2020 | NORTHWEST
SPRING/SUMMER

TRENCHLESS JOURNAL

THE OFFICIAL PUBLICATION OF THE NORTHWEST CHAPTER OF
THE NORTH AMERICAN SOCIETY FOR TRENCHLESS TECHNOLOGY

2019 TRENCHLESS PROJECT OF THE YEAR:

WAPITI RIVER

Three-Peat Parallel HDD Crossing

PM #40065075

GROAT ROAD STORM TRUNK SEWER REHABILITATION PHASE 2 | 2020 NASTT-NW BUYERS' GUIDE

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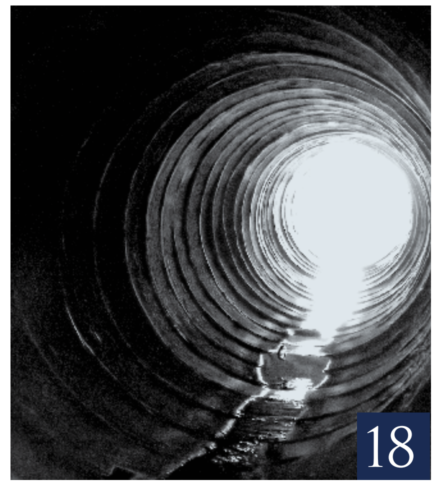

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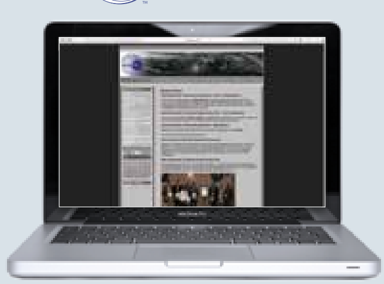

ON THE COVER: Sulphur Gates at Grande Prairie, Alberta, Canada. | dreamstime.com

RISING TO THE OCCASION

Greetings from the NASTT Northwest Chapter and welcome to the Spring/Summer issue of the 2020 *Northwest Trenchless Journal*. We hope you enjoy the content, including a great article on the 2019 Trenchless Project of the Year awarded at the No-Dig North show this past October, and Chris Lamont's excellent piece on the Groat Road Rehabilitation project. We are always on the lookout for content for our publications, so please reach out to us if you have an idea or suggestion for future issues. Thank you so much to all the contributors as well as the advertisers for their hard work and support preparing our first issue of 2020.

I must admit that from the time I first contemplated writing this message, many things have changed. Indeed, it seemed for a short time that circumstances were changing for us all on a nearly daily basis. The current global pandemic has affected each and every one of us in different ways, and while 2020 may not look like what anyone could have expected, as this issue goes to print, we are starting to see the easing of health restrictions across Canada and the Unites States as well as other parts of the world. It certainly doesn't feel like we are back to normal and every jurisdiction is dealing with this unprecedented situation in their own way on their own timeline. But many of us will hopefully start returning to some of our regular routines even if this means making some adaptations for the present circumstances.

I'm sure that we don't fully understand what the permanent changes will be and how they will impact our industry. What we do know is that delivery of the essential services and products that support our communities and industries will continue to be as important as ever. The trenchless community plays a critical part in the construction, operation, and maintenance of this vital infrastructure, and NASTT will continue to advocate and support the efforts and initiatives of our members and provide opportunities for networking and education.

We are coming off a year of tremendous success in the Northwest Chapter. The No-Dig North show in Calgary last October, which had more than 600 attendees, was arguably the most successful trenchless event that has been held in Canada. The hard work of the organizing committee, the collaboration of the British Columbia, Northwest, and Great Lakes, Saint Lawrence and Atlantic chapters, as well as the greater NASTT organization, delivered a conference that exceeded all of our expectations and set a high bar for future events in Canada. The trenchless community has always been strong in the Northwest Chapter and it was amazing to see this show delivered in our own backyard.

Planning is still underway and registration is open for the next No-Dig North show this fall in Vancouver on October 19–20, 2020. And while it should be acknowledged that current events may have an

"What we do know is that delivery of the essential services and products that support our communities and industries will continue to be as important as ever. The trenchless community plays a critical part in the construction, operation, and maintenance of this vital infrastructure."

impact on how that conference is delivered, the planning committee is still working hard to navigate the challenges in these uncertain times. Please stay tuned to the No-Dig North website for updates.

Whenever I am asked why I enjoy working in the trenchless industry and with the NASTT organization, my response is always the same. It is because of the people. There is a spirit of problem solving and ingenuity that exists within it that is unique. We are so fortunate that the trenchless community is made up of innovators and, more than ever before, we will need to harness these talents to overcome the obstacles currently before us. To that end, the Northwest Chapter will continue to find ways to deliver on our mandate of providing opportunities for teaching and bringing people together within the prairie provinces and advocating on behalf of all our membership. I have every confidence we will rise to the occasion and come out stronger because of it.

Finally, I would like to take the opportunity to thank our outgoing Board Members and Past Chair for their hard work and dedication to the NASTT and the Northwest Chapter. It was a pleasure working with all of you. I look forward to continuing with the talented members of our new Board as well as the rest of the membership and volunteers in the Northwest Chapter to navigate our organization through the coming year.

Ben Campbell
Chair – NASTT-NW

The North American Society for Trenchless Technology will be hosting the second annual No-Dig North in Vancouver, BC, October 19–21, 2020.

NASTT NO-DIG NORTH

OCTOBER 19-21, 2020
Vancouver, BC Canada

The show will consist of two days of technical paper presentations and industry exhibits in the trenchless technology field. Pre-event Good Practices Courses will also be available on Monday, October 19, 2020.The event will be held at the Vancouver Convention Centre in Vancouver, BC.

Registration for No-Dig North is now open.
Register by September 4, 2020 to receive the early bird rate.
Register at ***www.nodignorth.ca/registration.***

CELEBRATING 30 YEARS OF NASTT

"We are pleased to announce that the NASTT 2020 No-Dig Show and No-Dig North 2020 are coming together as one North American event to celebrate 30 years of trenchless as NASTT celebrates our 30th anniversary."

Hello Northwest members.

Just weeks before this publication was to go to print, Canada and the United States, along with the entire globe, began to deal with the COVID-19 pandemic. As shelter-in-place decrees and quarantine measures were enacted throughout the world, the 2020 NASTT No-Dig Show scheduled for April 5–9 in Denver, Colorado, was affected. The conference was postponed and the staff of NASTT, along with the board of directors, have been working diligently to re-imagine the show in the best possible way for all our stakeholders.

We are pleased to announce that the NASTT 2020 No-Dig Show and No-Dig North 2020 are coming together as one North American event to celebrate 30 years of trenchless as NASTT celebrates our 30th anniversary. The event will take place at the Vancouver Convention Centre in Vancouver, BC on October 19–21.

We are looking forward to an exciting and collaborative event where we bring together the entire industry from across North America to celebrate our great industry and this milestone anniversary of 30 years of NASTT. This will be a pinnacle event to get out and network and get back to business after these unprecedented times.

We were thrilled with the incredible success of the inaugural No-Dig North conference held in Calgary this past October. With nearly 600 attendees and 76 exhibitors, I could not be happier with the outcome of this show and the volunteer participation and leadership efforts of our Canadian Chapters. The 2019 conference set the bar high for 2020 and I know your Chapter is up to the task!

