Keeping It Flowing

Hamilton Water staff perform maintenance in the valve chamber.

Anti-Stagnation Valves Save Hamilton Water Hundreds of Thousands in Electricity Costs

By Dave Alberton & Mark Gimson

The City of Hamilton is a port city situated at the west end of Lake Ontario in the Canadian province of Ontario. As the tenth largest municipality in Canada, it has an elevation of 298 ft (91m) above sea level and is defined by unique geographical features like the Niagara Escarpment and the Hamilton Harbor. The City of Hamilton's water distribution system is one of the oldest and most complex water distribution systems in Canada. The city's water distribution network consists of:

- six separate water systems
- 1,262 miles (2,031 km) of water mains
- 144,691 water services
- 16 pressure reducing zones
- 145 pressure district level valves

The city's distribution system must maintain a minimum operating pressure of 20 psi (1.38 Bar) at ground level at all points under maximum day demand plus fire flow conditions. The normal operating pressure within the network is 40 to 100 psi (2.76 to 6.89 Bar).

Maintaining optimal pressure is a difficult undertaking due to the Niagara Escarpment, a steep rock face that runs through the middle of the city across its entire breadth, bisecting the city into 'upper' and 'lower' sections. This vertical wall ascends an average of 328 ft (100 m) and presents a unique challenge in the conveyance of water at acceptable flows and pressures. Due to this elevation change coupled with the sprawling geography of the city, the water distribution system is divided into 25 distinct pressure districts, both open and closed.

In an open district, continuous pumping is not required to maintain pressure due to the provision of floating storage, such as an elevated tank or reservoir. In a closed district, continuous pumping is required to ensure that the required flows and pressures in that portion of the distribution network are met.

In areas where a facility such as a reservoir or elevated tank is not present, pumping station discharge head must be enough to overcome system losses and to maintain the appropriate hydraulic gradient.

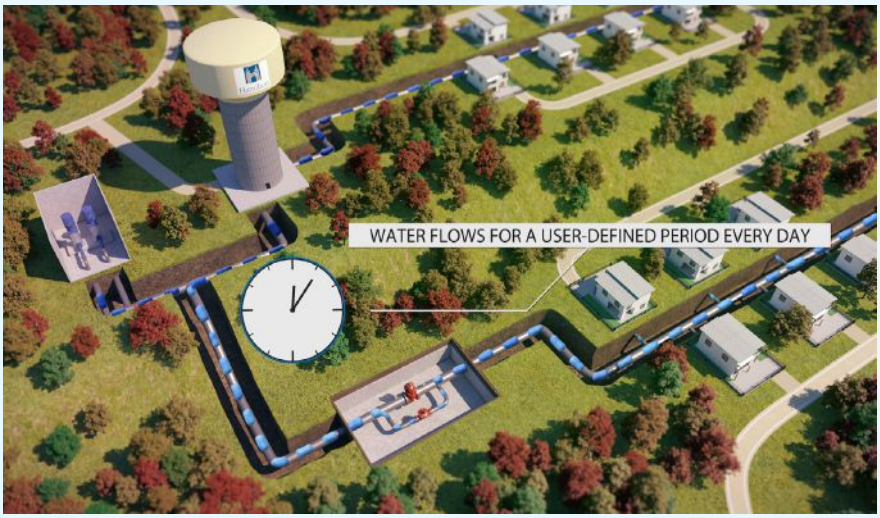
The placement of floating storage within the distribution system not only provides sufficient amounts of water to equalize demand, but also translates into energy savings when supplying the network via gravity.

The various pressure district zones are inter-connected via level valves and an open ¾-in. (20-mm) bypass line. Typically, bypass lines allow a continuous flow of water from the high to low pressure zones to provide a mixing of water to maintain acceptable residual chlorine levels. These bypassing flows consume significant pumping energy and are a contributor to Hamilton Water being one of the largest energy users within the city.

"The city has been actively looking for ways to reduce its energy consumption and the anti-stagnation valves looked like a good solution to lessen our electricity costs while also maintaining water quality by eliminating concerns of stagnant water within the DMA," said Don Young, Water Distribution and Wastewater Collection Manager for Hamilton Water.

A normally-closed Zone Boundary Valve creates two dead ends, resulting in stagnant water.

¾-in. bypass line eliminates stagnant water but (1) increases pumping costs, (2) increases main breaks, (3) instigates in-chamber "mini-breaks."



All problems eliminated by implementing an "anti-stagnation" valve to open only when required.

