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NASTT British Columbia Chapter

BC's Magazine for Trenchless Construction

2022

First Live Sanitary Sliplining

Taking A Shot in Richmond

BC Carbon Calculator

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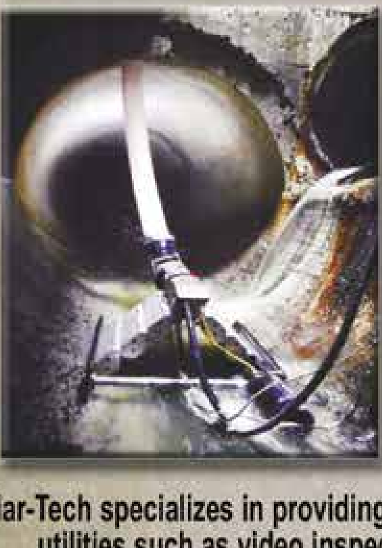
Traffic Plans, Lane Closures & Flagging Services



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MESSAGE FROM THE NASTT-BC CHAIR

Sam Eichenberger, P.Eng., NASTT-BC Chair

Hello NASTT-BC Chapter Members, I have had the pleasure of being on the board of directors of the British Columbia Chapter of NASTT since late 2019. Unfortunately, due to a certain global pandemic, my first few years on the board were quite quiet in terms of education sessions and conferences. I am happy to say that in November of 2021, we were able to host the No-Dig North show at the Vancouver Conference Center. The show was fantastic, and you could feel in the room that sponsors, exhibitors, and attendees alike were ecstatic to finally be back out in public and sharing knowledge about the trenchless industry.

We hosted our AGM at the closing of the show, where we were able to thank our board members for all their hard work and effort as volunteers. After thanking our departing members and welcoming our new board 2022-23 term we immediately got to work planning our next year and setting goals for our future events. We currently have a full board, but we are always looking for ways to involve members of the community especially young professionals, so please do not hesitate to contact your local chapter to find ways to get involved!

Our first event we are excited about in 2022 is the Trenchless Road Show in Kelowna at the Delta Marriot Grand Okanagan Resort. The TRS is hosted by NASTT-BC and CATT (Centre for Advancement of Trenchless Technologies) and is expected to be a great show with two full days of technical sessions, a day of training courses, and multiple networking events. Moving forward, the CATT board has decided to dissolve and join with CETT (Consortium for Engineered Trenchless Technologies) to form the Canadian Underground Infrastructure Innovation Centre (CUIIC) at the University of Alberta. NASTT-BC anticipates future partnerships with CUIIC and look forward to seeing their impacts on the Trenchless Industry.

You may be reading this magazine at the show! Feel free to track me down and say hello! Our Vice-Chair Robert Epp has been closely involved with the planning of this event as well, keep an eye out for him at this year's TRS.

Beyond the TRS we are also looking forward to the next No-Dig North Show. Mark your calendars for October 17-19th, 2022 and join us with all the NASTT Canadian Regional chapters in Toronto. We are expecting big things for Toronto, and we are projecting over 1000 attendees! Don't miss this must attend conference promoting the Canadian trenchless industry.

Outside of conferences, in recent years the BC Chapter developed the Carbon Calculator to allow municipalities the ability to gain carbon credits through the use trenchless technologies. The credits system was offered through the provinces Climate Action Revenue Incentive Program (CARIP) but has recently had a change in legislation. The board of NASTTBC will be following this closely and will be updating our followers on new legislation on nastt-bc.org.

Now in closing, I would like to specifically thank our Past Chair, Ophir Wainer, for his years of service leading the board. Ophir has a passion for the industry, and it shows in his dedication to multiple non-profit organizations promoting trenchless technologies. Thank you, Ophir!

Sincerely,

Sam Eichenberger

Sam Eichenberger, P. Eng.

MESSAGE FROM NASTT CHAIR

Alan Goodman, NASTT Chair

Our Chapter Members and Volunteers are Crucial to our Society

Hello NASTT-BC Chapter Members. The trenchless industry grows stronger every year. Even in the pandemic our membership and regional chapters moved forward to educate the public. It's amazing when you look back at what we were able to do during these challenging times. Now we are excited to start looking forward to the future! We've led the industry in safely meeting face to face. As an organization and an industry, we successfully met in Orlando last spring, in Vancouver, BC for No-Dig North this past fall and now in Minneapolis for the NASTT 2022 No-Dig Show. Not to mention the extremely successful Northeast Trenchless Conference held in West Point!

The NASTT 2022 No-Dig Show being held in Minneapolis, Minnesota, April 10-13 is anticipating 2,000 attendees and nearly 200 exhibitors. There are many new features we plan to roll out including enhanced educational forums, more networking opportunities and expanded exhibit hall time. Our industry is constantly growing in innovative ways and the No-Dig Show is a representative of our industry. We are excited to bring new value and educational experiences to you.

Mark your calendars for October 17-19 for the third annual No-Dig North in Toronto. The NASTT Canadian Regional Chapters, including the BC Chapter, come together with the entire trenchless industry for two days of training courses, technical sessions and networking opportunities. Attendees can choose to attend the full conference, do one day, or attend the exhibit hall only. If you do business in Canada, this is the must-attend trenchless event. The full agenda will be available soon.

NASTT's mission and vision are "to continuously improve infrastructure management through trenchless technology" and "to be the premier resource for knowledge, education, and training in trenchless technology." With education as our goal and striving to provide valuable, accessible learning tools to our community, one of the things of which we are most proud at NASTT is that even during uncertainty we have been able to grow. Recently, we welcomed our latest Regional Chapter to the NASTT family and completed our representation of the entirety of North America. NASTT was so excited to announce that we now have our first chapter in Mexico!

> *We are a Resilient Industry!*

For more information on our organization, committees, and member benefits, visit our website at www.nastt.org and please feel free to contact us at info@nastt.org.

We look forward to seeing you at a regional or national conference or training event soon!

Alan Goodman

NASTT Chair

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Live Sliplining of the North Surrey Interceptor

First Live Sanitary Sliplining Project in BC

By: David O'Sullivan, PW Trenchless Construction Inc.

LIVE SLIPLINING OF THE NORTH SURREY INTERCEPTOR

This is a brief overview of the first live sanitary sliplining project in BC.

- We were awarded a contract with Metro Vancouver in March 2020 to slipline a 220m of 1525mm Diameter trunk sewer in North Surrey.
- The pipe had suffered some abrasion from a steep sewer connection from the Guildford area of Surrey as well as Hydrogen Sulphide corrosion on its crown.
- Our proposal was to slipline in a GRP of 1430mm OD which gave us an annulus of 100mm in total.

The project was in 4 sections going from upstream.

- **Section 1** was from a chamber that received sewage from a twin syphon and that section was 15m long and straight from the chamber to an intermediary pit.
- **Section 2** turned out to be curved with joints pulled for 100m, from that intermediary pit to a manhole, more on that later.
- **Section 3** was a 100m straight from manhole to manhole.
- **Section 4** was 19m from a manhole to a blind end.

This was a first for Metro and as the pipe surcharged during storm events the operations staff were very cautious about any openings to their system. We were not allowed to remove the top of the pipe and attach a half steel pipe as a temporary patch, as we could not install any bolts into the existing pipe. Our containment structures had to be independent of the existing pipe. The pipe can have a HGL of 5m over crown in extreme storm events.

