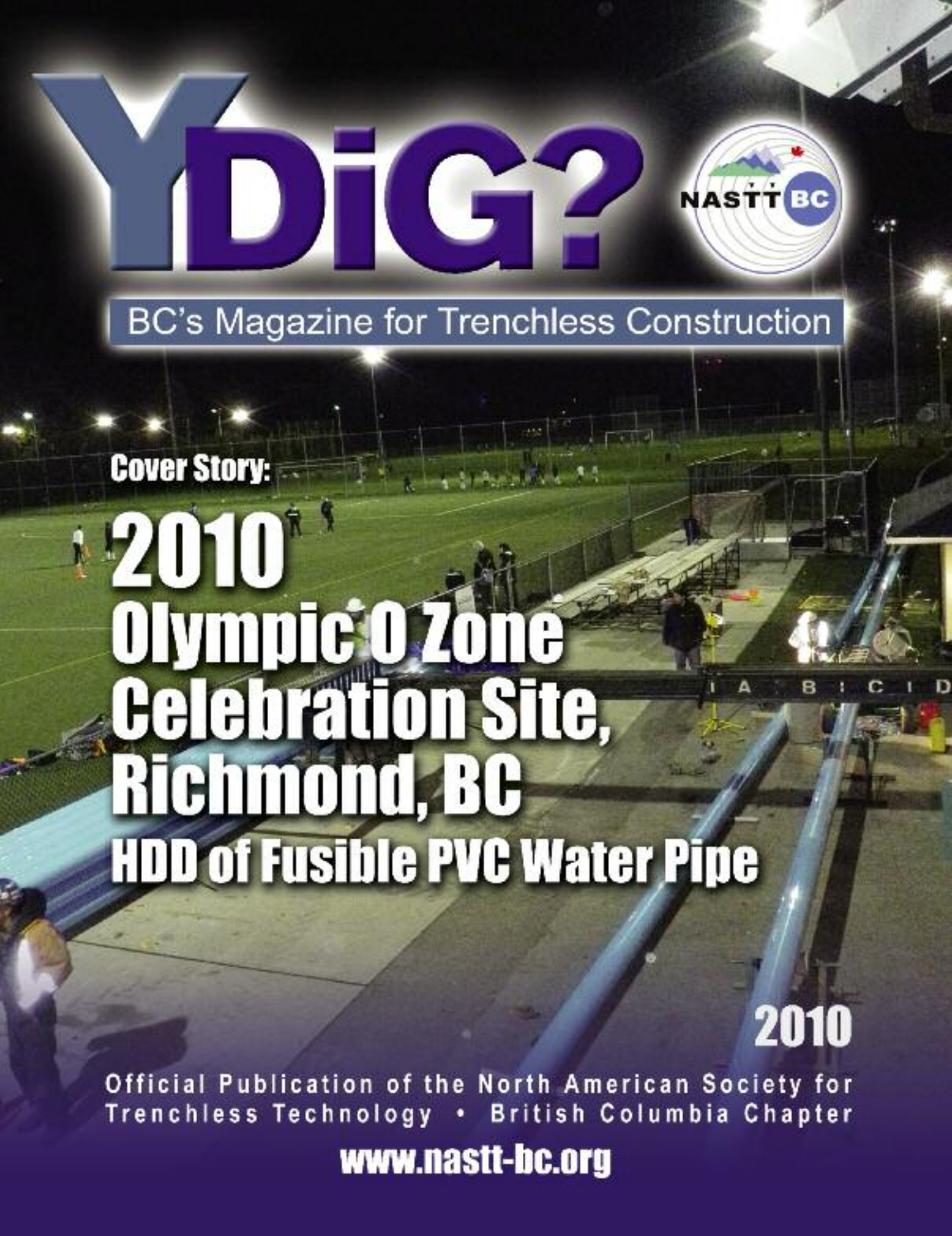
YDiG?

BC's Magazine for Trenchless Construction



Cover Story:

2010 Olympic O Zone Celebration Site, Richmond, BC

HDD of Fusible PVC Water Pipe

2010

Official Publication of the North American Society for Trenchless Technology • British Columbia Chapter

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NASTT BC

North American Society for Trenchless Technology - BC Chapter

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President's Message

Anton Benes

The economic instabilities of 2009 adversely affected all business sectors, including construction in BC. At the same time, many large infrastructure projects related to the Olympics drew to a close, exacerbating the situation. Trenchless construction projects most likely mirrored the same declines experienced by the construction industry in general.

Last year, NASTT-BC continued developing its first-of-a-kind Trenchless Carbon Calculator. The calculator, originally introduced at the 2007 UBCM, demonstrates how Trenchless Technologies can be effective for municipalities in reducing their carbon footprints. This simple tool is now recognized throughout North America, and in other parts of the world, as a valuable concept worthy of further development. Through private and public funding, and the tireless efforts of David O'Sullivan of PW Trenchless Inc. and others, the calculator has been made more versatile and powerful. It is now in Beta testing and will be unveiled to the municipalities and other interested parties in early 2010 (see articles pages 10 & 24).

The BC Government continues to mandate reductions in greenhouse gas emissions, and municipalities are under increasing pressure to track and reduce their carbon footprints. This was reflected in heightened interest in the trenchless solutions exhibited at the NASTT-BC booth at the 2009 UBCM tradeshow. This interest represents a golden opportunity to market the value of the Carbon Calculator and the trenchless industry in general.

NASTT-BC must increase its efforts to promote the trenchless industry, but to do so successfully, we need more members to become actively involved in the society. If you have not considered getting involved in NASTT-BC, please consider doing so now. We are looking for individuals to join the board of directors, but even a smaller commitment can make a big difference. Members who become active in the society learn and benefit from the exchange of ideas and business with others in their industry. More information can be found on page 27.

As we head through 2010, the trenchless industry continues to offer viable solutions for reducing CO2 emissions. NASTT-BC has an important role to play in this and will continue to build on the exceptional work completed to date. We look forward to working with you, our members, to build a stronger NASTT-BC.

Anton Benes, P.Eng.
Kerr Wood Leidal Associates Limited

NASTT - BC BOARD OF DIRECTORS

www.nastt-bc.org

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From the NASTT Chairman

Chris Brahler, Chairman, NASTT

The first part of my term as NASTT Chair has been exciting and energizing! It has been an honor to represent an association and an industry that in so many ways epitomizes the true spirit of innovation, ingenuity and good old fashion hard work. That hard work begins with NASTT Regional Chapters like the NASTT-BC.

I would like to personally acknowledge the tremendous accomplishments of NASTT-BC members on demonstrating the benefits of trenchless on a geo-environmental level. The extensive research into the carbon footprint of trenchless projects is by far some of the most exciting, engaging and cutting edge work being done in the trenchless industry. And the Carbon Calculator, available on the NASTT-BC Web site, is a major achievement!

Congratulations to the NASTT-BC chapter for all of the great work being done. Terrific job everyone!

Chris Brahler
Chairman, NASTT
TT Technologies, Inc.

NASTT Turns Platinum

Mike Willmets, Executive Director, NASTT

Twenty years ago, a small group of engineering people set out to make a difference. Great things often develop from humble beginnings, and this is certainly the NASTT story.

Our Platinum Anniversary celebration offers us an opportunity to reflect on our founders, on our past accomplishments, and upon what we are most proud of. Without question, NASTT owes its reputation and good standing to the tireless efforts of the volunteer membership, past and present, young and old. From these dedicated members, strong leadership has emerged, guiding the Society at both the national and regional levels, through good and bad times.

Certainly, the entire NASTT adventure has been made possible because of the Trenchless industry's loyal support. These contributions come in all forms and from all sectors, making our all - volunteer family rather a unique organization. Representation from suppliers, manufacturers, consultants, contractors, academics and from all levels of government has been our collective strength.

With maturity and growth, came new initiatives and improvements to old ones. Our training sessions and publications continue to be in great demand, and it would appear, in tune with current needs. Based on attendance, the "Jewel in our Crown", the annual NASTT No-Dig Show, has been blessed with the industry's stamp of approval. The No-Dig Show now presents 140 technical papers and our 50,000 sq. ft. exhibit hall hosts more than 120 vendors. While we offer more each year to our attendees, we also focus on keeping the cost as affordable as possible. Much like trenchless itself, No-Dig delivers a quality product at a reasonable cost.

NASTT is marking this 20th Anniversary by paying tribute to both achievement and education through our past champions. A scholarship program in the name of the late Michael E. Argent, one of the five founders of NASTT, will provide special financial assistance to five of our Students Chapter members. In the memory of the late Trent Ralston, our 6th NASTT Chairman, a new award for "Young Trenchless Achievement" has been created to recognize a young individual who has demonstrated excellence in the early stages of their career.

The prospects for NASTT's role in the years to come appear to be significant as the escalating need to be more environmentally, economically, and socially sustainable continues to pressure our communities. By continuing to provide education to the public and private sectors of the ever-evolving Trenchless Technologies, NASTT can and will be a significant contributor in achieving these goals, as well as making a positive change in the way we live and how we manage our critical infrastructure.

Happy Birthday NASTT and here's to twenty more years!

Mike Willmets
Executive Director, NASTT

MOVIN' ON UP!

NASTT Offices Address Change

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Web Sites: www.nastt.org & www.nodigshow.com

PLEASE UPDATE YOUR RECORDS AND COLLEAGUES!

QUESTIONS ABOUT TRENCHLESS?

We Have Answers.

NORTH AMERICAN SOCIETY *FOR* TRENCHLESS TECHNOLOGY

Get Connected to the Trenchless Industry

NASTT is your link to thousands of local, national and international trenchless professionals and industry leaders. Whether your business is engineering, public works and utilities, underground construction, or equipment manufacturing, NASTT is the definitive resource for the trenchless industry and the application of trenchless methods for the public benefit.

Education & Training

NASTT provides top-notch, quality education and training programs for trenchless professionals. Currently, NASTT offers six training courses covering Cured-in-Place-Pipe (CIPP), Horizontal Directional Drilling (HDD), pipe bursting, sewer lateral rehabilitation, an overview of trenchless technologies, and new installation methods such as auger boring, pipe jacking, pipe ramming, and the pilot tube method. Earn Continuing Education Units (CEUs) for your participation.

Join Today

From educational resources to training tools and more, NASTT members have access to a wealth of valuable information and networking opportunities.

Membership benefits include:

- Members-only discounts
- Complimentary access to online reference tools and publications
- Subscriptions to industry trade magazines
- Leadership opportunities
- Involvement in your regional chapter
- And much more! *Our members often join for one reason, only to discover the value of many others.*

Joining is easy. **Visit our Web site at www.nastt.org or call 613-424-3036 (in Canada) or 703-217-1382 (in U.S.) for membership details.**

The Show!

The annual No-Dig Show is the largest trenchless technology event in North America, offering an impressive collection of quality papers, an exhibition hall with more than 125 trenchless companies displaying their products and services, a series of specialized training courses, and many entertaining networking events and special awards.

Mark your calendars for NASTT's No-Dig Show, May 2-7, 2010, in Chicago (Schaumburg), Illinois!

1655 N. Ft. Meyer Drive, Suite 700
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www.nastt.org

NASTT Training Courses, Conferences & Chapter Events

2010 NASTT No-Dig Show

Sunday, May 2, 2010 - Friday, May 7, 2010

Renaissance Schaumburg Hotel - Chicago (Schaumburg), Illinois

Sponsored by the North American Society for Trenchless Technology (NASTT). 140 technical paper presentations, 50,000 sq. ft. exhibition hall, networking events, annual NASTT Educational Fund Auction, NASTT's good practices training courses, and special awards and events to commemorate NASTT's 20th anniversary! Early bird registration deadline is April 2, 2010. NASTT members save $200 on full conference registration rates. Renaissance Schaumburg Hotel cut-off date is April 2, 2010. Call today to make your reservations: 847-303-4100. Or go to: http://cwp.marriott.com/chirs/nasttn-odig/.

Contact Info:

Web site: http://www.nodigshow.com
Benjamin Media, Inc. (Conference Management)
Phone: 330-467-7588
Email: info@benjaminmedia.com

NASTT Pipe Bursting Good Practices Course

Wednesday, May 5, 2010 (2:30 PM) - Thursday, May 6, 2010 (12:00 PM)

Renaissance Schaumburg - Chicago (Schaumburg), Illinois

Held in conjunction with the 2010 No-Dig Show. Types, methods and applications of pipe bursting; planning and preliminary design; design and construction; and troubleshooting. Earn 0.8 Continuing Education Units (CEUs) for your participation.

Contact Info:

Web site: http://www.nodigshow.com
Benjamin Media, Inc. (Conference Management)
Phone: 330-467-7588
Email: info@benjaminmedia.com

NASTT Cured-in-Place-Pipe Good Practices Course

Wednesday, May 5, 2010 (2:30 PM) - Thursday, May 6, 2010 (12:00 PM)

Renaissance Schaumburg - Chicago (Schaumburg), Illinois

Held in conjunction with the 2010 No-Dig Show. In-depth overview of wastewater mainline and lateral pipe rehab using CIPP. Earn 0.8 Continuing Education Units (CEUs) for your participation.

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Web site: http://www.nodigshow.com
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Phone: 330-467-7588
Email: info@benjaminmedia.com

NASTT New Installation Methods Good Practices Course

Wednesday, May 5, 2010 (2:30 PM) - Thursday, May 6, 2010 (12:00 PM)

Renaissance Schaumburg - Chicago (Schaumburg), Illinois

Held in conjunction with the 2010 No-Dig Show. Topics covered: auger boring, pipe ramming, pipe jacking and pilot tube. Earn 0.8 Continuing Education Units (CEUs) for your participation.

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Benjamin Media, Inc. (Conference Management)
Phone: 330-467-7588
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NASTT Laterals Good Practices Course

Wednesday, May 5, 2010 (2:30 PM) - Thursday, May 6, 2010 (12:00 PM)

Renaissance Schaumburg - Chicago (Schaumburg), Illinois

Held in conjunction with the 2010 No-Dig Show. Provides techniques for maintaining, rehabilitating and replacing sewer laterals and connections, using case studies, field data and surveys results. Earn 0.8 Continuing Education Units (CEUs) for your participation.

