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TRENCHLESS TECHNOLOGY

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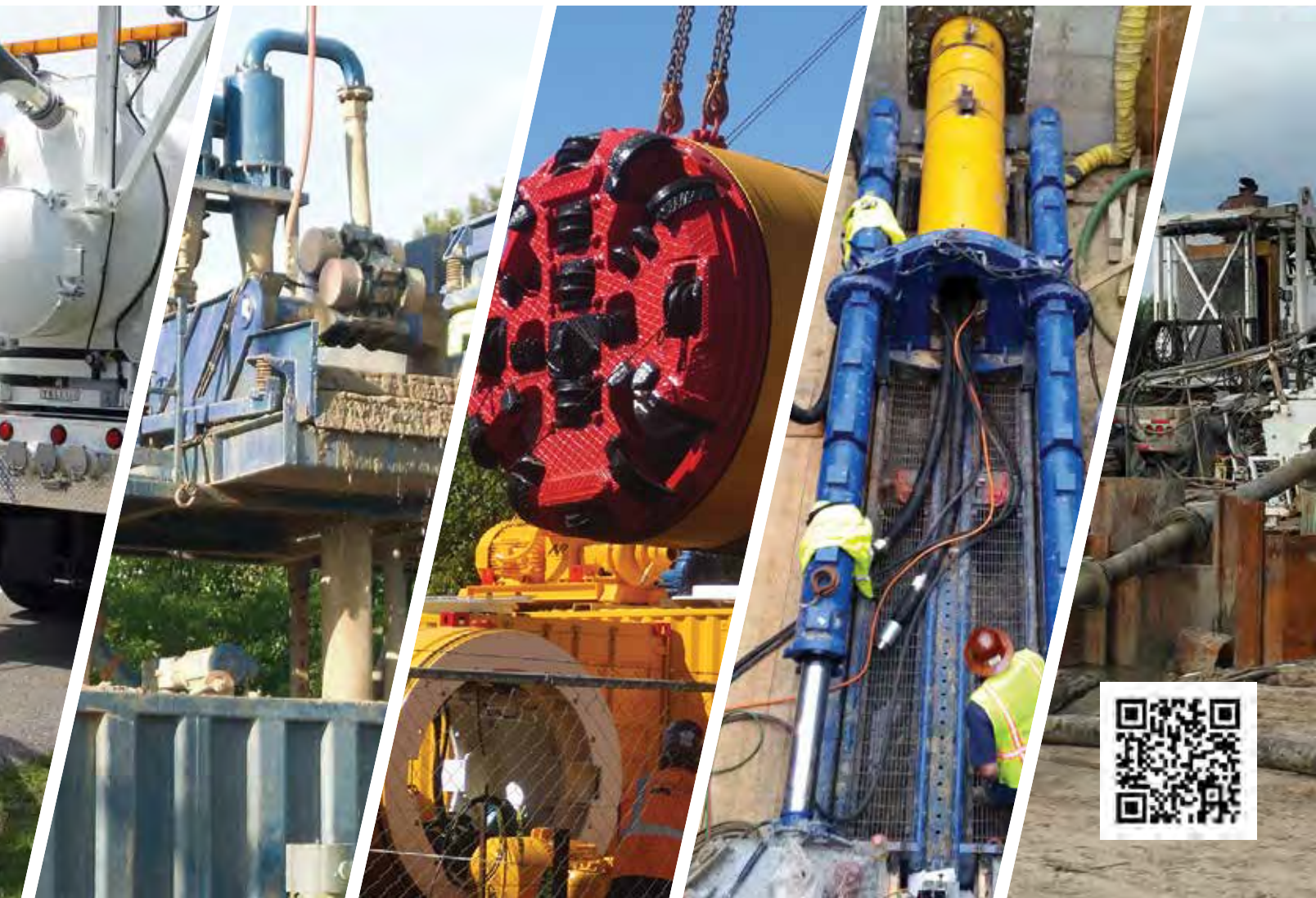

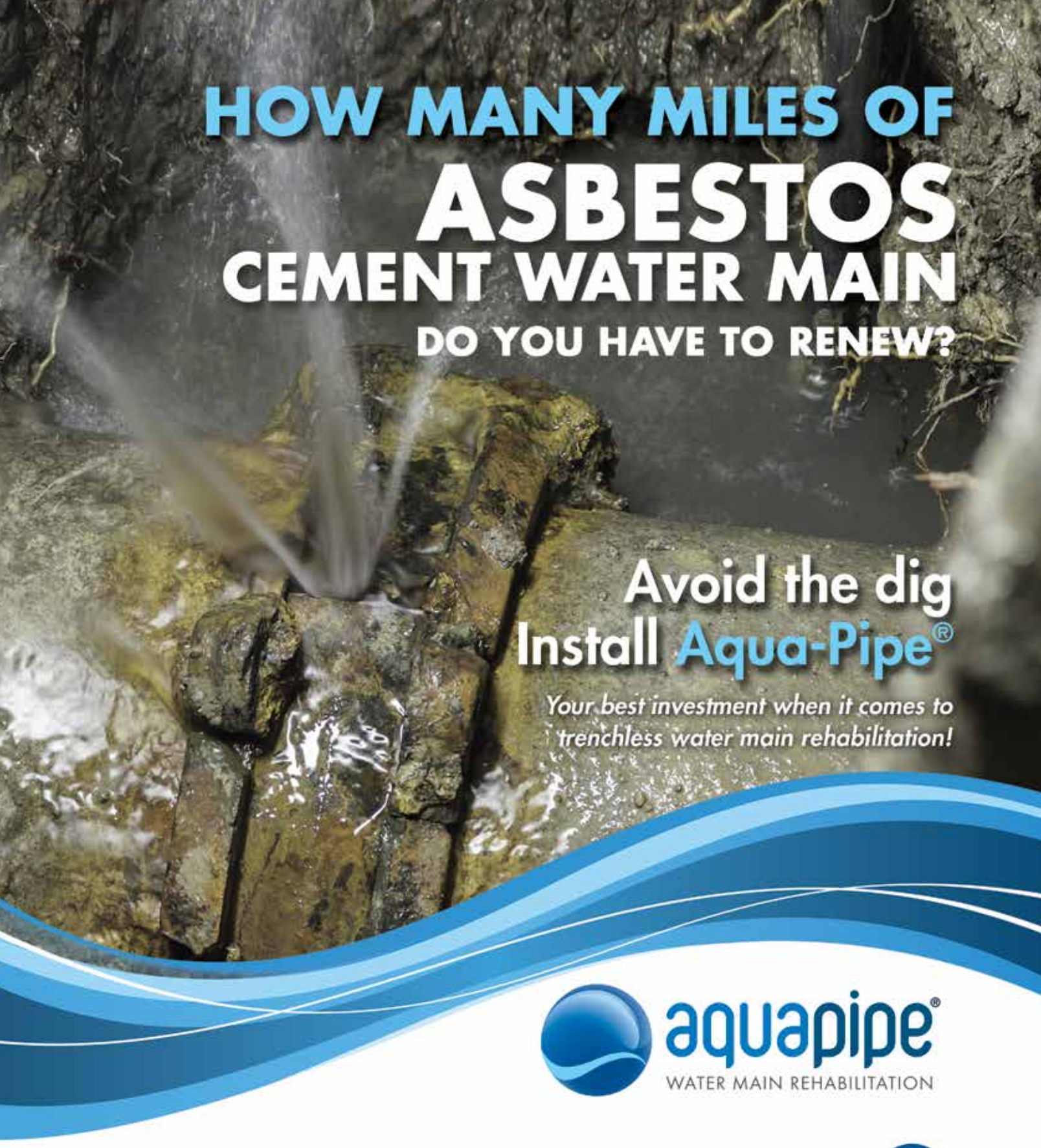

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MESSAGE FROM MASTT CHAIR

Richard Thomasson, P.E., MASTT Chair

Welcome to the first publication of the Mid Atlantic Society for Trenchless Technology (MASTT) Journal. The MASTT was founded in 2004 as a Chapter of the North American Society for Trenchless Technology (NASTT), and serves the geographical region of Virginia, West Virginia, District of Columbia, Maryland, Delaware, Pennsylvania and New Jersey. This area has a huge population and many large municipalities. There has been ongoing interest in trenchless technology throughout our region because of the older water and sewer systems needing rehabilitation or replacement.

The many academic institutions in the Mid Atlantic region, and the presence of the nation's Capital, create a tremendous focus on infrastructure – which is primary in the trenchless technology industry. Many industry leading technology and services companies are located within the MASTT area. Numerous trade associations and research foundations are headquartered here, such as the National Association of Sewer Service Companies (NASSCO), which leads the service providers of many trenchless technology applications. All these factors make MASTT a valuable grassroots resource for education, training, and promotion of the trenchless industry.

There have been many new developments and progress in the trenchless industry over the past 20 – 30 years. All of these new services products and innovations have been used by public and private infrastructure owners across the Mid Atlantic region. Educating and introducing new trenchless technologies and services, MASTT has conducted 21 seminars throughout the Mid Atlantic area. These seminars have been very informative and have introduced trenchless technology to many people over the last 11 years. A good sign is at least 50% of the attendees are first time attenders at the seminars. More short courses using NASTT developed course materials will be implemented in the future.

"WE LOOK FORWARD TO YOUR COLLABORATION & PARTICIPATION"

From every state and from a national perspective, there is an overwhelming task ahead of bringing the water and sewer infrastructure up from its existing deteriorated state to a fully operational service level. Asset management has been promoted as the only practical method of getting a handle on this large problem. Condition assessment, rehabilitation and replacement of buried assets tie in seamlessly with trenchless technology. Environmental, social and economic factors are all greatly enhanced through applications of trenchless technology. We need to focus on performance, sustainability and resiliency of our water and wastewater assets to provide the level of service necessary to maintain a healthy nation.

We feel that this *MASTT Mid Atlantic Journal of Trenchless Technology* is another step in providing information, education and focus on the growth and successes of the trenchless technology industry in the Mid Atlantic region. We look forward to your collaboration with, and participation in, MASTT!

Thank you,

Richard Thomasson
Chair, MASTT

MASTT SITE

GREETINGS FROM THE MASTT EXECUTIVE DIRECTOR

Leonard Ingram, Executive Director, MASTT

The Mid Atlantic Society for Trenchless Technology (MASTT) was founded in Pennsylvania in 2004 as a Chapter of the North American Society for Trenchless Technology (NASTT). I helped organize MASTT as a nonprofit corporation and then became its Executive Director. Since then, MASTT has presented 21 two-day seminars in 11 cities throughout the Mid Atlantic six-state and District of Columbia region. Through this active education outreach, MASTT has reached over 1050 classroom attendees. I want to thank our exhibitors, food sponsors, presenters, guest presenters and ASCE co-sponsor members for their support. MASTT could not have had such an active successful program without them.

Listed below is the 2015 Tentative Preliminary Proposed Seminar Schedule for the Mid Atlantic, Midwest (MSTT) and Southeast (SESTT) Societies for Trenchless Technology.

Please consider participating with these seminars as an attendee, exhibitor, food sponsor and/or presenter.

The MASTT Mt. Laurel NJ seminar is being organized for June 24th and 25th, 2015. ASCE New Jersey section is the co-sponsor for the seminar and the Guest Presenter is Mr. Jeff Twardzik, Engineering Supervisor, Philadelphia Water Department (Water & Sewer), with the presentation "Philadelphia's Trenchless Technology Program". There will be a lot of networking and learning at the seminar.

Please contact me at 888-817-3788 or leonard@engconco.com for additional information about attending or becoming more active.

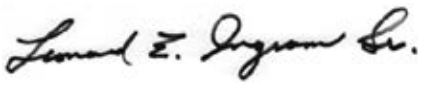
For the professionals who are responsible for design, installation and maintenance of infrastructure, certainty is critical and the greatest obstacle they face is fear of the new and unknown. As "trenchless technologists," it is our charge to educate these professionals with case studies, experiences, theory and demonstrations to help them overcome these fears. That is why MASTT and NASTT conduct seminars and trade shows.

We plan to use the publication of the Mid Atlantic Journal of Trenchless Technology to further those efforts. The magazine will be an annual publication that highlights some of the many trenchless projects performed in and around the Mid Atlantic area. One clear sign of our success is the continued growth in trenchless projects. Please help me thank the Officers of MASTT and their companies for their support through the year and for making this journal a reality. The MASTT Board of Directors is listed in this journal.

The future of "water quality" is vital to maintaining our American standard of living. At each MASTT seminar, I ask how many of the attendees are attending a trenchless technology event for the first time. I usually get a show of hands that reflects over 50 percent. This means that the seminars are drawing interested participants on a first-time basis to learn and network. Therefore, the public will benefit from education about trenchless technology and how it can improve their current and future water quality. This makes me very proud to be a part of this process and a part of this organization.

Thank you for your support!

Sincerely,



Leonard E. Ingram, Sr.
Executive Director, MASTT

SOCIETY	PROPOSED DATE	PROPOSED LOCATION	STATUS
MSTT	May 6 - 7, 2015	Council Bluffs IA	CONDUCTED
MASTT	Jun 24 - 25, 2015	Mt. Laurel NJ	DATE SET
SESTT	Aug 5 - 6, 2015	Birmingham AL	DATE MAY CHANGE
MSTT	Sep 16 - 17, 2015	Indianapolis IN	DATE MAY CHANGE
MASTT	Oct 21 - 22, 2015	Virginia Beach VA	DATE MAY CHANGE
SESTT	Dec 2 - 3, 2015	Shreveport LA	DATE MAY CHANGE

MASTT SEMINAR

MESSAGE FROM NASTT CHAIR

Dr. Kimberlie Staheli, PH.D, P.E., NASTT Chair

Greetings Mid-Atlantic Chapter Members! 2015 is shaping up to be a great year for NASTT. The future of our Society is very exciting and I am dedicated to facilitating the expanse of new and innovative trenchless initiatives during my term as Chair of the Board of Directors. As I'm sure you know, NASTT's 2015 No-Dig Show in Denver, Colorado was a huge success as we broke attendance records and experienced a sold out exhibit hall! This allowed for the best networking opportunities and exposure to trenchless equipment and products that our show has ever offered.

This year we had the privilege of honoring Mid-Atlantic Chapter Member George Ragula of Public Service Gas & Electric with NASTT's Service Award as the outgoing Immediate Past Chair. George has been an extremely active participant and supporter of the trenchless industry, at the local, regional and national levels for over 25 years. His enthusiastic involvement at the national level has included leadership roles on the NASTT Board of Directors, including Chair of the Board of Directors. He has also served on the Program Committee for many years; serves on NASTT's Educational Fund Auction Committee; and holds the record for outselling everyone in vacation raffle tickets! George has been instrumental in developing trenchless education for the gas industry. Thank you, George, for your many years of service and many years to come.

