The Calgary Courts Centre - Case Study

Application of Advanced Irrigation Design & LEED Technologies to Utilize Irrigation Water Efficiently

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PREAMBLE

I am going to sound like a zealot today but I firmly believe that we are at a crossroads in terms of landscape design/development and how our work is perceived in terms of irrigation water consumption.

As the graphic illustrates global water consumption has increased substantially over the last 125 years, and …

We are uniquely positioned to provide direction to the entire industry in terms of moving away from resource depleting, maintenance intensive and increasingly expensive landscape development.

1.0 CLIMATE CONSIDERATIONS

In Canada we are blessed with 25% of the world's fresh water, but to support our industrial, commercial, agricultural, residential and recreational water consumption we withdraw, on average, 120 billion litres every day from our rivers, lakes and aquifers. *That is a volume equal to the area of an NHL ice surface…47 miles high.*

Calgary's water source is the watershed consisting of the Eastern Slopes snow pack and the Bow glacier which feeds the Bow and Elbow Rivers within the South Saskatchewan River basin.

Recent research indicates that our droughts, in geological terms, are more frequent and of longer duration than had been previously thought. Rather than lasting from one to ten years, our droughts may have a duration measured in decades. What makes this particularly alarming is that the last 100 years, in Western Canada, has been the wettest century in millennia and hence our perception of what is normal in terms of water availability is even further skewed.

2.0 HISTORY OF WATER USE / INFRASTRUCTURE COSTS

In Canada we currently use 340 litres of water / per day / per person – almost three times what some European Countries use.

As the graphic also illustrates, there appears to be an unfortunate correlation between the unit cost of water and consumption volumes.

Of this total amount of potable water that we use every day, less than 3% is actually consumed by humans.

In 2002, U.S. households spent $3.5 billion on irrigation equipment. Outdoor watering, or irrigation accounts for, on average, over 30% of residential water use. During the summer months this outdoor water use can go as high as 70%. Our landscape expectations, coupled with the rising cost of the delivery of potable water has put the irrigation industry squarely in the cross hairs of water conservation interests as well as municipal water purveyors who are just starting to come to grips with irrigation water consumption, the rising cost of water treatment, and the bigger issue of water conservation itself.

Since 1949 the Irrigation Association (IA) and its members worldwide, have been working towards the vision of water conservation through efficient irrigation based on better design and construction practices through education.

3.0 DESIGN

TRADITIONAL APPROACH TO DESIGN / SITE

Calgary, with a population of 950,000 has an area of 278 square miles with 2,000 irrigated parks and 19,000 acres of “park” land.

Historically, irrigation design has been based on the volume of water applied rather than how it was applied.

Good irrigation design is no different than landscape design in that you must have a thorough understanding of the site and design parameters. To that end the following is a checklist of essential irrigation considerations as applied to the Courts site:

Plant Species Selection: Calgary is in Zone 3A according to Agriculture Canada’s Plant Hardiness classification, but equally as important as this general criteria is Calgary’s proximity to the eastern slopes of the Rockies and the “Chinook” weather fronts, which directly impact our weather conditions. The most extreme Chinook, on record, in the Calgary area, was in January of 1992 when the temperature rose 41ºC, from -19ºC to +22ºC in 1 hour. These, periodically extreme, weather conditions simply highlight the need to maintain plant material at the highest reasonable levels of health and vigour possible.

Microclimate: For the purpose of irrigation design microclimate consists of the site and its immediate contextual conditions such as architecture, surface treatments, site aspect, shade, and topography. Under “normal” circumstances none of these factors would unduly affect growing conditions. High microclimates are where the site is affected by heat absorbing/reflecting surfaces or high wind scour. Conversely, low microclimates are primarily a function of shade.

Both of these conditions exaggerate plant water requirements and therefore the irrigation system design in terms of how much water must be delivered to the plant material.

The Plants Themselves: There are five general factors, which affect plant growth:

- Genetics;
- Light;
- Air and Soil Temperature;
- Nutrient Availability; and
- Soil Moisture or Water.

As well as being a factor in itself soil moisture has a direct impact on soil temperature and nutrient availability.

Plant Available Water: Plants use water to transport nutrients, to control the shape and direction of growth, for photosynthesis and as a means of controlling plant body temperature through transpiration. In warm climates transpiration is by far the major water use by plants.

The sum of plant water use and water which evaporates from the surface of the root soil mass is called the EVAPOTRANSPIRATION RATE or ET. The graphic illustrates the six major ET categories that we use in North America to calculate irrigation water requirements.

Irrigation design is always based on peak ET rates.

