2016 WATER EFFICIENCY STRATEGY UPDATE

VERSION 5.0
SEPTEMBER 2016

Prepared by:

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VERSION	DATE	DESCRIPTION OF REVISIONS	REVISED BY	REVIEWED BY
1	April 5, 2016	Draft 2016 Water Efficiency Strategy	Bill Gauley Andrea Williams	Sam Ziemann
2	April 25, 2016	Draft 2016 Water Efficiency Strategy	Bill Gauley Andrea Williams	Sam Ziemann
3	June 15, 2016	Draft 2016 Water Efficiency Strategy	Bill Gauley Andrea Williams	Sam Ziemann
4	July 26, 2016	Final 2016 Water Efficiency Strategy	Bill Gauley Andrea Williams	Sam Ziemann

EXECUTIVE SUMMARY

ES-1 Background

The City of Guelph has been actively pursuing community water efficiency and conservation programming since 1998 and continues to be a Canadian leader in this field. Water Efficiency is recognised as a best management practice for water utilities by the Federation of Canadian Municipalities, National Research Council and the American Water Works Association. The success of Guelph's water conservation and efficiency programs to date have helped protect the City's water supply by reducing water demand on a daily basis which ensures that more water is made available for future use. Community participation in Guelph's water conservation programs has not only led to reduced water demand but also reductions in the amount of electricity and chemicals used to treat and convey water and wastewater. As a result of such efforts, the City's water and wastewater rates remain low and close to the median of Council's approved comparable Ontario municipalities.

Guelph's 2007 Water Supply Master Plan was developed to ensure that an adequate water supply would be available to support future growth in the City. The final plan identified enhanced water conservation and efficiency as a top priority in meeting future demand needs and it identified the following three time-based water reduction targets:

- Reduction of 10 percent (5,300 cubic metres per day) of 2006 production by 2010;
- Reduction of 15 percent (7,950 cubic metres per day) of 2006 production by 2017; and
- Reduction of 20 percent (10,600 cubic metres per day) of 2006 production by 2025.

In 2008, an update to the Water Conservation and Efficiency Strategy was initiated to define preferred water conservation and efficiency programs to meet the water reduction goals of the 2007 Water Supply Master Plan. In 2009, this Strategy was endorsed by Guelph City Council. This Strategy and Water Supply Master Plan reinforced water conservation as the most immediate and cost-effective source of new water for the City and defined programming recommendations to meet the 10-year reduction target. To date, the programs' water savings have surpassed the targets set out in the 2007 Water Supply Master Plan.

The City estimates that it would cost about $4.68 per litre per day of capacity to expand their water and wastewater treatment infrastructure. From 2006 to 2014, the City's water efficiency programs have reduced demands by about 6.6 million litres per day with about 42 percent of this savings (2.8 million litres per day) attributable to the City's water loss reduction program. With a total combined savings of about 6.6 million litres of water per day and a total program expenditure of approximately $8.65 million, the average cost per liter per day of savings is only $1.31, meaning that the City's water efficiency programs have generated a savings of about $4.68 for every $1.31 of spending.

In July 2014, City Council approved an update to the City's Water Supply Master Plan (http://guelph.ca/plans-and-strategies/water-supply-master-plan/) which evaluated the City's water needs over a 25-year planning horizon (2013 to 2038). Once again, savings through water conservation and efficiency was identified as the most cost-effective and immediate source of water. To that end, the 2014 Water Supply Master Plan identified a goal of reducing the projected 2038 annual average day water production from 69,872 cubic metres per day

to only 60,725 cubic metres per day – a reduction of 9,147 cubic metres per day or about 13 percent (Figure ES-1). Figure ES-2 presents the 2014 Water Supply Master Plan baseline and target values based on achieving a 13 percent reduction in residential, employment, and non-revenue water demands between 2013 and 2038. Figure ES-3 presents projected demands and targets on a per capita basis. While the City's overall water demands will continue to increase because of the growing population, per capita demands are projected to decline on an annual basis.

The mandate of the 2016 Water Efficiency Strategy Update was to identify a set of preferred water conservation and efficiency program alternatives that could be implemented over a 10-year planning horizon to achieve the 9,147 cubic metres per day water reduction goal outlined in the 2014 Water Supply Master Plan. While a 13 percent reduction has been projected for all sub-sectors, it is important to note more savings may be achieved in some sub-sectors and less savings in others similar in achieving the City's 2038 reduction goal.

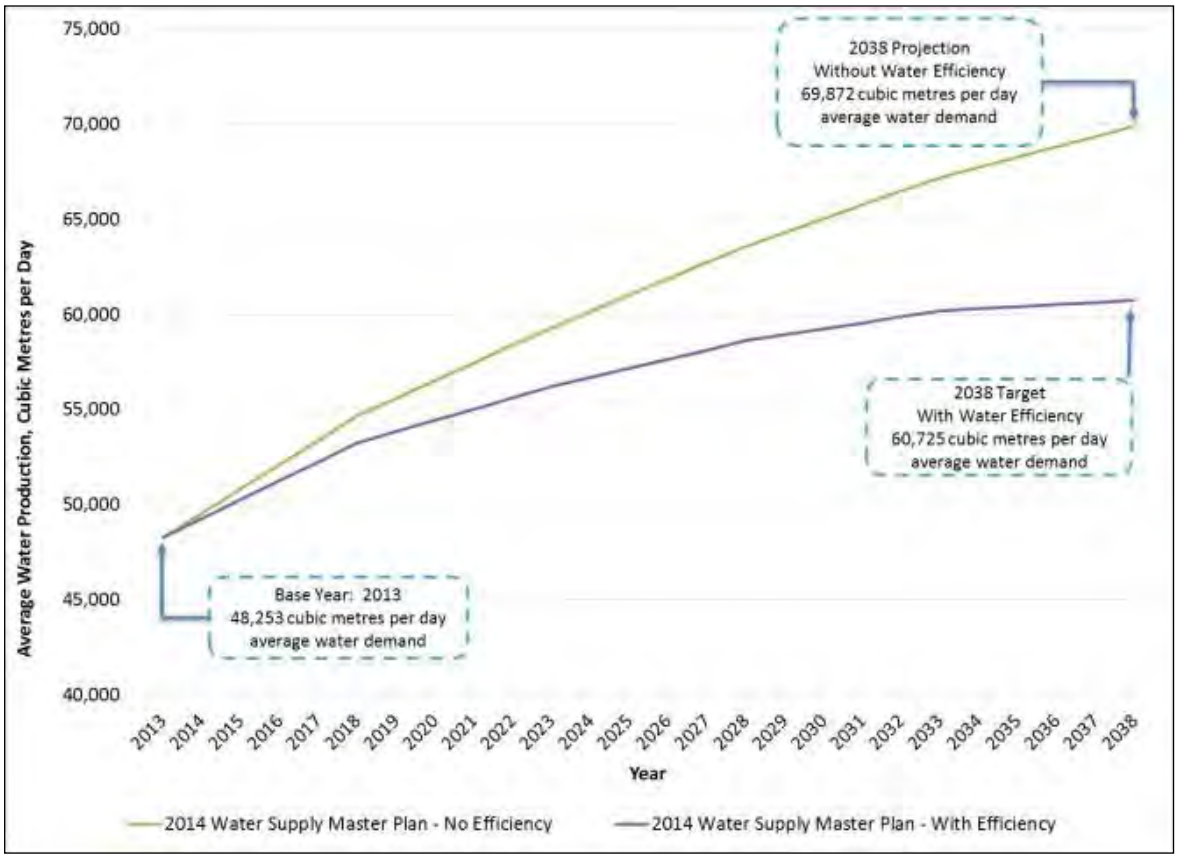

Figure ES-1: 2014 Water Supply Master Plan Production Rates with and without Water Efficiency

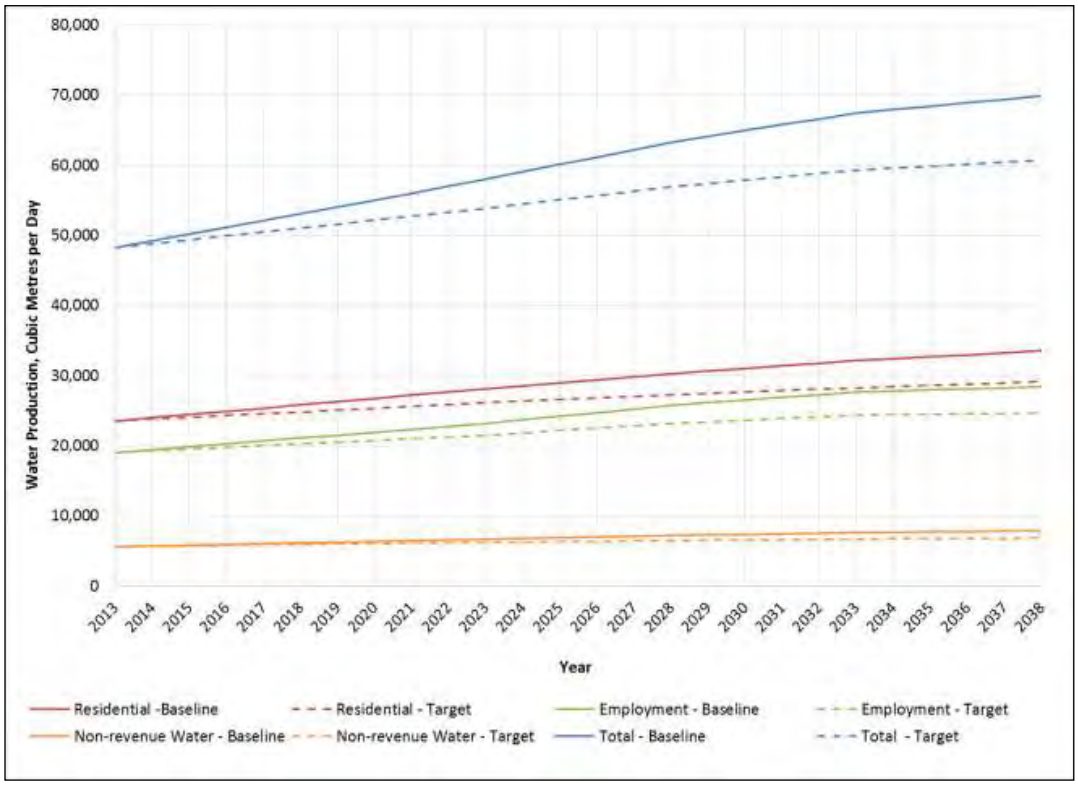

Figure ES-2: 2014 2014 Water Supply Master Plan Projections and Targets

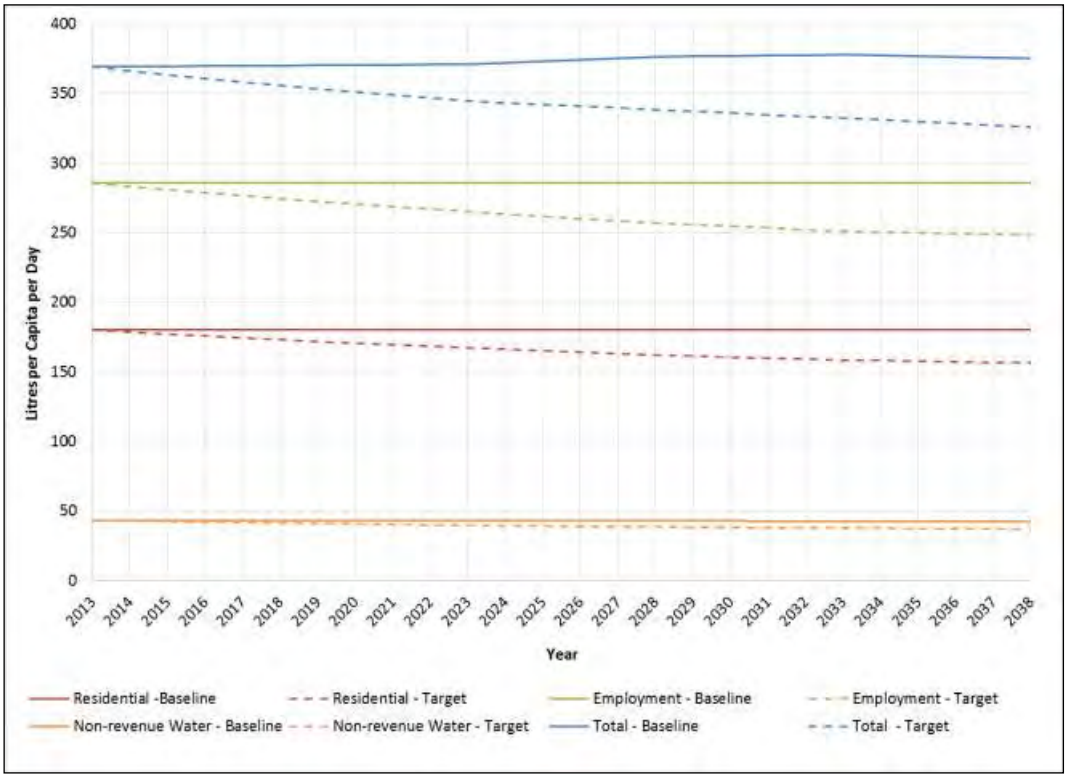

Figure ES-3: 2014 Water Supply Master Plan Per Capita Projections and Targets

ES-2 Linkages to Other City Initiatives and Regulation

Water efficiency is a core community and regulatory objective which transitions across City operations, future planning activities and provincial regulations. Since the development of the 2009 Water Conservation and Efficiency Strategy, many key City planning documents and legislation related to water conservation have been updated that reflect changing demographics and regulatory environment. While each document reflects its respective core business function, many also influence water use efficiency and resource protection. Such documents include the City's Official Plan and Strategic Plan, Water and Wastewater Master Plans, the Ontario Water Resources Act, the Water Opportunities and Conservation Act and the Clean Water Act.

ES-3 Water Efficiency Co-Benefits

While the potential to save money by deferring or downsizing infrastructure expansion projects is often one of the primary drivers for communities to implement water efficiency programs, there are other co-benefits to the municipality, such as reducing operational costs and greenhouse gas emissions. Further, customers who reduce their water demands will save money on their water bill and, if they reduce their hot water demands, they will save on their energy bill too.

ES-4 Water Efficiency Strategy Development

The 2016 Water Efficiency Strategy was comprised of a three-phase process designed to continually build on knowledge and feedback gained from research, analysis and community engagement. The development of the Water Efficiency Strategy was initiated in April 2015. This process resulted in a final strategy that has benefitted from continual collaboration between the project team, City stakeholders, and water consumers. The City's water conservation and efficiency programs are designed to support the needs of residential, industrial, commercial, and institutional customers. As such, the engagement process used to develop this Strategy Update was designed to include as many of stakeholder groups as possible.

As part of the Strategy Update process a Community Liaison Committee was formed to provide community input and guidance. The committee consisted of 20 key stakeholders drawn from a range of stakeholder groups. The City's existing Water Conservation and Efficiency Public Advisory Committee was employed as part of the Community Liaison Committee. Five meetings were held at City Hall over the course of the strategy development process.

In addition to the Community Liaison Committee engagement, three community consultation events were held between June 2015 and May 2016. An online tool called MindMixer was also used to gather community input throughout the process. This initial open house was held on June 23, 2015 to capture the community's general feelings towards water and gain some insight into preferred future programming. People in Places Events were held during the summer and fall (2015) at various events, including Jazz Festival, VegFest, Willow West Village Fall Fair, and Run for the Cure. Project team members asked the public to rank the proposed program rating criteria on a scale of 1 to 5 based on their importance to future water efficiency programming. A second open house was held on March 1, 2016. In addition to this event, the project team, complete with project boards and surveys, travelled to various City Venues (City Hall and the West End Community Centre) and the H2O Go Festival to gather feedback on the proposed program direction.

A residential market research session was held on June 16, 2015. The City recruited 32 single-family homeowners representative of the City's population demographic to participate in the session. Highlights of the research session include: information on the recognition of the city's current programming; that residents trust various sources of information with respect to landscaping; and the emotional connection Guelph residents have with their homes.

Certain common themes arose from the interviews with key informants regarding potential constraints and opportunities for future programming for this sector, including a desire for higher rebate levels and an improved working relationship between the City and its customers.

Representative high-water-using business categories, including builders/developers and relevant service providers (e.g., plumbers, landscaping contractors and retailers) in Guelph, were also invited to participate in a market research study. Interviews took place via phone calls and in-person meetings during the fall of 2015. The responses helped to identify constraints of the current water efficiency and conservation programming.

A literature review of municipal best practices was also completed in conjunction with a series of technical memos. These documents outlined areas of potential opportunity and inform discussion of future program alternatives. The following are the topics were covered in the technical memos: Residential Water Softening; Water Reuse and Demand Substitution Technologies; Industrial Consumptive Cooling Process and Water Conditioning Technology Efficiencies; Mass Fixture Retrofit Programs for Multi-residential Settings; Private Customer Leak Detection Notification Technologies; On-bill Efficiency Repayment Systems, Local Improvement Charges Financing & Other Alternate Incentive Models for Water Efficiency Programming; and New Construction Based Irrigation System Design and Construction Standards.

Once a draft Water Efficiency Strategy was completed, it was released in May 2016 for a two week final public consultation period. Comments received during this time period were reviewed and addressed where appropriate.

ES-5 Analysis of Water Demand and Consumption Data

Approximately 51 percent of water produced by the City is used by residential customers, 34 percent is used by industrial, commercial, and institutional customers, and about 15 percent is considered to be non-revenue water. Between 2006 and 2014, the City's water production rates declined by approximately 852 cubic metres per average day per year (based on the linear trend) and water consumption rates declined by 725 cubic metres per average day per year. While peak day demands (the highest day of water production per year) declined by an average of 983 cubic metres per day per year during this time, peak demands are highly variable from year to year based on local weather conditions, making them difficult to accurately predict in the future based on past results.

The water efficiency of customer sectors is best illustrated by considering per capita demands. As presented in Figure ES-4, per capita rates declined for all aspects of water production between 2006 and 2014. Annual average day production rates declined by an average of 12.3 litres per capita per average day per year, winter day rates (reflecting indoor use) declined by 12.0 litres per capita per average day per year, summer day rates declined by 12.6 litres per capita per average day per year, and peak day rates declined by 14.4 litres per capita per average day per year.

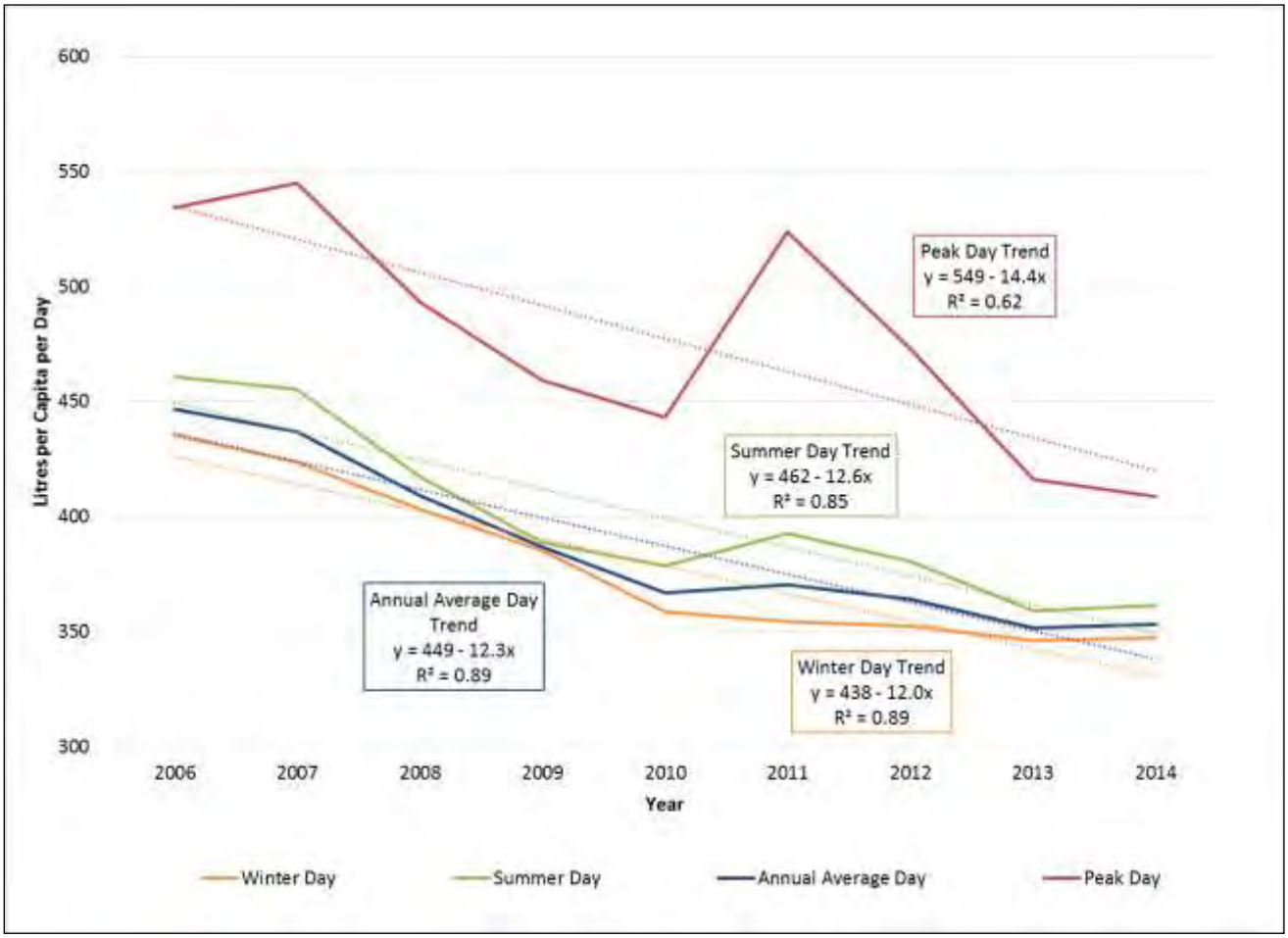

Figure ES-4: Historical per Capita Water Production Rates (2006-2014)

ES-5.1 Residential Water Demands

Water demands in the low-density residential customer sector has declined by about 6.1 litres per capita per average day per year during this period, while demands in the combined medium- and high-density residential customer sector declined by slightly more at 7.4 litres per capita per average day per year.

The reduction in Guelph's residential water demands has been the result of the effectiveness of the City's water efficiency programs (direct savings) combined with changes to the Ontario Building Code, recent marketplace transformation towards more efficient plumbing fixtures and appliances (natural savings), a growing public awareness of the need to use our natural resources wisely (indirect savings), and customer response to annual water/wastewater user rate price increases (price elasticity).

Since the introduction of the United States Environmental Protection Agency's WaterSense® program in 2006, the focus of most plumbing fixture manufacturers has been on developing water-efficient products. As such, most toilet, showerhead, and faucet models currently available in the marketplace are efficient. The United States Environmental Protection Agency's ENERGY STAR program has had a similar impact regarding the efficiency of clothes washers and dishwashers available in retail. Largely because of the improved efficiency of plumbing fixtures and appliances available in the marketplace there has been a decline in per capita residential water demands across North America. In fact it is estimated that the current rate of natural indoor residential savings is about 2.7 litres per capita per average day per year.[1]

Such a significant rate of decline in per capita demands cannot go on indefinitely[2]. The current rate of demand decline is expected to slow down as average residential demands move closer to approximately 138 litres per capita per average day and there are fewer inefficient customers available in the City to convert to efficient customers (DeOreo, 2016). With a current combined low, medium, and high density residential demand of only 174 litres per capita per average day, the City anticipates it will reach its 2038 single-family water demand target ahead of schedule.

ES-5.2 Industrial, Commercial and Institutional Water Demands

Between 2006 and 2014, the average per capita demands (based on the total city employment population), in the industrial, commercial and institutional customer sector, declined by an average of 3.7 litres per capita per average day per year. The 2038 demand target for this customer sector is approximately 133 litres per capita per average day (based on city population) – or exactly what the demand rate was in 2014. As such, the City is well ahead of schedule to reach its 2038 industrial, commercial, and institutional target. Nevertheless, further reducing demands in this customer sector will benefit the customers (e.g., reduce operating costs, increase market competitiveness) and the City (e.g., reduce capital and operating expenditures, increase business retention and local employment).

[1] *Residential End Uses of Water, Version 2*, Water Research Foundation, released 2016, states that between 1999 and 2014 average per capita indoor demands have declined by from 262.3 litres per capita per average day to 221.8 litres per capita per average day, a reduction of 40.5 litres per capita per average day in 15 years for an average of 2.7 litres per capita per day per year. This reduction was found to be statistically significant at the 95 percent confidence level.

[2] With the growing impact of WaterSense® and ENERGY STAR on the efficiency of fixtures and appliances in the marketplace, achieving an average City-wide indoor residential water demand of about 138 litres per capita per average day should be achievable.

ES-5.3 Non- Revenue Water

Non-revenue water is the term used for water that is produced by the City but not sold to customers. It includes physical losses, such as water used for firefighting, flushing of water mains, system leakage, un-metered municipal uses, amongst other end uses, as well as apparent losses resulting from metering or accounting inaccuracies. If the City spends too little to reduce system leakage, the volume and value of water lost each year will increase; if the City spends too much, the cost of the program will outweigh the savings. Between these two extremes is an economic level of leakage where program costs and program savings are optimized. The City's goal is to reduce and maintain leakage levels at the economic level of leakage for their system[3].

The City of Guelph has adopted the International Water Association/American Water and Wastewater Association Water Audit Method – broadly accepted as the industry Best Practice of water loss accounting – to measure levels of non-revenue water through routine water distribution to customers. The Water Audit Method allows water utilities to assess non-revenue water levels in their system compared to established benchmarks. One of the most important elements of the Water Audit Methodology is the calculation of system performance indicators, including the Infrastructure Leakage Index – a ratio of the Current Annual Real Losses in the system versus Unavoidable Annual Real Losses of the system. A system with an Infrastructure Leakage Index value of 1.0 would theoretically have no unavoidable leakage; a system with an Infrastructure Leakage Index value of 2.0 would theoretically be able to reduce their leakage level by half. Guelph's 2014 Infrastructure Leakage Index value was 2.54, lower than the 3.01 value calculated during first system audit in 2006, indicating that the City is reducing the level of avoidable leakage in their system. A rating system introduced in 2005 by the World Bank Institute considers any Infrastructure Leakage Index value less than 2.0 as efficient.

ES-6 Water Efficiency Criteria Development and Analysis

Draft criteria for the selection of the Water Efficiency programs were presented to Community Liaison Committee members, community members and stakeholders via outreach events and online engagement for feedback. Consultation with Community Liaison Committee members, the City's Water Efficiency Team, community residents and City stakeholders led to the selection, refinement and weighting of the final criteria.

From technical research, data analysis, market research, community engagement, and consultation with City staff, a comprehensive list of potential water conservation programs was developed. All programs that provided quantifiable water savings underwent financial and water savings modelling to calculate yearly, 5-year, and 10-year estimated costs and water savings values. The short-list of programs underwent a detailed financial analysis to: compare individual water efficiency programs; compare program combinations; and determine what would happen under a "do nothing" scenario.

[3] It is not possible to eliminate all leakage in a water supply system. The Economic Level of Leakage is the term used for the level of leakage below which it costs the municipality more to eliminate than it would recover in cost savings.

A discounted cash flow analysis was completed to evaluate water efficiency programs and their impact on capital deferral and operating costs for both water supply and wastewater operations where water loss management provided the highest net financial benefit. When all water efficiency programs are combined, total savings are valued at approximately $29 million in deferred infrastructure expansion over the 10-year planning horizon.

While it is not possible to quantify the water savings or cost-effectiveness associated with every program, some programs provide non-financial value to the community or build capacity for the City to attain new opportunities for water savings in the future. These include public and educational awareness programs, innovation, reduction in carbon emissions, and positive ecological benefits. It is noted that the 2016 Alliance for Water Efficiency Report *Improving Water Conservation and Efficiency* states that behaviour-based programs are often ended too early based on an assumption that they have a limited life cycle and water savings stop at the end of the program life. The report also states that these supporting programs should be maintained indefinitely to reinforce and maintain changed behaviour.

For programs where it is possible to quantify water savings, the next step is to evaluate the expected per unit cost of water savings for each program. Program costs, savings, and cost per cubic metre per day of savings are presented in Table ES-1. The proposed water efficiency measures are expected to achieve 6,265 cubic meters per average day in reclaimed capacity by year end 2026 at a reclaimed capacity unit value of $2.17 per litre per average day, based on estimated cost of implementation and operation of recommended conservation programs. This unit rate is 54 percent more cost of effective than the base cost of constructing one unit of new capacity of water and wastewater infrastructure ($4.68 per litre per average day) to deliver equivalent daily servicing capacity and are based from capital unit construction cost estimates of the 2014 Water Supply Master Plan and 2009 Wastewater Treatment Master Plan, respectively. Based on these unit construction cost estimates, this strategy shows the potential to save approximately $29 million dollars in infrastructure spending between 2016 and 2031 if anticipated water savings are achieved.

ES-7 10-Year Water Efficiency Strategy Implementation Plan

A 10-year strategy implementation plan was developed to identify the preferred sequencing, timing, and costs of recommended water efficiency program alternatives. The 2014 Water Supply Master Plan presented a 2038 annual average day production under a “no water efficiency” scenario of 69,872 cubic metres per day and a “with water efficiency” water production target of 60,725 cubic metres per day – equating to a reduction of 9,147 cubic metres per day. A production target of 60,725 cubic metres per day equates to an overall per capita demand of 326 litres per day.

In 2013, the actual water production rate was 44,379 cubic metres per average day or about 352 litres per capita per average day. Therefore, with a goal of reducing annual average day water production rates from 375 to 326 litres per capita per average day between 2013 and 2038, and a current (2014) rate of only 352 litres per capita per average day, the City is ahead of schedule to reach their 2038 target and is very likely to exceed this target (an annual average day production rate of 352 litres per capita per average day was not expected until about 2026).

Part of the reason that the City is ahead of schedule to meet their long-term water efficiency targets is that the 2014 Water Supply Master Plan assumed a natural savings rate (i.e., a naturally occurring decline in per capita water demands due to a general improvement in the efficiency of water-using fixtures and appliances in the marketplace) of only 0.286 litres per capita per average day per year. As stated earlier, the current actual rate of natural decline in demands is almost a magnitude higher at about 2.7 litres per capita per average day per year. However, this rate is expected to slow as the number of inefficient customers in Guelph decreases each year and there are fewer opportunities for savings.

Projected production rates at the end of the current 10-year planning horizon as per the Water Supply Master Plan, i.e., in 2027, under a "do nothing" scenarios are estimated as 62,706 cubic metres per day. Under a "with water efficiency" scenario as per the Water Supply Master Plan, water production is expected to reach 58,128 cubic metres per day – equating to a savings of 4,578 cubic metres per day (Figure ES-5).

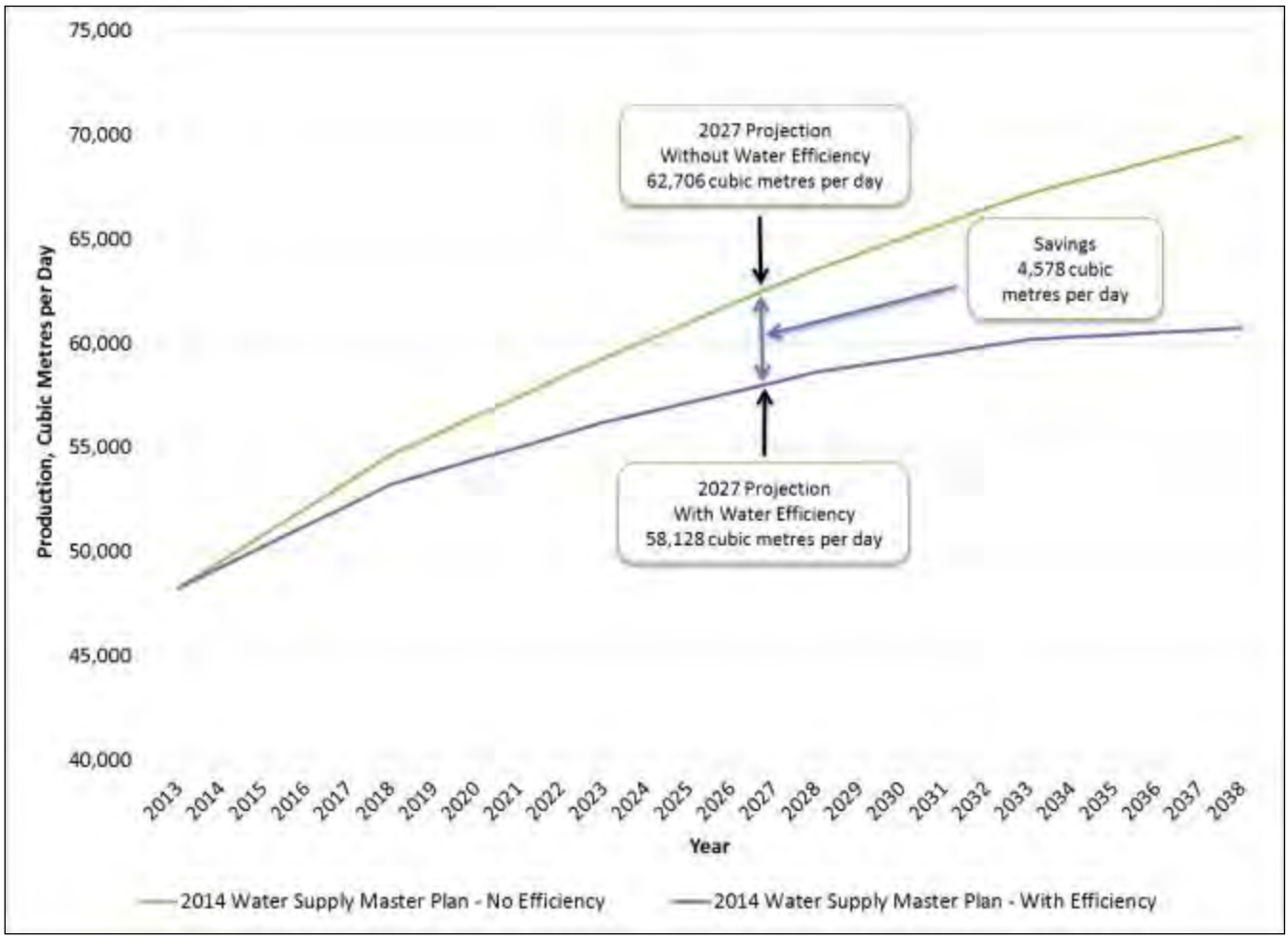

Figure ES-5: 2014 Water Supply Master Plan Production Rates with and without Water Efficiency for the 10-year planning horizon

ES-8 Water Efficiency Programs

Based on the stakeholder engagement, community feedback, technical reviews and research, potential programs were weighted based on the developed evaluation criteria, financial review and potential volumetric costs. The following is summary of the proposed Water Efficiency Programs to be implemented over the next 10 years.

ES-8.1 Direct Water Savings Programs

Residential Sector

- Royal Flush Rebate Program - $50 rebate to be provided to customers replacing toilets flushing with six litres or more with WaterSense®-certified models flushing with 4.8-litres or less (the program previously offered $75 rebates to customers replacing 13-litre model toilets).
- Blue Built Home Water Efficiency Standards and Rebate Program – The existing three-level certification will be transitioned to a single-level program where rebates are offered for a variety of water saving fixtures and appliances to both existing and new homes if they achieve indoor demands of no more than 150 litres per capita per average day.
- Home Visits and Audits – The City will offer residents a free one-hour in-home water audit to define home specific water efficiency retrofit opportunities.
- Water Softener Rebate – A program recommended beginning in 2022, following continued research of water softener technology. A rebate of $200 will be offered to customers who install an approved non-salt based residential water softener, or a very efficient low-salt-use ion exchange softener.

Multi-residential Sector

- Multi-residential Audit Program – The City will offer multi-residential customers a free water demand analysis of their building, including completing 24-hour data logging of water demands and visually inspecting a number of apartment suites to identify water saving opportunities.
- Multi-residential Sub-Metering Program – A new program will provide funding to companies to install permanent sub-metering in multi-residential buildings. Eligibility to participate in this pilot program will work in concert with the Multi-residential Audit Program.

Industrial, Commercial, and Institutional Sector

- Industrial, Commercial, and Institutional Capacity Buyback Program – The City will offer industrial, commercial, and institutional customers a free facility water audit and a one-time rebate of $0.75 per litre per day towards capital process retrofits that permanently reduce facility water demand. Furthermore, to aid program marketing and engagement it is recommended that the current Capacity Buyback program be rebranded as the “Water Smart Business Program”.

Municipal Operations

- Municipal Facility Upgrades Program – The City will continue to lead by example and make water-saving upgrades in City buildings and conducting pilot and research projects within municipal facilities (e.g., rainwater harvesting and wastewater reuse programs).

- Water Loss Management Program – The City's goal is to achieve and maintain distribution system leakage at the lowest economically viable level. The City utilizes District Metered Areas (considered an industry Best Management Practice) where possible to manage system leakage. The City will continue its current leak detection and sounding programs and it will commission an additional 20 district metered areas between the years of 2016-2018, bringing the total number to 27.
- Automated Meter Reading Installation – It is recommended that the City install automated meter reading starting in 2022 if the research conducted in the next five years supports installation.

