SOUTH CENTRAL CHAPTER

TEXAS & OKLAHOMA

TRENCHLESS REPORT 2022

OFFICIAL PUBLICATION OF THE NASTT SOUTH CENTRAL CHAPTER (NASTT-SC)

2022

Trinity River Main Stem Project

Water Main Pipe Bursting

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NASTT NO-DIG SHOW 2023

Call for Abstracts

Submission Deadline: June 30, 2022

The North American Society for Trenchless Technology (NASTT) is now accepting abstracts for its 2023 No-Dig Show in Portland OR at the Oregon Convention Center April 30 - May 4, 2023. Prospective authors are invited to submit a 250-word abstract outlining the scope of their paper and the principal points of benefit to the trenchless industry. The abstracts must be submitted electronically at NASTT's website by June 30, 2022: nastt.org/no-dig-show.

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

Potable Water and Pressure Systems

- Pipeline Inspection, Locating, and Condition Assessment
- Pipe Rehabilitation
- Pipe Bursting
- Emerging Technologies
- Case Studies

Wastewater, Storm water and Non-pressure Systems

- Advanced Pipeline Condition Assessment
- I&I and Leak Detection
- Pipeline and Laterals Rehabilitation
- Pipeline Inspection, Locating, and Condition Assessment
- Cured-in-Place Pipe Lining
- Sliplining
- Pipe Bursting
- Spray Applied Linings
- Grouting
- Manhole Rehabilitation
- Case Studies

Energy Pipeline Systems

- Pipeline Inspection, Locating, and Condition Assessment
- Aging System Rehabilitation
- New Trenchless Installation
- Standards and Regulations

Trenchless Research and Development

- University and Industry Initiatives
- Education and Training

Industry Issues

- Subsurface Utility Engineering
- Submittal Requirements and Quality Assurance/Quality Control
- Project Budgeting and Prioritization
- Funding for "Green" Technologies
- Selection Criteria for Contractors
- Social Costs and Impacts
- Carbon Footprint Reduction
- Sustainable Construction Practices
- Industry Trends, Issues and Concerns
- Differing Site Condition Claims

New Installations – Tunneling, Boring and Pipe Ramming

- New Concepts or Trenchless Equipment, Materials and Methods
- New Applications for Boring Techniques (Auger Boring and Pipe Ramming)
- Pilot Tube Boring (Tunneling)
- Case Studies

Horizontal Directional Drilling (HDD)

- New Concepts and Applications for Horizontal Directional Drilling Equipment, Materials and Methods
- Case Studies

Microtunneling

- New Concepts and Applications for Microtunneling Equipment, Materials and Methods
- Case Studies

Questions?

Please contact:
Michelle Hill
NASTT Program Director
E: mhill@astt.org
P: 888-388-2554

For more

information visit
nodigshow.com

The No-Dig Show is owned by the North American Society for Trenchless Technology (NASTT), a not-for-profit educational and technical society established in 1990 to promote trenchless technology for the public benefit. For more information about NASTT, visit our website at nastt.org.

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MESSAGE FROM THE NASTT SOUTH CENTRAL CHAIR

Justin Taylor, NASTT South Central Chair

Welcome to the 5th publication of the ***Texas and Oklahoma Trenchless Report***. Established in 2017, the South-Central Chapter of the North American Society for Trenchless Technology (NASTT) is proud to present this journal documenting trenchless projects and technology which are the result of the growth and impressive level of support from professionals within our industry.

The South-Central regional chapter of NASTT represents Texas and Oklahoma, two states comprising a geographic area experiencing significant growth in population. As the population grows, so does the need to expand, upgrade and replace existing infrastructure. Now more than ever, the benefits of trenchless technologies are critical to addressing our infrastructure challenges. The ***Texas and Oklahoma Trenchless Report*** is focused on providing a better understanding of trenchless methods and best practices on a regional level.

The South-Central chapter was formed in January of 2016, and has since hosted five chapter events, including in 2016, 2017, and 2019 at The University of Texas at Arlington, and at Oklahoma State University in 2018. After taking a break in 2020 due to Covid-19, we followed up in 2021 with a conference in Sugar Land, Texas for the first time, and despite a tropical storm's best efforts to stop us, the conference was a hit. We are looking forward to being back at UT Arlington again in 2022 for our annual conference in May. These events are averaging roughly 150 attendees and include utility owners, engineering firms, municipalities, and contractors. At these events, attendees learn about the trenchless projects that are taking place in their local areas as well as the new technologies that may be able to assist them in their projects, and enjoy the professional networking opportunities to learn from their peers.

> *"The South Central Chapter is excited to continue to support eligible students and members through scholarships, education, and future employment within our industry."*

The South-Central Chapter is committed to supporting education through scholarships for our members. A total of 10 student scholarships at $1000 each will be awarded at the 6th Annual Chapter Conference on May 24th in Arlington, Texas for the 2022-2023 school year. The South Central Chapter is excited to continue to support eligible students and members through scholarships, education, and future employment within our industry.

I would like to take this opportunity to thank the members of the South Central Chapter Board, which we recently expanded to include more members and better diversify our team. This publication, the educational conferences we produce, and the scholarships and support we are able to supply would not be possible without the hard work and support of the board members who work to make this chapter what it is. Thank you for your continued service.

The South Central Chapter has seen exceptional growth over the past several years, and we hope to continue that growth in order to better serve the industry and our communities, and be a resource for the personal and professional growth of our members. I challenge each of you reading this publication to consider joining the South-Central Chapter of NASTT and get involved with our organization. We hope you find this publication to be a valuable resource for all things trenchless and we truly appreciate your continued support.

Sincerely,

Justin Taylor

Justin Taylor
NASTT South Central Chair

MESSAGE FROM THE NASTT CHAIR

Alan Goodman, NASTT Chair

In Person Events are Back and Better than Ever!

Hello South Central Chapter Members. It feels like we are embarking on a fresh start now that restrictions are lifting across North America. We are excited as we look forward to the future! We're riding high on the success of the NASTT 2022 No-Dig Show held this past month in Minneapolis. We hosted over 1,700 attendees and more sponsors than ever before. The trenchless industry is ready to be back to in person with networking and education leading the way.

I am proud to share that the South Central Chapter of NASTT is the fastest growing chapter with engaged volunteers from all industries. We are excited to see you at the 6th Annual NASTT-SC Texas/Oklahoma Trenchless Technology Conference being held in sunny Arlington, Texas on May 23, 24, & 25. This annual event is a great opportunity to network, build relationships, and develop business opportunities with municipal attendees, contractors, consultants, and exhibitors from all aspects of underground infrastructure. Lastly, this conference gives the chapter an opportunity to award 10 scholarships to students that are engaged in trenchless technology.

We hope you will make your plans to join us for three days of trenchless presentations and networking with a reception, continental breakfast, lunch, and refreshment breaks. Registration also includes a complimentary USB of the Conference Proceedings. Visit https://uta.engineering/TTP2022/ for details and registration!

> *It is important that our industry is a steward of our precious natural resources!*

Additionally, in the coming months we have many events planned to bring the underground infrastructure community together. This fall we hope you will join us in Toronto, ON for the 2022 No-Dig North conference, October 17-19. No-Dig North is hosted by the Canadian Chapters of NASTT and offers two full days of training, education and networking. This is a must-attend event for trenchless training and networking in Canada. Visit www.nodignorth.ca for details!

Be sure to mark your calendars and save the date for the NASTT 2023 No-Dig Show in Portland, OR, April 30 – May 4, 2023. The city of Portland is a perfect location for our industry to come together to celebrate and educate with the theme, **Green Above, Green Below**. It is important that our industry is a steward of our precious natural resources, and we welcome the opportunity to provide a forum to learn about the latest in innovative trenchless products and services. Learn more at www.nastt.org/no-dig-show.

If you or your company has attended a NASTT Conference (National or Regional) you may leave that conference wondering how you could get more involved. I ask that you consider getting engaged in one of the many NASTT committees that focus on wide variety of topics. Everything from Publications Committee, Good Practice Course Committee, No Dig Planning Committee with many others for you to consider. With education as our goal and striving to provide valuable, accessible learning tools to our community, one of the things of which we are most proud at NASTT is that we have been able to grow. In keeping with our mission of education and training, we are offering our Good Practices Courses in a live, virtual format throughout the year. For the latest information on upcoming events, visit our website at www.nastt.org/training/events.

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

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

Alan Goodman

NASTT Chair

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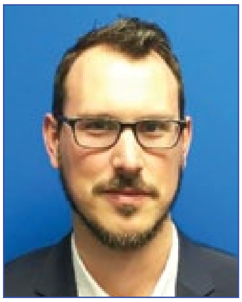
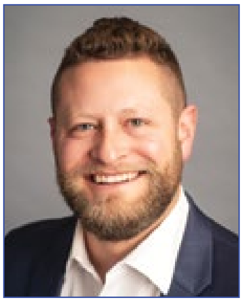


JUSTIN TAYLOR – CHAIR

justin.taylor@cciandassociates.com

Justin Taylor, P.E. is the VP of Engineering for CCI & Associates, an engineering, design, and inspection firm specializing in trenchless technology. Justin holds a B.Sc. in Mechanical Engineering from the University of Alberta. After almost 10 years of various engineering and management roles in the Western Canadian CCI offices, Justin moved to Houston, Texas to head the engineering team in CCI's first stateside offices. Justin is a licensed P.E. in multiple states including Texas, Oklahoma, and Louisiana. In his time with CCI, Justin has worked on trenchless crossings for various high profile projects such as Keystone/Keystone XL, Enbridge Line 3, Plains Wink to Webster, and Kinder Morgan TMEP Pipelines, and has been involved in the development of tools for real-time measurement of strain and stress on steel pipe during Horizontal Directional Drill installations. Justin is an active member of NASTT, having authored and co-authored several papers for the organization, and being a member of the NASTT Program Committee.



NIK TAYLOR – TREASURER

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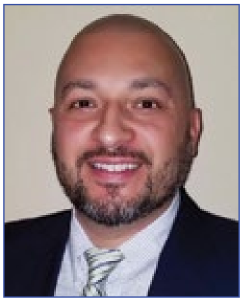
Nik Taylor has been in the underground construction industry for 7 years, and works for Utilicor Technologies Inc. as the Manager of Business Development. Nik started his career in underground construction with HammerHead Trenchless and Subsite Electronics. He began his professional career as an Art Director at a Newspaper in San Diego County and worked in marketing and project management in electrical sign construction before joining the underground construction industry.

Nik currently serves as the Treasurer of the Board for the NASTT South Central Chapter. He has worked with the Ditch Witch dealer channel, assisted damage prevention associations, and has helped develop training and best practices for large organizations.



SHAWN GARCIA – VICE CHAIR

sgarcia@aegion.com

Shawn Garcia is a licensed Professional Engineer in the state of Texas and currently serves as Regional Manager for Underground Solutions (an Aegion Company) for the North Texas/Oklahoma Region, where he manages and oversees all business development, operations, and activities in the region. Shawn has over 20 years of engineering development, design, and construction experience in the Municipal Water/Wastewater Utility Infrastructure Rehabilitation and New Construction industry. He previously worked for Archer Western Construction and the City of Wichita Falls. He received a Bachelor of Science in Engineering from Texas Tech University. Shawn is an active member of NASTT, UCT, AWWA, and ASCE.

PAUL BEARDEN – SECRETARY

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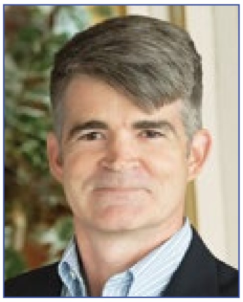
Paul is HDR's Trenchless Services Program Leader and has nearly 30 years of experience in the design, project management, and construction of oil, gas, water and utility pipelines utilizing trenchless technologies, specifically horizontal directional drilling (HDD), conventional boring methods, and Direct Pipe®. Paul has special expertise in the construction of complex, large-diameter HDD pipeline installations and extensive on-site experience with major projects around the world. Paul has demonstrable management skills and works effectively with multi-skilled, international teams to complete pipeline projects from front-end engineering design through construction. Paul possesses excellent communication, negotiation, and writing skills and the ability to develop positive working relationships.

BOARD OF DIRECTORS 2022-2023



JIM WILLIAMS – PAST CHAIR

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Jim Williams, P.E. is the Trenchless Division Manager for Global Underground Corp. He has 28 years of experience in a wide range of projects primarily in horizontal directional drilling and other trenchless construction methods. His experience includes design, planning, construction and project management of trenchless projects throughout North America.

Jim received his bachelor's degree in engineering from the University of Florida and is a licensed civil engineer in 15 states. He began his career working for several engineering firms in Florida before founding a trenchless engineering firm in 2006 that focused on contractor support services. In 2010 he joined Mears Group as HDD Engineering Manager until 2017 when he joined Brierley Associates as a Senior Consultant. He also has authored numerous technical papers and taught many HDD training classes in North America, Europe, and Australia.

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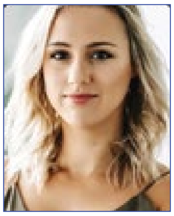

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6TH ANNUAL NASTT-SC TEXAS/OKLAHOMA

TRENCHLESS TECHNOLOGY CONFERENCE

May 23, 24, 25, 2022

THE UNIVERSITY OF TEXAS AT ARLINGTON (UTA)
NEDDERMAN HALL, 416 YATES STREET, ARLINGTON, TX 76019

Direction: http://www.uta.edu/maps/?building=NH

Join us in sunny Arlington, Texas for two days of trenchless presentations and networking with breakfast, lunch and refreshment breaks!

$10,000
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Click here
$129.00 room rate!

Best Practices Book Giveaway

Monday Events:

- Lunch and Tour at Thompson Pipe Group's Manufacturing Facility - about 15 minutes from the event venue. An insider's look on how various trenchless pipes like Steel, Concrete Jacking pipe, and Fiberglass pipe are manufactured. Tour includes lunch
- Please sign up for the tour here by May 13th: https://www.surveymonkey.com/r/2V3QZRM
- Conference Opening Social at the Exhibit Hall

Tuesday Events:

- Full Day Conference Agenda - Technical sessions, networking, exhibits on Trenchless Technology PACKED with leading industry professionals there to help you with your projects! New forums this year!
- CEU's, Lunch, and Exhibitor Hours on Tuesday May 24th, 2022

Wednesday Events:

- Pipe Bursting, HDD & CIPP Good Practice Courses
- In person classroom instructors - includes book

A great opportunity

to network, build relationships, and develop business opportunities with attendees and exhibitors from all aspects of underground infrastructure including public works officials, utility company personnel, oil and gas companies, engineers, underground contractors, industry suppliers and students. Registration includes complimentary USB of the Conference proceedings.

Limited space available! Act Now!

