

INTEGRATION OF WATER LOSS ANALYSIS TOOLS INTO A WATER SCADA SYSTEM

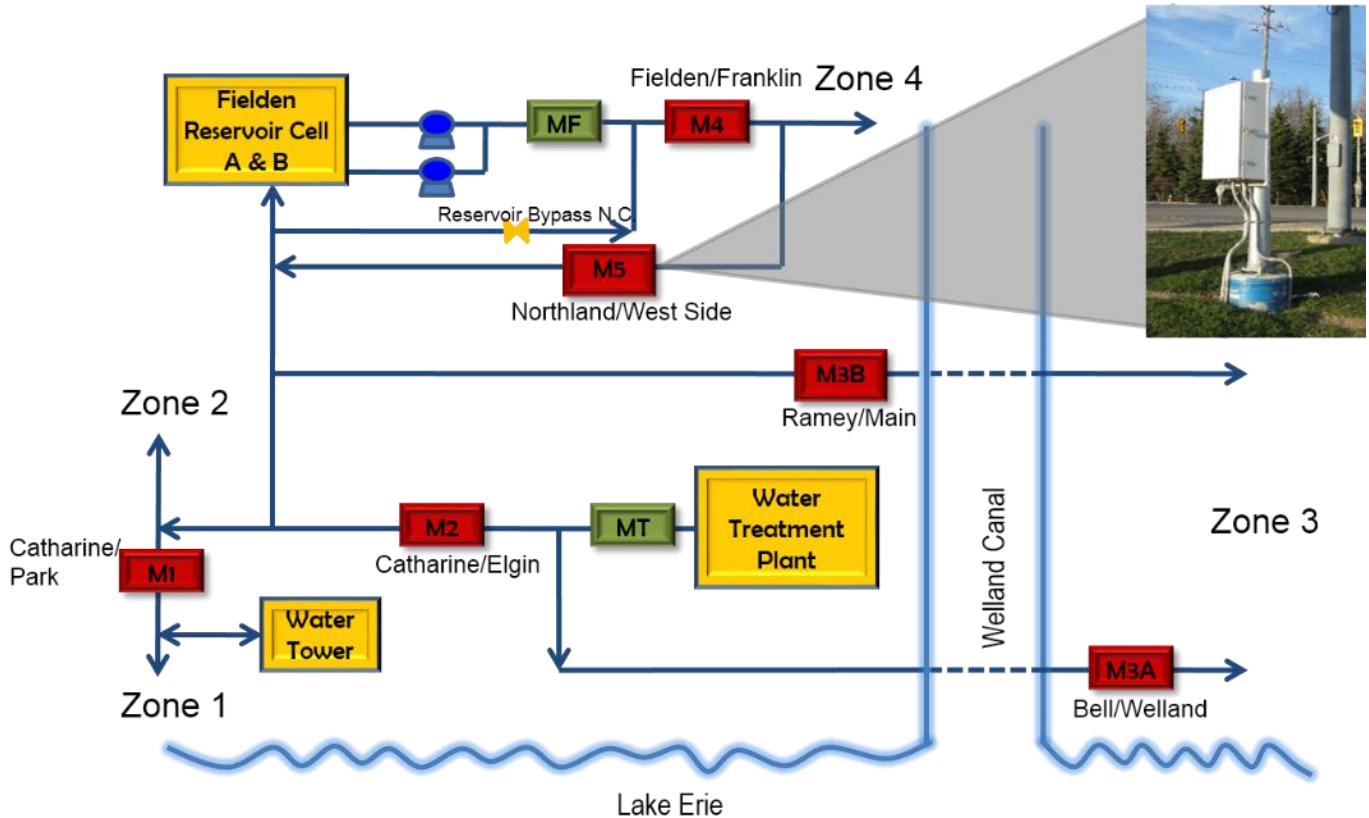


Figure 1: Flow monitoring locations

High Level Results

- Created a software tool that compiles and analyzes all water meter and flow data for trend analysis and helping locate water losses.
- Provided a comprehensive understanding of where water is used throughout the City.
- Identified and addressed challenges with the city's water billing system.
- Determined unauthorized, unbilled water usage as the main component of the City's unaccounted for water loss.
- Created new procedures for tracking authorized, unbilled water usage.
- Identified one source responsible for approximately 3.3% of the City's unaccounted for water.

Project Context

Unaccounted for water losses are not unique to the Port Colborne Distribution System. They occur in every distribution system around the world.

Knowing when and where unaccounted for water losses are occurring is a struggle for all municipalities. Small municipalities, in particular, have the added challenge of limited resources such as staff, equipment and finances.

This project provides an option to automate water loss analysis, and provide real-time flow monitoring to assist staff with locating the sources of unaccounted for water losses.

Challenge

The City of Port Colborne is a two-tier municipality in the Regional Municipality of Niagara (Region), and operates a stand-alone distribution system.