ES-8.2 Indirect Water Savings Programs

Outdoor Water Use

- Healthy Landscapes – The City will continue to provide free home visits to residents where program staff explain how to reduce outdoor water use while maintaining a healthy and vibrant landscape.
- Water Efficient Landscaping Incentives – In 2021 it is recommended that the City begin developing a Water Efficient Landscape Incentive program with the intention of implementing the full program beginning in 2022.

Public Outreach/Education Programs

- Public Education – Public education programs support and facilitate participation in all other program initiatives. Education activities can include in-school programs, workshops, ads or articles in newspapers and flyers, audits, websites, television ads, and much more.
- Mobile Application – The City will continue developing the Watr mobile water engagement application with the local startup company Focus21. This app will allow users to see their water consumption data and compare it to their peer grouping. Challenges to reduce consumption will be presented along with conservation messaging through push notifications.
- Drinking Water Promotion – The City will continue to execute programs including the Water Wagon service with a potential to increase program capacity by adding an additional Water Wagon.
- Outdoor Water Use Program – The City will continue with its Outdoor Water Use Program to manage peak water demands by ensuring all community members are aware of the summer outdoor water use by-law and how they can reduce their outdoor water use.

Research Programs

- Water Reuse and Demand Management Study –Projects that fall into this research category include:
    - Rainwater Harvesting – Research and pilot new technology and verify savings by sub-metering or monitoring billing data of participants.
    - Rainwater Collection Network Regulations – Facilitate a review of rainwater harvesting solutions to allow for potential changes to regulatory documents.
    - Greywater Reuse – Research and pilot new technologies and verify savings by sub-metering or monitoring billing data of participants.

  - Municipal Water Reuse – Investigate the potential for water reuse pilot projects, including increasing social acceptability, potential management frameworks, communal systems and large scale deployments.

- Water Conservation and Rebound Effects Study – A study to investigate the effects (both positive and negative) of water conservation on plumbing and municipal water infrastructure, including the potential for a rebound in water use due to conservation efforts.
- Water/Energy Nexus – Leverage federal/provincial energy programming to provide educational materials to customers on the connection between water demands and energy use.
- Water Softener Pilot Study – Continue current work with Region of Waterloo of piloting the nucleation-assisted crystallization technology in the residential sector to determine if the technology is technically viable and if it will be embraced by customers.
- Municipal Upgrades Best Practices Study – This study would research and develop a Best Practices document for municipal facility upgrades and new facility construction.
- Distribution System Pressure Management – It is recommended that the City investigate the potential for pressure management when designing future pressure zones (5-10 years).
- Automated Meter Reading Study – A study would pilot small-scale automated meter reading installation to assess preferred technology alternatives and define a business case for larger deployment.
- Cooling Tower Audit/Rebate Program – The City will assess the feasibility of cooling tower conductivity meter retrofits amongst Industrial/Commercial/Institutional customers to assess participation rates, program costs, and water savings.
- Irrigation Audit (Water Smart Irrigation Professional) Program – In 2022 it is recommended that the City implement a Water Smart Irrigation Professional program involving offering qualified irrigation professional's in-class training and access to a proprietary software program to help them optimize irrigation schedules of automatic irrigation systems.
- Irrigation System Rebate Program – In 2022 it is recommended that the City begin offering customers with automatic irrigation systems a $300 rebate towards the purchase of 'smart' weather-based controllers to prevent automatic irrigation systems from operating when supplemental irrigation is not needed.

The average operating budget per year over the entire 10-year plan is $1,359,000. Over the next five years, the average yearly operating budget is slightly higher at $1,457,000 with this increase weighted by capital funding installments needed to implement final phases of the City's District Metered Area water loss reduction program, approximately $2 million, in 2017. As part of this, funding resources have also been allocated to a number of research programs with the expectation that at least some of these programs may be implemented as full programs during the 5- to 10-year timeframe. Further, it is anticipated that the City will seek external funding through grants and partnerships for the completion of the outlined water efficiency measures and research programs. Water efficiency measures presented in the 6 to 10 year planning horizon are currently

proposed, and will be confirmed through the update to this Water Efficiency Strategy in 2022. Therefore, all programming costs will be revised at that time.

As presented in Table ES-1, the total annual water savings per program per year were calculated over the 10-year implementation period and the total forecasted water savings during this period is estimated to be 6,265 cubic metres per day. The 5-year implementation forecast is estimated to save approximately 2,557 cubic metres per day with the majority of the projected program water savings will be derived from the Water Loss Management Program and the Water Smart Business Program. Further, it is noted the cost of the 10-year program is $13 million with a projected program savings of $29 million based on the predicted water savings from the proposed programs.

Table ES-1: Summary of the 10 Year Total Water Efficiency Programs Cost and per Cubic Metre Saved

	Water Efficiency Programs	10-Year Program Cost	10-Year Water Savings	Cost per Cubic Metre per Day Savings	Program Savings
Direct Water Savings	**Royal Flush Toilet Rebate Program**	$605,000	210	$2,881	$982,800
	Blue Built Home Water Efficiency Standards and Rebate Program	$109,500	14	$7,964	$64,350
	Home Visits/Audits	$122,500	65	$1,899	$301,860
	Water Softener Rebate	*$50,000*	*4*	*$14,286*	$16,380
	Multi- Residential Audit Program	$142,500	74	$1,919	$347,490
	Sub-metering Program	$95,000	11	$8,796	$50,544
	Water Smart Business	$2,225,000	1,500	$1,483	$7,020,000
	Municipal Facility Upgrades	$602,953	220	$2,744	$1,028,196
	Water Loss Management	$1,595,000	3,962	$403	$18,542,160
	Automated Meter Reading Installation	*$760,000*	*56*	*$13,620*	$261,144
Indirect Water Savings	**Healthy Landscapes Home Visit**	$2,411,000	N/A	N/A	N/A
	Water Efficient Landscaping Incentives	*$330,000*	*N/A*	*N/A*	*N/A*
	Public Outreach and Education	$1,150,000	N/A	N/A	N/A
	Mobile Applications (Watr)	$140,000	N/A	N/A	N/A
	Drinking Water Promotion	$150,000	N/A	N/A	N/A
	Outdoor Water Use Programs	$300,000	N/A	N/A	N/A
Research	**Water Reuse and Demand Management**	$550,000	N/A	N/A	N/A
	Water Conservation and Rebound Effects Study	$100,000	N/A	N/A	N/A
	Water/Energy Nexus	$60,000	N/A	N/A	N/A
	Water Softening Pilot Rebate Study	*$100,000*	*N/A*	*N/A*	*N/A*
	Municipal Upgrades Best Practices Study	$25,000	N/A	N/A	N/A
	Distribution System Pressure Management	*$20,000*	*100*	*$200*	$468,000
	Automated Meter Reading Study	$180,000	N/A	N/A	N/A
	Cooling Tower Audit Research Program	*$120,000*	*15*	*$8,000*	$70,200
	Irrigation Audit (Water Smart Irrigation Professional)	*$27,000*	*30*	*$913*	$138,477
	Irrigation System Rebates	*$18,000*	*6*	*$3,042*	$27,695
	Water Efficiency Strategy Implementation	$3,775,200	N/A	N/A	N/A
	Total	**$13,593,653**	**6,265**	**$2,170**	**$29,319,296**

ES-9 Summary

The City of Guelph continues to face challenges in receiving timely regulatory approvals for new water supplies, with known new water supply opportunities bound by significant periods of study time and financial investments prior to approval. In absence of securing new water supplies, Water Services actively monitors available water capacity, and forecasts possible environmental conditions, to ensure adequate servicing capacity is available and Permit to Take Water terms are honored when taking water supply stations offline for required maintenance. To date water servicing capacity reclaimed through Water Conservation and Efficiency (which is directly under City's authority/autonomy) has helped to create servicing contingency to bridge wait periods for regulatory approval and support the planning, sequencing and execution of maintenance activities.

As illustrated in Figure ES-6, the program recommendations outlined in this update are projected to exceed the 2027 target set by the 2014 Water Supply Master Plan. This will place the City ahead of schedule to meet the 2014 Water Supply Master Plan target of reducing annual average day production by 9,147 cubic metres per day by 2038.

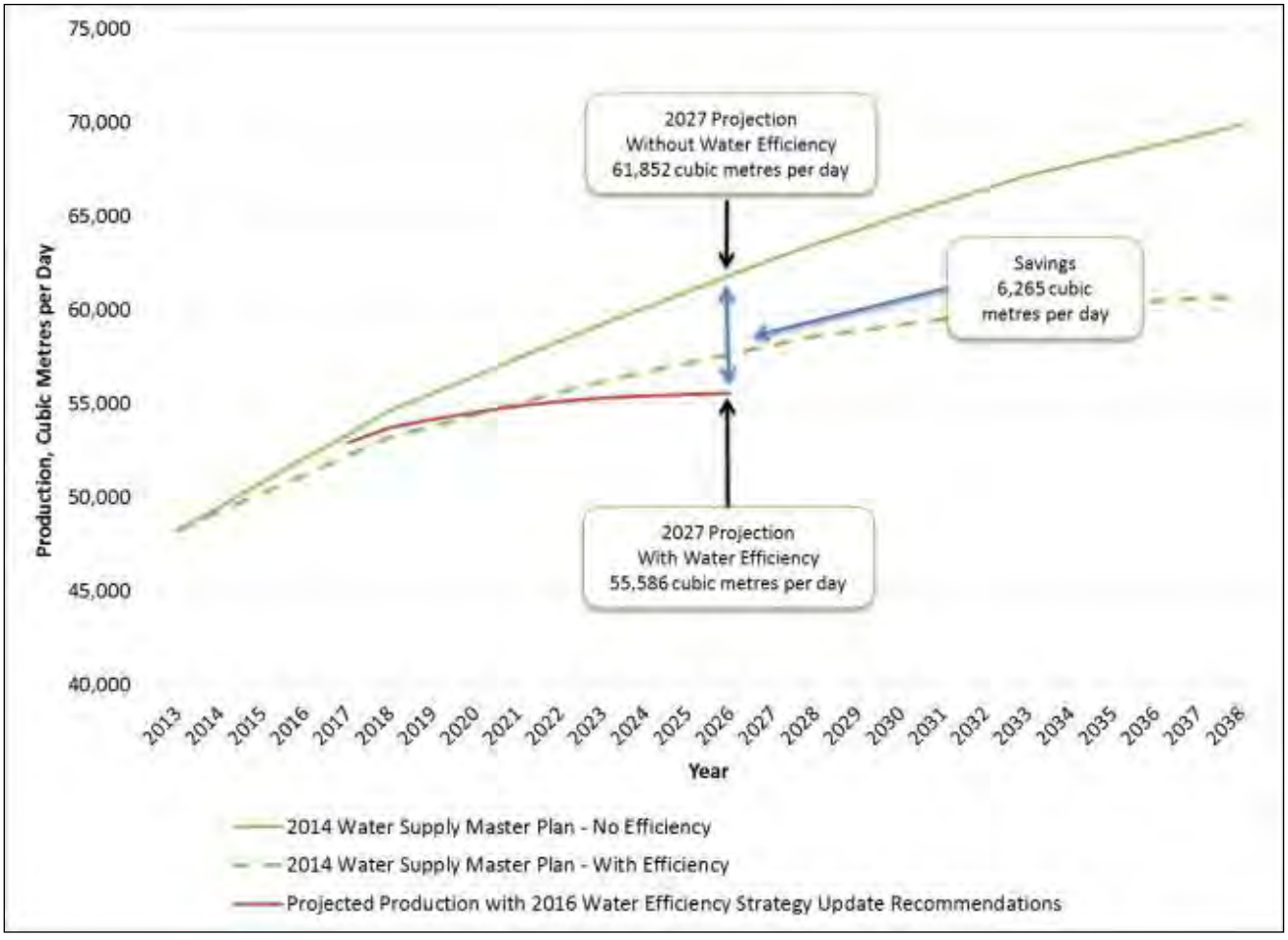

Figure ES-6: Projected Production with and without Water Efficiency Programs/Measures as per the Water Efficiency Strategy

As Guelph's Water Efficiency Strategy has been designed to reduce the need for costly infrastructure expansion projects, to reduce the cost of operations, and to minimize the environmental impact associated with their water and wastewater systems, it is important that Guelph's water efficiency measures achieve their expected water savings – if not on a per measure basis, at least on a program-wide net basis. As such, the City should continue to track overall water production values, overall water demand values, and per capita water demand values for the various customer sectors.

This Water Efficiency Strategy Update is expected to build on the City's previous success to achieve the following:

- Continue to increase the awareness and consumer perception of the value and importance of a safe, dependable water supply.
- Promote innovation and research new emerging water efficiency technologies.
- Achieve a reduction in annual average day production of 6,265 cubic metres per day by 2027, contributing to the 2038 target of a reduction in annual average day production of 9,147 cubic metres per day as outlined in the Council approved 2014 Water Supply Master Plan.
- Provide a financial net benefit of approximately $15.7 million in deferred water and wastewater capacity expansion.
- Assist with keeping water rates low by ensuring efficiencies within Water Services.
- Eliminate the need for a Guelph Lake Water Treatment Plant and a final expansion of the wastewater treatment plant (valued at approximately $37 million in 2014 Water Supply Master Plan).

Throughout the Update process, a common theme emphasised via public consultation in general was the importance of innovation and the necessity to pursue new technology to allow for future potential in water efficiency. The recommendations outlined in this report are not only projected to achieve the targets set out in the 2014 Water Supply Master Plan, but allow for further research and innovation with the intent to progress water efficiency and develop new measures and programming that can be utilized for future water savings.

It is anticipated that this Strategy will be revised starting in 2019 for implementation in 2022 following the revision of the 2014 Water Supply Master Plan. At this time, if new water reduction targets are set, the programs set for implementation in 2022 and beyond will be reviewed to ensure they are still relevant based on market changes and programming requirements.

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1.0 INTRODUCTION

1.1 *Background - Water Efficiency in Guelph*

Like many municipalities, the City of Guelph continues to grow. Along with population growth comes more jobs and businesses, which means increasing water use, as well as, potential threats to our drinking water supply. Guelph's groundwater supply requires us to use water efficiently so to limit impacts to our finite water resources, while meeting the future water needs of our community.

The City of Guelph continues to be a leading Canadian municipality in the field of water conservation and efficiency. Water Efficiency is recognised as a best management practice for water utilities by the Federation of Canadian Municipalities, National Research Council and the American Water Works Association. The success of Guelph's water conservation and efficiency programs has helped to protect the City's water supply. This has been achieved by reducing water demand on a daily basis as Guelph pumps less water from the aquifer which, in turn, ensures that more water is made available for future use and the current system can accommodate our reduced peak water demands. Less pumping also means less dependence on regular rainfall events to recharge the aquifer, a factor that is becoming less predictable as our climate changes. Wetlands, streams and rivers all benefit when we take less water from our natural systems as this helps keep aquatic ecosystems, including fish and aquatic plants that live in them, healthy. Community participation in Guelph's water conservation programs has not only led to reduced water demand, but also to reductions in the amount of electricity and chemicals used to treat and convey water and wastewater. The City estimates that the conservation and efficiency programs has resulted in annual operational savings of over $534,000 per year, a significant financial benefit to our rate payers (City of Guelph, 2016). As a result of such efforts, the City's water and wastewater rates remain low and close to the median of Council approved comparable Ontario municipalities.

Water conservation has been an integral part of water management within the City of Guelph for almost 20 years. In June 1998, the City of Guelph initiated a Water Conservation and Efficiency Study which developed a comprehensive water conservation and efficiency program targeted to residential, industrial, commercial and institutional sectors. This study highlighted the relationships between the environment, technical, regulatory and social acceptability of numerous water efficiency alternatives. Upon completion of the study, the 1999 Water Conservation and Efficiency Program were implemented in part through various Council approved pilot programs.

In 2004, the City commenced a Water Supply Master Plan which looked to ensure water supply was available for future growth as identified in the Province of Ontario's Places to Grow legislation. The Water Supply Master Plan process evaluated the potential growth in water demands associated with expected population growth over a 50-year planning horizon and identified preferred future sources of water supply in meeting the future needs of the Guelph community. Upon completion and endorsement by City Council in 2007, the final Water Supply Master Plan identified enhanced water conservation and efficiency as the top priority in reclaiming finite water supply capacity and identified three time-based annual average day water reduction targets based on 2006 average daily water production to guide the City's Water Conservation Program, stated below for reference:

- Reduction of 10 percent (5,300 cubic metres per day) of 2006 production by 2010;
- Reduction of 15 percent (7,950 cubic metres per day) of 2006 production by 2017; and
- Reduction of 20 percent (10,600 cubic metres per day) of 2006 production by 2025.

As presented in Figure 1, the green line represents a "do nothing approach" where the purple line represents water savings from water conservation and efficiency.

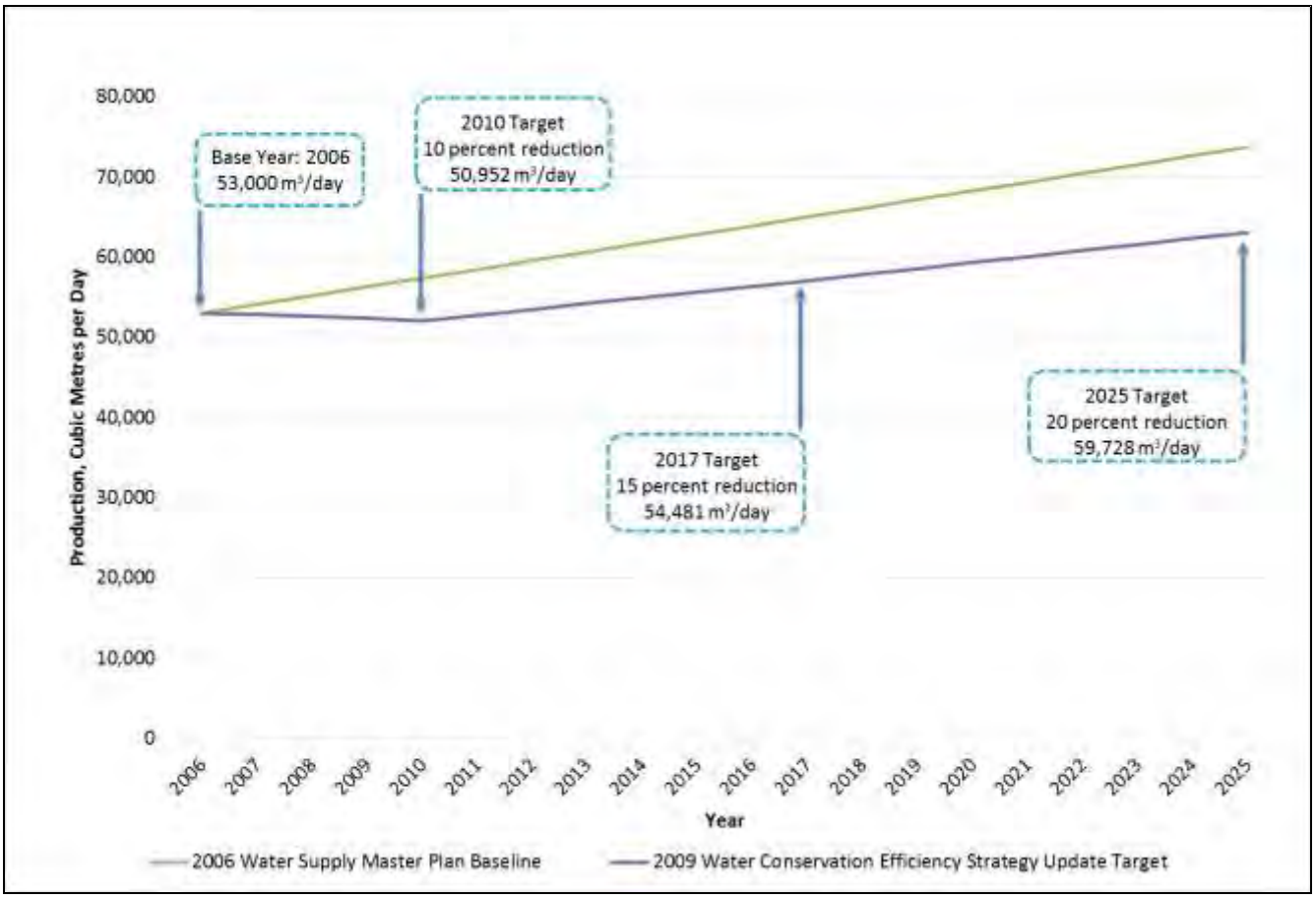


Figure 1: Establishing Targets for the 2009 Water Conservation and Efficiency Strategy Update

In 2008, an update to the Water Conservation and Efficiency Strategy was initiated to define preferred water conservation and efficiency programs to meet the water reduction goals of the 2007 Water Supply Master Plan (Figure 1). This Strategy Update, endorsed by City Council in 2009, reinforced water conservation as the most immediate and cost effective source of new water supply and defined programming recommendations for various sectors to meet the target 10-year water production reductions. The 2009 Water Conservation and Efficiency Strategy not only met but exceeded the goals of the Water Supply Master Plan by an additional reduction in water production of 1,370 cubic metres per day (purple line).

In July 2014, Guelph City Council approved an update to the City's 2007 Water Supply Master Plan (http://guelph.ca/plans-and-strategies/water-supply-master-plan/). This plan evaluated water needs associated with community growth over a 25 year planning horizon (from 2013 to 2038) and identified a series of preferred water supply projects to achieve our future community water supply requirements. Through this detailed master plan, water capacity reclaimed through Water Conservation and Efficiency was once again identified as the most cost effect and immediate source of water supply and, as a result, the primary programming recommendation of this plan. This plan also outlined the value of multiple water conservation program scenarios with the final 2014 Water Supply Master Plan recommending the City's water production reduction target be revised to achieve an additional 9,147 cubic meters per average day of supply capacity by 2038, the planning period of the City's Official Plan.

With this revised target, the City initiated an update to the 2009 Water Conservation and Efficiency Strategy in February 2015 to define the preferred programs, resources and policies to meet our community's desired water future. With Guelph's great successes in water conservation to date it is necessary that the City's approach to water management will need to change over time, as certain programs reach their potential and other opportunities come forward (e.g. technology improvements, new community engagement approaches, etcetera). Furthermore, there have been proactive changes to the Ontario Building Code and updates to related City master planning documents supporting enhanced efficient use of water. With this in mind, the 2016 Water Efficiency Strategy Update aims to reflect these changes and advances to ensure ongoing benefit and value to our community.

1.2 *Linkages to Other City Initiatives*

Water efficiency is a core community objective which transitions across City operations and future planning activities. Since the development of the 2009 Water Conservation and Efficiency Strategy, many key City planning documents have been updated. These reflect the changing demographics and regulatory environment within the City's municipal services. While each document reflects its respective core business function, many also influence water use efficiency and resource protection (Figure 2). For the reader's reference, further information on these documents and respective Water Efficiency Strategy linkages are presented below.

Figure 2: Linkages to Other City of Guelph Initiatives

1.2.1 City of Guelph Corporate Strategic Plan

The City's Strategic Plan identifies ways the City works to ensure it prospers today and in the future (http://guelph.ca/plans-and-strategies/corporate-strategic-plan/). The 2012-2016 Corporate Strategic Plan vision, mission, goals and strategic focus areas are noted below (Table 1).

Table 1: City of Guelph's Corporate Strategic Plan (2012 – 2016)

Vision	To be the City that makes a difference… acting locally and globally to improve the lives of residents, the broader community and the world.
Mission	To build an exceptional City by providing outstanding municipal service and value.
Values	Integrity, Excellence, Wellness
Strategic Focus Areas	1. Organizational Excellence 2. Innovation in Local Government 3. City Building

The strategic plan is an ongoing priority setting and decision making management tool. Within the 2012-2016 framework, the Water Efficiency Strategy encompasses all three strategic focus areas including creating a community that is attractive for business, delivering public services better, being accountable and transparent, and working collaboratively with other City departments and the community.

1.2.2 City of Guelph Official Plan

The City of Guelph Official Plan (http://guelph.ca/plans-and-strategies/official-plan/) is a statement of goals, objectives and policies for growth and development for the next 20 years. The Official Plan is developed based on input from the community and it promotes the public interest in the future development of the City. The Official Plan is focused on sustainability and establishes policies that have a positive effect on the social, economic, cultural and natural environment of the city. The Official Plan strives to maintain a high quality of life for the residents of Guelph, reduce uncertainty concerning future development, and provides a basis for the Zoning By-law and other land use controls.

The Official Plan also includes policies for the protection of water resources including the City's drinking water sources, as well as, surface water and groundwater features. The protection of the quality and quantity of these resources is important in order for the City to provide safe and reliable sources of drinking water for its residents, as well as, for the protection of natural heritage features including rivers, streams, fish habitat and wetlands.

1.2.2.1 Natural Heritage System

One of the City's most valuable assets is its natural heritage system (http://guelph.ca/plans-and-strategies/natural-heritage-strategy/). How the City protects, maintains, enhances and restores its natural heritage system is part of an environment first approach for managing the natural heritage features and areas in the City and includes updated policies with the City's Official Plan.

Building on the recommendations of the City's Natural Heritage Strategy, the City updated its natural heritage policies included in the Official Plan through Official Plan Amendment No. 42 (OPA 42). The objectives of the Natural Heritage System policies include implementing a system based approach to ensure that the connectivity, long-term ecological functions and biodiversity of natural heritage features in the City are maintained, restored or where possible improved, and recognises the linkages between and among natural heritage features and areas, surface water features and ground water features.

The City's Natural Heritage System is made up of a combination of natural heritage features and areas. Together, these elements represent the City's biological, hydrological and geological diversity, support ecological and hydrologic functions, provide connectivity, support populations of indigenous species, and sustain local biodiversity.

1.2.2.2 Growth Management Strategy

In 2009, the City completed the development of a Local Growth Management Strategy to manage the future residential and employment growth attributed to the City by the Provincial Growth Plan for the Greater Golden Horseshoe (http://guelph.ca/plans-and-strategies/growth-management-strategy/). The City's Official Plan, which is currently implementing the objectives and recommendations from the Local Growth Management Strategy, plans to achieve a population of 175,000 and employment of 92,000 by the year 2031. This future growth is expected to be accommodated throughout the entire City, however, a minimum of 40 percent of new residential development is planned to occur within the built-up area of the City.

Through the City's updates to the Official Plan, the following direction is provided:

- The City plans to grow to a population of 175,000 by the year 2031 (equivalent to a Census population of 169,000).
- The City plans for a steady rate of population increase.
- The employment growth in the City is planned to keep pace with population growth.
- Intensification is encouraged, where a minimum of 40 percent of future residential development is planned to occur within the built-up area.
- That the objectives of the Provincial Growth Plan to 2031 will be accommodated on lands contained within the existing corporate boundaries for the City of Guelph.

Amendment number two to the Growth Plan, which was released by the Province in 2013, extends the population and employment forecasts to 2041 for municipalities located within the Greater Golden Horseshoe. The amendment forecasts Guelph to grow to a population of 191,000 and 101,000 jobs by 2041. The City is currently assessing these updated figures to determine if they are sustainable.

1.2.3 **Water Supply Master Planning**

Water Supply Master Planning is key to ensuring the long term water supply capacity for the City of Guelph (http://guelph.ca/plans-and-strategies/water-supply-master-plan/). Updating these documents on a five years cycle allows for the review of our existing system and an opportunity to discuss with the community how to best manage future water supply needs.

In 2007, the Water Supply Master Plan's purpose was to "carry out a study to identify a strategy that will increase the capacity of the City's existing water system and provide additional security of supply." Further, the purpose was to provide water supply in a, "safe, reliable and cost-effective manner to satisfy current and long-term municipal demand requirements." (Earth Tech Canada Inc., Lura Consulting, Lotowater Geoscience Consultants Ltd., C.N. Watson and Associates Ltd., 2006). This plan identified three time-based annual average day water reduction targets based on 2006 average daily water production:

- Reduction of 10 percent (5,300 cubic metres per day) of 2006 production by 2010;
- Reduction of 15 percent (7,950 cubic metres per day) of 2006 production by 2017; and
- Reduction of 20 percent (10,600 cubic metres per day) of 2006 production by 2025.

In July 2014, Guelph City Council approved an update to the City's 2007 Water Supply Master Plan. The 2014 Water Supply Master Plan evaluated water needs associated with community growth over a 25-year planning period and identified a series of preferred water supply projects to meet the City's future community water supply requirements. Through this detailed Master Plan, water capacity reclaimed through water conservation and efficiency was again identified as the most cost–effective and immediate source of available water supply. As a result, it was selected as the primary programming recommendation of this plan.

The 2014 Water Supply Master Plan built upon previous water efficiency efforts completed within the City and considered more recent studies and work activities completed over the past six years. Baseline water production projections and production reduction targets outlined in the 2007 Water Supply Master Plan were revised to reflect the lower production rates being experienced by the City. The 2014 Water Supply Master Plan projected that baseline production rates (i.e., without water efficiency or conservation) would increase from 48,253 cubic metres per day in 2013 to 69,872 cubic metres per day in 2038 as presented in the Figure 3.

The 2014 Water Supply Master Plan also set a target of reducing this projected 2038 water production rate by 9,147 cubic metres per day to 60,725 cubic metres per day average water production – a reduction of about 13 percent in average day water use (Figure 3).

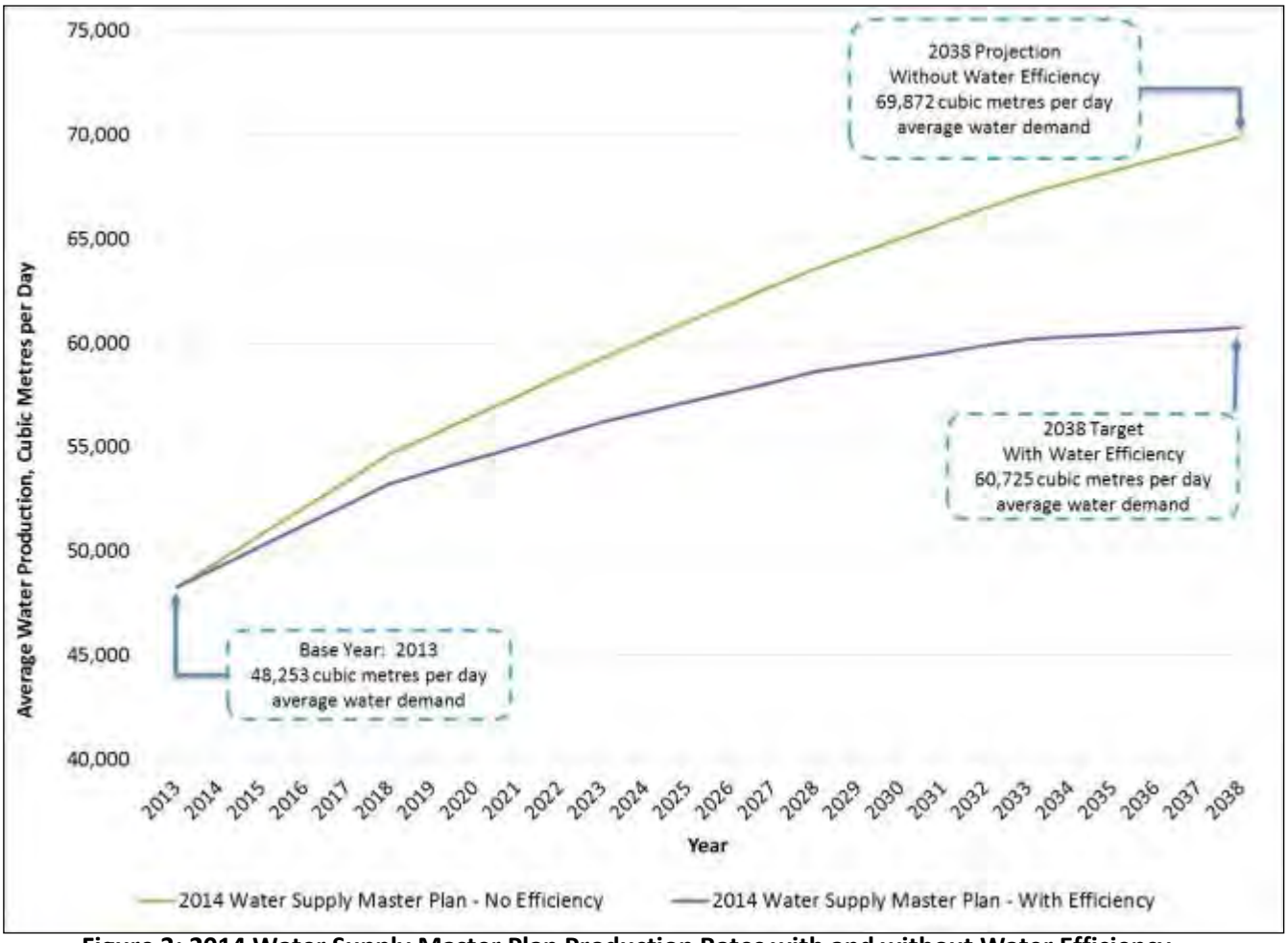


Figure 3: 2014 Water Supply Master Plan Production Rates with and without Water Efficiency

The 2014 Water Supply Master Plan projections and targets were developed based on expected population growth in the City, residential water demands, industrial, commercial, and institutional water demands (based on equivalent population values), and non-revenue water volumes. Figure 4 and Table 2 present the 2014 Water Supply Master Plan baseline and target values based on achieving a 13 percent reduction in residential, employment, and non-revenue water demands between 2013 and 2038. It should be noted that because of the growing population the overall average daily demand for the City, as well as demands for all sub-sectors, will continue to increase under both the baseline (no efficiency and conservation) and target savings scenarios.

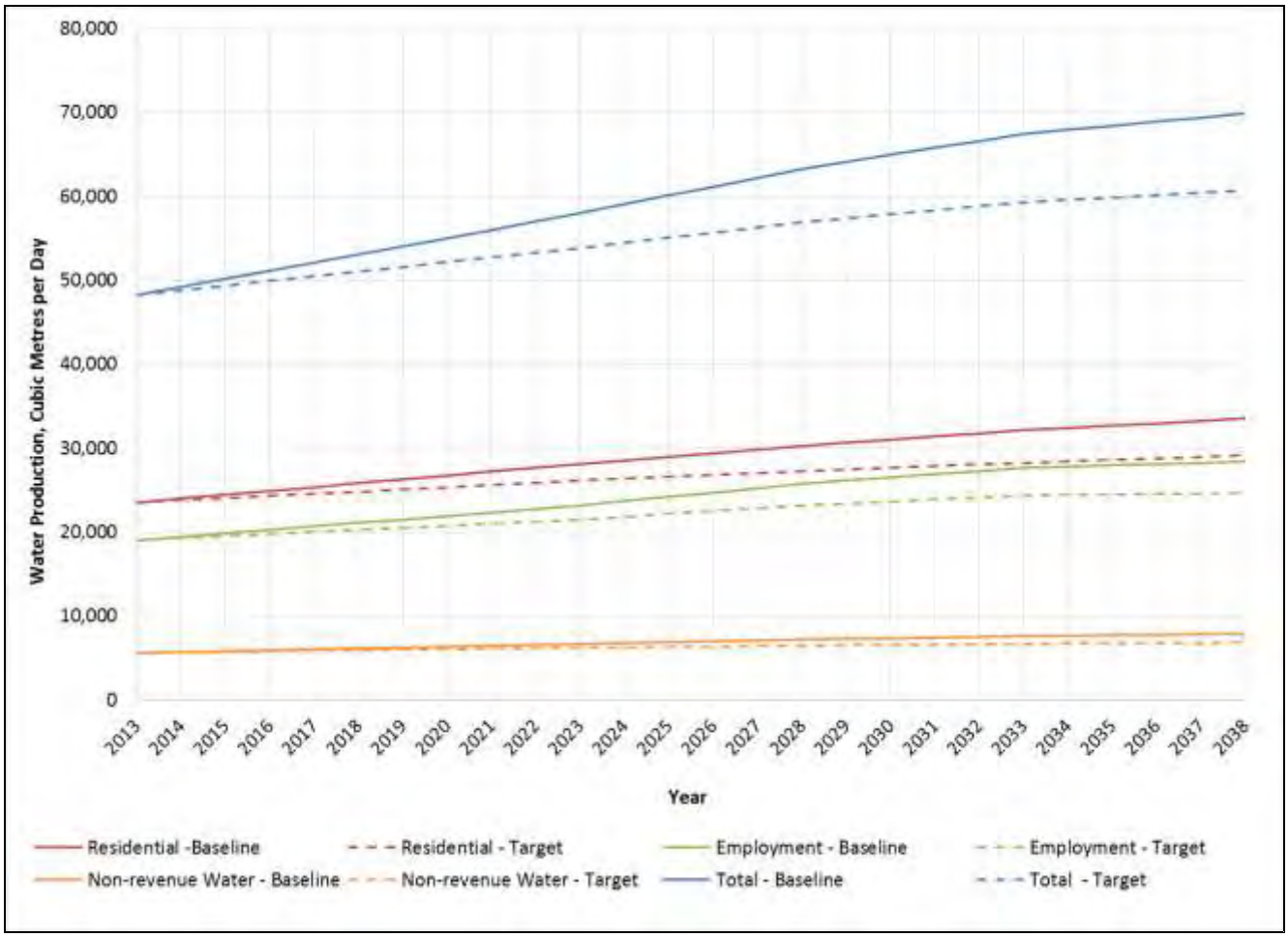


Figure 4: 2014 Draft Water Supply Master Plan Production Projections and Targets

Table 2: 2014 Draft Water Supply Master Plan Production Projections and Targets, Cubic Metres per Day

Year	Residential		Employment		Non-revenue Water		Total	
	Baseline	Target	Baseline	Target	Baseline	Target	Baseline	Target
2013	23,536	23,536	19,059	19,059	5,658	5,658	48,253	48,253
2018	25,843	24,842	21,100	20,283	6,175	5,936	53,118	51,061
2023	28,150	26,152	23,140	21,497	6,691	6,216	57,981	53,865
2028	30,293	27,246	25,803	23,207	7,208	6,483	63,304	56,936
2033	32,144	28,272	27,690	24,354	7,628	6,709	67,462	59,335
2038	33,555	29,162	28,413	24,693	7,903	6,868	69,871	60,724

When demands are presented on a per capita basis it appears that the 2014 Water Supply Master Plan is targeting declining demands overall and for all sub-sectors (Figure 5 and Table 3).

