Optimatics

optimizing water systems

Water Supply Joint Optimization Study

Optimizing water network infrastructure for future demands

This joint optimization study for the City of Toronto and Region of York identified least-cost water supply and infrastructure solutions to meet projected near-term (2011) and long-term (2031) demands in their combined service area.

KEY POINTS

- Large and complex network with millions of potential improvement combinations
- Optimal mix of new infrastructure and operational settings identified
- Three distinct scenarios optimized

"We used GA optimization to determine optimal future supply infrastructure requirements for Toronto and our neighbour, the Region of York, to the year 2031. The technique proved to be a cost-effective method of evaluating hundreds of variables to determine the best solution. We certainly could not have evaluated a fraction of the options considered using traditional design techniques."

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BACKGROUND

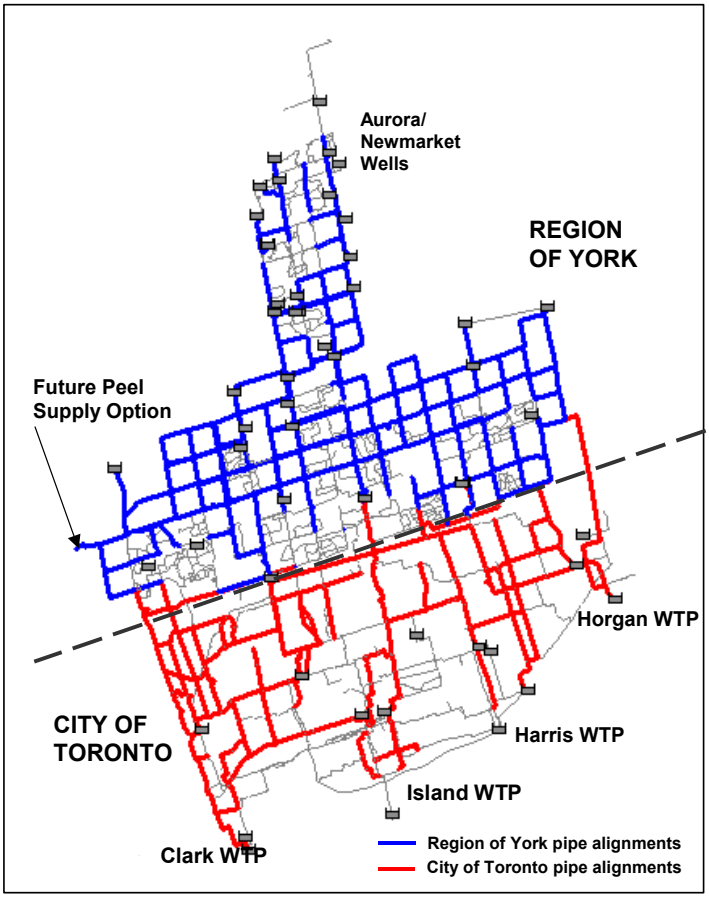
The Toronto system supplies an average of about 1,400 megalitres per day (370 MGD) via nearly 500 km (310 miles) of mains ranging from 150-2,500 mm (6"-100") diameter. Water is pumped from Lake Ontario to four water treatment plants and then pumped on to twelve separate pressure districts. Ground level reservoirs (ten) and elevated tanks (four) provide operating and emergency storage. A Central Pumping Control facility controls pumping operations and system valves. Total installed pump capacity is 9,100 ML per day (2,400 MGD) at twenty two major pumping stations.

A significant portion of the population in the Region of York utilizes water provided from Lake Ontario via the City of Toronto water treatment facilities. The York region system has thirteen interconnection points with the Toronto system. Plans are being made to supply additional water in the future via a new interconnection with the Region of Peel to the west. The Toronto and York Region water systems are thus interdependent, giving rise to this joint water supply study.

THE PROJECT

The Region of York's population is expected to increase from 600,000 to 1.2 million over the next 30 years. In order to meet projected long-term water demands both for York as well as those projected for Toronto, the combined water system will require significant investment in new and replacement infrastructure, as well as an increase in water supply options for York.

