Keeping Water in the Pipes through Irrigation Auditing

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Abstract: *The purpose of this paper and ensuing presentation is to demonstrate what can and cannot be accomplished through irrigation auditing. Irrigation Auditing is frequently misunderstood and often undervalued. In our region the value of outdoor auditing often gets lost when compared to the barrage of indoor water audits and toilet replacement programs to save water. This paper seeks to illuminate what an irrigation audit can provide and present sound rationale for investing in an irrigation auditing program. Creating more informed end users and painting a more complete picture of the positive impacts of irrigation auditing will result in greater investment in the process. Experience both in the field and with clients will be presented to create the business case for irrigation auditing. Audit information from institutional green spaces will be included to show the water savings available as recommendations are implemented. For anyone living where potable water is still the prevalent source for irrigation, being able to keep more water in the pipes is a particularly powerful tool.*

Keywords: Irrigation auditing, irrigation efficiency, sustainability

Introduction

Irrigation Auditing is a powerful tool that when utilized correctly can lead to dramatic water conservation results through improvements in the efficiency of irrigation systems. Achieving this goal will occur as awareness increases around irrigation auditing and what can be accomplished.

In our short time together we are going to look at -

1. WHAT information is obtainable through irrigation auditing and how that data can help with irrigation responsibilities;

2. WHY implement an irrigation auditing program. Determining return on investment;

3. WHO are the end users; some specific findings and impacts.

You may be wondering about the other two "W's" from the list; the when and the where. These are implied in all you will hear today. If it isn't happening already, make it happen now; in your sports fields, parks and as far as you can reach.

1. WHAT information is obtainable through irrigation auditing and how that data can help with irrigation responsibilities?

Those interested in this topic will be irrigation auditors or end users or both. You will likely have experienced the disconnect that can happen at the very beginning of the irrigation auditing process where what the audit can provide and what the client wants to see are not aligned. Both parties end up unhappy and irrigation auditing loses credibility.

Ever done the employment evaluations where you complete a questionnaire about yourself and then your supervisor completes the same one? Then you compare and look at the differences. Seems pretty straightforward; both answering the same questions. Then why the different responses? We see things differently and certainly have differing motivations.

Determine specifically what type of information the client is looking for and work with them to understand that investing in the audit is step 1 of a two step process.
What is the second step? Investing in the implementation of recommendations.

An irrigation audit DOES PROVIDE VALUABLE INFORMATION including:

- Site specific precipitation rates
- Site specific distribution uniformity (often referred to as efficiency)
- Irrigation equipment deficiencies and/or safety concerns
- Irrigation design and/or installation deficiencies
- Insight into the volume of water being wasted on the site
- Observations with respect to the health of plant material
- Informed recommendations to improve the system performance

An irrigation audit DOES NOT EQUAL WATER SAVINGS.
Step Two, the implementation phase, is where the quantifiable impacts will be felt.

When a Certified Landscape Irrigation Auditor steps onto a site, to bring the maximum value to the client, they should bring with them a background in irrigation and making good irrigation water use decisions. She or he will have a broad base of irrigation experience and years of industry involvement to assist in providing valuable insights. A strong auditor will quickly identify areas of concern and before even setting out the catch cans, they begin imparting valuable water saving, plant improving knowledge to their client.

As for creating the report, the client will often want the list of recommendations for changes prioritized. The more we as auditors simplify the steps to success, the better the chances that some or all of the changes will occur. Too much information is as detrimental as not enough and if the client feels overwhelmed they are not inspired to action. There are too many audit report binders sitting on shelves collecting dust.

Irrigation System Efficiency

Before moving on and because it comes up frequently in irrigation auditing, I would like to address irrigation system efficiency. The word efficiency is too often used interchangeably with uniformity when talking about irrigation system performance. It is a misconception that a system found to have a Distribution Uniformity of 70% is a system that will operate at 70% efficiency. Efficiency is bigger than the DU alone and how the system is scheduled and maintained moving forward must be considered.