During the NASTT 2015 No-Dig Show we honored Mid-Atlantic Chapter Member Alison St. Clair, by awarding her the Ralston Award for Young Trenchless Achievement. This annual award was established to recognize young individuals who demonstrate excellence in the early stages of his or her career and who have made a valuable contributions to the trenchless industry. Alison is a project engineer for Gibson-Thomas Engineering Co. located in Pennsylvania where she serves as the water distribution and wastewater modeling and management specialist. Alison's NASTT volunteerism includes assisting in the coordination of NASTT's No-Dig Show student activities and as a member of the Young Trenchless Professionals Committee. Congratulations Alison! You are well deserving of this award.

The volunteers at NASTT are the critical component to making our society successful. We are lucky to have a large number of people who offer grass roots support from regional chapters. I would like to take this opportunity to thank the Mid-Atlantic Chapter Members that served on the 2015 No-Dig Show Program Committee: George Cowan, Paul Headland, Tony Hranicka, Peter Oram, George Ragula, Camille Rubeiz, Ariamatar Selvakumar, Jim Shelton, Richard Thomasson and Dennis Walsh. I'd like to give a special thank you to Tony Hranicka, Peter Oram, George Ragula, Camille Rubeiz, Ariamatar Selvakumar, Jim Shelton and Dennis Walsh who also served as Session Leaders this year- a task that takes a tremendous time commitment and dedication to the quality of our show.

NASTT is all about education, and we offer many excellent courses on a variety of trenchless topics. However, the key to their quality is the instructors who provide their expertise. The instructors willingly give their time on a volunteer basis. They take personal time to travel all over North America to provide top notch training about trenchless technologies. I would like to thank George Ragula who has developed and teaches our Gas Good Practices Course. Thank you again, George!

One of my major goals this year is to engage more trenchless professionals to become involved with NASTT. As you may know, NASTT has a wide variety of volunteer opportunities. If you are interested in more information, please visit our website at nastt.org/volunteer. There you can view our committees and learn more about these opportunities.

Our future is bright and your Mid-Atlantic Chapter is stronger than ever. Thank you again for your continued support and dedication to NASTT and the trenchless technology industry.

MASTT BOARD OF DIRECTORS

Richard Thomasson – *Chair*

Richard O. Thomasson has over 45 years of experience working in the water and wastewater field. He has been closely involved with Trenchless Technology for nearly his entire career. While at the Washington Suburban Sanitary Commission he directed many uses of new trenchless technologies, retiring after 31 years as the Director of Construction. He has worked with Parsons Brinckerhoff for 8 years, and Arcadis for the past 6 years, continuing his involvement in numerous trenchless projects.

Richard has a B.Sc. in Civil Engineering from Virginia Tech, a M.Sc. in Civil Engineering and a MPP in Public Affairs from the University of Maryland. He is presently in a Ph.D. program at Virginia Tech, and is a licensed P.E. in Virginia and Georgia.

As a Founding Director and the very first Chair of the North American Society for Trenchless Technology (NASTT), Richard believes fully operational water and wastewater systems are crucial assets for a healthy growing nation.

Michael Delzingaro – *Vice Chair*

Michael Delzingaro is the VP & Director of Sales of Xylem Dewatering, including Flygt and Godwin brands.

Michael has 23 years of experience in the water industry and a background in entrepreneurial-driven businesses.

Michael holds a B.Sc. and M.Sc. in Mechanical Engineering from Villanova University as well as a Certificate in Technical Management from Purdue University, Krannert Graduate School of Management. He co-authored two patents for measuring thrust & torsion in gate and check valves.

Dennis Walsh – *Secretary*

Dennis M. Walsh, P.E., is a senior project manager and associate for Woodard & Curran and leads the Natural Gas Service Line, based in East Windsor N.J. Dennis has a B.Sc. in Civil Engineering, University of Dayton, Ohio and a M.Sc. in Technology, Polytechnic University of New York.

Dennis retired from KeySpan Energy Co. in 2005 after a 28-year career in the gas utility field with a background in engineering, operations, construction, quality assurance and HVAC. He led KeySpan's efforts to expand the use of trenchless technology in the early 1990s to decrease its main and service installation costs.

In addition to his memberships in the American Gas Association and the Society of Gas Operators, Dennis also serves as a NASTT Board member and is on the annual NoDig Show Program Committee. He has designed numerous HDD installations for various utilities. When Dennis is not involved in trenchless projects, he consults on gas engineering and other utility projects.

Tom Wyatt – *Treasurer*

Tom Wyatt has over 40 years of experience in construction and wastewater facilities. Since 1999 he has focused on Trenchless Technology, Inspection, Rehabilitation, & Condition Assessment of Sanitary Sewers. He has helped municipalities with developing and incorporating procedures and programming elements for their CMOM programs. He strongly believes in using trenchless technology along with new technologies that make rehabilitation of Wastewater systems easier and more cost effective. He is currently an Associate with KCI Technologies Inc. in Newark Delaware., Tom is an active member in NASTT, NASSCO, WEF, CWEA, Voting member ASTM, ASHE and ACEC.

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UPCOMING TRENCHLESS EVENTS

June 4, 2015
NASTT Gas Good Practices Course
Bryant University,
Smithfield, Rhode Island
9:15 AM - 12:00 PM
Information: www.nastt.org/calendar

June 24-25, 2015
MASTT Trenchless Technology, SSES & Buried Asset Management Seminar
Mt. Laurel, New Jersey
(Date may change)
Information: Leonard Ingram, mastt@engconco.com

July 14, 2015
NASTT Gas Good Practices Course
Hampton Inn Chicago,
Chicago, Illinois
8:00 AM - 12:00 PM
Information: www.nastt.org/calendar

August 5-6, 2015
SESTT Trenchless Technology, SSES & Buried Asset Management Seminar
Birmingham, Alabama
(Date may change)
Information: Leonard Ingram, mastt@engconco.com

August 17-20, 2015
Asset Management Training for Water Infrastructure, CTAM Courses 100 - 400
Holiday Inn Raleigh Downtown
Raleigh, North Carolina
Information:
www.bami-i.com/events-meetings.html

September 1, 2015
"Trenchless Trends - A Growing Industry" Panel Discussion
2:00 PM - 3:30 PM
Phoenix Convention Center
Phoenix, Arizona
Information: www.nastt.org/calendar

September 16-17, 2015
MSTT Trenchless Technology, SSES & Buried Asset Management Seminar
Indianapolis, Indiana
(Date may change)
Information: Leonard Ingram, mastt@engconco.com

September 30, 2015
NASTT Pipe Bursting Good Practices Course
9:00 AM - 11:00 AM
Kentucky Exposition Center
Louisville, Kentucky
Information: www.nastt.org/calendar

October 21-22, 2015
MASTT Trenchless Technology, SSES & Buried Asset Management Seminar
Virginia Beach, Virginia
(Date may change)
Information: Leonard Ingram, mastt@engconco.com

December 2-3, 2015
SESTT Trenchless Technology, SSES & Buried Asset Management Seminar
Shreveport, Louisiana
(Date may change)
Information: Leonard Ingram, mastt@engconco.com

March 20-24, 2016
NASTT 2016 No-Dig Show
Gaylord Texan Hotel & Convention Center
Dallas, Texas
Information: www.nodigshow.com

TRENCHLESS ACHIEVEMENT!

MASTT Chapter member Alison St. Clair is a recipient of the *2015 Trent Ralston Award for Young Trenchless Achievement*. Alison was honored with this award at the Gala Dinner during the recent NASTT NO-DIG Conference in Denver CO. Since 2010, this annual award has recognized a young individual who has demonstrated excellence in the early stages of his or her career and who has made a valuable contribution to the trenchless technology industry.

Alison received her B.Sc. from the University of Pittsburgh at Johnstown, M.Sc. at Pennsylvania State University and her Ph.D. in Civil Engineering at Virginia Polytechnic and State University. Her dissertation presented a fuzzy inference prediction model used to forecast the performance rating of individual drinking water pipelines, which utilities can easily apply to their drinking water infrastructure system. Alison is now a project engineer for Gibson-Thomas Engineering Co., Latrobe PA where she serves as the water distribution and wastewater modeling and management specialist. Alison continues her NASTT volunteerism by assisting in the coordination of No-Dig Show student activities. Congratulations Alison!

DESIGN-BUILD MICROTUNNELING THROUGH THE FORMER WASHINGTON NAVY YARD

By: Richard Palmer and Peter Sudkamp,
Northeast Remsco Construction Inc., Farmingdale, NJ

In May 2012, Northeast Remsco Construction (NRC) of Farmingdale NJ was awarded the lead Design-Build contract for the new Tingey Street Diversion Sewer (TSDS) in Washington DC. The TSDS is part of the ongoing $2B DC Water Clean Rivers (DCCR) program. Due to the scale and schedule of the program, necessary coordination with affected parties, and concurrent projects (e.g. 14th Street Bridge Replacement, Poplar Point Development, etc.), DC Water subdivided the DCCR into several Design-Bid-Build and Design-Build packages, including the TSDS. This flexible structure has allowed the program to advance and evolve as changes arise.

Use of the Design-Build approach with the TSDS project provided the framework to meet the specific project challenges within limitations and goals established by DC Water and other affected parties. Due to the cooperative nature and flexibility inherent in the Design-Build process, NRC found solutions by proposing several innovative changes from the original 30% bid documents in the technical component of its Design-Build proposal as well as making rapid modifications as unexpected conditions arose during construction.

Challenging project conditions dealt with during the installation of this 1200 LF 72-inch RCP microtunnel project arose from a combination of underlying geological conditions, weak in-situ soils and varied historical use and river shorelines. Unexpected traffic requirements and the proximity of Washington Metropolitan Area Transit Authority (WMATA) Green Line subway tunnels posed further challenges. The design and construction also had to accommodate unique existing infrastructure within and adjacent to the construction limits and the potential for abandoned and undocumented foundations and utilities due to the site's historic use.

Site History – The Washington Navy Yard

The project site extends along Tingey Street, SE approximately between New Jersey Avenue and Isaac Hull Avenue within land that was formerly part of the Washington Navy Yard (Yard). The Yard is the US Navy's oldest shore establishment with the original boundaries created around 1800 from M St as the northern boundary, 9th Street SE as the eastern boundary, and the Anacostia River and its inlets forming the western and southern boundaries.

At first, the Yard was a base and ship yard, then in the War of 1812 it was burned to the ground to protect it from falling into enemy hands. After this it was decided the Yard would focus on ship and ordnance manufacturing. During the mid-1800s ship building was phased out, and ordnance manufacturing was ramped up.

By the end of World War I, the Yard's primary function was designing and manufacturing naval ordnance. It became the largest naval ordnance facility in the world during World War II. Over the years as its operations expanded, the Navy created more useable land by filling in river wetlands to the south making room for factories, foundries, steam and power plants, and a maze of rail

and utility networks to support the complex. During the two decades following World War II, ordnance and manufacturing work was phased out, and many of the abandoned factory buildings were converted to office space. Today, the Yard still functions as headquarters of Naval District Washington with offices in many historic and new buildings.

In the mid-90s, the Navy began investigating and planning to reduce the size of the Yard ultimately turning over sections of the facility to non-Navy entities for mixed use residential and commercial development. Because of these developments, the TSDS was constructed out of sequence with other DCCR segments in order to finish prior to the developer's other projects in this new neighborhood. Ultimately ownership of these streets will be turned over to DC.

Challenging Ground Conditions

As Washington DC and the Yard grew, fill was placed along the Anacostia River to create the land needed for expansion. Before development of the Yard, the river encompassed approximately 50 percent of the TSDS project limits, but by 1910 this entire area had been filled, and by the 1920s the basic shoreline as it exists today had been created.

Figures 1 and 2 show the three main fill areas of the project: the first is where Tiber Creek spilled into the Anacostia River to the west of the Main Pump Station encompassing the launch shaft area and the first 130 feet of the tunnel; the second is the middle 670 feet of the tunnel and is over the original land of the Yard, including the CSO-013 Diversion Chamber and Manhole; and the third is the final 400 feet of the tunnel over the wide area of the river reclaimed in the early 1920s. This third area includes the tunnel receiving shaft and CSO-014 Diversion Chamber.

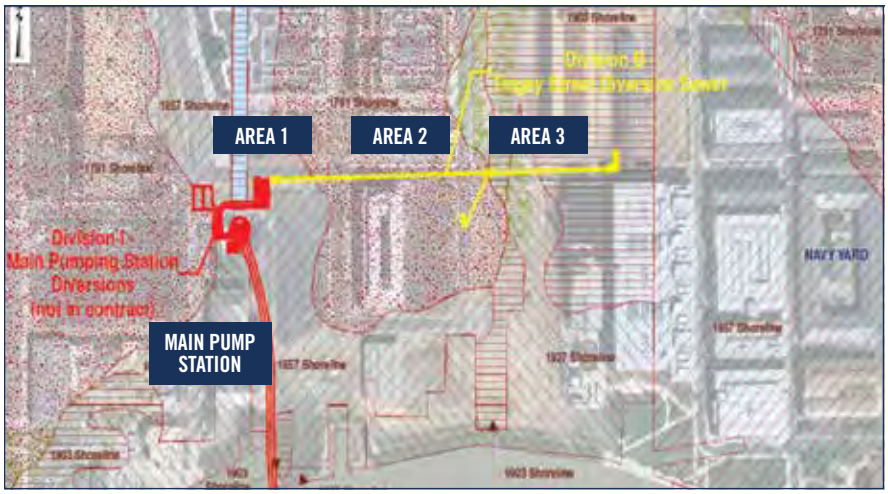

Figure 1 - Variations in the Anacostia River Shoreline with Time

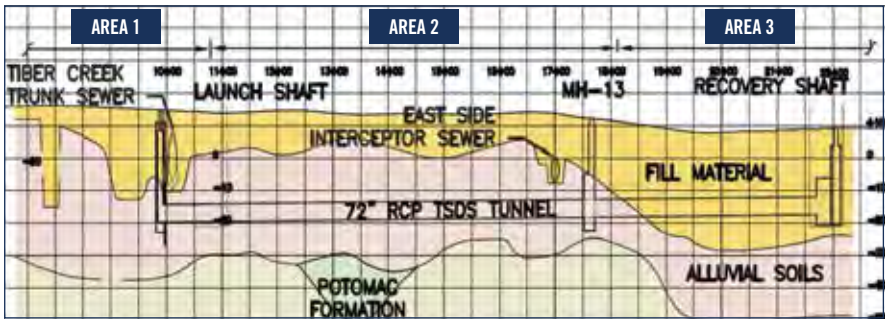

Figure 2 - Geologic Profile

Within the project limits, the first and second areas are geotechnically similar with 8 to 12 feet of fill overlaying 10 to 20 feet of alluvial soils. The only areas in these segments where the subsurface investigation indicated the fill thickness significantly increased were at the locations of known deep cuts at the existing sewers including Tiber Creek to the west of the jacking shaft, and the East Side Interceptor Sewer (ESI) at the intersection of Fourth Street and Tingey Street SE.