For 2022 Conference Information and Registration Visit: https://uta.engineering/TTP2022

The 6th Trenchless Technology and Pipe Conference (TTP 2022)
Monday - Wednesday, May 23 - 25, 2022

Monday, May 23, 2022

12:00 Noon	***Lunch and Tour of Thompson Pipe Group's Manufacturing Facility***
5:00 – 7:00 pm	***Reception, Conference Opening Social at the Exhibit Hall, UTA***

Tuesday, May 24, 2022

7:00 am	***Registration with Refreshments at Exhibit Area Sponsored by …***
8:00 am	**Welcome/Board Introduction** Dr. Mo Najafi-Professor and Director of CUIRE, Mr. Alan Goodman-President of NASTT National, Mr. Justin Taylor-President of South-Central Chapter of NASTT, Scholarships
8:30 am	Honorable Jim Ross, Mayor, City of Arlington
8:45 am	Dr. Peter Crouch, Dean, College of EngineeringDr. Ali Abolmaali, Chair, Civil Engineering
9:15 am	Steven Metzler - Manager, Construction Services -Trinity River Authority (TRA)
9:45 am	Shelly Hattan, Project Manager, Tarrant Regional Water District (TRWD)
10:15 am	***Coffee Break at Exhibit Area Sponsored by …***

Start of Technical Sessions 10:30 am – 12 noon

Time/Tracks	**Track A -- Room 105 -- New Installations** ***Moderator: TBA***	**Track B -- Room 106 -- Rehabilitation** ***Moderator: TBA***	***Track C -- Room 108 – Trenchless Planning*** ***Moderator: TBA***
10:30 am	Unique Design Reroutes a Critical Force Main while Minimizing Community Impact, Bailey Ratcliff, Zoltan Fekete, Josh Kristinek, Kent Riker, **City of Lubbock**	Pipeline Rehabilitation Design with FRP, Firat Sever**, QuakeWrap, Inc.**	Trenchless Technology for Pipeline Construction in Expansive Soils, Dorairaja Raghu, and Mo Najafi, **UTA**
11:00 am	Fort Worth Water Proactive Leak Survey Plan, Billy Cofflet and Adam Farguson, **Fort Worth Water**	Manhole Rehabilitation, James Dugger, **Wastewater Prime Resins**	Comparative Analysis of Environmental and Social Costs of Trenchless CIPP Renewal, Method with Open-cut Pipeline Replacement for Sanitary Sewers, Vinayak Kaushal and Mo Najafi, **UTA**
11:30 am	DTE Energy-Grosse Ile Trenton Channel HDD, Nicholas Michels and David Bearden, **Mears Group Inc. and HDR**	Condition Assessment Regulations, Diego Calderon and Smith Rangell, **CUIRE**	State of Transportation Projects in the City of Dallas, Gus Khankarli, **City of Dallas**
12:00 pm	***BBQ Buffet Lunch (Provided with the Program) Sponsored by …***		
1:00 pm	***Technical Sessions***		

Time/Tracks	**Track A -- Room 105 -- New Installations** ***Moderator: TBA***	**Track B -- Room 106 -- Rehabilitation** **Moderator: TBA**
1:00 pm	Culvert Replacement for DOT's & RR using the Pipe Ramming Method, Jason Pollock, Alan Goodman, **Hurk Underground and HammerHead Trenchless**	Replacing Water Main Pipes via Trenchless Technology, John Newell, **NO-DIGTEC, LLC**
1:30 pm	Drone Inspection and Monitoring of Pipeline Right-of-Ways & Horizontal Directional Drilling Sites, Gabriel Garcia & Kerby Primm, **CCI & Associates**	Evaluation of a Hybrid Polyurea Spray Applied Pipe Lining for Structural Pipe Rehabilitation, Sanaz Ghalambor, Kawalpreet Kaur and Mo Najafi, **Nukote Coating Systems International and CUIRE**
2:00 pm	Guided Boring Solutions for Extended Lengths and Diameters, Troy Stokes and Jon Valin, **Akkerman**	Prediction of Sanitary Sewer Pipes Condition Using Artificial Neural Network, Daniel Atambo, Vinayak Kaushal, Mo Najafi, **City of Dallas and UTA**
2:30 pm	***Coffee Break at Exhibit Area Sponsored by …***	
3:00 pm	Here a Tunnel, there a Tunnel, everywhere a Tunnel: Putting a 72-Inch Waterline Through Town, Philip Wheat, **Lockwood, Andrews & Newnam, Inc.**	Rehabilitating Large Diameter Sanitary Sewer Main in Fort Worth with Trenchless Technology, Amy Robinson, Walter Norwood, Carmen Drake, **CDM Smith and City of Fort Worth**
3:30 pm	Trenchless Technology Applied to River Intake Pump Stations, Cameron Lawrence, **Freese and Nichols**	Complicated Sewer Upsize in Houston offers Insight into Overcoming Obstacles when Pipe Bursting Ductile Iron, Yonin Villares**,** Alan Goodman, **T Construction LLC and HammerHead Trenchless**
4:00 pm	Extending Hydraulic Fracture and Inadvertent Returns Analyses Beyond Preliminary Calculations, David Bearden, **HDR**	Emergency Force Main Repair Using Pressure CIPP, Lauren Kubin, Tim Peterie, **North Texas Municipal Water District and Insituform Technologies, LLC**

Distribution of Certificates (7 PDHs, 0.7 CEUs)

Wednesday, May 25, 2022

8:00 am – 4:30 pm	**Room – 108** **Pipe Bursting Best Practices**	**Room – 109** **HDD Best Practices**

Distribution of Certificates (7 PDHs, 0.7 CEUs)

Trenchless Technology Applied to River Intake Pump Stations:

Trinity River Main Stem Water Supply Project

By: Cameron Lawrence, Freese and Nichols

CHALLENGE:

Many river intake pump stations include two pump stations - a low-lift into a sedimentation basin then a high-head pump station to send the water down the pipeline. The Trinity River Main Stem Pump Station (MSPS) used a gravity-fed intake from the river to a basin to eliminate the low-head pump station.

With this configuration, a challenge presents itself. How do you tap into the river for your pump station? Do you open cut and expose your construction site excavation to flood risk? Although open cut construction is achievable, the MSPS Project chose to pursue a trenchless technology alternative by utilizing a microtunnel boring machine (MTBM) to connect the MSPS to the Trinity River. The MTBM excavated through a bentonite slurry wall and gaps in a sheet pile wall, with inches of tolerance to spare, ultimately tapping into the river.

Figure 1. Main Stem Pump Station nearing completion of construction

PROJECT BACKGROUND:

The Trinity River Main Stem Water Supply project was conceived as a drought contingency measure back in 2011. Freese and Nichols served as the design engineer for the North Texas Municipal Water District's (NTMWD's) Trinity River Main Stem Project (the Project) delivered by Garney Construction using the construction manager at risk (CMAR) project delivery method. The MSPS delivers raw water from the Trinity River near Ennis, TX southeast of Dallas ultimately to NTMWD's water treatment plant in Wylie, TX located northeast of Dallas. The Project includes the 114 MGD raw water MSPS and intake structure, a 14-mile 72-inch transmission pipeline, and a pump expansion to increase capacity at the NTMWD Conveyance pump station.

> *Microtunneling can achieve installation accuracies within several inches due to its inherent ability to steer and correct.*

Additionally, the MSPS includes dual 48-inch, 250-foot long river intake pipes installed by microtunneling, connecting the sediment-capturing pump station forebay basin to the Trinity River.

Microtunneling was performed by Bradshaw Construction Corporation and the intake pipe material was steel Permalok casing with an abrasive resistant overcoat (ARO) and an epoxy lining.

SETTING THE STAGE:

The MSPS site is located completely within the 100-year flood plain of the

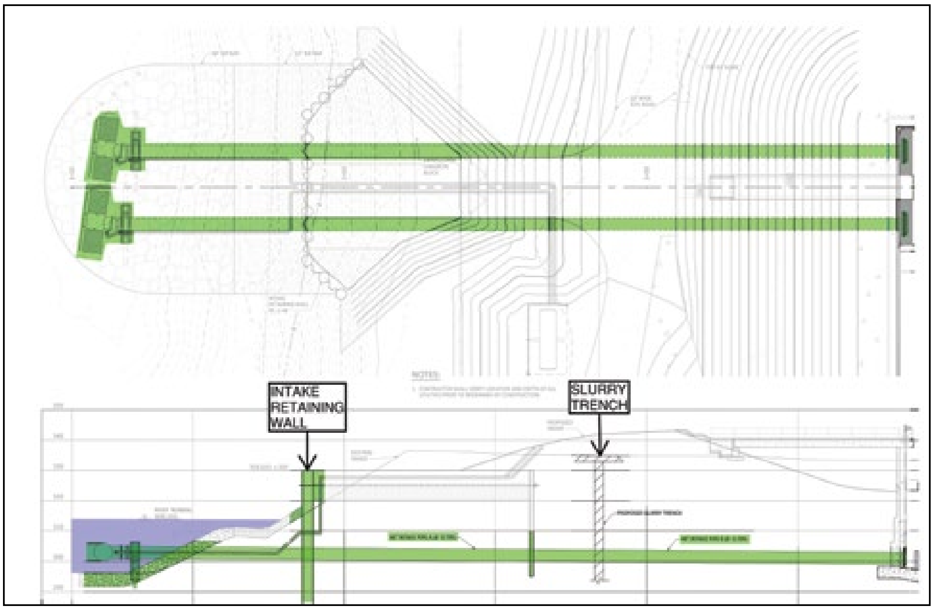


Figure 2. Plan and profile view of the Microtunnel

Trinity River. The Trinity River watershed has several primary drainage swales that run in close vicinity to the site, exposing the construction area to increased flood risk from the wide variability of Trinity River elevations. Building a large-scale pump station within the floodplain presented many challenges including flood prevention, riverbank stabilization, construction dewatering, and infrastructure protection.

Building the MSPS required a 50-foot deep, large excavation the size of a football field directly adjacent to the Trinity River with suspected groundwater conductivity between the excavation and the water table influenced by the Trinity River. Prior to construction, a quarter-mile, circular bentonite slurry wall was installed to minimize groundwater interference with the proposed excavation.

The slurry wall was installed by digging a 3-foot wide trench, approximately 70 feet deep to key the water resistant slurry wall into the surbsurface marl formation. The trench was then backfilled with a high plasticity, bentonite soil mixture to cut off groundwater interference between the Trinity River and the proposed excavation. The slurry wall proved critical during construction as it allowed for the excavation to take place with minimal dewatering required.

When the time came to connect the pump station forebay basin to the river, the contractor minimized disruption to the slurry wall by installing the pipes trechlessly via slurry microtunneling. The MTBM was able to penetrate the slurry wall, then re-establish the waterproof barrier with the slurry lubrication used around the outside of pipe wall, typically used in slurry microtunneling to reduce pipe friction as the pipe is jacked into place. The MTBM installed the intake pipes from the pump station forebay basin through the slurry wall and into the river, all while handling a wide variety of subsurface conditions identified in the geotechnical exploration varying from non-cohesive sands to a high plasticity slurry wall.

NAVIGATING TIGHT TOLERANCES:

The MSPS is located on the outside of a meandering bend of the Trinity River. The bank of the river migrated up to 80 feet between the first design survey and the beginning of construction due to flooding in 2015 and 2016. Further

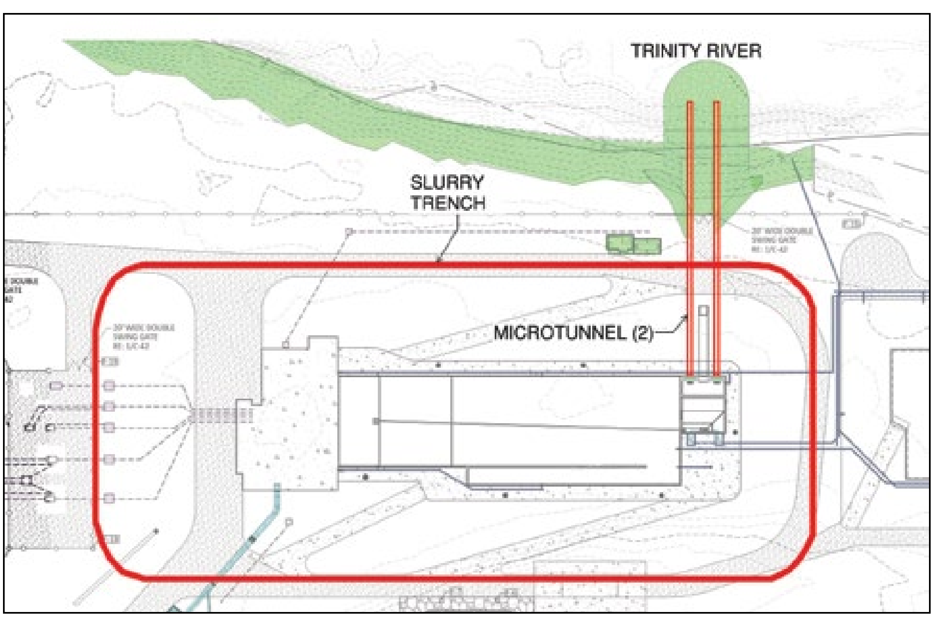


Figure 3. Circular bentonite slurry wall was installed to minimize groundwater interference

Figure 4. MTBM launch pit from the forebay basin

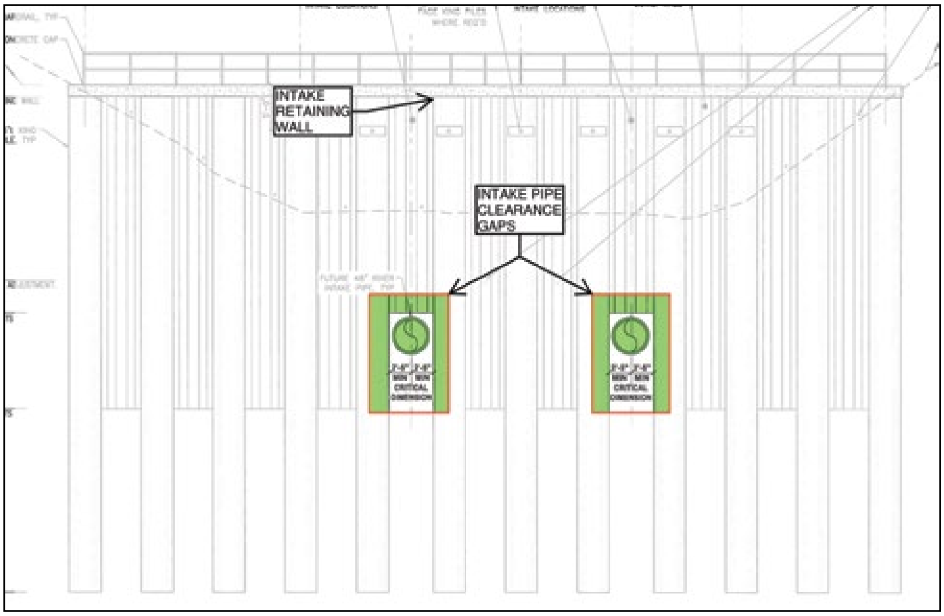


Figure 5. Two openings were strategically placed in the sheet pile system to allow passage of the MTBM through the sheet piles

movement of the riverbank took place during construction due to record rainfall and elevated river levels in 2018 and 2019.

A combination of sheet piles, a palisade system, and a mechanically stabilized earth wall were included in the construction package to stabilize the riverbank. The bank stabilization components of construction were identified as critical, early install items to halt the migration of the riverbank. Therefore, the bank stabilization improvements were installed prior to the river tap trenchless installation. The improvements to the riverbank appeared to be a success but were yet another obstacle for the installation of the intake pipes that connect the MSPS to the river.

How does an MTBM advance through sheet piles? It doesn't without special provisions. Two openings were strategically placed in the sheet pile system to allow passage of the MTBM through the sheet piles.

Depending on the guidance system, pipe material, and geologic conditions; microtunneling can achieve installation accuracies within several inches due to its inherent ability to steer and correct horizontal/vertical alignment as the MTBM advances through the ground. The project was able to leverage the accuracy of MTBM technology to successfully pass through these window cut-out openings with inches to spare on either side.

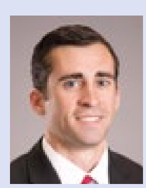
Figure 6. The second microtunnel drive was done as wet retrieval in conjunction with divers

COMPLETING THE MICROTUNNEL:

During construction, the Trinity River watershed received record rainfall which translated to elevated river levels approaching the 500-year floodplain elevation. During one of these flood events, the temporary cofferdam in the Trinity River used for retrieval of the MTBM was damaged by river debris. Fortunately, this coffer dam damage happened after successful completion of the first microtunnel drive, river intake pipe supports and screens. The second microtunnel drive was able to audible to a wet retrieval in conjunction with divers without the need to rebuild the costly cofferdam to complete the installation in the river.

Despite the challenges, trenchless technology, particularly microtunneling was able to make this project a success. The MSPS came online in 2021 and now supplies the NTMWD and its customers with 114 MGD of raw water.

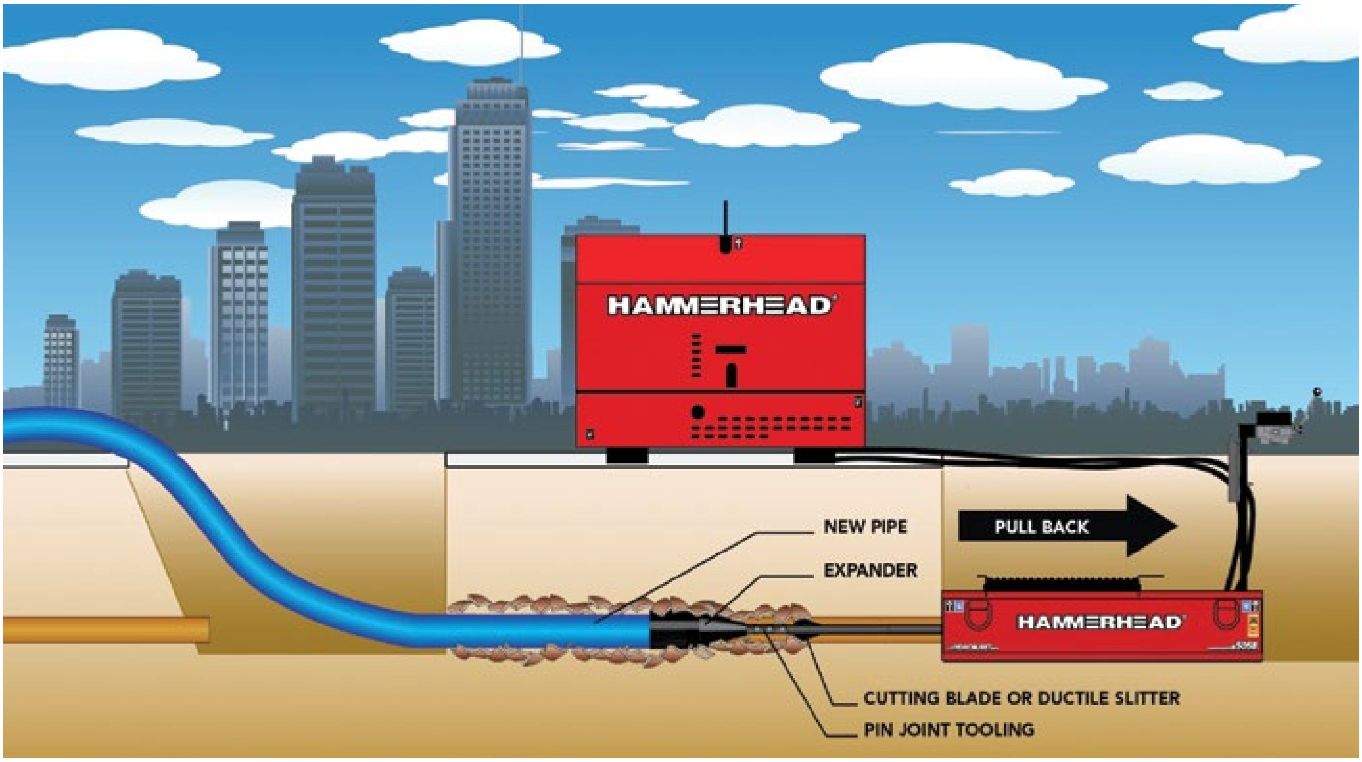
ABOUT THE AUTHOR:



Cameron Lawrence *is a Project Manager for Freese and Nichols in the Water/Wastewater Transmission Group. His skills include trenchless design, raw/treated water pump station design, transmission pipeline design, and resident engineering inspection services.*

Replacing Water Main Pipes via Trenchless Technology

By: Joe Bradfield, Hammerhead Trenchless



Pipe bursting tool assembly. New product pipe fastened to an expander behind the bursting head is drawn into place as the assembly progresses through the run, fracturing pipe and pressing its fragments into the surrounding soil

The pipe bursting technique originated in Europe as a trenchless solution for pipeline replacement. The method made it possible to replace pipes in dense urban areas and beneath sensitive, highly valued surface environments that render traditional "dig and restore" pipe replacement infeasible. In certain ground conditions, it is the only practicable means of pipeline rehabilitation.