The 2020 combined conference will begin with four Pre-event Good Practices courses on Monday, October 19. The courses include NASTT's Cured-In-Place Pipe Good Practices Course, NASTT's New Installation Methods Good Practices Course, NASTT's Pipe Bursting Good Practices Course, and NASTT's Horizontal Directional Drilling Good Practices Course. Following the courses, an opening reception for all attendees will take place in the exhibit hall.

All attendees are invited to join us the morning of Tuesday, October 20, at the Kick-Off Breakfast in the exhibit hall. Additionally, four tracks of technical paper presentations will take place on Tuesday, October 20 and Wednesday, October 21. Tracks include CIPP, Condition Assessment, Horizontal Directional Drilling, Microtunneling, Sliplining, Tunneling and more. The exhibit hall will also be open all day on both Tuesday and Wednesday.

We are also planning additional celebrations and events at the conference to honour our award winners, recognize the Canadian projects of the year, celebrate NASTT's 30th anniversary and more!

We look forward to growing and learning from these recent challenges and coming back stronger than ever. Thank you for all your support and dedication to NASTT and the trenchless technology industry. We are only as strong as our Regional Chapters. We are always looking for volunteers and new committee members not only locally but nationally. Don't be afraid to get involved! With the trenchless market growing so fast now is the time to get involved.

Craig Vandaelle
Chair, NASTT

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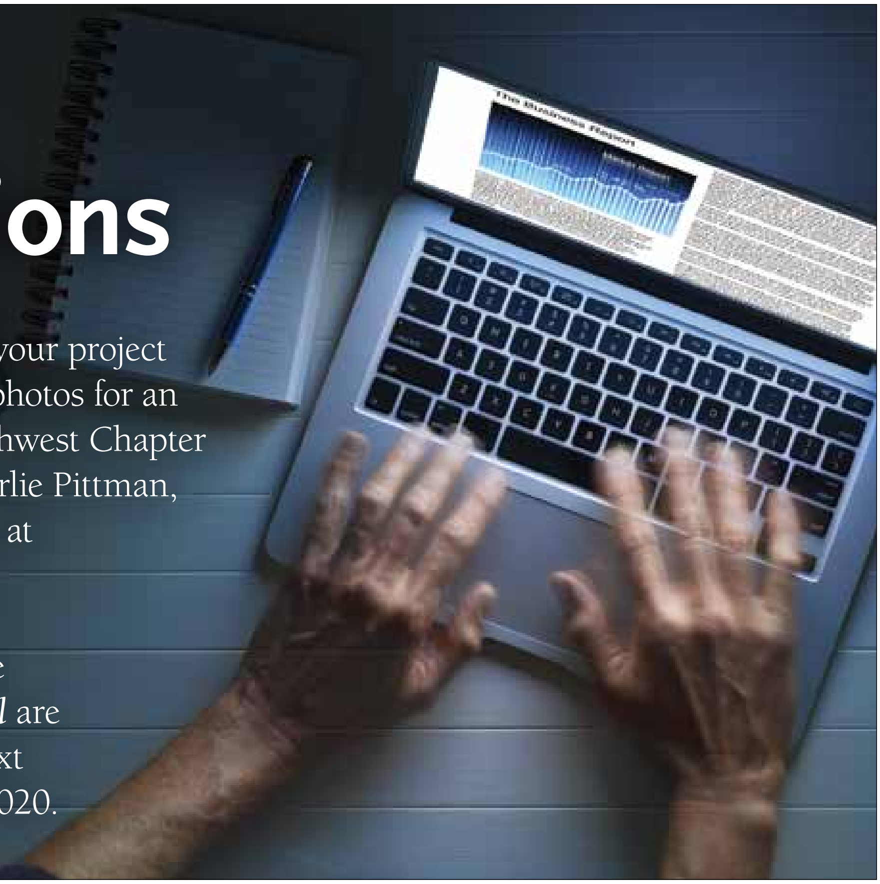
Call for Submissions



If you would like to submit your project paper or other content and photos for an upcoming issue of this Northwest Chapter magazine, please contact Carlie Pittman, Magazine Committee Chair, at *pittmanc@ae.ca.*

Editorial submissions for the *Northwest Trenchless Journal* are welcome and due for our next publication by late August 2020.

IN THIS ISSUE

Welcome to the Spring/Summer issue of the *Northwest Trenchless Journal*, the official publication for members of the NASTT-NW Chapter. This issue of the magazine features the 2019 Trenchless Project of the Year Winner, Wapiti River Three-Peat Parallel HDD Crossing. To read more about the winning project, see page 12 in this magazine.

In addition, we are pleased to present the 2020 NASTT-NW Buyers' Guide, as well as information from the Chapter Chair about the upcoming No-Dig North 2020 event and some big news from NASTT.

Be sure to turn to page 18 to learn about Phase 2 of the Groat Road Storm Trunk Sewer Rehabilitation.

Our Chapter magazine is published twice a year. The next issue of the *Northwest Trenchless Journal* is scheduled for distribution in the fall and will highlight full details about No-Dig North 2020.

We are always interested in relevant, regional content to share with members. We welcome submissions such as technical papers and project profiles. Please contact Carlie Pittman at *pittmanc@ae.ca* before the end of August if you would like to contribute to the next issue of this magazine.

> "We are always interested in relevant, regional content to share with members. We welcome submissions such as technical papers and project profiles."

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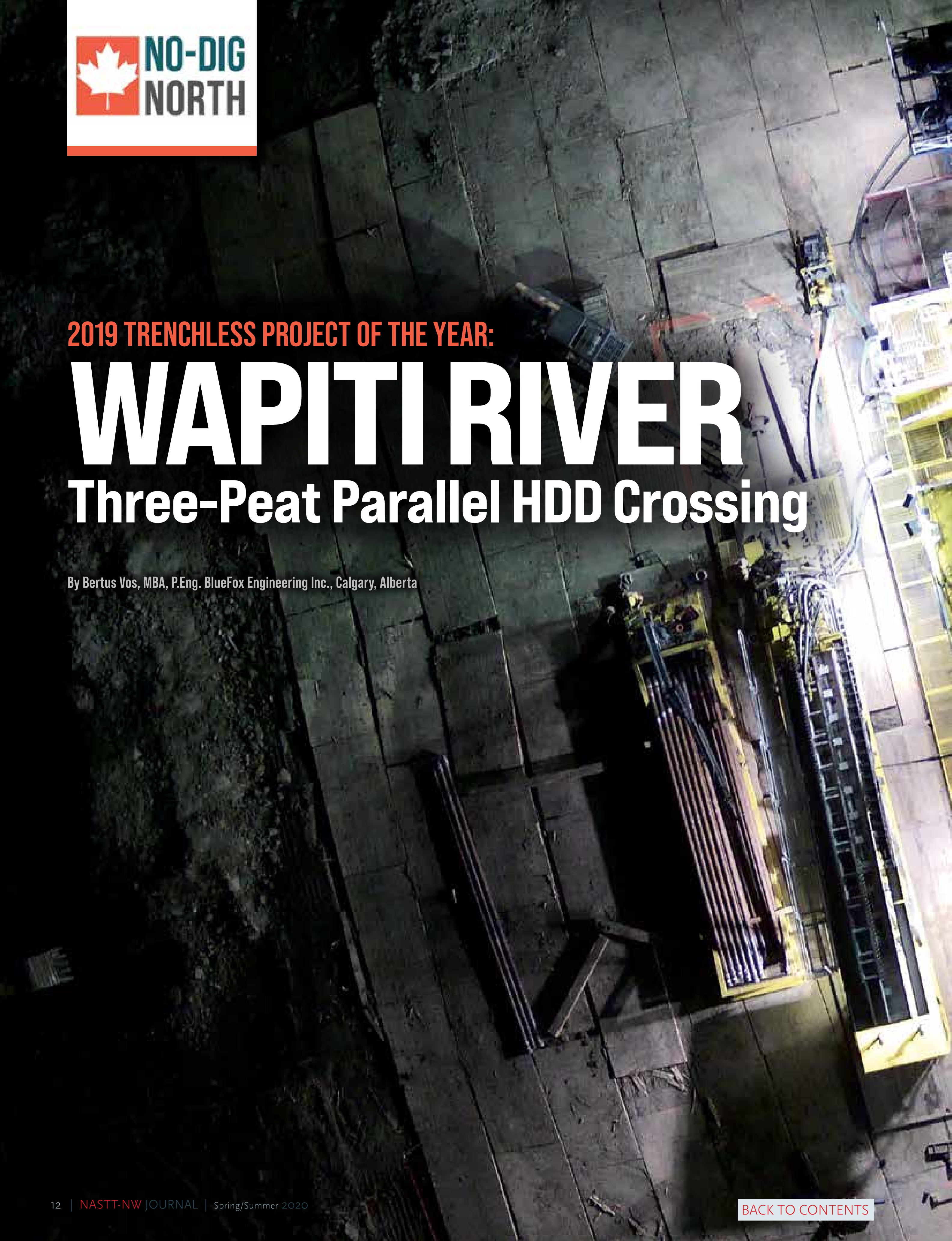

