ABSTRACT

The Regional Municipality of Wood Buffalo is in the process of implementing upgrades to the Timberlea sewer system with the Confederation Way Sanitary Sewer Bypass project in Fort MacMurray, Alberta, Canada. With the current trunk sewer nearing capacity, the Confederation Way Sanitary Sewer Bypass project is critical in allowing for future sewer demands and alleviating the risks of flooding in residential neighborhoods during peak wet weather events. Contract 1 was tendered in 2016 with construction commencing in the spring of 2017. The scope comprised of 1,200 m of sanitary trunk sewer with design and construction by various installation methods. The project included 685 m of 750mm diameter sanitary sewer by open trench and 515m of 1200mm to 1500mm sanitary sewer installed by microtunnelling. Three trenchless lateral connections to the existing system were completed on critical grades by pilot tube guided boring in lengths ranging between 50m and 65m.

Challenges during design and construction included complex geotechnical conditions with the presence of oilsand, unstable slopes, and installation near an existing interchange pile wall. Trenchless methods were utilized for critical crossings of existing utilities including oil and gas pipelines and a water supply line, as well as for the crossings of collector roadways including Confederation Way and the Eagle Ridge Interchange. A total of 13 manhole structures and three entry shafts ranging from 3–8 m in depth were also included. Due to the sensitivity of the area and haul routes for 2016 wildfire recovery work, minimal impact construction was required and coordination with stakeholders was critical. This paper provides an overview of the project and discusses key design features and lessons learned in construction to complete this challenging project.

1 INTRODUCTION

The need for the Timberlea trunk sewer upgrade was first identified in 2014 through the Wastewater Master Plan (WWMP) by Associated Engineering. In 2015, the Municipality began construction of Phase 1 of the Confederation Way Sanitary Sewer Bypass Project. Phase 1 traverses through the existing Timberlea neighborhoods and along the top of bank (south of Confederation Way) and terminates at the existing trunk sewer in the north boulevard of Confederation Way as seen in Figure 1. Construction was completed in 2016.

Phase 2 of the Confederation Way Sanitary Sewer Bypass project extends from Phase 1 and includes upgrades to an existing 450mm gravity trunk sewer along the Confederation Way embankment. The existing sewer then transitions into 500mm and 300mm outfall siphons near the Highway 63 overpass prior to crossing Highway 63 and draining into the Waste Water Treatment Plant (WWTP).

Phase 2 was separated into three (3) contracts for phasing purposes. Contract 1 construction was completed in 2017 with minor restoration planned for 2018. Contract 2 is scheduled to commence in July of 2018 with construction completion scheduled for November 2018. Figure 2 shows the proposed alignment for all of Phase 2.

Figure 1. Timberlea Trunk Sewer Upgrades
Contract 1 of Phase 2 was tendered in August of 2016 and awarded to OCL Construction Group. Construction commenced in April of 2017 and was commissioned in October of 2017. Ward and Burke was the subcontractor for Microtunneling and Kamloops Augering was the subcontractor for pilot tube guided boring.

This paper will provide an overview of various design and construction features of the project including:
1. Hydraulic Design
2. Geotechnical Consideration
3. Trenchless Crossings
4. Stakeholder consultation including the Public, Wildfire Rebuild, and Suncor

2 HYDRAULIC DESIGN

As part of the WWMP plan, Associated Engineering developed a PCSWMM hydraulic model which identified system deficiencies and made recommendations for system upgrades.

Upgrades identified in the 2014 WWMP were based on the 25-year return period design storm. However, Phase 1 design was completed for the 100-year return period design storm. For continuity and consistency of the project, Associated Engineering confirmed the rainfall design criteria with the Municipality and adopted the 1:100 year design criteria.

The majority of Phase 2 is gravity sewer with a transition to siphon prior to crossing Highway 63 as seen in Figure 3. Based on the hydraulic analysis for pipe replacement, the recommended pipe size for the gravity sewer was 750mm diameter.

The 1:100 year 4-hour design storm was simulated with the updated hydraulic model to confirm the required Phase 2 upgrades. The model results showing the peak Hydraulic Grade Line (HGL) from the Phase 1 tie-in to the WWTP before and after the Phase 2 upgrades are displayed in Figures 4 and 5.

The Contract 1 portion of Phase 2 had a general design grade of 1%. Drop manholes were included in order to reduce pipe slopes and sewer velocity, with one location requiring a 3m drop structure. For operation and maintenance purposes, the Municipality was hesitant to install a 3m external drop manhole on a large diameter trunk sewer, and instead opted for an internal drop manhole. Due to proximity to a busy intersection and residential housing, the Municipality requested that steps be taken to reduce the odor often encountered with drop manholes.