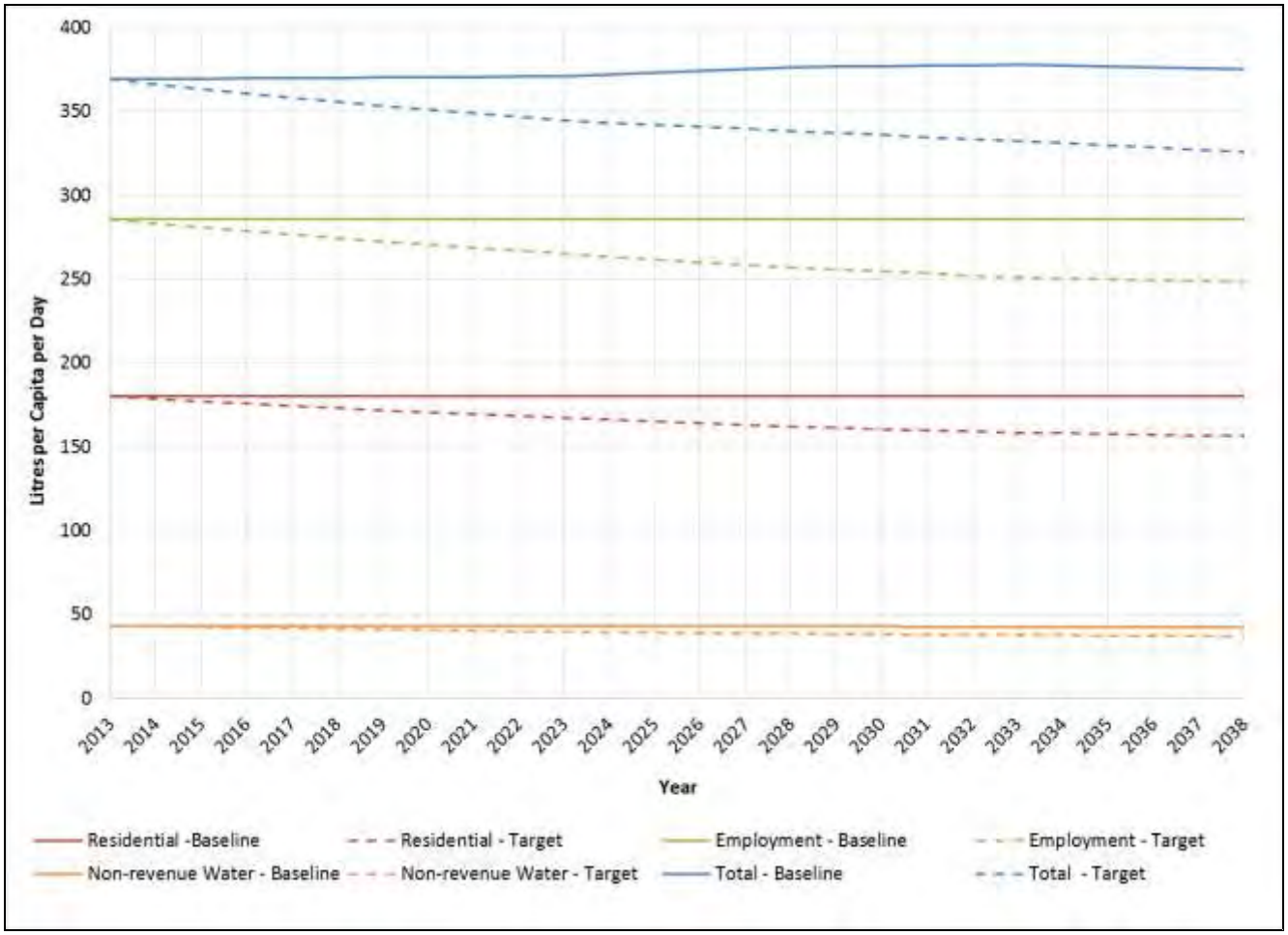


Figure 5: 2014 Water Supply Master Plan Litres Per Capita, per Day Projections and Targets

Table 3: 2014 Draft Water Supply Master Plan Water Production Projections and Targets, Litres per Capita per Average Day

Year	Residential		Employment		Non-revenue Water		Total	
	Baseline	Target	Baseline	Target	Baseline	Target	Baseline	Target
2013	180	180	286	286	43	43	369	369
2018	180	173	286	275	43	41	370	356
2023	180	167	286	265	43	40	371	345
2028	180	162	286	257	43	39	376	339
2033	180	158	286	251	43	38	378	332
2038	180	157	286	248	42	37	375	326

Note that for illustrative purposes a 13 percent reduction has been shown for all sub-sectors; in reality, more savings may be achieved in some sub-sectors and less savings in others. The key target is an *overall* reduction in production rates of 9,147 cubic metres per day or 13 percent in average day water use by 2038. Therefore, these targets have defined the goals of the 2016 Water Efficiency Strategy Update and the programming proposed in this document in Section 13 and implementation plan in Section 14.

1.2.4 Water and Wastewater Master Service Plan

In 2008, the City completed the Water and Wastewater Servicing Master Plan (http://guelph.ca/plans-and-strategies/water-and-wastewater-servicing-master-plan/). This plan confirmed the operations of each system to enhance reliability, efficiency and capability to service existing and new city residents well into the future. The projects were based on the Growth Management Strategy. The Plan identified preferred servicing strategies and related system improvements for water distribution/ storage and wastewater conveyance.

This plan identified the need for the development of a water distribution hydraulic model to assist water loss management. Further, additional recommendations include the study for a large scale wastewater reuse initiative. Therefore, these two programs are included within the Water Efficiency Strategy.

1.2.5 Wastewater Treatment Master Plan

The purpose of the Wastewater Treatment Master plan is to provide strategy and direction for wastewater infrastructure planning, investment and implementation to the year 2054 (http://guelph.ca/wp-content/uploads/WastewaterTreatmentMasterPlan.pdf). The 2009 Wastewater Treatment Master Plan identified water conservation initiatives as a key component of the master plan and as a non-expansion, source control alternative as water conservation leads to a reduced per capita wastewater generation for the City. Therefore, the Wastewater Treatment Master Plan recommends that short-term water conservation will achieve a 20 percent reduction in water consumption (10 percent by 2010) if the Water Conservation and Efficiency Strategy is fully implemented.

Water conservation was also included in the long-term forecast which would lead to a 15 percent reduction in per capita water consumption by 2017, and 20 percent by 2025 (CH2M Hill, 2009).

Lastly, water reuse was also considered as part of the long-term plan for the wastewater treatment plant. With water conservation and reuse as significant aspects of the 2009 Wastewater Treatment Master Plan, the link between the Water Efficiency Strategy and this initiative can easily be seen, as such the Water Efficiency Strategy aims to meet the targets outlined in the 2009 Wastewater Treatment Master Plan.

1.2.6 Stormwater Management Master Plan

The Stormwater Management Master Plan is a long-term plan for the safe and effective management of stormwater runoff from existing urban areas, while improving the ecosystem health and ecological sustainability of the Eramosa and Speed Rivers and their tributaries (http://guelph.ca/plans-and-strategies/stormwater-management/). The Plan's approach is to integrate flood control and stormwater drainage with opportunities to improve and protect groundwater and surface water quality and the natural environment.

Three key areas are identified in the plan which related to Water Efficiency. These include; management of stormwater runoff as it related to aquifer recharge, low impact development to increase the efficient use of outdoor water and water sensitive urban design to minimize impacts to water quality.

1.2.7 Grand River Source Water Protection Plan

The Grand River Source Water Protection Plan (http://guelph.ca/living/environment/water/source-water-protection-program/) aims to ensure clean, safe drinking water for the City of Guelph. As required under the Clean Water Act, the City of Guelph's Source Protection Plan contains a number of policies to manage water quality. This includes specific education and outreach policies with respect to water quality, such a winter salt use.

Policies to manage water quantity threats have not been developed as yet but it is anticipated that such policies will be developed and approved by the province before the revision to the Water Efficiency Strategy in 2022. The water quantity polices that will be developed will likely consider water conservation, efficiency and sustainability. There will also be a public education and outreach component of the program.

1.2.8 Urban Forest Management Plan

The City's 2012 Urban Forest Management Plan (http://guelph.ca/plans-and-strategies/urban-forest-management-plan/) ensures a healthy urban forest which cleans air, conserves energy, decreases water use, increases property values and makes Guelph's neighbourhoods more beautiful and enjoyable. Guelph is committed to having the highest tree canopy among comparable municipalities.

The City's Healthy Landscapes program is identified as one method in which the City can communicate with residents about their outdoor water use. This includes the promotion of trees to assist with the urban tree cover, the planting of non-invasive plants and best practices. Further, the program forges relationships with the community and local businesses.

The Healthy Landscapes program is one key component of the Water Efficiency Strategy and is linked here through the Urban Forest Management Plan.

1.2.9 Community Energy Initiative

The goal of the Community Energy Initiative (http://guelph.ca/plans-and-strategies/community-energy-initiative/) is to manage energy differently and better than the City has in the past. The Community Energy Initiative outlines three Goals for Guelph. These are:

1) Use less energy in 25 years than we do today;
2) Consume less energy per capita than comparable Canadian Cities;
3) Produce less greenhouse gases per capita than the current global average.

The Water Efficiency Strategy helps the City achieve these goals as using less water, thus using less energy. This is further described in Section 5.0 of the report.

1.2.10 Ontario Low Water Response

Ontario Low Water Response Plan coordinates and facilitates provincial and local efforts in managing "low water conditions". The City of Guelph is a member of the Ontario Low Water Response team for the Grand River Watershed. This team meets periodically to review watershed conditions and other information. Based on the available information, the team may declare a "low water condition" for all or part of the Grand River Watershed. The Ontario Low Water Response team is made up of water users and stakeholders in the Grand River Watershed including the Grand River Conservation Authority, municipalities, First Nations, farmers, golf courses, gravel pits, other levels of governments and private industry. The City's Outside Water Use Program has been developed and implemented to meet drought management requirements of the Ontario Low Water Response Plan for the Guelph community.

1.3 *Regulatory Linkages*

Beyond local policies and planning documents, the need for Water Efficiency is also defined through governing legislation at the Provincial Level. The following section describes the regulatory linkages between the water efficiency and existing provincial legislation and programs.

1.3.1 Ontario Water Resources Act

To protect the sustainability of the Province of Ontario's water resources, the Ontario Water Resources Act requires all private land owners seeking a permit for significant new water supply (50,000 litres or greater per day) to obtain a Permit to Take Water. Guelph currently maintains 22 Permits to Take Water, all requiring renewal, some as frequently as annually. As part of the Ministry of the Environment and Climate Change's application process for a new or renewed Permit to Take Water, the applicant must demonstrate current and future water conservation programs, which are taken into consideration by the Ministry of the Environment and Climate Change when determining whether to approve the Permit to Take Water application. Not maintaining a robust conservation program could jeopardize the City's ability to obtain new water supplies. Furthermore, if the Permit to Take Water is approved, our conservation programs become a regulatory requirement of the Permit to Take Water upon issuance. Revisions to current conservation programming could be construed as non-compliance.

1.3.2 Water Opportunities and Conservation Act

The Water Opportunities and Conservation Act require municipalities and other public agencies to develop a Water Sustainability Plan. These plans will allow the Minister of the Environment and Climate Change to establish performance indicators and targets for municipal water, wastewater and stormwater services and operations. Requirements of a Water Sustainability Plan include:

- an asset management plan;
- a financial plan;
- a water conservation plan;
- a risk assessment;
- strategies for maintaining and improving the service; and
- other prescribed information.

The detailed requirements of each component are not provided through the Act, however, it is anticipated that the Province will be releasing subsequent regulation defining associated requirements in the future.

1.3.3 **Clean Water Act**

The City of Guelph is committed to ensuring clean, safe drinking water for our citizens — today, and into the future. The Source Water Protection Program, managed under Ontario's Clean Water Act, is a key initiative in delivering on this commitment. The Clean Water Act was enacted in 2006 in response to the Walkerton tragedy. The aim of the Clean Water Act is to protect Ontario's existing and future municipal drinking water sources, and is part of an overall commitment to safeguard human health and the environment.

The Clean Water Act requires communities to develop collaborative, locally-driven, and science-based plans to protect existing and future municipal drinking water supplies. The Act and associated regulations also provide a framework for the development and implementation of local and watershed-based Source Protection Plans.

2.0 WATER EFFICIENCY STRATEGY DEVELOPMENT PROCESS

The 2016 Water Efficiency Strategy was comprised of a three-phase process designed to continually build on knowledge and feedback gained through research, analysis and community engagement findings in each phase. The development of the Water Efficiency Strategy was initiated in April 2015 and completed in September 2016. The process, as outlined graphically in Figure 6 below, resulted in a final strategy that benefitted from continual collaboration between the project team, City stakeholders, and Guelph water consumers.

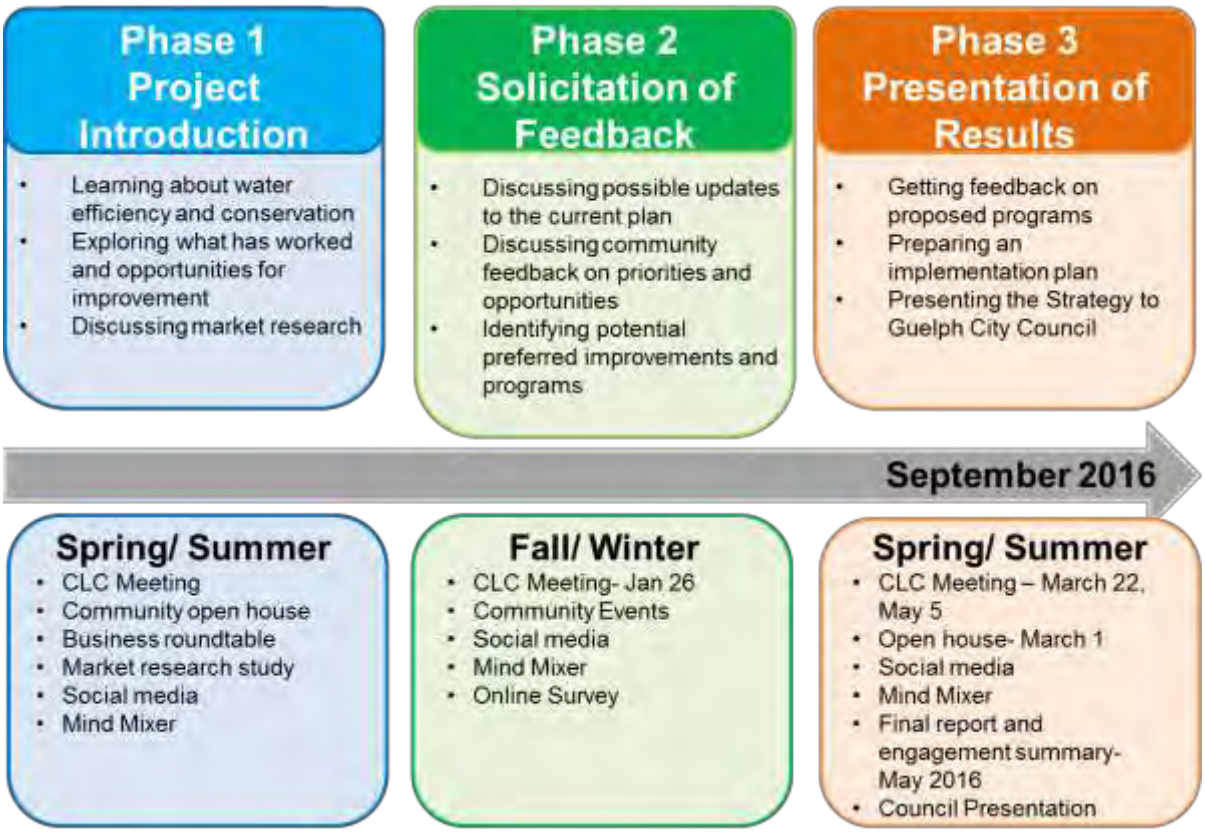


Figure 6: 2016 Water Efficiency Strategy Development Process

The Water Efficiency Strategy Update endeavoured to identify a set of preferred program alternatives, associated water savings, program implementation forecasts and supporting program resources required to meet the water reduction goals as outlined in the 2014 Water Supply Master Plan. The programs presented were developed for a 10-year planning horizon. The following sections describe the work completed during each phase of the strategy's development. For reference, the technical and consultation reports described below can be found at www.guelph.ca/wesu.

2.1 *Phase 1 – Project Introduction*

The Water Efficiency Strategy was initiated in April 2015. In order to create a solid foundation for the strategy development, research was completed to determine best in class water efficiency practices and emerging technologies in the field of water conservation and efficiency. Further, as community engagement was key to the strategy development process, a comprehensive community engagement plan was developed to gain feedback throughout strategy development from local stakeholders. Strategically engaging the community during the development of a municipal strategy can magnify the impact of municipal programs, leverage limited resources and, most significantly, move the marketplace toward desired water management practices.

Market research for all affected sectors was also completed in concert with technical research in order to identify options that marry technical applications with market-based opportunities. The following tasks were completed as part of Phase 1 of the 2016 Water Efficiency Strategy Update:

- Completion of a market research session with a demographically representation sample of single-family homeowners in the City;
- Interviews with key informants (business owners and managers) to supplement the market research from the residential sector;
- Research and preparation of a literature review of available information on water efficiency best management practices;
- Preparation of technical memoranda discussing the extent of current municipal practice, market potential and local feasibility of selected topics of interest in the field of water conservation; and
- Hosting of an introductory Community Liaison Committee meeting and a public open house.

2.2 *Phase 2 – Solicitation of Feedback*

A list of potential programs was developed from the research and input gathered during the completion of the Phase 1 tasks. In order to narrow the list of programs, evaluation criteria were developed and presented to the public for feedback. The public was asked to identify which criteria were most important to them (Section 3). The resulting criteria were then further refined and weighted based on consultation from the Community Liaison Committee and the public (Section 9). This process created a draft list of programs which were presented to the public in Phase 3 of the strategy development. The following list of tasks was completed as part of Phase 2 of the 2016 Water Efficiency Strategy Update:

- Development of evaluation criteria to assess potential water efficiency programs;
- Attendance at Public Events to gain feedback on weighting of the criteria being developed to assess the long-list of potential water efficiency programs;
- Hosting of Community Liaison Committee meeting to gain feedback on criteria and weighting;
- Preparation of program alternatives report outlining the short-listed programs that resulted from scoring weighted by public feedback;
- Development of a financial model to evaluate economic benefit of capital deferral and associated operational expenses;
- Modelling of alternative strategies and annual water reduction targets and the affordability to local rate payers; and

- Development of a 10-year Water Efficiency Strategy update implementation plan to meet the targets of the 2014 Water Supply Master Plan.

2.3 *Phase 3 – Presentation of Results*

Once Phase 2 was completed, the listing of draft final recommended programs was ready to be presented to the public for final comment. This final report summarizes the findings, feedback and results that formed the programs which will ensure the water savings targets are met. Program descriptions (Section 13 and Appendix A) and recommendations for the next 20-year planning period, with specific focus to the immediate 5-year planning period (2017-2022), were developed and are presented in Section 13 of this report. The following tasks were completed as part of Phase 3:

- Presentation of proposed water efficiency programming at an open house to gain community feedback;
- Hosting of two Community Liaison Committee meetings to solicit feedback on the proposed programs;
- Preparation of a draft final report to present to the public for comments;
- Preparation of a final report incorporating feedback gained from City Stakeholders and the public, and;
- Presentation of the report to City council for approval in September 2016.

The following sections in this report provide more detail with respect to the progress and final reporting products as outlined above.

3.0 COMMUNITY ENGAGEMENT

Community engagement is an important part to forming any successful strategy. Effective public consultation ultimately results in a Strategy that is inclusive of the community's vision for water conservation and efficiency in Guelph.

As successful water conservation and efficiency programming involves actions of residents, as well as, industrial, commercial and institutional customers in the City, it was important that the engagement process endeavour to include as many of these stakeholders as possible through Strategy development. Consistent with the City's Community Engagement Framework, the Strategy Update engagement process involved diverse modes of community engagement targeted to reach respective community stakeholders throughout the Strategy development process. For reference, initiatives undertaken as part of the Water Efficiency Strategy update community engagement process are presented in Figure 7 and detailed below.

Figure 7: Water Efficiency Strategy Community Engagement Activities

3.1 *Community Liaison Committee*

A Community Liaison Committee was formed to provide a forum for community input and guidance to the Project Team throughout the Strategy development process. The Community Liaison Committee consisted of 20 key representatives which were drawn from a balanced variety of stakeholder groups that reflected a range of perspectives within the community. In alignment with the terms of its recruitment, the City's existing Water Conservation and Efficiency Public Advisory Committee was employed as part of the Community Liaison Committee, representing "Public at Large/Residential Rate Payers". For reference, Table 4 provides an overview of member stakeholder composition of the Committee. The full terms of reference for this committee, agendas and minutes from the meeting are presented at www.guelph.ca/wesu.

Table 4: Community Liason Committee Stakeholder Membership

Stakeholder Group	Stakeholder Category	Number of Members
Cargill ABS Friction	Business / Industry	2
University of Guelph	Academia	2
Reid's Heritage Homes	Home Builder / Developer	2
Guelph and District Home Builders' Association		
Wellington Water Watchers	Environmental Interest	3
Council of Canadians		
eMERGE Guelph		
Grand River Conservation Authority	Conservation Authority	1
Guelph Chamber of Commerce	Guelph Chamber of Commerce	1
Wellington County- Housing Services	Social Assisted / Rental Housing	1
Water Conservation and Efficiency Public Advisory Committee	Public at Large/ Residential Rate Payers	8

The mandate of the Community Liaison Committee was to provide an ongoing forum for consultation and feedback to the Project Team at key points throughout the development of the Guelph Water Efficiency Strategy Update, including:

- Objectives and scope of the Strategy Update;
- Issues and opportunities to be addressed;
- Alternative solutions to be assessed;
- Evaluation method and criteria to be applied; and
- Preferred alternatives and go-forward strategy;

The Community Liaison Committee also helped the Project Team ensure that Community Engagement efforts provided the public with a clear understanding of the project as well as identified opportunities to encourage

greater community participation in Strategy development, in honouring the City of Guelph's Community Engagement Framework.

In total, five meetings were held (June 2015, September 2015, January 2016, March 2016 and May 2016) at Guelph City Hall (1 Carden St, Guelph, ON N1H 3A1) lasting approximately 150 minutes each. A full summary of the meetings and their content is presented in Appendix B and at www.guelph.ca/wesu.

3.2 *Open Houses, Events and Online Engagement*

Public input beyond the Community Liaison Committee was important to gain insight from the community at large. To that end, three community consultation events were held between June 2015 and March 2016. A summary of these events is included in Appendix B. All public documents and discussion guides are presented at www.guelph.ca/wesu.

The following is a brief summary of these three public events.

An initial open house was held on June 23, 2015. This open house was to capture the community's feelings towards water and gain some insight into potential future programming to be considered in the Water Efficiency Strategy Development. In conjunction with the public open house, the online digital engagement tool MindMixer was also used to solicit further community input.

In place of a second Open House, People in Places Events were also held during summer 2015 at various community events, including Jazz Festival, VegFest, Village Fall Fair and Run for the Cure. At these events members of the project team asked the public to rank criteria on a scale of 1 to 5 to gain feedback from members of the public on what was important to them in looking to the evaluation of future water efficiency programming. These criteria were:

- Minimize Costs to the City
- Reduce water use as a part of new growth
- Reduce water use to existing buildings
- Similar the Guelph economy
- The technology is proven and easily implemented in the City of Guelph
- Develop/pilot new technologies to save water

In concert with these events, the public was asked to rank these same criteria on MindMixer. This feedback was also used in the development and weighting of the evaluation criteria for proposed water efficiency programs as presented in Section 9 of this report.

A third open house was held on March 1, 2016. This Open House kicked off a month of public engagement on the proposed draft water efficiency programming. Coupled with online engagement through MindMixer, "People in Places" displays and surveys travelled to various City Venues (City Hall and the West End Rec Centre) and the H2O Go Festival in Quebec Street Mall. The final draft was posted online for public review and received comments during a two week period which ended in May 2016

The results of these events and engagement activities are presented in Appendix B and online at www.guelph.ca/wesu.

3.3 *Market Research*

As part of the strategy update process focus groups were conducted for residential and commercial water users to gain additional context on their water use practices and evaluate their opinions on future water efficiency programming opportunities. A summary of these market research activities are presented below with further details found for reference in Appendix C and online at www.guelph.ca/wesu.

3.3.1 **Residential Market Research Study**

A residential market research session was held on June 16, 2015 including 32 residents, recruited to be demographically representative of single-family homeowners in Guelph. The following highlights the findings of the research session:

- Guelph residents typically used emotional terms such as “beauty”, “curb appeal”, “reflection of me [respondents]”, and “important” to describe what their home landscape means to them;
- Respondents indicated a high level of trust in peer groups (family, friends and neighbours) for advice about their home, landscape, design and third-party referrals;
- Aesthetics rank above function as the primary motivation for household expenditures for indoor and outdoor (landscape) renovations;
- Retailers and third–party service providers are primary “trusted” sources of materials and/or services pertaining to home and landscape improvements;
- Respondent recognition of Guelph’s outdoor water use levels was high; and
- Respondent recognition of Guelph’s Healthy Landscapes Home Visits program was low.

The findings from the residential research informed the development of programs to enhance uptake of water conservation and efficiency practices amongst property owners in the single-family residential sector. As an example, the Water Efficient Landscaping Incentives Program recommended in this report evolved from these key findings:

- Homeowners value their landscapes and view them as a reflection of themselves; therefore homeowners will more likely adopt water efficiency landscapes if suppliers stock appealing options in their stores. Retailers would stock more options if there was a demand for them. A rebate for water efficient landscapes should provide the incentive required to increase demand.
- Homeowners refer to landscape retailers for advice and view them as knowledgeable and trustworthy. Store owners would be more motivated to supply and recommend water efficient plants and designs if there is a demand for them.

The Homeowners Research Report is included in Appendix C.

3.3.2 **Business Market Research Study**

Businesses in the industrial, commercial, and institutional sectors, including builders/developers and relevant service providers (e.g., plumbers, landscaping contractors and retailers) in Guelph, were invited to participate in a market research study. The project team identified priority business sectors and sub-sectors to research by

securing a representative sample of Guelph-based businesses. The team ensured that high water use customers were captured in this research sample. Sixteen key informant interviews were selected from both the City's Economic Development Department Business Listing and a listing of water-using businesses operating in Guelph (determined through non-residential customer water demand analysis). The research sample was comprised of property owners/managers in the industrial, commercial and institutional sector, including builders/developers, and service providers in plumbing and landscaping. Table 5 provides a listing of the business sectors and representatives interviewed as part of market research.

Table 5: Key Business Research List

Business Sector	Organization
Industrial	Owens Corning Canada
	Gay Lea Foods
	LPP Manufacturing (A division of Linamar)
	Blount International
	Skyjack
Commercial	Primaris (A division of H&R REIT)
Institutional	Schlegel Villages
	St Joseph's Health Centre
Home Builders	Sloot Construction
	Gemini Homebuilders
Service Providers	The Landplan Collaborative Ltd
	Brydges Landscape Architecture Design
	Royal City Nursery
	AquaMaster (ACi Distributing Inc.)
	Jim-L Plumbing & Heating Inc.
	Wellington Plumbing & Heating Ltd.

Key informants were selected to contribute feedback regarding water efficiency programming. These interviews took place via phone calls and in-person meetings during the fall of 2015. Their responses helped to identify constraints of the current water efficiency and conservation programming and define opportunities for future water efficiency programming. Such feedback was considered in the development of the criteria for the programming selected included in Section 9 of this report.

Key themes noted from the interviews with key informants in the research sample are provided in Table 6 below for reference.

Table 6: Constraints and Opportunities

INDUSTRIAL, COMMERCIAL, AND INSTITUTIONAL	
Constraints	• The return on investment is often too long (greater than 3 years) for implementing water efficiency measures. • Currently the focus is on energy saving investments due to acceptable payback periods. • There is an administrative burden associated with participating in the City's Capacity Buyback Program. • Inconsistent and generic communications and engagement of businesses by City Capacity Buyback programming representatives.
Opportunities	• Corporate-level environmental commitment. • Reducing operating costs is a primary driver. • Willingness to make water saving investments (with a return on investment under 3 years).
BUILDERS/DEVELOPERS	
Constraints	• Must remain cost competitive. • Perception that buyers do not consider water efficiency a worthwhile upgrade. • Delays in approvals due to beyond code construction.
Opportunities	• Willingness to "push the envelope". • Most Net Zero homes qualify as a bronze Blue Built Home. • Builders are receptive to implementing water efficient measures as long as they are profitable. • Reduction in approvals time was identified as a potential driver.
SERVICE PROVIDER	
Constraints	• Services must be cost competitive. • One service provider indicated that it was unfair competition with City-subsidized "free" services. • Homeowners' preconceived priorities of aesthetics focused on "big flowery plants" and upgrades on finishes that they "can see and touch".
Opportunities	• High awareness of the latest technology/concepts in the marketplace. • Service all customer sectors (potential broad impact). • Willing to pursue further education and certification. • For service providers, the quality of service and cost competitiveness is major considerations/ drivers. • Service providers consider regional and municipal water conservation and efficiency initiatives as being developed in silos, but there is opportunity for collaboration and consistency of message.

For reference, the detailed Business Research Report is in Appendix C.

4.0 ANALYSIS OF WATER DEMAND AND CONSUMPTION BY SECTOR (2006 – 2014)

An analysis was completed of water demand by sector for the period 2006 to 2014 to determine how the current water conservation programs are preforming and confirm water production and demand rates for future planning. This analysis was completed by reviewing the metered customer billing data from January 2006 to December 2014 against the Municipal Property Assessment Corporation housing codes. Conducting analysis of the City's water demand highlighted areas of high demand and time based patterns of water use, therefore allowing for tailor-made programming in each sector.

4.1 *Historical Water Production and Demand Rates*

Since 2006, metered customer water demands (employment and residential) have accounted for about 85 percent of total water production volumes. Therefore, only about 15 percent of all water produced by the City is not used by its customers (Table 7[4]).

Table 7: Actual Production versus Actual Demand, 2006 – 2014

Year	Average Daily Production, Cubic Metres per Day	Average Daily Demand, Cubic Metres per Day	Percentage of Metered Demand of Total Demands, Water Production Volumes
2006	51,387	43,626	85
2007	51,005	43,188	85
2008	48,492	40,499	84
2009	46,607	39,120	84
2010	44,442	38,714	87
2011	45,578	39,460	87
2012	45,244	38,179	84
2013	44,379	38,326	86
2014	45,463	37,478	83

Water that is produced but not billed to customers is referred to as non-revenue water. Non-revenue water includes physical losses such as water used for firefighting, flushing of water mains, system leakage; un-metered municipal uses (e.g. commission of new infrastructure and apparent losses resulting from metering or accounting inaccuracies).

An analysis of the production and consumption values for 2006 and 2014 indicates that approximately 51 percent of the water produced was consumed by residential customers, 34 percent by industrial, commercial and institutional customers, and about 15 percent was attributed to non-revenue water (Figure 8 and Table 8).

[4] The water demand values presented were determined by dividing by the water rate by the revenue generated from the water rates to determine consumption. These values do not include potential back-billing, or rate changes and therefore are an under-estimate.

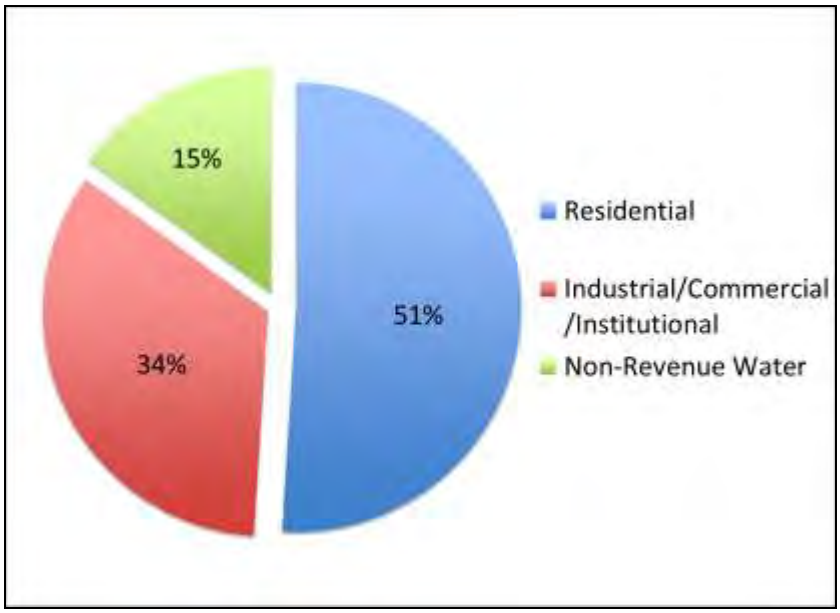


Figure 8: Historical Water Production, 2006 – 2014

Table 8: Historical Water Production, 2006 – 2014, Cubic Metres per Day

Year	Production	Residential Demand [4]	Industrial/Commercial /Institutional Demand[4]	Non-revenue Water
2006	51,387	25,752	17,873	7,762
2007	51,005	26,053	17,134	7,818
2008	48,492	25,013	15,486	7,993
2009	46,607	23,138	15,982	7,487
2010	44,442	22,635	16,079	5,728
2011	45,578	22,243	17,217	6,118
2012	45,244	23,233	14,946	7,065
2013	44,379	22,714	15,612	6,053
2014	45,463	22,373	15,374	7,716

Water production rates in Guelph have declined since 2006 despite a growing population. Between 2006 and 2014 the City's production rates declined by an average rate of approximately 852 cubic metres per day per year (based on the linear trend) and water consumption rates have declined by only slightly less by a rate of 725 cubic metres per day per year (Figure 9 and Table 9). The higher rate of production decline is a result of a higher rate of decline of non-revenue water than that of metered consumption.

While peak day demands (representing the absolute highest day of water utility production per year) have also declined by an average rate of 983 cubic metres per day per year during this time, peak demands are also highly variable from year to year based on local weather conditions – making them difficult to accurately predict in the future based on past results. Peak day demands generally occur after an extended period of hot

and dry weather and are largely due to an increase in irrigation demands. While an unusually hot or dry summer season would be expected to produce a high peak day demand, a cool and wet summer can also produce high peak day demands during a short period of drought (2-3 weeks) and annual irrigation season (May to September). During these seasonal periods the City's Outdoor Water Use Program continues to be very successful tool in curving the severe seasonal spikes in water use experienced in other Canadian and Ontario communities.