Because of delays due to Covid etc. we did not receive pipe delivery until late August which meant that the sliplining had to be delayed until 2021. The sealing chamber were installed in 2020 and all preparations made for the summer of 2021. In June of 2021 the pipes were cleaned, and the GRP installed and grouted into place in July 2021. There were some manhole details remaining, but the project was essentially finished.

On **Section 2** as all the existing pipes were laid in a curve it meant that we had to push our GRP around a corner.

There were concerns that because we expected the joints to open and close as the individual GRP pipes negotiated the numerous 2.4m tangents that some joints would open more and beyond the gasket. We were successful and all performed as required.

We also had 3 pre-manufactured miters to install just short of 2, 3 and the chamber.

On **Section 4** we were pushing down stream and to a flattened pipe where it went under a creek. This meant that we had to be innovative in the bulkhead to allow grouting as it had to be completed remotely. It is normal to install bulkheads from an entrance pit.

2. ACCESS CHAMBERS

These were required to allow us access and to then allow the sealing of the pipe structure when work was not being carried out. As already said, we had to be able to withstand surcharges of approx. 7psi.

We were able to remove and replace the lids in 30 minutes.

Cleaning process

As this was a 50-year-old sewer it had deposits in the invert that had to be removed to allow the sliplining to proceed. This was completed with a dredge being pulled back and forth numerous times to remove all existing gravels and rocks. These would have hindered any slipline efforts. These photos show the conditions we had to work in to install the sewer. During this dry weather the flows changed depending on the time. The morning rush hit us about 10 to 11 am and then moderated in the afternoon.

Pipe installation process

We spoke about some of the challenges in installing around a curve and the blind lowest section. The remaining installation is routine, installing the pipe one at a time. Each pipe is installed and held in place while the next is installed and pushed into the previous pipe. Then the whole column of GRP is advanced to allow the next pipe to be installed.

Installation process

We spoke about the curved section, but the basic process is as follows.

A pipe is laid into the existing channel and pushed into the existing pipe until about 200 mm is exposed. This GRP pipe is then blocked-in place to hold it. The next section of GRP pipe is then installed and pushed into the bell of the first GRP pipe. The blocking is then removed and the whole stick of GRP pipe is pushed into place.

This process is continued until the next pit is accessed.

We then install bulkheads to seal the annulus between the GRP and the host pipe, then we proceed with grouting and create monolithic structure.

The last segments of GRP are installed, and a concrete cap or manhole is installed to protect the GRP pipe.

Metro Vancouver has 153km of trunk sewers some of which is displaying symptoms of H2S attack and in need of rehabilitation. This is a very effective way of pipe rehabilitation. A more conventional method of bypassing and then rehabilitating an isolated pipe is a very expensive operation and very high risk.

A proper bypass system can be well over 50 percent of the costs of these jobs. Eliminating that makes sense.

ABOUT THE AUTHOR:

David O'Sullivan emigrated to Canada having trained in Civil Engineering in Ireland in 1978. He worked in consulting for 6 years before switching to contracting. He managed P Baratta Construction for 12 years before founding PW Trenchless Construction Inc, a BC contracting company specializing in trenchless projects in 2000. David has over 35 years experience in the use of many trenchless methods. PW Trenchless primarily utilize the two trenchless procedures of pipe bursting and slip lining. PW have performed several "bursts that were firsts" in North America over the years. David also spent almost 12 years in the development and revision(s) of a protocol to determine reduction in GHG emissions when a trenchless method is used. This protocol, the BC Carbon Calculator, has now been vetted and approved by the Province of BC.

Taking a Shot in Richmond

By: Tonia Jurbin, P.Eng.

Like a 7th game of the Stanley Cup Finals, this rehabilitation attempt in Richmond, BC was a nail biter down to the end! The challenge was to repair a breach in a 16m long 350mm diameter fiberglass sanitary sewer that connects a pump station to a manhole. The crown of the breached pipe was sitting on the on the pipe invert along with a considerable volume of backfill that has been migrating from the surrounding area into the pump station about 1.5m away from the breach. The City of Richmond installed a temporary bypass while they scrambled to explore repair options.

It would be a simple matter to repair the breach using open trench methods were it not for the multiple services between the failed pipe and the road surface about 5 metres above it including but not necessarily limited to two twin Metro Vancouver 900mm trunk sewers, a 600mm storm sewer, a 300mm watermain, a 300mm sanitary forcemain, a Fortis gas line and possibly a BC Hydro distribution cable.

Also noteworthy on the list of challenges, the original piece of pipe that needed repairs enters the pump station offset from the centre, almost at the edge of the station resulting in an awkward confined space to work in. More importantly the site is a mere 400m away from the bank of the Fraser River resulting in a high and fluctuating water table as the Fraser River is very much tidal in Richmond, BC.

The city received estimates in the order of $1.5 to $2 million for a conventional repair. With a long track record of successful and innovative pipe rehabilitation projects in their portfolio the City of Richmond invited PW Trenchless to sharpen their pencil and come up with a proposal for a less expensive, less disruptive solution.

David O'Sullivan of PW Trenchless proposed attempting the repair by sliplining and microbursting a new 300mm diameter PVC pipe using about 20 pieces of custom-made 750mm long sections with a modified bell and spigot joint, reminiscent of an old-fashioned woodworking tongue and groove joint to avoid having to fuse the pipe sections under wet confined space conditions. To ensure good connections between the pipe sections after installation, a 16.4m long ready rod from the newly installed sections to the MH was added to act as a clamping devise to hold the new pipe sections together while giving the glue a chance to cure.

Installed 750mm pipe section with ready rod 'clamp'. Note 'awkward' position of pipe entering pump station

Depth of the repair work about 5 metres down

Custom 750mm PVC sections - note the modified bell and spigot joint

The PW Trenchless estimates came in at about $200K. "This is a unique situation and we hope this methodology will work, if it does, great, if it doesn't, we haven't lost anything, we will have learned something, and we will propose something else so we'll give this proposal our best shot." To slide the new pipes into the existing failed pipe, PW had a specially designed sliplining head fabricated by Charlie Smith Machine Works Ltd of Surrey, BC. This device was pushed into the failed pipe from the pump station and acted as a guide or a casing for pushing the fabricated pipe sections from the pump station while at the same time being pulled by a cable through the pulling eyes from the manhole 16 metres away.

Two issues were at play that caused this repair attempt to fail. First the sliplining head got hung up and the job had to be shut down. David suspects that the bottom leading and cutting edge of the sliplining head dug itself into the existing much weakened fiberglass, or, had possibly become stuck on the some of the backfill inside the failed pipe that was once pipe bedding for any of the utilities in the congested utility corridor.

The second reason for the keeping the site shut down for further evaluation was the discovery that somewhere between 5m^3 - 9m^3 of material had infiltrated the breach and migrated back through the breached pipe into the pump station. This unanticipated movement of fill explains the large sinkholes shown in the attached photographs. Although this material was easily removed from the pump station the concern is the alarming volume of material migrating below the surface possibly creating risk to the other services in the immediate vicinity of the breach and perhaps even well away from the repair area.

