plan update will proceed in accordance with remaining Class EA requirements.

Guelph's Current Water Supply System

Information Reviewed

- Guelph's existing water supply system
- Current water supply capacity

Discussion Highlights

Guelph's existing water supply relies on groundwater to meet demand. Through a system of municipal wells and the Arkell Spring Grounds collector system, Guelph maintains its water supply needs. Existing well capacity was explained for each of the wells, with 17 operating on a near continuous basis. Six wells were not operated at their peak capacity due to maintenance, poor water quality sampling results, or operated only as needed to address peak demands.

Questions and Comments:

Could the total water supply capacity be raised to more than 83,000 m^3/day?
If necessary, the system could be pushed to supply more water, although there may be some additional risks, permit constraints, and costs.

Is Guelph's water supply system designed to meet peak demand?
Yes, we are required by the Ministry of the Environment to design our system so that it will meet peak demand. The WSMP update process allows us the opportunity to assess current and future demands, and to ensure we plan to develop the necessary infrastructure to meet this demand.

Is the 75,000 m^3/day capacity based on peak demand?
The 75,000 m^3/day capacity is what can typically be produced. Since 2007, two new wells (Arkell 14 and Arkell 15) were constructed to provide additional capacity since some wells are currently off line.

I find the overview of the current systems lacks clarity. Is 75,000m^3/day available 100% of the time?
The capacity of 75,000 m^3/day is a calculation based on actual testing and modeling and represents the ability to continuously deliver this quantity on a sustainable and functional way. As the total system capacity is required only to meet maximum day demand conditions, it generally does not need to provide this quantity on an ongoing basis. Furthermore, Guelph has seasonal supplies which provide more water in "wet" parts of the year which allows operations staff to take supply facilities offline for maintenance and repairs and still maintain this capacity.

Do you expect the four wells currently off-line to go back on-line?
The Sacco, Smallfield, Edinburgh, and Clythe Creek wells are currently off-line because of water quality issues. The water quality is monitored for improvements that could potentially allow them to return to service. These will be evaluated through this master plan update.

Progress Since 2007 Water Supply Master Plan

Information Reviewed

- Preferred solution from the 2007 Water Supply Master Plan
- Water conservation and demand management goals from 2007

  - Progress achieved since 2007
- Strategies and programming resources for water conservation and demand management
- Water conservation data since 2007 and forecast to 2019
- Water production, relative to water consumption and population
- City-wide studies completed and in-progress
  - Guelph Tier 3 Water Budget and Local Area Risk Assessment
  - Guelph Drinking Water Source Protection Plan and Policies
- New infrastructure since 2007
- Progress regarding class environmental assessments and treatability projects since 2007
- Progress made since 2007 on hydrogeological investigations and studies

Discussion Highlights
Project staff provided context for the new Water Supply Master Plan update by re-examining the 2007 plan and its recommendations. Short term goals of the 2007 Master Plan included creating demand management and conservation programs, while also constructing two new wells. Investigations were also conducted to examine existing wells, and to determine the need for new wells inside the city. Medium and longer term goals included further investigation and development of groundwater supplies inside and outside the city, and the development of other surface water sources through Aquifer Supply Recharge (ASR).

Since completion of the 2007 Master Plan, significant progress has been made to conserve water by establishing demand management and conservation programs for both residential and ICI sectors. As well, two new wells have been built, and Environmental Assessments and studies have been launched to investigate new water sources.

Principles of adaptive management were also established for the Arkell Spring Grounds, and are ongoing.

<u>Questions and Comments:</u>

What is the reason for the drop in peak consumption in 2011?
Typically peaks are lower in “wet” years. Peak consumption may have declined because conservation programs were beginning to have an impact. When looking at the graphs, it is important to focus on trends rather than extremes.

Has the composition of water users been changing over time?
No. The composition has stayed the same.

Is average daily use changing? Can we track savings from individual programs?
Yes, we can track savings from individual programs.

What programs are targeted at industrial, commercial and institutional (ICI) customers? Is there information available showing the difference in consumption between residential and ICI customers?”
Many of the water conservation programs have an ICI element to them. One program that is only for ICI users is the “ICI Capacity Buyback program.” This information is available, but individual consumption records for residents or ICI customers cannot be released.

How successful is the City of Guelph leak detection program?”
The program is considered good to average. City staff are not seeing reductions in proportion to other programs, but more effort is still required over the next five years.

In 2005 there was a peak in demand, yet population was low. Can you explain?

When looking at the graphs, it is important to focus on trends rather than extremes.

Is the population growth trend going to change?
Population levels fluctuate, and population changes are always possible. Updating the Guelph Water Supply Master Plan every 5 years is an important way to keep the plan current.

How do projections from 2007 compare to actual results?
Guelph is on track with its projections from 2007. There are a number of factors such as economic conditions that have an impact on projections. The recession, for example, lowered consumption. The City of Guelph is still implementing programs which should further reduce consumption. Some ICI customers also have their own water conservation goals and programs. University of Guelph is an example as it has lowered water consumption since 2007.

2013 Water Supply Master Plan Update

Information Reviewed

Overview

- Objectives of 2013 WSMP update
- Purpose statement of 2013 WSMP update
- Scope of work and timeline for update
- Community engagement goals and consultation plan

Work Underway

- Population and water supply demand forecasts from 2013 to 2038
    - Methodology used when developing water demand projections
- Water supply capacity of existing system
- Alternatives for developing water supply
    - New groundwater supply opportunities – in and outside
    - Local water sources, including aquifer storage and recovery alternatives
    - Water Conservation and Demand Management Alternatives

Assessing Alternatives

- Directed members to the methodology for assessing alternatives, and the evaluation criteria to be used

Discussion Highlights

The objectives of the 2013 Water Supply Master Plan update and Purpose Statement were reviewed and explained to the CLC members. The purpose statement of this Water Supply Master Plan update aligns with that of the 2007 Master Plan; ensuring that the recommendations from the 2007 are built upon, including water conservation and efficiency measures.

The objectives of the study were also reviewed and are:

- 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; over the next 25 years
- To "…establish a sustainable water supply to regulate future growth." - City of Guelph Council Resolution, October 20 2003

- 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

Participants were provided with the schedule for the Water Supply Master Plan update, and the scope of work tasks. Charts were provided to explain the existing water supply capacity assessment and population demand forecasts.

The facilitator also identified the four water supply alternatives to be considered as part of this Master Plan update, namely:

- Demand Management/Conservation Programs
- Groundwater Sources In and Outside of the City
- Surface Water Sources (Local)
- Do nothing

Project staff explained the process for identifying potential new well areas, and for the aquifer storage and recovery (ASR) system which could re-inject potable water back into an aquifer for later recovery and use. The Grand River Conservation Authority would closely monitor an ASR system throughout the year.

Water supply alternatives will be assessed using a consistent approach, with the goal of developing a short-list of alternatives for ranking and further evaluation. Evaluation criteria will examine the ability to meet regulations, costs, technical feasibility, environmental or social affects, construction, and traffic.

Questions and Comments:

Are regulations similar for water sources outside of Guelph?
Yes they are. The City needs to comply with the same federal and provincial guidelines and regulations that apply to the Townships.

Does infrastructure need to be updated to accommodate increased capacity?
The City has undertaken a water and wastewater systems optimization master plan that reviews future linear infrastructure requirements.

Is the price of water going to be considered as part of the WSMP update? How are current rates for water determined?
The City is working with the economics department at Brock University on this issue. Pricing is based on a cost-recovery basis to keep the water supply and costs in line with appropriate regulations.

Is development (paving) near the Arkell (Rockwood) expected to affect Guelph's water quality?
The capture area of the Arkell Spring Grounds systems is very large and areas affected by development are relatively small by comparison, and we are getting smarter with environmental planning. Therefore, we are able to mitigate the risk.

What are the new approaches to consider?
Guelph is a city that obtains water exclusively from groundwater sources. Guelph has already captured all of the easy to access water. New alternatives will be increasingly more difficult to find.

While we may only be looking at Guelph's water supply, a larger ecological area is at play. Should we be expanding the scope of view?

The City of Guelph recognizes the need to be good neighbours and to cooperate with local communities. Our staff are working with representatives from Wellington County, the township of Puslinch, and the Township of Guelph-Eramosa.

Are you prepared to develop well head protection areas?
Well head protection areas need to be taken into consideration, however, the areas may result in imposed land use restrictions. Guelph source protection programs have focused to date on water quality but protecting water quantity is the next step.

How are water trade-offs made? What issues take priority when considering trade-offs?
Water restrictions and regulations for ICI users should be assessed on a case-by-case basis.

How much water does Sleeman Breweries and Nestle use?
Many large water takers have their own permit to take water (PTTW) which is approved by the Ministry of the Environment. This water is not included in the municipal system.

- "Nestle takes approximately 2,000 m^3/day.
- "Sleeman Breweries uses approximately 1,150 m^3/ day

Has the City of Guelph considered the impact of using grey-water? Has grey-water been suggested as a secondary water source (such as from contaminated wells) that could be used for firefighting and other water intensive uses?
Guelph is interested in hearing about many alternatives. Grey-water is at the core of the "Grey-water Reuse Rebate Program," a pilot program to receive a cash incentive from the City of Guelph for installing an approved grey-water reuse system.

Has Guelph considered new grass from Saskatchewan? It has been developed to not require as much watering and is drought resistant.
Guelph is happy to see that there are new developments being made to reduce outdoor water use and stays abreast of these initiatives.

What are other organizations and countries doing? Have they progressed beyond what we are doing?
It is difficult to compare water use in other jurisdictions and countries. Some of the problem is a societal issue where we are use to our current standards to service.

Many Guelph businesses supply bottled water to their employees, customers or clients. How will the Project Team account for this water use?
The use of non-tap water is an important consideration. Why the businesses are not using tap water is an issue that needs to be understood and addressed.

Next Steps

- Community Open House – October 10, 2013 (tentative)
- Community Liaison Committee meeting #2 – Mid November
- Municipality/Agency meeting #2 – Mid November

Community Liaison Committee Meeting #2 Minutes

Date of Meeting	April 8, 2014	6:00 pm to 9:30 pm	60287843
Project Name	City of Guelph Water Supply Master Plan Update		
Location	Guelph City Hall, Meeting Room C		
Regarding	Community Liaison Committee Meeting #2		
Attendees	Ed McCallum Mike Darmon Wayne Stokley Ken Hammill Andrea Williams Angela Kroetsch Jeremy Shute Brady Deaton Saveena Putara John Pawley Bob Carter City of Guelph: Dave Belanger, Peter Busatto, Wayne Galliher, Vince Suffoletta, Arun Hindupur, Peter Rider, Vladislav Frumkin, Kiran Suresh AECOM: Avril Fisken, Patty Quackenbush, David Kielstra, Joe Gemin		
Distribution	Attendees		
Minutes Prepared By	David Kielstra		

PLEASE NOTE: If this report does not agree with your records of the meeting, or if there are any omissions, please advise, otherwise we will assume the contents to be correct.

Agenda

- Registration & Welcome
- Opening Remarks/ Public Consultation To Date
- Project Update Presentation
  - Technical Memo 1 – Population and Water Supply Demand Forecasts
  - Technical Memo 2 – Existing Water Supply Capacity Assessment
  - Technical Memo 3 – Review of Water Supply Alternatives
- Round Table – Evaluation of Alternatives
- Next Steps

* Presentation reviewed at the meeting is appended.

Actions

Future Actions

Action	Responsibility	Action Timeline
Change Sleeman Breweries	DK	Completed following the

Action	Responsibility	Action Timeline
water takings statistics from previous CLC minutes.		meeting.

Minutes

Registration and Welcome

Information Reviewed

- Meeting objectives
- Roundtable introduction of participants and the project team
- Overview of the Agenda

Discussion Highlights

Participants were welcomed, and the meeting agenda was presented by Dave Belanger of the City of Guelph and Patty Quackenbush of AECOM. Participants were asked to add their name to the sign-in sheet. A brief overview identified the participants and their affiliation, if applicable.

The meeting summarized the three technical memorandums prepared to date for the project. A facilitated session to obtain feedback regarding the preliminary assessment of alternatives was also included in the meeting.

Note: A correction was made to the previous minutes: The Sleeman Brewery's water usage should be 1,150 m^3/ day rather than 5,000 m^3/ day as previously reported.

Opening Remarks/ Public Consultation Update

Information Reviewed

- Process for updating the Water Supply Master Plan
- Public Consultation Process, including Round 1 Consultation Overview: "What we Heard"

Discussion Highlights

The Water Supply Master Plan Update is currently at the completion of tasks 2, 3, and 4:

- Task 2 – Population and Water Demand Forecasts
- Task 3 – Existing Water Supply Capacity Assessment
- Task 4 – Water Supply Alternatives

This meeting provides a high level view of the preliminary alternatives, and time was set aside at the end of the meeting to address questions regarding the evaluation of alternatives.

A flow chart showing the Municipal Class Environmental Assessment process was provided, indicating that the team is now in the "Evaluate Alternatives and Develop Plan for Implementation" stage. The results of this meeting will assist with identifying which alternatives are preferred for the Water Supply Master Plan update.

A brief overview of Public Consultation Round 1 was provided along with a summary of the main comments received.

- **Community Liaison Committee Meeting #1** – Sept. 17, 2013
  - 14 of 19 members attended

- Feedback:
  - More action on conservation and management of existing sources. The project should consider re-use alternatives
  - Concern regarding balancing conservation with growth & development
  - Concerns regarding environmental contamination
  - In favour of prioritizing water sources inside the City and promoting sustainability

- **Municipality & Agency Workshop #1** – Sept. 19, 2013
  - 13 representatives from local municipalities & agencies attended
  - Follow-up engagement with surrounding Townships:
    - presentations to Puslinch Township Council – Oct. 2, 2013 & Guelph-Eramosa Township – Oct. 21, 2013
- **Community Open House #1** – Oct .10, 2013
  - 16 members of the general public, including developers and surrounding municipalities
- **Water Conservation & Efficiency Public Advisory Meetings** – held in the Fall and ongoing.

Project Overview Presentation

Technical Memorandum #1 – Population and Water Supply Demand Forecasts

Information Reviewed

- Technical Memorandum 1 – Population and Water Supply Demand Forecasts
  - Historic water demand
  - Historic/ Forecasted population

Discussion Highlights

The memo looked at historic water usage between 2006 and 2012 and projected population levels over a 25 period (2013-2038) to forecast future demand from residential, Industrial, Commercial Institutional (ICI) customers, as well as non-revenue water usage.

For the historic period (2006-2012), water demands have dropped while growth increased. Guelph has had positive success with conservation strategies resulting from the 2007 Master Plan, and is on track to meet the conservation goals set out in the 2009 strategy document. There is a sustained downward trend evident due to conservation measures.

Residential, Commercial, and Institutional sectors have lower water consumption between 2006 and 2012. The industrial sector is lower than 2006 and 2007, however rose slightly in 2012 which may indicate responsiveness due to changes in the economy.

A comparison of water consumption and population suggests that population is expected to exceed the maximum day demand (the maximum volume over a day that must be supplied) for water before 2038. In preparing a baseline, the project team does not account for additional conservation since the proposed alternatives include reviewing various conservation targets.

<u>Questions and Comments:</u>

Average demand appears to go down in 2013, but the previous slide shows a projected increase in demand? Please explain.
The forecast does not include conservation measures so that a status quo can be established to allow conservation scenarios to be added as alternatives to establish required water system capacity at various levels of reduction.

Did you account for students expected at Guelph (University of Guelph/ Conestoga College) in the demand forecast?
A follow-up response from Guelph Planning indicates tehat the Census includes ome but not all students depending on whether they declare Guelph as their place of residence. Additional students are captured in the undercount..

What figure was used to look at Watson & Associates population projections?
The project team was given a year by year breakdown for the residential and employment for the population forecast to 2031. Beyond 2031, forecasts reled on an internal planning memo with projections to 2041. The team had to interpolate to get to 2038.

Technical Memorandum #2 – Existing Water Supply Capacity Assessment

Information Reviewed

- Technical Memorandum 2 summary
  - Existing well quadrant analysis
  - Drought and contamination scenarios

Discussion Highlights

The goal of the memo is to examine existing capacity, and to identify future water supply capacity requirements. The current Guelph water supply and geology was explained including the status of the existing 25 current production wells and the four wells that are offline due to man-made or naturally occurring reasons.
Existing wells and water supply options were assessed to determine their existing capacity and potential under the Water Supply Master Plan Update. It was determined that the capacity has increased from 75,000 m^3/day to 83,000 m^3/day. The analysis also examined potential drought conditions and contamination event scenarios to help plan for system redundancy.

<u>Questions and Comments:</u>

Referencing the deficit and surplus values, are they existing capacities or maximum capacities?
Water supply systems are always designed to service maximum day demand, with additional redundancy to allow for in case of potential shortfalls (e.g., plants go off line, contamination issues, etc.)
Do shortfalls always require new wells, or can surplus be purchased as a commodity?
Temporary demand reductions to address shortfalls could be put in for a short term only.

Is there an option to buy back water, which would restrict the amount of water that could be available, similar to an energy system?
This is not a concept that is easily applied to the City. The City currently goes tocontactsencourages major water users consumers to see ifton adopt conservation initiatives which ultimately results infrees can help freed up capacity. Also, users do not have a Permit to Take Water (PTTW) which could limit the ability to obtain the water. IfFor (?) For industries withhave their own water supplyies and their own allotment under a Permit to Take Water

(PTTW), the city City could explore potentially seeking to take over permits or excess capacity when these permit holders no longer require the capacity. This proposal is included in the WSMP as non-municipal sources.

Technical Memo 3 – Review of Water Supply Alternatives

Information Reviewed

- Technical Memorandum 3 summary
    - Explanation of Alternatives
        - Water Conservation and Re-Use
        - Expand Existing Groundwater Sources
        - Establish New Surface Water Supply
        - Limit Growth/ Do Nothing

Discussion Highlights

The third technical memorandum reviewed the alternatives available for providing the future water capacity requirement identified in technical memorandum #2.

Alternative #1: Water Conservation

Water conservation was the first alternative examined, explaining that conservation was a preferred course of action from the 2007 Water Supply Master Plan. Progress towards meeting the 2009 strategy goals is encouraging. Guelph was assessed against other comparable communities, and the community has one of the lowest residential per capita consumption. Five scenarios for conservation were identified to help determine the potential costs associated with varying target reductions.. A centralized re-use option was also considered.

Alternative #2: Expand Existing Groundwater Sources

Alternative #2 examined the potential for expanding groundwater systems through a number of options including optimizing/refurbishing existing wells, develop test wells, develop additional wells, and using an Aquifer Storage and Recovery (ASR) system. The potential tasks involved in each of the options was identified, along with a capital cost estimate and a cost per capacity (m^3 /day) to develop the options.

- Optimization was identified to ensure maintenance of existing capacity through ongoing investment in equipment, pumps, and other items. The Water Supply Master Plan Update will include some recommendations for optimization.

- Developing test wells: Each test well was identified along with its potential available capacity, and capital cost estimates to develop the options. Some issues were identified:
    - SW Quadrant: de-watering of the Dolime quarry limits the potential of this area.
    - Good water supply and quality is expected at the Ironwood/Steffler and Logan/Flemming test wells
    - High capital costs are typically indicative of the need for advance treatment

- New Wells: Model simulations were conducted for three general locations (Guelph North, Guelph Central, Guelph South) to determine water production potential. Further study would be required, along with investment in infrastructure, permits and assessments.
- Aquifer Storage and Recovery: This system involves taking water surface water during high flows and storing it underground in aquifers until there is a need. This is used effectively in the United States and the Region of Waterloo. One possible option could take advantage of the existing collector system at Arkell Springs to capture high spring and fall flows in the Eramosa River pumped to the recharge system.

Alternative #3: Surface Water Sources

Two options were identified for surface water:

- Guelph Lake downstream of the dam
- Eramosa River at the Arkell Spring Grounds

The Project team worked with the Grand River Conservation Authority to identify potential water available on a continous basis and seasonally. Through discussions, it was determined that 150 Litres/ second and 300 Litres/ second were appropriate continuous and seasonal flows respectively, for design of a water treatment plant. Surface water supply options carry a high capital cost due to the treatment requirements.

Alternative #4: Limit Growth/ Do Nothing

The Limit Growth/ Do Nothing alternative was included, however, it does not meet the needs of the study since the current water supply would not meet the needs of the projected growth in the Official Plan.

Questions and Comments:

Are there some conservation scenarios that are more favoured than the others at this point?
The scenarios provide a range of demand reduction opportunities with associated costs; each requires further review and determination of public acceptance

Have you looked at ranking the conservation scenarios?
At this point, the scenarios have been developed to allow comparison of different levels of reductions and associated costs. These will be compared to other water supply alternatives during a financial evaluation.

Have you looked at recycled water for the Aquifer Storage Recovery system?
We have only considered treated surface water in the ASR alternative. There are some regulatory concerns and public perception issues with using re-use water for the ASR. Wastewater would need to be treated to potable water quality before being injected in an ASR system.

What is the status of the "purple pipe" option considered in the 2007 Water Supply Master Plan?
The York Trunk Sewer Class Environmental Assessment reviewed the capital cost and feasibility for implementing a purple pipe in the same corridor as the York trunk sewer from the WWTP to a new business park. There were challenges because it would be a utility without year-round customers. There were also regulatory issues. A technical memorandum was developed that is available on-line. If there was a customer willing to take volume all year long, it may expedite this option. The City would only be a seasonal user.

What would be the cost of putting in a trial purple pipe?
The cost for dual piping in the distribution system is very expensive, particularly in developed areas. Opportunities for implementation will be best in new areas where dual piping could be installed initially.

Guelph North Potential Well: What is the potential for industrial contamination in this area?
Potential contamination from surrounding industries would be investigated during class environmental assessments; to be undertaken on a project specific basis.

Has there been any thought to water storage behind the Guelph dam?
The project team worked with the Grand River Conservation Authority to determine the reliable availability of water from the Speed River just upstream of the Guelph dam for both surface water options (continuous and ASR).

Round Table – Evaluation of Alternatives

Information Reviewed

- Evaluation tables from the Technical Memoranda

Discussion Highlights

Participants were asked to divide into two groups to examine the evaluation tables provided in the Technical memorandum and to answer the following 5 questions:

1. Do you have any comments or suggestions regarding the criteria or indicators used?
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?
4. Do you have any feedback on any other aspects of the presentation?
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?

The following is a list of answers recorded for the questions:

	Group 1 Responses	Group 2 Responses	Group 3 Responses
1. Do you have any comments or suggestions regarding the criteria or indicators used?	• Insufficient time to digest during the time allowed in the meeting	• No response.	• Apply a sustainability factor to each category • Consider impacts on adjacent land owners across multiple categories
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.	• Public acceptance – Stay the course on groundwater	• Quality is important to residents: taste, hardness • ASR systems may be unknown to residents – may need additional explanations • Reuse of water may have trouble getting public acceptance due to perceptions of dirty water – may take additional education	• Re-use and treatment of existing wells will require public education • Use of wells outside City limits requires additional consultation • Optimize resources within city vs. outside city
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?	• No response.	• Conservation seemed to be rated high, but there is a risk that behaviours could change over time. Should only allow for more conservative scenario; i.e. lower target.	• No response.

4. Do you have any feedback on any other aspects of the presentation?	• Population projections require more explanation	• Group 2 liked the graphs, but they could be larger.	• Need additional explanation of charts to show increasing trends vs. decreasing trends
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?	• No response.	• Presentation at the public open house should be at least 15-20 minutes • Simplify the contents of the presentation • Cost will be the bottom line • Explain the problem/opportunity statement	• Explain acronyms, definitions, terminology • Use layman's terms • Break down charts into smaller pieces •

Next Steps

Information Reviewed

- Upcoming meeting dates for the round 2 of consultation (i.e., CLC Meeting, Open House)

Discussion Highlights

The following next steps were presented for the information of the members present:

- Next phase of public consultation:
  - **Water Conservation & Efficiency PAC Meeting** – Thursday, April 3
  - **Municipality / Agency Workshop #2** – Monday, April 7
  - **CLC Meeting #2** – Tuesday, April 8
  - **Community Open House #2** – Tuesday, April 29
- Update WSMP and complete evaluation of alternatives based on feedback from the public consultation events
- Incorporate input from City/University of Toronto Survey
- Complete financial analysis and develop implementation plan
- Draft Water Supply Master Plan Update document
- 30 day public review

Participants were encouraged to get in touch with the project team if they had any additional questions or concerns related to the project.

APPENDIX C: MUNICIPAL/AGENCY MEETING MINUTES AND PRESENTATION

Municipality/Agency Workshop #1 Minutes

Date of Meeting	September 19, 2013	1:00pm	60287843
Project Name	City of Guelph Water Supply Master Plan Update		
Location	Guelph City Hall, Meeting Room C		
Regarding	Municipality/Agency Workshop		
Attendees	Karen Landry, Mayor Dennis Lever – Puslinch Township Mayor Chris White, Rod McClure – Guelph-Eramosa Township Gary Cousins – County of Wellington James Etienne – Grand River Conservation Authority Bo Cheyne – Wellington-Dufferin-Guelph Public Health Carola Serwotka, Amy Shaw, Pamela Grande, Cynthia Doughty, Barb Slattery, Lisa Williams – Ministry of the Environment (MOE) Dave Belanger, Wayne Galliher, Peter Busatto, Brian Pett, Vince Suffoleta, Andrew Janes, Karl Cober, Kiran Suresh, Valdislav Frumkin, Arun Hundupur – City of Guelph Avril Fisken, Patty Quackenbush, Jacob Stemeroff - AECOM		
Distribution	Attendees		
Minutes Prepared By	Jacob Stemeroff		

PLEASE NOTE: **If this report does not agree with your records of the meeting, or if there are any omissions, please advise, otherwise we will assume the contents to be correct.**

Agenda

- Welcoming & Opening Remarks
- Water Supply Master Plan Update – Overview
- Guelph's Current Water Supply System
- City Updates since 2007 WSMP
- Water Supply Master Plan Update
- Work Underway
- Assessing Alternatives
- Next Steps

* Presentation reviewed at the meeting is appended.

Actions

Future Actions

Action	Responsibility	Action Timeline

Action	Responsibility	Action Timeline
Provide more background information regarding WSMP on the City of Guelph website, including: • **Quadrant studies from the 2007 WSMP** • **Forecasted capacities** • **New water sources under investigation**	• Dave Belanger	For Next Meeting
Modify purpose statement to say 'strategies and policies' not just 'strategies', and to include 'planning for peak demand.'	• Patty Quackenbush	For Next Meeting
Provide map showing well head protection areas	• Dave Belanger	For Next Meeting
Present to Townships at next Council meeting	• Dave Belanger	As per Township Council Schedule

Minutes

Welcoming and Opening Remarks

Information Reviewed
- Meeting objectives
- Roundtable introduction of participants and the project team
- Role of the Municipality/Agency Meeting

Discussion Highlights
The role of the Municipality/Agency meeting was discussed. Members are expected to provide guidance on key aspects of the Master Plan and the Class EA, including:

- Objectives and scope of the Master Plan Update
- Issues and opportunities to be addressed
- Alternative solutions to be assessed
- Evaluation method and criteria to be applied
- Preferred alternatives and strategy

A brief overview identified the participants and their affiliation, including representatives of the Township of Puslinch, the Township of Guelph/Eramosa, the City of Guelph, Wellington County, the Ministry of the Environment, the Grand River Conservation Authority, and Wellington-Dufferin-Guelph Public Health.

Water Supply Master Plan Update Overview

Information Reviewed
- Process for updating the Water Supply Master Plan

- Master planning process

Discussion Highlights

The Master Plan update will follow the requirements of a Municipal Class Environmental Assessment. Individual projects identified as part of the Guelph Water Supply Master Plan update will proceed in accordance with remaining Class EA requirements.

Guelph's Current Water Supply System

Information Reviewed

- Guelph's existing water supply system
- Current water supply capacity

Discussion Highlights

Guelph's existing water supply relies on groundwater to meet demand. Through a system of municipal wells and the Arkell Spring Grounds collector system, Guelph maintains its water supply needs. Existing well capacity was explained for each of the wells, with 17 operating on a near continuous basis. Six wells were not operated at their peak capacity due to repairs, poor water quality sampling results, or operated only as needed to address peak demands.

Questions and Comments:

How do you define current level of service?
Level of service is a general metric which should be examined as a pro/con trade off, for example, do the negatives outweigh the benefits when I look at what I am getting for my water supply? We want to find out whether the City of Guelph should continue the current level of service (status quo), impose restrictions, or make adjustments.

Has there ever been an effort to characterize peaks in demand? Does increased pumping lead to increased loses?
The City of Guelph does look for externalities when facing peaks and any external factors that may have had an impact on those peaks. Guelph experiences small peaks in comparison to other local municipalities.

What is Guelph's bulk supply policy?
Some bulk water users exist in Guelph. Organizations or businesses classified as bulk users must pay a premium to recover additional costs due to their service requirements. Bulk users have unlimited use until outdoor water use by-law restrictions are applied.

You have been pumping some wells for a long time. Are any wells going dry?
The wells are not going dry. The wells are managed sustainably and well levels are monitored regularly.

Progress Since 2007 Water Supply Master Plan

Information Reviewed

- Preferred solution from the 2007 Water Supply Master Plan

- Water conservation and demand management goals from 2007
  - Progress achieved since 2007
- Strategies and programming resources for water conservation and demand management
- Water conservation data since 2007 and forecast to 2019
- Water production, relative to water consumption and population
- City-wide studies completed and in-progress
  - Guelph Tier 3 Water Budget and Local Area Risk Assessment
  - Guelph Drinking Water Source Protection Plan and Policies
- New infrastructure since 2007
- Progress regarding class environmental assessments and treatability projects since 2007
- Progress made since 2007 on hydrogeological investigations and studies

Discussion Highlights

Project staff provided context for the new Water Supply Master Plan update by re-examining the 2007 plan and its recommendations. Short term goals of the 2007 Master Plan included creating demand management and conservation programs, while also constructing two new wells. Investigations were also conducted to examine existing wells, and to determine the need for new wells inside the city. Medium and longer term goals included further investigation and development of groundwater supplies inside and outside the city, and the development of other surface water sources through Aquifer Supply Recharge (ASR).

Since completion of the 2007 Master Plan, significant progress has been made to conserve water by establishing demand management and conservation programs for both residential and ICI sectors. As well, two new wells have been built, and Environmental Assessments and studies have been launched to investigate new water sources.

Principles of adaptive management were also established for the Arkell Spring Grounds, and are ongoing.

2013 Water Supply Master Plan Update

Information Reviewed

Overview

- Objectives of 2013 WSMP update
- Purpose statement of 2013 WSMP update
- Scope of work and timeline for update
- Community engagement goals and consultation plan

Work Underway

- Population and water supply demand forecasts from 2013 to 2038
  - Methodology used when developing water demand projections
- Water supply capacity of existing system
- Alternatives for developing water supply
  - New groundwater supply opportunities – in and outside
  - Local water sources, including aquifer storage and recovery alternatives
  - Water Conservation and Demand Management Alternatives

Assessing Alternatives

- Directed members to the methodology for assessing alternatives, and the evaluation criteria to be used

Discussion Highlights

The objectives of the 2013 Water Supply Master Plan update and Purpose Statement were reviewed and explained to the CLC members. The purpose statement of this Water Supply Master Plan update aligns with that of the 2007 Master Plan; ensuring that the recommendations from the 2007 are built upon, including water conservation and efficiency measures.

The objectives of the study were also reviewed and are:

- 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; over the next 25 years
- To "…establish a sustainable water supply to regulate future growth." - City of Guelph Council Resolution, October 20 2003
- 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

Participants were provided with the schedule for the Water Supply Master Plan update, and the scope of work tasks. Charts were provided to explain the existing water supply capacity assessment and population demand forecasts.

The facilitator also identified the four water supply alternatives to be considered as part of this Master Plan update, namely:

- Demand Management/Conservation Programs
- Groundwater Sources In and Outside of the City
- Surface Water Sources (Local)
- Do nothing

Project staff explained the process for identifying potential new well areas, and for the aquifer storage and recovery (ASR) system which could re-inject potable water back into an aquifer for later recovery and use. The Grand River Conservation Authority would closely monitor an ASR system throughout the year.

Water supply alternatives will be assessed using a consistent approach, with the goal of developing a short-list of alternatives for ranking and further evaluation. Evaluation criteria will examine the ability to meet regulations, costs, technical feasibility, environmental or social affects, construction, and traffic.

Feedback Received – Questions and Comments

Questions and Comments from Meeting

If the municipality wanted to maximize supply and started to draw more from the wells, would there be an impact on other water users?

"Yes. Pumping permits (Permit to Take Water) dictate how much water can be taken. There have been occasions when other water users have been impacted, and the City must rectify impacts.

Have impacts been determined for the potential water source at Ironwood?

The impacts on potential water sources will be part of the environmental assessment (EA) process. If some impacts are predicted, the EA will recommend mitigation strategies.

Are there similar activities occurring in local communities? Is a pipeline being considered?

We have been directed by our Guelph City Council to not include a pipeline as an alternative. A pipeline is not a locally sustainable option, and it is outside of Guelph's control. Cambridge is going through a similar Water Supply Master Plan process. Guelph is integrating Tier 3 Water Budget Studies with the Region of Waterloo.

Should we be encouraging ICI users to investigate chillers that reuse water? Could wastewater be converted to drinking water using an approach similar to that being used on the International Space Station?
There are funding issues with using re-used water. There are no customers yet, but intensive capital will be needed up-front to develop such a system. Guelph Engineering Services is investigating the idea. The idea is also hampered by the lack of standards in place for such a system. The issue is addressed in a linear master plan and is also part of the Wastewater Master Plan.

Is a regional water supply system an option?
Not at this time. Other municipalities in the region have different water qualities and infrastructure, which would create compatibility issues with each of the systems integrating.

Are Guelph's neighbours being properly included in engagement?
Guelph's neighbours have been engaged early in the project, and we have reached out to local townships for meetings and comments on our progress to date. Advertisements for the next public session, the Community Open House, will be published in local media.

Can water storage address peaks in demand?
Yes it can, however water storage facilities are very expensive, and storage of excess water results in water quality concerns.

Could a rate system based on time of usage be developed?
Peak demand is a significant issue for all municipalities. It is a question suited for MOE.

Question for MOE representatives: Will MOE change design criteria from Max Day Factor of 1.5?
Max Day Factor has been used for over 40 years in Ontario. If a municipality can provide information showing that a different rate is more suitable, MOE will consider the new approach and potentially allow.

When considering Aquifer Storage and Recovery, is there water loss?
With a confined bedrock aquifer, almost 100% of the water is recovered. A permit is needed to extract the water. Modelling is conducted to determine the best location to inject water back into the aquifer.

Have potential water sources outside of the city been tested yet?
Some potential water sources have been tested, while some other potential water sources are known based on available information collected from desktop studies.

Are all water supplies the same with regard to permitting? For peak days, is there a water source which can be made temporarily available?
Other water supply options would need to have their impacts assessed as part of the permitting process. Municipalities will need to start considering options such as water sources that can be used temporarily to meet peak demand.

Municipality/Agency Workshop Meeting #2 Minutes

Date of Meeting	April 7, 2014	1:00 pm to 4:15 pm	60287843
Project Name	City of Guelph Water Supply Master Plan Update		
Location	Guelph City Hall, Meeting Room C		
Regarding	Municipality/Agency Workshop #2		
Attendees	Puslinch Township: Karen Landry, Mayor Dennis Lever Guelph-Eramosa Township: Mayor Chris White, Kimberly Wingrove County of Wellington: Gary Cousins Grand River Conservation Authority: James Etienne Ministry of Environment: Barbara Slattery, Cynthia Doughty, Lisa Williams Carola Serwotka, Greta Najcler Wellington-Dufferin-Guelph Public Health: Bo Cheyne, Wendy Briggs Centre Wellington, Guelph-Eramosa, Puslinch - Kyle Davis City of Guelph: Peter Rider, Arun Hindupur, Vince Suffoletta, Ron Maeresera, Wayne Galliher, Peter Busatto, Dave Belanger AECOM: Avril Fisken, Patty Quackenbush, David Kielstra, Joe Gemin		
Distribution	Attendees		
Minutes Prepared By	David Kielstra		

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- Registration & Welcome
- Opening Remarks/ Public Consultation To Date
- Project Update Presentation
  - Technical Memo 1 – Population and Water Supply Demand Forecasts
  - Technical Memo 2 – Existing Water Supply Capacity Assessment
  - Technical Memo 3 – Review of Water Supply Alternatives
- Round Table – Evaluation of Alternatives
- Next Steps

* Presentation reviewed at the meeting is appended.

Actions

Future Actions

Action	Responsibility	Action Timeline
Check population growth and development plans beyond 2031	Planning Department	To be updated in draft Master Plan document
Consider Potential Impacts to	Project Team	To be incorporated into draft

Action	Responsibility	Action Timeline
Township Development Plans in the Evaluation of Alternatives		Master Plan document

Minutes

Registration and Welcome

Information Reviewed
- Meeting objectives
- Roundtable introduction of participants and the project team
- Overview of the Agenda

Discussion Highlights
Participants were welcomed, and the meeting agenda was presented by Dave Belanger of the City of Guelph and Patty Quackenbush of AECOM. Participants were asked to add their name to the sign-in sheet.

A brief overview identified the participants and their affiliation, including representatives of the Township of Puslinch, the Township of Guelph/Eramosa, the City of Guelph, Wellington County, Township of Centre Wellington, the Ministry of the Environment, the Grand River Conservation Authority, and Wellington-Dufferin-Guelph Public Health.

The meeting will summarize the three technical memoranda prepared to date for the project, and move into an evaluation exercise at the end of the session to obtain feedback regarding the preliminary assessment.

Opening Remarks/ Public Consultation Update

Information Reviewed
- Process for updating the Water Supply Master Plan
- Public Consultation Process
- Round 1 Consultation Overview: “What we Heard”

Discussion Highlights
The Water Supply Master Plan Update currently includes the completion of tasks 2, 3, and 4:
- Task 2 – Population and Water Demand Forecasts
- Task 3 – Existing Water Supply Capacity Assessment
- Task 4 – Water Supply Alternatives

This meeting provides a high level view of the preliminary alternatives, and time was set aside at the end of the meeting to address questions regarding the evaluation of alternatives.

A flow chart showing the Municipal Class Environmental Assessment process was provided, indicating that the team is now in the “Evaluate Alternatives and Develop Plan for Implementation” stage. The results of this meeting will assist with identifying which alternatives are preferred for the Water Supply Master Plan update.

A brief overview of Public Consultation Round 1 was provided along with a summary of the main comments received.

- **Community Liaison Committee Meeting #1** – Sept. 17, 2013

- 14 of 19 members attended
- Feedback:
  - More action on conservation and management of existing sources. The project should consider re-use alternatives
  - Concern regarding balancing conservation with growth & development
  - Concerns regarding environmental contamination
  - In favour of prioritizing water sources inside the City and promoting sustainability

- **Municipality & Agency Workshop #1** – Sept. 19, 2013
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- **Community Open House #1** – Oct .10, 2013
  - 16 members of the general public, including developers and surrounding municipalities
- **Water Conservation & Efficiency Public Advisory Meetings** – held in the Fall and ongoing.

Project Overview Presentation

Technical Memorandum #1 – Population and Water Supply Demand Forecasts

Information Reviewed

- Technical Memorandum 1 – Population and Water Supply Demand Forecasts
  - Historic water demand
  - Historic/ Forecasted population

Discussion Highlights

The memo looked at historic water usage between 2006 and 2012 and projected population levels over a 25 period (2013-2038) to forecast future demand from residential, Industrial, Commercial Institutional (ICI) customers, as well as non-revenue water usage.

For the historic period (2006-2012), water demands have dropped while growth increased. Guelph has had positive success with conservation strategies resulting from the 2007 Master Plan, and is on track to meet the conservation goals set out in the 2009 strategy document. There is a sustained downward trend evident due to conservation measures.

Residential, Commercial, and Institutional sectors have lower water consumption between 2006 and 2012. The industrial sector is lower than 2006 and 2007, however rose slightly in 2012 which may indicate responsiveness due to changes in the economy.

A comparison of water consumption and population suggests that population is expected to exceed the maximum day demand (the maximum volume over a day that must be supplied) for water before 2038. In preparing a baseline, the project team does not account for additional conservation since the proposed alternatives include reviewing various conservation targets.

Technical Memorandum #2 – Existing Water Supply Capacity Assessment

Information Reviewed

- Technical Memorandum 2 summary
  - Existing well quadrant analysis
  - Drought and contamination scenarios

Discussion Highlights

The goal of the memo is to examine existing capacity, and to identify future water supply capacity requirements. The current Guelph water supply and geology was explained including the status of the existing 25 current production wells and the four wells that are offline due to man-made or naturally occurring reasons.
Existing wells and water supply options were assessed to determine their existing capacity and potential under the Water Supply Master Plan Update. It was determined that the capacity has increased from 75,000 m^3/day to 83,000 m^3/day. The analysis also examined potential drought conditions and contamination event scenarios to help plan for system redundancy.

Questions and Comments:

What is the maximum population in the City of Guelph boundary?
The "Places to Grow" estimate is 175,000 in 2031. Official planning includes lands for development beyond 2031, but numbers are not assigned yet.
Is this study going to generate more capacity than is needed, or require additional land?
The intent of this study to determine the capacity required to meet the needs of the projected population. It does not address land requirements for growth.

Technical Memo 3 – Review of Water Supply Alternatives

Information Reviewed

- Technical Memorandum 3 summary
  - Explanation of Alternatives
    - Water Conservation and Re-Use
    - Expand Existing Groundwater Sources
    - Establish New Surface Water Supply
    - Limit Growth/ Do Nothing

Discussion Highlights

The third technical memorandum reviewed the alternatives available for providing the future water capacity requirement identified in technical memorandum #2.