NO-DIG NORTH

2019 TRENCHLESS PROJECT OF THE YEAR:

WAPITI RIVER

Three-Peat Parallel HDD Crossing

By Bertus Vos, MBA, P.Eng. BlueFox Engineering Inc., Calgary, Alberta

OVERVIEW

Pembina Pipeline Corporation and SemCAMS Midstream, as two independent companies, both have development projects near Grande Prairie, Alberta. A large component of both projects required pipelines to be installed across the Wapiti River. BlueFox Engineering was retained on behalf of the two owner parties to work on three parallel crossings using the HDD intersect method, in order to install six pipelines. A collaborative agreement was achieved between various parties to share resources and information, including subsurface investigation information, the HDD contractor, HDD entry and exit workspaces, pipeline layout space, lessons learned from each crossing, support services and access maintenance. The successful collaboration resulted in a significant reduction in cost, time, and environmental footprint.

INTRODUCTION

As part of the multi-phase expansion program by Pembina Pipeline Corporation, several project upgrades, new pump stations, civil works, and pipelines were proposed for 2019 construction in northwestern Alberta, near Grande Prairie.

A significant component of these projects was the construction of the La Glace to Wapiti pipeline expansion, which required two parallel HDD installations for NPS 16 (406.4 mm) and NPS 12 (323.9 mm) pipelines across the Wapiti River. Both new pipelines would transport high vapor pressure (HVP) products in order to expand the company's capacity in this region.

Simultaneously, SemCAMS Midstream also proposed the construction and operation of a central facility and associated pipelines to support the ongoing development of the Montney liquids rich natural gas formation. The proposed Central Facility will include gas processing capability up to 280 million cubic feet per day of sour gas and 20,000 barrels of condensate and other natural gas liquids. In addition to the plant, up to six pipelines will be constructed in a common right-of-way leading south of the plant. These pipelines would transport sweet natural gas, sweet natural gas liquids, produced water, and waste gases to existing infrastructure in the area.

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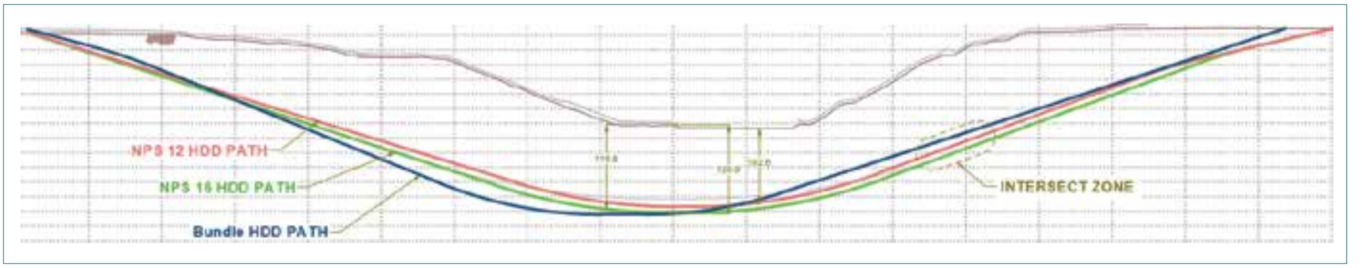
Figure 1. Designed drill path of three parallel drills



Similarly, a significant component of this company's project also required crossing the Wapiti River. As such, four pipelines, 3x NPS 8 (219.1 mm) 1x NPS 4 (114.3 mm) were designed by BlueFox Engineering in a bundle crossing beneath the Wapiti River to transport sour gas, liquids, and fuel gas, within an adjacent right-of-way to the NPS 12 and NPS 16 right-of-way for Pembina's HVP transportation pipelines.

The proposed Wapiti River crossings are located roughly 25 km southwest of Grande Prairie, Alberta, with the subject section of the Wapiti River flowing primarily east to west, just before the river turns south immediately to the west of the proposed crossing alignments. The route for the three adjacent HDD crossings were selected to align roughly perpendicular to the watercourse, adjacent to an existing overhead powerline river crossing.

The Wapiti River is situated at the base of a ravine that is approximately 130 m deep and 800 m wide from crest to crest at this location. The north slope is steeply inclined at approximately 1:1, whereas the south slope is more gradual with a general inclination of 2:1.

BlueFox Engineering was retained on behalf of the midstream owner companies via EPCM firms (Grey Owl Engineering and Tridyne Projects) to provide HDD engineering, detailed design, construction planning and tendering, environmental monitoring, UAV thermal imaging, mud management, and construction inspection services in order to complete the crossings. As part of our scope of work, a significant component was dedicated to feasibility and risk assessment, as well as management of construction resources and collaboration between two independent owner parties completing parallel crossings sequentially, while not disturbing adjacent construction activity.

GEOTECHNICAL INVESTIGATION

Given the Wapiti River valley size and ravine depth, an extensive geotechnical program was undertaken, totaling five deep (up to 130 m) geotechnical boreholes and one geophysical electrical resistivity tomography scan. Subsurface information gathered was agreed to be shared with both owner firms completing the crossings.

Subsurface investigations encountered varying stiffness high plasticity clays with occasional gravel and cobbles, overlying sand with silt or clay till above bedrock. The bedrock primarily consisted of interlayered sandstone, siltstone, and claystone with significant variability in compressive strength and identified poor quality bedrock zones of intense fracturing and coal seams.

As part of the subsurface investigations, a slope stability analysis was performed which identified signs of bank erosion and debris avalanches along the northern bank of the Wapiti River, which was identified as an area of high risk for landslide initiation.

Based on subsurface investigations, slope stability requirements, and pipeline stress criteria, BlueFox Engineering elected to design the HDD crossings with significant setback from top of banks and considerable depth of cover to mitigate the identified risks of impact to the pipeline. Entry and exit points and HDD work pads were selected based on the HDD geometry, equipment sizing specifications, sufficient water storage, and collaboration for sharing support resources between both parties.