Soils: Soil texture is absolutely critical to how irrigation water is available for plant use and one of the prime determinants in terms of the rate at which irrigation water should be applied. The graphic illustrates the relationship of the three principal soil components: clay, silt, and sand. In short, sandy, or course textured soils, have high water intake rates and low storage capacity; clay soils have a low water intake and high storage capacity. Silty or organic soils have medium to low water intake rates and medium to high storage capacities. As you can see water movement in the three soil types is quite different.

As landscape architects and irrigation designers, we do not always have the opportunity to modify site soils, hence, we must tailor the irrigation water application rate to suit the soil type.

Type, Source and Size of Water Service: With a potable or treated water source designers have not been required to be as attentative to irrigation water consumption volumes, as we probably should be. On sites where non-potable water is utilized, irrigation water volume availability is typically lower.

A water source must have the ability to provide the total amount of flow rate (gpm) demanded by the irrigation system at any given time and provide sufficient water pressure to carry the flow, and energy to make the sprinklers function properly.

When possible, irrigation zones should be established based on combining plant species, which have similar water use characteristics.

Plant physiology, in combination with daily temperature cycles, indicate that irrigation water applied at night or early in the morning is used much more efficiently by the plants than water applied during the day.

Irrigation Product Considerations: Sprinkler heads or emission devices (ED's) are the most visible and variable components of an irrigation system. ED selection criteria should consist of:

- Size and configuration of areas to be irrigated.
- Type and number of obstructions within areas to be irrigated.
- Available irrigation water volume and pressure.
- Type of vegetation.
- Physical activities within irrigated area.

4.0 LEED® CONSIDERATIONS

How do LEED initiatives relate to irrigation design?

The US Green Building Council, as the governing agency for LEED criteria in the United States, and its recent counterpart, the CaGBC in Canada, promote similar, but less specific, design criteria as the Irrigation Association in terms of irrigation water conservation.

As you may be aware LEED design considerations are divided into five key performance categories:

- Sustainable Sites (14 possible points);
- Water Efficiency (5 possible points);
- Energy and Atmosphere (17 possible points);
- Materials and Resources (14 possible points); and
- Indoor Environmental Quality (5 possible points).

A sixth category: Innovation and Design Process (5 possible points) rewards exceptional environmental and/or design performance.

The LEED program is directed primarily at commercial, institution, and highrise residential building projects, but can be applied to any type of architectural project. Obviously, for projects that are, for example, industrial in nature it is a bigger challenge to score points. The LEED point system is as follows:

Certified:	26 – 32 points
Silver:	33 – 38 points
Gold:	39 – 51 points
Platinum:	52 – 70 points

From an irrigation design standpoint, we focus on the Sustainable Sites, Water Efficiency and Innovation categories. In the Sustainable Sites category…

SS Credit 6.1:

The intent is to…

Limit disruption of natural water flows by managing stormwater runoff.

This point hinges on reducing the peak storm discharge rate.

AND / OR

Quality of stormwater runoff.

SS Credit 6.2:

The intent is to…

Limit disruption of natural water flows by eliminating stormwater runoff, increasing on-site infiltration and eliminating contaminants.

This point requires the removal of 80% of average annual post-development Total Suspended Solids (TSS) and 40% of average annual post development Total Phosphorus (TP).

SS Credit 7.1:

The intent is to…

Reduce heat island effect to minimize impact on microclimate through providing: shade for 30% of the site's non-roof surface within 5 years.

OR

Underground or covered parking stalls.

OR

Use open grid paving system (less than 50% imperviousness) for a minimum of 50% of the parking lot area.

In the Water Efficiency category…………..

WE Credit 1.1:

The intent is to…

Limit the use of potable water for landscape irrigation to 50%.

To achieve this point, potable water consumption for irrigation purposes must be reduced by 50% over conventional means by using captured rain or recycled site water.

WE Credit 1.2:

The intent is to…

Eliminating the use of potable water completely for landscape irrigation purposes.

This point is achieved by using only rainwater or captured site water as the source for irrigation water.

In the Innovation Design category…………..

ID Credits 1.1 to 1.4 Inclusive:

The intent is to…

These credits are awarded for exceptional performance, on a discretionary basis, for resource conserving efforts above LEED Rating System requirements.

ID Credit 2.0:

This credit is somewhat self-serving in that it encourages design integration of the project team to streamline the LEED application and certification process and hinges on at least one principal participant of the project team being LEED® Accredited. From a personal experience standpoint I would suggest that at least one person from each and every discipline on the project team be LEED Accredited to facilitate design development discussions that are as constructive as possible.