The Geotechnical Data Report indicated the alluvial soils in the first two areas to be predominately dense sands with lenses and layers of stiff clays and silts which are suitable for direct bearing of the diversion sewer. Within the tunnel horizon, the soil encountered was predominately gravely sand to sandy gravel with some fine grained material.

The third area changes drastically from this composition as the TSDS tunnel advances beyond the 1791 shoreline eastward through the reclaimed land. As shown in the Figure 2 profile, the fill rapidly increases from 10 feet to nearly 40 feet deep. Typical of the era, the fill operation was uncontrolled and undocumented, so there is a highly variable conglomerate of sand and clay with organic matter and debris. The excavated fill included: timber, concrete, brick, cinder, steel plates, bolts, rails, and guns. Due to the historic industrial use of the Yard, the fill is frequently contaminated with heavy metals, PCBs, and hydrocarbons. The underlying alluvial soils in this area are also quite different from the first two areas; the layer is predominately very soft lean organic silts and clays with occasional sand layers and cobbles and boulders. The alluvial layer in this section varied from 10 to 20 feet thick, and due to its very soft and compressible nature, was not suitable to support the tunnel.

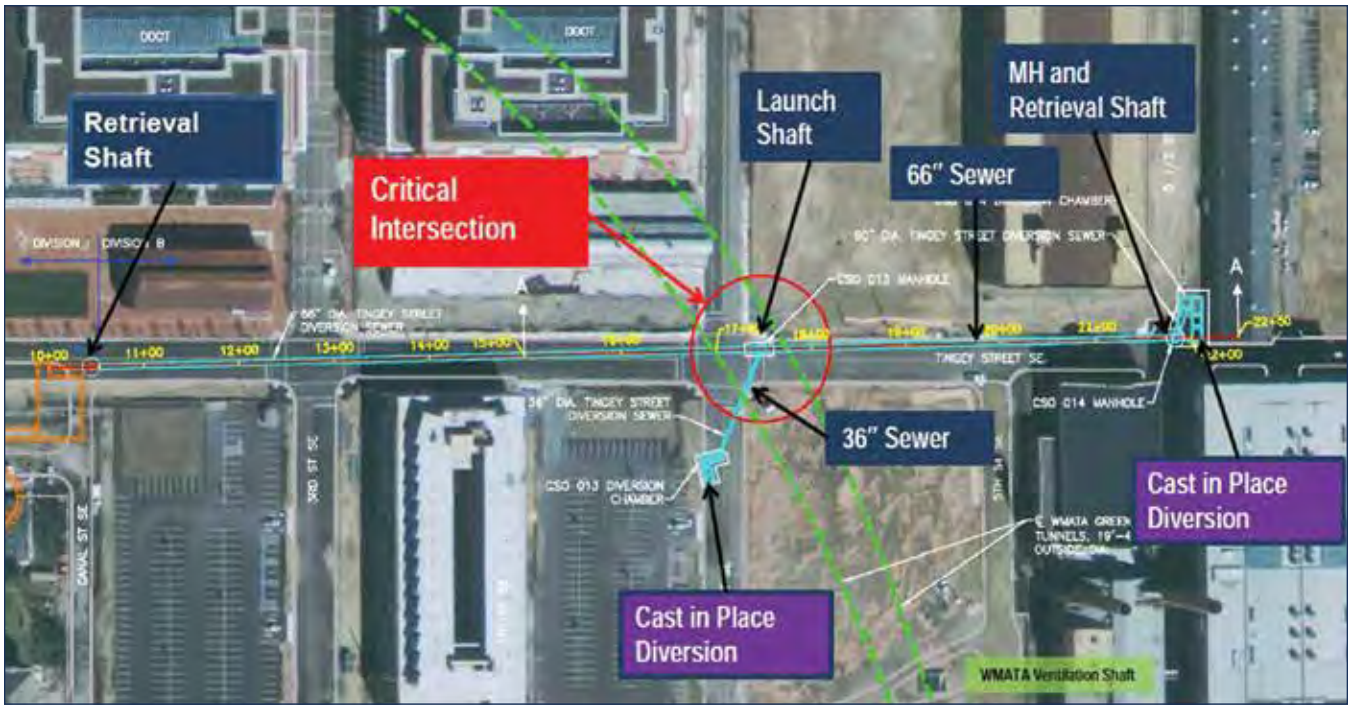

Figure 3 - DC Water's 30% Design Concept

Design Solutions from Initial Concept through Construction

The initial construction concepts from DC Water's original 30% design documents are shown in Figure 3. To accommodate existing infrastructure and adjacent development within the site constraints and address the varied natural and manmade soil conditions, NRC included several alternatives in the technical component of its Design-Build proposal:

1. Increase the TSDS from 66 inch diameter to 72 inch diameter.

Given the tight installation tolerance (+/- 1.5 inches) and the weak soil, NRC proposed the installation of a 72 inch pipe in lieu of the specified 66 inch pipe. If sections of the tunnel were found to be low and out of tolerance, a cast-in-place concrete floor could be constructed to return the TSDS to its design invert. Increasing the diameter also allowed NRC to use its company-owned equipment thereby mitigating scheduling problems.

2. Construct the 72 inch TSDS in one long drive rather than two drives from a common center shaft.

NRC proposed constructing the TSDS as one long drive, a cost saving measure due to elimination of one MTBM setup, launch and recovery. The risks associated with a longer drive were mitigated by using intermediate jacking stations to overcome higher jacking forces and by the use of a guidance system specifically designed for long distance and curved pipe jacking applications with pipe diameters above 40 inches. In addition, NRC has a track record of successfully completing long micro-tunnel installations using the proposed MTBM.

Constructing the sewer as a single drive moved the launch shaft away from the critical Fourth Street and Tingey Street intersection - a buzz of activity due to new commercial construction underway. This move reduced the shaft size and staging area and also reduced the time NRC needed to work directly over the WMATA subway tunnels.

Figure 4 - Sawcut 72" TSDS for MH-13 construction

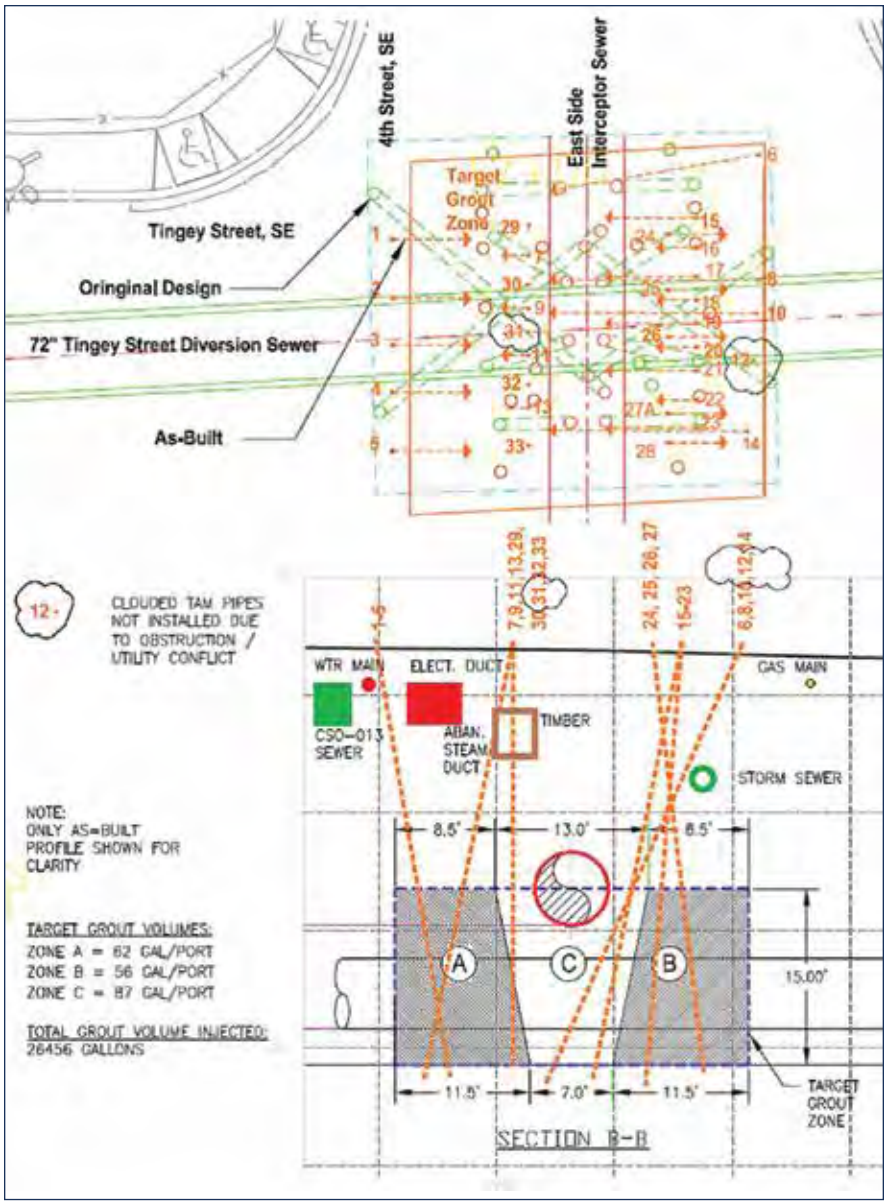

Figure 5 - Permeation Grout Plan and Profile

The change did not eliminate the need for MH-13, so NRC pre-installed the MH-13 shaft, including tunnel entry and exit portals, temporarily backfilling with flowable fill. After mining was complete, NRC re-excavated the shaft to expose the installed RCP, then sawcut and removed the top half of the installed pipe between the joints of one stick of pipe, as shown in Figure 4. Work was completed using an 8 foot square precast concrete dog-house manhole set over the cut pipe on a cast-in-place concrete foundation.

3. Permeation grout in lieu of jet grout to support the East Side Interceptor (ESI) sewer.

The TSDS passes beneath the existing ESI sewer running along Fourth Street at the "critical intersection" noted above in Figure 3, with approximately 3 feet of vertical clearance. The RFP documents required underpinning of the ESI (presumably with jet grout) prior to microtunneling.

During the development of its proposal, NRC considered four ground modification options: jet grout, ground freezing, compaction grouting, and permeation grouting. All four options would provide the support required to protect the ESI from the mining operation, however each one had disadvantages as well. These included: high cost, too much space required, and that the improvement method itself could damage the ESI. Ultimately, NRC chose permeation grouting because it was it was the option least likely to damage the ESI with the main disadvantage being risk that areas within the grout zone would be insufficiently treated due to pockets of soil with higher fines content. NRC believed the ground where the permeation grout does not "take" because of the high percentage of fines is also the ground that has the higher probability of providing sufficient stand-up time to stabilize the overcut outside the jacked RCP with the bentonite lubrication used during tunneling.

The permeation grout was installed from the surface using the Tube-A-Manchette (TAM) method. Figure 5 illustrates the as-designed and as-built permeation grouting program. A drill pattern and orientation were developed during the design process based on the objective of underpinning the ESI while maintaining at least one-way traffic on Fourth Street. The plan was developed to accommodate the known utilities in this intersection, but the subsurface conditions actually encountered severely limited the drill locations and orientations. Many obstacles were unanticipated and only discovered while drilling for the TAM installation. The collaborative Design-Build process facilitated quick responses to each of these obstructions, allowing work to proceed with minimal disruption.

4. Use large diameter, low strength jet grout columns.

The 350 feet of tunnel at the eastern end of the drive would mine through a fill stratum consisting of very loose and very soft highly plastic organic clay and silty sand, with similar alluvial soils beneath the pipe. In the RFP, DC Water anticipated the construction of a jet grout envelope through which the

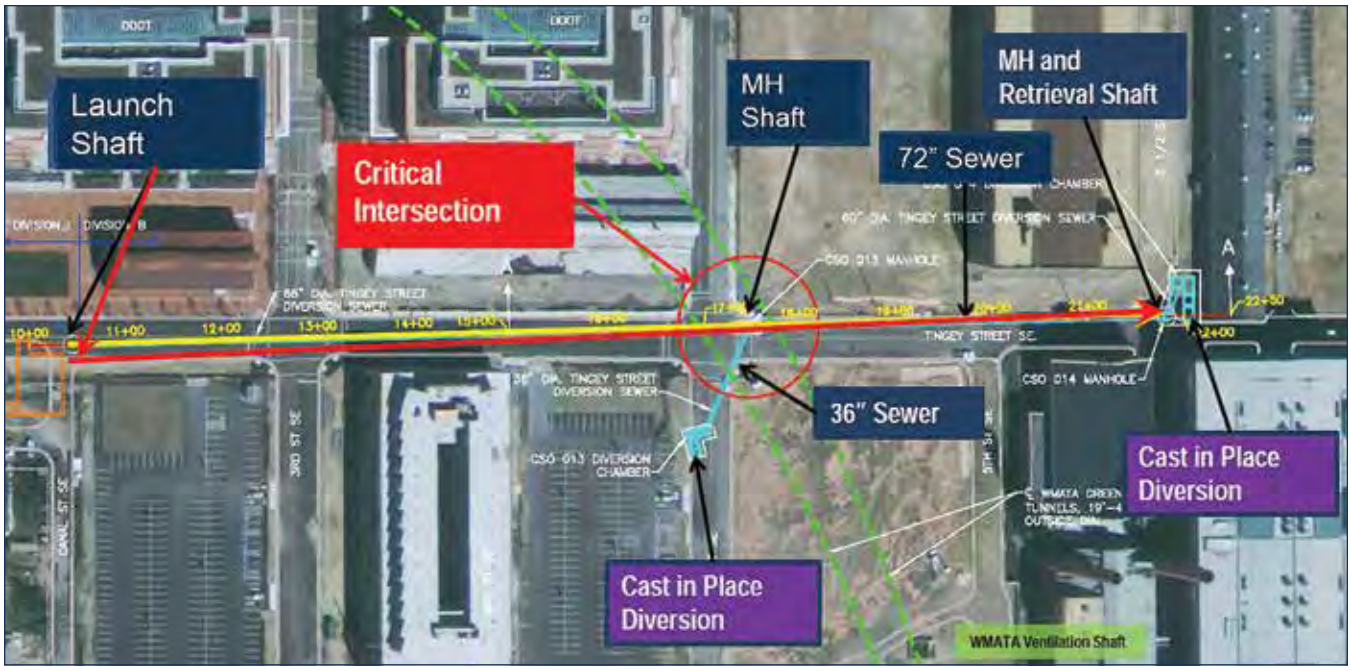

Figure 6. Final project configuration with all approved changes

MTBM would mine. This envelope of grout would be supported by jet grout columns extending to the underlying Potomac Formation equally spaced along the tunnel alignment. This approach would provide face stability for the tunneling operation and support the pipe against long term settlement. The original specifications required an unconfined compressive strength between 300 PSF and 1,000 PSF.