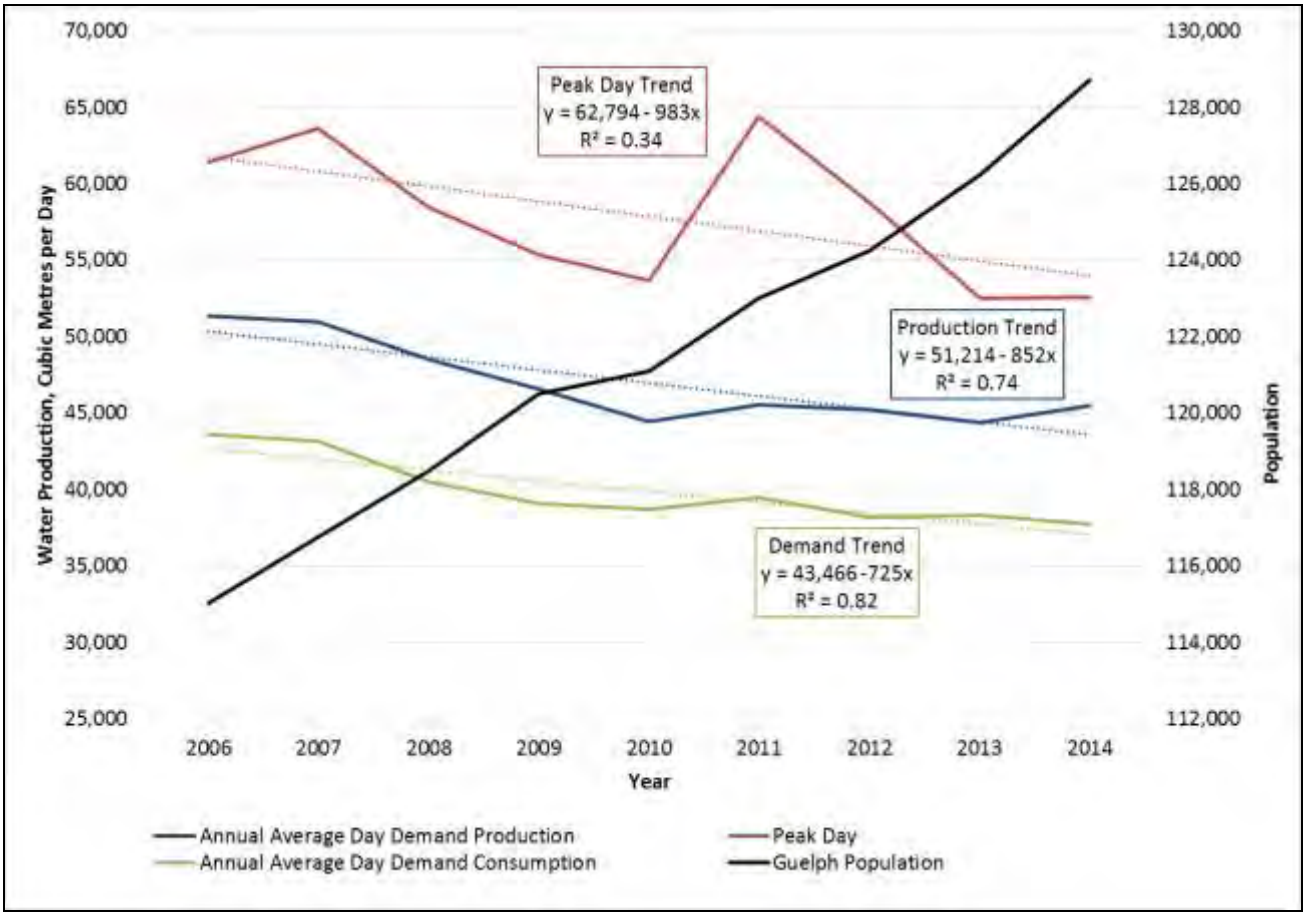


Figure 9: Historical Water Production and Water Demand Rates

It should be noted that when linear trend lines are included in figures in this report, the equation and R^2 value for the trend line is displayed. The R^2 value is a statistical measure of how close the data are to the fitted regression line - the higher the R^2 value the better the fit with a value of 1.0 indicating a perfect fit.

Table 9: Historical Water Production Values, 2006 - 2014, Cubic Meters per Day

Year	Population	Annual Average Day Production	Annual Average Day Consumption[4]	Peak Day
2006	115,040	51,387	43,626	61,456
2007	116,766	51,005	43,188	63,652
2008	118,491	48,492	40,499	58,440
2009	120,491	46,607	39,120	55,337
2010	121,093	44,442	38,714	53,691
2011	123,000	45,578	39,460	64,416
2012	124,250	45,244	38,179	58,764
2013	126,250	44,379	38,326	52,539
2014	128,726	45,463	37,748	52,614

4.2 *Per Capita Water Demands*

The real impact of improved water and conservation efficiency in the City is best illustrated by considering per capita demands. As presented in Figure 10 and Table 10, per capita rates declined for all aspects of water production between 2006 and 2014, including annual average day, average winter day, average summer day, and peak day. Annual average day production rates declined by an average rate of 12.3 litres per capita per average day per year (based on the linear trend), and winter day rates (reflecting indoor use) declined by 12.0 litres per capita per average day per year. By comparison, summer day rates declined by a rate of 12.6 litres per capita per average day per year, and peak day rates declined by 14.4 litres per capita per average day per year.

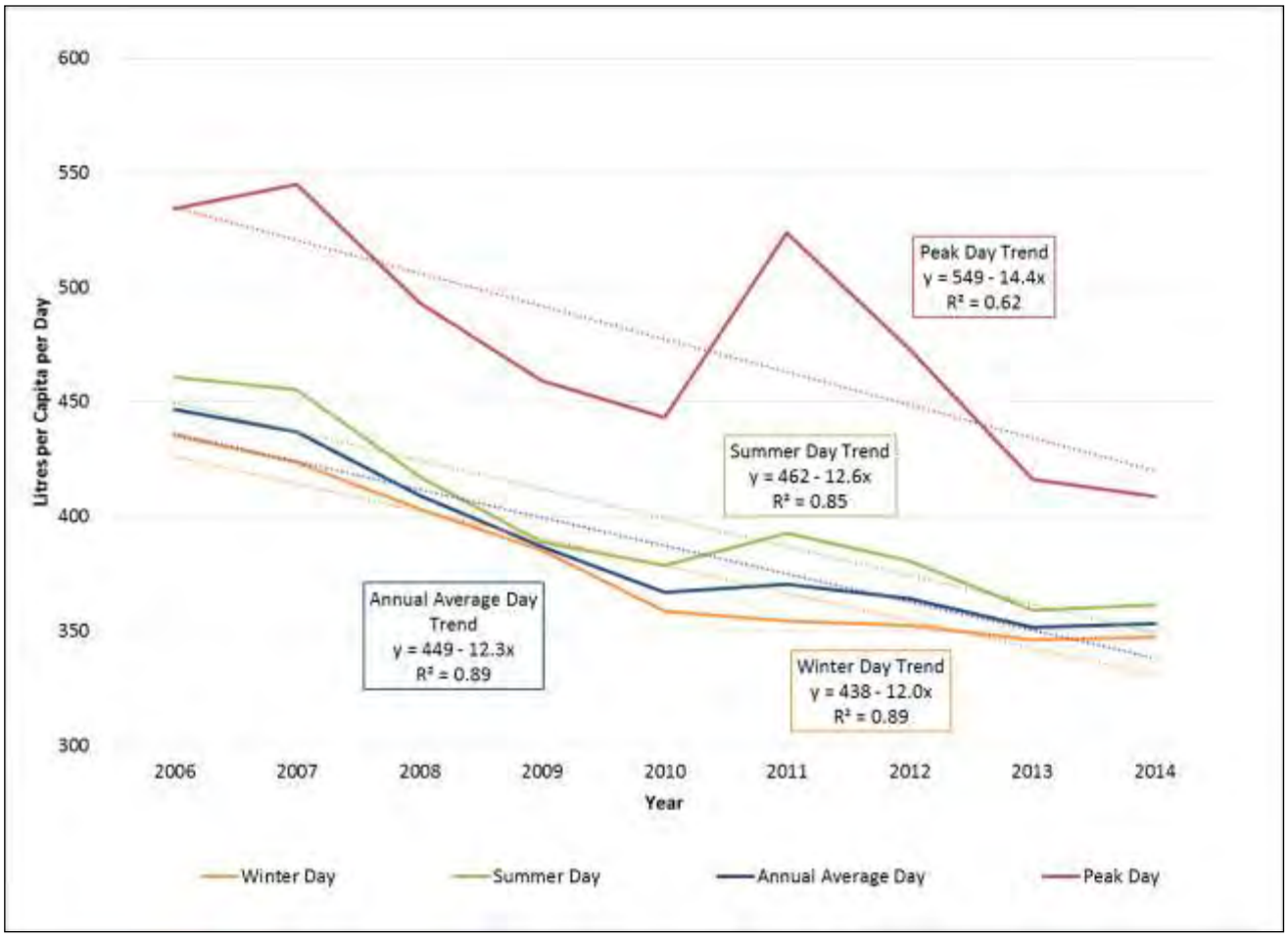


Figure 10: Historical Seasonal Water Use, Litres per Capita per Average Day

Table 10: Historical Seasonal Water Production Rates, Litres per Capita per Average Day

Year	Winter Day	Summer Day	Annual Average Day	Peak Day
2006	435	461	447	534
2007	423	455	437	545
2008	403	417	409	493
2009	385	389	387	459
2010	359	378	367	443
2011	355	393	371	524
2012	352	381	364	473
2013	346	359	352	416
2014	347	361	353	409

While annual average day water *production* rates declined by an average rate of 12 litres per capita per average day per year (based on the linear trend 2006-2014), annual average day metered consumption rates declined by only 10.4 litres per capita per average day during the same period (Figure 11). When only the years 2009 to 2014 are considered the decline in per capita production rates was 6.3 litres per capita per year and the decline in per capita consumption rates was very similar at 6.6 litres per capita per year (Figure 12). Therefore, the rate of annual decline of production and demand is lower now, than it was a decade ago. The following sections outline water demands in the various customer sectors.

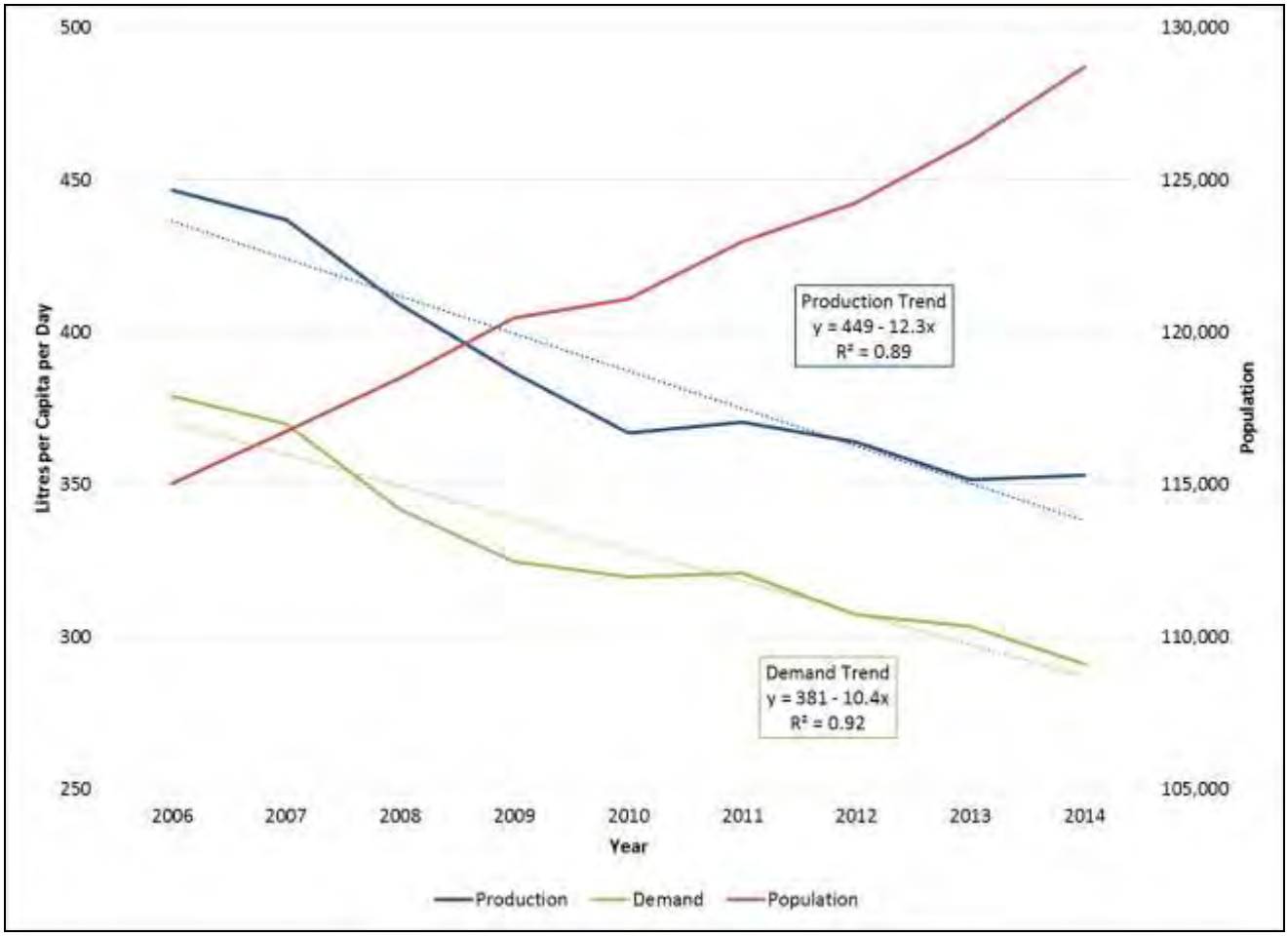


Figure 11: City of Guelph Historical Values; Population, Gross per Capita Daily Production, and Gross per Capita Daily Demand (2006 – 2014)

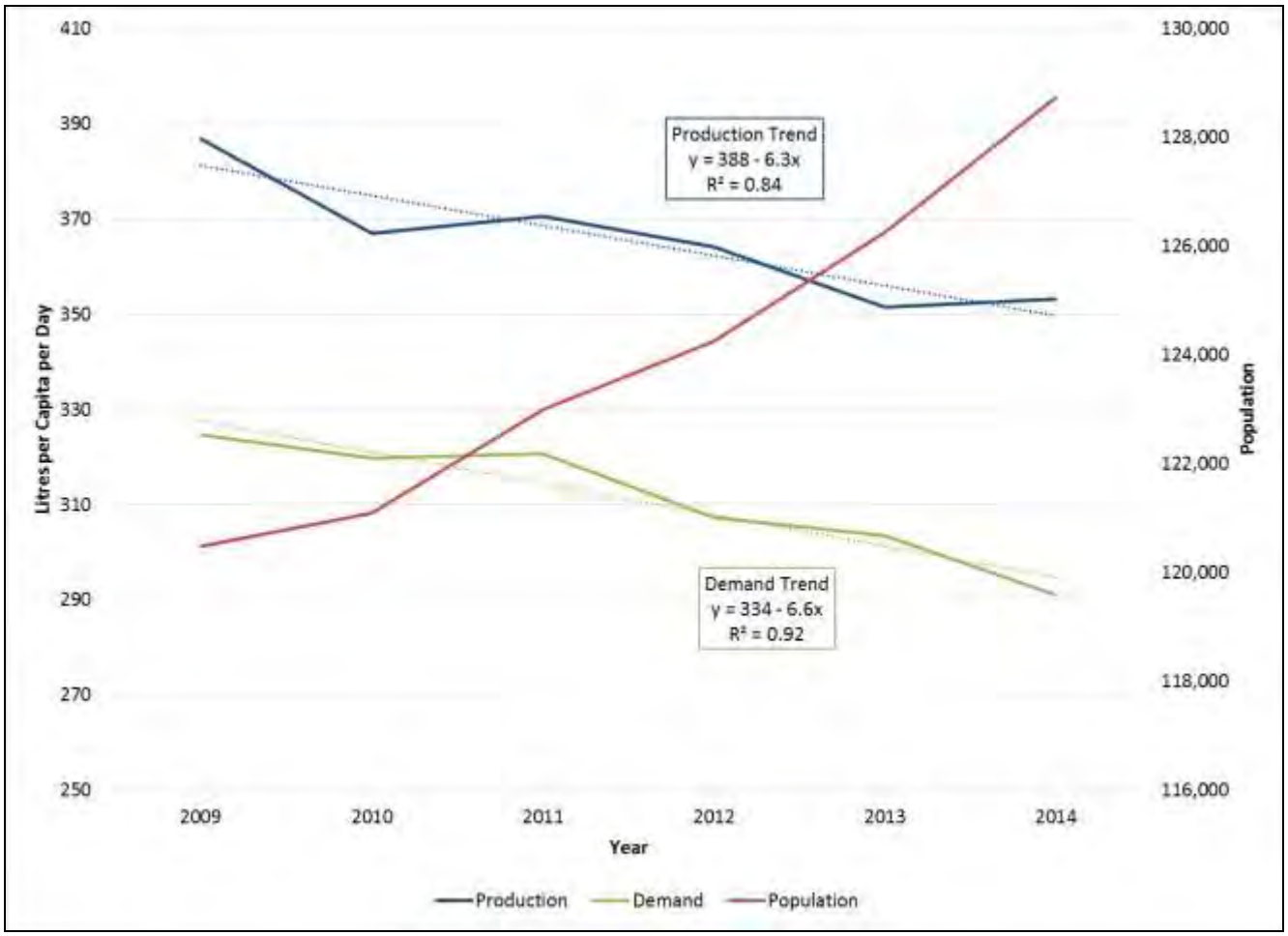


Figure 12: City of Guelph Historical Values; Population, Gross per Capita Daily Production, and Gross per Capita Daily Demand (2009 – 2014)

4.3 *Historical Customer Sector Demand Rates*

Overall water production, consumption, and per capita demand values have all declined in the City since 2006. By evaluating the demands for each customer sector individually it was possible to identify the demand trend for low, medium and high density residential customers, as well as industrial, commercial, and institutional customers respectively. Table 11 provides the property codes used to define the data sets used and the sample size.

Table 11: Description of the Customer Data Set Used for Analysis

Customer	Municipal Property Assessment Corporation property codes	Number of Customers Analyzed	Percent of Total Customers
Low Density Residential	301	27,466	77
Medium Density Residential	302 – 336	5,279	15
High Density Residential	340 – 380	1,001	2.8
Industrial	400 - 499	896	2.5
Commercial	500 - 599	424	1.2
Institutional	600 - 899	177	0.5

4.3.1 **Residential Customers**

Detailed residential customer billing data was available for the years 2006 through 2014 (inclusive). Figure 13 and Table 12 present historical annual average day residential water demands in the City between 2006 and 2014. As presented, water demands in the low-density residential customer sector declined by an average rate of 6.1 litres per capita per average day per year during this period (based on the linear trend), while demands in the combined medium- and high-density residential customer sector declined by slightly more at 7.4 litres per capita per average day per year. It is noted that the accuracy of the linear trend is very high for both residential customer sectors (R^2 values of 0.96 and 0.97).

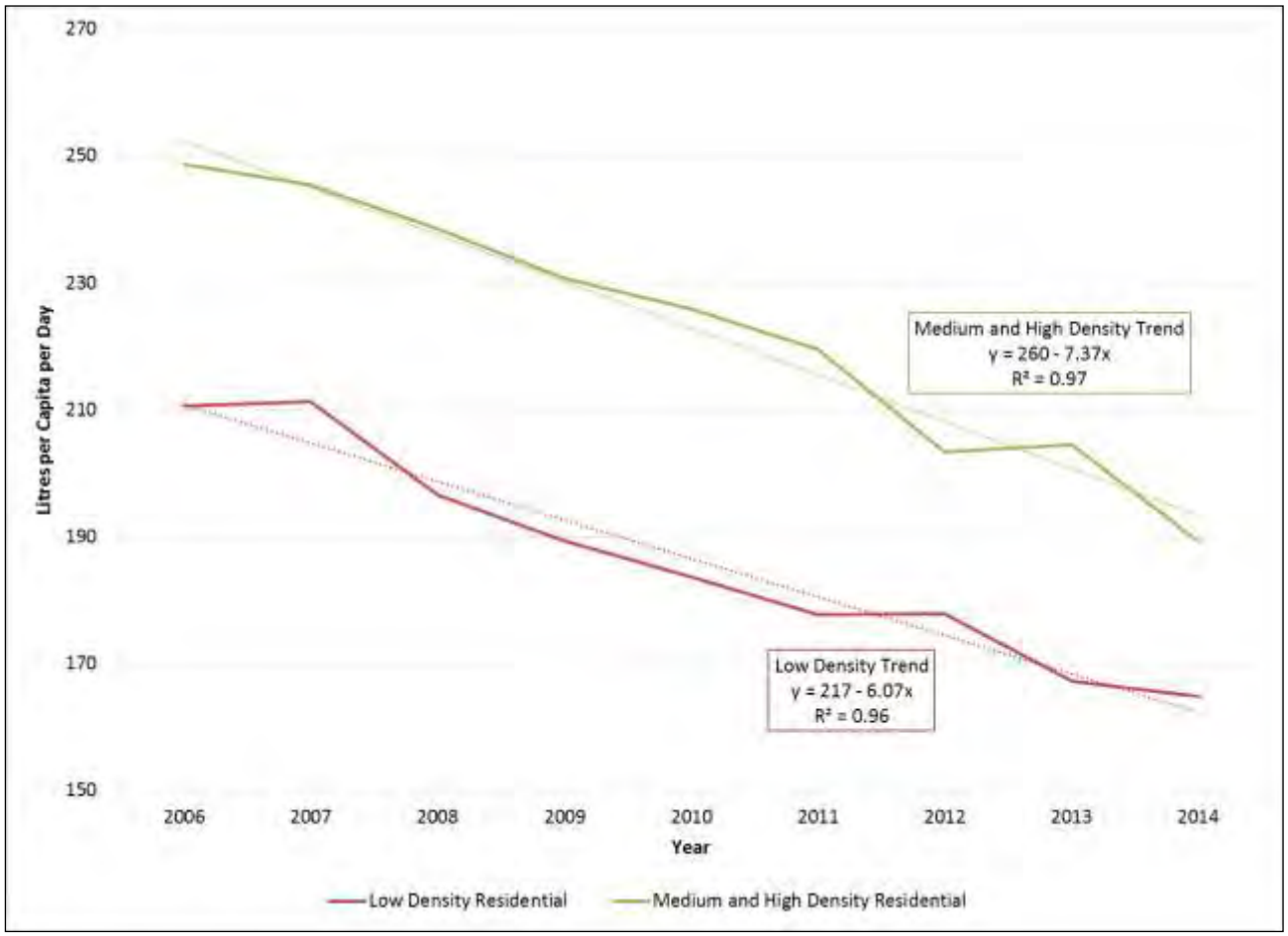


Figure 13: Historical Water Demands for Low, Medium and High Density Residential, Litres per Capita per Average Day (2006 - 2014)

Table 12: Historical Low, Medium and High Residential Water Demands, Litres per Capita per Average Day

Year	Combined	Low Density	Medium and High Density
2006	224	211	249
2007	223	211	245
2008	211	197	238
2009	204	189	231
2010	198	184	226
2011	192	178	219
2012	187	178	203
2013	180	167	205
2014	174	165	189

The reduction in Guelph's residential water demands has been the result of the effectiveness of the City's water efficiency programs (direct savings) combined with changes to the Ontario Building Code, recent marketplace transformation towards more efficient plumbing fixtures and appliances (natural savings), a growing public awareness of the need to use our natural resources wisely (indirect savings), and customer response to annual water/wastewater user rate unit price increases (price elasticity).

Since the introduction of the United States Environmental Protection Agency's WaterSense® program in 2006, the focus of most plumbing fixture manufacturers has been on developing water-efficient products. As such, most toilet, showerhead, and faucet models currently available for sale in the marketplace are efficient. The United States Environmental Protection Agency's ENERGY STAR program has had a similar impact regarding the efficiency of clothes washers and dishwashers available in retail. Largely because of the improved efficiency of plumbing fixtures and appliances available in the marketplace there has been a decline in per capita residential water demands across North America. In fact it is estimated that the current rate of natural indoor residential savings is about 2.7 litres per capita per average day per year.[5] With Guelph's average water production rate declining by about 12.3 litres per capita per average day per year since 2006 (Figure 11) it can be calculated that approximately 22 percent of the reduction in the City's production rate was due to natural savings (i.e., 2.7 / 12.3 = 22 percent).

Of course, such a significant rate of water use decline cannot go on indefinitely[6]. The current rate of demand decline is expected to slow down as average residential demands move closer to approximately 138 litres per capita per average day and there are fewer inefficient customers available in the City to convert to efficient customers (DeOreo, 2016). With a current low, medium, and high density combined residential demand of only

[5] Based on detailed in-home monitoring completed in 737 representative homes in nine different cities in the USA and Canada as part of the 1999 Residential End Use Study (AWWRF) and the 2014 Residential End Use Study Update (National Research Centre Inc.) over the 15-year period between 1999 and 2014 average per capita indoor demands have declined by from 262.3 litres per capita per average day to 221.8 litres per capita per average day, a reduction of 40.5 litres per capita per day in 15 years for an average of 2.7 litres per capita per average day per year. This reduction was found to be statistically significant at the 95 percent confidence level.

[6] With the growing impact of WaterSense® and ENERGY STAR on the efficiency of fixtures and appliances in the marketplace, achieving an average City-wide indoor residential water demand of about 138 litres per capita per average day should be achievable.

174 litres per capita per average day, the City anticipates it will reach its 2038 single-family water demand target ahead of anticipated timing of its 2014 Water Supply Master Plan.

4.3.2 Low Density Residential Sector

Guelph's low density (single family homes) residential sector had a daily demand of 165 litres per capita in 2014. To put these values into context, Table 13 outlines per capita daily residential demands for leading municipalities and jurisdictions in water use efficiency.

Table 13: Single-family Per Capita Demands

City/Country	Litres per Capita per Day
Calgary (2015)[7]	219
Region of York (2014)[8]	200
Toronto (2014)[9]	200
Markham (2014)[10]	189
Region of Peel (2015)[11]	188
Region of Waterloo (2014)[12]	184
Guelph (2014)	**165**
United Kingdom (2014)[9]	150
Austria (2014)[9]	135
Germany (2014)[9]	122

The following section provides an analysis of the residential sector water use trends. For purpose of analysis, metered water demand was categorized into the following three groups:

- Top 5 percent water consumers- these are the top 5 percent of water users based on annual water demand within the residential category.
- Top 5 to 20 percent water consumers - these are the mid-range water users based on annual water demand for this category.
- Bottom 80 percent water consumers - these users are considered efficient water users.

Figures 14, 15 and 16 illustrate the total amount of water consumed in 2013 and the number of accounts for each category for low, medium and high residential respectively. The total number of accounts is less than the total stated in Table 11 because the top and bottom 1 percent were removed to minimize error and reduce outliers. For reference, geospatial mapping trends and further detail for the low density residential sector is presented in Appendix D.

[7] Value from 2016 Water Efficiency Plan Update
[8] Value from 2016 Long Term Water Conservation and Efficiency Strategy
[9] Value provided by City of Toronto Staff
[10] Markham website (www.markham.ca/wps/portal/Markham/Residents/Water/WaterConserv/Conservation/)
[11] Value provided by Peel Region.
[12] Value extrapolated from single-family demands identified in May 13 Water Efficiency Master Plan Update Technical Memo #1 (Figure 22).

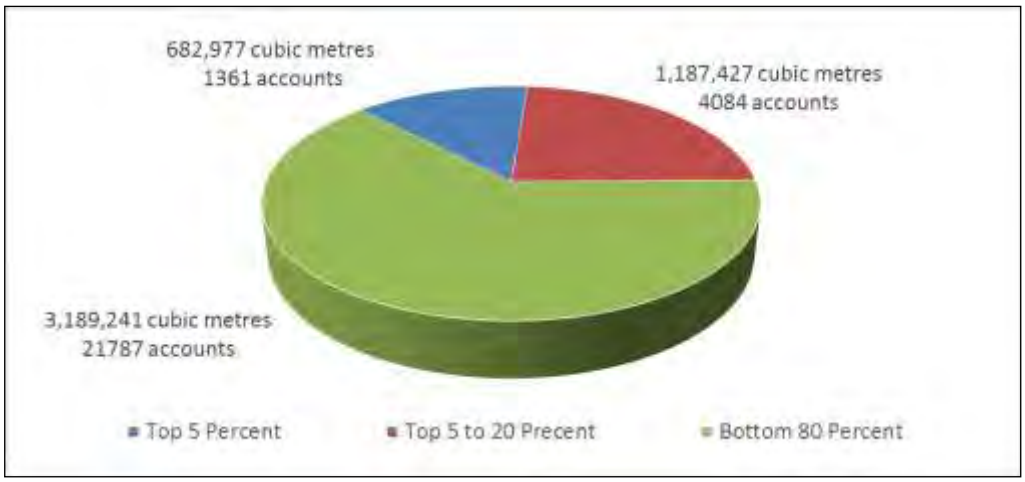


Figure 14: Low Density Residential Water Consumption Categorizes Analyzed

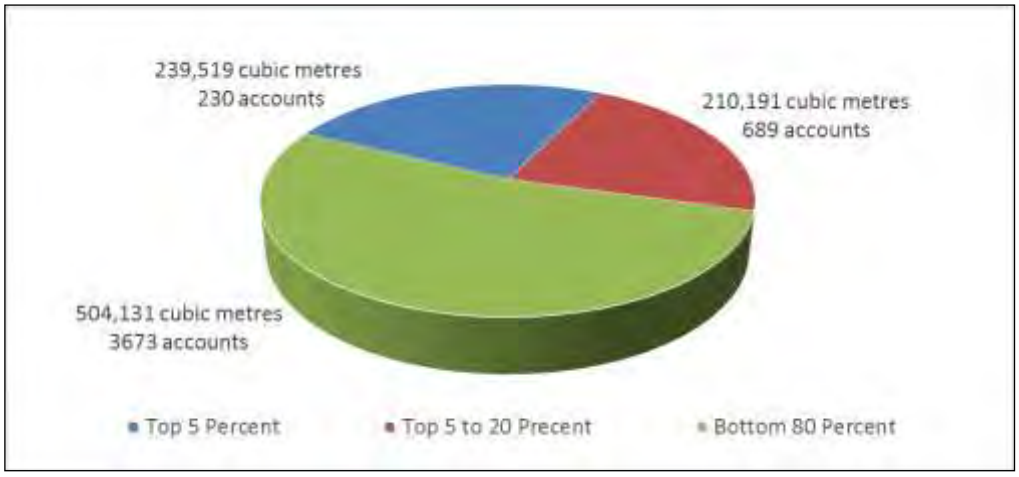


Figure 15: Medium Density Residential Water Consumption Categorizes Analyzed

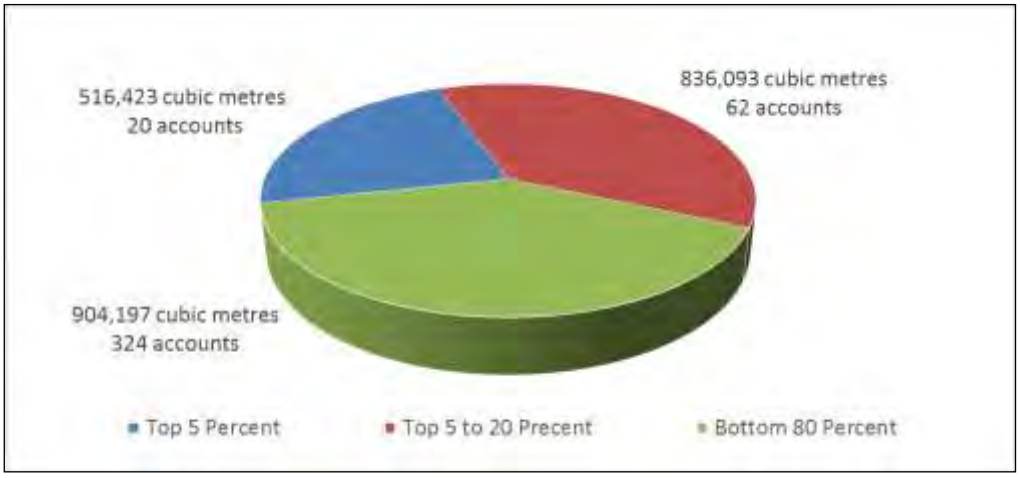


Figure 16: High Density Residential Water Consumption Categorizes Analyzed

4.3.2.1 Trends in Low Density (Single Family) Residential Sector

Trends in the low density residential sector were geospatially mapped using 2013 geographical information system data files. In 2013, 13.5 percent of the total low density (single family) residential water demand was consumed by the top 5 percent of users within this group, 23.5 percent of demand was consumed by the middle group the top 5 to 20 percent, and 63 percent of demand was consumed by the bottom 80 percent of accounts (Figure 14). Therefore, it can be stated that the majority of single family homeowners are efficient in their water practices. "Hot spots" for high annual use were shown to occur in the centre-north; centre-south, west and southeast side suburban areas of the City (see Figure 17 for reference). These observations agree with those outlined in previous water demand reports (Fortin, 2013), which noted high annual use in the centre-west and southwest areas of the City.

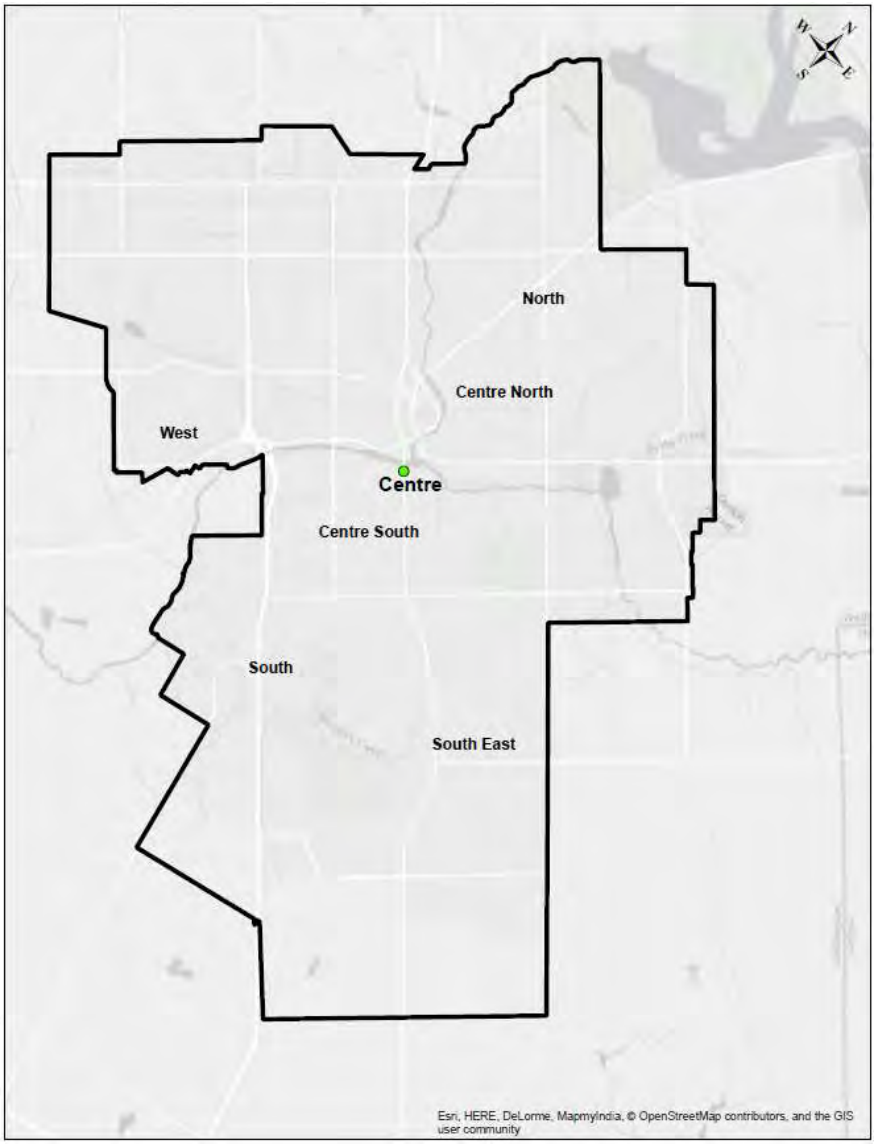


Figure 17: Reference Map of Guelph

Several attributes were reviewed to identify key relationships between the different high water use "hot spots" in the low density water demand residential sector. Figure 18 and Table 14 define the attributes and associated averages for the 3 ranges in water use and is summarized as follows:

- The average age of homes in the two top ranges is the same at 34 years, but the average home size in the top 5 percent customers is 522 square feet larger than that of the 5 to 20 percent customers.
- The top 5 percent customers also have an average of 0.4 more bathrooms than the top 5 to 20 percent customers. That said, even these differences don't fully explain why the top 5 percent customers tend to use an average of 175 percent more water than the top 5 to 20 percent customers as more bathrooms do not always correlate to more water use.
- The bottom 80 percent of customers tend to live in older, smaller homes with fewer bathrooms, however, people do not tend to base how often they use the washroom, wash their clothes, or take a shower based on the size of their home or the number of bathrooms they have.
- The average summer and winter demands are similar for all three ranges indicating that the difference in demands between the ranges is not due to differential summer irrigation use. While the magnitude of the difference in water demands in the three ranges cannot be fully explained by the age or size of home, or even number of bathrooms, it may be that larger homes fitted with more bathrooms have higher occupancy rates, i.e., the difference in the per capita demand for these three ranges is not as pronounced as the difference in household demand.

