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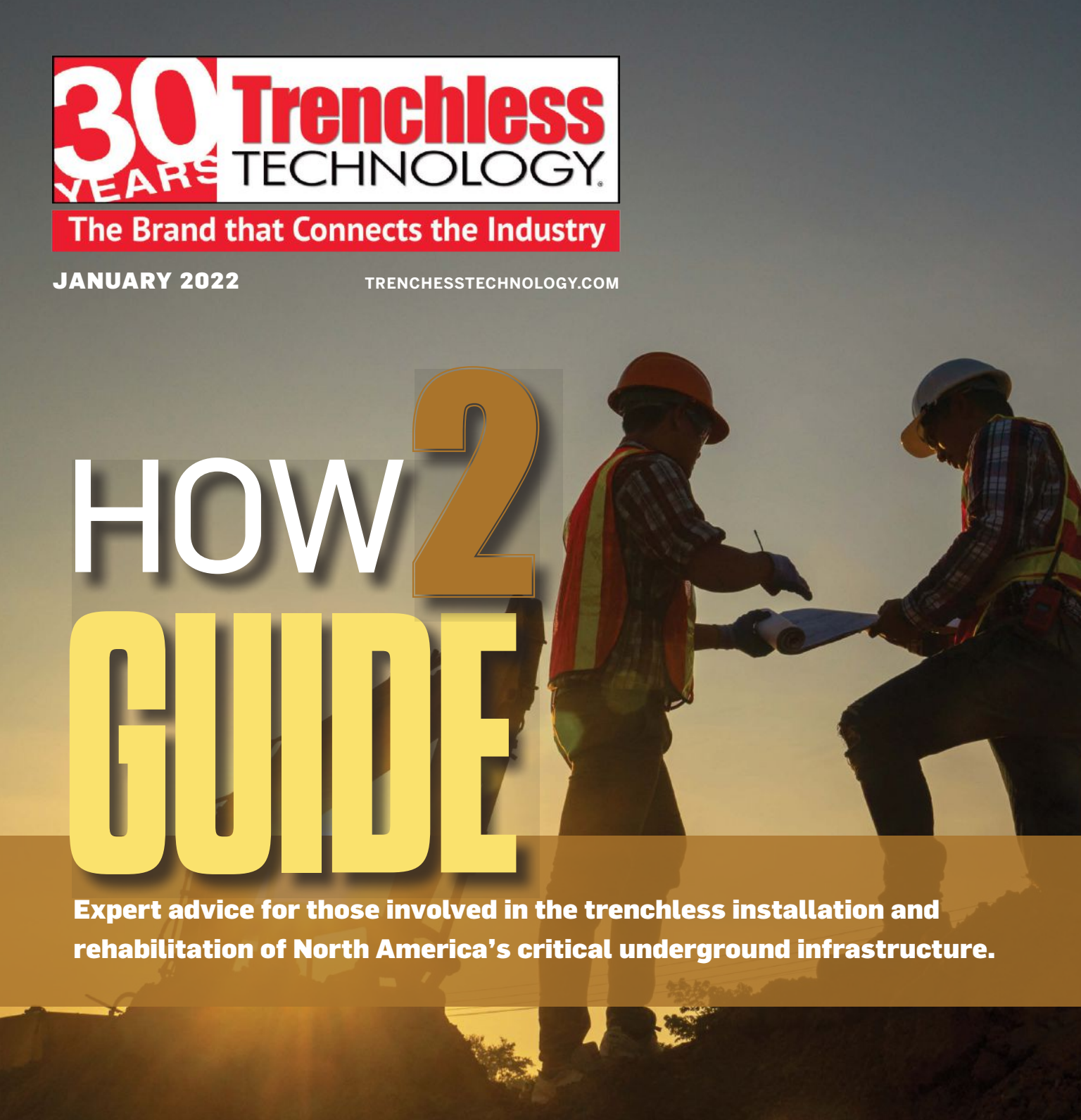

HOW 2 GUIDE

Expert advice for those involved in the trenchless installation and rehabilitation of North America's critical underground infrastructure.

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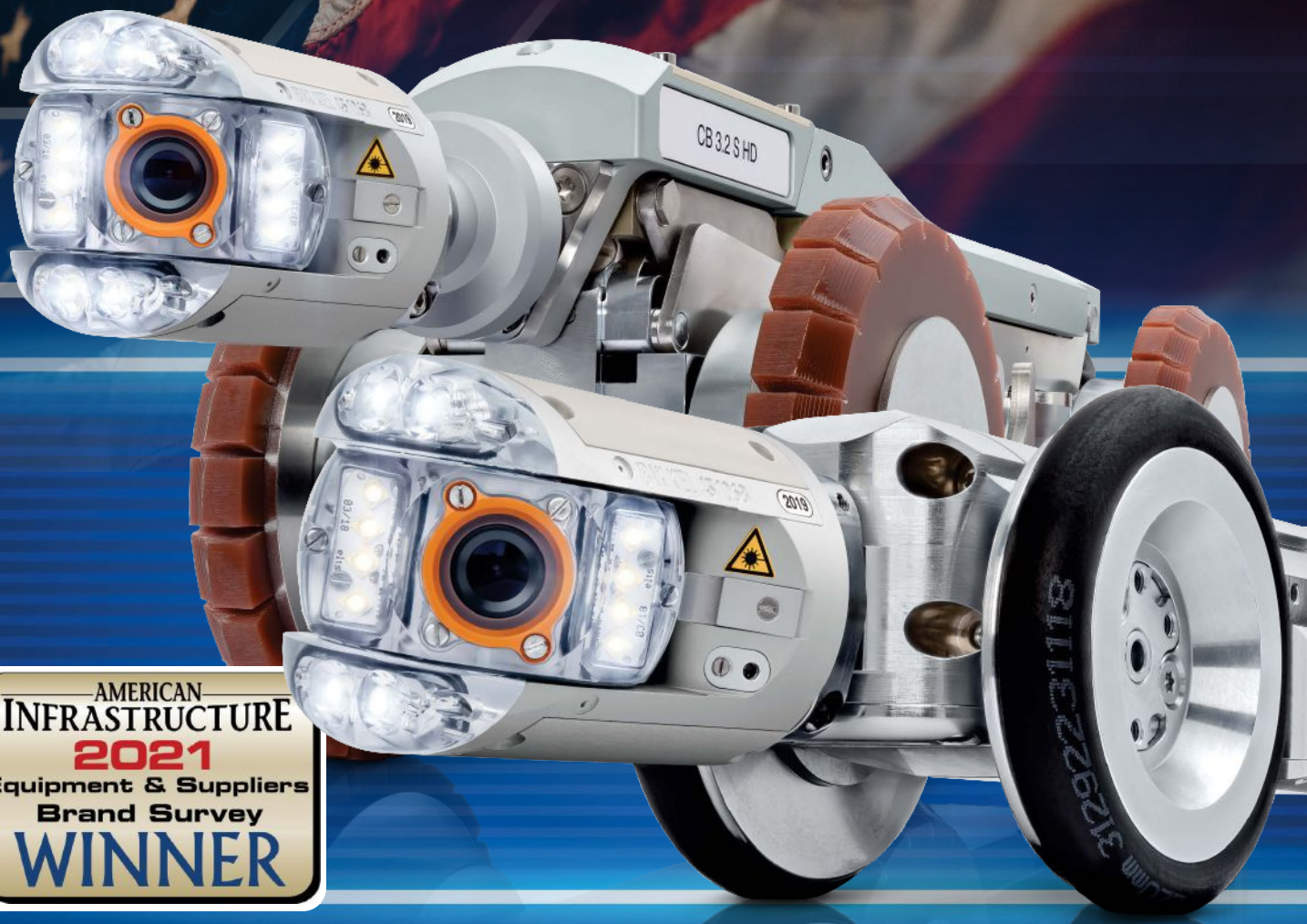

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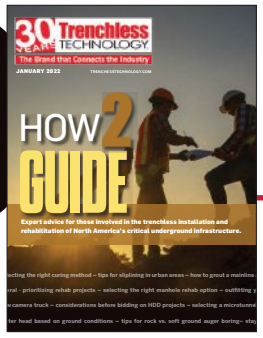
HOW 2 GUIDE



Expert advice for those involved in the trenchless installation and rehabilitation of North America's critical underground infrastructure.

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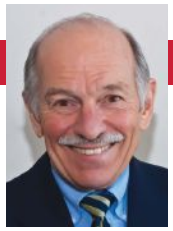
BY BERNARD P. KRZYS



TRENCHLESS TECHNOLOGY MAGAZINE LEADERSHIP

We launched *Trenchless Technology* magazine in 1992. At the time, the term trenchless technology was virtually unknown. When it was explained as the construction of new or renewal of utilities services with minimal disruption to the surface, people had their doubts. We are now 30 years later and the doubts about our industry are gone. We are a multi-billion industry and trenchless is a commonly practiced construction discipline.

As the industry has grown, it has been something to see how it has developed into a close-knit group of construction professionals. Perhaps, it is due to the fact that younger people embraced trenchless technology and have grown up within the industry. We have been pleased to be part of that process and the conduit to promoting this industry for these 30 years. We have developed many friends — and even personal and family events.

As the industry has evolved and everyday life has been dramatically affected by technology, we likewise have evolved from a strictly print publication (or brand as we prefer to say now) to various digital media platforms, including Webinars, Enewsletters, Special Reports, videos, podcasts — as well as sharing all of the news and stories via the social media outlets, such as LinkedIn, Facebook and Twitter. Between our print and digital editions, we are, in 2022, reaching each month more than 38,000 subscribers vs. 12,500 way back in 1992. Additionally, our monthly digital network includes 33,000 readers through our Enewsletters, website and social media.

I say all of this to set the stage for some exciting news. I have been the publisher of *Trenchless Technology* from the start. After 30 years at the helm of this incredible brand, I have decided that now is the time to turn over the leadership reins to our talented and veteran staff, who literally have trenchless technology in their blood. I am pleased to announce our "new" leadership staff, whom are no strangers to this special industry:

Publisher: Kelly (Dadich) VanNatten
Editor: Sharon M. Bueno
Trenchless Ambassador: Dan Sisko

I say "new," but each of these individuals have been in the trenchless industry and our brand for more than 20 years. Kelly has led our sales/conferences teams, served as Associate Publisher and has been visible at many events and exudes a welcoming personality. Sharon has held the position of managing editor for many years and has been more of a background person delving into projects, special focus subjects, the primary editor of our cover stories and, most recently, outstanding podcasts. Dan, the leader of our sales team, is an outgoing person, eager to meet and engage people to talk about the industry and fun stuff, too. Many of you already know these individuals. Please extend to them your congratulations as they settle and thrive in their new roles.

A "Titanic (movie) moment," sailing with Paul Nicholas in the British Virgin Islands.

As for me, I am certainly not going away. You will still see me at industry events and I will be serving as an advisor to this leadership group. I look forward to seeing you at the NASTT No-Dig Show in Minneapolis in April. The show will be extra special for me as my good friend Paul Nicholas, AECOM, will be inducted into the NASTT Hall of Fame. I met Paul in 1988 in the U.K. when he was with a manufacturer in which he focused on microtunneling, specifically the Soltau Microtunneling system; and I was marketing/selling Soltau in the U.S. and Canada.

It's a relief as we leave 2021 and the up-and-down aspects of the COVID-19 virus. 2022 certainly looks a lot brighter, as the trenchless industry has been booming. With the recent passage of the $1.2 trillion U.S. federal infrastructure bill, there is much enthusiasm to start construction on much-needed infrastructure work. Our January issue, is a special How to Guide, offering trenchless professionals invaluable information to take on trenchless projects as we start this New Year.

I wish you all a healthy, safe and prosperous new year.

Bernard P. Krzys
(now former) Publisher

Jacobs Ranked No. 1 in Top 50 Trenchless Firms List for Seventh Consecutive Year

Jacobs is honored to be named No. 1 on Trenchless Technology's Top 50 Trenchless Engineering Firms list for the seventh consecutive year. Together with our clients, communities, employees, and industry partners, we will continue to push the limits of what's possible to make the world smarter, more connected, and more sustainable.

From trenchless project planning, design, and construction management experience, Jacobs' worldwide team of trenchless experts work on complex projects around the globe.

Jacobs' networked community of 850+ trenchless practitioners means that our clients directly benefit from lessons learned from projects completed near and far. This enables public agencies big and small to manage and extend the service life of their existing infrastructure or install new drinking water, wastewater, and energy conveyance systems without disrupting their communities.

As trenchless technologies continue improving, more of our clients are looking to companies like Jacobs to help repair or replace their aging underground infrastructure or install new buried infrastructure. We're honored to work on our clients' critical infrastructure projects and help meet an ever-increasing demand for trenchless services.

Jacobs' trenchless practice is led by Dan Buonadonna and Andrew Finney.

"We are grateful to be a leader in the professional community that is dedicated to helping our cities take care of aging public infrastructure during this time of unique challenges and increasing demand. Building on this recognition, Jacobs continues to invest in new solutions and technologies to help assess, prioritize, and design cost-effective and equitable solutions to maintain buried infrastructure," says Jacobs Dan Buonadonna, Global Technology Lead (GTL) for Condition Assessment and Rehabilitation.

Andrew Finney, GTL for Trenchless Design, concurs. "The business of infrastructure repair and replacement is still as strong as ever, and our collective support for our clients has adapted to respond to the challenges posed by the pandemic. New climate challenges — such as wildfires in the west and hurricanes in the east — are driving an ever more urgent need to harden our infrastructure through undergrounding, and new opportunities related to energy have us drilling deeper and longer than in the past."

Trenchless Technology Starts 30th Year with Leadership Announcement

January begins a new year and new beginnings. 2022 is bringing exciting and dynamic changes to *Trenchless Technology* — the No. 1 source for trenchless news. As we celebrate our 30th anniversary year, company founder and publisher Bernie Krzys has announced that associate publisher Kelly (Dadich) VanNatten has been promoted to publisher.

As publisher, VanNattan will oversee the business operations of the *Trenchless Technology* brand and work with the leadership team to ensure we continue to provide timely and relevant content across all of our print and digital network channels.

VanNatten is well known in the trenchless industry, having been with *Trenchless Technology* for 25 years. She started as marketing coordinator and became a sales representative and later director of sales and associate publisher. She has also worked in several departments, including advertising sales, marketing, circulation and conferences. In her new position at *Trenchless Technology*, VanNattan will continue to serve as director of sales in addition to her publisher duties.

"I'm excited for this new role and am truly looking forward to working with the *Trenchless Technology* team to build on the successes of our past 30 years," VanNattan says.

"Our goal is to connect the industry by serving trenchless professionals with interesting, relevant, useful and inspiring content. Thirty years ago, we did this once a month via *Trenchless Technology* magazine. Today, we serve the trenchless industry daily, through our website, eNewsletters, topic-specific Special Reports, webinars, Guides and much more. Looking ahead, we will continue to evolve with the way we deliver content, reaching subscribers where they are."

Bernie Krzys has served as publisher since he founded the magazine and has been the face of the trenchless media for more than 30 years. He is also a member of the NASTT Hall of Fame, inducted in ts inaugural class in 2012. Though taking a step back, he will still be found at industry shows and events. "After 30 years at the helm of this incredible brand, I have decided that now is the time to turn over the leadership reins to our talented and veteran staff, who literally have trenchless technology in their blood," Krzys says. "I am certainly not going away. You will still see me at industry functions and I will be serving as an advisor to this leadership group."

These are exciting times for *Trenchless Technology*, as well as the trenchless technology industry. VanNattan is looking forward the innovative and significant changes the industry will be experiencing in the coming years and coming to *Trenchless Technology* magazine to have those innovative and significant changes presented in an objective and informative fashion.

"I think back to when I first started with *Trenchless Technology* 25 years ago and how much the industry has changed since then," says VanNattan. "Trenchless technology has become more widely accepted; there's been significant growth in the number of companies involved in trenchless; and numerous advancements have been made with trenchless products/equipment. Looking ahead, I see continued growth and development in the years to come… think electric equipment, advancements in artificial intelligence (AI), the work coming ahead due to undergrounding power/communication lines, etc."

McLaughlin Achieves 100 Years of Equipment Innovation and Service

McLaughlin, a Vermeer Brand, was founded in 1921 and has proudly marked a century providing workable solutions for the construction, utility and trenchless industries. Today, the brand continues to innovate and expand the capabilities of auger boring equipment for customers worldwide.

"Through much of the McLaughlin company's 100-year history, Vermeer and its network of dealers have been important partners," said Dave Gasmovic, business development manager for Vermeer MV Solutions. "That mutual commitment solidified when Vermeer acquired McLaughlin. Since then, we're proud to say that many of our original product lines have been incorporated into the Vermeer-branded product line-up."

McLaughlin's own roots go all the way back to the early part of the last century. After returning to the U.S. from service in World War I, ex-coal miner Joseph McLaughlin had an idea for a product that would simplify a coal miner's job and make the coal industry itself more productive. In 1921, in a rented space in Rockdale, Illinois, he began production of his innovative improvements to the mining auger, and the company that would become McLaughlin Group Inc. was born.