Alternative #1: Water Conservation

Water conservation was the first alternative examined, explaining that conservation was a preferred course of action from the 2007 Water Supply Master Plan. Progress towards meeting the 2009 strategy goals is encouraging. Guelph was assessed against other comparable communities, and the community has one of the lowest residential per capita consumption. Five scenarios for conservation were identified to help determine the potential costs associated with varying target reductions.. A centralized re-use option was also considered.

Alternative #2: Expand Existing Groundwater Sources

Alternative #2 examined the potential for expanding groundwater systems through a number of options including optimizing/refurbishing existing wells, develop test wells, develop additional wells, and using an Aquifer Storage and Recovery (ASR) system. The potential tasks involved in each of the options was identified, along with a capital cost estimate and a cost per capacity (m^3 /day) to develop the options.

- Optimization was identified to ensure maintenance of existing capacity through ongoing investment in equipment, pumps, and other items. The Water Supply Master Plan Update will include some recommendations for optimization.

- Developing test wells: Each test well was identified along with its potential available capacity, and capital cost estimates to develop the options. Some issues were identified:
  - SW Quadrant: de-watering of the Dolime quarry limits the potential of this area.
  - Good water supply and quality is expected at the Ironwood/Steffler and Logan/Fleming test wells
  - High capital costs are typically indicative of the need for advance treatment

- New Wells: Model simulations were conducted for three general locations (Guelph North, Guelph Central, Guelph South) to determine water production potential. Further study would be required, along with investment in infrastructure, permits and assessments.
- Aquifer Storage and Recovery: This system involves taking water surface water during high flows and storing it underground in aquifers until there is a need. This is used effectively in the United States and the Region of Waterloo. One possible option could take advantage of the existing collector system at Arkell Springs to capture high spring and fall flows in the Eramosa River pumped to the recharge system.

Alternative #3: Surface Water Sources

Two options were identified for surface water:

- Guelph Lake downstream of the dam
- Eramosa River at the Arkell Spring Grounds

The Project team worked with the Grand River Conservation Authority to identify potential water available on a continuous basis and seasonally. Through discussions, it was determined that 150 Litres/ second and 300 Litres/ second were appropriate continuous and seasonal flows respectively, for design of a water treatment plant. Surface water supply options carry a high capital cost due to the treatment requirements.

Alternative #4: Limit Growth/ Do Nothing
The Limit Growth/ Do Nothing alternative was included, however, it does not meet the needs of the study since the current water supply would not meet the needs of the projected growth in the Official Plan.

<u>Questions and Comments:</u>

For re-use of water, did you find the objection was due to technology, or psychological barrier for water from previous uses?
Generally people prefer groundwater and surface water sources to re-use options. Re-use requires more advanced water treatment processes to achieve potable water quality.

What are the communities that Guelph was compared against for conservation?

We cannot publish the names of other municipalities participating in the National Water-Wastewater Benchmarking Initiative due to confidentiality. In previous City documentation and presentations to Council, the annual budgets show comparison communities for reviewing water rates. Council wants to be a leading conservation community.

Why are the Logan/Flemming wells identified together?
The combination of the two sites refers to two municipal test wells in an area where a future municipal production well could be located based on preliminary hydrogeological investigations.

How big would the general area be around the point (potential well sites)?
The indicated location is only a general area. The potential areas were identified where there would be less potential impacts to nearby watercourses. Areas are approximate and used for evaluation of area groundwater potential and would be reviewed further in a groundwater investigation study.

Are land acquisition costs included in cost estimates for new wells? In the park as well?
Yes, land acquisition is included except where we are confident that location in a park is feasible. This would be subject to discussion with the City's Parks and Recreation department..

Is there a cost upset limit for alternatives?
No. Cost estimates are developed for all alternatives; financial impact is one of several factors considered in evaluation.

If there is a fairly large subdivision/development near Guelph, would there be impacts?
Potential impacts would be taken into consideration in the Class Environmental Assessment for any project resulting from the Water Supply Master Plan Update. For any proposed new water takings, existing and proposed developments that will require potable water would also be taken into consideration when evaluating potential impacts.

At what point will you develop well protection areas?
Guelph will be developing policies under the Source Water Protection regulations. The actual well protection areas will be determined through modeling. Land use restrictions within the protection zones will be identified as part of these studies.

Who picks up the potential costs of additional wells?
It would be unreasonable to ask Township residents to pick up additional costs for a City municipal well. With reference to source water protection and wellhead protection areas, the City will continue its discussions with neighbouring communities.

Comment: New wells may create a new dynamic between the City of Guelph and the townships.
Comment noted.

Comment: Township residents want to make sure they aren't picking up unreasonable costs or to businesses in the area.
A dialogue will be in place with Townships on this issue.

Comment: Township development plans should be considered as part of the evaluation of alternatives.
This comment has been noted.

Has Aquifer Storage and Recovery (ASR) been done in other areas?

Yes. It is used in the United States and closer to home in the Region of Waterloo. It has been around for 20 years. It requires good geology, but works well since it gets around the issue of seasonal variation and allows for some banking of water.

Round Table – Evaluation of Alternatives

Information Reviewed

- Evaluation tables from the Technical Memoranda

Discussion Highlights

Participants were asked to divide into two groups to examine the evaluation tables provided in the Technical memorandum document based on the following 5 questions:

1. Do you have any comments or suggestions regarding the criteria or indicators used?
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?
4. Do you have any feedback on any other aspects of the presentation?
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?

The following is a list of responses:

Questions	Group 1 Responses	Group 2 Responses
1. Do you have any comments or suggestions regarding the criteria or indicators used?	• Difficult to comment due to uncertainty related to source protection • Wellhead areas need to be added	• Assessment: why was it qualitative?
2. Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.	• Aquifer Storage and Recovery – the option may be foreign to some members of the public	• The impact to individual wells, limitations and considerations should be identified. • Guelph residents are concerned about costs going up, while consumption is going down. This should generate better feedback from the public.
3. Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?	• Use of options within the city boundaries first – The Township options should be the last resort	• Information on these wells should be obtained from the Townships
4. Do you have any feedback on any other aspects of the presentation?	• No response.	• Use more graphics – logical graphics such as trees, dollar signs to make the categories stand out.

		• The graph should show costs currently compared to 5 years ago. • Litres per person should be spelled out • Provide an understanding of what other jurisdictions higher than Guelph are doing to achieve conservation targets • Look at other measures to compare ICI sector businesses.
5. What advice do you have for presenting this information at the upcoming Community Open House meeting?	• The public meeting should answer the question "why is this necessary and important?" • Potential cost implications – it is hard to quantify	• Make sure the public understands why it was not quantitative • Pros, cons, costs, etc. should be boiled down for the public • Costs to the individual ratepayers – when phased in, who pays?

Next Steps

Information Reviewed

- Upcoming meeting dates for the round 2 of consultation

Discussion Highlights

The following next steps were presented for the information of the members present:

- Next phase of public consultation:
    - **Water Conservation & Efficiency PAC Meeting** – Thursday, April 3
    - **Municipality / Agency Workshop #2** – Monday, April 7
    - **CLC Meeting #2** – Tuesday, April 8
    - **Community Open House #2** – Tuesday, April 29
- Update WSMP and complete evaluation of alternatives based on feedback from the public consultation events
- Incorporate input from City/University of Toronto Survey
- Complete financial analysis and develop implementation plan
- Draft Water Supply Master Plan Update document
- 30 day public review

Participants were encouraged to get in touch with the project team if they had any additional questions or concerns related to the project.

APPENDIX D: COMMUNITY OPEN HOUSE NOTICES

PUBLIC NOTICE

City of Guelph Water Supply Master Plan Update

Community Open House #1

The City of Guelph is updating its Council-approved **Water Supply Master Plan** to define how we will continue to access a sustainable supply of water—for residential and industrial use—over the next 25 years.

Reviewing our existing water supply system is an opportunity to discuss with the community 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.

Our review will follow 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 either increase the capacity of our existing system or to reduce our demand for water.

You're invited to attend

You're invited to attend the first Community Open House to learn more about the Water Supply Master Plan update. The Open House will run from 6–8:30 p.m. You're welcome to drop–in anytime during the open house. A short presentation and a question and answer session will run from 7–7:30 p.m. Project team members will be on-hand to discuss any questions or comments that you may have.

Thursday, October 10

6–8:30 p.m.
Council Chambers, City Hall
1 Carden Street

To find out more about the project, visit **guelph.ca/water** and follow the Water Supply Master Plan link, or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T **519-822-1260 x 2186**
E **dave.belanger@guelph.ca**

Patty Quackenbush
Senior Project Engineer
AECOM
T **519-650-8691**
E **patty.quackenbush@aecom.com**

City of Guelph
Making a Difference

CITY OF GUELPH PUBLIC NOTICE

City of Guelph Water Supply Master Plan Update/Class Environmental Assessment

Community Open House #2

The City of Guelph is updating its Council–approved **Water Supply Master Plan** to define where and how we will continue to access a safe and sustainable supply of water—for residential, industrial, commercial and institutional use—over the next 25 years.

Reviewing our existing water supply system is an opportunity for community discussion about how best to manage this vital supply so that we continue to meet the needs of the City and the local environment, and 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.

Our review is following 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. The input provided at this community open house will help the team evaluate alternatives with the objective of developing the preferred water supply alternatives and implementation strategy.

You're invited to attend

You're invited to drop into the second Community Open House at any time between 6–8:30 p.m. to learn more about the Water Supply Master Plan update, and to speak to project staff, ask questions and provide comments. A short presentation will begin at 7 p.m. to provide an overview of the progress to date, and will be followed by a formal question and answer session.

Tuesday, April 29

6–8:30 p.m.
Formal presentation at 7 p.m.
Council Chambers
City Hall
1 Carden Street

To find out more about the project, visit **guelph.ca/water** and follow the Water Supply Master Plan link, or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T **519-822-1260 x 2186**
E **dave.belanger@guelph.ca**

Patty Quackenbush
Senior Project Manager
AECOM
T **519-650-8691**
E **patty.quackenbush@aecom.com**

CITY OF Guelph
Making a Difference

APPENDIX E: COMMUNITY OPEN HOUSE AGENDAS

City of Guelph – Water Supply Master Plan Update
Community Open House #1
October 10, 2013 from 6:00 to 8:30 pm
Guelph City Hall
Council Chambers

Registration and Welcome Participants will be welcomed at the door and asked to sign-in	6:00 pm
Information Board Viewing	6:00 pm to 7:00 pm
Presentation Water Supply Master Plan Overview (Dave Belanger and Patty Quackenbush) • WSMP – Overview • Guelph's Current Water Supply System • City Updates – Since 2007 WSMP • WSMP Update – Objectives / Scope of Work • Next Steps	7:00 to 7:45 pm
Information Board Viewing	7:45-8:30 pm
Adjournment	8:30 pm

Agenda: Community Open House #2

City of Guelph – Water Supply Master Plan Update
Community Open House #2
April 29, 2014 from 6:00 to 8:30 pm
Guelph City Hall
Council Chambers

Registration and Welcome Participants will be welcomed at the door and asked to sign-in	6:00 pm
Information Board Viewing	6:00 pm to 7:00 pm
Presentation **Water Supply Master Plan overview (Dave Belanger and Patty Quackenbush)** • WSMP – Update • Consultation Progress • Demand and Existing Conditions • Review of Alternatives • Preliminary Assessment of Alternatives • Next Steps	7:00 to 7:30 pm
Information Board Viewing	7:30-8:30 pm
Adjournment	8:30 pm

APPENDIX F: COMMUNITY OPEN HOUSE SIGN IN SHEETS

Community Open House #2

Tuesday April 29, 2014

City of Guelph
Making a Difference

Welcome! Please sign in.

Name	Street Address	Phone	Email
Arun Hindupur	City of Guelph	519-822-1260 ext 2282	
Ron Mageresera	C of Guelph	519-822 1260 ext 2231	
David DeCorso	Victoria Park Golf Club	519 821-2211	

Community Open House #2

Tuesday April 29, 2014

City of Guelph
Making a Difference

Welcome! Please sign in.

Name	Street Address	Phone	Email
Kiran Suresh	530, Wellington Street	519-822-1260	
Wayne Galliher	129 Waterhouse R	" " " x 2166	
Jim Yardley	651 Colby Drive	519-884-0510	
Bill Mungall	34 Hickory	836-5567	
Don McKay	84 Queen St RR#2 Puslinch	519-822-2984	
Dan Maclachlan	U of G	824-4120 x 52114	

Community Open House #2

Tuesday April 29, 2014

City of Guelph
Making a Difference

Welcome! Please sign in.

Name	Street Address	Phone	Email

Community Open House #2

Tuesday April 29, 2014

Welcome! Please sign in.

Name	Street Address	Phone	Email

Community Open House #1

Thursday October 10, 2013

City of Guelph
Making a Difference

Welcome! Please sign in.

Name	Street Address	Phone	Email	Affiliation, if any	Add me to the mailing list?
* Tom Krizsan	295 Southgate Dr., Guelph, Ont.	519 836 4332		Thomasfield Homes	Yes
Kiran Suresh	1 Carden Street	519 837 5629			Yes
Vlad Frumkin	— —	— —			Yes.
Wayne Galliher	— —	519-822-1260 x2215		city.	no
Jennifer Gilks	— — —	822 1260 x 2189		City.	No
Joe Gomm		519 650 8690		Aecom	No

	Name	Street Address	Phone	Email	Affiliation, if any	Add me to the mailing list?
	Karen McKeown					
*	Aldo Salis	COUNTY OF WELLINGTON			ton.ca	
*	DENNIS LEVER	PUSLINCH				
*	TOM MCLAUGHLIN	PINE RIDGE DR	226 343 4603		THOMASFIELD HOMES	YES
*	Katherine McLaughlin	"	"		"	"
	Arun Hindupur	City of Guelph	519-822-1260			"
*					none	
*					None	Yes
*	ANDREW LAMBDEN	45 Speedvale Ave E	519-841-8500		Terra View Homes	yes.
*	Colin Oaks	21 Valleyview Dr.	519-823-1143		crs.com Nature Guelph	Yes

Community Open House #1

Thursday October 10, 2013

CITY OF Guelph

Making a Difference

Welcome! Please sign in.

Name	Street Address	Phone	Email	Affiliation, if any	Add me to the mailing list?
Steve Davis	166 Lou's Blvd Rockwood	519 856 2812		Matrix Solutions	Yes
Jeff Parnar	144 Curzon Crs	519 939 0337		RJ Burnside	NO
					already on the list
					YES
					Yes
				RMOW	Yes

Community Open House #1

Thursday October 10, 2013

City of Guelph

Making a Difference

Welcome! Please sign in.

Name	Street Address	Phone	Email	Affiliation, if any	Add me to the mailing list?
					Y

APPENDIX G: COMMENT CARD AND DISCUSSION GUIDE QUESTION RESPONSES

Water Supply Master Plan Update
Community Open House #2
Comment Card

City of Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your interests. Please let us know your thoughts on today's Open House. We welcome your feedback.

Meeting Name: Open house No. 2

Date: 29th April 2014

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☑

No ☐

If no, please explain: ______________________

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain: ______________________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ______________________

Thank you for your feedback!

Water Supply Master Plan Update
Community Open House #2
Comment Card

City of Guelph
Making a Differe

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

- [x] Yes
- [ ] No

If no, please explain:

Overall, how would you rate this Open House?

- [ ] Poor
- [ ] Fair
- [ ] Good
- [x] Excellent

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

Good job AECOM & COG staff!

Thank you for your Feedback!

Water Supply Master Plan Update
Community Open House #2
Comment Card

CITY OF Guelph
Making a Differe

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your interests. Please let us know your thoughts on today's Open House. We welcome your feedback.

Meeting Name: WSMPU OPEN HOUSE #2

Date: ______________________

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☑

No ☐

If no, please explain: ______________________

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain: ______________________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ______________________

Thank you for your feedback!

Water Supply Master Plan Update
Community Open House #2
Comment Card

CITY OF Guelph
Making a Differe

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑
No ☐

If no, please explain:

Overall, how would you rate this Open House?

Poor ☐
Fair ☐
Good ☐
Excellent ☑

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

Thank you for your Feedback!

Water Supply Master Plan Update

Community Open House #1

Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ______

Overall, how would you rate this workshop?

Poor ☐

Fair ☐

Good ☐

Excellent ☑

Please let us know if there is anything in particular you would like to discuss at our next Community Open House?

______

Thank you for you Feedback!

Water Supply Master Plan Update

Community Open House #1

Comment Card

City of Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on today's community open house. We welcome your feedback.

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain:

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain:

Thank you for your feedback!

Providing your Feedback

The following sheets can be used to provide feedback on the project. Feel free to make note of your thoughts as you review the display panels and discuss your comments with the project team. Please leave your completed comments sheets in the comment box at the welcome desk.

All feedback will be used to prepare recommendations to improve the Water Supply Master Plan update, and will be included in the Consultation Summary Report for the project.

General Questions

1. Are you comfortable with the level of service (water supply) currently provided by the City of Guelph?

YES B/C IT'S GROUND WATER SOURCED VS. SOMEWHERE LIKE WATERLOO REGION.

2. Do you feel the City's current water conservation goals are adequate? Are there additional goals that you feel should be considered?

YES. THE BEST CONSERVATION IS BY A FEE BASIS, VS INCENTIVE FOR WATER CONSERVATION.

3. Do you believe the City should consider establishing water use goals for new growth (e.g., attracting industries that require less water or conservation-oriented new residential developments?)

NO. SOME HEAVY WATER USERS ARE LARGE HIGH PAYING EMPLOYERS E.G. SLEEMANS, WELLINGTON BREWING.

Open House Display Boards

4. **Is the Problem/ Opportunity Statement adequate for this WSMP update? Are there any changes (i.e., additions or deletions) that you feel should be considered?**

YES.

5. **Are the evaluation criteria suitable for this study? Is there anything you would like to add or change?**

- FUTURE LOW DENSITY DEVELOPMENT

6. **Are there existing activities / programs that you would like to see continued or prioritized?**

LOW & MEDIUM DENSITY HOUSING IN THE GROWTH CONFORMITY.

7. **Are there new approaches or alternatives that we should consider to improve or expand our water supply system?**

NO.

8. **Are there pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan?**

- HIGH MINERAL CONTENT.

Preliminary Water Supply Alternatives

Developing Water Supply Solutions

9. **Do you have concerns regarding any of the alternatives presented? Should any of these not be considered through the Water Supply Master Plan update?**

NO ALTERNATIVES ?

10. **Are there other water supply alternatives that should be considered by the project team?**

NO

11. **Should water supply sources inside the City be prioritized over those outside City boundaries?**

NO. GO TO THE WATER.

Do you have any additional feedback or ideas?

Providing your Feedback

The following sheets can be used to provide feedback on the project. Feel free to make note of your thoughts as you review the display panels and discuss your comments with the project team. Please leave your completed comments sheets in the comment box at the welcome desk.

All feedback will be used to prepare recommendations to improve the Water Supply Master Plan update, and will be included in the Consultation Summary Report for the project.

General Questions

1. Are you comfortable with the level of service (water supply) currently provided by the City of Guelph?

Yes

2. Do you feel the City's current water conservation goals are adequate? Are there additional goals that you feel should be considered?

They are good but how will "Places to Grow" affect this plan?

3. Do you believe the City should consider establishing water use goals for new growth (e.g., attracting industries that require less water or conservation-oriented new residential developments?)

Definitely! Would like to see more efforts to conserve in Condo towers.

4. **Is the Problem/ Opportunity Statement adequate for this WSMP update? Are there any changes (i.e., additions or deletions) that you feel should be considered?**

Since province has dictated pop'n growth then that portion is out of our hands & so we must concentrate on Conservation & adding to supply of water

5. **Are the evaluation criteria suitable for this study? Is there anything you would like to add or change?**

6. **Are there existing activities / programs that you would like to see continued or prioritized?**

More enforcement / education for "Water Levels" pgm.

7. **Are there new approaches or alternatives that we should consider to improve or expand our water supply system?**

Continue to remove red-tape surrounding grey-water systems & retrofitting

8. Are there pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan?

____

____

____

____

Preliminary Water Supply Alternatives

Developing Water Supply Solutions

9. Do you have concerns regarding any of the alternatives presented? Should any of these not be considered through the Water Supply Master Plan update?

____

____

____

____

10. Are there other water supply alternatives that should be considered by the project team?

____

____

____

____

11. Should water supply sources inside the City be prioritized over those outside City boundaries?

____

____

____

____

Do you have any additional feedback or ideas?

Water Supply Master Plan Update Municipality/Agency Workshop — Comment Card

CITY OF Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on today's meeting. We welcome your feedback.

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update Municipality/Agency Meeting — Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ____________________

Overall, how would you rate this workshop?

Poor ☐

Fair ☐

Good ☐

Excellent ☑

Please let us know what you would like to discuss at our next Municipality/Agency meeting?

____

Thank you for you Feedback!

Water Supply Master Plan Update Municipality/Agency Workshop — Comment Card

City of Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on today's meeting. We welcome your feedback.

____

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain: ____

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain: ____

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ____

Thank you for your feedback!

Water Supply Master Plan Update Municipality/Agency Meeting — Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ______________________________

Overall, how would you rate this workshop?

Poor ☐

Fair ☐

Good ☑

Excellent ☐

Please let us know what you would like to discuss at our next Municipality/Agency meeting?

Thank you for you Feedback!

Water Supply Master Plan Update Municipality/Agency Workshop — Comment Card

CITY OF Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on today's meeting. We welcome your feedback.

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update Municipality/Agency Meeting — Comment Card

City of Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ______________________________

Overall, how would you rate this workshop?

Poor ☐

Fair ☐

Good ☑

Excellent ☐

Please let us know what you would like to discuss at our next Municipality/Agency meeting?

____

Thank you for you Feedback!

Water Supply Master Plan Update Municipality/Agency Workshop — Comment Card

CITY OF Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on today's meeting. We welcome your feedback.

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☒
No ☐
If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☒
No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☒
No ☐
If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update Municipality/Agency Meeting — Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☒

No ☐

If no, please explain: ______________________________

____

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____

Overall, how would you rate this workshop?

Poor ☐

Fair ☐

Good ☒

Excellent ☐

Please let us know what you would like to discuss at our next Municipality/Agency meeting?

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Thank you for you Feedback!

Water Supply Master Plan Update Municipality/Agency Workshop — Comment Card

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on today's meeting. We welcome your feedback.

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☑

If no, please explain: Public Health's level of knowledge of existing system and 2007 Plan is limited, so a more detailed overview provided ahead of the meeting may have allowed participants to provide more useful feedback during the meeting. However, info presented was excellent and invitation very much appreciated.

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain: However, as noted above, could use additional time to process info so feedback provided is valid and useful

Did you get answers to your questions?

Yes ☐

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update Municipality/Agency Meeting — Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ______

Overall, how would you rate this workshop?

Poor ☐

Fair ☐

(Good) ☐ — circled

Excellent ☐

Please let us know what you would like to discuss at our next Municipality/Agency meeting?

Public Health will provide feedback to questions posed by Email as soon as possible. PH will also consider discussion items to propose and submit later by Email.

Also, earlier notice of mtgs. would be helpful

Thank you for you Feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

City of Guelph

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your interests. Please let us know your thoughts on today's meeting. We welcome your feed-back.

Meeting Name: Water Supply Master Plan Update: Pub. Cons. Round 2

Date: April 8, 2014

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☑

No ☐

If no, please explain: ____________________

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain: ____________________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ____________________

Thank you for your feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

CITY OF Guelph

Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ______

Overall, how would you rate this meeting?

Poor ☐

Fair ☐

Good ☐

Excellent ☑

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

GREATLY APPRECIATE THE INFO. BEFORE HAND

EXCELLENT PRESENTATIONS!

Thank you for you Feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your interests. Please let us know your thoughts on today's meeting. We welcome your feedback.

Meeting Name: ______________________

Date: April 8

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☑

No ☐

If no, please explain: ______________________

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain: ______________________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ______________________

Thank you for your feedback!

Water Supply Master Plan Update
Consultation Round #2
Comment Card

CITY OF Guelph

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ____________________

Overall, how would you rate this meeting?

Poor ☐
Fair ☐
Good ☑
Excellent ☐

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

write out acronyms

Thank you for you Feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

City of Guelph

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Meeting Name: ______________________

Date: Apr 8

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☐

No ☐

If no, please explain: I got information in the breakout session but the content was over my head

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain: ______________________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: during breakout session

Thank you for your feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ______________________________

Overall, how would you rate this meeting?

Poor ☐
Fair ☐
Good ☑
Excellent ☐

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

____

Please note: Under the *Freedom of Information and Protection of Privacy Act* and the *Environmental Assessment Act*, unless otherwise stated in the submission, any personal information such as name, address, telephone number and property location included in a submission will become part of the public record files for this matter and will be released, if requested, to any person.

Thank you for you Feedback!

Water Supply Master Plan Update
Consultation Round #2
Comment Card

City of Guelph

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your interests. Please let us know your thoughts on today's meeting. We welcome your feedback.

Meeting Name: KEN HAMMILL

Date: APRIL · 8

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☑

No ☐

If no, please explain:

WATER QUALITY IS KEY

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

CITY OF Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ______

Overall, how would you rate this meeting?

Poor ☐
Fair ☐
Good ☐
Excellent ☑

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

NEXT MEETING TO MEASURE PROGRESS.
6 MOS – 1 YEAR ?

Thank you for you Feedback!

Guelph Water Supply Master Plan Update Class Environmental Assessment

Consultation Round #2 – Discussion Recording Sheet

Meeting Name: Municipal / Agency Meeting

Meeting Date: April 7/14

Discussion Questions:

1. **Do you have any comments or suggestions regarding the criteria or indicators used?**

   - difficult to comment since don't know extent of new WHPAs / Vulnerability score
   - add WHPA's to legal / jurisdictional categories

2. **Provide your thoughts on public acceptance of the different alternatives – e.g. conservation; wells requiring treatment; wells inside vs. outside the City; surface water.**

   - Sustainable water taking from a quantity?
   - Can conservation go further?
   - up front about residential 50%
   - what is impact to public? - conservation
   - changes in demography in future
   - Why is this necessary?
   - clearer explanation of quantity per option
   -> Explain ASR more generally,
   - increase in water rates in Guelph vs. Mississauga

3. **Should any alternatives be ranked differently? Why? Will the suggested change alter the alternative overall priority rating?**

   - how to incorporate potential costs due to SP (source protection) impacts to properties
   - selling people on using treated wells (TCE)
   -> Township water is last resort
   -> proof that City has tried all options
   -> better data needed on costs & impacts
   -> need to adjust scoring for Table 2 -> Existing, off-line wells, Municipal Test Wells to reflect higher cost to Townships for these wells (because on boundary or in Township)

4. **Do you have any feedback on any other aspects of the presentation?**

5. **What advice do you have for presenting this information at the upcoming Community Open House meeting?**

- criteria not understandable to general public
- slides - reduce #'s / complexity

Thank you!

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Water Supply Master Plan Update

Consultation Round #2

Comment Card

City of Guelph

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your interests. Please let us know your thoughts on today's meeting. We welcome your feed-back.

Meeting Name: ______________________

Date: Apr. 7 / 14

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☑

No ☐

If no, please explain: A lot of info to absorb

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain: ______________________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ______________________

Thank you for your feedback!

Water Supply Master Plan Update
Consultation Round #2
Comment Card

CITY OF Guelph

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ____________________

Overall, how would you rate this meeting?

Poor ☐

Fair ☐

Good ☑

Excellent ☐

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

Please note: Under the *Freedom of Information and Protection of Privacy Act* and the *Environmental Assessment Act*, unless otherwise stated in the submission, any personal information such as name, address, telephone number and property location included in a submission will become part of the public record files for this matter and will be released, if requested, to any person.

Thank you for you Feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your interests. Please let us know your thoughts on today's meeting. We welcome your feedback.

Meeting Name: WATER SUPPLY MASTER PLAN UPDATE - PUBLIC CONSULTATION #2

Date: APR 7/14

Was the information provided adequate for you to gain an understanding of the Water Supply Master Plan update and its progress to date?

Yes ☑

No ☐

If no, please explain: ______________________

Did you feel encouraged to provide feedback?

Yes ☑

No ☐

If no, please explain: ______________________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ______________________

Thank you for your feedback!

Water Supply Master Plan Update

Consultation Round #2

Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: SPLENDID PRESENTATION

Overall, how would you rate this meeting?

Poor ☐
Fair ☐
Good ☐
Excellent ☑

Please let us know if there is anything in particular you would like to discuss that hasn't been mentioned?

- GREAT LAKES PIPELINE COMPLETLY IGNORED
- I DON'T LIKE THE IDEA OF DRINKING PEE ESPECIALLY MINE!

Thank you for you Feedback!

Providing your Feedback

The following sheets include the questions we will be discussing this evening. Although we will be documenting much of the Committee's conversation, it would valuable to also receive your individual feedback. Feel free to make note of your thoughts. A team member will gather your feedback at the end of the evening. 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 comfortable with the level of service (water supply) currently provided by the City of Guelph?

Yes, as a residential user.

2. Do you feel the City's current water conservation goals are adequate? Are there additional goals that you feel should be considered?

- water conservation goals should increase with increase population growth.
- technology advances will provide a resource for increasing conservation goals.
- so far, ICI Capacity buyback program appears to have a more financial incentitive package than residential rebate programs

3. Do you believe the City should consider water use goals for new growth (e.g., industries that require less water or conservation-oriented new residential developments?)

• should focus incentive programs to new builds in both residential and ICI sectors.

• Are retrofits as efficient as new builds?

• more marketing / promotion of the programs.

4. How much water (i.e., percent of existing supply capacity) do you believe should be considered as 'back-up' to ensure security of supply?

→ stated in presentation that Guelph only uses a percentage of recharge capability.

∴ We should be using less than the recharge rate so that the initial total groundwater volume be considered "back-up".

5. **Are there existing activities / programs that you would like to see continued or prioritized?**

• ICI Capacity buyback program
→ however I feel that their payback period is shorter than expected.

• purple pipe research/planning studies.

6. **Are there new approaches that we should consider to improve our water supply system?**

• "purple pipe program"
• wastewater reuse.

7. **Are there pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan?**

→ new development programs should be a pressing issue due to window of action.

Objectives and Scope of Work

8. **Are the Objectives and Purpose Statement adequate for this WSMP update? Are there additional objectives that you feel should be considered?**

9. **Are there changes (i.e., additions or deletions) that should be considered for the Scope of Work; to improve the recommendations resulting from the Water Supply Master Plan update?**

Developing Water Supply Solutions

10. Do you have concerns regarding any of the alternatives presented? Should any of these not be considered through the Water Supply Master Plan update?

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11. Are there other water supply alternatives that should be considered by the project team?

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12. **Do you have a preferred approach for expanding our water supply capacity? If so, what and why?**

- deep well development within the City's limit
- decontaminating offline wells
- treating manganese/sulphur wells.

Water Conservations & Demand Management

13. **Should there be bylaw changes to restrict or prohibit new groundwater use in the City; to protect water supply sources?**

Developing Groundwater Sources

14. 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?

15. Should water supply sources inside the City be prioritized over those outside City boundaries?

Water inside the City should be prioritized.

Promote the mentality of sustainability, going outside the City limits weakens Guelph's perception by "the world" of being green.

16. **Would you be comfortable obtaining water from sources that required treatment to remove contaminants (i.e., natural or industrial)? (Assumes that all regulatory standards are met after treatment)**

Yes, as technology advances, our ability to meet water standards for drinking water may be met at a reasonable cost.

Evaluation Criteria & Methodology

17. **Are the evaluation criteria suitable for this study? Is there anything you would like to add or change?**

18. **Is the proposed approach adequate? Are you comfortable with us using a qualitative assessment rather than a numerical ranking?**

Any additional feedback or ideas?

Questions

Providing your Feedback

The following sheets include the questions we will be discussing this evening. Although we will be documenting much of the Committee's conversation, it would valuable to also receive your individual feedback. Feel free to make note of your thoughts. A team member will gather your feedback at the end of the evening. 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 comfortable with the level of service (water supply) currently provided by the City of Guelph?

THE INFORMATION ON PER CAPITA DAILY CONSUMPTION & RELATED CONSERVATION INITIATIVES ARE GREAT & I AM COMFORTABLE WITH THE RELATED LEVEL OF SERVICE. FROM THE STREET THE PUBLIC TELLS ME THERE IS AN APPARENT DISCONNECT BETWEEN COUNCIL PUSHING GROWTH BUT TELLING EXISTING RESIDENTS TO USE LESS WATER

2. Do you feel the City's current water conservation goals are adequate? Are there additional goals that you feel should be considered?

EXCELLENT & PROBABLY MORE TO COME

3. Do you believe the City should consider water use goals for new growth (e.g., industries that require less water or conservation-oriented new residential developments?)

No

4. How much water (i.e., percent of existing supply capacity) do you believe should be considered as 'back-up' to ensure security of supply?

THIS (FIRM CAPACITY) MUST BE PROVIDED BY THE PROJECT TEAM.

5. **Are there existing activities / programs that you would like to see continued or prioritized?**

YES CONSERVATION PROGRAMS ACCORDING TO COST EFFECTIVENESS.

6. **Are there new approaches that we should consider to improve our water supply system?**

ENLARGE THE SCOPE OF STUDY BEYOND THE CITY LIMITS OF GUELPH THE RIVER CONSERVANCY SYSTEM IN ENGLAND.

7. **Are there pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan?**

COUNCIL SHOULD GUIDE TECHNICAL STAFF TO FOCUS ON TECHNICAL ISSUES & COUNCIL SHOULD GUIDE POLICY ISSUES

8. **Are the Objectives and Purpose Statement adequate for this WSMP update? Are there additional objectives that you feel should be considered?**

YES - BUT COORDINATION OF POPULATION & WATER SUPPLY DEMAND FORECASTS ~~WILL ASSIST~~ TO WITH WASTE LOADING ON SPEED RIVER & POPULATION WOULD HELP.

9. **Are there changes (i.e., additions or deletions) that should be considered for the Scope of Work; to improve the recommendations resulting from the Water Supply Master Plan update?**

SOME CONCERN ABOUT IMPLICATIONS OF POPULATION & WATER SUPPLY DEMAND FORECASTS, WILL LEAD TO POSSIBLE CHANGES FOR SCOPE OF WORK.

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

CITY OF Guelph
Making a Differe[nce]

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on tonight's meeting. We welcome your feedback.

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☒

No ☐

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☒

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☐

No ☒

If no, please explain: time restraints, lots of information to gather and questions to answer.

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☐

No ☐

If no, please explain: ____________________

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____

____

Overall, how would you rate this Open House?

Poor ☐

Fair ☐

Good ☐

Excellent ☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

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Thank you for your feedback!

Water Supply Master Plan Update
CLC Meeting #1 — Comment Card

City of Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☒

No ☐

If no, please explain: ______________________

Overall, how would you rate this Open House?

Poor

Fair ☐

Good ☒

Excellent ☐

☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting? The meeting was good for educating Committee members, less effective for eliciting answers to your 17 questions. Perhaps you will get these answers/opinions through our written comments. Perhaps encourage people to read materials and submit comments on line for next meeting

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

CITY OF Guelph

Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on tonight's meeting. We welcome your feedback.

Learned a great deal from the presentations and printed materials

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☒

No ☐

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☒

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☒

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update
CLC Meeting #1 — Comment Card

City of Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑
No ☐

If no, please explain: ____________________

Overall, how would you rate this Open House?

Poor
Fair ☐
Good ☐
Excellent ☑ +
☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

BUDGET –
DEMAND – 2031 –
ARE WE LOOKING BEYOND 2031 – YES LATER IN MTG
WE HAD A AGREEMENT WITH ROCKWOOD WHICH
PUT A LID ON GROWTH. STILL THERE?
HOW DO WE EDUCATE PUBLIC?

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

CITY OF Guelph

Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on tonight's meeting. We welcome your feedback.

WELL DONE

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update
CLC Meeting #1 — Comment Card

CITY OF Guelph
Making a Differen

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on tonight's meeting. We welcome your feedback.

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑ GENERALLY BUT SOME OF MY QUESTIONS WERE OUT OF CONTEXT

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

CITY OF Guelph

Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑

No ☐

If no, please explain: ____________________

Overall, how would you rate this Open House?

Poor ☐

Fair ☐

Good ☑

Excellent ☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

City of Guelph

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Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

- [x] Yes
- [ ] No

If no, please explain:

Did you feel encouraged to provide Feedback?

- [x] Yes
- [ ] No

If no, please explain: ~~was here~~

Did you get answers to your questions?

- [x] Yes
- [ ] No

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

City of Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☒
No ☐

If no, please explain: ______________________________

Overall, how would you rate this Open House?

Poor ☐
Fair ☐
Good ☒
Excellent ☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

____

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

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Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain: ____________

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain: ____________

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain: ____________

Thank you for your feedback!

Water Supply Master Plan Update
CLC Meeting #1 — Comment Card

CITY OF Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑
No ☐

If no, please explain: ______

Overall, how would you rate this Open House?

Poor
Fair ☐
Good ☐
Excellent ☑
☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

More information regarding new potential water supply areas → surface ?
→ shallow ?
→ aquifer ?

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

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Making a Difference

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____

____

____

____

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☐

No ☐

If no, please explain: ______________________________

____

____

____

Did you feel encouraged to provide Feedback?

Yes ☐

No ☐

If no, please explain: ______________________________

____

____

____

Did you get answers to your questions?

Yes ☐

No ☐

If no, please explain: ______________________________

____

____

____

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

City of Guelph

Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☐

No ☐

If no, please explain: ______________________

Overall, how would you rate this Open House?

Poor ☐

Fair ☐

Good ☐

Excellent ☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

PERHAPS A MICROPHONE FOR SOFT SPEAKING PRESENTERS.

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

CITY OF Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on tonight's meeting. We welcome your feedback.

Need more information

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑ top level.

No ☑ need more.

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑ confirmed more information to follow.

No ☐

If no, please explain:

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

City of Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑
No ☐

If no, please explain: ____________________

____

Overall, how would you rate this Open House?

Poor ☐
Fair ☐
Good ☐ (circled)
Excellent ☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

____

Thank you for your feedback!

Water Supply Master Plan Update
CLC Meeting #1 — Comment Card

City of Guelph

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

Yes ☑
No ☐

If no, please explain:

Overall, how would you rate this Open House?

Poor
Fair ☐
Good ☐ (circled)
Excellent ☐ ☐

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

① More information (detailed) should be provided in advance.

② I'd like to learn a bit more about how water rates are set.

~~I [illegible] We should consider~~

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

CITY OF Guelph

Making a Differen[ce]

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on tonight's meeting. We welcome your feedback.

____

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☐

No ☐

If no, please explain: ____________________________

Did you feel encouraged to provide Feedback?

Yes ☐

No ☐

If no, please explain: ____________________________

Did you get answers to your questions?

Yes ☐

No ☐

If no, please explain: ____________________________

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

City of Guelph
Making a Difference

Were our staff forthcoming with their answers and knowledgeable in their area of expertise?

- [x] Yes
- [ ] No

If no, please explain: ______________________________

Overall, how would you rate this Open House?

- Poor
- [ ] Fair
- [ ] Good
- [x] Excellent
- [ ]

Please let us know what you would like to discuss at our next Community Liaison Committee meeting?

* Groundwater supply development in adjacent townships.
* Comments from township representatives on this.

Thank you for your feedback!

Water Supply Master Plan Update

CLC Meeting #1 — Comment Card

CITY OF Guelph
Making a Difference

We hope the information provided helped you better understand our plans for updating the City's Water Supply Master Plan, and that you've had a chance to ask questions and discuss your concerns. Please let us know your thoughts on tonight's meeting. We welcome your feedback.

Great!

Was the information provided adequate for you to gain a preliminary understanding of the Water Supply Master Plan update?

Yes ☑

No ☐

If no, please explain:

Did you feel encouraged to provide Feedback?

Yes ☑

No ☐

If no, please explain:

Did you get answers to your questions?

Yes ☑

No ☐

If no, please explain:

Thank you for your feedback!

1. Are you comfortable with the level of service (water supply) currently provided by the City of Guelph? YES, though access to public taps could be improved. More water fountains in parks, and a map to public taps should be made available online and at city hall. That way people can plan picnics, runs, etc. This also helps displaced youth and homeless.

2. Do you feel the City's current water conservation goals are adequate? Are there additional goals that you feel should be considered? CONSERVATION CAN BEST BE ENCOURAGED THROUGH EFFECTIVE PUBLIC EDUCATION INITIATIVES, WHICH CAN BE CARRIED OUT BY THE CITY IN COOPERATION WITH SPECIAL INTEREST GROUPS, NGO'S, SCHOOLS AND OTHER ORGANIZATIONS. IN THE PAST, THE CITY HAS SUPPORTED WATER EFFICIENT GARDENING EDUCATION, AND THIS HAS POTENTIAL FOR FURTHERING CONSERVATION. We must give more thought to new industrial uses. For example when Nestle came to the City and argued that it would create jobs and was good for business, when in reality this industry is largely automated. Now Nestle is taking advantage of us and our tax payers must pay for new infrastructure as well as for municipal recycling programs to deal with their silly bottles.

3. Do you believe the City should consider water use goals for new growth (e.g., industries that require less water or conservation□oriented new residential developments?) DEFINATELY, NEW INDUSTRIES AND CONSTRUCTION OF RESIDENTIAL HOUSING SHOULD EMPLOY STATE OF THE ART WATER CONSERVATION TECHNOLOGIES, AND NEW INDUSTRIES SHOULD BOTH BE EVALUATED FOR THEIR WATER NEEDS AND REQUIRED TP PAY THE COST OF EXPANDING WATER RESOURCES TO MEET THEIR NEEDS.

4. How much water (i.e., percent of existing supply capacity) do you believe should be considered as 'back□up' to ensure security of supply? 20%

5. Are there existing activities / programs that you would like to see continued or prioritized? AGAIN, PUBLIC EDUCATION AROUND WATER CONSERVATION ISSUES. PROMOTION OF RAIN WATER HARVESTING TECHNOLOGIES AND MEASURES TO CAPTURE RAIN WATER TO RECHARGE AQUAFERS.

6. Are there new approaches that we should consider to improve our water supply system? ENCOURAGEMENT OF URBAN AGRICULTURE USING HARVESTED RAIN WATER AS A MEASURE TO RECHARGE AQUAFERS.