Table 14: Low Density Residential Statistics, 2013 Averages

	Monthly Water Demand, Cubic Metres per Month			Selected Attributes		
Ranges of Water Consumers	Annual Average	Summer Average	Winter Average	Age of Home, Years	Structural Area, Square Feet	Number of Bathrooms
Top 5 percent	42	42	41	34	2,684	2.2
Top 5 to 20 percent	24	23	25	34	2,162	1.8
Bottom 80 percent	12	12	12	43	1,827	1.6

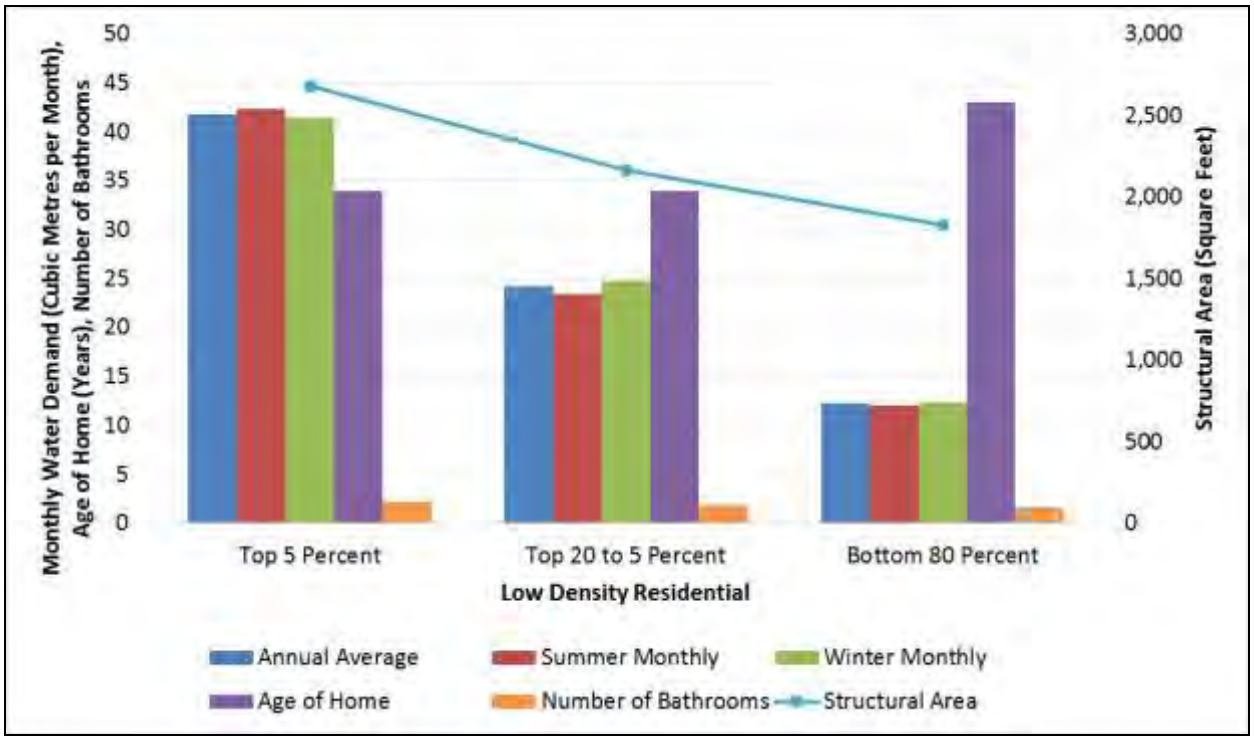


Figure 18: Low Density Residential Statistics, 2013 Averages

4.3.2.2 Consumption Analysis for Homes Built pre-1996 (2006 – 2014)

Prior to January 1996 the Ontario Building Code permitted the installation of toilets flushing with 13.25 litres of water. To reinforce water efficiency, the Ontario Building Code mandated that as of January 1996 toilets in new construction could flush with no more than 6 litres. Thus, an analysis was conducted to compare demands for homes built pre- and post-1996. Household water demand data from 2006 to 2014 (inclusive) was analyzed with the top and bottom 1 percent removed to help reduce/eliminate errors and outliers.

Annual average monthly demands, average summer demands, and average winter demands were compared as presented in Figures 19, 20 and 21. As seen in Figure 19, the annual average day demand for both groups of homes (those built pre-1996 versus homes built post-1996) was almost identical. In 2007, however, the average water demand in the older homes (built pre-1996) begins to trend lower than demands in the newer homes (built post-1996) even though 13.25-litre toilets were allowed in the older homes and 6-litre toilets were required in the newer homes. When only winter water demands are considered (reflecting indoor water use) the average water demand in older homes is consistently lower than that in the newer homes – see Figure 21. When only summer water demands are considered (reflecting indoor and outdoor water use) the relationship between demands in older versus newer homes is much more erratic with older homes having higher demands from 2006 to 2009 (inclusive) and newer homes having higher demands from 2010 to 2014 (inclusive) – see Figure 20.

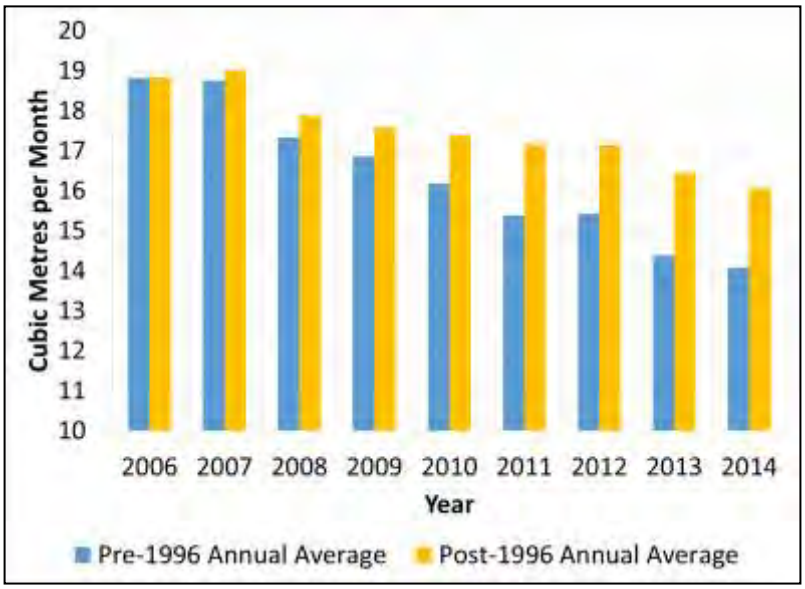


Figure 19: Low Density Residential Annual Average Demand (2006 – 2014), Homes Constructed Pre- and Post-1996, Cubic Metres per Month

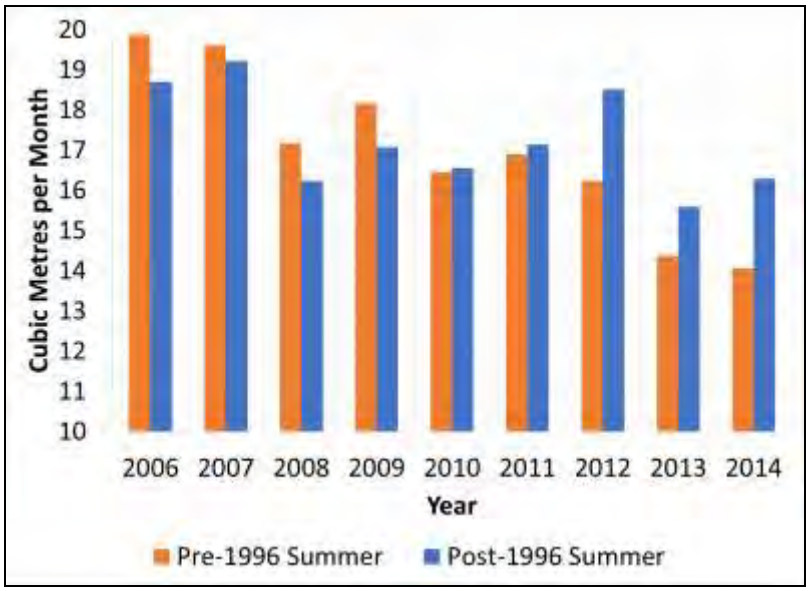
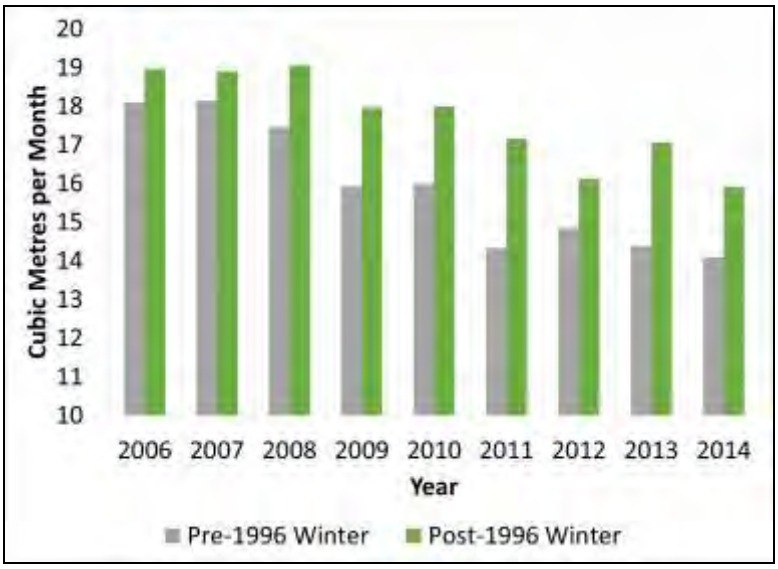


Figure 20: Low Density Residential Average Summer Demand (2006 – 2014), Homes Constructed Pre- and Post-1996, Cubic Metres per Month



Figures 21: Low Density Residential Average Winter Demand (2006 – 2014), Homes Constructed Pre- and Post-1996, Cubic Metres per Month

The results indicate that homes built pre-1996 tend to have a lower indoor water demands than homes built post-1996. The results also indicate that the average outdoor water use of pre-1996 homes has declined at a faster rate in recent years than the demands of newer homes. It should be noted however that Figures 19, 20 and 21 present household water demand data and do not consider household occupancy rates or property size. The reason for the lower indoor water demands in the older homes is not known but could be a result of lower occupancy rates or perhaps many of these homes have already replaced their existing plumbing fixtures and appliances with water efficient models. The reason why average summer water demands have declined at a faster rate in older homes since 2006 has not yet been determined. Since older homes tend to have larger lot sizes and more irrigable land, the reduction in outdoor water use for this group of homes may be related to the adoption of more efficient watering practices or the use of more drought tolerant landscape materials.

Figures for average annual, summer and winter demand for low, medium and high density residential consumption by vintage of homes are presented in Appendix D.

4.3.3 **Multi-family Residential Sector**

Multi-family residences in Guelph are either directly metered (each unit has its own water meter) or bulk metered where a single meter services more than one unit or an entire building. Multi-residential buildings include both townhomes and high rise communities. Water demand data from 2006 to 2014 were analysed and results are discussed below. Note, the water demand data was not separated based on how the water is metered.

Figure 22 depicts the average monthly consumption of bulk and directly metered accounts by average annual, summer and winter months on a per unit basis. As presented, directly metered accounts have lower average annual demands than bulk metered accounts. The annual average monthly consumption between 2006 and

2014 is 13.5 and 10.8 cubic metres for bulk and directly metered accounts respectively. This differential may be the result of higher occupancy rates, less efficient fixtures, or less efficient occupants (i.e. don't pay directly for their water with costs included in rent/condo fees) in bulk metered buildings. Higher winter versus summer water demands in directly metered units may be the result of higher occupancy rates during the winter months due to potential student housing property uses. This differential in demand by metering type highlights an opportunity to implement water use efficiencies.

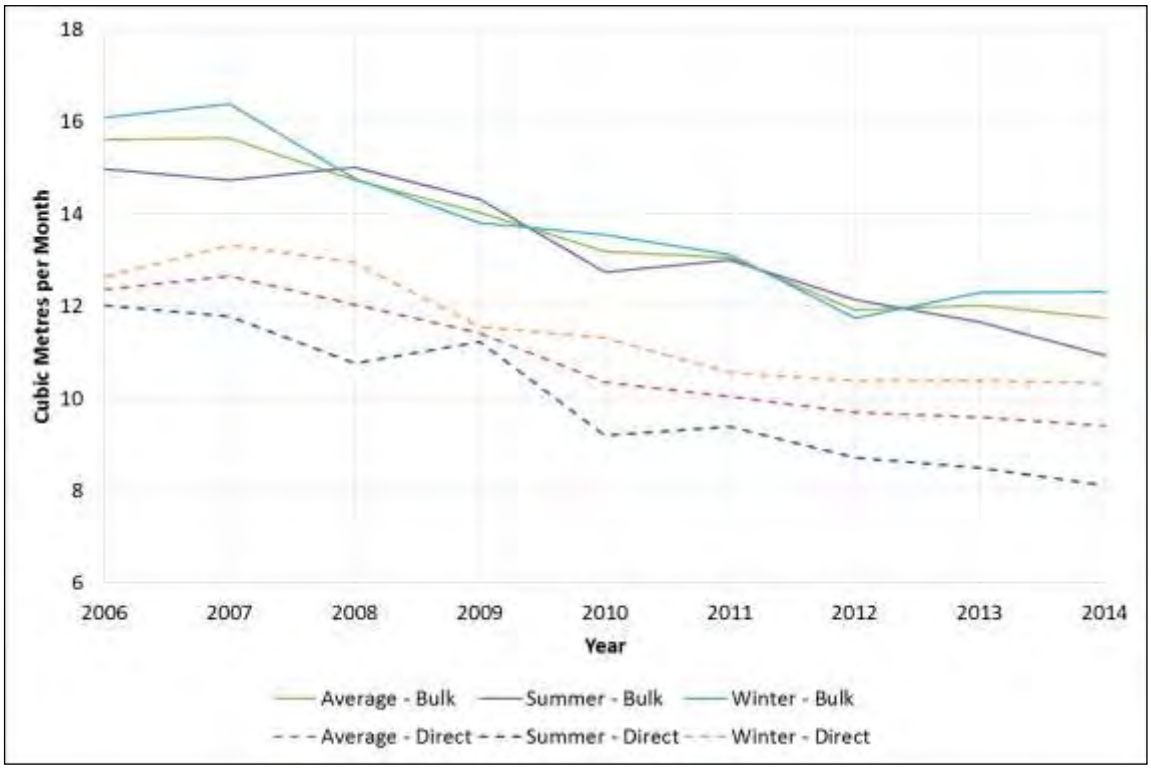


Figure 22: Average Monthly Demand of Bulk versus Directly Metered Multi-family Residential Customers (2006 - 2014)

4.3.4 Medium Density Residential Sector

4.3.4.1 Trends in Medium Density Residential

"Hot spots" of water demand in the medium density residential sector occurred in the suburban areas, especially in the western and southern areas of the City. In 2013, 25 percent of the total medium density residential water demand was consumed by the top 5 percent of water accounts. The top 5 to 20 percent of medium density residential accounts consumed 22 percent of the water demand, while the lower 80 percent of accounts consumed 53 percent of the medium density residential demand. Table 15 and Figure 23 define the attributes and associated averages for these ranges.

The results indicate that:

- Older homes tend to use more water (pre 1996);
- That larger homes tend to use more water (average size of 3,362 square feet per home); and

- Homes with more bathrooms tend to use more water (average 4 bathrooms per home).

While it is expected that larger homes with more bathrooms are likely to have higher occupancy rates, the top 5 percent of homes use an average of eight times more water than the bottom 80 percent of homes. It is likely that this significant differential is the result of a combination of higher occupancy rates in the top 5 percent of homes combined with a lower level of fixture and appliance efficiency.

Table 15: Medium Density Residential Statistics, 2013 Averages

	Monthly Water Demand, Cubic Metres per Month			Selected Attributes		
Ranges	Annual Average	Summer Average	Winter Average	Age of Home, Years	Structural Area, Square Feet	Number of Bathrooms
Top 5 Percent	89	92	83	71	3,362	4.0
Top 5 to 20 Percent	25	25	26	50	1,953	2.0
Bottom 80 Percent	11	11	12	38	1,617	1.5

Figure 23: Medium Density Residential Statistics, 2013 Averages

4.3.4.2 Consumption Analysis for Homes Built pre-1996 (2006 – 2014)

Medium housing density average annual, summer and winter monthly water demands were analyzed for the period of 2006 to 2014. Medium density residential homes constructed post-1996 was seen to have

significantly lower monthly average demands in all three metrics compared to pre-1996 homes. Please see Appendix D for additional details.

4.3.5 **High Density Residential Sector**

4.3.5.1 Trends in High Density Residential

"Hot spots" of water demand the for high density residential sector were evident in the south, west and southeast areas of the City. In 2013, the top 5 percent of high density accounts used 23 percent of the water demand. The top 5 to 20 percent of accounts used 37 percent of the water, and the lower 80 percent of accounts used only 40 percent of the demand.

Table 16 lists the attributes and average monthly water demands for the 3 metrics, which are also illustrated in Figure 24. As expected, as the size of the building and number of washrooms increase, the overall water demand increases (larger buildings are likely to have more living units). The difference in water demand per square foot of area for these three ranges is not as pronounced as the number of bathrooms metric. The average annual water use for the top 5 percent customers is 0.16 cubic metres per square foot, for customers in the 5 to 20 percent bracket the average demand is 0.13 cubic metres per square foot, and for the bottom 80 percent the average demand is 0.12 cubic metres per square foot. It is noted that high water users also tend to use more water per bathroom than low water users, possibly because of higher occupancy rates or less efficient fixtures. The age of the building does not seem to be a critical factor.

Table 16: High Density Residential Statistics, 2013 Averages

	Monthly Water Demand, Cubic Metres per Month			Selected Attributes		
Ranges	Annual Average	Summer Average	Winter Average	Age of Home, Years	Structural Area, Square Feet	Number of Bathrooms
Top 5 percent	2,152	1,794	2,407	34	165,257	121.5
Top 5 to 20 percent	1,124	1,062	1,168	35	97,570	82.2
Bottom 80 percent	233	223	240	57	22,522	18.8

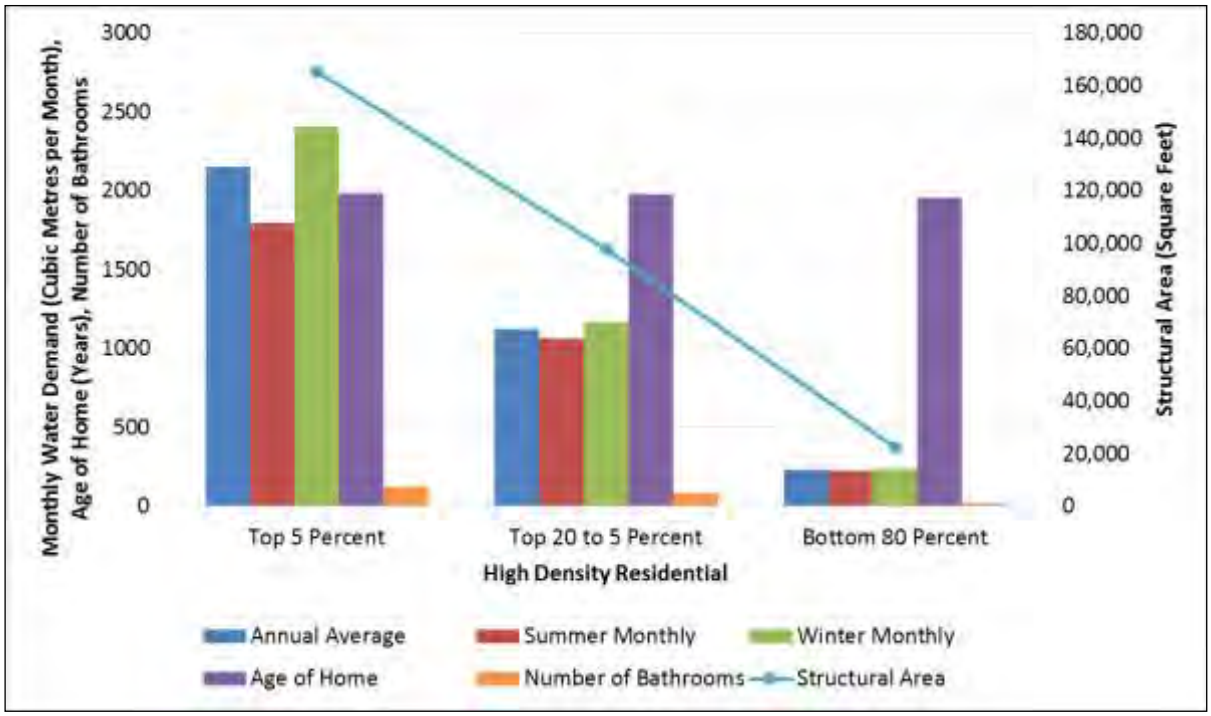


Figure 24: High Density Residential Statistics, 2013 Averages

4.3.5.2 Consumption Analysis for Homes Built pre-1996 (2006 – 2014)

High density residential consumption data was analyzed for the period 2006 to 2014. High density pre-1996 residential buildings were seen to have significantly lower demands in all three metrics compared to post-1996 buildings, likely indicating that they are smaller buildings with fewer units. For additional information please see Appendix D.

4.4 *Industrial, Commercial, Institutional Customers*

Metered customer billing data for industrial, commercial and institutional Municipal Property Assessment Corporation land use codes was also analyzed for the years 2006 through 2014. Figure 25 illustrates historical annual average day industrial, commercial and institutional water demands in the City during this time period. Note that because the Municipal Property Assessment Corporation codes changed in 2012, miscellaneous customers with property codes of '000s', '100s', and '200s' are included as 'Other' in the institutional customers within the analysis completed (Table 17). Note that while industrial demands declined in 2008 and 2009 due to the economic downturn, by 2014 industrial demands had returned to near 'pre-downturn' values.

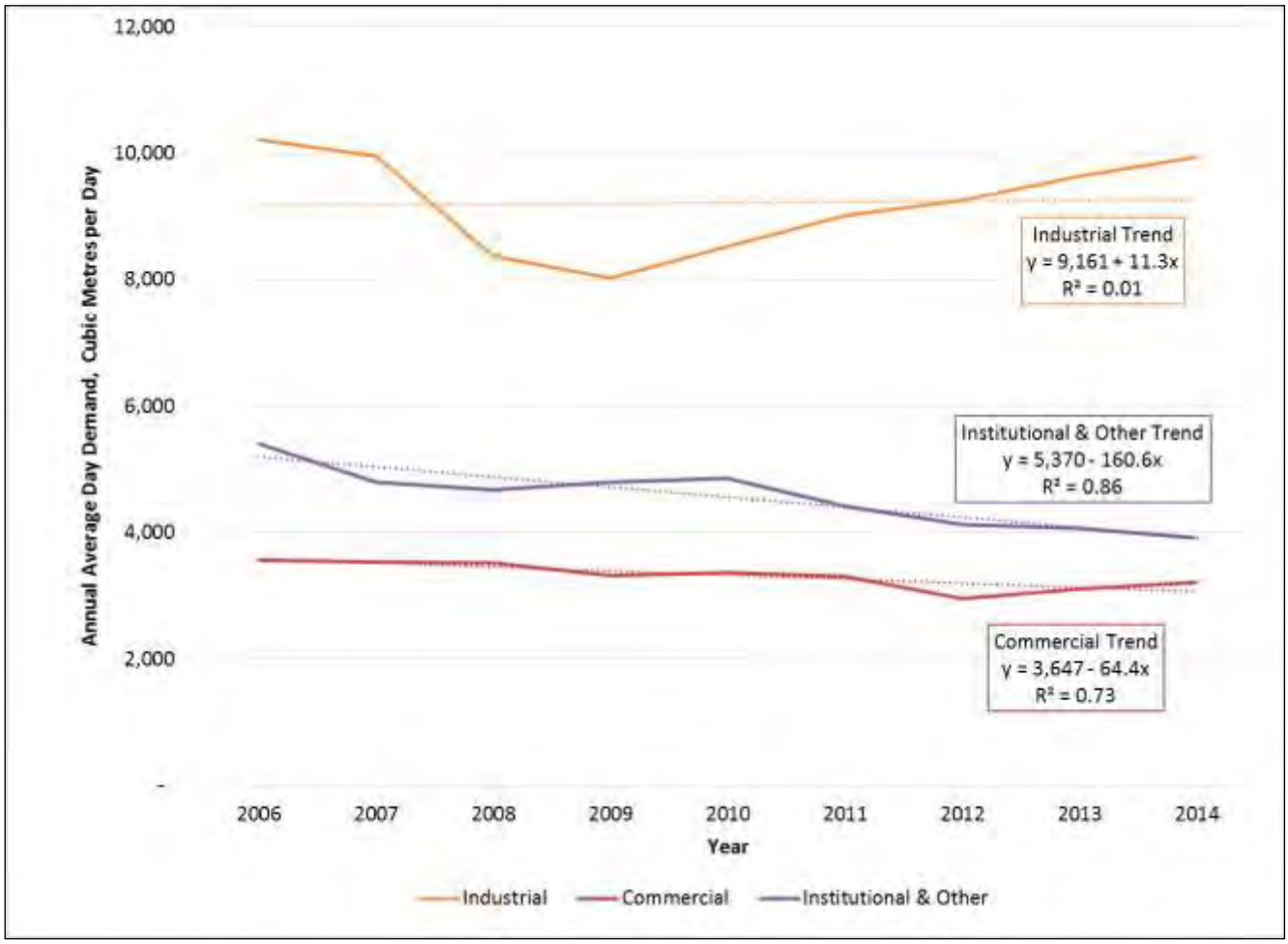


Figure 25: Historical Industrial, Commercial and Institutional Customer Sector Demands (2006 - 2014)

Table 17: Historical Industrial, Commercial, and Institutional Average Annual Demands, Cubic Metres per Day

Year	Industrial	Commercial	Institutional and Other
2006	10,223	3,570	5,414
2007	9,955	3,540	4,796
2008	8,375	3,526	4,682
2009	8,023	3,320	4,800
2010	8,533	3,374	4,864
2011	9,010	3,312	4,421
2012	9,261	2,956	4,135
2013	9,633	3,114	4,067
2014	9,944	3,209	3,921

Between 2006 and 2014 the overall annual average day demand of the City's industrial, commercial and institutional customer sector declined by an average rate of 214 cubic metres per day while the average per capita gross demand (based on the total city population) declined by an average of 3.7 litres per capita per average day per year (Figure 26).

The 2038 target for industrial, commercial, and institutional customers identified in the 2014 Water Supply Master Plan (based on achieving a 13 percent reduction) is approximately 133 litres per capita per average day (based on city population) – exactly what the demand rate was in 2014 (Figure 26). As such, the City is well ahead of schedule to reach its 2038 industrial, commercial, and institutional sector target. Nevertheless, the City should continue to pursue programming as outcomes are mutually beneficial to the customers (i.e. reduces operating costs and increases market competitiveness) and the City (i.e. reduces capital and operating expenditures, increases potential of business retention and local employment).

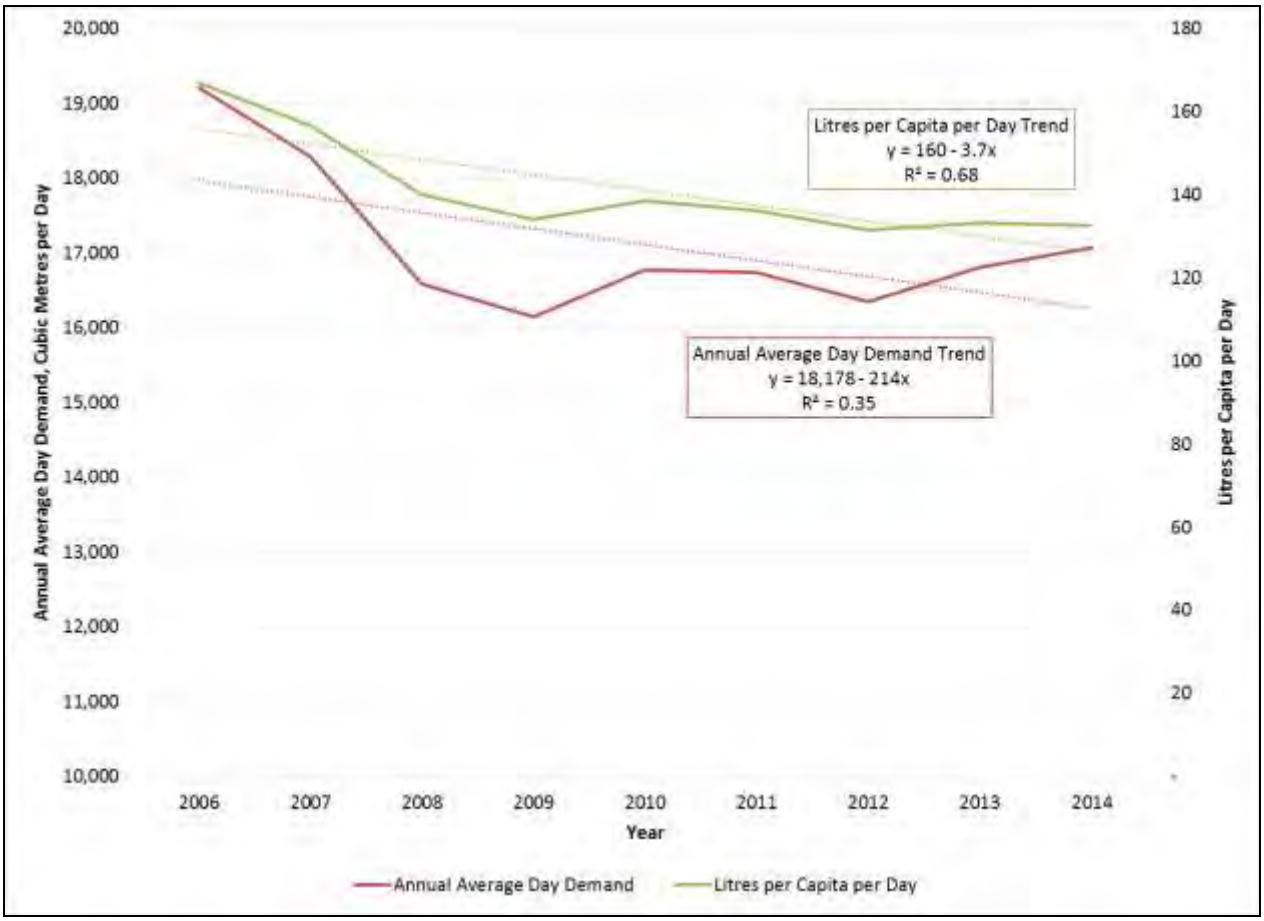


Figure 26: Historical Industrial, Commercial and Institutional Water Demands (2006 – 2014)

4.4.1 Water Consumption by Industry

In defining consumption by industry type in the City all customer accounts for industrial, commercial and institutional sector customers were grouped by their North American Industry Classification System (NAICS) codes and were analysed based on their average annual, summer (May 1 to September 30), and winter (October 1 to April 30) metered monthly water consumption. Figure 27 highlights the findings per sector with the number of accounts per industry type stated above each column for reference.

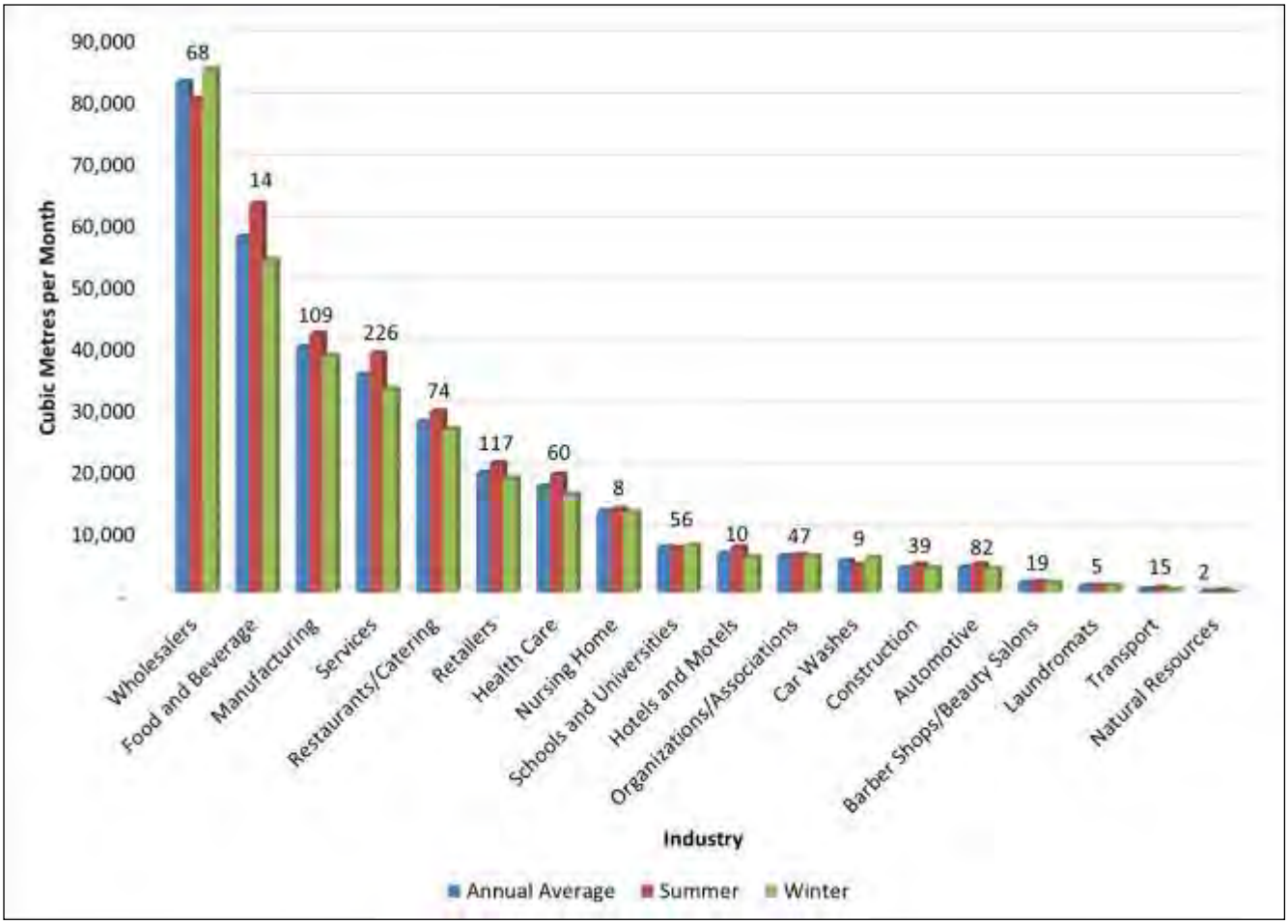


Figure 27: Average Monthly Consumption by Industry (2006 – 2014), Cubic Metres per Month

Table 18 presents the data points for the graph, as well as the average monthly demand per account for each industry type. From the table, the Food and Beverage industry possesses the highest water demand per account per month, followed by Nursing Homes and Wholesalers.

Table 18: Average Monthly Consumption by Nature of Industry (2006 – 2014), Cubic Metres per Month

Industry	Average Annual Monthly Demand	Average Summer Monthly Demand	Average Winter Monthly Demand	Number of Accounts	Average Monthly Demand per Account
Wholesalers	82,718	80,010	84,806	68	1,216
Food and Beverage	57,656	62,985	53,857	14	4,118
Manufacturing	39,803	41,967	38,386	109	365
Services	35,307	38,788	33,000	226	156
Restaurants/Catering	27,631	29,358	26,485	74	373
Retailers	19,413	21,043	18,510	117	166
Health Care	17,216	19,167	15,932	60	287
Nursing Home	13,196	13,556	12,986	8	1,650
Schools and Universities	7,368	7,236	7,588	56	132
Hotels and Motels	6,321	7,326	5,741	10	632
Organizations/Associations	5,957	6,089	5,881	47	127
Car Washes	5,159	4,480	5,644	9	573
Construction	4,000	4,529	4,024	39	103
Automotive	4,126	4,579	3,849	82	50
Barber Shops/Beauty Salons	1,617	1,699	1,569	19	85
Laundromats	1,092	1,083	1,099	5	218
Transport	563	734	447	15	38
Natural Resources	158	335	43	2	79

4.4.2 Top 100 Industrial, Commercial and Institutional Accounts

The top 100 industrial, commercial, and institutional accounts were grouped by industry type with their associated water demands (calculated based on the reviewed North American Industry Classifications Systems). Table 19 provides the percentage increase or decrease in average annual, summer, and winter monthly consumption from 2006 to 2014. The industries with reduced water consumption have been highlighted. The following is noted:

- The decline in water demands could be the result of water efficiency technology implementation, recessionary effects on the industry (2008), or closure of some businesses during the timeframe examined.
- Many industries had increases in demand, possibly related to Guelph's 15 percent growth in population since 2006 and therefore, growing economy.
- Demands in the automotive and construction industries have increased significantly.