By the early 1950s, McLaughlin was a leading supplier of drilling tools to mines across the U.S. and was ready to expand its operations, moving into a new facility in Joliet, Illinois. In the 1960s, the company once again expanded, building a new, state-of-the-art facility in Plainfield, Illinois.

Even though Joseph McLaughlin died in 1964, the company continued to follow his innovative spirit and commitment to offering equipment that solves real-world challenges.

"Innovation is in McLaughlin's DNA," said Gasmovic. "And it's always been a guiding

principle for the brand. For example, when, two large companies approached McLaughlin with a request to help solve the challenge of how to control the expense of residential underground utility installations, including the cost of surface restoration, McLaughlin was ready to respond."

Company leadership began working on a new type of system that would drill under roads, driveways and sidewalks to allow installation of small diameter services. The resulting product was called the Mighty Mole, and it set the stage for McLaughlin's future success in the development and deployment of trenchless construction technology.

Continuing to grow its brand presence, in 1970 McLaughlin bought Western Boring Equipment Co., an auger boring manufacturer. The purchase allowed McLaughlin to expand its business, and it gave them larger-diameter boring machines for an entirely new market.

This led to a decade of significant company growth and expansion. McLaughlin added plants in Greenville, South Carolina, and Arlington, Texas. The Texas facility began the redesign of the auger boring machines, particularly regarding increases in thrust and horsepower.

When horizontal directional drilling began to take off in the late 1980s, McLaughlin saw the need for tracking and detection systems. The company brought to market the original Spot D Tek I. Development and improvements continued, and in the mid-1990s, the Verifier G3 utility locator was introduced. "That same legacy lives on today in the form of the Vermeer Verifier G3 utility locator," said Gasmovic.

In 1999, Vacuum Source Inc. was founded as a subsidiary of McLaughlin serving customers with a new line of vacuum excavation and sewer cleaning systems. In 2001, Vacuum Source was made a division of McLaughlin, and the products took on the McLaughlin brand name. A major milestone was reached for these products in 2006 when McLaughlin began manufacturing them for Vermeer.

In 2012, Vermeer bought a minority interest in McLaughlin, selling McLaughlin's vacuum excavators, utility locators, pneumatic piercing tools, core saws and auger boring equipment to contractors through the Vermeer dealer network. In 2017, after the synergies of the two companies were well-understood, Vermeer acquired the rest of McLaughlin. Then in 2018, Vermeer purchased Vac-Tron Equipment LLC, and integrated the two companies' product lines as Vermeer MV Solutions.

Vermeer MV Solutions continues to produce the McLaughlin auger boring products and has introduced important innovations, like the Workhorse 225 and Workhorse 175 auger boring machines, to the trenchless industry.

The company continues to offer additional innovations to underscore the brand's commitment to continued progress. One example is the McLaughlin SRS (Steerable Rock System), the auger boring market's first steerable head designed to navigate through solid and severely fractured rock. Another is the On-Target Steering system (OTS), designed to work with any auger boring system ranging from 16 to 60 inches in diameter. It is designed to install on-grade/on-line casings in one pass compared to the multiple passes required with pilot tube guided boring.

"We've done all this while increasing our manufacturing capacity, service and support capabilities," said Gasmovic. "Everything that McLaughlin has accomplished in the last 100 years has to provide innovative solutions to our customers' problems. So, although we are proud of our century of service, we are focused on the future — always working toward the next development that will benefit the industry."

IDEX Corp. to Acquire Envirosight, WinCan Parent Company

IDEX Corp. announced that it has entered into a definitive agreement to acquire Nexsight LLC, the parent company of Envirosight, WinCan, MyTana and Pipeline Renewal Technologies (PRT).

The acquisition, which is subject to customary post-closing adjustments, is for cash consideration of $120 million. The acquisition will complement and bolster existing IDEX business units iPEK and ADS, which design and create sewer crawlers, inspection and monitoring systems, and software applications that allow teams to identify, anticipate and correct wastewater system issues remotely.

Through the Nexsight acquisition, IDEX will expand to include iPEK's key North American channel partner and its leading wastewater video inspection software platform, which we foresee helping to broaden the capabilities of ADS's cloud-based wastewater system monitoring and predictive analytics platform.

With annual sales of approximately $50 million, Nexsight will join the water group within IDEX's Fluid & Metering Technology segment. The transaction is expected to close in the first quarter of 2021, subject to regulatory approvals and customary closing conditions.

ClockSpringNRI Acquires Fyfe North America, Fyfe Europe

FYFE®
A Division of ClockSpring|NRI

ClockSpring|NRI, a portfolio company of Wind Point Partners, announced the acquisition of the Fyfe North America and Fyfe Europe business from Aegion Corp. Fyfe designs and manufactures fiber-reinforced polymer systems for strengthening, repairing, and restoring civil and commercial structures and water transmission pipelines.

Fyfe, founded in 1988 to strengthen deficient bridge columns in California using aerospace composite materials, today holds numerous patents for the use of composites in the Civil and Structural strengthening market.

"Fyfe's focus on the civil, structural and water transmission pipeline markets is a strong complement to the ClockSpring|NRI critical infrastructure solutions portfolio," noted Frank Firsching, CEO of ClockSpring|NRI. "Fyfe is recognized around the world as the pioneer of the FRP structural strengthening market and its industry leading Tyfo solutions broaden the infrastructure markets we serve."

Mark Brand, the current general manager of Fyfe, will join the ClockSpring|NRI executive leadership team as president of the Fyfe Division and will report directly to Firsching.

"By joining ClockSpring|NRI Fyfe North America and Fyfe Europe are now part of a composites-centric organization that can continue to bring Fyfe maintenance and rehabilitation solutions to our valued customers," stated Brand. "We look forward to continuing to serve our customers and work with our best-in-industry trained network of Certified Applicators to deliver the highest-quality installation of Fyfe materials."

In February 2019, Wind Point simultaneously acquired and merged Clock Spring Company Inc. and Neptune Research LLC. The combined company was renamed ClockSpring|NRI. Subsequently, Milliken Infrastructure Solutions was added to the platform in June 2019, extending technical capabilities in sewer, water and wastewater applications. Firsching joined as CEO in March 2020. Firsching was president of Aegion's Infrastructure Solutions group from March 2016 to December 2018.

FyfeAsia and Fibrwrap will remain part of Aegion Corp.

Michael Byrne Mfg. Names Dave Kauffman Manufacturing Engineer

Mansfield, Ohio-based Michael Byrne Mfg. – a premiere manufacturer of auger boring and trenchless drilling technology – announced that it named Dave Kauffman as manufacturing engineer.

Kauffman has a Bachelor of Science in business administration/management and brings more than 25 years of experience in the trenchless industry to Michael Byrne Mfg. He received extensive training in fluid power at The Ohio State University's Agricultural Technical Institute (ATI).

Kauffman began his career at American Augers; working his way up from saw operator, fabricator, assembler, lead man, CIP manager and manufacturing manager. He was then employed at Underground Professionals Inc., specializing in horizontal directional drill (HDD) repair, refurbishing and parts sales.

Prior to joining the Michael Byrne Mfg., Kauffman and a partner started D&L Underground Solutions, which specialized in parts sales, service, HDD repair, modernization and refurbishments.

Kauffman supplies a wealth of knowledge with hydraulic and CAN bus systems relating to the mobile construction industry. Dave brings a hands-on approach to implementing incremental improvements and problem solving for HDD and auger boring equipment.

"Dave's addition to the Michael Byrne team brings another perspective from a respected industry leader with experiences hard to find today," says Michael Byrne Mfg. president Jim Weist.

Derek Potvin Announced as the 2022 *Trenchless Technology* Person of the Year

Trenchless Technology magazine is pleased to announce the recipient of its 2022 *Trenchless Technology* Person of the Year: Derek Potvin, P.Eng., who has had a long and distinguished career in the trenchless rehabilitation sector, serving as an engineer, educator and is a past NASTT chairman.

Potvin is also just the second Canadian to be selected as the *Trenchless Technology* Person of the Year — an honor first bestowed on deserving trenchless professionals in 1993. The *Trenchless Technology* Person of the Year Award is considered the most prestigious trenchless industry award.

Potvin is president of Robinson Consultants, an Ottawa, Ontario-based multi-disciplinary consulting engineering firm that provides engineering services, which includes trenchless technology, asset management and municipal infrastructure. He also has an extremely long tenure of service to the trenchless technology industry.

"We congratulate Derek Potvin on his selection as our 2022 *Trenchless Technology* Person of the Year. His practice, promotion and passion of the trenchless industry, particularly in the area of rehabilitation, has ascended him to the top levels of the industry," says *Trenchless Technology* managing editor Mike Kezdi, who coordinated the Person of the Year selection process. "An advocate and leader of trenchless technology, Derek is a most deserving choice for this year's highest industry honor."

When notified of his Person of the Year selection, Potvin was moved and touched by the honor. "Being named *Trenchless Technology* Person of the Year is very humbling and I am honored to be included amongst a highly respected group of recipients," says Potvin. "Receiving this honor has prompted me to reflect on my 25 years in the trenchless industry and the innovative, creative, dedicated, and committed people who are a part of it. I am grateful that my contributions have had an impact to this industry."

Potvin earned his degree in civil engineering from the University of Ottawa. He started working for Robinson Consultants in 1987 as a student on a Co-Op term and became a full-time employee in January 1990. After attending his first NASTT No-Dig Show in 1995, he received a call from the City of Ottawa Engineering Department about a chance to work on a large diameter water main rehab project. Using knowledge he gained at No-Dig, he realized that trenchless was the best and least disruptive approach. And the rest, as they say, is history.

Potvin soon embraced the volunteer spirit of NASTT and began a lengthy relationship with the local Regional Chapter. He subsequently joined the Board of Directors of the Great Lakes, St. Lawrence, and Atlantic Chapter and, in 2004, was appointed as the Chapter Treasurer. Potvin continued to attend the NASTT No-Dig Shows as a regular presenter in the technical paper program and as a volunteer NASTT Good Practices Training Instructor for well over a decade. As an instructor, he presented at NASTT No-Dig Shows, Regional Chapter Events and at other partner conferences such as the APWA Congress.

Potvin has also presented at the International Society for Trenchless Technology No-Dig events and represented North America as part of an expert panel discussion at the ISTT show in Brazil. In 2010, Potvin, along with two other Canadian engineers, was invited to Cairo, Egypt, to provide a course on municipal infrastructure management, including trenchless technology.

Potvin also co-authored NASTT's Introduction to Trenchless Technology Rehabilitation Methods Good Practices Guideline. He became a NASTT director in 2010 and he volunteered on numerous committees and eventually became NASTT Vice Chair. This appointment led to Potvin to becoming the NASTT Chair for 2013 and 2014.

His time as NASTT Chair included growing the NASTT staff complement to aid with growth of the society; building relations with ISTT and its societies; revamping and updating of the NASTT By-Laws; and perhaps most importantly the development of the NASTT Strategic Plan. His term delivered constructive change and substantial growth to an already vibrant society.

Potvin will be formally recognized for this honor Monday, April 11 at NASTT's 2022 No-Dig Show Kick-Off Breakfast at the Minneapolis Convention Center in Minneapolis.

Barbco Once Again Joins the Fight Against Childhood Cancer

East Canton, Ohio-based Barbco Inc. hosted its second St. Baldrick's head shaving fundraiser to benefit the fight against childhood cancer and the event was a resounding success. The event, called "Bald is Badass at Barbco," happened Oct. 29, 2021, with Barbco converting its assembly bay into a St. Baldrick's Barbershop.

Barbco hosted its inaugural event in 2019 when 34 of its community-minded employees braved the shave and raised $6,199 for the St. Baldrick's Foundation. Unfortunately, Barbco had to stand down in 2020 due to COVID-19 safety considerations.

This year the team raised $5,306 and had 37 men braving the shave to help in the fight against childhood cancer. Todd Hindman, of National Tube Supply, sponsored a luncheon for the Barbco crew featuring barbecue provided by Old Carolina Barbeque.

Joining Barbco in this fundraiser are many corporate partners: U.S. Shoring & Equipment Co., Trenchless Rental Solutions, SACS Consulting & Investigative Services Inc., Midwest Mole, National Tube Supply, Kraft Fluid Systems, Great Work Employment, MECO, Shale Directories, Ohio CAT, Industrial Tube & Supply, Brent Scarbrough & Co., Wolff Brothers Supply, Akron Bearing and The Universal Steel Co. In addition, community volunteers David Angione, Stark County's Bald Realtor for You; Toni "The Cookie Diva" Cotopolis; and Trisha Mossor, of Aim Transportation Solutions were on hand to help with the event.

Learn more about St. Baldrick's important work at *stbaldricks.org*.

Municipal Grout School Planned for March 2022

Avanti International, CUES and Logiball are partnering together for a two-day Municipal Sewer Grout School in Tavares, Florida, March 23-24.

The school is for both newbies and veterans. Attendees can actively participate in each of the breakout and classroom sessions. An emphasis will be placed on grouting, safety, operating the equipment, testing/ troubleshooting equipment, making sure the chemical grout mix has the right mixture and how to determine how much grout is used per joint or lateral.

The two-day session will present technical information on:

- Lateral and mainline Test and Seal packer operation and maintenance
- Mixing and optimizing AV-100 Acrylamide Grout performance
- Review and demonstration of new NASSCO/ICGA grout specifications
- Live infiltration and grout sealing demos
- New grout testing and monitoring information and methods

Learn about the CUES EZ Grout Panel, which is instrumental for training with minimal learning curve, accurate recording and timing for air tests, packer pressure and injecting the grout properly.

To register or for more information, visit *https://conta.cc/3tfD19C*.

ISCO Industries Acquires IPF Fabrication Business from Plasson USA

Lousiville, Kentucky-based ISCO Industries Inc. has signed a definitive agreement to purchase the HDPE fabrication portion of Plasson USA, which was formerly known as IPF and includes the Spirolite product line.

IPF has been an innovator in the fabrication business for 25 years. The combination of two HDPE fabrication leaders will provide ISCO customers with the most comprehensive product and service offerings in the industry.

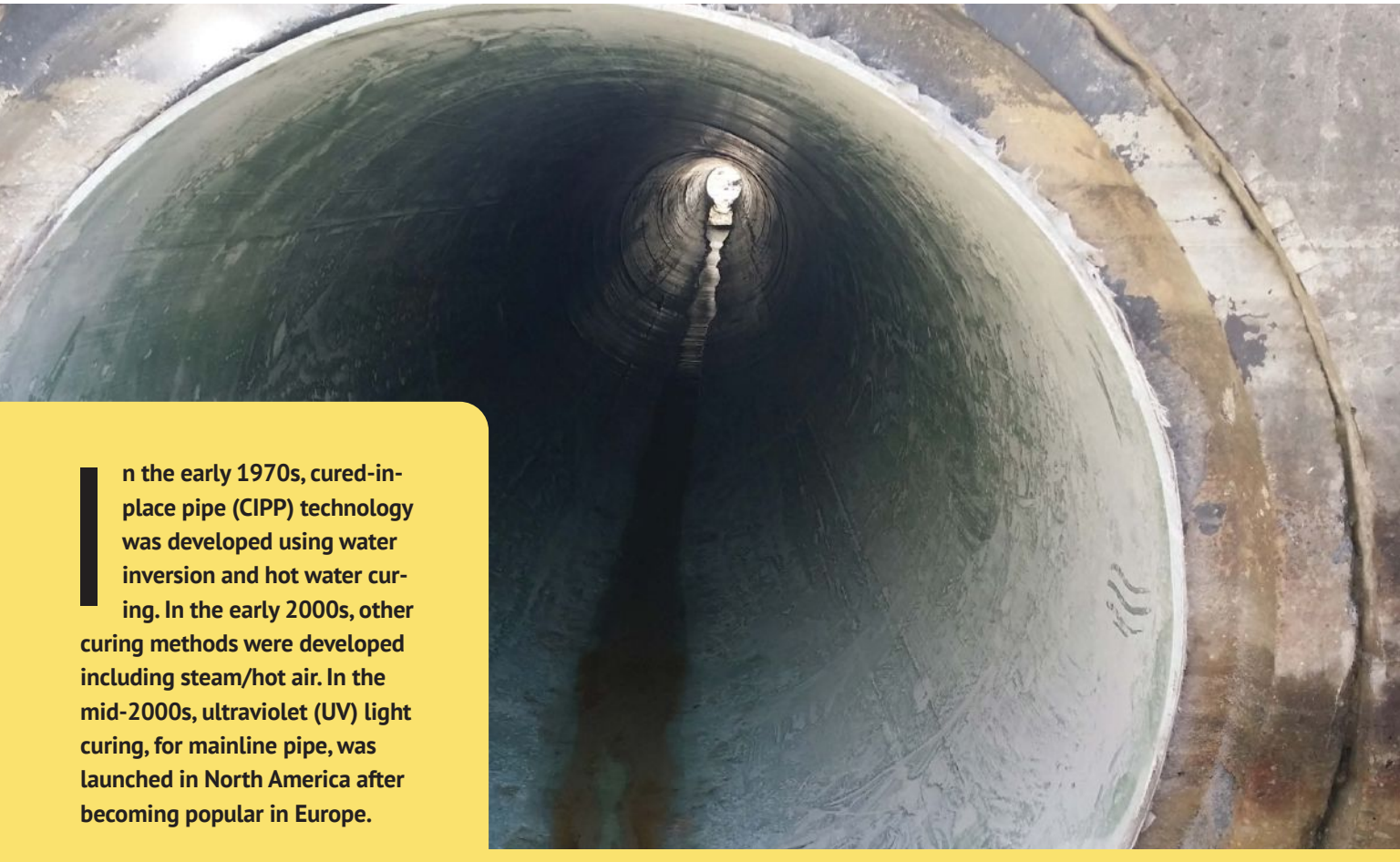
The combination of ISCO and IPF's Factory Mutual (FM) product listing offers the most complete and comprehensive FM listing in the world. Along with fabrication capabilities, the acquisition brings employees with decades of experience in the HDPE industry. That knowledge is an invaluable resource for ISCO customers.