Contact Info:

Web site: http://www.nodigshow.com
Benjamin Media, Inc. (Conference Management)
Phone: 330-467-7588
Email: info@benjaminmedia.com

Horizontal Directional Drilling Good Practices Guidelines Course

Wednesday, May 5, 2010 (2:30 PM) - Thursday, May 6, 2010 (12:00 PM)

Renaissance Schaumburg - Chicago (Schaumburg), Illinois

Held in conjunction with the 2010 No-Dig Show. In-depth overview of HDD from planning to job completion. Receive a complimentary copy of the HDD Good Practices Guidelines Manual and earn 0.8 Continuing Education Units (CEUs) for your participation.

Contact Info:

Web site: www.nodigshow.com
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Phone: 330-467-7588
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ISTT International No-Dig 2010

Monday, November 8, 2010 - Wednesday, November 10, 2010

Suntec Convention Center - Singapore

Exhibition space is already attracting an excellent line-up of international companies wishing to display their products to the Asian market. Early bird rates effective until Nov. 30, 2009.

Contact Info:

Web site: www.nodigsingapore.com
Paul Harwood, Westrade Group Ltd.
Phone: +44 845 0948066
Email: pharwood@westrade.co.uk

2011 NASTT No-Dig Show

Sunday, March 27, 2011 - Friday, April 1, 2011

Gaylord National - Washington, D.C.

Sponsored by the North American Society for Trenchless Technology (NASTT).

Contact Info:

Web site: http://www.nodigshow.com
Angela Ghosh
Phone: 703-217-1382
Email: aghosh@nastt.org

ISTT International No-Dig 2011

Monday, May 2, 2011 - Thursday, May 5, 2011

Berlin, Germany

This event will be held in conjunction with the Wasser Berlin International at the Berlin Exhibition grounds. Exhibition space is now available. Early bird discounts effective - 20% reduction for bookings received by Dec. 31, 2009 and 10% for bookings received by June 30, 2010.

Contact Info:

Web site: www.nodigberlin2011.com
Dr. Klaus Beyer, German Society for Trenchless Technology
Email: beyer@gstt.de

2012 NASTT No-Dig Show

Sunday, March 11, 2012 - Friday, March 16, 2012

Gaylord Opryland - Nashville, Tennessee

Sponsored by the North American Society for Trenchless Technology (NASTT).

Contact Info:

Web site: http://www.nodigshow.com
Angela Ghosh
Phone: 703-217-1382
Email: aghosh@nastt.org

2014 NASTT No-Dig Show

Sunday, April 13, 2014 - Friday, April 18, 2014

Gaylord Palms - Orlando, Florida

Sponsored by the North American Society for Trenchless Technology (NASTT).

Contact Info:

Web site: http://www.nodigshow.com
Angela Ghosh
Phone: 703-217-1382
Email: aghosh@nastt.org

NASTT Forum: Reduce Your Carbon Footprint Using Trenchless Technology

The North American Society for Trenchless Technology (NASTT) held an expert panel discussion on the timely issue of Reducing Your Carbon Footprint Using Trenchless Technology, in conjunction with the Underground Construction Technology (UCT) International Conference and Exhibition, Tuesday, Jan. 19, at the Tampa Convention Center in Tampa, Florida.

Looming federal carbon legislation is challenging cities and municipalities across North America to consider carbon loading as an integral element of their construction business. The good news for both owners and contractors is that by using trenchless technology, carbon emissions can be reduced to as much as 85 percent.

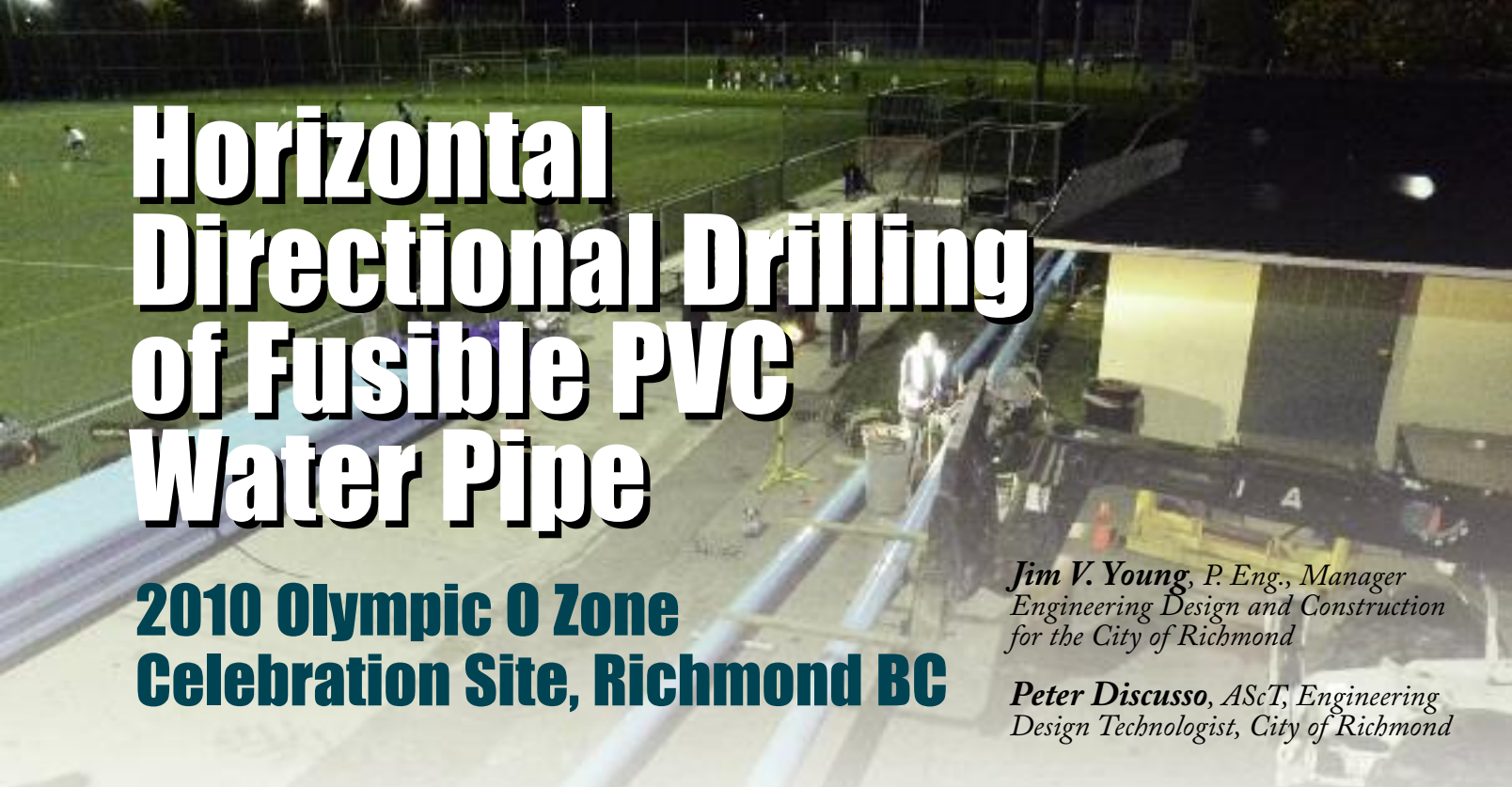
George Ragula, Distribution Technology Manager at Public Service Electric and Gas and the 2010 Vice Chairman of NASTT, served as moderator.

The NASTT carbon calculator, developed by the NASTT-British Columbia Chapter, allows users to estimate the reduction in CO2 emissions when trenchless is used versus open-cut methods. This new software program is developed to accept construction parameters and calculate the carbon loading of the job.

L-R: Isabel Tardif, Samuel T. Ariaratnam, Keith Hanks, David O'Sullivan and George Ragula.

David O'Sullivan presented on the benefits of the NASTT carbon calculator. Following his presentation, NASTT panelists discussed how we can be proactive in reducing our carbon footprint using trenchless technologies and invited input and questions from audience members. Approximately 25 people attended.

Panelists included: Samuel T. Ariaratnam, Ph.D., P.E. - Professor, Del E. Webb School of Construction, Arizona State University and 2010 ISTT Chairman; Chris Brahler - President, TT Technologies Inc. and 2010 NASTT Chairman; Keith Hanks, P.E. - Senior Engineer, City of Los Angeles and Past NASTT Board Member; David O'Sullivan - President, PW Trenchless Construction and member of the NASTT- British Columbia Chapter; and Isabel Tardif, B.Eng., LL.B., M.P.M. - Technologies Director, Centre for Expertise and Research on Infrastructure in Urban Areas (CERIU) and NASTT Board Member. ●



Horizontal Directional Drilling of Fusible PVC Water Pipe

2010 Olympic O Zone Celebration Site, Richmond BC

***Jim V. Young**, P. Eng., Manager Engineering Design and Construction for the City of Richmond*

***Peter Discusso**, AScT, Engineering Design Technologist, City of Richmond*

ABSTRACT

The City of Richmond is part of Metro Vancouver in British Columbia, Canada and is located on a flood plain with elevations ranging from approximately 0.6 metres to 2.5 metres above sea level. These physical attributes present numerous challenges and opportunities with underground utility design and construction. Design and construction of water mains in combination with soft soil, river delta ground conditions in particular, lends itself to trenchless construction opportunities.

The City established an Asbestos Cement water main replacement program in the 1990's and the Minoru Park water main replacement project was designed to be undertaken through directional drilling. As a first for the City, the City used a fusible C900 DR18 PVC water pipe system as supplied by IPEX, as an innovative "trenchless" opportunity and one that would reduce costs, minimize schedule and bring to a minimum the impacts on the highly utilized Minoru Park, located in the forefront of the City center and the location of the Richmond 2010 Olympic celebration site. Implementation of this alternative method proved to be successful and was recognized as an opportunity for future water main installation work.

BACKGROUND

The City of Richmond is located on a flood plain with elevations ranging from approximately 0.6 metres to 2.5 metres above sea level. These physical attributes present numerous challenges and opportunities with underground utility design and construction.

The City purchases potable water from Metro Vancouver and has a distribution system of approximately 750 km of water mains ranging in diameter from 100 mm to 1050 mm. Approximately 52% (387 km) of the water mains in Richmond are Asbestos Cement pipe.

THE RICHMOND 2010 OLYMPIC WINTER GAMES O ZONE

As a Venue City for the 2010 Olympic Winter Games, Richmond has the privilege of producing and hosting one of the official 2010 Olympic Winter Games Celebration Sites, the Richmond O Zone. The O Zone, located in Minoru Park, is one of the most important components in the City of Richmond Olympic Plan to help achieve the City's Olympic and Community goals. Produced by the City of Richmond, the O Zone is a live celebration site in the Richmond City Center that will be open to the public for Olympic viewing, family fun, entertainment, activities and more.

One of the many challenges with the O Zone was the ability to provide a reliable source of potable water to the numerous venues, including the unique outdoor skating path/rink. The existing 150 mm (6-inch) water main crossing Minoru Park was constructed using Asbestos Cement pipe in 1969 and was nearing the end of its useful service life. More alarming was the significant and recent history of breaks – a water main break(s) in the O Zone during the 2010 Olympic Winter games would be considered disastrous to the success of the O Zone and to the City of

Pipe staging and fusing looking north

Richmond's reputation in general.

Horizontal directional drilling is gaining popularity in the Metro Vancouver area as an accepted method of installing watermains. In the City of Richmond's Minoru Park, approximately 476 meters (1560 feet) of aging 150mm (6-inch) diameter Asbestos Cement pipe was replaced using horizontal directional drilling and Fusible PVC C900 DR18 Pressure Pipe, a first for Richmond.

ASBESTOS CEMENT WATER MAIN REPLACEMENT PROGRAM

The City established a proactive water main replacement program in the 1990's with particular emphasis on replacing the asbestos cement (AC) mains. AC mains were installed as the small diameter watermain material of choice over the period 1952 to 1985 in the City and were in common use throughout the municipal sector in most areas of Canada and North America. In general, those AC mains that are under 300 mm (12-inch) in diameter have been prone to a decreased life expectancy through an accelerated loss of structural strength leading to diminished water system reliability. There is also the unfavorable public perception of drinking water being in contact with asbestos.

AC water mains in the City of Richmond have been found to be particularly vulnerable to the local conditions, specifically groundwater and the soil composition. As the City is located essentially at sea level, the phreatic surface is influenced by the tidal cycle and typically ranges from approximately 1.0 to 2.5 metres below ground level. During rainfall events it is not uncommon for the phreatic surface to be at the ground surface.

The City's AC pipelines are eroding from both the inside and outside of the pipe. Water in the past supplied from the Greater Vancouver Water District had a low ph that accelerates leaching of cement mortar from the inside wall of the AC water pipes. Similarly, the high water table and aggressive soil in Richmond accelerates the cement mortar leaching from the outside pipe wall of the AC water mains. These two factors have combined to reduce the effective life of the City's AC pipelines below the anticipated 75-year design life.

Given the reduced life expectancy of AC watermains and the asso-

200mm diameter Ipex Fusible PVC pipe on site awaiting installation

ciated impacts on system reliability, the City has taken a proactive role in this regard by developing an AC watermain replacement program.

MINORU PARK WATER MAIN REPLACEMENT DESIGN

The Minoru Park water main replacement project was designed to facilitate installation of fusible C900 PVC water pipe through Horizontal Directional Drilling. The alternative of completing pipe installation through traditional open-cut methods was not acceptable given the significant impact to Minoru Park landscaping/amenities and the complete inability to satisfactorily restore this showcase park prior to the commencement of the 2010 Olympic Winter Games.