HDD DESIGN

Final detailed HDD designs included 30 m surface casing to be installed at both entry and exit points of each crossing in order to mitigate the effects of the surficial clays, cobbles, and gravel and to mitigate the effects of hole ovalization near surface due to the long duration anticipated of the project. Casing diameters were specified to be NPS 48 (1,219 mm), NPS 36 (914 mm) and NPS 30 (762 mm) respectively, based on the final borehole reaming diameters of each crossing, which were 30" (762 mm), 24" (610 mm) and 18" (457 mm).

Entry and exit angles for each of the drills ranged between 13 degrees and 18 degrees in order to balance pipeline lifting height requirements with the amount of surface casing required. In collaboration with both midstream companies, BlueFox Engineering designed the three parallel HDD crossings within two right-of-ways in order to provide vertical and horizontal offsets to meet specifications, allow for adequate steering tolerances, minimize the risk of drilling fluid communication between boreholes, and to facilitate HDD equipment setup and configuration requirements on surface while allowing tie-in and pipeline completion activities on the adjacent drills.

The three parallel drills were each designed to be executed using the HDD intersect method, Figure 1. This was selected due to surface casing installation on both entry and exit points, the overall duration of the project and length of the crossings, which totaled 1,781 m, 1,862 m and 1,856 m, respectively. The pilot intersect location was designed with relative consistency for all three drills, with the entry side rig drilling approximately 2/3 of the pilot hole and the exit rig completing the intersection near bottom of the inclination tangent near the exit side. The resulting HDD geometry experienced over 240 m of elevation change and consisted of seven-segment drill paths for all three crossings: entry tangent, entry arc, bottom tangent, exit side inclination tangent, declination arc and exit tangent.

The maximum allowable annular pressure was calculated using modified Delft equation.

By combining hydrostatic pressure induced by the weight of the drilling fluid and the frictional pressure calculated based on Bingham Plastic Model, we determined the circulating pressure. This circulating pressure was designed to be maintained lower than the maximum allowable annular pressure in order to reduce the risk of hydrofracture and inadvertent drilling fluid release to the ground surface.

In Figures 2 to 4, the circulating pressure was calculated from both entry and exit points due to the intersect construction method and this value was increased by 20% (the circulating pressure + 20%) to take account for uncertainty during construction for material not fully cleaned from the borehole.

Overburden pressure was calculated based on the assumed soil unit weight and measured ground profile as a reference. It is noted that the circulating pressure + 20% is always below the limitation (maximum allowable annular pressure obtained by Delft SF method), except for a short distance near the entry and exit points. However, due to the installation of surface casing at the entry and exit points, the risk of hydrofracture in these two regions is reduced. This held true during the construction phase that no inadvertent drilling fluid releases to surface occurred.

COLLABORATION AND SHARED RESOURCES

As part of the planning and collaborative approach between all parties, the HDD entry and exit workspaces, as well as the near 2,000 m pipeline drag section layout space, were able to be shared in a common temporary workspace, significantly reducing required tree clearing, the environmental impact, costs, schedule, and resources required.

Due to a late winter start and the overall duration of the project, access to the HDD locations became increasingly difficult and significant ongoing maintenance was required. Early engagement with multiple parties during the project planning phase allowed for shared resource agreements to be established, reducing project costs as several support services and access maintenance was able to be shared throughout the construction life cycle.

A mud management program was developed by BlueFox Engineering during the detailed design engineering phase, which illustrated the drilling fluid program required for each HDD borehole, along with water consumption and drilling mud disposal requirements. Several water sources and disposal locations were scouted by BlueFox pre-construction, and upon completion of the first and second HDD boreholes, the remainder of nearby water sources and disposal locations were shared by SemCAMS and Pembina for the rest of the HDD program, which significantly reduced travel times and upheld positive relationships with landowners in the region.