In view of these issues, the stuck repair equipment with only 4 of the specially fabricated pipe sections installed, and the migrating backfill, the City of Richmond made the prudent decision to stop the repair work, to further investigate the issues at this site and come up with a new rehabilitation plan. Liam O'Connell of Aplin Martin elaborates, 'The City is planning on using ground penetrating radar (GPR) methods to identify other voids in the area where densification will be necessary to prevent further loss of material causing

Sinkhole caused by migrating fill

more sinkholes in the area. Once the areas at risk are identified they will be prioritized and densified before further repair attempts can be carried out'.

A GPR contractor was retained to carry out a survey in the vicinity of the breach and surrounding area however the engineers did not find the results reliable, voids were identified but there was not sufficient resolution of the results to be useful in shaping the details for the next repair attempt.

About 3 weeks after the failed attempt PW excavated a rescue / exploration pit at the location of the sliplining head to better understand the nature of the failure so they could propose a new repair plan. The roughly 1.8m wide by 2.4m long excavation was as described earlier about 5m down and required extensive dewatering before a determination could be made.

Once exposed it quickly became apparent that the pipe on either side of the breach, where the crown of the pipe was sitting in the pipe invert, had become severely ovalized, and at risk of imminent collapse. After some deliberation between the City and the Contractor a consensus to install the largest possible diameter pipe that could confidently be installed as quickly as possible was reached. PW was able to easily install off-the-shelf 200mm HDPE pipe in roughly 2m lengths using conventional sliplining techniques from the rescue pit by pushing the pipes away from the breach in both directions, towards the pump station and the manhole. With PW now able to work in the excavation pit which had considerably more room than working from the pump station the pipes could be fused conventionally where they were being installed.

The final step of the repair involved building 4 bulkheads, 2 at the rescue pit on either side of the breach, one at the pump station and one at the manhole as well as a cradle for the 8-inch pipe at the breach. Everything was then grouted in place around the newly inserted 200mm pipe. Once the repair was completed a CCT camera was run through the pipe for a final inspection.

The final price tag for the work by PW Trenchless was about $275K while the total cost to the City of Richmond including dewatering, debris and water removal (vacuum excavation), the GPR study, the bypass, traffic control etc. was about $800,000, still well under the original estimates of $1.5 to $2.0 million.

The City has since been monitoring the pump station daily because of the reduced storage capacity in the newly repaired pipes. The intent is to alert the operators if the pumping rates need to be adjusted to accommodate the overall reduced capacity. Four months after the final repair no volume issues due to reduced flow and storage capacity have been noted indicating that the original 350mm pipe may have been oversized.

Although it is unfortunate that the original repair attempt was unsuccessful, the deeper exploration of the area through both the rescue pit excavation and the GPR raises issues that may or may not materialize in the future. While the repair of the breach has been solidly addressed it is possible that over time the other issue identified, that is the voids in the surrounding vicinity, may still create difficulties for the City of Richmond as the high and ever fluctuating water table could cause sediment (fill) migration to continue over time. Whether the volume of material migration creates further issues for the City remains to be seen but it couldn't hurt to occasionally check the area for alarming rates of settlement around the repair.

ABOUT THE AUTHOR:

Tonia Jurbin, P. Eng. *is a professional geotechnical engineer and freelance writer living and working in Greater Vancouver. Her extensive background in the trades and technology has given her years of experience in industrial workshops, materials testing laboratories, on urban construction sites and in remote areas of British Columbia. Tonia has worked as a surveyor, inspector, technologist, and finally as a senior design engineer. www.toniajurbin.com*

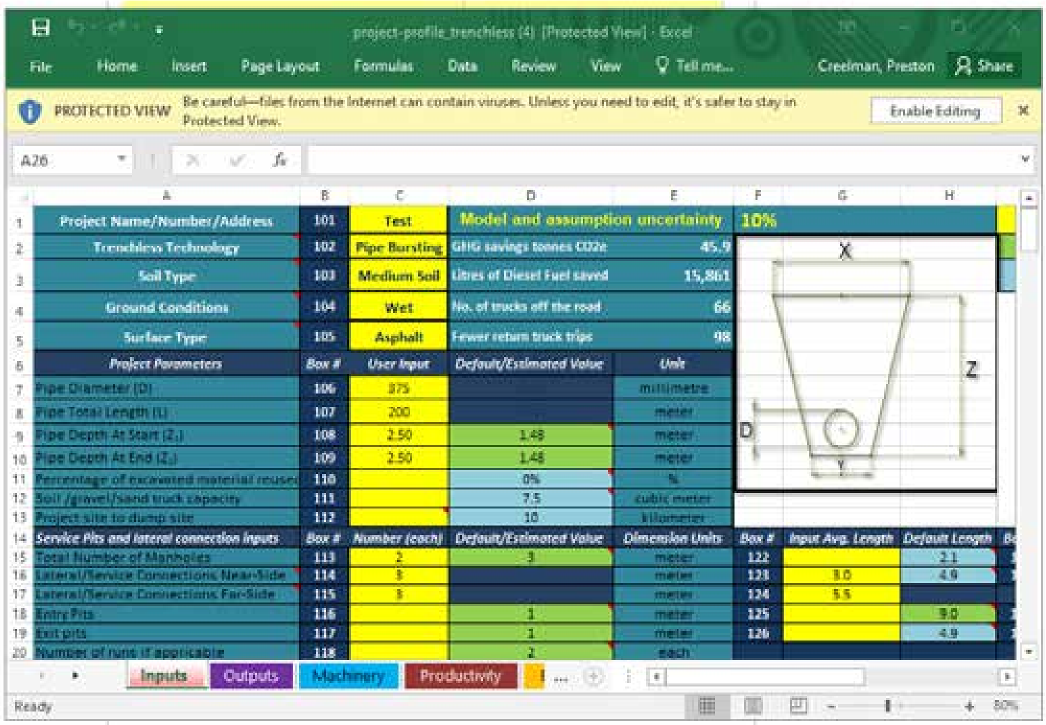
Obtain GHG Emission Reductions at No Cost!!!

By: Preston Creelman, P.Eng.

By using the BC Carbon Calculator, municipal owners can show that GHG emission reductions were realized when an underground utility was installed/rehabilitated with the use of a Trenchless Technology. Best of all, these GHG reductions are available at no cost!

This past year, 2021, the Sustainability/Climate Action teams, along with some Capital Works/Engineering departments, at cities/districts around the Province of BC were contacted to ensure that they were aware of the benefits that they could claim in the annual CARIP reporting protocol. Although in 2020, five owners showed 3,000 tonnes of GHG emission reductions for use of trenchless, in the Option 1F section of their reports; most municipal owners were unaware of this benefit. This tonnage would have increased greatly in 2021, had the Province not cancelled the CARIP program.

Response from 21 out of 46 municipal owners, indicated that they would be using the BC Carbon Calculator program to show GHG emission reductions for work done using trenchless procedures in their jurisdictions. The new CleanBC policy that was announced last fall as the next protocol to address Climate Action in BC, however, has so far neglected to include these benefits that had been approved prior. Hopefully, this oversight will be addressed soon, so that "trenchless using owners" may be rewarded for their efforts to lessen GHG emissions.



BC Carbon Calculator Input Page

"Very unfortunate that we cannot claim over 1,000 tonnes of GHG emission reductions," Jason Hartley, P.Eng., Manager of Capital Works, " that the City of Campbell River realized by the use of CIPP Trenchless Technology for the 2020 and 2021 years."