7. Are there pressing issues or concerns related to water supply that we should consider while updating the Water Supply Master Plan? THE FAILURE

OF LARGE INDUSTRIAL WATER USERS TO PAY THE REAL COSTS OF SUPPLYING THEIR NEEDS, ESPECIALLY AS THOSE NEEDS REQUIRE THE CITY TO INCREASE WATER TAKING TO MEET INDUSTRY'S NEEDS.
Taxpayers will be responsible for paying for new infrastructure when water becomes scarce, yet most of them don't know this. Also we could have more public education about the difficulty/infeasibility of removing many chemicals from our water supply. We need to help people understand that everything that is put in the sink/toilet ends up in the ecosystem and that small changes can affect whole ecosystem health. Prevent dumping of medicines and cleaning agents into water. Education is needed about rising levels of estrogen being found in freshwater and impeding the ability of important amphibians to reproduce, for example.

8. NO COMMENT
9. NO COMMENT

10. Do you have concerns regarding any of the alternatives presented? Should any of these not be considered through the Water Supply Master Plan update? WE WOULD NOT WANT TO INCLUDE A PIPELINE TO LAKE ERIE AS AN OPTION FOR MEETING GUELPH'S CURRENT AND PROJECTED WATER NEEDS.
The pipeline could be avoided entirely if local industries were charged a realistic rate for their water (which would require updating a provincial system) or there should be a clause in business agreements where they assume responsibility for replenishing water as quickly as the natural rate. We need more incentives for industry to conserve and restore.

11. Are there other water supply alternatives that should be considered by the project team? YES, RAIN WATER HARVESTING AND RECHARGING OF AQUAFERS, FURTHER CONSERVATION EFFORTS. Eg. Permeable pavement and other features built into building codes for any new developments or upgrades .

12. Do you have a preferred approach for expanding our water supply capacity? If so, what and why? AS ABOVE – Q 11

13. **Should there be bylaw changes to restrict or prohibit new groundwater use in the City; to protect water supply sources? YES, WE MUST NOT PERMIT LARGE INDUSTRIAL USERS TO CONTAMINATE GROUND WATER SUPPLIES WITH THEIR WASTES or to use water at a rate that cannot be replenished naturally. The permit to take water system is outdated and ineffective, so the city needs to take measures into their own hands as our water supply is being taken advantage of. The city should charge Nestle's so much that a bottle of water costs $5, so that people will quit fouling their own nests.**

* Very Important

14. **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? UNFORTUNATELY, THE CITY IS ALREADY MOVING DOWN THE PATH TO ENVIRONMENTAL DEGRADATION BY ALLOWING PRIME FARM LAND TO BE CONVERTED TO SUB-DIVISIONS. WHILE FARMING ALLOWS THE RECHARGING OF AQUAFERS NATURALLY, SUB-DIVISIONS VASTLY INCREASE THE DISCHARGE OF RAIN WATERS INTO STORM SEWERS, CREEKS AND RIVERS, AND THIS WATER IS LOST TO THE AREAS FROM WHICH GUELPH HARVESTS WATER.**
The current level of degradation is already unacceptable. Water scarcity will cause violent conflict and illness in our lifetimes, and will be exacerbated by climate change which at this point is irreversible. Given the current uncertainty of future weather patterns, we should be doing everything we can to protect our current water supply and do more with less.

* Very Important

15. **Should water supply sources inside the City be prioritized over those outside City boundaries? YES, WE SHOULD STEWARD AND PROTECTOUR INTERNAL SOURCES OF WATER, RATHER THAN ACCESS WATER RESOURCES FROM OUTSIDE. THIS HAS BOTH FINANCIAL IMPLICATIONS (THE TRANSPORT OF WATER FROM OUTSIDE RESOURCES) AND CONTROL CONCERNS – (OTHER GOVERNMENT BODIES COULD CONTROL OR DENY ACCESS TO OUTSIDE WATER RESOURCES.**

16. **Would you be comfortable obtaining water from sources that required treatment to remove contaminants (i.e., natural or industrial)? (Assumes that all regulatory standards are met after treatment) NOT AT ALL – WHO WOULD WANT TO DRINK FROM LAKE ERIE, NO MATTER HOW MUCH IT IS TREATED?**
Furthermore the Great Lakes are at all-time low levels. We are just moving the problem around. Conservation should be built in to all building codes – grey water recycling, rain water harvesting, permeable pavement, landscaping restrictions, must become common place regardless of where our water source is.

APPENDIX H: DISPLAY MATERIALS – COMMUNITY OPEN HOUSES

WELCOME!
CITY OF GUELPH WATER SUPPLY MASTER PLAN UPDATE
COMMUNITY OPEN HOUSE #2

Thank you for your interest in the City of Guelph's Water Supply Master Plan Update

Display boards are set up around the room to explain:

- Guelph's existing water supply system;
- Alternatives that are being considered to meet water supply requirements to 2038; and
- Evaluation criteria and preliminary results.

A presentation will be held at 7:00 pm to walk through the WSMP Update and answer your questions

Feel free to read the display boards, ask questions of the project team, and listen to the presentation. We want to hear from you! We welcome your comments.

WHY UPDATE GUELPH'S WATER SUPPLY MASTER PLAN?

Problem / Opportunity Statement

Guelph is seeking to:

- Define how the City will get its safe and reliable water for residential, industrial, commercial and institutional use over the next 25 years.
- "Establish a sustainable water supply to regulate future growth."
  City of Guelph Council Resolution, October 20, 2003
- Consider changes – since 2007 – to predicted population growth, available water supply, and the demand for water.

The City of Guelph is committed to developing strategies for ensuring a clean, safe and adequate water supply for now and into the future.

Study Objective

- The City of Guelph is responsible for supplying clean, safe drinking water to its customers.
- The City has initiated an update to its Water Supply Master Plan (WSMP, 2007) that will define how we will continue to provide a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers over the next 25 years.
- The updated Master Plan will identify individual projects required to implement the master plan and prioritize these projects based on need.

Problem

- Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water.
- Recent analysis confirms that the existing water supply system capacity will not meet future demands.
- Updating the WSMP is an opportunity to discuss with the community how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.

Approach

- When investigating existing and new water supply options, including water conservation strategies, we will consider water quality and quantity, economic factors, environmental concerns and 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.

WHAT'S INVOLVED IN THE MASTER PLAN UPDATE?

- Planning for Guelph's water supply needs involves listening to stakeholders, determining demand needs, and evaluating alternatives. Each of the tasks below help our team work towards the final evaluation of alternatives.
- We rely on feedback from events such as this open house to ensure that we are on the right track with our evaluation (Task 5).

Task 1 – Public Consultation	Task 2 – Population and Water Demand Forecasts	Task 3 – Existing Water Supply Capacity Assessment	Task 4 – Water Supply Alternatives	Task 5 – Water Supply Master Plan Update
• Pre-consultation interviews • WSMP Community Liaison Committee (CLC) meetings (2) • Municipality / Agency workshops (2) • Community Open Houses (2) • Water Conservation and Efficiency Public Advisory Committee	• Develop population projections – residential and Industrial/Commercial /Institutional • Develop water demand projections	• Update the assessment of existing well performance, maximum system capacity and minimize potential constraints for each supply source • Compare existing capacity with demand forecast	• Demand management & conservation programs • Re-use • Groundwater sources inside city • Groundwater sources outside city • Local surface water supply • Limit growth/Do nothing	• Evaluate alternatives • Develop Implementation Strategy • Complete WSMP Update Report

CONSULTATION PROCESS

Class EA Phase 1 → **Class EA Phase 2**

- Additional groundwater & alternative municipal supplies are identified
- Constraints / opportunities identified. Evaluation methodology / criteria defined
- Evaluate alternatives & Develop plan for Implementation
- Preferred alternatives determined / Draft Plan submitted

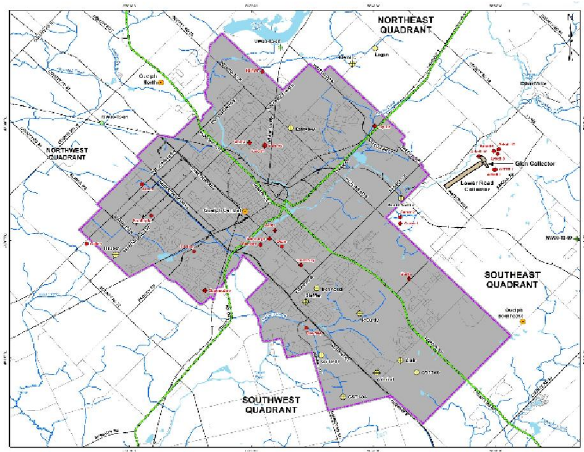
Getting Started	Scoping the Project	Review of Alternatives	Implementation Plan	Confirmation & Approval
Notice of Project Initiation	Pre-consultation Discussions	Water Conservation & Efficiency (WCE) PAC Meeting	WCE PAC Meeting	Notice of Completion
CLC Advertisement		Community Liaison Committee (CLC) Meeting #1	CLC Meeting #2	
		Agency / Municipal Forum #1	Agency / Municipal Forum #2	
		Notice of Community Open House #1	Notice of Community Open House #2	
		Community Open House #1	Community Open House #2	← We are here

Issue Management, Tracking, and Reporting

What we have heard to date:

- Need for contingency in supply capacity
- Support for continued and increased conservation
- Support for management of existing sources
- Consider re-use alternatives
- Concern regarding balancing conservation with growth & development
- Concern regarding environmental contamination
- In favour of prioritizing water sources inside the City and promoting sustainability
- Preference for groundwater over surface water
- Concern about cost of future water supplies
- Concern regarding Source Water Protection around new well supplies, particularly in Townships

WHERE DO WE GET OUR WATER?

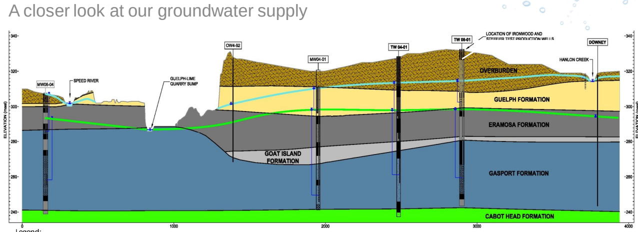


- Guelph has relied on groundwater to meet water demands since 1879
- Our water supply comes from production wells installed in the ***Gasport Formation*** deep bedrock aquifer and the ***Arkell Spring Grounds*** collector system
- Guelph's existing municipal supply system includes 25 production wells:
  - o 21 wells are in continuous operation
  - o 4 wells are offline because of water quality concerns

Ensuring that Guelph has enough water to support current and future needs is an important reason to update the 2007 Water Supply Master Plan.

GUELPH'S WATER SUPPLY

A closer look at our groundwater supply



Legend:
TW: Test Well
MW: Municipal Well

The Arkell Spring Grounds

- Natural springs discharge along the south side of the Eramosa River Valley. This shallow groundwater supply has six (6) production wells (5 bedrock wells & 1 overburden well).
- A seasonal *Groundwater Recharge* system augments flow in the collector system by pumping water from the Eramosa River to a pit and trenches. This water recharges the groundwater, making more water available for our use.

- Private wells and municipal production wells do not draw from the same source.
  - o Private wells in Guelph and the surrounding area take water primarily from the Guelph Formation, a shallow bedrock aquifer
  - o Municipal production wells are drilled much deeper, and take water primarily from the Gasport Formation. This deep bedrock aquifer is the primary source of Guelph's main groundwater supply
- This means there is very little potential for interference between private wells and the municipal water supply.

EXISTING WELL CAPACITY ASSESSMENT RESULTS

- Guelph wells can be divided into geographic quadrants
- Potential supply capacity was determined for each well, based on all wells being operated concurrently
- The summary table compares 2014 capacity to the 2007 well capacities. The existing potential water supply capacity for Guelph is **83,836 m³/day.**

SUMMARY BY QUADRANT

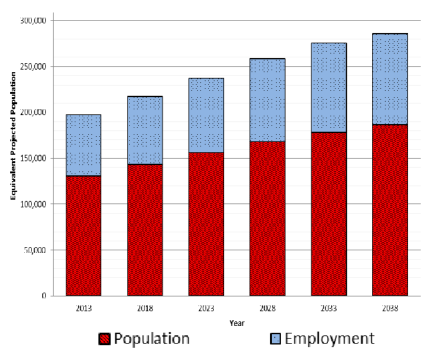
Quadrant	WSMP (2007) (m³/day)	WSMP Update (2014) (m³/day)
Southeast	40,400	49,700
Southwest	17,800	17,936
Northeast	12,300	12,300
Northwest	4,500	3,900
Total	75,000	83,836

Well Field	Well	WSMP (2006) m³/day	WSMP UPDATE m³/day	Update
Southeast Quadrant				
Southeast Quadrant	Arkell 1	2,000	2,000	Unchanged
	Arkell 6	6,500	28,800	Revised based on Arkell Spring Grounds Water Supply Class Environmental Assessment
	Arkell 7	6,500		
	Arkell 8	6,500		
	Arkell 14	N/A		
	Arkell 15	N/A		
	Burke	6,500	6,500	Unchanged
	Carter 1	5,500	5,500	Unchanged
	Carter 2			Unchanged
Arkell Infiltration Galleries - Glen Collector		6,900	6,900	Unchanged
	Total	**40,400**	**49,700**	
Southwest Quadrant				
Southwest Quadrant	Membro	6,000	6,000	Unchanged
	Water Street	2,700	2,700	Unchanged
	Dean	1,500	1,500	Unchanged
	University	2,500	2,500	Unchanged
	Downey	5,100	5,236	Increased 136 m3/d
	Total	**17,800**	**17,936**	

Well Field	Well	WSMP (2006) (m³/day)	WSMP UPDATE (m³/day)	Update
Northeast Quadrant				
Northeast Quadrant	Park 1	8,000	8,000	Unchanged
	Park 2			
	Emma	2,800	2,800	Unchanged
	Helmar	1,500	1,500	Unchanged
	Total	**12,300**	**12,300**	
Northwest Quadrant				
Northwest Quadrant	Paisley	1,400	1,400	Unchanged
	Calico	1,100	1,400	Increased 300 m3/d
	Queensdale	2,000	1,100	Decreased 900 m3/d
	Total	**4,500**	**3,900**	

POPULATION PROJECTION

Potential Demand based on predicted population (2013-2038)

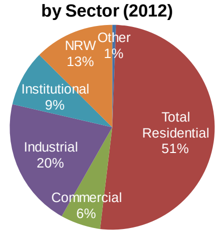


Source:
2013 to 2031 Source : Watson & Associates (2013)
2032 to 2038 Source: Proposed Amendment 2 to the Growth Plan for the Greater Golden Horseshoe, 2006, 2012

Municipal water supply systems are required to meet **maximum daily demand**. This means that with all supply wells operating, the system can supply the peak day demand in any given year. This includes:

- Customer demand from ***Residential, Industrial, Commercial and Institutional*** sectors, and,
- ***Non-Revenue Water (NRW)*** = water that is used but not billed, for example, street cleaning, hydrant testing, losses in the distribution system, and fire flows.

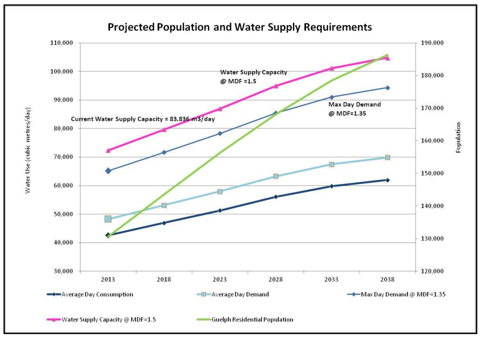
Water Consumption by Sector (2012)



HOW MUCH WATER DO WE NEED?

Security of supply: An additional 10 to 15% above the actual maximum day demand is included in determining the existing and future requirements to address potential risks (e.g., long droughts, loss of well due to contamination, mechanical failure

Therefore, the design maximum day factor (MDF) used for calculating required water supply capacity = 1.5



Based on projected demand, in 2038 we need:

- Under normal conditions = 10,500 m^3/day
- In a 10 year drought period = 23,200 m^3/day
- In a loss of supply scenario = 18,500 m^3/day

Demand/Capacity	2013	2038
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (m^3/day) (actual MDF of 1.35)	64,100	94,300
Total Existing System Capacity (m^3/day)	**83,836**	
Surplus/Deficit (m^3/day)	**19,736**	**-10,464**
Existing Capacity under Drought Condition – short term (m^3/day) *	71,128	
Surplus/Deficit (m^3/day)	**7,028**	**-23,172**
Existing Capacity with Loss of Supply (m^3/day) **	75,800	
Surplus/Deficit (m^3/day)	**11,700**	**-18,500**

** represents reduction in supply capacity of 15%*
** represents reduction in supply capacity of 10%*

PROPOSED ALTERNATIVE WATER SUPPLY SOLUTIONS

Determining how to meet future water supply requirements

- Alternatives were developed to assess their potential to meet future water supply needs.
- The list of alternatives reflects the importance of conservation in our planning, as well as the need to find sources beyond conservation.
- Innovative approaches such as Re-use and Aquifer Storage and Recovery (ASR) are also considered.
- Each of the alternatives is assessed against criteria to determine feasibility and suitability.

Alternative #1A - Water conservation and demand management
- Five conservation scenarios used to evaluate demand reduction targets

Alternative #1B – Re-Use
- Centralized Non-Potable and Potable Re-Use

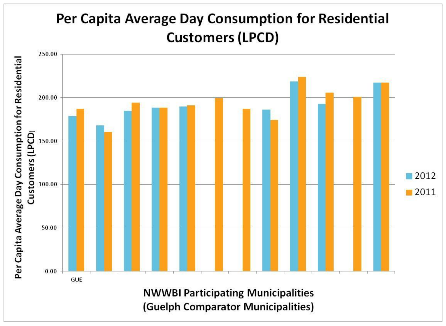
Alternative #2 - Expand existing groundwater system
- 2A - Optimize existing operating municipal wells
- 2B - Restore existing off-line municipal wells
- 2C - Develop existing municipal test wells
- 2D - Install new wells inside City boundaries
- 2E - Install new wells outside City boundaries
- 2F - Install new Aquifer Storage and Recovery wells inside City to optimize excess Arkell Collector system volumes

Alternative #3 - Establish new surface water supply
- Guelph Lake/Speed River
  - Surface Water Treatment Plant (WTP)
  - Surface WTP plus Aquifer Storage and Recovery (ASR) Wells
- Eramosa River

Alternative #4 - Limit growth
- Significant impact on the growth potential for the City is expected with these alternatives

Alternative #5 – Do Nothing
- Consider no improvements or changes

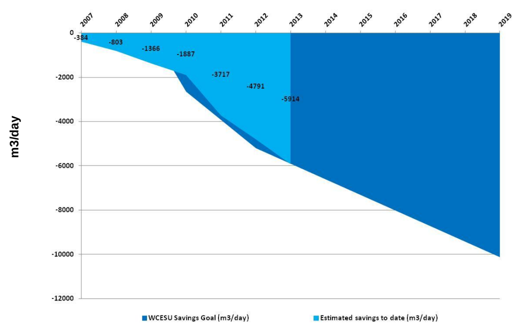
ALTERNATIVE #1A - WATER CONSERVATION AND DEMAND MANAGEMENT



We know it makes sense to use our water wisely. Since 2006, we've reduced our average daily water production by 12%, with Guelph residents now using 20% less water per person per day than the average Ontarian.

- **The City is on track** with respect to its current water conservation goals.
- The figure below tracks actual demand reductions (in m^3/day) directly associated with City programs against proposed targets for each year since the last WSMP

Water Conservation: Reductions Achieved since 2007



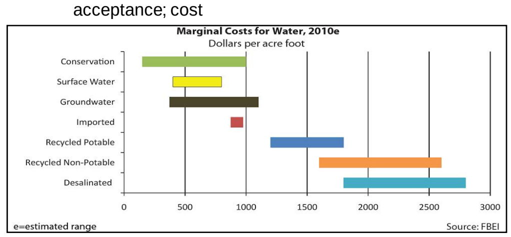
ALTERNATIVE #1A – CONSERVATION

- Conservation scenarios, each consisting of various residential and ICI programs, were considered to assess a range of realistic demand reductions with the associated total capital and operating costs. The results of five of these scenarios are provided in the table below.
- The preferred reduction target will be incorporated into the next Water Conservation and Efficiency Strategy Update, which will consist of a number of conservation and demand management programs.

Scenario	Total Potential Savings (m^3/day)	Direct Program Costs ($M)	Total Program Cost for Period ($M)	Capital Cost per (m^3/day)	LCC - Cost per m^3 avoided
1	5,556	$5.7	$15.9	$1,023	$0.65
2	9,842	$43.8	$67.7	$4,447	$0.75
3	9,690	$24.6	$48.5	$2,539	$0.55
4	8,448	$23.1	$47.0	$2,734	$0.61
5	7,419	$22.6	$46.4	$3,040	$0.69

ALTERNATIVE #1B –RE-USE

- **Non-Potable Re-Use:** landscaping irrigation, construction uses, street cleaning, industrial re-use; requires a dual plumbing system
  - Challenges: dual piping infrastructure; customers/end-uses – seasonal & peak demands; public acceptance; regulatory; quality dependent on use; cost
- **Direct and Indirect Potable Re-Use:** to the distribution system
  - Challenges: regulatory; treatment residuals; public acceptance; cost



Reference: San Diego's Water Sources: Assessing the Options (Fermanian Business & Economic Institute, 2010)

ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2A – Optimize Existing Operating Municipal Wells:

Continuous maintenance of existing supply wells to ensure capacity is optimized; including:

- Well rehabilitation;
- Installation of well liners;
- Water quality monitoring; review of future treatment requirements;
- Equipment maintenance & replacement; and
- Optimization of well pumps and highlift pumps

2B – Restore Existing Offline Municipal Wells:

- These wells have existing permits but have been taken offline due to water quality issues due to contamination or naturally occurring parameters
- In general, water treatment requirements require significant capital investment

Quadrant	Well	Required Upgrades	Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Northeast	Clythe	upgrade; H2S, Fe&Mn treatment	3,395	$4.8M	$1,490
Northwest	Sacco	upgrade; TCE treatment	1,150	$4.1M	$3,700
Northwest	Smallfield	upgrade; TCE treatment	1,408	$3.6M	$2,590
Southwest*	Edinburgh	upgrade; TCE treatment;	SWQ (3,000)	$6.0M	$2,050
Southwest*	Admiral	wellhouse; connect to system; sulphate treatment	SWQ (500)	$3.0M	$6,100
Southeast	Lower Road Collector	New pipe system & infrastructure	2,000 – 3,000	$9.2M	$4,580
Total			**7,953**		

2C – Develop Existing Municipal Test Wells

- These test wells were installed and tested in and outside the city for future municipal water supplies
- Previous investigations provide confidence in potential quantity and quality, and understanding of potential impacts

Quadrant	Well	Required Infrastructure	Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southeast	Scout Camp	wellhouse upgrade; H2S treatment	5,789	$4.7M	$830
Southwest*	Ironwood/ Steffler	wellhouse; disinfection; connect to distribution	4,500 (Ironwood – 8000m^3/d Steffler - 3600m^3/d)	$3.3 to 4.0M	$500 to 900
Northeast	Logan/ Fleming	new well/ property connect to distribution	4,700	$4.7M	$1,000
Northwest	Hauser	new well/ property; connect to distribution	900	$3.7M	$4,100
Total			**15,889**		

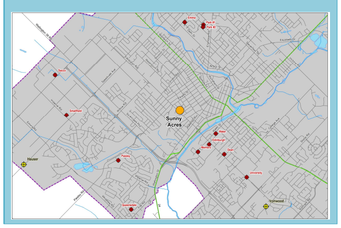
* SWQ options under consideration in SWQ Class EA; total additional SWQ capacity = 4500 m^3/d

ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2D – New Well Inside City Boundaries:

Guelph Central – Sunny Acres

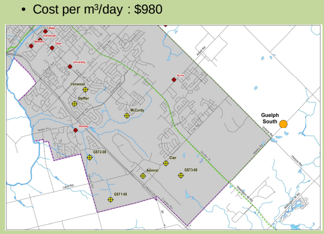
- Approximate location – in/near Sunny Acre Park (final location TBD)
- Estimated available capacity - 1500 m^3/day
- Assumed requirement to treat for TCE based on experience with other municipal wells in the area
- Estimated Capital Cost: $4.5M
- Cost per m^3/day (produced) : $3,080



2E – New Wells Outside City Boundaries

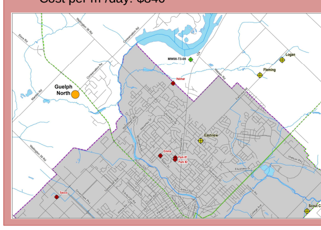
Guelph South - Victoria Rd & Maltby Rd

- Approximate location - southeast of the City within the Mill Creek watershed (final location TBD)
- Estimated available capacity - 3900 m^3/day on an average basis; and 5300 m^3/day to meet maximum day demands
- Baseline reduction to surface water features is predominantly limited to Mill Creek (cold water trout stream)
- Good quality water is expected
- Estimated Capital Cost: $5.2M
- Cost per m^3/day : $980



Guelph North – Conservation Rd W

- Approximate location - north of the City (final location TBD)
- Estimated available capacity - 4660 m^3/day on an average basis; and 6300 m^3/day to meet maximum day demands
- Baseline reduction to surface water features predominantly limited to the Middle Speed River catchment
- Good quality water is expected
- Estimated Capital Cost: $5.3M
- Cost per m^3/day: $840



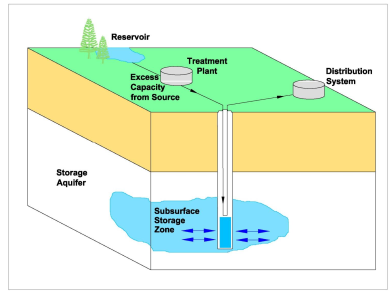
ALTERNATIVE #2F – INSTALL NEW AQUIFER STORAGE AND RECOVERY WELLS INSIDE THE CITY

Opportunity:
- Glen Collector system and off-line Lower Road Collector system flows - high seasonal variability, with elevated flows in spring
- Not considered as part of the maximum daily supply capacity
- Total increase = 3,300 m^3/day

Assumptions:
- excess of 10,000 m^3/day would be available continuously for a period of 4 months + optimization of the Eramosa River PTTW
- Lower Road Collector system is repaired and placed back online
- 2 ASR wells located within the City; each capable of injection at 5000 m^3/day

Advantages:
- Surface water treatment plant not required ; treatment via existing recharge system
- Maximum use of existing infrastructure:
  - Arkell aqueduct to disinfection at the Woods PS UV system
  - Pumped to distribution system

Estimated Capital Cost	$ 9.0M
Cost per m³ /day	$ 2,700

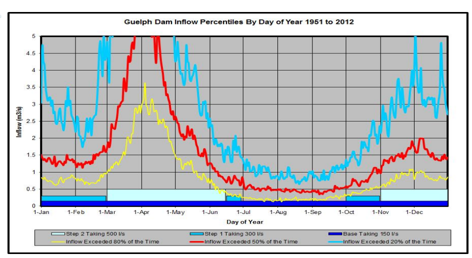


Aquifer Storage and Recovery (ASR)

Injection of potable water into an aquifer for later recovery and use

ALTERNATIVE #3 - ESTABLISH NEW SURFACE WATER SUPPLY

- Two possible local surface water sources for water taking:
  - Guelph Lake – downstream of the dam
  - Eramosa River – at Arkell
- A surface water treatment plant (WTP) is required to meet Ontario Drinking Water Quality Standards (ODWQS). Treatment is required for both possible alternatives:
  - Treatment & direct continuous flow into the distribution system
  - Treatment & stored in ASR wells; recovery as required
- The Grand River Conservation Authority completed yield analyses for Guelph Lake and the Eramosa River to determine reliability of continuous and stepped takings:



Eramosa River Yield Analysis Results (GRCA)	Guelph Lake Yield Analysis Results (GRCA)
• Assumes existing Eramosa River Permit to Take Water for Arkell recharge system is maximized • No potential for continuous taking • Very limited potential for increased stepped takings	• Good potential for continuous taking at 150 L/s • Good potential for an additional stepped taking of 150 L/s for nine months of the year

ALTERNATIVE #3 - ESTABLISH NEW SURFACE WATER SUPPLY

3A - Guelph Lake Water Treatment Plant

- Approximate location: North East part of the City of Guelph or at Guelph Lake
- Surface WTP consisting of conventional treatment and connection to distribution system
- Estimated available capacity: 12,300 m^3/day (WTP intake at 150 L/s)
- Estimated Capital Cost: $42.7M
- Cost per m^3/day : $3,470

3B - Guelph Lake Water Treatment Plant, Aquifer Storage and Recovery (ASR) Wells in NE Guelph

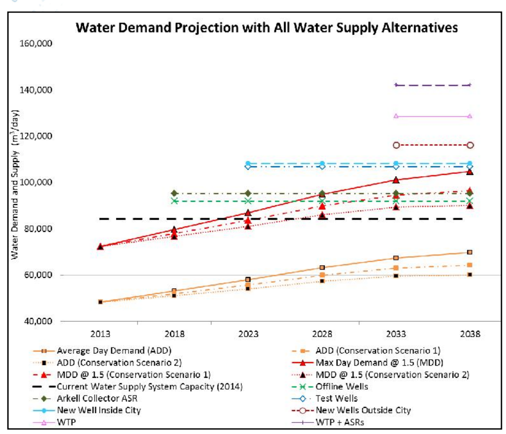
- Approximate location: Guelph Lake or near Park/Emma Wells
- Surface WTP, ASR (injection and recovery) wells; connection to distribution system
- Estimated available capacity: 26,600 m^3/day (WTP intake at 150 to 300 L/s)
- Estimated Capital Cost: $78.9M
- Cost per m^3/day : $3,060

WATER DEMAND PROJECTION WITH ALL WATER SUPPLY ALTERNATIVES

This figure shows……

- Guelph's current water supply system capacity - dashed black line
- Guelph's projected water supply requirements (without future conservation) - solid red line- from 2013 to 2038.
- Guelph's projected water supply requirements (with reduced demands as a result of a range of conservation scenarios) – dashed red lines - from 2013 to 2038.
- Each of the water supply alternatives is shown in a cumulative way to indicate the total water capacity available through these options
- The preferred selection and prioritization of water supply alternatives will be developed into an implementation strategy to meet the required future water needs

This graph is to demonstrate the additional capacity available from the water supply alternatives as compared to the projected demand with and without conservation. We welcome your input on which of these options should be pursued.



EVALUATION OF PROPOSED ALTERNATIVES

- The Water Supply Master Plan Update considers a number of factors related to the suitability of potential water supply options. The assessment covers the following topic categories:
  - Technical
  - Natural Environment
  - Legal/Jurisdictional
  - Financial
  - Built Environment
  - Social/Cultural Environment
- More details about each category and sub-category for our assessment is included in the following tables.

EVALUATION CRITERIA

Technical Category	
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
Potential Productivity and Reliability	An evaluation of the productivity potential of the water supply alternative based on: 1. Total available supply quantity 2. Suitable hydrogeological conditions (i.e., aquifer thickness & available drawdown; transmissivity) 3. Surface water flows & seasonal reliability
Water Treatment Requirements	An evaluation of the raw water quality and review of treatment requirements; based on: 1. Preliminary or estimated water quality results, available historical water quality data 2. Consideration for 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 (Permit to Take Water, Environmental Compliance Approval/Drinking Water License) 3. Grand River Conservation Authority (GRCA) 4. Ability to respond to change in permitting requirements

EVALUATION CRITERIA (CONTINUED)

Natural Environment Category	
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
Effect on Surface Water Quantity & Quality	An evaluation of temporary and/or long-term change in quantity or quality of surface water bodies (including those identified in the "Proximity to wetlands/streams" criteria used to assess the Potential Alternative Well Areas) due to: 1. Construction or operation 2. Groundwater drawdown during operation of the well
Legal/Jurisdictional Category	
Location Inside vs. Outside City boundaries	An evaluation of need to work with adjacent townships and County for land requirements for facility and utility easements
Financial Category	
Capital Costs (Life cycle cost per m^3/day)	An evaluation of the capital and operation & maintenance costs, including: 1. Estimated Capital Cost 2. Estimated Operating Cost 3. Life Cycle Cost (20 year)

Built Environment Category	
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)
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
Social/Cultural Environment Category	
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
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
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

PRELIMINARY EVALUATION OF ALTERNATIVES

Methodology

- Each potential alternative is assessed using a consistent approach and evaluation criteria
- The evaluation is qualitative – not a numerical ranking system – to consider alternative solutions and strategies based on significant advantages and disadvantages
- Comparisons and trade-offs will be identified to determine the preferred solution or water strategy
- The assessment uses the scale below to identify the least preferred to most preferred options

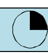
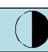
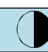
Least preferred → Most preferred

Category of Consideration	1A: Conservation (Status Quo)	1A: Conservation (increase)	1B: Re-Use	4: Limit Growth	5: Do Nothing
Technical Category	Most preferred for achieving reduction	Most preferred for achieving reduction	Advanced treatment and residuals management required Extensive approvals	Does not result in added capacity	Does not result in added capacity
Natural Environment Category	No impact	No impact	High potential impact from residuals management	No impact	No improvements to existing system; minimal impact
Built Environment Category	Minor changes to existing & planned building	Minor changes to existing & planned building	Moderate impact due to new infrastructure	High impact to planned growth (does not meet growth targets)	High impact to planned growth (does not meet growth targets)
Social/Cultural Environment Category	Contributes to meeting future demands; high public acceptance	Contributes to meeting future demands; high public acceptance	Contributes to meeting future demands; low public acceptance	Does not meet growth targets	Does not meet growth targets
Legal/Jurisdictional Category	In City	In City	Potential impacts outside of City due to residuals management requirements	May drive growth to Township	May drive growth to Township
Financial Category	Moderate costs as compared to supply alternatives	Moderate to high costs as compared to supply alternatives	High to very high	Not evaluated; does not address problem statement	Not evaluated; does not address problem statement
Overall Results					

PRELIMINARY EVALUATION OF ALTERNATIVES

Category of Consideration	2B – Groundwater - Existing Municipal Off-line Wells (Clythe, Sacco, Smallfield, Lower Road)	2C – Groundwater - Municipal Test Wells (Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser)	2D – Groundwater - New Well Inside City (Sunny Acres)	2E – Groundwater - New Wells Outside City (Guelph North; Guelph South)
Technical Category	High probability of success due to level of available information on existing municipal wells; More complexity to treatment requirements	High probability of success due to level of available information on existing test wells Better water quality	Moderate probability of success due to level of available information on nearby wells Possible TCE treatment required	High probability of success due to ideal hydrogeological conditions Good water quality expected
Natural Environment Category	Sustainable pumping established historically; impacts known	Requires investigation at wells near or adjacent to natural heritage features	Proposed well area not near sensitive receptors	Requires investigation at wells near or adjacent to natural heritage features
Built Environment Category	Minimal disruption at existing well facilities; some sites require added land Existing Well Protection Areas (WPA)	Property acquisition required New WPA may impact current and future land use	Park land or new property acquisition in area New WPA may impact current and future land use	Property acquisition in areas outside City New WPAs may impact current and future land use in Townships
Social/Cultural Environment Category	Moderate ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated	Low ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated
Legal/Jurisdictional Category	No issues	Logan/Fleming well in Guelph Eramosa Township (GET)	No issues	Guelph North well in GET Guelph South well in Puslinch Township (PT)
Financial Category	Low to moderate costs depending on well capacity	Lowest costs due to high capacity wells (except Hauser)	Moderate cost due to low capacity well	Low costs due to high capacity wells and assumed good water quality
Overall Results				

PRELIMINARY EVALUATION OF ALTERNATIVES

Category of Consideration	2F - Arkell Collectors & ASR	3A - Surface Water – Guelph Lake WTP	3B - Surface Water - Guelph Lake WTP & ASR
Technical Category	Moderate probability of success – need to confirm available recharge water surplus through optimization of Eramosa PTTW	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	Capturing excess collector system flows has minimal impacts to natural heritage features	Impacts to natural heritage features to be assessed and mitigated	Impacts to natural heritage features to be assessed and mitigated
Built Environment Category	Property acquisition for ASR wells inside City. New WPA may impact current and future land use	Potential disruption to recreational use of Guelph Lake & Speed River. Potential impacts to agricultural operations from new Source Water intake protection zone	Potential disruption to recreational use of Guelph Lake & Speed River. Potential impacts to agricultural operations from new Source Water intake protection zone
Social/Cultural Environment Category	Low ability to meet future demand Noise impacts to be mitigated	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	Arkell collectors are part of existing Arkell wellfield system in PT ASR wells inside City	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 cost	Moderate to high cost	Moderate to high cost
Overall Results			

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:

April 29, 2014

guelph.ca/water

STAY INFORMED AND ENGAGED!

Thank you for your interest in the City of Guelph's Water Supply Master Plan update

- Do you have any questions? Project team members are on hand to help.
- Ask any member of the project team. If we don't have the answer, we'll get it for you.
- We are interested in your feedback today on the evaluation of the alternatives, as well as anything that should be considered when developing the implementation strategy.
- Following the completion of our report, there will be a 30 day review period of the draft WSMP report where we welcome feedback.
- For more information on the project, visit **guelph.ca/water**.

Be sure to drop off your Open House Feedback Form before you leave!

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:

April 29, 2014

guelph.ca/water

We appreciate the time you took this evening to learn about Guelph's water supply system and plans for the future!

To find out more about the project, visit guelph.ca/water and follow the Water Supply Master Plan link, or contact:

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Water Supply Program Manager
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Dave.Belanger@guelph.ca

Patty Quackenbush
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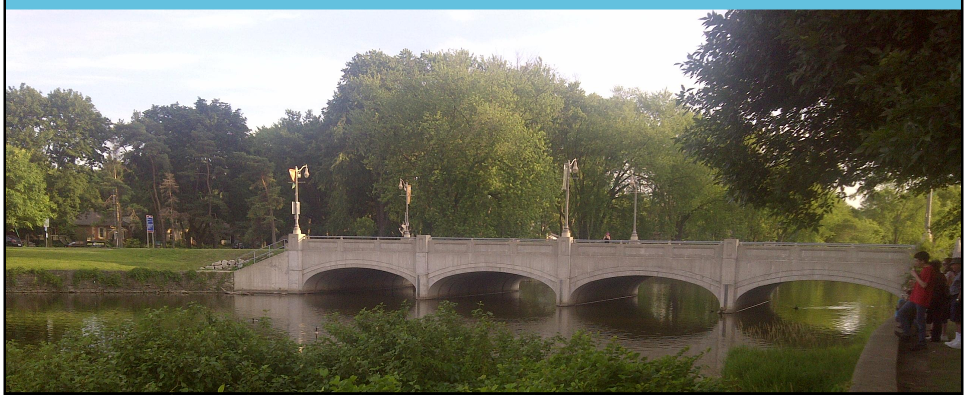
City of Guelph
Water Supply Master Plan Update: Community Open House #2

April 29, 2014



WELCOME!

- Introductions
- This presentation will walk through the Water Supply Master Plan update to explain:
  - Guelph's existing water supply system,
  - Alternatives that are being considered to meet water supply requirements to 2038; and
  - Evaluation criteria and preliminary results.
- Questions?
- Additional details are also provided on the display boards

We welcome your comments!

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE

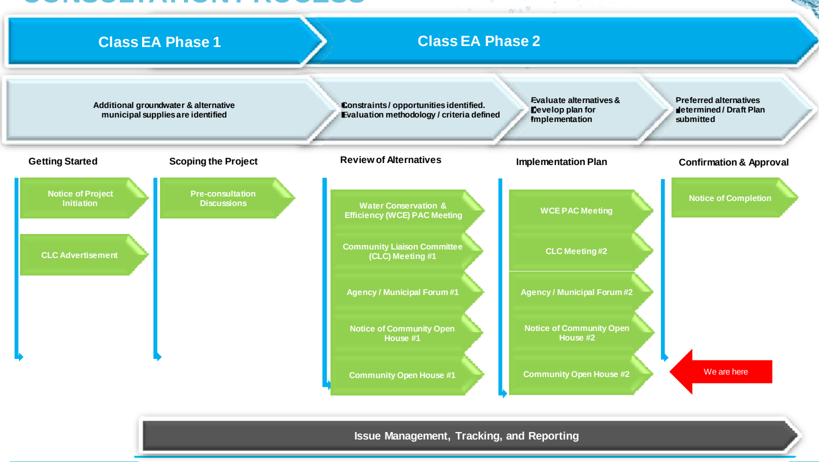
April 29, 2014

guelph.ca/water

PROBLEM / OPPORTUNITY STATEMENT

- The City of Guelph is responsible for supplying clean, safe drinking water to its customers.
- The Water Supply Master Plan update will define how we will continue to provide a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers over the next 25 years.
- Updating the WSMP is an opportunity to discuss with the community how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.
- The updated Master Plan will identify individual projects required to implement the master plan and prioritize these projects based on need.

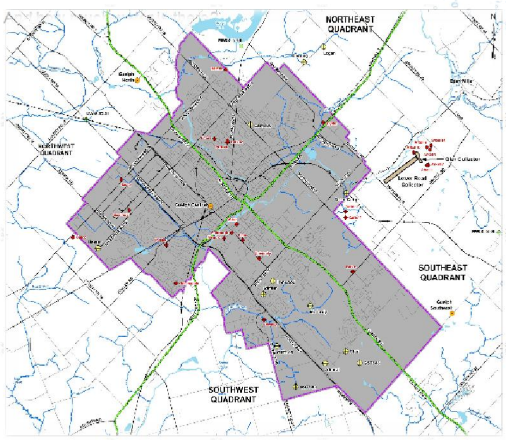
CONSULTATION PROCESS



GUELPH'S WATER SUPPLY SYSTEM

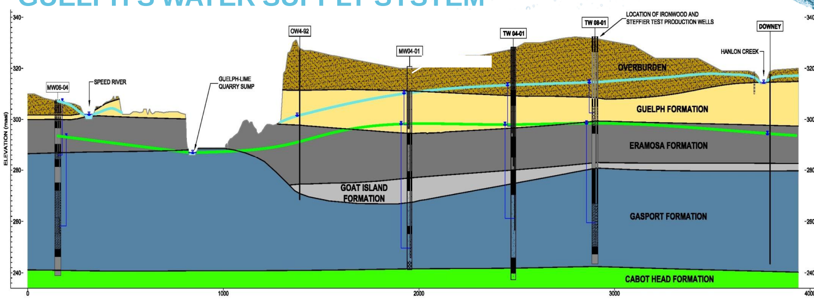
WHERE DO WE GET OUR WATER?