Figure 2. Annular pressure prediction of Bundle crossing

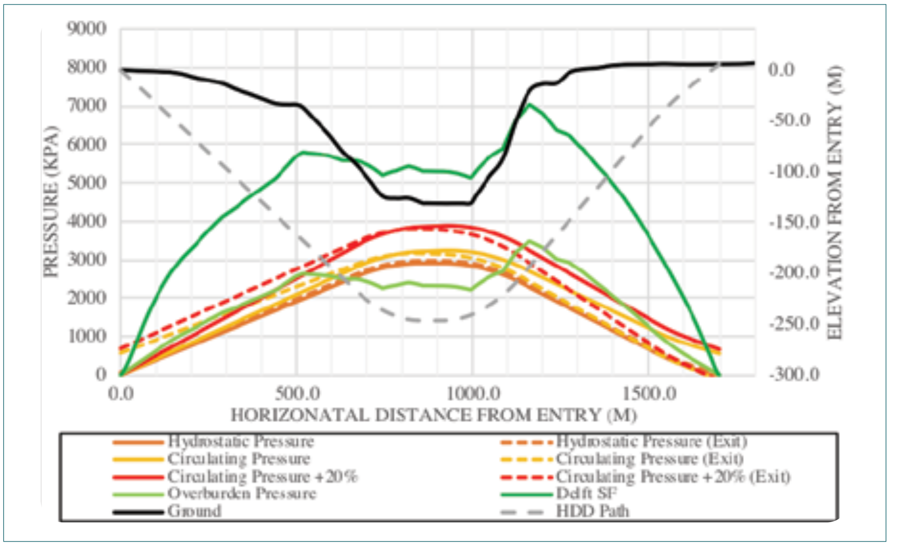


Figure 3. Annular pressure prediction of NPS 16 crossing

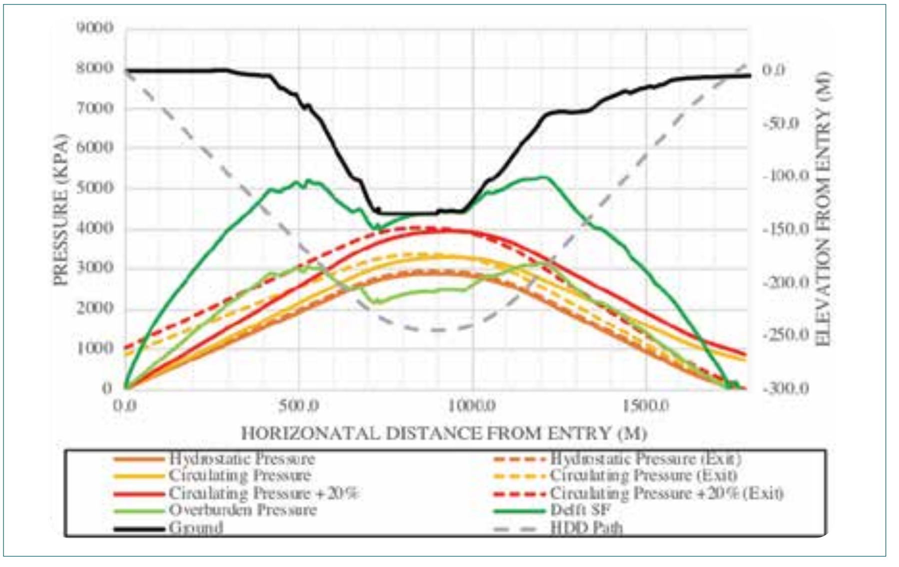


Figure 4. Annular pressure prediction of NPS 12 crossing

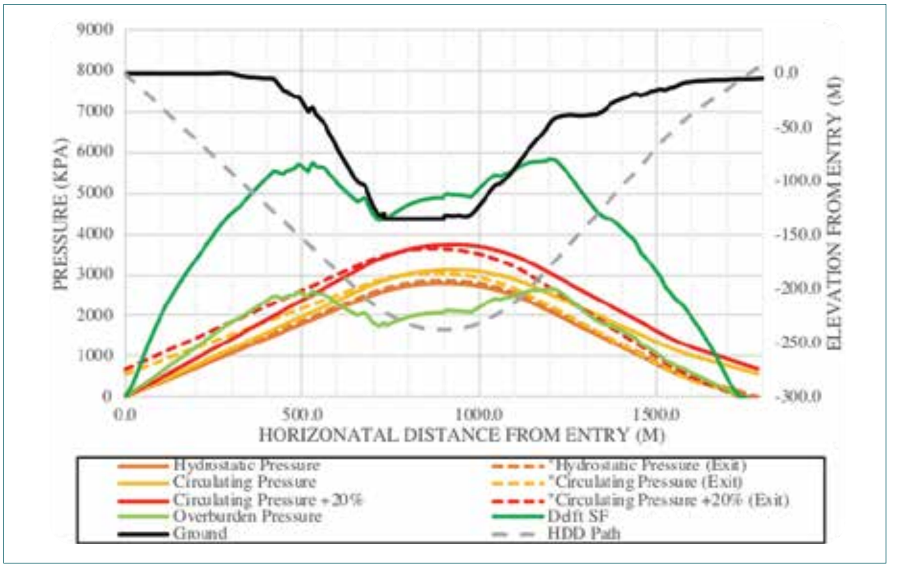


Table 1. Equipment specifications

	Push/Pull		Rotary Torque		Centrifuge		Mud Pump	Shale Shaker
	Entry	Exit	Entry	Exit	Entry	Exit	2x	2x
Unit	N (lbf)	N (lbf)	N·m (lbf·ft)	N·m (lbf·ft)	m^3/min	m^3/min	m^3/min	m^3/min
Capacity	1,957,880 (440,000)	1,957,880 (440,000)	101,686 (75,000)	81,349 (60,000)	2x 1.5	1x 1.5	1.8	0.15

Figure 5. Comparison of planned and actual days of three parallel crossings

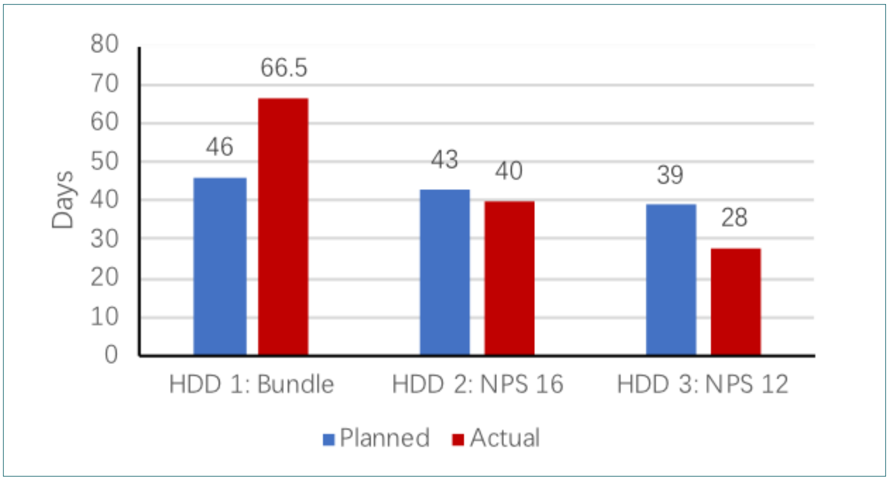
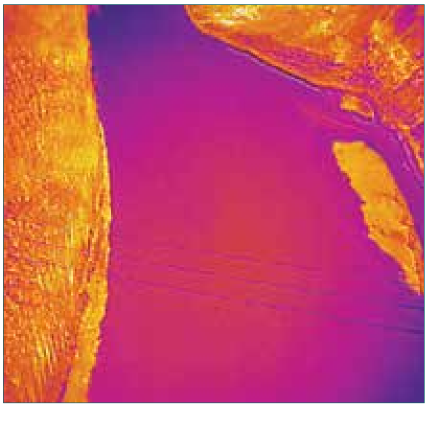


Figure 6. RGB color photo taken by UAV

Figure 7. Thermal image taken by UAV



CONSTRUCTION

Construction of the three parallel crossings was awarded to Direct Horizontal Drilling, to be executed with two equivalent HDD rigs, Table 1.

Construction on the first drill commenced on February 10, 2019 with the four-pipe pipeline bundle successfully pulled on April 16, 2019 and the HDD rig demobilized over to the second right-of-way on April 18, 2019.

Several successes and lessons learned on the first HDD were discussed between BlueFox Engineering and Direct Horizontal Drilling, including a thorough bedrock mapping and loss of circulation zones which identified and correlated to the measured depth elevation on the upcoming drills. In addition, an adjustment to the reamer tooling assembly was made based on feedback throughout the alternating bedrock formation and corresponding rates of penetration encountered on the first drill.

Construction for the NPS 16 drill commenced on April 19, 2019 with the pipeline pull successfully completed on May 27, 2019 and construction on the NPS 12 line starting immediately thereafter. Again, with lessons learned on the successful passage through this location for the NPS 16 pipeline, BlueFox Engineering and Direct Horizontal Drilling proposed to forward ream to the final 18" diameter on the exit tangent to 600 m while waiting for the entry side HDD rig to complete its journey of 1,200 m during the pilot hole stage. The decision was approved by the Pembina project team and the final NPS 12 pipeline was successfully installed on June 26, 2019, approximately 30% ahead of schedule. Figure 5 shows the planned and actual days of all three crossings.

Throughout the project, full-time in-stream water quality monitoring and unmanned-aerial-vehicle (UAVs)

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monitoring for inadvertent fluid release to surface were utilized as part of the environmental monitoring program. In combination with scheduled terrestrial walks, the day shift UAV pilot would perform UAV flights in areas difficult to access by foot and across the watercourse from both entry and exit side. Daytime interpretation was based on RGB color photo, video data, and visual interpretation, Figure 6. Night-shift UAV flights were conducted using a larger vehicle, fitted with a thermal imaging camera, Figure 7. Corresponding photo, temperature, and video data were interpreted by the UAV pilot to detect surface fluid release. Baseline readings of drilling fluid, ambient air, and ground surface were taken several times per day in order to calibrate equipment. If anomalies were detected by a UAV, additional investigation on surface was conducted by terrestrial monitoring personnel. On average, the drilling fluid temperature was recorded at 30 degrees Celsius by downhole sensors, contrasted by average ground surface temperatures below 10 degrees Celsius.

Although drilling fluid circulation was intermittently lost, it was subsequently regained throughout each of the three crossings through implementation of various drilling techniques and addition of intermittent drilling mud additives in select zones. No drilling fluid to surface or within the water course was detected by UAV, terrestrial environmental monitors, or in-stream sonde monitors (Figure 8), attributing to the success of the installations.

CONCLUSION

In total, 10,842 m of pipelines were installed within the three parallel boreholes, 35 m apart, over the course of four months without any lost time incidents, significantly reduced surface disruption due to the collaborative efforts of the projects, and without any environmental impact to the watercourse or fluid release to surface.

This was achieved utilizing various shared resources between the two owner companies, continuous 24-hour per day drilling utilizing the HDD intersect method, a thorough understanding of site-specific and subsurface conditions, various detailed engineering and execution plans, ongoing lessons learned, swift response to changing drilling conditions, and a robust team of support contractors, consultants, and specialists working towards a common goal.