Gal Wexsler, CEO of PLASSON Ltd., noted that PLASSON will now concentrate on its core electrofusion products and the company will continue its product offerings in North America as Plasson USA.

THE MOST APPROPRIATE CIPP

INSTALLATION & CURING METHOD

By Gerhard P. Muenchmeyer



In the early 1970s, cured-in-place pipe (CIPP) technology was developed using water inversion and hot water curing. In the early 2000s, other curing methods were developed including steam/hot air. In the mid-2000s, ultraviolet (UV) light curing, for mainline pipe, was launched in North America after becoming popular in Europe.

Today, a variety of installation and curing methods offer choices on how best to accomplish the manufacture of a new cured-in-place pipe. Existing host pipe materials and ground conditions, however, will affect the proper and efficient installation and curing of the CIPP requiring evaluation.

Initial project evaluation includes:

- Consideration of pipe size.
- Different pipeline materials have different heat dispersion characteristics (heat sink). Selection of appropriate liner materials and curing techniques will minimize damage to the CIPP and ensure proper curing.
- In pipelines containing pipe sections with different materials, the curing method should be selected considering all materials being lined.
- Pipelines previously lined with a plastic material.
- Ground conditions, water levels and infiltration surrounding the pipeline.

To achieve a successful installation requires that the installer becomes thoroughly familiar with existing project conditions, understands the product, the heating and cooling requirements and how it's affected by the existing pipe material.

Ambient Resin Curing

Curing is achieved by mixing a set volume of resin and catalyst, causing the materials to react and cure, usually two hours at 75 F. The cure time ,however, will be dependent on

the ambient temperature in the installation environment. Applications for ambient curing are primarily for short liners, service connections and repair products that can be installed in a fast, predictable amount of time prior to the resin cure.

Water Inversion & Heat Curing

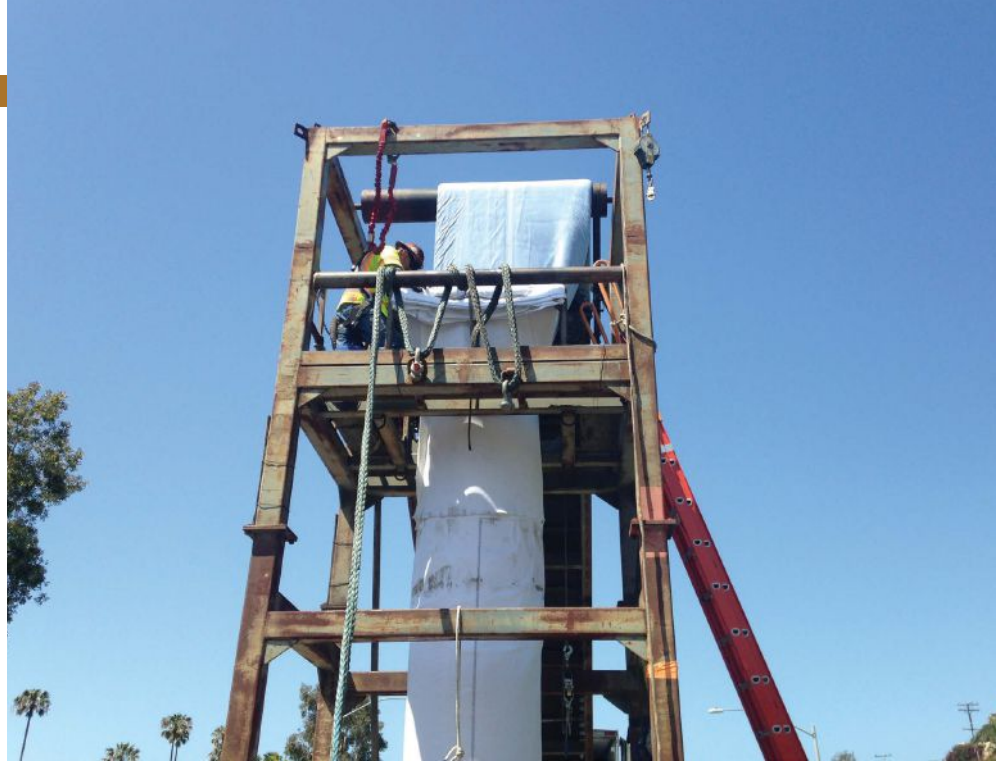
With water inversion and heat curing, the installer must have enough water available and equipment capable of heating the water to reach required temperature, for curing. The liner is then heated and cooled until the cure cycle is complete.

Water installation and heat curing have shown to provide consistent installation quality. Opportunities include:

- Hot water installation and heat curing, apply to all pipe sizes, types of materials and installation conditions where a moderate curing temperature (usually 180 degrees or less) is maintained. This is a consideration when installing a liner, into host pipe, having low heat sink characteristics.
- Water installation and heat curing is commonly selected for long and large liner installations such as onsite over-the-hole installations.
- The heat from the resin chemical cure will generally be absorbed and dissipated in the water, limiting potentially excessive heat spikes during curing.

Some requirements, that should be evaluated when selecting this cure method.

- Water installation and curing is typically a longer time compared to other technologies.
- The installer has the responsibility to supply and dispose of any liner processing water, in an environmentally acceptable and approved manner.



Air Inversion & Inflation Steam Curing

With steam and air curing, compressed air and steam equipment is required for curing the liner. The installation includes inverting or pulling the liner into place. Air-pressure is required to hold the liner tight against the existing pipe during installation. Then combining steam with the air to elevate the temperature, will cause the liner to cure.

Opportunities for using the steam and air technology for curing CIPP are many.

- Provides higher temperatures, is more efficient and generally will provide for a faster cure.
- Will eliminate need, handling, disposal and cost of large amounts of water.
- Less overall installation equipment is required on the jobsite.
- Less labor is required depending on project conditions.
- Steep grade installations

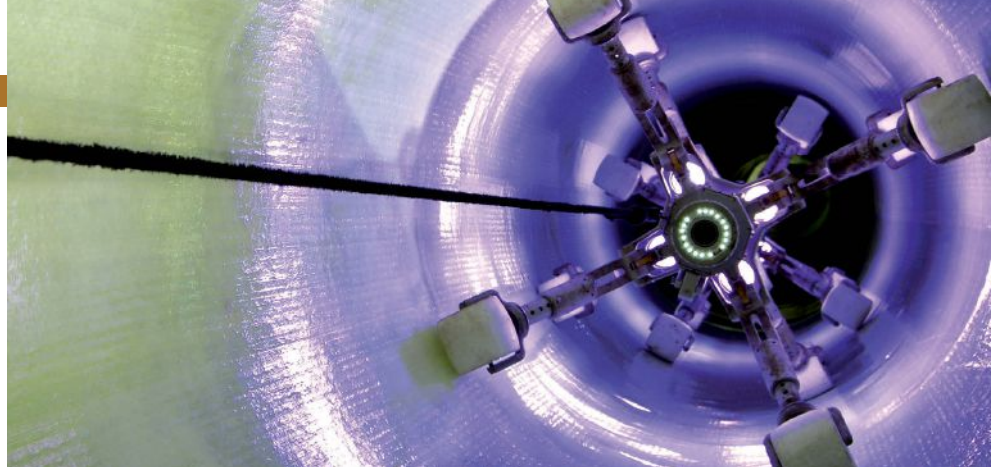
Some conditions, however, should be evaluated when selecting this cure method.

- Long length liner installation. Curing requires sufficient volumes of steam and air pushed through the entire pipe length, while maintaining and exceeding the required cure temperature. Limiting installation lengths.
- When using steam directly to affect the cure, water condensation must be removed. This can be an issue when the condensate accumulates in a pipe low point or "belly" preventing proper curing.
- When using steam directly, the cure temperature must be properly controlled to avoid excessive temperature increases caused by combination of steam and resin curing temperature, to prevent damage to the liner materials being installed.

Pull-In and Inflate & Curing with Ultraviolet (UV)

Liner material components include a corrosion resistant fiberglass fabric tube in conjunction with photoinitiated resin. Several additional UV technologies are available and provide options for installation and curing of the CIPP product.

Typically, pulled-in and inflated with air, the cure of the resin is initiated by light administered by a mechanical train pulled through the liner, thus curing and creating a CIPP. After the curing process, the inner protective film is removed. The UV light cure has generally become



accepted, in North America and is available as an addition to heat cured methods.

Consideration for use of the light cured technology are many.

- Generally, less equipment needed resulting in smaller project footprint
- No residual water or steam condensate disposal required.
- Curing is computer controlled and fast.
- Is not affected by temperature
- Steep grade installations
- Visual inspection of the liner available after installation and before curing.
- No excessive heat during liner curing. The heat generated by the resin cure is recorded
- Can effectively be cured in high and low heat sink environments.
- Infrared sensors monitor key installation and cure information.

Some conditions, however, should be evaluated when selecting this technology and cure method.

- Long installations length, limited by pulling distance
- Seriously cracked and broken pipe may damage the liner during pull-in installation.
- Limited availability of large diameter liners.

It is important to define the existing pipe material, its condition and the ground water environment. Though most of the underground piping systems can be rehabilitated using any of the available installation and curing systems, occasionally a system will need additional evaluation to determine which system will be most applicable. They include pipelines with multiple pipe materials with different heat sinks, various plastic pipe materials, very smooth wall pipelines with minimal mechanical interlocking between host pipe and liner materials and pipelines affected by high heat, to illustrate a few examples.

Gerhard P. Muenchmeyer, P.E., is owner of Muenchmeyer Associates.

How to better understand Biogenic Corrosion and Its Effect on Portland Cement

Around North America, deterioration of wastewater infrastructure due to H_2S biogenic corrosion is a serious headache for owners and operators. Wastewater infrastructure is typically constructed with Portland cement concrete. Portland cement is a calcium silicate and its hydration inescapably liberates calcium hydroxide $Ca(OH)_2$. Sewer bacteria excrete sulfuric acid H_2SO_4 which reacts with the liberated calcium hydroxide according to the following reaction:

$$Ca(OH)_2 + H_2SO_4 \quad ----> \quad CaSO_4 + 2H_2O$$

This reaction produces gypsum and water. In a humid sewer environment, gypsum is dissolved. This ongoing disruptive phenomenon continually leaves a fresh layer of portland cement for attack.

The H_2S biogenic corrosion mechanism is a well-known phenomenon but the specifics of the process are sometimes misunderstood. Surprisingly, wastewater itself is rarely corrosive. The corrosion begins with H_2S created by the decomposition of the organic materials within the wastewater. This H_2S builds in concentration in the areas of laminar flow. The H_2S is then released into the sewerage network in areas of turbulent flow (outfall and force main type situations). Turbulent flow can occur in numerous areas of the system, including piping systems, manholes, pumping situations, treatment plants, etc. This turbulent flow causes the dissolved H_2S to become an airborne H_2S gas. The H_2S gas is heavier than air and initially exists above the effluent level, dissolving in the moisture on the concrete surfaces above the flow level. As water is formed by the oxidation of the hydrogen, the H_2S gas deposits elemental sulfur onto these surfaces. This elemental sulfur is a food source for naturally occurring bacteria present in the sewerage system. These bacteria, present generally in the slime layer, actually "eat" the elemental sulfur (as a source of oxygen). The byproduct of the bacteria's digestion process is sulfuric acid. It is this sulfuric acid that is corrosive to wastewater structures, not the H_2S gas itself.

Factors that can enhance this biogenic corrosion cycle include long retention times, high ambient temperatures, flat terrain, and low flow values. With the current growth of outlying suburban areas, feeding into the existing infrastructure of larger metropolitan areas, these factors are becoming increasingly prevalent throughout North America as treatment plants are commonly several miles from the city center, requiring very long distances to transport the effluent.

Contrary to the chemistry of Portland cement, the hydration process of calcium aluminate cement does not produce calcium hydroxide but liberates calcium aluminate hydrates and $Al_2O_3.3H_2O$ "gibbsite". The gibbsite liberated from calcium aluminate cement hydration is not susceptible to H_2S attack. At pH levels above 3.5 the gibbsite is insoluble and blocks the pores of the concrete, protecting it from the ingress of acid. Below a pH of 3.5 the gibbsite contributes to neutralizing the acid at the surface by the consumption of hydrogen ions:

$$2[Al_2(OH)_3]^{3-} + 6H^+ \quad --> \quad 2Al^{3+} + 6H_2O$$

The measure of an acidic pH is a measurement of the molecular concentration of hydrogen ions (H^+). Therefore, the more H^+ there are in solution, the lower the measured surface pH will be. In the equation above 6 H^+ ions are removed from solution making them neutral. This is the "neutralization capacity" of a calcium aluminate. This neutralization reaction releases alumina ions (Al^{3+}) which have an inhibitory effect on the metabolism of the bacteria creating the acid. By removing hydrogen ions from solution, the surface pH is locally raised. The released alumina ions react with the bacteria present to slow their activity. Calcium aluminates act as a Protective - Reactive Barrier, greatly reducing the corrosion of the concrete.

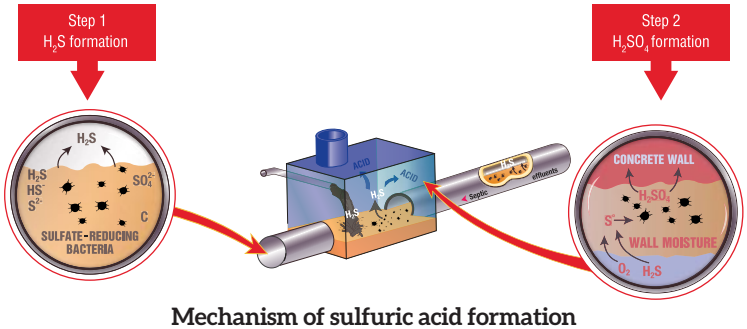
Biogenic corrosion of Portland Cement

The more gibbsite available, the more corrosion resistant a calcium aluminate based product will be. A typical calcium aluminate mortar contains 20% - 35% calcium aluminate cement, with the remaining 65% - 80% being a natural aggregate system such as silica sand, limestone, granite, etc. While a calcium aluminate / natural aggregate material will perform better than a Portland cement based material, only the 20% - 30% cement portion will have the ability to neutralize acid and inhibit bacterial activity.

SewperCoat® by Imerys is a 100% calcium aluminate mortar (both cement and aggregate system), 100% of the product has the ability to neutralize acid and inhibit bacterial activity. SewperCoat® brings 30 years of proven performance protecting wastewater infrastructure assets against H_2S biogenic corrosion.

For more info:

www.sewpercoat.com
sewpercoat@imerys.com
+1 757 284 3278



Mechanism of sulfuric acid formation

THE ART AND SCIENCE OF MANHOLE REHABILITATION

By William Shook

Manhole chambers are one of the major components in every sewer system and occur, on average, every 300 lf in every gravity sewer pipe. These "windows" provide access for CCTV inspection, as well as entry for repairs to the main sewer pipe. While each buried component has its own set of problems, manholes are remarkably more complex in size, shape, components and material. Benches, channels, pipe penetrations, walls, cones, chimneys, grade rings, frames and covers make for unique problems that require innovative methods and materials to make no-dig renovations possible.

↑ Hand Sprayed Polymer Coatings

The EPA estimates that there are more than 30 million manholes in North America's sewer systems and half of these were installed more than 40 years ago. The need for repair and replacement this huge volume of defective manholes exceeds city budgets. Priorities, therefore, must be established to address each problem in the most cost-effective means possible.

Our industry has learned that the lowest cost method is not always the best long-term solution. Critical investigation and sound engineering is imperative; and, of course, early diagnosis is critically important for choosing least cost solutions.

Over the past 30 years our industry has witnessed development and implementation of a wide variety of innovative technologies that address the primary problems found in manholes, which are erosion from inflow and infiltration and decay from corrosion, both of which can cause major structural damage.

Rehab Due to Erosion

Mechanical chimney seals and sewer dishes have a long and successful record of eliminating inflow at the cover, frame-joint and grade rings. Also available are cured-in-place vertical liners from the frame through the chimney and flexible sealants applied internally and/or externally have also grown in popularity as surface preparation has improved and installations can be made without any damage to or replacement of the street.

Infiltration control has benefited by using improved chemical grouts to stop major leaks in manhole walls, channels and pipe penetrations whereby a grout-curtain completely encapsulates the old manhole. Chemical grouting is also a frequent first step prior to installation of a manhole liner to stop leaks so the interior surfaces can be properly prepared. Early attention to small leaks avoids greater costs later.