WHERE DO WE GET OUR WATER?



- Guelph has relied on groundwater to meet water demands since 1879
- Our water supply comes from production wells installed in the ***Gasport Formation*** deep bedrock aquifer and the ***Arkell Spring Grounds*** collector system
- Guelph's existing municipal supply system includes 25 production wells:
  - o 21 wells are in continuous operation
  - o 4 wells are offline because of water quality concerns

GUELPH'S WATER SUPPLY SYSTEM

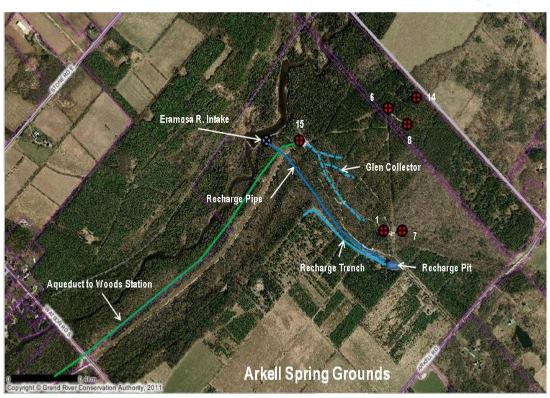


Legend:
TW: Test Well
MW: Municipal Well

- Private wells and municipal production wells do not draw from the same source.
  - Private wells take water primarily from the Guelph Formation, a shallow bedrock aquifer
  - Municipal production wells are drilled much deeper, and take water primarily from the Gasport Formation, the primary source of Guelph's main groundwater supply
- There is very little potential for interference between private and municipal wells

GUELPH'S WATER SUPPLY SYSTEM

Arkell Spring Grounds



- Natural springs discharge along the south side of the Eramosa River Valley
- Six (6) production wells (5 bedrock wells & 1 overburden well)
- Groundwater Recharge system - augments flow in the collector system by pumping water from the Eramosa River to a pit and trenches; this water recharges the groundwater, making more water available for our use

EXISTING WATER SUPPLY CAPACITY

- Potential supply capacity was determined for each well, based on all wells being operated concurrently
- The summary table compares 2014 capacity to the 2007 well capacities.
- Two new wells in Arkell since 2007
- The existing potential water supply capacity for Guelph is **83,836 m^3/day.**

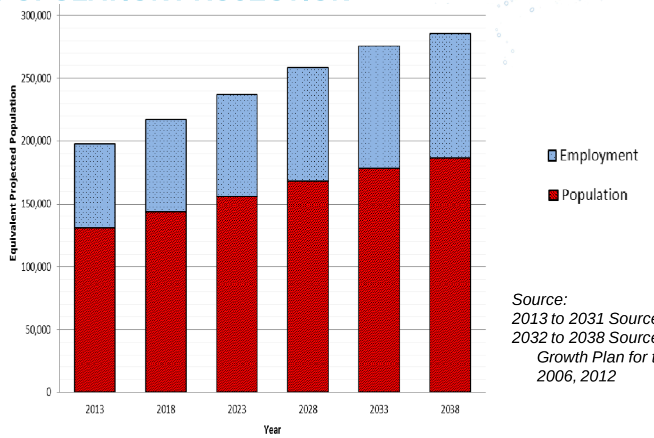
SUMMARY BY QUADRANT

Quadrant	WSMP (2007) (m^3/day)	WSMP Update (2014) (m^3/day)
Southeast	40,400	49,700
Southwest	17,800	17,936
Northeast	12,300	12,300
Northwest	4,500	3,900
Total	75,000	83,836

GUELPH'S POPULATION AND DEMAND PROJECTIONS

HOW MUCH WATER DO WE NEED

POPULATION PROJECTION



Source:
2013 to 2031 Source : Watson & Associates (2013)
2032 to 2038 Source: Proposed Amendment 2 to the Growth Plan for the Greater Golden Horseshoe, 2006, 2012

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE

April 29, 2014

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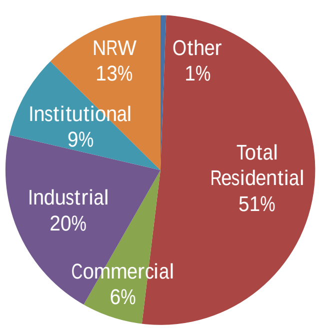
WATER DEMAND



•Municipal water supply systems are required to meet maximum daily demand. This means that with all supply wells operating, the system can supply the peak day demand in any given year.

•This includes:

- •**Customer Demand:** from Residential, Industrial, Commercial and Institutional sectors, and,
- •**Non-Revenue Water (NRW):** water that is used but not billed, for example, street cleaning, hydrant testing, losses in the distribution system, and fire flows.

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE

April 29, 2014

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HOW MUCH WATER DO WE PLAN FOR?

- **Security of supply:** An additional 10 to 15% above the actual maximum day demand is included in determining the existing and future requirements to address potential risks (e.g., long droughts, loss of well due to contamination, mechanical failure
- **Design maximum day factor (MDF):** for calculating required water supply capacity = 1.5

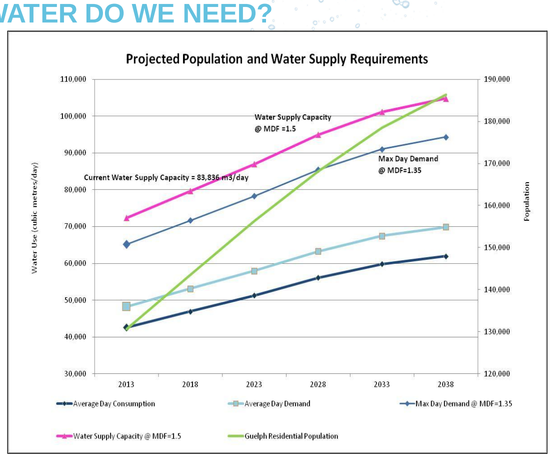
Demand/Capacity	2013	2038
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (m^3/day) (actual MDF of 1.35)	64,100	94,300
Total Existing System Capacity (m^3/day)	**83,836**	
Surplus/Deficit (m^3/day)	**19,736**	**-10,464**

Existing Capacity under Drought Condition – short term (m^3/day) *	71,128	
Surplus/Deficit (m^3/day)	**7,028**	**-23,172**

Existing Capacity with Loss of Supply (m^3/day) **	75,800	
Surplus/Deficit (m^3/day)	**11,700**	**-18,500**

** represents reduction in supply capacity of 15%*
** represents reduction in supply capacity of 10%*

HOW MUCH WATER DO WE NEED?



WATER SUPPLY ALTERNATIVES

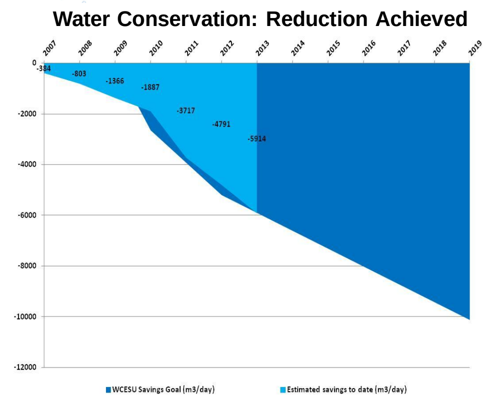
MEETING OUR FUTURE NEEDS

DEVELOPMENT OF ALTERNATIVES

- **Alternative 1A: Water Conservation and Demand Management**
- **Alternative 1B: Re-use**
- **Alternative 2: Expand Existing Groundwater System**
    - 2A - Optimize existing operating municipal wells
    - 2B - Restore existing off-line municipal wells
    - 2C - Develop existing municipal test wells
    - 2D - Install new wells inside City boundaries
    - 2E - Install new wells outside City boundaries
    - 2F - Install new Aquifer Storage and Recovery wells inside City to optimize excess Arkell Collector system volume
- **Alternative 3: Establish New Surface Water Supply**
    - Guelph Lake/Speed River
        - 3A - Surface Water Treatment Plant (WTP)
        - 3B - Surface WTP plus Aquifer Storage and Recovery (ASR) Wells
    - Eramosa River
- **Alternative 4: Limit Growth**
- **Alternative 5: Do Nothing**

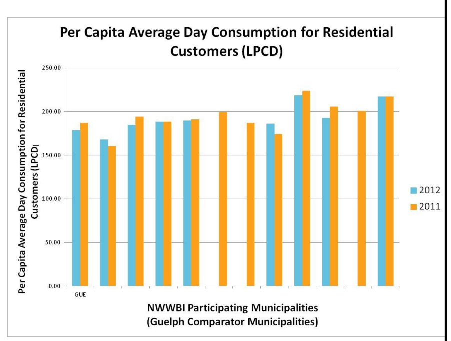
ALTERNATIVE #1A - WATER CONSERVATION AND DEMAND MANAGEMENT

- **<u>The City is on track</u>** with respect to its current water conservation goals
- This figure tracks actual demand reductions (in m^3/day) associated with City programs against proposed targets
- Since 2006, we've reduced our average daily water production by 12%



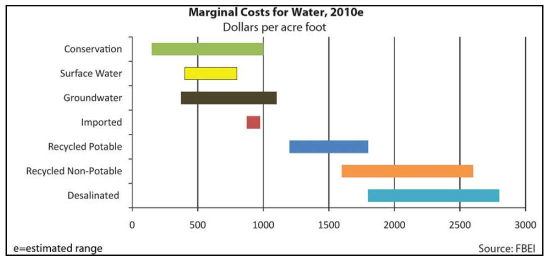
ALTERNATIVE #1A – WATER CONSERVATION AND DEMAND MANAGEMENT

- Conservation scenarios to assess a range of realistic demand reductions with the associated total capital and operating costs.
  - Scenario 1: status quo; 25% reduction by 2025
  - Scenario 2: highest reduction; 32% reduction by 2038
  - Scenarios 3-5; target reductions between 28 and 32%
- The preferred reduction target will be incorporated into the next Water Conservation and Efficiency Strategy Update



ALTERNATIVE #1B – RE-USE

- **Non-Potable Re-Use:** landscaping irrigation, construction uses, street cleaning, industrial re-use
- **Direct and Indirect Potable Re-Use:** to the distribution system
- Challenges:
  - – dual piping system (non-potable)
  - – customers/end-uses – seasonal
  - – quality dependent on use
  - – treatment residuals
  - – public acceptance
  - – regulatory
  - – cost



Reference: San Diego's Water Sources: Assessing the Options (Fermanian Business & Economic Institute, 2010)

ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2A – Optimize Existing Operating Municipal Wells

– Existing wells are optimized

– Continuous maintenance of existing supply wells to ensure capacity is sustained; including:
- Well rehabilitation;
- Installation of well liners;
- Water quality monitoring - review of future treatment requirements;
- Equipment maintenance & replacement; and
- Optimization of well pumps and highlift pumps

ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2B – Restore Existing Offline Municipal Wells:

- Wells with existing permits
- Taken offline due to water quality issues due to contamination or naturally occurring parameters

Quadrant	Well	Required Upgrades	Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Northeast	Clythe	upgrade; H2S, Fe&Mn treatment	3,395	$4.8M	$1,490
Northwest	Sacco	upgrade; TCE treatment	1,150	$4.1M	$3,700
Northwest	Smallfield	upgrade; TCE treatment	1,408	$3.6M	$2,590
Southwest*	Edinburgh	upgrade; TCE treatment;	SWQ (3,000)	$6.0M	$2,050
Southwest*	Admiral	wellhouse; connect to system; sulphate treatment	SWQ (500)	$3.0M	$6,100
Southeast	Lower Road Collector	New pipe system & infrastructure	2,000 – 3,000	$9.2M	$4,580
Total			**7,953**		

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE

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ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2C – Develop Existing Municipal Test Wells

- Test wells installed and tested in and outside the city for future municipal water supplies
- Previous investigations provide confidence in potential quantity and quality, and understanding of potential impacts

Quadrant	Well	Required Infrastructure	Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southeast	Scout Camp	wellhouse upgrade; H2S treatment	5,789	$4.7M	$830
Southwest*	Ironwood/ Steffler	wellhouse; disinfection; connect to distribution	4,500 (Ironwood – 8000m^3/d Steffler - 3600m^3/d)	$3.3 to 4.0M	$500 to 900
Northeast	Logan/ Fleming	new well/ property connect to distribution	4,700	$4.7M	$1,000
Northwest	Hauser	new well/ property; connect to distribution	900	$3.7M	$4,100
Total			**15,889**		

* SWQ options under consideration in SWQ Class EA; total additional SWQ capacity = 4500 m^3/d

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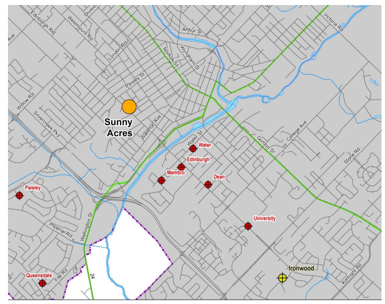
ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2D – New Well Inside City

Guelph Central – Sunny Acres

- Approximate location – in/near Sunny Acre Park (final location TBD)
- Estimated available capacity - 1500 m^3/day
- Assumed requirement to treat for TCE based on experience with other municipal wells in the area
- Estimated Capital Cost: $4.5M
- Cost per m^3/day (produced) : $3,080

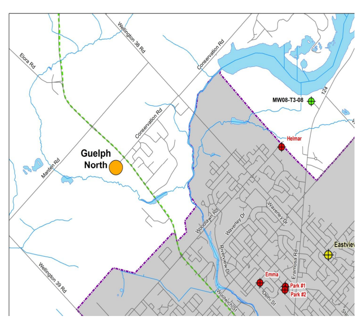


ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2E – New Wells Outside City

Guelph North – Conservation Road W

- Approximate location - north of the City in Guelph Eramosa Township (final location TBD)
- Estimated available capacity - 4660 m^3/day on average basis; and 6300 m^3/day to meet maximum day demands
- Baseline reduction to surface water features predominantly limited to the Middle Speed River catchment
- Good quality water is expected
- Estimated Capital Cost: $5.3M
- Cost per m^3/day: $840

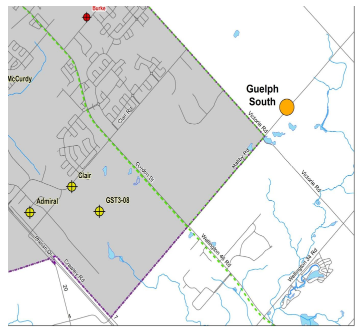


ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2E – New Wells Outside City

Guelph South – Victoria Road/ Maltby Road

- Approximate location - southeast of the City in Puslinch Township (final location TBD)
- Estimated available capacity - 3900 m³/day on an average basis; and 5300 m³/day to meet maximum day demands
- Baseline reduction to surface water features is predominantly limited to Mill Creek (cold water trout stream)
- Good quality water is expected
- Estimated Capital Cost: $5.2M
- Cost per m³/day : $980



ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2F – ASR Wells Inside City

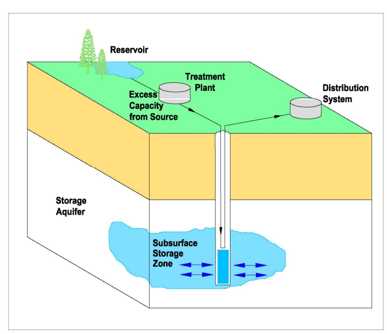
Opportunity:

- Arkell Recharge System: Glen Collector system and off-line Lower Road Collector system flows - high seasonal variability, not considered as part of the maximum daily supply capacity
- Optimize current Eramosa River PTTW; excess of 10,000 m³/day for 4 months/year
- Treatment via existing recharge system & UV disinfection at Woods PS

Alternative includes:

- 2 ASR wells located within the City; each capable of injection at 5000 m³/day
- Potential capacity= 3,300 m³/day

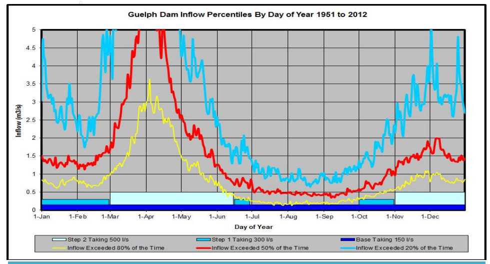
Estimated Capital Cost	$ 9.0M
Cost per m³ /day	$ 2,700



Aquifer Storage and Recovery (ASR)

ALTERNATIVE #3 - ESTABLISH NEW SURFACE WATER SUPPLY

- There are two possible local surface water sources for water taking:
  - Guelph Lake – downstream of the dam
  - Eramosa River – at Arkell
- A surface water treatment plant (WTP) is required to meet Ontario Drinking Water Quality Standards (ODWQS). Treatment is required for both possible alternatives:
  - Treatment & direct continuous flow into the distribution system
  - Treatment & stored in ASR wells; recovery as required



Grand River Conservation Authority (GRCA)

Completed Guelph Lake Yield analysis to determine reliability of continuous and stepped takings; concluded good potential for:
- continuous taking at 150 L/s
- additional stepped taking of 150 L/s for 9 months/yr

ALTERNATIVE #3 - ESTABLISH NEW SURFACE WATER SUPPLY

3A – Guelph Lake WTP

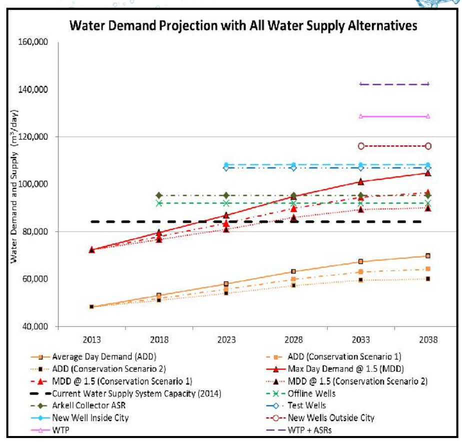
- Location: at Guelph Lake; intake near dam
- Surface WTP and connection to distribution system
- Estimated available capacity: 12,300 m^3/day (WTP intake at 150 L/s)
- Estimated Capital Cost: $42.7M
- Cost per m^3/day: $3,470

3B – Guelph Lake WTP + ASR Wells

- Approximate location: Guelph Lake or near Park/Emma Wells
- Surface WTP, ASR (injection and recovery) wells; connection to distribution system
- Estimated available capacity: 26,600 m^3/day (WTP intake at 150 to 300 L/s)
- Estimated Capital Cost: $78.9M
- Cost per m^3/day: $3,060

WATER DEMAND PROJECTION WITH ALL WATER SUPPLY ALTERNATIVES

- Each of the water supply alternatives is shown in a cumulative way to indicate the total water capacity available
- The selection of preferred water supply alternatives and prioritization will be developed into an implementation strategy to meet the required future water needs
- We welcome your input on the alternatives



PRELIMINARY EVALUATION OF ALTERNATIVES

EVALUATION OF ALTERNATIVES - CRITERIA

Financial Considerations

- Estimated capital costs; capital cost per capacity
- Estimated operation and maintenance costs
- Life cycle cost (per volume produced)

Legal and Jurisdictional Considerations

- Location inside vs. outside of City boundaries

Technological Considerations

- Constructability
- Potential productivity and reliability
- Water treatment requirements
- Approval requirements

Built Environment

- Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities
- Effect on private and municipal wells

Natural Environment

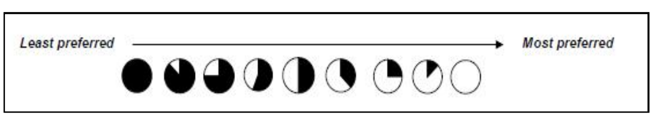
- Effect of construction and operation on aquatic and terrestrial species & habitat
- Effect on surface water quantity and quality

Social and 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

PRELIMINARY EVALUATION OF ALTERNATIVES

- Each potential alternative is assessed using a consistent approach and evaluation criteria
- The evaluation is qualitative – not a numerical ranking system – to consider alternative solutions and strategies based on significant advantages and disadvantages
- Comparisons and trade-offs will be identified to determine the preferred solution or water strategy
- The assessment uses the scale below to identify the least preferred to most preferred options



PRELIMINARY EVALUATION - EXAMPLE

Category of Consideration	2B – Groundwater - Existing Municipal Off-line Wells (Clythe, Sacco, Smallfield, Lower Road)	2C – Groundwater - Municipal Test Wells (Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser)	2D – Groundwater - New Well Inside City (Sunny Acres)	2E – Groundwater - New Wells Outside City (Guelph North; Guelph South)
Technical Category	High probability of success due to level of available information on existing municipal wells; More complexity to treatment requirements	High probability of success due to level of available information on existing test wells Better water quality	Moderate probability of success due to level of available information on nearby wells Possible TCE treatment required	High probability of success due to ideal hydrogeological conditions Good water quality expected
Natural Environment Category	Sustainable pumping established historically; impacts known	Requires investigation at wells near or adjacent to natural heritage features	Proposed well area not near sensitive receptors	Requires investigation at wells near or adjacent to natural heritage features
Built Environment Category	Minimal disruption at existing well facilities; some sites require added land Existing Well Protection Areas (WPA)	Property acquisition required New WPA may impact current and future land use	Park land or new property acquisition in area New WPA may impact current and future land use	Property acquisition in areas outside City New WPAs may impact current and future land use in Townships
Social/Cultural Environment Category	Moderate ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated	Low ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated
Legal/Jurisdictional Category	No issues	Logan/Fleming well in Guelph Eramosa Township (GET)	No issues	Guelph North well in GET Guelph South well in Puslinch Township (PT)
Financial Category	Low to moderate costs depending on well capacity	Lowest costs due to high capacity wells (except Hauser)	Moderate cost due to low capacity well	Low costs due to high capacity wells and assumed good water quality
Overall Results				

STAY INFORMED AND ENGAGED!

- Do you have any questions? Project team members are on hand to help.
- If we don't have the answer, we'll get it for you.
- We are interested in your feedback today on the evaluation of the alternatives, as well as anything that should be considered when developing the implementation strategy.
- Following the completion of our report, there will be a 30 day review period of the draft WSMP report where we welcome feedback.
- For more information, visit **guelph.ca/water**.

Be sure to drop off your Open House Feedback Form before you leave!

We appreciate the time you took this evening to learn about Guelph's water supply system and plans for the future!

To find out more about the project, visit **guelph.ca/water** and follow the Water Supply Master Plan link, or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
519-822-1260 ext. 2186
Dave.Belanger@guelph.ca

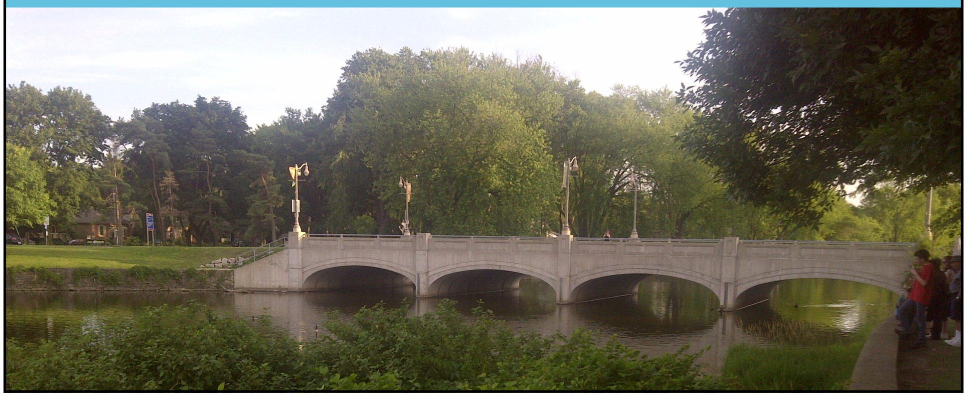
Patty Quackenbush
Senior Project Manager
AECOM
519-650-8691
Patty.Quackenbush@aecom.com

As per the *Accessibility for Ontarians with Disabilities Act*, this content is available in an alternate format by contacting 519-650-8691.

City of Guelph

Water Supply Master Plan Update: Community Open House #2

April 29, 2014



WELCOME!

- Introductions
- This presentation will walk through the Water Supply Master Plan update to explain:
  - Guelph's existing water supply system,
  - Alternatives that are being considered to meet water supply requirements to 2038; and
  - Evaluation criteria and preliminary results.
- Questions?
- Additional details are also provided on the display boards

We welcome your comments!

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE

April 29, 2014

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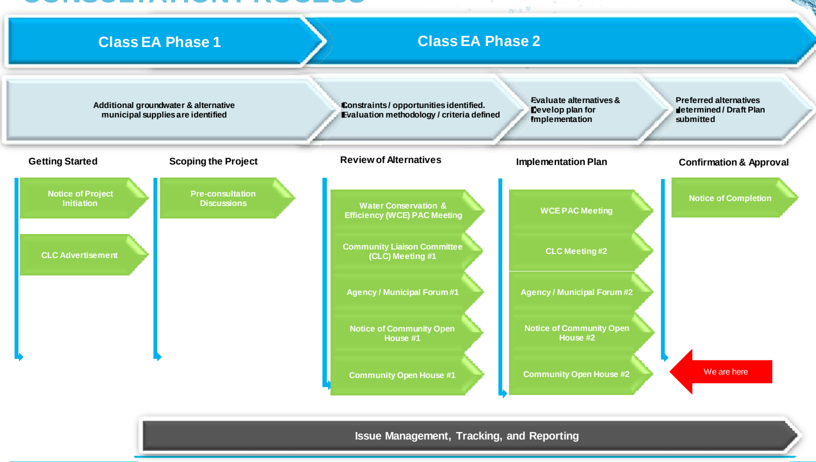
PROBLEM / OPPORTUNITY STATEMENT

- The City of Guelph is responsible for supplying clean, safe drinking water to its customers.
- The Water Supply Master Plan update will define how we will continue to provide a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers over the next 25 years.
- Updating the WSMP is an opportunity to discuss with the community how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect.
- The updated Master Plan will identify individual projects required to implement the master plan and prioritize these projects based on need.

CONSULTATION PROCESS



CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
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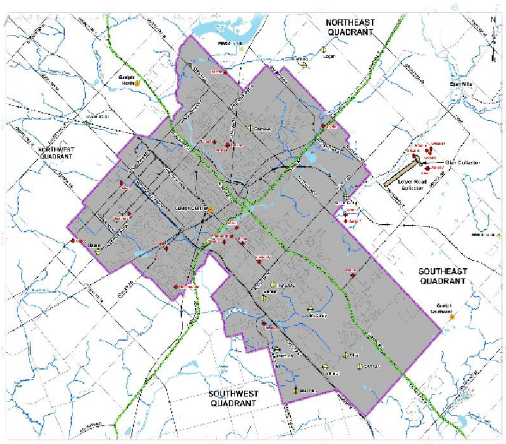
GUELPH'S WATER SUPPLY SYSTEM

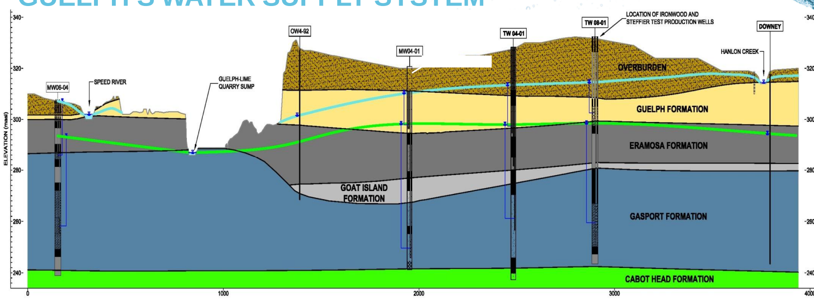
WHERE DO WE GET OUR WATER?

WHERE DO WE GET OUR WATER?



- Guelph has relied on groundwater to meet water demands since 1879
- Our water supply comes from production wells installed in the ***Gasport Formation*** deep bedrock aquifer and the ***Arkell Spring Grounds*** collector system
- Guelph's existing municipal supply system includes 25 production wells:
  - 21 wells are in continuous operation
  - 4 wells are offline because of water quality concerns

GUELPH'S WATER SUPPLY SYSTEM

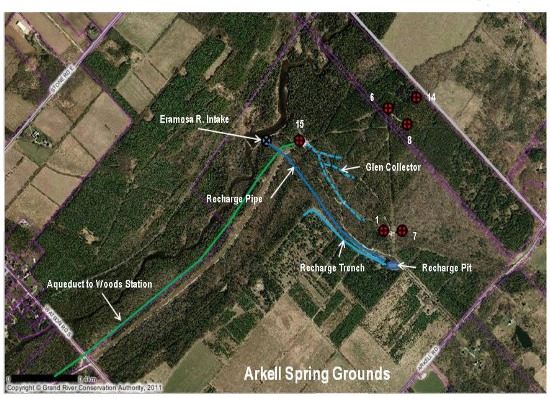


Legend:
TW: Test Well
MW: Municipal Well

- Private wells and municipal production wells do not draw from the same source.
  - Private wells take water primarily from the Guelph Formation, a shallow bedrock aquifer
  - Municipal production wells are drilled much deeper, and take water primarily from the Gasport Formation, the primary source of Guelph's main groundwater supply
- There is very little potential for interference between private and municipal wells

GUELPH'S WATER SUPPLY SYSTEM

Arkell Spring Grounds



- Natural springs discharge along the south side of the Eramosa River Valley
- Six (6) production wells (5 bedrock wells & 1 overburden well)
- Groundwater Recharge system - augments flow in the collector system by pumping water from the Eramosa River to a pit and trenches; this water recharges the groundwater, making more water available for our use

EXISTING WATER SUPPLY CAPACITY

- Potential supply capacity was determined for each well, based on all wells being operated concurrently
- The summary table compares 2014 capacity to the 2007 well capacities.
- Two new wells in Arkell since 2007
- The existing potential water supply capacity for Guelph is **83,836 m^3/day.**

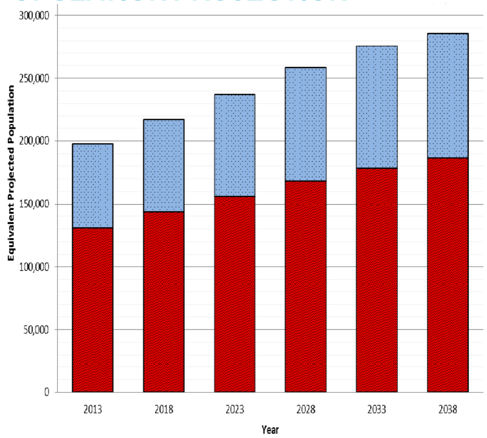
SUMMARY BY QUADRANT

Quadrant	WSMP (2007) (m^3/day)	WSMP Update (2014) (m^3/day)
Southeast	40,400	49,700
Southwest	17,800	17,936
Northeast	12,300	12,300
Northwest	4,500	3,900
Total	75,000	83,836

GUELPH'S POPULATION AND DEMAND PROJECTIONS

HOW MUCH WATER DO WE NEED

POPULATION PROJECTION



Source:
2013 to 2031 Source : Watson & Associates (2013)
2032 to 2038 Source: Proposed Amendment 2 to the Growth Plan for the Greater Golden Horseshoe, 2006, 2012

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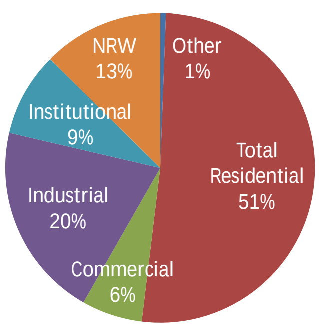
WATER DEMAND



- Municipal water supply systems are required to meet maximum daily demand. This means that with all supply wells operating, the system can supply the peak day demand in any given year.
- This includes:
  - **Customer Demand:** from Residential, Industrial, Commercial and Institutional sectors, and,
  - **Non-Revenue Water (NRW):** water that is used but not billed, for example, street cleaning, hydrant testing, losses in the distribution system, and fire flows.

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WATER SUPPLY MASTER PLAN UPDATE:
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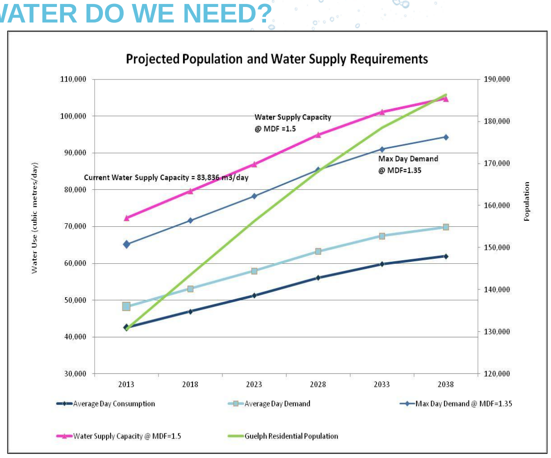
HOW MUCH WATER DO WE PLAN FOR?

- **Security of supply:** An additional 10 to 15% above the actual maximum day demand is included in determining the existing and future requirements to address potential risks (e.g., long droughts, loss of well due to contamination, mechanical failure
- **Design maximum day factor (MDF):** for calculating required water supply capacity = 1.5

Demand/Capacity	2013	2038
Average Daily Demand (m^3/day)	48,300	69,900
Maximum Daily Demand (m^3/day) (actual MDF of 1.35)	64,100	94,300
Total Existing System Capacity (m^3/day)	**83,836**	
Surplus/Deficit (m^3/day)	**19,736**	**-10,464**
Existing Capacity under Drought Condition – short term (m^3/day) *	71,128	
Surplus/Deficit (m^3/day)	**7,028**	**-23,172**
Existing Capacity with Loss of Supply (m^3/day) **	75,800	
Surplus/Deficit (m^3/day)	**11,700**	**-18,500**

** represents reduction in supply capacity of 15%*
** represents reduction in supply capacity of 10%*

HOW MUCH WATER DO WE NEED?



WATER SUPPLY ALTERNATIVES

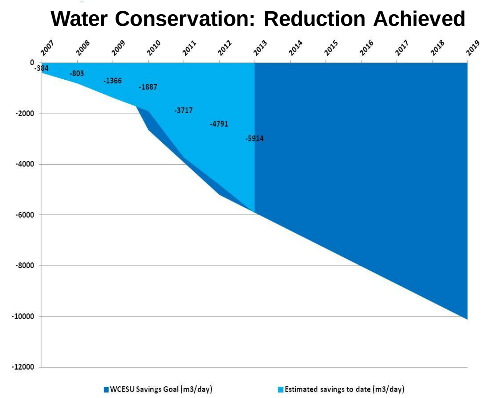
MEETING OUR FUTURE NEEDS

DEVELOPMENT OF ALTERNATIVES

- **Alternative 1A: Water Conservation and Demand Management**
- **Alternative 1B: Re-use**
- **Alternative 2: Expand Existing Groundwater System**
  - 2A - Optimize existing operating municipal wells
  - 2B - Restore existing off-line municipal wells
  - 2C - Develop existing municipal test wells
  - 2D - Install new wells inside City boundaries
  - 2E - Install new wells outside City boundaries
  - 2F - Install new Aquifer Storage and Recovery wells inside City to optimize excess Arkell Collector system volume
- **Alternative 3: Establish New Surface Water Supply**
  - Guelph Lake/Speed River
    - 3A - Surface Water Treatment Plant (WTP)
    - 3B - Surface WTP plus Aquifer Storage and Recovery (ASR) Wells
  - Eramosa River
- **Alternative 4: Limit Growth**
- **Alternative 5: Do Nothing**

ALTERNATIVE #1A - WATER CONSERVATION AND DEMAND MANAGEMENT

- **The City is on track** with respect to its current water conservation goals
- This figure tracks actual demand reductions (in m^3/day) associated with City programs against proposed targets
- Since 2006, we've reduced our average daily water production by 12%



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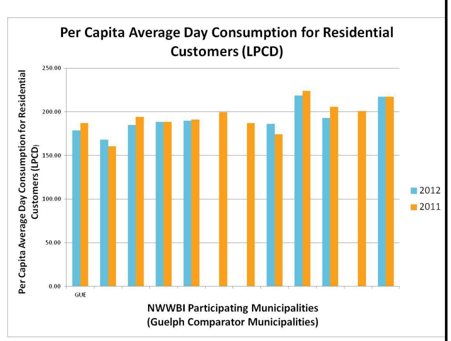

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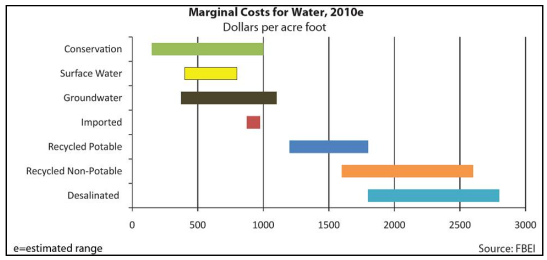

Reference: San Diego's Water Sources: Assessing the Options (Fermanian Business & Economic Institute, 2010)

ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

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Southeast	Lower Road Collector	New pipe system & infrastructure	2,000 – 3,000	$9.2M	$4,580
Total			**7,953**		

ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2C – Develop Existing Municipal Test Wells

- Test wells installed and tested in and outside the city for future municipal water supplies
- Previous investigations provide confidence in potential quantity and quality, and understanding of potential impacts

Quadrant	Well	Required Infrastructure	Additional Capacity (m^3/d)	Estimated Capital Cost	Cost per m^3/d
Southeast	Scout Camp	wellhouse upgrade; H2S treatment	5,789	$4.7M	$830
Southwest*	Ironwood/ Steffler	wellhouse; disinfection; connect to distribution	4,500 (Ironwood – 8000m^3/d Steffler - 3600m^3/d)	$3.3 to 4.0M	$500 to 900
Northeast	Logan/ Fleming	new well/ property connect to distribution	4,700	$4.7M	$1,000
Northwest	Hauser	new well/ property; connect to distribution	900	$3.7M	$4,100
Total			**15,889**		

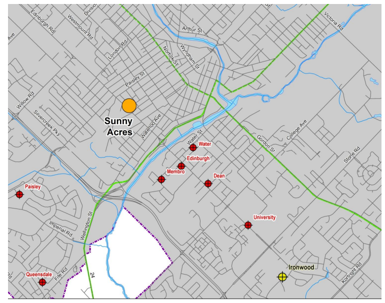
* SWQ options under consideration in SWQ Class EA; total additional SWQ capacity = 4500 m^3/d

ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2D – New Well Inside City

Guelph Central – Sunny Acres

- Approximate location – in/near Sunny Acre Park (final location TBD)
- Estimated available capacity - 1500 m^3/day
- Assumed requirement to treat for TCE based on experience with other municipal wells in the area
- Estimated Capital Cost: $4.5M
- Cost per m^3/day (produced) : $3,080

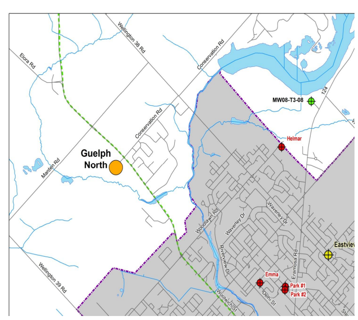


ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2E – New Wells Outside City

Guelph North – Conservation Road W

- Approximate location - north of the City in Guelph Eramosa Township (final location TBD)
- Estimated available capacity - 4660 m^3/day on average basis; and 6300 m^3/day to meet maximum day demands
- Baseline reduction to surface water features predominantly limited to the Middle Speed River catchment
- Good quality water is expected
- Estimated Capital Cost: $5.3M
- Cost per m^3/day: $840

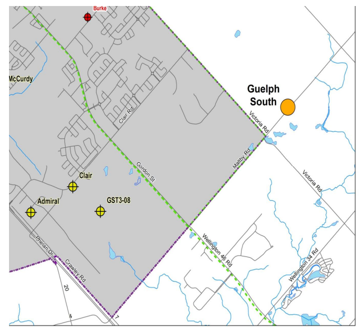


ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2E – New Wells Outside City

Guelph South – Victoria Road/ Maltby Road

- Approximate location - southeast of the City in Puslinch Township (final location TBD)
- Estimated available capacity - 3900 m^3/day on an average basis; and 5300 m^3/day to meet maximum day demands
- Baseline reduction to surface water features is predominantly limited to Mill Creek (cold water trout stream)
- Good quality water is expected
- Estimated Capital Cost: $5.2M
- Cost per m^3/day : $980



ALTERNATIVE #2 - EXPAND EXISTING GROUNDWATER SYSTEM

2F – ASR Wells Inside City

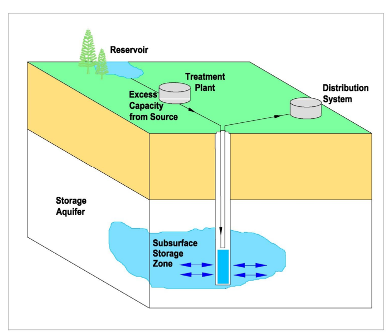
Opportunity:

- Arkell Recharge System: Glen Collector system and off-line Lower Road Collector system flows - high seasonal variability, not considered as part of the maximum daily supply capacity
- Optimize current Eramosa River PTTW; excess of 10,000 m^3/day for 4 months/year
- Treatment via existing recharge system & UV disinfection at Woods PS

Alternative includes:

- 2 ASR wells located within the City; each capable of injection at 5000 m^3/day
- Potential capacity= 3,300 m^3/day

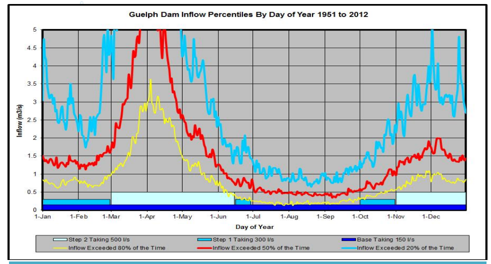
Estimated Capital Cost	$ 9.0M
Cost per m^3 /day	$ 2,700



Aquifer Storage and Recovery (ASR)

ALTERNATIVE #3 - ESTABLISH NEW SURFACE WATER SUPPLY

- There are two possible local surface water sources for water taking:
  - Guelph Lake – downstream of the dam
  - Eramosa River – at Arkell
- A surface water treatment plant (WTP) is required to meet Ontario Drinking Water Quality Standards (ODWQS). Treatment is required for both possible alternatives:
  - Treatment & direct continuous flow into the distribution system
  - Treatment & stored in ASR wells; recovery as required



Grand River Conservation Authority (GRCA)

Completed Guelph Lake Yield analysis to determine reliability of continuous and stepped takings; concluded good potential for:

- continuous taking at 150 L/s
- additional stepped taking of 150 L/s for 9 months/yr

ALTERNATIVE #3 - ESTABLISH NEW SURFACE WATER SUPPLY

3A – Guelph Lake WTP

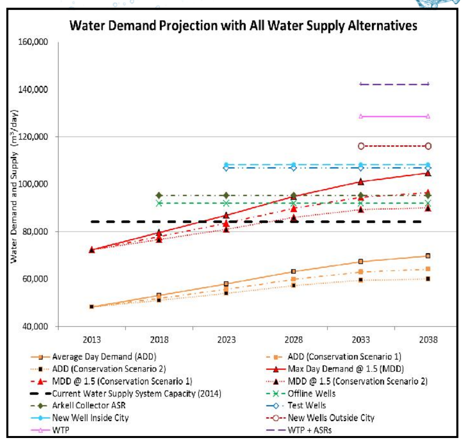
- Location: at Guelph Lake; intake near dam
- Surface WTP and connection to distribution system
- Estimated available capacity: 12,300 m^3/day (WTP intake at 150 L/s)
- Estimated Capital Cost: $42.7M
- Cost per m^3/day: $3,470

3B – Guelph Lake WTP + ASR Wells

- Approximate location: Guelph Lake or near Park/Emma Wells
- Surface WTP, ASR (injection and recovery) wells; connection to distribution system
- Estimated available capacity: 26,600 m^3/day (WTP intake at 150 to 300 L/s)
- Estimated Capital Cost: $78.9M
- Cost per m^3/day: $3,060

WATER DEMAND PROJECTION WITH ALL WATER SUPPLY ALTERNATIVES

- Each of the water supply alternatives is shown in a cumulative way to indicate the total water capacity available
- The selection of preferred water supply alternatives and prioritization will be developed into an implementation strategy to meet the required future water needs
- We welcome your input on the alternatives



PRELIMINARY EVALUATION OF ALTERNATIVES

EVALUATION OF ALTERNATIVES - CRITERIA

Financial Considerations
- Estimated capital costs; capital cost per capacity
- Estimated operation and maintenance costs
- Life cycle cost (per volume produced)

Legal and Jurisdictional Considerations
- Location inside vs. outside of City boundaries

Technological Considerations
- Constructability
- Potential productivity and reliability
- Water treatment requirements
- Approval requirements

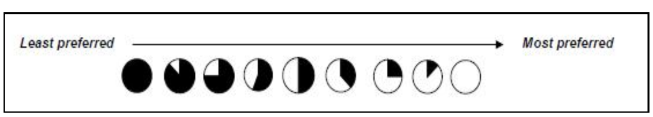
Built Environment
- Effect on existing and/or planned residences, businesses, community, institutional or recreational facilities
- Effect on private and municipal wells

Natural Environment
- Effect of construction and operation on aquatic and terrestrial species & habitat
- Effect on surface water quantity and quality

Social and 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

PRELIMINARY EVALUATION OF ALTERNATIVES

- Each potential alternative is assessed using a consistent approach and evaluation criteria
- The evaluation is qualitative – not a numerical ranking system – to consider alternative solutions and strategies based on significant advantages and disadvantages
- Comparisons and trade-offs will be identified to determine the preferred solution or water strategy
- The assessment uses the scale below to identify the least preferred to most preferred options



PRELIMINARY EVALUATION - EXAMPLE

Category of Consideration	2B – Groundwater - Existing Municipal Off-line Wells (Clythe, Sacco, Smallfield, Lower Road)	2C – Groundwater - Municipal Test Wells (Scout Camp, Ironwood/Steffler, Logan/Fleming, Hauser)	2D – Groundwater - New Well Inside City (Sunny Acres)	2E – Groundwater - New Wells Outside City (Guelph North; Guelph South)
Technical Category	High probability of success due to level of available information on existing municipal wells; More complexity to treatment requirements	High probability of success due to level of available information on existing test wells Better water quality	Moderate probability of success due to level of available information on nearby wells Possible TCE treatment required	High probability of success due to ideal hydrogeological conditions Good water quality expected
Natural Environment Category	Sustainable pumping established historically; impacts known	Requires investigation at wells near or adjacent to natural heritage features	Proposed well area not near sensitive receptors	Requires investigation at wells near or adjacent to natural heritage features
Built Environment Category	Minimal disruption at existing well facilities; some sites require added land Existing Well Protection Areas (WPA)	Property acquisition required New WPA may impact current and future land use	Park land or new property acquisition in area New WPA may impact current and future land use	Property acquisition in areas outside City New WPAs may impact current and future land use in Townships
Social/Cultural Environment Category	Moderate ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated	Low ability to meet future demand Noise impacts to be mitigated	High ability to meet future demand Noise impacts to be mitigated
Legal/Jurisdictional Category	No issues	Logan/Fleming well in Guelph Eramosa Township (GET)	No issues	Guelph North well in GET Guelph South well in Puslinch Township (PT)
Financial Category	Low to moderate costs depending on well capacity	Lowest costs due to high capacity wells (except Hauser)	Moderate cost due to low capacity well	Low costs due to high capacity wells and assumed good water quality
Overall Results				

STAY INFORMED AND ENGAGED!