In order to control odor, as well as H2S levels which contribute to manhole corrosion, an IPEX Vortex™ Flow Insert was installed as shown in Figure 6.
According to IPEX, The Vortex™ uses the wastewater’s own flow energy to suppress the turbulence which releases noxious gases. The spiral flow creates a downdraft which traps airborne gases and forces air into the sewage flow to oxidize odorous gases.

3 TRENCHLESS CROSSINGS

The scope of the Phase 2 Contract 1 included 1,200 m of sanitary trunk sewer with design and construction by various installation methods. The project included 650 m of 750 mm PVC sanitary sewer installed by open cut, as well as the six trenchless crossings as summarized in Table 1 with locations shown in Figure 7.

<table>
<thead>
<tr>
<th>Installation Method</th>
<th>Distance (m)</th>
<th>Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microtunnel (Prospect Drive)</td>
<td>195</td>
<td>750 FRP</td>
</tr>
<tr>
<td>Microtunnel (Suncor ROW)</td>
<td>70</td>
<td>750 FRP</td>
</tr>
<tr>
<td>Microtunnel (Eagle Ridge Interchange)</td>
<td>250</td>
<td>750 FRP</td>
</tr>
<tr>
<td>Pilot Tube Auger Boring (Prospect Drive)</td>
<td>60</td>
<td>375 PVC</td>
</tr>
<tr>
<td>Pilot Tube Auger Boring (Confederation Way)</td>
<td>65</td>
<td>375 PVC</td>
</tr>
<tr>
<td>Pilot Tube Auger Boring (Confederation Way Tie-in)</td>
<td>50</td>
<td>525 PVC</td>
</tr>
</tbody>
</table>

Figure 7. Trenchless Crossing Location

3.1 MICROTUNNEL

The project scope included three microtunnel crossings located at Prospect Drive, Suncor Pipeline ROW and the Eagle Ridge Interchange.

The Municipality indicated in preliminary design that disturbance to roadways would be limited. Open cut installation was not initially considered as Prospect Drive is a busy collector roadway and the existing sanitary line has 5-6 m cover. Furthermore, as the crossing is part of the gravity trunk sewer, the ability to maintain the required grade for a long length is crucial. With this in mind, microtunnelling was the preferred trenchless method.

Similar to that of the Prospect Drive microtunnel, accuracy during installation, grade requirements, length and large diameter made microtunnelling the preferred option for the crossing of the Suncor Pipeline ROW.

The Eagle Ridge Interchange was also complete by Microtunnel due to depth of installation and critical grades. Additionally, the area has a history of slope failure and it was important to the Municipality to not increase the risk of slope failure with traditional open cut methods.

A single caisson entry shaft of 5 m diameter was constructed for each of the Microtunnel crossings. Entrance to each site was via Confederation Way, a busy collector roadway. This also made setup of the Confederation Way sides slopes challenging. Photos of the Eagle Ridge Interchange Microtunnel site setup are shown in Figure 8 and Figure 9. A detail of the Caisson Shaft is shown in Figure 10.
3.2 PILOT TUBE GUIDED BORING

Pilot tube guided boring was the method of choice for the remaining trenchless crossings including connections into the existing system within Confederation Way. This method was preferred due to the critical grade, short distance, and small diameter of pipe.

The pilot tube guided boring connections to the existing system included tie-ins to existing manholes. Two of the three manholes were located within roadways where the contractor was limited to a single lane closure to complete the tie in. A small excavation with trench box was made outside the manhole to act as a receiving pit while limiting work within the existing manhole. The design of the pilot tube guided bore is shown in Figure 11, and exit pit excavation outside the existing manhole on Prospect Drive is shown in Figure 12.

4 GEOTECHNICAL CONDITIONS

In January 2016 Thurber Engineering Ltd. (Thurber) commenced with a Geotechnical Investigation program along the preliminary alignment proposed for the project. Eight (8) new test holes were completed and desktop geotechnical reports were compiled for the preparation of a geotechnical report.

Thurber concluded that the subsurface conditions are quite variable along the Phase 2 alignment and consist of weak interbedded sand, gravel and clay alluvial deposits. The alluvial deposits are underlain by limestone bedrock of variable quality near the bottom of the slope which transitions to glacial deposits underlain by weak to very weak Clearwater shale over interbedded shale and oil sand of the McMurray Formation within the plateau at the top of the slope.

The surface conditions for Phase 2 Contract 1 were relatively flat with subsurface conditions consisting of clay till and sand layers above the clay shale of the Clearwater Formation.