Manhole walls, especially when constructed of brick and mortar, can fail catastrophically if repairs are ignored. Full structural replacement is the best option in these cases and no-dig solutions are available, as well as replacement methods that require only partial excavation.

If cutting and removal of pavement sections is selected, fiberglass and plastic pipe inserts can be placed and then backfilled with standard concrete. Special care must be taken where the insert fits into the bench and around pipe penetrations at the channels and drop inlets. Pavement removal and replacement can be avoided with other methods that assemble steel or plastic forms inside the old manhole equipped with eccentric and concentric forms for cone placement at grade. Again, the space between the existing wall and the forms is filled with rapid setting, high-strength concrete for same day return to service.

Alternative methods at lower costs are hand-sprayed or centrifugally cast liners that also provide a fully structural replacement with cement-based materials imparting high-strength and impermeability compacted in-place at the appropriate design thickness. The thickness design was developed at Iowa State University in 1990 under a grant from the National Science Foundation whereby liners were centrifugally compacted onto cardboard tubes, cured and then tested under compression in the soil cell at Spangler Underground Lab. These tests provided minimum material performance criteria at different thicknesses to replicate the pressures encountered at various depths and from dynamic traffic loads.

↑ Frame and grade ring external seal

The ISU design was based on minimum material strengths of 3,000 psi in 24 hours (10,000 psi at full cure) and application made by precision placement and centrifugal

compaction producing values not consistently possible with spraying and troweling by hand. This design has been used by engineers since it was first presented at the 1995 NASTT No-Dig Conference in Toronto, Canada.

Other structural liner options include cured-in-place liners applied vertically, hand laid fiberglass cloth and thick polymer liners. Since external pressures vary by depth and diameters, the F-1216 thickness guide for buried pipe with uniform depth and diameter is not appropriate for manholes. Hand-sprayed polymer liners depend entirely upon the skill of the applicator in the hole where hazardous conditions exist.

Rehab Due to Biogenic Corrosion

When biogenic corrosion is the problem, which is common at some level in sewer systems regardless of climate, protection must be used. Polymer coatings, when properly prepared and applied, provide an excellent barrier between the manhole wall and biogenic acid. Polymer coatings may be applied to existing

Centrifugal compaction and precision placement safely

walls when they are placed in service or undamaged or when applied to a newly installed cement-based liner.

Thorough coverage is necessary to avoid pinholes, bubbles, thin spots and exposed areas which can cause delamination of the coating. Post installation testing for proper thickness can be performed by a trained tester with high-voltage equipment. Surface preparation prior to coating is also important. Removal or limitation of moisture on or in the material surface is also important.

Many cement-based liners contain moisture until fully cured at 28 days. Since manhole walls are wet from use and condensation, special care must be exercised to enable bonding/adhesion. Adhesion is tested with a pull-tester at representative areas after the coating is fully cured.

An alternative method of protection against biogenic corrosion in manholes is acid-

resistant materials. Materials such as high alumina cements and geopolymer cements offer a level of protection against mild biogenic acids. Once the biogenic mechanism starts, however, acid production from the conversion of hydrogen sulfide gas continues to greater and greater concentrations achieving levels of pH 0.10. In such cases, resistance is usually overcome and corrosion will accelerate. Using these types of cements in mild environments can extend their useful life. Alternatively, the production process of biogenic acid generation can be eliminated entirely by antimicrobial additives mixed into the cements. This prevents colonization of the acid-producing bacteria and acid cannot be produced where the bacteria cannot grow as evidenced by more than 25 years of successful use. Cement-based liners are not threatened by pinholes, thin spots or bonding problems.

Four Links

Manhole renewal is like a chain with four links. And, if any link fails, the solution fails. The four links are:

1. Sound engineering – proper assessment of the problem
2. Proper design and method selection
3. Proven technology – third party verification of materials and methods
4. Factory trained contractors who are reliable and experienced.

Over this past year, ASCE and NASSCO collaborated on the third edition of Manual of Practice 92 – Manhole Rehabilitation and it is scheduled for publication in 2022. This MOP provides a comprehensive list of trenchless renovation methods and materials with specific details of benefits and limitations. It is an excellent reference.

William Shook is founder of A/PM Permaform and Conshield Technologies. Though retired, he remains active in committees at NASSCO, ASTM, ASCE and AWWA.

How To…rid the world of infiltration and re-rehabilitation

It's Simple: Use Resinating LLC's Patented EIPI Technology to Rehabilitate Every Manhole and Every Pipe Everywhere!

At the heart of **EIPI (Expand-in-Place Integration) Technology** is the **Resinating Fiberglass Expansion Liner**. The Liners are fabricated in our plant by winding continuous strands of fiberglass, 32 at a time, soaked in resin, around a mandril, while spraying chop between the layers to add further strength and structural integrity. The result…solid, strong and indestructible **Resinating Liners** fabricated with no fillers. After the Liner is cured, it's cut axially so it can be compressed to a smaller diameter than the structure being lined…this is key.

Compressing the Liners enables them to be easily inserted into a manhole or pipe. Once in position, the Liner is expanded and securely bonded to the substrate of the existing manhole or pipe using **Resinating's Proprietary Primer** which enables our **Proprietary Bonding Agent** to function properly in wet conditions. After all the seams and joints are glassed, we will have created a single, integrated, structural unit, one that is 100% leakproof and far stronger than the existing structure was when it was new. No other rehabilitation option does this.

EIPI Technology…rehabilitating a manhole

Before…lots of bricks | Installing the Liner… | …and the new floor & trough

EIPI Technology…rehabilitating a pipe

Before…lots of obstructions | Glassing the seam | Done…lots of fiberglass

EIPI Technology bonds **Resinating Liners** to any substrate – RCP, brick, FRP, VCP, etc and conforms to literally any shape – cylindrical, tapered, rectangular, domed, horseshoe, etc and is available in diameters from 30" to 192", enabling it to rehabilitate pipes, manholes, junction boxes, wet wells, culverts, etc in wastewater, stormwater and freshwater systems. When we complete the design of some robotics, we will be able to reduce the minimum diameter to 8".

EIPI Technology was awarded a patent by the US Patent & Copyright Office in June, 2020 and is currently being patented in major countries around the world…where there's a pipe or manhole in need of rehabilitation, there's a need for **EIPI Technology**!

Why? Because **EIPI Technology** offers a set of benefits that are not available from any other rehabilitation option. These benefits include the fact that:

- **EIPI Technology** is trenchless…it can often renew collapsed pipes and failing manholes that would otherwise be planned for replacement.
- **EIPI Technology** is warrantied to be 100% leakproof for 20-years and is likely to remain leakproof for its useful life of 100+ years. The warranty covers both materials and workmanship.
- **EIPI Technology** is strong, adding an unequaled level of structural integrity to every project, leaving each rehabilitated manhole or pipe far stronger than it was when it was new. ASTM tests we ran show structures lined using **EIPI Technology** are 50% to 100% stronger than when new.
- **EIPI Technology** is a high-flow solution for pipes with little if any impact on the flow capacity due to its low profile (typically 1/4" to 1/2" thick) and with the very low coefficient of friction associated with the smooth interior of the fiberglass liner itself, lining a pipe with **Resinating Fiberglass Expansion Liners** using **EIPI Technology** to install them might even improve its flow capacity.
- **EIPI Technology** is environmentally friendly with no health hazards, emitting no VOC's or styrene on the job site.
- **EIPI Technology** is hugely cost-effective as it conserves capital. It is competitively priced on Day 1 and generates ongoing savings throughout its long life by eliminating the cost of treating ongoing infiltration and avoiding the need to ever rehabilitate the rehabilitated structure again.

Whether a project involves the rehabilitation of manholes, pipes or other structures,
Resinating LLC's patented **EIPI Technology** is always **The Better Choice!**
EIPI Technology…the "forever" rehabilitation solution!

www.resinatingllc.com

RESINATING LLC™
Your Solution for Sewer Pipe and Manhole Renewal

info@resinatingllc.com

EIPI Technology…the "forever" rehabilitation solution!

Resinating LLC's Patented EIPI (Expand-in-Place Integration) Technology
will reshape the rehabilitation industry in the years to come…it's a game changer!

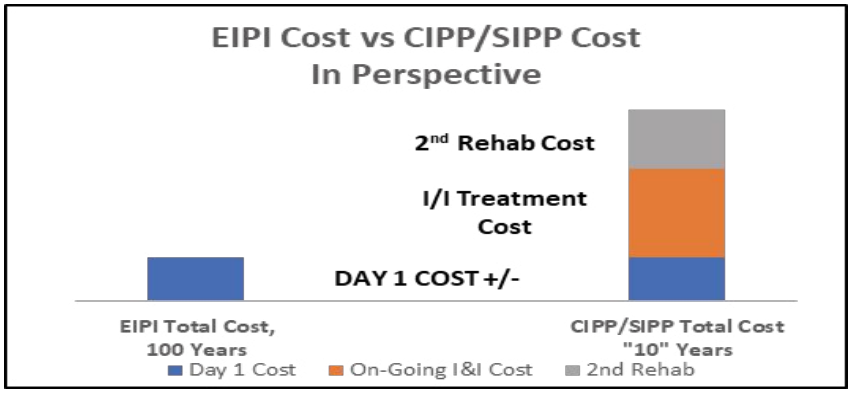
EIPI Technology is superior to all other rehabilitation options when manholes, pipes, wet wells, etc in wastewater, stormwater or freshwater systems need to be rehabilitated.

- **Trenchless**
- **Eliminates Infiltration**
- **Unequalled Structural Integrity**
- **Warrantied for 20-Years**
- **100+ Year Useful Life**
- **High Flow Capacity**
- **Environmentally Safe**
- **Highly Cost-Effective**

A recently finished section of 30" pipe was rehabilitated with **Resinating Fiberglass Expansion Liners** using **EIPI Technology** to bond them to the original walls. **There isn't a drop of water leaking though the liner even though it's below the water table…that's leakproof!** There's a Feature Article on this project in the August, 2021 issue of Trenchless Technology.

A Pull-Test: A **Resinating Liner** was secured to wet 3,000 psi concrete by a thin layer of **Resinating's Proprietary Bonding Agent**. As increasing force was applied, the first thing to break was the concrete! **What other rehabilitation option can perform like this?**

COST: With a competitive Day 1 Cost, infiltration eliminated and no future rehabilitations due to the structural integrity of **EIPI Technology**, the lifetime cost of **EIPI Technology** cannot be matched.



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THE KEY STEPS IN MAINLINE AND LATERAL GROUTING

By Jessica Williams

Injection grouting using acrylamide grout is known as one of the original trenchless technologies and has a long and successful, track record, spanning decades.

Injection grouts are used to eliminate infiltration in structurally sound mainlines, laterals, lateral connections and manholes among other underground structures. The infiltration carries soil fines into the system, eroding supporting soils and creating voids outside the pipe or manhole which can lead to sinkholes. The soil fines settle in the mainlines, reducing the pipe's designed sewerage capacity, which often leads to an increase in SSOs, requiring the need for cleaning more often.

As infiltration continues, the collection system will eventually become structurally incapable and what could have been a simple repair becomes a costly rehabilitation project, a complete replacement or a danger to the surrounding community.

Injection grouts do not stop sewer leaks by simply filling joints and cracks. Instead, grout is forced under pressure through joints and cracks and into the surrounding soil where it gels with the soil to form a waterproof mass which cannot be pushed back into the sewer system. Grouting provides additional support to the system while preventing further soil erosion.

The most economical way to stop infiltration in structurally sound pipes such as mainlines and laterals is with injection grout. This how-to will walk you through the steps to mainline and lateral grouting your collection system.

Mainline Grouting

Mainline grouting is executed using multiple technologies: a grout truck (or customized rig), inflatable mainline packer (for use in 6- to 120-in. pipe) and a low viscosity, two component injection grout such as acrylamide.

From the grout truck, an operator controls all aspects of the project. Closed-circuit television (CCTV) is used inside the pipe to locate the joint, crack, or defect to be tested and/or injected, and to strategically position the packer in place, and inflate the packer's end bladders.

It is important to air test all the joints as joints that were not visibly leaking during video inspection may leak in the future after sealing surrounding joints. Joints that fail the air pressure test can immediately be injected and sealed with grout – with or without visible leaks.

Grout is forced under pressure through the joint or defect into the surrounding soil forming a waterproof mass that cannot be permeated by water. The operator will pump the grout through the defect until refusal – or until grout has filled the void area outside pipe.

A general rule of thumb for the volume estimate of grout needed to seal a mainline joint is 0.5 gallons of grout per inch diameter of pipe. For example, if the mainline pipe is 8 in., a fair estimate per joint is 4 gallons. After the joint or defect is properly sealed, a post-air pressure test is administered. If the joint or defect does not leak air, it will not leak water.

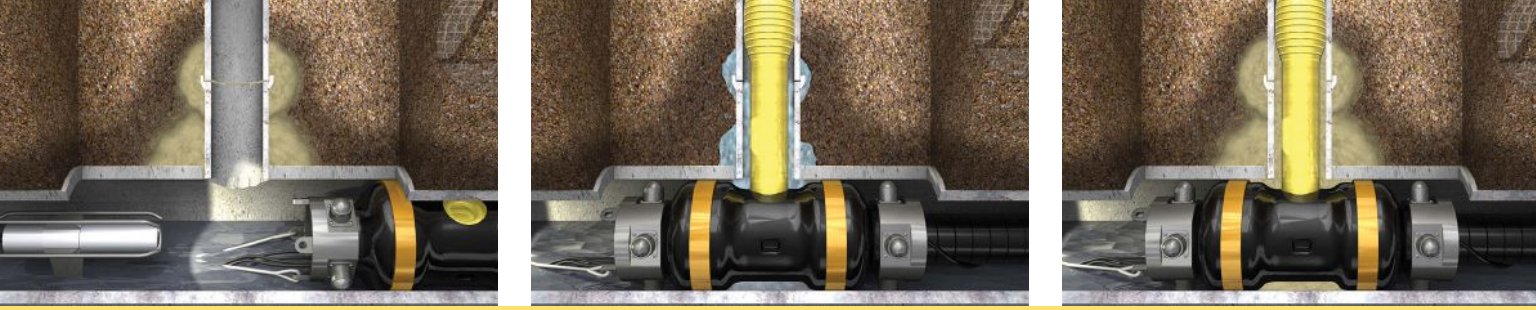
Once documented, the packer's bladders are deflated, and it gets moved to the next joint or defect in the pipe to repeat this process. Mainline grouting can also be used as a complimentary technology to pipe lining. By eliminating infiltration before lining pipes, maximum performance is achieved by creating an infiltration-free environment for the lining process.

Lateral Grouting

Lateral grouting is completed much like mainline grouting, except the packer has an inflatable plug that extends up the lateral from the mainline.

Once the packer is positioned in place, the lateral plug is fully inverted up the lateral, and the mainline bladders are inflated. The top, ribbed portion of the lateral plug expands against the lateral pipe wall, while the lower portion expands enough to create a thin annulus for the grout to travel between packer and pipe.

Grout is forced under pressure through the defects into the surrounding soil forming a waterproof mass that cannot be permeated by water. A general rule of thumb for the volume estimate of grout needed for sealing a lateral is 0.33 gallons of grout per inch diameter pipe plus an additional gallon per foot of lateral. For example, if the lateral pipe is 6 in. and you



are sealing 3 ft up the lateral, a fair estimate per lateral is approximately 5 gallons.

After the lateral is properly sealed, a post-air pressure test is administered. If no leaks are detected, the seal is documented, mainline bladders are deflated, the lateral plug is reinverted into the packer assembly, and the packer is moved to the next lateral in need of rehabilitation.

Depending on application and municipal requirement, lateral grouting can be performed as far as 35 ft from the mainline. Lateral grouting can also be a complimentary technology to lining pipes.

After lining, grout is the optimum technology to seal the annulus between host pipe and liner at the lateral reinstatement – a primary source of infiltration.

Injection Grout Is Here to Last

At times, grouting has been misconstrued as a temporary fix that will dehydrate and only last a few years. These misconceptions are false. Third party studies over longevity and hydration of grout have shown:

- Properly injected acrylamide grout at 20 percent concentration has a 362-year half-life in the soil determined by the United States EPA. Most acrylamide grout in municipal applications is injected at 10 percent or 12 percent concentrations making the approximate life expectancy more than 50 years.
- At typical depths that sewer systems are located underground, there is enough relative humidity (RH) to keep the acrylamide grout hydrated thus never dehydrating or shrinking (Doug Cobos, 2018).

Everyday communities battle infiltration in their collection systems. At first, infiltration may not seem troublesome. However, when infiltration is allowed to exist over time, systems become compromised, and the safety of the community may be in jeopardy. A proactive rehabilitation approach versus a reactive repair or replacement approach should be top of mind. For decades, injection grouts have been the most economical product to stop infiltration in structurally sound collection systems.

Jessica Williams is marketing manager at Avanti International.