- Do you have any questions? Project team members are on hand to help.
- If we don't have the answer, we'll get it for you.
- We are interested in your feedback today on the evaluation of the alternatives, as well as anything that should be considered when developing the implementation strategy.
- Following the completion of our report, there will be a 30 day review period of the draft WSMP report where we welcome feedback.
- For more information, visit **guelph.ca/water**.

Be sure to drop off your Open House Feedback Form before you leave!

We appreciate the time you took this evening to learn about Guelph's water supply system and plans for the future!

To find out more about the project, visit **guelph.ca/water** and follow the Water Supply Master Plan link, or contact:

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Dave.Belanger@guelph.ca

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AECOM
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As per the *Accessibility for Ontarians with Disabilities Act*, this content is available in an alternate format by contacting 519-650-8691.

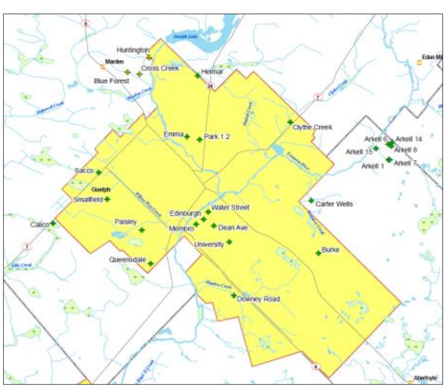
City of Guelph

WATER SUPPLY MASTER PLAN UPDATE COMMUNITY OPEN HOUSE #1

- Where Our Water Comes from
- Progress Since Guelph's 2007 Water Supply Master Plan
- Maintaining a Sustainable Supply to 2038
- Opportunities for Engagement and Feedback

WHERE DO WE GET OUR WATER?

And how much water is there?



- Guelph has relied on groundwater to meet water demands since 1879
- Our water supply comes from production wells installed in the ***Gasport Formation*** deep bedrock aquifer and the ***Arkell Spring Grounds*** collector system
- There are 25 production wells in Guelph's municipal supply system:
  - 21 wells are in continuous operation
  - 4 wells are offline because of water quality concerns

- **Guelph's current water supply is about 83,000 m³/day**
  - Guelph's total water supply in 2007 was about 75,000 m³/day
  - Since 2007, two new wells (Arkell 14 and Arkell 15) were constructed to provide additional capacity

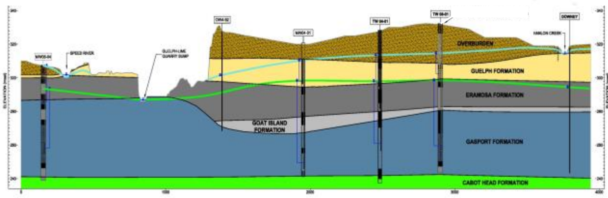
Guelph Municipal Production Wells Capacity (m^3/day)

Region	Well	Capacity	Region	Well	Capacity
Northwest	Paisley	1,400	Northeast	Park#1	8,000
Northwest	Calico	1,100	Northeast	Park#2	
Northwest	Queensdale	2,000	Northeast	Emma	2,800
Northwest	Sacco	0	Northeast	Helmar	1,500
Northwest	Smallfield	0	Northeast	Clythe Creek	0
Southwest	Membro	6,000	Southeast	Arkell 1	2,000
Southwest	Water	2,700	Southeast	Arkell 6	6,500
Southwest	Dean	1,500	Southeast	Arkell 7	6,500
Southwest	University	2,500	Southeast	Arkell 8	6,500
Southwest	Downey	5,100	Southeast	Arkell 14	new
Southwest	Edinburgh	0	Southeast	Arkell 15	new
	Arkell Infiltration Galleries	6,900	Southeast	Burke	6,500
			Southeast	Carter-1	5,500
			Southeast	Carter-2	

Ensuring that Guelph has enough water to support current and future needs is an important reason to update the 2007 Water Supply Master Plan.

GUELPH'S WATER SUPPLY

A closer look at our groundwater supply



Legend:
TW: Test Well
MW: Municipal Well

- Private wells and municipal production wells do not draw from the same source.
  - Private wells in Guelph and the surrounding area take water primarily from the Guelph Formation, a shallow bedrock aquifer.
  - Municipal production wells are drilled much deeper, and take water primarily from the Gasport Formation. This deep bedrock aquifer is the source of Guelph's main groundwater supply.
- This means there is very little potential for interference between private wells and the municipal water supply.

The Arkell Spring Grounds

- Natural springs discharge along the south side of the Eramosa River Valley; the City has used these springs as a water source since 1908. This shallow groundwater supply is now augmented with six (6) production wells.
- A seasonal *Groundwater Recharge* system augments flow in the collector system by pumping water from the Eramosa River to a pit and trenches. This water recharges the groundwater, making more water available for our use.

HOW MUCH WATER DO WE NEED?

Estimated Water Supply Capacity Projections

The City's water supply capacity (pumping) requirements are based on meeting peak day demand and providing system redundancy:

- **Peak Day Demand** is the maximum amount of water (m^3/day) consumed in a day; estimated as approximately 1.35 X Average Day Demand*
- **System Redundancy** is the amount of system capacity 'set aside' as contingency to allow for regular maintenance of existing water supply facilities, and to safeguard against unplanned events.
- **Average Day Demand** – is defined as the total annual volume of water consumed by residential + ICI (industrial, commercial, institutional) sectors + non-revenue water (flushing, hydrant testing, leakage) ÷ 365 days

Current water supply capacity requirement:

- average day demand = 45,000 m^3/day
- peak day demand + system redundancy = 5,000 X 1.5 = 67,500 m^3/day

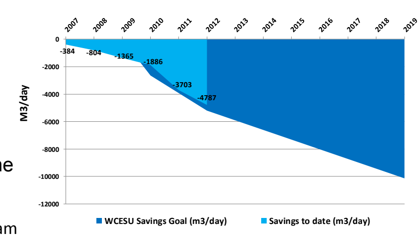
PROGRESS SINCE GUELPH'S 2007 WATER SUPPLY MASTER PLAN

CONSERVATION IS KEY!

Water Conservation and Demand Management Progress since 2007

- In May 2009, when Guelph City Council endorsed the ***Water Conservation and Efficiency Strategy*** they committed to:
  - Fund the development of a 10 year, $20 million Community Water Sustainability Strategy
  - Reduce water use by 8.7 Million Litres per Day (MLD) by 2019m
- By late 2011, the Strategy had been fully implemented, including the following Water Conservation Programs and Resources:

- Outside Water Use By-law/Program
- Toilet Rebate Program
- Clothes Water Rebate Program
- ICI Capacity Buyback Program
- Municipal Leak Detection Program
- In-School Education / Partner in Waterloo/Wellington Children's Water Festival
- Rainwater Harvesting Rebate Program
- Greywater Reuse Rebate Program
- Healthy Landscapes Program
- Blue Built Home Program
- City Facility Water Efficiency Upgrades & Demonstration Projects



Estimated Annual Savings vs. Annual Program Reduction Targets

We know it makes sense to use our water wisely. Since 2006, we've reduced our average daily water production by 12% , with Guelph residents now using 20% less water per person per day than the average Ontarian.

WATER SUPPLY STUDIES IN GUELPH AND AREA SINCE 2007

Guelph Tier 3 Water Budget and Local Area Risk Assessment

- Evaluated the sustainability of City of Guelph's water supply system from a quantity perspective
- Identified potential threats to sustainability
- Helps the City manage its reliable water supply system now and in future
- Provided an accurate model of Guelph's municipal aquifer system in and outside the City.

Guelph Drinking Water Source Protection Plan and Policies

- Developed policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants
- Ensures compliance with the Clean Water Act requirement to develop local and watershed based Source Protection Plans

New Supply & Treatment Projects

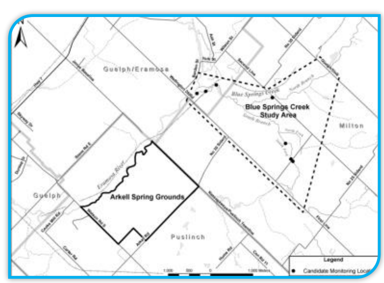
- Guelph Southwest Quadrant Water Supply Class EA
- Clythe Well Class EA
- Clythe and Helmar Treatability Assessment
- Clythe Well Rehabilitation and Assessment

Hydrogeological Investigations & Studies

- Smallfield and Sacco Production Wells – Well Rehabilitation and Hydrogeological Assessment
- Guelph South Groundwater Supply Investigation
- Arkell Spring Grounds – Hydrogeological Study in Support of a Caisson Collector System

NEW WATER SUPPLY INFRASTRUCTURE SINCE 2007

- Guelph constructed two new wells in 2011 to increase municipal supply. This was a key recommendation of the 2007 Water Supply Master Plan.
- The **Arkell Adaptive Management Plan** – which includes an Operational Testing Program and a Groundwater Monitoring Program – were launched in 2011 and will run until 2014.
    - These programs will ensure that water taking in the Arkell Spring Grounds is sustainable, while avoiding impacts on the Blue Spring Creek ecosystem (located 2 km Northeast of the Arkell Spring Grounds) and local domestic wells.



CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE
MAINTAINING A SAFE AND SUSTAINABLE SUPPLY TO 2038

WHY UPDATE GUELPH'S WATER SUPPLY MASTER PLAN?

Guelph is seeking to:

- Define how the City will get its safe and reliable water – for residential, industrial, commercial and institutional use – over the next 25 years.
- "Establish a sustainable water supply to regulate future growth."
  City of Guelph Council Resolution, October 20 2003
- Consider changes – since 2007 – to predicted population growth, available water supply, and the demand for water.

The City of Guelph is committed to managing population growth and developing strategies for ensuring an adequate water supply for now into the future.

Draft Problem / Opportunity Statement

Problem

- Recent analysis confirms that Guelph's existing water supply will not meet future demands. It is, therefore, prudent to update the previous Master Plan (2007) to identify strategies to increase the capacity of the City's water supply system.

Approach

- The strategies must ensure that an adequate amount of water is provided in a safe and cost-effective manner, while ensuring that environmental sustainability is not compromised. This update will build on the recommendations made during the 2007 Water Supply Master Plan, including those pertaining to additional sources of water supply and water conservation and efficiency measures.

Study Objective

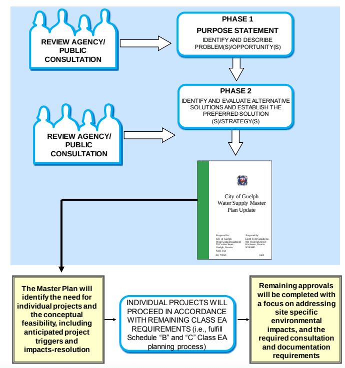
- The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. **The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers over the next 25 years.**

THE MUNICIPAL CLASS EA PROCESS AND OUR CONSULTATION PLAN

- The Water Supply Master Plan is being developed according to the Municipal Class Environmental Assessment process.
- There are many opportunities for public and review agency comments throughout the process.
- This Community Open House is one of two planned for this project. As well, three Community Liaison Committee meetings and two Municipality & Agency Workshops are planned.

Provide comments, stay involved, and help the City of Guelph ensure a sustainable supply of water for current and future uses!

Municipal Class EA Process



WHAT'S INVOLVED IN THE MASTER PLAN UPDATE?

- **Population Projection:** Guelph's population – including residential and industrial, commercial and institutional – will be projected to 2038.
- **Estimate Demand:** The City's demand for water over the next 25 years will be estimated.
- **Determine Need:** The amount of water the City's current water supply system can provide will be assessed, and compared to the estimated future demand for water.
- **Identify and Evaluate Alternatives:** Alternative sources of water, and ways to conserve supply and manage demand will be identified.
- **Develop Preferred Solution:** Short, mid and long-term recommendations will include implementation of defined projects.

Proposed Alternative Solutions

Demand Management and Conservation Programs	• Maintain commitment to conservation initiatives • Determine realistic conservation goals, and costs for program implementation • Develop means to measure effectiveness
Groundwater Sources In & Outside of City	• Restore lost capacity by making infrastructure improvements and optimizing existing well supplies • Restore existing wells with treatment • Identify new potential water supply areas
Local Surface Water Sources	• Establish feasibility / risks of surface water alternatives, including Aquifer Storage Recovery (ASR) • Assessment areas include: • Eramosa River • Guelph Lake
Do Nothing	• Consider no improvements or changes • Significant impact on the growth potential for the City is expected with this alternative

HOW THE PROPOSED ALTERNATIVES WILL 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 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

Economic and Financial Considerations

- Estimated capital costs
- Estimated operations and maintenance costs
- Impacts to agricultural operations and other private land owners

Legal and 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
- Water quality
- Allowance for future treatment needs
- Expandability
- Ability to respond to changes in regulations
- Ability to use existing infrastructure

STAY INFORMED AND ENGAGED!

Thank you for your interest in learning about the City of Guelph's Water Supply Master Plan update.

- Do you have any questions? Project team members are on hand to help.
- Ask any member of the project team. If we don't have the answer, we'll get it for you.
- There are many ways to stay informed:
    - Visit the Water Supply Master Plan update website at www.guelph.ca/water
    - Attend a Community Liaison Committee meeting
    - Join us at the next community Open House. Meeting dates will be advertised on our website and in local newspapers.

Be sure to drop off your Open House Feedback Form and Discussion Guide before you leave!

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE
OCTOBER 10, 2013
guelph.ca/water

CITY OF GUELPH

WATER SUPPLY MASTER PLAN UPDATE:

COMMUNITY OPEN HOUSE

Thank you for your interest in learning about the City of Guelph's Water Supply Master Plan update.

Display boards are setup around the room to explain:

- Guelph's current water supply,
- Progress since the 2007 Water Supply Master Plan
- How we are undertaking the Master Plan update

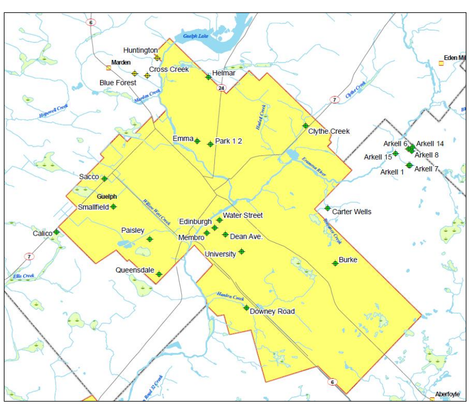
A presentation will be held at 7:00 pm to further explain the content of the display boards.

Feel free to read the display boards, ask questions of the project team, and listen to the presentation. We want to hear from you!

October 2013 guelph.ca/water

WHERE DO WE GET OUR WATER?

And how much water is there?



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- Guelph's current water supply is about 83,000 m^3/day
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Guelph Municipal Production Wells Capacity (m^3/day)

Northwest	Paisley	1,400
	Calico	1,100
	Queensdale	2,000
	Sacco	0
	Smallfield	0
Southwest	Membro	6,000
	Water	2,700
	Dean	1,500
	University	2,500
	Downey	5,100
	Edinburgh	0
Arkell Infiltration Galleries		6,900

Northeast	Park#1 Park#2	8,000
	Emma	2,800
	Helmar	1,500
	Clythe Creek	0
Southeast	Arkell 1	2,000
	Arkell 6	6,500
	Arkell 7	6,500
	Arkell 8	6,500
	Arkell 14	new
	Arkell 15	new
	Burke	6,500
	Carter-1 Carter-2	5,500

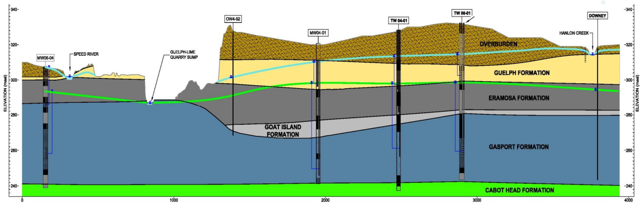
Ensuring that Guelph has enough water to support current and future needs is an important reason to update the 2007 Water Supply Master Plan.

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE
OCTOBER 10, 2013

guelph.ca/water

GUELPH'S WATER SUPPLY

A closer look at our groundwater supply



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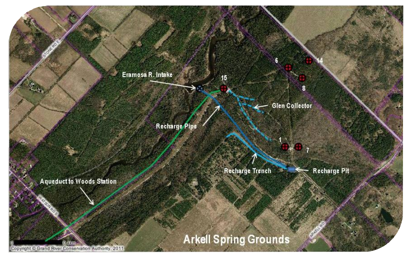


The Arkell Spring Grounds

- Natural springs discharge along the south side of the Eramosa River Valley; the City has used these springs as a water source since 1908. This shallow groundwater supply is now augmented with six (6) production wells.
- A seasonal *Groundwater Recharge* system augments flow in the collector system by pumping water from the Eramosa River to a pit and trenches. This water recharges the groundwater, making more water available for our use.

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE
OCTOBER 10, 2013

guelph.ca/water

HOW MUCH WATER DO WE NEED?

Estimated Water Supply Capacity Projections

The City's water supply capacity (pumping) requirements are based on meeting peak day demand and providing system redundancy:

- **Peak Day Demand** is the maximum amount of water (m^3/day) consumed in a day; estimated as approximately 1.35 X Average Day Demand*
- **System Redundancy** is the amount of system capacity 'set aside' as contingency to allow for regular maintenance of existing water supply facilities, and to safeguard against unplanned events.
- **Average Day Demand** – is defined as the total annual volume of water consumed by residential + ICI (industrial, commercial, institutional) sectors + non-revenue water (flushing, hydrant testing, leakage) ÷ 365 days

Current water supply capacity requirement:

- average day demand = 45,000 m^3/day
- peak day demand + system redundancy = 45,000 X 1.5 = 67,500 m^3/day

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE
OCTOBER 10, 2013

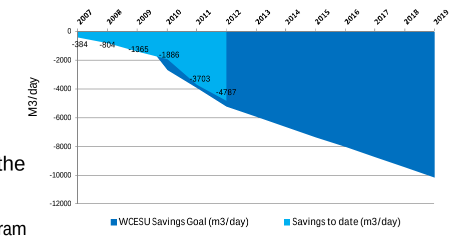
guelph.ca/water

CONSERVATION IS KEY!

Water Conservation and Demand Management Progress since 2007

- In May 2009, when Guelph City Council endorsed the ***Water Conservation and Efficiency Strategy*** they committed to:
  - Fund the development of a 10 year, $20 million Community Water Sustainability Strategy
  - Reduce water use by 8.7 Million Litres per Day (MLD) by 2019m
- By late 2011, the Strategy had been fully implemented, including the following Water Conservation Programs and Resources:

- Outside Water Use By-law/Program
- Toilet Rebate Program
- Clothes Water Rebate Program
- ICI Capacity Buyback Program
- Municipal Leak Detection Program
- In-School Education / Partner in Waterloo/Wellington Children's Water Festival
- Rainwater Harvesting Rebate Program
- Greywater Reuse Rebate Program
- Healthy Landscapes Program
- Blue Built Home Program
- City Facility Water Efficiency Upgrades & Demonstration Projects



Estimated Annual Savings vs. Annual Program Reduction Targets

We know it makes sense to use our water wisely. Since 2006, we've reduced our average daily water production by 12% , with Guelph residents now using 20% less water per person per day than the average Ontarian.

WATER SUPPLY STUDIES IN GUELPH AND AREA SINCE 2007

Guelph Tier 3 Water Budget and Local Area Risk Assessment

- Evaluated the sustainability of the City of Guelph's water supply system from a quantity perspective
- Identified potential threats to sustainability
- Helps the City manage its reliable water supply system now and in the future
- Provided an accurate model of Guelph's municipal aquifer system in and outside the City.

Guelph Drinking Water Source Protection Plan and Policies

- Developed policies to protect existing and future drinking water sources from unwanted impacts and harmful contaminants
- Ensures compliance with the Clean Water Act requirement to develop local and watershed based Source Protection Plans

New Supply & Treatment Projects

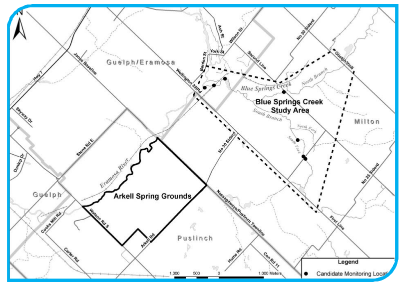
- Guelph Southwest Quadrant Water Supply Class EA
- Clythe Well Class EA
- Clythe and Helmar Treatability Assessment
- Clythe Well Rehabilitation and Assessment

Hydrogeological Investigations & Studies

- Smallfield and Sacco Production Wells – Well Rehabilitation and Hydrogeological Assessment
- Guelph South Groundwater Supply Investigation
- Arkell Spring Grounds – Hydrogeological Study in Support of a Caisson Collector System

NEW WATER SUPPLY INFRASTRUCTURE SINCE 2007

- Guelph constructed two new wells in 2011 to increase municipal supply. This was a key recommendation of the 2007 Water Supply Master Plan.
- The **Arkell Adaptive Management Plan** – which includes an Operational Testing Program and a Groundwater Monitoring Program – were launched in 2011 and will run until 2014.
  - These programs will ensure that water taking in the Arkell Spring Grounds is sustainable, while avoiding impacts on the Blue Spring Creek ecosystem (located 2 km Northeast of the Arkell Spring Grounds) and local domestic wells.



WHY UPDATE GUELPH'S WATER SUPPLY MASTER PLAN?

Guelph is seeking to:

- Define how the City will get its safe and reliable water – for residential, industrial, commercial and institutional use – over the next 25 years.
- "Establish a sustainable water supply to regulate future growth."
  City of Guelph Council Resolution, October 20 2003
- Consider changes – since 2007 – to predicted population growth, available water supply, and the demand for water.

The City of Guelph is committed to managing population growth and developing strategies for ensuring an adequate water supply for now into the future.

Draft Problem / Opportunity Statement

Problem

- Recent analysis confirms that Guelph's existing water supply will not meet future demands. It is, therefore, prudent to update the previous Master Plan (2007) to identify strategies to increase the capacity of the City's water supply system.

Approach

- The strategies must ensure that an adequate amount of water is provided in a safe and cost-effective manner, while ensuring that environmental sustainability is not compromised. This update will build on the recommendations made during the 2007 Water Supply Master Plan, including those pertaining to additional sources of water supply and water conservation and efficiency measures.

Study Objective

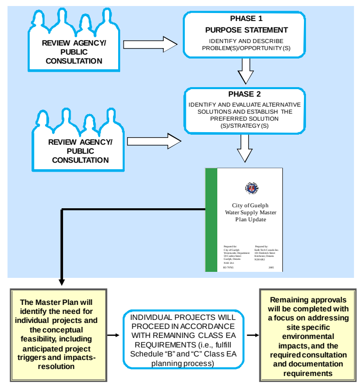
- The City of Guelph is committed to managing population growth as it continues to develop strategies for ensuring adequate water supply. The goal is to develop a reliable and sustainable supply of water to meet the current and future needs of all residents, industrial, commercial and institutional customers over the next 25 years.

THE MUNICIPAL CLASS EA PROCESS AND OUR CONSULTATION PLAN

- The Water Supply Master Plan is being developed according to the Municipal Class Environmental Assessment process.
- There are many opportunities for public and review agency comments throughout the process.
- This Community Open House is one of two planned for this project. As well, three Community Liaison Committee meetings and two Municipality & Agency Workshops are planned.

Provide comments, stay involved, and help the City of Guelph ensure a sustainable supply of water for current and future uses!

Municipal Class EA Process



WHAT'S INVOLVED IN THE MASTER PLAN UPDATE?

- **Population Projection:** Guelph's population – including residential and industrial, commercial and institutional – will be projected to 2038.
- **Estimate Demand:** The City's demand for water over the next 25 years will be estimated.
- **Determine Need:** The amount of water the City's current water supply system can provide will be assessed, and compared to the estimated future demand for water.
- **Identify and Evaluate Alternatives:** Alternative sources of water, and ways to conserve supply and manage demand will be identified.
- **Develop Preferred Solution:** Short, mid and long-term recommendations will include implementation of defined projects.

Proposed Alternative Solutions

Demand Management and Conservation Programs
- Maintain commitment to conservation initiatives
- Determine realistic conservation goals, and costs for program implementation
- Develop means to measure effectiveness

Groundwater Sources In & Outside of City
- Restore lost capacity by making infrastructure improvements and optimizing existing well supplies
- Restore existing wells with treatment
- Identify new potential water supply areas

Local Surface Water Sources
- Establish feasibility / risks of surface water alternatives, including Aquifer Storage Recovery (ASR)
- Assessment areas include:
  - Eramosa River
  - Guelph Lake

Do Nothing
- Consider no improvements or changes
- Significant impact on the growth potential for the City is expected with this alternative

HOW THE PROPOSED ALTERNATIVES WILL 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 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

Economic and Financial Considerations

- Estimated capital costs
- Estimated operations and maintenance costs
- Impacts to agricultural operations and other private land owners

Legal and 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
- Water quality
- Allowance for future treatment needs
- Expandability
- Ability to respond to changes in regulations
- Ability to use existing infrastructure

STAY INFORMED AND ENGAGED!

Thank you for your interest in learning about the City of Guelph's Water Supply Master Plan update.

- Do you have any questions? Project team members are on hand to help.
- Ask any member of the project team. If we don't have the answer, we'll get it for you.
- There are many ways to stay informed:
  - Visit the Water Supply Master Plan update website at www.guelph.ca/water
  - Attend a Community Liaison Committee meeting
  - Join us at the next community Open House. Meeting dates will be advertised on our website and in local newspapers.

Be sure to drop off your Open House Feedback Form and Discussion Guide before you leave!

THANK YOU FOR COMING!

We appreciate the time you took tonight to learn about Guelph's water supply system and the plans in the making!

To find out more about the project, visit guelph.ca/water and follow the Water Supply Master Plan link, or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
519-822-1260 extension 2186
dave.belanger@guelph.ca

Patty Quackenbush
Senior Project Engineer
AECOM
519-650-8691
patty.quackenbush@aecom.com

CITY OF GUELPH
WATER SUPPLY MASTER PLAN UPDATE:
COMMUNITY OPEN HOUSE
OCTOBER 10, 2013

guelph.ca/water

APPENDIX I: SURROUNDING COMMUNITIES CONSULTATION LETTERS

Kielstra, David

From: Peter.Busatto@guelph.ca
Sent: Thursday, September 26, 2013 11:10 AM
To: klandry@puslinch.ca
Cc: dennisl@wellington.ca; wstokley@puslinch.ca; Dave.Belanger@guelph.ca; Fisken, Avril; Kielstra, David; Quackenbush, Patricia
Subject: Notice of Upcoming Open House, City of Guelph Water Supply Master Plan Update
Attachments: Water Supply Master Plan Update Package..pdf

Hello Ms. Landry, please find attached a letter addressed to Mayor Lever and related correspondence containing information on our upcoming open house for the City's Water Supply Master Plan Update.

I apologize for not providing this information sooner. As discussed with you at our recent meeting, the project team would be available to update Puslinch Council at upcoming Council meetings at your convenience.

Please advise us of your wishes and we look forward to working together with you and residents of Puslinch on this important Study Update.

Sincerely,

Peter Busatto

Peter L. Busatto | General Manager, Guelph Water Services
Planning, Building, Engineering and Environment | Water Services
City of Guelph

T 519-837 -5627 x 2165 | F 519-822 -8837
E peter.busatto@guelph.ca

October 8, 2013

Ms. Karen Landry
CAO/Clerk Treasurer, Township of Puslinch
7404 Wellington Road #34
Guelph, ON
N1H 6H9

Dear Ms. Landry,

RE: Request to Delegate, City of Guelph Water Supply Master Plan Update

On September 24, 2013, Peter Busatto (Manager Waterworks) provided a letter to inform your Council of progress made to the City of Guelph's Water Supply Master Plan update, and to invite your Township staff, Council and interested residents to the upcoming Community Open House; scheduled for Thursday, October 10th from 6:00-8:30 pm in the County Chambers at Guelph City Hall. I sincerely hope to meet interested members of the Puslinch community there, and look forward to speaking with them about our plans.

This letter is to formally request to be a delegate at your upcoming Council meeting on October 16th, 2013. The intent of our presentation is to introduce Council and the Puslinch community to the Water Supply Master Plan update, inform you about our progress to date and next steps, and to answer any questions Council may have.

Enclosed you will find the presentation I propose to deliver to your Council. In place of the Request to Delegate form, I have provided our contact information below. A projector for the power point presentation is requested.

If you have any questions or require additional information, please contact me (dave.belanger@guelph.ca).

Sincerely,

D Belanger

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager

Guelph Waterworks
Environmental Services
Location: 29 Waterworks Place
T 519-822-1260 x 2186
F 519-822-8837
E dave.belanger@guelph.ca

C: Janet Laird, Peter Busatto/Guelph Water Services
Patty Quackenbush, Avril Fisken/AECOM

October 9, 2013

Mr. Chris White
Mayor, Township of Guelph/Eramosa
8348 Wellington Road 124
P.O. Box 700
Rockwood, ON
N0B 2K0

Dear Mayor White,

RE: Request to Delegate, City of Guelph Water Supply Master Plan Update

On October 1, 2013, Peter Busatto (Manager Waterworks) provided a letter to inform your Council of progress made to the City of Guelph's Water Supply Master Plan update, and to invite your Township staff, Council and interested residents to the upcoming Community Open House; scheduled for Thursday, October 10th from 6:00-8:30 pm in the County Chambers at Guelph City Hall. I sincerely hope to meet interested members of the Guelph/Eramosa Township community there, and look forward to speaking with them about our plans.

This letter is to formally request participation as a delegate at your upcoming Council meeting on October 21st, 2013. The intent of our presentation is to introduce Council and the Guelph/Eramosa Township community to the Water Supply Master Plan update, inform you about our progress to date and next steps, and to answer any questions that your Council may have.

Enclosed you will find the presentation I propose to deliver to your council. In place of the Delegation Request form, I have provided our contact information below as well as our presentation. A projector and laptop for the powerpoint presentation is requested.

If you have any questions or require additional information, please contact me at dave.belanger@guelph.ca.

Sincerely,

D Belanger

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager

Guelph Waterworks
Environmental Services
Location: 29 Waterworks Place
T 519-822-1260 x 2186
F 519-822-8837
E dave.belanger@guelph.ca

Incl. Council Presentation

CC: Janet Laird, Peter Busatto/ Guelph Water Services
Patty Quackenbush, Avril Fisken/ AECOM

August 13, 2013

Town of Milton
Chief Mario Belvedere, Administrative Officer
150 Mary Street
Milton ON
L9T 6Z5

Dear Chief Mario Belvedere:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

Our review will follow the requirements of a Municipal Class Environmental Assessment (Class EA) to identify constraints and opportunities related to our existing water supply system. We'll also evaluate and prioritize a number of individual projects to increase the capacity of our system. Some individual projects recommended in our Master Plan update – such as those that might have an environmental impact – will require individual approvals before we proceed with implementation. These projects will also follow the Class EA process.

There will be many opportunities for input on the update. **Two Community Open Houses** are planned to provide residents and other stakeholders with an opportunity to learn more about our water supply system and services, and to provide their thoughts on how Guelph can best maintain a sustainable water supply. A **Community Liaison Committee (CLC)** will provide guidance on key aspects of the Master Plan update and the Class EA.

Two meetings will also be held to bring agencies and municipal officials together, providing a forum to discuss plans for the updated Guelph WSMP and to gather input. We are tentatively scheduling our first meeting for mid to late September 2013 and are interested in hearing from you regarding your availability; please indicate your interest in attending and any scheduling constraints by emailing David Kielstra at david.kielstra@aecom.com. We will follow up closer to the planned session date with a formal invite and a proposed agenda.

If you have any questions prior to the planned meetings, please contact either Patty Quackenbush at (519) 650-8691, or myself at (519) 822-1260 x 2186. We would be happy to hear from you.

Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

CITY OF Guelph
Making a Difference

Sent VIA Email Only

September 24, 2013

Mr. Dennis Lever
Mayor, Township of Puslinch
7404 Wellington Road #34
Guelph, ON
N1H 6H9

Dear Mayor Lever,

RE: Upcoming Open House, City of Guelph Water Supply Master Plan Update

The City of Guelph Water Supply Master Plan update is underway, and I am pleased to inform you and the Township of Puslinch Council that **our first Community Open House is scheduled for Thursday, October 10th from 6:00 to 8:30 pm in the Council Chambers at Guelph City Hall**. Attached to this letter is a copy of the notification to be published in the Milton Canadian Champion and the Guelph Tribune on September 26th, and in the Wellington-Advertiser on September 27th.

Community input is an essential part of the Water Supply Master Plan update process. We know people care about where their water comes from, and that they want to maintain a safe and sustainable supply for present and future generations. This Community Open House – the first of two – is an opportunity to discuss plans and progress around Guelph's Water Supply Master Plan update with residents from Guelph, the Townships and the County. We'd love to see Puslinch community members there! We invite you, your Council, and any other interested individuals to attend the meeting, ask questions directly to the project team members, and provide feedback.

We're making it easy for people to get involved. On September 17, 2013 we held our first Community Liaison Committee (CLC) meeting to familiarize members with our current water supply system, and the improvements and water conservation activities completed since the 2007 Water Supply Master Plan. We also discussed the progress to date related to the Water Supply Master Plan update. As a reminder, the CLC includes members from a wide cross-section of the community including residents, community groups, local government and business leaders. Thank you for nominating Councillor Wayne Stokley as Puslinch Township's Committee representative.

On September 19, 2013, we also held the first Municipality/Agency meeting to inform government and approval agency representatives of our plans and to receive their input. Mayor Dennis Lever and Ms. Karen Landry CAO/Clerk of Puslinch Township both attended this meeting and provided valuable input to the discussions.

City Hall
1 Carden St
Guelph, ON
Canada
N1H 3A1

T 519-822-1260
TTY 519-826-9771

guelph.ca

Since our project team's last correspondence with you, (June 12, 2013), we have been reviewing Guelph's current water supply system, and assessing historical and current water supply demands – by sector – to help forecast future needs. In investigating new water supply options – like new groundwater sources in and outside of the City and local surface water sources – the project team will consider the quality and quantity of the water source, the potential impacts on the environment and on existing water supplies, and all relevant regulations. Regardless of source, Guelph's 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. In keeping with the 2007 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 neighbouring Townships.

Today, the City's existing water supply system fulfills our commitment to provide a safe and sustainable supply of water. The 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 closing, we would be happy to update you and your Council at your next Council meeting (i.e., October 16, 2013) as a delegate to answer any questions you might have. I will follow up with Ms. Landry after your October 2, 2013 Council meeting to confirm that our attendance is of value to you.

In the meantime, if you have any questions please contact either Dave Belanger (dave.belanger@guelph.ca) or Patty Quackenbush (patty.quackenbush@aecom.com). Please also see the attached discussion guide and slides from the Municipality / Agency meeting for more information on our community engagement efforts to date.

Sincerely,

Peter Busatto
Manager Waterworks
Environmental Services, City of Guelph
T 519-837-5627 x 2165
E peter.busatto@guelph.ca

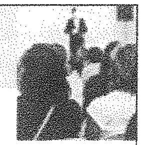
Incl.

Notification of Community Open House

Discussion Guide

Municipality/Agency Meeting Slides

PUBLIC NOTICE



City of Guelph Water Supply Master Plan Update

Community Open House #1

The City of Guelph is updating its Council-approved **Water Supply Master Plan** to define how we will continue to access a sustainable supply of water—for residential and industrial use—over the next 25 years.

Reviewing our existing water supply system is an opportunity to discuss with the community 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.

Our review will follow 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 either increase the capacity of our existing system or to reduce our demand for water.

You're invited to attend

You're invited to attend the first Community Open House to learn more about the Water Supply Master Plan update. The Open House will run from 6–8:30 p.m. You're welcome to drop–in anytime during the open house. A short presentation and a question and answer session will run from 7–7:30 p.m. Project team members will be on-hand to discuss any questions or comments that you may have.

