CANADIAN CONSULTING ENGINEERING AWARDS 2022

ZONE 4 TRAFALGAR ROAD FEEDERMAINS & ASHGROVE 30ML RESERVOIR

LOCATION: HALTON REGION, ON
CLIENT/OWNER: HALTON REGION
LEAD CONSULTANT: ASSOCIATED ENGINEERING

CANADIAN CONSULTING engineer

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Associated Engineering

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PROJECT SUMMARY

Halton Region retained Associated Engineering to provide design and construction services for 13 kilometres of feedermain and a 30 million litre reservoir. The feedermain traverses challenging ground conditions, an aquifer that provided drinking water, and one of Canada's busiest highways. Associated's design employed four trenchless construction techniques to economically mitigate issues. The Trafalgar Road Feedermain & Ashgrove Reservoir provides sufficient, secure water supply from Lake Ontario to support growth and economic development in Halton Region.

INNOVATION

Located in southwestern Ontario, Halton Region provides drinking water to the City of Burlington and Towns of Halton Hills, Milton, and Oakville. One of the fastest-growing regions in Canada, the Region expects its population of approximately 600,000 will increase to over 1 million by 2041.

The Region developed the "Sustainable Halton Water and Wastewater Master Plan" to expand and improve its water supply to meet future demands. The Region retained Associated Engineering to provide design, contract administration, and site services for the Trafalgar Road Feedermains and Ashgrove Reservoir and Valve Chamber to serve Milton and Halton Hills.

Design of the 13 kilometres of feedermain was complex due to the large diameter infrastructure ranging from 1,800 mm to 3,500 mm diameter, as well as challenging local conditions. The feedermain had to be installed in difficult ground conditions, including cobbles and boulders, alluvial sands with artesian aquifers, and high-water tables. The feedermain had to cross seven creeks, a tributary of Sixteen Mile Creek, transmission gas mains, Canadian Pacific Railway, eight-lane Highway 401, major intersections, Steeles Avenue, Toronto Premium Outlet Mall, and two box culverts through the confined artesian aquifer.

To navigate these complex crossings and ground conditions and minimize impact to the public and businesses, the design team recommended 6.3 kilometres of the feedermain be installed by trenchless construction. While trenchless construction addresses the difficult conditions, it is more costly than traditional open-cut construction. The team conducted extensive geotechnical and hydrogeological investigations and multi-criteria decision analysis to determine the type of trenchless construction to be employed. Based on their broad expertise in trenchless methods, the team designed four different trenchless techniques to address the challenging ground conditions, while minimizing costs.

The 30 million litre reservoir consists of two cells, expandable to four cells and 90 million litres. The two story Valve Chamber consists of valves, piping, and a control system that allows for remote, automated operation of the reservoir and water distribution under present and future water demands. The reservoir is designed with an overflow trough and 2,100 square metre, on-site overflow basin to protect the facility in case of emergencies.

Construction of the Trafalgar Road Feedermain and Ashgrove Reservoir were completed on time and on budget in 2020. The new infrastructure upgrades the water supply in Milton, and supports sufficient lake-based water to accommodate future growth in the Town of Halton Hills and continued growth and economic prosperity of Halton Region.

COMPLEXITY

The team drew upon their knowledge of trenchless techniques and employed proven decision-analysis techniques, selecting microtunneling, earth pressure balance, conventional tunnel boring machines, and auger boring techniques for feedermain installation, thus addressing issues, risks, and balancing costs.

Tunnelling through the confined aquifer with artesian pressure 1.5 metres above ground level posed significant risks and added complexity. Protecting the aquifer was paramount to safeguard the water supply to residents and businesses. Although the artesian pressure was high, active dewatering of the aquifer was strictly prohibited. In addition, active dewatering would not be feasible for the 8-lane crossing of Highway 401. The design considerations for tunneling through the confined aquifer on the 2,470-metre tunnel section and the mitigation measures limited impact on the wells.

Design of the 2,470 metre section of feedermain with two intermediate shafts, one north and one south of the busy Highway 401, presented significant design challenges. The team designed the horizontal tunnel alignment around obstacles while positioning the tunnel shafts outside the travelled road lanes.

The 2.2 kilometre crossing of the Canadian Pacific Railway lines on Trafalgar Road involved significant challenges. The team undertook extensive planning, design, and consultation with CP Rail to develop the solution for this 3,500 millimetre diameter tunnel.