The City had successfully completed directionally drilled watermain projects in the past using continuously "welded" pipe, usually High Density Polyethylene. While C900 PVC pipe has widely been used throughout the City on standard open-cut projects, the City had limited previous experience with Fusible PVC pipe in a directionally drilled application. Fortunately, the use of Fusible PVC pipe had been proven in numerous similar applications throughout North America.

Pipe staging and entry pit looking south

The soil conditions in general in the City represent excellent conditions for trenchless technologies, including horizontal directional drilling. A typical soil profile is generally a thin layer of construction related granular materials at the surface overlying an approximately 2 to 4-metre thick layer of a soft to firm silt mixed with clay. It is within the silt/clay layer where main installation is completed. The City could proceed at this location and others with a great deal of confidence that uniform conditions would exist and that there would be no significant obstacles, i.e., boulders, etc., that would impede progress. Accordingly, the City completed a detailed review of this opportunity and considered the following main items.

Evening operation during sporting event allowing use of facility

Advantages

1. Minimized disruption to park users – Open-cut procedures on the Minoru Park water main replacement project would have considerable impact on the park patrons and residents in general in the vicinity of the work. Specifically, the water main crossing Minoru Park traverses an all weather artificial turf playing field, numerous park related amenities, a cricket field and considerable landscape features. With strategic placement of the three entry/exit pits, horizontal directional drilling would eliminate virtually all park related impacts and allow sports and recreational related activities to proceed unhindered. Installation of fusible PVC pipe in particular through horizontal directional drilling

Ulmer Contracting set-up of drill rig at south entry pit

Vermeer D20x22 drilling rig in operation

could be completed quickly, i.e., over a period of a few days, as compared to a few weeks using conventional open-cut methods.

2. PVC pipe versus High Density Polyethylene pipe – From the City's viewpoint, both PVC and HDPE pipe represent excellent watermain building materials that are well suited to local conditions and facilitate horizontal directional drilling. As the City completes the vast majority of new and replacement watermain construction with PVC pipe, the operations and maintenance program has been geared in this direction accordingly. The use of HDPE pipe would require significant staff training and purchase of relatively expensive equipment. As the PVC pipe would be continuously restrained, seismic properties similar to High Density Polyethylene pipe were anticipated.

3. Sustainable practice – An important measure of success to the City is to be recognized as leaders in sustainable practices. Installation of the watermain through directional drilling would facilitate this success descriptor as the need to import granular bedding materials and various surface restoration requirements including asphalt and concrete would be entirely eliminated and/or reduced.

4. Schedule – Disruption to park users was further minimized as the schedule provided by the contractor for water main installation through horizontal directional drilling allowed for quicker completion as compared to the open-cut method.

Disadvantages

1. Risk associated with a technique new to the City – The City had completed numerous horizontally directionally drilled projects in the past, but had no previous experience using fusible PVC pipe over the distances contemplated on the Minoru Park crossing project. The use of IPEX Fusible PVC C900 DR18 Pressure Pipe was also new to the City, but does comply with the City's standard specifications.

2. Unknown utility conflicts – Utility conflicts become obvious through open-cut installation methods as the excavation proceeds. The discovery of a direct conflict with an unknown utility(s) would require open cut excavation(s) thereby defeating the purpose and advantage of horizontal directional drilling. The City also had previous experience with other organizations whereby they completed their utility installation, i.e., gas main, through horizontal directional drilling, didn't realize there was a conflict, and installed their pipe through the City's existing

Table 1 - IPEX Fusible PVC Pipe System

Safe Allowable Bend Radius and Pulling Force

Class 150 (DR18)

Nominal Size mm (inch)	Min. Bend Rad. mm (ft)	Straight (no bending) kN (lbs)
100 (4)	6,700 (30.5)	48.9 (11,000)
150 (6)	9,000 (43.9)	100.1 (22,500)
200 (8)	18,000 (57.6)	171.3 (38,500)
250 (10)	25,600 (70.4)	258.4 (58,100)
300 (12)	26,400 (83.8)	364.3 (81,900)

From IPEX Fusible Brute™ Pipe Installation and Handling Guide

sewer pipe.

3. Concerns with reduced PVC pipe structural capabilities

a) The City typically completes PVC watermain construction through conventional open-cut methods and realizes the benefit of engineered backfill, compacted to a minimum of 95% Proctor density. As pipe installation through directional drilling would be completed in native ground, the City would not realize this benefit.

The recommended maximum out of round deflection for PVC pipe is generally considered to be 7.5%. Calculations completed on the construction basis condition (empty pipe with live load conditions) using the Modified Iowa Formula (below) with a Modulus of Soil Reaction value of 500 psi provided for an acceptable result of approximately 0.8% deflection, which was considered to be a minor compromise.

$$\frac{\%\Delta Y}{D} = \frac{(D_L K P + K W')(100)}{\left(0.149 \frac{F}{\Delta Y} + 0.061 E'\right)}$$

b) While PVC pipe may be pulled onto a curved path, the pipe curvature limits the ability to tap the main to install services as part of the construction project and in future installations. Tapping a curved PVC pipe is discouraged by the City of Richmond.

The City reviewed the merits of the advantages and disadvantages and concluded that proceeding with directional drilling of Fusible PVC pipe was warranted and would provide an overall benefit to the City.

DESIGN/CONSTRUCTION

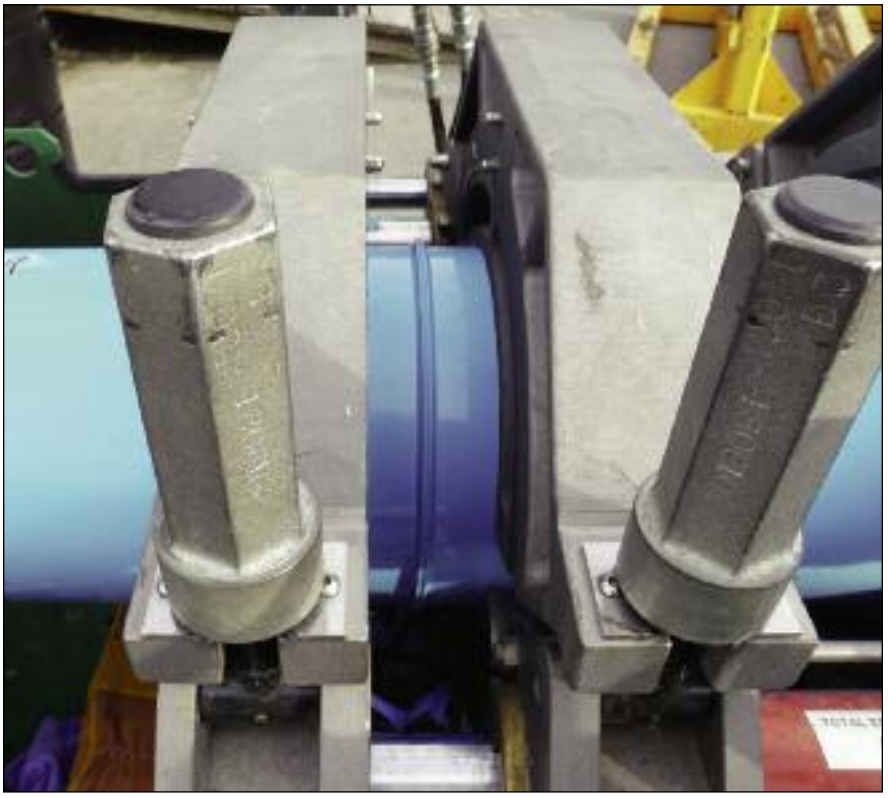
Horizontal directional drilling is one of several trenchless construction methodologies whereby a drilling bit is guided through soil to create a round cavity, which will stay intact for at least several days. The drill head is propelled by adding segments of rod as the head proceeds forward though a start-and-stop procedure. Once a cavity is created, the drill bit is removed and a pulling adaptor is attached to the drilling stem. A significant length of Fusible PVC pressure pipe is affixed to the adaptor and pulled into place. As the adaptor is pulled back to the rig, segments of drill rod are removed.

Design - The design was completed specifically to accommodate a directionally drilled water main. The possibility of implementing a structural liner was considered, but ruled infeasible given the reduction in pipe hydraulic capacity and the need to keep the existing water main in service at all times. Similarly, the option to complete water main replacement through pipe bursting was infeasible for the same reasons plus the numerous pipe repair couplings on the existing water main that would render pipe bursting impractical.

As with most projects, it was paramount that all existing utility crossings were identified. The proposed alignment was parallel to and in close proximity to the existing 150 mm diameter AC water main, the as-built records for which were very sketchy. As several park amenities are serviced from

South entry pit and pipe pullback in process

Pipe fusing machine and operator with data logger



Pipe fusing

this main, it was not an option to discontinue water supply and therefore it was necessary to determine its exact location through the use of ground penetrating radar. Hydraulic modeling based on the Official Community Plan build-out scenario dictated that the existing 150 mm (6-inch) water main required upsizing to 200 mm (8-inch) to accommodate City Centre growth.

Drilling - The drill rig used by Ulmer Contracting to install the pipe on this project was a Vermeer D20x22, 89 kN (20000 lb) pull. Existing utilities were exposed via a Hydrovac Excavator prior to drilling. Maximum spindle torque was 2980 Nm (2200 ft lbs). A 300 mm (12-inch) diameter wing cutter / back reamer was used to drill the hole. The line was installed in 2 runs, with an average of 10 hours to drill each cavity.

Pullback - This was followed by a compaction reamer ahead on a swivel, which was attached to the pipe to pull in the new IPEX Fusible PVC C900 DR18 Water Pipe. Drilling mud was used as a conservative measure to maintain the drill hole cavity and to reduce friction during the pullback process. Drilling mud is typically not used in Richmond on small diameter water main projects because the soil layer is normally a damp, firm silt mixed with clay. Actual individual pipe string installation (there were two pipe strings in total) took approximately 2 hours each. Maximum pull encountered over the course of the job was 44 kN (10,000 lbs) which was well below the limit of the rig and the maximum allowable for the IPEX Fusible PVC Pipe system (see Table 1).

Pipe Pull Force

Maximum Pulling Forces as shown in the following table were determined from applying a safety factor of 2 to the pipe yield strength tested in tension. (Note, typically the pipe wall itself can withstand much greater axial pull forces; 1.8 to 2.7 times the forces noted in the table for the system.)

Pipe/Joint Assembly

IPEX Fusible BruteTM PVC pressure pipe is manufactured in 12.2-meter (40 feet) lengths to meet the requirements of AWWA C900. Pipe fusing was sub-contracted to Magnum Road Builders Inc., who retained the specialty fusing equipment required for Fusible PVC pipe. The 12.2 meter length Fusible PVC pipe ends were faced and then fused by heating to a range of 400 to 420 degrees Fahrenheit (204 to 215 degrees Celsius) and applying a pressure ranging from 2790 kPa to 2896 kPa (405 to 420 psi). After fusing, the pipe cooled to 38 degrees Celsius (100 degrees Fahrenheit), within 5 minutes. Approximately 30 minutes was required to allow the pipe to sufficiently cool down prior to handling given the ambient temperature ranged from 8 to 13 degrees Celsius (46 to 55 degrees Farenheit). A data logger to record all pertinent technical information was used continuously throughout the fusing process.

CONCLUSION

Trenchless construction methods are being used more commonly in British Columbia, especially Horizontal Directional Drilling as described above. Residents gain the added benefits of less traffic disruption/congestion, reduced dust and site debris, minimal restoration of properties, and participation in a more sustainable community. All these attributes were realized on this City of Richmond project including reduced costs. These hidden/intangible advantages to the municipalities are recognized by industry as opportunities for future works.

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About the Authors

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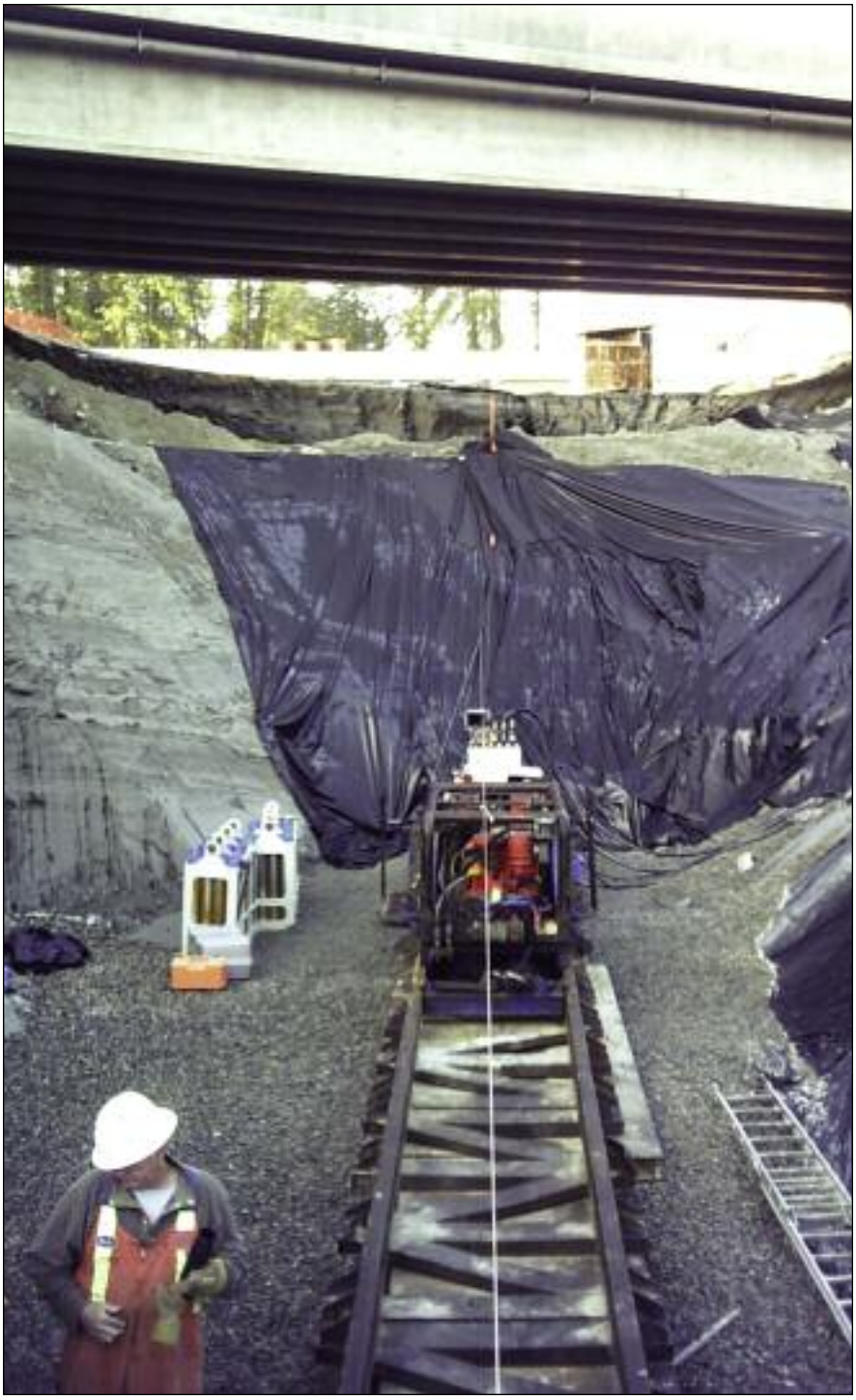
***Peter Discusso**, AScT, is an Engineering Design Technologist with the City of Richmond and has worked on municipal design projects for the past 25 years. He is currently a board member on the British Columbia chapter of NASTT. He graduated from the British Columbia Institute of Technology in 1985.*

Pioneering New Technology

Kamloops Augering & Boring Ltd.