Thursday, October 10

6–8:30 p.m.
Council Chambers, City Hall
1 Carden Street

To find out more about the project, visit **guelph.ca/water** and follow the Water Supply Master Plan link, or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T **519-822-1260 x 2186**
E **dave.belanger@guelph.ca**

Patty Quackenbush
Senior Project Engineer
AECOM
T **519-650-8691**
E **patty.quackenbush@aecom.com**

City of Guelph
Making a Difference

August 13, 2013

Township of Puslinch
Karen Landry
7404 Wellington Road #34
Guelph ON
N1H 6H9

Dear Karen Landry:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

Our review will follow the requirements of a Municipal Class Environmental Assessment (Class EA) to identify constraints and opportunities related to our existing water supply system. We'll also evaluate and prioritize a number of individual projects to increase the capacity of our system. Some individual projects recommended in our Master Plan update – such as those that might have an environmental impact – will require individual approvals before we proceed with implementation. These projects will also follow the Class EA process.

There will be many opportunities for input on the update. **Two Community Open Houses** are planned to provide residents and other stakeholders with an opportunity to learn more about our water supply system and services, and to provide their thoughts on how Guelph can best maintain a sustainable water supply. A **Community Liaison Committee (CLC)** will provide guidance on key aspects of the Master Plan update and the Class EA.

Two meetings will also be held to bring agencies and municipal officials together, providing a forum to discuss plans for the updated Guelph WSMP and to gather input. We are tentatively scheduling our first meeting for mid to late September 2013 and are interested in hearing from you regarding your availability; please indicate your interest in attending and any scheduling constraints by emailing David Kielstra at david.kielstra@aecom.com. We will follow up closer to the planned session date with a formal invite and a proposed agenda.

If you have any questions prior to the planned meetings, please contact either Patty Quackenbush at (519) 650-8691, or myself at (519) 822-1260 x 2186. We would be happy to hear from you.

Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Guelph / Eramosa Township
Ms. Janice Sheppard, CAO
8348 Wellington Road 124
P.O. Box 700
Rockwood ON
N0B 2K0

Dear Ms. Janice Sheppard:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

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There will be many opportunities for input on the update. **Two Community Open Houses** are planned to provide residents and other stakeholders with an opportunity to learn more about our water supply system and services, and to provide their thoughts on how Guelph can best maintain a sustainable water supply. A **Community Liaison Committee (CLC)** will provide guidance on key aspects of the Master Plan update and the Class EA.

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If you have any questions prior to the planned meetings, please contact either Patty Quackenbush at (519) 650-8691, or myself at (519) 822-1260 x 2186. We would be happy to hear from you.

Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

County of Wellington
Mr. Scott Wilson, CAO
74 Woolwich Street
Guelph ON
N1H 3T9

Dear Mr. Scott Wilson:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan (WSMP) to define how the City will continue to access a sustainable supply of water over the next 25 years. This update will follow the requirements of the Municipal Class Environmental Assessment (Class EA).

As we begin this process, we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

Our review will follow the requirements of a Municipal Class Environmental Assessment (Class EA) to identify constraints and opportunities related to our existing water supply system. We'll also evaluate and prioritize a number of individual projects to increase the capacity of our system. Some individual projects recommended in our Master Plan update – such as those that might have an environmental impact – will require individual approvals before we proceed with implementation. These projects will also follow the Class EA process.

There will be many opportunities for input on the update. **Two Community Open Houses** are planned to provide residents and other stakeholders with an opportunity to learn more about our water supply system and services, and to provide their thoughts on how Guelph can best maintain a sustainable water supply. A **Community Liaison Committee (CLC)** will provide guidance on key aspects of the Master Plan update and the Class EA.

Two meetings will also be held to bring agencies and municipal officials together, providing a forum to discuss plans for the updated Guelph WSMP and to gather input. We are tentatively scheduling our first meeting for mid to late September 2013 and are interested in hearing from you regarding your availability; please indicate your interest in attending and any scheduling constraints by emailing David Kielstra at david.kielstra@aecom.com. We will follow up closer to the planned session date with a formal invite and a proposed agenda.

If you have any questions prior to the planned meetings, please contact either Patty Quackenbush at (519) 650-8691, or myself at (519) 822-1260 x 2186. We would be happy to hear from you.

Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

Sent Via Email

October 1, 2013

Mr. Chris White
Mayor, Township of Guelph/Eramosa
8348 Wellington Road 124
P.O. Box 700
Rockwood, ON
N0B 2K0

Dear Mayor White,

RE: Upcoming Open House, City of Guelph Water Supply Master Plan Update

The City of Guelph is updating its Council-approved Water Supply Master Plan to define how the City will continue to access a sustainable supply of water—for residential, and industrial, commercial and institutional (ICI) use—over the next 25 years. I'm pleased to inform you and the Township of Guelph/Eramosa Council that **our first Community Open House is scheduled for Thursday, October 10th from 6:00 to 8:30 pm in the Council Chambers at Guelph City Hall**. Attached to this letter is a copy of the notification to be published in the Milton Canadian Champion and the Guelph Tribune on September 26th, and in the Wellington-Advertiser on September 27th.

Community input is an essential part of the Water Supply Master Plan update process. We know people care about where their water comes from, and that they want to maintain a safe and sustainable supply for present and future generations. This Community Open House – the first of two – is an opportunity to discuss plans and progress around Guelph's Water Supply Master Plan update with residents from Guelph, the Townships and the County. We'd love to see Guelph-Eramosa community members there! We invite you, your Council, and any other interested individuals to attend the meeting, ask questions directly to the project team members, and provide feedback.

Today, our existing water supply fulfills the City's commitment to provide a safe and reliable supply of water, but as our population and ICI base grows, so will the demand for a sustainable supply. In updating the Water Supply Master Plan, we'll carefully consider Guelph's plans for growth, and will confirm that our demand management and water supply recommendations meet the needs of the community today and into the future.

Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. When investigating existing and new water supply options – like new groundwater sources in and outside

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of the city and local surface water sources—we'll consider the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations. Regardless of source, Guelph's 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. In keeping with the 2007 Water Supply Master Plan, any development of water supply options outside of the city will only be considered with the cooperation and participation of the County and the relevant Township.

Conservation is key! In Guelph—like the surrounding area—we depend mostly on groundwater for our water supply so we know it makes sense to use water wisely. Conservation and demand management are critical components of this Master Plan update. 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 per capita water use by nine per cent—meaning that we now use about 20 per cent less water in Guelph than the average person in Ontario.

Our review is following the requirements of a Municipal Class Environmental Assessment (Class EA.) When we are finished—after our Water Supply Master Plan Update is reviewed by Guelph and area communities, 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 system. Some individual projects recommended in our Master Plan Update—like those that might have an environmental impact—will require additional work and community consultation before they can be approved for implementation. These projects will also follow the Class EA process.

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 and the Townships to be involved and kept up-to-date on our progress. On September 17, 2013 we held our first Community Liaison Committee (CLC) meeting to familiarize members with our current water supply system, and the improvements and water conservation activities completed since the 2007 Water Supply Master Plan. We also discussed the progress to date related to the Water Supply Master Plan update. The Water Supply Master Plan CLC is made up of close to 20 people with membership drawn from a cross-section of the community so as to provide a broad and balanced perspective.

On September 19, 2013, we also held the first Municipality/Agency meeting to inform government and approval agency representatives of our plans and to receive their input. Mayor Chris White and Mr. Rod McClure, Acting Manager of Public Works for Guelph/Eramosa Township both attended this meeting and provided valuable input to the discussions.

In closing, we would be happy to update you and your Council at your next Council meeting (i.e., October 21st) as a delegate and answer any questions you might have. I will follow up with your Chief Administrative Officer Ms. Sheppard after your October 7, 2013 Council meeting to confirm that our attendance is of value to you.

In the meantime, if you have any questions please contact either Dave Belanger (dave.belanger@guelph.ca) or Patty Quackenbush (patty.quackenbush@aecom.com). Please also see the attached discussion guide and slides from the recent Municipality /Agency meeting for more information on our community engagement efforts to date. In the meantime, if you have any questions please contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T 519-822-1260 x 2186
E dave.belanger@guelph.ca

Patty Quackenbush
Senior Project Manager
AECOM
T 519-650-8691
E patty.quackenbush@aecom.com

Sincerely,

Peter L. Busatto
General Manager, Guelph Water Services Department
Planning, Building, Engineering and Environment
T 519-837-5627 x 2165
E peter.busatto@guelph.ca

Incl.
Notification of Community Open House
Discussion Guide
Municipality/Agency Meeting Slides

C: Dave Belanger, Janet Laird, Guelph
Patty Quackenbush, Avril Fisken/AECOM

April 23, 2014

Mayor Dennis Lever
Township of Puslinch
7404 Wellington Road #34
Guelph, ON
N1H 6H9

Dear Mayor Lever,

RE: Upcoming Open House, City of Guelph Water Supply Master Plan Update

Thank you for attending the April 7, 2014 Agency / Municipality meeting for the Guelph Water Supply Master Plan Update, along with Karen Landry. Our team is pleased to have active participation from the Township of Puslinch, and welcomes the opportunity to share the City's plans for maintaining a safe and sustainable water supply for present and future generations.

Our **2nd Community Open House** is fast approaching, and we'd like to see Puslinch community members there. We believe that community input is an essential part of the Water Supply Master Plan update process, so please join us on **Tuesday April 29, 2014 from 6:00 to 8:30 pm in the Council Chambers at Guelph City Hall.**

We know people care about where their water comes from. This Community Open House—the second of two—is an opportunity to discuss plans and progress around Guelph's Water Supply Master Plan update with residents from Guelph, the Townships and the County. We invite you, your Council, and any other interested individuals to attend the meeting, ask questions directly of the project team members, and provide feedback.

Reviewing our existing water supply system is an opportunity for community discussion about how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect. To date, the Water Supply Master Plan project team has estimated how much water Guelph will need up until 2038, and has compared that to how much water our current system can supply. With this information in mind, and using established evaluation criteria, the project team has identified potential water supply alternatives to ensure an adequate supply of water into the future. Feedback from Guelph and surrounding communities will provide valuable insight into the work to date and will help inform decision making around our water supply.

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1 Carden St
Guelph, ON
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T 519-822-1260
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Our review is following 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 and area communities and approved by Council—we will have identified constraints and opportunities related to our existing water supply system. The input provided at this community open house will help the team develop the preferred water supply alternatives and implementation strategy. In keeping with the 2007 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 neighbouring Townships.

In closing, we would be happy to update you and your Council—as we did previously—at your next Council meeting (i.e., May 7, 2014) as a delegate. I can follow up with Ms. Landry to confirm details if our attendance is of value to you.

In the meantime, if you have any questions please contact either Dave Belanger (dave.belanger@guelph.ca) or Patty Quackenbush (patty.quackenbush@aecom.com).

Sincerely,

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager

Guelph Waterworks
Environmental Services
Location: 29 Waterworks Place
T 519-822-1260 x 2186
F 519-822-8837
E dave.belanger@guelph.ca

CC: Janet Laird, Peter Busatto/ Guelph Water Services
Patty Quackenbush, Avril Fisken/ AECOM

CITY OF Guelph
Making a Difference

April 23, 2014

Mayor Chris White
Township of Guelph/Eramosa
8348 Wellington Road 124
P.O. Box 700
Rockwood, ON
N0B 2K0

Dear Mayor White,

RE: Upcoming Open House, City of Guelph Water Supply Master Plan Update

Thank you for attending the April 7, 2014 Agency / Municipality meeting for the Guelph Water Supply Master Plan Update along with Kimberly Wingrove. Our team is pleased to have active participation from the Township of Guelph/Eramosa, and welcomes the opportunity to share the City's plans for maintaining a safe and sustainable water supply for present and future generations.

Our **2nd Community Open House** is fast approaching, and we'd like to see Guelph/Eramosa community members there. We believe that community input is an essential part of the Water Supply Master Plan update process, so please join us on **Tuesday April 29, 2014 from 6:00 to 8:30 pm in the Council Chambers at Guelph City Hall.**

We know people care about where their water comes from. This Community Open House—the second of two—is an opportunity to discuss plans and progress around Guelph's Water Supply Master Plan update with residents from Guelph, the Townships and the County. We invite you, your Council, and any other interested individuals to attend the meeting, ask questions directly of the project team members, and provide feedback.

Reviewing our existing water supply system is an opportunity for community discussion about how best to manage this vital supply so that we continue to provide the high level of service Guelph residents have come to expect. To date, the Water Supply Master Plan project team has estimated how much water Guelph will need up until 2038, and has compared that to how much water our current system can supply. With this information in mind, and using established evaluation criteria, the project team has identified potential water supply alternatives to ensure an adequate supply of water into the future. Feedback from Guelph and surrounding

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communities will provide valuable insight into the work to date and will help inform decision making around our water supply.

Our review is following 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 and area communities and approved by Council—we will have identified constraints and opportunities related to our existing water supply system. The input provided at this community open house will help the team develop the preferred water supply alternatives and implementation strategy. In keeping with the 2007 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 neighbouring Townships.

In closing, we would be happy to update you and your Council – as we did previously - at your next Council meeting (i.e., May 5, 2014) as a delegate to answer any questions you might have. We can follow up with Ms. Wingrove to confirm details if our attendance is of value to you.

In the meantime, if you have any questions please contact either Dave Belanger (dave.belanger@guelph.ca) or Patty Quackenbush (patty.quackenbush@aecom.com).

Sincerely,

Dave Belanger, M.Sc., P.Geo.
Water Supply Program Manager

Guelph Waterworks
Environmental Services
Location: 29 Waterworks Place
T 519-822-1260 x 2186
F 519-822-8837
E dave.belanger@guelph.ca

CC: Janet Laird, Peter Busatto/ Guelph Water Services
Patty Quackenbush, Avril Fisken/ AECOM

APPENDIX J: ABORIGINAL CONSULTATION LETTERS

August 13, 2013

Ministry of Aboriginal Affairs
Consultation Unit, Aboriginal Relations and Ministry Partnerships Division
160 Bloor Street East
4th Floor
Toronto, Ontario
M7A 2E6

Dear Ms. Heather Levesque:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan to define how the City will continue to access a sustainable supply of water over the next 25 years. As we begin our review of the existing water supply system we want to provide your agency and interested aboriginal communities with some initial information about the study.

Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

Our review will follow the requirements of a Municipal Class Environmental Assessment (Class EA). When we are finished, 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 system. Some individual projects recommended in our Master Plan update – such as those that might have an environmental impact – will require additional work and community consultation before they can be approved for implementation. These projects will also follow the Class EA process.

There will be many opportunities for input on the project. Two Community Open Houses and two municipality & agency meetings are planned so that people can learn more about our water supply system and services, and provide their thoughts on how Guelph can best maintain a sustainable water supply. We are also establishing a Community Liaison Committee to provide guidance on key aspects of the Master Plan Update and the Class EA.

To ensure that aboriginal interests and concerns are taken into consideration and addressed, we will notify those communities that might have an interest in the update of the timing of future open houses and meetings. Currently, we plan to provide information to the Six Nations of the Grand River First Nation and the Mississaugas of the New Credit First Nation. **Please confirm that these communities are the most appropriate for consultation, and also identify any other interested communities or groups.**

Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

August 13, 2013

Aboriginal Affairs and Northern Development Canada
Consultation and Accommodation Unit
10 Wellington, North Tower
Gatineau, Quebec
Postal Address: Ottawa, Ontario
K1A 0H4

To whom it may concern:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan to define how the City will continue to access a sustainable supply of water over the next 25 years. As we begin our review of the existing water supply system we want to provide your agency and interested aboriginal communities with some initial information about the study.

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Sincerely,

Dave Belanger, M.Sc., P.Geo., Water Supply Program Manager

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

Ministry of Aboriginal Affairs

160 Bloor St. East, 9th Floor
Toronto, ON M7A 2E6
Tel: (416) 326-4740
Fax: (416) 325-1066
www.aboriginalaffairs.gov.on.ca

Ministère des Affaires Autochtones

160, rue Bloor Est, 9e étage
Toronto ON M7A 2E6
Tél. : (416) 326-4740
Téléc. : (416) 325-1066
www.aboriginalaffairs.gov.on.ca

Ontario

Reference: EA #
2013-0012

September 11th, 2013

Dave Belanger
Water Supply Program Manager
Water Services,
29 Waterworks Place,
Guelph, ON, N1E 6P7

Re: Notice of Study Commencement-Guelph Water Supply Master Plan Update/Class Environmental Assessment

Dear Mr. Belanger:

Thank you for informing the Ministry of Aboriginal Affairs (MAA) of your project. Please note that MAA treats all letters, emails, general notices, etc. about a project as a request for information about which Aboriginal communities may have rights or interests in the project area.

As a member of the government review team, the Ministry of Aboriginal Affairs (MAA) identifies First Nation and Métis communities who may have the following interests in the area of your project:

- reserves;
- land claims or claims in litigation against Ontario;
- existing or asserted Aboriginal or treaty rights, such as harvesting rights; or
- an interest in the area of the project.

MAA is not the approval or regulatory authority for your project, and receives very limited information about projects in the early stages of their development. In circumstances where a Crown-approved project may negatively impact a claimed Aboriginal or treaty right, the Crown may have a duty to consult the Aboriginal community advancing the claim. The Crown often delegates procedural aspects of its duty to consult to proponents. Please note that the information in this letter should not be relied on as advice about whether the Crown owes a duty to consult in respect of your project, or what consultation may be appropriate. Should you have any questions about your consultation obligations, please contact the appropriate ministry.

You should be aware that many First Nations and/or Métis communities either have or assert rights to hunt and fish in their traditional territories. For First Nations, these territories typically include lands and waters outside of their reserves.

In some instances, project work may impact aboriginal archaeological resources. If any Aboriginal archaeological resources could be impacted by your project, you should contact your regulating or approving Ministry to inquire about whether any additional Aboriginal communities should be contacted. Aboriginal communities with an interest in archaeological resources may include communities who are not presently located in the vicinity of the proposed project.

With respect to your project, and based on the brief materials you have provided, we can advise that the project appears to be located in an area where First Nations may have existing or asserted rights or claims in Ontario's land claims process or litigation, that could be impacted by your project. Contact information is below:

Mississaugas of the New Credit First Nation 2789 Mississauga Rd., R.R. #6 HAGERSVILLE, Ontario N0A 1H0	Chief Bryan LaForme (905) 768-1133 (Fax) 768-1225 bryanlaforme@newcreditfirstnation.com
Six Nations of the Grand River Territory P.O. Box 5000, 1695 Chiefswood Road OHSWEKEN, Ontario N0A 1M0	Chief William K. Montour (519) 445-2201 (Fax) 445-4208 wkm@sixnations.ca arleenmaracle@sixnations.ca
Haudenosaunee Confederacy Chiefs Council 2634 6th Line Road RR 2 Ohsweken, Ontario N0A 1M0	Hohahes Leroy Hill Secretary to Haudenosaunee Confederacy Chiefs Council Cell 519 717 7326

The information upon which the above comments are based is subject to change. First Nation or Métis communities can make claims at any time, and other developments can occur that could result in additional communities being affected by or interested in your undertaking.

Through Aboriginal Affairs and Northern Development (AANDC), the Government of Canada sometimes receives claims that Ontario does not receive, or with which Ontario does not become involved. AANDC's Consultation and Accommodation Unit (CAU) established a "single window" to respond to requests for baseline information held by AANDC on established or potential Aboriginal Treaty and rights. To request information from the Ontario Subject Matter Expert send an email to: UCA-CAU@aadnc-aandc.gc.ca

Additional details about your project or changes to it that suggest impacts beyond what you have provided to date may necessitate further consideration of which Aboriginal communities may be affected by or interested in your undertaking. If you think that further consideration may be required, please bring your inquiry to whatever government body oversees the regulatory process for your project. MAA does not wish to be kept informed of the progress of the project; please be sure to remove MAA from the mailing list.

Yours truly,

Heather Levecque
Manager, Consultation Unit
Aboriginal Relations and Ministry Partnerships Division

Letterhead

August 13, 2013

Six Nations of the Grand River
William Montour, Chief
P.O. Box 5000
Ohsweken ON
N0A 1M0

Dear Chief William Montour:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan to define how the City will continue to access a sustainable supply of water – for residential, and industrial, commercial and institutional (ICI) use – over the next 25 years.

As we begin our review of the existing water supply system we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

Conservation is key! In Guelph we depend mostly on groundwater for our water supply so we know it makes sense to use water wisely. Conservation and demand management are critical components of this Master Plan update. 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 per capita water use by nine per cent – meaning that we now use about 20 percent less water in Guelph than the average person in Ontario.

Our review will follow the requirements of a Municipal Class Environmental Assessment (Class EA). When we are finished – after our Water Supply Master Plan update is reviewed by Guelph and area communities, 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 system. Some individual projects recommended in our Master Plan update – such as those that might have an environmental impact – will require additional work and community consultation before they can be approved for implementation. These projects will also follow the Class EA process.

We want people to join the conversation! There will be many opportunities for input on the project. Two Community Open Houses and two municipality & agency meetings are planned so that people can learn more about our water supply system and services, and provide their thoughts on how Guelph can best maintain a sustainable water supply. We are also establishing a Community Liaison Committee to help us understand what's important and to provide guidance on key aspects of the Master Plan Update and the Class EA.

Should you have any questions about the City's Water Supply Master Plan Update, please visit www.guelph.ca/water or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T 519-822-1260 x 2186
E dave.Belanger@guelph.ca

Patty Quackenbush
Senior Project Manager
AECOM
T 519-650-8691
E patty.quackenbush@aecom.com

We look forward to additional opportunities to discuss this project with you.

Sincerely,

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

T **519-822-1260 x 2186**
F 519-822-8837
E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

Letterhead

August 13, 2013

Mississaugas of the New Credit First Nation
Chief Bryan LaForme
2789 Mississauga Road
RR #6
Hagersville ON
N0A 1H0

Dear Chief Bryan LaForme:

RE: Notice of Commencement – Guelph Water Supply Master Plan Update/Class Environmental Assessment

The City of Guelph is updating its Council-approved Water Supply Master Plan to define how the City will continue to access a sustainable supply of water – for residential, and industrial, commercial and institutional (ICI) use – over the next 25 years.

As we begin our review of the existing water supply system we want to provide you with some initial information about the study. Our updated Master Plan will provide short-term, mid-term and long-term water supply options to meet Guelph's predicted demand for water. 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 the quality and quantity of the water source, the potential impacts on the environment or on existing water supplies, and all relevant regulations.

Conservation is key! In Guelph we depend mostly on groundwater for our water supply so we know it makes sense to use water wisely. Conservation and demand management are critical components of this Master Plan update. 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 per capita water use by nine per cent – meaning that we now use about 20 percent less water in Guelph than the average person in Ontario.

Our review will follow the requirements of a Municipal Class Environmental Assessment (Class EA). When we are finished – after our Water Supply Master Plan update is reviewed by Guelph and area communities, 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 system. Some individual projects recommended in our Master Plan update – such as those that might have an environmental impact – will require additional work and community consultation before they can be approved for implementation. These projects will also follow the Class EA process.

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Should you have any questions about the City's Water Supply Master Plan Update, please visit www.guelph.ca/water or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T 519-822-1260 x 2186
E dave.Belanger@guelph.ca

Patty Quackenbush
Senior Project Manager
AECOM
T 519-650-8691
E patty.quackenbush@aecom.com

We look forward to additional opportunities to discuss this project with you.

Sincerely,

Water Services
29 Waterworks Place
Guelph ON N1E 6P7

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E **dave.belanger@guelph.ca**

CC: Peter Busatto, Janet Laird, Laura Mousseau/Guelph
Patty Quackenbush, Avril Fisken/AECOM

Kielstra, David

From: CAU-UCA [CAU-UCA@aadnc-aandc.gc.ca]
Sent: Friday, September 27, 2013 10:45 AM
To: Kielstra, David
Subject: Re: Public Notice – City of Guelph Water Supply Master Plan Update

Follow Up Flag: Follow up
Flag Status: Completed

Hello Project Leadership,

I am writing on behalf of the Consultation and Accommodation Unit (CAU) of Aboriginal Affairs and Northern Development Canada (AANDC).

As a rule, AANDC officials do not participate in environmental assessments that pertain to projects off-reserve, nor does the department track how other parties carry out their EAs. Therefore, in future please omit AANDC officials from your public information notification for projects that do not intersect with reserve land. This information has been relayed to the Ministry of Environment, and their contact list will be updated.

If you are contacting AANDC to request Aboriginal consultation information (community information, claims and assertions), please reply and I will be happy to provide it. The CAU's Consultation Information Service (CIS) has been established as a 'single window approach' to help co-ordinate departmental responses to consultation-related queries coming from federal departments and third parties. We provide information (based on a buffer size of your choice around a project) related to Aboriginal groups and their asserted or established Aboriginal and/or treaty rights and claims, to the extent that these are known by AANDC.

Future requests for Aboriginal consultation information from AANDC, can be submitted directly to the following mailbox: UCA-CAU@aadnc-aandc.gc.ca. To facilitate a more timely response, use the following subject heading in your e-mail: request for 'Aboriginal consultation information'. If you do not require this information from the CAU, please remove us from your notification mailing list.

Kind regards,

Lisa L. Patterson
Regional Subject Expert for Ontario / Consultation & Accommodation Unit / AANDC HQ //
Phone: (819) 934-3696 / E-mail: Lisa.Patterson@aadnc-aandc.gc.ca

>>> "Kielstra, David" <David.Kielstra@aecom.com> 9:46 AM Friday, September 27, 2013 >>>
Good morning,

The City of Guelph is updating its Council-approved Water Supply Master Plan to define how we will continue to access a sustainable supply of water—for residential and industrial use—over the next 25 years.

Reviewing our existing water supply system is an opportunity to discuss with the community 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.

Our review will follow 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 either increase the capacity of our existing system or to reduce our demand for water.

You're Invited to Attend

You're invited to attend the first Community Open House on October 10, 2013 to learn more about the Water Supply Master Plan update. The Open House will run from 6:00 pm to 8:30 pm – you're welcome to drop–in anytime. A short presentation and Question & Answer session is also planned from 7:00 to 7:30 pm. Project team members will be on-hand to discuss any questions or comments that you may have.

Date: Thursday October 10, 2013
Room: City Hall Council Chambers
Location: Guelph City Hall
1 Carden Street
Guelph, ON
N1H 3A1
Time: 6:00 p.m. to 8:30 p.m.

To find out more about the project, visit guelph.ca/water and follow the Water Supply Master Plan link, or contact:

Dave Belanger
Water Supply Program Manager
City of Guelph
T: 519-822-1260 x 2186
E: dave.Belanger@guelph.ca

Patty Quackenbush
Senior Project Manager
AECOM
T: 519-650-8691
E: patty.quackenbush@aecom.com

Thank you,

Dave Kielstra
AECOM
On behalf of the Water Supply Master Plan update project team.

Kielstra, David

From: Dave Kielstra [dkielstra@gmail.com]
Sent: Wednesday, September 04, 2013 4:03 PM
To: Kielstra, David
Subject: Fwd: FW: Consultation re Guelph Water Supply Master Plan

---------- Forwarded message ----------
From: "Fisken, Avril" <Avril.Fisken@aecom.com>
Date: Sep 4, 2013 3:50 PM
Subject: FW: Consultation re Guelph Water Supply Master Plan
To: "Dave Kielstra (dkielstra@gmail.com)" <dkielstra@gmail.com>

See below.

Avril Fisken, M.Sc.
Senior Communications & Engagement Consultant
Impact Assessment & Planning Leader, Guelph Office
D: 519-840-2260, M: 519-546-8454
avril.fisken@aecom.com

AECOM
55 Wyndham Street North, Suite 215
Guelph, ON N1H 7T8
T. 519.763.7783 F. 519.763.1668
www.aecom.com

From: Dave.Belanger@guelph.ca [mailto:Dave.Belanger@guelph.ca]
Sent: Tuesday, September 03, 2013 9:09 PM
To: Fisken, Avril; Quackenbush, Patricia
Subject: FW: Consultation re Guelph Water Supply Master Plan

FYI

From: Lisa Patterson [Lisa.Patterson@aadnc-aandc.gc.ca]
Sent: August 27, 2013 2:26 PM
To: Dave Belanger
Subject: Consultation re Guelph Water Supply Master Plan

Hello Mr. Belanger,

Thank you for your letter of August 13, 2013 regarding your request for information held by Aboriginal Affairs and Northern Development Canada (AANDC) on established or potential Aboriginal or treaty rights in the vicinity of Guelph, Ontario. As you indicated, in connection with the update of the Guelph Water Supply Master Plan you plan to notify and provide information to the Six Nations of the Grand River and the Mississaugas of the New Credit First Nation. I can confirm that these are the two main Aboriginal groups within a 50 km radius of Guelph.

However, it is the Master Plan Project leadership which is best placed to determine what the overall "footprint" of the project is, and therefore how distant to the project consultation should extend. This determination is not made by AANDC. If the Master Plan project could affect communities greater than 50 km away, please contact us with a preferred radius (in kilometers), and the Consultation Information Service (CIS) will provide you with more information.

Regards,
Lisa

Lisa L. Patterson
Regional Subject Expert for Ontario / Consultation & Accommodation Unit / AANDC HQ //
Phone: (819) 934-3696 / E-mail: Lisa.Patterson@aadnc-aandc.gc.ca

APPENDIX K: MAILING LIST

Organization	Salutation	First Name	Last Name	Stakeholder Title	Phone	Phone2	Fax	Email	Address	City	Province	Postal Code	Country
Local Municipality/Agency Meeting Mailing List													
Ministry of Natural Resources	Mr.	Ian	Hagman	District Manager, Guelph	(519) 826-4931		(519) 826-4929	ian.hagman@ontario.ca	1 Stone Road West	Guelph	Ontario	N1G 4Y2	Canada
Ministry of Natural Resources	Ms.	Paula	Thompson	Senior Policy Advisor, Great Lakes and Water Policy Section	(705) 755-1218			paula.l.thompson@ontario.ca	300 Water Street, PO Box 7000, 5th Floor, North Tower	Peterborough	Ontario	K9J 8M5	Canada
Ministry of the Environment	Ms.	Annamaria	Cross	Manager, Environmental Approvals Branch	(416) 314-7967	(416) 314-7288	(416) 314-8452	Annamaria.Cross@ontario.ca	2 St. Clair Avenue West	Toronto	Ontario	M4V 1L5	Canada
Ministry of the Environment	Ms.	Jane	Glassco	District Manager, Guelph District Office	(519) 826-4255		(519) 826-4286	jane.glassco@ontario.ca	1 Stone Road W,4th Floor	Guelph	Ontario	N1G 4Y2	Canada
Ministry of the Environment	Ms.	Lisa	Williamson	Water Compliance Supervisor	(519) 837-6386			Lisa.Williamson@ontario.ca	1 Stone Road West, 4th Floor	Guelph	Ontario	N1G 4Y2	Canada
Ministry of the Environment	Ms.	Carola	Serwotka	Water Inspector, Guelph				Carola.Serwotka@ontario.ca	1 Stone Road West, 4th Floor	Guelph	Ontario	N1G 4Y2	Canada
Ministry of the Environment	Ms.	Amy	Shaw	District Supervisor, Guelph	(519) 826-3126			Amy.Shaw@ontario.ca	1 Stone Road West, 4th Floor	Guelph	Ontario	N1G 4Y2	Canada
Ministry of the Environment	Ms.	Barbara	Slattery	EA/Planning Co-ordinator, Air, Pesticides and Environmental Planning	(905) 521-7864			Barbara.Slattery@ontario.ca	Ellen Fairclough Building, 119 King Street West, 12th Floor	Hamilton	Ontario	L8P 4Y7	Canada
Ministry of the Environment	Ms.	Greta	Najcler	Area Supervisor, Guelph				greta.najcler@ontario.ca	1 Stone Road West, 4th Floor	Guelph	Ontario	N1G 4Y2	Canada
Ministry of the Environment	Ms.	Cynthia	Doughty	Hydrogeologist, Hamilton Water Unit	(905) 521-7866			Cynthia.Doughty@ontario.ca	119 King Street West	Hamilton	Ontario	L8P 4Y7	Canada
Ministry of the Environment	Ms.	Pamela	Grande	Hydrogeologist, Hamilton Technical Support Section	(905) 521-7671			Pamela.Grande@ontario.ca	119 King Street West	Hamilton	Ontario	L8P 4Y7	Canada
WDG Public Health		Wendy	Briggs					Wendy.Briggs@wdgpublichealth.ca					
OMAFRA		Carol	Neumann					carol.neumann@ontario.ca					
WDG Public Health	Mr.	Shawn	Zentner					shawn.zentner@wdgpublichealth.ca	474 Wellington Road #18, Suite 100, RR#1	Fergus	Ontario	N1M 2W3	Canada
WDG Public Health	Mr.	Bo	Cheyne					Bo.Cheyne@wdgpublichealth.ca	474 Wellington Road #18, Suite 100, RR#1	Fergus	Ontario	N1M 2W3	Canada
WDG Public Health	Mr.	John	Yan					john.yan@wdgpublichealth.ca	474 Wellington Road #18, Suite 100, RR#1	Fergus	Ontario	N1M 2W3	Canada
Ministry of Tourism, Culture and Sport	Mr.	Chris	Stack	Manager, West Region	(519) 650-3421		(519) 650-3425	Chris.Stack@ontario.ca'	4275 King Street, 2nd Floor	Kitchener	Ontario	N2P 2E9	Canada
Martin Keller (GRCA)	Mr.	Martin	Keller	Source Protection Program Manager				mkeller@grandriver.ca	400 Clyde Road, P.O Box 729	Cambridge	Ontario	N1R 5W6	Canada
James Etienne (GRCA)	Mr.	James	Etienne					jetienne@grandriver.ca	400 Clyde Road, P.O Box 729	Cambridge	Ontario	N1R 5W6	Canada
Ministry of Municipal Affairs and Housing - Southwestern Region	Mr.	Bruce	Curtis	Manager, Community Planning and Development	(519) 873-4026		(519) 873-4018	bruce.curtis@ontario.ca	659 Exeter Road, 2nd Floor	London	Ontario	N6E 1L3	Canada
Kimberly Wingrove (GET)	Ms.	Kimberly	Wingrove	CAO, Guelph Eramosa Township	(519)856-9596 ext 105			kwingrove@get.on.ca	8348 Wellington Road 124, P.O. Box 700	Rockwood	Ontario	N0B 2K0	Canada
Saidur Rahman	Mr.	Saidur	Rahman	Director of Public Works, Guelph Eramosa Township				srahman@get.on.ca	8348 Wellington Road 124, P.O. Box 700	Rockwood	Ontario	N0B 2K0	Canada
Scott Wilson - Wellington County	Mr.	Scott	Wilson	CAO, Wellington County	(519) 837-2600 x 2330				74 Woolwich Street	Guelph	Ontario	N1H 3T9	Canada
Puslinch Township	Ms.	Karen	Landry	CAO/Clerk-Treasurer	519-763-1226 ext 214			klandry@puslinch.ca	7404 Wellington Road 34	Guelph	Ontario	N1H 6H9	Canada
Puslinch Township	Mr.	Wayne	Stokley	Councillor, Puslinch Township	519-621-9346			wstokley@puslinch.ca	7404 Wellington Road 34	Guelph	Ontario	N1H 6H9	Canada
Town of Milton	Ms.	Stephanie	Jarvis	Town of Milton	(905) 878-7252 x.2567			stephanie.jarvis@milton.ca	150 Mary Street	Milton	Ontario	L9T 6Z5	Canada
Wellington County	Mr.	Gary	Cousins	Wellington County				'garyc@wellington.ca'					
Mark Paoli (Wellington County)	Mr.	Mark	Paoli	Wellington County				markp@wellington.ca					
Colin Baker (Centre Wellington)	Mr.	Collin	Baker	Centre Wellington				CBaker@centrewellington.ca					
Kyle Davis (Centre Wellington)	Mr.	Kyle	Davis	Centre Wellington, Drinking Water Source Protection - Wellington County	519-846-9801 ext. 30			kdavis@centrewellington.ca					
Other Ontario Government Staff													
Ministry of Tourism, Culture and Sport	Mr.	Chris	Schiller	Manager, Culture Services Unit, Programs and Services Branch	(416) 314-7144		(416) 212-1802	chris.schiller@ontario.ca	401 Bay Street, Suite 1700	Toronto	Ontario	M7A OA7	Canada
Ministry of Natural Resources - Strategic Policy and Economics Branch	Ms.	Renee	Bowler	Manager, Economics, Research, and Environmental Planning Section	(705) 755-5870		(705) 755-1971	renee.bowler@ontario.ca	300 Water Street, PO Box 7000, 5th Floor, North Tower	Peterborough	Ontario	K9J 4R5	Canada
Ministry of Transportation	Ms.	Patricia	Boeckner	Director, Transportation Planning Branch	(416) 585-7238		(416) 585-7324	patricia.boeckner@ontario.ca	College Park Suite 3000, 777 Bay St	Toronto	Ontario	M7A 2J8	Canada
Ministry of Transportation	Ms.	Karen	Grottick	Manager, Design and Contract Standards Office	(905) 704-2293		(905) 704-2040	karen.grottick@ontario.ca	301 St. Paul Street, 2nd Floor	St. Catherines	Ontario	L2R 7R4	Canada
Ministry of Transportation	Mr.	Kevin	Bentley	Regional Director, Southwestern Region	(519) 873-4333		519-873-4236	kevin.bentley@ontario.ca	659 Exeter Road	London	Ontario	N6E 1L3	Canada
Ministry of Aboriginal Affairs - Consultation Unit								maa.ea.review@ontario.ca	160 Bloor Street East, 4th Floor	Toronto	Ontario	M7A 2E6	Canada
Ministry of Aboriginal Affairs	Ms.	Heather	Levecque	Consultation Unit, Aboriginal Relations and Ministry Partnerships Division	(416) 325-4044		(416) 326-1066	heather.levecque@ontario.ca	9th Floor, 160 Bloor Street East	Toronto	Ontario	M7A 2E1	Canada
Ministry of the Environment	Mr.	Bill	Bardswick	Director, Hamilton Region Office	(905) 521-7682		(905) 521-7820	bill.bardswick@ontario.ca	12th Floor, 119 King Street West	Hamilton	Ontario	L8P 4Y7	Canada
Ministry of the Environment	Ms.	Mary Ellen	Scanlon	Hamilton Region, Great Lakes Advisor	(905) 521-7715			mary.ellen.scanlon@ontario.ca	12th Floor, 119 King Street West	Hamilton	Ontario	L8P 4Y7	Canada
Other Federal Government Staff													
Fisheries and Oceans Canada	Ms.	Sara	Eddy	Senior Habitat Biologist	(905) 336-4535		(905) 336-6285	Sara.Eddy@dfo-mpo.gc.ca	867 Lakeshore Road	Burlington	Ontario	L7R 4A6	Canada
Fisheries and Oceans Canada - OGLA Southern Ontario District	Ms.	Lisa	Fowler	Regional Environmental Assessment Analyst	(905) 639-4022		(905) 639-3549	Lisa.Fowler@dfo-mpo.gc.ca	304-3027 Harvester Road	Burlington	Ontario	L7R 4K3	Canada
Environment Canada - Environmental Protection Operations Division - Ontario Region	Mr.	Rob	Dobos	Manager, Environmental Assessment Section	(905) 336-4953		(905) 336-8901	rob.dobos@ec.gc.ca	867 Lakeshore Road	Burlington	Ontario	L7R 4A6	Canada
Utilities and Emergency Services													
Guelph-Wellington EMS	Mr.	Stephen	Dewar	Guelph Wellington EMS Chief	(519) 822-1260 x2805		(519) 824-5960	stephen.dewar@guelph.ca	160 Clair Road W	Guelph	Ontario	N1L 1G1	Canada
Fire and Emergency Services	Mr.	Shawn	Armstrong	Fire Chief	(519) 822-1260 x 2125	519-824-6590	(519) 824-2147	shawn.armstrong@guelph.ca	50 Wyndham St S	Guelph	Ontario	N1H 4E1	Canada
Guelph Police Service	Mr.	Bryan	Larkin	Chief of Police	(519) 824-1212 x220		(519) 822-0949	bryan.larkin@police.guelph.on.ca	15 Wyndham Street S	Guelph	Ontario	N1H 4C6	Canada
Hydro One	Ms.	Leslie	Koch	Sustainment Manager, Lines Information Systems and Programs	(416) 345-6275		(416) 345-5443	Leslie.koch@HydroOne.com	483 Bay Street (location TCT15)	Toronto	Ontario	M5G 2P5	Canada
Guelph Hydro	Mr.	Barry	Chuddy	Chief Executive Officer	(519) 822-3010		(519) 822-0960	cservice@guelphhydro.com	395 Southgate Drive	Guelph	Ontario	N1G 4Y1	Canada