> *Efficient system performance means that water is applied as uniformly as possible. It is the result of appropriate design, installation, operation and maintenance of the system.* [1]
>
> Irrigation Association Golf Irrigation Auditor manual; 2006

2. WHY implement an irrigation auditing program? Determining return on investment.

Finding the motivation to conduct audits and encourage change is not difficult if you have an environmental consciousness. Since I took the course and wrote the exam five years ago I have been espousing the *do the right thing philosophy*, as I'm sure have many of you. The reality is that argument doesn't always create the necessary motivation. However there are now many more reasons to invest in an Irrigation Auditing Program from financial to legal to accountability.

A) Landscape irrigation improvements make the same investment sense as replacing toilets

Many of you will have had discussions with potential clients about the merits of what irrigation auditors do and in particular, how our audits compare to the indoor water use audits that are so prevalent. When presenting to commercial clients we have often heard "doesn't it make more sense to replace all the toilets to save water?". This is a valid question as water conservation is a business and those of us in it are competing for funds. For many, creating and implementing an outdoor based water conservation program can be daunting while replacing an old toilet seems rather simple. The process of finding appropriate irrigation industry partners for the program can be intimidating as well. Having said all that, a strong return on investment is possible as demonstrated by the two options in the following scenario:

Option A: Replace old toilets

Government building with 100 employees and 10 older toilets.

Replace the 3.5 gallon flush toilets with 1.6 gallon flush toilets at a cost of $6000 for new toilets, installation, removal and disposal of old toilets.

Annual water savings: 337,500 gallons [2]

Investment per gallon saved: 6,000 / 337,500 = .02 /gallon

Option B: Improve the irrigation system of the soccer field adjacent to the building.
Soccer field on a 2 acres site with an irrigation system operating at 40% uniformity.
Improve the irrigation system to 75% at a cost of $35,000 for audit, labour and materials.
Annual water savings: 1,750,000 gallons
Investment per gallon saved: 35,000 / 1,750,000 = .02 / gallon

B) Water pricing structures are changing…

In our part of the world there is the appearance of an endless supply of freshwater that has led to low water prices and low levels of concern for water waste. This has paved the way for subpar irrigation systems and subpar performance. So long as the grass and plants look green, don't worry about the water running down the road into the storm sewers. The following excerpt from a paper by Steven Renzetti puts the situation in perspective and shows the less than progressive situation we are in.

Different water pricing structures

There is considerable diversity in the forms of water pricing that exist across Canada. A 2004 report from Environment Canada sketched the national pattern as follows:

37% of Canadian households pay a **flat rate** for water, irrespective of the quantity they use. 62% have some kind of **volumetric pricing**, based on the volume of water consumed.

Volumetric pricing breaks down into three general categories:

- 39% pay for the quantity of water they consume at a **constant** unit price.
- 13% pay for water used at a rate that **decreases** as the volume they consume rises.
- 10% pay water prices that **increase** with the amount consumed, thus promoting conservation.[3]

Municipalities are formulating and implementing strategies that are more financially sound including metering. The caveat to metering is that without correct pricing strategies it may not have a lasting effect. However for those of us in the irrigation auditing arena, meters are a welcome addition to any site. In the best case scenario, the pricing is high enough to be a key factor in the return on investment for auditing and making changes. But even where pricing does not have a significant impact, knowing what is being used on a site allows us to benchmark and document results.

C) Government policies and laws being introduced for better use of water resources

In the United States, the Energy and Water Integration Act 2011 is a very recent example of this type of legislation. This bill calls for investigations into the many ways that water and energy are connected and demonstrates how we must move to a better position with respect to the efficiency of water use. It draws attention to the water-energy nexus and the importance of

using less water not only because of the long standing argument of conservation but also because it is an integral part of energy production as well as every aspect of the economy. At last check the bill had been placed on the Senate Legislative Calendar under General Orders. Calendar No. 102 [4].