SLIPLINING
IN URBAN AREAS

By Todd Grafenauer

With cities needing to replace a vast amount of aging water and sewer infrastructure, many find value in one of the oldest and simplest trenchless technologies of sliplining.

The method installs a new pipe inside the existing failing pipeline. The new pipe is typically installed either by pushing or pulling the new pipe into the host pipe with installation distances of a few hundred feet up to one mile at a time.

The sliplining technology is advantageous for replacement as the method is cost-effective, requiring only a few access pits. This reduces restoration efforts including environmental impact. The method also follows the existing utility path that can be critical as many cities do not have an available easement to relocate the new pipeline, especially for large diameter transmission mains located in congested utility corridors. Following the existing utility path also affords the city to reduce upfront design time and cost.

While cities may ultimately select the sliplining method due to the many advantages the method offers, another consideration is constructability. Installing or replacing water and sewer infrastructure in mature urbanized areas presents its own set of challenges for any construction method, including sliplining. An important part of the evaluation of selecting the best construction method for a given project is not only in finding value, but one that can be constructed within the constraints of mature residential neighborhoods and business districts.

The trend of cities preferring trenchless methods in mature urban areas continue due to the reduction in social impact. These include limiting road

and intersection closures, reducing the impact to businesses, homeowners and pedestrians and preference for expeditated construction schedules to return the area back to normal. With the reduction in social impact that trenchless methods afford, cities still need to understand the constructability of the methods during the planning and design phase of the project.

Sliplining Constructability

Sliplining has generally utilized two methods for installing the new pipe within the failing host pipe:

The first is pre-assembling the new pipe before installation. Continuous or pre-assembling the new pipe before installation, such as using the butt fusion method with HDPE pipe, has often been the preferred method of installation by the contractor.

By pre-assembling the new pipe to correspond to the pull in distance, allows the contractor to focus on the proper procedures for butt fusion in advance of the pull. It also allows the contractor to focus solely on installation on the day of the pull, which helps to expedite pulling in the pipe.

However, many cities have limited laydown areas in which it is not feasible to pre-assemble more than 500 to 1,000 ft of pipe in one continuous length. Many cities cannot block major intersections or approaches to businesses.

In these situations, there are alternatives that can be utilized to ensure the constructability of continuous sliplining. These include pre-assembling the new pipe in an area that has room to assemble the pipe in the predetermined installation distance of 2,000 ft or more. In this case, the new pipe would be moved the morning of the installation to the sliplining location. This would limit the pipe blocking any intersections or business approaches

to only a few hours as the new pipe is pulled into place.

It must be noted that the new pipe material selected for installation plays a critical factor if this is an option. One reason why HDPE pipe has become a preferred option for sliplining is the pipe material has the characteristics required to move the pipe from the pre-assemble area to the sliplining location. These characteristics include the material properties of being light weight, extremely flexible with a scratch resistance property.

Another option is the fuse-pull-fuse-pull method. This option includes pre-assembling the new pipe at the sliplining installation location, however, only to assemble lengths of new pipe that fit within the existing landscape that minimize impact to the area.

An example of this would be if the sliplining installation distance is 3,000 ft, but a major intersection is located 1,000 ft away and cannot be shut down, then to pre-assemble three sections of new pipe at 1,000 ft each.

With this option, sliplining activity would first install the first 1,000-ft section, then operations would pause to connect the next 1,000-ft section, continue sliplining until the last 1,000-ft section is connected, and then finish the pull.

The second option for sliplining the new pipe includes the cartridge method or segmental installation.

With this method, each section of new pipe is assembled in the insertion pit. Once the connection is made, the new pipe section is either pushed or pulled in. Many cartridge sliplining installations will utilize the pushing method and can be assisted with equipment such as a jacking machine.

With the cartridge method, after the first section of pipe is installed, the pull is then stopped, and another section is lowered into the insertion pit. The next joint is then connected and sliplining operations resume.

This method continues until then entire section for replacement is completed. There are multiple new pipe materials that can be utilized with the cartridge method including steel, ductile iron, concrete, PVC and HDPE pipe.

With the trend of cities preferring trenchless methods in mature urban areas continuing to grow due to the need to reduce traffic and pedestrian disruption, resident and commercial inconvenience – there are multiple solutions with sliplining that can address constructability concerns of limited laydown areas that exist within mature urban areas.

Todd Grafenauer is vice president and education director at Murphy Pipelines.

HOW TO PRIORITIZE TRENCHLESS PIPELINE REHABILITATION PROJECTS

By Jennifer Glynn

We've all heard the story before...the single most important issue facing North American municipalities is the renewal or replacement of aging water, wastewater and stormwater infrastructure.

According to recent estimates, more than $600 billion is required to rehabilitate failing infrastructure within the next five years. Many municipalities have gone through the master-planning process and completed inspections and condition assessment of their systems. Now, they have loads of information on hand and find it's time to sift through the data, reports, and recommendations.

Where to Begin

With so many projects to complete and a limited budget to do so, how does a municipality decide how to prioritize its trenchless pipeline rehabilitation projects?

It doesn't have to be a daunting task. With an understanding of the trenchless rehabilitation marketplace, established municipality-specific goals, and some common sense, choosing how to prioritize rehabilitation projects can be a straightforward process.

The first step in prioritizing rehabilitation projects is to look at the results of a system's condition assessment and develop an initial project prioritization list based solely on remaining useful life of each asset. This is tied to a likelihood of failure (LOF)analysis.

It certainly stands to reason that those pipe segments deemed to be the most structurally compromised should be rehabilitated first. However, what happens when most of a system is structurally deficient, as seems to be the case for a lot of cities and town throughout North America? How does one break the compromised portions of a given system into projects and prioritize them for design and bid?

Once asset condition has been established and an initial prioritization list based on structural integrity of the system has been completed, the next step is to consider the trenchless rehabilitation marketplace and what rehabilitation method(s) are appropriate for each pipe segment identified as structurally deficient.

In this step in the process, key criteria will be considered to assess different rehabilitation alternatives and generate rehabilitation recommendations for each pipe segment within the impacted portion of the system.

These criteria include:

- Hydraulic requirements (i.e., Can you stand to lose some hydraulic capacity with a lining system? If so, what is the maximum liner thickness allowed?)
- Number of available contractors
- Schedule restrictions
- Construction footprint and access requirements
- Cost

Setting Goals

Now that recommended rehabilitation methods have been determined, the next step is to group the pipe segments into projects based on the specific goals for your municipality.

Goals may include:

- Staying within allocated budgetary spending
- Completing a certain number of miles of pipe rehabilitation per year
- Meeting important stakeholder wants/needs
- Limiting or sectoring disruption to commercial and residential entities within your jurisdiction
- Being a good environmental steward
- Limiting the number and/or type of permits required
- Complying with any agency consent decrees
- Staying within treatment capacity limits (i.e. reduce infiltration/inflow into your sanitary sewer system)
- Or all the above

These goals generally tie into a pipeline's consequence of failure (COF). Once an inventory of goals has been established, it is then necessary to weigh those goals by importance. Those goals with a higher importance to the municipality will receive a higher weight. This will be the lens through which pipe segments will be grouped to establish projects and update the initial prioritization list.

Highest score = Highest-Ranking alignment. Criteria are scored from 1 - 10 based on scoring system developed by Municipality. See scoring metrics below.

TOTAL SCORE		9.0		8.7		6.1		7.5		8.4	
		Project 1		Project 2		Project 3		Project 4		Project 5	
Objective	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1. Goal #1	30%	3.0		3.0		3.0		2.7		2.7	
		10		10		10		9		9	
2. Goal #2	40%	4.0		4.0		0.4		4.0		4.0	
		10		10		1		10		10	
3. Goal #3	15%	1.4		1.4		1.5		0.5		0.2	
		9		9		10		3		1	
4. Goal #4	15%	0.6		0.3		1.2		0.3		1.5	
		4		2		8		2		10	

The Final List

After the updated rehabilitation prioritization list has been constructed, the next step is to apply good old fashioned common sense to develop a final project prioritization list. Some questions you may want to ask yourself in this part of the vetting process include:

• Are these projects grouped to limit disruption to a specific area only once?

If I end one project and begin a second within the same residential easement, then I am impacting that homeowner twice on two different projects. Perhaps that is better avoided by combining them into a single project within the easement.

» Perhaps it makes sense to group all the pipe segments in a busy road together as one project, so you only set up traffic control in that area once?

» Or perhaps you want to complete all the pipe segments in an environmentally sensitive area so that you don't have to acquire permits twice if there is project overlap when in the environmental area.

- Does the current project grouping work in conjunction with a bypass pumping plan?
  - » It often makes sense to have contiguous pipe segments in one project so that you only require one bypass pumping set up to complete rehabilitation of that project.

- Would I get a better price creating a bigger project to take advantage of economy of scale?
  - » Contractors will often give a better per foot rehabilitation cost for a much larger project if a municipality has the budget to approve a large project.

- Are the projects on the initial prioritization list grouped by rehabilitation technology?
  - » Sometimes it makes sense to group all the CIPP segments together on one project and all the pipe bursting segments together on a separate project, so you are not having to deal with two different contractor specialties on the same project.

- Are the projects grouped by pipe size?
  - » This is especially true if you have a wide range of pipe diameters that require rehabilitation. There is often a different pool of contractors who will bid on a small diameter versus large diameter rehabilitation project.

Keep in mind that project prioritization is an iterative process that should be "gut checked" and updated based on input of decisionmakers within your organization. The initial prioritization list if often not the best approach but is instead a starting point that should be revisited based on your municipalities budget and project goals.

The criteria are often intertwined with one another and there is never a clear-cut answer. However, with an understanding of your trenchless rehabilitation options and your organization's goals tempered with some good old common sense, it doesn't have to be an overwhelming and laborious process.

Jennifer Glynn, P.E., is senior technical practice leader for Woodard & Curran out of its Sacramento, California office.

PROPERLY OUTFITTING AN

INSPECTION VEHICLE

By Matt Sutton

Outfitting a pipeline inspection vehicle can seem like a daunting task. You and your team are likely going to use this vehicle for the next decade, and the decisions you make at the beginning of the process can have large impacts on crew safety, efficiency, and capabilities. In our decades of experience building and servicing these vehicles, we have discovered a few key things to consider that will make your decision easier.

What kind of equipment are you installing?

Determining the equipment that will be installed in the finished vehicle may seem like the last step, however the physical size and internal space requirements can vary dramatically from one type of system to another. Some systems such as lateral launching or rehabilitation equipment may require space for a second cable winch. Some types of work may require a larger portion of the vehicle to include storage areas for safety equipment, tools, water storage and tool storage. In short, start with what you want to deploy out of the vehicle, not the vehicle itself.

Ask your crew

This is likely not your first inspection vehicle purchase. Early in the process you should ask your crews what they like and do not like about their current and past vehicles. They have invaluable opinions, formed over years of working in your current vehicles. Where do they wish they had extra storage? What would make their current vehicle more comfortable, productive, and safe? There are many accessories that you can consider at this stage. Examples include higher quality safety lighting, retractable canopies that protect workers and equipment from rain, cold weather packages, extra storage options, and built-in bathrooms. Brainstorm with your crew and your vendor to determine what options are important for your team and achievable with your budget.

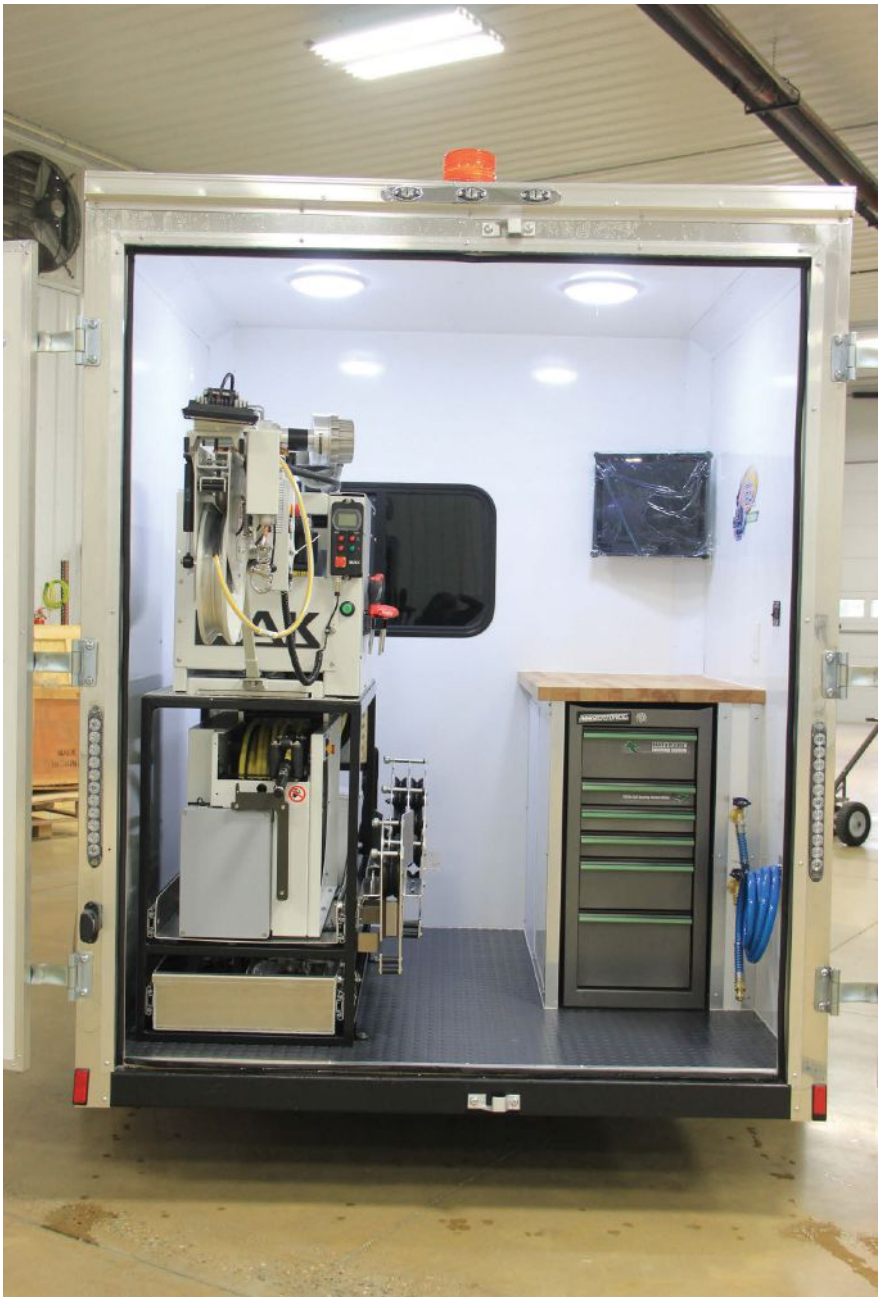
Deployment vehicle selection

At this stage you will need to consider a few basic questions that often get overlooked. We consider anything that delivers equipment to the jobsite to be a deployment vehicle. This can be an all-terrain vehicle, trailer, cargo van, pickup, or a large box truck (of varying size). It is important to consider the payload capacity of these vehicles. On average, we have found that we add about 1,500 lbs to a vehicle when it is completely outfitted. Below are some of the vehicle options and their characteristics.

- All-terrain vehicles are great for off-road and easement work. They are capable, fit in small areas, have limited environmental impact, but need to be delivered to the jobsite by a support vehicle, and are often not road legal.
- Trailers can be outfitted to be as comfortable and as spacious as many box trucks, but also require another vehicle to pull them and can be hard to maneuver in some areas. They cost less than a complete vehicle conversion and you likely have a pickup truck in your fleet that can pull them.
- Cargo vans are compact, have great fuel economy, and can be outfitted to be comfortable. However, space is always limited, and you will need to make hard decisions regarding storage and workspace. Cargo vans can be an excellent choice for deployment in cities with narrow streets and heavy traffic.
- Box vans are the most common inspection vehicle choice. They can be built on truck or van chassis, and can be of varying length, width and height. Larger versions can provide large storage and work areas. Narrow width bodies can fit in tight spaces. Box vans provide you with the most freedom to outfit special requirements and larger equipment packages.