Organization	Salutation	First Name	Last Name	Stakeholder Title	Phone	Phone2	Fax	Email	Address	City	Province	Postal Code	Country
Elected Officials													
City of Guelph	Ms.	Karen	Farnbridge	Mayor	(519) 837-5643			mayor@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Jim	Furfaro	Councillor- Ward 1	(519) 822-1260 x2502			jim.furfaro@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Bob	Bell	Councillor -Ward 1	(519) 822-6152			bob.bell@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Ian	Findlay	Councillor- Ward 2	(519) 830-4681			ian.findlay@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Andy	Van Hellemond	Councillor - Ward 2	(519) 822-1260 x2503			andy.vanhellemond@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Ms.	Maggie	Laidlaw	Councillor- Ward 3	(519) 822-1260 x2510			maggie.laidlaw@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Ms.	June	Hofland	Councillor- Ward 3	(519) 822-1260 x2505			June.hofland@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Ms.	Gloria	Kovach	Councillor - Ward 4	(519) 822-1260 x2512			gloria.kovach@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Cam	Guthrie	Councillor - Ward 4	(519) 822-1260 x2513			cam.guthrie@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Ms.	Lise	Burcher	Councillor - Ward 5	(519) 822-1260 x2294			lise.burcher@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Ms.	Leanne	Piper	Councillor - Ward 5	(519) 822-1260 x2295			leanne.piper@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Todd	Dennis	Councillor - Ward 6	(519) 822-1260 x2296			todd.dennis@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Karl	Wettstein	Councillor - Ward 6	(519) 763-5105			karl.wettstein@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Township of Guelph/Eramosa	Mr.	Chris	White	Mayor of G.E.T/Warden of Wellington County	(519) 856-0450	(519) 837-2600		whitecj@sympatico.ca	8348 Wellington Road 124, P.O. Box 700	Rockwood	Ontario	N0B 2K0	Canada
Town of Erin	Mr.	Lou	Maieron	Mayor	(905) 855-4407 x232		(519) 833-2492	lou.maieron@erin.ca	5684 Trafalgar Rd.	Hillsburgh	Ontario	N0B 1Z0	Canada
Town of Minto	Mr.	George	Bridge	Mayor	(519) 323-1642	(519) 338 2511	(519) 338 2005	georgeabridge@gmail.com	5941 Hwy 89	Harriston	Ontario	N0G 1Z0	Canada
Township of Centre Wellington	Ms.	Joanne	Ross-Zuj	Mayor	(519) 846-9691	(519) 846-0213	(519) 846-2825	mayor@centrewellington.ca	1 MacDonald Square	Elora	Ontario	N0B 1S0	Canada
Township of Mapleton	Mr.	Bruce	Whale	Mayor	(519) 638-2230	(519) 638-3313	(519) 638-5113	brucew@wellington.ca	7275 Sideroad 16, Box 160	Drayton	Ontario	N0G 1P0	Canada
Township of Puslinch	Mr.	Dennis	Lever	Mayor	(519) 220-1593	(226) 971-2067	(519) 763-5846	dennisl@wellington.ca	7404 Wellington Road 34	Guelph	Ontario	N1H 6H9	Canada
Township of Wellington North	Mr.	Raymond	Tout	Mayor	(519) 323-9146	1 (866) 848-3620		township@wellington-north.com	7490 Sideroad 7 West, PO Box 125	Kenilworth	Ontario	N0G 2E0	Canada
Municipal Staff - Guelph													
Chief Administrative Officer	Ms.	Ann	Pappert	C.A.O.	(519) 822-1260 x 2221	(519)837-5602		ann.pappert@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Clerk's Office - Guelph					(519) 837-5603			clerks@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Building Services - Guelph					(519) 837-5615	(519) 822-4632		building@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Engineering Services - Guelph					(519) 837-5604	(519) 822-6194		engineering@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Planning Services - Guelph					(519) 837-5616	(519) 822-4632		planning@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Zoning Services - Guelph					(519) 837-5615	(519) 822-4632		zoning@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Corporate Communications - Guelph					(519) 822-1260			communications@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Wastewater Services - Guelph					(519) 837-5629			wastewater@guelph.ca	530 Wellington Street	Guelph	Ontario	N1H 6J4	Canada
Water Services - Guelph					(519) 837-5627			waterworks@guelph.ca	29 Waterworks Pl.	Guelph	Ontario	N1E 6P7	Canada
Operations, Transit and Emergency Services	Mr.	Derek	McCaughan	Executive Director	(519) 822-1260 x 2018			derek.mccaughan@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Planning, Building, Engineering and Environment	Ms.	Janet	Laird	Executive Director	(519) 822-1260 x 2665			janet.laird@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Community and Social Services	Ms.	Colleen	Bell	Executive Director	(519) 822-1260 x 2665			colleenbell@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Economic Development	Mr.	Peter	Cartwright	General Manager of Economic Development	(519) 837-5600		(519) 837-5636	peter.cartwright@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph Committees													
Planning and Building, Engineering and Environment Committee					(519) 822-1260			clerks@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Economic Development Advisory Committee					(519) 837-5603			clerks@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Water Conservation and Efficiency Public Advisory Committee					(519) 837-5627			waterservices@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
River Systems Advisory Committee					(519) 837-5616			planning@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Environmental Advisory Committee					(519) 837-5616			planning@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Well Interference Committee								waterservices@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
Guelph Safe City Committee	Ms.	Astrid	Clos						295 Southgate Drive, P.O. Box 1112	Guelph	Ontario	N1H 6N3	Canada
Federal and Provincial Elected Officials													
Federal Elected Official	Mr.	Frank	Valeriote	Member of Parliament, Guelph	(519) 837-8276	(613) 996-4758		Frank.Valeriote@parl.gc.ca	40 Cork Street East	Guelph	Ontario	N1H 2W8	Canada
Provincial Elected Official	Ms.	Liz	Sandals	Member of Provincial Parliament, Guelph	(519) 836-4190	(416) 325-2600	(519) 836-4191	lsandals.mpp.co@liberal.ola.org	173 Woolwich Street	Guelph	Ontario	N1H 3V4	Canada
Other Municipalities													
City of Hamilton	Mr.	Chris	Murray	City Manager	(905) 546-2489		(905) 546-2095	CityManager@hamilton.ca	71 Main Street West	Hamilton	Ontario	L8P 4Y5	Canada
Regional Municipality of Halton	Ms.	Janet	MacCaskill	Chief Administrative Officer	(905) 825-6000 x6070			jane.macaskill@halton.ca	1151 Bronte Road	Oakville	Ontario	L6M 3L1	Canada
Region of Waterloo				Chief Administrative Officer	519-575-4585		519-575-4440	regionalclerk@regionofwaterloo.ca	150 Frederick Street, 1st Floor	Kitchener	Ontario	N2G 4J3	Canada
City of Cambridge	Mr.	Jim	King	Chief Administrative Officer	(519) 740-4683			cao@cambridge.ca	73 Water Street North	Cambridge	Ontario	N1R 7L6	Canada
County of Haldimand	Mr.	Donald	Boyle	Chief Administrative Officer	(519) 318-5932		905-772-2085	dboyle@haldimandcounty.on.ca	45 Munsee Street North, P.O Box 400	Cayuga	Ontario	N0A 1E0	Canada
City of Brantford	Mr.	Ted	Salisbury	Chief Administrative Officer	(519) 759-4150				100 Wellington Square, P.O Box 818	Brantford	Ontario	N3T 5R7	Canada
County of Brant	Mr.	Paul	Emerson	Chief Administrative Officer	(519) 449-2451		(519) 448-3105		P.O Box 160	Burford	Ontario	N0E 1A0	Canada
City of Guelph Staff													
City of Guelph	Mr.	Ronald	Maeresera					Ronald.Maeresera@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Dave	Belanger	Water Supply Program Manager				Dave.Belanger@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Peter	Busatto	General Manager, Water Services				peter.busatto@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Brian	Pett	Guelph Water Services				brian.pett@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Wayne	Galliher	Water Conservation Project Manager				wayne.galliher@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph		Arun	Hindupur	Infrastructure Planning Engineer				arun.hindupur@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	John	Michalofsky					john.michalofsky@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph		Kiran	Suresh	General Manager, Wastewater Services				kiran.suresh@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Kier	Taylor	Compliance Co-ordinator				kier.taylor@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Ms.	Melissa	Aldunate	Senior Policy Planner				Melissa.aldunate@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Andrew	Janes	Project Engineer Supervisor				Andrew.janes@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Vladislav	Frumkin	Manager, Projects and Asset Management				Vladislav.Frumkin@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Peter	Rider	Risk Management				Peter.Rider@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Karl	Cober	Waterworks Project Manager				Karl.cober@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	Vince	Suffoletta	Water Supply Supervisor				Vincent.suffoletta@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada
City of Guelph	Mr.	John-Paul	Palmer	Water Services				John-Paul.Palmer@guelph.ca	1 Carden Street	Guelph	Ontario	N1H 3A1	Canada

Organization	Salutation	First Name	Last Name	StakeholderTitle	Phone	Phone2	Fax	Email	Address	City	Province	Postal Code	Country
Aboriginal Organizations													
Six Nations of the Grand River		William	Montour	Chief	(519) 445-2201		(519) 445-4208	wkm@sixnations.ca	P.O. Box 5000	Ohsweken	Ontario	N0A 1M0	Canada
Mississaugas of the New Credit First Nation		Bryan	LaForme	Chief	(905) 768-1133		(905) 768-1225	bryanlaforme@newcreditfirstnation.com	2789 Mississauga Road RR #6	Hagersville	Ontario	N0A 1H0	Canada
Haudenosaunee Confederacy Chiefs		Hohahes	Leroy Hill	Secretary to Haudenosaunee Confederacy Chiefs Council	5197177326			hdi2@bellnet.ca	2634 6th Line Road RR#2	Ohsweken	Ontario	N0A 1M0	Canada

Organization	Salutation	First Name	Last Name	StakeholderTitle	Phone	Phone2	Fax	Email	Address	City	Province	Postal Code	Country
Ratepayer/ Neighbourhood Groups													
Howitt Park Neighbourhood Resident's Association	Mr.	Rob	Fischer		(519) 826-5338	(519) 826-6147		info@hpng.ca	P.O Box 1857	Guelph	Ontario	N1H 7A1	Canada
Old University Neighbourhood Residents' Association	Mr.	John	Gruzleski	President	(519) 829-3225	(519) 823-9601		treasurer@urbanneighbourhoods.ca					
The Ward Residents' Association	Ms.	Maria	Pezzano	Chair				thewardguelph@gmail.com					
Brant Avenue Neighbourhood Group	Ms.	Lynne	Kloostra	Neighbourhood Support Worker	(519) 821-9243		(519) 821-7519	brant.ave.ng@gmail.com	5 Algonquin Drive	Guelph	Ontario	N1E 3P2	Canada
Kortright Hills Neighbourhood Group	Ms.	Leone	Schadenberg	Neighbourhood Support Worker	(519) 837-0974			www.khng.ca					
Hanlon Creek Neighbourhood Group								hanlon_creek_neighbourhood@yahoo.ca					
Grange Hill East Neighbourhood Group	Ms.	Dorota	Lukomska	Neighbourhood Support Worker	(519) 836-9427			info@gheng.ca	525 Grange Road	Guelph	Ontario	N1E 7C4	Canada
Two Rivers Neighbourhood Group	Ms.	Hannah	Senitt	Neighbourhood Support Worker	(519) 837-4248			info@tworiversng.ca	131 Ontario Street	Guelph	Ontario	N1E 3B3	Canada
Downtown Neighbourhood Association	Ms.	Cathy	O'Meara	Neighbhourhood Support Worker	(226) 979-9390			guelphdna@gmail.com					
Parkwood Gardens Neighbourhood Group	Ms.	Sally	Belogus	Neighbourhood Support Co-ordinator	(519) 824-6340		(519) 824-0456	parkwood.g.n.g@bellnet.ca	21 Imperial Road South	Guelph	Ontario	N1K 1X3	Canada
Waverley Neighbourhood Group	Ms.	Caroline	McCullough	Neighbourhood Support Worker	(519) 821-9677			waverleyneighbourhoodgroup@hotmail.com	140 Waverley Drive	Guelph	Ontario	N1E 1H2	Canada
Exhibition Park Neighbourhood Group	Ms.	Barb	McPhee	Neighbourhood Support Co-ordinator	(519) 767-5750			epng70@yahoo.ca	70 Division Street	Guelph	Ontario	N1H 4R5	Canada
Beech Street, Shadow Drive & Highway 124 Neighbourhood Group	Dr.	Mary	Rubio	University of Guelph Professor Emeritus	(519) 821-0604			mary.h.rubio@gmail.com	6 Beech Street, RR#6	Guelph	Ontario	N1H 6J3	Canada
Beech Street, Shadow Drive & Highway 124 Neighbourhood Group	Mr.	Noel	Hudson		(519) 823-5796			Noelhudson@rogers.com	4 Beech Street, RR#6	Guelph	Ontario	N1H 6J3	Canada
NGOs													
Guelph Field Naturalists	Mr.	Peter	Kelly	President	(519) 824-4965			info@guelphfieldnaturalists.org	P.O. Box 1401	Guelph	Ontario	N1H 6N8	Canada
Guelph Civic League	Mr.	Andy	Best	President	519-803-0187			info@civicleague.ca	P.O Box 1061	Guelph	Ontario	N1H 6N1	Canada
Guelph Horticultural Society	Ms.	Diane	Marchese	President	(519) 265-6223	(519) 780-0872		contactus@guelphhort.org	293 Ironwood Road	Guelph	Ontario	N1G 3G2	Canada
Guelph Youth Eco-Council	Mr.	Dillon	March					gyec@live.ca					
Wellington Water Watchers	Ms.	Arlene	Slocombe					wellingtonwaterwatchers@gmail.com	10 Carden Street	Guelph	Ontario	N1H 3A2	Canada
Nature Conservancy of Canada, Ontario Region	Ms.	Laura	Mousseau	Communications Co-ordinator	(519) 826-0068		(519) 826-9206	Ontario@natureconservancy.ca	5420 Hwy 6 N, RR5	Guelph	Ontario	N1H 6J2	Canada
Clean Water Coalition	Ms.	Lynda	Walters		(519) 822-0712		(519) 824-8171	bearjakey@rogers.com	759 Eramosa Road	Guelph	Ontario	N1E 5Z1	Canada
OPIRG					(519) 824-2091		(519) 824-8990	opirg@uoguelph.ca	1 Trent Line	Guelph	Ontario	N1G 2W1	Canada
Council of Canadians	Mr.	Robert	Barron					coc.guelph@gmail.com		Guelph	Ontario		Canada
Friends of Guelph	Mr.	Ken	Hammill					khammill@uoguelph.ca	18 Elmridge Drive	Guelph	Ontario		Canada
Guelph Community Foundation	Mr.	Chris	Willard	Executive Director	(519) 821-9216			cwillard@guelphcf.ca	P.O. Box 1311	Guelph	Ontario	N1H 6N6	Canada
Royal City Fishing Club/ Ontario Federation of Anglers and Hunters	Mr.	Randy	MacPherson	President, Royal City Fishing Club	519-843-6310			mrmac1954@hotmail.ca		Fergus	Ontario		Canada
Local Media													
Guelph Mercury	Mr.	Phil	Andrews	Managing Editor	(519) 823-6060			editor@guelphmercury.com	14 Macdonell Street	Guelph	Ontario	N1H 6P7	Canada
Guelph Tribune	Mr.	Chris	Clark	Editor	(519) 763-3333		(519) 763-4814	cclark@gulphtribune.ca	27 Woodlawn Road West, Unit 1	Guelph	Ontario	N1H 1G8	Canada
School Boards:													
Upper Grand District School Board	Mr.	Mark	Bailey	Chair	(519) 822-4420		(519) 826-9534	inquiry@ugdsb.on.ca	500 Victoria Road North	Guelph	Ontario	N1E 6K2	Canada
Wellington Catholic District School Board	Mr.	Marino	Gazzola	Chair	(519) 821 4600		(519) 824 3088	generalinquiries@wellingtoncdsb.ca	75 Woolwich Street	Guelph	Ontario	N1H 6N6	Canada
University of Guelph													
University of Guelph	Mr.	Alastair	Summerlee	President & Vice Chancellor	(519) 824-4120 x 52200			president@uoguelph.ca	50 Stone Road East	Guelph	Ontario	N1G 2W1	Canada
Associations and Water-Taking Businesses													
Wellington Federation of Agriculture	Mr.	Gordon	Flewwelling	President	(519) 434-9953	519-509-4663		gflewwelling@gto.net	RR#3	Arthur	Ontario	N0G 1A0	Canada
Christian Farmers Federation of Ontario	Mr.	Nathan	Stevens	General Manager	(519) 837-1620		(519) 824-1835	stevens@christianfarmers.org	7660 Mill Road, RR#4	Guelph	Ontario	N1H 6J1	Canada
Guelph Chamber of Commerce	Ms.	Janet	Roy	Chair and CEO	(519) 822-8081		(519) 822-8451	chamber@guelphchamber.com	111 Farquhar Street	Guelph	Ontario	N1H 3N4	Canada
Sleeman Breweries	Mr.	Dave	Klaassen	National Director of Total Quality	519-829-4617	519-830-0383			505 Southgate Drive	Guelph	Ontario	N1G 3W6	Canada
Nestle Waters North America		John	Challinor	Director, Corporate Affairs	(519) 763-9462			john.challinor@waters.nestle.com	101 Brock Road S.	Guelph	Ontario	N1H 6H9	Canada
River Valley Developments Inc. (Dolime Quarry)	Mr.	Robert	Baxter	General Manager	(519) 822-3682				183 Dufferin Street	Guelph	Ontario	N1H 4B3	Canada
Wellington-Waterloo CFDC	Mr.	Rick	Whittaker	General Manager	(519) 846-9839		(519) 846-9839	rick@wwcfdc.com	294 Mill Street East, Unit 207	Elora	Ontario	N0B 1S0	Canada
Guelph Homebuilders' Association	Mr.	John	Sloot		(519) 836-8560		(519) 489-1405	guelph.homebuilders@gmail.com	7 Clair Road West, Box 27075	Guelph	Ontario	N1L 0A6	Canada
Guelph Wellington Developers Association	Mr.	Alfred	Artinger	President	(519) 822-8511		(519) 837-3922	info@reidsheritagehomes.com	Box 964	Guelph	Ontario	N1H 6N1	Canada
Lafarge Canada Inc. (Guelph Pit/Whitelaw Quarry)	Mr.	Regan	Watts	Communications -Eastern Canada	(905) 738-7761			regan.watts@lafarge-na.com	7051 Wellington Road 124	Guelph	Ontario	N1H 6H7	Canada
Dufferin Aggregates					(519) 763-0200	1 (877) 532-3020	(519) 763-0412		125 Brock Road	Aberfoyle	Ontario	N1H 6H9	Canada
Golf Courses													
Victoria Park East Golf Club	Mr.	David	DeCorso	Superintendent and General Manager	(519) 821-2211		(519) 821-3039	david@victoriaparkgolf.com	1096 Victoria Rd. South	Guelph	Ontario	N1L 1C6	Canada
Guelph Lakes Golf & Country Club					(519) 822-4222		519) 822 4532		7879 Wellington Road	Guelph	Ontario	N1H 6H7	Canada
Club 6 Practice Golf	Mr.	Moe	Anand	Owner	(519) 341-6160				4560 Concession 7	Guelph	Ontario	N1G 4T4	Canada
Victoria Park Valley Golf Club	Mr.	James	Sewell	Golf Course & Grounds Superintendent	(519) 821-1441			golf@victoriaparkvalley.com	7660 Maltby Road East	Guelph	Ontario	N0B 2J0	Canada
Springfield Golf and Country Club					(519) 821-4655			springfield.golf@hotmail.com	2054 Gordon Street	Guelph	Ontario	N1L 1G6	Canada
Cutten Fields	Mr.	David	Kuypers	Golf Course Superintendent	(519) 824-2650 x241		(519) 824-9699	dkuypers@cuttenfields.com	190 College Avenue East, P.O Box 666	Guelph	Ontario	N1H 6L3	Canada
Guelph Golf and Curling Club	Mr.	David	Vogel	Director of Golf and Club Operations	(519) 824-2741		(519) 824-3100		130 Woodlawn Road East	Guelph	Ontario	N1E 7H9	Canada

Organization	CLC # (if applicable)	Salutation	First Name	Last Name	StakeholderTitle	Phone	Phone2	Fax	Email	Address	City	Province	Postal Code	Country
CLC Recuitment														
Business / Industry	2													
University of Guelph	1a	Mr.	Bob	Carter	Assoc. VP, Physical Resources	519-824-4120 ext. 53303			rjcarter@pr.uoguelph.ca	50 Stone Road East	Guelph	Ontario	N1G 2W1	Canada
University of Guelph	1b (alternate)	Mr.	Dan	Maclachlan	Director, Design, Engineering and Construction	519-824-4120 ext. 52114			danma@pr.uoguelph.ca	50 Stone Road East	Guelph	Ontario	N1G 2W1	Canada
Chamber of Commerce	2	Ms.	Janet	Roy	Chair and CEO	(519) 822-8081		(519) 822-8451	janet.roy@premiumhrsolutions.com	111 Farquhar Street	Guelph	Ontario	N1H 3N4	Canada
Sleeman Breweries Ltd.	3a	Mr.	Ed	McCallum	Director of Brewing Development				emccallum@sleeman.ca	505 Southgate Drive	Guelph	Ontario	N1G 3W6	Canada
Sleeman Breweries Ltd.	3b (alternate)	Mr.	Dave	Klaassen	National Director of Total Quality	519-829-4617	519-830-0383		dklaassen@sleeman.ca	505 Southgate Drive	Guelph	Ontario	N1G 3W6	Canada
Environment	2													
Water Conservation & Efficiency Advisory Committee	1	Mr.	Mike	Darmon	Chair	519-836-0033			mikedarmon@yahoo.ca	63 Riverview Drive	Guelph	Ontario	N1E 3R7	Canada
Wellington Water Watchers	2	Ms.	Kim	Gutt	Communications Director	519-994-9800			kgutt@danby.com	10 Carden Street	Guelph	Ontario	N1H 3A2	Canada
Agriculture	2													
Wellington-Guelph Federation of Agriculture	1	Mr.	Gordon	Flewwelling	President	519-434-9953	519-509-4663 (work)		gflewwelling@gto.net	RR#3	Arthur	Ontario	N0G 1A0	Canada
	2													
Land Development	2													
Guelph Wellington Developers' Association	1	Ms.	Angela	Kroetsch		519-748-1440	519-240-9959		akroetsch@gamsby.com	330 Trillium Drive, Unit D	Kitchener	Ontario	N2E 3J2	Canada
Guelph & District Homebuilders'	2	Mr.	Glenn	Anderson		519-836-8560			ganderson@gamsby.com	330 Trillium Drive, Unit	Kitchener	Ontario	N2E 3J2	Canada
Community/Social	2													
Friends of Guelph	1	Mr.	Ken	Hammill					khammill@uoguelph.ca	18 Elmridge Drive	Guelph	Ontario	N1G 4X7	Canada
River Systems Advisory Committee	2	Mr.	Jeremy	Shute	Chair	519-993-2706	226-706-8888 x 5 (work)		Jeremy.shute@sharedvaluesolutions.com	143 Wyndham Street North, Suite 201	Guelph	Ontario	N1H 4E9	Canada
Academia	2													
University of Guelph	1	Mr.	Brady	Deaton	Assoc. Professor, Food, Ag. & Resource Economics	519-824-4120 ext. 52765			bdeaton@uoguelph.ca					
University of Guelph	2	Mr.	Peter	Chisholm	School of Engineering				pchishol@uoguelph.ca	50 Stone Road East	Guelph	Ontario	N1G 2W1	Canada
Community at large (Guelph)	3													
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]			anscott@lakeheadu.ca	34 Shoemaker Cresent	Guelph	Ontario	N1K 1J6	Canada
[illegible]				[illegible]			[illegible]7603		steve@chomyc.com	182 Arkell Road	Guelph	Ontario	N1L 1E6	Canada
Region of Waterloo; prior head of water services	3	Mr.	John	Pawley		519-823-5967			jcpawley@rogers.com	165 Terraview Crescent, Unit 63	Guelph	Ontario	N1G 5G8	Canada
Community at large (Outside Guelph)	3													
Hydrogeologist	1	Mr.	Bill	Banks		519-829-4808			bill.banks@banksgroundwater.ca	940 Watson Road South, RR#1	Puslinch	Ontario	N0B 2J0	Canada
Puslinch Councillor	2	Mr.	Wayne	Stokley	Puslinch Councillor	519-621-9346			wstokley@puslinch.ca; b_wstokley@xplornet.ca					
Representative for Guelph / Eramosa	3	Mr.	Rod	McClure	Acting Manager of Public Works, Guelph Eramosa				rmcclure@get.on.ca	8348 Wellington Road 124, P.O. Box 700	Rockwood	Ontario	N0B 2K0	Canada

Organization	Salutation	First Name	Last Name	StakeholderTitle	Phone	Phone2	Fax	Email	Address	City	Province	Postal Code	Country
Former PAC Residents (if not on current CLC)													
Dave Hume (Puslinch)	Mr.	Dave	Hume					dhume@uoguelph.ca	63 Farnham Road, RR#2	Guelph	Ontario	N1H 6H8	Canada
Gary Martin (Guelph/Eramosa)	Mr.	Gary	Martin					carol.martin@sympatico.ca	7869 Wellington Road 29	Guelph	Ontario	N1H 6H7	Canada
F									123 Downey Rd	Guelph	Ontario	N1C 1A3	Canada
F									43 Bishop Court	Guelph	Ontario	N1G 2R8	Canada
University of Guelph (Student)	Ms.	Georgia	Simms		519-763-8491			georgia@imageo.ca					
Other Individuals (Asked to be on the Mailing List):													
University of Water	Mr.	Rob	de Loe	Chair, Water Policy and Go	519-888-4567 ext. 38648			rdeloe@uwaterloo.ca	200 University Avenue West	Waterloo	Ontario	N2L 3G1	Canada
Milton Resident (Former Milton Councillor)	Mr.	Barry	Lee		519-824-0679	1-888-317-2292		barry@barrylee.ca					
Ludwig Batista	Mr.	Ludwig	Batista	National Technical Director	(519) 826-5465		(519) 822-0430	lbatista@sleeman.ca	551 Clair Road West	Guelph	Ontario	N1L 1E9	Canada
Stan Denhoed								sdenhoed@hardenv.com					
Jim Yardley	Mr.	Jim	Yardley	Conestoga Rovers and Asso	519-884-0510		519-884-05	jyardley@craworld.com	651 Colby Drive	Waterloo	Ontario	N2V 1C2	Canada
Nestle Water	Mr.	John	Challinor					john.challinor@water.nestle.com					
Nestle Water	Ms.	Andreanne	Simard					andreanne.simard@waters.nestle.com					
Thomasfield Homes	Mr.	Tom	Krizsan		519-836-4332			tomk@thomasfield.com	295 Southgate Drive	Guelph	Ontario	N1G 3M5	Canada
Thomasfield Homes	Mr.	Tom	McLaughlin		226-343-4603			tom.mcl@gmail.com	295 Southgate Drive	Guelph	Ontario	N1G 3M5	Canada
Thomasfield Homes	Ms.	Katherine	McLaughlin		226-343-4603			tom.mcl@gmail.com	295 Southgate Drive	Guelph	Ontario	N1G 3M5	Canada
Resident	Mr.	Bruce	Weaver		519-824-9052			b.weaver@rogers.com	22 Marilyn Drive	Guelph	Ontario	N1H 7T1	Canada
Terra View Homes	Mr.	Andrew	Lambden		519-841-8500			andrew@terra-view.com	45 Speedvale Avenue East	Guelph	Ontario	N1H 1J2	Canada
Nature Guelph	Mr.	Collin	Oaks		519-823-1143			raptorredy2k@rogers.com	21 Valleyview Drive	Guelph	Ontario	N1H 6E2	Canada
Matrix Solutions	Mr.	Steve	Davies		519-856-2812			sdavies@matrix-solutions.com	166 Lou's Boulevard	Rockwood	Ontario	N0B 2K0	Canada
									15 Wagoners Trail	Guelph	Ontario	N1G 3M9	Canada
									16 Wagoners Trail	Guelph	Ontario	N1G 3M10	Canada
Region of Waterloo	Mr.	Karl	Belau		519-265-6571			kbelau@regionofwaterloo.ca	39 Ptarmigan Drive	Guelph	Ontario	N1C 1E8	Canada
Region of Waterloo/Guelph Resident	Mr.	Dave	Arsenault		519-400-8012			arsenault@sentex.net	299 Westwood Road	Guelph	Ontario	N1H 7X2	Canada

APPENDIX L: GUELPH CORRESPONDENCE LOG

Project Name: Guelph Water Supply Master Plan
Project Number: 60287843

Key Dates:

Notice of Commencement – May 16, 2013
- Milton Canadian Champion –May 16, 2013
- Guelph Tribune – May 16, 2013
- Wellington Advertiser – May 16, 2013
- Posted to the City of Guelph Website – May 16, 2013
- Letters Sent to Mailing List – May 13, 2013
- Aboriginal Letters – August 8, 2013

Consultation Round #1
- CLC Email: September 6, 2013
- CLC Event: September 17, 2013
- Municipality/Agency Meeting Email: September 6, 2013
- Municipality/Agency Meeting Event: September 19, 2013
- Community Open House #1 Notification Email: September 27, 2013
- Community Open House #2 Notification Event: September 25, 2013
- Milton Canadian Champion – September 26, 2013
- Guelph Tribune – September 26, 2013
- Wellington-Advertiser – September 27, 2013

Consultation Round #2
- CLC Email: March 7, 2014
- CLC reminder email: April 2, 2014
- CLC Event: April 8, 2014
- Municipality/Agency Meeting email: March 7, 2014
- Municipality/Agency Meeting Event: April 7, 2014
- Community Open House #1 Notification Email: April 14, 2014
- Community Open House #2 Notification Event: April 29, 2014
- Milton Canadian Champion – April 10 and 24, 2014
- Guelph Tribune – April 10, 17, and 24, 2014
- Wellington-Advertiser – April 11 and 25, 2014

Notice of Completion – May 29, 2014
- Milton Canadian Champion – May 29, 2014
- Guelph Tribune – May 29, 2014
- Wellington Advertiser – May 30, 2014
- Letters sent to mailing list (including Agencies and Aboriginal communities)– May 29, 2014

#	Stakeholder Contact Information	Date of Comment	Comments	Date of Response/ Action	Project Team Response/Action
1	Gary Cousins, Wellington County	May 16, 2013	Mr. Cousins responded to an introductory email about the project by stating he will follow the Master Plan, but largely to try to minimize the impact on the County. He asked for	May 16, 2013	Avril Fisken sent the notification that was published in the Guelph and area newspapers.

			information in writing before meeting.		
2	Mayor Dennis Lever, Puslinch Township	June 12, 2013	An introductory meeting was held between Avril Fisken and Mayor Lever. In follow up, Mayor Lever wrote an email stating that his township does not require any additional information at this point in time and delegated Wayne Stockley to represent their council on the CLC.	None required.	
3	Danna Tremblay, Puslinch Township	June 14, 2013	The Township of Puslinch provided Dave Belanger with the resolution passed by the Council meeting on June 5, 2013 regarding the Water Supply Master Plan.	None required.	
4	Lisa Patterson, Aboriginal Affairs and Northern Development Canada	August 27, 2013	Thank you for your letter of August 13, 2013 regarding your request for information held by Aboriginal Affairs and Northern Development Canada (AANDC) on established or potential Aboriginal or treaty rights in the vicinity of Guelph, Ontario. As you indicated, in connection with the update of the Guelph Water Supply Master Plan you plan to notify and provide information to the Six Nations of the Grand River and the Mississaugas of the New Credit First Nation. I can confirm that these are the two main Aboriginal groups within a 50 km radius of Guelph. However, it is the Master Plan Project leadership which is best placed to determine what the overall "footprint" of the project is, and therefore how distant to the project consultation should extend. This determination is not made by AANDC. If the Master Plan project could affect communities greater than 50 km away, please contact us with a preferred radius (in kilometers), and the Consultation Information Service (CIS) will provide you with more information. Regards,	None required.	Project impacts are within the City of Guelph, or within 50 km of the city.

			Lisa		
5	Carol Neumann, OMAFRA	September 6, 2013	Carol declined participation in the Municipality and Agency Meeting. She indicated that future correspondence should be sent to her attention instead of David Cooper.	September 6, 2013	Remove David Cooper from the project mailing list.
6	Stephanie Jarvis, Town of Milton	September 19, 2013	Ms. Jarvis was unable to attend the Municipality and Agency Meeting #1, but asked to be kept abreast of any developments and future meetings. She also asked for any information ahead of the meeting so that she could provide some input.		Meeting minutes and materials were provided as part of subsequent meeting notices to Municipality and Agency participants.
7	Chris Stack, Ministry of Tourism, Culture and Sport	September 19. 2013	Mr. Stack asked to be added to the project distribution list.	September 19, 2013	Mr. Stack was added to the project mailing list.
8	Lisa Patterson, AANDC Consultation and Accommodation Unit	September 27, 2013	AANDC asked that, unless the project impacts a reserve, to omit AANDC officials from the public information notification for this project.	September 27, 2013	AANDC was removed from the project mailing list.
9	Ministry of Aboriginal Affairs (Ontario)	September 17, 2013	MAA requested that consultation should occur with the Mississaugas of the New Credit FN, Six Nations of the Grand River FN, and the Haudenosaunee Chiefs Council. MAA also identified that it is primarily concerned with impacts to aboriginal treaty rights, land claims, and reserve lands. Archaeology may also be of interest to the First Nations communities.	September 17, 2013	The Haudenosaunee Confederacy Chiefs Council was added to the contact list. The project does not impact treaty rights, land claims or reserve lands. No archaeology is to be completed for this project since it is a Master Plan rather than an infrastructure project.
10	Joseph Muller (Culture Services Unit of the Ministry of Tourism, Culture and Sport)	October 17, 2013	Mr. Muller identified that he has carriage of the Water Supply Master Plan file for the Ministry of Tourism, Culture and Sport. He indicated that he found background material on the project website, but asked that the most recent PIC material will be made available online, or that a digital copy can be sent for information and review.	October 22, 2013	Dave Belanger responded, and provided the presentation for the Agency and Municipality workshop, as it is more detailed than the PIC presentation. He also asked whether Mr. Muller would like to attend the next Agency and Municipality workshop. An invitation will be sent when it is scheduled.
11	Hugh Whitely (member of the WCEPAC)	November 7, 2013	Suggested re-wording for the “Introduction to the Master Plan Update” was provided.”	None required.	Re-wording ideas will be considered for future discussion guides or presentation slides/posters.
12	Nestle Employees	November 11, 2013	Two Nestle employees asked to be added to the mailing list.	November 11, 2013	Added to the mailing list.
13	Joseph Muller, Heritage Planner at MTCS	December 16, 2013	The Ministry of Tourism and Culture responded to the materials from the first Community Open House, CLC and Municipal Workshop. The email from MTCS: *As noted in the letter, I recognize that this*	January 7, 2014	Given the high-level nature of the project, general details about the identification and evaluation of cultural heritage resources will be incorporated into the EA as requested.

			project is a high-level process, and so a detailed response on resources and mitigation is not required: some details on how the identification and evaluation of cultural heritage resources potentially impacted will be incorporated into the overall master plan process, in addition to potential approaches to mitigation of these impacts, would be appropriate and appreciated. Checklists were provided to determine if there is potential to impact archaeological or built heritage resources. If either checklist indicated potential, further studies would be required.		
14	Kimberly Wingrove, Guelph-Eramosa Township	March 7, 2014	The new CAO of Guelph-Eramosa Township provided updated contacts for the township staff.	March 12, 2014	Guelph-Eramosa Township new contacts added to the project mailing list.
15	Kyle Davis, Risk Management Official	March 11, 2014	The staff member from the Township of Centre-Wellington asked to be added to the project mailing list, along with four other individuals.	March 12, 2014	The individuals were added to the project mailing list.
16	Ian Hagman, Ministry of Natural Resources	March 20, 2014 and March, 25, 2014	The Ministry of Natural Resources wrote that the will not be coming to the Municipality/Agency Meeting. After a follow-up seeking an alternate meeting date and time, the Ministry of Natural Resources replied that they do not need to meet regarding the project. Text: *Hi Dave,* *I don't see a need for MNR's involvement in this project at this time. Our main role would be to approve application(s), if any, made under the Lakes and Rivers Improvement Act if the City was proposing to build a dam. Other than that MNR has no legislated role in water taking projects.*	March 25, 2014	On March 25, 2014, the project team replied to the Ministry of Natural Resources to seek an alternate meeting time and opportunity to provide comments on the Water Supply Master Plan project. Text: *Mr. Hagman,* *Thank you for getting back to me about the upcoming Guelph Water Supply Master Plan Update meeting. Are you interested in meeting separately with a member of our project team about this project at an alternate time? We value your opinion about the project, and we will keep you on the mailing list in any case.* *Dave*

			We may have a regulatory role if any proposal were to negatively impact endangered species or their habitat. However, that role would only come into effect, if and when, a proposal is submitted that indicates there may be a negative effect. *Regards, Ian*		
17	Peter Chisholm	April 7, 2014	The CLC mentioned that he was unable to attend the CLC meeting on April 8, 2014 due to an illness. He provided the following comments: (i) I probably missed it but I did not find reference to requirements for disposal of iron/manganese waste effluent from treatment of Burke Well raw water: (ii) I believe it would be useful to note that any distribution piping changes to the Burke well system will be undertaken according to their integration into overall piping network for water distribution: perhaps the overall piping network will be designed according to supply sources that make up the "firm capacity" of the supply system. (iii)I continue to be uncomfortable about the absence of reference to essential coordination of planning for water supply and the carrying capacity of the Speed River System to receive treated and untreated municipal waste from Guelph study area. I recommend a frank notice of this issue be brought into focus in records of our proceedings. (iv). During discussions about the last master plan, there was a proposal to seek advice from turf experts about the feasibility of using drought-tolerant grasses, in Guelph, to reduce water consumption in lawn-watering. I recommend this proposal be retained in current planning.	April 16, 2014	I was sorry to hear that you were unwell and unable to attend the CLC meeting; I certainly hope you are feeling much better now. You should have since received an invitation to the second Community Open House on April 29, 2014. Please find responses to your questions below (*in blue italics*). Let me know if you have any further questions or comments. Thank you for your continued interest in this important project. (i). I probably missed it but I did not find reference to requirements for disposal of iron/manganese waste effluent from treatment of Burke Well raw water: *The Burke well upgrades are included in the WSMP overview of the existing well supply assessment, but have not been detailed because the proposed capacity remains the same; i.e., it is an existing supply that is not intended to provide additional capacity. Review of the Burke Well Class EA conceptual design indicates that Burke well water treatment residuals will be discharged to a holding tank; decanted with the clean water returned to the WTP; concentrated residuals will be discharged to sanitary sewer and/or hauled to the WWTP.*

					(ii). I believe it would be useful to note that any distribution piping changes to the Burke well system will be undertaken according to their integration into overall piping network for water distribution: perhaps the overall piping network will be designed according to supply sources that make up the "firm capacity" of the supply system. *The Burke well is an existing supply well already connected to the City's distribution system. Changes to linear water infrastructure (including storage and distribution) is addressed in a separate Master Plan (i.e. the Water-Wastewater Servicing MP).* (iii).I continue to be uncomfortable about the absence of reference to essential coordination of planning for water supply and the carrying capacity of the Speed River System to receive treated and untreated municipal waste from Guelph study area. I recommend a frank notice of this issue be brought into focus in records of our proceedings. *Assimilative capacity of the WWTP is addressed through the Wastewater Treatment Master Plan; however, analysis of options in the WSMP update which could result in reduced river flows (e.g. surface water and surface water/ASR alternatives) include modeling by GRCA to determine available surface water flows after establishing that the minimum flow requirements for assimilative capacity for the WWTP are met. As described in the Wastewater Treatment Master Plan, it is integrated with other City master plans and growth strategies and similar population projections and Water supply demands are used as inputs for determining the projected wastewater generation rates to ensure that the WSMP and WWTMP are coordinated.*

					(iv). During discussions about the last master plan, there was a proposal to seek advice from turf experts about the feasibility of using drought-tolerant grasses, in Guelph, to reduce water consumption in lawn-watering. I recommend this proposal be retained in current planning. *The City continues to work closely with the Guelph Turf Grass Institute and other agencies, via its Healthy Landscapes Program, to evaluate grass seed cultivars for local use and recommendation through public educational resources. Currently there are many grass species in the marketplace promoting drought resistance but field trials have shown challenges with sustaining plantings through local climatic extremes and within high traffic environments. Similarly, barriers have also been noted in meeting the aesthetic standards and a competitive price point desired by local residents and business to facilitate transition to use of these grass types.* *Based on potential water savings to be experienced, City staff share your recommendation to continue research into drought tolerant grass species for future application. In the interim, the City's Healthy Landscapes Program continues to actively engage the Guelph community on the creation of low impact outdoor environments, including the establishment of low water use alternates to common turf and best management cultural practices to sustain turf through drought conditions, amongst other topics. For reference, more information on this program may be viewed at www.guelph.ca/healthylandscapes.*
18	Chris Stack, Ministry of	April 3, 2014	Mr. Stack replied to the email invitation for the	n/a	n/a

	Tourism, Culture and Sport		Municipality/Agency Meeting: "I will not be able to attend this session due to other commitments at that time, but we will continue to follow this."		
19	Karen Landry, Township of Puslinch	April 8, 2014	Karen Landry provided an email following the Municipality/Agency meeting with the availability for presenting at the Township of Puslinch council meeting.	April 30, 2014	Dave Belanger from the City of Guelph provided a formal email requesting to speak at the next Council meeting.
20	Linda Busuttil, West Willow Village Neighbourhood Group	April 22, 2014	Comment: Hello Dave I just called your office and heard from the message that you are out of the office today. I am writing on behalf of the West Willow Village Neighbourhood Group. I am following up with an email as I am not able to attend the Public Meeting this evening and would like a copy of the City of Guelph Policy on Community Gardening and Water. I have not been able to find any information on the city website and would like to read this document as water availability and access has a direct link to our neighbourhood food security initaitives. Many thanks Linda Busuttil	April 22, 2014/ April 23, 2014	Wayne Galliher of the City of Guelph responded by identifying Kelly Guthrie, Community Engagement Co-ordinator, who oversees the City's Community Garden Program and asked her to respond with more details about the program. Kelly Gutherie replied to the resident with an excerpt from the Guelph community garden policy with respect to water issues.

APPENDIX M: NOTICE OF COMPLETION

NOTICE OF COMPLETION

Guelph Water Supply Master Plan Update Class Environmental Assessment

The City of Guelph has completed an update to the 2007 council–approved Water Supply Master Plan. The purpose of the Guelph Water Supply Master Plan Update is to define where and how Guelph will continue to access a safe and sustainable supply of water—for residential, industrial, commercial and institutional use—over the next 25 years.

