CITY OF GUELPH

NEW CONSTRUCTION BASED IRRIGATION SYSTEM DESIGN AND CONSTRUCTION STANDARDS

C3 WATER INC.

31 August 2015

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1.0 INTRODUCTION

The 2015 Water Efficiency Strategy Update will identify a set of preferred program alternatives, associated water savings, program implementation forecasts, and supporting program resources required to achieve the water demand reduction outlined in the 2014 Water Supply Master Plan. As part of the strategy scope, a series of technical memos are being prepared on technology and policy areas of opportunity, as identified through ongoing program operation, industry best practice research and common areas of customer/stakeholder inquiry. The objective of this report is to outline the potential water savings (financial and consumption) associated with developing irrigation system design and construction standards for new construction.

It has been estimated that as much as 50 percent of the water applied in landscape irrigation is wasted due to over-watering caused by inefficiencies in irrigation methods and systems (United States Environmental Protection Agency, 2015). Ideally, landscapes should be designed such that they require little or no supplemental irrigation, e.g., the use of drought tolerant plants or non-plant material. When irrigation systems are required, they should be designed and constructed to function as efficiently as possible. This requires coordination between the irrigation contractor and the landscape contractor during the initial stages of the program - once a system is installed it is far more difficult to make improvements. An effective irrigation system design and construction standard can significantly reduce overwatering by applying water only where and when it is required.

2.0 NEW CONSTRUCTION IRRIGATION SYSTEM DESIGN AND CONSTRUCTION STANDARDS

2.1 Definition

It is important to note that a standard differs from a code or a bylaw in that a standard is intended to help ensure that certain common (“standard”) practices are followed. A standard is a voluntary benchmark ensuring the end product is safe, reliable, and meets the expectations of the marketplace. A code or bylaw is a prescriptive and mandatory requirement, generally intended to ensure a certain minimum level of health and safety is maintained or that regulations are followed. Design and construction requirements for outdoor irrigation systems are not covered by the Ontario Building Code. The City of Guelph does have a backflow prevention bylaw which requires a device and associated testing to protect the City’s water supply from potential threats.

Irrigation System Design and Construction Standards can be relatively simple guidelines or they can include very extensive and detailed specifications. Standards intended to foster efficient landscape irrigation should identify minimum expectations for various elements, including:

- Use of a master valve to prevent potential continuous leakage with an easy to get at shut off feature,
- Use of a system sub-meter to monitor water demands,
- Use of a weather-based controller that uses evapotranspiration rates to avoid over-watering or watering when not required,
- Use of rain sensor to prevent system operation during or immediately after a rain event,
• Sprinkler spacing and selection,
• Local evapotranspiration rates,
• Pressure control options including pressure regulated rotary spray nozzles and check valves, and
• Backflow Prevention.

2.2 Descriptions of Standard Components

2.2.1 Master Valve
A master valve is an electric valve installed on the water supply connection to the irrigation system. When closed, there is no water supply to the irrigation system. As such, a master valve will greatly reduce water lost due to a leaky zone because water will only be provided to the system when the master valve is open versus the valve being open 24 hours per day. A master electric valve is typically connected to the "master" or "pump" connection in the system controller.

2.2.2 Sub-Meter
It is not uncommon for irrigation contractors and homeowners alike to have little perspective of the volume of water that is applied each time the irrigation system operates. There are, however, several advantages to installing a sub-meter on the water supply to an automatic irrigation system, including the following:
• Allow the irrigation contractor to verify that the depth of water being applied to each zone on a weekly basis matches the irrigation needs of the landscape.
• Make it easier for the owner to identify leaks, as unusually high water demand in any zone could indicate a leak.
• Provide information to the homeowner regarding the volume and cost of water used on an annual basis, as knowing the cost may prompt the homeowner to operate their system more efficiently.
• Make it easier to identify savings related to making improvements to the irrigation system (e.g., spray heads, pressure regulators, etc.), to the irrigation control system (e.g., installing a weather-based controller or rain sensor), or to the landscape itself (e.g., converting to native plant material or xeriscaping).