However, its introduction to the western hemisphere nearly 30 years ago was primarily limited to replacing cast iron (CI) sewer pipe with modern products such as high-density polyethylene (HDPE) pipe. While the method has since become widely accepted as a reliable, long-term and low-cost solution to address aging wastewater collection infrastructure throughout North America, it is grossly underutilized in potable waterline replacement applications here.

The goal of this article is to sufficiently educate readers regarding the viability of pipe bursting technology, materials and technique specific to potable water delivery infrastructure, so that they might confidently research the method further for use in their own water pipeline rehab projects and become experienced industry advocates of the method themselves.

PIPE BURSTING TECHNIQUE'S ADVANTAGES

The primary advantages of pipe bursting technique over traditional dig-and-replace are as valid for potable water applications as they are for wastewater pipe replacement. What follows are just a couple of the technique's more prominent benefits:

Reduced project time and cost

Municipal water department directors generally assume that any funding they are allotted for their urgent asbestos concrete (AC) pipe and cast iron (CI) pipe replacement plans, at least half must be set aside to pay for restoration costs, patching or replacing

Minimal excavation/restoration. The pipe bursting method reduces digging requirements are reduced as much as 90 percent compared to an open cut "dig and replace" method. The only excavation required is for the pulling machine, insertion pit and accesses to service connections

pavement and repairing surface construction. In some jurisdictions, project restoration costs can exceed two thirds of total project spending.

The pipe bursting technique significantly reduces restoration needs, and eliminates the need for hazardous material mitigation, transport and disposal, greatly reducing overall project time and cost, while also reducing risks to environmental and personal safety.

The result is that substantially more AC and CI pipe can be replaced with the same funding in the same calendar period.

Viability

For more than 70 years, AC and CI pipes have played an important part in waterline distribution across the US. Decades of construction and additional buried services now often crowd the easement they share with them, some lying parallel to the aging water lines and others crossing over it. Unless the pipeline must be relocated (such to move it deeper below the frostline) or has greatly offset joints, the pipeline can be fully replaced and even upsized using this technique exactly as it lays in situ, following in the same path as the existing pipe. The method greatly reduces the risk of damage or harm to property, shared utilities and personnel during the pipe replacement process. For this reason, the method is often viable when some other trenchless methods, such as horizontal directional drilling (HDD), are not.

> *"The biggest barrier to greater utilization of the pipe bursting method for waterline replacement is lack of industry awareness."*

OBSTACLES TO WIDER ACCEPTANCE

In Europe, approximately 80 percent of waterline rehabilitation is performed using the pipe bursting technique. Yet in the U.S. and Canada, while the use of pipe bursting in waterline applications has increased within the past five years in isolated areas of the continent, many municipalities have not yet adopted it for this purpose. There are several reasons for this, all deriving from either human nature or contemporary, societal events. None of them are attributable to the method, its technology, tooling or materials.

Lack of familiarity

Some municipal wastewater collection and water department officials simply do not realize that the technique they already endorse for use in their sewer replacement program is equally viable for potable waterline replacement. Even within the state of Texas, one of the world's largest pipe bursting markets, it is still possible to find city engineers who admit they did not know pipe bursting could be used for waterline rehabilitation as well.

Waterline replacement is less urgent

Municipalities are highly motivated to prevent and immediately clean up leaks and repair failures in sewer lines, responding as rapidly as possible to mitigate environmental hazards, health risks and negative social impact. One simply chooses the most expedient solution from a wide array of acceptable repair or replacement strategies and products. When an equally effective, much less costly, alternative technology such as pipe bursting rehabilitation presents itself, adopting it poses no great dilemma to project owners.

Replacement projects scheduled within a water delivery system are comparatively less urgent, unless they somehow jeopardize assurance of clean water. Clean water leaking into the environment poses little risk itself to public health or safety. Therefore, water infrastructure replacement projects are often delayed until they inevitably become urgent, unscheduled repair jobs redirecting time and money designated for other projects. The cost is compounded by their inability to re-coup their investment in treating water that never reaches a billable customer.

Resisting change

Many people are simply reluctant to embrace change. It may be fear of blame, should they adopt a "new" technique with unforeseeable consequences in the future. Maintaining the status quo offers psychological comfort, the ability to reassure oneself that "The costs and risks associated with what we have been doing are known

Joint fusing and pipe staging area. Sticks of PVC are joined to full run length prior to the day of the burst, stored conveniently out of the way near the insertion point

variables, predictable and, therefore, acceptable. Let's not adopt a new technique until it is more prevalently used throughout the market." Some simply quote the adage, "If it isn't broken, don't fix it."

However, pipe bursting specialist John Newell counters that the current situation is "broken." Founder of Texas-based NO-DIGTEC, Newell is a guest lecturer on trenchless pipe replacement techniques each semester at University of Texas. He describes the current infrastructure crisis to senior engineering students: "There are over 630,000 miles of asbestos cement pipe laid from the 1930s through the '70s still in North America and is at the end of its expected useful life. Multiply that by 5280. That's roughly 3.3 billion feet deal with, and that's just AC. Add to that all the cast iron that's nearing or past its useful life expectancy and giving families brown water."

It is not possible to meet current waterline replacement needs continuing as usual, spec'ing out replacement projects as large-scale "dig-and-extract" jobs.

Societal hindrances

North America's adoption of pipe bursting for waterline rehabilitation projects has also been hindered the past few years by a construction industry labor shortage. Contractors who would like to begin offering water line pipe bursting services are having difficulty attracting, training and keeping employees. Therefore, many have been reluctant to dedicate existing human and material resources to an additional pipeline rehabilitation technique at this time.

Newell noted, however, that since he began educating existing and prospective customers on the technique's availability and benefits, NO-DIGTEC waterline pipe bursting jobs have steadily increased. More and more locations across the country are now observing a similar rise in waterline pipe bursting, as well. Increasing efforts to educate the market will likely accelerate a growing trend.

The continuing global pandemic, however, which has exacerbated a pre-existing labor shortage, has also created supply chain issues. This has made it harder for contractors entering this market to obtain parts and equipment necessary for establishing themselves in this niche.

EQUIPMENT AND MATERIALS

Tooling & machinery

Waterline pipe bursting crews use the same hydraulically powered pulling machines and bursting assemblies used for VCP and CI pipe in wastewater pipe bursting applications. Pneumatic percussion tools ("hammers") used in some wastewater pipe bursting applications are typically not used in waterline applications. Only "static" pipe bursting method, using powerful, steady-tension pulling machines, is used due to the possibility of encountering repair clamps in the line.


The majority of the insertion pit does not need to be much wider than the pipe itself

Cable pulling machines are used in shorter runs of smaller diameter pipe (less than 100 feet of 2- to 4-inch pipe). Hydraulically powered rod pulling machines with 50, 100 or more tons of pulling force are used for waterline up to 36 inches in diameter and in runs that may be hundreds of feet long.

The pulling machines draw bursting tools with expansion heads through the existing pipe while simultaneously sliding new product pipe of superior, modern materials into place as the installation progresses.

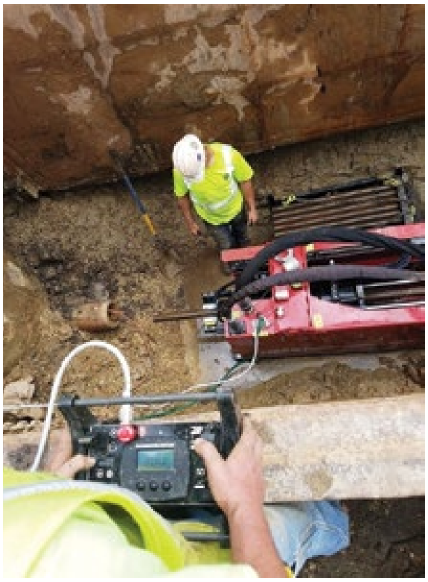
Materials

The most common replacement pipe products are high-density polyethylene (HDPE) and Fusible PVC®. Since 2004, Fusible PVC has become more prevalent, for several reasons. While HDPE is readily familiar in other pipe bursting applications, PVC is a long-established, widely used material in the potable water market. Fusible PVC enables water department crews to use connections and fittings they already have on hand and are familiar with, maintaining uniformity of product type and service technique throughout their delivery system.

WATERLINE PIPE BURSTING PROCESS

Waterline pipe bursting is like other static (drawn by hydraulic cable or rod pulling machines) pipe bursting applications. New product pipe follows behind the pipe bursting tools, which usually consist of a pulling rig, pipe bursting head and bore expander.

A powerful hydraulic pulling machine at the opposite end of the run pulls the bursting head and expander through the existing AC or CI pipe. The tooling fractures and pushes the existing pipe into the surrounding ground away from the bore while simultaneously drawing new pipe into place as it progresses.


Enhanced safety. Some modern pulling machine designs free the operator from the pit, offering a superior view of the operation and of worksite surroundings during an installation

Minimal excavation

A waterline pipe bursting job may reduce excavation requirements by as much as 90 percent compared to open cut replacement. Each pipe bursting run requires only a pulling pit (machine pit) at one end, an insertion pit at the other, and small access pits as necessary at each service connection along the run. The machine pit dimensions generally need to be only big enough to accommodate a 4-foot by 12-foot shore box, at a depth not much deeper than the lay of pipe being replaced. The insertion pit need only be wide enough to access the pipe being replaced.

Insertion pit length depends on the depth of the pit and stiffness of the new pipe, being long enough to ensure the new pipe can flex sufficiently without damage during its transition from the surface to point of insertion.

Staging area, bypass

The new waterline is made up to length on the surface prior to a bursting operation. This can be done in a separate staging area to limit any disruption to traffic, commerce or social activity prior to an installation.

Creating a temporary waterline by-pass ensures customers are not without water during installation, even though the operation takes place within a short span of time. Installation rates typically average 3 to 7 feet a minute, with a whole run generally not taking more than a couple hours depending on length of run, site conditions and the equipment used.

Installing a temporary line offers two valuable advantages. One, the contractor has the ease of converting over the newly installed main to the services run to the home. Two, it affords the operator the ability to address any obstacle that may arise during the bursting process, such as unknown repair clamps the crew must stop to access and cut through, encountering a concrete encasement, directional changes, etc.). Customers will not be inconvenienced should anything delay the replacement process.

"Waterline pipe bursting jobs have steadily increased."

- John Newell, President, No-DigTec

Completing the installation

Once the line and services have been reconnected, restoration consists of simply backfilling the pits and patching any pavement, if any were removed to perform the installation.

As the replaced pipe remains in the ground, there is no disposal requirement, nor in the case of AC, hazardous material mitigation requirement. The project is complete.

Capacities and materials

Pipe bursting is primarily used to replace pipe made of fracturable materials, including AC and CI waterline pipes, and can be used to replace pipe of diameters ranging 2 to 48 inches. The method is used not only for size-on-size replacement but to upsize pipe where increased capacity is desired.

CONCLUSION

The North American water supply industry urgently needs an effective, fast, environmentally safe and economical means of replacing over 3 billion feet of AC waterline, as well as millions of feet of CI waterline now past its rated useful life. Pipe bursting is a viable, proven yet underutilized replacement method that meets all these requirements.

The technique narrows the construction footprint, minimizing project work impact on daily traffic, commerce and social routines around the installation zone. Few if any passersby realize a significant project is underway, which in many cases is completed in a few days. The result is a renewed waterline guaranteed to last a century and will likely last much longer.

The biggest barrier to greater utilization of the pipe bursting method for waterline replacement is lack of industry awareness. We hope that this paper gives its readers the incentive they need to further investigate pipe bursting for use in their own waterline replacement programs and become the technique's enthusiastic ambassadors, educating other industry professionals of its viability and many benefits. Waterline pipe bursting is a powerful tool the market urgently needs to prevent what will inevitably become a crisis in waterline delivery/distribution systems across this continent without it.

ABOUT THE AUTHOR:

Joe Bradfield *is a freelance writer specializing in case stories, technical writing and photography for the mining, construction, drilling and energy industries. Prior to the global pandemic of 2020, Bradfield was senior editor/writer for an international communications agency, providing site-based photojournalism of high-profile mining, drilling and construction projects around the world.*

Pipe Bursting Advantages

The pipe bursting method usually requires less than 15 percent of the excavation that would be required to dig up a line for replacement. And while the slip-lining method always decreases diameter of the line, the pipe bursting technique can be used not only for size-on-size wastewater pipe replacement but also for upsizing lines.

Although the HDPE pipe typically used as replacement pipe in a pipe bursting project provides a long-term solution against I&I, a variation of the pipe bursting method known as pipe slitting (or pipe splitting) can be used if necessary or desired for subsequent size-on-size or even upsize pipe replacement in the same line.

Pipe bursting offers advantages over the horizontal directional drilling (HDD) method to install a new pipe, as well. In a pipe bursting operation, the replacement pipe follows exactly in the path of the existing pipe. No new path for the line is required. There is no crowding of utilities nor need to create a new easement. The method inherently minimizes the potential for interference with shared utilities and associated risks, such as charged line strikes.

Replacing slip-lined pipe using the pipe bursting method is not an easy process. A contractor must decide on a case-by-case basis whether to first remove the PEP liner before performing a conventional pipe bursting operation, or to leave the liner in place. Each project's time and cost depend on making the right choice and competent execution.

Sinkholes in the Desert Create Chaos

By: Kevin D. Fredley, PE, CCM; and Valerie Edgren, Parkhill

Figure 1 – SUV trapped in the sinkhole (Courtesy of Debra Pazos)

This project started at 5:27 p.m. on July 22, 2017, with a frantic 911 call from a driver in her SUV that had just sunk into an enormous sinkhole in a city street. A partial transcript of the 911 call is shown below:

911 Operator – "911 Operator, what is the location of your emergency?"
Driver – "The ground just fell down on me. I'm on La Placita and Villa Hermosa. I'm in my car. My car is – The ground ... I was driving up and the ground just fell down on me. My car is in a big, big hole."
911 Operator – "So the ground caved out?"
Driver – "Yes ma'am, I'm in my car."
911 Operator – "Stay on the line with me, OK? Is there water there around you?"
Driver – "Yes, there's a lot of water; it's like a river around me. It's like a big hole. The water just hit the ground. Can you hurry up, please."
911 Operator – "I already contacted them. Stay on the line with me, OK?"
Driver – "Help me, the car is moving!"
911 Operator – "Is there any way you can safely get out the vehicle, or would that be hazardous? Only if it's safe."
Driver– "My car is moving... I'm gonna try, I gonna try something, but it keeps moving."
911 Operator – If it's not safe to do so, I need you stay inside where it's safe. The sinkhole, was it near the intersection?
911 Operator – What is your name?
Driver – (Yelling her name) (Scream) "Oh my God!"
911 Operator – What's going on? Ma'am? Ma'am? Ms.----------, are you still with me?
(rushing water sounds)

The occupant of the car climbed out onto the top of her car and was assisted by residents. Although shaken, she was OK.

While the sinkhole that swallowed the car was the largest one that appeared, other sinkholes developed over the next couple of days on La Placita Drive. The tremendous amount of rain that El Paso received was a major contributing factor to the sinkholes. Little did anyone know there was another major problem hiding beneath the surface. After the rains had stopped and we started assessing the damage, the team identified the alarming condition of the Corrugated Metal Pipe (CMP).

Aging infrastructure is a growing problem across the U.S. Every four years, the American Society of Civil Engineers (ASCE) publishes "The Infrastructure Report Card, 2017" rating the current state of the national infrastructure with a grade of A through F. This report covers 16 specific items, and in 2017, this report rated the combined items of the infrastructure in the United States with a grade of D+. It has since risen to a C-.

