North American Society for Trenchless Technology (NASTT)
NASTT's 2023 No-Dig North Show

Edmonton, AB
October 23-25, 2023

WA-T1-04

Live Sliplining in Surrey

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1. ABSTRACT

Metro Vancouver (MV) is a regional district in the western province of British Columbia, Canada that serves 21 municipalities and one Treaty First Nation with a population of about 2.7 million. MV owns and operates 530km of sanitary sewers ranging in size from 200mm to 3,000mm, which only accounts for about 10% of all the municipal sanitary pipes in the region. Condition assessments using video inspections are carried out a rate of 5% per year which may not sound ambitious, at a cost upwards of $25,000 to inspect and interpret small sections of pipe it is a long-term program. Smaller immediate-needs issues are dealt with as maintenance items, larger issues and upsizing projects are capitalized.

Typical rehabilitation methodologies involve bypassing a sewer to allow the process to be completed. Live flow sliplining allows the sewer to continue to function within the existing pipe during the rehabilitation work. This process substantially lowers the risk of spills and eliminates the significant costs associated with bypassing a trunk sewer which can be up to 70% of the project costs depending on location, environmental and social setting, duration of the bypass, pipe size, and whether the pipe is gravity or pressure. Regardless of the specifics, bypassing will always add risk and cost to the project.

Being open to new solutions and technologies MV opted to rehabilitate the first section of a critical sanitary interceptor using a glass reinforced pipe liner (GRP) which would be installed under live flow conditions. This paper describes the method selection, tender considerations, installation and lessons learned in live flow sliplining.

2. INTRODUCTION

Regional Districts (RDs) are a unique governing feature in British Columbia (BC) that date back to the 1960's. There are 27 RD's serving 161 BC municipalities. A simplified explanation of the division of responsibilities is to consider the RD as the wholesaler and the municipalities as the retailers. The municipalities serve the general public while the RDs serve municipalities in all issues that transcend municipal boundaries including drinking and agricultural water, air quality, parks, economic development, liquid waste and solid waste. The RD’s also offer an administrative framework for moving regional interests forward and for managing large projects or programs such as a community centre that benefits multiple municipalities or a fire protection program that benefits a region.

The project under discussion is a 220m section of 1,525mm diameter concrete sanitary sewer pipe installed in the 1970’s. The North Surrey Interceptor is a major sanitary conveyor in the system serving one of the largest catchment areas in the region that includes North Surrey, Pitt Meadows, Maple Ridge and part of Delta BC, or, a population of about 150,000.

The idea that such a large section of sanitary pipe could be rehabilitated under live flow conditions resulted from MV staff attending conferences and trade shows (such as this No Dig) that provided opportunities for making important connections with other municipal staff in Ontario and California where such projects have been successfully completed.

After careful consideration MV decided to try this particular section as a pilot project; it would be the first live flow sliplining installation in the region and likely in the province of BC. Request For Qualifications went out in 2019. Four contractors responded, two pre-qualified. The pre-qualification documents were weighted heavily on the proposed project team, while the tender documents were later evaluated on price.

PW Trenchless Construction Inc (PW) scored high on the team evaluation as they committed to retaining on-site expertise and training from Mladen Buntich Construction Co. Inc. of California who have much experience in this area of pipe rehabilitation. PW’s local presence gave them a benefit and also the fact that they had completed several GRP projects for storm sewer rehabilitation around BC. Using GRP in live sanitary flows would be new to all involved.

3. PROJECT OVERVIEW & PREPARATIONS

This stretch of sewer is unique even for a gravity sewer in that it experiences some of the highest surcharge levels - up to 4m over the crown - in the region which materialize during times of high inflow and infiltration (I&I). It often operates under pressure which is not ideal for gravity sewers. In all cases, sewers that pressurize during wet weather events require a rehabilitation approach that carefully manages the risk of working with sanitary flows under pressure, and that will also result in a very robust final product.

The existing pipe was a 1,525mm reinforced concrete pipe installed circa 1970’s. Severe corrosion was discovered in some parts of the pipe, particularly at the crown. This type of corrosion is caused by bacterial processes that start during anerobic conditions when Hydrogen Sulfide is released into the flow. When it is exposed to air it turns into Sulfuric Acid which corrodes the concrete and eventually the rebar causing deterioration which could lead to catastrophic failure. While the term ‘catastrophic’ might sound dramatic, the consequences of a collapse of this pipe, with its occasional 4m of head would cause a sewage spill with extremely significant impacts, especially as there is a fish bearing water channel at the western limit of the project.