Stagnant water can be a problem in large reservoirs. Adding mixing nozzles helps prevent water from becoming stagnant and unpalatable. Computational fluid dynamics (CFD) analysis was used to develop a mixing nozzle layout to adequately mix the reservoir water under both current and future operating conditions.

SOCIAL AND ECONOMIC BENEFITS

Highway 401, Steeles Avenue, and Trafalgar Road experience some of the busiest traffic in Halton Region, and nationally. By staging the tunnelling from four, off-road, isolated shaft areas and using trenchless methods under the right-of-way, the design minimized traffic impacts, ensuring the efficient and safe movement of people and goods throughout the four-year construction period.

There was no piped water supply along Trafalgar Road, so all residents and businesses relied on groundwater from the aquifer for their drinking water. Thus, it was imperative to develop a design that protected and mitigated impacts to the aquifer during construction. Working in collaboration with subconsultant, Palmer Environmental, we developed a groundwater management plan. Extensive groundwater monitoring was carried out during the design to obtain the baseline quality and quantity for construction. Monitoring continued during construction and mitigation measures were established to ensure that water supply to residents and businesses was not impacted by construction activities.

To foster community engagement, residents and businesses were invited to participate in the well monitoring program. The community engagement program garnered a strong response rate, and supported the success of the well monitoring program.

To reduce the potential safety issues associated with use of chlorine gas for water disinfection, the team designed the rechlorination system at the reservoir using sodium hypochlorite. Sodium hypochlorite is safer for operators to handle, and provides similar disinfection efficacy as chlorine gas.

An outdoor, self-contained, emergency diesel-generator was included at the reservoir to sustain water supply in case of a power outage.

ENVIRONMENTAL BENEFITS

Employing trenchless methods for construction reduced ecological disturbance on creeks and habitat, and the project's overall environmental impacts. The project's carbon footprint was reduced where possible by locating the feedermains within naturalized areas of the Region's right-of-way, thus allowing backfilling with native material and reinstatement with grass surface rather than pavement. Sections of the feedermains were located in a cold water creek that also served as a home to local fish. The creek needed to be protected during construction so as not to have a detrimental impact on aquatic life.

The team collaborated with key agencies, including Conservation Halton, the Ministry of Northern Development, Mines, Natural Resources and Forestry, and internal Halton Region departments to identify sensitive habitat and water ways that could be impacted by construction, adjust locations, and/or develop strategies to mitigate construction impacts.

An extensive groundwater testing program was implemented during design to obtain baseline water quality information for the aquifer. The program continued throughout construction to ensure that activities did not impact water quality nor have any long-term impacts on the aquifer.

The design of the future Zone 5/Zone 6 Booster Pumping Station was both considered and optimized to integrate with minimal future impact to the environment by providing ease of future connectivity now as part of this assignment.

The site stormwater management for the reservoir included Low Impact Development techniques to restrict site stormwater discharge to pre-development flows.

MEETING CLIENT'S NEEDS

Halton Region developed its "Sustainable Halton Water and Wastewater Master Plan" to expand and improve its water supply to meet future demands. The Trafalgar Road Feedermains & Ashgrove Reservoir project is a major undertaking as part of this Plan, intended to improve the water supply to Zone 4 in Milton and support lake-based drinking water service to the Town of Halton Hills.

Associated Engineering collaborated with the Region to successfully deliver the water infrastructure in challenging ground conditions, including an artesian aquifer, busy urban area, and creek, road, rail, and highway crossings. Employing triple bottom line decision-making, the team identified a variety of trenchless techniques (microtunnelling, earth pressure balance, conventional tunnel boring machine, and auger boring) to mitigate risks and minimize construction impacts.

The reservoir is designed with the future in mind, expandable to 90 megalitres to meet future demands with minimal impact to future operations. The reservoir will help to ensure a secure water supply, especially in cases of emergency such as power outages.

The Reservoir improves water supply to Milton, creates redundancy, and supports lake-based water to Halton Hills, which will assure sufficient water supply to accommodate the Town's future growth. The $130 million feedermain and reservoir project was constructed on time and on budget, while minimizing risks to groundwater supply for local residents and business, reducing environmental impact, and minimizing impacts to the travelling public. The infrastructure supports the Regions plan for sustainable water, as well as its planned growth and economic development for decades to come.