NASTT's Trenchless Today

Educate - Train - Research - Publish

Summer 2012
Volume 2
Issue No. 2

THE OFFICIAL MAGAZINE OF THE NORTH AMERICAN SOCIETY FOR TRENCHLESS TECHNOLOGY

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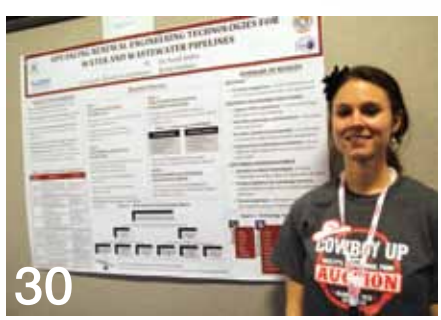
Summer 2012 Edition

Volume 2, Number 2

Features



Departments

Columns

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Message from the Executive Director

Third Time's the Charm!

For this year's second issue of *NASTT's Trenchless Today*, we are devoting our pages to the overwhelming success of the 2012 No-Dig Show. What a fantastic event! After holding two outstanding No-Dig Shows at the Gaylord Opryland in Nashville, our third gathering proved to be the charm. This year's conference and exhibition far exceeded our high expectations in terms of attendance, innovative technology, networking, new ideas, technical information and most of all….fun!

The No-Dig Show has been a fortunate beneficiary of the success of our growing industry with increasing numbers of event sponsorships, exhibitors, volunteers and attendees. I want to express my sincere thanks to our event sponsors and valued exhibitors for their unbridled generosity and loyalty to the show. Notably, our exhibit hall floor continues to be the launching pad for more and more trenchless companies as they use the No-Dig Show to showcase their new products and innovative technologies directly to the industry leaders. It is not surprising that we experienced a 19 percent increase in the number of new exhibitors at this year's event.

Volunteerism is the jewel in the NASTT crown and how do you properly thank this incredible group of trenchless professionals who give so much of their time to ensure the No-Dig Show is the success that it is? My gratitude and thanks goes to the 2012 Program Committee. Led by George Ragula and Kim Staheli, this group put together a record-setting, high-caliber technical program, featuring 155 peer-reviewed papers. I guarantee that you will always learn something new and valuable when you attend these incredible sessions.

The 2012 No-Dig Show was full of special moments and I'd like to share my thoughts with you on two that stand out prominently in my memory. First, the NASTT Hall of Fame ceremony. Once again, I want to extend my congratulations to this very special group of trenchless trailblazers: Frank Canon, Bernie Krzys and the late Gary Vermeer. On a personal level, I had been anticipating this part of the Gala Dinner since we first announced the creation of our Hall of Fame. The moment did not disappoint. What caught me off guard was how emotional the ceremony turned out to be. Listening to their acceptance speeches and learning what motivated these fine individuals to develop and nurture our industry, you heard their voices crack and their powerful pauses. As I watched each person take to the podium, you could feel their passion for the trenchless industry and I believe there was a genuine sense of collective pride from the entire audience. I have no doubt that in the coming years the NASTT Trenchless Hall of Fame ceremony will be the centerpiece event of our Gala Awards Dinner.

The second special event was honoring John Hemphill as the recipient of this year's NASTT Chairman's Award for Outstanding Lifetime Service — a most deserving honor for someone who nursed NASTT back to life in the early 2000s. John was my predecessor and mentor for this job, serving from 2001 until 2008, when he retired from NASTT to become the executive director of ISTT. When John came aboard, NASTT wasn't doing particularly well financially and was struggling to gain membership. In fact, we had hit rock bottom. Under John's leadership, NASTT was re-energized, re-organized and re-built. He weathered our financial lean years, making difficult decisions to keep NASTT going and get it out of substantial debt. He mapped out a plan to increase our membership and chapter organizations. When John started, we had just two student chapters and four regional chapters; when he retired, those numbers grew to 10 and 7, respectively. John laid the foundation for the success we enjoy today in our finances, membership and volunteers. When I was hired as executive director, I was blessed with a growing and vibrant organization to manage and that is because of the hard work and vision of John Hemphill.

NASTT is indebted to the countless hours our volunteers donate to make the No-Dig Show the event that it is. As you might expect, plans are under way for the 2013 No-Dig Show in Sacramento, Calif. I hope you enjoy *NASTT's Trenchless Today's* reflections of the 2012 No-Dig Show and that they inspire you to be a part of the 2013 show.

Sincerely,

Mike Willmets
NASTT Executive Director

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NASTT's 2013 No-Dig Show Call for Abstracts

The Great Trenchless Gold Rush!

Submission Deadline: June 30, 2012

The North American Society for Trenchless Technology (NASTT) is now accepting abstracts for its 2013 No-Dig Show in Sacramento, California, located at the Sacramento Convention Center, March 3-7, 2013.

Prospective authors are invited to submit a 250-word abstract outlining the scope of their paper and the principal points of benefit to the trenchless industry. The abstracts must be submitted electronically via the No-Dig Show website at: www.nodigshow.com by June 30, 2012. NASTT's 2013 No-Dig Show Program Committee will review abstracts in mid-July and notify the primary authors of acceptance immediately afterward. To ensure meaningful and commercial free technical content, all papers will be peer-reviewed. Final papers will be published in the conference proceedings.

Abstracts from the following subject areas are of interest to the No-Dig Show Program Committee:

HDD
- Pipeline Inspection and Locating
- Condition Assessment
- Subsurface Utility Engineering
- I&I and Leak Detection

Cutting-Edge Advances in Pipeline and Manhole Rehabilitation
- Cured-in-Place Pipe Lining
- Sliplining
- Pipe Bursting
- Laterals Rehabilitation
- Grouting
- Lining Materials and Application Methods

New Installations
- New Concepts for Trenchless Equipment, Materials and Methods
- Horizontal Directional Drilling (HDD)
- Microtunneling
- New Applications for Boring Techniques (Auger Boring and Pipe Ramming)
- Pilot Tube Boring (Tunneling)

Trenchless Research and Development
- University and Industry Initiatives
- Education and Training

Environmental Incentives, Challenges and Sustainability
- Carbon Reduction
- Sustainable Construction Practices

Municipal Issues
- Selection Criteria for Contractors
- Development of Submittal Requirements
- Measuring Quality Assurance/ Quality Control
- Project Budgeting and Prioritization
- Selection Criteria for Materials
- Funding for "Green" Technologies
- Lessons Learned

Industry Issues
- Social Costs and Impacts
- Industry Trends, Issues and Concerns

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Chairman's Message

No-Dig Continues to Exceed Expectations

The 2012 No-Dig Show has been over for more than a month but its outstanding success continues on, as its message returns home with those who attended and participated. I want to start off by thanking everyone who joined NASTT in Nashville and hope they found their experience rewarding and purposeful. Your attendance at the No-Dig Show is a huge part of what makes our industry so special, being able to attract so many enthusiastic participants.

Nashville proved once again to be an outstanding host for our 22nd conference and exhibition. Hosting the No-Dig Show for the third time, Nashville and the Gaylord Opryland delivered to the more than 1,600 NASTT members, engineers, contractors, manufacturers, academics and public works officials who came. I hope you were able to enjoy all or at least some of what this city has to offer – and there is a lot to do and experience in Nashville!

The 2012 Program Committee outdid itself in presenting the best the trenchless industry has to offer – the exhibit floor to the record number of technical papers to the Gala Dinner and Educational Fund Auction. Saying a job well done doesn't seem adequate in expressing my thanks, as well as the appreciation of our membership. The amount of hours this committee volunteers above and beyond their "day jobs" is invaluable to the success of the show.

As your Chairman, it is immensely gratifying to witness the No-Dig Show unfold before me in such a positive way. The exhibit floor showcased the latest in trenchless technologies and products from our exhibiting companies. We are honored that so many companies choose the No-Dig Show to unveil their innovative ideas that make our industry even stronger and more competitive.

Our technical program remains the cornerstone of our conference. Simply put, our program is often imitated, but never duplicated. Each paper is peer-reviewed to ensure the highest level of information without commercialism. This year, our technical program featured 155 high-quality technical papers that ran the gamut of trenchless information in a record-breaking six track series. I hope you were able to participate in these sessions, as either a presenter or attendee.

I want to share with you a few of the milestones the 2012 No-Dig Show achieved. First, we saw a 19 percent increase in the number of new exhibiting trenchless companies at the show, proving that trenchless companies recognize the quality of those who attend this event, as well as the value of exhibiting at our event. The Educational Fund Auction also set a new standard in the amount of money it raised. This year, due to the overwhelmingly generosity of the bidders, the $100,000 mark was reached. I want to thank all who bid and purchased items at the live auction, the silent auction and eBay auction, as they help NASTT support the future of the industry. Since 2002, NASTT has raised more than $533,000 for educational initiatives. Due to your generosity, proceeds for this unique social event benefit scholarships, student participation at the show and provide targeted trenchless training courses.

One of the highlights of this year's No-Dig Show was also an inaugural event: NASTT inducted its first class into its Hall of Fame. Congratulations again to Frank Canon, Bernie Krzys and the late Gary Vermeer. Their tireless contributions to the industry can never be overstated and what a special moment it was to formally induct these individuals before their families, friends and peers.

Our networking events were fun and enjoyed by everyone. One of the most entertaining events was held just prior to the live auction: the Best Western Costume contest. There were plenty of sheriffs and deputies, gamblers (that includes me!) and cowboys, but the clear winner (as voted by your enthusiastic applause) was Kim Staheli – aka Dolly Parton. She really captured the spirit of the event!

A lot of hard work and effort goes into organizing, managing and presenting a trenchless event of this size, importance and magnitude. I would like to personally thank and commend Program Committee Co-Chair Kim Staheli for all of her time and effort, as well as the 50-plus members of the Program Committee and countless volunteers who have worked to present an outstanding event at all levels. My thanks doesn't seem like enough for what we owe you for all you did but THANK YOU! I hand over the Program Committee Chair reins to Kim with the utmost confidence in her leadership, with no doubt that the 2013 No-Dig Show will mirror, if not surpass the success of 2012.

I also want to offer my congratulations to ISTT Chairman Dr. Sam Ariaratnam for his selection as the 2012 Trenchless Technology Person of the Year. Dr. Sam is just the third academic to be honored with the Person of Year award and the first Canadian. He has been instrumental in educating and mentoring the next generation of trenchless engineers at the university level, as well as industry professionals through NASTT's Good Practices programs. Congratulations Dr. Sam — your honor is well deserved!

I also want to congratulate John Hemphill – this year's recipient of the NASTT Chairman's Award for Outstanding Lifetime Service. John guided NASTT under some turbulent years as the organization was struggling financially and in its membership. Acknowledging Dr. Sam and John segues me to encouraging your attendance at the 2012 International No-Dig Show in Sao Paulo, Brazil, Nov. 12-14. This conference, hosted by the Brazilian Society for Trenchless Technology (ABATT), offers the opportunity to learn about trenchless technology on a global scale.

With the success of the 2012 No-Dig in the books, I cannot help but feel excited for the future of NASTT and our industry. We are only as strong as our members and we have the best there is. I encourage you to participate in NASTT, whether through your regional chapter, student chapters or through one of our subcommittees or helping out with our Good Practices programs. Whatever you can contribute will make a difference!

Again, thank you to all who helped to make the 2012 No-Dig Show such an outstanding and successful event. The 2013 show is less than a year away and I'm looking forward to bringing No-Dig to Sacramento!

George Ragula
NASTT Chairman

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Q&A

John Hemphill, ISTT Executive Director and Former NASTT Executive Director Talks About His Career in Trenchless

NASTT's Trenchless Today (NTT): Could you tell our readers a little bit about yourself and how you got into the trenchless field?

Hemphill: I grew up in Oklahoma, and thinking back, I was surrounded by trenchless – oil wells and armadillos. Oil rigs were everywhere. The drilling may have been vertical, but it was drilling all the same. And for anyone not familiar with the burrowing habits of armadillos, they are first class tunnelers.

I studied engineering (B.S. University of Oklahoma; M.S. University of Maryland) and I've had a variety of professional work experiences. I started out as an engineer in transportation and moved to the energy and the environment field. I served as Director of the Office of Conservation Policy at the U.S. Department of Energy. Later, I was Deputy Director of Conservation Policy at the International Energy Agency in Paris before returning home where I joined a consulting firm and first became aware of trenchless technologies. By the late 90s, I was chosen to be ASCE's first Congressional Fellow. Shortly thereafter, I joined NASTT. The path was somewhat circuitous, but it led me to trenchless.

NTT: How did you first get involved in NASTT and later, ISTT?

Hemphill: I am a lucky guy. I studied the market opportunities and benefits of trenchless when I was a management consultant in the early 80s. In the late 90s, NASTT relocated its headquarters from Chicago to Washington D.C. and I was in the right place at the right time to be hired as a staffer. I became the Executive Director about a year later.

It was a great work environment – a society with a growing and diverse membership with a mission to advance technologies that have social and economic benefits. It was easy to become a huge advocate for trenchless. Ten years later, I announced my decision to retire as Executive Director of NASTT. Coincidentally, that same year, the long-term ISTT Executive Secretary also announced his plans to retire. ISTT broke with tradition and decided the new Executive Director did not need to be located in the United Kingdom, which opened the door for me to apply.

NTT: What are some of the key issues being faced in the international trenchless market as opposed to in North America?