Table 19: Annual Average Percentage Change in Monthly Water Demand for Top 100 Industrial, Commercial, and Institutional Water Users by Industry Type (2006 – 2014)

Industry Type	Average Annual, Percent	Summer, Percent	Winter, Percent
Automotive	274	325	240
Construction	220	754	134
Nursing Home	51	44	56
Services	34	49	26
Car Washes	19	-40	65
Manufacturing	16	22	13
Food and Beverage	15	7	25
Organizations/Associations	5	-29	-16
Wholesalers	-6	4	-13
Restaurants	-7	-11	-5
Retailers	-12	-8	9
Health Care	-16	4	-30
Hotels and Motels	-40	-45	-36
Schools and Universities	-45	-35	-49

4.5 *Non-revenue Water*

Non-revenue water is the term used for water that is produced by the City but not metered in end use or sold to a customer. Non-revenue water includes physical losses such as water used for firefighting, mains flushing, system leakage, un-metered municipal uses, etcetera, as well as apparent losses resulting from metering or accounting inaccuracies in managing system water loss. If the City spends too little to reduce system leakage, the volume and value of water lost each year will increase; if the City spends too much, the cost of the program will outweigh the savings. Between these two extremes is an economic level of leakage where program costs and program savings are optimized. The City's goal is to reduce and maintain leakage levels at the economic level of leakage for their system. [13].

The City of Guelph has adopted the International Water Association/American Water and Wastewater Association Water Audit Method – broadly accepted as the industry Best Practice of water loss accounting – to manage the level of non-revenue water. The Water Balance Audit methodology allows water utilities to assess non-revenue water levels in their system compared to established benchmarks. Included in Appendix E is the most recent City of Guelph Water Balance Audit for reference.

One of the most important performance metric outputs of the Water Audit Methodology is the calculation of the system performance indicators, including the Infrastructure Leakage Index – a ratio of the Current Annual

[13] It is not possible to eliminate all leakage in a water supply system. The Economic Level of Leakage is the term used for the level of leakage below which it costs the municipality more to eliminate than it would recover in cost savings.

Real Losses in the system versus Unavoidable Annual Real Losses of the system. A system with an Infrastructure Leakage Index value of 1.0 would theoretically have no unavoidable leakage; where a system with an Infrastructure Leakage Index value of 2.0 would theoretically be able to reduce their leakage level by half. However, as even new linear water systems will possess a background level of loss, it is impossible in most cases to have an Infrastructure Leakage Index of 1.0.

Guelph's 2014 Infrastructure Leakage Index value is 2.54. In 2006 the first audit of the system was completed resulting in with an Infrastructure Leakage Index value of 2.87. The Leak Detection program initiated in 2011 influenced the drop in Infrastructure Leakage Index down to 2.58 in 2011. This program contributed to a further drop in Infrastructure Leakage Index to 1.61 in 2013. A declining Infrastructure Leakage Index value indicates that the City is reducing the level of avoidable leakage in their system. However, the system is dynamic and is highly influenced by climatic conditions. The Infrastructure Leakage Index value increased in 2014 as a result of an increase in main breaks and frozen services due to cold winter temperatures. Table 20 presents historical Infrastructure Leakage Index values in Guelph between 2006 and 2014. Note that as existing leaks are discovered and repaired, new leaks are forming, so Infrastructure Leakage Index values will fluctuate from year to year. Table 21 presents the banding/rating system introduced in 2005 by the World Bank Institute into their non-revenue water training manuals to help assess system performance.

Table 20: Infrastructure Leakage Index Values

Criteria	2006	2007	2008	2009	2010	2011	2012	2013	2014
Infrastructure Leakage Index Value	2.87	2.73	3.3	3.37	3.42	2.58	1.91	1.61	2.54

Table 21: World Bank Institute Target Matrix for Infrastructure Leakage Index

Infrastructure Leakage Index Range	Band	General Description of Real Loss Management Performance Categories for Developed and Developing Countries
1-2	A	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost effective improvement.
2-4	B	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network management.
4-8	C	Poor leakage record, tolerable only if water is plentiful and cheap; even then, analyse level and nature of leakage and intensify leakage reduction efforts.
>8	D	Very inefficient use of resources; leakage reduction programs imperative and high priority.

The current (2014) estimated non-revenue water volume of 8,247 cubic metres per day is slightly above the 2014 Water Supply Master Plan 2038 target of 6,868 cubic metres per day.

5.0 WATER CONSERVATION AND EFFICIENCY PROGRAM IMPACT TO DATE

5.1 *Quantification of Program Savings; 2006 – 2014*

The Council approved 2009 Water Conservation and Efficiency Strategy recommended a 10-year plan to meet the targets outlined in the 2007 Water Supply Master Plan as described in Section 1 of this report. Table 22 below presents the target savings from the 2007 Water Supply Master Plan and the estimated actual program water savings as of the end of 2014. While not all sectors had reached their target water savings, overall program water savings surpassed the 2014 target by an additional 1.37 million litres per day (1,370 cubic metres per day). It should be noted that the total reduction in water production rates (including all direct, indirect, and natural savings) by 2014 was 13.5 million litres per day.

Table 22: Water Conservation and Efficiency Programs' Target and Actual Water Savings, Million Litres per Day 2006 – 2014 Inclusive

Program/Sector	2007 Water Supply Master Plan Target Water Savings for 2014	Actual Water Savings
Residential	2.96	2.42[14]
Industrial/Commercial/Institutional	0.57	1.29
Water Loss Management	1.73	2.80
City retrofits	0.00	0.11
Total	**5.25**	**6.62**

5.2 *Quantification of Net Present Value*

The City estimates that it would cost $4.68 per litre per day of capacity to construct the next phase of their water and wastewater treatment infrastructure.[15] Since 2006, the City's water efficiency programs have reduced demands by about 6.6 million litres per day with about 42 percent of these savings (2.8 million litres per day) attributable to the City's water loss reduction program.

As shown in Table 23, the net present value of each program (not including supporting costs) can be evaluated separately. Costs were inflated based on the Canadian yearly inflation rate released by Statistics Canada (Statistics Canada, 2015). When all program and supporting costs are included, the net present cost of the City's 2006-2014 water efficiency programs is about $11.4 million and the net present benefit is about $30.9 million, resulting in a benefit/cost ratio of 2.7. Therefore, the City has achieved a benefit of approximately $2.70 for each dollar they spent on their water efficiency programming between 2006 and 2014.

[14] Value includes natural water savings.

[15] Cost of increasing capacity provided by City of Guelph staff.

Table 23: Net Present Value for Direct Water Saving Programs, 2006 - 2014

Program	Cubic Metres per Day Saved	Present Value Cost ($)	Present Value Benefit ($)	Net Present Value ($)	Benefit/Cost Ratio
Royal Flush	1,944	$1,206,244	$9,096,886	$7,890,642	7.5
Smart Wash	389	$461,268	$1,819,397	$1,358,129	3.9
Green Impact Guelph Multi-Residential	70	$86,446	$325,728	$239,282	3.8
Floor Drain	1.2	$1,791	$5,635	$3,844	3.2
Humidifier	10.7	$4,837	$50,100	$45,263	10.4
Blue Built Home	3.9	$12,996	$18,645	$5,649	1.4
Industrial/Commercial/ Institutional Programs	1,264	$710,369	$5,916,080	$5,205,711	8.3
City Retrofits	110	$257,415	$514,098	$256,683	2.0
Leakage	2,800	$929,151	$13,104,000	$12,174,849	14.1
Supporting Expenses					
Staffing	N/A	$2,488,940	N/A	N/A	N/A
Professional Services	N/A	$1,191,996	N/A	N/A	N/A
Purchased Goods and Services	N/A	$832,691	N/A	N/A	N/A
Education	N/A	$1,123,399	N/A	N/A	N/A
Operational Overhead	N/A	$2,117,052	N/A	N/A	N/A
Capital (Facility/Operational Improvements)	N/A	$303,607	N/A	N/A	N/A
Total	**6,592**	**$11,430,895**	**$30,850,569**	**$19,419,674**	**2.7**

5.3 *Co-benefits of Water Conservation and Efficiency Programming*

While the potential to save money by deferring or downsizing infrastructure expansion projects is often one of the primary drivers for communities to implement water efficiency programs, there are also many other co-benefits to municipalities such as reducing operational costs (i.e., energy costs) and greenhouse gas emissions. Further, customers who reduce their water demands will save money on their water bill and save on their energy bill in cases of hot water savings.

Table 24 shows the total volume of direct savings for each of Guelph's programs on an annual basis between 2006 and 2014. Table 25 shows the total cumulative savings, as well as, the estimated percentage and total volume of hot water savings associated with each program (where applicable).

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Table 24: Direct Annual Water Savings, Cubic Metres per Year

Year	Royal Flush	Smart Wash	Green Impact Guelph	Floor Drain	Humidifier	Blue Built Home	Municipal Retrofit	Industrial/ Commercial/ Institutional Programs
2006	14,491							
2007	26,390							113,844
2008	65,481	11,206						76,285
2009	95,849	21,645	12,775					67,270
2010	123,772	29,967	12,629	37	219		15,695	7,118
2011	138,956	26,061		256	1,971	438	2,519	19,455
2012	111,836	17,666		146	876	621	347	88,951
2013	64,970	19,236			730	329	18,250	88,440
2014	67,781	16,097			110	37	3,285	
							Total Volume	**1,384,025**

Table 25: Cumulative Water Savings and Hot Water Savings, 2006-2014, Cubic Metres per Year[16]

Cumulative	Royal Flush	Smart Wash	Green Impact Guelph	Floor Drain	Humidifier	Blue Built Home	Municipal Retrofit	Industrial/ Commercial/ Institutional Programs
Water Savings	3,082,900	569,948	139,795	1,643	13,177	4,307	129,374	2,405,496
							Total Volume	**6,346,638**
Percent Hot Water	0	30	35	0	0	5	5	5
Hot Water Savings	-	170,984	48,928	-	-	215	6,469	120,275
							Total Volume	**346,871**

[16] Actual hot water percentages are not available; the percentages assumed in Table 25 are deemed sufficiently accurate for calculation purposes.

5.4 *Energy Savings from Direct Programs*

The energy savings achieved by reducing water demands in Guelph can be calculated by multiplying the energy intensity factor of each component in the City's water use cycle by the total volume of water saved. For Guelph, the municipal energy (indirect) costs were calculated using the following energy intensity values[17]:

- Source water extraction, treatment, and distribution: 0.673 kilowatt-hours per cubic metre
- Wastewater collection and treatment: 0.061 kilowatt-hours per cubic metre

As such, a total Energy Intensity Factor of 0.734 kilowatt-hours per cubic metre was used to assess energy and greenhouse gas emission savings when both water and wastewater pumping are involved (e.g. for programs that affect indoor water use) and an Energy Intensity Factor of 0.673 kilowatt-hours per cubic metre was used when only water pumping is involved (e.g. for irrigation programs and leak detection programs).

Reducing water demands will also reduce the amount of chemicals required for water treatment[18] and, therefore, the energy used to produce these chemicals. This energy is referred to as embedded energy. A study conducted by the Polis Project (Maas, 2009) determined that the embedded energy factor for chemicals used in water treatment is approximately 0.01 kilowatt-hours per cubic metre of water production.

Reducing energy demands also reduces greenhouse gas emissions. In Ontario the greenhouse gas coefficient is 0.27 kilograms of carbon dioxide equivalent[19] per kilowatt-hour of energy produced[20]. Table 26 presents the indirect and embedded energy savings (based on an approximate average cost of $0.12 per kilowatt-hour[21]), as well as the greenhouse gas savings achieved by Guelph through the implementation of their water efficiency programs.

Table 26: Municipal Energy and Greenhouse Gas Savings from Direct City Programs

Water Saved, Cubic metres	Indirect Energy Megawatt-hours	Embedded Energy, Megawatt-hours	Total, Megawatt-hours	Cost per Megawatt-hour	Municipal Savings	Carbon Dioxide Equivalent Reductions, Tonnes
6,346,638	4,271	63	4,334	$120	$520,080	1,170

[17] Energy intensity values were calculated by City staff and found in excel file "Guelph data and calculations" August 21, 2015.

[18] Chemical use in wastewater treatment is largely dependent on the biological loading that is not affected by lower water demands. As such, no savings in embedded energy has been assigned to lower wastewater volumes.

[19] Equivalent carbon dioxide is the concentration of carbon dioxide that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas (e.g. methane, perfluorocarbons and nitrous) (Maas, 2009)

[20] Greenhouse Gas and Energy Co-Benefits of Water Conservation, Polis (Maas), March 2009

[21] Guelph Hydro rates as of April 2016: 17.5 cents per kWh (on-peak), 12.8 cents per kWh (mid-peak), and 8.3 cents per kWh (off-peak).

It is also estimated that the City has reduced non-revenue demands by about 2.8 million litres per day since 2006. It is estimated that the total volume of water saved from 2006 to 2014 through the City's leak detection and repair program is about 3,675,116 cubic metres[22]. Since there are no wastewater savings associated with reducing leakage, the energy co-efficient for leakage savings is 0.673 kilowatt-hours per cubic metre of water saved. Table 27 presents the energy and greenhouse gas savings achieved by the City's water loss reduction program.

Table 27: Municipal Energy and Greenhouse Gas Savings from Water Loss Reduction

Leakage Saved, Cubic metres	Indirect Energy Megawatt-hours	Embedded Energy, Megawatt-hours	Total, Megawatt-hours	Cost per Megawatt-hour	Municipal Savings	Carbon Dioxide Equivalent Reductions, Tonnes
3,675,116	2,473	37	2,510	$120	$301,242	678

As stated above, water efficiency measures that involve heating water not only save water but energy as well – for example, the Smart Wash program because efficient clothes washers can save both cold water and hot water. This energy savings is referred to as direct energy savings for the customer. The percentage and volume of hot water savings is presented in Table 25 above. It has also been estimated that it requires approximately 8 cubic metres of natural gas to heat 1.0 cubic meters of water by 55 degrees Celsius[23], that 5.3 tonnes of carbon dioxide equivalent are produced for every 2,705 normal cubic metres[24] of natural gas burned (Environmental Protection Agency, 2015), and that the current marginal cost for natural gas in Guelph is about $0.20 per cubic metre. Table 28 shows the energy and greenhouse gas savings achieved by City customers during the 2006 to 2014 study period.[25],[26]

Table 28: Customer Energy and Greenhouse Gas Savings from Direct City Programs, 2006 – 2014 inclusive

Heated Water Savings, Cubic metres	Natural gas savings, Cubic metres	Cost Savings, Customers	Natural gas savings, Cubic metres	Carbon Dioxide Equivalent Reductions, Tonnes
346,871	2,774,971	$554,994	2,702,268	5,297

[22] Value based on leakage flow rates and the assumption that leaks ran all year. This is the cumulative annual volume from 2006 to 2014.

[23] Using a water heater efficiency of 75 percent (Abraxas Energy Consulting, 2016)

[24] Natural gas is measured in normal cubic metres corresponding to 0 degrees Celsius at 101.325 kilopascals

[25] Assuming that the greatest majority of Guelph customers have natural gas water heaters is deemed to be sufficiently accurate for this level of analysis.

[26] It is assumed that virtually all City customers have natural gas water heaters.

5.5 *Cost per Cubic Metre Reclaimed of Direct Programs*

The cost of the water saved from 2006 to 2014 averaged $1,313 per cubic metre or $1.31 per litre (Table 29). As stated previously, the City estimates that it costs about $4.68 for every litre per day added to their system for increased supply and wastewater capacity. Therefore, the cost of water efficient programming has been cost-effective in extending the operational horizon for the existing system.

Table 29: Water Conservation and Efficiency Direct Programs Cost per Cubic Metre Saved, 2006 - 2014

Year	Total Annual Program Costs	Average Daily Water Savings (cubic metres per day)	Cost of Savings (cost per cubic metres per day)
2006	$434,475	40	$10,862
2007	$303,666	384	$791
2008	$319,869	419	$763
2009	$799,788	541	$1,478
2010	$1,046,585	519	$2,017
2011	$1,327,831	1358	$978
2012	$1,391,042	909	$1,530
2013	$1,412,708	917	$1,541
2014	$1,622,311	1505	$1,078
Total (2006 – 2014):	**$8,658,276**	**6592**	**$1,313**

6.0 TECHNICAL REVIEWS

6.1 *Literature Review*

A literature review of current municipal best practices for municipal water conservation and efficiency was undertaken as part of Strategy development. A "best practice" is a method, approach, or technique that has been shown to consistently produce superior results when striving to meet a specific goal, such as a reduction in water demands. These best practices inform opportunities to improve water conservation and efficiency in either a general context or in a specific sector (residential, industrial or municipal).

Several of the identified best practices have already been implemented in Guelph, including: water management planning, information and education programs, water loss control, rebate incentive programs, dedicated staffing capacity, and water efficient technology. While the industrial and residential best practices are not under the City's direct influence, there is the possibility of relevant promotion and incentives. Table 30 shows the water efficiency best practices discussed in the review along with the corresponding City program (where present). This table also highlights areas where future program alternatives could be incorporated to complement existing programs with those from other categories found during the best practice literature review. For reference the literature report is found in Appendix F.

Table 30: Summary of Water Efficiency Best Practices, Guelph's Current Action and Future Program Alternatives

Category	Best Practice	Guelph's current action
General Best Practices	Water Management Planning	• Water Conservation Department • Water Conservation and Efficiency Public Advisory Committee • Municipal Facility Upgrades: - installation of a rainwater harvesting systems - irrigation system upgrades
	Information and Education Programs	• Resources for Youth: - The Yellow Fish Road Program - Grade 2 and 8 In-school Education Programs - The Waterloo Wellington Children's Groundwater Festival - H2Awesome • Healthy Landscapes – a one-hour consultation on how to have a water efficient landscape. • Home Visits – a one hour consultation to inform residents on how to further reduce home resource use, including water conservation, and directing homeowners to further resources and tools to assist with the implementation of recommended improvements.
	Smart Metering	Preliminary research on implementation – no smart meters have been installed.

Category	Best Practice	Guelph's current action
	Water Loss Control	Water Loss Management – through annual leak detection: - Sonic condition assessment - Installation of district metered areas

General Best Practices	Financial Incentive Programs	• Water Conservation Rebate Programs:
		  • Royal Flush Toilet Rebate Program
		  • Greywater Reuse Rebate Program
		  • Smart Wash Washing Machine Rebate Program
		  • Rainwater Harvesting System Rebate Program
		• Blue Built Home Water Efficiency Standards and Rebate Program – Bonze, Silver or Gold certification.
		• Industrial/Commercial/Institutional Water Capacity Buyback Program.

	Regulatory Enforcement	Outside Water Use Program – enforced by City of Guelph Water Services and Bylaw Enforcement Officers.
	Billing System Considerations	Guelph water rates are currently under review.
	Water Audits/Surveys	Can be applicable to the Industrial/Commercial/Institutional Water Capacity Buyback Program and Home Visit program.
Residential Best Practices	Water Efficient Fixtures	Royal Flush Toilet Rebate Program
	Water Efficient Appliances	Smart Wash Rebate Program
	Rules for New Construction	No current action
	Residential Water Loss	Toilet lead detection strips, at home water use and leak educational materials, and Home Audits.
Irrigation Best Practices	Water Efficient Landscaping	Healthy Landscapes – free home visits to residents of the City of Guelph and demonstration gardens. Spring Rain barrel Sale.
	Water Efficient Irrigation	Water Smart Irrigation Professional program – Guelph is a Level 1 Partner. Spring Rain barrel Sale.
	Water Reuse	No current action
	Drip/Micro-Irrigation Systems	No current action
	Low Pressure Center Pivot Sprinkler Irrigation Systems	No current action
Industrial Best Practices	Boiler and Steam Systems	Can be applicable to the Industrial/Commercial/Institutional Water Capacity Buyback Program
	Industrial Alternative Sources and Reuse of Process Water	Can be applicable to the Industrial/Commercial/Institutional Water Capacity Buyback Program
	Rinsing/Cleaning	Can be applicable to the Industrial/Commercial/Institutional Water Capacity Buyback Program
	Increasing Cooling Systems' Efficiency	Can be applicable to the Industrial/Commercial/Institutional Water Capacity Buyback Program

6.2 *Technical Memorandums*

As part of the Water Efficiency Strategy update, a series of technical memos were prepared outlining areas of opportunity within both technology and local policy. These memos were developed to inform discussion of future program alternatives. A summary of each technical memo is found in Table 31, with each memo presented in full in Appendix F to this report and at www.guelph.ca/wesu.

Table 31: Technical Memo Summary

Technical Memo #1: Residential Water Softening and Salinity
About 77 per cent of Guelph's homes have an ion exchange water softener. Cumulatively, these softeners use about 50,000 cubic metres of water to regenerate their resin tanks each year, and discharge about 10,000 tonnes of salt into the environment each year. Moving to more efficient ion exchange water softeners, to tank-exchange systems (where regeneration is done off-site), or to non-ion exchange softeners (such as Nucleation-Assisted Crystallization) will help reduce the related water demand and volume of salt discharged to the environment.
Technical Memo #2: Water Reuse and Demand Substitution Technologies
Only about 10 per cent of the water we use needs to be potable, yet all of the water produced by the City is fit for consumption. As per the Ontario Building Code, grey water reuse systems and rainwater harvesting systems can be used to provide water for toilet flushing, irrigation or other purposes where potable water is not required. Generally the return on investment for these types of systems is prolonged with economic return improving with increased size of the system.
Technical Memo #3: Industrial Consumptive Cooling Process and Water Conditioning Technology Efficiencies
Industrial processes create excess heat that needs to be removed by cooling equipment/processes (i.e. air-cooled or water-cooled). Water evaporated for heat removal cannot be reduced. However, there are potential ways to reduce water use associated with the cooling processes such as: increasing the concentration of minerals in recirculated water, reducing blow down and makeup volumes.
Technical Memo #4: Mass Fixture Retrofit Programs for Multi-residential Settings
The mass fixture retrofit practice involves taking current plumbing fixtures (e.g. toilets, faucets, showerheads, washing machines) and replacing or retrofitting with modern, high performing, and water–efficient models. Multi-residential properties are of particular interest because the high number of fixtures present can result in a great amount of potential water savings (25 to 50 percent in water use based on North American case studies).
Technical Memo #5: Private Customer Leak Detection Notification Technologies
Leaks are 100 per cent waste and impact both the City and the end customer. It is easy for a home to lose 100 litres per day in leaks without noticing. In the fall of 2015 Guelph began monthly billing cycle for all water customers, which enables residents to be notified of any unexpectedly water demands on a more frequent basis, encouraging customers to check for and resolve leaks. However, a more effective method would be to utilize automatic meter reading systems that are checked once or twice a day. This would allow for customers to be notified immediately in the case of unusual usage patterns. An improved means for detecting leaks serves to be beneficial to water conservation.

Technical Memo #6: On-bill Efficiency Repayment Systems, Local Improvement Charges Financing & Other Alternate Incentive Models for Water Efficiency Programming
Incentive models that promote water use efficiency are an effective way to motivate customers to get on board with conservation efforts. There are four main models that can accomplish this: on-bill efficiency repayment system; local improvement charges; capacity buyback programs; and tax incentives. Reducing the full cost or initial cost of implementing a water efficiency measure will improve participation.
Technical Memo #7: New Construction Based Irrigation System Design and Construction Standards
Inefficiencies within irrigation systems can result in a high amount of water loss and increases operational costs to customers. It has been estimated that as much as 50 per cent of the total water applied by an automated irrigation system is wasted due to over watering. It can be more difficult to fix irrigation issues once a system is installed, thus developing improved and consistent construction standards is a feasible solution to mitigate issues in future development.

6.3 *Water Rates Study*

In assessing all tools for Water Conservation, an evaluation of conservation rate structures was completed by consulting economist Mike Fortin in support of the Water Efficiency Strategy Update based on recommendations of the Community Liaison Committee. The goals of the study were to conduct a statistical analysis of Guelph customer water use and to present potential water savings based on modelled customer response to price under differing rate structure formats.

Analysis included a qualitative comparison that evaluated five rate structures: a uniform rate, an increasing block rate, a humpback rate, a seasonal rate, an excess use rate and a water budget rate. The overall score favours the uniform rate for residential and industrial, commercial and institutional customers. An equivalent score was also achieved by an increasing block rate for residential customers and a uniform rate for industrial, commercial and institutional customers.

Quantitative tests demonstrated that the most effective scenario, the very aggressive increasing block rate scenario applied to residential and industrial, commercial and institutional customers, yielded an estimated reduction in average annual demand of 6 percent. However, due to the diversity amongst the industrial, commercial and institutional and multi-residential customers, it would be difficult to create a rate structure that is equitable for these customers.

The report concluded that due to the limited expected impact of most conservation rate structures and issues with equity it was not advised to implement conservation-based rates at this time.

The findings were presented at the third Community Liaison Meeting, followed by an open discussion. Feedback from the committee aligned with the conclusions made in the report and resulted in a consensus not to pursue water conservation rates at this time. The complete Evaluation of Conservation Rate Structures Report can be found in Appendix B.

7.0 EVALUATION OF MUNICIPAL LEAK DETECTION

The City actively pursues water efficiency in its own operations. Water loss in the distribution system is managed with annual leak detection activities including sonic leak detection in areas with metallic watermains and the installation of district metered areas where practical.

The City's leak detection program was initiated in 2011 and aims to reduce the amount of water lost between the time of production and end delivery to customers. This program includes sounding and correlation of all metallic watermains within the City's distribution system. In 2015, 287 kilometers of linear infrastructure were tested with a total of 22 potential system leaks identified. Based on the flow rate of each leak, this resulted in approximately 3,100 cubic metres per day of servicing capacity being reclaimed through the location and remediation of ongoing sources of field water loss.

The Leak Detection Program also included detailed design of district metered areas within the Guelph water distribution system, as well as, ongoing monitoring of six of the City's district metered areas (C3 Water Inc., 2014). This industry best practice for water loss management involves installation of permanent underground flow meter(s) and chamber(s) are installed in parallel with isolation of an area of the water distribution system to allow water use in this area to be monitored through a single or multiple metered watermain feed, on a continuous basis. This approach to water loss mitigation will allow staff to define the normal profile of efficient water delivery for defined areas of the water distribution system and provide a baseline against which to evaluate future demands against, so to assess the occurrence of potential leakage within the area. As an innovative feature of the City's field implementation of district metered areas, field information from each flow meter will be transmitted via cellular network to the City's supervisory control and data acquisition system. This information will be recorded and flows will be assessed and compared to established control limits in order to define the occurrence of previously unknown leaks in areas of the distribution system. This approach to water loss management is anticipated to allow for the proactive response to distribution system leaks and support the retention of water savings already reclaimed from prior leakage restoration.

In recognition of benefits offered through this proactive water loss management approach, Guelph Water Services will be working to implement an additional 20 district metered areas over the period of 2016 to 2018 with funding provided through local development charges. The goal of the district metered area program is to reclaim and sustain 1.5 million litres per day (approximately 3.3 percent on 2015 daily system input volume) in water servicing capacity by 2019.

Each year the City completes an International Water Association / American Water Works Association Water Audit and Water Balance of their distribution system to identify levels of water loss (Section 4.5). This auditing methodology is generally considered to be Best in Class.

The components of the International Water Association standard water balance are presented in Figure 28. As can be seen, there are three main categories of non-revenue water: 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). Real losses typically represent the greatest portion 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, right up to the point of the customer water meter.

<table>
<tr><td rowspan="10">SYSTEM INPUT VOLUME</td><td rowspan="3">AUTHORIZED CONSUMPTION</td><td rowspan="2">BILLED AUTHORIZED CONSUMPTION</td><td>BILLED METERED CONSUMPTION</td><td rowspan="2">REVENUE WATER</td></tr>
<tr><td>BILLED UNMETERED CONSUMPTION</td></tr>
<tr><td rowspan="2">UNBILLED CONSUMPTION</td><td>UNBILLED METERED CONSUMPTION</td></tr>
<tr><td>UNBILLED UNMETERED CONSUMPTION</td><td rowspan="7">NON-REVENUE WATER</td></tr>
<tr><td rowspan="7">WATER LOSSES</td><td rowspan="3">APPARENT LOSSES</td><td>UNAUTHORIZED CONSUMPTION</td></tr>
<tr><td>CUSTOMER METER INACCURACIES</td></tr>
<tr><td>SYSTEMATIC DATA HANDLING ERRORS</td></tr>
<tr><td rowspan="4">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>
<tr><td></td></tr>
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Figure 28: International Water Association Water Balance

Based on historical production and demand data, between 2006 and 2014 the City reduced system water loss by 2,800 cubic metres per day (2.8 million litres per day), that is, from an average of 7.6 million litres per day in 2006 to only 4.8 million litres per day in 2014. A pilot leak reduction study implemented by the City in 2011-2012 estimated a reduction in real losses in 2011-2012 of 3.1 million litres per day. As such, it is clear that as some leaks are found and repaired, new leaks are forming. However, between 2006 and 2014 the City's infrastructure leakage index – the ratio of Current Annual Real Losses to Unavoidable Annual Real Losses in Guelph's system – declined from 3.01 in 2006 to 2.54 in 2014, indicating that the City is continuing to reduce the level of avoidable leakage in their system. As stated in Section 4.5, a system with an infrastructure leakage index of 1.0 would theoretically have no unavoidable leakage; a system with an infrastructure leakage index value of 2.0 would theoretically be able to reduce their leakage level by half. As existing leaks are discovered and repaired, new leaks are forming, so infrastructure leakage index values will fluctuate from year to year. If the City spends too little to reduce system leakage, the volume and value of water lost each year will increase; if the City spends too much, the cost of the program will outweigh the savings. Between these two extremes is an economic level of leakage where program costs and program savings are optimized. The City's goal is to reduce and maintain leakage levels at the economic level of leakage for their system[27].

[27] It is not possible to eliminate all leakage in a water supply system. The Economic Level of Leakage is the term used for the level of leakage below which it costs the municipality more to eliminate than it would recover in cost savings.

A copy of the most recently available International Water Association Water Audit and Water Balance completed by the City (Lamberts, 2016) is available in Appendix E. The report identifies a number of system parameters, including: annual volume of water supplied to system, billed and unbilled demands, metered and unmetered demands, number of customers, kilometres of water mains, etcetera. The report also identifies that the annual cost of operating Guelph's water system has declined from about $3.5 million in 2006 to only $2.9 million in 2013 despite a 6.5 percent increase in the kilometres of water mains and a 16.5 percent increase in the number of customers. Total Annual Operating Costs includes hydro, treatment chemicals, materials and supplies and maintenance costs only.

Table 32 below presents the key International Water Association water audit parameters, including the system's infrastructure leakage index values, the annual volume of non-revenue water, and the annual percentage of non-revenue water versus total system input. Revenue water continues to drop year to year, while the unavoidable annual real loss continues to increase. This increase is a result of the expanding infrastructure, including more water mains and an increase in service connections. The current annual real losses and production values were the lowest in 2013, which is reflected by the low infrastructure leakage index. In 2014, increases in the volume of water supplied to the system, the volume of non-revenue water, and the volume of current annual real losses were a result of the extreme cold winter and a number of frozen services, and main breaks. This influenced the infrastructure leakage index, bumping the value up to 2.54. Further details are found in Appendix E.

Table 32: The City of Guelph's Historical Yearly Water Audits

Parameter	Value								
	2006	2007	2008*	2009*	2010*	2011*	2012*	2013	2014
Current Annual Real Losses (Million Litres)	2,030	1,988	2,488	2,580	2,661	2,058	1,534	1,309	2,087
Unavoidable Annual Real Losses (Million Litres)	707	727	755	765	778	796	805	813	822
Infrastructure Leakage Index	2.87	2.73	3.3	3.37	3.42	2.58	1.91	1.61	2.54
System Input Volume (Million Litres)	18,931	18,790	18,130	17,622	17,584	17,329	16, 594	16,098	16,702
Revenue Water (Million Litres)	15,939	15,784	14,783	14,171	14,127	14,440	14,169	13,919	13,692
Non-Revenue Water (Million Litres)	2,992	3,001	3,347	3,450	3,457	2,888	2,426	2,179	3,010

* Data from 2008 to 2012 was reviewed and updated entirely in April 2016.

8.0 EVALUATION OF MUNICIPAL FACILITY WATER DEMAND

The City of Guelph has chosen to lead by example through its operations in the area of water efficiency and conservation. To achieve this, it has implemented water-savings measures such as upgrading some of its water consuming equipment with more efficient alternatives at the City Facilities. An example of one of these measures is the recent rainwater harvesting system installed at Guelph Transit's Operational Center to offset potable water needs for bus washing. This section discusses municipal facility water demand and the potential for future savings.

8.1 *Municipal Facility Water Demand*

The City of Guelph actively tracks the water consumption of its municipal facilities. The following figures show water consumption from 2006 through 2015 for various facility categories. Figure 29 presents, in general, that water use has decreased in facilities that operate year-round.

Water consumption in seasonal facilities (i.e. parks, sports fields, splash pads etcetera) has increased with time, which can partially be attributed to an increase in the number of recreation centres and sports fields in the City as the population grows and public facilities such as these are built in new areas. This can also be seen in the figures in Appendix G that illustrate the water consumption of each City facility from 2006 through 2015 grouped by facility type. This increase in consumption, while partially attributable to population growth, is also likely due to changes in the number of irrigated fields and changes to health regulations for pools and splash pads (requiring more fresh water to be added to such systems for patron safety).

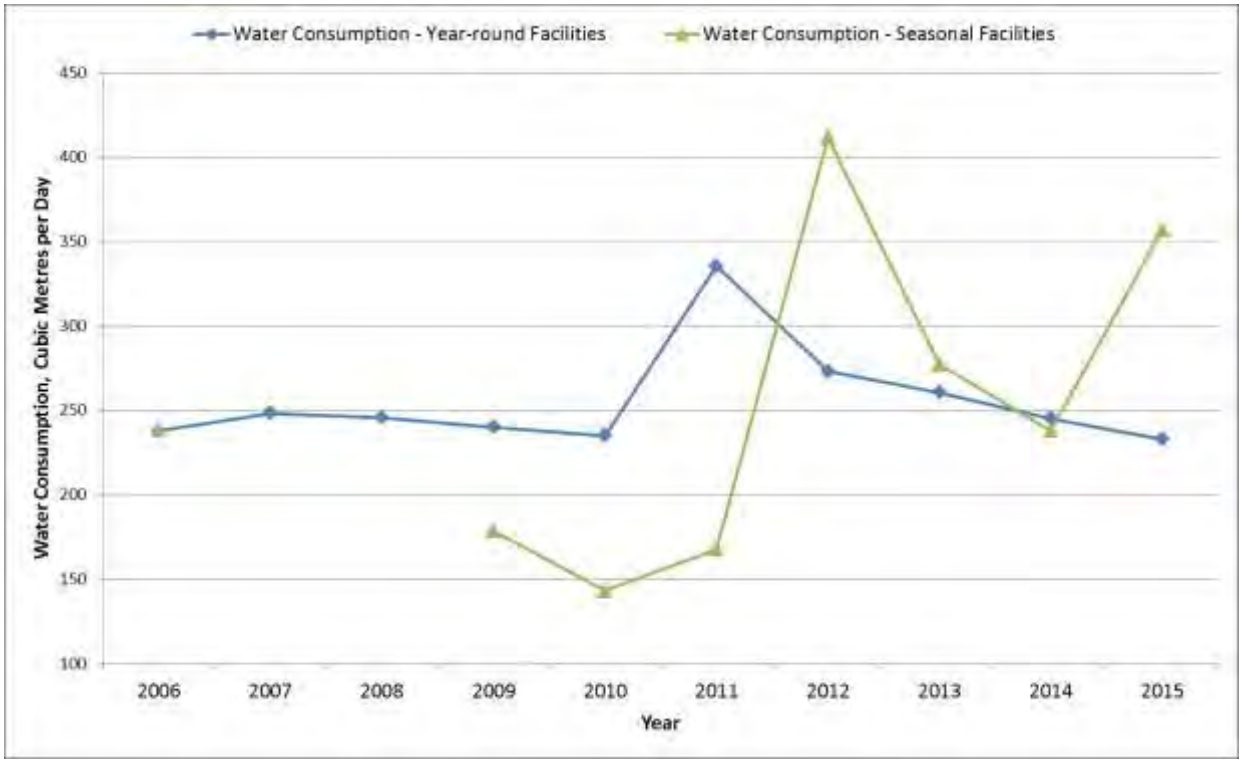

Figure 29: City of Guelph Municipal Facilities Average Daily Water Consumption (2006 - 2015)

Since the time of approval of the 2009 Conservation Strategy, the City has undertaken retrofits in a number of its facilities listed in Table 33. The retrofits have amounted to water savings of 110 cubic metres per day (0.101 million litres per day). Upgrading municipal facilities between 2006 and 2014 has contributed about three percent of the estimated overall water savings from conservation programming.

Table 33: Municipal Facility Water Savings (2006 – 2014), Cubic Metres per Day

City Facility	2010	2011	2012	2013	2014
West End Community Centre Splash Pad Float Valve Replacement	20				
Victoria Road Recreation Centre	9				
Exhibition Arena Condenser Float Valve Replacement	14				
Police Services Toilet Upgrades		1.1			
Sleeman Centre Floor Drain Solenoid Valve Replacement		5.8			
Library, Main Branch Toilet Upgrades			0.95		
Norm Jary Splash Pad Leak Repair				50	
Transit Building Facility Rainwater Harvesting System					1
Total	43	6.9	0.95	50	1
Grand Total	**101.85**				

8.2 *Recommended Water Efficiency Projects*

In July of 2013, the City initiated a review of seasonal facility water consumption and in 2014 the City initiated internal audits of sixteen of the largest water consuming year-round municipal facilities. Site visits, historical data analysis and week-long water flow monitoring were used to identify potential water efficiency measures, to estimate the water savings potential at each facility, and to calculate the associated implementation costs. Further details are presented in Appendix G.