NRC was concerned about the slurry separation challenges associated with microtunneling through a solid jet grout mass. After further study of the in-situ soil, it was determined there was sufficient face stability for closed-face microtunneling to be successful. Therefore only long-term settlement needed to be addressed by the jet grout design. Instead of smaller diameter higher strength jet grout columns, NRC proposed the installation of 6 foot diameter columns spaced on 10 foot centers with a compressive strength of 50 PSI. The columns extended up to the spring line of the TSDS rather than 2 feet above the crown of the pipe as shown in original 30% design.

These larger diameter columns allowed NRC to reduce compressive strength while still achieving required structural support. The lower strength allowed successful microtunneling through the columns, passing in and out of the grouted zones without difficulty. Larger diameter columns also eliminated concerns regarding point loaded support of the TSDS as a result of not grouting the entire tunnel envelope. Fewer columns also eased installation problems associated with drilling around the many utilities in the area.

5. During Final Design - Realign the drive to accommodate unexpected traffic requirements.

As preliminary construction work began, final design for the 72 inch RCP microtunnel was submitted for DDOT approval and permitting. The launch shaft was near the center of the street, so the traffic control plan maintained a single west bound lane to the north side of the shaft while closing the road to all east bound traffic. Tingey Street would become a "one-way" street for several months. Despite preliminary conversations with DDOT and compliance with the original design, it quickly became apparent this traffic control plan would not be approved.

After several brainstorming sessions involving various iterations of temporary travel lanes and moving traffic onto sidewalks, etc., NRC proposed revising the horizontal alignment of TSDS to eliminate the need for one way traffic altogether. This was accomplished by holding the location of MH-13 constant and rotating the alignment counterclockwise approximately 1 degree, thus shifting the launch shaft south approximately 18 feet and the receiving shaft north approximately 10 feet. Launch shaft construction and microtunneling were then completed while two-way traffic was maintained on the north side of the shaft.

Construction Monitoring of Subway Tunnels

Trenchless installations through developed urban areas require significant monitoring to ensure construction activities have no adverse impact on adjacent infrastructure. Along the tunnel alignment, ground monitoring arrays were established at 100 foot intervals, and utility monitoring points were installed on all the buried utilities within the TSDS zone of influence. While these surface down monitoring points are standard within the trenchless industry, the crossing

Launch shaft site on Tingey Street with Washington Nationals stadium in background

above the concrete segmental lined WMATA subway tunnels presented a unique monitoring challenge.

WMATA operates and manages the DC subway system and requires review and approval of all construction within their system properties, right-of-ways, and easements. Access to the system tunnels is controlled by WMATA and restricted to non-revenue hours, typically midnight to 4:00 AM, and all contractors must be escorted by WMATA staff. Access must be scheduled months in advance, and may be cancelled by WMATA without notice. Given these restrictions, and the potential for work stoppage due to inability to complete the required monitoring, an automated monitoring system was used.

This automated system exceeded WMATA requirements and provided monitoring during working as well as non-working hours at no additional cost. Further the system eliminated the need to conduct nightly manual surveys, thus mitigating the possibility of suspension of work due to monitoring being incomplete. The system worked well, and showed the TSDS construction had no impact on WMATA facilities. Due to automation, only ten days of manned track access were required to complete the monitoring work including the preconstruction and post construction surveys.

From initial concept through preliminary construction, development of the final design by NRC and the whole project team in response to specific project challenges was instrumental in making the Tingey Street Diversion Sewer project a success. The TSDS tunnel was completed successfully, on time and on budget, in October, 2013.

(Condensed from paper TM2-T5-01 presented at NASTT No-Dig Conference 2015 Denver, Colorado)

ABOUT THE AUTHORS:

***Richard Palmer** is the Tunneling Manager for NRC. He has over 30 years of construction experience and is a licensed Professional Engineer in five states. He earned a BSCE from Lehigh University and an MBA from Rider College. Mr. Palmer is a member of the Executive Board of the North American Microtunneling Association and is active on AREMA and ASCE subcommittees as they pertain to trenchless work.*

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CHALLENGES OF TRENCHLESS TECHNOLOGY FOR GAS PIPELINE PROJECTS

By: Dennis Walsh, P.E. and Steve Ewing,
Woodard & Curran

HDD Drill Rig with Control Cab and Mud Pumping Operation

It seems like every day a new gas pipeline project is being proposed and right away the environmental activists line up to oppose the project and attempt to block the required Federal and State permitting agencies from issuing approvals. No matter what pipeline project is proposed, it has its objectors, who seek to stop the projects in an effort to stop drilling for natural gas.

Understanding this resistance, applying good project planning, and sound engineering will make a project more likely to succeed. This article describes the overall considerations and trenchless technology best practices that will help get a project permitted and built.

Route study crucial to success

First is the route study. Alternate routes should be identified and ranked on a variety of considerations. These considerations include impact on the environment, quality of life in the community, traffic flow impact, permittability, constructability and meeting the project needs. A good route analysis review will consider these and other factors for each route segment. The use of trenchless technology plays a major role in the route analysis and planning effort because it can open up options that would not be possible using conventional means.

Looking at each route and ranking it will indicate the best route to supply a project. While not intended to be an absolute solution, it will point out the two or three best routes, and every permitting agency will look to see that no stone is left unturned in an effort to minimize the impact of the project.

Trenchless technology expands possibilities

Once the best route has been determined, the project becomes a classic pipeline design effort. The route is surveyed with aerial and/or ground survey, environmental field investigations are done, base maps are prepared, plan and profile drawings are completed, and the project takes shape. Part of the design process is to decide where you will use trenchless technology to complete the project.

Crossing of rivers, streams, waterways, highways and other obstacles can be done using Horizontal Directional Drilling (HDD). The design engineer and the utility owner review the route and determine the areas where HDD and other trenchless methods can be employed based on a variety of factors such as constructability, cost, permitting needs,

Water Crossing Completed Using HDD

and other construction considerations. Sufficient area to set up drilling operations and an area to weld or fuse gas pipe is critical. If a railroad needs to be crossed, jack and bore will be the preferred method - although HDD can be used if the pipe is deep enough and preferably in rock.

Preliminary designs are completed, temporary and permanent land use requirements identified, and geotechnical investigations are done to ascertain field conditions for the final trenchless design. Geotechnical investigations are critical to the HDD design in terms of both planning for the drilling effort and minimizing the potential for an inadvertent breakout of the drilling fluid. If there is concern for a breakout in the entry and exit areas, conductor casings may be installed prior to drilling. Conductor casings are steel pipes jacked or rammed in place for the HDD drill to enter and exit the ground. Use of Intercept Drilling can increase the length of the design and assist in mudflow and drilling operations.

Trenchless technology often improves permittability

Permitting experts are integral to the HDD design. Involved in the design process right from the start, they will ultimately submit the applications to the appropriate agencies. Communication with the permitting agencies is done as early in the design process as possible. Reviewing options and HDD designs will increase the understanding of how trenchless technology can minimize the impact on the environment.

The process of permitting a new gas pipeline involves all professionals and the client. There are numerous environmental evaluations included in the route selection process that could lead to recommendations to utilize trenchless technology to avoid environmentally sensitive areas. In the past, routes may have been identified as not viable due to the environmental impacts associated with open cut installation in environmentally sensitive areas. Today's HDD technology provides the opportunity to include routes that may be more direct, avoid community impacts and may even reduce the overall cost of the pipeline. In fact, there are federal and state agencies that not only understand trenchless technology but have also included its use into their permitting programs.

The State of New Jersey recognizes that HDD is the preferred method or industry standard for the installation of pipelines in environmentally sensitive areas. The New Jersey Department of Environmental Protection has reviewed the potential impacts on freshwater wetlands and waterways under N.J.A.C. 7:7A, Freshwater Wetlands Protection Act Rules, and specifically created a General Permit for the installation of underground utility lines. This General Permit authorizes activities in freshwater wetlands, transition areas, and/or open waters, necessary for the construction and/or maintenance of an underground utility line. In this General Permit, N.J.A.C. 7:7A-5.2(b) states:

"TRENCHLESS TECHNOLOGY IS A VIABLE SOLUTION TO AVOID ENVIRONMENTAL IMPACTS"

> "If a utility line is jacked or directionally drilled underground, so that there is no surface disturbance of any freshwater wetlands, transition areas, or State open waters and there is no draining or dewatering of freshwater wetlands, no Department approval is required under this chapter. Jacking or directional drilling is regulated under this chapter if any disturbance occurs to the ground surface in the freshwater wetlands, transition area, or State open water; for example, if the drilling is conducted from a pit located in a freshwater wetland or transition area."

No approval would be required because the regulator has concluded that the activity will not have a significant impact.

The Federal government recognizes that HDD is the preferred method or industry standard for the installation of pipelines in environmentally sensitive areas as evidence by the following permit-specific regional condition associated with the Nationwide General Permit 12 for Utility Line Activities:

> "2. For the installation of utility lines, the following applies: b. The utility line should make a direct or perpendicular crossing of a stream. Directional drilling is the preferred method of installation when possible, especially in tidal waters;"

Addressing regulator concerns in advance

While trenchless technology has been utilized for over 50 years, projects can still encounter questions from regulatory agencies, objectors and the public about safety and potential impacts associated with the implementation of trenchless technology. Many of the reviewers at the regulatory agencies do not have the background or experience with this technology to understand how extensively it is being employed with positive

results. Preparing for these objections at the outset of a project will improve the chances for a smoother approval process.

Regulatory agencies are very concerned with potential impacts associated with inadvertent returns or drilling fluid "breakout" during the HDD process. This potential impact is minimized by incorporating good engineering design, collecting geotechnical information and incorporating it into the design and drilling process as well as developing a sound drilling and mitigation plan.

A breakout contingency plan should be incorporated that requires monitoring of the entire HDD drill path to identify and contain any breakout that might occur. Any sign of a breakout condition should cause drilling to be halted immediately. The driller should utilize a downhole pressure-monitoring device as an additional precaution against a breakout. This technology helps the driller monitor the drill head pressures to avoid a condition where the drilling fluid pressure exceeds the allowable pressure of the soil conditions thus resulting in a breakout. The driller should also observe the drilling fluid return to ensure circulation of the drilling fluid, which also reduces the chance of a breakout.

An HDD monitoring program should include visual monitoring of the overland drill alignments and the surface waters by on-site monitoring personnel on a continuous basis to watch for evidence of any drilling fluid breakout points. It should also include drilling fluid volume flow monitoring by drilling technicians on a continuous basis throughout the drilling and borehole reaming operations for each HDD conduit system and development and implementation of a fluid loss response plan and protocol (water and land) by the drill operator in the event that a fluid loss is discovered.

All HDD projects need to be properly designed and constructed with good drilling practices using a proper drilling fluid to be successful. This is true for all HDD routes. What makes every HDD project different are the conditions present at the drilling locations and the obstacles that are being avoided. The NASTT publication, *HDD Good Practices Guidelines*, is an excellent reference.

Overview of Typical HDD Drilling Operation

Proving the case for trenchless technology

As more pipelines are proposed and constructed, data should be collected to quantify the reduced environmental impacts resulting from the use of trenchless technology as well as the incidence of breakouts during HDD. Collecting this data would provide valuable information for the industry to show that trenchless technology is a viable solution to avoid environmental impacts, while also providing utilities with a cost effective way to address pipeline route obstacles.

As an industry, making every effort to implement the best available technology where appropriate, collect the data necessary to effect a sound design, work with talented experienced drillers, and implement best management practices is essential. Being vigilant on every project, will contribute to a growing reputation that repudiates unfounded objections aimed at trenchless technology intended to derail the overall project.

ABOUT THE AUTHORS:

Dennis Walsh, *P.E. has over 35 years of experience in gas engineering design and construction management. He leads Woodard & Curran's natural gas utility consulting practice, helping clients plan, design, permit, and build gas transmission and distribution systems with a focus on using trenchless technology to facilitate the process.*

Steven Ewing *has over 35 years of experience in environmental consulting, including field investigations regulatory negotiation, environmental impact assessment, and permitting. He has particular expertise in permitting natural gas pipelines and land development projects.*

WSSC ANACOSTIA TRUNK SEWERS CONDITION ASSESSMENT AND REHABILITATION

At Historic Bladensburg Waterfront Park, MD

By: Calvin D. Farr, Jr., P.E. Group Leader, WSSC
Glen Diaz, Unit Coordinator, WSSC
Andrew Fitzsimons, Project Manager, WSSC
Aaron Hughes, Project Manager, WSSC

Purpose

The purpose of the project was to develop a condition assessment, structural analysis, design, and rehabilitation of the Anacostia Trunk Sewers and siphons in the area of historic Bladensburg Waterfront Park, MD.

Background

The Washington Suburban Sanitary Commission (WSSC) owns and operates the 8th largest water and wastewater utility in the country. Approximately 1/3 of WSSC's wastewater passes through the Anacostia River Valley as it makes its way to WSSC Anacostia Pumping Stations. The trunk sewers range in size from 36-inch to 102-inches. The sewers in the area have a significant history of hydrogen sulfide generation and resulting corrosion. See Figures 1 and 2.