Hemphill: The trenchless community world-wide faces the same challenges – raising the visibility of trenchless technologies and methods, and dispelling myths about alleged problems associated with trenchless installations. Trenchless markets in North America and throughout the world vary by location and run the gamut from being little known, to being seen as new and innovative, or mature and established. In all cases, there is a clear and compelling need for education and training, whether it is for broad introductory seminars or higher level technical how-to training courses. NASTT, ISTT and the 28 other national trenchless societies located throughout the world serve an important role in addressing this need by providing high-quality, objective trenchless education and training programs.

NTT: How has NASTT evolved over the years? What have been the organization's strengths?

Hemphill: NASTT has matured along with the trenchless industry. Since NASTT is a member-based organization, this is to be expected. To me, the strength of NASTT lies in the breadth of its membership. NASTT, unlike many industry-specific associations, has members from every part of the trenchless community – users, academics, contractors, consultants, manufacturers and suppliers. The broad-based membership of NASTT provides a foundation for healthy debate and the exchange of ideas and experiences across the industry.

NTT: What did you think of this year's No-Dig Show in Nashville and how did it feel to receive the NASTT's Chairman's Award for Outstanding Lifetime Service?

Hemphill: It was a great and humbling honor. The NASTT No-Dig Show clearly has become the premier trenchless conference in North America and is recognized as a leading trenchless conference worldwide. It may sound trite to say that each year the NASTT No-Dig Show is better than the last but that seems to be the case.

NTT: How do you think the trenchless community benefits from No-Dig?

Hemphill: No-Dig, first and foremost, is known for its superb technical sessions where high-quality, peered-reviewed papers are presented. No other conference in North America can match the educational level that the NASTT No-Dig Show offers. The quality of these technical sessions attract leaders in the trenchless community, who both present papers and come to learn the latest in trenchless developments. I often hear exhibitors comment that the quality of No-Dig attendees is what makes the show so successful and special.

NTT: As we move forward into 2012, what outlook do you have for NASTT, ISTT and the trenchless industry as a whole?

Hemphill: Optimism. Trenchless is no longer considered a novelty. Many trenchless technologies have now been around for decades and are well established, proven technologies. Past successes and continued innovation, coupled with a huge need to expand and rehabilitate underground infrastructures worldwide are all positive signs for the continued growth of the industry. The potential for growth in the trenchless market calls for more education and training programs to help ensure that trenchless solutions are used to the greatest extent practical. That means NASTT, ISTT and other trenchless societies around the world will continue to play a critical role.

DRINKING WATER FOR TEL AVIV.

The population is growing in Tel Aviv, but the rainfall is restricted to the winter months. Therefore people's drinking water supply is secured by seawater desalination plants filtering the seawater and making it drinkable.

Currently, one of the largest seawater desalination plants in the world is being built in Sorek, 15 kilometers south of Tel Aviv. It will produce an annual volume of up to 150 million cubic meters of drinking water. Intake and outfall tunnels connect the plant with the Mediterranean Sea. Pumps at the coast suck in the seawater through pipelines. After the separation of salt and the filtering of impurities, the drinking water is channeled into the urban infrastructure. The brine flows back into the sea through the outfall.

Three Herrenknecht AVN Micromachines (Ø 3,100mm) are excavating three routes in a total of 9 drives using a cutterhead power of 315 and 160 kilowatt respectively. They are digging through a total of around 10 kilometers of sand, clay and calcareous sandstone, reaching top performances of up to 20 meters in an 8 hour shift. The seawater desalination plant is expected to start operation in 2013.

SOREK | ISRAEL

PROJECT DATA	CONTRACTOR:
M-1275M, M-1575M, AVND2000AB, AVND2500AH Diameter: 2x 3,100mm Max. torque: 780kNm, 800kNm Total tunnel length: 7,305m Geology: sand, clay, calcareous sandstone	EHPH-Tunnelling Client: IDE Hutchison Water
M-870M, AVN1800AB Diameter: 3,100mm Max. torque: 520kNm Total tunnel length: 2,100m Geology: sand, clay, calcareous sandstone	Shimshon Client: IDE Hutchison Water

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In the Trenches

By Andrew Farr

The annual No-Dig Show never fails to recognize several outstanding members of NASTT and their contributions to trenchless construction. While this year's show in Nashville was no exception, *NASTT's Trenchless Today* would like to take a moment to introduce Collins Orton, Matthew Wallin and Kevin Bainbridge – a few more members who have devoted their careers to the trenchless industry.

Collins Orton

Collins Orton began his career in the construction industry when he was 18 years old after answering an ad for a job with the title "pipe fitter trainee." The job was with Smith-Blair, a pipe fitting manufacturer based in San Francisco at the time. He said he recalls a co-worker telling him "as long as people drink water, we'll be in business," which he said initially made an impression on him.

After that, Orton began his path into the trenchless world by first working with U.S. Pipe, becoming more familiar with pipe practices. He later joined Miller Pipeline Corp., where he worked for nine years, becoming more heavily involved in the trenchless process.

"Lots of things were new at that time," Orton said. "Contracting and manufacturing have really evolved since then."

Orton is now a product specialist and California regional sales manager for trenchless equipment manufacturer, TT Technologies, based in Aurora, Ill. He has dedicated the last 15 years of his career to trenchless technology, working with water, wastewater and gas utilities, telecommunication companies, engineers and contractors to develop the emerging market for trenchless solutions of decaying infrastructure. Working with TT Technologies, he has gained a wealth of trenchless equipment experience including specialization in pipe bursting systems, pipe ramming systems and boring systems.

Orton attended his first No-Dig show in San Jose, Calif., in 1993 – only the second year the event was held. Since then, he has been to the conference just about every year.

"People attending No-Dig now seem to be more sophisticated than in the beginning," he said. "There's not as many people looking at exhibits in awe, saying, 'How did they do that?'"

Orton said along with No-Dig, the trenchless industry as a whole has evolved.

"A lot of times, we used to just go

out and try something new," he said. "Now we know exactly what to do because things work better and technology and techniques have grown. None of this stuff is easy. One thing I look forward to is constantly pushing the envelope on new technology. If any of this was easy, it would already be done."

Orton is a lifetime member of AWWA, as well as a past Chairman of the Pipeline Rehabilitation Committee for the AWWA CA/NV Section. He has also contributed to several technical papers through the American Society of Civil Engineers (ASCE) and Louisiana Tech University. He is a lifetime resident of the San Francisco Bay area.

Matthew Wallin

Matthew Wallin doesn't quite remember when he knew he wanted to get into engineering. He just remembers always having an interest in math and science. However, due to the fact that his father is a civil engineer, it isn't surprising that Wallin's career followed a similar path. Since graduating with both a bachelor's and master's in civil engineering from Case Western Reserve University in Cleveland, Ohio, Wallin now has 12 years of experience in geotechnical engineering and trenchless technology.

Geotechnical engineering, a branch of civil engineering, focuses on the properties and behavior of earth materials and how they affect the design and construction of civil projects. Wallin said he initially found work involving constantly changing soil conditions interesting because he saw it as a blend of science and art.

Early in his career, Wallin worked for URS Corp. in Oakland, Calif., an engineering and construction firm that introduced him to the trenchless process.

"At URS I worked a lot on tunnel projects and trenchless design work," he said. "That was really my introduction. I think I studied just one tunnel project the whole time I was in school."

Today, Wallin is a senior project engineer and project engineer with Bennett Trenchless Engineers in Folsom, Calif., focusing primarily on the design of challenging horizontal directional drilling and microtunneling projects.

"The industry is getting more mature and sophisticated and changing all the time, especially in the ways we characterize ground conditions and try to fairly apportion risk between the owner and the contractor," he said. "And we still have a lot more that we can learn."

Wallin attended his first No-Dig in 2003 in Las Vegas and said it is something that Bennett Trenchless (and the firm's predecessor Bennett/Staheli Engineers) has always been involved in.

"No-Dig is just great for networking," he said. "You have the opportunity to meet so many experienced people who you can talk to right there – the people who helped create and continue to define our industry."

Wallin has been involved in NASTT since 2001. He has authored and co-authored over 15 technical papers that have been presented at No-Dig, as well as RETC and the Nor-Cal Pipe Users Group Conference. He is the current treasurer of the Western Regional Chapter of NASTT and is an active member of the NASTT program committee.

One accomplishment Wallin is particularly proud of is a microtunneling project called the Upper Northwest Interceptor Section 9 and Associated NEA Projects. It involved 27,500 ft of consecutive microtunneling drives of 24-36 in. in diameter and between 41 shafts, up to 65 ft deep. The project was designed for the Sacramento Regional County Sanitation District (SRCSD) and Sacramento Area Sewer District (SASD). Wallin was the trenchless design engineer and along with the lead consultant HDR and the owners SRCSD and SASD, wrote a paper on the project and presented it at the 2009 No-Dig Show. They plan to resubmit it for consideration as NASTT's Project of the Year at next year's show.

Kevin Bainbridge

Kevin Bainbridge is a civil engineering technologist and has worked in the municipal sewer and water industry for over 15 years. Early in his career, Bainbridge developed an interest in investigative work in water and sewer main lining when he began working with the City of Hamilton, Ontario in 2000. Bainbridge said at that time, the city had only started looking into using trenchless technology for that type of work.

For the next 10 years, Bainbridge served as the senior project manager of subsurface infrastructure for Hamilton's Infrastructure Asset Management group. In this role, he directed the research, development, implementation and management of the city's first comprehensive trenchless rehabilitation programs for sewer and water mains.

Some of his projects have included the use of numerous rehabilitation and condition assessment technologies, including CIPP (thermal set and UV cured), GRP, epoxy lining, cement mortar lining, RFTC, leak detection, grout sealing and sliplining. To date, the city has completed over 300 km of sewer line rehabilitation and has established the same type of program to address water mains.

With the growing infrastructure deficit across North America, Bainbridge is a strong believer that trenchless rehabilitation is a significant key to the sustainable management of underground infrastructure. He said the trenchless industry is especially important because its application can intersect several areas of the construction industry, particularly sewer and water main rehabilitation.

"Looking at all the value trenchless can bring, it certainly brings a high level of value across water," he said. "Trenchless provides lots of options for how we make decisions and how we invest in infrastructure."

At the same time, Bainbridge said he believes trenchless is still one of the most underutilized methods in the construction industry, despite its use in specific areas. To him, that's where No-Dig comes in.

"There really aren't any educational opportunities in trenchless," he said. "We rely on NASTT and No-Dig for this education about the industry and to provide exposure for the companies that do this type of work."

Since 2011, Bainbridge has been the infrastructure management practice leader for Robinson Consultants Inc., leading the firm's practice in trenchless rehabilitation, condition assessment and asset management. He is also a registered member of the Ontario Association of Engineering Technologists and Technicians (OACETT).

Bainbridge is also currently the chair of the Great Lake St. Lawrence & Atlantic (GLSLA) chapter of NASTT and has been actively involved with the organization since 1999 including serving as a past No-Dig program committee member, No-Dig session moderator and presenting numerous papers at past No-Dig shows.

He has authored and co-authored over 25 papers on various aspects of infrastructure management and trenchless technologies and has spoken at numerous conferences and seminars on the subject, including NASTT's No-Dig Show, *Trenchless Technology* Road Show, AWWA, WEAO, ASCE, BCWWA and WCWWA.

Andrew Farr is the assistant editor of *NASTT's Trenchless Today*.

NASTT Heads to Anaheim!

NASTT will once again exhibit at the International Public Works Congress & Exposition this year to spread the word about trenchless technology. This year's conference is being held Aug. 26-29 at the Anaheim Convention Center in Anaheim, Calif. Each year, the APWA show features numerous education sessions that address current public works issues as well as ongoing challenges. Attendees can choose from more than 125 technical and professional development sessions based on the very latest learning models — classroom, interactive and "live" learning labs. They will also have the chance to see an extensive gathering of exhibitors, including the "The Expo Experience," that will showcase the latest products, services and technologies specific to public works. There are also opportunities to network with your peers, hone your leadership abilities and learn new job skills. On Aug. 29, NASTT will be presenting a complementary "Introduction to Trenchless Technology" short course. Be sure to mark your calendar for this premiere event!

NASTT Chairman George Ragula (left) with Communications and Training Manager Michelle Hill and Executive Director Mike Willmets at last year's APWA show.

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June 26 **NASTT's Introduction to Trenchless Technology Webinar – Rehabilitation Part 1**

Aug. 8 **NASTT's Introduction to Trenchless Technology Webinar – Rehabilitation Part 2**

Aug. 29 **NASTT's Introduction to Trenchless Technology Short Course**
Anaheim, CA

Oct. 17 **NASTT's Introduction to Trenchless Technology Webinar – New Installations Part 1**

Oct. 29-30 **8th Annual Western Regional No-Dig Conference & Exhibition**
Ontario, CA

Oct. 30 **NASTT's New Installation Methods Short Course**
Ontario, CA

Oct. 30 **NASTT's Pipe Bursting Short Course**
Ontario, CA

Nov. 7-8 **3rd Annual Rocky Mountain Regional No-Dig Conference and Exhibition**
Westminster, CO

Nov. 8 **NASTT's HDD Consortium Horizontal Directional Drilling Good Practices Guidelines Course**
Westminster, CO

Nov. 14 **NASTT's Laterals Good Practices Course**
Edmonton, AB

Nov. 15 **Northwest Chapter Trenchless Conference**
Edmonton, AB

Dec. 4 **NASTT's Introduction to Trenchless Technology Webinar – New Installations Part 2**

See Full Course Descriptions at
www.nastt.org

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c/o Losi & Ranger, PLLC
7445 Morgan Rd. • Liverpool, NY 13090 USA
Michael Willmets: 703-351-5252 (U.S.) or 613-424-3036 (Canada)
Michelle Hill: 440-638-4676

2012 No-Dig Award Winners

John Hemphill (left) accepts the award from Chairman George Ragula.