In our backyard, the provincial government in British Columbia has introduced their Water Smart Plan. Like many government initiatives it is slow in coming with a seemingly unending stream of facilitated input sessions from community stakeholders. There are many vague statements regarding water conservation concepts but there is one mandate in particular within that plan stands to have a significant impact.

Fifty percent of new municipal water needs will be acquired through conservation by 2020. [5]

That is a powerful statement. Consider a small city like Kelowna at 119,000 people.
The population is projected to grow at an annual rate of 1.88% until 2015 and then 1.58% until 2020 [6], adding 22,666 people with increased residential, business and agricultural water demands. The city currently uses approximately 15.8 million cubic meters for its 119,000 residents which is 132m3 per person. Looking at projected population growth and per capita consumption for Kelowna, by 2020 the water requirement for new municipal needs would be 2.99 million cubic meters. Half that volume, 1.5M cubic meters, must be acquired through conservation from 2020 onwards.

The City of Vancouver, also facing the same conservation challenge and estimated to be using 542 liters per capita per day [7] (198m3 per resident annually). The city is projected to grow by 71,800 people by 2021.[8] That equates to requiring an additional 14M cubic meters to keep pace with anticipated growth; half of which must be "found water".

<u>D) Energy saving initiatives have become standard practice and saving water saves power</u>
It is rare these days to find an organization of any magnitude that does not have some form of an Energy Management Plan. Potable water is still the most prevalent irrigation water source and potable water systems consume a lot of energy, from the pumping system to the treatment facility to the stormwater/sewer system. As a result there is significant support for organizations with large power bills to hire Energy Efficiency Managers -

BC Hydro's Community Energy Manager Program will provide $50,000 of the $100,000 cost of creating the full-time position. After the first two years, the city will explore other financing options to keep the energy manager for an additional three years. [9]

Reducing potable water used for irrigation purposes will result in energy savings.

Continuing with the soccer field example, what might be the related energy savings?
The example shows a saving 2.68M (US) gallons of water. That equates to 10,145 cubic meters; our billable unit in Canada.

For the delivery of these 10,145 cubic meters, we will assume there is a pump station involved as well as a reservoir and/or a booster station. Also consider the energy for treatment of the water by UV or whichever method is employed.

Estimated consumption	1.75kWh/m3.
	10,145m3 x 1.75kWh = 17,754 kilowatt hours
	17,754kWh x $.0864kWh[10] = **$1,534 annual savings**

Notes: Energy costs vary dramatically depending on the sources of that energy. Hydroelectric being the predominant source in British Columbia, costs on both sides of the border for this type of energy were looked at and found to be similar. A US source for the kWh cost was used for the calculations.
1 cubic meter = approximately 35 cubic feet or 265 US gallons

E) It costs less to save water than to find, treat and deliver more water.

Large municipalities across North America have recognized that keeping water in the pipes for future use makes good business sense. In fact, water efficiency costs between 20% and 50% less than traditional infrastructure expansion. [11]
Some examples of this:

- $11 million dollar water efficiency program 42% more cost effective than new infrastructure (City of Guelph, 118,000 people)

- $10.1 million capital budget for a six year program versus new infrastructure costs of $40 million (York Region)

- Seattle's Saving Water Partnership achieves long term water saving of 10 million gallons (38 million litres) and defers **indefinitely** $70 million new infrastructure. Program cost over 10 years; 3.8 million per year.[11]

The Federation of Canadian Municipalities (FCM) has calculated that an investment of at least $31 billion is needed to maintain and repair water infrastructure across Canada [12]. These types of calculations are done assuming that the demand on those water systems will continue at a particular rate based on historical data. With each successful irrigation auditing experience, we are reducing that overall cost and prolonging the life of the water systems, many of which are nearing their anticipated life expectancy.