How are these GHG reductions achieved at No Cost? When Capital Works/Engineering decide to use a trenchless method for a capital project, the cost to do the work is covered by monies from their budget. In most instances, the use of a trenchless method is the most economic! With the approved BC Carbon Calculator program, the added benefit of lesser GHG emissions can also be shown to municipal residents. And these GHG emission reductions can be claimed at no cost. As Capital Works/Engineering already covered the cost for the work to be done from their budget.

In January 2019, the BC Carbon Calculator program was posted on the Province of BC website as an approved methodology for municipal owners to estimate GHG emission reductions for use of trenchless to perform a capital works. This approval by the Province was after a lengthy process that stretched over almost 12 years. The first version of this program was created in 2007. Over the ensuing 10 years, there were 4 more revisions made to the program. So as it now stands, it is quite accurate. As part of the process to attain approval, several

> *In most instances, the use of a trenchless method is the most economic!*

Static Pipe Bursting, West Vancouver

traditional open cut projects and several trenchless ones were audited closely to record actual fuel consumption of all construction equipment used to do these works. These actuals compared closely to the estimates showed by the program. The Province was almost satisfied. Several additional changes were requested by provincial staff, with the result as the current posted edition.
(See: www.toolkit.bc.ca/cnlg)

The basis for the GHG emission reduction estimated is the difference between fuel consumption if the work was done using traditional open method versus were it done using a trenchless procedure. Less 10 percent. One of the "add-ons" from the Province was to reduce the estimated difference by 10 percent as the value of GHG emission reductions being assessed, was by calculation versus actual. Even with this added/subtracted 10 percent handicap/penalty, trenchless methods can still afford a significant amounts of GHG emission reductions.

Initially, the use of the BC Carbon Calculator to claim GHG emission reductions was aimed at Capital Works/Engineering teams. However, over the first 2 years of the program's availability, it only received minimal use. And review of the last CARIP reports and discussion with the few users, showed that it was the Sustainability/Climate Action/Environment Monitoring teams that used it. Thus in early 2021, it was decided to "re-introduce" the program to this additional sector of municipal staffs. This resulted in much greater interest in the BC Carbon Calculator, as 21 additional owners indicated they anticipated using it to claim credits in their next CARIP report. This "anticipated use" was prior to Municipal Affairs suspending use of the CARIP reporting, after CleanBC policy was announced. As noted at the opening, municipal owners are still unable to claim/show GHG emission reductions to the Province of BC when they employ a trenchless method for capital works on an underground utility. However, some owners are planning to use the BC Carbon Calculator program to show their respective citizens that some of the municipal capital works projects are affording many tonnes of GHG emission reductions in local neighbourhoods.

Cured In Place Pipe, Campbell River

Installation and/or rehabilitation of an underground utility using a trenchless method generates far less GHG emissions as much less and much smaller equipment is involved. On a traditional open-cut project, there will be one (or two) large excavator(s), a medium-sized loader, pavement saw, compactor, roller, de-watering pumps, etc. And a varying number of dump trucks. Hauling away removed material as spoil and bring back graded material as backfill, is where a significant quantity of fuel is consumed by those dump trucks. Versus one or two small excavators, a portable generator and/or a small backhoe is often the only equipment on a trenchless jobsite. It is obvious that with smaller and fewer pieces of equipment on the trenchless site, that GHG emissions are reduced when compared to work done by traditional open-cut.

After the many contacts in the first half of 2021, It was truly gratifying to observe increased interest by municipal owners to use the BC Carbon Calculator to show GHG emission reductions. As noted above, it is hoped that the Province of BC will soon announce how the benefits of using trenchless construction practices will be accommodated in CleanBC. In this way, those owners may then may claim the many tonnes of GHG emission reductions for 2021 capital work performed using trenchless methods.

ABOUT THE AUTHOR:

Preston Creelman, P. Eng. *has over 35 years of experience in the production, Q/C and technical marketing of concrete and PVC pipe, including specialized pipe used for trenchless construction. He is a member of the AWWA Pipe Rehab Committee.*

Coastal GasLink Pipeline - Murray River HDD

By: Thomas Husch & Ashkan Faghih, CCI Inc.

1. ABSTRACT

The Coastal GasLink Pipeline Project (NPS 48) included a trenchless crossing of the Murray River. To construct the crossing, Horizontal Directional Drilling (HDD) methodology was selected to complete the trenchless installation. The crossing is located approximately 30 km east of Chetwynd, British Columbia.

The overall designed crossing length was 1,347 m, making it one of the longest NPS 48 HDD installations in Canada which included 114 m and 58 m of NPS 72 temporary casing to be installed at the entry and exit locations, respectively. The project included challenging terrain, telescoped casing, tight steering requirements, intersect methodology, high entry angle, and large diameter reaming passes.

The length and diameter of the installation make it one of the largest HDD's completed in North America. The installation of the pipe within the borehole was completed in June 2021 by Surerus Murphy Joint Venture (SMJV), utilizing The Crossing Company (TCC) as the HDD installation contractor. The crossing was designed by CCI Inc. (CCI) with input and support from the Coastal GasLink (CGL) project team and TC Energy and geotechnical investigations completed by WorleyParsons Canada Services Ltd. (WorleyParsons) and Golder Associates Ltd. (Golder).

2. INTRODUCTION

Coastal GasLink Pipeline Ltd. (CGL) will construct and operate a natural gas pipeline from the area near the community of Groundbirch (about 40 km west of Dawson Creek, British Columbia [BC]) to the LNG Canada Development Inc. (LNG Canada) liquefied natural gas (LNG) export facility (LNG Canada export facility) near Kitimat, BC. as shown on Figure 1.

Along the pipeline alignment, the Murray River would need a trenchless crossing solution due to stakeholder, environmental, and regulatory requirements.

The overall designed crossing length was 1,347 m, making the crossing one of the longest NPS 48 HDD installations in North America. The crossing included 114 m and 58 m of minimum size NPS 72 casing on entry and exit, respectively, as well as tight steering tolerances, high entry angle, intersect methodology, and large diameter reaming passes..

This paper is a review of the design, development and construction of the Murray River HDD. The crossing location along the CGL alignment (blue line) is shown in Figure 1.

Figure 1. CGL Alignment and Murray River Crossing Location

3. SITE OVERVIEW

The CGL alignment crosses the Murray River from east to west near a bend in the river, as shown in Figure 2. The Murray River flows from south to north at the crossing location with a channel that is approximately 100 m wide. The banks are steep and approximately 20 m high and the valley containing the river, banks, and sloping floodplain on the west side is roughly 600 m wide.

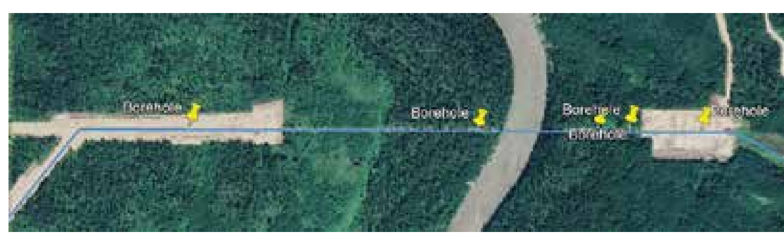


Figure 2. Murray River Crossing Alignment

Both HDD and directional pipe thrusting microtunneling (commonly referred to as Direct Pipe) were assessed based on pipe specifications, operating conditions, geological formations, topography, and the construction limitations. HDD was selected as the primary construction methodology for the Murray River based on assessments by both CCI Inc and Engineering Technology Inc. (Entec) . Directional microtunneling was removed from consideration based on the shallow bedrock conditions beneath the river, gravel layers on the banks, topography, approximate length of 900 m, and elevation changes across the profile.