Under a Consent Decree WSSC has a comprehensive proactive sewer inspection and rehabilitation program ongoing throughout the collection system using the most up to date inspection methods and trenchless technologies. WSSC directed the sewer condition assessment at the Bladensburg Waterfront Park as part of this proactive inspection program. The results of the investigation were of interest to the US Army Corps of Engineers (USACE) and the Prince George's County Stormwater Management Division who jointly operate a levee system along the Anacostia River because the trunk sewers pass under the levee at several points.

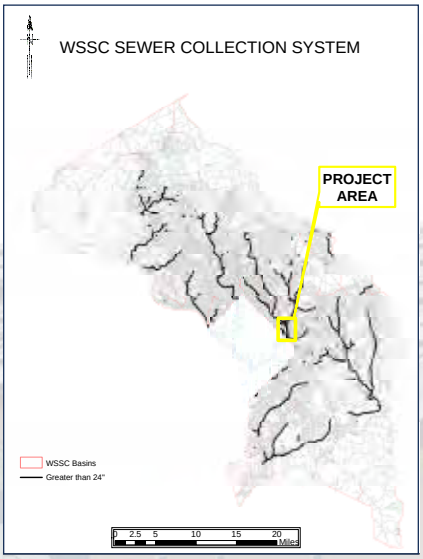

Figure 1 – WSSC Project Location

Condition Assessment

Inspections of approximately 2,100 linear feet of the 102-inch Anacostia trunk sewer were conducted in 2012 and 2014. The inspection results from 2012 revealed that corrosion of the interior wall of the pipe caused an increase of the internal diameter ranging from an average of 1-inch to over 2 inches in certain areas. The CCTV survey revealed that the steel reinforcement in the interior is continuously exposed throughout the length of the sewers inspected. The 2014 inspections revealed little additional change in the increase in the internal diameter of the interior wall.

From the data gathered and analyzed, the structural analysis findings are:

1. The pipe will likely experience concrete wall loss at the spring line of 3.0 inches in the near future. This anticipated interior wall loss results in a computed overstress of 19 %. This level of overstress is unsustainable; putting the pipes at risk for structural failure.

2. Manhole inspection results indicate the manhole frames and covers are in need of replacement, due to severe corrosion and pitting from the effects of hydrogen sulfide. The concrete walls of the structures are severely deteriorated and all mechanical devices inside the structures are also corroded.

As a result of these findings, once the Condition Assessment of the 102-inch Anacostia Trunk Sewer was completed, recommendations were made to rehabilitate the inspected portion of the 102-inch trunk sewer as well as all the associated manholes.

Rehabilitation Recommendations

Pipeline Rehabilitation

- Proceed with design of pipe rehabilitation and construction to repair via grouting and panel lining or other technology that is capable of accommodating the deflections in the existing pipeline configuration

Structure Renewal

- Replace all covers and frames due to pit and corrosion
- Rehabilitate junction chamber and manhole covers

Rehabilitation Design

Pipeline Rehabilitation/Bypass Pumping

As shown in Figure 2, the 102-inch gravity trunk sewer to be rehabilitated as part of this project extends from structure 09012071J located on Bladensburg Waterfront Park property (owned and operated by Maryland- National Capital Park and Planning Commission (M-NCPPC)), to structure 09012018J located on WSSC's Anacostia Depot property. The 102-inch trunk sewer between structures 09012071J and 09012054M is buried within a United States Army Corp of Engineers levee (USACE). Between structure 09012054M and 09012019U the 102-inch sewer becomes an inverted siphon to convey flows under a tributary stream feeding the Anacostia River.

Naturally, the rehabilitation of such a large pipe requires a significant flow control plan. The capacity of the proposed bypass system is approximately 100 MGD. Fortunately, WSSC owns and operates an underused wastewater pumping station

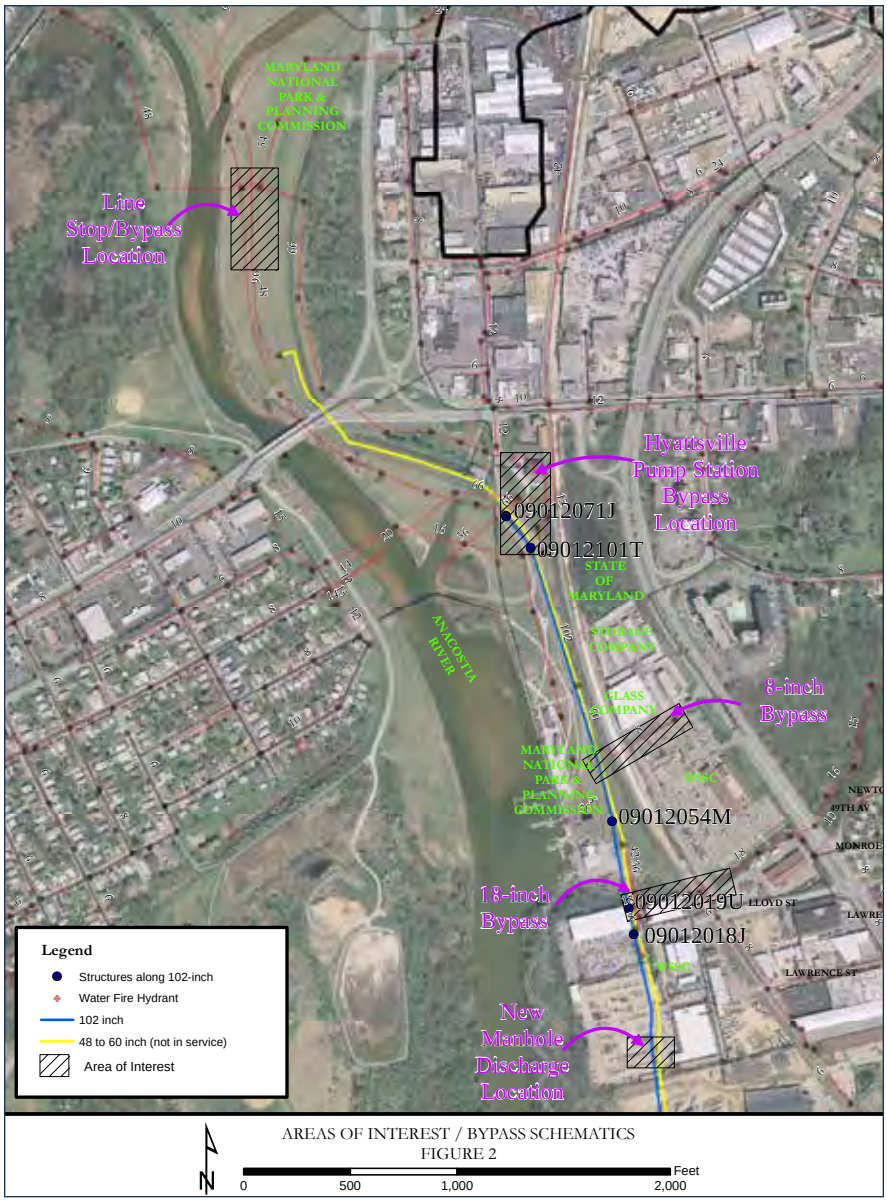

Figure 2 – Anacostia Trunk Sewers

"ONCE THE CONDITION ASSESSMENT OF THE 102-INCH ANACOSTIA TRUNK SEWER WAS COMPLETED, RECOMMENDATIONS WERE MADE TO REHABILITATE THE INSPECTED PORTION"

located at the entrance to the project area so the bypass plan takes advantage of this excess capacity and pumping capability. The plan includes the installation of tandem 96-inch line stops and uses an existing 66-inch pipe to bypass the primary flow (approximately 70 MGD) to the Hyattsville Pumping Station and a secondary 48-inch (increase to 60" and 70") sewer that runs parallel to the 102-inch.

The proposed bypass plan also presents the WSSC with the opportunity to line approximately 1,800 LF of 96-inch pipe between the line stop location and structure 09012071J and an additional 580 LF of 102-inch pipe between structure 09012018J and the proposed bypass discharge structure.

Several rehabilitation alternatives were considered but slip lining and grout-in-place lining were the two finally considered for thorough evaluation because there were many challenges being able to work in the levee with other rehabilitation techniques. Evaluation of the slip lining and grout-in-

place liner alternatives was based on amount of disruption to the park, permitting requirements, siphon rehabilitation, flow capacity, estimated service life and construction cost. Based on this evaluation, both slip lining and spiral wound lining (SWL) provide long service life at approximately the same cost. However, SWL provides a complete internal pipe rehabilitation (including the siphon) with the least amount of disruption to the park and with minimal disruption to the levee. Therefore, SWL was selected.

Manhole Structure Renewal

The five manhole structures on the 102-inch pipe will be rehabilitated as part of this project. The existing concrete tops will be removed and replaced with new concrete tops lined with corrosion resistant material or constructed of corrosion resistant polymer concrete. Corrosion resistant access hatches shall be installed in each of the structures to facilitate manned entry and future investigations. The existing concrete structures will be cleaned, structurally repaired and lined with a corrosion resistant material.

Discussion

This project has major points of interest to the trenchless industry. A robotic system was deployed to inspect the sewers. Over 2,100 linear feet (LF) of 102-inch concrete pressure pipe was inspected using a multi-sensor inspection system to collect data: digital CCTV, Sonar, 3D Lidar/Laser imaging, and gas sensors. An adjustable buoy system was deployed to help center the sonar during the inspection of the siphon. Overall, approximately 7,300 LF of pipe was inspected. The defects were documented using the NASSCO-PACP rating system.

The many details associated with working in a historic waterfront park on the Anacostia River within a US ACE levee required careful coordination with several relevant agencies. Involvement of the MD National Park & Planning Commission, US Army Corps of Engineers, Maryland Department of The Environment (MDE), Department of Public Works and Transportation, Local County and town agencies along with the Bladensburg Marina were necessary to ensure success to this point and are essential for the successful completion of this project.

Additionally, internal coordination with WSSC's Production Team, which manages the nearby 70 MGD wastewater pumping station, and the WSSC Utility Management Group which manages collection system activities was essential to be able to safely perform the inspection and design the rehabilitation.

Design work is currently underway to address the pipeline and manhole rehabilita-

tion. Design of the complex bypass pumping operation necessary for this project required reviewing flow meter data, the installation of two temporary 96-inch line stops, two temporary 48-inch line stops, and the installation of a 96-inch flow control valve while minimizing impacts upon a USACE levee.

The Design stages of the 102-inch Anacostia Trunk Sewer Rehabilitation are ongoing and approximately 60-90% complete. The design, including the permit application, is scheduled to be completed in early October 2015.

ABOUT THE AUTHORS:

***Calvin D. Farr, Jr.**, P.E. is the Group Leader of the Utility Management Group for the WSSC.. He oversees the condition assessment of WSSC underground infrastructure and is heavily involved in capital improvement planning efforts, including prioritization of design & construction, enhanced maintenance efforts, enhanced inspection protocols, life-cycle cost analyses, and strategies to improve levels of service to ratepayers. Farr's condition assessment efforts drive improvement needs detailed in the WSSC Reconstruction Programs at an estimated cost of $1.6 billion over the next 6 years.*

***Glen Diaz** has served as a utility management specialist for the WSSC for the past 20 years. In his current role Glen serves as the Utility Management Group Unit Coordinator responsible for directing operation and maintenance activities of more than 5,000 miles of sanitary sewer pipelines ranging in size from 4-inches to 102-inches. On a daily basis Glen's unit oversees the inspection, flow monitoring, I/I analysis, force main condition assessment and rehabilitation recommendations needed to maintain the sanitary sewer system at a level that meets the needs of over 1.8 million customers.*

***Andrew Fitzsimons** is a Georgia Tech CE graduate with 40 plus years of Water and Sewer experience. He has spent 30 years with WSSC where he was privileged to supervise Flow Monitoring, Source Detection, SSES Studies and Analysis, Sewer Rehab, and Research & Development.*

***Aaron Z. Hughes** is Project Manager with WSSC in the Sewer Analysis Unit. Aaron has a Bachelor's degree in engineering, holds master's degrees in both Project Management and Business Administration and brings years of experience in wastewater O & M activities, SSES, FOG, SSO analysis and GIS.*

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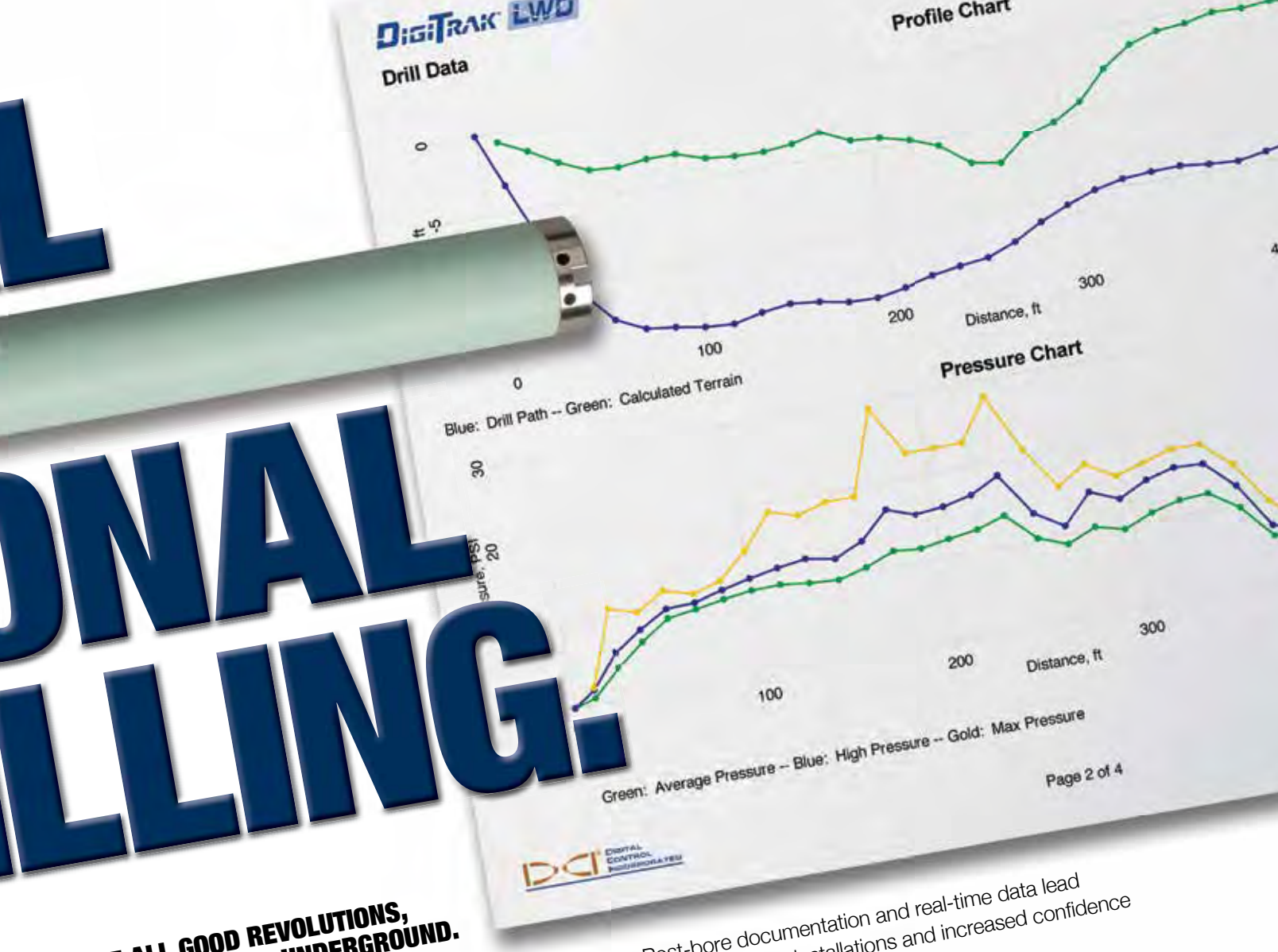

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ADVANTAGES OF MICROTUNNELING IN WET SANDS & CLAYS

Successes in the Hampton Roads VA Area

By: Doug Piper, Bradshaw Construction Corporation, Eldersburg, MD

Bradshaw Construction Corporation (Bradshaw) has recently subcontracted three microtunneling projects in the Hampton Roads area of Virginia:

1. East Princess Anne Trunk Force Main Reinforcement Project;
2. College Drive Waterline Project;
3. Hampton Roads Sanitation District (HRSD) Division C Sewerage System Improvements.