The Master Plan Update followed the requirements of the Municipal Class Environmental Assessment (Class EA) and satisfies Phases 1 and 2 of the planning and design process. This involved investigating Guelph's existing water supply capacity, identifying and evaluating potential alternatives, and recommending implementation options. The Master Plan update included two Community Open Houses, a dedicated Community Liaison Committee, and meetings with agency representatives and municipalities. These engagement opportunities provided valuable input in the development and evaluation of alternatives.

30 Day Review Period

The draft Water Supply Master Plan update report will be available for thirty (30) days for public comment, after which the report will go to Guelph City Council for approval. To review the update report, visit guelph.ca/water and follow the Water Supply Master Plan link, or view a paper copy of the report at the following locations:

- Library, Main Branch, 100 Norfolk Street, Monday to Thursday-9am to 9pm. Fridays 9am to 5pm. Saturdays 9am to 5pm. Sundays 1pm to 5pm.
- City of Guelph, Water Services Department, 29 Waterworks Place, Guelph, Ontario. Monday to Friday 8 am to 4 p.m.
- City Clerk's Office, City Hall, 1 Carden Street, Guelph, Ontario. Monday to Friday, 8:30 a.m to 4:30 p.m.

Interested parties should provide written comments to the addresses below within 30 calendar days from the date of this Notice, May 29, 2014:

Dave Belanger,	**Patty Quackenbush**,
Water Supply Program Manager	Senior Project Manager
City of Guelph	**AECOM**
T **519-822-1260 x 2186**	T **519-650-8691**
E **dave.belanger@guelph.ca**	E **patty.quackenbush@aecom.com**

If concerns regarding the Guelph Water Supply Master Plan update cannot be resolved through discussion with the City of Guelph, a person may request that the Minister of the Environment make an order for the project to comply with Part II of the Environmental Assessment Act (referred to as a Part II Order) which addresses individual environmental assessments. Requests must be received by the Minister at the address below by June 27, 2014. A copy of the request must also be sent to the City of Guelph.

Ministry of the Environment
Environmental Assessment and Approvals Branch
2 St. Clair Avenue West, Floor 12A
Toronto, Ontario M4V 1L5

This notice issued May 29, 2014.

Please note: Under the Freedom of Information and Protection of Privacy Act and the Environmental Assessment Act, unless otherwise stated in the submission, any personal information such as name, address, telephone number and property location included in a submission will become part of the public record files for this matter and will be released, if requested, to any person.

CITY OF Guelph
Making a Difference

Appendix F

Technical Memorandum
Financial Analysis

Appendix F

City of Guelph Water Supply Master Plan Update (Draft Final Report)

Technical Memorandum – Financial Analysis

Note: As per the Accessibility for Ontarians with Disabilities Act, this document is available in an alternate format by contacting Dave Belanger – City of Guelph (519-822-1260 Ext. 2186)

AECOM
50 Sportsworld Crossing Road, Suite 290 519.650.5313 tel
Kitchener, ON, Canada N2P 0A4 519.650.3424 fax
www.aecom.com

DRAFT FINAL Memorandum

To	David Belanger, Wayne Galliher	Page	1 of 17
CC	City of Guelph		
Subject	Financial Analysis of Guelph's Water Supply Alternatives, including Water Conservation		
From	JME Maxwell, Jacob Stemeroff, Patty Quackenbush		
Date	May 27, 2014	Project Number	60287843

1. Introduction

Water conservation is an important tool in the City of Guelph's Water Supply Master Plan. Reducing per capita water demand allows the City to service a larger residential and Industrial/ Commercial/ Institutional (ICI) population without expanding the City's water supply. The City of Guelph continues to undertake hydrogeological studies and testing for groundwater sources within and outside the City boundaries.

From a water supply planning perspective, water conservation delays the requirement to implement high cost water supply projects to meet demand. Although there are still several low cost opportunities for reducing per capita water demand, as Guelph continues initiatives to incrementally reduce water usage, marginal costs will increase. In order to fully understand the trade-offs between demand management and the need for additional water supply, a full comparison of water conservation scenarios is appropriate. A full comparison of water conservation scenarios needs to forecast the future costs of both water conservation and water supply and compare it to the corresponding reductions in water consumption.

2. Water Supply Projects

The City of Guelph has identified numerous projects that will increase the available water supply to keep up with increasing demand due to the forecasted increases in population, and growth in the ICI sector. While the City will undertake a phased implementation of these projects to ensure Guelph residents receive the maximum value for the water rates they pay, there are currently ongoing and future studies to support these. The City of Guelph is considering the water supply projects detailed in Section 8 of the main WSMP report, and listed in **Table 2-1** below. The order of the individual projects is not to suggest any priority or the implementation strategy of the City. It does reflect a preference of development of water supplies inside the City first including Development of off-line wells, test wells and new wells, with the more expensive wells as a function of treatment requirements deferred to later that those with less treatment requirements. All inside City options are exhausted before moving forward with wells within the Township, and then surface water options.

Table 2-1. Proposed Projects for Increasing Guelph's Water Supply

	Name	Type	Phasing	Maximum Day Finished Water (m^3/d)	Likely Cumulative Capacity (m^3/d)	Capital Cost ($)	Annual O&M Cost ($/yr)*
Project 0	Existing Supply	Existing	1	83,836	83,836	$-	$-
Project 1	SWQ (Ironwood)	Test Wells	2	4,500	88,336	$4,036,000	$111,243
Project 2	Clythe	Offline Wells	3	3,225	94,390	$4,809,000	$154,384
Project 3	Logan	Test Wells	4	2,829	91,165	$4,735,000	$92,150
Project 4	Sacco	Offline Wells	5	1,127	96,897	$4,135,000	$22,275
Project 5	Smallfield	Offline Wells	6	1,380	95,770	$3,820,000	$23,440
Project 6	Lower Collector	Offline Wells	7	2,000	98,897	$9,161,000	$80,229
Project 7	Sunny Acre	New Well Inside City	8	1,470	100,367	$4,522,000	$25,070
Project 8	Scout Camp	Test Wells	9	3,169	103,535	$4,702,000	$79,169
Project 9	Hauser	Test Wells	10	720	104,255	$3,691,000	$19,945
Project 10	Arkell Collector ASRs	Arkell Collector	11	3,342	107,598	$8,954,000	$12,628
Project 11	Guelph South	New Wells Outside City	12	4,225	111,823	$5,185,000	$80,229
Project 12	Guelph North	New Wells Outside City	13	3,775	115,597	$5,289,000	$92,904
Project 13	Guelph Lake WTP	Surface Water	14	12,312	127,909	$42,738,000	$490,543
Project 14*	Guelph Lake WTP and ASRs in Northeast Quadrant	Surface Water	15	13,513	141,422	$36,167,000	$1,149,796

** Project 14 consists of expansion to WTP (Project 13) and incremental capacity (not stand-alone alternative)*

However, much of the investigative work required for groundwater alternatives is funded in the next few years with many of these projects being undertaken concurrently recognizing the difficulty in developing groundwater sources and often the lengthy timeline. Some projects may be delayed for unforeseen reasons, and the City would require the ability to move other projects ahead in order to meet the demand requirements.

3. Water Conservation

In addition to the Water Supply Projects detailed above, part of the City's Water Supply Master Plan includes consideration for a wide range of water conservation programs. These programs are forecasted to range in cost from $0/year to approximately $1.8 million/year, and reduce average day water demand by 990 m^3/d to 9842 m^3/d. Each of the water conservation scenarios explored will delay the need to implement proposed projects for increasing the water supply, assuming that the conservation is successfully implemented to achieve the desired targets.

While 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 scheduled sooner rather than later. This study looked at a range of possible water conservation scenarios which are described in detail in Section 5 of the WSMP report, four of which were reviewed in more detail through this financial analysis in **Table 3-1**.

Table 3-1. Water Conservation Scenarios for Decreasing Guelph's Demand for Water

	Timing	Reduction in Average Day Demand (m^3/d)	Total Program Cost (Non-Discounted)
Base Case	NA	990	$ –
Current WCESU Approved Programming	2014 to 2025	5,556	$5,685,930
Enhanced Water Conservation	2014 to 2038	9,147	$13,864,780
Maximum Water Conservation	2014 to 2038	9,842	$42,267,600

Under the base case without any spending on water conservation, reductions in water demand are forecasted due to improving building standards (changes in 2014 Ontario Building Code), and consumer reaction to real increases in the price of water. The current Water Conservation and Efficiency Strategy Update (WCESU) Approved Programming is a continuation of the program the City is currently implementing. Enhanced Water Conservation goes beyond the current approved programing and could include initiatives such as rate reform, new retrofit incentives, active water loss management, and other initiatives. Maximum Water Conservation looks at implementing all potential demand management options without consideration of the system cost.

4. System Cost Comparison

The following sections present and compare the forecasted impacts of different water conservation 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 analysis done in the following sections does not look at the costs of any one water supply project on conservation scenario in isolation. Rather the analysis looks at the total combined system cost of all of the initiatives, giving consideration for timing of projects.

5. Methodology

The Financial Assessment of the four water conservation scenarios considers the time value of money and is analyzed in real (non-inflated) dollars. In order to fairly assess system costs, cash flows that do not occur in the same year need to be compared across scenarios. Discounting cash flows to determine their net present value (NPV) is done to compare costs occurring at different times. Discounting cash flows takes into consideration the preferences for monies to be received sooner than later. The value of money sooner rather than later is separate and different from inflation. The methodology used to calculate the NPV of cash flows is the same as is recommended by the Treasury Board of Canada in the Canadian Cost-Benefit Analysis Guide. For this analysis, an annual real discount rate of 3.24% was used.

6. Demand for Potable Water

The City of Guelph has achieved significant per capita reductions in water demand since 2006. For each of the demand scenarios there are several assumptions made which will be discussed. The first assumption is that the residential population of the City of Guelph grows from 130,670 in 2014 to 186,299 in 2038. The next assumption is over this time period the ICI equivalent population increases from 66,730 in 2014 to 99,480 in 2038. Another demand scenario assumption is the per capita equivalent water demand number in 2014 is 0.325 m^3/day, and is calculated using updated data and reflects reductions in demand over the past 8 years. We also assume the ratio of the maximum day demand to the average day demand is 1.35, while the required capacity of the water supply system is 1.5 times the average day demand. New water supply projects will be brought online when required capacity reaches 90% of the system capacity, such that commitments may continue to be applied to proposed developments in the interim.

Figure 6.1 and **Figure 6.2** present the assumptions made for each of the water conservation scenarios. Water conservation results in savings from the 2014 base water demand number. Full water conservation scenario savings are gradually achieved over the duration of the program.

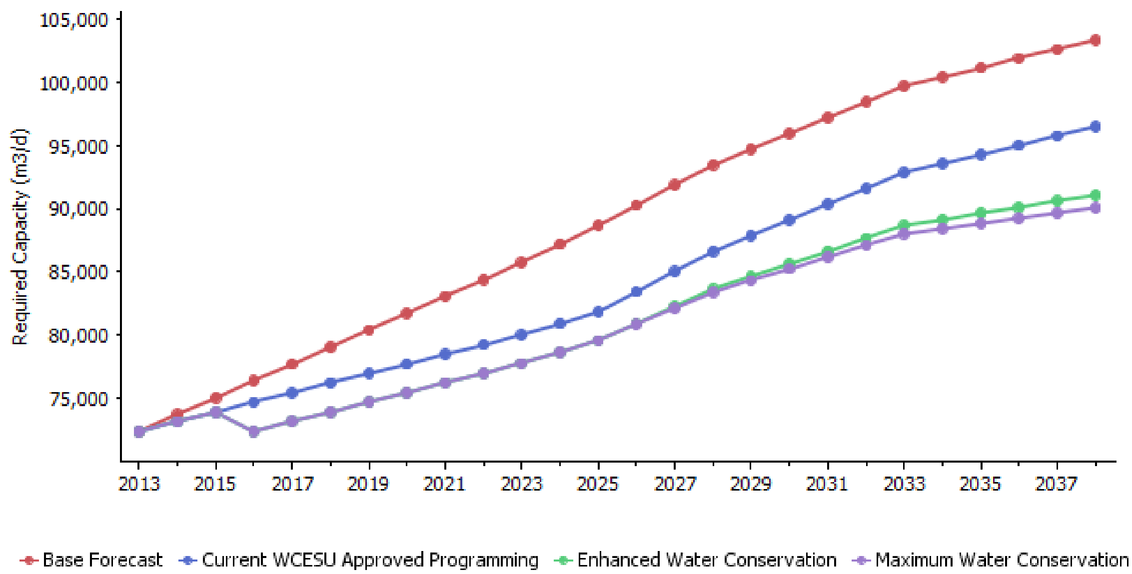

Figure 6.1. Annual Required Capacity by Conservation Scenario

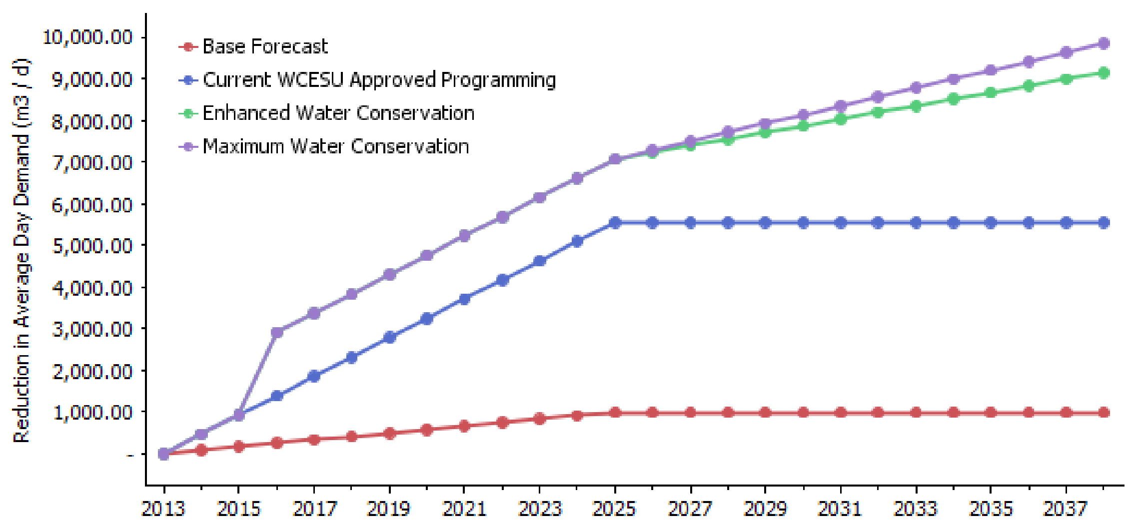

Figure 6.2. Cumulative Annual Reduction in Average Day Demand by Scenario

7. Timing of Projects

Water Conservation allows water supply projects to be delayed and/or avoided within the 25 study period. This is because as increased water conservation is achieved, per capita demand is reduced, lowering overall water demand. If overall demand is lowered, the City's current water sources will meet demand for a longer period of time before more sources are needed to meet an increased overall demand. **Figure 7.1** through **Figure 7.4** show the relationship between the availability of and demand for water supply for each of the different conservation scenarios. The water demands reference the total water supply demand as established through the forecasts in **Section 0**. The future system capacity incorporates new supply sources as required in the order found in Table 2 to ensure that capacity exceeds 90% demand at all times.

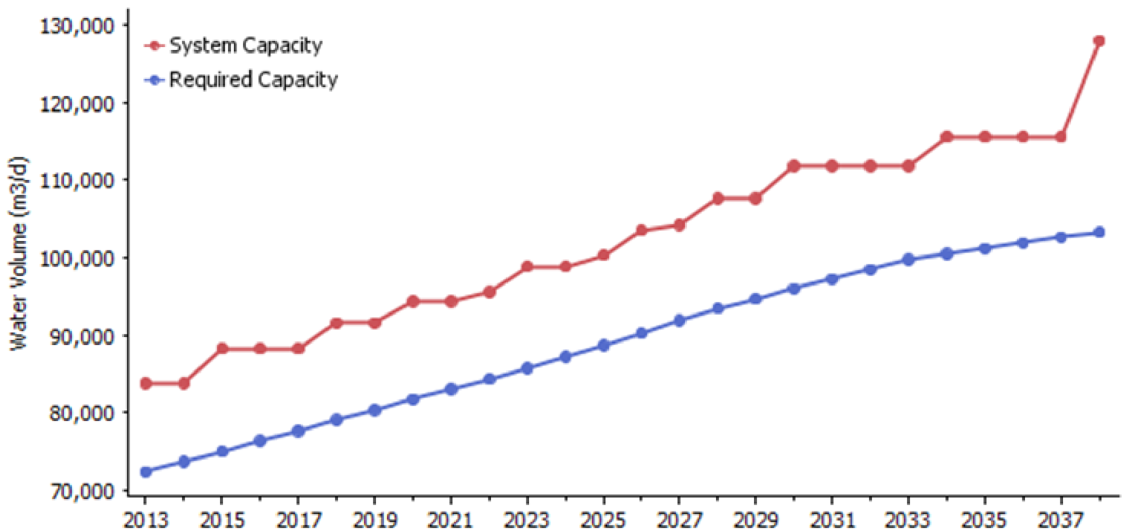

Figure 7.1. Water Supply and Required Capacity with Base Conservation Scenario

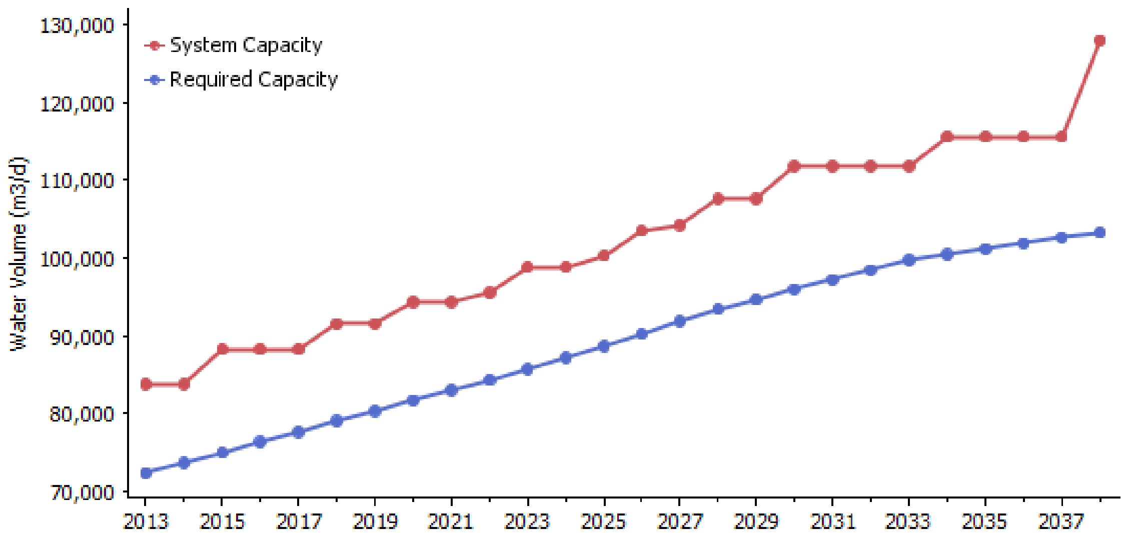

Figure 7.2. Water Supply and Required Capacity with WCESU Approved Conservation Scenario

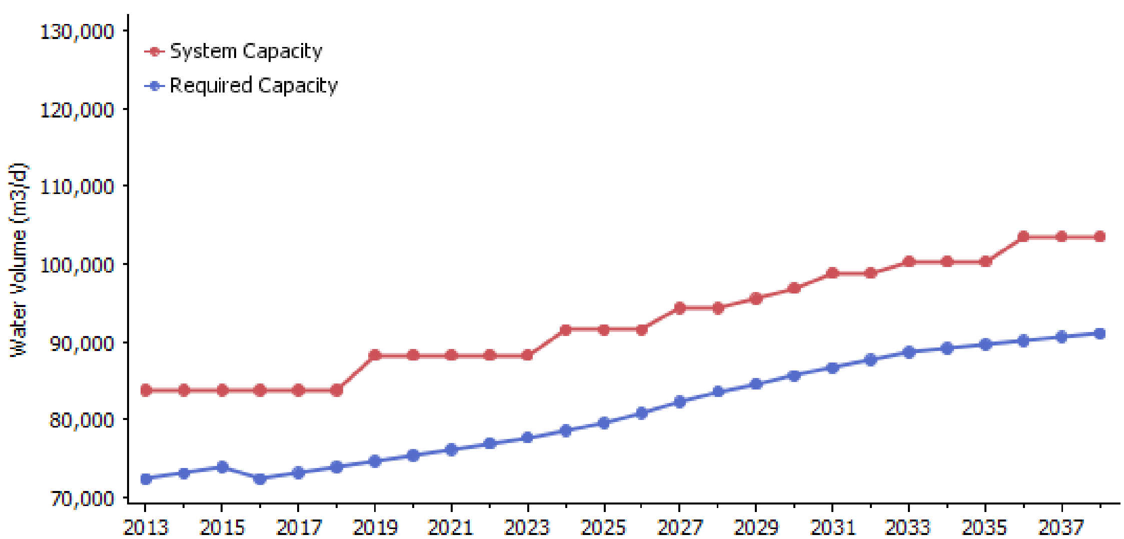

Figure 7.3. Water Supply and Required Capacity with Enhanced Conservation Scenario

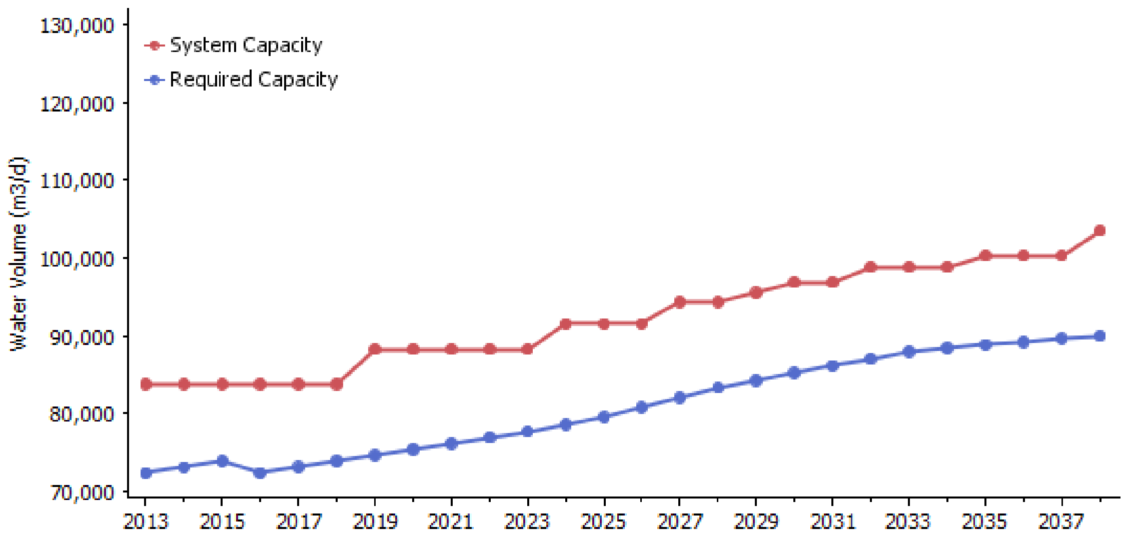

Figure 7.4. Water Supply and Required Capacity with Maximum Conservation Scenario

The forecasted timing of proposed water supply projects under the different scenarios is presented in **Table 7-1**. It has modelled that project expenditure is to start several years in advance of the year when the project is required based on our best understanding the form the project might take. Most of the leading costs are background studies, design work, and construction that will take place in advance of the go-live date. For groundwater supplies, investigative work is assumed to take place within the next three years to confirm feasibility of the proposed alternative. Five years are allowed for implementation including Class Environmental Assessment (EA) studies, land acquisition where required, treatability studies, preliminary and detailed design, and construction. For surface water alternatives and those including aquifer storage and recovery (ASR) wells, this timeline is extended up to ten years to allow for considerable investigation and modeling with the Grand River Conservation Authority, water quality analysis, natural environmental impact analysis and other required studies. Therefore, while the schedule below indicates timing of the need for new water supply to be in place within the 25 year study period (to 2038), the City must consider the need to also initiate the work required for future supply alternatives (i.e., beyond 25 years) within the study period.

Table 7-1. Timing of Proposed Water Supply Projects under Different Conservation Scenarios

Project No.	Project Name	Timing			
		Base Forecast	Current WCESU Approved Programming	Enhanced Conservation	Maximum Conservation
Project 0	Existing Supply	2006	2006	2006	2006
Project 1	SWQ (Ironwood)	2015	2017	2019	2019
Project 2	Clythe	2018	2022	2024	2024
Project 3	Logan	2020	2025	2027	2027
Project 4	Sacco	2022	2026	2029	2029
Project 5	Smallfield	2023	2027	2030	2030
Project 6	Lower Rd Collector	2023	2028	2031	2032
Project 7	Sunny Acre	2025	2029	2033	2035
Project 8	Scout Camp	2026	2030	2036	2038
Project 9	Hauser	2027	2033	2040	2041
Project 10	Arkell Collector ASRs	2028	2034	2040	2041
Project 11	Guelph South	2030	2038	2043	2045
Project 12	Guelph North	2034	2042	2047	Post 2048
Project 13	Guelph Lake WTP	2038	2045	Post 2048	Post 2048
Project 14	Guelph Lake WTP and ASRs in Northeast Quadrant	Post 2048	Post 2048	Post 2048	Post 2048

Under the four different conservation scenarios, there are projects that will take place outside of the study period (**Table 7-2**). Assuming no additional reductions in water supply demand, a number of projects will likely be scheduled for implementation between 2039 and 2048.

Table 7-2. Timing of Proposed Water Supply Projects Beyond the Study Period (2039 – 2048)

	Project Name	Timing			
	Base Forecast	Base Forecast	Current WCESU Approved Programming	Enhanced Conservation	Maximum Conservation
Project 9	Hauser	2027	2033	2040	2041
Project 10	Arkell Collector ASRs	2028	2034	2040	2041
Project 11	Guelph South	2030	2038	2043	2045
Project 12	Guelph North	2034	2042	2047	Post 2048
Project 13	Guelph Lake WTP	2038	2045	Post 2048	Post 2048
Project 14	Guelph Lake WTP and ASRs in Northeast Quadrant	Post 2048	Post 2048	Post 2048	Post 2048

8. Impacts on Cash Flows

The schedule of when water supply projects come online is dependent on the City of Guelph's overall demand for water and is different under each of the four water conservation scenarios. This in turn impacts capital and operational spending. The capital spending on water supply projects combines with the spending on water conservation. This combined expenditure over time results in a specific net present value of cost for each of the four different water conservation scenarios and is presented in **Table 8-1**.

Table 8-1. Present Value and Reduction in Average Day Demand of Conservation Scenarios

	Reduction in Average Day Demand (m^3/d)	PV Cost of System
Base Forecast	989.52	$78,260,258
Current WCESU Approved Programming	5,555.84	$58,696,349
Enhanced Water Conservation	9,147.24	$59,958,561
Maximum Water Conservation	9,842.24	$75,466,822

This analysis considers four types of expenditure:

- Water Supply Capital Cost (Supply.Capx)
- Water Supply Operating Cost (Supply.Opx)
- Water Conservation Indirect Cost (Conservation.Indirect)
- Water Conservation Direct Cost (Conservation.Direct)

Water Supply Capital Cost is the spending on one-time investments to implement identified water supply projects. Water Supply Operating Costs are the annual costs incurred in the operation of the various water supply sources. Water conservation Indirect Cost is the fixed annual base spending to maintain an organization that can implement various water conservation initiatives. Water Conservation Direct Cost is the project specific spending targeted at reducing water demand.

9. Base Forecast

The base forecast requires the most water supply projects to meet the City's demand to 2038 and projects are required sooner than in the other scenarios. This scenario has a NPV of $46,682,712. **Figure 9.1** shows the combined water supply and conservation cash flow.

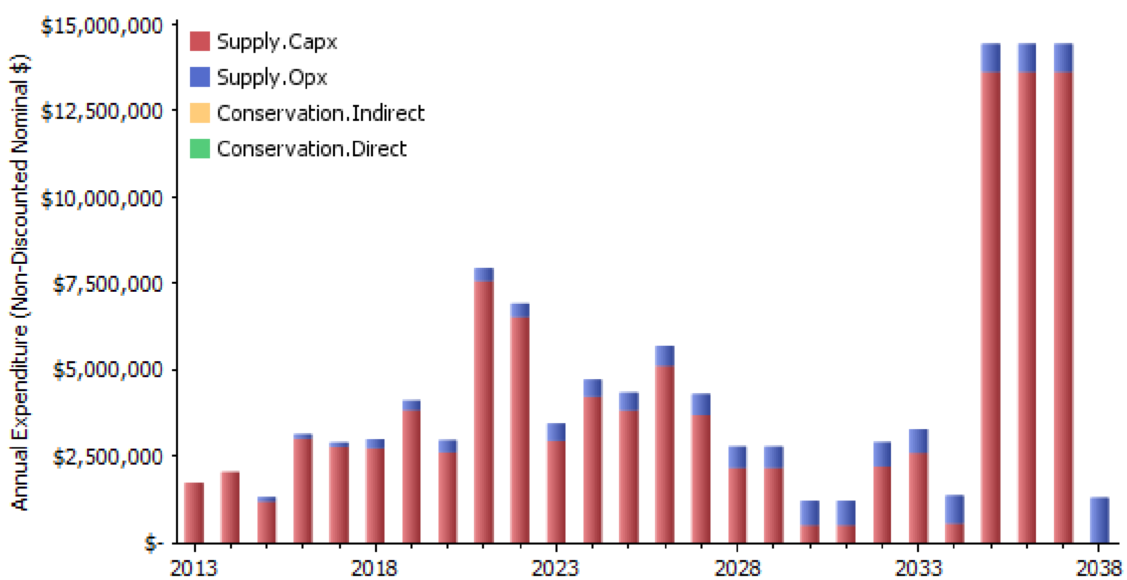

Figure 9.1. Incremental Spending on Water Supply from 2014–2038 – With Base Water Conservation

10. Current WCESU Approved Programming

The current WCESU Approved water conservation programming is ongoing and runs to 2025. The net present value of this scenario ($46,555,744) is comparable to the cost of the Base Case Scenario, and the Enhanced Water Conservation program. **Figure 10.1** shows the combined water supply and conservation cash flow.

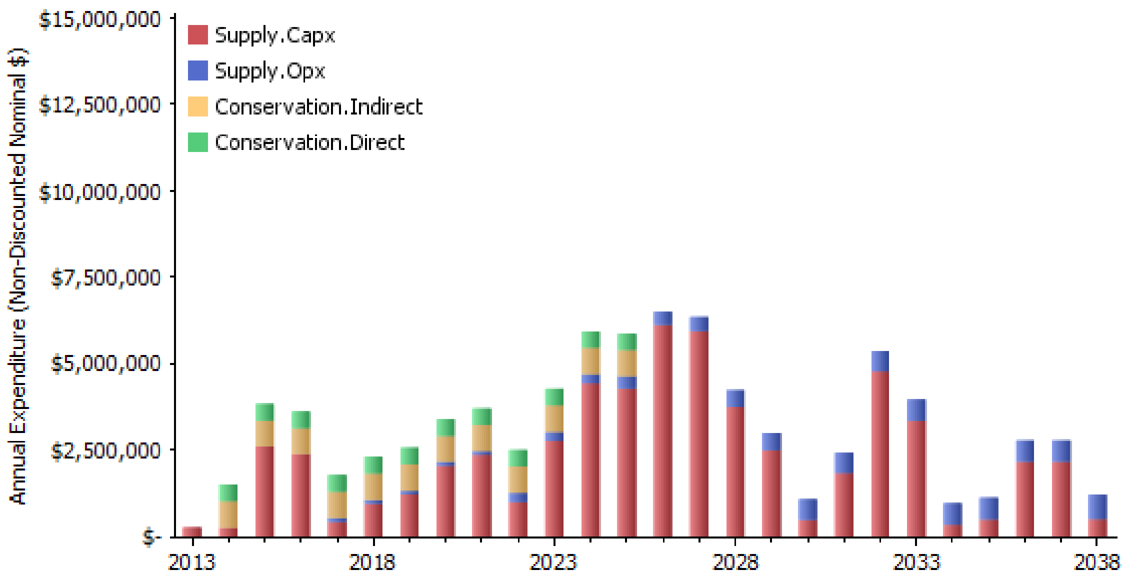

Figure 10.1. Incremental Spending on Water Supply from 2014–2038 – With WCESU Approved Program for Conservation

11. Enhanced Conservation

The Enhanced water conservation programming extends the WCESU program and continues to 2038. The net present value of this scenario is ($45,841,257). This is the conservation option that results in the lowest system costs. **Figure 11.1** shows the combined water supply and conservation cash flow.

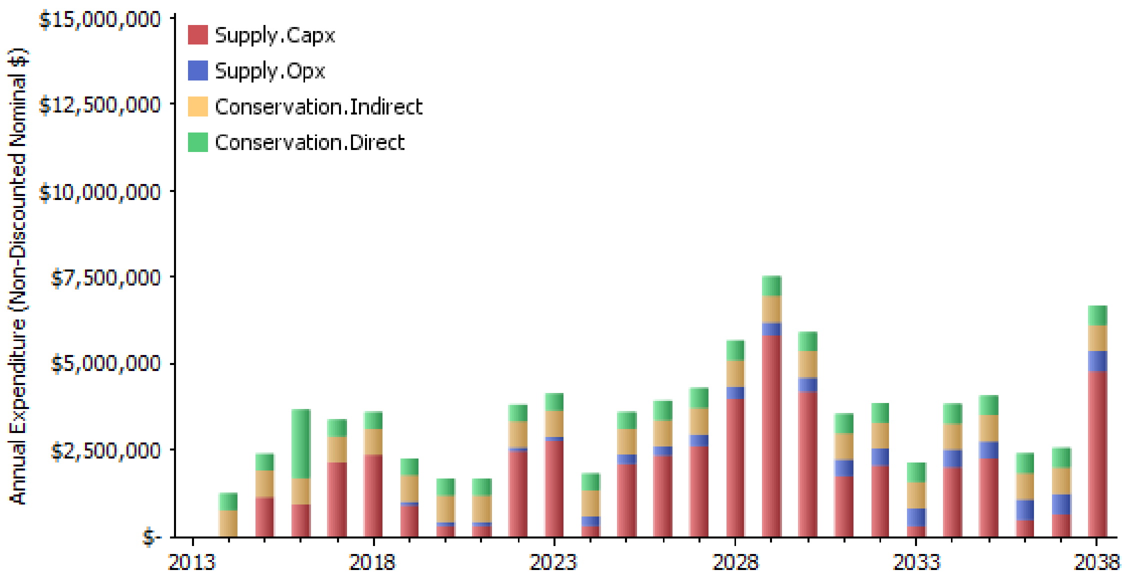

Figure 11.1. Incremental Spending on Water Supply from 2014–2038 – With Enhanced Water Conservation Program

12. Maximum Conservation

The Maximum Water Conservation program has the most aggressive spending on water conservation. The net present value of this scenario ($61,615,351) is the most expensive. **Figure 12.1** shows the combined water supply and conservation cash flow.

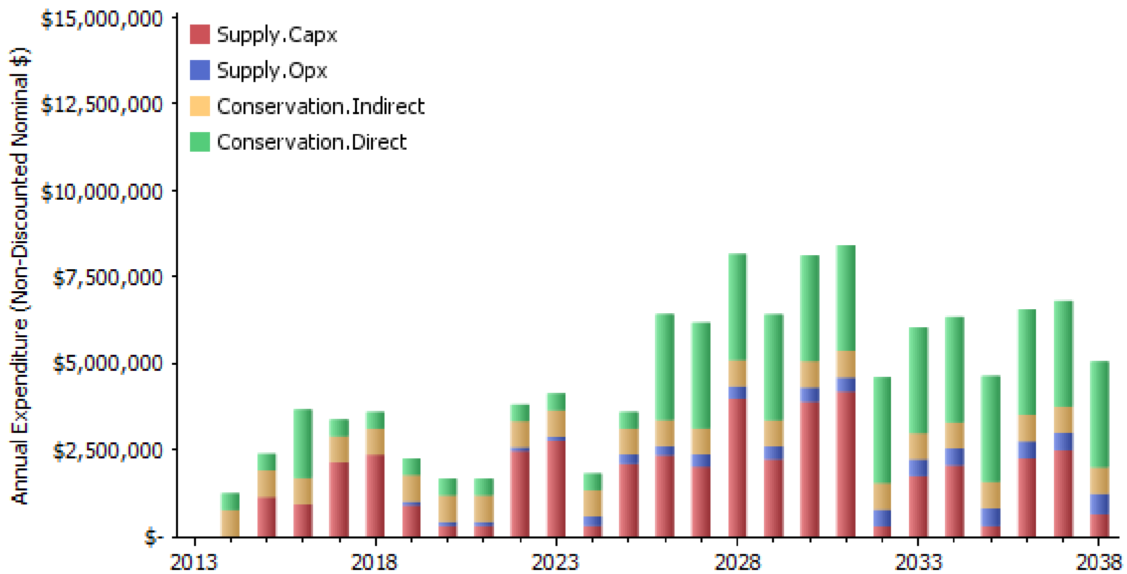

Figure 12.1. Incremental Spending on Water Supply from 2014–2038 – With Maximum Water Conservation Program

13. Comparison of Combined System Costs and Water Demand Reduction

Beyond the straight financial benefits from water conservation, there are additional ecological and other intangible benefits associated with reduced water demand. **Figure 13.1** shows the NPV of cost of each of the scenarios against the reduction in water demand.

The Base scenario is comparable in NPV system cost ($46,682,712) with the current conservation scenario, and the enhanced water conservation scenario, yet has the lowest reduction in water demand (990 m^3/d). The current WCESU Program has a slightly lower NPV system cost ($46,555,744) and reduces water demand by 5,556 m^3/d. The enhanced water conservation program has the lowest NPV system cost ($45,841,257) and achieves the second greatest reduction in water demand of 9,147 m^3/d. The maximum water conservation program has the highest NPV cost ($61,615,351) and only achieves a marginally greater reduction in demand for water, a reduction of 9,842 m^3/d.

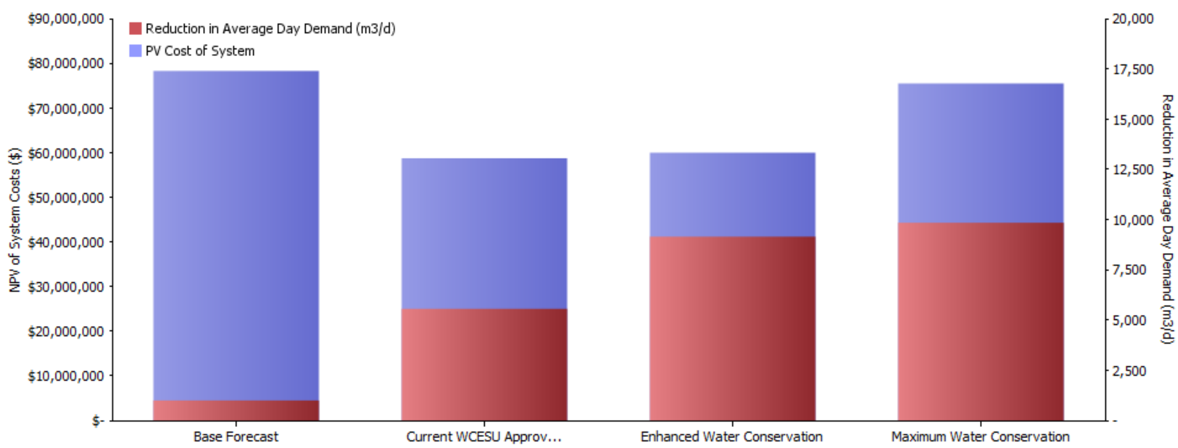

Figure 13.1. NPV Cost vs Reduction in Average Day Demand for Water

This results in the NPV Cost/ m^3/d reduction in average day water demand as presented in **Table 13-1**.

Table 13-1. NPV System Cost / m^3/d Reduction in Average Day Water Demand

	NPV System Cost / m^3 reduction in water demand
Base Forecast	$79,089
Current WCESU Approved Programming	$10,565
Enhanced Water Conservation	6,555
Maximum Water Conservation	$7,668

14. Conclusions

The enhanced water conservation program is a strong water conservation option that has the lowest NPV system cost while delivering up to 65% greater reduction in water demand over the current approved water conservation program. The enhanced water conservation program has the lowest NPV cost per m^3/d reduction in water demand and is penultimate in its reduction of water demand when compared to the other scenarios. While the base water conservation scenario has a NPV cost slightly more than $2 million dollars less than the enhanced water conservation scenario it achieves less than 11% of the reduction in average day demand of the same scenario. Without any consideration for cost the maximum water conservation scenario has the greatest impact on demand for water. However, this scenario only achieves 7.6% more reduction in demand for 134% of the NPV Cost.

Based on the above analysis AECOM recommends implementing the Enhanced Water Conservation Scenario. This scenario will result in a target for reduction in average day demand of 9,147 m^3/d by 2038. Although the water conservation programs included in the Enhanced Water Conservation Scenario are not fully specified to allow for flexibility in achieving the water conservation target; however, rate reform is a key driver of water conservation in the Enhanced Scenario. If the City does not proceed with rate reform as part of the Enhanced Scenario it will likely be challenging to hit the specified water conservation target, and will likely require additional water supply projects to meet the greater required system capacity.

While this analysis has been system focused, the full water system hasn't 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.

Considering the time value of money delaying the currently identified phase III expansion of the wastewater treatment plant (2023 – 2031; $62.2 Million) by just one year could result in a NPV system cost savings of up to $1.5 million dollars. Including the wastewater treatment in the system

costs impacted by water conservation could result in changes in the order ranking of scenarios on NPV cost.

The net present value cost savings of conservation were not as large as they were relative to the base case in the last study. We believe that the cause of this is that many of the “easy”, inexpensive projects to reduce water demand have already been implemented by the City. This increases the marginal cost reductions in water demand.