4. PRE-CONSTRUCTION GEOTECHNICAL INFORMATION

WorleyParsons Canada Services Ltd. (WorleyParsons) carried out a geotechnical investigation program that included a borehole investigation and an electrical resistivity tomography geophysical survey. WorleyParsons drilled six (6) boreholes along the proposed pipeline crossing alignment of the Murray River crossing as shown on Figure 2.

On the east side of the river, the subsurface formations consisted of a mixture of clay, silt, sand, gravels and cobbles over top of layers of shale, sandstone, and siltstone bedrock. The clay was typically low plastic and ranged from firm to hard. The clayey silt / sandy silt ranged from loose to dense. The silty sand/sand encountered was found to be fine to coarse-grained and was typically well graded. The sand/gravel was compact to very dense. The bedrock was weak to strong and ranged from not fractured to intensely fractured. Artesian water conditions were encountered on the east side of the river in the borehole furthest from the river at a depth of 38.0 m and at a flow rate of 10 to 12 L/min.

The boreholes on the west side of the river encountered primarily gravel with a small clay layer over shale, sandstone, and siltstone bedrock. The boreholes on the west side of the river encountered similar conditions to those on the east side.

Based on the proposed geometry of the installation, it is expected the HDD will encounter all of the formations described above . Throughout the geotechnical investigations and site assessments mentioned above, there were concerns regarding the slope stability on the east slope of the Murray River near the proposed crossing location. Golder Associates Ltd . completed reports summarizing the previous studies and latest field reconnaissance. The report considered the preliminarily proposed HDD path to be reasonable; however, some suggestions were made regarding the HDD and pipeline alignment on the east slope of the river. Minor re-routes were suggested to navigate the slope and active earth flow west of the proposed entry point. The other suggestion was a shift of the HDD entry point 20m to 30m north to increase separation from hummocky terrain and a tributary channel on the south side of the entry workspace.

During the development of the design, CCI recommended an additional borehole to confirm the bedrock elevation near the point of the proposed entry casing as boreholes that were drilled in the previous investigation were over 80 m away. The additional borehole was drilled in March of 2020 by Golder Associates Ltd. (Golder). The findings of the borehole were used to adjust the final design profile to optimize the profile geometry and the required casing length. Details of the casing installation are discussed later in this report.

5. HDD PROFILE DESIGN

The HDD design profile was developed with primary considerations of maintaining the drill path within favorable conditions, minimizing the length of the required surface casing, pipe specifications, pipe operating conditions, and minimizing the risk of a fluid release to the river. Secondary considerations in the development of the drill path were minimizing the overall length, optimizing pipe support requirements for pullback, and availability of workspace for construction. In addition to the above design considerations, CGL design and construction specifications were also considered.

The majority of the drill path was designed to be within the shale and sandstone bedrock formations. The gravel formations at surface on both sides of the crossing were assessed to require temporary surface casing to support the borehole. With the initial assessment of over 90m total length of casing required on the entry side to reach the competent bedrock material, it was decided to complete an additional borehole to determine the elevation of the bedrock at the preliminary proposed end of the casing. This was to reduce the risk of not seating the casing into competent bedrock material at the specified casing length. Based on the additional borehole drilled by Golder in 2019, the final designed entry casing length was 114 m at a 21-degree entry angle with a minimum final size of NPS 72.

Based on the profile changes required to accommodate the increased length of entry casing, the exit had to be moved to a location with increased gravel depth. The final exit casing length was 58m with a minimum diameter of NPS 72. The exit point was positioned to target an area of shallower bedrock, reducing the overall length of casing required. The minimum 72-inch casing diameter on either side was sized to accommodate the reamers required to open the borehole to the 60-inch final ream size required. Both casings were to be installed using "telescope" methodology.

The crossing radius of curvature (ROC) was designed for the crossing at 1,300 m. The selected ROC was at variance to CGL specifications and industry rule of thumb that call for a design radius of 1,200 times the product pipe diameter (1463 m). The variance to these rules was maintained as the radii were within allowable stress limits and allowed for a reduced overall length of the crossing. The HDD geometry was pinched between specifically selected entry and exit, the compact design radius and a short horizontal base tangent . This drove a requirement for strict adherence to the steering tolerances, and an accurate pilot bore.

A 21 degree angle was specified for the design to reduce the length of the entry casing. This allowed for a significant reduction in the overall required casing length, though with an increased risk associated with cuttings transport out of the borehole. It was also considered that rigs of the size required would require modifications or a custom setup to accommodate the specified entry angle. The pilot hole was specified to be completed as an intersect with the intersect zone specified along the exit tangent. The pilot hole intersect was required due to the casing on each side of the crossing.

An annular pressure analysis was used to assess the risk of drilling fluid release to surface during the pilot hole. An assessment was completed based on overburden pressure calculations and USACE Delft calculations. Overburden calculations showed a risk to the waterbody, though considering the bedrock, the risk of fracture was moderate to low.

Risks were assessed throughout the design process. Key risks identified for the crossing included:

- **Casing installation** – there was a risk that the casing may not be able to be installed to the designed depth. There was also the risk that the alignment of the entry casing at the final depth would not match the design profile.
- **Steering challenges** – tight steering tolerances were specified based on CGL specifications and pipe design. Only short tangent sections were available at the end of the entry casing and between the entry and exit build sections limiting the room available to make corrections.
- **Fracture to waterbody** – this was considered a key risk to the waterbody and was high considering the interests of all stakeholders, including local communities.
- **Poor cuttings transport within the borehole** – the large final borehole size and the steep entry angle were considered to contribute to the risk of cuttings not being transported effectively out of the hole.
- **Drilling fluid control** – the large volume of drilling fluid required increased the risk of being unable to maintain the fluid properties within specified parameters.
- **High pullforces** – the size of the pipe and length of the crossing considered the risk of pullforces rising above the theoretical as calculated using Pipeline International Research Council (PRCI) recommended methods.

6. CONSTRUCTION

Construction of the Murray River HDD began in autumn of 2020 with entry casing installation by Surerus Murphy Joint Venture (SMJV) and The Crossing Company (TCC).

For the extensive entry casing installation required, reviews of the material at the final depth of the casing and the survey of the casing alignment were required prior to progressing to the pilot hole stage. The casing installation was telescoped from NPS 96, to NPS 84, to a final diameter of NPS 72. In addition to the 24-inch pneumatic hammer used to complete the installation; a durango tool was used to excavate ahead of the casing to allow the installation to continue after refusal at approximately 100 m. The Durango tool excavated outside the end of the casing to allow casing installation to continue. The casing encountered bedrock at 108 m depth, 6 m shallower than identified in the design. The exit casing installation had not been initiated to allow for the final position of the entry casing to be assessed and confirm the suitability of the entry casing installation for the designed drill path.