The City previously identified a major unaccounted for water problem, with 30% of the water purchased from the Region being “lost” and a calculated Infrastructure Leakage Index (ILI) of 8.7. In 2013, that water loss totalled approximately \$2.1 million in lost water and wastewater revenue. It was previously identified that unauthorized water usage, totally approximately 31,000m³, was occurring on unmetered fire systems. The City lacked a comprehensive approach to verifying and quantifying this usage.

Staff considered simply ramping up leak detection activities using acoustic leak detection devices. However, a number of consultants were retained over the years and none were able to identify the source of the unaccounted for water. Frustrated by the inability to detect the source, staff sought alternatives to traditional leak detection methods and in 1998, the City established four (4) District Metered Areas (DMAs), or zones. Despite this advancement, the usefulness of the data was limited since the data logged for each zone had to be downloaded and manipulated manually. Beginning in 2009, the City upgraded all flow monitoring stations and established a comprehensive, wide area network (WAN), wireless SCADA system to collect data and display flows and pressures in real-time.

The City was on the cusp of having all the hardware and basic software in place to provide real-time flow and pressure monitoring of the distribution system. However, with no software in place to analyze the data received from the flow monitoring stations and compare it to the City’s water meter data, the information provided by the flow monitoring stations was very limited. The City wanted the ability to use the SCADA WAN system to its full potential for finding sources of unaccounted for water.

Project Goals

In order to realise the full potential of the SCADA WAN system, the goals of the project were to:

Develop software tools to:

- Centralize water usage data
- Enable real-time detection of water loss
- Automatically calculate water loss using industry standards (i.e. ILI) and lost revenue

Utilize SCADA software to:

- Monitor distribution flows and pressures in real-time

Ultimately, reduce water loss!

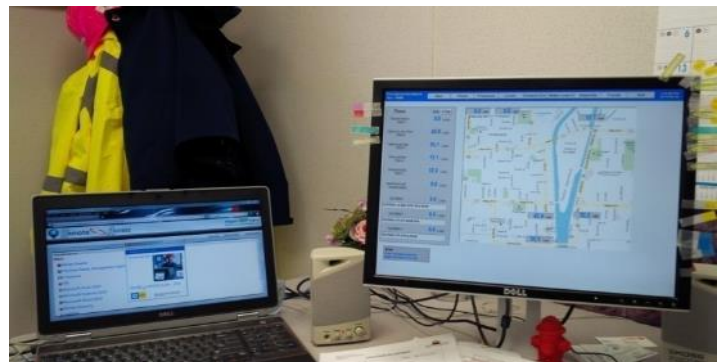


Figure 2: Real-time, on-line SCADA monitoring

Solution

In 2011, the City received Showcasing Water Innovation funding to integrate a water loss analysis tool into the city's water SCADA system. The project was proposed to provide staff with the capability of monitoring flow and pressure in the distribution system using off-line and real-time software tools. This project would enable staff to respond to flow and/or pressure changes in a timely manner by providing them with a smaller "search area" when trying to pinpoint where water losses are occurring. Additionally, staff would be provided the tools to show, in real-time, IWA (International Water Association) Standard Water Balance values (i.e. ILI) and the financial impact of the unaccounted for water.

Results

The project provided a comprehensive evaluation of the demand (zone flows) versus consumption (water billings and other authorized consumption) in each zone and provided insight into which zones experienced the highest percentage of authorized consumption. Comparing the quarterly demand to the quarterly billed volume, it is evident that zone 1 is the City's "tightest" zone, with authorized consumption averaging 83%. In zone 2/4, authorized consumption declines to 69% while in zone 3, authorized consumption is only 57% (Table 1).

Table 1: Quarterly percent authorized consumption per zone.

Year	Quarter	Percent Authorized Consumption			
		Zone 1	Zone 2/4 ^a	Zone 3	Quarter Total
2013	Q1	102	62	66	70
	Q2	84	73	63	71
	Q3	87	70	67	72
	Q4	94	71	49	64
2014	Q1	51	41	67	50
	Q2	82	96	31	55
Average^b		83	69	57	64

Notes:

a. Zone 2 and 4 were not physically isolated until August 2014, and then a programming error in the second flow monitoring location between zones 2 and 4 was not detected until April 2015; therefore the zones are analyzed together for the purposes of this project.

b. Data from the last 2 quarters of 2014 was not included in the analysis due to data discrepancies and anomalies. See "Next Steps"

This project not only provided the City with the software tools to assist with calculating and detecting unaccounted for water, it also provided additional benefits which were not considered when the project was conceived:

Water Billing Data

Challenges associated with importing the water billing data were not clearly understood when the project was proposed. The City's circa 1980's DOS-based water billing software program was not designed to extract customer consumption data, nor could the individual account manipulations (i.e. decimal location for large meter accounts), be extracted from the software.