2.2.3 Weather-based Controllers
The use of a weather-based “smart” controller rather than the simple timer used in ‘standard’ controllers can result in significant water savings. Weather-based controllers use local evapotranspiration values, on-site soil moisture values, or information provided by a local weather station to tailor the system’s watering schedule to suit current site conditions. The water savings generated by “smart” controllers can vary greatly from site to site based on climate and vegetation, as well as, how efficiently water is being applied by the system. Conservative estimates indicate a savings of between 10 and 25 percent of current demand (Southern California Area Office, Temecula, California; Water Resources Planning and Operations Support Group, Denver, Colorado, 2008).
2.2.4 Sensors

Rain sensors prevent irrigation systems from operating during or immediately after a rain event. The resulting savings will vary from year to year depending on the frequency of rain events. For example, there would be little or no savings during a drought year but there could be almost 100 percent savings during a year with frequent rain events. Rain sensors are relatively inexpensive – often costing less than $40. Not only can rain sensors pay for themselves very quickly with the water savings they achieve, they help eliminate the negative impression associated with operating an irrigation system is operating during a rainstorm.

Similar to rain sensors, soil moisture sensors suspends a watering cycle when the soil moisture is above a set threshold. The soil sensor also monitors temperature and electrical conductivity. Knowing the electrical conductivity of the irrigated soil is especially valuable when reclaimed water is used for irrigation. Reclaimed water can be high in dissolved ions which can accumulate overtime and cause a negative impact of plant health (Rain Bird, 2015). Depending on the application, water savings can be up to 40 percent and the device could pay for itself within a year (Rain Bird, 2015).

2.2.5 Sprinkler Spacing and Selection

For proper coverage, sprinkler heads should be installed such that the spray from each head just reaches all the heads adjacent to it (head-to-head coverage). Head-to-head coverage helps ensure a more uniform water application, which saves water and promotes a healthy landscape. The following is recommended for sprinkler placement.

- Sprinklers with the greatest radius should be used in the larger areas. Sprinklers should be placed in such a way to minimize or avoid spraying hardscapes such as sidewalks and driveways, or other non-plant materials.
- Half-circle sprinklers should be placed on edges and borders, quarter-circle sprinklers in corners, and full-circle sprinklers in the middle of open spaces.
- Bubblers or drip irrigation should be used where possible to irrigate small areas, flowerbeds, or individual plants.

Dividing the landscape into areas with similar water needs will create zones which should only contain a single “type” of sprinkler (e.g., rotors, sprays, drip) to avoid ‘mixed precipitation’ issues. Another aspect to consider is micro-climates in the yard, i.e.shady areas will not need as much water as sunny areas.

2.2.6 Local Evapotranspiration Rates

Evapotranspiration is the combination of water evaporating from the soil and water transpiring from the vegetation as shown in Figure 1. Water lost through evapotranspiration must be replaced or the plant will not have enough water. Sometimes it is possible to deficit irrigate (i.e., replace less than the total volume of water lost through evapotranspiration) for short periods of time with only a minimum negative effect on the plant health.
Local evapotranspiration rates are used to determine how much water the plant material in an irrigation zone should receive on a weekly basis based on the zone’s micro-climate, primary plant material, soil type, and soil slope. For example, Landscape Ontario’s Water Smart Irrigation Professional program states that a turf landscape exposed to full sun needs about 1-inch of water replacement per week during the peak summer month (including both precipitation and supplemental irrigation). Water replacement values are used to properly adjust the irrigation schedule (controller) to ensure that the landscape receives sufficient water without over-watering. Evapotranspiration values can also be used by some controllers to automatically reduce zone runtimes during the spring and fall months when the plants’ water requirements are lower (i.e., some controllers have an automatic seasonal adjustment feature).

2.2.7 Pressure Control Options

Uneven water pressure in an irrigation system can cause uneven water application rates, thus reducing the efficiency of the system. For example, a 5 pounds per square inch reduction in pressure can reduce the application rate by approximately 7 percent (Rain Bird Sprinkler Manufacturing Corporation, 2000). Uneven pressure in an irrigation system can be caused by uneven terrain, long pipe lengths, headloss at fittings, etc.