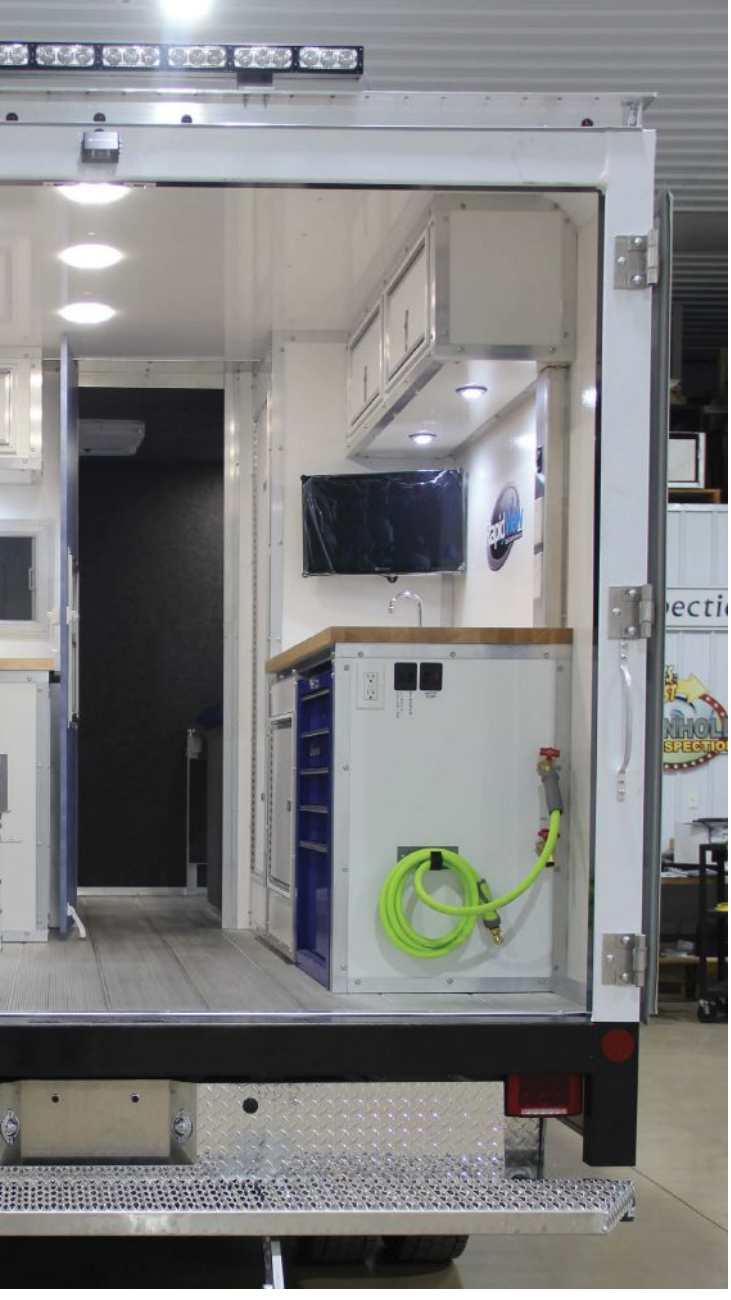
Power systems

Of the decisions you will make, the power system that provides electricity to the equipment and accessories is perhaps one of the most nuanced and important of the early decisions. Each type of



system has its benefits and costs. These systems can also be combined to provide unique solutions and capabilities. Each type also changes the build out of the conversion, so it is important to consider them early in the process.

- Gas or diesel generators are currently the standard choice. Good quality, modern generators are dependable, however, they take up considerable space and require air intake and exhaust. They also require regular maintenance. Modern generators are often quieter than older models, but they still emit sound that can be disruptive to crews and residents if working in populated areas and emit exhaust which must be considered.
- Engine-mounted generators are common systems in emergency vehicles. These systems use an installed generator on the vehicle motor to generate power while the engine is running. This requires the vehicle to run while in use but replaces the separately installed generator saving space. Depending on the vehicle this can be a more fuel efficient, quieter solution.
- Battery and inverter systems use energy stored in batteries to power the system and accessories. A battery powered system is silent and clean, however there are limitations. High quality batteries can be expensive, and you will need to charge the system. Systems can be designed to charge off the vehicle engine and/or be plugged in to charge overnight. Contractors who stay at hotels during longer projects can find it difficult to charge their systems at night, and the power storage required to run air conditioning in hot climates can result in prohibitively large, expensive, and heavy battery banks.



Finalize design

It is useful to think of vehicle builds as a small construction project. You and your supplier representative should go over all the options, set goals, and begin the design process. If it is a standard build with few accessories, it may be easy. But if it is a more complex build you will want to clearly define all custom options. Your vendor should be able to provide a CAD drawing of the build for your review and approval. As a vendor, we focus on this stage to avoid potential misunderstandings, and set the appropriate expectations.

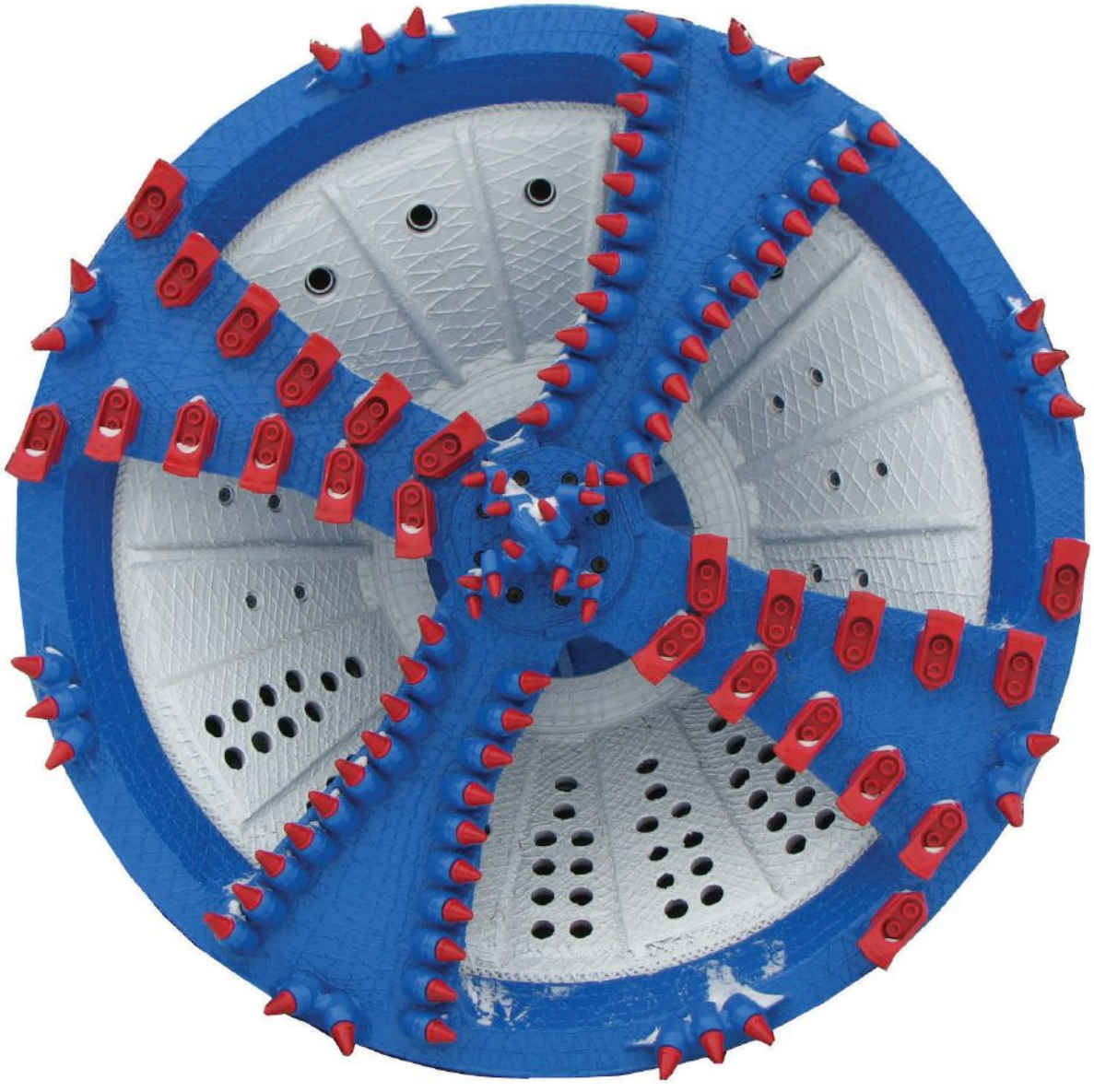
You will have to make more choices than those listed above. However, we have found that if you consider these factors, it can help make sure that you receive a vehicle that meets your needs and helps you achieve your inspection goals.

Matt Sutton is vice president of sales and marketing at RapidView IBAK.

CUTTER HEAD SELECTION:

A MANUFACTURER'S PERSPECTIVE

By Cameron Landherr



Soft ground cutter head tooling typically includes cutter teeth, cutter bits, and scrapers. Soft ground cutter heads have the largest percentage of openings to allow for material consumption, typically between 40 to 60 percent.

A tunneling project consists of numerous intertwined puzzle pieces. Often, the cutter head on the tunnel boring machine is the most critical. It is the front line to progress. Without a properly designed cutter head, production can be slow or nonexistent.

The cutter head design and its tooling are dictated by the anticipated ground conditions on the project. The best results come from a cutter head design that is specific to the project's ground conditions. Deciding where the cutter head tooling should fall on that spectrum requires some considerations:

- How long is the drive?
- How hard is the ground?
- Is the ground abrasive?
- Will you be able to dig up the machine if you encounter an obstruction or need to replace tooling?
- What will it take to replace tooling underground?
- Is it possible to replace the tooling underground?

A good geotechnical report can answer many of these questions.

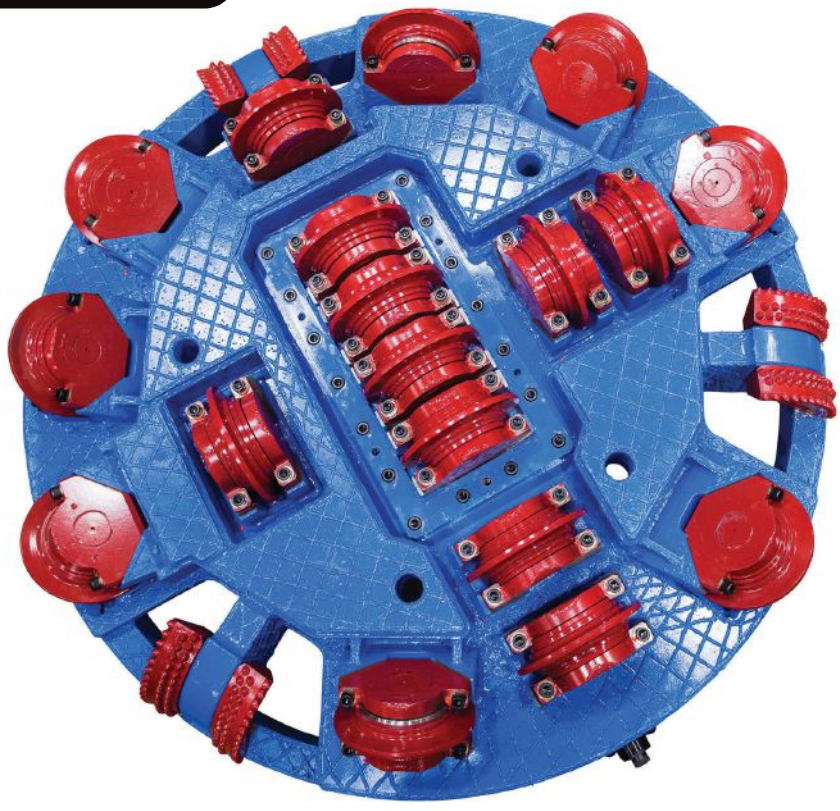
Ground Conditions

Ground conditions can vary significantly from one project to the next and even every few feet along the same alignment. For now, let's focus on some of the most common ground types experienced when tunneling – sand and gravels, clay, mixed ground and rock.

Each ground condition requires different cutter head tooling to be successful, and when appropriately selected, can significantly mitigate risk. Soft ground cutter head tooling typically includes cutter teeth, cutter bits, and scrapers. When hard ground or rock is expected, cutter discs are used. Mixed ground cutter heads blend the soft ground and hard ground tooling and are required when softer materials surround cobble or boulders.

The most reliable tooling usually costs the most, but there is peace of mind knowing that the cutter head will handle it if something unexpected is encountered while mining.

The manner of tooling installation should be considered – specifically whether the tooling will need to be serviced underground or not. Soft ground tooling is mounted on the cutter head in two manners, weld-on or bolt-on. Soft ground tooling comes in many different styles ranging from a simple mild steel plate to purpose-built bits with mounts and carbide tipped inserts. Discs cutters are installed from the front of the cutter head or the rear. Some cutter heads are designed to maintain the tooling integrity throughout the entire drive length. In other instances, cutter heads will need to have the option to replace tooling underground. If the cutter head will need maintenance while underground, a machine with face access is required, allowing for cut-



When hard ground or rock is expected, the rock cutter head contains disc cutters discs to process the material to the appropriate size in front of the faceplate before consuming the fractured rock. Hard ground cutter heads openings are typically in the 10 to 20 percent range.

ter head access from inside the machine. Rear-loaded discs are replaced from behind the cutting face. Keep in mind, in some conditions, ground stabilization or hyperbaric pressurization may be required to perform underground maintenance of the cutter head.

When considering a rock cutter head, it is essential to understand the characteristics of the rock. How strong is the rock? How much rock is there? Is the rock fractured, stratified, or bedded? What is the orientation relative to the alignment? The answers to these questions will guide the design of the cutter head and should be discussed with your supplier. In general, closer disc spacing and higher thrust is required to process harder rock. The quantity and the size of the disc cutters increases the thrust capacity of the cutter head. Also, understanding of the thrust capacity of the cutter head is critical to disc cutter longevity and suitable production. Thrusting too hard will reduce the disc-bearing life. A damaged disc bearing will result in skidding and loss of production.

Another important disc cutter head design feature allows the discs to process the material to the appropriate size in front of the faceplate before consuming the fractured rock. Some cutter head designs incorporate material grading screens to control the size of material allowed to pass through the cutter head openings; often these are called grizzly bars. Grizzly bars are added to the design to alter the openings in the faceplate. They are welded or bolted in place and screen the size of the material allowed through the faceplate. Bolt-on grizzly bars can also be used as access doors to the face and removed if tooling replacement must occur.

Cutter head faceplates have substantially different opening percentages based on the project's anticipated ground conditions. Soft ground tends to be easier to process; therefore, the design allows for fast advance rates. Soft ground cutter heads have the largest percentage of openings to allow for material consumption, typically between 40 to 60 percent. Hard ground cutter heads experience the slowest production, and spoils created by a disc cutter head are small, fractured chips consumed by the spacing around a disc cutter. Hard ground cutter heads openings are typically in the 10 to 20 percent range. Mixed-ground cutter heads fall somewhere between the two bounds set by the soft ground and hard ground heads. A 20 to 40 percent opening percentage allows hard material to become processed by the disc cutters while the soft and fractured hard material to be processed through a larger scoop opening.

The abrasivity of the ground is another consideration for cutter head selection. Protection of the cutter head from abra-

Mixed-ground cutter heads blend the soft ground and hard ground tooling and are required when cobble or boulders are surrounded by softer materials. A 20 to 40 percent opening percentage allows hard material to become processed by the disc cutters while the soft and fractured hard material to be processed through a larger scoop opening.

sive material is just as important as selecting the correct tooling. Over time, abrasive material will erode the tooling and base structure of the cutter head, causing carbide inserts to fall out of the cutter bits rendering them useless for the remainder of the drive. Abrasive material can also wear away at the disc cutters. If the material wears through the disc body, it could breach the bearing cavity causing the disc cutter to stop rotating. Some manufacturers add hard face weld or carbide impregnated wear plates to increase life and combat abrasive material wearing at the cutter head. By reducing the risk of failure, a cutter head can perform as intended for a long time.

Every tunnel will have its unique challenges regarding ground conditions, and no two tunnels will be alike. There can be a lot to consider when picking a cutter head but planning to minimize risk after the machine is launched will help streamline the path to success. The best way to assess the risk is to get a hold of someone involved in cutter head design – they will be more than happy to help.

Cameron Landherr, P.E., is a design engineer at Akkerman Inc.

HOW TO AUGER BORE

IN SPECIFIC GROUND CONDITIONS

By Steven Gallyer

Auger boring is an art that takes a significant amount of training and seat time to master. Pacific Boring has more than 40 years of auger boring experience primarily in the Western United States.

Over these years, we've done a significant amount of research and development with auger boring and pipejacking. We've partnered with other contractors and manufacturers, sharing ideas and techniques to help advance the industry.

The goal of this article is to continue this effort, to provide knowledge to engineers, owners and add value to other contractors who can reference these essential tips when operating in both hard and soft ground conditions.

Auger Boring in Soft Ground

1. Lead Casing Preparation

The lead casing should be beveled and flared to provide a cutting edge and overcut. The overcut amount should not exceed that specified by the contract documents, which is typically specified in the 1-in. radial overcut range. If the pipe is a larger diameter (more than 36 in.) a band is typically welded around the leading edge. Bands should also be used in smaller diameters (less than 36 in.) where tough ground conditions are anticipated to reinforce the leading edge.

2. Auger Placement

If the ground is firm, the cutterhead can be placed slightly outside the leading edge. Too often we see specifications that require the contractor to push a "plug" however, in most cases where the ground is not soft enough or does not exhibit running behavior, and it doesn't work. The force required to push the casing through this ground can damage the casing or simply "stick" the casing stopping forward progress altogether.

Running ground behavior, such as clean sands, would justify retracting the cutterhead inside the casing. This is typically accomplished by welding a 2-ft long piece of casing on without adding any auger. This will retract the auger 2 ft inside the casing. If necessary, the cutterhead can also be removed, increasing the distance from the leading edge to the point of excavation.