The data challenges included developing a method to extract approximately 96 meter reads requiring manipulation (i.e. correct decimal location) from the approximate 5,900 accounts read quarterly, and more critically, assigning meter reads to the correct zone. This data manipulation was one of the most troublesome and time-consuming tasks of the project, as it required the re-creation in the City's GIS software of twelve circa 1993-94 hard copy walking route "Books", each containing up to 600 accounts/properties. This electronic copy was required due to the fact that several of the "Books" straddle zone boundaries and the off-line tool had to be programmed to assign the correct accounts to the correct zone to ensure water consumption was accurately accounted for in each zone. This would have been nearly impossible with the hard copies. The re-creation of the "Books" was not completed until October 2014 and required over 475 hours of staff time to make the GIS system and the City's billing system information somewhat compatible.

This GIS database has already provided value to another project; the City is embarking on a water meter replacement program in 2016. Without this database, the replacement program would have been very challenging to implement.

Authorized, Unbilled Water Usage Data

Prior to the project, authorized, unbilled water usage data was not reliably tracked. This project has resulted in new procedures to track unbilled water usage in the following activities:

- Fire fighting
- Fire response training
- Dead-end hydrant flushing
- Watermain breaks
- Flushing after watermain breaks
- Flushing due to dirty water complaints
- Flushing for watermain commissioning activities
- Other City department uses (i.e. street sweeping)



Figure 3: Watermain break

Field Testing

Part of this project required the completion of leak detection activities on the entire distribution system. Results of that monitoring, which included listening on every distribution valve, hydrant and curb stop valve, revealed no significant leaks. This pointed to unauthorized, unbilled water usage as the main component of the City's unaccounted for water loss.



Figure 4: Portable flow monitoring station solar panels and directional antenna

Quantification of Unauthorized Water Use

The City had originally targeted “reclaiming” the estimated 31,000m³ of unauthorized water use estimated by a consultant in 2008. A portable flow monitoring station was deployed at an industrial facility where previous discrepancies between a temporary flow meter and the water meter had been noted. During the 123 days that the portable flow monitoring station was in operation, it was discovered that 90% more water entered the property than what the water meter registered. Both the flow meter and the water meter were calibrated to ensure the results were representative. If the facility's usage was consistent throughout the remainder of the year, it was calculated that the unauthorized usage would total approximately 96,000m³, representing 3.34% of the City's unaccounted for water and totalling just over \$100,000 in lost revenue. Based on these findings, the City budgeted for the purchase and installation of a fire service water meter at this property, to be installed in 2016.

Overall, the development of this program has provided the City with a tool that is capable of compiling and analyzing all water consumption data on a regular basis, thus allowing for trend analysis and providing staff with more information regarding where the City's water losses are occurring. Continued refinement of the tools and training staff on how to use the SCADA screens will ensure that the program becomes a powerful tool for staff to identify water losses.

Next Steps

Although the City is very pleased to have discovered a significant source of unaccounted for water during this project, more analysis is required to ensure that the off-line and on-line tools are performing as intended. Data discrepancies and other operational challenges prevented comprehensive evaluation of the software tools at calculating water loss values. After the final report was issued, the consultant discovered a mathematical error in the programming which potentially affected the data in three of the four zones in the second half of 2014. A technical review of the report and the data is planned for 2016. For analysis purposes, Q3 and Q4 of 2014 are not included as the data is not deemed to be representative.

There are several changes to the distribution system occurring over the next few years which will require updating of the analysis tools and SCADA programming. The Region is in the process of tendering out the construction of a new water tower which is to be constructed in zone 4, beginning in 2016. Upon commissioning, the current water tower, located in zone 1, will be decommissioned.

Moving the tower to the north end of the City will have a significant impact on how water moves in the distribution system and on the zones. Additionally the Region has plans to construct a third feed under the Welland Canal to provide servicing to lands the City has designated for industrial development. Construction is anticipated for 2018 and this feed will also affect the zones.

A positive change, which will improve the usefulness of the program, is the upgrading of the City's water meters. In 2016, all of the City's analog water meters will be upgraded to RF (radio frequency) water meters. As all the water meters will be able to be read in a single day, the accuracy of the tool will be improved as there will be no need to average the meter reading values. Additionally, the meters being installed have the capability to be wirelessly read so, in the future, the water meter data can be linked directly to the SCADA program, providing true real-time monitoring of water usage in the distribution system.



Figure 5: Regional Municipality of Niagara water tower

Application for Other Communities

Most, if not all municipalities already use a SCADA system to monitor their water treatment plant processes and this project is an example of an on-line water loss monitoring tool that can be developed as an extension of an existing water SCADA system. Automating the collection of data from DMAs in the distribution system and from the water billing data as well as automatically calculating industry benchmarks and the cost of the lost water, provides real-time monitoring of the distribution system.

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Contact Information

Darlene Suddard
Environmental Compliance Supervisor
905-835-5079
darlenesuddard@portcolborne.ca

City of Port Colborne
66 Charlotte Street
Port Colborne, ON L3K 3C8