NASTT Chairman's Award for Outstanding Lifetime Service

John Hemphill, ISTT Executive Director, former NASTT Executive Director

2011 Outstanding Papers in Rehabilitation and New Installation

Paper D-5-04:

Forensic Investigation of CIPP Liners

Erez Allouche, Shaurav Alam and Ray Sterling from the Trenchless Technology Center, Louisiana Tech University, Ruston, La.; Wendy Condit from Battelle Memorial Institute, Columbus, Ohio; and Ari Selvakumar from U.S. EPA, Edison, N.J.

2011 Outstanding Paper Rehabilitation winner. Accepting (from left) are Ari Selvakumar, U.S. EPA, Ray Sterling and Shaurav Alam, Trenchless Technology Center.

Paper F-2-03: *The First Planned Curved Microtunnel in the United States*

Richard Palmer from Northeast Remsco Construction, Inc., Farmingdale, N.J.; Leo Martin from AECOM, Rocky Hill, Conn.; and Alexander Seilert from VMT GmbH, Bruchsal, Germany.

2011 Outstanding Paper New Installation winner. Accepting on behalf of AECOM, Northeast Remsco and VMT GmbH, is Northeast Remsco's Richard Palmer (right) with Jack Burnam presenting.

Trent Ralston Award for Young Trenchless Achievement

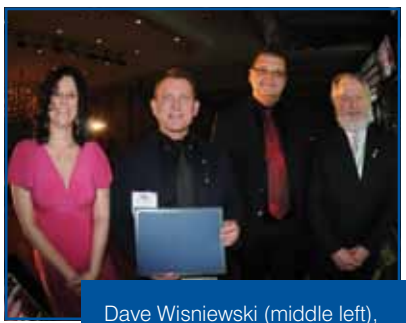
Dan Willems, City of Saskatoon

Dan Willems (left) of the City of Saskatoon accepts the Trent Ralston Award from Derek Potvin, president of Robinson Consultants Inc.

Special Thanks to the 2012 No-Dig Program Committee Members

Erez Allouche	Trenchless Technology Center
Samuel Ariaratnam	Arizona State University
Alan Atalah	Bowling Green State University
Brian Avon	Carollo Engineers
Frank Badinski	York Region
Joe Barsoom	Parsons Brinckerhoff Inc.
David Bennett	Bennett Trenchless Engineers
Richard (Bo) Botteicher	Underground Solutions Inc.
Glenn Boyce	Jacobs Associates
Chris Brahler	TT Technologies, Inc.
Mark Brownstein	Haley & Aldrich Inc.
Mark Bruce	Can Clay Corp.
Jack Burnam II	CH2M HILL
Craig Camp	Jacobs Associates
Ralph Carpenter	American Ductile Iron Pipe / American SpiralWeld Pipe
Ken Chua	City of Edmonton
George Cowan	HAKS
David Crowder	R.V. Anderson Associates Ltd.
Don Del Nero	CH2M Hill
Dennis Doherty	Haley & Aldrich, Inc.
Brian Dorwart	Brierley Associates, LLC
Glenn Duyvestyn	Hatch Mott MacDonald
John English	Horizontal Technology Inc.
John Giese	JR Giese Operations
Jennifer Glynn	RMC Water and Environment
Sanjiv Gokhale	Vanderbilt University
Greg Goral	Michels Directional Crossings
Mark Hallett	SAERTEX multiCom LP
Keith Hanks	City of Los Angeles
Larry Kiest, Jr.	LMK Technologies
Brenda Kingsmill	Region of Halton
David Krywiak	Stantec Consulting
Bernie Krzys	Benjamin Media, Inc.

Joseph L. Abbot, Jr. Innovative Product Awards



Dave Wisniewski (middle left), accepting the award for Vermeer, along with (l-r) Jennifer Glynn, Jim Rankin and Dave Krywiak.

New Installation Award:
Vermeer for its D36x50 Series II Navigator horizontal directional drill featuring the MAGnum rock drilling system.

Rehabilitation Award:
LiquiForce for its Junction Liner lateral rehabilitation system.

NASTT Hall of Fame Inducts First Class

One of the premier presentations at the Gala Dinner was the induction of NASTT's inaugural Hall of Fame class. Honored at the dinner were: the late Gary Vermeer, founder of Vermeer Mfg., Frank Canon, Baroid IDP, and Bernie Kryzs, publisher of *Trenchless Technology* magazine.

Inaugural class of NASTT's Hall of Fame are (l-r) *Trenchless Technology* publisher Bernie Krzys, Mary Andringa on behalf of her father, the late Gary Vermeer, founder of Vermeer, and Frank Canon, Baroid IDP.

Gary Vermeer's daughter and current Vermeer CEO Mary Andringa accepted the award on behalf of her father. Vermeer was the founder and chairman of Vermeer Corp. and was known for his innovation and contributions to the agricultural and construction equipment industries, as well as his philanthropic efforts. He was a strong supporter of pursuing trenchless drilling methods and markets that were new to the industry. By the early 1990s, HDD was the company's leading product line and is a mainstay of Vermeer's equipment offerings today.

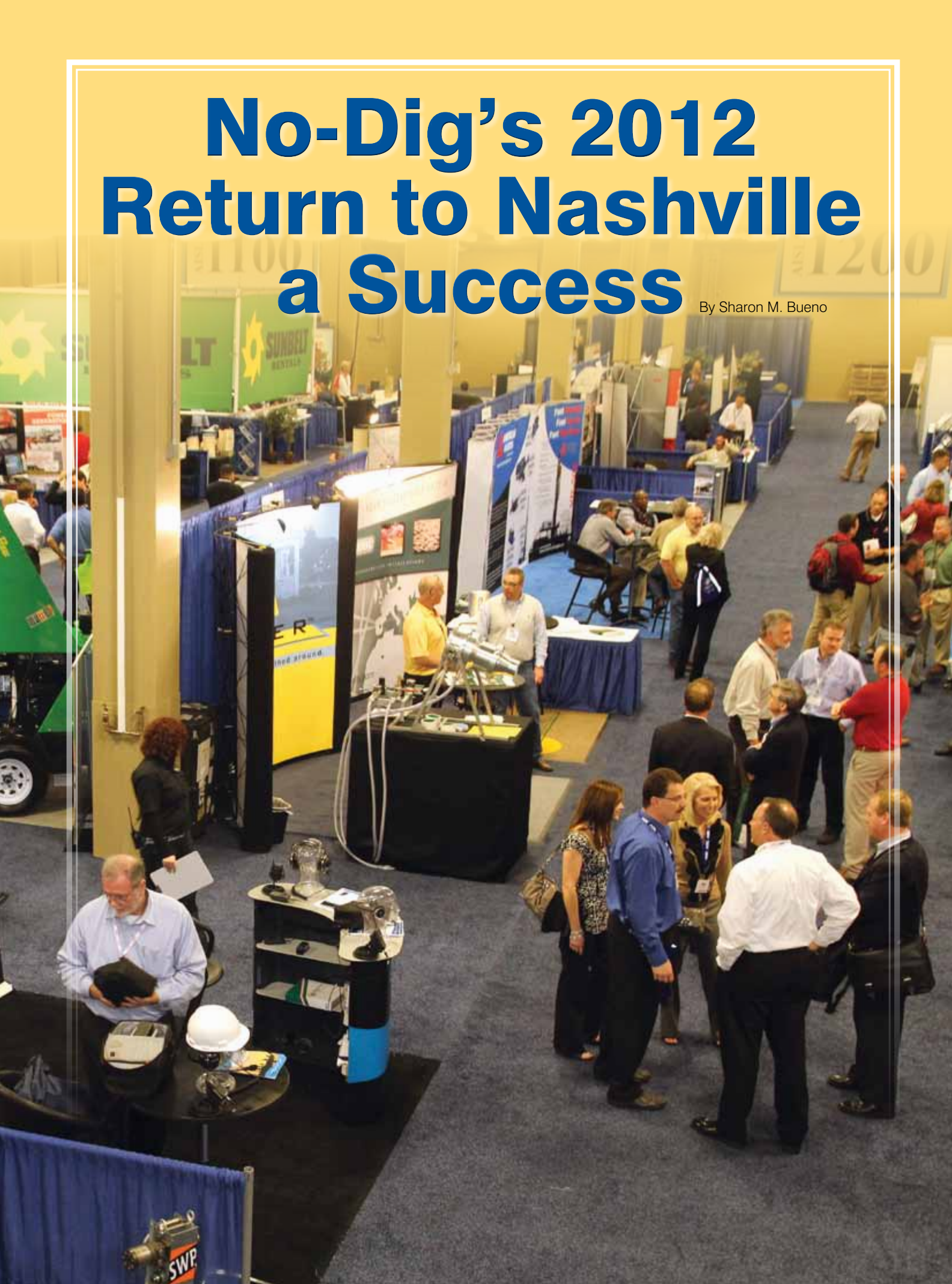
Frank Canon joined Baroid IDP in the oilfield 1975 and today is known throughout the trenchless industry for his expansive knowledge and expertise of drilling fluids, focusing on HDD, microtunneling, auger boring and pipe bursting. Over the years, he started sharing the information and experience he obtained in solving the many problems and situations he encountered through seminars and training sessions. In 2000, he was named the Trenchless Technology Person of the Year and is a past NASTT board member.

Bernie Krzys was part of the trenchless technology industry for many years on the manufacturing side before leaving that behind to produce the first magazine dedicated to trenchless technology. Today, the magazine *Trenchless Technology* is celebrating its 20th anniversary and has spawned countless other construction magazines under Krzys. He also introduced educational seminars on trenchless technology and launched the popular HDD Rodeos during the 1990s. Today, his company Benjamin Media manages the No-Dig Show. Krzys is a past NASTT board member and remains an active participant in the annual Educational Auction.

George Kurz	Barge, Waggoner, Sumner & Cannon
Joe Lane	SAK Construction LLC
Marc Lehman	CDM
Joseph Loiacono	Sanexen/Aqua-Pipe
Jason Lueke	Arizona State University
John Matthews	Battelle Memorial Institute
John Messina	Boh Bros.
Dorian Modjeski	Cardno TBE
Jim Murphy	Cimarron Engineering Ltd.
Kevin Nagle	TT Technologies, Inc.
Mohammad Najafi	University of Texas at Arlington/CUIRE
Peter Oram	AECOM
Collins Orton	TT Technologies, Inc.
Matt Pease	Staheli Trenchless Consultants
Cindy Preuss	Harris & Assoc.
George Ragula	Public Service Electric & Gas Co.
Kaleel Rahaim	Interplastic Corporation
Michelle Ramos	GeoEngineers, Inc.
Jeanette Rankin	Malone Motorsports
Jim Rankin	Vermeer Corp.
Paul Reilly	Rain for Rent
Piero Salvo	GENIVAR Inc.
John Schroeder	CDM
Chris Schuler	Miller Pipeline Corp.
Ariamalar Selvakumar	USEPA
Sunil Sinha	Virginia Tech University
Casey Smith	SAK Construction LLC
Kim Staheli	Staheli Trenchless Consultants
Isabel Tardif	CERIU
Richard Thomasson	Malcolm Pirnie
Ernie Ting	Town of Markham Waterworks Department
Matthew Wallin	Bennett Trenchless Engineers, Inc.
Dennis Walsh	Woodard & Curran

No-Dig's 2012 Return to Nashville a Success

By Sharon M. Bueno



The No-Dig Show, the annual conference and exhibition of the North American Society for Trenchless Technology (NASTT), returned to Nashville and brought with it more than 1,600 attendees who successfully mixed business, education and country western hospitality.

Trenchless professionals from around the globe gathered in the Tennessee capital city March 11-15 for the 21st annual No-Dig Conference and Exhibition. The all-trenchless event took place at the Gaylord Opryland Hotel and Convention Center.

The show was a great tribute to the trenchless industry, as NASTT inducted its first Hall of Fame class: the late Gary Vermeer, founder of Vermeer Corp., Frank Canon, Baroid IDP, and Bernie Krzys, publisher/president of *Trenchless Technology* magazine. International Society of Trenchless Technology (ISTT) executive director John Hemphill received NASTT's Chairman's Award for Outstanding Lifetime Service; and Dan Willems, Stantec, received the NASTT Trent Ralston Award for Young Trenchless Achievement. The 2012 *Trenchless Technology* Person of the Year Award was presented to Dr. Sam Ariaratnam and all the winners for the 2011 *Trenchless Technology* Projects of the Year were recognized.

There are two main attractions that draw people to the No-Dig Show. One is the technical paper sessions that provide detailed, peer-reviewed papers covering a broad range of topics relevant to the industry. This year, there were 155 papers presented covering the gamut of trenchless methods and issues. The other main component of the No-Dig Show is the exhibition hall, in which attendees can see first-hand the latest products that are keeping the industry at the forefront of utility construction and repair. About 140 exhibiting companies occupied the 70,000-sq ft exhibit hall.

The 11th annual Educational Fund Auction was held on March 12 and raised a record-amount: $100,636. The auction raises financial support for NASTT's 11 student chapters, while attendees have a great time bidding on amazing items. Since 2002, the auction has raised more than $533,636.