Harry Dickinson



Setting up Line & Grade

The management of the design and construction of the Golden Ears Bridge, crossing the Fraser River in Langley, BC has been delegated to the Golden Crossing Constructors Joint Venture (GCCJV), combining some of the world's leading experts in bridge construction with solid local experience. The GCCJV is working with some of B.C.'s most respected engineering and construction companies to deliver the project. Kamloops Augering & Boring Ltd. (KAB) was contacted to look at the feasibility of doing one long trenchless crossing underneath the Trans Canada Highway for storm drainage.

The original design had called for 4 man holes to be constructed during the road construction phase of the Barnstrom – unnamed creek area. This road was to be built underneath the Trans Canada Highway after the new overpass structures were completed. However, during construction the demand for the new drainage system to be completed before the overpass was finished was imperative. The new system with 4 manholes had to be reduced to 2 manholes, with KA&B Ltd installing a 425' x 24" storm pipe online and grade. Even though the manholes had not been constructed, the downstream drainage system had, so there was no room for error.

Several site visits were made and ground conditions were reviewed. An Akkerman pilot

Guidance System Setup

tube system was chosen as the installation method of choice. The initial set up and survey was critical in completing this task. The accuracy of this method is only as good as the survey. Once the jacking pit was excavated and graded a 48/900 American Auger Bore Machine was set up online and grade. The Guided Bore Machine (GBM) was set up and an additional survey of equipment was completed to confirm the elevation of the pilot tube and correct alignment for the crossing. There was only 200mm of tolerance for this installation and the set up of the guidance system was an essential key to our success. Typically, a pilot tube crossing is completed in one day as to minimize the number of daily set ups. We were not so lucky. After starting the crossing the hard drive on the guidance system failed. Akkerman was able to supply another computer within less than 24hrs from Minnesota to Bellingham. We were able to re-set the guidance system and continue pushing the pilot tube.

If that was not enough of a set back, the ground conditions were. The crossing proved to be the hardest ground the equipment had ever pushed through, up to 50 blow count till. With a total of 4 set ups and 3 days of steering we were successful within 25mm of design elevation and grade for the pilot tube crossing.

Setting up Line & Grade

Now we had to install the 24" casing that was going to be used for the storm line.

The ground conditions proved to be more difficult than the initial geo-technical investigation had indicated. Once, the pilot tube adapter was welded to the 24" casing the augering was to begin. This was an impossible task. The 48/900 maxed out on pressure and the backstop was moving. Only 10' of casing was installed using this methodology.

We had to go to ramming the casing into place. With our Taurus hammer we were able to ram approximately ±5 ft/hour. With the material continuing to pack off inside the casing, the slow rate of advancement and continually cleaning the casing with the augers made for a scheduling nightmare for both KA&B & GCCJV. The continued construction activity at both entrance and exit pits made for other unforeseen delays. However, given KAB's devoted and skilled crew the casing installation was completed successfully and on time. If it was easy, everyone would be doing it! Kamloops Augering & Boring Ltd. now has another impressive tool in our tool box to get the job done!

Harry Dickinson is a Project Manger with Kamloops Augering & Boring Ltd. and has 9 years experience in the Trenchless Technology Industry.

Pipe Bursting Installation of Watermains in Telkwa

Paul Wellington AScT,
Dayton & Knight Ltd.

The Village of Telkwa is a small municipality located in northern British Columbia approximately half-way between Prince George and Prince Rupert. The Village straddles Highway 16, which is the only route west to Prince Rupert and north to the Yukon and Alaska via Highway 37.

The majority of the Village's water mains were installed in 1957. The Village has only schematic information about the existing water system and no detailed location information for the mains, valves, hydrants and services. Many of the valves on the mains have been buried over time and their locations are now unknown.

The north end of the Village (consisting of approx. 45 homes and 9 commercial and institutional properties) was fed by a single 150 mm diameter main running along the highway. The main was located under the shoulder of the road at a depth of 2.1 to 3.0m deep, with a long diagonal road crossing midway along the main.

The existing main ran under the shoulder.

This main had experienced several failures in recent years that required excavation of the highway road structure to repair. Because the location of many of the watermain valves is unknown, water supply to large areas of the community had to be shut down to make the repairs.

The Ministry of Transportation and Infrastructure (MoTI) has scheduled a highway improvement project in 2010 to widen and overlay the highway through Telkwa. Given the history of failure, and because a recent water system study showed that the main needed to be upsized to 300 mm diameter to provide adequate fire flows to the north end of the Village, Council wanted to replace the failing watermain prior to the highway upgrade.

The section of main to be replaced was in a very constrained location. The highway right-of-way is narrow and the road structure occupies most of the right-of-way. Existing water and sewer mains run along each side of the highway. The Bulkley River, containing a world renowned recreational fishery, flows on the west side of the highway, coming within 30 m at the closest point. On the opposite side of

the highway at this point, the terrain slopes up steeply from the road. In the 1960's, MoTI identified this as a slide area, raising concerns about increased risk of excavation in this area. Bedrock outcrops are visible adjacent to the site, indicating a high potential of encountering rock in any new trench excavations.

As this section of the highway is the only route west, the traffic flow is high and must be maintained. At a minimum, single lane traffic flow had to be maintained through the site for the duration of the work.

Pre-design engineering for the project explored three potential options for replacing the main; open cut installation of a new main along the existing main alignment, open cut installation of a new main along a new alignment, or pipe bursting the existing main.

Open cut installation of a new main on the existing alignment would require substantial excavation and disturbance to the highway structure. While this option would eliminate the potential for rock excavation, restoration and repaving would be costly and considered undesirable from MoTI's perspective. The large volume of soil from the excavations to be stockpiled would also make maintaining traffic flow through the site difficult and would require careful storm water management to avoid runoff carrying sediment to the Bulkley River. Another difficulty with this option is removal and disposal of the old AC pipe. Because it is considered a hazardous substance when exposed and disturbed, the handling and disposal requirements are onerous and the associated costs are high. This option would also require taking the existing main out of service for the duration of the work. A temporary bypass main to supply the north end of the village and a temporary supply main and services to the homes in the work area would be required.

Open cut installation along a new alignment would enable the existing main to remain in service, but would face the same MoTI approval, traffic control, and storm water management challenges as installation on the existing alignment. Excavation on a new alignment would likely encounter bedrock, which would increase installation costs significantly. The quantity of restoration and road reconstruction and repaving would also be large with this option.

The third installation option considered was pipe bursting. This method would also require the provision of temporary bypass mains and services, but it would create significantly less disturbance to the highway. The excavation required for pipe bursting is limited to a small number of entry and exit pits for the main line and tie-in pits for the service connections. The amount of disturbance to the highway would be reduced to a very small percentage of that required for open cut installation, facilitating traffic through the site and decreasing the potential for silt run off to the river.

Cost comparisons for the three options estimated that pipe bursting would provide a $775,000 cost saving over open cut installation. Pipe bursting was the favoured option and Council approved proceeding with detailed design and construction.

The final project scope included bursting the existing 150mm main along the highway with 220 m of 200 mm diameter HDPE and 640 m of 300 mm diameter HDPE plus bursting one existing 100 mm diameter highway crossing with 150mm HDPE. Also included were three new highway crossings installed by open cut, and six new hydrants and 21 services to be connected to new main (with new curb stops and pipe to main).

The successful tenderer, PW Trenchless Construction Inc. from Surrey, BC, started work on August 19, 2009. The bypass mains and services were installed and the main to be replaced disconnected from the water system.

The 150 mm diameter main along the highway was burst in eight sections of 60 to 140 m long. Entry and exit pits were excavated using trench shoring to minimise the size of the excavations. Pipe was butt fused into the appropriate length sections and staged behind the entry pit. A 200 mm burster with a 350 mm diameter rear expander were used and were powered through a 75 mm diameter air hose from a 13,000 CFM compressor. A "schnoze" adapter on the front of the burster was used to guide it along the existing pipe alignment. A 20 tonne trailer-mounted winch pulling on the "schnoze" was

The 200 mm burster with rear expander and "schnoze" adapter.

The new sections of HDPE main were joined using electro-fusion couplings.

used to assist the burster. Each section took approximately a day and a half to prepare and about four to six hours to burst. The existing valves, tees, and bends were burst as the new main was installed, saving the need to locate and remove them. The sections of new main were joined using electro-fusion couplings.

The last section was the longest at 140 m long of new 300 mm diameter pipe. This section of the old main had an existing bend, a valve,and two tees on it. This burst took about six hours. David O'Sullivan, President of PW Trenchless Construction Inc. was very happy with this particular burst given the length, number of existing fittings on the main, and the diameter upsize.

The existing 19 mm diameter copper service connections under the highway were replaced with 19mm polyethylene pipe using static bursting. A cone splitter towing the new pipe is pulled through the existing service using a steel cable pulled by a backhoe. In most instances, the existing copper pipe was pulled out ahead of the new pipe and was able to be recycled.

The service laterals were connected to the new HDPE main using electro-fusion saddles with the main being accessed by 1.5m x 1.5m shored pits.

The project was successful, with both the Village and MoTI satisfied with the execution and the end result. Traffic delays during construction were minimal (typically only 3-4 minute waits), the disturbance to the Village was minimal and the cost savings realised were substantial. More local pipe bursting work is anticipated in the future now that MoTI and others are aware of the method and have seen successful implementation on the Telkwa watermain project.

Paul Wellington works for Dayton & Knight Ltd. providing consulting engineering services for municipal infrastructure projects in northern British Columbia.

Service connections under the highway were replaced using a static burster.

WHY GO TRENCHLESS?

Carbon Reduction & Trenchless Technology

David O'Sullivan

In the last 30 years or so, the world has started to become aware of the effects of global warming. We will not see this as local warming, but as a significant change in climate patterns in various part of the world. We do in fact already see various changes in long-term weather patterns, such as recent droughts in California, heat waves in Europe, unheard of snowfalls in the Washington, D.C area, and so forth.

So to change our way of living and reduce our carbon output is something we all want to do, isn't it? Well, only after our neighbour starts first. It is interesting to look at the various countries around the world and how they have worked (or not) to reduce their carbon footprint.

In Europe, Germany grew from East and West, joining in the early 90's, and eliminated many of the old high-polluting factories from the East, but did little to change the carbon outputs in West Germany. However, the results for Germany as a whole look good. Spain, Portugal, and Ireland signed on to KYOTO, but all increased their outputs and only paid lip service to any thoughts of reduction, while the UK and Sweden are two countries that did work on reductions. In fairness to any country, a reduction in the output of carbon is generally closely linked with a reduction in a country's productivity, and no politician wants to have a reduction in productivity during his or her term. Even though some countries did encourage some carbon reductions, it seems as if most waited for their neighbours to start first.

Thus, in the last few years since Kyoto we have not seen any real reductions in the world output of carbon. This is because of a fear that a reduction is going to change quality of life in a big way, and that the populace will not accept it.

Utilities & Infrastructure

Utilities are by definition the entities that supply or dispose of water, power, gas, or information to or from our homes or businesses. They are the lifeblood that allows us to exist, and are by definition one of, if not the most important component of any city's infrastructure. In fact, in a recent survey of the readers of the Lancet, the provision of clean water over the last 100 to 150 years in the developed world is regarded as the main reason for our improved health care - not vaccines, penicillin, or the entire healthcare system that now exists. The importance of good and properly functioning utilities, to our way of life, can not be over emphasised. However, they are often forgotten until something goes wrong.

Having established the importance of utilities, we need to look at how we can maintain our existing utilities and install new ones in a way that emits as little pollution as possible. In this utility industry, if we can move to reduce our pollution levels and offer these new methodologies to governments, we benefit by controlling our own destiny rather than having governments dictate methods to us that we may not like.

The Problem in Utility Construction

The biggest problem is where we install utilities. In the case of sewers, we need to follow gravity, and thus have to install our sewers at depth to allow the liquids to flow downhill. In the case of most other utilities, we bury pipes for protection from the elements or to protect them from traffic and later excavations.

In all these cases, we first excavate a trench to allow the pipe to be placed at the required depth, and wide enough to allow safety equipment to be used for the workers to install these pipes. Stop and think about that for a second..... We dig and remove material, say 1m wide by 2.5m deep, to install a 200mm wide pipe. We dig, remove, and replace 2.5m^3 of material in order that we can install a pipe that has a volume of 0.031m^3 (per linear meter of trench). That translates to removing 80 units of material to access and remove the one unit of material necessary so that the pipe can be installed. How can we improve this?