Potential opportunities identified at seasonal facilities include:

- Replacement of toilets, faucet aerators, showerheads with WaterSense® Certified fixtures
- Urinal replacement/repair
- Controls for filling of wading pools
- Transitioning of splash pads to sensor-operated features only
- Investigation into noted increased irrigation water consumption and optimization of these irrigation systems

Potential opportunities at the year-round high water user facilities include:

- Replacement of toilets, faucet aerators, showerheads with WaterSense® Certified fixtures

- Installation of rainwater harvesting systems where appropriate
- Investigation and repair of potential leaks
- Improved control of backwashing at pools
- Batch controllers for Zamboni filling
- Softener upgrades
- Adjustment and repair of flush valves and sensors on toilets and urinals
- Cooling tower blowdown controls
- Improved efficiency of reverse osmosis systems

It is recommended that the City continue to lead by example and implement the identified water-saving opportunities in its facilities. Efforts should be made to coordinate with other planned retrofits in order to save on implementation costs.

9.0 WATER EFFICIENCY PROGRAMS EVALUATION

As available markets, technology, regulations, and standards change over time, it is important to periodically review existing water efficiency programs and to evaluate and consider new opportunities to secure additional water savings in the years ahead. This was completed during first two phases of strategy development where program ideas were collected based on feedback from all stakeholder groups as described in Section 3 of this report.

The following methodology was used to develop the draft final water efficiency programming as described in Section 13 and Appendix A of this report.

9.1 *Background Research*

The project team reviewed available literature and information regarding current municipal best practices in water conservation and efficiency as described in Section 6.1. A series of technical memorandums (Section 6.2) were prepared discussing the extent of current municipal practice, market potential and local feasibility of water conservation and efficiency technologies and programs for the Guelph community. These technical memorandums can be found in Appendix F and at www.guelph.ca/wesu .

Market research of local residents and businesses was also conducted to provide insight into new opportunities for water efficiency programming. Strategically engaging the marketplace can magnify the impact of municipal programs, leverage limited resources and, most significantly, move the marketplace toward desired water management practices. Over the longer term, and if leveraged successfully, market transformation will occur and water efficiency and conservation practices and technologies become embedded in the marketplace; in other words, it becomes the way business is done.

9.2 *Public Consultation*

At the time of program development, members of the public and local stakeholders had provided feedback through a variety of engagement forums including the Community Liaison Committee, an Open House, Online engagement through MindMixer, Facebook and Twitter, and participation at local public events (Jazz Festival, Vegfest, Village Fall Fair and Run for the Cure). This consultation aided the project team in the development of the selection criteria, and the development of the proposed programs list as described in the following Sections 9.3 and 9.4 of this report, respectively.

In order to align future programming with other City of Guelph initiatives, representatives from City stakeholder departments also provided feedback on programming and implementation planning feasibility. A summary of this alignment is presented in Section 3 of this report.

9.3 *Criteria Development*

Water efficiency programs were scored utilizing the evaluation criteria developed from consultation with the community liaison committee, City Stakeholders, Guelph residents and the Project Team. This feedback informed the selection and refinement of the criteria used to weight the suggested programs as presented in Figure 30. This section briefly describes the process undertaken to develop and weigh the final criteria.

Appendix H provides a detailed report for additional information. After development of the criteria and weighting of the programs, further analysis was completed as described in Section 10 before the final list of programs was created.

Figure 30: Determining Evaluation Criteria and Weighting.

9.3.1 **Criteria Weighting**

Draft criteria were presented to Community Liaison Committee members, community members and stakeholders via outreach events and on-line engagement for feedback. Consultation with Community Liaison Committee members, the City's Project Team, community residents and stakeholders led to the selection and refinement and weighting of the final criteria as shown in Table 34.

Table 34: Evaluation Criteria, Description and Weighting

Draft Criteria	Description / Examples	Weighting
Focus is on new construction.	Affects demands in new development - exceeds Ontario Building Code requirements. Examples that would score high are on-demand hot water circulation, greywater rough-in, and deeper topsoil.	0.99
Measure is innovative.	Measure is relatively new and innovative, at least in Guelph. Examples that would score high are bioswales, water reuse, and district metered water.	0.95
Focus is on high water users.	Examples that would score high are irrigation reduction, and capacity buyback programs.	0.91
Maximize social benefits.*	Fair to all customers and customer classes. Examples that would score high are equitable rate structures for all customer classes, sewer surcharge rebate where appropriate, and forgiveness for in-home leakage if corrected.	0.90
Measure based on proven technology.	Measure has been proven in other markets and is suitable for implementation in Guelph. Examples that would score high are toilet rebates, industrial/commercial/institutional capacity buyback program, and irrigation reduction programs.	0.87
Measure has positive environmental benefit.	Examples include limiting the need to develop new water supply; maintains water and wastewater quality and provides source water protection. Other positive environmental benefits considered will be recycle or reuse of materials, extension of the life cycle of a fixture, appliance, or piece of equipment, provide cleaner discharges and infiltrates more water into the ground. Examples that would score high are water reuse, and alternative landscapes (water efficient and reduce runoff).	0.87
Reduces energy use and greenhouse gases associated with water and wastewater system operation.	Maximize climate change resilience. Examples that would score high are gravity-fed rainwater harvesting systems for greywater use and water banking.	0.81
Easy for customer to implement.*	Little effort required by customer. Examples that would score high are Blue Built Home, and Point-of-Purchase rebates.	0.80
Benefits local economy.	Supports local businesses, does not compete with local businesses. Examples that would score high are professional landscape audits and direct to contractor rebates.	0.77
Cost-effective to City vs. expanding supply.	Total implementation cost to City equal to or less than equivalent cost of supply of $4.682 per litre per day of capacity. Examples that would score low are the “purple pipe” and municipal rainwater systems.	0.72
Reduces water and/or wastewater infrastructure costs.	Examples that would score high are alternative sources for fire-flow (smaller pipe sizes, reduced need for flushing) and risk-based asset management for pipe replacement.	0.70
Cost-effective to the customer.	Total savings over 3-year period equal to or greater than	0.53

Draft Criteria	Description / Examples	Weighting
	implementation costs. Examples that would score high are irrigation reduction and the Industrial, Commercial and Institutional capacity buyback program.	
Minimize administrative burden for City.*	Requires minimal staffing and administration to City. An example that would score high is third-party delivered initiatives.	0.50

*Indicates criteria developed and weighted by Water Efficiency Team based on comments from the second Community Liaison Committee meeting.

9.3.2 Criteria Scoring

Each criterion was scored based on the following scale that includes both positive and negative values (Table 35). It is possible for an efficiency measure to have both positive and negative aspects (e.g. a measure could score high on the "Focus on High Water User" criteria but low on the "Easy for Customer to Implement" criteria).

Table 35: Criteria Scoring Scale

Score	Reasoning.
2	Strong agreement with criteria.
1	Somewhat agrees with criteria.
0	Neutral.
-1	Somewhat disagrees with criteria.
-2	Strong disagreement with criteria.

Once assigned a score, this score was then multiplied by the weighting. The water efficiency measure score was the sum of all weighted scores for each criterion.

9.3.3 Using the Evaluation Criteria

Based on the range in scores calculated for all potential programs, a minimum score of 6.0 was established as the threshold for inclusion in the program. If a measure scored at least 6.0 it was considered for immediate implementation and research/pilot studies. If a measure scored less than 6.0 but was considered to have validity in future planning, it was often considered for implementation in either 5, 10, or 20 years (Figure 31). Alternatively, if a measure scored below 6.0 but high for innovation, it was often considered as a research/pilot study. If a measure scored less than 6.0 and was not considered a viable option for either long-term planning or as a research/pilot study, it was discarded.

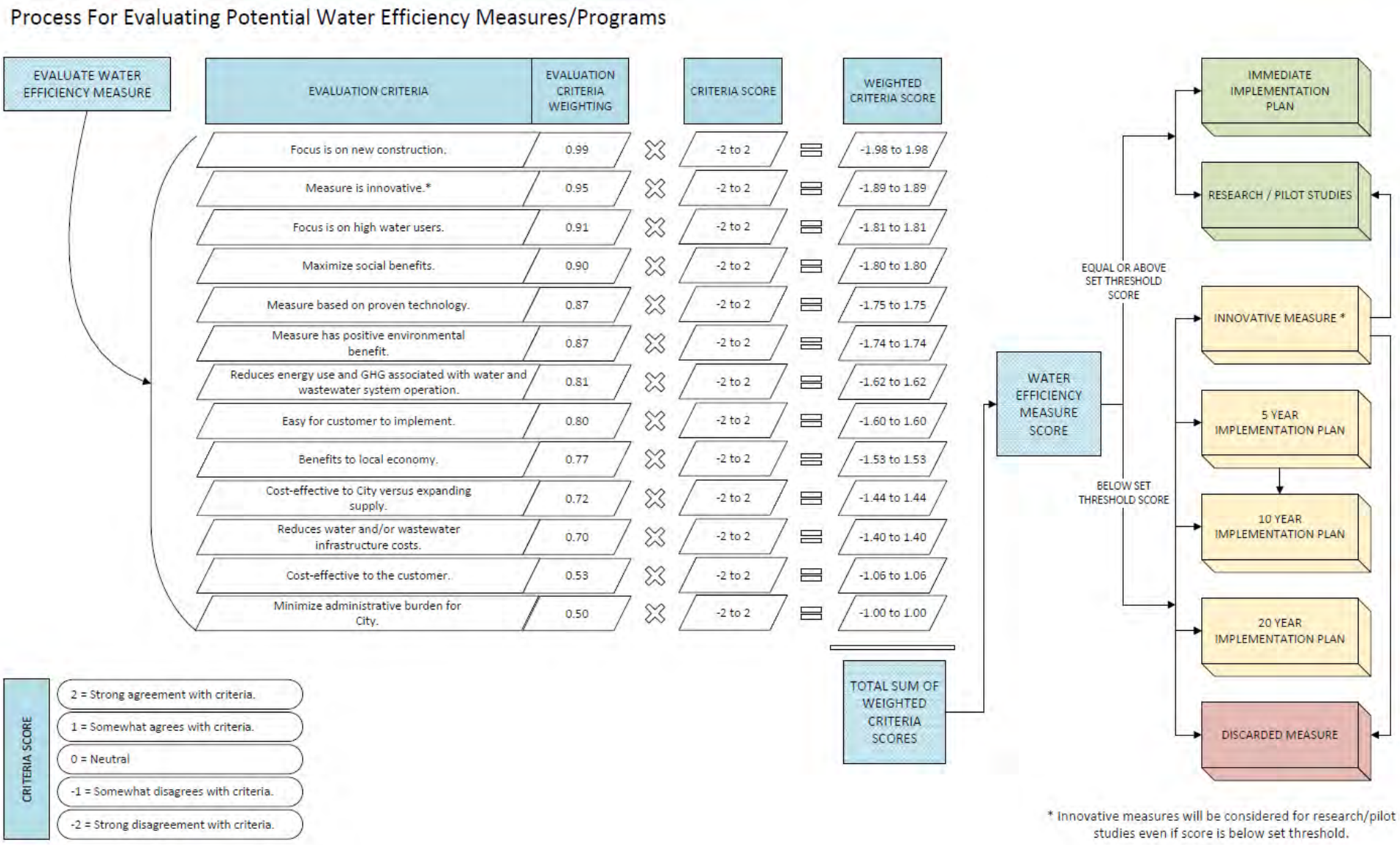

Figure 31: Process for Evaluating Potential Water Efficiency Programs

9.4 *Results – Proposed Programs*

All suggested programs identified through consultation were recorded and are provided for reference in Appendix I. The comprehensive list of potential water conservation programs was developed from research findings (technical memorandums), consultation with stakeholders (public, residential and business), and consultation with City staff. The summary gives the source of the programs, describes the water efficiency programs, and outlines the results of preliminary vetting by the consultation team. If the measure was considered to impact similar sectors/customers as another measure, they were grouped together for further/future consideration. A response of "Yes" in the column "Merits Further/Future Consideration?" indicates that the measure will be scored through the criteria, but does not automatically short-list the measure for financial modelling.

Also included in Appendix I are the scores of programs that were considered to merit further consideration. Each measure was scored based on the developed evaluation criteria and weighting (Section 9).

After further consultation with City departmental stakeholders to gain input on feasibility of timelines for implementation of short-listed programs, the following list (Table 36) was formed. The programs were divided into two categories: programs that would provide quantifiable water savings and were labelled direct water savings programs, and those that could not provide measureable savings at this time, but provided value through indirect water savings. The listed programs underwent financial and water savings modelling to calculate yearly, 5-year and 10-year estimated costs and water savings when implemented.

Table 36: Proposed Programs that Underwent Financial and Water Savings Models

Direct Water Saving Measure Programs	Education, Promotion and Regulation (no direct savings) Programs
Water Loss Management	Drinking Water Promotion
Water Smart Business	Outdoor Water Use Programs
Royal Flush Toilet Rebate Program	Public Outreach and Education
Municipal Facility Upgrades	Mobile Applications (watr)
Distribution System Pressure Management	Water Reuse and Demand Management
Automated Meter Reading Installation	Water Conservation and Rebound Effects Study
Multi- residential Audit Program	Water/Energy Nexus
Multi-residential Sub-metering Program	Water Softening Pilot Study
Home Visits/Audits	Best Practices for Municipal Upgrades Document
Blue Built Home Water Efficiency Standards and Rebate Program	Automated Meter Reading Study
Irrigation Audit (Water Smart Irrigation Professional)	Water Efficient Landscaping Incentives
Cooling Tower Audit Research Program	
Irrigation System Rebates	
Water Softener Rebate	
Hot Water Re-circulation Systems Rebate	
Healthy Landscapes Home Visit	

10.0 WATER EFFICIENCY PROGRAMS FINANCIAL REVIEW

Once programs underwent the weighted criteria evaluation, it was important to ensure if implemented that they would meet a financial affordability threshold, as well as, the weighted criteria threshold. The programs which met this threshold moved forward to a detailed cash flow financial analysis. A summary of this analysis is found below with further information is provided in Appendix J.

For the purposes of defining future program impact the discounted cash flow analysis included the following:

- Comparison of individual water efficiency programs;
- Comparison of combined programs to each other; and
- Determination of what would happen with a do nothing scenario.

This financial review encompasses both water supply and wastewater operations since both are impacted by water efficiency programs. Further the review estimates the total cost—capital and operating—of these operations under three alternative water efficiency scenarios.

The basic measure of cost in a discounted cash flow analysis is the present value of annual operating and maintenance costs incurred over the period of a common planning horizon applied to each scenario. The net present value calculation expresses all costs incurred over the planning horizon in terms of present day costs by discounting future costs to account for the time value of money.[28]

Each scenario that was consider below is distinguished by the amount of expenditure for water efficiency program, the resulting demand for water and generation of wastewater and the incremental changes in capital and operating costs required to produce water and treat wastewater. In these scenarios higher costs for water efficiency programs are being traded off against lower costs to produce water and treat wastewater. A water efficiency program is beneficial from a financial perspective if the present value of aggregate costs with that measure or program in place is lower than the present value of costs without the measure or program.

The financial model was developed using an EXCEL software platform to facilitate the discounted cash flow analysis. The Sequencing of programs and weighting of annual water reduction targets model for the Implementation Plan were informed and evaluated by determining their:

- Economic benefit to the City through deferral and/or avoidance of new servicing infrastructure and associated operational expenditures,
- Affordability to local water rate payers when looking to annual utility revenue needs, and
- Impacts to water rate revenues based on the expected costs and savings derived through the implementation strategy.

The following is a summary of the results from the discounted cash flow analysis:

[28] The discount rate calculation is analogous to an interest rate calculation.

- Five programs were found to cost less on a unit basis than the cost of new supply and wastewater capacity:
    - Distribution System Pressure Management,
    - Water Loss Management,
    - Irrigation Audits,
    - Home Visits/Audits, and
    - Water Smart Business.

Further, the following is noted:

- Water Loss Management provided the highest net financial benefit when comparing individual programs with a savings of $18 million during the 10-year implementation timeframe.
- When all programs are combined, there is a total savings of approximately $20 million in deferred expansion.

The results indicate that there is a cumulative impact associated with the implementation of multiple water efficiency measures that cannot be realized by individual programs. This cumulative impact is evident in Table 37 showing the timing of investments in capacity expansions. It is only when the three top measures are combined that the large water supply and wastewater treatment plants are no longer needed within the planning horizon.

Table 37: Timing of Capacity Expansions with Alternative Water Efficiency Programs

	Water Supply Capacity			Wastewater Treatment capacity	
	1st New Well - Ironwood	Last New Well - Guelph North	Guelph Lake WTP	1st Expansion to 85 Megalitres/day	Last Expansion to 125 Megalitres/day
Do nothing	2017	2062	2069	2024	2071
Water Loss Management	2017	2068	2074	2028	2074
Water Smart Business	2017	2065	2071	2026	2072
Royal Flush Toilet Rebate Program	2017	2063	2069	2025	2071
Top 3 programs	2027	2071	not needed	2029	not needed
All WCE Programs	2027	2072	not needed	2030	not needed

The benefit of an increasingly comprehensive water efficiency program with multiple measures is shown in Figure 32. After the first four or five measures are included in the overall program, there is little additional benefit to be gained by adding additional programs. But the fact that cost increases are virtually zero or minimal beyond the first four of five water efficiency programs suggest that each measure is paying for it in terms of operation and maintenance cost savings that accrue over time. For this reason, the selection of water efficiency programs beyond those that are known to yield a significant impact should be based on criteria other than costs.

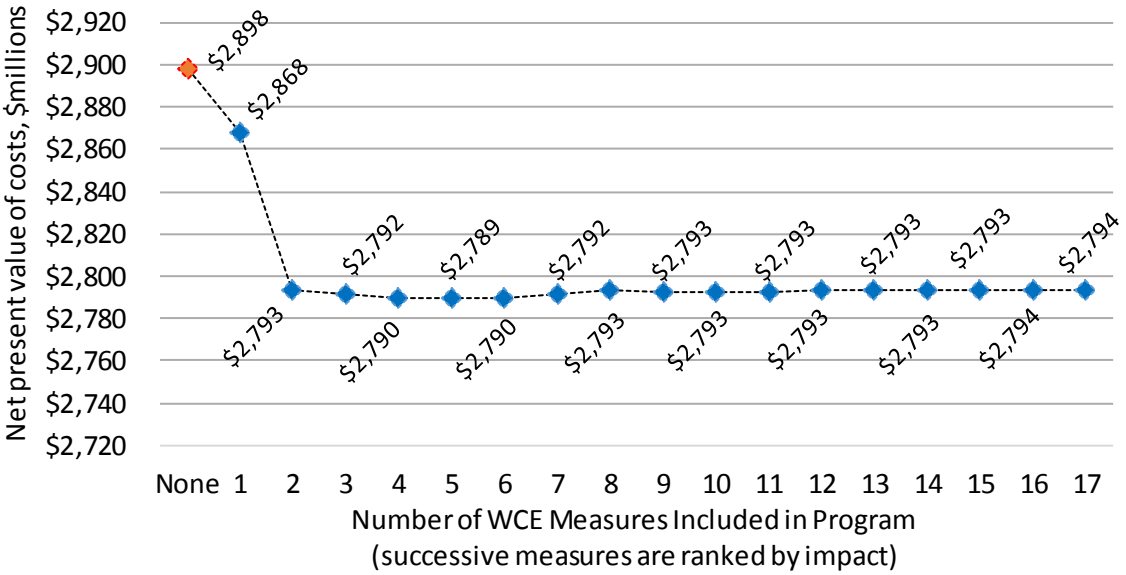

Figure 32: Benefit of Increasing the Number of Programs in a Water Efficiency Program

Some programs were found not to be cost effective in terms of the dollar value threshold. However, these programs provide non-financial value to the community presented in the Table 38 below. The Alliance for Water Efficiency Report on Improving Water Conservation and Efficiency that behavior based programs are often ended early based on an assumption that they have a limited life cycle and water savings stop at the end of the program life (Christiansen, 2016). However, it should be noted that in order to continue savings and changing behaviors, these programs must be continued. The report states, "It is a common assumption for efficiency programs that achieve savings predominately through behavioral changes because of the need for programs to effectively reinforce and maintain the changed behavior."

Table 38: Non-financial Factors Bearing on the Selection of Water Efficiency Programs

ITEM	Description / comment
Awareness of Water Efficiency program	There are a number of programs that involve education, promotion, research and regulation; programs which have an indirect impact on water use. By raising awareness, these programs may serve to assure the uptake of the direct savings programs and may therefore be needed to achieve the estimated financial gains.
Innovation	The research oriented programs, while not yielding immediate savings, may serve to expand the potential for water savings beyond the limits that can be achieved using proven programs.
Carbon emissions	Water efficiency programs reduce the use of energy used in water supply and wastewater systems. One estimate made in 2009 for the City of Guelph indicates an aggregate reduction in CO_2 emissions of about 0.5 tonnes per year for every cubic meter of daily demand that can be avoided.[29] The total reduction in CO_2 emissions associated with implementation of all WCE programs is about 2,800 tonnes per year by 2025. The social worth in present value terms of this emission reduction is conservatively estimated to be $4 million.[30]
Ecological values	Certain water efficiency programs address outdoor water use by promoting drought tolerant herbaceous and woody plants. These programs provide benefits beyond water conservation such as expansion of the urban tree canopy, increase in biodiversity of the urban ecosystem and protection of pollinators.

[29] Carol Maas. Greenhouse Gas and Energy Co-Benefits of Water Conservation POLIS Research Report 09-01 March 2009

[30] Based on R. Clarkson and K. Deyes, 2002. Estimating the Social Cost of Carbon Emissions. Environment Protection Economics Division, Department of Environment, Food and Rural Affairs: London. The estimate of damages caused by CO2 emissions in this report was £70/tC. This translates to $58/tCO2 at 2016 prices.

11.0 POTENTIAL VOLUMETRIC COST OF THE WATER EFFICINCY PROGRAMS

The last step in determining the water efficiency programs listed in Section 13 is to review the potential volumetric cost of water savings for each program. Although it is not possible to quantify the water savings associated with every water efficiency program, some programs are included based on other benefits they provide that are not captured though typical financial costing, such as awareness, societal and environmental benefit, and innovation (i.e. future planning for the 2022 Water Efficiency Strategy Update) as noted in Section 10.

The total water efficiency programs costs, savings and cost per cubic metre is presented in Table 39. The overall program cost is $2,170 per cubic metre per day saved which is less than the City's current estimate of the construction unit cost for water and wastewater expansion ($4,684 per cubic metre per day). Note that future programming, beyond the five year planning horizon, has been included and italicized in Table 39.

Based on this analysis, it is recommended that the water efficiency programs listed below be included as part of the 10 year strategy implementation plan outlined in Section 12.

Table 39: Summary of the 10-Year Water Efficiency Programs Cost and per Cubic Metres per Day Savings

	Water Efficiency Programs	Total 10-Year Program Cost	Total 10-Year Water Savings	Cost per Cubic Metre per Day Savings
Direct Water Savings	**Royal Flush Toilet Rebate Program**	$605,000	210	$2,881
	Blue Built Home Water Efficiency Standards and Rebate Program	$109,500	14	$7,964
	Home Visits/Audits	$122,500	65	$1,899
	Water Softener Rebate	*$50,000*	*4*	*$14,286*
	Multi-residential Audit Program	$142,500	74	$1,919
	Multi-residential Sub-metering Program	$95,000	11	$8,796
	Water Smart Business	$2,225,000	1,500	$1,483
	Municipal Facility Upgrades	$602,953	220	$2,741
	Water Loss Management	$1,595,000	3,962	$403
	Automated Meter Reading Installation	*$760,000*	*56*	*$13,620*
Indirect Water Savings	**Healthy Landscapes Home Visit**	$2411,000	N/A	N/A
	Water Efficient Landscaping Incentives	*$330,000*	*N/A*	*N/A*
	Public Outreach and Education	$1,150,000	N/A	N/A
	Mobile Applications (Watr)	$140,000	N/A	N/A
	Drinking Water Promotion	$150,000	N/A	N/A
	Outdoor Water Use Programs	$300,000	N/A	N/A
Research	**Water Reuse and Demand Management**	$550,000	N/A	N/A
	Water Conservation and Rebound Effects Study	$100,000	N/A	N/A
	Water/Energy Nexus	$60,000	N/A	N/A
	Water Softening Pilot Rebate Study	*$100,000*	*N/A*	*N/A*
	Municipal Upgrades Best Practices Study	$25,000	N/A	N/A
	Distribution System Pressure Management	*$20,000*	*100*	*$200*
	Automated Meter Reading Study	$180,000	N/A	N/A
	Cooling Tower Audit Research Program	*$120,000*	*15*	*$8,000*
	Irrigation Audit (Water Smart Irrigation Professional)	*$27,000*	*30*	*$913*
	Irrigation System Rebates	*$18,000*	*6*	*$3,042*
	Water Efficiency Strategy Implementation	3,775,200	N/A	N/A
	Total	**$13,593,653**	**6,265**	**$2,170**

12.0 10 YEAR STRATEGY IMPLEMENTATION PLAN

A 10-year strategy implementation plan was developed to identify the preferred sequencing, timing, and costs of recommended water conservation and efficiency program alternatives. As stated in the 2014 Water Supply Master Plan, the projected 2038 annual average day demand under a "no water efficiency" scenario of 69,872 cubic metres per day, equating to approximately 375 litres per capita per average day. The Water Supply Master Plan also identified a 2038 "with water efficiency" water production target of 60,725 cubic metres per day – or 9,147 cubic metres per day lower than the "no efficiency" scenario – and equating a gross per capita demand of approximately 326 litres per capita per average day (Figure 33).

In 2013 the actual production rate was 44,379 cubic metres per day, equating to approximately 352 litres per capita per day. Therefore, with a goal of reducing annual average day water production rates from 375 to 326 litres per capita per average day between 2013 and 2038 and a current (2014) rate of only 352 litres per capita per day, the City is ahead of schedule to reach their 2038 target and is very likely to exceed this target (an annual average day production rate of 352 litres per capita per average day was not expected until about 2026).

Part of the reason that the City is ahead of schedule to meet their long-term water efficiency targets is that the 2014 Water Supply Master Plan assumed a natural savings rate (i.e., a naturally occurring decline in per capita water demands due to a general improvement in the efficiency of water-using fixtures and appliances in the marketplace) of only 0.286 litres per capita per day per average year. The current actual rate of natural decline in demands is almost a magnitude higher at about 2.7 litres per capita per day per average year[31] but this rate is expected to slow as the number of inefficient customers in Guelph decreases each year and there are fewer opportunities for savings.

As stated above, the City's target is to reduce annual average day production rates by 9,147 cubic metres per average day by 2038 through the implementation of a number of selected water efficiency programs. The 2014 Water Supply Master Plan identified a 10-year target (i.e. by 2027) savings of 4,578 cubic metres per average day based on a "no water efficiency" production rate of 62,706 cubic metres per day and a "with water efficiency" production rate of 58,128 cubic metres per average day (Figure 33).

While the City's current water production rate is below that projected in the 2014 Water Supply Master Plan, per capita water rates must decline from the current (2014) level of 352 litres per capita per average day to 326 litres per capita per average day by 2038 if the City is to reach its target.

The next section outlines the programs that have been selected for implementation over the next 10-year planning period to help achieve the City's target water reduction. Section 14 includes projected implementation schedules and costs for each of these programs.

[31] Based on detailed in-home monitoring completed in 737 representative homes in nine different cities in the United States and Canada as part of the 1999 Residential End Use Study (American Water Works Research Foundation) and the 2014 Residential End Use Study Update (National Research Centre Inc.) over the 15-year period between 1999 and 2014 average per capita indoor demands have declined from 262.3 litres per capita per average day to 221.8 litres per capita per average day, a reduction of 40.5 litres per capita per average day in 15 years for an average of 2.7 litres per capita per year. This reduction was found to be statistically significant at the 95 percent confidence level.

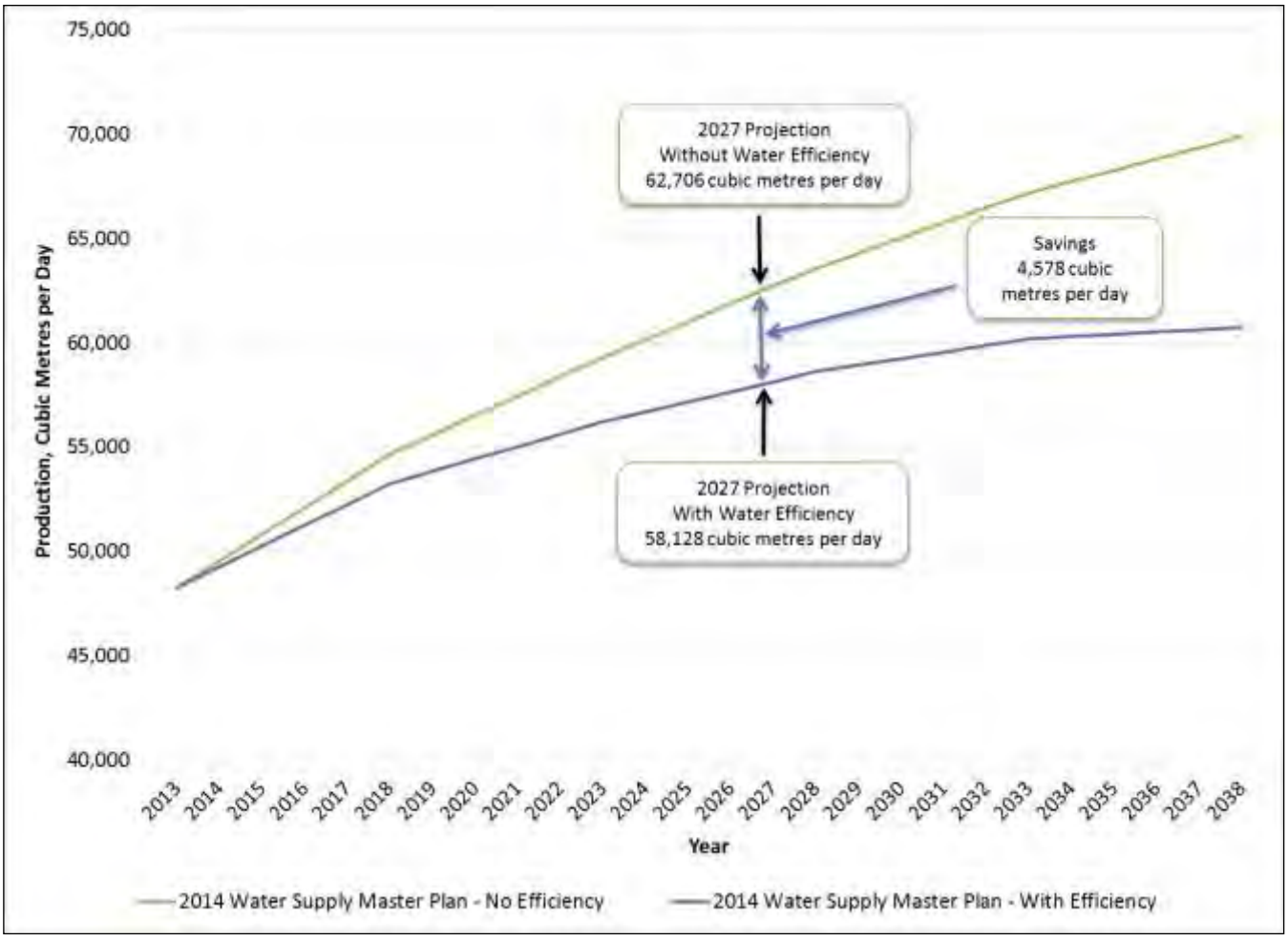

Figure 33: 2014 Water Supply Master Plan Production Rates with and without Water Efficiency for the 10-Year Planning Horizon

13.0 WATER EFFICIENCY PROGRAMS

Based on the stakeholder engagement (Section 3), community feedback (Section 3), technical reviews and research (Section 6), potential programs were weighted based on the developed evaluation criteria (Section 9), financial review (Section 10) and potential volumetric costs (Section 11). The following is summary of the proposed Water Efficiency Programs to be implemented over the next 10 years. Programming beyond the 5-year planning time frame (2022 to 2026) is proposed at this time. These programs will be reviewed during the planned strategy update in 2020. Further program details, including individual business cases, are provided in Appendix A to this report for those programs to be implemented with the first five year planning horizon (2016 to 2021).

13.1.1 **Direct Water Savings Programs**

13.1.1.1 Residential Sector

- Royal Flush Rebate Program – The City will offer rebates to customers replacing inefficient toilets using six litres or more per flush with WaterSense®-certified toilets that have effective flush volumes of 4.8-litres or less. Rebates will be available to all customer sectors. Single-family residential customers which will be limited to 2 toilets per household. The existing rebate level of $75 per fixture will be reduced to $50 per fixture to ensure that the program remains cost-effective to the City. This change in the program will also allow more residents/ businesses in the City to obtain this rebate and address performance issues associated with first generation 6 litre per flush toilets (previously ineligible for rebate under this program).
- Blue Built Home Water Efficiency Standards and Rebate Program – The existing three-level certification will be transitioned to a single-level program where rebates are offered for a variety of water saving fixtures and appliances to both existing and new homes and multi-residential communities (to be researched if possible). Homes would need to achieve an average indoor water demand of no more than 150 litres per capita per average day. Examples of possible fixtures/equipment that are eligible for rebates include:
    - Toilets that flush with 4.0 litres or less ($75),
    - Hot water re-circulation system ($100), a rebate of $100 will be offered to residents that install an on-demand hot water circulation system in either a new or existing home. When activated, these systems circulate hot water through a piping circuit, returning ambient temperature water in the supply piping back to the water heater and bringing hot water to the fixture. Systems must have a dedicated return line to the water heater. Timer-based, motion sensor-based and continuous systems will not qualify for a rebate.
    - Waterless floor drain ($20),
    - Rainwater harvesting system ($2,000),
    - Greywater reuse system ($1,000).
- Home Visits and Audits – The City will continue to offer a free one-hour home water efficiency visit and audit for residential homes. This program would provide educational materials and recommendations on water saving initiatives (e.g. check for leaking toilets, measure flow rates for faucets and

showerheads, identify how to check for leaks using the home's water meter and identify efficient behavioural changes). In order to verify water savings achieved by program, it is recommended to audit participants complete a customer water billing data analysis. Fixtures installed as part of this program should meet or exceed WaterSense® efficiency levels.

- Water Softener Rebate – A water softener rebate program is recommended beginning in 2022, following continued research of water softener and conditioning technologies. A rebate of $200 is proposed for customers who install an approved non-salt based residential water softener, such as a Nucleation-Assisted Crystallization or a very efficient low-salt-use ion exchange softener.

13.1.1.2 Multi-residential Sector

- Multi-residential Audit Program – A new program will offer high-density customers a free 24-hour water demand analysis of their building through flow monitoring and logging of the building's main municipal water meter. The building's daily water demand pattern can be used to provide an estimation of potential water savings related to installing efficient plumbing fixtures and/or define the presence of leakage in the building, allowing property managers/owners to make sound business decisions on water efficiency opportunities in their building. This program lends itself well to the possibility of piloting a bulk procurement program with the Guelph Energy Efficiency Retrofit Strategy (GEERS). In addition, there is the possibility of considering the reduction or removal of disposal fees for removed fixtures.
- Multi-residential Sub-Metering Program – A new program will provide funding to companies to install permanent sub-metering in multi-residential buildings. Eligibility to participate in this pilot program will arise from the Multi-residential Audit Program. Opportunities will be identified on a building-by-building basis where plumbing layouts are favourable. For example, condos and row houses typically have piping infrastructure that is favourable to sub-metering individual living units while the plumbing infrastructure in high-density multi-residential buildings is generally not conducive to sub-metering. Based on the results of a similar program being implemented in the Region of Waterloo it is estimated that the total average cost per installation would be about $500 with half the cost related to buying the water meter and half the cost related to installation. It is assumed that Guelph's program would offer approximately the same level of rebate as the Region of Waterloo: 50 percent of the cost of the meter or about $125 per meter installed. This rebate would be provided directly to the property owner/manager or to a third-party agent of the property owner/manager.

13.1.1.3 Industrial, Commercial, and Institutional Sector

- Industrial, Commercial, and Institutional Capacity Buyback Program – This program provides industrial, commercial and institutional water consumers with financial assistance for facility water use audits and one-time financial incentives for the implementation of retrofits to permanently reduce water use. The City currently offers $0.30 per litre per day of water saved and a free water audit. To increase accessibility, the program will be renamed so that it makes clear the focus or goal of the program and at whom it is targeted. Currently, the name uses an acronym that perhaps not everyone is familiar with (ICI), and focuses on what the City gets out of it (increased water supply capacity). It is proposed that

the name of the program be changed to "Water Smart Business Program", which is a more appropriate and meaningful name that may attract more participation. Further, it is recommended that the incentive be increased from $0.30 per litre per day of saved water to $0.75 per litre per day of sustained water savings. Permanent metering and sub-metering opportunities may also be identified in large facilities. A review of the current program administration should be performed with the aim to simplify requirements for customer participation – perhaps looking to the Energy Sector audits as an example. Additionally, it is recommended to review the potential to remove or amend the existing requirement that any water efficiency measure implemented by a customer must have a payback period of greater than one year to qualify for a City incentive.