NASTT annually recognizes two companies with state-of-the-art products in either new installation or rehabilitation for their achievements in advancing the trenchless industry—called the Joseph L. Abbott Jr. Innovative Product Awards. The recipients of this year's honor were Vermeer Corp. and LiquiForce, and were formally recognized at the Gala Dinner.

Vermeer received the New Installation Award for its D36x50 Series II Navigator horizontal directional drill, featuring the MAGnum rock drilling system. The drill was unveiled at the ICUEE show in October. LiquiForce received the Rehabilitation Award for its Junction Liner lateral rehabilitation system, which was unveiled at the No-Dig Show.

So while the 2012 No-Dig Show may have just ended, plans are already underway for the 2013 show in Sacramento, Calif. The event will take place March 3-7 at the Sacramento Convention Center. The deadline to submit an abstract is June 30, 2012.

NASTT members join Chairman George Ragula and Program Commitee Co-Chair Kim Staheli to open the 2012 No-Dig Show in Nashville, Tenn.

The No-Dig 2013 program chair is Kim Staheli, who served as co-chair of the 2012 Program Committee. "I am excited to have the No-Dig show return to the West Coast because of all of the trenchless advances that have occurred on projects in the West since the No-Dig Show was here last," Staheli said. "Sacramento is a wonderful city to host the show since it just finished its series of big Interceptor projects that included thousands of feet of trenchless pipeline installation."

All additional information will be available at www.nodigshow.com as it is finalized.

Sharon M. Bueno is managing editor of *Trenchless Technology*.

Clockwise from top left: (l-r) NASTT Executive Director Mike Willmets with Bernie Krzys, *Trenchless Technology* publisher, Jim Rankin of Vermeer Corp., and Kevin Nagle of TT Technologies have some fun at the western-themed Educational auction; 2011 *Trenchless Technology* Project of the Year Rehabilitation winners; 2011 *Trenchless Technology* Project of the Year New Installation winners; Attendees take part in one of the many classroom presentations featured at No-Dig.

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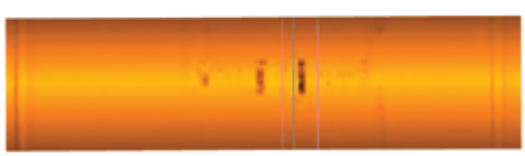

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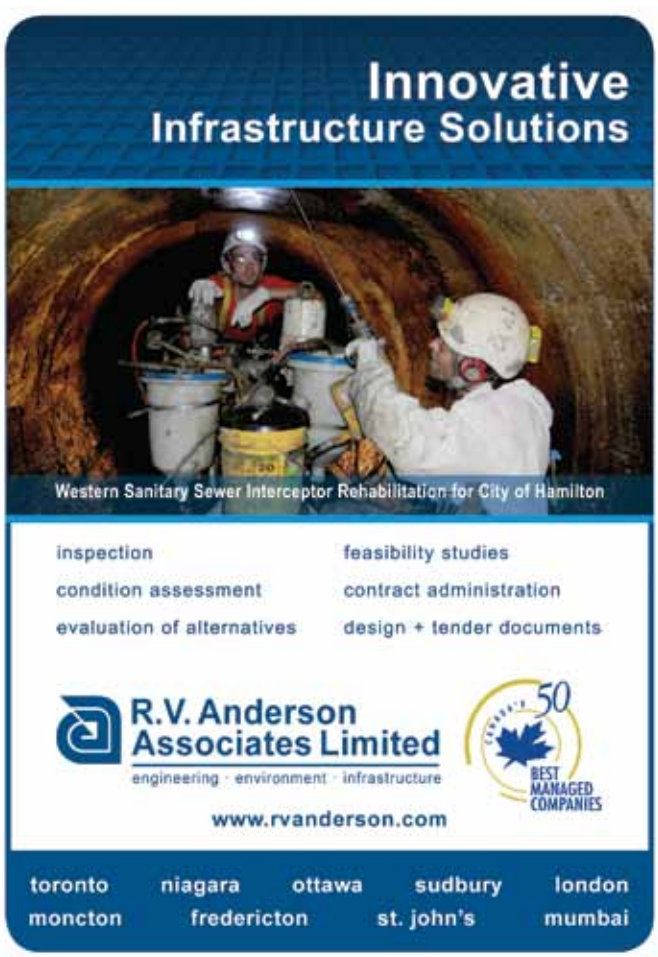
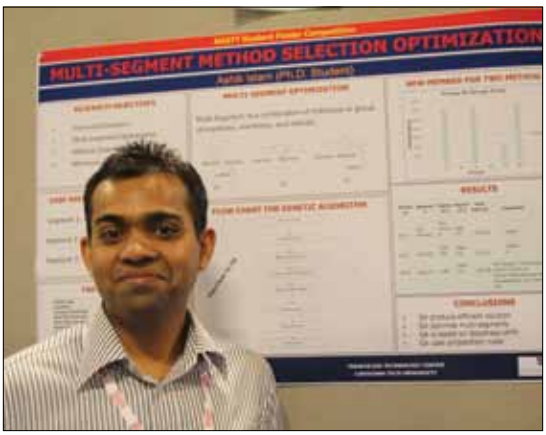
Clockwise from top left: NASTT Hall of Fame inductee Frank Canon (left) of Baroid IDP with Dave Gasmovic, president of McLaughlin Mfg.; Matt Pease of Staheli Trenchless Consultants with Program Commitee Co-Chair Kim Staheli at the Gala Dinner; A group photo of all the students who assisted during the No-Dig Show; Students holding a piercing tool donated by TT Technologies at the Educational Fund Auction.





Clockwise from top left: Ashik Islam, first place winner of the NASTT Student Research Poster Competition; (from left) Benoît Côté, vice president of Aqua-Pipe, Sanexen Environmental Services Inc., with student scholarship winner Olalekan Sodeinde and Tom Hayes, president of Haywood Associates, LLC; LMK held its annual demos on the show floor; and (from left) Maynard Akkerman and Chris Sivesind of Akkerman Inc., with Sandra Gelly of Genivar Inc.

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NASHVILLE

This year's auction raised a record $100,636.85 in funds! That's an increase of 25% over last year's donations and brings our grand total since 2002 to over $500,000. These funds will be directed toward educational and outreach activities offered by NASTT, including student scholarships, educational publications and developing new training courses.

This fund would not be possible without the generous donations made by the following organizations:

Thank you!

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Michelle Hill, 440-638-4676

NASTT Chapter News

Regional Chapter News

British Columbia

Coming off a busy and successful end to 2011, the British Columbia Chapter looks forward to an exciting summer and fall in 2012.

Great Lakes St. Lawrence & Atlantic

The GLSLA Chapter is pleased to announce the release of its spring issue of the "Trenchless Report." This publication features new sections, including a global look at trenchless activities along with GLSLA Chapter updates, feature projects, product news, trenchless news and views and an update from NASTT. GLSLA would like to thank everyone involved in making the magazine possible, including new publisher Great Southern Press.

Elections were held this past winter and the newly appointed GLSLA board members officially took office during the AGM held at the No-Dig Show in Nashville, Tenn. The board would like to thank everyone who voted.

The CATT 2012 Trenchless Road Show will be held June 5-6, in Niagara Falls, Ontario, the ACWWA will be held on Oct. 14-16, in Charlottetown, Prince Edward Island, and INFRA 2012 will be held Nov. 19-21, in Montreal, Quebec.

For more information on GLSLA, future events or to obtain a PDF copy of the magazine, please visit *www.glsla.ca.*

Mid Atlantic

The Mid Atlantic Chapter has two seminars coming up in 2012. The tentative dates are Sept. 19-20 in Pittsburgh and Nov. 28-29 in Atlantic City, N.J.

Midwest

Coming off a successful 2011, the Midwest Chapter recently held a "Trenchless Technology, SSES and Buried Asset Management" seminar in Joliet, Ill., April 18-19. The seminar featured guest presenters Jim Eggen, Director of Public Utilities for the City of Joliet, and Holly Sauter and Patrick Jensen of the Metropolitan Water Reclamation District of Greater Chicago. The MSTT also has two seminars planned tentatively for Aug. 15-16 in Detroit and for Dec. 19-20 in Kansas City, Mo.

Jim Eggen, Director of Public Utilities for the city of Joliet, Ill., presents at the MSTT seminar in April.

Pacific Northwest

The Pacific Northwest Chapter recently published its second annual *Pacific Northwest Trenchless Review* magazine, which was released just before the No-Dig Show in Nashville. The Chapter also held a board meeting at No-Dig, where members discussed the possibility of having a trenchless forum in conjunction with the city of Portland, Ore., at its next Trenchless Symposium in early 2013. In addition, the new PNW Chapter website is up and running and can be viewed at *www.pnwnastt.org.*

Northwest

The Northwest Chapter is coming off of a very successful year of activities in 2011. In September, the Chapter organized a four paper trenchless track at the Western Canada Water Conference in Saskatoon, and the Calgary and Edmonton Sections continue to host several technical luncheons each year.

The Chapter hosted its annual Northwest Trenchless Conference in Calgary, Alberta, Nov. 16-17, 2011. The CIPP short course had 34 attendees, while the overall conference attracted 140 attendees, 25 trade show exhibitors and 11 sponsors. The 2011 Northwest Trenchless Project of the Year award was also presented during the conference to the City of Saskatoon for its "Preston Avenue and Taylor Street Storm Sewer Rehabilitation" project.

In January, the Northwest Chapter hosted NASTT's New Installations short course in Winnipeg, Manitoba, where 36 attendees enjoyed learning more about trenchless technology. The Chapter has also organized a trenchless track for the 2012 Western Canada Water conference in Winnipeg this September and is evaluating options to host a NASTT short course in Saskatchewan later this year.

Rocky Mountain

The Rocky Mountain Chapter (RMC) elected new officers, committee chairs and conference session leaders for 2012, building on the success of the 2011 programs. Planning for the Rocky Mountain No-Dig Conference and Exhibition has begun and the date has been set for Nov. 8. A NASTT short course "HDD Consortium Horizontal Directional Drilling Good Practices Guidelines," will be conducted on Nov. 7.

The RMC committee is meeting on a bi-monthly basis in 2012 and members are welcome to attend or dial in for the meetings. The committee conducted its first field lunch program on April 9, hosted by the city of Westminster, Colo., Public Works and Utilities Department. The goal of the program is to promote trenchless technology application, share real world experiences and meet on site to observe trench-

less technology construction, planning or management programs. The Westminster field lunch program focused on the asset management tools and software used to manage and maintain buried infrastructure. The meeting was a success and promoted discussion on current best practices, future needs and the application of trenchless technology in rehabilitation and replacement programs.

Key goals and activities for 2012 include:

- 2012 conference planning - Bo Botteicher, RMNASTT vice chair and conference committee chair, is leading the planning efforts with the session leaders to organize the 2012 conference.

- WY/UT outreach – Tracy Lyman 2011 RMNASTT chair and Joe Lane, 2012 conference session leader are leading efforts to increase RMC-NASTT participation in Wyoming and Utah. The focus of the outreach activity is to encourage membership, increase conference participation, promote short course and establish local meetings and networking to promote trenchless technology.

Southeast

Coming off a successful seminar in Atlanta in February, the Southeast Chapter is currently planning a seminar in Tampa, Fla., with the tentative schedule date of either June 20-21 or June 27-28. The Chapter is also in the process of planning another seminar in Greensboro, N.C., later this year.

Western

The Western Chapter held its Annual General Meeting at No-Dig in Nashville. The Chapter welcomed three new members to the WESTT Board of Directors including Mo Ehsani, Cory Street and Brian Avon. WESTT is also busy planning its eighth annual Regional No-Dig Conference in Ontario, Calif., Oct. 29-30 at the Ayres Hotel & Suites Ontario Convention Center. This event will feature the tra-

The SESTT held its February seminar in Atlanta.

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ditional conference and exhibition on Oct. 29, with concurrent offerings of the Pipe Bursting and New Installation NASTT Best Practices Short Courses on the 30th. Keith Hanks from the City of Los Angeles will be keynoting a program containing regionally relevant presentations. More details will follow on the website at *www.westt.org*. For exhibitor or sponsor inquires, please contact Jason Lueke, WESTT chair, at *jason.lueke@asu.edu* or (480) 965-7417. WESTT is also planning its annual *WESTT Magazine*, which will be published in conjunction with its conference. Please contact the Chapter with any story ideas.

Student News

Student participation is a huge part of NASTT, as these talented young individuals help shape the future of the trenchless industry. As always, this year's No-Dig recognized several of these students for their leadership and excellence. The competition and scholarship winners are listed below:

NASTT Student Chapters Activities Presentation Competition
First Place: University of Alberta
Second Place: Louisiana Tech
Third Place: Virginia Tech

NASTT Student Research Poster Competition
First Place: Ashik Islam, Louisiana Tech
Second Place: Mir Abdullah Al-Masud and Tanvir Ahmed, Louisiana Tech
Third Place: Jinsung Cho, Arizona State

Charles P. Lake Rain for Rent Academic Scholarships
Kristi Steiner, Virginia Tech
Jose Rojas,
University of Arlington, Texas
Lindsay Jenkins, Vanderbilt University
Maureen Cassin,
Arizona State University
Courtney Alyssa Watts,
Louisiana Tech University

Students Awarded Michael E. Argent | Scholarships at No-Dig

Scholarship Winners

Mohamed Almahakeri, Queen's University
Samuel Betten, Vanderbilt University
Matthew Olson, Arizona State University
Olalekan Sodeinde, Vanderbilt University
Stephen M. Welling, Virginia Tech

Mohamed Almahakeri

Mohamed Almahakeri is a research assistant and a Ph.D. candidate at Queen's University, Canada. His experimental and numerical research program focuses on the longitudinal behavior of energy pipelines due to ground movements. He serves as the president of the NASTT student chapter at Queen's University. Some of his activities in the chapter are promoting the NASTT's activities and goals, informing students about general trenchless technologies, encouraging them to join the chapter and attending the No-Dig Show. He also helped organize field trips for students to monitor projects utilizing trenchless technology. Almahakeri is a member of the Professional Institute of Pipeline Engineers (PIPE), the American Society of Mechanical Engineers (ASME) and the American Society of Civil Engineers (ASCE).

