OUT OF THE BOX INTO A PIPE:

Use of Large Diameter HDPE Pipe in Place of Channels

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The Harmony Creek Water Pollution Control Plant (WPCP), operated by the Regional Municipality of Durham (Durham Region), is located in Oshawa, Ontario and provides wastewater treatment to the City of Oshawa and the urban areas of Courtice. This WPCP consists of two separate plants (Plant 1 and Plant 2). Plant 1 was constructed in 1952 and Plant 2, in its current configuration, was completed in 1974. Plant 2 was originally intended to be a primary treatment plant, but an expansion in 1974 added secondary treatment processes. Flow from Plant 1 has recently been diverted to the newly constructed Courtice WPCP and Plant 1 has subsequently been removed from service. Plant 2 remains in operation and is required to do so for an additional 15-20 years, when a planned expansion of the Courtice WPCP will allow Courtice to process Plant 2 flows.

However, several of the major pieces of equipment in Plant 2 have reached or are about to reach the end of their service life. Durham Region has embarked on a Major Maintenance Project to upgrade or replace crucial components in Plant 2 to ensure that the plant will continue to operate successfully for the additional 15-20 years.

Since Plant 2 was originally intended to be a primary treatment plant, design of the plant's only primary clarifier did not include a means of diverting flow around the clarifier to facilitate maintenance activities that require a clarifier shut-down. In order to perform such maintenance activities, the options available were a by-pass of all of Plant 2 or construction of a by-pass for the primary clarifier. Since a complete by-pass of Plant 2 would lead to a violation of the plant's Certificate of Approval, it was decided to construct a primary clarifier by-pass. This by-pass will also facilitate the Major Maintenance Project, which includes replacement of the primary clarifier's travelling bridge sludge collection mechanism and will require a shut-down of the primary clarifier.

Typically, concrete channels are used to by-pass such major unit processes, however, the handrails and gratings required as part of a channel would have impeded access to the primary clarifier. Clear access to the primary clarifier will be needed during replacement of the travelling bridge mechanism and any future maintenance of that clarifier. As a result, it was decided to look at using buried pipe for this application, as buried pipe would not require any above-grade structures.

Four types of pipes were considered: reinforced concrete sewer pipe, concrete pressure pipe, high density polyethylene (HDPE), and steel pipe. Factors such as performance, ease of installation, and cost of the different types of pipe were evaluated. Results of the evaluation

Figure 1: 5mm diameter channel on exterior of HDPE pipe

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showed that corrugated HDPE pipe was the best option for this by-pass, as it met the performance requirements for physical fit and its ability to withstand vehicular loadings with minimal ground cover, and it was also the least costly option.

The HDPE pipe chosen was the N-12® WT corrugated HDPE pipe, as supplied by Advanced Drainage Systems Inc. (ADS). This pipe has an annular corrugated exterior for strength and a smooth interior wall to maximize flow capacity. A 1200mm diameter pipe was chosen to accommodate a flow up to 2.0 m^3/s. Although this pipe is classified as a drainage pipe, it can be supplied with bell and spigot joints, with a proprietary sealing gasket to provide water-tight connections. Under normal flows, the HDPE pipe would see gravity flow. However, at times, the flow could be sufficient to fill the pipe. Under such conditions, the pipe would operate under a small amount of pressure.

One of the design considerations with using buried pipe was the pipe's ability to withstand vehicular loading with minimal cover. The area where the by-pass is installed will be the access area for heavy equipment, during replacement of the travelling bridge. The invert elevation of the pipe is 1800mm below grade and the 1200mm diameter pipe provided no more than 600mm of cover over the pipe. According to ADS' literature, with 600 mm of cover, the N-12® WT corrugated HDPE pipe system is capable of withstanding an E-80 load, which is equivalent to loadings used in the design of railway lines.

HDPE pipe was significantly less costly than the other types of pipe. The installed cost of approximately 58 meters of 1200mm diameter corrugated HDPE pipe was $134,000. This is significantly lower than the estimated $250,000 minimum cost of installing a channel or the other types of pipe. The difference in cost was a result of the low supply cost of HDPE compared to the other types of pipes and the relative ease of installation of the HDPE pipe.