The Answer is Trenchless Technology

Trenchless technologies allow us to vastly reduce this removal of extra material in order to access existing pipes or install

new ones. It is this reduction in the removal of material that can cause a very large reduction in the use of energy, and thus a reduction in the emissions of various gases, including carbon.

It is changes like this that our society desperately needs, in order to allow us to continue to enjoy our standard of living with little change to quality of life. It is also easier to sell to the populace if the disruption is very small and causes no reduction in productivity. The use of trenchless technology has been known to reduce traffic and excavation for as long as the technology has existed, but we have never been able to measure the results. The results have always been subjective, and as we all know, subjectivity is becoming harder to justify in this modern age.

With this in mind, the British Columbia Chapter of the North American Society of Trenchless Technology proceeded to develop a simple computer program to allow the calculation of carbon emitted during construction in 2007, and thus provide a defined, measured, quantity comparison between using trenchless methods and various methods of traditional open cut ones. We commissioned the University of Waterloo and some students from UBC to develop this program for us. In 2009 we commissioned the ACT department of SFU University in BC to take that program and make it a much more robust calculator. We are now in the final stages of that development and hope to have the new program available in the next few weeks. This new program is available at www.nasttghgcalculator.com and is free to use by anybody.

The program shows carbon reductions in the region of 90% or greater, depending on the type of trenchless method used. If all other industries could achieve this kind of reduction, we would very quickly comply with the KYOTO protocol. However, even just the adoption of trenchless methods for a significant amount of utility placement will cause a large reduction in carbon emissions.

With the United States adopting legislation this year (or the EPA will adopt rules as already ordered by the courts) to reduce their carbon output, we think that most first world countries will now begin to move forward and embrace and enforce meaningful carbon reduction. Trenchless technology offers existing methods to help achieve this, and with the Carbon Calculator, a scientific methodology to quantify the carbon emission reductions. ●

Y-Join NASTT BC?

The British Columbia Chapter of the North American Society for Trenchless Technology (NASTT)

NASTT BRITISH COLUMBIA CHAPTER: Leaders in Innovation

The BC Chapter of NASTT was established 2005, and exists to promote the use of trenchless technology in B.C. through education and standards. NASTT-BC has worked hard over the last 6 years to have trenchless standards adopted throughout the Province. In 2008, work began by the Chapter to develop a tool for accurately determining the reduced carbon footprint that various trenchless technologies offer - the Carbon Calculator! In wide use across North America, a revised version has now been completed and will be used by trenchless professionals to illustrate perhaps the most important benefit of trenchless - a reduced carbon footprint! **(See articles on pages 10 & 24)**. Other chapter achievements include:

- In the MMCD's new Platinum boot, CIPP and Pipe Bursting are included, with remaining trenchless methods to follow.
- NASTT-BC has worked hard to provide training programs for government and consultants, as well as contractors, on the cost and carbon savings available.
- NASTT-BC has worked to be a leader in promoting the use of trenchless as a low cost /low carbon method of construction.
- Since 2005, the chapter has published their Annual Magazine Y-DIG?
- The chapter and Y-DIG? Magazine is a great way for consultants to promote their successes, for cities to learn about the projects, methods, lessons and experiences of other cities, and for all 3 partners (owners, consultants and contractors) to share information.

WHAT IS NASTT?

Founded in 1990, NASTT is a not-for-profit, educational and technical society that is dedicated to promoting the benefits of trenchless technology for public awareness through education, training and research. NASTT is the definitive resource for trenchless professionals like you, who are concerned with underground systems and the applications of trenchless technology.

Trenchless Technology

By using trenchless technology methods, you are reducing the impact of underground construction on your community. The benefits of trenchless technology are priceless:

- Minimizes surface disruption & trenching
- Reduces public inconvenience
- Cost-effective methods
- Less traffic congestion
- Widely utilized & accepted
- And this all adds up to - REDUCING CARBON FOOTPRINT BY UP TO 90%!

Membership

If you're interested or concerned in underground systems and the application of trenchless technology, then NASTT membership is right for you.

NASTT connects you to the people and businesses involved in the trenchless industry.

NASTT is your link to thousands of trenchless professionals and leaders working in regional, national and international levels. Membership is open to individuals, agencies and companies involved with providing gas, water, sewage, communications and electrical services.

Your Regional NASTT Chapter: Get Involved

NASTT has a network of nine regional chapters throughout North America. Regional chapters offer valuable educational and networking opportunities in your local area. Share your ideas, network with colleagues and find solutions to your everyday challenges. When you join NASTT, you automatically become a member of your regional chapter and a member of the International Society for Trenchless Technology (ISTT).

JOIN NASTT and NASTT-BC TODAY!

For further information visit www.nastt.org or call Peter Discusso at 604.276.4024 • PDiscusso@richmond.ca

Alternative Fusible PVC™ Pipe Improves Water Quality And Cuts Cost for Rural Québec Municipality

When the small agricultural municipality of Saint Paulin, Québec needed to connect several residents to the town's sewer and drinking water systems for improved water quality, they wanted to ensure that it was done properly, quickly and cost effectively. Located in the historical Trois-Rivières area between the cities of Montréal and Québec, the municipality was also faced with the challenge of running the new sewer and water pipe system under the Rivière du Loup. Ultimately, the town needed to decide between using traditional HDPE (high-density polyethylene) pipe or alternative Fusible PVC (polyvinyl chloride).

An Improved Alternative Choice

Recent water quality testing completed on the wells of several residents not connected to Saint Paulin's existing sewer and water distribution system showed water contamination in the drinking water. The source of the contamination was thought to be caused by the traditional septic systems used in this area of the municipality.

Following the testing, the Ministère des Affaires Municipales Québec required Saint Paulin to extend the water distribution and sewer system to those residents experiencing water quality problems. With 80% funding provided under programs overseen by the Ministère des Affaires Municipales, Saint Paulin set out to deploy the new system. The town first needed to decide between using traditional HDPE pipe, which has long been installed in trenchless applications, or PVC, which has grown steadily in popularity throughout North America and is fast becoming the most widely installed material in water systems today.

Municipalities who have been used to using HDPE in trenchless applications for several decades are not always fast to change, and Saint Paulin was no exception. Fortunately, IPEX has introduced CIOD (cast-iron outside diameter) Fusible Brute™ PVC pipe that enables fully restrained joints with a tensile strength equal to that of the pipe. By combining the mechanical properties of PVC with an innovative patent-pending butt fusion process (in Canada, patented in the US), Fusible Brute PVC pipe is capable of being installed in long continuous trenchless applications.

"At first, the municipality was hesitant to use PVC in the trenchless application. We met with the engineering consultant, explained the differences between PVC and HDPE, showed him the testing and specification information and demonstrated how Fusible PVC could ultimately offer more cost-effective installation and long-term maintenance," recalls Alain Charky, manufacturer representative for IPEX.

With HDPE, Saint Paulin would have to special order the pipe and use expensive transition fittings due to its nonstandard outer and inner diameter that didn't match the town's existing PVC water system. In addition, HDPE's overall weight and material for the given pressure class would have resulted in a higher material and installation cost.

On the other hand, Fusible PVC would allow for easy connections to Saint Paulin's existing PVC water distribution and sewer system via simple standard fittings, providing material consistency across the entire municipality. PVC's reduced wall thickness also requires less material and yields better flow.

In addition to ensuring reduced initial deployment costs, the total cost of ownership was also a concern for a small municipality like Saint Paulin. CIOD Fusible PVC pipe is easy to maintain over the life of the system because all the accessories are readily available and can be deployed by the town's public works employees. The Fusible PVC's gasket-free joints and excellent abrasion and scratch-resistant properties also ensure long-term reliability and reduced maintenance of the system.

"When the consultant took everything into consideration, from the installation to the life of the system, they clearly saw that Fusible PVC was the better choice for the municipality," says Charky. "It was a win-win situation."

The town of Saint Paulin Quebec selected IPEX Fusible HDD pipe to connect its rural residents to the town's sewer and drinking water systems.

An Innovative Fusion Process

For the forced sewer system, Saint Paulin used a total of 2,208 meters of 100mm (4 inch) pressure-rated 165 psi (cast-iron outside diameter) CIOD Fusible Brute PVC pipe (DR25). For the potable drinking water system, they used a total of 2,611 meters of 150 mm (6 inch) pressure-rated 235 psi CIOD Fusible Brute PVC pipe (DR18). The Fusible Brute PVC pipe meets CSA B137.3, AWWA C900, AWWA C905, NSF-61, NQ 3660-950 and ASTM cell classification 12454. For the majority of the system, the two pipes run side by side, separated by approximately one meter (3.3 feet).

The Fusible Brute PVC pipe is available in 12.2-meter lengths. To create longer pipe lengths for the installation, the patent-pending fusion process for the Fusible Brute PVC incorporates a proprietary PVC formulation and a unique combination of heat, pressure, and time, using slightly modified standard industry fusion machines. The fusion process is carried out by trained and licensed individuals to ensure consistent, reliable fusion that creates piping systems of unparalleled strength.

Fusion time with Fusible Brute PVC is comparable to other thermoplastic materials. The overall fusion of the Saint Paulin system was accomplished at an average of 19 joints per day, which took place at the

The shelter of a tent combined with the heat from the fusion machine was enough to keep the pipe ends at the required temperature for fusing.

end of October 2009 and was complete by 10 November 2009. Fusion also can be performed under any temperature, as long as the pipe ends are maintained at a temperature above 4°C and both the pipe ends and fusion machinery are sheltered from the elements.

For the Saint Paulin system, a remote field was used as the staging area and a tent was set up to shelter the fusion process from the elements. Under the tent, heat from the fusion machinery itself was enough to keep the pipe ends above 4°C. Once the fusion was complete, the lightweight, flexible lengths of pipe were then simply dragged from the staging area to the installation site.

A Cost-Effective, Greener Deployment

For maximum cost-effectiveness and limited disturbance for residents, Saint Paulin specified a trenchless application using horizontal directional drilling (HDD) methods. HDD offers several key benefits, including faster installation, ability to place pipe under natural and man-made obstacles and a greener more environmentally-friendly approach. The use of HDD eliminates the need to excavate a trench, which often requires tearing up asphalt and disturbing roadways, destroying the surrounding natural environment, and risking damage to other underground systems. These can require significant repair costs after the pipe is installed.

It wasn't just cost concerns that had Saint Paulin specifying HDD methods. In 1988, the village of Saint Paulin merged with the township of Hunterstown. This increased the number of residents to approximately 1,600. Today, Saint Paulin encompasses more than forty farms and 90 small and medium-sized businesses. The urban section of the original Hunterstown area is crossed by the Rivière du Loup, and it was under this river that the new water system needed to traverse to reach residents on the other side. Only HDD could be used for this 84 meter (276 feet) section of the new water system.

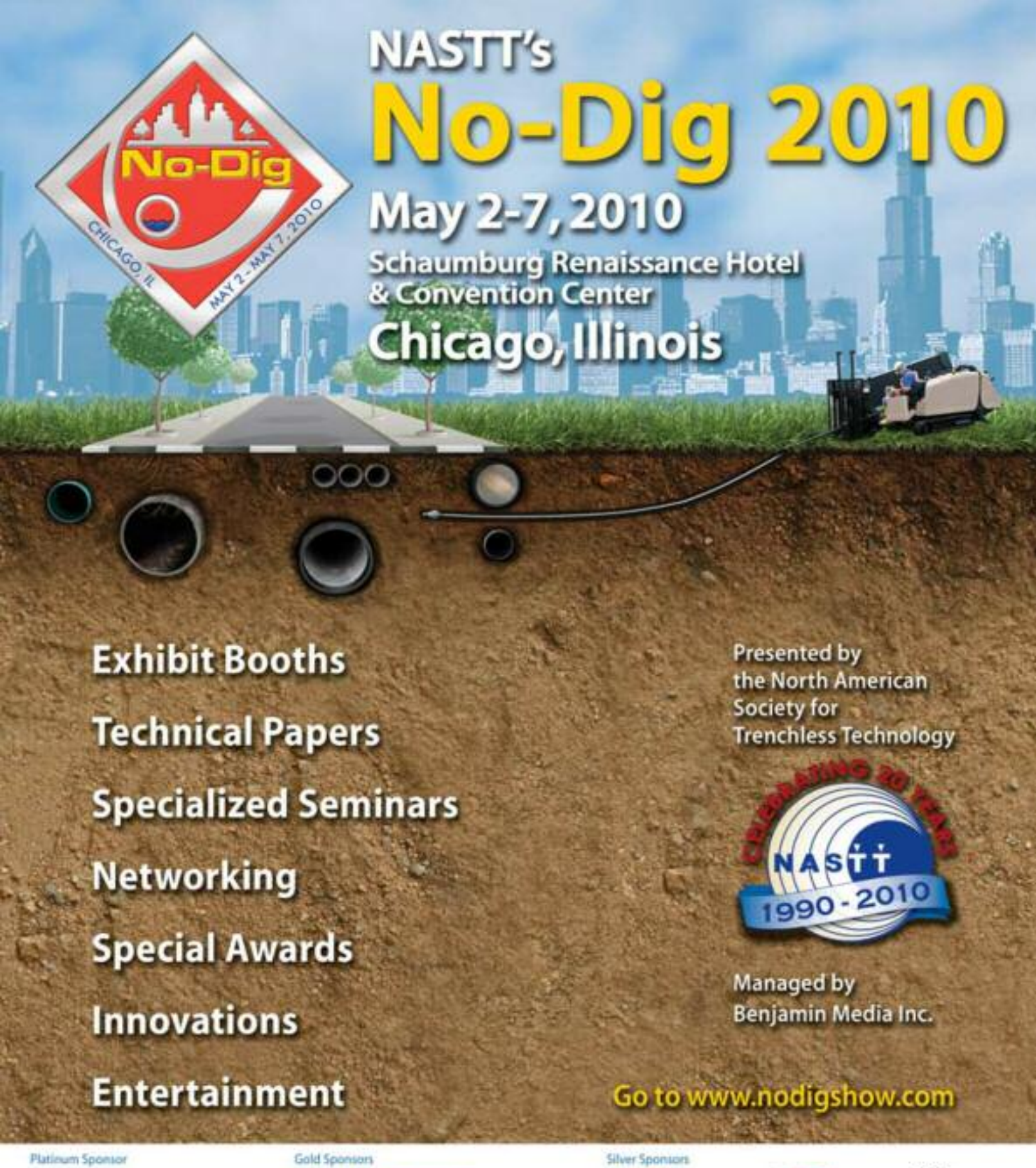
"HDD equipment bored one path for the sewer and water pipes under the river, and when the drilling head reached the other side, it was replaced with pulling equipment that pulled both lines of the pre-fused lengths of Fusible Brute PVC pipe side-by-side under the river," explains Charky. In addition to the 84-meter pull under the river, the entire Saint Paulin project consisted of approximately another 25 pulls, with the longest pull being 207 meters.