Figure 3. Durango tool

During installation, the 108 m of unguided casing deflected from the designed, optimized path. A 2-degrees vertical and 1-degree lateral deflection was measured in the casing as-built survey. This deflection posed a high risk that the pilot hole would not remain within the required design geometry and meet the radial tolerances over 10 m and 30 m increments. A redesign of the HDD was required and incorporated a compound radius, a lateral shift in the drill alignment, and the removal of the tangent portion of the drill path between the entry and exit build sections. The tight radii led to an increased schedule required for the pilot hole, though TCC was able to complete the intersect within specifications based on the updated design.

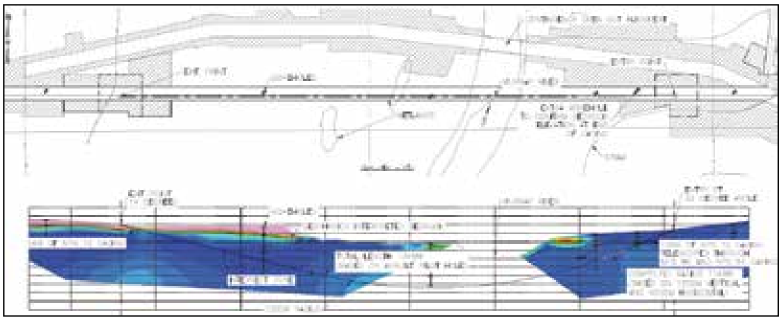


Figure 4. Updated Design Plan and Profile.

Several other challenges were faced throughout the crossing installation. Some key issues that came up included a drill pipe break, fluid control issues, and cuttings removal from the borehole. The drill pipe break occurred during the 60-inch ream . Reaming was completed using a drill rig on both sides of the crossing to support the reaming process. The reamer and drill string were recovered, and the drill string was able to be re-established across the borehole.

Cuttings transport within the borehole proved problematic during the larger ream passes. A parasite string was used to assist with moving cuttings from the bottom of the casing. Additional pump capacity may have helped with the transport of the cuttings. A large amount of cuttings and drilling waste were generated throughout the larger reams. Adequate capacity

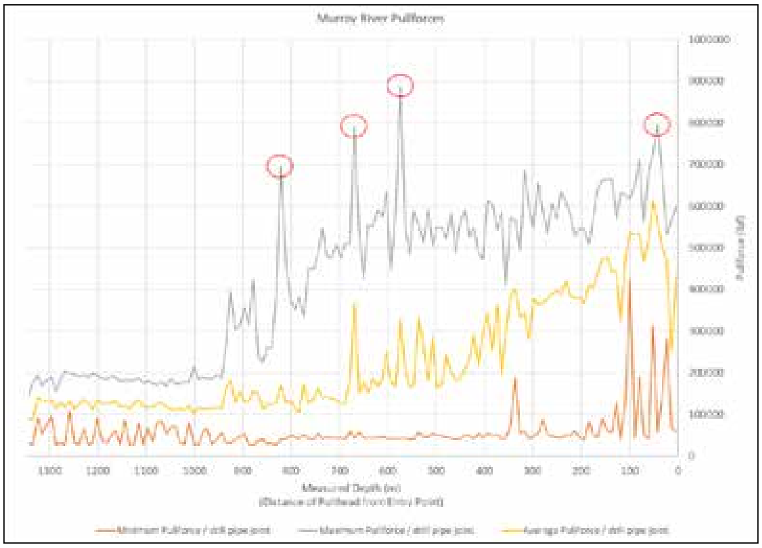


Figure 5. Murray River observed Pull forces

Figure 6. Pipe pulled in. PHOTOS PROVIDED BY CGL.

for drilling waste disposal was available due to the contingency planned . Additional shakers and centrifuges and a premix tank may have reduced the overall disposal volume and assisted with controlling the drilling fluid properties downhole .

Calculated pullforces were carefully reviewed prior to pullback of the product pipe. Limits of the drill pipe were evaluated and a contingency plan of using a pneumatic hammer on the back end of the product pipe to assist with the pullback was put into place. A 5 m long pup was mounted to the back end of the product pipe prior to pullback to allow a pneumatic hammer to be quickly mounted to the back end to hammer on the pipe and avoid damaging the product pipe. This contingency was implemented as the pullforces climbed above 700,000 lbs.The maximum pull force measured during the pull was 886,000 lbs. For each joint of the drill pipe removed, the minimum, maximum, and average pull forces were recorded. The hammer was utilized 4 times throughout the pullback. Figure 5 shows a record of the pull forces throughout the pullback. The four (4) highest spikes seen in the record of maximum pull forces (circled in red below) are the instances where the hammer was used.

The use of the hammer assisted the drill rig in getting the pipe moving again to allow the pipe pull to continue, leading to the successful pullback of the 1,348m long NPS 48 pipe.

The overall schedule for the entire crossing extended to 190 days of drilling activities. The challenges mentioned above, including adjustments to the design, pilot hole corrections, drill pipe break, and cuttings transport, among others, extended the schedule from the original schedule of approximately 110 days.

7. CONCLUSION

The CGL NPS48 crossing of the Murray River was a highly technical and challenging crossing. The 1,348m crossing was successfully completed in 190 days of drilling, not including casing installation and extraction. Collaborative efforts from CGL, SMJV, TCC, TerraHDD, TC Energy, and CCI, as well as many other supporting elements on the numerous challenges faced, led to the success of the HDD installation.

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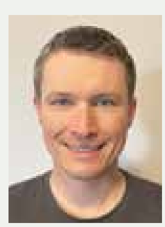

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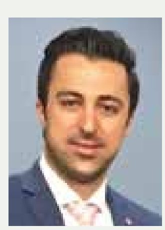

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CERTA-LOK® RJIB Restrained Joint PVC Reduces Ground Surface Disruption and Improves Productivity for Static Pipe Bursting Project

Municipal Case Study

By: NAPCO Pipe & Fittings

PROJECT TYPE: Water Main and Gravity Sewer	**OWNER:** City of Lloydminster	**CONTRACTOR:** Rusway Construction	**ENGINEER:** BAR Engineering
APPLICATION: Static Pipe Bursting	**PRODUCT USED:** Certa-Lok® RJIB	**SUB-CONTRACTOR:** 3D Pipe Bursting	

Infrastructure upgrades for the City of Lloydminster included replacing an aging water main and sanitary sewer. The city had to consider the identified constraints in order to select the right pipe and installation method for the project: minimize surface disruption, reduce impact on shallow utilities, alleviate soil settlement concerns and shorten the project schedule.

CHALLENGE

Located on the border of Alberta and Saskatchewan provinces in Canada, the City of Lloydminster was tasked with replacing 138 m (453 ft) of 200 mm (8 in.) vitrified clay sanitary sewer and 83 m (272 ft) of asbestos cement water main that lay below the intersection of 44th Street and 62nd Avenue. After careful study, the city planned to replace the existing pipe for both projects with PVC pipe. The engineer on the project reviewed both open trench and static pipe bursting applications to determine which would best support the project challenges with soils, existing utilities, surrounding infrastructure and speed to completion. Disrupting shallow utilities and concerns over soil settlement were key considerations to move away from open trench installation as an option.