Government agencies and municipalities realize they have problems with the condition of their infrastructure. However, fixing these problems comes with a substantial price tag. These

Figure 2 – Condition of the CMP

agencies and municipalities must balance the risk of raising taxes or increasing fees to make the much-needed repairs before repairing/correcting when it occurs. In most cases, the thought process is to fix it when it breaks.

When the twin 48-inch CMP in this area was reviewed several years earlier, the condition of the pipe was in fair shape. The repair of this pipe section was deemed low priority, and replacing the CMP was delayed.

INVESTIGATION & EMERGENCY REPAIR DESIGN

Having one of the current on-call contracts with El Paso Water and technical expertise with large pipes, Parkhill met with El Paso Water to develop a scope of work. El Paso Water wanted some options for repairs and to investigate the condition of the pipe from the intersection of La Placita and Villa Hermosa to the outlet concrete drainage structure at the intersection of Villa Hermosa and Belvidere Streets.

Parkhill coordinated with multiple manufacturers and provided El Paso Water with several options for the repairs. El Paso Water chose ADS (Advanced Drainage Systems) Sanitite HP pipe for the repairs along La Placita. The manufacturer could have the first pipe shipment delivered within two days. The contractor would begin the open-cut installation and provide follow-up shipments for the remaining amount of pipe. The plans called for approximately 1,900 linear feet of dual 48-inch pipe to replace the pipe along La Placita.

To assess the condition of the pipe along Villa Hermosa and the potential for future failures, Parkhill obtained video of a prior assessment and coordinated with a local company to provide ground penetration radar (GPR) of Villa Hermosa. The project team identified several locations of potential sinkholes.

While the original plan was to open-cut along La Placita and CIPP along Villa Hermosa, with the new information, El Paso Water directed Parkhill to open-cut both streets.

Before the design, Parkhill contacted a local firm to provide line spots of any existing utilities in the area that would require additional attention during the design or construction. Two existing conditions dictated the slope of the open-cut pipe. The upstream end was controlled by an existing drop-inlet and the downstream end by a concrete drainage channel. Engineers were also asked to reduce the number of manholes located along the open-cut.

With preparation work being done by the contractor and Parkhill working on a set of drawings, El Paso Water began focusing on the condition of the single 48-inch CMP under Belvidere Street. El Paso Water expanded Parkhill's task order to assess the condition of approximately 2,200 linear feet along Belvidere, one of the busiest streets on the west side of El Paso.

Parkhill finished the design of the open-cut, provided the contractor with the set of drawings, and then began assessing the single 48-inch CMP along Belvidere. GPR and CCTV showed that this section of the line, while not great, was in fair shape. Parkhill suggested using CIPP, which would greatly reduce the impact on traffic and reduce construction time in the area.

CONSTRUCTION

The construction of the project was broken into two phases. Phase 1 was to open-cut from the intersection of Westwind and La Placita to the intersection of La Placita and Villa Hermosa and then from the intersection of La Placita and Villa Hermosa to the intersection of Villa Hermosa and Belvidere. Phase 2 was CIPP and tied into a manhole approximately 900 feet east of the intersection of Westwind and Belvidere near the inlet of a concrete channel to another manhole at the intersection of Villa Hermosa and Belvidere, 2,200 feet away.

PHASE 1

The project was getting a lot of press coverage, and El Paso Water needed to act rapidly getting the repairs started. El Paso Water gave the open-cut construction to a local contractor with which they currently had an on-call contract. Within a few days, the contractor began setting up traffic control, and excavating the CMP along La Placita began. Coordination within this portion of the construction area was critical due to two cross streets intersecting La Placita, a Montessori school, a public school, residences, commercial businesses and a large apartment complex as well as curious on-lookers.

The engineers coordinated with El Paso Water to replace existing water and sewer lines that were not included in the contractor's scope of work. The contractor was required to remove and dispose of the existing asbestos cement

Figure 3 – CIPP insertion

> *This project underscores the importance of asset management and its benefits*

(AC) water lines and clay pipe sewer lines while El Paso Water personnel replaced the lines.

The contractor placed flowable fill around the pipe, instead of bedding material, continuing this method throughout the open-cut installation.

While this was a more costly option, it expedited the backfill efforts, which decreased the time required for the street closure.

PHASE 2

To help speed up the process, El Paso Water used the services of the Texas BuyBoard.

The BuyBoard is an "intergovernmental purchasing cooperative created in order to obtain member benefits and efficiencies in purchasing through the compliance with state bid laws, identifying qualified vendors and realizing potential economies of scale that can be achieved from volume purchasing on a large scale." (BuyBoard, 2014). By using the BuyBoard, El Paso Water selected a contractor using this expedited process.

CIPP used on this project included a polyester felt tube impregnated with a polyester resin. When a source of heat (water, steam or UV light) is introduced, an exothermic reaction happens, causing the resin in the tube to be transformed into a fully structural pipe.

Parkhill coordinated with the chosen contractor to perform the agreed-upon work. El Paso Water added the CIPP work and contract amount to the general contractor's contract.

Belvidere is a five-lane road with two eastbound and westbound travel lanes and one center turn lane. It has a high traffic volume due to the nearby schools, commercial businesses and residential areas. Because of the traffic, the contractor had to be careful with their equipment and workers working in the middle turn lane. To assist in the safety, the traffic control approved by the City of El Paso allowed the subcontractor to work in the middle turn lane and close off the two inside lanes, pushing traffic to the two outside lanes.

The CIPP contractor used existing manholes within Belvidere as points of insertion. CIPP can be inserted into the host pipe through water or air, as shown in Figure 3. The contractor for the project elected to use air because it saves approximately 30% in time. More importantly, the contractor saved 206,593 gallons that would have been wasted filling the tube and then having to discharge the water into a nearby drainage channel.

As alternate methods can accomplish the insertion, so can the curing. UV, hot water or steam can be used in the curing of the pipe. The subcontractor utilized steam for the project.

The steam inside the pipe reaches a temperature of 222 degrees (F). The time it takes to cure is based on the wall thickness and diameter of the CIPP. To mitigate a premature exothermic reaction (curing) of the pipe during the insertion of the pipe, the contractor uses an ice bucket to cool the air coming out of the compressor. Once the subcontractor is ready to introduce the steam, the ice will then melt. The ice is then replenished when the steam has stopped, and the subcontractor begins the cooling process.

Using a combination of air and steam saves valuable contractor time, which saves money and, more importantly, reduces the project's carbon footprint.

CONCLUSION

This project underscores the importance of asset management and its benefits, although it does not come cheap. The longer an asset is left unmanaged, the more critical it becomes. Costs will increase, and the possibility of severe injury or even death could occur.

Using a risk-based approach allows utilities to prioritize replacement, but also rehabilitation, preventative maintenance, and inspection. A typical asset management program will group assets into risk tiers. Utilities can schedule the replacement of the very highest risk assets, plan frequent inspection and rehabilitation on assets of high risk, conduct preventive maintenance and less frequent inspection on the next tier, and perform infrequent or random inspections and as-needed maintenance on the lowest risk assets. Using and managing this approach will save utilities time, money and spare future catastrophes.

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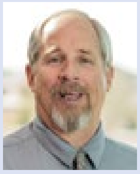
ABOUT THE AUTHORS:



Kevin Fredley, PE, CCM, *retired from Parkhill after 22 years. He was an Associate and headed Parkhill's construction management team in Parkhill's El Paso office.*

Valerie Edgren *is a Marketing Coordinator at Parkhill. She is a published author of articles about water, wastewater, architectural, and engineering projects.*

COMCD Del City Pipeline - Medium Diameter Compressed Fit HDPE Lining Rehabilitation Project

By: Alan Swartz, P.E., Plummer Associates, Inc.
Robert Weinert, P.E., Plummer Associates, Inc.
Timothy Peterie, Aegion

1. INTRODUCTION

The Central Oklahoma Master Conservancy District (COMCD) is a water district formed in 1959 through the United States Bureau of Reclamation (BoR) to create the Lake Thunderbird Reservoir and manage the water supply for the central Oklahoma cities of Norman, Del City, and Midwest City. A map of the COMCD service area is provided in Figure 1.

COMCD's infrastructure includes, among other pipelines, the Del City Pipeline ("the pipeline"), constructed in the 1960s, which supplies raw water from a relift pump station on the south side of Interstate 240 to the Del City Water Treatment Plant (WTP). The existing AWWA C302 non-cylinder concrete pipeline is 18-24 inches in diameter.

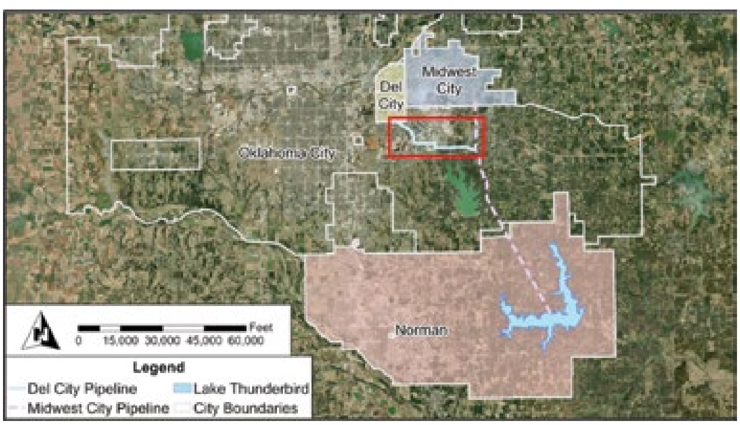


Figure 1: COMCD Municipalities, with Del City Pipeline Highlighted

The pipeline is approximately 34,300 linear feet (LF) in length. (Roughly 7,000 LF of the pipeline is within the boundaries of Tinker Air Force Base (AFB) and was not included in this project.) A map of the Del City Pipeline alignment is provided in Figure 2.

While the Del City Pipeline supplies municipal water to Del City, nearly the entire pipeline is contained within the limits of Oklahoma City and Tinker AFB. The pipeline begins at the COMCD Relift Pump Station on the south side of Interstate 240, travels northwest across Interstate 240, undeveloped lands, Tinker AFB, and then eventually through several single-family residential

Figure 2: Existing Del City Pipeline Alignment

neighborhoods before ultimately reaching the Del City WTP. The pipeline was constructed while nearly the entire alignment was undeveloped land. In the ensuing decades, residential neighborhoods and commercial properties were platted and built directly on top of the pipeline, resulting in an easement with very limited space for construction and some development quirks; as seen in Figure 3 below, an entire storage unit facility was built around the pipeline (bottom left) and a neighborhood was built with the pipeline bisecting residents' front yards (bottom right).

Figure 3: Development Around Del City Pipeline (Google Earth, 2021)

Throughout its history, the pipeline has had numerous issues. In addition to the aforementioned tight development around its alignment, the pipeline has required 350+ point repairs, due to failures at joints and circumferential cracking at different locations

along the pipe. Two main methods of point repair have been utilized:
1. During the first several decades, repairs were conducted by excavating the failure location and pouring large amounts of concrete to encase the failure.
2. More recently, pipe repair collars (see Figure 4) have been used.


Figure 4: Pipe Repair Collar on Del City Pipeline

The cause of these failures is attributed to poor installation methods – during initial construction the project did not have a full-time construction inspector, and excavation for these point repairs has revealed the pipe was bedded with a mix of in situ soil, large rocks, concrete debris, and other miscellaneous trash that can impose point loads on the pipe material.

Because of the extensive number of point repairs, the pipeline has had and continues to have high lifetime operations and maintenance costs. Many of these point repairs are located in the residential neighborhoods built over the pipeline, which increases the cost of the repairs and directly impacts residents. Therefore, COMCD considered the pipeline inadequate for continued use in its current state and requiring of rehabilitation and/or replacement.

2. PROJECT OVERVIEW

To address the challenges referenced above, COMCD retained Plummer Associates, Inc. (Plummer) to design improvements to the existing Del City Pipeline. At project onset, Plummer was presented with the following project constraints:

1. COMCD required:
   a. That no permanent easement acquisition be necessary
   b. The improved pipeline to have minimal (if any) reduction in hydraulic capacity
   c. The trenchless liner to be a fully structural liner, meaning it is not reliant upon the host pipe (the existing pipeline) for any structural support
   d. Construction to have minimal impact on local residents
2. Del City WTP personnel required:
   a. That each shutdown for installation of the trenchless liner last no more than three weeks
   b. The pipeline to be in service for at least one week between each shutdown to allow plant to be recharged using well water
   c. That shutdowns only occur during low-demand winter months, between October and February

From these constraints it was determined that the following approach would be used:

1. In the undeveloped areas (such as those east of Tinker AFB) where COMCD's easements are up to 66 feet wide and no development impedes site access, the existing pipeline would be replaced by a parallel 24-inch ductile iron (DIP) pipeline.

> *"During installation, the liner is placed in tension."*

2. In the developed areas and at all Oklahoma Department of Transportation (ODOT) crossings, the existing pipeline would be lined trenchlessly using the most economical method that met project constraints.

The existing pipeline within Tinker AFB boundaries (approximately 7000 LF, as previously mentioned) would be left in place, with the new Pipeline sections connected at each end. (This section of pipeline was re-aligned in the 1970s to allow for an expansion of a General Motors assembly plant. The land on which it was re-aligned was later acquired by the US Air Force and annexed into Tinker AFB. This section of pipe is constructed of C301 Prestressed Concrete Cylinder Pipe (PCCP) and has not experienced the failures that plague the remainder of the pipeline, although it is nearing the end of its useful life.

3. TRENCHLESS INSTALLATION METHODS

Based on the trenchless constraints listed above, Plummer considered four technologies:

Pipe Bursting

Pipe bursting allows for replacement of a pipeline by cracking ("bursting") the existing pipe in place utilizing a bursting head while simultaneously pulling a new, replacement pipe attached to the bursting head through the existing space in the process. Pipe bursting requires limited entry and exit pits, and all construction can usually be completed within existing easements and public Right-of-Way (ROW). Proper access to those areas is requisite but usually does not require additional permanent easement acquisition.

After discussions with COMCD staff, pipe bursting was deemed impractical. Pipe bursting cannot easily cut through the repair methods mentioned above in the Introduction (concrete encasement and pipe repair collars) and there are no comprehensive records for the repair locations. Therefore, prior to the existing pipeline being burst, all of the repair collars and encased sections would need to be located and removed, greatly increasing disruptions to neighborhood residents as well as increasing costs and installation times.

Cured in Place Pipe

Cured in Place Pipe (CIPP) for pressure applications involves pulling a resin-saturated reinforced felt liner through the existing pipe and inverting, expanding, and curing the liner using water or steam, thereby fixing leaks and structural issues. For pressure applications, CIPP is a higher-cost trenchless rehabilitation method on a per linear foot basis than pipe bursting, but unlike pipe bursting does not disturb the outside of the pipe, meaning that point repairs can be left in place. CIPP requires that the existing pipe be completely cleared of blockages and cleaned but bonding to the host pipe wall is not necessary and the CIPP can be designed to be fully structural with no support necessary from the host pipe.

In gravity flow situations, CIPP can be installed in lengths of up to 1,000 LF between insertion pits or manholes, but in pressure applications (such as on this project) the maximum installation length is reduced to approximately 600-700 LF. This project has uninterrupted sections of up to 2,500 LF in residential neighborhoods without easily accessible locations for pits. CIPP would require several pits to be placed in residents' front yards or backyards, increasing costs and disruption to the public. Additionally, the cost of installing Pressure CIPP can be significantly higher than that of other trenchless rehabilitation technologies. The higher installation cost combined with the disruption to the residents made CIPP a non-viable trenchless rehabilitation option.

Traditional Sliplining

Traditional sliplining involves pulling a liner (frequently HDPE or fusible polyvinyl chloride (PVC) pipe) into an existing larger-diameter host pipe. The outer diameter of the pipe liner is smaller than the inner diameter of the host pipe, allowing it to be easily pulled into and through the host pipe. Once the liner is in place, the annular space between the liner and host pipe is typically grouted, as the liner is usually not fully structural and relies on the host pipe for strength.

This method of trenchless rehabilitation works well in many situations in which the hydraulic capacity loss due to the reduced inner diameter of the pipeline is less important (such as gravity lines and larger-diameter pressure pipelines where the increased friction coefficient counteracts the diameter reduction). However, for the smaller diameter pressure pipelines on this project, the change in the friction coefficient is not enough to make up for the hydraulic losses associated with the necessary reduction in diameter of the liner pipe. As mentioned, one of COMCD's primary requirements was that overall hydraulic capacity of the pipeline be minimally (or not) reduced. Therefore, this method was not considered to be viable for this project.

Compressed Fit HDPE Lining

A compressed fit HDPE lining is similar to traditional sliplining in that it involves pulling an HDPE pipe liner into an existing host pipe. However, a compressed fit liner is slightly oversized relative to the host pipe; that is, at its natural state the pipe liner has a larger outer diameter than the inner diameter of the host pipe into which it will be inserted. The system can be used for diameter ranges from 4 to 54 inches, is NSF approved for drinking water applications, meets AWWA C901 and C906 Standards, and can be designed with pressure ratings up to 250 psi. During installation, the liner is placed in tension and reduced in diameter using either a roller box or diameter-reducing die (see Figure 5), temporarily reducing the diameter, allowing it to be pulled into the host pipe. Once the liner is in place, tension is removed, letting it naturally relax and expand in diameter so that the outside of the liner is compressed against the host pipe's inside. The system does not require grouting and allows for the use of standard IPS or DIPS connections.