The material chosen for this project was supplied by Channeline International - GRP Structural Lining Systems. It has a 1.5mm thick smooth corrosion resistant inner lining. Having a smaller overall inside diameter of 1,375mm, the assumption is that because there is a smaller cross-sectional area that the capacity will decrease. In this case, when comparing the smooth surface of the GRP to the rougher surface of the corroding concrete that creates turbulence the capacity of the new pipe will in fact increase. Of course, the existing flow capacity was also diminished by the four decades of accumulated sediment in the existing pipe. The GRP liner outside diameter of 1,420mm is treated with a bonded graded aggregate to enhance adhesion to the annular grout required after the liner installation is complete. Figure 1 shows the smooth inside and the rough outside of the GRP liner.

Figure 1 – GRP Liner - Note the bonded brown aggregate outside and smooth inside

The construction services contract was awarded in March 2020 and scheduled to be complete by July 2020. The construction window for this pipe rehabilitation project was mid-June to mid-September when the weather in Greater Vancouver has predictably long dry periods with reduced or no additional I&I.

After the contract was awarded, the existing pipe had to be measured internally and its alignment checked. The pipe then had to be manufactured and shipped so even without the Covid pandemic the completion date of July 2020 was unrealistic. The custom manufactured pipe takes a minimum of 10 weeks from time of order to the delivery. In March 2020 at the start of the global Covid pandemic, supply chain delays were occurring around the world. The GRP deliveries started arriving on site in September 2020 at which point the work could not be started. The lower section, or the western limit of the project was close to a fish bearing creek that has specific time restrictions or 'fisheries windows', and the fall in Greater Vancouver is typically very wet resulting in high levels of I&I.

Another unique challenge on this project was the requirement to create both temporary and permanent solutions to the presence of a 10m Hydraulic Grade Line (HGL) resulting from I&I. The normal solution at the access pits is to shotcrete the walls of the pits to create a sealed, but open topped pit. Because in this case with a HGL of 10m and a pipe invert of 5m, a method of containing the material at a HGL of 10m or a pressure of 7psi had to be built into the system. Rather than build a 5m high containment structure around the entrance pits a steel pressure chamber had to be designed, built, and installed at each of the insertion pits.

The lack of knowledge of the possible fragility of the existing pipe dictated that no part the existing pipe could be used as part of the containment structure. The pressure chambers had to be constructed independent of the existing pipe and use only its own weight to counter the expected surcharges. This meant that the chambers had no mechanical connection to and yet had to seal to the existing pipe. This included sealing around the pipe including underneath the pipe as the westernmost sections of the pipe is on piles and there is potential for underground voids.

No cuts into the existing pipe were allowed until these chambers were fully operational. The watertight chambers were designed to withstand surcharges of up to 7psi with lids that could be removed and replaced in 30 minutes. The chambers were large enough to allow a worker to work from inside the chamber while cutting the existing pipe. The sealing chambers were installed in 2020 but the pipe installation work could not begin until the spring of 2021. Figure 2 shows the flow control chamber.

Figure 2 - Water tight flow control chamber with lid that can be removed or replaced in under 30 minutes.

4. INSTALLATION

As the existing pipe is about 50 years old the invert had a considerable accumulation of deposits ranging in size from silt to small rocks that had to be dredged. Debris from previous repairs was also discovered during the dredging all of which had substantially reduced the available cross-sectional area restricting the flow, see Figure 3. During the dry weather, the flows varied throughout the day with the morning rush from the Fraser Valley hitting the site around mid-morning and moderating later in the afternoon. There were four main sections of pipe on this project that all required slightly different dredging techniques and preparation.

Figure 3 - Dredging and debris removal

Section 1 starting at the east extent of the project was a 15m long straight section from a sewage receiving chamber to an intermediary pit. The 15m of pipe was pushed from the intermediary pit east to the chamber. Figure 4 shows an insertion pit.

Figure 4 - an insertion pit with next pipe ready to go in.