A SUCCESSFUL PILOT PROJECT

In late 2017, a pilot project was implemented to review and investigate the significant increase in flow from two reservoirs (PD4 – Greenhill Avenue and PD8 – Dewitt Road), in comparison to the trends from previous years. It had been determined that it was acceptable and feasible to significantly reduce water flow through the bypass lines from a 24/7 continuous flow to approximately 15 minutes per day, and still maintain water quality, while using a timer controlled, anti-stagnation valve. These valves significantly reduced the required water flow from pumping stations.

Each valve is a ¾-in. (20 mm) Cla-Val Model 139-10A, a programmable timer control valve, and is an on/off control valve that can be programmed to operate on a time schedule. It utilizes a long life 9-volt lithium battery and the whole assembly is IP-68 submersible.

The pilot project focused on 37 water distribution level valves and open bypass lines that separate two pressure districts. The 37 valves were all installed and operational by the end of June 2018. The previous one-year historic pumping station electrical demand (kW) and energy consumption (kWh) were used as a baseline for the pilot project.

The results of the pilot study were that total demand reduction in power for the pumping stations in the two pressure zones was 497 kW. If a continuous 24-hour-per-day, 7 days-per-week operation is taken into consideration, that equates to 4,353,720 kWh per year of energy use reduction. Based on the product calculations, it was estimated that each valve saves 44,000 kWh of energy, or 1,628,000 kWh per year in total for 37 valves. Savings in the order of $200,000 per year were seen in the pilot study and with a total installed project cost of under $90,000, the simple payback was under six months.

"We were really pleased with the results, not only in energy savings but also reducing demand for water, which led us to implementing a second and third phase," Young said.

Hamilton Water staff connect to the anti-stagnation valve to set the flow schedule.

PHASES 2 & 3

Phase 2 involved the installation of an additional 37 Cla-Val anti-stagnation valves while phase 3 added a further 36 valves. Now the pressure district boundary valves in the City of Hamilton all have anti-stagnation valves, making the total 146. Based on a savings of 44,000kWh per valve, the city is saving over 5,000,000 kWh per year, amounting to over half a million dollars.

Some valve chambers are situated in areas with elevated levels of groundwater, posing a significant risk to the functionality of the anti-stagnation valves. Groundwater infiltration presents a multifaceted challenge, potentially compromising the performance of these valves through corrosion, sedimentation, or hydraulic pressure imbalances. These valves play a pivotal role in maintaining water quality and preventing stagnation within the system.

By installing a waterproof cover over the anti-stagnation valve, the city is able to mitigate these risks and ensure uninterrupted operation. The waterproof covers for the anti-stagnation valves are a prudent investment to ensuring the long-term viability of Hamilton's water distribution network in the face of evolving environmental challenges.

HW2 here/caption: Hamilton Water staff connect to the anti-stagnation valve to set the flow schedule.

FLUSHING TO MAINTAIN WATER QUALITY

As the name implies, "anti-stagnation valves" are used to eliminate stagnant water. The city tests chlorine residual levels to determine flushing times – a critical aspect of maintaining water quality and ensuring the efficient operation of the distribution system. Chlorine eradicates harmful pathogens and safeguards against microbial regrowth during the transit of water to consumers. Accurate monitoring of chlorine residual levels is essential to upholding water quality standards and protecting public health.

Flushing times are directly influenced by chlorine residual levels, as they dictate the duration required to purge stagnant water and maintain adequate disinfection throughout the system. Flushing too briefly may leave behind pockets of stagnant water with inadequate chlorine residual, increasing the risk of bacterial contamination and compromising water quality. Conversely, excessive flushing can lead to unnecessary over pressurizing of the pressure district and operational inefficiencies that lead to high power consumption. Hence, precise determination of flushing times based on chlorine residual measurements is imperative to strike a balance between effective disinfection and resource (water and energy) conservation.

EFFICIENT BATTERY CHANGE OUTS

Efficient battery change-outs are crucial for extending the lifespan of anti-stagnation valves and minimizing operational costs. The city has implemented a maintenance schedule and is using high-quality batteries to maximize the longevity of the valves, reducing the frequency of replacements and the associated costs. Proactive monitoring and timely battery replacements will ensure uninterrupted operation of anti-stagnation valves helping preserve water quality and system integrity.

"By prioritizing battery longevity, we optimize resource utilization and enhance the sustainability of water distribution infrastructure," Young said. "We are very happy with the success of the anti-stag valve program as it is doing a great job of reducing our energy consumption and ensuring we are serving safe, good quality drink water to our customers."

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