While this trenchless rehabilitation method also reduces the inner diameter of the host pipe (much like traditional sliplining), the compressed fit of the liner against the host pipe combined with the higher friction coefficient of the liner (versus the existing concrete pipe) means that flow capacity remains much closer, albeit still slightly lower, to the existing conditions. Because the open cut portion of the pipeline is to be upsized from 21 inches in diameter to 24 inches, hydraulic losses from the lined portions will be offset. This results in very similar hydraulic capacity as the existing system. For this project, this was the deciding factor between Traditional and Compressed Fit Modified Slip lining – the hydraulic losses from traditional sliplining were too great to be adequately countered by the upsized portions of the pipeline. An additional benefit of this solution is the elimination of corrosion as the liner isolates the flow stream from the host pipe wall.

Similar to most trenchless rehabilitation methods on the market, a significant amount of pre-work is necessary prior to installation of the liner pipe: The host pipe must be dewatered and inspected using a closed-circuit camera (CCTV) to locate any areas that may impair or damage the liner during the installation process. Problem areas identified in the inspection video require point repairs prior to lining. The line is then pigged with a sized steel die to remove any remaining debris and finally a short test section of pipe is run through the reducing box and then pulled through the host pipe to triple check that the liner will not be damaged during installation.

Additionally, compressed fit HDPE liners can be installed in lengths of up to 3,000 LF between insertion and receiving pits. This gives the contractor flexibility to place pits in locations that will be easily accessible and limit disruptions to neighborhoods as well as limit the number of shutdowns necessary for liner installation. Finally, installation of the HDPE liner can be conducted at speeds of up to 100 ft/min, allowing long pulls to be completed in a matter of minutes.

Figure 5: Compressed Fit HDPE Liner Insertion Pit and Roller Box (Aegion, 2019)

However, there are a few limitations with this method – large open areas are required for the stringing and fusing of liner material. Additionally, because of the tight fit between the host pipe and the liner, the liner may only be pulled through bends with no more than 11.25° of deflection. And finally, the pre-work mentioned above must be included when considering the total amount of time that the host pipeline may be out of service.

Ultimately, the compressed fit HDPE lining was chosen because it best fit within the project constraints. It allowed for:

1. The improved pipeline to have a similar overall hydraulic capacity when combined with the upsized parallel pipeline
2. Quick installation within the shutdown schedule of the WTP
3. A fully structural liner, such that the liner did not depend on structural support from the original concrete pipeline
4. Minimal disruption to local residents, due to the long pull lengths

Finally, it was the most economical trenchless installation method considered, making it the clear choice for this project.

> *Compressed fit HDPE liners can be installed in lengths of up to 3,000 LF between insertion and receiving pits.*

4. CONSTRUCTION

Construction Issues

Project construction began with installation of the open cut sections of the pipeline in October of 2019. While construction of the open cut and bored sections of the pipeline had only minor schedule limitations, the trenchless liner was required to be constructed between October and March. Without enough lead time to review submittals and procure liner materials, installation of the trenchless liner was delayed until Winter 2020-2021.

During this waiting period the first construction issue came to light. Record drawings showed the existing pipeline under I-240 to be 21 inches in diameter. However, field measurements during a tie-in shutdown revealed the pipe to be 24 inches in diameter. There was not a bid item included for 24-inch liner and a change order was required for the increased material costs as well as the larger equipment that would be necessary to mobilize and complete the pull.

The second construction issue arose while the Contractor was attempting to CCTV a section of the pipeline to verify the location of a material and diameter transition located under a section line road. The initial line that was excavated was partially filled with soil. Further investigations verified the depth and location of the pipeline as shown on the record drawings and a vacuum truck was used to clean out the line, but the camera kept encountering blockages; each time, the camera was removed, and the blockage cleaned. The camera eventually encountered an electrical conduit that had been installed through the pipe using horizontal directional drilling (HDD). With each blockage, it became more apparent that this pipeline could not be supplying water to the Del City WTP. The contractor moved five feet laterally and dug beside the exposed pipeline and located a parallel pipeline at the same elevation. Finding this parallel pipeline indicated that the contractor had originally exposed an abandoned section of pipeline with the same material and diameter as the one in service. This abandoned segment was not shown on any of the original project drawings or record drawings and none of the parties could determine how or why it was originally installed.

The project also encountered two major weather-related construction issues. On October 26-27, 2020, a historic ice storm swept through central Oklahoma, downing thousands of trees throughout the region, and leaving hundreds of thousands without power. The Del City WTP's only source of water during construction shutdowns are aging wells that supplement water supply as demand dictates. As a result of the ice storm, the City lost four out of their seven wells due to various issues. This meant that they could not produce enough water to meet demand for upcoming shutdowns. The liner installation had to be delayed by two weeks and the shutdown period shortened from three weeks to two weeks, offering less room for error. Additionally, a historic cold front and snowstorm descended on Oklahoma City between February 8-19, 2021. As with the prior ice storm, this event caused major electrical and water supply issues throughout central Oklahoma and required the shutdown of work on the project. The contractor was in the middle of the last two liner pulls and was required to stop work and return the pipeline to service in case the wells shut down during the storm.

Figure 6: Winch and 90° Pulleys in Liner Receiving Pit

Additional construction issues arose with regards to anticipated insertion and receiving pit locations and conflicting utilities. Due to the stiffness of the liner pipe and the size of the equipment necessary to pull it through the host pipe, insertion and receiving pits require a large amount of room. Utility locates were called in during design and the surveyor picked up all the utilities that were marked, but multiple unknown conflicting utilities were discovered during field verification in critical areas. This necessitated moving several pit locations to avoid existing utilities, delaying scheduled shutdowns.

Liner Installation

Once the installation shutdown was scheduled and the equipment moved into place, the liner installation typically occurred without major challenges. The construction workflow was as follows:

1. Excavate all pits, move equipment into place, and fuse all HDPE pipe.
2. CCTV the existing line, identifying areas requiring repair prior to liner insertion. The identified areas are then repaired or removed.
3. Snake the winchline that pulls the liner and all pigs through the host pipeline.
4. Pull through a cleaning pig to remove any debris or irregularities from the inside of the pipeline.
5. Pull through a steel truthing pig (sized to the same outside diameter as the liner) to ensure that the liner is sized properly for the host pipeline.
6. Pull a short (fewer than 20 LF) test section of HDPE liner to ensure that the actual pipe liner will pull through without damage.
7. Pull the reduced-diameter HDPE liner into the host pipeline.
8. Allow the liner pipe to relax for 24 hours prior to making pipeline connections.
9. Remove all equipment, make final connections, conduct leakage test, and backfill pits.

Figure 6 shows the winch setup during one of the trenchless pulls. Note that, because of limited space within the pipeline easement (an OKC street is immediately behind where the photo was taken), the contractor utilized two 90° pulleys so that they could pull the liner into place with the winch pulling in the opposite direction.

5. LESSONS LEARNED

From this project, there are several lessons that have been learned. These include:

1. Compressed-Fit HDPE liners are a specialty product that, while not right for every project, is a good option for certain applications.
2. Record drawings are extremely useful but only go so far:
   a. Field verification of record data prior to construction is necessary to ensure accurate data. Shutdowns during design were not allowed so verification of the existing pipe was by record only. Next time, even though it comes with more upfront cost to the client, more effort will be placed on securing additional design data.
   b. CCTV during design of any pipelines to be rehabilitated can save substantial time and effort during construction. This allows additional verification for point repairs and coordination with property owners in advance of construction.
3. Early coordination with the manager of the WTP on shutdown schedules is critical. The shutdown schedule had to be revised twice to allow for federally mandated water quality testing. This could have been avoided with earlier shutdown coordination.
4. The three weeks allowed for each shutdown was determined assuming that the Del City WTP had full capacity of its water wells. However, weather-related issues during construction reduced capacity to as little as two wells at times, shortening shutdown lengths and requiring additional time between shutdowns for the WTP to recharge its system. It would be good practice to prepare a risk register for discussion with the client and the WTP manager concerning shutdown risks.
5. Close coordination between affected parties is useful for the success of the project:
   a. Plummer relied upon the expertise of contractors to provide guidance for a specialty product, worked closely with several governmental entities to ensure that all rules and regulations

were being followed, and coordinated closely with Del City WTP personnel to ensure that the construction could fit their limitations.

b. However, it is also important to communicate with all parties on the system limitations that can cause potential setbacks during construction.

6. CONCLUSION

Ultimately, the compressed fit HDPE liner was the right tool for this project. In addition, the project has been successful because all involved parties have been willing to coordinate closely to ensure that the design meets the needs of COMCD and Del City, that construction was as seamless as possible, and ultimately that the people of Del City will have a reliable raw water pipeline for 50+ years.

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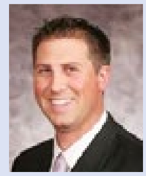
ABOUT THE AUTHORS:



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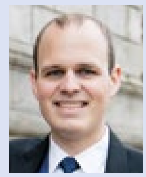

***Robert Weinert, P.E.**, has nearly seven years of experience working on the planning and design of conveyance systems in Oklahoma and Texas, including 6-inch to 72-inch diameter water and wastewater pipelines, pump stations, lift stations, and ground storage tanks. This includes experience coordinating with various clients, consulting firms, utilities, and government entities.*

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Never Settle!

Importance of Settlement Analysis and Monitoring in Trenchless Design & Construction

By Stefan Goerz, CCI Inc.

INTRODUCTION

A major concern among third party owners when trenchless projects are constructed near their infrastructure is settlement. Settlement of the surface can have detrimental effects on roads, railways, buildings, pipelines or other facilities. In the past trenchless installation methods have been the preferred method of these third party owners to cross beneath their infrastructure because of the less intrusive nature of the construction. However, there have been growing concerns of settlement and damage from over excavation, and therefore detailed assessments and plans at the application stage have become a more common requirement, as well as including a plan for inspection or settlement monitoring in the field during construction.

Surface settlement during trenchless construction can occur in various ways. Systematic settlement occurs from normal construction practice. This type of settlement is generally small in magnitude and occurs over a consistent settlement trough extending perpendicular to the trenchless alignment. Collapse of the overcut or annular space in the long term, dissipation of the fluid used during construction leading to volume loss, and convergence of the borehole wall during construction due to excavation and support pressure imbalance are some of the causes of systematic settlement. Random or unplanned settlement is a more severe condition that can be much more detrimental. These types of settlements are unpredictable and can form sinkholes or large amounts of surface displacement at locations along the alignment that would be considered undesirable, at the very least, and in many cases dangerous.

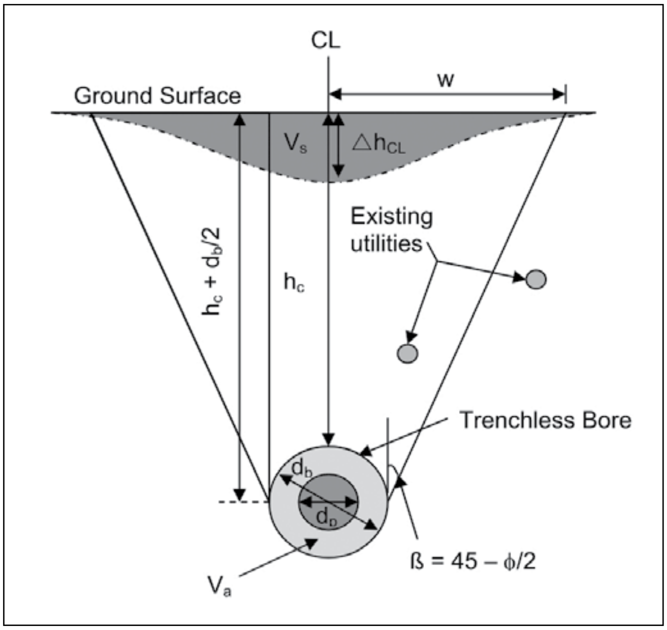


Figure 1: Graphic shows the projected settlement trough development (Bennett etal. 2008)

SYSTEMATIC SETTLEMENT AND MITIGATION BY DESIGN

During the design and permit application phase of a trenchless project, it is important to characterize the subsurface conditions, and assess the methodology selected for suitability in those conditions. There are risks associated with shallow depth of cover in some geology such as loose granular soil, and there may be not as much with others, such as clay or bedrock. It is very important to understand the trenchless method selected, and how the support system (I.E. fluid) is used during construction. Systematic settlements can be assessed using simple calculations and Normal Probability Methods (Bennett etal. 2008, "Analysis and Mitigation of Settlement Risks in New Trenchless Installations"), or using more sophisticated finite element analysis models.

The depth of the trenchless design can be adjusted to maintain the calculated settlement below the required limits. If two parallel alignments are planned, this needs to be considered in the settlement assessment as both alignments can influence each other and increase the total surface settlement. In the case of parallel alignments, the spacing can be increased which is another design mitigation to decrease the total settlement. Requirements from the third party owners issuing permits may have settlement tolerances that need to be adhered to for their infrastructure. These tolerances need to be met prior to issuing a final design for the permit application.

UNEXPECTED SETTLEMENT AND MITIGATION BY CONSTRUCTION

Concerns for unexpected settlement during construction are more difficult to manage at the design stage, and mainly rely on

Figure 2: Robust self-contained GPS units that can be utilized to monitor settlement remotely

Figure 3: Robotic Total Station or Levels can also be used by qualified personnel to complete the monitoring or construction surveys

the contractor's utilization of best practice and proper mitigation strategies. Over-excavation is generally the leading cause of unexpected settlement. This happens when the volume of soil removed from the tunnel or borehole is greater than the diameter of the downhole tools or cutting faces used. Sand, Gravel, cobble or other unconsolidated granular soils are the most prone to over excavation if the support fluids aren't adjusted accordingly. These soils do not exhibit cohesive strength, and therefore once confining pressure is relieved the soils will collapse. The confining pressure that is relieved during excavation is generally replaced by fluidic support pressure, which stabilizes the borehole wall. The properties of the fluid need to be designed in accordance with the geotechnical formation because if the fluid dissipates into the surrounding soil its support function is lost, and there is an increased risk of collapse or over excavation. Specific to HDD construction, drill path designs which include portions of the hole above HDD entry elevation are understood to have limited, if any fluid support pressure. In cases where sand or other loose granular soils are present at elevations above rig elevation, sinkholes or excessive over excavation are likely. Additional risks to be considered in the case of tunnelling are the size of the soil grains relative to the tunnelling equipment internals. If a large cobble is encountered and passes through the crushing chamber without being broken down there is a risk of blockage leading to limited face pressure and collapse of the soil, at the face of the formation. In both tunneling and HDD applications, improper rate-of-penetration can also lead to over-excavation. These are a few scenarios which can lead to unexpected settlements during trenchless construction. It is important to identify these issues for a particular project and for the contractor to have mitigation plans for these potential settlement hazards. It is also important for the contractor to have contingency plans available and ready to implement in a short timeframe to protect the public in the case any unexpected settlement does happen. Although contingency plans are very important, the best way to eliminate unexpected settlement is by prevention and mitigation through the contractor following good construction practices.

MONITORING

Once the planning, design, and permitting phase has been completed and approved, a monitoring plan needs to be completed and implemented during construction. The monitoring plan needs to outline the methods and means used to systematically measure the ground surface and report any changes. These plans should also include the visual observations that would take place during construction to monitor potential locations of over excavation. The monitoring could include surface and subsurface monitoring points laid out along the projected settlement trough. These points can be measured using conventional survey techniques, remote highly accurate GPS units or other means, however the accuracy of the measurement system needs to be considered.

Generally, a measurement system with errors within +- 1mm (1/32") are required to ensure reliable measurement. It is important to note that if settlement in excess of the tolerances outlined by the third party owner are realized, there may be a requirement to stop construction and review, or even submit a new crossing plan.

This could be detrimental to the project, and therefore, the engineer of record needs to ensure the measurements taken are trustworthy and reliable. Visual observation and communication with the contractor are other tools that should be utilized in order to make a proper assessment of potential unwanted settlement. Following the completion of construction, it is important to communicate the results of the monitoring to the client, and/or the third party owner, and state that the construction has been complete and there is no expectation of further settlement.

Normally this is the final stage and closes out the settlement monitoring process, and allows the third party owner as well as the client to move forward confident their infrastructure is safe. Depending on the client, the timeframe for how long after construction the settlement measurements are required to be monitored can vary. In cases where excessive or continuing settlement are identified, additional measures such as grouting may be necessary. Although such instances are rare (with proper front end design and planning), accurate monitoring ensures these issues are caught and addressed before they can become catastrophic.

CONCLUSION

Settlement of third party above ground or underground infrastructure has become a prominent concern that needs to be addressed both in design and through permit application, as well as construction mitigations. There are many forms of systematic settlement that can be predicted with relative confidence, and these forms of settlement should be mitigated during design in order to set the contractor and the project up for success. Unpredictable settlements are of much more concern as they may happen rapidly and in undesirable locations. These types of settlement need very careful input from the contractor to assist in providing mitigations for these issues. In addition, if these large, unpredictable settlements do occur, it is very important that contingency plans are developed and implemented in a very short timeframe to ensure public safety is maintained.