Samuel Betten

Samuel Betten would like to thank the scholarship review committee for selecting him as one of the five Michael E. Argent Memorial Scholarship winners. Betten's interest in the trenchless field began while working for the CN in Chicago. Using trenchless solutions to improve, relocate or expand utility trenches without stopping train movements was vital to the success of the railroad. While obtaining his Master of Engineering at Vanderbilt, he learned more about trenchless technology while becoming involved in NASTT. In the fall of 2011, Betten was elected president of the Vanderbilt NASTT Student Chapter. He would like to thank his friends and family for their support during his academic journey. This summer, Betten will begin working for the Norfolk Southern.

Matthew Olson

Matthew Olson received his B.C.E. from the University of Minnesota Twin Cities in 2010 and will obtain his M.S. in Civil, Environmental, and Sustainable Engineering from Arizona State University (ASU) in 2013. The goal of his master's research is to measure the thrust required to install pilot tubes, casing pipe and product pipe in pilot tube microtunneling

installations. Data collected for his thesis was gathered while working on a pilot tube microtunneling project for Bore Master Inc. He has additional field experience with auger boring and tunnel boring projects. Matthew is the 2012 president of the NASTT Student Chapter at ASU and recently presented a paper on instrumenting and monitoring of pilot tube microtunneling installations at the 2012 No-Dig Show.

Olalekan Sodeinde

Olalekan Sodeinde is a senior consultant of Geographic Information Systems (GIS) at the Tennessee Department of Transportation. He is also a civil engineering student at Vanderbilt University, studying construction management. His interest in trenchless technologies lies in the use of GIS and Global Positioning Systems (GPS) technologies for aiding trenchless excavations and underground asset management. Sodeinde has a Bachelor of Science in Surveying and Geo-Informatics from the University of Lagos and Masters in Space Studies from the University of North Dakota. When he is not with his family, he enjoys watching football or playing soccer with friends. He can be reached at *olalekan.sodeinde@vanderbilt.edu*.

Stephen M. Welling

Stephen M. Welling has been in the civil infrastructure industry for nearly 20 years. From 1993 to 2007, he was involved in the construction of numerous road, airport and utility projects in northwestern Montana and Utah. In December 2007, he began working in consulting for the design and construction management of various water and wastewater projects in Montana, Washington and Wyoming. He received a B.S. in civil and environmental engineering from Utah State University in 2005, followed by a MBA in 2006. He is now pursuing a Ph.D. at Virginia Tech, being heavily involved in the research of improved asset management for drinking water and wastewater pipelines through trenchless methods. He currently serves as the student chapter president of NASTT there.

NASTT Regional Chapters

British Columbia

The British Columbia (NASTT-BC) Chapter was established in 2005 by members in the province of British Columbia, Canada.

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Website
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Elected Officers
Chair - Karl Mueller
Vice Chair - Rod Loewen
Secretary - vacant
Treasurer - Gurjit Sangha

Great Lakes, St. Lawrence & Atlantic

The Great Lakes, St. Lawrence & Atlantic (GLSLA) Chapter was established in 1995 and represents the Eastern Canadian perspective of the trenchless technology marketplace. GLSLA members are from Ontario, Quebec and the four Atlantic provinces.

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Elected Officers
Chair - Kevin Bainbridge
Vice Chair - vacant
Secretary - Gerald Bauer
Treasurer - Derek Potvin

Mid Atlantic

The Mid Atlantic (MASTT) Chapter was established in 2004 by members from the states of Delaware, Maryland, New Jersey, Pennsylvania, Virginia, West Virginia and the District of Columbia.

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Elected Officers
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Secretary - Dennis Walsh
Treasurer - Tom Wyatt

Midwest

The Midwest (MSTT) Chapter was established in 1998 to promote trenchless technology education and development for public benefit in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio and Wisconsin.

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Elected Officers
Chair - Jeff Boschert
Vice Chair - Larry Kiest, Jr.
Secretary - Randy Fries
Treasurer - Bill Shook

Northwest

The Northwest Chapter was established in 1988 by members in the Canadian provinces of Alberta and British Columbia, Canada, and in Washington state. In 2005, the members in British Columbia established the NASTT-BC Chapter. In 2009, the members in Washington state established the Pacific Northwest Chapter and the Northwest Chapter adjusted the geographic area to include the members in the provinces of Manitoba and Saskatchewan, Canada.

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Vice Chair - Dan Willems
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Pacific Northwest

The Pacific Northwest Chapter was established in 2009 by members in the states of Alaska, Idaho, Oregon and Washington.

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Rocky Mountain

The Rocky Mountain Chapter was established in 2009 by members in the states of Colorado, Utah and Wyoming.

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Vice Chair - Al Paquet
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Southeast

The Southeast (SESTT) Chapter was established in 2001 to serve the members of NASTT from Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Puerto Rico.

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Western

The Western (WESTT) Chapter was established in 2003 by members from the states of Arizona, California, New Mexico, Nevada and Hawaii.

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Vice Chair - Cindy Preuss
Secretary - Cory Street
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Forensic Investigation of CIPP Liners

Erez Allouche, Shaurav Alam and Ray Sterling — *Trenchless Technology Center, Louisiana Tech University, Ruston, La.*
Wendy Condit — *Battelle Memorial Institute, Columbus, Ohio*
Ari Selvakumar — *U.S. EPA, Edison, N.J.*

INTRODUCTION

During the early stages of the Environmental Protection Agency's (EPA) Task Order 58, titled the Rehabilitation of Water Distribution and Wastewater Collection Systems, the need for a quantitative, retrospective evaluation of the performance of pipe rehabilitation systems emerged. This need was reinforced by participants of an international technology forum held in September 2008. Major reasons for this interest are:

1. The biggest data gap in asset management involving rehabilitation is prediction of remaining asset life and how long rehabilitation techniques can extend that life. Municipalities have expressed a strong desire for some hard data on the current condition of previously installed systems to validate or correct the assumptions made at the time of rehabilitation.

2. Since several of the major pipe lining techniques have now been in use for at least 15 years (some 40 years internationally), it is a good time to undertake such an investigation to see if, on the basis of the current condition of the liner, whether the originally planned lifetime (typically 50 years) is reasonable.

The outcome of such an evaluation would be to address one of the most significant unknowns in terms of decision making for engineers and life-cycle cost/benefit evaluations and to provide shared experiences among municipalities in a systematic and transferable manner. This research is aimed at providing answers to the question: "How long can I extend the life of the asset if I rehabilitate it versus outright replace?" Other benefits include providing data that can be used to develop answers to questions such as "what properties/defects are critical?" and "what accelerates deterioration?" Discussions with research centers in Canada and Europe revealed that the city of Montreal and a number of cities in Germany have already engaged in similar efforts to revisit previous rehabilitation projects (Isabel Tardif, Personal Communication, 2009).

The research team developed a general test protocol applicable to the retrieval and testing of CIPP rehabilitation liner systems. This protocol was evaluated via demonstration of a retrospective evaluation of an in-situ liner. As the research team searched for viable candidate cities/utilities with which to undertake the evaluation, it contacted all the major CIPP providers that were involved in the early development of the CIPP industry in the U.S. and several other industry figures that were involved in the development of CIPP use. This paper provides preliminary results of retrospective evaluation of a CIPP liner exhumed from an 8-in. VCP gravity sewer line in the city of Denver.

REMOVAL & TESTING OF CIPP SPECIMEN

The test protocol consists of a comprehensive data collection effort in the field and the laboratory, which put an emphasis on quantifiable data whenever possible. The host pipe was excavated and a 6-ft long section of the lined pipe exhumed with care, packaged and shipped to the TTC research laboratory. Annual gap measurements were conducted both on the edges of the exhumed section, as well as on the edges of the sections that remain in the ground.

The host pipe selected for the retrospective study was a circular, 8-in. inside diameter vitrified clay pipe (VCP). The host pipe was lined in 1984. The 26-year old liner consisted of a 6 mm thick unwoven fabric (similar to those used today) saturated with isophthalic polyester unfilled resin. The primary catalyst was Perkadox 16 while the secondary catalyst was Trigonox C. The 0.015-in. sealing layer was made of polyurethane. In recent years, some vendors switched from polyurethane to polyethylene and/or polypropylene as the seal layer in CIPP liners. Simultaneously, higher grades of polyurethane became available for CIPP liners.

Figure 1. The exhumed liner.

Figure 2. The invert of the CIP liner.

VISUAL INSPECTION OF LINER

Overall, the liner appeared to be in a good shape. The polyurethane coating seemed to erode away at the invert of the pipe. Upon discussion with the vendor, it was established that the polyurethane laminate coating intended to serve as a sacrificial layer and act as a barrier for preventing resin from entering the interior of the tube. It was expected that this coating would hydrolyze over time (a chemical reaction causing the breakdown of certain polymers). The vendor was surprised to find out that most of the

polyurethane layer remained intact (some newer CIPP liners utilize a polyethylene or polypropylene coating, which is considered to be a permanent layer). In locations where the polyurethane coating hydrolyzed, the fibers into which the polyurethane coating dissolved were exposed. However, the resin-impregnated felt beneath it was solid and intact. The stitch holding together the CIPP tube was found to be in good condition. Signs of wear were restricted to the bottom third of the tube. A deposit made of silt and what appeared to be residue of an organic matter, was found at the invert of the CIP liner.

CCTV INSPECTION OF LINED SEWER

The city of Denver ordered CCTV scans of the lines in the area from which the sample was retrieved. Also, historical maintenance reports of these lines were requested. A review of the CCTV reports suggested that overall the liner was in good condition. Several tap break-in defects were noted as well as lining deficiencies in undercut connections, which could allow for root intrusion between the lateral outer wall and the liner covering the interior of the main pipe. This could be attributed to the robotic cutters used by the industry 26 years ago, which were far less sophisticated and accurate than the units used today. Some of the images revealed root intrusion via tap connections, resulting in a partial blockage of the sewer line, but the liner itself appeared to be intact in these images. On the line stretch in the alley between Garfield Street and Jackson Street (between 3rd and 4th Avenue), at chainage 212.6 ft, there was what appeared to be a liner deficiency in the vicinity of a tap break-in. Another liner deficiency was found at the alley between Jackson Street and Garfield Street, from the first manhole north to the first manhole south to 1st Avenue. At chainage 20.8 ft, a bulge was found at the invert of the liner that prevented further advancement of the CCTV equipment. A third liner deficiency location was identified in the line running in the alley between Jackson and Harrison streets, as it crossed 3rd Avenue, at chainage 239.8 ft. This liner deficiency appeared to be attributed to improper restoration of a nearby lateral connection. A significant portion of the polyurethane coating was hydrolyzed along this line. A lining deficiency was also noted at 2nd Avenue and Jackson Street, which was attributed to a connection cut shift. Similar occurrences of a liner connection cut shift were noted on a couple of other lines. A location where the liner appeared to be detached from the host pipe was located at chainage 39 ft, in the alley between 3rd Avenue and Garfield Street.

Figure 3. Image of the inner surface of the 26-year old, 6-ft long CIP liner section.

TESTING OF BEDDING SOIL AND RESIDUE FOUND INSIDE THE LINER

The trench was divided into six regions. Soil samples collected from each region were placed in airtight bags to avoid foreign contamination and/or loss of moisture. Standard test methods, ASTM C136 and ASTM C128, were followed to classify the soil and determine its particle size distribution. In addition to those tests, the pH of the soil samples was measured using a pH meter.

ASTM C136 is a standard testing method for performing sieve analysis on geological material. Based on grain size distribution, both the backfill and bedding soils can be considered to be sandy soils. The steep slopes of the resulting gradation curves for the samples taken from the spring line and invert elevations suggest that the bedding material consists of uniform (poorly-graded) soil. Review of bore logs collected as part of utility construction projects performed in nearby areas revealed that the native soil in the top 5 ft consist of sandy-silt underlying by gravelly sand (between 5 and 12 ft).