Toronto - York decision variables
385 allowable new pipe alignments



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STUDY OBJECTIVE

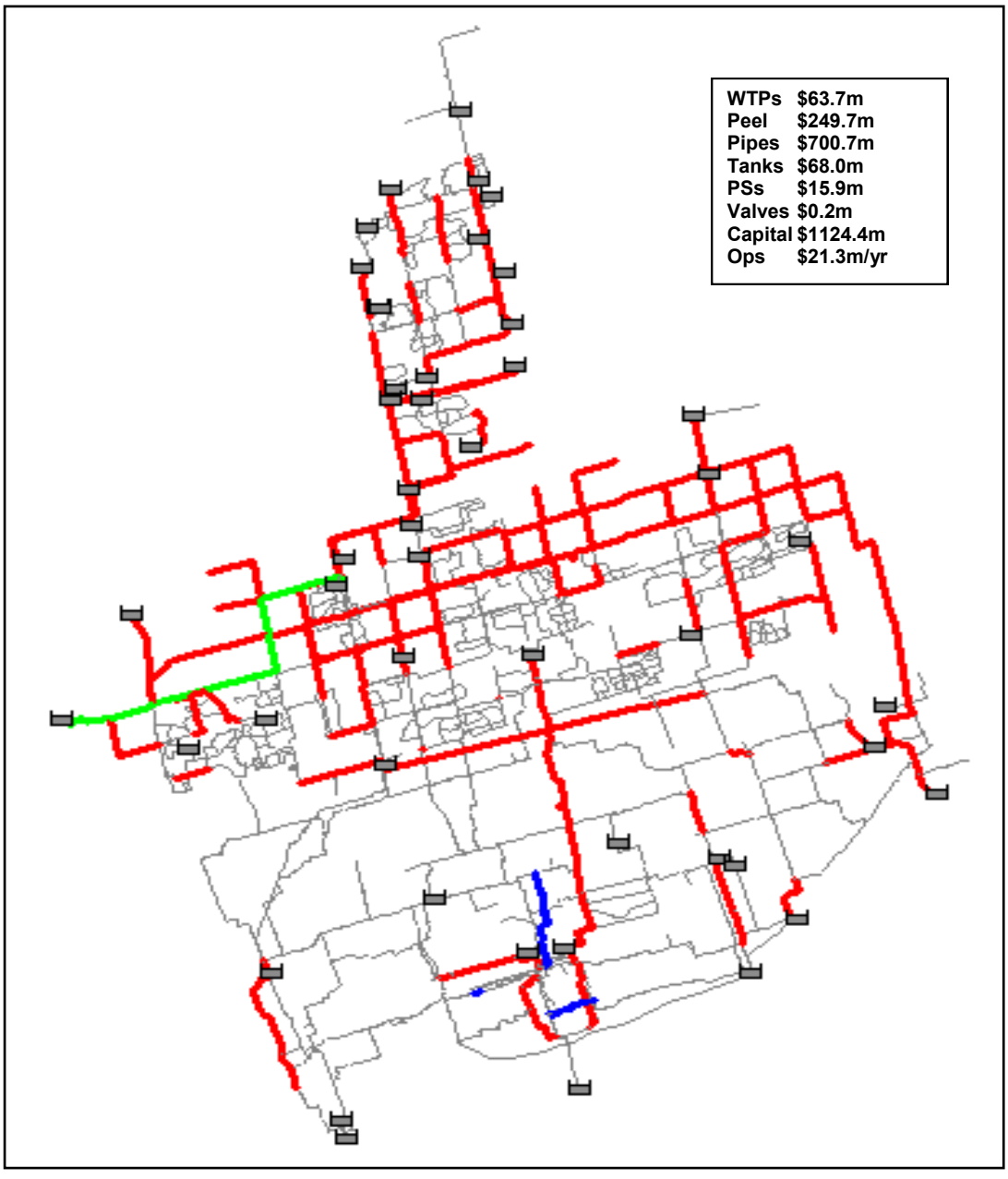
The overall objective was to produce optimized solutions for different demand cases and different supply mixes to minimize both capital costs and operating costs. Using the combined City of Toronto/Region of York hydraulic model developed by Earth Tech Canada, optimization analyses were developed to meet predicted year 2031 peak day demands, year 2011 peak day demands, and mixed 2031 and 2011 demands.

KEY OUTCOMES

The OGA searched for and determined optimal locations and sizes of new distribution pipes, new storage tanks or reservoirs, new or expanded pump stations, and new regulating valves. Operating decisions were optimized simultaneously including production at the four existing or expanded Toronto water treatment plants, flow from the new Region of Peel supply point, and set points for new and existing pumps and regulating valves.

BENEFITS

The final optimized solutions for the three 2011 and 2031 scenarios ranged from US$698-$1,127 million in capital improvement costs. Though no baseline master plan exists for comparison, the OGA optimization undoubtedly achieved capital cost savings for Toronto and Region of York of tens of millions of dollars. In addition, the OGA was very successful in minimizing project life cycle costs, so Toronto and Region of York will be achieving operating cost savings in future years.



Toronto—York
Optimized Year 2031 Solution