Observations and careful monitoring needs to be a focus during the construction planning and the monitoring program must be specific to the project. Communication between all parties is paramount to ensure clear instruction is given and trust between third parties, owners and contractors are maintained. The final documents written for the project need to summarize the construction works, and issues that arose and document that there is not expected to be issues moving forward. This document is important to give peace of mind to all owners that their infrastructure will be safe in the future.

The trenchless industry needs more successful stories in the area of settlement monitoring. Sinkholes, heaves or other settlement related mishaps place a black mark on the trenchless industry. Proper planning by the owner, consultant and contractor can limit many negative occurrences which will move our industry even further forward and establish a much lower perceived risk for third party owners.

ABOUT THE AUTHOR:

Stefan Goerz has over 10 years of direct experience in projects related to trenchless pipeline construction, geotechnical investigation and assessment for pipeline and trenchless design, geotechnics for tunnel/microtunnel design as well as geohazard assessment for linear infrastructure. Stefan is the Geotechnical Manager for the CCI Group of Companies.

Unique Design Reroutes a Critical Force Main while Minimizing Community Impact: City of Lubbock

By: Kent Riker, PE, Provenance Engineering

THE BACKGROUND

The City of Lubbock serves over 250,000 customers by operating a wastewater collection system with over 50 lift stations and 2 water reclamation plants. The City's second largest collection system lift station, Lift Station 31, serves the critical hospital district of Lubbock. Lift station 31 was replaced 15 years ago. At that time, the associated force main still had some functioning years ahead of it. 15 years later the force main was deteriorating. The 70-year-old, 14-inch diameter cast iron pipe had reached the end of its useful life. It was time to take action. Kent Riker, PE, and his team at Provenance Engineering was selected to perform a conceptual analysis and route study to provide a solution for this aging force main, and design 4,475 linear feet of 14-inch new force main sewer piping with minimal disruption to the existing system. The route study revealed that replacing the alignment of this existing infrastructure would not come without challenges.

THE PROBLEMS

The force main sewer pipe of Lift Station 31 was under a concrete, high-traffic, major thoroughfare. Furthermore, many high traffic establishments were accessed by way of the thoroughfare, including Covenant Health System Hospital, Commander William C. McCool Academy Middle School, and a COVID Testing Center. See Figure 1. Closing this roadway and disrupting traffic to these vital community resources could cause detriment to the citizens of the City of Lubbock. Kent's team would have to find a way to minimize community impacts. Also high on the priority list was ease of long-term maintenance. The city of Lubbock desired a cost-effective solution with flow capacity for future needs. The project budget required the engineers to utilize the systems existing pumps and receiving trunk sewer main. Because pump replacement was not included in the scope of the project, the system hydraulics were critical to maintain successful operation of the existing pumps. The new system curve would have to match the optimal operating range of the existing pumps.

Figure 1

THE OPTIONS

The conceptual analysis and route study concluded with several options to move the project forward: rehabbing the existing force main in-place, full replacement with a new force main, or performing both options to have redundancy and flexibility for future capacity. Additionally, the option for the new force main included various route alternatives: parallel to the existing force main in a busy thoroughfare or new, longer alignments (of up to 50%) to avoid the concrete, high traffic area.

Three challenges were identified with rehabbing the existing force main. The first challenge was the physical location of the existing force main under Quaker Ave, the busy concrete thoroughfare. Work on this street would be more expensive and complicated than construction on nearby asphalt roads. The second challenge came in the form of allowable down time. Lift Station 31 could not be out of service for more than 2 hours without bypass pumping. Replacing the existing force main in place would require significantly more down time than constructing a new line. This leads to the third challenge, which was the additional cost of bypass pumping. These three challenges made the option of constructing a whole new alignment the obvious choice for the city.

Figure 2

> *The Lift Station 31 Force Main Reroute Project was a huge success for the City of Lubbock!*

ANALYSES OF NEW ALIGNMENT ALTERNATIVES

With the decision made to construct a new alignment, the team now focused their attention on determining which route the piping would take. Three alternative routes for the new alignment were analyzed during the route study phase of the project. See Figure 2.

A grading rubric was developed for the three alignment alternatives. The rubric was used in determining which alternatives were optimal.

The Rubric includes the following criteria: Capital Cost, Social Impact, Constructability, Ease of Maintenance, and Impacts to Existing Pumps. When analyzing the capital cost of each alternative, Provenance considered the direct costs of material and labor. Social Impact was considered very important due to the high visibility of the project, and potential disruptions to business and social activities due to the project. Constructability was the third most important criteria since poor constructability can add considerable risk and potential cost to a project. Impacts to the existing pumps ended up being one of the largest differentiators between the alternatives.

For each of these criteria, Provenance graded each alternative with a score between 1 and 5. The best alternative for any given criteria received a ranking of 5. If no advantage for a given criteria could be determined for any one of the alternatives, all alternatives were given a score of 5. No averaging weights were applied to the criteria since no criteria was considered more important than any of the other criteria. This method resulted in a score out of 25 points for each alternative. A summary of the rankings can be found in Figure 3.

Alternative 1 was selected due to its high ranking in each of the criteria.

	Alternative 1	Alternative 2	Alternative 3
Capital Cost	5	2	2
Social Impacts	5	4	2
Constructability	5	3	2
Ease of Maintenance	5	4	3
Impacts to Existing Pumps	3	1	5
Totals	**23**	**14**	**14**

Figure 3

FINAL DESIGN

Once Alternative 1 was determined to be optimal, the route was refined in final design.

During final design pipe diameter, and pipe material were evaluated to ensure that the new hydraulic system curve mirrored the existing system curve. The four factors that affected the system curve were pipe diameter, pipe material (C-factor), pipe alignment, and discharge elevation. The discharge elevation is the same between the existing and new alignments. The pipe material changed from old cast iron pipe to PVC, thus increasing the C factor and decreasing energy losses. However, the C factor did not change the system curve dramatically enough to justify a change in pipe diameter. The pipe diameter for the new force main remained at 14 inches. The existing lift station pump curve was checked to confirm the new system curve would be within pumps preferable operating range.

Provenance Engineering recommended re-routing the force main using PVC pipe. This alternative provided the most cost-effective solution, while minimizing social impacts, reducing constructability risk, providing long-term ease of maintenance access, and the ability to operate the existing pumps within their operating range. The project included a Base Bid of traditional bell and spigot pipe installed by open cut and an Alternate Bid of Fusible PVC installed primarily by Horizontal Directional Drilling.

BID ALTERNATIVES

During Design, HDD Installation with C900 Fusible PVC DR18 was raised as an alternative to open cut installation with bell and spigot C900 DR18. It was decided to bid the open cut alternative as a base Bid and the HDD with Fusible PVC as an alternative bid to make the market decide between the two.

This bid alternative represented a challenge for the designers since some additional design checks were required after the addition of the alternative Bid Item. Because HDD would require a different vertical profile than the open cut installation method, design checks were done on Soil Types, Water Table, required depth of force main. Design checks were also completed on Construction Staging Areas, and the max allowable pull lengths of the selected 14-Inch C900 DR 18 pipe.

	Alt. Bid HDD with Fusible PVC	Base Bid Open Cut with Bell & Spigot
Capital Cost	5	5
Social Impacts	5	3
Constructability	4	5
Schedule	5	2
Totals	19	15

Figure 4

ANALYSES OF BID ALTERNATIVES

The contract solicitation was released in October of 2020. Contractors submitted competitive seal proposals to determine the best value solution for City, however on Bid Day, the purchasing agent was unavailable, and bidding got pushed back to Jan. 2021. When Bids finally came in, the low bidder for the Opencut base bid was $792,000 and the Low Bidder for the alternative Bid was $787,700. There was no appreciable difference in cost between the two bid alternatives.

Once the Bids were submitted, an analysis of the two alternatives was carried out using a similar grading rubric as previously discussed. However, this grading rubric utilized the following criteria: Capital Cost, Social Impacts, Constructability, and Schedule. Social Impact and Schedule ended up being the largest differentiators between the two alternative bids. The results of the rubric can be found in Figure 4.

The specific advantages that were identified during the analysis for HDD including minimal traffic disruption, reduced street repair, ability to install new force main without exposing 6-inch

Figure 5. One of Lubbock's first Fusible PVC pipeline and one of the city's first full HDD pipe installations.

gas lines and preventing the disruption to middle school and residential neighborhood traffic patterns. Furthermore, the time of installation using the HDD method was shorter than the time required to replace the street and curb with an open-cut method. In turn, the HDD method was faster and caused less disruption to the surrounding areas.

Some specific benefits that the Fusible PVC pipe material provided included the reduced cost advantage reflected in the bid alternative; the significant reduction in the number of gasket joints; the ability of use standard ductile iron fittings during installation and with any future repairs.

CONSTRUCTION

Construction began with a pipe fusion demonstration for the City of Lubbock and Provenance Engineering as multiple 500-foot segments of Fusible PVC force main were fused together at the main staging area along Salem Avenue. After the demonstration the contractor, MH Civil, began installation of the Fusible PVC via was able to install the new Fusible PVC force main while the Middle School was out on summer break, thus eliminating any interruptions to the school. The construction time savings by using the HDD method coupled with Fusible PVC allowed for float in the schedule that would be need due to supply chain delays effecting other materials and addressing an unforeseen field condition. By selecting the HDD installation method, the City of Lubbock enabled the critical intersections to remain open for not only neighborhoods but also a COVID-19 drive though testing site along Brownfield Drive.

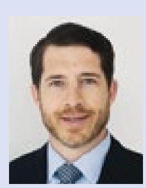
Despite volatile market and supply chain disruptions the Substantial Completion date was met at 180 days.

- ➢ Only one Change Order due to unforeseen field condition
- ➢ Total Change Order – $10,400 [$798,075 total]
- ➢ Final Completion – 45 additional days [225 days total]

MH Civil, finalized construction of the project with cooperation from the owner, City of Lubbock, and the project designer, Provenance Engineering, and Underground Solutions' Fusible PVC.

The Lift Station 31 Force Main Reroute Project was a huge success for the City of Lubbock. The city's staff were very helpful and great to work with on this project. This project was the city's first Fusible PVC pipeline and one of the city's first full HDD pipe installations. MH Civil provide a quality installation without delays and were fair and honest organization. The project substantial completion schedule was achieved. The force main has been in full operation for over six months with no problems to date.

ABOUT THE AUTHOR:



***Kent Riker, PE**, is a civil engineer with experience that includes long-range planning through construction of all phases of municipal water and wastewater systems. His technical expertise has been focused on water/wastewater treatment and conveyance systems. He is the Founding Principal of Provenance Engineering, a firm solely focused on the water/wastewater industry, and he serves as the firm's President.*

Direct Design of the Atoka Large Diameter Reinforced Concrete Microtunneling Pipe (RCMTP)

By: Carl Pitzer P.E., Thompson Pipe Group

INTRODUCTION

Located in rural Byng, Oklahoma, the primary intent of the Atoka Canadian River Crossing project is to create a crossing under the Canadian River by tunneling an 84-inch RCMTP for the new 72-inch steel water pipeline being constructed. The project also requires the installation of a 72-inch casing in order to bury an existing 60-inch aerial crossing. The 60-inch aerial crossing has sustained damage in past floods, and the construction of the new pipeline creates a great opportunity to bury the existing line at a lower cost.

Designed to start tunneling from a central shaft at a depth of 120 LF below ground and proceed in two directions toward the surface at a slope of 6-8 percent, the Atoka Microtunnel pipe design required closer inspection from the start. Figure 1 shows the early design concept for the microtunneling drives. Each drive is roughly 1,200 – 1,500 LF long. Due to the rural nature of the project, the shaft sizes are large enough to allow for the use of 20-foot long pipes. The specifications left the pipe length up to the contractor.

The initial specifications called for a wetcast ASTM Class V Wall C Jacking pipe and pipe joints to be in accordance with ASTM C443. An allowable jacking load with a factor of safety of 3 was required to be provided and, initially, there was a curve of radius R= 6,000LF planned for one of the drives.

After reviewing the project conditions during the submittal phase, Thompson Pipe Group (TPG) proposed some changes after further discussion with the contractor so that the pipe design would be more in line with the project requirements. These changes included designing for a hydrostatic head pressure much higher than specified and utilizing the direct design method prescribed in the ASCE 27-17 - Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction over the specified ASTM C76 Standard.

HYDROSTATIC HEAD PRESSURE

The project specifications called for the pipe joint to be in accordance with ASTM C443: Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe. ASTM C443 calls for the joint to be subjected to a 13 psi (30 foot) pressure head for 10 minutes without leaking. The test can be performed internally or externally. The project specifications amended C443 and called for the joint to withstand 20 psi of hydrostatic head for 10 minutes during hydrostatic testing. After the project conditions were further evaluated, TPG and the contractor felt that the 20 psi joint specification had the potential to underperform.

The external hydrostatic pressure head is found by using Eq.1:

Eq.1: $P = \varrho g h$

P = hydrostatic pressure

ϱ = density of the liquid

g = acceleration due to gravity

h = height of the water column

Using the density of water and the acceleration due to gravity on earth the equation can be shortened to:

$P = 0.43h$

The height of the water column (in feet) is the only variable that determines the external hydrostatic head pressure (in psi) Figure 2 shows the water table height in the approximate location of the shaft. The groundwater level was measured to be at elevation 830

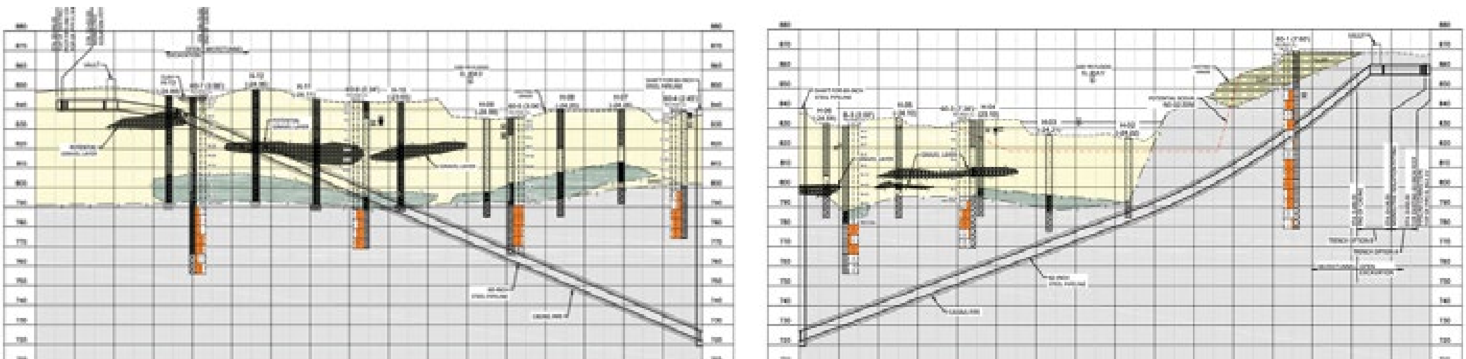


Figure 1 – Initial Atoka Microtunneling Scheme

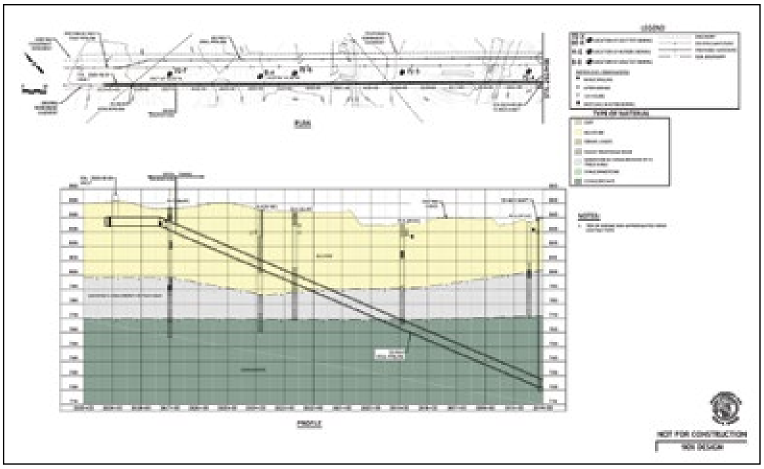


Figure 2 - Ground Water Elevation

C76 – 14

TABLE 5 Design Requirements for Class V Reinforced Concrete Pipe[A]

NOTE 1—See Section 5 for basis of acceptance specified by the owner.

The strength test requirements in pounds-force per linear foot of pipe under the three-edge-bearing method shall be either the D-load (test load expressed in pounds-force per linear foot per foot of diameter) to produce a 0.01-in. crack, or the D-loads to produce the 0.01-in. crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in feet.