F) Green marketing

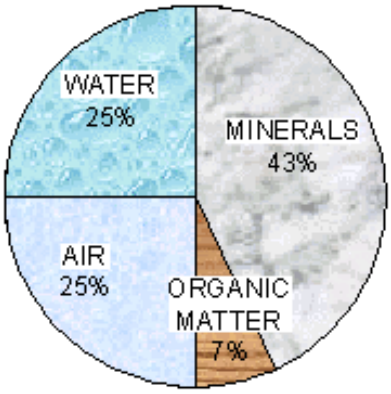
Worth mentioning but difficult to quantify is the marketability of making inroads in outdoor water conservation. Along with energy saving initiatives, many organizations will have ongoing sustainability projects like high profile Water Smart programs. Where large green spaces are managed, an irrigation audit process is ideally suited and highly marketable.

3. WHO are the end users; some specific findings and impacts.

Once we have connected with a client and have determined that the information we can provide will address their needs, we are presented with opportunities to evaluate various green spaces. Public organizations often charged with maintaining large amounts of green space have afforded the most volume and variety of opportunity in our area. Where central control systems are involved but not maximized, irrigation auditing and related processes are the best option to realize the system potential. Private companies, also managing significant plant material will commit to the process recognizing the opportunity to not only improve plant health but to incorporate the process into the marketing of their "green" initiatives.

The following are highlights from three sites evaluated and audited over the past year. Each site presented some distinct issues but in each case the condition of the growing medium (soil) either mitigated system concerns or exacerbated them. Too often the plant material and the irrigation manager are at a disadvantage regardless of the uniformity of the irrigation system or how well it is managed. It is the foundation for the health of these sites and when it is healthy and of sufficient depth it is powerful in its ability to offset system inefficiencies.

Healthy Soil is made up of 4 components necessary for plant growth:
43% Minerals
7% Organic Matter
25% Air
25% Water



Source: Chatham-Kent Organic Epicentre, http://ckorganic.ca/soilhealth.html

Site One

This is a high profile site with that was constructed approximately 20 years ago. Some system renovations have occurred as necessary however no improvement strategy existed.

Client concerns:

- excessive water consumption
- mainline breaks becoming more frequent
- visible runoff resulting in standing water

Client goals:

- reduce water consumption
- investigate mainline breaks
- improve site aesthetics / public perception.

For this site the client also requested a GPS as-built to assist with site management including scheduling.

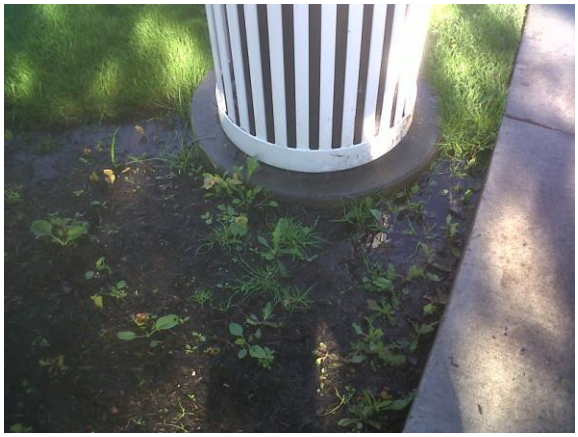
Audit process revealed the following:

- Site DU of 59%
- Overwatering in combination with no check valves leading to runoff
- Original irrigation design failed to incorporate topographical challenges and calculations for maintaining safe velocities were incorrect
- Scheduling not based on site information and not seasonally adjusted
- Healthy soil in some areas compensating for low uniformity

Improvements Overview:

Projected annual savings with improvements: Over 500,000 gallons

Within the first week, the findings of mixed product and product without check valves were addressed immediately, reducing runoff and improving appearance. Spring will begin improvements to scheduling to further reduce water use and assist in reducing velocities which are likely contributing to the mainline breaks. Total system renovation was not a possibility but the smaller changes will have a significant impact.



