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Orleans Watermain Link Horizontal Directional Drilling
Steep ravines, heavily forested next to Hwy 174
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Innovation

Water supply for 100,000 residents of Orleans was at risk. Serviced by a single, aging feedermain, a new 7,000m-long watermain was needed but would cross Green’s Creek, an environmentally-sensitive watercourse. To reduce environmental impacts and expedite construction, horizontal directional drilling was used for a 600m section of 914mm diameter watermain. This was one of the longest, deepest, and largest HDD pulls ever completed in Canada. Stantec provided complete design and construction review services.

The community of Orleans in Ottawa’s east end supports over 100,000 residents. This growing area had been serviced by a single large-diameter watermain installed in the 1970s. A similar vintage watermain in Barrhaven failed in 2011 affecting 11,000 homes and resulting in emergency repairs and months of severe water restrictions. A failure of infrastructure linking the City’s central water system to Orleans would have catastrophic impacts on the City’s ability to meet daily water demands. Recognizing the importance of improving the reliability of water delivery, the City embarked on a major initiative to install over 7,000m of watermain to Orleans. With significant operational challenges, the need to minimize community disruptions, and the crossing of significant features, a unique solution was required for the Orleans Watermain Link project.

The most difficult and risky portion of this major watermain installation was crossing Green’s Creek (an environmentally-sensitive watercourse), as well as the smaller Middle Creek and the Rockcliffe Parkway (a scenic “gateway” in Ottawa managed by the National Capital Commission [NCC]). Early in design, a formal two-day Value Engineering session was held to determine the most effective construction method. Although it was clear that horizontal directional drilling (HDD) would have the least environmental impact and would facilitate approvals, there was considerable concern related to the success of HDD, given the large watermain diameter, length of pull, pipe material, soil conditions and possibility of a pipe failure during or following installation. HDD installation of 600m of large diameter pipe at this depth (20m+) had never been successfully completed in eastern Canada. Construction failure could have severe consequences including environmental impact (potential lethal impacts to fish in Green’s Creek), delays in providing redundancy of critical infrastructure, and risk of large budget overruns.

Engineering involved multiple design reviews and iterations by trenchless specialists at Stantec as well as a detailed risk management exercise to provide assurance that the HDD installation would be successful. The City involved 3rd party reviews by outside specialists to confirm the analyses. By completing the necessary engineering and addressing potential risks, the project team was able to develop a plan and specifications to the appropriate level of detail to ensure that the contractors would be capable of installing the watermain using HDD while meeting all necessary natural, social, and economic environment criteria. The crossing was successfully completed in December 2014. The remaining sections of the watermain were installed through 2014-15.
Horizontal Directional Drilling

Green’s Creek
Complexity

Considerable engineering and design efforts were completed to confirm that horizontal directional drilling of 600m of 914mm diameter watermain would be feasible and to ensure that all identifiable installation risks could be mitigated to an acceptable level. This required the engineers to analyze and determine acceptable design criteria, such as minimum bending radiuses for a DR11 HDPE pipe (selected as 100m at entry pits and 330m through the pull length), frictional forces using different bentonite slurry mixes, expected pull forces and the impact on pipe integrity (over 600m length and 23m maximum depth), soils analysis to calculate the risk for frac-out of bentonite into Green’s Creek with differing installation depths under the creek bed (selected at 10m below the creek bed), staging area limits for connecting piping prior to final installation (alignment along Highway 174 with parts of the embankment at almost a 1:1 slope and a 15m vertical variation), size and availability of HDD drill heads and installation machinery (high groundwater table and homogeneous soft clay soil), and appropriate methods for chlorinating a deep large diameter watermain.

As the timing was crucial once the initial bore was drilled, site conditions and contractor preferences required the designers to continually monitor and update the design parameters to ensure the pipe was being installed per the intent of the contract, and to ensure that the long term integrity of the pipe would not be compromised.

Social and/or Economic Benefits

The 600m HDD section crosses under Green’s Creek and the Rockcliffe Parkway. More traditional construction methods would have triggered multiple approvals by entities including the NCC. Their mandate includes features that support the City’s position as the capital of Canada. For example, the Rockcliffe Parkway is a route commonly used to welcome dignitaries to the residences of the Prime Minister and Governor-General. As such, the aesthetics, accessibility, and availability of this route are critical. NCC approval of open-cut methods could have required 1-2 years before construction could begin.

As an underground construction method, HDD avoided removal or reinstatement of trees and landscaping features as well as traffic impacts due to above-ground construction. The deep construction of the HDD method reduced potential impacts (to schedule and budget) of the weak soils in this area (as evidenced by the 2012 sinkhole on nearby Highway 174).

Advancing the installation also avoided the emergency measures budget needed for the Barrhaven watermain failure including $2M to help residents deal with the outdoor water ban and a special water supply. It was determined that for the Green’s Creek crossing, HDD installation would be less costly and could be completed in far less time than a conventional method would require. Time savings could be realized not only for the construction itself, but for the approval processes that would be required using any non-trenchless methods. It was estimated that installation of this critical watermain would have been delayed by 1.5 to 2 years if conventional open-cut was adopted.
Environmental Benefits

Using HDD for this portion of the watermain installation significantly reduced the impact to the environment compared to any other construction method. Traditional open-cut would have required the removal of major trees and vegetation along the entire 600m watermain path. Similarly, a bridge crossing of the creek would have required significant removal of vegetation and would have long lasting impacts on the natural ecosystem. The steep embankments and proximity to the nearby highway would likely have required a very wide construction easement, affecting not only the vegetation, but also animals and birds in this part of the NCC Greenbelt.

Most importantly, however, was that the sensitive Green’s Creek watercourse was not impacted in any way during construction. The steep, forested slopes of Green’s Creek provide an important wildlife corridor and support a wide variety of provincially and regionally rare species.

HDD ensured there was no impact on local fisheries or downstream fish habitats. By installing the pipe more than 10m beneath the creek bed, the potential for frac-out of bentonite slurry into the creek was minimized (bentonite can be lethal to aquatic life). This was monitored continuously during construction and no evidence of frac-out was recorded. This was the result of careful analysis, and considerable attention to ensuring appropriate safety factors were implemented at every phase of the construction.

Meeting the Client’s Needs

With only one feedermain supplying water to over 100,000 people, the community of Orleans required a unique solution to ensure a reliable and safe supply. Traditional open-cut construction was simply not an option for many areas due to significant natural impact concerns and due to the extraordinary time required for specific approvals. This was especially true for Green’s Creek, where the potential natural environment impacts were so significant and where approval delays could jeopardize the implementation of this critical piece of infrastructure. Proper installation of this portion of the watermain using HDD alleviated the City’s concerns for these two critical items.

The Orleans Watermain Link project is the first of its kind in Ottawa to use HDD for such a major crossing, making this project very unique for the City. While originally concerned about application of this technology for a 914mm watermain, this project has given the City the confidence to consider using HDD for virtually all sizes and lengths of new watermain installation in the City, and to consider other trenchless technologies as preferred approaches. This cost effective approach reduced environmental and stakeholder impacts, led to an easier approval process, provided a redundant watermain system that allows for operational flexibility, and met the long term development needs of the community. As trenchless construction methods continue to develop, projects like the OWL HDD are pushing the envelope on the types of projects that can be successfully delivered with – and benefit from – trenchless technology.
Pulling the HDPE pipe