D-load to produce a 0.01-in. crack	3000
D-load to produce the ultimate load	3750

Reinforcement, in.^{2}/linear ft of pipe wall

Internal Designated Diameter, in.	Wall A: Concrete Strength, 6000 psi				Wall B: Concrete Strength, 6000 psi				Wall C: Concrete Strength, 6000 psi			
	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]	Wall Thickness, in.	Circular Reinforcement[B] Inner Cage	Circular Reinforcement[B] Outer Cage	Elliptical Reinforcement[C]
12	[A]	...	...	...	2	0.10	...	...	2¾	0.07[D]	...	...
15	[A]	...	...	...	2¼	0.14	...	...	3	0.07[D]	...	...
18	[A]	...	...	...	2½	0.19	...	0.16	3¼	0.10	...	...
21	[A]	...	...	...	2¾	0.24	...	0.21	3½	0.10	...	...
24	[A]	...	...	...	3	0.30	...	0.24	3¾	0.12	0.07	0.12
27	[A]	...	...	...	3¼	0.38	0.23	0.42	4	0.14	0.08	0.16
30	[A]	...	...	...	3½	0.41	0.24	0.45	4¼	0.18	0.11	0.20
33	[A]	...	...	...	3¾	0.45	0.27	0.51	4½	0.23	0.14	0.24
36	[A]	...	...	...	4	0.50	0.30	0.56	4¾	0.27	0.16	0.30
42	[A]	...	...	...	4½	0.60	0.36	0.67	5¼	0.36	0.21	0.40
48	[A]	...	...	...	5	0.73	0.44	0.81	5¾	0.47	0.27	0.52
54	[A]	...	...	...	[A]	......	...	...	6¼	0.58	0.35	0.64
60	[A]	...	...	...	[A]	...	...	...	6¾	0.70	0.42	0.78
66	[A]	...	...	...	[A]	...	...	...	7¼	0.84	0.50	0.93
72	[A]	...	...	...	[A]	......	...	...	7¾	0.99	0.59	1.10

Figure 4 - ASTM C76 Class V Wall C Specification

feet. The pipe invert leaving the shaft is at 720 feet. If water finds its way down to the lower elevation pipes, the pipe joints could be subjected to a hydrostatic pressure of 47psi.

Due to the discrepancy between the potential 47 psi head pressure and the 20 psi specified joint, it was decided to design the joint for the potential 47 psi.

The 500-year flood elevation is 854 feet, so any flooding during the project could further increase the hydrostatic pressure on the joint.

Due to the higher potential pressure, the joint was designed to 55 psi. Figure 3 depicts what this joint looks like. The design for the 55 psi joint was accomplished with a robust steel bell band. A ½ x 12-inch external steel bell band with a 1 ½ x 1 ½ -inch mechanical water stop is welded internally. The gasket utilized is almost 2 inches wide and 1.3 inches high. A gasket groove is cast into the spigot end to ensure the gasket remains seated during the tunneling operation and also acts to confine the gasket so a certain amount of compression on the gasket can be calculated. This in combination with the wetcast pipe structure ensured that the joint tested over the 47 psi potential. Another benefit of utilizing an external steel bell band in microtunneling pipe design is that the bearing area of the joint is maximized. The bell band also provides protection for the joint by keeping external elements like water, dirt, rocks, slurry, etc. out of the joint. Utilizing a wetcast pipe for an operation like this is equally important for the structural integrity of the pipe as well as the water tightness.

DIRECT DESIGN VS PRESCRIBED DESIGN

The specification called for the pipe design to be in accordance with ASTM C76 Class V Wall C. This is the strongest pipe

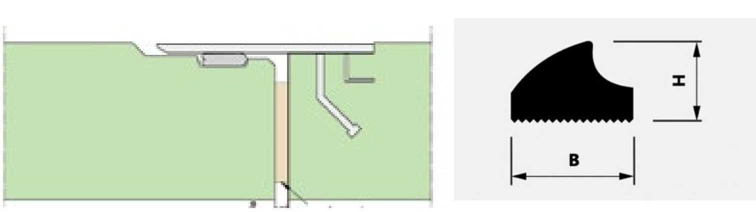


Figure 3 - Thompson Pipe Group Microtunneling Joint

classification in the C76 specification. The ASTM C76 standard prescribes the pipe wall thickness, reinforcement, and compressive strength in the concrete based on a D-Load requirement. This is shown Figure 4. You can also plug the requirement into a program like PIPECAR which will calculate what reinforcement is needed. Figure 5 shows an example of a PIPECAR analysis based on the required D-Load.

```
PIPECAR - 3EB -                              PAGE 2

      PIPECAR - THREE-EDGE BEARING - REINFORCING DESIGN
            72 INCH SPAN CIRCULAR PIPE
************************************************************************
S P E C I F I E D   D - L O A D S
----------------------------------------------------------------------
  DL.01 = 3000 LBS/FT/FT      DLult = 3750 LBS/FT/FT

C A P A C I T Y   R E D U C T I O N   F A C T O R S
----------------------------------------------------------------------
  PhiF = .95   PhiC = .95   PhiD = .9   PhiR = .9

D E S I G N   C O E F F I C I E N T S
----------------------------------------------------------------------
 Cm = 1.    Cmo = 1.    Cs = .6     Cx = 1.    Cmp = 1.

P I P E   S P E C I F I C A T I O N S
----------------------------------------------------------------------
WALL THICKNESS (IN.)---------------------------------------------   7.75
INSIDE REINFORCING COVER (IN.)-----------------------------------     1.00
OUTSIDE REINFORCING COVER (IN.)----------------------------------      1.00
NO. OF REINFORCING LAYERS----------------------------------------    2.
PIPE WEIGHT (LBS/FT)---------------------------------------------  2040.
CONCRETE STRENGTH (PSI)------------------------------------------  6000.
REINFORCING YIELD STRENGTH (PSI)--------------------------------- 65000.
REINFORCING ULTIMATE STRENGTH (PSI)------------------------------ 75000.
DEVELOPABLE STIRRUP STRESS (PSI)--------------------------------- 40000.
DESIGN CRITERIA-------------------------------------------------   YIELD
SPACING OF CIRCUMFERENTIAL REINF. (IN.)--------------------------      2.00
TYPE 2 REINFORCEMENT
   WELDED SMOOTH WIRE FABRIC, 8 INCH MAX. SPACING OF LONGITUDINALS
```

```
PIPECAR - 3EB -                               PAGE 3
R E I N F O R C I N G   D E S I G N   C R I T E R I A
------------------------------------------------------------------------
   FLEXURE STEEL AREA (FIRST YIELD) - (SQ.IN./FT)------------------  .726
   0.01 INCH CRACK STEEL AREA - (SQ.IN./FT)------------------------ .792
   0.01 INCH CRACK STEEL AREA WITH TYPE 3 REINF. - (SQ.IN./FT)-----  .696

   DIAGONAL TENSION STEEL AREA - (SQ.IN./FT)---------------------- 1.437
   MAXIMUM RADIAL TENSION D-LOAD - (LBS/FT/FT)-------------------- 3303

G O V E R N I N G   R E I N F O R C I N G   D E S I G N
------------------------------------------------------------------------
   INNER REINFORCING AREA - (SQ.IN./FT)---------------------------  .726
   OUTER REINFORCING AREA - (SQ.IN./FT)---------------------------  .475

 STIRRUPS ARE REQUIRED AT THE CROWN AND INVERT
   REQUIRED STIRRUP AREA - (SQ.IN./FT/LINE)----------------------- .197
   REQUIRED STIRRUP SPACING AND EXTENT----------- 16 LINES AT 4. IN.
```

Figure 5 - PIPECAR Analysis for ASTM C76 Class V Wall C

Figure 5 - PIPECAR Analysis for ASTM C76 Class V Wall C

Using a prescribed standard is that it does not allow for design of the project at hand and that the ASTM C76 standard, in particular, does not seem geared toward trenchless projects but more toward opencut installation.

One example of this is when it comes to the use of stirrups. ASTM C76 Class V Wall C will prescribe a certain reinforcement requirement and a 6,000 psi compressive strength concrete mix. When the prescribed combination of reinforcement and concrete is not strong enough to resist a certain D Load, stirrups are required at the crown and invert. During an open cut operation, the pipe top and bottom are marked to make sure the stirrups line up with the pipe crown and invert locations when the pipe is installed in the trench. What happens in a microtunneling operation though, if the pipe rotates during the drive and the stirrups end up at a location other than at the crown and invert of the pipe? Could the pipe fail? It would be hard to tell, because the pipe was manufactured to a specification not relevant to the project conditions. Using a standard like the ASCE 27-17 or DWA 161 allows for the pipe to be designed for the project conditions and considers the microtunneling operation.

Figure 6 is an example of how ASCE 27-17 guides the design for jacking pipe specific operations. If stirrups are needed, ASCE 27-17 calls out that they should be installed circumferentially to account for the uncertainty of where the pipe will end up after the tunneling operation is complete.

15.5.4 Extent of Stirrups

15.5.4.1 When stirrups are required at the invert or crown regions for shear strength or for shear and radial tension, they shall be spaced at s_v along the inner reinforcing and extend around the entire circumference of the pipe.

Figure 6 - ASCE 27 - 17 guidance for use of stirrups when designing jacking pipe

DWA-A 161

Appendix B (informative) **Minimum Specifications for the Structural Calculation of Jacking Pipes**

Construction project: .... Client: ....
Designer: .... Construction company: ....
Construction manager: .... Specifications by: ....

			Version 1	Version 2
Pipe DN		1		
Pipe material	Reinforced concrete (with/without inliner)	2		
	Vitrified clay	3		
	UP-GF (SN .....)	4		
	Other	5		
Jacking length	Linear metres	6		
Covering over pipe	min. $h_{ü}$ (m)	7		
	max. $h_{ü}$ (m)	8		
Traffic load	LM1	9	□	□
	LM 71 (1-/multi-track)	10	□ single-track □ multi-track	□ single-track □ multi-track
	Other (e.g. aircraft)	11	□ Type:	□ Type:
	None	12	□	□
Soil at pipe height	G1 non-cohesive	13	□	□
	G2 weakly cohesive	14	□	□
	Packing density *D*	15	□ loose □ medium density □ dense □ very dense	□ loose □ medium density □ dense □ very dense
	G3 cohesive mixed soils, silt	16	□	□
	G4 cohesive soil	17	□	□
	Consistency I_C	18	□ pulpy □ soft □ stiff □ half solid	□ pulpy □ soft □ stiff □ half solid
	Solid rock	19	□ weathered □ solid	□ weathered □ solid
Soil Cover fill	G1 non-cohesive	20	□	□
	G2 weakly cohesive	21	□	□
	Packing density *D*	22	□ loose □ medium density □ dense □ very dense	□ loose □ medium density □ dense □ very dense
	G3 cohesive mixed soils, silt	23	□	□
	G4 cohesive soil	24	□	□

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Appendix B *(continued)*

			Version 1	Version 2
	Consistency I_C	25	□ pulpy □ soft □ stiff □ half solid	□ pulpy □ soft □ stiff □ half solid
	Solid rock	26	□ weathered □ solid	□ weathered □ solid
	Minimum height of solid rock (bedrock) above pipe crest	27	m	m
Values deviating from Standard DWA-A 161/DVGW GW 312	Specific gravity in kN/m³	28		
	Friction angle φ′	29		
Groundwater in the construction state	min......... m above invert level max......... m above invert level	30		
Groundwater in the operating state	min......... m above invert level max......... m above invert level	31		
Jacking under compressed air in the pipeline	max ...... bar .... m water column	32		
Excess water pressure in the pipe	max ...... bar .... m water column	33		
Structural concerns for jacking processes in accordance with Standard DWA-A 125/DVGW GW 304	Working face support with fluid or slurry and continuous annular gap support of the entire pipe run from shield with documentation	34	□	□
	Other jacking method and continuous annular gap support of the entire pipe run from shield with documentation	35	□	□
	Overlap ≤ 1.0 cm (measured at the springing), without secured, continuous annular gap support of the entire pipe run	36	□	□
	Overlap > 1.0 cm (measured at the springing), without secured, continuous annular gap support of the entire pipe run	37	□	□
Grouting after jacking completed	None	38	□	□
	With insulation, or similar	39	□	□
Jacking route	Straight	40	□	□
	Bent, l/r, 1st curve R = m	41		
	Bent, l/r, 2nd curve R = m	42		
	Bent, l/r, 3rd curve R = m	43		
	Planned transition bends	44	□ yes □ no	□ yes □ no
Pressure transfer ring	Material	45		
	Thickness mm	46		
	Internal/outer diameter mm	47		
Construction length	Standard construction length pipe m	48		
Additional details		49		

Date: .... Signature: ....

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Figure 7 - DWA 161 - Jacking Pipe Design Project Condition Checklist

By making simple tweaks, ASCE 27-17 steers the pipe design to address issues that would come up in tunneling.

Figure 7 below is a simple checklist from Appendix B in the DWA 161 Standard. Reviewing a checklist like this when writing project pipe specifications or double checking pipe design before production can help eliminate grey areas in specifications or point out considerations that were missed.

CONCLUSION

A complete review of project specifications versus project conditions is necessary to ensure that a tunneling pipe is designed correctly for the project at hand. If a standard is called out that is a prescriptive specification versus a performance specification, it is imperative that the specification is vetted before the specification is put out to bid to ensure the pipe will meet the project requirements. On the other hand, if a direct design is specified and used, the design will have to be checked to make sure the correct project conditions were used in the design of the pipe.

REFERENCES

ASCE standard ASCE/CI 27-17: standard practice for direct design of precast concrete pipe for jacking in trenchless construction.

ASTM C76 – 14 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

ASTM C443- 12 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

Pipecar Indirect Design Program 3 – Edge Bearing Design and Analysis

Version 3.09 – 15 April 2002

Standard DWA-A 161E - Static Calculation of Jacking Pipes – October 2017

ABOUT THE AUTHOR:

Carl Pitzer P.E., *graduated with a bachelor of science in construction engineering from Oregon State University. After graduating he worked for Kiewit Infrastructure West on the SR520 Floating Bridge in Seattle, Washington as the structures field engineer. In 2015 he left the bridge world for pipes and started with Thompson Pipe Group. He is currently located in DFW, TX and manages Thompson Pipe Group's trenchless focus in North America.*

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Contact NASTT Education Specialist Kari Schiffner at kschiffner@nastt.org with any questions.

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Site Access Plan Case Study:

Lancaster Areas Sewer Authority Lower Little Conestoga Interceptor Rehabilitation Project - Phase 2

By: Eric Mathiesen, Sunbelt Rentals

Over the last few decades, technological advancements have provided new and innovative methods to accomplish trenchless construction and rehabilitation. Benefits associated with trenchless technologies, such as reduced infrastructure costs, have been complemented by advancements and optimization of the site access required to make this work possible. Site access is a critical path activity that can greatly reduce risk to both project schedule and cost, while also delivering key components of Environmental, Social and Governance (ESG) goals.

In 2021, Lancaster Areas Sewer Authority contracted Sunbelt Rentals to support its Lower Little Conestoga Interceptor Rehabilitation Project — Phase 2. This project included developing a site access design, engaging with multiple prime contractors to provide unique contractor specific designs, and working hand-in-hand with the selected prime contractor along with Sunbelt Rentals to safely execute the access plan.

Sunbelt Rentals was chosen as a partner due to its diverse fleet of ground protection inventory in addition to the company's expertise of site access professionals and their turnkey project capabilities.

Sunbelt Rentals started the project by developing site access plans with a goal of creating safe and low-risk access to enhance production and generate value for all project stakeholders. The team began by taking the project plans and plotting the route out in Google Earth to better understand the current topography of the project area. With most of the project along the edge of a golf course, the project

engineer had already decided that a pinned heavy-duty composite mat road was the best product for this project to reduce damage to the course. The composite mats specified for the project are a sustainable product with a life span of more than 10 years. The mats pin together and distribute the weight of equipment over a greater surface area, thereby reducing soil compaction and restoration costs.

The initial design was calculated via Bluebeam directly off the project plans and called for 1,440 composite mats for the access roads and site pads, 10 medium-duty pads to protect a homeowner's driveway, and 156 mats for the 100 x 100-foot fusing pad. Next, the Sunbelt Rentals ground protection and pump solutions project team walked the jobsite to identify potential hazards and issues associated with the routes for the bypass and access, as per the project plans. Verification of field conditions determine any necessary adjustments to the site access plan to maintain a safe and productive bypass. In this case, the collective Sunbelt Rentals team determined that additional matting was needed to address the bends in many of the roads to keep equipment and crews safely on the mats and to minimize restoration costs. Sunbelt Rentals then

Utilizing matted road for bypass installation reduced damage to the course

The mats pin together and distribute the weight of equipment over a greater surface area, thereby reducing soil compaction and restoration costs

Sunbelt pump solutions team gets started on the bypass

> *Site access can greatly reduce risk to project schedule and cost.*

engaged with the prime contractors considering the project to discuss their specific plans for access, lining, and pads; eventually walking the job again with several other key stakeholders to finalize a complete custom access plan unique to each stakeholder's respective plan of work.

The prime contractor utilized 1,430 composite mats for all right-of-way temporary access roads and work pads. The project started in November of 2021, with the installation, inspection, and turnover of the mats for use by the prime contractor. Close integration with onsite project managers led to a well-orchestrated execution with no delays and included the efficient utilization of proper traffic control. Sunbelt Rentals returned to the site several times during the execution of the project and determined that the contractor successfully kept vehicles, equipment, and crews safely on the mats.