The full-strength butt fusion joints of the Fusible Brute PVC pipe offered Saint Paulin a greater pull force rating than they would have had with HDPE and other restrained PVC systems. A greater pull force offers safer installation in tough conditions for HDD trenchless applications. In addition, the smaller outside diameter of the Fusible PVC pipe means that the drilling equipment can make smaller bore holes. A smaller bore hole makes for an easier, faster drilling process and reduces the amount of drilling fluid required. In turn, using less drilling fluid reduces the amount of fluid waste that has to be disposed of, making the project even more environmentally friendly.

A Better System in Place

After the new Saint Paulin system was installed, a one hour 125 psi pressure test was completed in accordance with ASTM D-638 methods on 1800 meters of the 150mm (6 inch) pressure-rated 235 psi CIOD Fusible Brute PVC pipe (DR18) used for the drinking water distribution system. The pipe passed with no make-up water required, indicating absolutely no leakage in the system.

The water distribution system located south of Rivière du Loup, which makes up most of the project, is currently in service. The forced sewer system and remaining water distribution system will be up and running by mid 2010. Thanks to innovative Fusible Brute PVC pipe from IPEX, the small rural municipality of Saint Paulin, Québec has a reliable system that will solve its water quality issues. At the same time, they achieved a more environmentally-friendly deployment and ensured an overall lower cost of ownership through easier installation, stronger fused joints and reduced maintenance. ●



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Top 10 Reasons You Should Attend NASTT's 2010 No-Dig Show in Chicago

Mark Hallett, *No-Dig 2010 Program Chair*

Dear Trenchless Colleagues,

As your 2010 No-Dig Program Chair, I can speak from personal experience how NASTT's annual conference has positively impacted my business, my career, and my involvement in NASTT, the industry's #1 organization devoted exclusively to promoting trenchless technology. In the spirit of David Letterman's Late Show Top Ten list, here are my top ten reasons why I believe you should either attend, exhibit and/or sponsor the 2010 No-Dig Show in Chicago, May 2-7.

1. You face a fast-changing market:: New options have emerged for rebuilding North America's underground infrastructure using trenchless technology. There are new products, new services, and new players. No-Dig creates a unique opportunity for you to explore our 50,000 sq. ft. exhibition hall to see, hear, and interact with each approach available in the trenchless marketplace.

2. Your time is respected: The overall No-Dig program is focused on one objective: Helping you maximize your investment in trenchless technologies, services, and applications. Every conference session, every course, and the exhibition are designed to provide you with the information you need to make the best possible decisions for your company and your career.

3. You'll meet the industry leaders and market movers: Every conference claims to present the "industry leaders," but no other event delivers on that promise like No-Dig. 75% of No-Dig attendees are buyers or specifiers of trenchless products/services.

4. Celebrate NASTT's 20-year history: The 20th anniversary of NASTT will be celebrated with pomp and in a fitting manner at No-Dig in Chicago. NASTT is planning an eventful and memorable No-Dig commemorating this very special occasion, including the presentation of the first-ever Michael E. Argent Memorial Scholarships and the Trent Ralston Award for Young Trenchless Achievement.

5. Networking, networking, networking: From the opening kick-off breakfast to the Educational Fund Auction and the gala awards dinner to the closing luncheon, you'll have plenty of opportunities to interact with your industry peers.

6. Cut through the hype: At No-Dig, the technical paper program is peer-reviewed by a committee for non-commercialism, relevance, and a high level of quality of information. Our goal is to ensure that you don't have to sit through sales pitches. The No-Dig conference program has been expanded to include 140 technical paper presentations over five concurrent tracks. Every paid full conference attendee will receive a CD-ROM with the complete papers of the conference presented during the event.

7. Attend one of NASTT's Good Practices Courses: Choose to attend one of NASTT's five good practices post-conference courses on HDD, pipe bursting, laterals, new installation methods, and CIPP lining and you'll receive objective, reliable information that you can use.

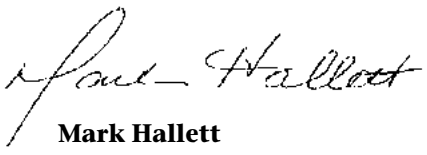
8. Earn valuable Continuing Education Units (CEUs): Benefit from the in-depth sessions and courses offered at No-Dig 2010 in more ways than one. For every ten hours you attend, you receive one (1) continuing education unit to advance your professional career.

9. Support NASTT's Educational Fund Auction: The annual Auction is the must-attend event for No-Dig attendees. All monies raised at the auction support the activities of the NASTT student chapters. I personally encourage you to get involved in this effort by donating items and/or services to the Auction. By doing so, you are literally supporting the future of our industry in a real and substantive way.

10. The only conference focused on you: No-Dig is the ONLY conference totally focused on the needs of key decision-makers in the trenchless industry. It is the premier event where you can meet with your peers and see what your competitors are up to.

These are the ten best reasons why you should attend No-Dig 2010. I look forward to meeting you personally in Chicago, so you can discover for yourself how No-Dig can benefit you and your company. For more information, please visit the conference web site at www.nodigshow.com.

Sincerely,



Mark Hallett

2010 No-Dig Program Chair

Support NASTT's Student Chapters

Donate to the Educational Fund Auction

Don't miss NASTT's must-attend event - the annual Educational Fund Auction and Reception - on the evening of Monday, May 3 at the No-Dig Show in Chicago (Schaumburg), Illinois. The Auction is a wonderful way to support the students while having a great time bidding on amazing items.

Since its inception in 2002, the Auction has raised over $312,000 and directed those funds exclusively toward educational activities offered by NASTT.

Thanks to the generous support of our past contributors, monies raised through the auction provide funding for student chapters' activities; funding of the NASTT 20th Anniversary - Michael E. Argent Memorial Scholarship Program; research initiatives; and room accommodations for student members attending and volunteering to work at the No-Dig Show.

To continue meeting the needs of our students, we need your help. Get involved and make an investment in the future of our industry by donating items and/or services to the Auction or by sponsoring this well-attended event. This may be the single best investment you make!

If you have any questions, please contact Angela Ghosh at NASTT, phone: 703-217-1382 or e-mail: aghosh@nastt.org. Or visit the NASTT web site for a donation form: www.nastt.org.

Student winners of the 2010 NASTT Student Poster Competition (L-R: Rajyalakshmi Kola and Manu Agarwal, Virginia Tech University and Charles Ormsby, McGill University)

John P. Lake Rain for Rent Academic Award Scholarship Award Winners (L-R: Eric Steward, Louisiana Tech University and Alison St. Clair, Virginia Tech University)

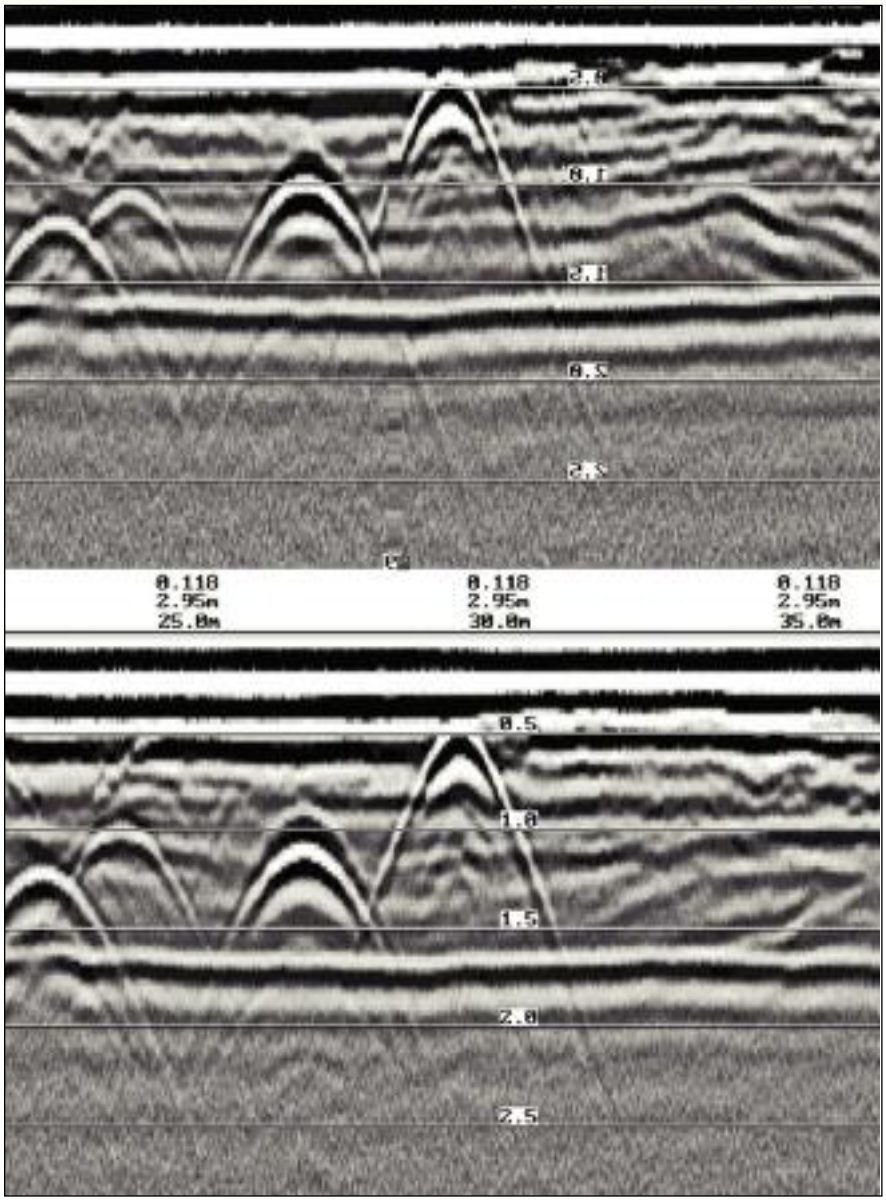
The Auction is conducted by Ritchie Bros. Auctioneers, the world's largest industrial auctioneer.

GPR & Laser Profiling
See What's There Before You Dig!

Maverick Inspection Ltd.

There are centuries of human activity using up our subsurface real estate. There are almost random-seeming nests of utilities and underground infrastructure. You can include in the list other hazards such as archeological sites, wells, subway systems, foundations and footings, mine shafts, voids and sinkholes, natural water systems, all sorts of disposal sites, and even artifacts such as unexploded ordinance and time capsules. Engineers, inspectors, and project managers are faced with deciphering, locating, and even evaluating the condition of all sorts of underground systems and artifacts.

Maverick Inspection Ltd., based in Sherwood Park Alberta, is hired to tackle these challenges every day. Traditional line-locating and remote video inspection tools are very powerful, but they can only provide so much information. Unless there is a tracer wire installed or the utility can carry a continuous signal, electromagnetic line locating systems will be defeated. Video analysis of underground piping is typically limited to qualitative impressions and interpretation. Technology and



Data from two separate Ground-Penetrating Radar passes across a utility corridor

James Harrison from Maverick performing Ground-Penetrating Radar as part of a large-scale utility locate for a uranium mine

