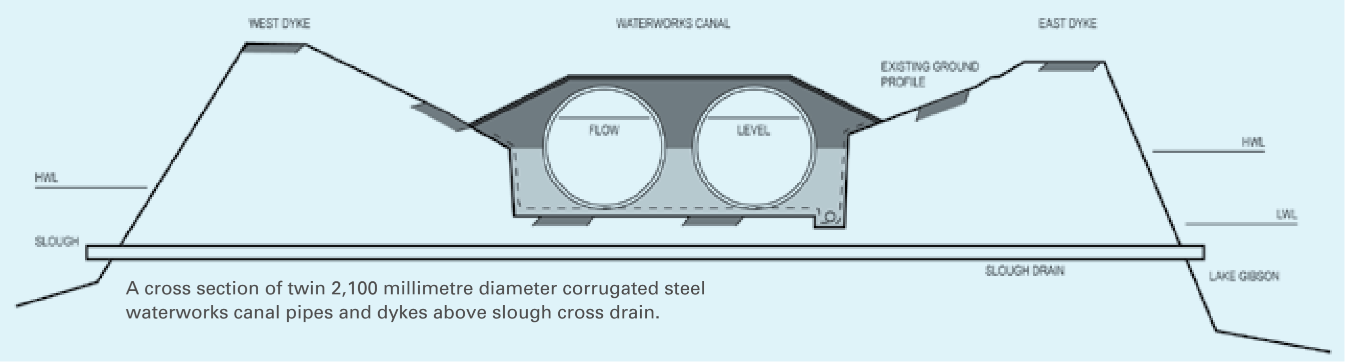
Credit: CSPI

The new enclosed waterworks canal ensures water tightness, isolating raw drinking water from surface drainage and lake water.

Credit: Rankin Construction

With Lake Gibson in the background, installers apply neoprene gaskets and couplers to ensure watertight seals when joining sections of the 2,100-millimetre twin corrugated steel pipes.



Credit: CSPI

A cross section of twin 2,100 millimetre diameter corrugated steel waterworks canal pipes and dykes above slough cross drain.

Real Steel

Corrugated steel pipes key to upgrades for Niagara's waterworks canal.

BY DAVID PENNY

FOR MORE THAN A CENTURY, Ontario's Niagara region has effectively managed massive water volumes and elevation differentials to raise and lower cargo ships, generate hydroelectric power, and provide safe drinking water.

At the turn of the 20th century, the Cataract Power Company of Hamilton Ltd.—predecessor of Ontario Hydro and, later, Ontario Power Generation—constructed a 6.5-kilometre waterworks canal for the City of St. Catharines, which involved carving through hillsides, passing under roadways, and building elevated, bermed channels across the sloughs. Cross pipe drains carried surface water from the hills, roadside ditches, and sloughs into Lake Gibson. Ownership of the waterworks canal was later transferred to the Regional Municipality of Niagara. A 2011 inspection of the slough pipes running beneath the canal confirmed they were nearing the end of their service life and there were concerns regarding the integrity of the earth berms and reliability of the water supply.

Having collaborated on a number of projects over the years, Warren Hoyle of Hatch Consultants in Niagara Falls, Roger Armstrong of St. Catharines-based Rankin Construction, and Frank Mandarin, who works with corrugated steel pipe (CSP) manufacturer Armtec, combined their many decades of experience in soil and water management solutions to put together a comprehensive bid proposal to design and build the required upgrades.

After an intense review of all the necessary critical elevations and hydraulic capacities involved, the consortium proposed using twin 2,100-millimetre-diameter CSP lines at the slough crossing locations. While easily capable of handling the required 60-cubic-feet-per-second design flow, installation of the lower-profile design would also require less excavation below the water table; less backfilling material; and a completed cross section, below the top of berms, to maintain an overflow capture area with minimal visual or physical obstructions.

The pipes were set at an elevation that maintained 600 millimetres of free board above the water to ensure passage of ice and debris, and to provide air space for animals or persons that might accidentally enter the open canal. The Aluminized Type II CSP, featuring 125-by-25-millimetre corrugations, was supplied in eight-metre lengths, which were joined and sealed with closed-cell, neoprene-gasketed corrugated couplers, to ensure water tightness along the 120-to-160-metre-long pipe runs.

To manage external ground and surface water outside of the pipe, the backfill envelope used was a composite design, consisting of a geotextile base layer to screen out fine sediment materials; clear stone to the pipe spring line with perforated pipe sub-drains; compacted native soil to a depth of 200 millimetres over the pipe, and finally, 75 millimetres of topsoil combined with hydra mulch to encourage fast regrowth of indigenous plant life on the berms.

"The success of this project required that we remained diligent in staying focused on a great many details and installation innovations, which, together, enabled us to keep the municipal water supply flowing throughout the entire construction process," explains Craig Copping, project manager for Rankin Construction.

At one location, where even greater water tightness of the trench was required, a bentonite-geotextile clay shield was installed below the clear stone. Reinforced concrete headwalls and toe walls were also constructed at the ends of each pipe run, and clay seals were installed in the backfill, and at cold joints to ensure all of the canal water flowed into the pipes and was unable to enter the backfill zone.

At each slough crossing, a water-tight, 686-millimetre-diameter slough drain pipe was installed, under and across both the canal pipes and berms, to deliver surface water to Lake Gibson. At two locations, depressed elevation of the canal required surface drainage water be carried over and across the canal in elevated corrugated steel pipes. One of these is within the Ministry of Transportation's right-of-way for Highway 406, so the pipe was selected and designed in accordance with the Ontario Gravity Pipe Design Guidelines. Based on the environmental review and 75-year design-life requirements in the guideline, a 1,200-millimetre, polymer-laminated CSP pipe was selected for this elevated cross drain.

The operation of this entire system is driven by an abundance of source water from Lake Erie and gravity. These new system upgrades ensure the canals and pipes are now optimally aligned and elevated to manage differential head pressures of water, which will serve the needs of residents in the Niagara region. WC

David Penny is the executive director of the Corrugated Steel Pipe Institute. On July 1, 2014, David will become the director emeritus of the institute.