The first two projects are completed, and Bradshaw is currently mobilizing on to the third project. This article will discuss each project individually and highlight how microtunneling is becoming a valuable trenchless tool for utility owners in the Hampton Roads area, with demonstrated success in mining through difficult ground.

East Princess Anne

In the summer of 2013, Bradshaw installed 352 feet of 60-inch OD Permalok casing under the intersection of Nimmo Parkway and General Booth Boulevard in Virginia Beach VA as part of the East Princess Anne Trunk Force Main Reinforcement Project. The tunnel was mined in sandy soils (SP-SM) below the water table, at a depth of 15 feet below the existing grade. Inside of the casing, Bradshaw installed a 42-inch restrained joint DIP sanitary force main. The Project Owner was Hampton Roads Sanitation District (HRSD) and the general contractor was Branscome Incorporated.

The General Booth/Nimmo Parkway Intersection is prominent in the area. Both roads have two travel lanes in each direction and expand to accommodate additional turn lanes. The surrounding community includes residential and commercial buildings. The drive shaft was located on the southern edge of Nimmo Parkway adjacent to a residential neighborhood. The receiving shaft was situated in the grass median of Nimmo parkway on the opposite side of the intersection with General Booth Boulevard. The main challenges included the limited work space, noise restrictions,

and traffic which could be heavy at times. Fortunately, Nimmo Parkway ends in a dead end approximately one-half mile beyond the work shaft area. Traffic was lighter along the work area, and significant portions of the median were available for material staging and parking.

Bradshaw set up its microtunneling equipment linearly along the Nimmo Parkway right of way and was able to maintain enough room to allow the operation to be serviced with a rubber tired loader. The mining was performed on a 24/7 basis as specified and was completed in 4 days. The sand mined easily with the only challenge being balancing the microtunnel advance rate with the capacity of the sand screens on the separation plant without overwhelming them. In the end, the tunnel was installed on line and grade without impact to the critical highways above. The 42-inch DIP was installed on casing spacers and the annulus left unfilled as specified.

Sand coming off the shakers @ East Princess Anne

MTBM launch @ College Drive Waterline Project

College Drive

In April 2015, Bradshaw completed its second microtunnel in the Hampton Roads area, the College Drive Waterline Project. The owner was the City of Suffolk, whose waterline was connecting to an HRSD treatment plant. Once again, Branscome Incorporated was the general contractor.

For this project, 370 feet of 30-inch Permalok casing was installed under I-664 near the College Drive interchange. The line ran from the west side of the I-664 right of way, and under I-664, which has three travel lanes in each direction, to the HRSD plant just beyond the eastern right of way. The tunnel conditions were predominantly sands and clays (SC) below the water table at a depth of 18 feet below the interstate highway. Again, mining was performed on a 24/7 basis as specified.

Mining was completed in 6 days, which included some lost time due to equipment issues. Despite those interruptions, the tunnel was installed on line and grade, with no impact to I-664. Bradshaw installed the 16-inch DIP carrier pipe before moving to its next project in the area.

HRSD Division C Improvements

After the College Drive project, Bradshaw's crew relocated to Portsmouth, VA to microtunnel 110 feet of 43-inch casing under a CSX railroad spur line as part of the HRSD Division C Sewerage System Improvements project. The general contractor was Tidewater Utility Construction, Inc. (TUC). The tunnel was installed at a depth of 15 feet below grade in predominantly silty sand (SP-SM) below the water table. 24/7 mining was specified under the CSX rail road. The rail road was crossed in 1 shift, with the entire run requiring two shifts. The line was installed on line and grade with no surface settlement. Bradshaw is now preparing to install the

MTBM hole out in wet sand & clay @ College Drive Waterline

30-inch HDPE carrier pipe, which will be welded by TUC.

Advantages of Microtunneling

During the preconstruction meeting for the East Princess Anne project, the HRSD representative expressed some frustration with previous trenchless operations in their region. Apparently, the main concern was the multiple instances of surface settlement along the tunnel alignments. Bradshaw made further inquiries to HRSD and to some local engineering firms about the trenchless efforts up to that time and received some anecdotal evidence. It is likely that equipment issues have played a significant role in the poor results on some auger bore projects. Likewise, it is common knowledge that trenchless techniques such as auger boring, guided auger boring (pilot tube microtunneling), and conventional pipe jacking have trouble controlling the running to flowing ground conditions which are often encountered in this region.

Most likely, the 24/7 requirement that Bradshaw has seen on all of its projects in the area came about as a reaction to poor results from auger boring. Continuous mining offers the best hope for a successful auger bore because one is attempting to jack the casing pipe faster than the ground can run through the augers. In contrast, microtunneling machines are designed to deal with these exact conditions and are equipped with valves at the front of the machine which can be closed by the operator on the surface to completely seal off soil and water. Therefore, overnight downtime or delays for equipment maintenance and repairs generally do not result in surface settlement or any other adverse effects to the final product. In the case of microtunneling operations, owners and engineers can safely remove the continuous mining requirement.

One local design engineer offered the insight that design firms may shy away from specifying microtunneling due to their lack of familiarity with the method. Hopefully Bradshaw's recent successes mining through running to flowing sands in the HRSD region will raise awareness and spark other owners and engineers to consider microtunneling as the preferred tunneling method whenever difficult ground conditions are expected.

ABOUT THE AUTHOR:

Doug Piper *is an estimator/project manager with 20 years of experience in heavy/civil construction, including 6 years at Bradshaw. Bradshaw Construction Corporation is a tunneling contractor with over 50 years of experience covering a wide range of trenchless techniques.*

RISK OF HDD EXCAVATION: CROSS BORES

By: Dan Lucarelli, Pennsylvania One Call System, Inc.

CROSS BORE: An intersection of one underground utility or structure by a second utility resulting in a direct contact between the utilities.

A cross bore compromises the structural integrity of either the utility or the underground structure, and is created when a utility is mistakenly and unknowingly installed to pierce or pass through another utility, e.g., when a gas or electric line installed by mini-HDD, impact moling or plowing ends up passing through an existing sewer lateral.

Although HDD excavation to install underground utilities has many advantages (cost, installation time, reduced need to restore area to its original state), there are dangers. One danger is a cross bore: when an installed utility compromises the integrity of a second and existing utility within the area of excavation. The above photo depicts a sewer lateral compromised with the installation of a natural gas service line that was installed with HDD equipment and techniques. (Check this video link: https://vimeo.com/129108501)

The danger in the installation depicted may not be in the compromised sewer lateral. The sewer lateral appears as if it will still function. The real danger is not today, but tomorrow or next week or 5 years from now, when the sewer lateral eventually becomes clogged and needs to be cleaned.

The plumber who cleans this sewer lateral will typically use a rotating cutting tool snaked through the sewer lateral, to cut or grind through the blockage. The cutting tool can easily cut through a plastic gas line compromising its integrity, causing the escape of natural gas. Because natural gas is lighter than air, it will migrate upwards, or back into the house. The accumulation of natural gas in the house can be catastrophic when it finds an ignition point, such as a water heater pilot light or a light switch.

Prevention

Prevention of a cross bore during the installation of new underground facilities via HDD technologies is critical, and mostly involves common sense planning, observation and practices.

1. **Call 811 in advance of your excavation.** State and federal laws obligate excavators to notify underground utility companies of their intent to excavate. The national 8-1-1 three digit number is reserved for this use. Laws vary, but in general excavators are obligated to place an excavation notification 48 hours (Washington DC), two days (West Virginia), two business days (Delaware, Maryland, Virginia) or three business days (Pennsylvania and New Jersey) in advance of the start of work.

2. **Identify every facility near or across the proposed excavation path.** With the work site marked, every utility and service lateral must be identified and accounted for. HDD excavation does not follow an exact planned path, and it is critical to know what's below, above,

around and across the proposed excavation path in the event the cutter head deviates from plan. Facility owners are a resource during the identification process – helping an excavator avoid damage is always safer and less expensive than repairing a damaged facility.

3. **Expose every facility near or across the proposed excavation path.** Vacuum excavation and hand digging (potholing) are used to expose every facility that may cross or is near the proposed excavation path. Without exposing the facility, the excavator will not be able to visually confirm that the new installed facility does not compromise an existing facility in the ground. Some facility owners may insist on having a representative onsite during the planning and excavation, to ensure their facilities are not damaged and that backfilling occurs according to their specifications.

4. **Adjust the plan as necessary.** The path or depth may need to be adjusted based on the location and depth of existing facilities

within the planned excavation path. Some facility owners may have clearance minimums between their facility and anything installed in the right of way near their facilities. When in doubt, a telephone call or face-to-face meeting with the facility owner is prudent.

5. **Use a spotter.** When the actual excavation takes place, a spotter should be used when the cutting head is anywhere near an existing facility. Visually check the drill head as it passes through potholes, entrances and exit pits.. The spotter should be empowered to halt the excavation at any time.

6. **Inspect existing underground facilities.** After excavation is complete and the new facility is installed, inspect the existing facilities before backfilling. If any facilities have been damaged (such as a nick, or a hole, or a crack, or a cross bore), the appropriate facility owner must be contacted for inspection and repair before backfilling is completed.

Resources

There are a variety of resources available to assist excavators in learning how to safely use HDD excavation equipment in the installation of new underground facilities:

HDD Consortium, "Horizontal Directional Drilling Good Practices Guidelines", ISBN 1-928984-13-4. This guide covers all aspects of Horizontal Directional Drilling, and is incorporated by reference in the PA One Call law. The third edition is available at https://www.nastt.org/products/13.

"Guidelines for Use of Mini-Horizontal Directional Drilling for Placement of High Density Polyethylene Pipe", Dr. Larry Slavin, The Plastics Pipe Institute. https://plasticpipe.org/pdf/tr-46-hdd-guidelines.pdf.

The **Mid Atlantic Society for Trenchless Technology (MASTT)** conducts seminars on trenchless technology. For a list of seminar locations, dates and cost, please see http://www.mastt.org.

ABOUT THE AUTHOR:

***Dan Lucarelli** is the Director – Marketing and Education for Pennsylvania One Call System, Inc. He can be reached at djlucarelli@pa1call.org.*

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CULVERT REHAB

Using Aluminum Tunnel Liner Plate, Clarks Summit PA

By: Hugh B. Mickel, P.E.,
Contech Engineered Solutions LLC

A time proven structural design method utilizing 2-flange tunnel liner plate provided a fully restored triple barrel culvert

Engineers in the Douglassville, PA office of STV Inc., noticed a potential issue in inspection videos that looked like the pipe structures running under a Pennsylvania DOT (PennDOT) arterial highway could have major corrosion and structural issues. The overall project consists of nearly 8 miles of four-lane divided arterial roadway of SR 6 (US6/US11) constructed in the early 1950's.The triple barrel culvert carries Ackerly Creek under SR 6 and immediately empties into Glenburn Pond.

During a lunchtime continuing education seminar hosted by STV and conducted by several engineers from Contech Engineered Solutions on January 31, 2012, it became evident that Contech could provide valuable assistance with evaluating the condition of the structures. At the forefront of the invention of the steel structural plate culvert pipe systems, Contech has extensive experience with corrosion of culverts and storm sewers as well. After the seminar, a video from a recent inspection was reviewed. Although grainy, it gave a reasonable depiction of the overall geometric shape and the general condition of the existing structure from a corrosion standpoint. It was evident to Contech that the structures were galvanized steel structural plate with a 6" by 2" corrugation and had been field coated with a bituminous coating at the time of installation. This was a common practice at the time these structures were designed and built. What wasn't clear was the extent of the corrosion at the normal pool water line, a location roughly three feet up from the invert on both sides of each structure.

Once at the site, all three structures were walked. They had 1' to [3]' of sediment in them. The water depth and sediment prevented full inspection of the invert but given the apparent age of the sediment, it was presumed that the part of the structures that were buried were probably in better condition than the visible portions. Unfortunately the fuzzy jagged line seen in the video was a full depth corrosion failure along the entire length of two out of three pipes. Just one rain event could bring down these pipes.

The construction duration for any of the replacement alternatives would lead to including the pipe project in the main project, delaying the solution. Contech was very concerned that any construction activity and removing half of the length of the pipe would cause the pipes to collapse. Constructing a bridge over the pipes would be better but would also require excavation and probably pile driving due to very poor foundation soils.

STV realized the benefits and recommended the aluminum pipe lining alternative from the beginning. It provides in excess of 100 years of service life using PennDOT's linear metal loss rate for aluminum pipe of 0.001 mils per year. This particular grade of aluminum has been used in culvert pipe and small bridge applications since Kaiser Aluminum introduced it to the U.S. transportation market in the mid 1960's. A zinc-rich primer was applied to the exterior of the plates at the point of manufacture – Contech's plant in Winchester, KY. The primer prevents consumption of any aluminum during the hydration phase of the grout curing process. Another positive feature with tunnel liner plate is it can be custom manufactured to the diameter that was required to maximize the hydraulic opening while also providing adequate space between the old pipe and the liner for constructability.