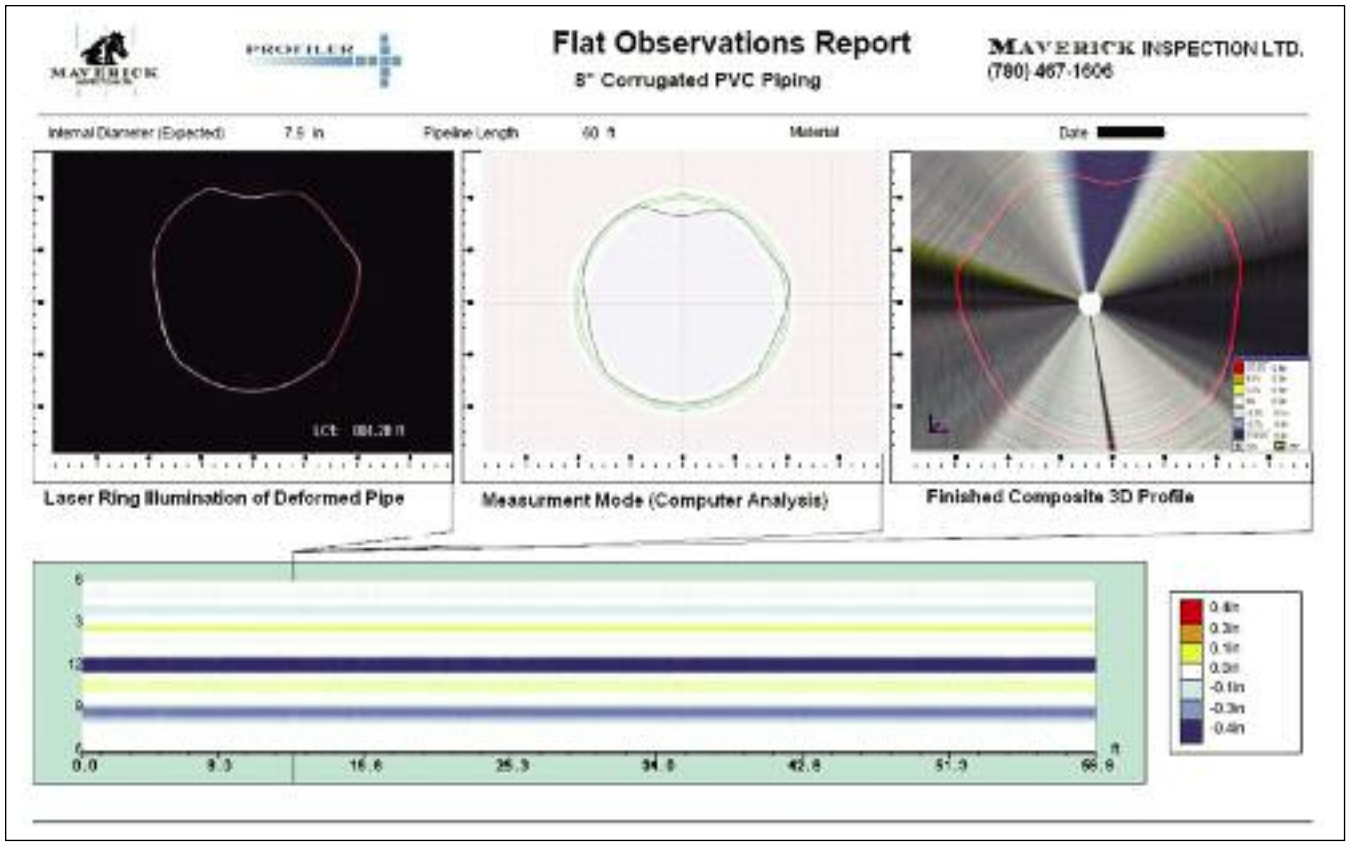
inspection methods have evolved to overcome some of these challenges, and Maverick's mandate has been to source out, modify, and develop cutting-edge solutions.

Two fields of Specialized Non-Destructive Evaluation that have been pioneered and expanded for trenchless applications in Western Canada by Maverick Inspection Ltd. are Ground-penetrating Radar (GPR) and Internal Laser Profiling.

GPR itself is not new. When WWII pilots crashed onto the ice during attempted landings on Greenland, there was a sudden realization that radar could penetrate solid objects. Their instrumentation was looking through the ice. Since then, the hardware, software, and expertise have grown, especially during recent years. Now we are able to provide detailed information about the location of subsurface objects.

For example, Maverick Inspection was recently employed to map out extensive subsurface utilities at both the Sherritt and DOW Chemical sites

Technicians gathering data under a roadway to non-destructively determine the extent of voiding

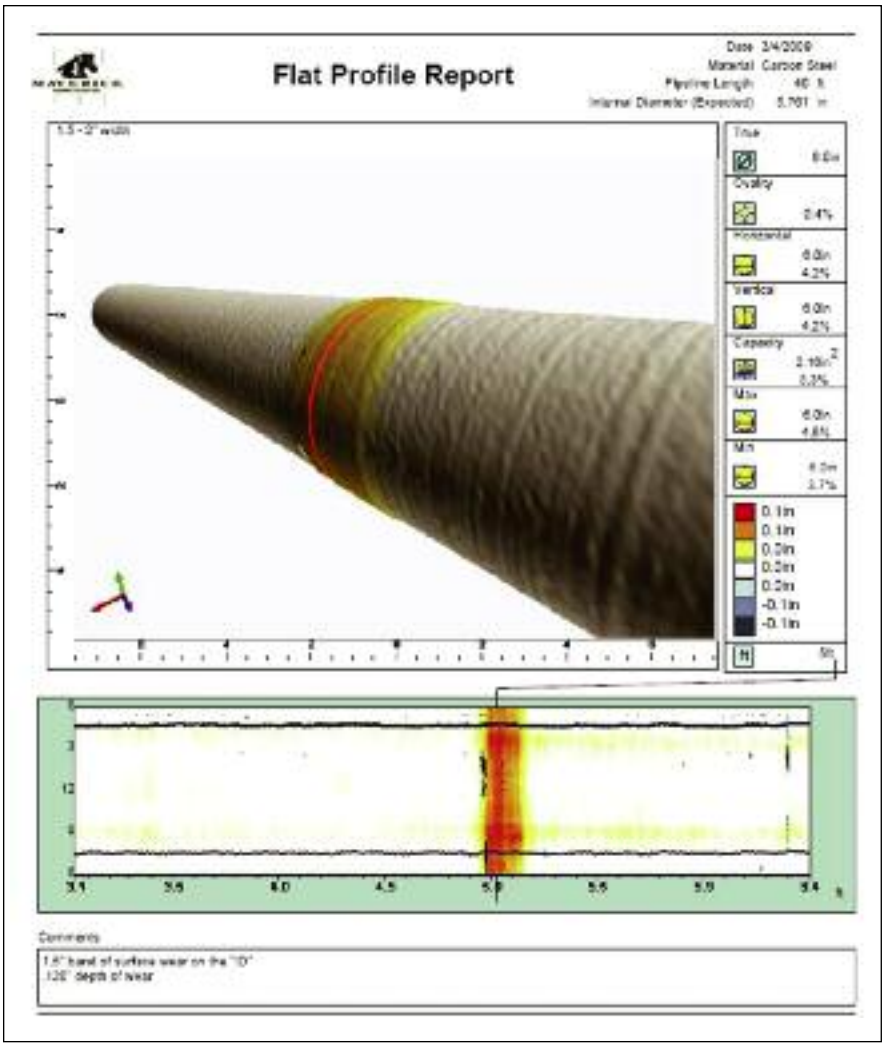


Some of the reporting options available after Laser Profiling of pipe internals.

at Fort Saskatchewan prior to directional drilling projects for additional underground systems. In both cases a combination of traditional line-locating was used with GPR. Many systems such as fiberglass lines, flanged piping, PVC, and other non-conductive utilities are undetectable with traditional line-locating tools unless a trace wire is installed.

Even choosing where to try potholing options such as hydrovac to confirm the existence, location, and depth of lines can be hit-and-miss and expensive without effective locating technology. Fortunately, GPR was very practical for locating both known and unknown utilities in these projects in the busy Fort Saskatchewan soil, and both directional drilling projects were completed without disturbing other underground systems.

This is not unusual for Maverick. Crews from the Alberta-based company have travelled around the world doing projects ranging from mapping out industrial facility-wide utility systems for mines and petrochemical facilities, to locating graves of US Marines who fell at the WWII Battle of Tarawa in the South Pacific, to providing documentary film support in Aklavik



3D model of a pipe resulting from Laser Imaging. Even small wall loss is noticeable in the software.

for Myth Merchants' Hunt for the Mad Trapper, to locating First Nations burial-sites during recent infrastructure work in Westbank BC for the new bridge.

Radar is not, however, a magic bullet for all situations. Soil type, pH, saturation, the amount of disturbance of the natural soil horizons, and the type and number of underground artifacts all play a role. Even so, compared to other methods James Harrison, the GPR Department Manager at Maverick, describes radar as a "fast, convenient, and cost-effective way of gathering the compelling evidence needed for project decisions."

It requires adaptable methods and extensive experience to gather and present useful data. Understanding and communicating the limitations of GPR is as important as exploiting its strengths and selling features. "In the Edmonton area," says James, "there is a layer of blue clay that stops our signal penetration completely at around three meters. In other areas with sandy soil, we have been able to gather useful data from around thirty meters. Every job is unique in some way, and you need the skills and experience to recognize that and work with it."

Another trenchless application for radar became apparent during a recent pipeline expansion which required boring under major Edmonton-area roadways. After a near collapse of a roadway, radar was turned to as a solution. By examining the soil around and above the bored utility both before and after the procedure, the gathering of quick and non-destructive radar data

was chosen to confirm the existence of problems such as instability or voiding.

The scope of this work was very similar to typical work Maverick performs on plant sites prior to heavy crane lifts. For these types of projects further three-dimensional and GIS analysis of the data is safely done by technicians away from busy traffic areas, and a report of the data-gathering methodology and results is provided to client representatives for review by engineers, geophysicists, and other professionals.

Laser Profiling is another method that Maverick has been exploring to quantify subsurface features and defects. Laser systems are added to robotic camera systems to confirm and measure deflection, offsets, ovality, scale, and other problems in underground piping.

Recently, Laser Profiling was used to locate and internally measure a faulty section of a conduit that was damaging electrical cables. The cables were pulled through a conduit bank during a retrofit at Syncrude near Fort McMurray Alberta, and the conductors were unusable after the expensive replacement. As a result of the inspection, the source of the damage was identified, measured, and quickly pinpointed for repairs so the project suffered no further downtime or loss of materials due to conduit bank issues. The defect was not detectable by video alone without the laser measurement add-on.

Leonard Olchove, the Remote Video Department Manager at Maverick has seen his share of underground piping. "We can now quantify the extent of corrosion, erosion, obstructions, ovality, sediments, fouling, and coating defects. If you have measurements and precise locations, then you have a solid basis for repair decisions and for confidence in the serviceability of a piping system."

As with GPR, laser and software video measurement are not for every situation. Unless you want to measure fouling, the line has to be fairly clean, and the access and length and layout of the run can limit how much data is gathered. In some situations, a representative section is sufficient for imaging and measurement. Other times, additional access is required for a full internal survey.

As the subsurface world continues to present new challenges, technology and experience continue to move forward. The need to locate and quantify unseen features will grow, and companies like Maverick will grow along with the industry and explore new inspection solutions.

For more technology updates, case studies, and sample application results, visit www.maverickinspection.com.

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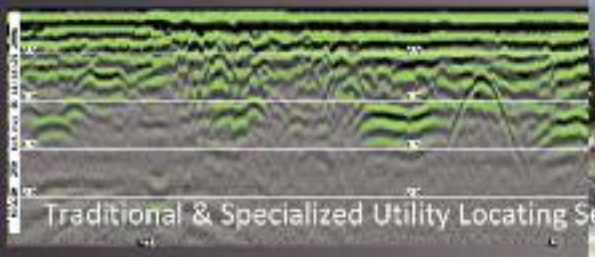

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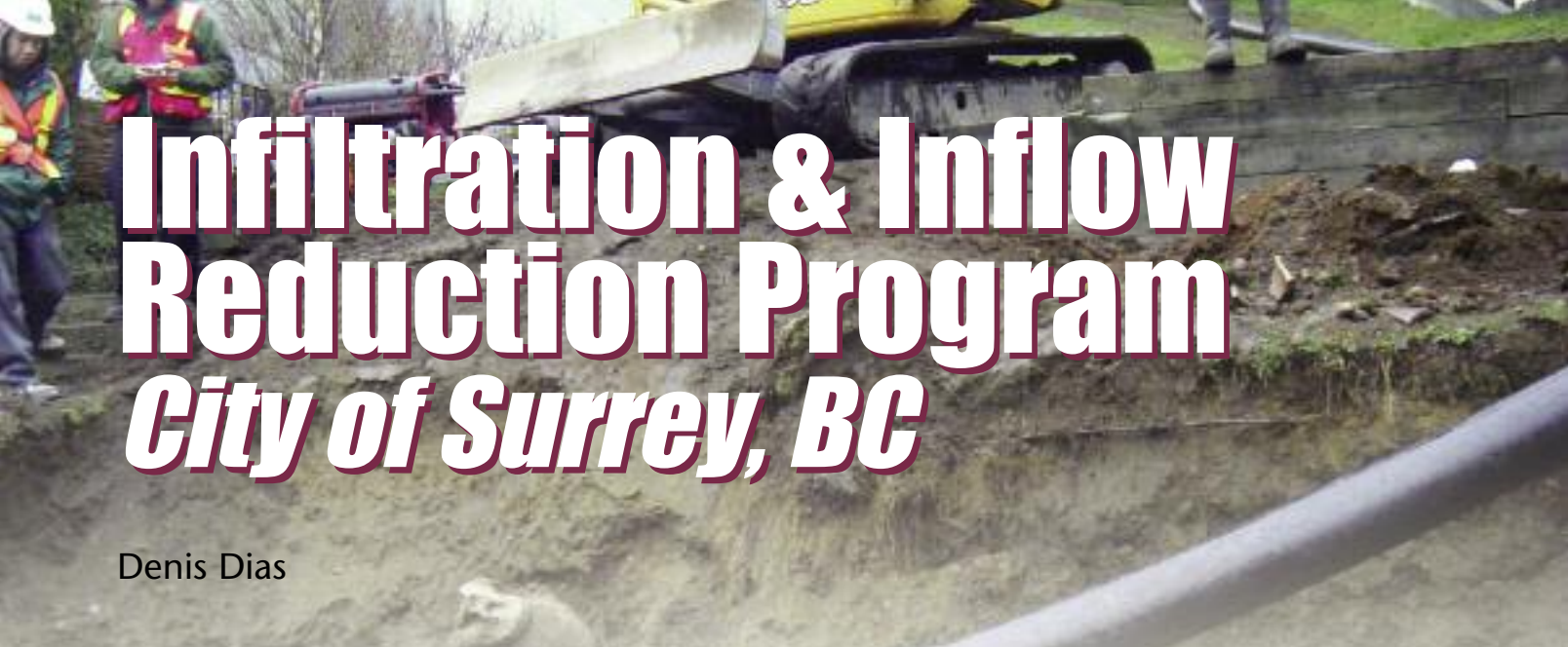


Infiltration & Inflow Reduction Program
City of Surrey, BC

Denis Dias

Introduction: Infiltration and inflow is defined as an occurrence of ground water or rainwater entering into the municipal sewer system through cracked pipes, bad joints, or leaking manholes. Once this ground water or storm water enters into the sanitary sewer mains, it adds up to the daily volume of wastewater that is collected, pumped, or treated and burdens the entire sewer system. Metro Vancouver, who manages the wastewater for Vancouver and the Lower mainland, has established I&I rate limits in their Liquid Waste Management Plan, and most of the Cities are trying to comply with those standards.