The partnership between all stakeholders and open communication on this job helped ensure a productive and safe access plan, which in turn kept the project on budget and reduced risks during the planning and execution phases. Sunbelt Rentals took into consideration all design options such as driving on grade, rocking, or matting, and made certain to maintain transparent interactions with contractors throughout the entire rehabilitation to help ensure its ultimate success.

ABOUT THE AUTHOR:

SUNBELT RENTALS

Eric Mathiesen *is a Strategic Customer Manager with Sunbelt Rentals Ground Protection Division. In his role he works with customers to design access solutions for sewer rehabilitation, electrical transmission, oil and gas and construction projects throughout the United States.*

A pinned heavy-duty composite mat road was the best product for this project to reduce damage to the course

Summary: Hydrotesting HDPE Water Lines

By: Camille George Rubeiz, P.E., F. ASCE, Plastics Pipe Institute, Inc. (PPI)

High-density polyethylene (HDPE) pipe has been used for municipal and industrial water applications for some 50 years. HDPE's heat-fused joints create a leak-free, self-restraint, monolithic pipe structure. The fused joint will also eliminate infiltration into the pipe and exfiltration into the environment. HDPE pipe has other benefits including chemical, abrasion, fatigue, seismic and corrosion resistance, and is designed for water and wastewater applications meeting the latest AWWA C906 and ASTM F714 standards.

It is advisable to begin testing early during the pipeline installation to confirm adequacy of the fusion, laying, embedment procedures, and then later to progressively increase the length of test section as experience is gained.

Hydrostatic testing is universally known and accepted as the primary means of demonstrating the fitness for service of a pressurized component. HDPE pipelines as long as 3000 feet have been commonly tested.

Hydrotesting can be used on runs of HDPE pipe that are hundreds of feet long

The following is an overview of using hydrotesting and the steps to take before a potable line is put into service. The purposes of hydrostatic field testing of HDPE pressure pipes using water include:

- Assessing the installed structural integrity of the pipeline for acceptability.
- Revealing the occurrence of faults or defects in the pipe laying procedures, as exemplified by damaged pipe or fusion joints non-conforming to the qualified fusion procedures.
- Finding the occurrence of faults in the assembly procedures for pipeline components, as exemplified by tapping bands or saddles, flange sets, or mechanical joint assemblies.
- Validating that the pipeline will sustain an acceptable level of overpressure slightly greater than its design pressure, without leakage.

It is important to note that field testing is not intended to supplement or replace product standard test requirements.

Polyethylene pipe is a lower modulus visco-elastic material that dilates in diameter (creep-strains) when subjected to higher stress during hydrotest. This means that for a fixed volume of clean fill water, the hydrostatic pressure will decline slightly during the test time, as the polyethylene molecular chains stretch and align under high stress. This pressure decline does not mean the polyethylene is leaking. It is a visco-elastic material parameter that requires adjustments to the hydrostatic test procedure as compared to rigid elastic metallic pipes. This effect is more noticeable in larger diameter HDPE pipes, due to the large mass of clean fill water. Alternately, to hold constant pressure, an additional volume of make-up water will be required to fill the expanded volume of the stretched pipe diameter. Neither of the above two observations means that a leak is present in the pipeline.

There are two test methods which can be used, depending upon the objectives of the test program. The easiest and quickest method suitable for all pipe diameters is the Modified Rebound Method originally developed by Lars-Eric Janson in the 1980's. As a similar alternate, ASTM F2164 instructs to fill and then thermally stabilize the pipeline with no air entrapment, pressurize the pipeline at test pressure for four hours, slightly reduce the pressure, and then observe the pressure for one hour to remain essentially constant (within five percent variation) to achieve an acceptable test.

In the US and Canada, the prevailing hydro-test method is ASTM F2164, *Standard Practice for Field Leak Testing of Polyethylene Pressure Pipe Systems Using Hydrostatic Pressure*. The ASTM method is essentially a hydrostatic "pressure rebound method" and is referenced in the AWWA M55 (2020), *PE Pipe- Design and Installation* and is summarized below:

- Test pressure: Up to 1.5 times the working pressure and is taken at the lowest point in elevation along the pipe's test section.
- Leak test can be dangerous; restrain test section against movement
- Fill slowly to remove air
- Maintain test pressure for 4 hours; add makeup water as needed to keep the pressure constant; water amount is not monitored
- Reduce pressure by 10 psi and monitor pressure for 1 hour
- Pass if pressure stays within 5% of the reduced pressure

In addition, the AWWA M55 (Chapter 9) describes general hydrostatic testing, based on ASTM F2164.

There are basically six steps to putting a new waterline in service:

- Flushing
- Filling
- Testing for Leaks
- Record Keeping
- Disinfection
- Commissioning

1. Flushing

A new pipeline should be thoroughly flushed prior to testing. This will help to prevent any damage to valves or other fitting from any foreign material left in the pipeline. This can be done by opening and closing hydrants, blow-offs or drains with flow velocities sufficient to flush the foreign material from the pipeline. A minimum of 3ft/s is suggested.

2. Filling

Slowly fill the pipeline to limit the flow to low velocities that prevent surges and air entrapment. Also, air valves at high points should be opened to allow air to escape as the water level increases inside the pipeline. Temporary valves can be installed. Do not loosen flanges or connections to bleed air from the system. The critical filling rate for pipes with air vents is usually based on five to fifteen percent of the pipe design flow.

3. Testing for Leaks

Leak testing can be done either inside or outside the trench. Because joints for HDPE pipe are fused together, leakage should be zero. Leak tests need to be conducted in accordance with ASTM F2164. For HDPE pipe, a pressure of 1.5 times the design working pressure at the lowest point in the test section is used as the test pressure. Acceptance is found by reducing the test pressure by 10 psi and monitoring the pressure for one hour. If the pressure remains steady – within five percent of the target value – for one hour, leakage is not indicated.

4. Record Keeping

Test records should include:

- Name of person conducting the test, including company and contact information
- Test medium – usually water
- Test pressure
- Test duration and data
- Pressure recording chart of pressure log

When disinfecting an HDPE potable waterline, it is important that purging applies to distribution mains as well as each service line and service connection.

- Pressure vs. makeup water added chart
- Pressure at high and low elevations
- Elevation at the point test pressure is measured
- Ambient temperature weather conditions
- Pipe and valve manufacturers
- Pipe specifications and/or standards such as AWWA C906-21
- Description of the test section length, location and components
- Description of any leaks, failures and their repair/disposition
- Test times and dates

5. Disinfection

All new potable water pipelines require disinfection in accordance with ANSI/AWWA C651. This should take place after the initial flushing and after pressure testing the line. Disinfecting solutions containing chlorine should not exceed two percent active chlorine. As soon as the normal pipe disinfection period is over, the disinfection solution should be purged and/or neutralized, and the pipeline filled with fresh, clean water. Remember, purging applies to distribution mains as well as to each service line and service connection.

6. Commissioning

The commissioning of a new or repaired pipeline is normally carried out in the following sequence:

- Cleaning and/or pigging of the pipeline
- Water filling and pressure test
- Disinfection
- Flushing, purging, and/or neutralization
- Refilling the pipeline
- Bacteriological sampling and testing
- Certifying and acceptance
- Initiating the pipeline into service

Additional information can be found in:

- ASTM F2164
- AWWA Manual M55,
- PPI's *Handbook of Polyethylene Pipe*
- PPI's newest technical document, *TN-46 Guidance for Field Hydrostatic Testing of High-Density Polyethylene Pressure Pipelines.*

ABOUT PPI:

PPI Plastics Pipe Institute MUNICIPAL & INDUSTRIAL

The Plastics Pipe Institute, Inc. (PPI) is the major North American trade association representing the plastic pipe industry and is dedicated to promoting plastic as the materials of choice for pipe and conduit applications. PPI is the premier technical, engineering and industry knowledge resource publishing data for use in the development and design of plastic pipe and conduit systems. Additionally, PPI collaborates with industry organizations that set standards for manufacturing practices and installation methods.

A Family Adventure:

Texas' Rocky Grounds Are No Match for This Family of Drillers

By: Vermeer Corporation

Hitting it hard seven days a week, drilling fiber conduit through the rocky grounds of the greater Austin TX area, that's how Mike McCall, his two sons — Landon and Logan — and a couple of drilling crews spend every week. They wouldn't have it any other way.

"I don't believe we've taken a day off in the last three years," said oldest son Landon McCall.

But the family, who launched their horizontal directional drilling (HDD) career around the same time they had their last day off, wouldn't have it any other way. They love what they do. And they get to spend time together every day, working hard and growing the family business, McCall Drilling.

To navigate the challenging ground conditions around Austin, the McCalls rely on a couple of dual-rod Vermeer D23x30DR S3 HDDs, Vermeer MX125 mixing systems, water trucks, a pair of Vermeer trailer vacuum excavators for potholing and mud management and a plethora of rock tooling. This two-crew setup is a far cry from the equipment the family started with.

LAUNCHING A BUSINESS

March 21, 2018 — that was the day Landon McCall started a company Facebook page for the family's startup drilling company. At the time, they were

> *What keeps the McCalls busy these days is the push for 5G.*

living and working in the Atlanta area. There, Mike McCall ran a small plowing and trenching business performing shallow utility drops.

"I did utility trenching and plowing work for 20 years," Mike explains. "Around the age of 16, Landon took a real interest in helping. Logan, who's a few years younger, also started becoming interested around same time. When both kids finished high school, they still wanted to work with me, but I knew as a family we could build something bigger. That's when the three of us sat down and decided our future was in HDD work."

The McCalls purchased a used Vermeer D16x20 Series II HDD and a McLaughlin vacuum excavator built in 1998 that they still own and operate today. Then they started prospecting. "We created a Facebook page as a way to look for work," said Landon. "We didn't necessarily care where the work was. We just wanted a chance to prove ourselves."

Shortly after making the decision, the McCalls got the call they were waiting for. "We connected with a contractor working in Austin who needed another crew to help install fiber for AT&T," Landon says. "We were extremely upfront with him and told him we had little experience doing HDD work. His response was, 'Well, you're going to have to learn sometime.' So, we loaded up our belongings and headed south. We've been working in that area ever since."

MOVING SOUTH

What keeps the McCalls busy these days is the push for 5G. The two McCall crews are helping install the thousands of miles worth of fiber required to power Verizon's mobile network. The company did about 50,000 feet of fiber work last year, mostly in rock, and is on pace to beat that number this year.

"In this part of Texas, you have to fight for every foot," says Logan. "We did a lot of fighting with Texas sandstone that first year. We worked a small dirt drill in rock and got the most out of that machine. We also learned a lot along the way."

The biggest lesson the McCalls learned was there is a different way to drill in rock. "We saw a few other contractors in the area using dual-rod machines designed for boring in rocky grounds," Logan says. "It was time to upgrade our operations."

INVESTING IN DUAL-ROD TECHNOLOGY

The family demoed a few machines and accepted an invitation from their Vermeer rep, Scott Shuffield at Vermeer Texas-Louisiana, to demo a Vermeer dual-rod drill prototype getting ready to launch. It was

the D23x30DR S3, the dual-rod version of one of the most widely used utility drills in the industry. After trying it out, The Mc Calls placed an order almost immediately.

Having demoed other dual-rod machines, Landon said there is no comparison for fiber work. "Other machines have a giant footprint. They are heavy, loud and don't deliver any better production. Pound-for-pound, the D23x30DR S3 runs circles around the other machines we

demoed. Also, it's so quiet — when it's running you can carry on a conversation with someone near the drill without raising your voice. This is a huge plus when we're working in residential areas."

> *"In this part of Texas, you have to fight for every foot."*
>
> -LOGAN MCCALL

Today, the two dual-rod drills can be found working throughout greater Austin — downtown, suburbs and the rural area. "The constant change of scenery is one of the reasons why I like doing this job so much," expressed Logan. "Boring is never boring. There's always some new challenge to solve from one jobsite to the next."

RECIPE FOR SUCCESS

The drilling package and process McCall Drilling finds works best for them starts with their dual-rod drills, a mud mix of bentonite and bore gel, a Vermeer TCI tricone bit and a Vermeer pulling eye. On most shots, the drill operator will empty the 300-foot drill rod basket of the D23x30DR S3, pop out and swap out tooling, and then pull back a bundle of two 2-inch diameter fiber conduit. It's a process that gets repeated six days a week. On the seventh day, the crew prepares for the week ahead.

There are times when a bore may require the crew to drill longer than 300 feet. For those, they will borrow a few rods from their other D23x30DR S3. They have completed a few shots that required both baskets of drill rod — 600 feet.

"A few things we've learned out here is bore gel is critical, and you should use lots of fluid," Landon explains. "We also make it a point to spin off our drill bit after the pilot bore is completed in exchange for a pulling eye. We know many other folks will leave tooling in place during pullback, but we like having that bit of extra clearance without it. We would rather spend a little extra time swapping tooling than risk getting stuck during pullback."

The McCalls also have a D20x22 S3 HDD that doesn't get used every day. "We like keeping that machine around for doing shorter road crossing and those rare times we are not boring in rock," said Landon. "We can steer tighter with that machine, so on road crossings, we can turn at a sharper angle going down and coming back up. On the front of that machine, you will usually find a Vermeer Ace Pro bit because even the dirt in Texas feels like rock around here."

MAXIMIZING PRODUCTIVITY

Working the drills six days a week means machine hours add up quickly. Daily walkarounds, greasing, checking fluids, etc. and following the preventative maintenance schedule outlined in their machines' maintenance manuals is the way things are done at McCall Drilling. And it's that commitment that keeps those drills running almost every day, Mike said. "We have to take care of the equipment the same way we take care of our people, and that means doing preventative maintenance."

For almost all their service work, the McCalls rely on the team at Vermeer Texas-Louisiana. "In this line of work, we're constantly moving machinery. We want to keep the supplies we have on hand as minimal as possible, and our team focused on what we do best: drilling. Using our dealer to service equipment means we don't have to carry extra supplies for service work or haul a machine back to the shop. We make a call and the service team takes care of the rest. It's easy and allows us to keep going."

The McCalls don't necessarily see what they do as work; it's more of a shared adventure that keeps delivering positive results every day. "What father doesn't dream of building a business with his kids? Landon and Logan are the best business partners a person could ask for," Mike concluded.

ABOUT VERMEER:

Vermeer

Vermeer Corporation *offers one of the most comprehensive product offerings serving the underground construction industry. Products include horizontal directional drills, guided boring systems, trenchers, vibratory plows, rockwheels, piercing tools, vacuum excavators, core saws, and mini skid steers, as well as a range of tooling, accessories, and support equipment.*

Case Study: Pipe Jacking & Utility Tunneling

Project Name:
Mainline Segment 9, I-20/ Railroad Crossing

General/Subcontractor:
Culberson Construction, LLC/ J & J Boring, Inc

Location:
Midland, TX

Ground Conditions:
Varying UCS caliche and limestone rock

Akkerman Equipment:
TBM 48SCII, 50-in. OD Disc Cutter Head, Tunnel Boring System with 5200 Pump Unit, 524 Haul Unit

Pipe:
48-in. OD Steel Casing

Total Length/Hard Rock Section:
550-lf./250-lf. (DCH used for 250)

Disc Cutter Head attachment fractures hard caliche and limestone into pieces while maintaining alignment

PROJECT OVERVIEW

The project involved the construction of a 36-inch diameter HDPE water line inside of a 48-inch diameter casing, that ran under highway I-20 and a Union Pacifc Railroad near Stanton, TX.

While using their 48SCII TBM with standard carbide cutter head, J & J Boring, Inc. encountered rock conditions midway across the bore which were not stated in the pre-bid GDR. The unanticipated ground proved challenging to mine with the initial TBM cutter head setup. After a few worn tooling changes, the contractor decided to develop a better solution to mine the rock.

THE CHALLENGES

- Installation in hard caliche/limestone rock
- Crossing under active rail line and I-20 Highway
- Actual project rock rating was 40 percent harder than pre-project GDR indicated
- Hardest rock encountered within sensitive rail road Zone A, requiring 24-hour non-stop construction and no surface access

THE SOLUTION

Key benefits of owning an Akkerman TBM is the interchangeable cutter heads feature and the ability to access the face for obstruction removal. J & J Boring, Inc. contacted Akkerman for a Disc Cutter Head attachment for their 48SCII TBM to fracture the hard caliche and limestone rock into pieces while maintaining alignment despite geological variations.

Key benefit of the Akkerman TBM is ability to access the face for obstruction removal

Material encountered was 40% harder than pre-project GDR indicated

Great Christmas present for the J & J Boring crew to complete tunneling before the holidays!

The 48SCII TBM Cutter Head features:

- (16) 6.5-inch disc cutters, capable of 5 tons of thrust each
- Cutter head rock scrapers assist in transferring cuttings away from the face, to the conveyor, then to the haul unit for removal from the tunnel
- Heavy-duty bearing to handle disc thrust loads
- Recommended Uni-directional operation foreffective mining

The lead 48-inch casing was welded to the TBM to counteract the rotational torque necessary to mine the rock with the uni-directional cutter head. The operators monitored the thrust loads on the cutters to ensure they did not become overloaded.

OUTCOME

- J & J Boring, Inc. completed the drive in challenging rock that would have been otherwise improbable
- No cutter head tooling replacements required
- Mid-project rock testing indicated project rock samples of 13,000 PSI UCS

For more information please visit:

www.akkerman.com

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