Another issue for irrigation systems is high water pressure. Most spray head nozzles are designed to operate at 30 pounds per square inch yet municipalities commonly provide water to their customers at pressures of 50 pounds per square inch or higher. Excessive pressures can cause sprinklers to over-spray and to ‘mist’ or ‘fog’ rather than providing concentrated streams of water, thus wasting more water than what is needed for base irrigation purposes. Solutions include controlling the pressure to the entire irrigation system (suitable for smaller systems) or using pressure-regulating heads to ensure that all heads are operating at the proper pressure.
2.2.8 Backflow Prevention

Most irrigation systems are supplied via municipal potable water – the same water system that supplies drinking water to the customer. Irrigation systems are constructed under gardens and lawns where they may be exposed to weed killers, pesticides, fertilizers, pet waste, etc. A pipe break or a low water pressure problem may cause potentially dangerous water to be drawn into the irrigation system (i.e., to backflow). Backflow can introduce contaminated water inside the home and to the municipal drinking water system. All irrigation systems should be fitted with a suitable backflow prevention device in accordance with the City’s Backflow Prevention By-Law.

2.3 Current Municipal Practice

Since new irrigation system installation projects are often awarded based on price, designers and installers sometimes don’t include important features or aspects that would help improve system efficiency. In fact, not all installers and almost no customers are fully aware of the difference between a properly designed and operated irrigation system and an inefficient system. As long as the customer’s turf and plants appear healthy there is no perceived problem with the current system by either the contractor or the customer. Landscape maintenance is the primary driver (i.e., keep the grass green) with very little thought given to the water efficiency of the system. Because of this, there is a huge potential for water savings related to optimizing automatic irrigation systems with no negative impact on landscape health and appearance.

Many municipalities and irrigation companies have developed irrigation design and construction manuals. As such, should Guelph decide to develop their own irrigation design and construction standard, it may be beneficial for the City to review some of the following to identify suitable criteria:

• Saskatchewan Irrigation Design and Construction Standards Manual (Government of Saskatchewan, 2015)
• City of Kelowna, British Columbia – Landscape & Irrigation Guide to Water Efficiency (City of Kelowna, 2010)
• Irrigation Industry Association of British Columbia – Standards for Landscape Irrigation System (Irrigation Industry Association of British Columbia, 2008)
• RainBird Landscape Irrigation Design Manual (Rain Bird Sprinkler Manufacturing Corporation, 2000)
• TORO Do-It-Yourself Sprinkler Planning & Installation Guide (The Toro Company, 2008)

The City of Kelowna in British Columbia has a semi-arid climate and typically high outdoor water use that combine to strain the water supply infrastructure. As such, the city has adopted a water regulation bylaw that requires a permit application for any residential or commercial irrigation installation. The permit requires that every system be installed with an irrigation master shut-off valve, include a backflow protection device, and every system be equipped with a “smart” controller.

Landscape Ontario, Peel Region and York Region have partnered to develop a Water Smart Irrigation Professional program designed to shift the water-efficiency focus from the customer to the contractor.
Traditionally, the main goal for both customers with automatic irrigation systems and their maintenance contractors was maintaining a lush and green landscape. Neither the customer nor the contractor is typically aware of how much water is being applied on a weekly basis or how much water could be saved. While there are visible cues that indicate if a plant is being under-watered, there are no visible cues to indicate over-watering unless the over-watering is extremely severe. The Water Smart Irrigation Professional program trains contractors how to calculate the optimum level of irrigation for each zone based on plant type, micro-climate, soil type and slope, etc., using a custom-designed computer program. The qualifying contractors are paid a set fee by Peel or York Region, depending on the location of the customer, to audit and optimize their customers’ irrigation systems. Customers receive a report showing how much water and cost savings they will achieve each year with an optimized system. While many customers may not be motivated to make changes to their irrigation systems for a relatively small cost savings each year, the Water Smart Irrigation Professional program is financially beneficial to the irrigation contractors (a small financial incentive for each optimized system multiplied by many system optimizations each year) and the contractors are able to provide a higher level of customer service at no additional cost. The average water savings during the pilot study for the Water Smart Irrigation Professional program saved 10,000 litres per day per acre of landscape (a reduction in depth of water applied of about 17mm per week) without compromising the health and beauty of the landscape. Should Guelph decide to develop an Irrigation System Design and Construction Standard, they may wish to consider including aspects of the Water Smart Irrigation Professional program.