5.0 INTRODUCTION TO COURTS PROJECT

The Calgary Courts project entails the redevelopment of 1.5 blocks of downtown Calgary

Phase One of the Calgary Courts Centre is a $275 M, 8,000 m^{2} / 86,000 ft^{2} development. It will be one of the first buildings in Calgary to achieve LEED Silver status and be based on the advanced design practices promoted by the Irrigation Association. It consists of north and south towers which are 24 and 20 stories respectively with a 26 story central atrium separating the towers. Because Phase One represented development of an existing Government of Alberta site landscape development was limited to at grade and raised planters in combination with trees in at-grade boxes. The irrigation water source will be harvested rainwater.

When we combine the irrigation design criteria with the architectural design and the LEED parameters:

- All plant species selected are Zone 3 hardy.
- Because of the “High” microclimate, with Chinook complications, we also selected species that were low and medium water users.
- On Phase 1 of the project we had the opportunity to completely modify the planting medium, so that a sandy clay loam would be utilized.
- In terms of evapotranspiration rates, Calgary is classified as a Cool, Dry climate, so an ET rate of 0.20 inches / day was utilized for the calculations.
- Because the tree and shrubs species selected for the project were similar in their water use characteristics, we used root mass and depth as the criteria to separate the site into irrigation hydro zones.
- The deciduous canopy trees will be planted in at-grade, oversized tree boxes and the raised planters will contain a combination of deciduous flowering trees, shrubs and groundcovers. The configuration of the planting structures in combination with the creation of a planting trench will allow us to increase the planting medium mass and run the irrigation lines between the planting areas without hard surface conflicts.

Based on the species selected it was determined that, at maturity, each deciduous canopy tree would require 140 US gallons per week. The deciduous flowering trees would require 77 gallons and the shrub and ground cover material would require 4.0 gallons per m^{2}. Our total maximum irrigation water requirement per week would be approximately 4,000 US gallons per week.

Now that we know what we need, where does it come from: potable water, harvested at-grade stormwater or harvested roof stormwater?

The creation of a stormwater cistern between structural components in the basement of the building allowed us to address LEED SS Credit 6.1 (managing stormwater runoff).

By combining a primary storm cistern which would overflow into a secondary irrigation cistern, the storm cistern essentially becomes a settling tank and responds to SS Credit 6.2 (reducing TSS and TP).

In sizing the irrigation cistern we determined that a 2-week water supply would be our minimum capacity which means each cistern must hold 8,000 US gallons. This sounds like a lot but it is only 30 m^3…. the size of one parking stall and a depth equal to my height.

Because such a significant portion of the Phase One site would actually be building, we decided to use harvested rain from the roof as the non-potable irrigation water source. This satisfies WE Credit 1.2 (the elimination of potable water for irrigation) and partly satisfies WE Credit 1.1 (limiting irrigation water use by 50%).

Roof harvested rainwater is typically much cleaner that surface harvested rainwater and therefore requires far less treatment. Non-the-less we will incorporate self-flushing cyclonic filters in the rainwater conveyance system to remove debris before the water enters the storm cistern.

To irrigate the trees we will use a sequence of 4 low-flow bubblers for each tree. This particular model of bubbler is mounted in a 100 mm diameter tube and is available in lengths ranging from 300 – 900 mm. The intent is for the tubes to be filled with small diameter aggregate so that the irrigation water wets the root zone uniformly. To serve the immediate needs of the tree's 2 – 300 mm bubblers will be placed immediately adjacent to the root ball with 2 – 600 mm bubblers located further out form each root ball to accommodate future water needs as the trees grow. The 600 mm bubblers will be kept turned off for the first number of years after installation.

For the shrubs and groundcovers we will utilize a grid distribution pattern with in-line emitters. In this case we are using 600 mm O.C. spacing. This type of system is typically called drip, trickle, or micro-irrigation, and water supplied is measure in GPH rather than GPM. The O.C. spacing of the emitters must be matched to the soil type.

The use of deep watering bubblers and inline emitters reduces or eliminates water waste and promotes healthier plant growth because you can:

Match the water application to the specific needs of each plant.

More closely match the application rate to the soil's infiltration rate.

Apply water directly to the root zone to reduce overspray and evaporation.

Reduce or eliminate runoff.

These factors combine to complete the requirements for WE Credit 1.1 (reducing irrigation water consumption by 50%)

Traditionally, the irrigation water requirement is lower in the spring and fall, than in the summer, because of lower air temperatures and increased levels of plant available water through natural precipitation. We have incorporated spring and fall irrigation schedules as a percentage of peak summer demand, which represents a further reduction in irrigation water consumption.

In closing…

This presentation is structured as a case study on the Calgary Courts Centre but in my mind it is really a primer for the type advanced of irrigation design that we should all be practicing.