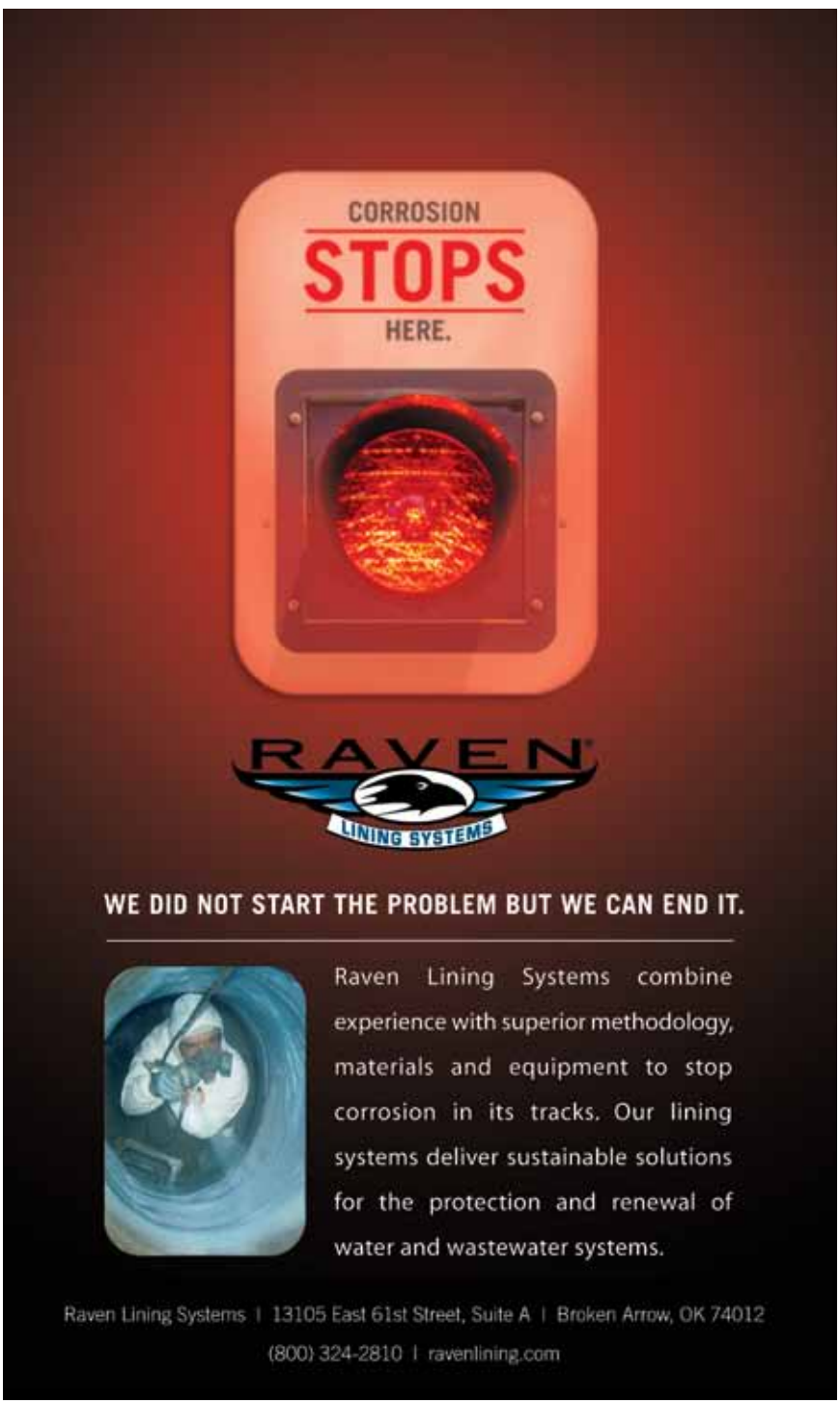
ASTM D2216 is a test method used to determine the moisture content in soils by mass. Samples weighing 1,000 gm from each of the six locations were placed in an oven for a period of 24 hours. After 24 hours, the soil samples were weighed and returned to the oven for an additional 24-hour period. The process was repeated until the difference between two subsequent measured weights was less than 1 gm. At this point, the soil was assumed to be moisture free.

The pH of the soil embedment and solid sediments collected from the pipe invert were measured using a Thermorion pH meter. The soil samples were placed in a pan (which was rinsed using distilled water) and distilled water was added to the samples. The soil sample was than stirred and the pH probe was inserted into the soil-water mixture. The process was repeated for the sediments collected from the invert of

the liner. The soil samples collected from around the pipe (bedding material) were found to be rather acidic in comparison to the backfill soil. The sediments inside the pipe were found to be only slightly acidic, as expected from a residential wastewater stream.

LINER HARNESS TESTS (ASTM D2240)

Durometer (Shore 'D') Hardness (ASTM D 2240) is used to determine the relative hardness of thermoplastic and thermosetting materials. This test measures the penetration of a specified indentor into the subject material under specified conditions of force and time. Specimens measuring approximately 1 in. by 1 in. were cut from the crown, spring line and invert of the retrieved CIPP liner. Next, the durometer was used to measure the hardness of each specimen. A total of 144 readings were performed on samples taken from the crown, springline and invert. Tests were conducted on the inner and the outer surfaces. It can be seen that the inner invert and inner springline sections, which were in continuous contact with the waste stream, are somewhat softer (54 and 55, respectively) compared with other surfaces of the liner. The outer side of the liner enclosed by the host pipe was neither in contact with the soil nor with the waste stream, and provided hardness values of around 80. This suggests that the constant contact with the waste stream might have resulted in softening of the liner material over time. All tests were performed using the Shore D hardness scale, which utilizes a weight of 10 pounds (4,536 g) and a tip diameter of 0.1 mm. For the purpose of interpreting the results, a value of 50 Shore D represents the hardness of a solid wheel (e.g., similar to those used by forklifts), while a Shore Hardness D scale value of 80 represents the hardness of paper making rollers. In summary, the liner hardness was found to be medium to high on the Shore D scale. The surfaces continuously exposed to the wastewater stream (inner invert, spring line) appeared to have had somewhat lower hardness values compared to the values recorded on outer surfaces of the CIPP liner.



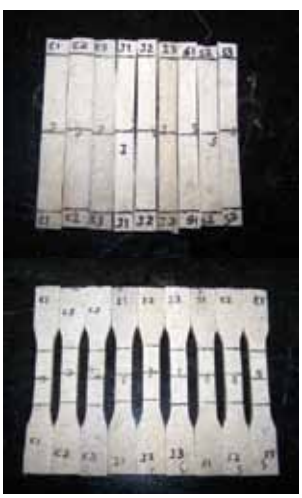
THICKNESS AND OVALITY OF THE LINER

A total of 72 readings were taken to measure the thickness at different locations around the pipe circumference. These readings were taken using a caliper with an accuracy of +0.0001 in. The thickness of the liner at the crown was found to be slightly greater than the thickness in other locations around the circumference of the liner. This was attributed primarily to the erosion of the polyurethane coating layer (approximately 0.015 in. thick), originally placed on the internal surface of the liner, at the invert zone.

A profile plotter was used to accurately map any deformation inside the liner. The system featured a linear variable displacement transducer (LVDT) connected to a motor-gear system that rotated around the inner circumference of the liner. An encoder system provided information used to determine the locations around the pipe where data was taken. The liner was placed inside a circular PVC tube as careful measurements were taken to ensure that the liner center was aligned with the measuring device.

Next, the profile plotter was aligned with the center of the CIPP liner tube. The liner was found to be somewhat oval with a reference to its centerline. Continuous readings were taken around the circumference of three cross-sections spaced 1 in. apart, and averaged. On the spring – line-spring – line plane, the liner was found to be somewhat more oval than on the crown-invert plane, most likely due to geometrical imperfections in the original host pipe.

BENDING TESTING (ASTM D790) AND TENSILE TESTING (ASTM D638)



Liner specimens – bending (top) and tensile (bottom).

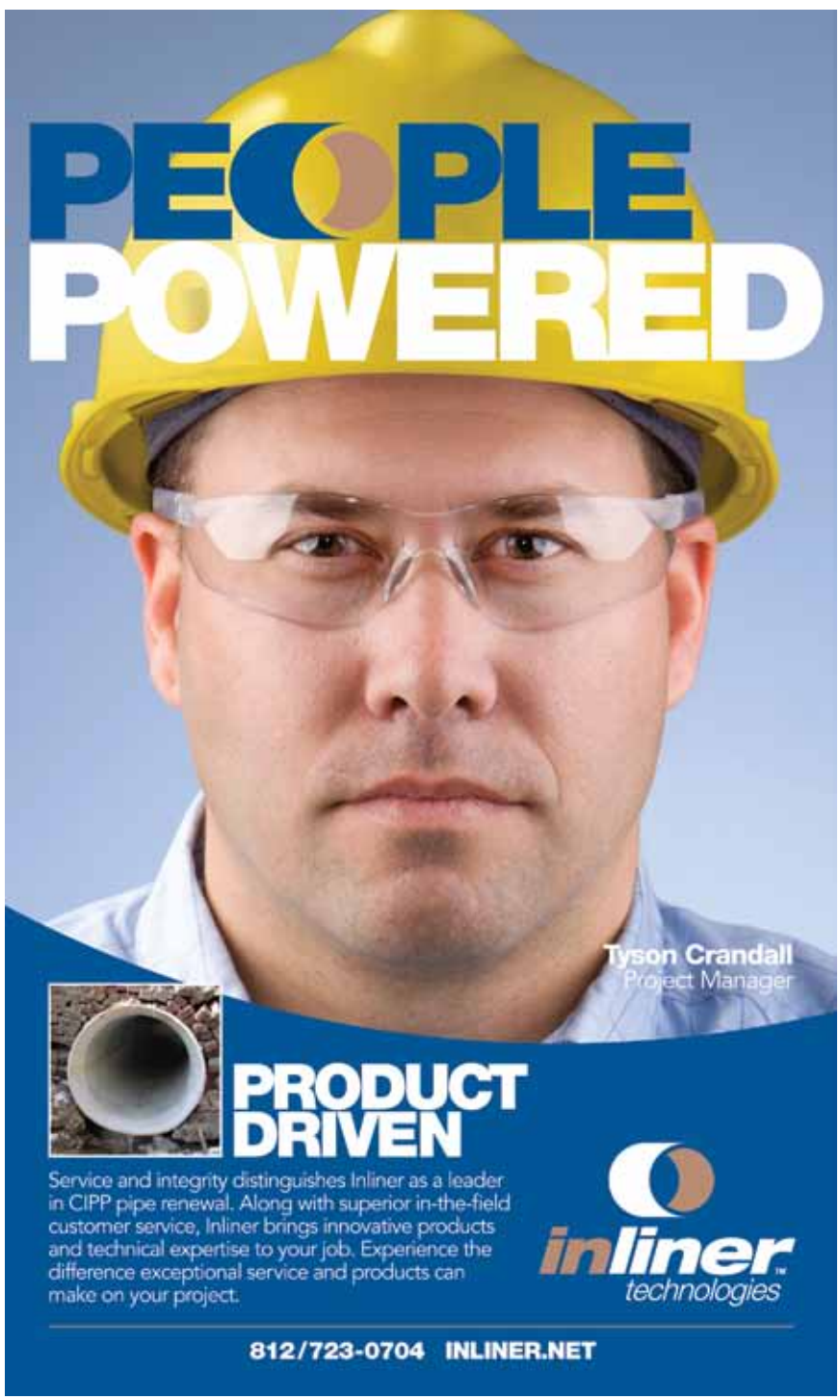
Specimens as described in ASTM D790 and ASTM D638 were cut from the crown, spring line and invert of the retrieved CIPP liner using a router and a band saw. A total of nine specimens were prepared and tested (three from each location). The sides of the specimens were smoothed using a grinder. The specimens were marked as shown in Figure 4. Images from the physical testing are shown in Figures 5 and 6.

Bending testing in accordance with ASTM D790.

RAMAN SPECTROSCOPY

Raman spectroscopy was used to assess the liner material aging. This is a technique based on inelastic scattering of monochromatic light, usually from a laser source. Inelastic scattering refers to change in the frequency of photons in the monochromatic light upon interaction with a sample. Photons of the laser light are absorbed by the sample and then reemitted. The frequency of the reemitted photons

Tensile testing in accordance with ASTM D638. The specimen before the test (top) and after the test (bottom).



is shifted in comparison with the original monochromatic frequency, a phenomenon called "Raman Effect." This shift provides information about vibrational, rotational and other low frequency transitions in the molecules, which are indicators of degradation and breakdown of the resin at its most fundamental (molecular) level. In order to be able to compare test results with known reference data, the manufacturer of the original resin was contacted to obtain a virgin sample of a very similar resin to that used in the original lining operations 26 years ago.

The specimens used were 1/2-in. by 1/2-in. as only a very small surface area of the sample was required for collecting Raman spectra. The specimens were polished using a mechanical polisher and cleaned with distilled water. Spectra from 200 to 2100 cm-1 were collected using R-3000 HR Raman spectrometer, utilizing a 785 nm diode laser operating at 290 mW via through a fiber optic probe. Integration time was 30 seconds. The measured intensity of the Raman signal in arbitrary units (a.u.) was plotted on the y-axis, while the wave length in cm-1 was plotted on the x-axis. The plots were nearly identical for the base resin and 25-year old liner, with no significant change in the intensity of the peaks or region shift, indicating high chemical stability.

SHORT-TERM BUCKLING TEST

A steel mechanical tube was prepared for the test to act as a host pipe for the liner. The tube was 2 ft long and machined to accommodate the ovality of the liner (the tube thickness was reduced 1/16 in.). Two 3/8-in. threaded holes were made on the opposite sides of the mechanical tube. Quick connectors were fixed to the pipe through the holes to allow attaching the pressure system). The liner was inserted into the tube and a lubricant was applied to the inside of the tube to ease the sliding of the liner. The liner was beveled on both sides using an air operated disk sander, and flushed with the pipe.