The City of Surrey has initiated a program to monitor, inspect, and mitigate infiltration and inflows and the third phase of this study has been awarded to P. W. Trenchless Constructions to inspect, test and mitigate infiltration and inflows in the City's sewer service connections.

Problems of I&I: When storm or ground water enters into the sanitary sewer system, the following problems occur:

1. Sewage may surcharge from manholes or bypass treatment facilities and contaminate surrounding properties as well as water courses, causing major damage to the environment.

2. Sewage may backup into the residences causing health hazards as well as expensive repair costs.

3. Sewer system may require upgrades to accommodate the increased flow volume, resulting in increased cost to utility bills.

4. Excessive water in the sewer system will decrease the efficiency of wastewater treatment plants and will result in higher operating costs.

City of Surrey's I&I Program: This is a joint initiative from the City of Surrey's Operation Division and the Engineering Utilities Division, who have initiated a program to monitor and study certain areas within the City limits for infiltration and Inflow and upgrade the system accordingly. The City has selected three areas in its study and they are 'Study area 1 - Cloverdale West', 'Study area 2 – Cloverdale East' and 'Study area 3 – Robson Creek'.

The complete program of monitoring, inspection and mitigation process was divided into four tiers. Tier 1 was inspecting and rectifying the sewer mains, tier 2 was to inspect all the manholes in the study areas and rectify the defects. Tier 3 is to rehabilitate the sewer service connections from the property line to city mains, and the last stage of the study, tier-4, will be to inspect and rectify the defects with in the private property.

Work on Tier-1 and 2 was carried out simultaneously and was completed three years back. Tier-3, rehabilitation of sewer services, is currently in progress and P.W. Trenchless Constructions is carrying out these works for the City, with R. F. Binnie being the Engineering Consultants for these works. Tier-4 will be commenced once tier-3 works have been completed.

The following are various monitoring, testing and mitigation measures considered to reduce infiltration and inflow in the study areas:

• Flow Monitor: Monitor flow through the sewer mains with the help of flow meters installed at various exit points in the study area and record them. With this

Infiltration of storm water due to bad joint

Repair of defective connection

system, they can fairly analyze the quantity of infiltration and inflows in the system. The Metro Vancouver Liquid Waste Management Plan has set a target of 11,000 liters/ha/day as the maximum liquid waste output in the residential area.

• Smoke test: Smoke test all three study areas and identify any defects or problems such as storm cross connections, rain down spot connections into sanitary services or any other openings where storm water can infiltrate into the sewer system. Smoke testing is a simple way of inspection, whereby you can find major defects of cross connections in the system. In this system, smoke is fed from one end of the main line, and if smoke leakage is noticed through any openings such as catch basins, culverts, rain drains etc. this indicates a strong possibility of a cross connection into the sewer system and is a source of inflow and infiltration which needs to be rectified.

• CCTV Camera: In closed circuit television (CCTV) method, a launch camera is remotely launched into the pipeline (sewer system) to video any cracks, joint misalignments, root intrusions or any other defects in the pipe. This complete video is recorded and any defects found will be documented in the report.

• Chemical root treatment: This is a process where the sewer line is soaked with non-synthetic herbicide to kill the intruding roots. Although this process will destroy the roots within the pipeline it will not damage the plants or trees.

• Rootcut and clean the mains and service connection: In this method a cutter machine is fed into the pipeline by air or water pressure to cut all the intruded roots and then this line is flushed and cleaned by hydrovac.

• Segmental point repairs: If any cracks or defects are noticed at isolated locations with in the pipe, then these spots are internally point repaired rather than open cutting and replacing the whole length of pipe. Point repairs are usually carried out by installing an internal liner or by pressure grouting the defective areas. Sometimes if the damage is too bad then this section may have to be open cut and repaired.

Point repair

• Air test and chemical grout: In this method, the pipeline is air tested in sections and if any leaks are noticed due to cracks or bad joints then it is repaired by injecting chemical grout into the failed areas and then re-tested.

• Rehabilitate or Replace sewer services connections: Due to the age of the service connections or due to the extent of defects in the pipe line, it is necessary to replace or rehabilitate these sections of pipeline and the common methods used to replace these service connections are by open cut, pipeburst or reline. The latter two are the most cost effective methods. In each study area in Tier-3 phase, the City has implemented set criteria for the mitigation work, so that they can analyze the effectiveness of each method as well as look into the costs incurred. The rehabilitation work in this phase mostly involves trenchless methods such as testing and grouting, repairs to defective pipes with segmental liners, relining the services with CIPP liners, or installing new service connections by pipe bursting.

In Study area-1 at Cloverdale West, all the PVC service connections are air tested and grouted, and all other type of service connections are replaced to new by pipe bursting, which is a cheaper option when compared to open cut.

In Study area-2 at Cloverdale East, all the service connections are replaced to new, either by pipe bursting or by open cut.

In Study area-3 at Robson Creek all the service connections will be air tested and any defects noted will be pressure grouted.

The mitigation / rehabilitation works on tier-3 will extend up to June 2010 and upon completion of the works, the City Engineers will analyze the reduction in flow and will plan on implementing the inspection and mitigation methods on other areas as well.

Denis Dias is a Project Manager for P. W. Trenchless Construction Inc.

Installing new service connection to old main

A River Ran Above It

The Highbury Interceptor Remediation Project

Rick Steadman

Sewer pipe remediation is not an unusual municipal project, but Metro Vancouver (the Greater Vancouver Regional District) was faced with a unique situation with its vital Highbury Interceptor Siphon. Tunneled deep underground, the Highbury Interceptor combined sanitary and storm sewer system conveys Vancouver's sewage to a point on the north bank of the Fraser River's north arm. From there, it flows beneath the river through the Highbury Interceptor inverted siphon to the Iona Island Wastewater Treatment Plant.

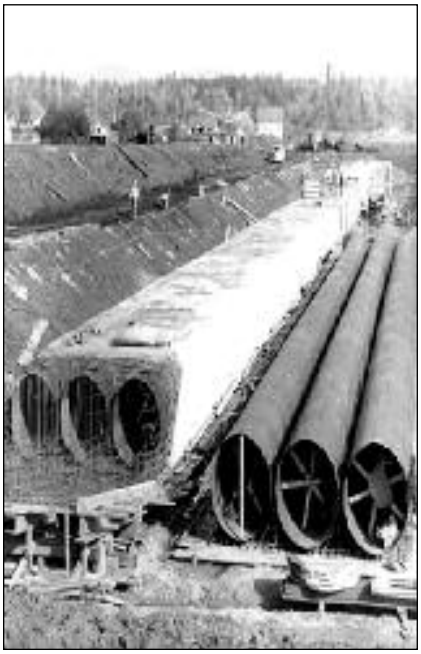
Originally built in the early 1960's, the Highbury Interceptor Siphon consists of three 1727 mm diameter siphon pipes. The siphons were constructed of reinforced concrete poured around three 1.5 mm steel forming liners. Over the years, Vancouver grew dramatically, but in recent years flows through the siphon have not increased, due to the City of Vancouver's program to progressively separate stormwater from the combined sewer system. The peak flow through the siphon is approximately 17.7 m?/sec. "That system worked well for over forty years," said Hein Steunenberg, Senior Project Engineer with Metro Vancouver. "But no municipal infrastructure lasts forever, and Highbury is no exception."

The system started to show its age in 1996, when portions of the steel liner began to exhibit signs of failure. The liner was subsequently completely removed from all siphons, leaving essentially three sewage tunnels through the surrounding concrete structure.

With the steel liner removed, CCTV inspections conducted by Metro Vancouver revealed cracking in the concrete. The Highbury site is under the North Arm of the Fraser just upstream from Georgia Strait, which meant that tidal salt water could enter cracks and corrode reinforcing steel in the concrete. Also, the steel submarine joints, tying the sections of the siphon together had been exposed to salt water for an extended period of time, and needed to be reinforced. Something had to be done, but what?

Metro Vancouver considered a number of solutions, including rehabilitating the existing pipes and outright replacement of the entire river crossing system. The major consideration when evaluating rehabilitation/replacement options was the short window during the summer when the siphon could be partially shut down. Rehabilitation was therefore selected as the most efficient and cost-effective option. Four methods were evaluated, including shotcreting with wire mesh, sliplining, spiral-wound lining, and cured-in-place-pipe (CIPP) lining. Shotcreting was the least costly alternative, but required more siphon downtime than Metro Vancouver could afford, and the application would decrease the siphon's flow capacity. The other three technologies were roughly equivalent in estimated cost.

In the end, CIPP lining was chosen as the optimum technical and logistical solution. The CIPP lining has a 50-year design life,



The Highbury Interceptor Siphon initial construction project in the early 1960's.

and offers technical properties that can restore the siphon to its original condition. Insituform Technologies® Ltd., a highly experienced contractor in trenchless technologies, was awarded the project through a competitive process. The remediation plan called for Siphon Three (the east siphon) to be repaired first, with the other two following in subsequent years.

The Fraser is a major salmon river, so to ensure the remediation project would meet strict environmental controls, ECL Envirowest Consultants assisted with developing environmental management plans and monitoring construction activities. Metro Vanvouver's Quality Control staff developed protocols to monitor water styrene levels associated with the repair work. With preplanning completed and approvals in place, the project was set to begin in early 2009.

One of the first tasks in the construction phase was to precisely locate Siphon 3 at the site of construction on the north bank of the river. Metro Vancouver called on Canadian Dewatering to assist. "We determined that with self-jetting wellpoints we could carefully probe the sandy soil and establish the exact position of the pipe," said Canadian Dewatering's Ken Smith. "The pipe was 10 metres down, so it took a fairly dense pattern of wellpoints to accurately delineate the pipe for Metro Vancouver."

A Canadian Dewatering crew sinking wellpoints to precisely locate the south end of Siphon Three.

The next phase called for the construction of a large 'manhole' to provide access to Siphon 3 for the re-lining process later in the year. Conventional dewatering was out of the question due to the high water table and sandy soil alongside the river. Possible settling of adjacent structures was the concern, so innovation was again required. The solution was to jet-grout a series of 29 cement columns in a circular pattern to act as a reinforcing wall, then to dig out the center to create the access manhole.

The re-lining project began in July 2009, when Vancouver's monsoon-like winter rains had abated. The decreased sewage flow into the Highbury Interceptor provided a window to shut down one or, for limited times, two siphons. Crack sealing and cleaning were conducted in Siphon 3 over a two-week period. As a safety precaution the middle siphon was taken offline to reduce hydrostatic pressure between on the dividing wall between the two siphons when workers had to enter Siphon 3. The remaining siphon was deemed capable of handling dry weather flow. A contingency plan called for the evacuation of Siphon 3 and re-opening of the middle siphon if unseasonable rain was encountered. With

Siphon 3 cleaned and the cracks repaired, Insituform was able to move its specialized equipment onsite in early August and begin the re-lining.

The process involved first saturating the liner tube with a special mix of non-filled (containing no talc) 102 NA resin in an onsite, "wet-out over the hole" procedure. This entails creating a vacuum in the liner, impregnating the liner with resin and feeding the resin-impregnated liner through a set of rollers to control the quantity of resin. The 330 metre-long, 1727 mm diameter liner was designed for a tight fit that matches the length and internal circumference of the original siphon pipe. The liner was manufactured from layers of absorbent, non-woven felt fabric. Seams tying the liner together are stronger than the fabric, and required 98 kilometres of thread. A flexible, impermeable outside membrane contains the resin, and allows monitoring during the wet-out process.

To handle the high head of water associated with installation in such a deep siphon, Insituform Technologies®, Inc. manufactured a liner with no splices over the entire length. "This presented a significant challenge for our tube manufacturing facility, as the unique combination of size,

Construction of the access 'manhole' to Siphon Three.

thickness and length of the required tube pushed our capabilities to the limit," said Mark Brand, Regional Manager of Insituform. Five tanker units containing 18,000 kilograms of resin were required to complete the job. This constitutes 40% more resin than has ever been used in a single installation on a CIPP project in Canada.

The liner resembles a giant sock turned inside-out. The end of the tube is firmly held over the access manhole and the resin-impregnated liner is then inverted into the pipe by water pressure. The "sock' then unrolls down the length of the pipe, creating a continuous and seamless pipe-within-a-pipe. Because of the high head involved, the possibility of tearing the liner existed, so the inversion was accomplished by "water break" where the concrete siphon was first filled with water, which was then removed to match the rate of inversion.

Once the liner was installed, the inversion water was heated, and the resin was allowed to cure for more than five days. The curing temperature was monitored by thermocouples installed at the bottom of the siphon. To heat such a large volume of water (800 m3) required the use of a 500 HP boiler and a 200 HP back-up boiler. "To our knowledge, there are only four 500 HP boilers available in all of North America, and they're all owned by Insituform." Brand said, adding "the boiler

The 'wetting out over the hole' process being performed at the access manhole.

– *One of the tanker units required to bring the resin to the site.*

The pipe liner arrives from the Insituform manufac turing facility.

branch inspector told me there was enough boiler power there to heat a 90-story building!"

Circulation of the curing water was accomplished by large diesel-powered pumps provided by Canadian Dewatering. Circulation was required to counteract the cold "heat sink" of the Fraser River by ensuring that heated water was delivered throughout the liner. At the end of the curing period, the inversion water was transferred to the Iona Island facility for treatment.

The cured liner was then tested for flexural properties and thickness, and the results met Metro Vancouver's design objectives. "We are very pleased with the project," Steunenberg said. "A lot of planning and cooperation with stakeholders, Metro Vancouver staff and contractors went into this project, and we're gratified to see it pay off so successfully."

View of pipe after completion of rehabilitation.

Rick Steadman is a freelance writer, journalist, and communications professional with over 25 years' experience.

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