Figure 8. In-stream sondes for water quality monitoring

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GROAT ROAD

Storm Trunk Sewer Rehabilitation

PHASE 2

Christopher Lamont, Associated Engineering, Edmonton, Alberta

The Groat Road Storm Trunk Sewer is constructed of galvanized multi-plate corrugated metal panels (CMP) installed between 1953 and 1955 in the City of Edmonton. Phase 2 is comprised of 2.14 km of 2.34 m diameter pipe along Groat Road from 107 Avenue to 118 Avenue, and 1.76 km of 1.73 m diameter pipe along 118 Avenue between 129 Street and 142 Street, and north on 142 Street to just south of 121 Avenue. Groat Road, 118 Avenue, and 142 Street are major arterial roads with Groat Road, averaging more than 38,000 vehicles per day.

The storm trunk ranges in depths from 7.66 m to 17.6 m and was installed using hand tunneling. Along the 3.9 km trunk sewer included in Phase 2, there are only 10 access locations. Visual inspections in 2014 identified concerns with the structural condition of the sewer, including sections where the invert was missing. As there were no obvious signs of major distress, it was determined that rehabilitating the sewer to extend its useful life was the preferred way forward.

In 2015, Drainage Services (then with the City of Edmonton) conducted a comprehensive inspection program, condition assessment, and design for the rehabilitation of the storm sewer. The inspection program was prepared following a review of the as-built drawings and previous inspection reports. Only 10 0f the 25 manholes along the section provided access for inspection purposes. Distances between access points ranged from 106 m to 855 m. The inspection program included HD CCTV, collection of 2D LiDAR data to supplement the visual information, as well as pipe wall coupons and soil samples at the coupon locations. The 2D LiDAR data provided accurate cross-sections of the storm trunk at 10 m intervals to determine the ovality or "out-of-roundness" of the pipe. There was an almost 300 m section of the storm trunk along Groat Road that was unable to be inspected with the HD CCTV and 2D LiDAR.

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FIGURE 1

FIGURE 2

Results of the inspection program were:

- The majority of the storm trunk was found to have ovality of less than 3%. Only 16 of the 400-plus cross-sections had ovality exceeding 5%.
- Of the 16 sets of three pipe wall coupons (3:00, 9:00, and 12:00), 13 locations had an average wall loss of greater than 30%, with the average wall loss ranging from 13% to 69%.
- Analysis of the soil samples collected from the coupon locations found the corrosiveness of the soil immediately outside the storm trunk to be high.

Since these initial inspections, the contractor has been able to complete the inspection of the 300 m section of the trunk previously not inspected. As expected, the conditions for this section are similar to the storm trunk on either side. During the inspection, the contractor discovered a 420 mm horizontal offset in the tunnel. This was not readily apparent from the 2D LiDAR information, making a case for a 3D LiDAR survey, especially for larger diameter pipes. A review of the CCTV of this location does show the offset, although it does not appear to be to this large a degree in the video image. To deal with this offset, the contractor is considering several options including locating a shaft at this location.

Following the condition assessment, a total of 14 rehabilitation technologies were identified, and using the value engineering approach, this was narrowed down to four technologies. The four technologies carried forward were:

- Sliplining
- Spiral Wound Pipe
- Centrifugally Cast Concrete Pipe (CCCP)
- Cured-In-Place Pipe (CIPP)

In preparing the final designs for each technology, the following criteria were developed as follows:

- Restore the structural stability of the storm trunk sewer (the ongoing external corrosion of the CMP required a fully deteriorated rehabilitation design)
- Utilize a hydrostatic pressure of 13 psi to 25 psi depending on the depth of the storm trunk as the ground water table is near the ground surface

- Geostatic pressure of three times the pipe diameter based on original installation by tunneling
- Minimum design life of 50 years
- Minimize loss of cross-sectional area/maintain at 100% of the original hydraulic capacity

Following completion of the design, a Negotiated Request For Proposal was issued for Design Build contractor teams. Four contractor teams responded with six proposals, with the successful contractor proposing a slipline installation.

The project was separated into two parts – Part A, which included the storm trunk along 142 Street, 129 Street, as well as 118 Avenue, and Part B, along Groat Road between 118 Avenue to 107 Avenue. In 2018, Part A was awarded to Shanghai Construction Group Corporation Canada (SCGCC) based on completing the project by sliplining with fiberglass reinforced pipe (FRP) supplied by HOBAS. Work began with conducting inspections, investigations, and design.

The alignment was composed of straight and curved sections. SCGCC requested permission to alter the project requirements to support the pipe from invert paving to a rail system which was comprised of the installation of two steel pipes as rails. These rails were to be secured to the CMP prior to sliplining. The rail system acts as a guide for the FRP to follow in an effort to minimize the damage by the bolts securing the CMP. Frictional forces required to slipline are also reduced. While curved terminology is used to describe the sections of the storm trunk which are not straight, they were chords separated by 15-degree bends. SCGCC selected to hand place the FRP in sections with the bends and chords, then use the sliplining machine to jack the FRP in place on the longer straight sections.

Three straight sections were identified for use of the sliplining machine: one along 142 Street approximately 260 meters in length, and one along 118 Avenue approximately 940 meters in length which was split into two drives of 500 meters and 440 meters. Four curved sections were identified: one at the corner of 142 Street and 118 Avenue, two at the traffic circle at 118 Avenue and Groat Road, and one at the intersection of 129 Street and 118 Avenue.

SCGCC conducted an assessment of the existing CMP to determine the feasibility of sliplining with a 1,524 mm OD fiberglass pipe based on the information at the time of tender. Inspections, 3D scanning, and mandrel testing were carried out that provided the information on the alignment and diameter of the CMP. SCGCC conducted walkthrough inspections of the storm trunk and measured the inside of the CMP including the clear inner diameter with the bolts. Measurements were taken at regular intervals to determine if any significant reduction in diameter