Section 2 was a wide radius curved section of about 75m. For the joints in this section to be watertight, very small pipe sections of about 0.6m long were used. By using the short sections around the curve, the integrity of the joint gaskets was maintained. This section was pushed west from the same intermediary chamber to an existing manhole. This sliplining process meant that the joints opened and closed as the sliplined pipe advanced through the existing host pipe. The work had to be carefully managed to ensure that all the joints took the deflecting opening and closing equally otherwise an errant pulled joint could have had made the grouting work at the end of the installation impossible. The joint integrity was checked by video after the installation was complete as the final step before grouting.

Section 3 was a straightforward 100m run from manhole to manhole.

Section 4 was 19m run from a manhole to the west extent of the project where the creek is located. There the new pipe had to meet and creatively blend in with the flattened creek crossing chamber that is founded on timber piles. This chamber was only 300mm high and 3000mm wide and acted as a syphon. The new pipe was installed as far as it could go but there was no opportunity to install a bulkhead by conventional methods at the creek, so a small window was cut in the crown of the existing pipe. Then a bulkhead was installed from the small window at the crown of the existing pipe.

Once the chambers were in place and the existing pipe cleaned out the installation process was straightforward. The 2.4m standard sections were lowered into the chamber and pushed towards the direction of the installation, then held in place while the next piece was brought in. The GPR pipe sections were lowered into the work area with the upstream end of the section slightly lower than the downstream end so that when the flow pushed on the pipe it would push the pipe down rather than up. Once the next piece was lowered it was held in place and then pushed into the bell of the previous section of GPR pipe section. For this project the pipe was placed directly on the invert of the existing pipe, no spacers were used. Finally, the total pipe string was pushed home as shown in Figure 5.

Figure 5 - The new liner in place during a moderate flow

5. HEALTH AND SAFETY

Although this was not a confined space, while working directly in the flow of the sewage, some additional health and safety measures were required. The crews working in the chambers, access pits and manholes had to wear full protective rubber clothing. Fresh air was continually pumped into the area to displace the noxious fumes and crew members working in the chambers were all equipped with fall arrest in the unlikely but possible event of falling into the sewer interceptor and being carried downstream. A physical barrier was added on the downstream end whenever possible as an additional safety measure.

6. LESSONS LEARNED & CONCLUSIONS

1. Because of the resistive nature of the Gel coatings, GRP liner pipes are considered to be highly suited for rehabilitating sanitary pipe. GRP is highly resistant to Hydrogen Sulfide, and other corrosive gasses and chemicals found in sanitary sewers.

2. A majority of live GRP sliplining has so far been performed in dryer locations such as Southern California where the issues of surcharging and high I&I flows are not as common as in BC's lower mainland. In the southwest corner of BC, a five times increase in flows are common in the winter and can raise the HGL 3m to 4m above the pipe crown. Therefore, manholes must be designed to contain these surcharges and the installation process must be adaptable to these sudden increases in surcharge. Experts brought in from Southern California as helpful and knowledgeable as they were with respect to lining, installing and grouting, were unprepared for the I&I that occurs in this region. Local knowledge is still important! Chambers that can be sealed and watertight within 30 minutes will never likely be required in Southern California.

3. The project went well with no major setbacks once the materials were on site. This was a first in BC, a pilot project meant to rehabilitate an aging and deteriorated section of an important collector pipe, but also an important training and learning opportunity for all stakeholders. Given the success of this pilot project live flow sliplining has already being considered for future projects in the region. On the next project the owner will work more closely with the manufacture to have secure hold down strap systems incorporated into the manufacturing process.

8. REFERENCES

June 9th, 2023 Site Visit & follow up discussions
David O'Sullivan, President – PW Trenchless

June 22, 2023 In person interview & follow up emails
Ania Palwelec, P. Eng. Project Manager – Metro Vancouver

June 23, 2023 In person interview & follow up emails
Mike Jokic P. Eng. Lead Senior Engineer - Metro Vancouver

June 23, 2023 Phone interview & follow up emails
Ravi Grewal, P. Eng. Lead Senior Engineer – Metro Vancouver

June 14, 2023 Phone call & follow up emails
Andy Sherwin, Technical Sales Director
Channel Line GPR Structural Lining Systems

2022 – *Live Sliplining of the North Surrey Interceptor* -
David O'Sullivan – NASTT-BC *Y-Dig?* Magazine

2020 – IFC Drawings – Metro Vancouver