The Clearwater Formation consists mainly of high plastic clay shale with occasional thin interbeds of strong siltstone. The Clearwater clay shale is strong when it is confined but is highly susceptible to erosion and slumping and is the origin of the colluvial deposits draping over the valley slopes.

The surface conditions for the Eagle Ridge crossing are steep slopes parallel to Confederation Way. The slopes consist of unstable colluvium above interbedded...
sandstone and clay shale. Below the clay shale is the McMurray Formation. The McMurray Formation generally consists of interbedded clay shale, oil sand and siltstone. Minimal oil sand was encountered during the Eagle Ridge Microtunnel and impacts on installation were limited to hauling and disposal of microtunnel process water and cuttings to accepting facilities.

The construction of the Eagle Ridge Interchange included the construction of stone columns and piles to stabilize the structure. However, the area around the Eagle Ridge Interchange is known to be unstable and has visible slope failures. The Microtunnel crossing was designed to maintain a minimum 1 m clearance from the piles and exit past the areas of instability. Plan view of the crossing is shown in Figure 13.

Figure 13. Alignment of Eagle Ridge Interchange Crossing.

5 STAKEHOLDER ENGAGEMENT

The Communications and Stakeholder Relations Department for the Municipality has three branches:

1. Stakeholder Relations
2. Strategic Communications
3. The PULSE Line

Stakeholder Relations works with other externally facing departments to engage with and gather input from the public. This branch promotes relationships between the Municipality and its stakeholders, which includes residents, communities, governments, and industry.

Strategic Communications provides information to residents and employees. This branch provides strategic communications counsel, advertising, media relations, issues management, creative services, as well as online content development and management.

The PULSE line is available to Regional Municipality of Wood Buffalo citizens 24-hours a day, seven days a week both online and over the phone. This service offers support for all inquiries, requests and complaints.

The Communications and Stakeholder Relations Department is heavily involved with construction projects while the degree and type of stakeholder engagement is done on a project specific basis.

5.1 Design

Throughout the preliminary tasks stage of the project, coordination and involvement of key internal stakeholders was completed for the purpose of defining the project implementation and evaluation of the upgrade alternatives. Table 2 includes a list of stakeholders along the Phase 2 alignment.

Table 2. Stakeholders Along the Phase 2 Alignment

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Contract 1</th>
<th>Contract 2&amp;3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional Municipality of Wood Buffalo</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Engineering</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sustainable Operations</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Underground Services</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Facilities</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Private Lease Holders</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Enbridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suncor Oil</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Public Infrastructure Leases</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Alberta Transportation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Municipal Outfall</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Municipal Powerline</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Municipal Waterline</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Municipal Sewer</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Shallow Utilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atco Gas, Atco Electric, Shaw, Bell, TELUS</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

In the early stages of design an open house for the public was held. Information was presented to residents including the necessity of the project and the anticipated construction methodology. The open house had few attendees and it was subsequently determined that other methods of stakeholder engagement would be completed during construction.

5.2 Construction

The proximity to Confederation Way played a significant role in the project. As it was a busy collector roadway in the neighborhood of Timberlea, careful consideration and management was required to protect property and ensure safety during construction.

The overall impact of construction activity including noise and heavy equipment work were mitigated with vibration monitoring. During active work hours, vibration-monitoring equipment was setup near residential homes, and at the end of each day the results of monitoring were reported back to contractors.
As part of PULSE, the Municipality had a website with construction update maps, notices, and videos of current projects which residents can access at their convenience. The extended efforts to communicate with stakeholders have led to positive feedback, and fewer complaints during construction.

5.3 2016 Wildfire

The 2016 Fort McMurray wildfire had an impact on this project as the Municipality had to minimize traffic disruptions on the Wildfire Rebuild Haul Routes of Stone Creek. Stone Creek is within the residential neighbourhood of Timberlea which had 379 structures destroyed in the Wildfire. Offloading of materials and equipment was restricted to single lane temporary closures as total closure would have impacted contractor’s completion of wildfire restoration works.

6 PROJECT UPDATE

Contract 1 of Phase 2 is substantially complete with minor restoration and tie-in commissioning to be finished during the summer of 2018.

Contract 2 of Phase 2 is tendered with construction scheduled to commence in August 2018. Contract 2 includes two 1200mm Microtunnels of 185m and 260m lengths down the Confederation Way Slope as well as the construction of a 12 m caisson shaft. Construction is scheduled for completion in November 2018.

Contract 3 is scheduled for tender in late 2018 and will include a triple barrel sanitary sewer siphon trenchless HDD crossing of Highway 63, open cut connections, and tie-in to the WWTP.