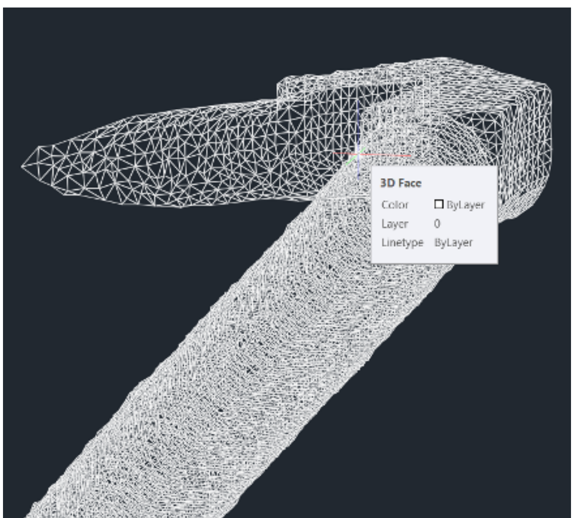

FIGURE 3

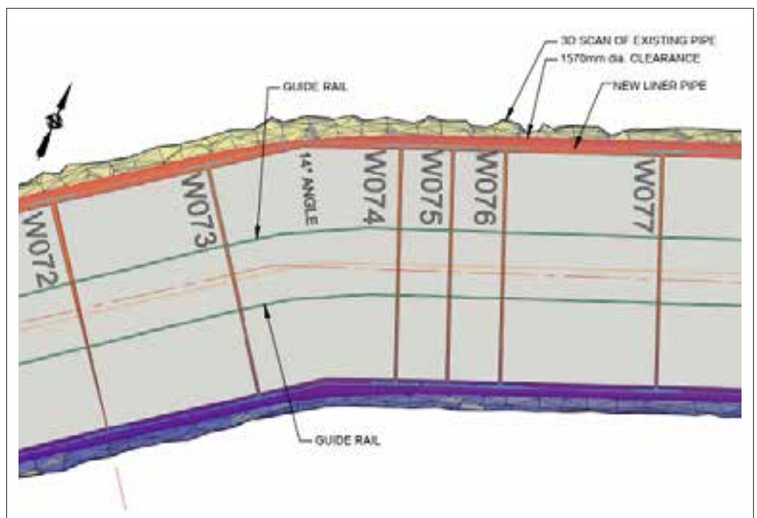

FIGURE 4

FIGURE 5

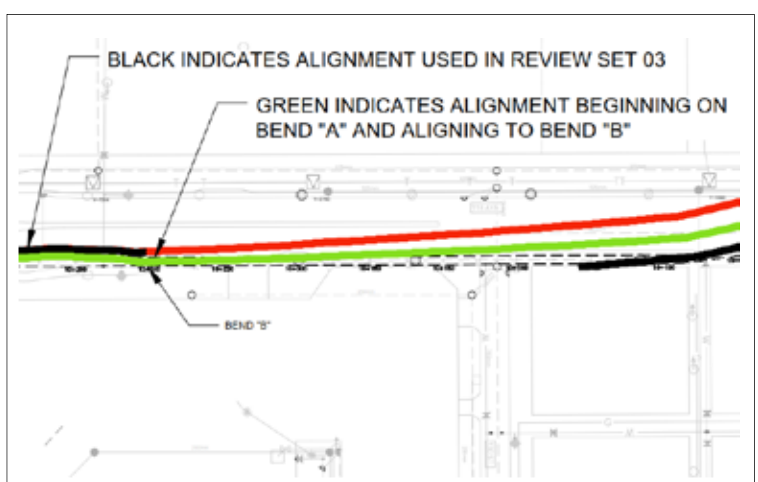

FIGURE 6

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or ovality existed. It was found that the clear space within the CMP pipe was less than previously noted and that the pipe size needed to be reduced to a 1,430 mm pipe. Mandrel testing was completed using mandrels of 1,524 mm and 1,430 mm to conduct clearance measurements and to provide a visual confirmation of the appropriate pipe size. Maintaining capacity of the storm sewer was a project requirement. Use of the FRP pipe maintained or, in some cases, increased the capacity of the storm sewer.


FIGURE 7


FIGURE 8


FIGURE 9

Redzone Inc. conducted scanning and provided a wireframe scan of the CMP for 3D modelling and pipe length selection. It was found that the wireframe scan taken did not match the internal measurements taken during the walkthrough inspection. Using the measured dimensions taken from the CMP inspection, the wireframe was calibrated to the actual size of the CMP.

The wireframe was used to generate 3D models of options to place segmented pieces of FRP pipe within the CMP. 300 mm, 900 mm, and 1,500 mm lengths of pipe as well as bends of select angles were used to model the FRP in place with the rail system. Lay schedules were used to cut the individual pieces of pipe to be installed by hand.

Prior to ordering and cutting all of the pipe, one curved section was completed first to confirm the method would be successful with such a small annular space. At that point the remaining pipe was ordered and cut as construction progressed. Curved sections ranged from 65–260 meters in length. Carrying pipe weighing 313 kg/m within a 1,570 mm clear space provided a challenge. A pipe carrier was designed that would run on the rail system, significantly reducing the effort needed to push the pipe to be placed instead of carrying it.

During the inspection other obstacles were found that affected construction, as the potential pipe length able to navigate the existing CMP does influence the size and type of shaft. Shaft types were changed because of a previously unknown bend. A sudden shift in alignment forced SCGCC to relocate the shaft, change its type, and change sliplining from jacking to hand placement and reduced the length of pipe by half. The 3D model was key to estimating the length of pipe that could be pushed through the bend.

The contract specified that the entire invert of the CMP was to be paved with a high strength concrete to support the slipline pipe during installation. Sections of the CMP were significantly deteriorated and, in some cases, completely missing. SCGCC completed invert repair on various sections where the invert was entirely corroded. Construction was planned over the course of the fall and winter months when base flows and the risk of severe storms and high flows were reduced. Cold winter base flows were found to be around 150–250 mm in depth. Patching the invert within base flows required the use of sand bag weirs and gravity bypass lines. Once the bypass was in place, efforts were made to pump out the water within the voids beneath the CMP to conduct the invert repair. Flows were also found to exist beneath the CMP, which made pumping out the void impractical. The flows, which travel beneath the invert of the CMP, pulled the initially placed concrete downstream out of the void. At that point SCGCC explored the use of a grout that had a quick set time and that could be used within flowing water. Sikaset Plug was found to have an initial set time of 60–90 seconds and stayed in place within the flows, which confirmed its viability for use.

Previous inspections of the storm sewer indicated a number of voids outside of the CMP; these were also seen during the inspections completed by SCGCC. As a result, void grouting with six ports every eight meters was specified in the design. These ports were installed at the spring line of the CMP, 300 mm down from spring line, and 600 mm down from spring line with additional port locations being identified during construction if additional voids were found. Grout was injected up to 69 kPa at each port. Holes for the grout ports were drilled and then the port, with a backflow preventing valve, was hammered into place. Large holes in the CMP were also patched.

Void grouting within the CMP experienced some challenges as the pipe was severely corroded, at times with dozens of holes per square meter, resulting in significant loss into the storm sewer as shown in Figure 5. Using pressurized grout resulted in the material escaping through open paths into the CMP. Additional ports were used while grouting the large invert repair section.

The hand placement installation experienced some challenges with the pipe carrier as well as the pipe puller. Operating the carrier in such a tight space resulted in two redesigns of the equipment, until one was found that worked well with minimal effort to push pipe sections up to 1.5 meters in length. Hand placement of the pipe began slowly with the crews working in tight spaces. Production reached a peak at a daily installation of 27 pieces of the 1.5 meter pipe segments (approximately 40.5 meters). Each hand-placed section was blocked in place to protect the pipe from buckling and floating during grouting.

FIGURE 10

FIGURE 11

FIGURE 12

The longest slipline sections were 500 meters and 440 meters in length. These sections crossed through multiple manholes including some with laterals from other minor storm systems. A challenge during the long installation lengths was maintaining a sufficient supply of pipe onsite, as pushing 180 meters would only take a few hours in the morning to complete but would deplete the stockpile onsite, requiring additional pipe being brought in over the next few days. Using the sliplining machine throughout the winter was a challenge due to the cold winter conditions as temperatures reached as low as -35 C. Cold winter conditions also resulted in the storm trunks base flow freezing at the bottom of the seven-meter deep shaft, creating an ice dam that halted sliplining operations until the ice could be removed.

The hand-placed sections of CMP were blocked in place, but flotation was considered an issue on sections installed with the sliplining machine. Contract documents specified grouting the annular space with a 6 MPa strength material, with potential options including cellular and a custom grout with no aggregate. Buoyancy calculations were completed based on multiple grouting material options to determine the most efficient option to grout the annular space.