Two specially designed, open-ended, conical steel caps filled with high temperature silicon were prepared and used to maintain the seal at the ends of the test specimen. The caps were pressed against each end of the pipe specimen using threaded rods and were designed to ensure that the annular space between the inner wall of the pipe and outer wall of the liner was sealed. This high level of effort and precision was considered paramount to allow effective sealing of the annulus under elevated internal pressure, while allowing free access to the interior of the pipe for conducting frequent deformation measurements of the liner. A pressure gage was connected on one of the threaded holes and another one was attached with a quick connector for applying high water pressure. A nitrogen gas pressure bladder system was used to generate the needed high water pressure.

A profile plotter developed in TTC was used to determine a profile of the interior of the liner to be tested. This system was equipped with an LVDT rotating a full circle in one and a half minutes. Voltage reading changed as the tip of the LVDT moved vertically and those readings were collected using a HP 3479A DAQ. Later, they were processed to get the actual profile of liner's inside. The pre-buckling profile plot showed that the liner was almost 1/4-in. tapered on the right top corner. Although minor leaks were observed when the specimen was held at the test pressure of 40 psi, the liner was found capable of resisting a sustainable external pressure of 40 psi with no signs of structural distress or the on-set of buckling failure.

SUMMARY

The test protocol for retrospective examination of CIPP liners consisting of a comprehensive data collection effort in the field and the laboratory, which put an emphasis on the collection of quantifiable data, was developed and demonstrated. A circular, 8-in. inside diameter vitrified clay pipe (VCP), which was lined using a 6 mm thick CIPP liner in 1984, was excavated and a 6 ft long segment of the host pipe was exhumed and sent to the TTC laboratory. The 26-year old CIP liner consisted of a 6 mm thick unwoven fabric saturated with polyester resin. Visual observations suggest that wear out of the liner was limited to the invert and the spring lines areas. Mechanical tests revealed that the flexural modulus of the liner ranged between 310,000 psi and 363,000 psi, surpassing the specified design value listed in ASTM F 1216 of 250,000 psi. The minimum flexural strength value recorded was 6,170 psi, which again is well above the minimum value of 4,500 psi listed in ASTM F 1216. The variability in test value is attributed to variations in one or more of the following reasons: a) resin content; b) average curing temperature (i.e., between crown and invert); and c) wear out rates due to applied mechanical loads. The Raman spectroscopy results revealed nearly identical results for the 25-year old resin and a sample made from identical resin by the research team. No significant change in the intensity of the peaks or region shift was noted, indicating high chemical stability. The buckling test demonstrated that the liner is capable of resisting an external pressure of 40 psi (more than 90 ft of water head) with minor leakage and no signs of on-set of a buckling failure.

To view the complete version of Paper D-5-04, please visit www.nastt.org.

The First Planned Curved Microtunnel in the United States

Richard Palmer — *Northeast Remsco Construction, Inc., Farmingdale, N.J.*
Leo Martin — *AECOM, Rocky Hill, Conn.*
Alexander Seilert— *VMT GmbH, Bruchsal, Germany*

INTRODUCTION

May 19, 2010 marked the completion of the first planned, curved microtunnel in the United States. The Homestead Avenue Interceptor Extension project in Hartford, Conn., consisted of approximately 3,500 linear ft of 72-in. RCP, 90 percent of which was designed to be installed by microtunneling. The contractor, Northeast Remsco Construction (NRC), proposed to install the remaining 10 percent of the 72-in. RCP using trenchless methods. This proposal included extending a planned microtunnel an additional 290 linear ft and incorporating a 1,359 linear-ft radius curve in order to avoid an arduous open cut pipe installation that would have involved installing sheeting near historic buildings and working around and beneath numerous old utilities.

The project owner, the Metropolitan District Commission and AECOM, the design engineer, recognized the potential benefits of the alternative and were receptive to the proposal. AECOM and NRC worked together to develop the new alignment and to minimize the risk associated with the proposal while providing maximum benefit to the owner.

NRC contracted with VMT GmbH to provide the guidance system. The VMT system, widely used outside the U.S., used a theodolite, prisms and a control system that integrated seamlessly with NRC's company-owned Herrenknecht AVND-1800AB MTBM and control cabin.

BACKGROUND

The Homestead Avenue Interceptor Extension Project (HAIE) is the first major project within the Metropolitan District's Clean Water Project (CWP). The purpose of the project is to extend the current Homestead Avenue Interceptor from its current discharge point at the Gully Brook Conduit to the Park River Interceptor. The diversion structures at the connection to the existing Homestead Avenue Interceptor and at the Park River Interceptor allow flow up to a one-year storm event to be directed to the Hartford Water Pollution Control Facility. Flows exceeding the one-year storm event will overflow weirs to the existing discharge locations. The HAIE will serve as the downstream conduit for several upstream separation projects that are designed to eliminate combined sewer overflow points and to reduce combined sewer overflows that eventually drain into the Connecticut River. The project area is in a densely populated urban area of Hartford, Conn.

The Metropolitan District Commission (District) is a municipal corporation that was chartered by the state of Connecticut in 1929, to provide water and sewer services to the communities of Bloomfield, East Hartford, Hartford, Newington, Rocky Hill, West Hartford, Wethersfield and Windsor. A combined sewer system serves Hartford and portions of West Hartford with 38 active combined sewer overflows (CSOs).

In 2006, the District entered into a consent order with the Connecticut Department of Environmental Protection (DEP) to reduce CSOs to a one year level of control within 15 years for Hartford and West Hartford. The district also entered into a consent decree that same year with the Environmental Protection Agency (EPA) and the U.S. Department of Justice to implement a sanitary sewer overflow (SSO) abatement program to eliminate structural SSO's over a seven year period for the communities of Rocky Hill, Wethersfield and Windsor, and to eliminate SSO's over a 12-year period for the communities of West Hartford and Newington. As a result of these two consent decrees, the district implemented a CWP to manage the program and ensure compliance with both regulatory ord

The work under the CWP includes three major elements: (1) construction of new sanitary sewers, interceptors and tunnels that reduce CSOs within the district's collection

system; (2) rehabilitation of existing sanitary sewers and construction of new interceptors that eliminate structural and non-structural SSOs from East Hartford, Bloomfield, Wethersfield, West Hartford, Windsor, Rocky Hill and Newington; and (3) improvements at the Water Pollution Control Facilities (WPCF) in Hartford, Rocky Hill and East Hartford to increase treatment flow capacity and to reduce nitrogen discharge levels.

HOMESTEAD AVENUE INTERCEPTOR EXTENSION PROJECT DESIGN

This project provided numerous challenges that included constructing approximately 3,500 ft of 72-in. tunnel in a highly urbanized section of Hartford, tunneling beneath active Amtrak rail lines and beneath an elevated section of Interstate I-84. As one may expect in an old New England city, there were smaller scale impacts created by the alignment that included: encroachment upon critical aging utilities, proximity to historically significant buildings, and maintaining traffic flow around the work areas. Four multi-story building footprints were located within 20 ft of the alignment. AECOM provided final design and construction management services for the project and in December 2008, Northeast Remsco Construction (NRC) of Farmingdale, N.J. was awarded the construction contract.

Figure 1. Proposed route layout for the New Homestead Avenue Interceptor Extension.

The layout for the project during design anticipated the use of three jacking shafts and three receiving shafts to complete the five tunnel drives. The planning for the work attempted to account for the needs of the contractor in providing sufficient space for the processing equipment to treat the slurry at each jacking pit and an area set aside to stockpile the slurry until such time that it could be characterized and properly removed. The design team investigated a number of routing alternatives to get the flow from the upstream interface with the Homestead Avenue Interceptor to the Park River Interceptor and Park River Storm Sewer located in historic Bushnell Park. The selection of the chosen route was based on the reduction of potential risks that could have a negative impact on the completion of any of the tunneling runs. Historical construction data on many of the large buildings that line the southern end of the project, as well as the elevated box-structure ramp leading into the Hartford's Union Station just south of the tunnel crossing, were not available. As additional design information was developed, the alignment of the tunnel was modified to avoid cutting into a parcel so that it would not restrict future development. Once the alignment was set, the final geotechnical program was completed.

Subsurface conditions along the proposed route included geologic units such as bedrock, glacial till, varved silt and clay and miscellaneous fill. The bedrock of the Connecticut Valley consists of conglomerates, feldspar-rich sandstone (arkose), red and black shale layers; and igneous sills and dikes. In the project area, the bedrock is red sandstone. As in much of New England, the bedrock surface has been ground down by glaciers and covered with a layer of dense glacial till. During much of the glacial period, the current Connecticut River Valley was the location for a large glacial lake. The deposits from this lake in the Hartford area are varved silts and clays.

The exploration for the design consisted of 26 test borings and geophysical surveys. Data from these investigations were used to develop a working geologic profile of the alignment. The saturated, soft to very-soft, varved silt and clay was selected to locate the tunnel alignment since the extent of other materials at the site was typically intermittent. They were generally located at depths that were inconsistent with other alignment selection criteria such as adequate ground cover; settlement considerations; concerns for utility and obstruction avoidance; and hydraulic design for the HAIE.

The goal was to maintain the tunnel horizon entirely within the varved clay unit. However, in order to maintain the hydraulic grade line for the project, this was not possible. Mixed face conditions would be experienced at the north and south ends of the project. The subsurface investigation indicated that the interface between the upper soft to very soft varved silt and clay and the lower very stiff glacial till would be encountered for nearly 180 ft on the first drive down Walnut Street, the longest drive for the project. The geotechnical investigation also indicated the thinning of the clay layer as the alignment approached the south end of High Street.

The goal during design was twofold: maintain two tunnel diameters of cover and remain entirely within the varved clay unit. The thinning of the clay unit resulted in the decision to stop the tunnel approximately half of the way down High Street, just south of Allyn Street. Based on the exploration program, the varved clay and silt unit thinned and an area of urban fill became prominent. Borings indicated that the fill used was mostly granular. From that point to the terminus of the project in Bushnell Park, the 72-in. pipe was designed to be installed by open cut methods.

CONSTRUCTION CHALLENGES

Weak Soils

The blow counts in the tunneling envelope ranged from one to five. Along the majority of the alignment, the liquid limit was about 40, while the moisture content ranged from 41 percent to 52 percent. This created a challenging tunnel wherein the tunneling machine must avoid its natural tendency to sink. This was extremely important because the design gradient for the new HAIE was 0.0008 ft/ft. Northeast Remsco overcame the weak soil issue by using an MTBM equipped with a second fully articulated steering joint positioned 25 ft from the cutting wheel. This unique feature allowed the MTBM to engage three times the surface area compared to the conventional steering joint in order to make horizontal and vertical course corrections. The joint provided an immediate reaction when engaged, proving beneficial on this project.

Slurry Processing

All excavated soil required stockpiling and characterization prior to disposal, so the tunnel muck had to be decanted sufficiently for stockpiling and testing. The high percentage of ultra-fine particles in suspension made slurry processing difficult. NRC's slurry processing plant included belt scalpers, shale shakers, mud cleaners, hydrocyclones, centrifuges and auxiliary storage tanks and a vertical

clarifier. Even with polymer dosing, the equipment worked around the clock to process the slurry generated by a single 12-hour shift.

Summer Construction Requirements

The contract documents required the 72-in. pipe to be installed across Asylum Street (a heavily travelled six-lane road in front of Bushnell Park) on seven successive summer weekends providing approximately 10 work hours on Saturday and Sunday. At the end of each weekend shift, traffic was to be restored. In lieu of open cut methods, Northeast Remsco proposed installing the 72-in. pipe beneath Asylum Street using a conventional open wheeled TBM from a launch shaft in Bushnell Park.

AECOM was concerned about the ground water level and the nature of the soils identified in the subsurface exploration. However, NRC believed the soil to be adequate for the proposed tunneling technique based on recently completed excavations in Bushnell Park to build the connection structure to the Park River storm sewer and test pits recently excavated for various utility work in the area. NRC believed the soils were more cohesive than indicated in the contract documents. If correct, AECOM would be less concerned with ground water problems while jacking the 120 ft across the street.

To better define the soils, Northeast Remsco performed four additional geoprobes. Logging of the probes indicated that the soils were mostly urban fill consisting of fine silty clay. AECOM recommended approval of the contractor's proposal with the proviso that additional geotechnical monitoring points must be installed and that the two gas mains being crossed must be excavated and supported prior to tunneling.

With only one pipe diameter of cover over the tunnel, some settlement was expected. NRC agreed to work around the clock in order to reduce the length of time the tunnel heading would be exposed to the soil, thereby reducing settlement concerns. The settlement that did occur would be corrected through pavement repairs during daily lane closures. The tunneling work did cause some pavement settlement, however there were no utility issues during the drive.

Numerous Utilities and Old Buildings

High Street is a 30-ft wide street, replete with old utilities and lined with historic buildings. The geology on High Street compelled AECOM to design this lower section as an open cut pipe installation. The contract documents required the Contractor to use tight sheeting for the open cut pipe installation and to maintain vehicular access to several businesses in this block. The close proximity of the historic buildings when added to the numerous utilities convinced the Contractor that alternate means of installation needed to be explored.

As designed, the new HAIE was to be installed by microtunneling beneath the upper section of High Street.

Figure 2. Numerous utilities were exposed to install just one sewer lateral.

Then a four degree horizontal bend was to be installed just south of the intersection with Allyn Street with the balance of the HAIE on High Street to be installed open cut. Northeast Remsco proposed to eliminate the arduous open cut work by using microtunneling methods to install the HAIE the full length of High Street.

However, this could only be accomplished by driving a curved microtunnel, something that had not been done previously in the United States. Northeast Remsco believed that the curved tunnel could be completed along an alignment that avoided utility conflicts and maintained sufficient clear distance from the zones of influence of the structures lining the end of High Street, the oldest buildings along the entire tunnel alignment. The alignment had to clear the steeply sloped 24-in. brick combined sewer and then run parallel to the other aging utilities in the street.