The structural design method used a time proven approach that has been included in the AASHTO Standard Specification for

Highway Bridges for many decades. The only deviation was the incorporation of the physical properties of the aluminum tunnel liner plate section selected. Contech provided a structural design which STV then reviewed and accepted.

Initially the Pennsylvania DOT decided to initiate an emergency process to get the structures fixed immediately. Ultimately they ran the project as a separate rush project following permit, right-of-way and bidding protocol in June 2013. The low bidder was Fabcor Incorporated of Jessup, PA, a qualified and experienced bridge builder in northeastern Pennsylvania. They had participated in a voluntary pre-bid webinar conducted by Contech that walked through a number of construction related challenges that could be anticipated on this project.

Aside from the service life advantages offered by the aluminum tunnel liner plate, it is very easy to work with from a construction standpoint. The heaviest plate only weighed 33 pounds which made sub assembly of some portions easy. Subassembly of half pipe sections of plates occurred at the ends where transporting the segments into place was easily done. It also made movement of pre-bundled plates to the point of assembly inside the host pipes easy.

Fabcor Inc. completed the installation in August 2014, paving the way for a $46 million overhaul of the 7.8-mile stretch along Route 6 between Clarks Summit and Wyoming County.

Lining the existing host pipe with tunnel liner plate provided the ability to build a safe working environment inside an unstable structure

Two of the three original culverts had full depth corrosion along the entire length

ABOUT THE AUTHOR:

***Hugh Mickel** is the Vice President of Reline Technologies for Contech Engineered Solutions and has been with the company for 30-years with 19-years of direct experience relining pipes, culverts and small bridges. Hugh holds a B.S. in Civil Engineering from Purdue University and has been a registered Professional Engineer since 1990.*

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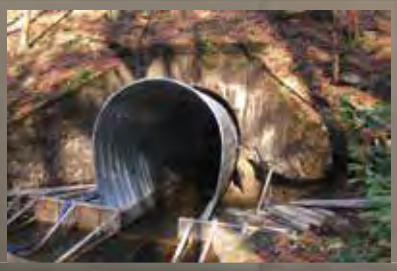

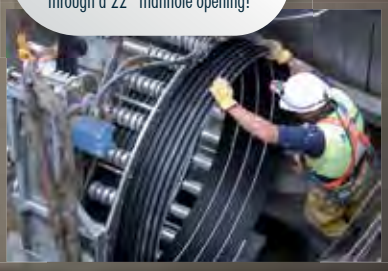

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TRENCHLESS TECHNOLOGY CENTER (TTC) DEVELOPMENT UPDATE

By: Saleh Behbahani, Trenchless Technology Center

The Trenchless Technology Center (TTC) at Louisiana Tech University was established by Dr. Tom Iseley in 1989. It was created to promote research, development and technology transfer in the trenchless technology industry. The TTC is a cooperative research hub for academia, government and industry, and has world-class research and testing facilities at the National Trenchless Technology Research Facility (NTTRF) in South Campus at Louisiana Tech.

National Trenchless Technology Research Facility

After a hiatus of almost 20 years, Dr. Iseley has re-joined the TTC as Director. "I am incredibly excited to be returning to the Trenchless Technology Center (TTC) after nearly 20 years" Dr. Iseley said.

In addition to its research activities, strong effort has been made by the TTC towards the education of engineers, contractors, government agencies and others about the availability and capability of trenchless methods for the solution of difficult underground infrastructure problems.

One example of a TTC program is the Certification of Training in Asset Management (CTAM). CTAM is an online educational series for obtaining certification of training in the management of underground asset

Soil box, small (with air pressure cover)

infrastructure, developed by the Buried Asset Management Institute – International (BAMI-I). In 2003, during the time Dr. Iseley was not at TTC, he was instrumental in establishing the Buried Asset Management Institute - International (BAMI-I).

With Dr. Iseley's return, TTC and BAMI-I continue working on the delivery of the CTAM program, which is comprised of four online courses. The first two levels - CTAM 100 (Overview of Asset Management) and CTAM 200 (Developing an Asset Management Program) - have already been completed. The remaining two levels - CTAM 300 (Managing an Asset Management Program) and CTAM 400 (Financing an Asset Management Program) will be available July 2015. These courses have been developed by and for professionals in the industry interested in achieving water utility infrastructure management excellence. To date, the CTAM program has been very successful with students from 14 countries.

After focusing for many years on the water and wastewater sector, TTC is now expanding into the oil and gas industry. TTC currently has a major contract involving a gas utility in China. This contract is between TTC and the University of Geosciences (CUG) in Wuhan, China.

Also, TTC is developing the Auger Boring & Pipe Jacking (AB&PJ) School for educating engineers, contractors, project superintendents and managers, foremen, and public utility personnel. This School is a four and a half day program and sessions include hands-on courses involving classroom, laboratory, and field experience. The first school program will be in the second week of October, 2015 at the TTC research facility in Ruston, Louisiana. The sessions are comprised of: Project Planning, Soils and Drilling Fluids, The Construction Process, Large Diameter Boring Attachment (LDBA), and Completing the Project. On the final day a banquet and graduation ceremony will be held at NTTRF.

Adjacent field test site in NTTRF

Committee members responsible for developing the AB&PJ School program are: Leo Barbera (Horizontal Holes), Vic Weston (Tri-State Road Boring), Dan Liotti (Midwest Mole, Inc), Frank Canon (Baroid Industrial Drilling Products), Dan Heath and Mike Varone (American Augers, Inc.), Maynard Akkerman, (Akkerman), Rick Barbera (Tri-State Trenchless), and Robert Carpenter (Underground Construction magazine).

For more information about the TTC and its programs please visit the website: http://ttc.latech.edu.

BAMI-I "Asset Management Training for Water Infrastructure", Certification of Training in Asset Management (CTAM) Courses 100 – 400, August 17 - 20, Raleigh NC

ABOUT DR. TOM ISELEY

Tom Iseley, Ph.D., P.E.
Professor of Civil Engineering
Director of the Trenchless Technology Center,
Louisiana Tech University,
Ruston, LA & Chairman,
Buried Asset Management Institute-International, Inc.

Dr. Tom Iseley has over 35 years of experience in the planning, design, and construction of underground infrastructure systems. From 1982 until 1995, he served on the faculty of Mississippi State University, Purdue University, Louisiana Tech University, and as chairman of the department of Construction Technology at the Purdue University School of Engineering and Technology in Indianapolis.

In 1989, Dr. Iseley established the Trenchless Technology Center (TTC), an industry/university cooperative research facility, at Louisiana Tech University and served as director for 5.5 years and director of development for 2 years. He returned to Louisiana Tech & TTC on July 1, 2014.

He is a founding director of the North American Society for Trenchless Technology (NASTT). Also, in 1993, Dr. Iseley was selected as the Trenchless Technology Magazine's Person of the Year. He received the ASCE 1995 John O. Bickel Award and the 1999 Stephen D. Bechtel Pipeline Engineering Award.

Dr. Iseley holds a B.S. degree in Civil Engineering and an M.B.A. degree from the University of Alabama in Birmingham and a Ph.D. degree in Civil Engineering from Purdue University.

electro scan inc.

SMALL AGENCY, BIG AMBITION

Pennsylvania Township Chooses New Condition Assessment Technology to Tackle I&I

The Electro Scan ES 620 Probe, integrated into a standard CUES CCTV truck, gets prepped for the day's activities

By: Mark Grabowski, Electro Scan, Inc.
and Sharon Purnell, Hamilton Township Municipal Authority (HTMA)

As the rain comes down the flows would go up. Most sewer agency directors panic when a large storm approaches, particularly if the system is older. While it remains important for all sewer agencies to spend their rehabilitation money wisely, it is considerably more vital for small agencies with limited budgets. Hamilton Township Municipal Authority (HTMA) Chambersburg, PA has less than 75 miles of sanitary sewer pipe, a very lean budget, and a need to reduce Inflow and Infiltration (I&I).

Too often I&I problems continue until it is it too late – events such as sanitary sewer overflows (SSOs), treatment bypasses, environmental damage, and poor public opinion can often culminate in fines and heavy orders from regulatory agencies. HTMA did not want to wait around until it was too late and began taking proactive steps towards finding and fixing their infiltration issues. But the question remained on the best approach to start locating the I&I problems.

Previously, HTMA conducted manhole inspections, smoke testing, and utilized CCTV for inspection. During heavy wet weather events the crews would undertake night isolations to identify locations of high infiltration. Each rain event would yield varying results depending upon the intensity of the rain and water table conditions. Once an issue was located, in-house crews would repair what they could find using acrylamide grout, trenchless point repairs, and dig-and-replace techniques. However, despite these efforts, wet weather flow levels were only reduced slightly. Changes to capacity allocation requirements as a result of a sewer plant expansion added urgency to the effort to tackle excess flows due to I&I.

Therefore, at the request of HTMA, Electro Scan, Inc. undertook a single-day project in May 2014 deploying its ES-620 System using a low voltage locating method to evaluate two different small interceptor pipe runs that had never been assessed due to high flows. In less than six hours, Electro Scan was able to investigate 2,000 feet of pipe for I&I. The findings from this one-day investigation surprised many, altered the I&I investigation and rehabilitation focus areas, and ultimately saved the HTMA tens of thousands of dollars. HTMA now operates its own Electro Scan ES-620 system as part of its routine condition assessment procedures.

Background – Treatment Plant Upgrade

Serving approximately 4,025 customers, the HTMA sewer system is a collection and conveyance system comprised of 14 pumping stations, 3 meter stations, approximately 70 miles of sewer line, and 1,215 manholes. Through partnership in an Inter-municipal Agreement between the Borough of Chambersburg, HTMA, and other local agencies, sewage collected by HTMA is transported to the Borough of Chambersburg Wastewater Treatment Plant (WWTP). Under the existing Agreement, present HTMA capacity allocation at the WWTP is 760,000 gallons per day (GPD).

In 2009 HTMA established and adopted an I&I Sewer System Management Plan. Since then HTMA developed a comprehensive and robust metering plan to analyze how the sewer system reacts to various wet weather events, prioritizing areas for I&I investigation. Under this plan, HTMA has made progress in I&I remediation over the past two years, as shown by a reduction in average daily flows of approximately 132,000 GPD. In 2009 and 2011, HTMA reached its capacity allocation limit with ADF of 762,750 GPD and 757,547 GPD, yet by 2013 ADF was reduced to 628,118 GPD.

Even with this progress, HTMA is challenged to further reduce I&I because the WWTP is currently undergoing an upgrade and expansion, in response to the Chesapeake Bay Strategy, and for future growth. Overall capacity at the WWTP will increase from 6.8 million gallons per day (MGD) to 11.28 MGD with maximum peak flow of 33.5 MGD. The HTMA capacity allocation share will increase to 2.0 MGD under a new 2010 Inter-municipal Agreement, effective when the upgraded plant is fully operational. However, under this new Agreement there are penalties for monthly average flows exceeding 90% of allocated capacity.

Despite this increase in capacity allocation, the HTMA is faced with the ongoing challenge of removing I&I because during significant heavy wet weather events the daily flow still exceeds 3.0 MGD, which will trigger penalties. Moving forwards, the HTMA believes it can lower its ADF and wet weather flows with a comprehensive condition assessment approach which includes Electro Scan equipment.

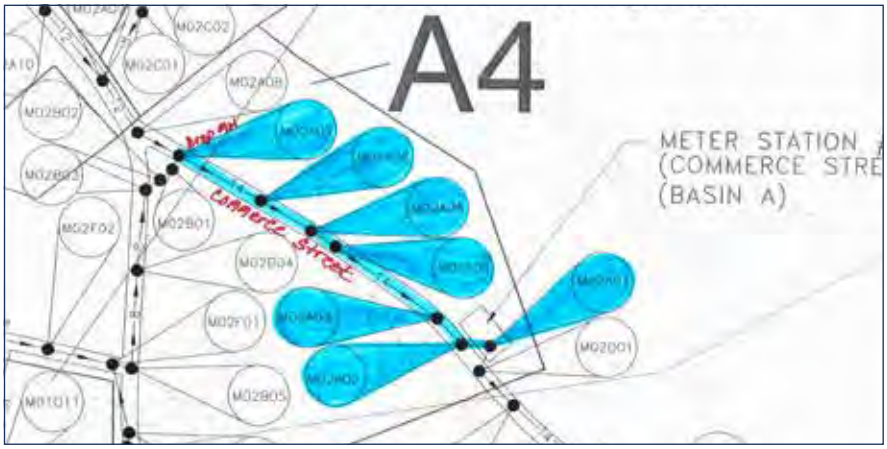

Figure 1. Map showing the pipe segments inspected on Commerce Street

Figure 2. Map showing the pipe segments inspected on Fern Lane

One-Day Investigation

Work began the morning of May 21, 2014. The sewer system pipe is ~70% PVC and ~30%Asbestos Cement (AC), between 30 to 40 years old. The first section of pipe examined was a 14" AC interceptor on Commerce Street installed in 1977 (Figure 1), and the second section a 10" PVC interceptor on Fern Lane, adjacent to a small creek (Figure 2).

The Commerce Street flow sources are from 4 pumping stations and gravity flows from 4 different developments. The AFD is approximately 248,000 GPD with an average hourly flow of 14,500 gallons. Extreme wet weather events have yielded as much as 1.2 MGD with peak hourly flows of 83,650 gallons. Manholes upstream of this section show significant hydrogen sulfide deterioration. This area is known for flooding with the road usually closed to traffic during heavy wet weather events. Due to constant flows, together with the location and size of pipe, the HTMA has been unable to assess this section of pipe via CCTV. This section of pipe has never been repaired.

The second section of pipe on Fern Lane is comprised of four pipe segments located within the flood plain of a creek. Data from

the pump station and creek level observations indicate that flow rates and pump run times increase in tandem with adjacent creek levels. During extreme wet weather conditions the pump station cannot keep up with the incoming flow and is pumping more than 60,000gallons per hour with metering data recording flows of nearly 1.1 MGD. Again, due to constant flows, the HTMA has not assessed this pipe via CCTV, and it has likewise never been repaired.