Very stiff to hard soils requires the cutterhead to be in front of the casing's leading edge. Wing cutters on the bit must cut slightly larger than the overcut band. If not, the casing will begin to egg if the band cannot cut the ground.

3. Groundwater Control

Auger boring should not be used below the groundwater table in sands or silts where the ground would exhibit flowing behavior. This type of ground requires dewatering of the alignment. Where the alignment cannot be dewatered, another method should be selected such as mircotunneling. Auger boring can be performed around the groundwater table in clays that have a low permeability. In these ground conditions you should anticipate some water reaching the pits and plan to sump out the pit.

4. Machine & Cutterhead Selection

The proper machine should be selected for the work. The ground type, diameter and length should all be taken into consideration. The machine should have enough thrust to advance the casing through the ground and enough torque to turn the augers.

There is a wide variety of cutterheads offered by several different manufacturers. Standard dirt bits are used in soft ground. Wing cutters are required in harder soil types or where large gravel and cobble may be pres-

ent. If there is a significant amount of cobble or boulders, hand-mining/removal is required.

5. Vasing Diameter

The casing size should not only be sized according to the carrier pipe size and to account for installation tolerances, but also for the anticipated ground conditions. For example, as mentioned above, if cobbles or boulders are anticipated, the casing should be sized to allow for man entry for removal and handling of the material.

Auger Boring in Rock

1. Lead Casing Preparation

The lead casing should be reinforced banded with a hand approximately 3 to 4 in. long. The overcut amount should not exceed that specified by the contract documents which is typically specified in the 1-in. radial overcut range. The amount of overcut isn't as concerning in rock since there is little risk of surface settlement. The band should not be sized larger than the overcut of the bit, but not so much smaller that it will not bring in fines from the cutterhead excavation. The lead casing is shortened so the cutterhead is in front.

2. Auger Placement

In rock, the augers should be all the way forward, placing the cutterhead outside the leading edge of the casing. Augers cannot be retracted for two reasons. First, the casing alone will not penetrate the rock without first being excavated. Second, the bit's overcut flippers will not open if it is inside the casing.

3. Groundwater Control

Ground water in rock is generally not an issue for auger boring projects. The crossings are relatively shallow, rock is not highly permeable, and there is no risk of the water changing the ground behavior. If the rock is fractured and contains water, the Engineer's design should have systems in place to properly deal with the water.

4. Machine & Cutterhead Selection:

The proper machine should be selected for the work. The rock strength, diameter and length should all be taken into consideration. The machine should have enough thrust to advance the cutterhead and casing through the ground and enough torque to turn the augers and cutterhead.

There is a wide variety of cutterheads offered by several different manufacturers. We use flat and "Christmas tree" style cutterheads. Both style of cutterheads have replaceable carbide tip bits. The Christmas tree style bits can cut through higher strength material, but the rule of thumb is not higher than 6,000-psi unconfined compressive strength. Higher strength rock would require a disc cutterhead like the Robbins SBU.

More recent innovations include Down the Hole Hammers (DTH), like what is offered by Geonex. I visited the first Geonex casing installation in the United States in 2019 in Wisconsin and was impressed with the machine's ability to excavate in rock. It is important that rock strength is provided prior to bid so that proper the proper cutterhead selection is utilized on the project.

5. Casing Diameter

Like soft ground, the casing should be sized appropriately for the carrier pipe and to account for installation tolerances. The casing diameter will also be driven by the rock strength and equipment availability. For example, the job may call for 36-in. casing in 14,000-psi rock. However, the contractor may upsize to 48-in. casing if they have a 48-in. Robbins SBU available.

As most readers know, auger boring is hard, which is probably an understatement. It's never as easy as just checking the boxes because each crossing presents its own challenges and takes on a life of its own. It takes good amount of research, planning and engineering to make a project successful. It is important that engineers design projects with realistic tolerances in mind and specify the appropriate method for the anticipated ground conditions.

Steven Gallyer is president of Pacific Boring Inc.

SHOULD I BID THIS HDD PROJECT?

THINGS TO CONSIDER BEFORE BIDDING ON HDD WORK

By Matt Olson

Efficient use of workspace illustrated on an HDD project *(photo credit: Adam Pring)*.

There are many factors a contractor must consider when evaluating whether to bid on a horizontal directional drilling (HDD) project.

Besides considering their current backlog, potential opportunity costs and crucial business relationships the contractor must estimate the profit they would generate if they were to execute the advertised work. With exception of change orders and other claims, the contractor must bid the work higher than it costs them to complete the work to make a profit.

Expenses can be reduced without sacrificing quality if a contractor is set up well for the specific HDD project. Mobilization requirements, union requirements, product pipe diameter, acceptable product pipe materials, quantity of work, bore length(s) and crew experience with similar installations are some factors that can influence a contractor's ability to minimize expenses. The contractor must also understand the project's risk profile. Identifying the risks, the probability of their occurrence, the consequence of the risks should they occur, the mitigation measures, and the cost of mitigation are the pieces of information required to evaluate project risk (Staheli, Hutchinson, and Moore 2017).

Constructability Risks

Constructability risks include risk factors that influence one's ability to effectively complete the required work without damaging necessary equipment or materials, damaging existing infrastructure, or negatively impacting third parties. First steps toward evaluating constructability risk include evaluating the bore path geometry with respect to the anticipated subsurface conditions. Strater and Dorwart (2015) identify common deficiencies or errors in alignment selection, such as insufficient depth of cover or unrealistic bending radii. A contractor must be able to effectively identify these inadequacies when deciding whether to bid on a project.

To do so requires a sound understanding of the subsurface conditions and anticipated ground behavior, which can be gained by calling upon prior experience in similar ground and reviewing the subsurface data and reports.

Findings from subsurface investigations are often provided in a geotechnical data report (GDR). A well-done subsurface investigation will include subsurface explorations appro-

priately distributed along the alignment at reasonable offsets. Further, laboratory testing on ground samples will be tailored such that proper equipment and tooling can be selected and drilling progress accurately estimated.

A geotechnical baseline report (GBR) may be produced, although not as commonly as it is for tunneling installations. The primary purpose of a GBR is to establish a single source document where contractual statements describe the geotechnical conditions anticipated to be encountered during underground construction (Essex 2007).

Although not every HDD project needs a GBR, the GBR can be effective at informing the contractor what to expect underground, at which point the ground conditions constitute a differing site condition, and what they need to know about anticipated ground conditions and challenges of the work (Brierley and Soule 2014). With a thorough understanding of the ground conditions and anticipated behavior, the contractor can better evaluate constructability risks present along the alignment.

Ensuring sufficient workspace for the HDD operation is also important. The contractor must understand the implications of the workspace constraints and ensure they have a plan that works well given those constraints. Figure 1 og pg. 43 highlights an efficient use of space within a tight construction easement.

Contractual Risks

Besides constructability risks, the contractor must understand their responsibilities as outlined in the contract documents and the contractual risks that accompany them. Key locations to identify a contractor's contractual risk exposure include baseline statements (often within a GBR) and requirements within technical specifications.

The contractor is responsible for including costs in their bid to perform the work in conditions equal to or less adverse than the baseline statements. The owner is responsible for providing compensation for encountered conditions more adverse than the baselines, that also negatively impact the contractor's expenses.

Technical specifications that are not tailored to the project at hand, include contradictions, do not use clear language, or place the responsibility of the design and the bulk of the risk on the contractor in a design, bid, build scenario are not characteristic of well written specifications (Wallin 2021). Contractors should proceed with caution when pursuing projects with specifications such as these or with overly conservative baseline statements.

Pricing the Risks

Once project risks are identified the contractor must consider how to price those risks and ultimately decide whether bidding the project aligns with their business goals. For each risk identified as the contractor's responsibility, it is recommended to estimate a probability of that risk occurring and the consequence that risk coming to fruition would create.

Estimating the probability is founded on

a thorough understanding of the project conditions and the contractor's ability to effectively execute the work plan. Quantifying the cost associated with fixing a realized risk can be especially challenging. Some factors to consider when quantifying cost of risk consequence may include: the propensity of the owner or engineer to cooperate and find a fair and equitable path forward in lieu of litigation should an adverse situation arise; knowledge of the owner or engineer in the HDD method, and/or their receptivity to learning; damage to equipment, materials, or surrounding infrastructure; availability of remedial equipment, supplies, or materials; impact to schedule; ability to save the existing installation without a redesign; ability to regroup and execute a plan B should the original design need to be abandoned; the availability of above or below ground space to execute the original design or plan B; fines; impact to available credit lines; and financial impacts due to injury, death, or increased insurance rates. If a project has a risk profile outside a contractor's willingness to manage it, the contractor may wish to refrain from bidding the project.

The contractor must consider their ability to make a profit when deciding whether to bid an HDD project. Synergy between the contractor's strengths and project requirements, as well as an understanding of the project risk profile are paramount to success. Numerous publications are available through organizations such as NASTT, NUCA, ASCE, ASTM, PRCI, and industry magazines to aid in evaluating HDD risks. Further, authors of these publications are often willing to provide consultation.

Matt Olson, P.E., is a project manager at Lithos Engineering.

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How to Combat Inaccurate Utility Markings

By Cory Schueller, Product Manager, TRUVAC®

The TRUVAC® FLXX™ midsize vacuum excavator designed to be easily maneuverable in locations like this new housing development, backfilled with red clay soil, in Georgia.

The best plan of attack to locate underground utilities and reduce risk of damage is to consider mapped utility locations and marking flags as "suggested" locations for those utilities. Despite good intentions, maps and location methods rarely provide an exact location, nor the precise depth, of a utility line below ground. Verification of utility locations is ultimately confirmed visually on the jobsite when the underground facilities have been exposed using extremely efficient vacuum excavation equipment.

Vacuum excavation provides a more precise, less destructive, and safer method for "daylighting." "Daylighting" is the term to describe digging to expose and visually confirm the location of underground utilities. Vacuum excavation can be performed with either pressurized air or water in addition to an industrial strength vacuum to simultaneously excavate and evacuate the soil spoils back into the debris body of the vacuum excavator. This minimally invasive method of excavation exposes the underground utilities with speed and minimizes damages in borehole and trenching applications.

Avoid Damage to Critical Infrastructure

Damage prevention remains the primary goal in underground utility location and digging surrounding underground infrastructure installations, repairs, and rehabilitation. Experienced utility contractors agree that the best weapon to combat inaccurate utility markings is to expect the unexpected. This means acknowledging that pre-plans rarely match reality and that unanticipated issues, such as a gas leak discovery while on the job, can affect the work scheduled to be performed.

Following the call to the national call-before-you-dig number 811, and the marking of the buried utility lines by the utilities, a work site has been properly staged for reviewing those locations and determining the best method for excavating. That determination is made based on answers to the following questions:

- What further geotechnical investigation work is scheduled for the site?
- What surface cover will need to be cut? Grass, asphalt, concrete?
- What type of soil is present?
- How much workspace is available for equipment access?
- What is the anticipated density of buried services?

Careful consideration of each unique jobsite and vacuum excavation best practices will support job productivity and mitigate risks.

Seeing is Believing

With the right tools at the job site, utility excavation is ready to safely begin. Again, using utility markings as "suggested" locations, the goal of excavation should be to visually locate the buried utility lines. Vacuum excavation is advantageous and known as "safe digging" because it allows the contractor to proceed using air and/or water to excavate in the ground in the marked locations until the facilities are visually identified. Vacuum excavation best practices define the pressure of air or water used, as well as the type of nozzle, based on excavation depth and soil conditions. The Gas Technology Institute (GTI) is a leading independent non-profit research, development, and training organization instrumental in establishing and publishing the most up-to-date trenchless best practices for damage prevention. GTI supports ongoing research and develops new tools and techniques for reducing excavation damage. New technology is available to prevent water system pressure from exceeding site or industry requirements and effectively eliminates human error in the excavation equation to provide increased safety.

TRUVAC® brand vacuum excavators are designed to support these safe practices and reduce risks inherent in underground utility location. Whether a job is a new installation, or repair to existing underground infrastructure, contractors will benefit from using marked utility locations as merely "suggested" locations, or a guide map to the construction area. Safe digging with non-destructive vacuum excavation will provide visual confirmation of the location of buried utilities and contribute to increased productivity on the job and smarter digging designed to be more profitable for contractors.

Underground utilities were exposed quickly and efficiently using a combination of air and hydro vacuum excavation to provide visual location of underground utilities.

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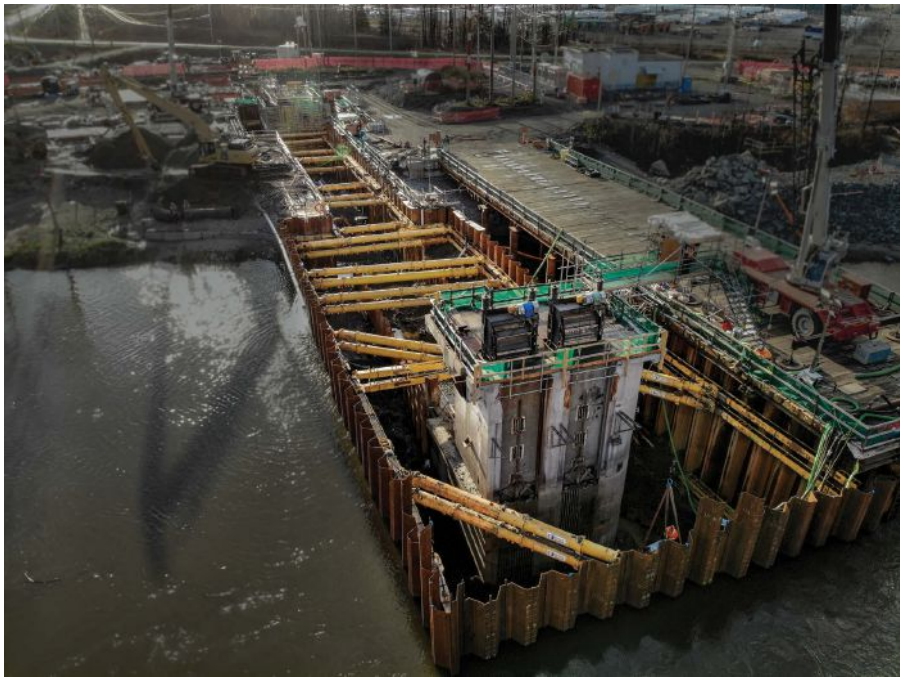
PLANNING FOR SUCCESS IN DEEP EXCAVATION WORK

By Jon Preston and Jerry Wagner

We're all familiar with the adage, 'proper planning prevents poor performance.' But the concept of proper planning is particularly important in deep excavation construction where the stakes for non-compliance can be extremely high.



Heavy duty hydraulic bracing and struts and interlocking sheet piling

Deep excavation construction work is complex, carrying with it a number of challenges that can affect overall project performance, and more importantly, the safety of your worksite. With early planning efforts and involving an expert shoring specialist, potential issues may be successfully avoided, allowing for increased safe working conditions and jobsite productivity gains.

There are three key steps in how to plan a successful deep excavation project. They are:

- Consider and understand project challenges, such as excavation size, soil and ground water, structures and accessibility.
- Select and engage with an expert partner who can assist through the shoring process.
- Follow best practices in deep excavation project planning.

Challenges in Deep Excavation

There are many challenges associated with deep excavations, and all potential issues must be considered. It is important to not get locked in on what is thought to be the single greatest risk. Deep excavations tend to be open for long periods. Those things thought to be not so important early can develop into big problems as the work progresses.

Excavation Size

The deeper the dig, the greater the lateral earth pressures become. The shoring system must be able to withstand those forces without a failure. The width of excavations can also be an issue where cross braces are needed. Traditional cross bracing may be inadequate, depending on the span. Unsupported cross bracing will have a potential to deflect over a long span. A deflected cross brace under a load can be extremely dangerous. Where lateral earth forces grow over time, a deflected cross brace may become a great risk.

Soil and Groundwater

Many factors go into selection of an appropriate protective system. One of the most important factors is the type of soil found where the work will take place. After all, the purpose of the retaining system is to hold back the soil to allow the work to happen. Some soils will be more stable than others – typically the more stable the soil, the lower the lateral earth pressures; less stable soils will have greater lateral earth pressure.

It would be a mistake to overlook the presence of, or the sudden appearance of, groundwater. Temporary retaining structures are usually designed to hold back the soil load, not the combination of soil and water. On this point, it is important to note that a number of manufactured systems, and many site-specific excavation plans, call for the groundwater to be kept at an elevation below the bottom of the excavation. The expectation from many designers is that the groundwater removal take place on the exterior of the shoring system –

that is the only way to remove any unexpected hydraulic load from the shoring system.

If it is not possible to remove the hydraulic load via some sort of well point system, then the load must be factored in, which may require a more robust shoring system.

Structures

Any structure adjacent to an excavation must be protected so as to not allow soil to subside from under that structure, which could lead to failure of that structure. Adjacent, in this context, will mean anything within the area away from the excavation equal to the depth of the excavation. As well, any surcharge created by the existence of that structure would need to be calculated into the protective system design. These structures may include roadways, railroads, and structures on floating slabs.

Where the adjacent structures would include traffic, whether motor vehicle or rail, special consideration must be given to both the weight and vibration from those sources.