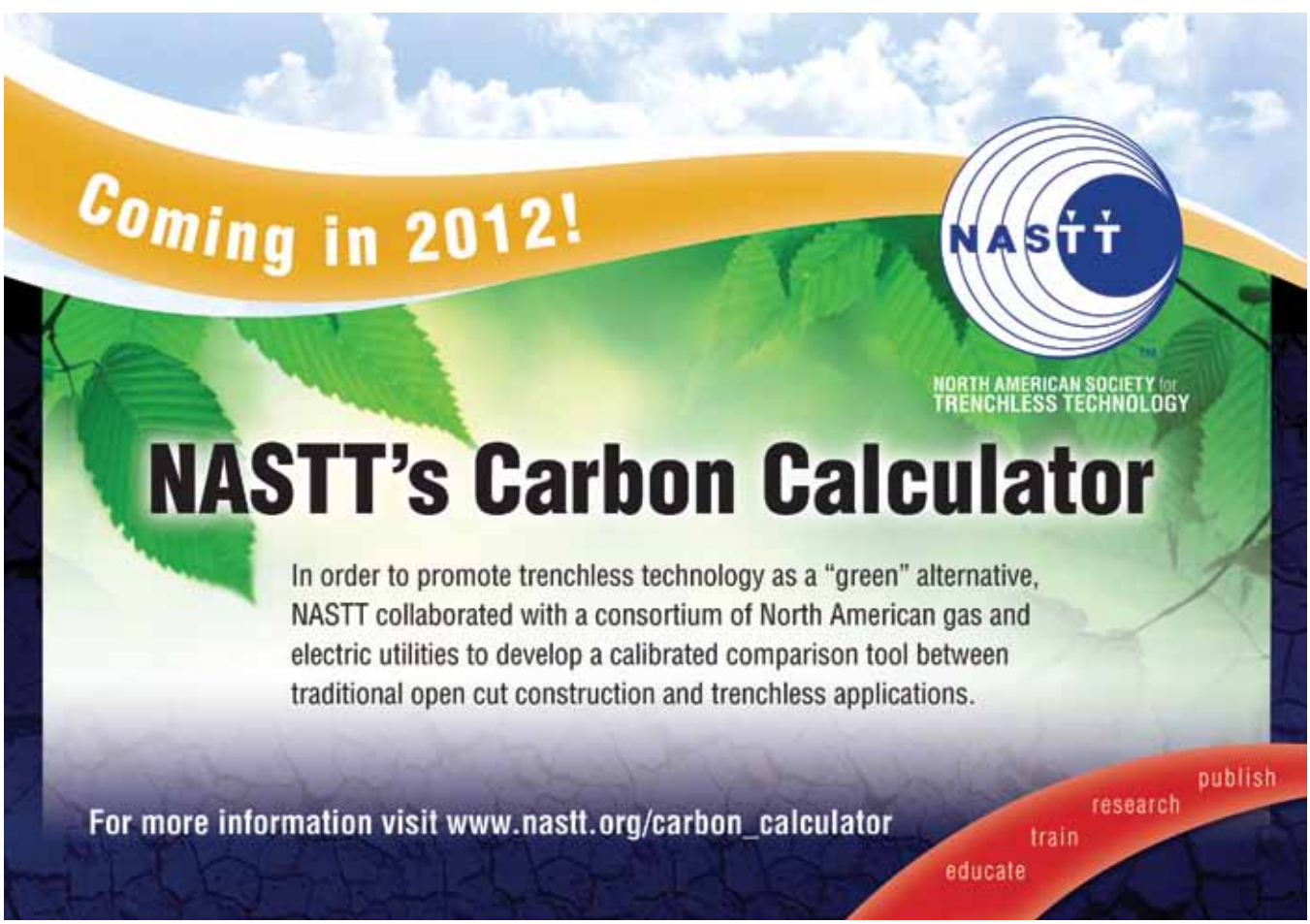
AECOM and the district's major concerns were protecting these utilities in light of the shallow depth of cover and maintaining safe differences from the footings along the street. The

Figure 3. The curved tunnel alignment.

soils discovered in the excavations for the utilities indicated that the fill soils were more cohesive than indicated in the boring at the end of High Street. After a number of iterations, NRC was allowed to move forward with the curved tunnel. To monitor the work properly, the geotechnical monitoring program was revised to reflect tunneling rather than open cut corners.

Curve Design

In other parts of the world, curved microtunneling is not uncommon. However those drives usually start with a straight run and end with a curve. In that way, the pipe sections subjected to the greatest jacking load do not have to be pushed through the curve. On this project, the requirements were such that NRC proposed a curve in the middle of the drive. In this way, the HAIE would cross beneath the existing 24-in. brick sewer running down the middle of High street with sufficient clearance. Then the curve would be constructed, making the new pipe run along the western edge of the road.



Capacity of the Jacking Pipe

The original calculated jacking capacity of the 72-in. RCP was 1,290 tons. However, as the pipe deflects to go through a curve, the calculation can no longer assume axial loads across the entire area of the joint. As the pipe passes through the curve, the contact area across the joint decreases and approaches a point load. Accordingly, the jacking capacity of the pipe must be reduced. In this case the pipe was derated to 563 tons capacity (still maintaining a factor of safety of 3.0), still significantly higher than the estimated jacking force of 312 tons. A single intermediate jacking station was installed after the laser total station as a contingency in case jacking pressures became too high. It was however not used on this drive.

The derating was based on a maximum 0.25 degree joint deflection and the use of a 3/4-in. plywood packer to aid in load transfer across the joint. The packer provides more uniform contact between the concrete surfaces which allows for uniform distribution of the jacking force across the joint (see open/closed joint details in figure 4). NRC considered a tighter radius of curvature but determined that the corresponding increase in joint deflection would reduce the jacking capacity of the pipe too much, given the estimated jacking loads.

Figure 4 cutline: Figure 4. The plywood packer provides uniform contact between the concrete surfaces, allowing for uniform distribution of the jacking force across the joint.

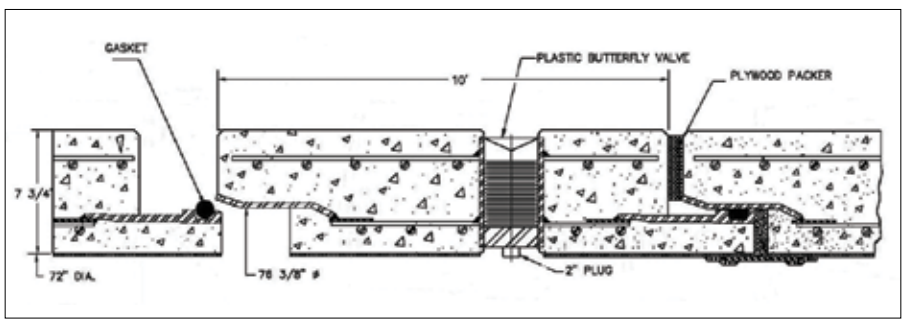


Figure 4. The plywood packer provides uniform contact between the concrete surfaces, allowing for uniform distribution of the jacking force across the joint.

The new alignment had to be coordinated with the connections required for the ancillary sewer and storm drain work. The same issues of numerous utilities and old buildings prompted Northeast Remsco to propose the trenchless installation of a new 15-in. sanitary sewer (approximately 18 ft deep and 200 ft long) using a guided boring machine (GBM). NRC proposed using No-Dig clay jacking pipe in lieu of the specified PVC pipe. After consideration of the high quality of contemporary clay pipe, the MDC agreed to the substitution. NRC used an Akkerman 339 GBM to accomplish this work, while lateral connections were made in an open cut using Insert-A-Tees.

Curved Tunnel Guidance

There were two options to consider for the guidance system for the curved drive: either a Laser Total Station or a Gyroscopic Navigation System. Northeast Remsco considered the benefits of each and decided that a Laser Total Station system was the best choice. This system is designed for the guidance of long distance and curved pipe jacking applications for pipe diameters above 40 in. The main component of the system is a servo motorized Laser Total Station which is mounted inside the tunnel on a special bracket and moves with the pipeline as the microtunneling progresses. The actual position of the station is continuously calculated based on the known as-built position of the already installed pipes. The advantage to using the Laser Total Station guidance system is the ability to continually determine the MTBM's position independent of drift or refraction.

Northeast Remsco hired VMT GmbH, a company very experienced in tunnel guidance systems, to provide the necessary hardware and expertise to guide the curved microtunneling operation. In addition to the guidance system, VMT supplied an experienced engineer to work with Northeast Remsco's microtunnel machine operator for the proper use of the equipment during the drive. The VMT equipment integrated seamlessly with NRC's company owned Herrenknecht AVND-1800AB microtunneling machine and control cabin.

The VMT Internet Viewer is a feature that provides remote visualization of the navigation and machine data via the internet. All data regarding the actual MTBM position, including the MTBM history, the MTBM Position on Google Maps and available MTBM performance data were displayed in the internet browser and frequently updated. This feature allowed the dissemination of relevant information to all interested parties. The machine and navigation data were also displayed in web charts to analyze the jacking process.

VMT´s SLS-Microtunneling LT system was used for the entire length of the drive. In the first phase, the Laser Total Station (a Leica TCA 1203 which includes an integrated diode laser mounted parallel to the visual axis and a sensor system allowing automatic targeting of prisms) was mounted between the push rams on a custom built measurement pillar. For reference, another pillar with a survey prism was installed outside the shaft. During excavation the laser beam is continuously maintained on the Herrenknecht ELS target in the rear of the MTBM and follows the MTBM during the advance. The calculated values of three-dimensional target positions are displayed on the screen of the system PC and also stored in the database.

As the MTBM progresses, the bored hole it creates constrains the jacked pipe following behind. Therefore, as you track the position of the MTBM during the progress of the tunneling work you get a reasonable estimate of the position and elevation of the jacked pipes behind it. The position and level of all further pipes are determined by the tunnel produced by the MTBM. This assumption is called invariance of the pipeline and is the basis of all calculations in the SLS-Microtunneling LT.

The system operates in the first phase condition until the laser can no longer activate the target unit either due to distance or line of sight limitations as the curve is started. On this project, this situation was reached after only two days when the tunnel reached a drive length of 210 ft. At this point, it was already 40 ft into the curve and was approaching the position where the laser would no longer activate the target.

For the second guidance phase, the Laser Total Station was moved into the tunnel onto a custom bracket and moved along with the pipeline as the tunneling continued. The station, the automatic tribrach and inclinometer were mounted directly onto the tenth pipe, approximately 120 ft behind the target, thus guaranteeing a line of sight to the ELS target at all times. The automatic tribrach is used to eliminate roll at the laser station and maintains the total station permanently in a horizontal position. Any lateral inclination caused by the roll of the pipe is detected by an inclinometer positioned at the laser station and is included in the calculations.

Two additional brackets for reference prisms were mounted five pipes (50 ft) ahead of the laser station. Their purpose was to allow measurement of the actual position of the advancing tunnel as near to the front of the laser total station as possible. The variance between the pipes' measured position and that of the theoretical position of the MTBM at the same station can be determined. Finally, the backsight reference prism was then mounted on the measurement pillar in the shaft. As the tunnel continues and the laser station advances, its position is known from the previously stored reference points, which are indexed via the distance driven and corrected for any minor variation due to pipe roll, pitch and yaw. Due to the very rapid advance rate on this project, the interval for the full measurement cycle to check the positions of all the reference prisms was set at 1 m.

The third phase began when the drive reached 405 ft. The Laser Total Station was too far around the curve to see the backsight prism. So, the backsight prism was moved into the tunnel together with its attendant inclinometer to allow roll of the pipes to be included in the computation. To ensure that an accurate measurement of the machine advance is made, a distance measurement wheel is mounted on the pipes in the shaft.

The guidance system was self-sufficient for the rest of the drive. Optical survey checks were recommended at every 300 ft of pipe advance to ensure that any accumulated errors were removed. But due to the very small tolerance of +/- 1 in., and the fast advance speed, this optical measurement was performed daily.

Figure 5. The completed curve with the tunnel support lines still in place.

SUMMARY

This 600 ft drive was completed in just nine days while undertaking a curve of a 1,359-ft radius for a length of 160 ft to complete this complex project. On day nine, the MTBM scratched the receiving shaft and was recovered the following day. The breakthrough accuracy was within a half- inch of the target line and grade, thus marking the successful completion of the first planned, curved microtunnel in the United States.

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NO MATTER WHERE YOUR ROAD LEADS, WE ARE THERE FOR YOU. DAY OR NIGHT.

As the world's largest independent manufacturer of CIPP felt liners, our day never ends. We support our customers 24/7, because they are our greatest asset. Why? Because when our customers succeed, so do we. Our commitment to ongoing research and development never ends, either. We are currently undergoing extensive expansion at our Martinsville, Virginia plant to accommodate the newest technologies and innovations.

Our liners are 100% vertically integrated. Every phase of manufacturing - including a 28-stage testing system - is done in one location, providing confidence that your liners will stand the test of time. With more than 140 million linear feet of successful installations underneath roads and other structures all around the globe - or enough to circle the earth - the sun is always shining, somewhere, on a successful Applied Felts project.

APPLIED FELTS

YOUR SUCCESS IS OUR SUCCESS

www.appliedfelts.com

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FM 56735
FM 35725