13.1.1.4 Municipal Operations

- Municipal Facility Upgrades Program – The City should continue to lead by example and make water-saving upgrades in City buildings. There may also be the possibility of conducting pilot/research projects within municipal facilities (e.g. rainwater harvesting and wastewater reuse). Therefore, this program should continue to upgrade City facilities and complete monitoring to verify savings.
- Water Loss Management Program – The City's goal is to reduce and maintain the annual average day leakage rate to the most economical level of leakage. The City is currently working to implement 27 district metered areas (considered an industry Best Management Practice) to manage leakage in the water distribution system where possible. However, because of the distribution system layout, the need to maintain minimum fire flows and system pressures, etcetera, it is not possible to use district metered areas in all sections of the system. In these areas, the City must consider other options including annual sounding/correlation programs and the use of field sensors and triangulation technologies.
- Automated Meter Reading Installation – It is recommended that the City install automated meter reading starting in 2022 if supported by pilot studies to be conducted in the next five years. These meters would be a great tool to provide more in depth information for Infrastructure Leakage Index calculations and to notify homes of potential leakage under short order. This technology also provides an education and management opportunity for homeowners, allowing the customer to have real time consumption readings available to them.

13.1.2 **Indirect Water Savings Programs**

13.1.2.1 Outdoor Water Use

- Healthy Landscapes – It is recommended that the City continue to provide a free home visit to residents as part of the Healthy Landscapes Program. Program staff will explain to homeowners how to reduce outdoor water use while maintaining a healthy and vibrant landscape. For continued program success it is important to ensure staff is trained with appropriate landscaping credentials for the site visits. This could include working closely with the landscaping community to create a common message with respect to the City's water efficiency goals. To ensure the continued success of the program, these trained consultants/staff will provide an unbiased recommendation based on what works in the City of Guelph to meet the goals of the Water Efficiency and Outdoor Water Use Programs. Since water

savings associated with this program have been historically difficult to quantify, it is also recommended to complete participant water billing analysis and look to develop potential methods to quantify water savings in the future.

- Water Efficient Landscaping Incentives – In 2021 it is recommended that the City will begin developing a Water Efficient Landscape Incentive program with the intention of implementing the full program beginning in 2022. The program details will be revised based on the development of the 2022 Water Efficiency Strategy Update. The program will only be offered through service providers, such as nurseries, garden centres, landscaping companies, etcetera, as research has shown that these types of companies are considered the "trusted advisors" for homeowners making landscaping choices. These service providers will provide guidance to customers regarding the creation of sustainable landscapes, including the proper selection of plants and flowers, the incorporation of low impact development designs (e.g., use of passive rainwater harvesting, rain gardens, permeable hardscapes, bioswales, etcetera). Participating service providers will be able to pass through City rebates to customers, such as rebates for: water efficient plants; rainwater harvesting systems; and installation of rain gardens. Rebate amounts will have to be defined based on the respective water reductions and benefits to other City utilities, most notably stormwater management.

13.1.2.2 Public Outreach/Education Programs

- Public Education – Education is a fundamental tool in engaging and motivating actions amongst all customer sectors (residential, industrial, commercial, and institutional). It is an attempt to alter peoples' attitudes and habits about water use with the hope that they adopt a more water-efficient behaviour and/or lifestyle. Some of the habits that can be affected include: turning faucets off when not needed, finding and fixing leaks quickly, and reducing lawn-watering frequency. Public education programming should be based in the principles of consumer based social marketing and may include school programs, workshops, ads or articles in newspapers and flyers, audits, websites, television ads and much more depending on target audiences for such campaigns. With the importance of youth education, the City will continue to offer interactive curriculum-linked education activities to reinforce the importance of protection and conservation of our precious water resources. Targeted public education efforts include, but are not limited to:
    - Reduction Challenge
    - Importance of Water Campaign – reach out to renters and students
    - Campaign Collaboration
    - Passive Leak Detection
    - H_2O Go Festival
    - Grade 2 and 8 School Education Programs
    - Waterloo Wellington Children's Groundwater Festival
    - H2Awesome
    - Water Services Facility Tours

- Mobile Application – The City will continue developing a mobile water engagement platform (called the "Watr" application) with the local startup company Focus21. Watr will allow users to see their water consumption data and compare it to their peer grouping. Challenges to reduce consumption will be presented along with conservation messaging through push notifications.
- Drinking Water Promotion – The City will continue to execute programs including the Water Wagon service with a potential to increase capacity by adding an additional Water Wagon or other means to increase public access to tap water throughout the City. Further, the City will continue to promote Guelph's safe, reliable and clean tap water to the community through the public education program. This includes Water Services' facility tours and special event attendance with the Water Wagon.
- Outdoor Water Use Program – The City will continue the programming associated with the Outdoor Water Use Program to ensure all community members are aware of the summer outdoor water use by-law and how to reduce their outdoor water use. This programming will continue to conserve Guelph's groundwater supply and protect against the impact of drought during the hot, dry summer months.

13.1.3 **Research Programs**

- Water Reuse and Demand Management Study – Projects that fall into this research category include:
  - Rainwater Harvesting – Research and pilot new technology and verify savings by sub-metering or monitoring billing data of participants.
  - Rainwater Collection Network Regulations – Investigate and update the necessary documents (by-laws) to regulate and allow for rainwater collection networks.
  - Greywater Reuse – Research and pilot new technologies and verify savings by sub-metering or monitoring billing data of participants.
  - Municipal Water Reuse – Investigate the potential for water reuse pilot projects, perhaps as a source for outdoor irrigation. Potential partners for this research may include local universities such as the University of Guelph or University of Waterloo.
- Water Conservation and Rebound Effects Study – A study of the effects of water conservation on the physical structures and buildings that supply Guelph's water and treat our wastewater. Study to include:
  - Investigation of the effects (both positive and negative) of water conservation on plumbing and municipal water and wastewater infrastructure.
  - Research efforts regarding the possibility for a rebound in water use should conservation technologies degrade in performance or significant changes in current land use change over time.
- Water/Energy Nexus – It is recommended to piggy back on federal/provincial energy programming to provide educational materials to customers outlining that because water is used to produce electrical energy and electrical energy is used to treat and pump water, reducing water demands will also reduce energy use. The City will also review the best opportunities to strategically implement technologies to reduce energy use and water loss in the distribution system (e.g., flow modulation / pressure

management). Further, the City will research methods to reduce energy consumption in water extraction and transmission.

- Water Softener Pilot Study – It is recommended that current work of piloting the use of Nucleation-Assisted Crystallization water conditioners continue in partnership with the Region of Waterloo. This includes field trials of this technology to assess real world performance (including but not limited to water quality objectives and end user social acceptance).

  Should this research prove successful, it is recommended that the City offer a rebate of $200 to customers who install an approved non-salt based residential water softener, such as a Nucleation-Assisted Crystallization model, or a very efficient low-salt-use ion exchange softener starting in 2022.

- Municipal Upgrades Best Practices Study – This study would research and develop a Best Practices document for municipal facility upgrades and new facility construction in partnership with the City's Corporate Energy Office.

- Distribution System Pressure Management – Currently the City's existing water distribution system is divided into 2 pressures zones, which are not conducive to pressure management due to challenging in varying the pressure to all customers while meeting basic servicing requirements and emergency flow demands. However, with the City planning to implement new pressure zones in the next 5-10 period (zones 2 and 3 East) it is recommended that the City investigate the potential for pressure management as part of future pressure zone design. This proactive approach is seen to reduce implementation costs and allow the City to reduce the amount of unavoidable water loss during periods of low customer demand.

- Automated Meter Reading Study – It is recommended that the City pilot a small scale automated meter reading installation in a new development to begin to define technology preferences and to define a business case for larger deployment of this technology.

- Cooling Tower Audit/Rebate Program – It is recommended that the City pilot cooling tower conductivity sensor/ meter rebates and assess participation, cost and water savings starting in 2022. At least five buildings should be studied in order to verify savings and cost effectiveness of the program. Eventually, the program shall:
  - Provide free cooling tower audits,
  - Provide rebates for conductivity meters ($1,000).

- Irrigation Audit (Water Smart Irrigation Professional) Program – It is recommended that the City will begin implementing a program to optimize automatic irrigation systems in 2022. While the City does not have a large number of customers with automatic irrigation systems, these systems can waste significant volumes of water if they are not properly designed and adjusted. The Water Smart Irrigation Professional program – originally developed by Peel Region and the Regional Municipality of York – involves offering qualified irrigation professionals in-class training and access to a proprietary software program to help them optimize irrigation schedules. Contractors that pass the course (delivered through Landscape Ontario) will be listed on Guelph's website as Water Smart Irrigation Professional - Certified contactors. The City could decide to pay each contactor $450 per site to optimize their customers' automatic irrigation systems. The contactor will have to follow Water Smart Irrigation

Professional protocol and provide the City with an audit report for each property quantifying the water savings achieved.

- Irrigation System Rebate Program – It is recommended that in 2022 the City offer customers with automatic irrigation systems a $300 rebate towards the purchase of a 'smart' weather-based controller. These controllers save water by preventing the irrigation system from operating during or immediately following a rain event.

13.1.4 **Water Efficiency Programs Summary**

A summary of the water efficiency programs is presented in Table 40. This table highlights the sectors in which recommended measures/programs will achieve water savings.

Table 40: Recommended Program Water Savings Impact Summary by Sector

Program/Measure	Residential	Industrial/ Commercial/ Institutional	Non-Revenue Water
Direct Water Savings			
Royal Flush Rebate Program	■	■	
Blue Built Home Water Efficiency Standards and Rebate Program	■		
Home Visits/Audits	■		
Water Softener Rebate	■	■	
Multi-residential Audit Program	■		
Multi-residential Sub-Metering Program	■		
Water Smart Business		■	
Municipal Facility Upgrades		■	■
Water Loss Management			■
Automated Meter Reading Installation	■	■	■
Indirect Water Savings			
Healthy Landscapes	■	■	
Water Efficient Landscaping Incentives	■	■	
Public Education	■	■	
Mobile Applications	■		
Drinking Water Promotion	■	■	
Outdoor Water Use Program	■	■	
Research/Pilot			
Water Reuse and Demand Management Study	■	■	■
Water Conservation and Rebound Effects Study	■	■	■
Water/Energy Nexus	■	■	■
Water Softener Pilot Study	■	■	■
Municipal Upgrades Best Practices Study		■	■
Distribution System Pressure Management			■
Automated Meter Reading Study	■	■	■
Cooling Tower Audit/Rebate Program		■	
Irrigation Audit Program	■	■	
Irrigation System Rebate Program	■	■	

14.0 10-YEAR WATER EFFICIENCY PROGRAM COST AND SAVINGS FORECAST

14.1 *Water Efficiency Program Costs*

In order to achieve the savings outlined in Section 11 and 12 of this report, there is a financial cost for the program marketing, management, administration, and staffing. A summary of these costs for the next five years is presented in Table 41. Based on benefit to now community growth, the Royal Flush Rebate Programs (rebates and administration) and the construction of 20 District Metered Areas are currently funded through development charges. It is anticipated that current user rate based costs of the strategy would be eligible for further development charges funding as part of the next revision to the City's Development Charges Bylaw Background Review Study in 2018. If successful, such costs would be removed from user rates and allow staff to reallocate current rate based funding to other utility needs (such as asset management and renewal).

With additional benefit to be experienced by local growth through implementation of this strategy it is anticipated that further opportunities for program funding be evaluated as part of the City's next Development Charges Bylaw Update. Development charges have off-set the cost of conservation programming by $1.3 million dollars (2009- 2014).

Table 41 highlights the expected annual project costs, including program marketing and management, and the overall strategy staffing. Detailed business cases are included in Appendix A for the programs implemented over the next five years.

Table 41: 10-Year Budget (Cost in $1,000s) [32]

Water Efficiency Measure	2017	2018	2019	2020	2021	5-Year Total	2022	2023	2024	2025	2026	Total
Royal Flush Toilet Rebate Program	83	78	73	68	63	365	58	53	48	43	38	605
Blue Built Home Water Efficiency Standards and Rebate	19	18	12	11	10	71	10	9	8	7	6	110
Home Visits/Audits	25	25	25	25	25	123	0	0	0	0	0	123
Water Softener Rebate	0	0	0	0	0	0	10	10	10	10	10	50
Multi- Residential Rebate Program	30	19	17	16	14	95	13	11	10	8	7	143
Sub-metering Program	18	18	8	8	8	58	8	8	8	8	8	95
Water Smart Business	223	223	223	223	223	1113	223	223	223	223	223	2225
Municipal Facility Upgrades	60	60	60	60	60	301	60	60	60	60	60	603
Water Loss Management	1520	0	0	0	0	1520	15	15	15	15	15	1595
Automated Meter Reading Installation	0	0	0	0	0	0	152	152	152	152	152	760
Healthy Landscapes Home Visit	24	24	24	24	24	121	24	24	24	24	24	241
Water Efficient Landscaping Incentives	0	0	0	0	30	30	60	60	60	60	60	330
Public Outreach and Education	115	115	115	115	115	575	115	115	115	115	115	1150
Mobile Applications (watr)	40	20	10	10	10	90	10	10	10	10	10	140
Drinking Water Promotion	10	10	10	60	10	100	10	10	10	10	10	150
Outdoor Water Use Programs	30	30	30	30	30	150	30	30	30	30	30	300
Water Reuse and Demand Management	55	55	55	55	55	275	55	55	55	55	55	550
Water Conservation and Rebound Effects Study	50	50	0	0	0	100	0	0	0	0	0	100
Water/Energy Nexus	0	0	30	30	0	60	0	0	0	0	0	60
Water Softening Pilot Study	50	50	0	0	0	100	0	0	0	0	0	100
Municipal Upgrades Best Practices Study	25	0	0	0	0	25	0	0	0	0	0	25
Distribution System Pressure Management	0	0	0	0	0	0	12	2	2	2	2	20
Automated Meter Research Study	0	0	60	60	60	180	0	0	0	0	0	180
Cooling Tower Audit Research Program	0	0	0	0	25	25	35	33	11	9	7	120
Irrigation Audit (Water Smart Irrigation Professional)	0	0	0	0	0	0	9	9	9	0	0	27
Irrigation System Rebate Program	0	0	0	0	0	0	6	6	6	0	0	18
Water Efficiency Strategy Implementation	290	296	302	308	614	1809	320	327	333	340	647	3775
Sub Total	**2666**	**1089**	**1053**	**1101**	**1375**	**7285**	**1234**	**1221**	**1198**	**1180**	**1477**	**13594**
Funding Source - Development Charges	**1025**	**153**	**148**	**143**	**438**	**1907**	**133**	**128**	**123**	**118**	**413**	**915**
Total Water Savings (cubic metres)	**424**	**891**	**1403**	**1958**	**2557**	**2557**	**3234**	**3955**	**4720**	**5469**	**6265**	**6265**
Cost per Litre	**6.29**	**1.22**	**0.75**	**0.56**	**0.54**	**2.85**	**0.38**	**0.31**	**0.25**	**0.22**	**0.24**	**2.17**

[32] Revision to the 2016 Water Efficiency Strategy is scheduled for 2021. The last year for district metered funding by development charges occurs in 2017 ($1.6 million), with ongoing work in 2018-2021 covered under operating expenses. Strategy implementation will require 2.4 full-time positions which equal 54 percent of the current conservation department budget. If approved, the Water Smart Business costs will be reduced by $100,000 per year. This cost will be merged into Strategy Implementation if full-time position is approved. External funding will be sought to best leverage the dollars noted above for research programs. This will be completed through grants and partnerships.

14.2 *Water Efficiency Program Water Savings*

The total annual water savings per program per year were calculated over the 10-year implementation period – these savings are outlined in Table 42. The total forecasted water savings over the duration of the strategy is estimated to be 6,265 cubic metres per day (Figure 34). The 5-year implementation forecast is estimated to save approximately 2,557 cubic metres per day. The majority of the projected program water savings will be derived from the Water Loss Management Program and the Water Smart Business Program.

Table 42: Annual Water Savings per Program (Cubic Metres per Day)

Water Efficiency Measure	2017	2018	2019	2020	2021	5-yr	2022	2023	2024	2025	2026	Total
Royal Flush Toilet Rebate Program	30	28	26	24	22	130	20	18	16	14	12	210
Blue Built Home Water Efficiency Standards and Rebate Program	3	2	2	2	2	10	1	1	1	1	0	14
Home Visits/Audits	13	13	13	13	13	65						65
Water Softener Rebate							1	1	1	1	1	4
Multi- Residential Rebate Program	14	12	11	9	8	54	7	5	4	3	1	74
Sub-metering Program	1	1	1	1	1	5	1	1	1	1	1	11
Water Smart Buisness	150	150	150	150	150	750	150	150	150	150	150	1500
Municipal Facility Upgrades	22	22	22	22	22	110	22	22	22	22	22	220
Water Loss Management	192	239	287	334	381	1433	428	475	525	525	576	3962
Automated Meter Reading Installation							11	11	11	11	11	56
Healthy Landscapes Home Visit												
Water Efficient Landscaping Incentives												
Public Outreach and Education												
Mobile Applications (watr)												
Drinking Water Promotion												
Outdoor Water Use Programs												
Water Reuse and Demand Management												
Water Conservation and Rebound Effects Study												
Water/Energy Nexus												
Water Softening Pilot Study												
Municipal Upgrades Best Practices Study												
Distribution System Pressure Management							20	20	20	20	20	100
Automated Meter Research Study												
Cooling Tower Audit Research Program							5	4	3	2	1	15
Irrigation Audit (Water Smart Irrigation Professional) Program							10	10	10			30
Irrigation System Rebate Program							2	2	2			6
Program Planning												
Total	**424**	**467**	**512**	**555**	**599**	**2557**	**678**	**720**	**766**	**749**	**796**	**6265**

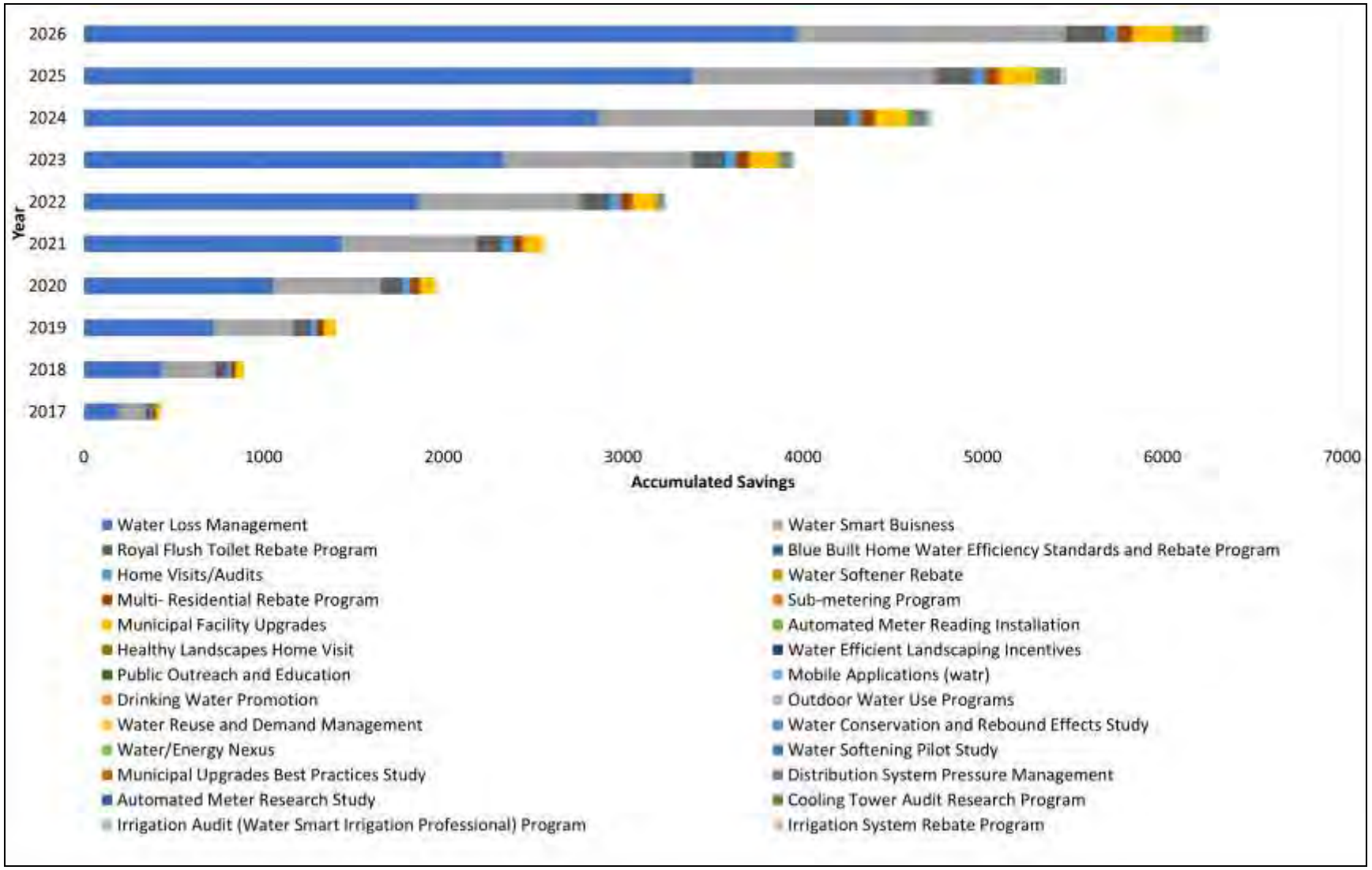

Figure 34: 10-Year Projected Water Savings for Recommended Measures/Programs (Cubic Metres per Day)

As illustrated in Figure 35, the program recommendations outlined in this update are projected to exceed the target set by the 2014 Water Supply Master Plan. This will again place the City ahead of schedule to meet the 2014 Water Supply Master Plan target of reducing annual average day production by 9,147 cubic metres per day by 2038. It is noted that The City of Guelph continues to face challenges in getting timely regulatory approvals for new water supplies, with known new water supply opportunities bound by significant periods of study time and financial investments prior to approval. In absence of securing new water supplies, Water Services actively monitors available water capacity, and forecasts possible environmental conditions, to ensure adequate servicing capacity is available and permit to take water terms are honored when taking water supply stations offline for required maintenance. To date water servicing capacity reclaimed through Water Conservation and Efficiency has help to create servicing contingency to bridge wait periods for regulatory approval and support the planning, sequencing and execution of maintenance activities.

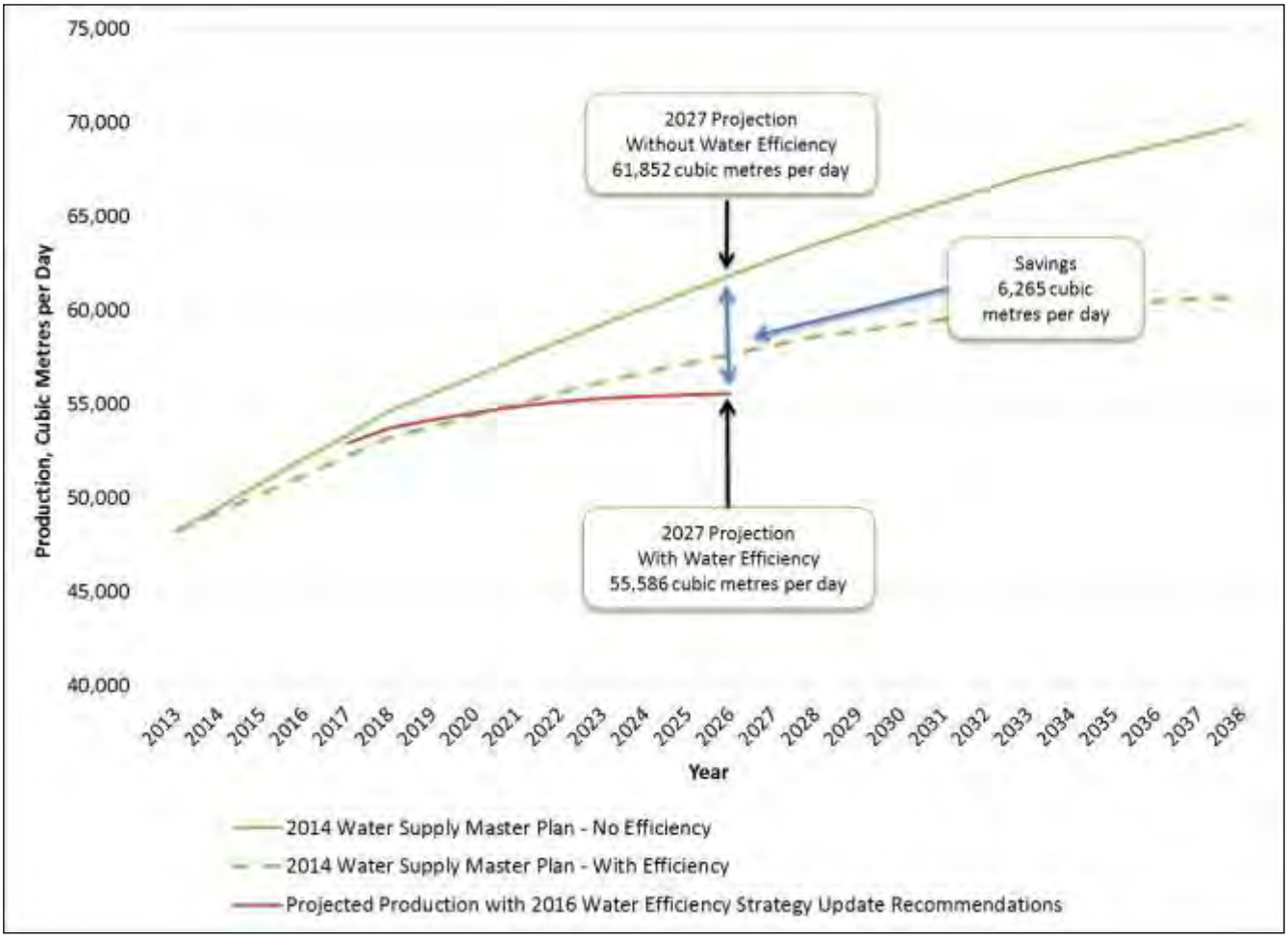

Figure 35: Projected Production with and without Water Efficiency Programs/Measures

14.3 *Water Efficiency Programs Phasing*

Program phasing is important for properly distributing research and innovation funds over the 10-year implementation period. Often studies and pilots must be undertaken before a full program can be developed.

Evenly distributing funds over the first five program years will avoid unnecessary front-loading of expenditures. Table 43 illustrates the phasing of the recommended programs measures outlined in Section 13.

Table 43: Program Phasing

Water Efficiency Program	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Royal Flush Toilet Rebate Program										
Blue Built Home Water Efficiency Standards and Rebate Program										
Home Visits/Audits										
Water Softener Rebate										
Multi- Residential Rebate Program										
Sub-metering Program										
Water Smart Business										
Municipal Facility Upgrades										
Water Loss Management										
Automated Meter Reading Installation										
Healthy Landscapes Home Visit										
Water Efficient Landscaping Incentives										
Public Outreach and Education										
Mobile Applications (watr)										
Drinking Water Promotion										
Outdoor Water Use Programs										
Water Reuse and Demand Management										
Water Conservation and Rebound Effects Study										
Water/Energy Nexus										
Water Softening Pilot Study										
Municipal Upgrades Best Practices Study										
Distribution System Pressure Management										
Automated Meter Research Study										
Cooling Tower Audit Research Program										
Irrigation Audit (Water Smart Irrigation Professional) Program										
Irrigation System Rebate Program										
Water Efficiency Strategy Implementation										

14.4 *Water Efficiency Strategy Implementation Staff Resource Requirements*

Implementation of the Water Efficiency Strategy requires staffing resources. Currently, implementation of these programs falls within the Water Conservation Department of Guelph Water Services. The staff within this department has various roles outside of the implementation of the water efficiency strategy, and support projects across Water Services and other City departments. As such, based on the proposed programing it is estimated that 2.5 full-time positions would be required for implementation of the proposed programs. This excludes the implementation of the Water Smart Business programs which currently falls in the portfolio of a dedicated consultant. Responsibilities and duties of the Water Conservation Department with respect to the implementation of the 2016 Water Efficiency Strategy are outlined below.

Project Manager - responsible for the overall development, implementation and oversight of the Water Efficiency Strategy. This includes annual reporting on program metrics and completion of the QA/QC monitoring. These duties are performed by the existing Supervisor of Water Efficiency's portfolio.

Water Conservation Program Coordinators - responsible for the development, modification and implementation of the direct, indirect water savings programs and research programs as outlined in Section 13 of this report. These duties will be included in existing portfolios the current three water conservation program coordinators on-staff.

Outdoor Water Use Technician - responsible for the implementation of the outdoor water use programs including the Healthy Landscapes program. These duties will be included in the existing position portfolio.

Industrial, Commercial and Institutional Water Efficiency Specialist - Work with local business with prominent opportunity as identified through recommended strategy. To date the City has supported business based programs through an annual contract for professional engineering services to provide specialized expertise in industrial water efficiency. Based on need for further time investment as recommended through the strategy, and the current value of this contract, it is recommended to internalize this ongoing consulting services contract into a full-time efficiency expansion through the 2017 Non-Tax Budget process. Efficiency expected to deliver approximately $10,000 per year in operational savings.

Support Staff - responsible for supporting the implementation of the Water Efficiency Strategy with respect to tasks such as the processing and receiving of rebates, development of communications materials, inspections of properties to ensure program compliance, seasonal support for implementation of indirect and direct water savings programs etc.

15.0 MONITORING AND EVALUATION

Guelph's 2016 water efficiency programming has been designed to be more cost-effective in meeting the City's growing water demands than the supply-side alternative of expanding infrastructure and taking more water from the aquifer. The water savings targets identified in the 2016 Update must not only be achieved, they must be sustained. Like capital infrastructure for new supply/capacity, water conservation programs require investments to maintain capacity reclaimed. As such it is necessary for Guelph to track and monitor the integrity of past water savings as well as evaluate performance associated with implementation of individual programs through this strategy.

If measures are saving significantly less than projected or costing significantly more to implement than projected, the City will need to determine if changes are required/possible to bring the savings and/or costs into line with projections, or if the measure should be implemented at a later time, or, in the worst case, if the measure should be abandoned. This evaluation will be completed through future update of this strategy in 2019 but is recommended that Guelph continue to implement interim performance monitoring to ensure desired program impact and cost effectiveness in the interim. Recommended areas for continued monitoring and evaluation include the following:

- Evaluation of public education program through available metrics (such as web analytics, surveys, program participation, etcetera) to ensure program effectiveness in reaching target audiences and motivating desired behaviours.
- Quantification of Outdoor Water Use Savings in accordance with the North American Alliance for Water Efficiency's Outdoor Water Research Program Report (document pending at the time of development of this strategy).
- As part of the monitoring program, the City should continue to track customer feedback regarding programs. The tracking should include the nature of the calls to delineate between "one-off" complaints or inquiries versus systemic issues. Of course, systemic issues should be addressed as soon as they are recognized.
- It is important that the City continue to track per capita water production and demand values on an annual basis such that they can better forecast the City's ultimate gross per capita water production/demand equilibrium and when this equilibrium is expected to be reached.

Because it is unlikely that the marketplace for water-using products will become less efficient over time (product efficiency and performance is currently improving each year), it is also unlikely that customers installing efficient products as part of Guelph's program will remove these products and replace them with less efficient models. As such, it is not recommended that the City conduct in-field inspection surveys of past program participants to ensure that products installed as part of the City's programs remain installed.

Since the City the possesses direct process and customer meters to monitor overall water production, as well as sector and account based water consumption, direct data feedback loops to support program evaluation already exist. However, other strategic investments (such as specialized monitoring equipment or professional

services) may be required to validate plan performance (when looking to plan research of future opportunities) and inform future decision making around programs.

16.0 CONCLUSIONS: KEY CONSIDERATIONS

The City of Guelph continues to strive to be a leader in water efficiency. With the additional help of changes to the Ontario Building Code and in the marketplace, current water efficiency programming has allowed the City to reduce its annual average day water production by 13 percent between 2006 and 2014 even though the City experienced a 13 percent increase in population during this same period. In order to continue with successful water savings, it is necessary to periodically re-evaluate current programming and revamp or discard programming that fails to meet expected participation or water savings objectives.

This Water Efficiency Strategy Update aims to achieve the following:

- Continue to increase the awareness and consumer perception of the value and importance of a safe, dependable water supply,
- Promote innovation and research new emerging water efficiency technologies,
- Achieve a reduction in annual average day production of 6,265 cubic metres per day by 2027, contributing to the 2038 target of a reduction in annual average day production of 9,147 cubic metres per day,
- Provide a financial net benefit of approximately $15.7 million in deferred water and wastewater capacity expansion,
- Assist with keeping water rates low by ensuring efficiencies within Water Services, and
- Eliminate the need for a Guelph Lake Water Treatment Plant and a final expansion of the wastewater treatment plant (valued at approximately $37 million in the 2014 Water Supply Master Plan).

Throughout the update process, a common theme emphasised via public consultation in general was the importance of innovation and the necessity to pursue new technology to allow for future potential in water efficiency. The recommendations outlined in this report are not only projected to achieve the targets set out in the 2014 Water Supply Master Plan, but allow for further research and innovation with the intent to progress water efficiency and develop new measures and programming that can be utilized to achieve future water savings.

It is anticipated that this plan will be revised in 2022 following the revision of the 2014 Water Supply Master Plan. At this time, if new water reduction targets are set, the programs set for implementation in 2022 and beyond will be reviewed to ensure they are still relevant based on market changes and programming requirements.

17.0 GLOSSARY

Annual average day water demand rates: the total yearly water demand divided by the total population, divided by 365 days.

Annual average day water production rates: the total yearly water production divided by the total population, divided by 365 days.

Annual average day demand: the total yearly water demands divided by 365 days.

Annual average day production: the total yearly water production divided by 365 days.

Commercial customer: commercial customers with Municipal Property Assessment Corporation codes in the 500's.

Current Annual Real Losses: includes Water Supplied - Authorized Consumption – Unauthorized Consumption – Customer metering inaccuracies – Systematic data handling errors. The last three components of this equation make up the "Apparent Losses".

Economical level of leakage: the level of leak management where the cost of water loss reduction equals the value of water saved. The lower the level of leakage, the higher the cost of reducing the leakage further.

Energy intensity: the amount of energy in kilowatt-hours that is applied to a cubic metre of water.

Equivalent carbon dioxide: the concentration of carbon dioxide that would cause the same level of radiative forcing as a given type and concentration of greenhouse gas (e.g. methane, perfluorocarbons and nitrous)

Gross per capita demands: water production divided by the total population.

High-density residential customer: refers to a multi-family dwelling with greater than 6 units (e.g. condominiums/apartment buildings) (Municipal Property Assessment Corporation property codes of 340 – 380).

Industrial customer: industrial businesses with Municipal Property Assessment Corporation codes in the 400's.

Infrastructure Leakage Index: the ratio of Current Annual Real Losses to Unavoidable Annual Real Losses.

Institutional customer: institutional customers with Municipal Property Assessment Corporation codes between 600 and 899, inclusive.

Linear trend lines: a best fit line used to show the trend in data sets.

Low-density residential customer: refers to a detached single family dwelling (Municipal Property Assessment Corporation property code of 301).

Medium-density residential customer: refers to a multi-family dwelling with 6 or less units (Municipal Property Assessment Corporation property codes of 302 – 336).

Non-revenue water: water that is produced but not billed to customers. Non-revenue water includes physical losses such as water used for firefighting, mains flushing, system leakage, un-metered municipal uses, such as commission of new infrastructure, as well as, apparent losses resulting from metering or accounting inaccuracies. It is the total of unbilled metered consumption, unbilled unmetered consumption, unauthorized consumption, customer metering inaccuracies, systematic data handling errors, and real losses.

Per capita demands: water demands divided by the total population.

R^2 value: a statistical measure of how close the data are to the fitted regression line - the higher the R^2 value the better the fit with a value of 1.0 indicating a perfect fit.

Revenue water: water that is produced and billed to customers. It is the total of billed metered consumption and billed unmetered consumption.

System Input Volume: equals the annual water pumped minus the source meter inaccuracies.

Unavoidable Annual Real Losses: value comes from the American Water Works Association software. It is a theoretical reference value representing the technical low limit of leakage that could be achieved if all of today's best technology could be successfully applied. It takes into consideration length of mains, number of service connections, total length of customer service lines, and pressure in the system.

Volume of Non-Revenue Water: equals the non-revenue water divided by the system input volume plus the percent of system input volume.

Water Demand/Water Consumption: equals the amount of water used by customers.

Water Production: equals the amount of water produced by the municipal water system.

18.0 REFERENCES

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Appendix A – Business Cases

Appendix B – Community Engagement

Appendix C – Market Research

Appendix D – Demand Figures

Appendix E – Water Audit

Appendix F – Technical Research

Appendix G – Municipal Facility

Appendix H – Evaluation Criteria

Appendix I –Program Alternatives

Appendix J – Financial Report