2.4 Benefits and Barriers
The use of irrigation system design and construction standards provides benefits, yet there are also barriers to a successful implementation of standards.

Table 2-1: Summary of benefits and barriers associated with implementing irrigation system design and construction standards.

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<td>Leads to a higher minimum level of efficiency for new irrigation systems.</td>
<td>Enforcement/auditing and program maintenance (especially if providing incentive) may be costly, time consuming and not sustainable over the long term.</td>
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<td>Clear description of expected minimum criteria for installation.</td>
<td>Developing a Standard (voluntary) is not the same as developing a mandatory bylaw and, as such, the industry may be free to ignore recommendations.</td>
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<td>Assist in reducing summer and peak demands.</td>
<td>Open to criticism – possibly seen as design restrictive.</td>
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<td>Provides customers additional criteria to evaluate contractors (e.g., contractors that meet or exceed requirements outlined in standard may be viewed more positively by customers).</td>
<td>Effectiveness may be reduced if not developed in concert with landscape</td>
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• Potentially provides city with some control over new installations, especially if city offers rebates or incentives to contractors meeting or exceeding the minimum requirements outlined in the standard.

• Many irrigation professionals do not exclusively work in the City of Guelph. Therefore, often have limited knowledge of the City’s programs and requirements.

• Communication of the program to irrigation professionals would be a challenge as they are often not located in the City of Guelph.

3.0 LOCAL FEASIBILITY

Currently, customers are not aware of how much water their irrigation systems use, how much systems should use, or how much additional money they are spending each season because of their inefficient practices\(^1\). Clients do not insist on system optimization because they are unaware that their system is not optimized and contractors do not see any financial benefits associated with reducing water demands of their clients. In fact, most contractors tend to adjust the system to over-irrigate somewhat to err on the side of caution. Developing an irrigation system design and construction standard defining the minimum requirements for efficient landscape design and operation and potentially offering rebates to contractors that follow the Standard and can provide verification of applying the optimum level of irrigation (e.g., perhaps through Landscape Ontario’s Water Smart Irrigation Professional program) supports the concept of market transformation in Guelph and, therefore, fits in with the City’s goals of the Water Efficiency Strategy.

In May 2013, Lura Consulting consulted the public for the Outside Water Use By-law Review on behalf of the City. One of the questions posed to the public was whether additional requirements should be included for those choosing to install an automated sprinkler system. 79 percent of survey respondents agreed to additional requirements. Further comments included that the City should provide incentives for residents to install water efficient systems, and the City should educate residents regarding the use of efficient irrigation systems. There was some concern expressed that additional requirements in installing automated sprinkler systems would be too intrusive and too costly. Other ideas to promote efficient irrigation systems included: monitoring the performance of irrigation systems with annual checks, as well as promoting the use of efficient designs, nozzles, and controller (Lura Consulting, 2013).

4.0 KEY CONSIDERATIONS

The goal of developing an *Irrigation System Design and Construction Standard for New Construction* is to help transform the marketplace in the City such that new irrigation systems incorporate the efficiency aspects that are currently so often left out because of cost, such as: weather-based control

\(^1\) Based on feedback obtained as part of Landscape Ontario Water Smart Irrigation Professional program development and training.
systems, master valves, pressure-regulated heads, and rain sensor shut-offs. The information contained in the Standard will help educate key market players and generate customer demand for efficient systems. It is anticipated that this program will improve the efficiency of new systems (including design, operations, and maintenance) and potentially the efficiencies of existing systems (related to maintenance and operation) as contractors become more familiar with the requirements set out in the Standard. Also, based on Lura Consulting’s 2013 survey, the Guelph residents are interested in further incentives and education on water efficient irrigation systems. As stated earlier, Peel and York regions have participated in Landscape Ontario’s Water Smart Irrigation Professional program – a program that provides training and other tools to qualifying irrigation contractors to help them optimize their customers’ irrigation practices. Both Peel and York offer incentives to contractors conducting Water Smart Irrigation Professional program irrigation assessments for their local customers. Perhaps Guelph could consider offering incentives to contractors that follow the recommendations outlined in the Standard (carrot approach). Issuing fines to contractors that fail to follow the recommendations outlined in the Standard is another approach (stick approach), but it may be much more difficult to enforce.
5.0 REFERENCES