Since the technology does not require an empty or clean pipe to perform the inspection, work was able to begin immediately on Commerce Street, even though the 14 inch diameter sewer was flowing about half full. All pipe segments were scanned using Electro Scan's ES-620 system which was integrated into a standard CUES Industries CCTV truck. From the upstream manhole, the probe was moved through the pipe downstream using a Vactor Jet Truck. The Jet Truck also provided water to the probe to allow it to complete its examinations of the pipe wall via focused electrical current. A proprietary 14" Sliding Funnel Plug kept the water in place, allowing for very limited water waste by re-using the same water for multiple pipe segments. Figure 3 shows an example of the process.

With the Electro Scan process, HTMA was able to complete the condition assessment on the first section of pipe within several hours because, unlike CCTV inspections, there was no need to bypass pump, thoroughly clean, set up and maintain traffic control for multiple days on site - Commerce Street carries a significant amount of traffic, so the HTMA cannot close it for long periods. In fact, the Commerce Street pipes were scanned in around four hours – roughly the same time it would take to set up bypass pumping. That same afternoon, the operation was mobilized on Fern Lane to inspect the 10" PVC interceptor thought to have high levels of infiltration. This 905 lf of pipe in 4 segments was scanned in under 1-1/2 hours. Figure 4 shows the creek adjacent to the pipe that was being scanned.

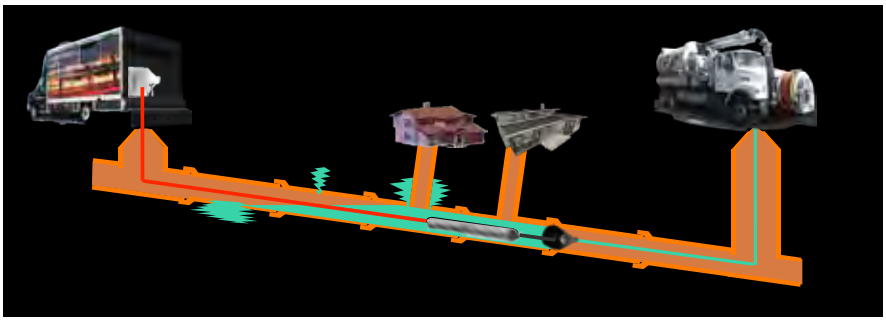

Figure 3: Simulation of Electro Scan process

Figure 4: Scanning the PVC pipes adjacent to the creek, which was suspected to be the cause of the pipe infiltration.

Results – Commerce Street

Immediately after commencing scanning, large defects were detected within the first pipe segment, and it appeared at first the entire 1,000+ LF of pipe was defective, as had been thought. However, after the first 60 feet, the defects subsided occurring only occasionally, mostly at joints, with low estimated infiltration rates.

- Electro Scan identified **51** locations of potential infiltration (defects) throughout the lengths of the pipes scanned (1,080 feet), for an average of 13 defects per pipe.
- Total estimated leakage of the pipes inspected in this section represents 23 gallons per minute, or **almost 33,120 GPD**, ±40% accuracy, assuming a 1 foot head.
- Average estimated flow through each defect is 0.44 gallons per minute (635 GPD), occurring approximately a little over every 21 feet.

Surprisingly, though it was initially suspected as a significant contributor of infiltration to the system, the Commerce Street section of pipe was shown by the Electro Scan method of low-voltage leak locating to be of minimal concern. Almost 70% of potential infiltration points in this entire section were identified as occurring within the first 60 feet of one pipe segment (2A07 to 2A06). Due to higher flows in these pipes, stagnant H2S gas did not appear to be a problem - the walls of this section of AC pipe were not as porous as typically seen in results from other AC collection sewers.

The HTMA is currently working to determine the best method for repair, and subsequently schedule repair/rehabilitation for this first 60 foot section of defective pipe under Commerce Street. The defects found in the individual segments of sewer are summarized in Table 1:

TABLE 1. COMMERCE STREET DATA SUMMARY

			NUMBER OF DEFECT COUNTS				TOTAL GPM			
MANHOLE FROM	MANHOLE TO	DISTANCE (FT)	SMALL	MEDIUM	LARGE	TOTAL	MINOR	MODERATE	LARGE	TOTAL
2A07	2A06	280	12	1	9	22	5.84	10.09	0.00	15.93
2A06	2A05	305	13	0	0	13	2.89	0.00	0.00	2.89
2A04	2A03	395	10	0	1	11	2.25	0.00	0.00	2.25
2A05	2A04	100	4	0	1	5	1.44	0.00	0.00	1.44
						TOTAL GROUP DEFECT FLOW (GPM):				22.51

Results – Fern Lane

As mentioned, whenever the creek adjacent to Fern Lane flooded, the lift station nearby saw significant increases that corresponded almost directly with the rise in creek levels. This section, although initially suspected as a significant contributor of infiltration, was shown by Electro Scan as actually in good shape overall with low levels of potential infiltration (see Table 2 below).

- Electro Scan identified only 10 locations of potential infiltration (defects) throughout the lengths of the pipes scanned (905 feet), for an average of less than 3 defects per pipe.
- Total estimated leakage of the pipes inspected in this section represents only about 4 gallons per minute, or approximately 5,700 GPD, ±40% accuracy, assuming a 1 foot head.
- Average estimated flow through each defect is 0.4 gallons per minute (570 GPD).

With only one pipe segment (P04A04 to P04A03) showing any sign of defects, this section was placed low on the rehabilitation priority list. In future, spot repair methods will probably suffice. HTMA will continue to monitor this section utilizing Electro Scan equipment.

Cost Analysis

Cost analysis based on the one day investigation present a compelling case for the use of Electro Scan equipment. Tables 3 and 4 present comparisons of the approximate CCTV inspection cost versus the Electro Scan method for Commerce Street and Fern Lane. Electro Scan provided quantitative data to the HTMA identifying and locating the major defects in these two sections of pipe at 1/3 the estimated cost of CCTV.

Even if the costs were equal, it is unlikely CCTV would find all the defects contributing to infiltration, due to the limitations of visual observation. The quantity of potential infiltration found by Electro Scan demonstrates how this method can objectively locate and measure defects. This helps make better inspection and rehabilitation decisions while minimizing consulting engineering costs. Before the one-day investigation both Commerce Street and Fern Lane were thought to be high sources of infiltration. The Electro Scan investigation revealed otherwise, resulting in cost savings and a more effective and focused condition assessment approach.

TABLE 3. COMMERCE STREET ELECTRO SCAN VS. CCTV COST ANALYSIS (APPROXIMATE)

CCTV

OPERATION	COST ($)	PER	UNIT	TOTAL
Mobilization	$1,000.00	1	ea	$1,000.00
Traffic Control	$85.00	10	hour	$850.00
Bypass Pumping	$800.00	10	hour	$8,000.00
Cleaning	$1.00	905	feet	$905.00
Televising	$2.00	905	feet	$1,810.00
		TOTAL COST		$12,565.00

ELECTRO SCAN

OPERATION	COST ($)	PER	UNIT	TOTAL
Mobilization	$1,000.00	1	ea	$1,000.00
Traffic Control	$85.00	4	hour*	$340.00*
Bypass Pumping	N/A		setups	N/A
Cleaning	N/A		feet	N/A
Televising	$3.00	1080	feet	$3,240.00
		TOTAL COST		$4,580.00

TABLE 4. FERN LANE ELECTRO SCAN VS. CCTV COST ANALYSIS (APPROXIMATE)

CCTV

OPERATION	COST ($)	PER	UNIT	TOTAL
Mobilization	$1,000.00	1	ea	$1,000.00
Bypass Pumping	$800.00	10	hour	$8,000.00
Cleaning	$1.00	905	feet	$905.00
Televising	$2.00	905	feet	$1,810.00
		TOTAL COST		$11,715.00

ELECTRO SCAN

OPERATION	COST ($)	PER	UNIT	TOTAL
Mobilization	$1,000.00	1	ea	$1,000.00
Bypass Pumping	N/A		setups	N/A
Cleaning	N/A		feet	N/A
Scanning	$3.00	905	feet	$2,715.00
		TOTAL COST		$3,715.00

TABLE 2. FERN LANE DATA SUMMARY

				NUMBER OF DEFECT COUNTS				TOTAL GPM			
	MANHOLE FROM	MANHOLE TO	DISTANCE (FT)	SMALL	MEDIUM	LARGE	TOTAL	MINOR	MODERATE	LARGE	TOTAL
7	P04A04	P04A03	285	1	4	1	6	2.37	0.00	0.00	2.37
10	P04A07	P04A04	265	1	0	1	2	0.09	1.20	0.00	1.29
11	P04A02	P04A01	290	2	0	0	2	0.29	0.00	0.00	0.29
12	P04A03	P04A02	65	0	0	0	0	0.00	0.00	0.00	0.00
							TOTAL GROUP DEFECT FLOW (GPM):				3.95

Ongoing Investigations

With these results, HTMA decided to invest in both an ES-620 Electro Scan system, which would integrate into their UEMSI CCTV system, and an ES-38 system for lateral investigations. Over the 3 months HTMA has been using this equipment it has discovered several situations causing it to revisit prior rehabilitation decisions. One section of pipe previously spot repaired after CCTV inspection was found to be in poor condition and in need of rehabilitation.

HTMA believes its use of Electro Scan equipment allows it to make more informed decisions regarding buried assets, both

Pete Dannenberg of Electro Scan monitors the Electro Scan ES 620 probe as it is deployed through a manhole located in a low-lying wetland adjacent to Fern Creek

structurally and financially. It can now essentially recreate its own wet weather events and incorporate this low-voltage leak locating technology into weekly routines. This technology enables HTMA to more effectively prioritize rehabilitation efforts and create a more targeted CCTV inspection program, assisting the HTMA in planning and implementing a long term, progressive rehabilitation program.

Being proactive rather than reactive regarding I&I reduction benefits both the community and HTMA long term, sustaining the integrity of the sewer system for years to come. Both cost and time effective, Electro Scan technology helps paint a more complete condition assessment picture for smaller local agencies like HTMA.

(Condensed from paper MA-T1-01 presented at NASTT No-Dig Conference 2015 Denver, Colorado)

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NEW VACUUM EXCAVATION TECHNOLOGY REVOLUTIONIZES SUBSURFACE UTILITY LOCATING

By: Frank Russo, Tellus Underground Technology

Revolutionary technological changes are rarely the result of the invention of a new device but rather arise from the condensation of a number of novel improvements to an established product or process that revolutionizes the way things are done. For example, the transition from "mainframe" computers to "personal" computers began in the 1980's when personal computers started to become more powerful and could be purchased for a fraction of the cost of a mainframe machine. This improvement in technology made it practical for anyone with a basic data processing need to take advantage of this revolutionary technological change. It no longer made economic sense to use a big mainframe computer when a smaller personal computer had more than enough capability to perform the job.

Similarly, the application of advanced technology combined with a number of innovative improvements has revolutionized the way subsurface utility locating can be performed with the development of new specialized vacuum excavation systems.

TELLUS
UNDERGROUND TECHNOLOGY, INC.

Subsurface Utility Engineering (SUE):

The development of ASCE guidelines for "Subsurface Utility Engineering" (SUE) established the need for equipment designed specifically for the excavation of numerous 6" to 12" diameter holes to "daylight" underground utilities. Vacuum

"...A FRACTION OF THE COST OF TRADITIONAL VACUUM TRUCKS..."

truck manufacturers offered existing equipment that had the ability to excavate quickly in any type of soil conditions using high-pressure water jets, but SUE providers discovered they were unable to restore the excavation with the excavated spoils. They also learned most of this equipment was large and expensive to purchase and operate. Alternately, SUE providers could use dry excavating systems, which increased the time required to expose the underground utilities in certain soil conditions, but provided the advantage of reusing the excavated spoils to restore every excavation.

While both system designs gave SUE providers capability to satisfy basic potholing needs, until recently there was little interest in development of vacuum excavation systems to meet these specialized needs. Because they did not purchase enough equipment, SUE providers had limited influence on the design specifications of these systems.

Requirements for Potholing & Subsurface Utility Engineering:

In exploring the possibility of developing a vacuum excavation system which addressed the specialized needs of the SUE process, a product design group recently put together a "wish list" of features that would give excavating crews the ability to do their job effectively regardless of work site conditions. Following are their requirements:

1. System has the ability to excavate down to the utility quickly using either the hydro-vac method or the dry compressed air method, as required by soil conditions.

Vacuum excavation rig at work with lighter, more versatile, configuration

2. Large spoils tanks are unnecessary on vacuum trucks designed specifically to support SUE locating.

3. System has a filtration system which does not restrict vacuum flow as the day progresses.

4. Operators are more productive when systems are equipped with a filtration system that never requires cleaning.

5. The truck on which the system is mounted is as light as possible to reduce the purchase and operating cost of the vehicle.

6. The truck used to mount the system has 4-wheel drive capability.

7. Initial cost of the vacuum excavation system is as low as possible.

8. Fuel consumption for the vacuum system is as low as possible.

Development of Revolutionary Filtration Technology:

The design group found its most formidable challenge in the items related to the filtration system. Filters that could process wet soil would clog quickly when dry soil was introduced and filters designed for dry soil would fail with the introduction of wet soil. This requirement was further complicated by the need for filters that never required cleaning. An extensive search found nothing on the market meeting these requirements, so a purpose-built filtration system for SUE was designed and manufactured.

Vacuum Excavation System for Subsurface Utility Engineering:

With the new specialized filtration system in place, the size of the spoils tank and chassis could now be tackled. SUE excavations that typically contained less than 4 cubic feet of soil meant the spoils tank could be a fraction of the size used in traditional systems. This smaller spoils tank also dramatically reduced the payload capacity of the truck specified to support the entire system.

When this smaller spoils tank was matched up with the light-weight materials used in the fabrication of the bed and tool boxes, a complete system could be assembled at substantially less weight. Low cost trucks rated at 19,500 lbs. could now be utilized to support these fully functional vacuum systems, and had the additional benefit of having 4-wheel drive capability.

These redesigned systems meeting SUE requirements can now be delivered at a fraction of the cost of traditional vacuum trucks and will operate at fuel consumption rates that are far less than the fuel costs of conventional equipment. Just as with the computer revolution in the 1980s', innovation and technological advancements have combined to deliver revolutionary changes in vacuum excavation systems which provide superior SUE locating capability at dramatically reduced cost!

ABOUT THE AUTHOR:

Frank Russo *is the founder and CEO of Tellus Underground Technologies. Russo and his team have been involved in the development and production of advanced equipment and operating methods for the underground utility locating and gas distribution industries for more than 25 years. He can be reached at frusso@tellusunderground.com*

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