Standing water as a result of overwatering and low head drainage.

Site Two (Sections A and B)

This site has been touted as the most photographed place in its city due to its natural features and convenient location making it another high profile location. It also presented a unique opportunity in that it was likely going to be renovated in two sections providing a comparison between the existing system and a new system.

Client concerns:

- excessive water consumption
- significant overspray onto hardscapes
- visible signs of incorrect system function (ie: runoff and mushy areas)
- past irrigation installation experiences less than favourable

Client goals:

- reduce water consumption
- reduce or eliminate water onto hardscapes
- improve site aesthetics / public perception
- have a project consultant manage an installation and assess the outcome

For this site the client also requested a GPS as-built to assist with site management including scheduling.

Audit process revealed the following:

Section A -

- **Site DU of 39%**
- Stretched spacing on hillside resulted in overwatering to compensate for dry areas with excessive saturation and runoff for other areas
- Scheduling not based on site information and not seasonally adjusted
- Healthy soil in some areas compensating for low uniformity

Improvements Overview:

Projected annual savings with improvements: 1,200,000 gallons

The size of the site and extent of the spacing challenges indicate that a system renovation is required and feasible.

Note that the second section was renovated that same season following a researched and peer reviewed design, new irrigation technology and hands on project management. Due to a product delay, correct nozzles were not installed in approximately 25% of the heads at the time of the second audit which had to be completed by a specific deadline. However the findings are still impressive and had the desired result of gaining support to continue renovating additional sites.

Section B –

- **Site DU of 73.5%**

Site Three

This site was at a state-of-the-art school where the building was created to achieve high environmental standards and yet the surrounding fields were not performing well.

Client concerns:

- excessive water consumption
- field condition substandard; patches of brown, sunken areas, hardpan sections and complaints as to the playability of the fields
- irrigation equipment difficult to locate and service

Client goals:

- reduce water consumption
- determine the cause(s) of the concerns
- improve site aesthetics / public perception
- explore how to avoid these failures in future

For this site the client also requested a GPS as-built to assist with site management including scheduling.

Audit process revealed the following:

- Site DU of 47%
- Point of Connection pressure different from what the client was told would be there
- Stretched spacing now exacerbated by the pressure drop
- Scheduling not based on site information and not seasonally adjusted
- Unhealthy soil, tested and found to be very high in potassium and very low (unreadable amount) in nitrogen

Improvements Overview:

Projected annual savings with improvements: 1,800,000 gallons

The key factor for improving system performance on this site is to increase site pressure. Following the audit the client began discussions with the water purveyor who had assured the installer a certain pressure and size of POC but had subsequently altered those parameters. If the purveyor does not cooperate then the next choice would be a booster pump installation which is a significant investment.

A soil amendment program has also been initiated which includes aeration and the addition of nitrogen. Improvements in the appearance of the plant material were noted but it is an involved process as nitrogen must be closely managed and runoff remains a concern on this site.

Interesting note:

An audit conducted on another school with a much older system (still primarily hydraulic) found the DU to be 67.5%. This generated discussion around assessing contractor qualifications for new installation and overall management of the installation process for new locations.

Conclusion

After embarking on an irrigation auditing program, an organization will often diversify its outdoor water conservation efforts. The audit process is initiated with the recognition of system concerns such as excessive water use and system failures. Frequently during the investigation, other unexpected issues may come to light that prompt expanded activities. Questions are asked such as “How was the installation of this irrigation system managed?” and “What is the knowledge base of the irrigation personnel who maintain the site?”.

It comes back to the concept of system efficiency. While conducting irrigation audits and implementing recommendations will enhance the performance of a system, there are other efforts required to achieve system efficiency. Working with clients to improve the installation process and supporting their efforts to create knowledgeable irrigation teams are just two of the many activities that irrigation auditors can also assist with. Experience has shown that expanding our roles as auditors is critical in keeping more water in the pipes.

Acknowledgements:

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