A concern associated with using HDPE pipe in this application was that the pipe, once filled with water, might heave due to its minimal weight. This possibility was put to the test during the leak test. Once the HDPE pipe was installed, the area was backfilled and compacted to 98% Standard Proctor Density Test (SPDT). The pipe was then filled to capacity with water and left to stand for approximately 20 hours. After this time, the area was inspected and no heaving was observed.

Installation of the HDPE pipe was straightforward, as expected. Nonetheless, there were two instances where unforeseen events occurred. The first event occurred, when during a heavy, night time rainfall, sand and silt from the banks of an open excavated section of the HDPE pipe flowed into the excavated area. The spacing between the ribs of the corrugations allowed the sand and silt to flow under the pipe and the light weight of the HDPE allowed the accumulated sand and silt to lift the pipe. The excavated area was at a 90° elbow (two 45° bends, with a bell and spigot joint) and the heaving caused the joint to separate. The following morning, when the result of the rainfall was discovered, the excess soil was excavated and the joint was easily reassembled. The results of the subsequent leak test showed that the integrity of the joint was not compromised by the heaving. Nonetheless, it brought to light an important consideration when using the corrugated HDPE pipe; measures must be taken to divert heavy rainfall away from sections of the pipe that have not yet been backfilled.

The second unexpected event occurred during leak testing. When the leak test was first performed, a small leak was observed at the connection point between the HDPE pipe and the newly constructed concrete effluent chamber at the outlet end of the HDPE pipe. The system was emptied, but when workers entered the concrete chamber to repair the leak, they observed

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Figure 2: 5mm diameter channel termination at end of pre-fabricated pipe segment.

water pouring out of a small hole in the corrugated portion of the HDPE pipe. A closer inspection revealed a small channel, approximately 5mm in diameter, that runs along the length of the exterior of the smooth inner pipe and connects all the ribs of the pipe (see Figure 1).

The HDPE pipe is supplied in pre-fabricated segments of equal lengths (bends and manways are supplied separately) and, in each pre-fabricated segment, a 5mm diameter channel runs through the ribs and is terminated and sealed at the last rib, thereby preventing fluid from entering the ribs (see Figure 2). However, in order to fit the pipe segments to the required length, the pre-fabricated segments at the inlet and outlet of the by-pass needed to be cut in the field. Cutting the pipe segments also cut through the small channel, which allowed water to flow from the influent and effluent chambers into the first and last ribs respectively.

Having water in the ribs of the HDPE pipe is not desirable, as it poses the risk that, if the water were to freeze in winter, the resulting expansion might cause the pipe to crack. To remedy the problem, the 5mm diameter channel was sealed using construction foam and then covered with Blueskin® (a high-performance, self-adhering, waterproofing underlayment) to prevent water from entering. Once this was done, the leak between the pipe and the concrete chamber was fixed and the leak test repeated. The system passed the leak test and another important consideration about installing the HDPE pipe was discovered.

At a later date, the manufacturer was asked about the purpose of the small channel and they indicated that the channel is needed in the manufacturing of corrugated HDPE pipe to vent hot air from the corrugations.

For the Harmony Creek WPCP, where a by-pass was needed, but a typical concrete channel was not feasible and ground cover above a buried pipe was minimal, the corrugated HDPE pipe was an ideal solution because it met the design requirements and was the least costly option.

THE STANDARD PROCTOR DENSITY TEST (SPDT)

In placing fill, it is often necessary and desirable to compact the fill to assure that the soil has sufficient shear strength, that it will not settle excessively, or both. In the field, the compaction is carried out by various machines such as sheepsfoot rollers, rubber-tired rollers, etc. These compact the soil to varying degrees, depending on the efficiency of the roller for the particular soil, the number of passes, etc. The density of the soil can be measured in the field by some form of field density test. The Standard Proctor Density Test provides one means of compacting the soil in the laboratory to determine the optimum moisture content and the maximum density.

- ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3))
- ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3))

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