APPLICATION

The design engineer on this project, BAR Engineering, specified spline-lock DR 18 Certa-Lok® restrained-joint integral bell (RJIB) from NAPCO Pipe & Fittings for the pipe replacement project. Three runs of existing pipe were designed for the pipe bursting application, two runs of sanitary sewer and one run of water main. The 138 m (453 ft) of 200 mm (8 in.) vitrified clay sanitary sewer will be replaced with 200 mm (8 in.) Certa-Lok pipe and the 83 m (272 ft) of asbestos cement water main will be replaced with 200 mm (8 in) of Certa-Lok. The engineer chose size-on-size pipe because an increase in pipe capacity was not required. A gravity sewer spline-lock pipe such as Certa-Flo® could also have been utilized for the sanitary sewer. The plan view drawing in Figure 1 shows the water main pipe burst in blue and the sanitary sewer in red. The aerial photo in Figure 2 shows the pipe burst setup for the 97 m (318 ft) length of sanitary sewer running north-south along 62nd Avenue. Certa-Lok spline-lock PVC was specified as the pipe material for both the sanitary sewer and water main replacements – the segmented nature with cartridge-style loading allows for ease of installation and a minimal assembly area.

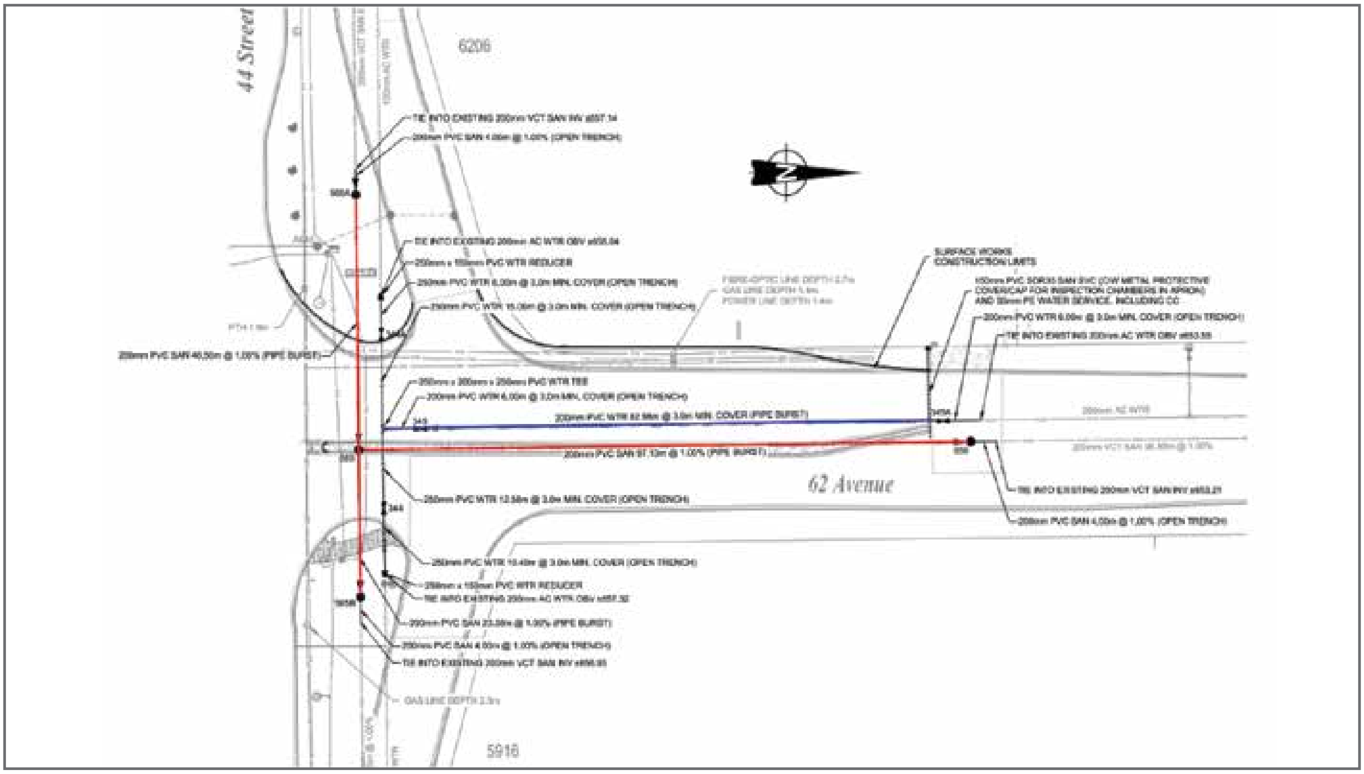

Figure 1. Plan View of Pipe Bursting Installations – 44th Street and 62nd Avenue

Figure 2. Aerial View of 200mm (8 in) Sanitary Pipe Bursting Installation – 62nd Avenue

SOLUTION

For static pipe bursting, an insertion pit and a machine pit must be dug prior to the new pipe installation. For this project, the pits were dug the day before the pipe installation. The bottom elevation of the two pits were dug just below the invert elevation of the existing pipe that will be receiving the new pipe. No mainline connections to laterals were required. The pits were dug at the manhole locations for the sanitary sewer and at the valve locations for the watermain. Access to 44th Street was temporarily closed to traffic, however, the Certa-Lok cartridge-style installation did not require a large staging area which allowed traffic access to 62nd Avenue and the businesses on either side of the street. With cartridge-style installation, there was no need to string out the pipe which would have blocked roadway access to traffic.

There were several reasons pipe bursting was the best choice for the project:

1. The minimum depth of cover for water mains in Lloydminster is 3 m (9.8 ft) due to ground frost conditions in the winter. The existing asbestos cement watermain had approximately 4 m (13.1 ft) of cover. Choosing pipe bursting allowed the city to leave the majority of the asbestos cement pipe in the ground.
2. Because of the flat topography in the area, sewer mains are deep in areas to allow for positive drainage. The two sections of sanitary sewer planned for pipe bursting have low grades at 1.0 % and have approximately 4m (13 ft) of cover. Open-cut pipe replacement would have required a significant amount of material to be removed and backfilled adding time and costs to the project, pipe bursting minimized these costs.
3. Pipe bursting was chosen was to minimize surface disruptions. For this project, more disruption than normal can be seen along 62nd Avenue. This is because the road surface was removed and replaced with concrete pads having a 75-year lifespan and the median was replaced as the additional cost quoted by the contractor was minimal. Normally, excavation would only be required at the insertion pit, machine pit, and the service connects.

Figure 3. Aerial View of Static Pipe Bursting Machine and Machine Pit– 62nd Avenue

Figure 4. Arial View of Insertion Pit – 62nd Avenue

Figure 5. Attachment of Expander Head to the Pipe

Figure 6. Attachment of Pipe Bursting Expander to Bursting Rods

The machine pit was excavated at the north end of 62nd Avenue and was approximately 4.5 m (15 ft) long. The static pipe bursting machine used was a Hammerhead HB-125 model and was operated by the pipe bursting subcontractor, 3D Pipe Bursting. The machine was placed in the pit using an excavator and the hydraulic power pack was placed above the pit, pictured in Figure 3. The HB-125 model is designed for replacement pipes in the range of 150 mm (6 in.) to 500 mm (20 in.) with a max pull force of 125 US tons.