As construction progressed into spring, flows began to increase. Originally, the annular space grouting was to be completed with ballast by using an inflatable plug to hold the existing flows within the section of pipe being grouted. In these conditions the grouting could be done with a few large lifts without floating the pipe. Due to the increased risk of storm flows as the weather warmed, ballast was not considered an option because of concerns of blocking the trunk in high flow conditions.

Initially plans to grout from one end to the other of the long stretches were developed with the grout expected to flow up to 500 m in large lifts. Due to the warming weather and the loss of ballast, the grouting lift heights were reduced significantly. As the modified grouting program started it was evident that having the small grout volume flow in the tight annular space that distance was not realistic. Grouting operations were then completed with grout placed from both upstream and downstream manholes.

Complications occurred when the grout would gel up on the surface prior to being pumped. The grout was highly flowable when being agitated, but when left to sit for a longer period of time, it would start to stiffen up and become a challenge to place. With the help of the grout supplier Lafarge, aeration grids were built to continually agitate the grout on the surface prior to being pumped into the annular space which helped reduce the gel effect.

Ten manholes and one chamber were identified for rehabilitation. After the manholes were cleaned, infiltration sealing and patch grouting were required prior to the spray-on application. Some manholes required removal of baffles to conduct the lining. Bypasses were set up within the manholes to contain the flows from the laterals and SCGCC conducted the rehabilitation using a spray-on cementitious liner.

EPCOR engaged SCGCC to conduct an inspection and investigation on Part B of the project. The purpose was to confirm the conditions within the 2,337 mm CMP and to determine if the proposed 1,916 mm FRP would be feasible. Through the inspection, the pipe size was confirmed as proposed, and in June of 2019 SCGCC was awarded Part B. Construction began in early September with the construction of shafts, with the sliplining occurring over the next 12 months.

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Congratulations on Your Retirement, Mike!

After more than a decade at the helm of NASTT, former Executive Director Michael J. Willmets is retiring.

Michael (Mike) Willmets joined NASTT in 1998 as the municipal representative for the Region of Ottawa-Carleton in Ottawa, Canada. He became the Chair of the Great Lakes, St. Lawrence & Atlantic Chapter of NASTT in 2004 and was elected to the NASTT Board of Directors in 2005. Mike has volunteered his time as a long-term member of the NASTT No-Dig Show Program Committee and served as an Instructor for NASTT's Trenchless Technology Short Course.

After 35 years in infrastructure management, Mike retired from the City of Ottawa in 2008 and started the next day as NASTT's Executive Director. Throughout his career, he has received many industry awards including a Canadian Engineering Award of Merit and NASTT's 2002 No-Dig Show Outstanding Paper Award for large diameter water main rehabilitation.

A former member of the Canadian Armed Forces, Mike maintains strong ties with several military associations and is an avid kayak/canoe enthusiast.

The NASTT Staff and Board of Directors will miss Mike's leadership, wisdom, and humour!

Best of luck on your next adventure, Mike!

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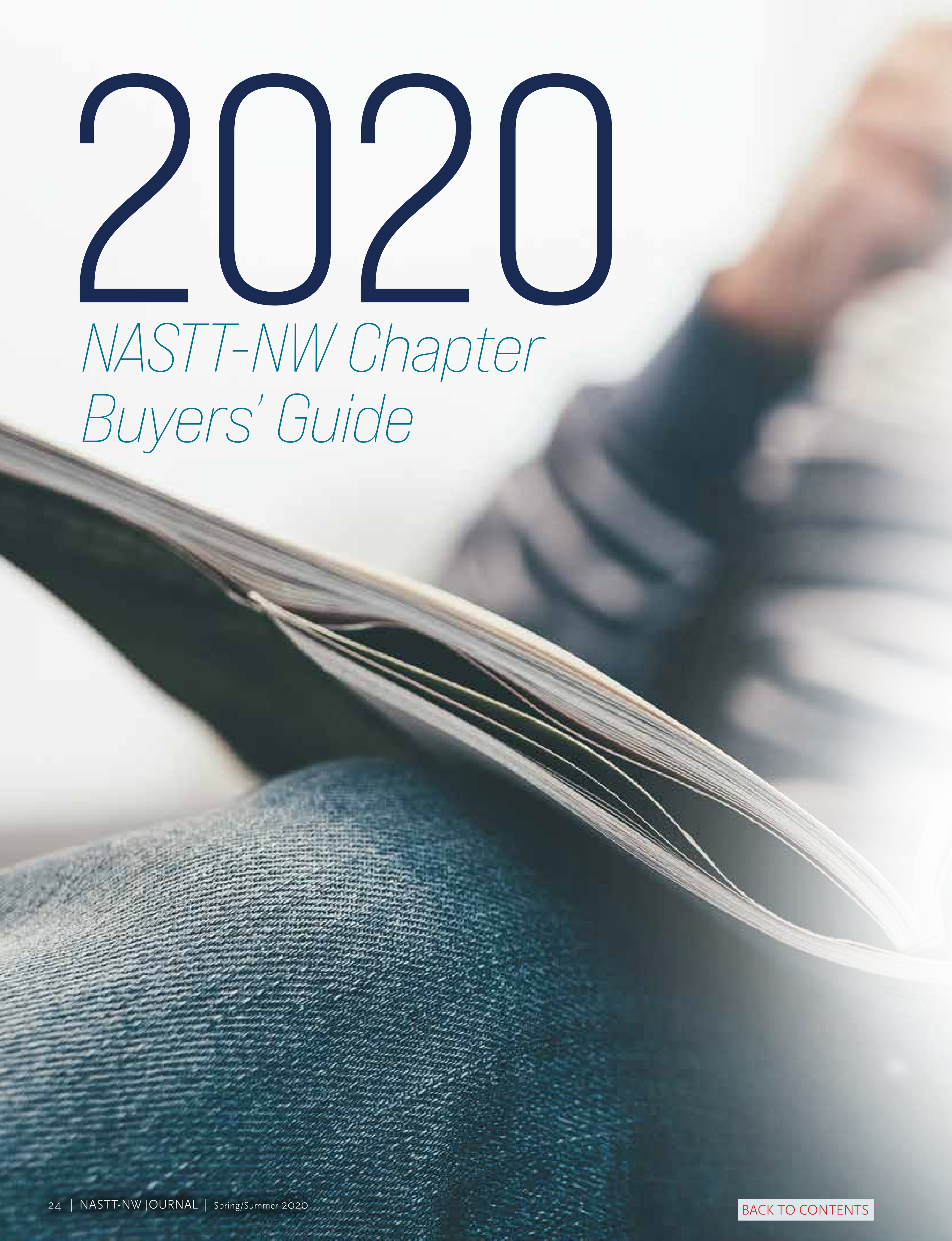
2020
NASTT-NW Chapter Buyers' Guide



When making purchasing decisions about products and services in the trenchless technology industry throughout Manitoba, Saskatchewan, Alberta, and beyond, please support the companies whose advertising makes the *NW Trenchless Journal* possible. You will find them quickly with our convenient, easy-to-use Buyers' Guide.

On the following pages, you will find information that will help you meet your purchasing requirements throughout the year ahead. The initial section of this Guide lists categories of products and services along with the various companies that can provide them to you. The following section provides an alphabetical listing of those companies, as well as the contact information you will need to reach them.

Listings By Category:

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CIPP Liner QC Testing
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IVIS Inc.

Construction Management
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Tridyne Projects Corporation

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Associated Engineering

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Direct Horizontal Drilling Inc.
Precise Crossings
Underground Magnetics

Directional Drilling Accessories
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Associated Engineering
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