An insertion pit was excavated at the south end of 62nd Avenue and was approximately 9 m (30 ft) in length, see Figure 4. For segmented PVC pipe, the pit needs to be dug just long enough to allow the placement and attachment of one length of pipe to the previously installed segment of pipe. The pipe used on this project was DR18 Certa-Lok PVC with a length of 6.1 m (20 ft). The pipe is also available in 3.05 m (10 ft) lengths, which would allow a further reduction in the insertion pit size.

The first step was to feed the bursting rods through the existing pipe from the machine pit towards the insertion pit. The rods used on this project were 3 ft in length. Once the bursting rods reached the insertion pit, they were attached to the expander (bursting steelhead 12.75 in. diameter) and pulled back towards the machine pit with the new pipe following behind.

The expander used on the project is a two-piece assembly. As shown in Figure 5, the general contractor, Rusway Construction, attached the inside piece of the expander to the spigot end of the pipe. Next, Figure 6 shows the outer piece of the expander, which includes the bursting fins, attached to the inner section. This assembly was fully anchored to the new pipe and ready to be pulled into place. The expander head has an outside diameter measuring several inches larger than the outside diameter of both the existing and new pipes. This allows the hole to be expanded, pushing the soil to the side creating room for the new pipe.

After the expander head was attached to the new pipe, the pipe and expander

Figure 7. Assembly of Spline Lock PVC Pipe

Figure 8. Insertion of Spline into Spline Lock PVC Pipe

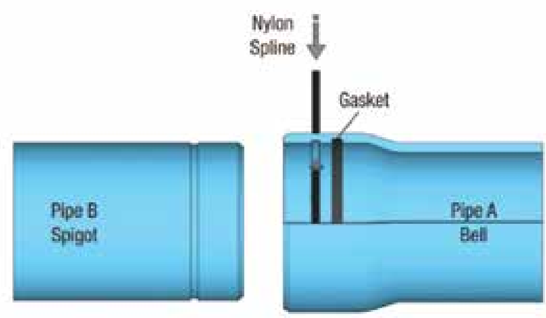

Figure 9. Spline Lock Configuration

Figure 10. Removal of Bursting Head from Machine Pit

were lowered into the insertion pit. The expander was then attached to the bursting rods which had already been fed through the existing pipe. The attachment of the expander to the bursting rod can also be seen in Figure 6. As the first 6.1 m (20 ft) length of pipe was being pulled back, the contractor in the pit assembled the joint.

Figure 7 shows the spline lock joint being prepared for assembly. First, the contractor lubed the gasket inside the bell, careful not to lube the spline groove positioned before the gasket. Next, the contractor lubed the spigot end, again careful not to lube the spline groove.

In Figure 8, the contractor then inserted the spigot end into the bell end lining up the two spline grooves. Finally, the nylon spline was inserted into the spline insertion hole completing the "spline lock," and the joint was fully restrained. The assembled joint can handle a maximum safe pull force of 27,500 lbs (200 mm / 8 in. DR 18) with a safety factor of 2. Figure 9 shows a cross-section of the spline lock joint system. The nylon spline is inserted in the spline insertion hole, which is oriented near the top of the pipe, and then runs around the circumference of the pipe, through the matching spline grooves.

After the expander entered the machine pit and the full 97 m (318 ft) pipe string was pulled into place, the bursting machine was removed from the pit using the excavator. Figure 10 shows the excavator was also used to remove the expander from the pit. The assembly of this section of Certa-Lok PVC pipe took approximately one hour and the spline can be inserted in less than one minute.

The other two lengths (83 m/272 ft and 40.5 m/133 ft) also took an hour or less to install once the set-up was complete. The three pipe bursting installations were carried out over a three-day period.

The installation of the Certa-Lok spline-lock pipe was deemed to be a big success by the general contractor, pipe bursting subcontractor, design engineer and the municipality. Feedback included: the spline-lock system assembled very quickly and easily, the pipe pulled well and the segmented nature of the pipe allowed the contractor to minimize their staging area. The engineer realized an added benefit of pipe bursting during the project – it allowed the contractor to work through heavy rain without any delays, further improving the project schedule. The pipe bursting installations were carried out over three days by Rusway Construction and 3D Pipe Bursting. Spline-lock PVC allowed them to quickly assemble the joints, utilizing cartridge-style installation, without the need for specialized equipment. All of those involved in the project were very pleased with the outcome.

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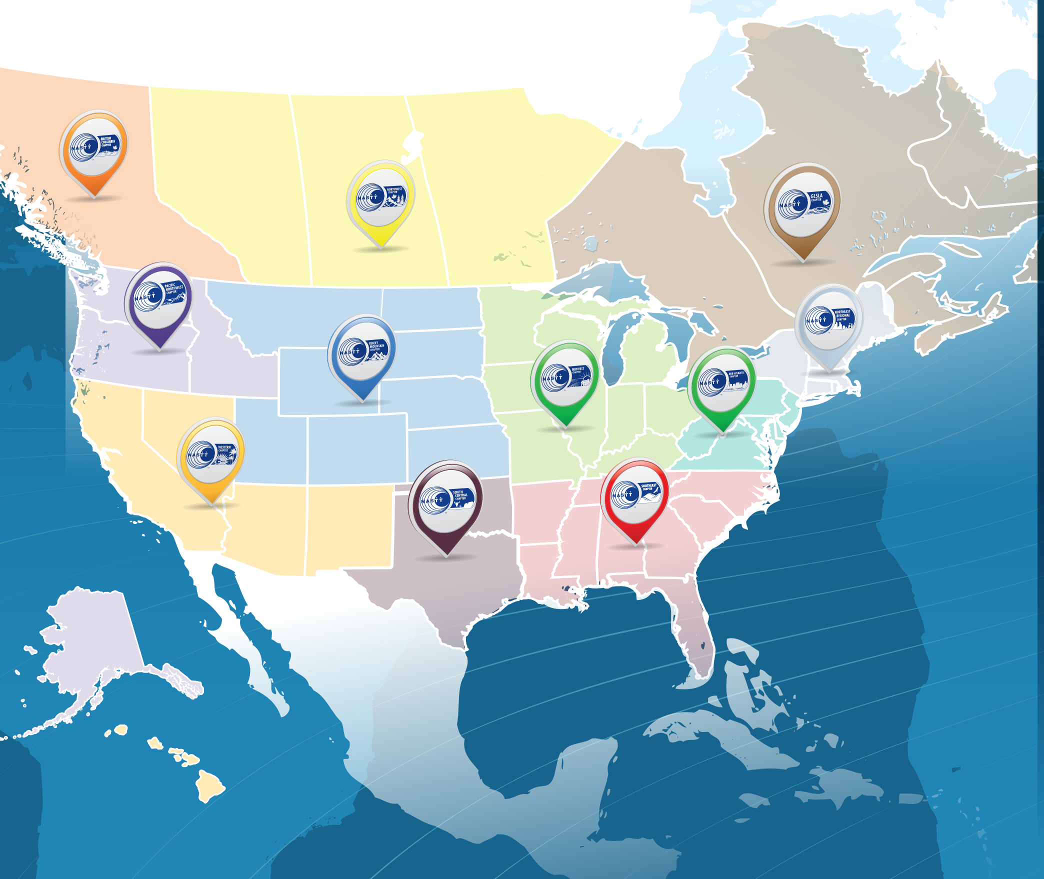

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