Exposed utilities are frequently found during the deep excavation process. Proper support measures need to be factored into the plan not only for those utilities crossing the excavation, but also many times for those running parallel to the site.

Accessibility

Finally, accessibility to the excavation site is also an important consideration. Tight spaces impose limitations on the size of equipment that can be used for excavating, as well as on how shoring equipment can be handled and maneuvered within the confines of a narrow or otherwise difficult to access jobsite.

A Key Consideration in Deep Excavation

With the wide range of potential challenges on a deep excavation project, it's often important to consider bringing in a qualified and experienced partner to assist through all aspects of the shoring design process. A trusted source of excavation-specific expertise can make the difference between a well-run and safe project and costly downtime and budget overages.

Engagement with a shoring partner early in the planning stages is critical. Through experience, engineering support and access to the proper shoring equipment and systems, a qualified trench shoring partner can speed the process and raise potential issues before they become significant problems. They can work with you during project execution to manage changes that inevitably arise during construction progress.

Four-sided slide rail system with tie-back beams

Flexibility during execution can be a significant factor in overall project success. Expertise and experience often translates into creativity and flexibility in shoring system design and adjustment as construction moves forward.

Jobsites may require a range of shoring systems such as slide rail, hydraulic bracing and steel sheeting. Ensuring your shoring partner has the capabilities and quantity of equipment on hand to safely and effectively put these solutions in place is an important fallback when conditions and timelines inevitably change mid-project.

Planning A Deep Excavation Project

As mentioned, planning comes first. Here are some deep excavation project planning best practices.

First, proper planning means having your shoring specialist review plans and schedule a site visit.

Groundwater control and management is frequently one of the initial considerations well in advance of breaking ground. Dewatering to provide a dry site must often be initiated well in advance of beginning the excavation.

As with trench shoring solutions, there are many types of dewatering and your specific system should be configured to the jobsite according to a range of environmental factors.

This is where an integrated provider of shoring and water management solutions can come in handy. They can streamline your planning and engineering process. The provider can also design and supply a shoring and dewatering system that works seamlessly to account for specific jobsite factors. Make sure to ask your shoring partner if they provide dewatering services as well.

Prior to initiating the excavation process, utility locates must be done to discover the exact location of any underground obstacles and utilities.

The planning process also includes identifying the best possible shoring solution for your project. Your system should be jobsite-specific, designed to accommodate the type of construction being conducted on the project. The plan should detail how the shoring system will be designed and constructed. This will typically involve manufacturer's tabulated data or perhaps a site specific engineered plan.

During the excavation process, any utilities that may cross the excavation or might simply be exposed must be supported and protected.

Once the excavation and protective system installation is completed, then the actual construction can commence.

It is absolutely critical to make certain that no employee is allowed to enter the excavation until the protective system is completely installed. Quality training can educate personnel so they are aware of the potential hazards of entering an unsafe excavation.

Planning Drives Productivity and Efficiency

With proper planning and careful execution, deep excavation projects can be completed safely and without costly damage to utilities, equipment or adjacent structures.

While some may consider extensive planning a costly process which slows down project progress, a thorough plan properly executed with the help of experienced shoring experts can be a productivity driver resulting in cost savings due to substantial efficiency gains.

Jon Preston is a regional product development manager and **Jerry Wagner** is a senior trench shoring specialist at United Rentals.

RECRUITMENT AND RETENTION IN THE UNDERGROUND INDUSTRY

By Jacob Trapani and Nicole Little

In these times of change, there is one glaring issue that companies in every industry are facing daily: how to fill the vacancies within the organization with qualified personnel in an ever-decreasing workforce pool from which to choose. The trenchless industry is no exception, facing its fair share of difficulty when it comes to recruiting and retaining valuable employees. Even though construction is considered an "essential industry" during this time, companies are finding it extremely difficult to find the right people to fill the voids.

So, what are some techniques for contractors to use in the recruitment process, and more importantly, retain those employees that bring value to their business? Here are a few practices that BLD Services LLC employs to safeguard the loyalty of our team members moving into the future.

Recruit Wisely

The first step is a difficult task in and of itself, targeting those individuals looking for work. Luckily, in this digital age, we have access to thousands of potential recruits at our fingertips through platforms such as: Indeed, Monster, Zip Recruiter among other industry-specific sites. WEF Member Associations consistently post open job opportunities in their monthly publications, and advertising on these platforms can be a great resource when looking to fill empty positions within the company.

Another effective solution for finding personnel is to utilize the resource of your current personnel for recommendations, especially those who excel at their job. They are more likely to endorse those who share the same work ethic and drive as they possess. Incorporating financial motivation, or some other reward, for the current and prospective employee can increase the odds of finding the right person for the job without expending too much time and energy during the recruitment process.

Other alternatives include organizations that promote the development of the younger generation, such as:

- Skills USA - *skillsusa.org*
- ACE Mentor Programs of America - *acementor.org*
- YouthBuild USA - *youthbuild.org*

These organizations focus on traditionally underrepresented students and communities by providing internships and mentoring programs with established companies as pathways into the construction industry. By developing a mentorship program, companies can reach a huge group of untapped potential that can not only fill empty positions immediately, but these programs can also shape and guide recruits into company leaders of the future.

Create an Attractive Work Environment

More so now than ever, people have a choice when it comes to opportunities for employment, so what makes your company stand out above the rest? Probably the most important factor for recruits is competitive pay and affordable benefits, but that's only part of the equation. Since approximately one-third of a person's life is spent at work, people want to feel like they are part of something meaningful. Cultivating a positive, team-oriented atmosphere in the workplace is key to finding the right personnel which creates a sense of loyalty and reliability. Job seekers want to know that there is a culture of work/life balance, safety, and family where they decide to hang their hat for eight, or more, hours a day.

Once you have found the right person, how do you keep them? How does a company cultivate a positive, team-oriented culture?

Maintain Open Communication

Taking time to sit down with team members to learn about their career goals goes a long way in establishing an atmosphere of respect and trust. Successful organizations incorporate programs for career advancement that are personalized for each employee so that the company can "recruit from within" when the time comes to fill empty positions due to retirement, expansion, etc.

Some thought-provoking questions to spur conversation could include:

- What are your professional goals for the next five years?
- What have you learned during your tenure with the organization?
- How can you apply what you learned for the betterment of yourself and

the company?
- How can the company help you achieve your goals?

Insightful questioning demonstrates that the company has just as much skin in the game as the team member.

Other options can also include industry training programs, such as NASSCO Pipeline Certification, CDL school, and other continuing education programs that add value to the employee's career. When companies invest in the personal development of their staff, there is a greater chance of the employee staying loyal to the company in the long-term.

As mentioned above, mentoring programs are also important for existing staff, as they can be the catalyst when it comes to facilitating the transfer of knowledge from veteran workers to less-seasoned personnel, retaining the continuity of company performance for its customers.

Two-way communication is crucial and including employees in the decision-making process fosters an atmosphere of camaraderie as they may have valuable insights on specific issues and offer solutions that managers might not think of at the time. Empowering the people around you inspire a sense of ownership and accountability knowing that they are a valued part of the team.

Show Gratitude

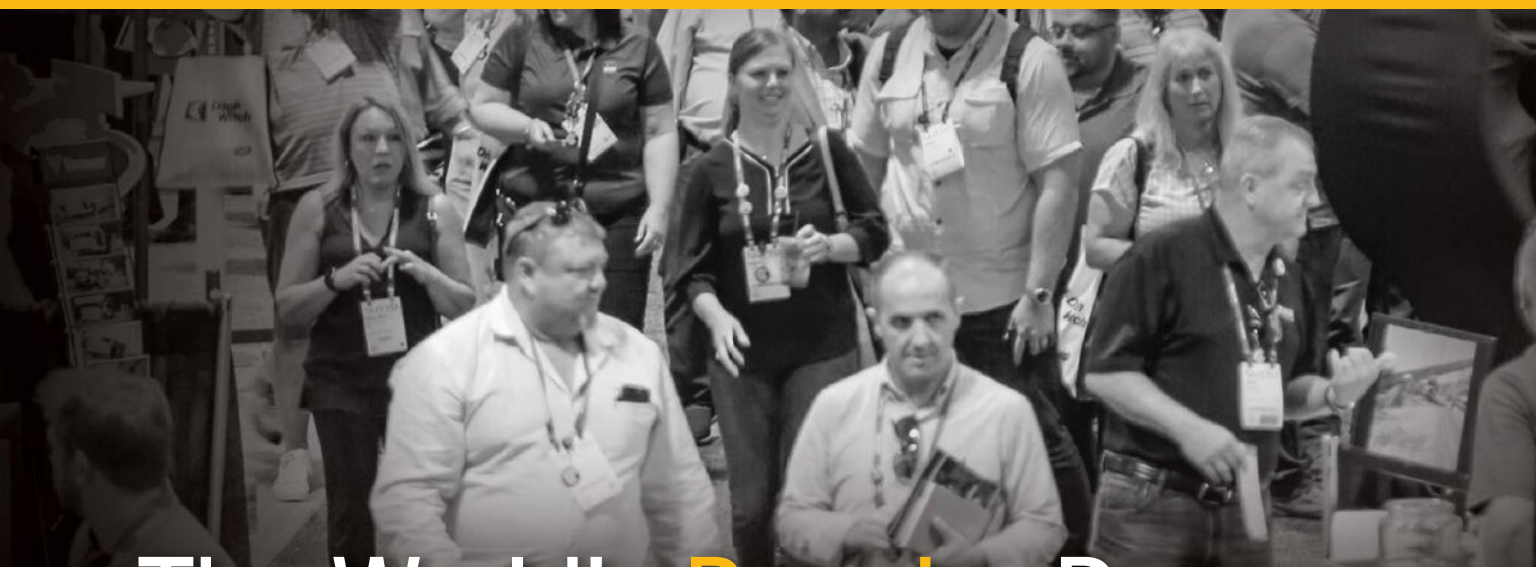
At the end of the day, people just want to know they are appreciated, and there are numerous ways to show your employees how much they are valued:

- Establish incentive programs to reward team members for taking on more responsibility or leadership roles such as cash bonuses, internal promotions, long-term loyalty compensation.
- Publicly recognize outstanding job performance in the presence of their peers with awards, prizes, gifts, etc.
- Host annual get-togethers like holiday parties, manager trips, or BLD's favorite… crawfish boils, to show appreciation for hard work.
- End-of-year incentives for exceeding expectations on yearly quotas.

Leadership

Company leaders shape the culture of a corporation; a sense of pride from upper management has a trickle-down effect throughout the organization. Employees are the most valuable asset of any business and are not easily replaced, so taking the time to consider their needs and encouraging open lines of communication reaps immeasurable benefits for all involved. Cultivating leadership qualities in your staff builds a sense of confidence and responsibility in their work which, in turn, improves productivity and the general work climate. The goal of any company should be to build a team strong enough that you don't recognize who the leader is.

Nicole Little is marketing manager and **Jacob Trapani** is vice president at BLD Services LLC.



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CRISIS MANAGEMENT IN CONSTRUCTION

By Tobias Cushing

It's no secret that all businesses should have a plan in case of emergency. For construction companies, it's extremely important because the business can be shut down due to disasters or unexpected events.

From natural catastrophes to global pandemics, a crisis can come at any moment and have a huge impact on jobsites and projects, affecting all subcontractors and trades involved. This includes carpenters, laborers, plumbers and electricians. No matter what happens or who's on the job, every emergency requires prompt action to help minimize or control the potential effects on the business and development. So, knowing what to do and how to create a crisis management plan can help.

A crisis can come out of nowhere.

Construction contractors like residential and commercial plumbers, municipalities and pipe cleaning contractors may encounter an unplanned event that requires immediate and decisive management action. This event may involve such things as: a natural disaster, major medical emergency, fire, crane or scaffolding collapse, a hazardous material event, threats of violence, serious injury/fatality, or any physical situation that endangers people on-site or the project itself.

And a crisis can occur on active or inactive jobsite. Idle construction projects are not immune from a crisis and can present challenging conditions, as well, so a risk assessment plan as part of a comprehensive crisis management plan can also help reduce the sudden impact and likelihood of losses. The key to success is the implementation of tactics that are specific for the type of construction and project location, as well as clearly communicating the plan's strategy and initiatives to all contractors involved with the site.

It's important for the plan to have specific steps to follow in creating and navigating a successful course of action that mitigates fallout from the crisis and protects workers, neighbors and the community.

Economic Crises

There may also be a crisis involving economic impacts, such as labor disputes, loss of key personnel, technology breakdowns delaying communications, or problems with material delivery schedules. These, too, can evolve into crisis situations that may present threats to the firm's reputation, ability to conduct business and ultimately its overall financial success.

Develop a Written Plan

Regardless of the type of event or situation, a crisis requires prompt action to help minimize or control the potential impact. To help prepare for such possible scenarios, companies should develop a written plan for their specific construction sites. The crisis management plan should outline step-by-step procedures and responsibilities for all personnel onsite, as well as key personnel offsite.

The following steps may be used as a guide for construction companies, contractors and subcontractors to navigate the situation:

Step 1:
Identify Potential Crisis

The planning process should begin with an attempt to identify any potential crisis before construction begins. Tailor the plan to the nature of the project. For example, construction companies should examine risk factors and unique hazards for each jobsite and evaluate weather patterns and external conditions that could lead to a crisis on the jobsite.

Then, the construction team should evaluate and consider the equipment and materials to be used and establish site security measures to help mitigate any fallout from a mishap.

The plan should also ensure that adequate resources are available to effectively deal with the crisis. Construction company leaders and jobsite forepersons should assess emergency escape routes, particularly if there are multiple floors or remote work areas involved and take evacuation procedures into consideration. In addition, it is imperative to make note of available offsite resources, including the proximity of hospitals, police/fire departments and other first aid responders.

Step 2:
Select Responders and Their Roles

The plan should identify the best people to respond to and manage a crisis, which is key at the early stages of the process because it establishes a crisis management team that begins with a team leader responsible for coordinating activities. This crisis management team would hold regular meetings to discuss step-by-step plans for specific emergency situations, and define each person's role before, during and after a crisis. From here, responsibilities would be assigned for collecting statements, preserving evidence and other areas of investigation.

At the regular meetings, team members would also review and discuss progress or updates to the written plans to maintain transparency and operational efficiency.

Step 3:
Establish Communication Channels and Chains of Command

Next, a communications plan that enables all members of the crisis management team to contact one another should be created, and an offsite staging area or command center needs to be identified to designate a place where the crisis plan can be coordinated from when the crisis occurs.

It is also important to develop a network that facilitates immediate contact between first responders and construction engineers, project managers or others who have detailed knowledge of the infrastructure, while maintaining a list of key personnel for suppliers and subcontractors, as well as utility company contacts. Then, the company should form an efficient and effective way to promptly communicate with employees and their families in the event of an emergency.

Step 4:
Develop a Public Relations Policy and Plan

It's imperative to not only have a plan to deal with the realities, but also to handle the perceptions of the crisis.

Construction companies should formulate a public relations strategy and appoint an individual who'll be responsible for media relations in the event of a crisis. This is important because the image and reputation of the company and its leaders is at stake during a crisis. One misstep or misstatement can cause irreparable damage to a company's credibility and revenue following a crisis. As a result, a business should establish a strict policy that only approved, accurate information is to be released to the media.

Step 5:
Conduct Practice Drills and Train New Workers

Ideally, in order to test the crisis plan, a business should conduct mock drills aimed at increasing preparedness and identifying weaknesses. As part of their jobsite orientation, construction workers should receive detailed instructions on what to do in a crisis. The information should be updated regularly as the construction project moves toward completion or as new personnel rotate in.

Planning is a necessary part of any construction project, and a carefully considered crisis management plan can help contractors quickly take charge and more efficiently manage unplanned events.

If remembering all the things that need to take place before an emergency is difficult, The Hartford offers a convenient checklist to help make sure key considerations are not overlooked. This may help ensure construction sites and projects stay as safe and secure as possible.

Tobias Cushing serves as the Head of Construction for Middle & Large Commercial at The Hartford.

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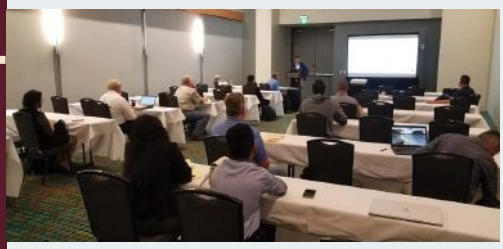


The 20th Annual Trenchless Technology Certification Schools will be held in-person on Jan. 24-25 at the Fort Worth Convention Center, in Fort Worth, Texas. This year's program includes Advanced Horizontal Directional Drilling Schools, Pipe Schools, Pilot Tube and Microtunneling School and Spray Applied Pipe Lining (SAPL) School, as well as a new course entitled Geotechnical Site Investigation and Planning for New Trenchless Technology Installation. The SAPL School was offered for the first-time last July. More than 50 professionals attended these Schools, which were taught by expert instructors from industry and academia with at least 20 years of experience of working in the trenchlessr technology field.

Attendees will receive discounted copy of book: "Trenchless Technology: Pipeline and Utility Design, Construction, and Renewal, 2nd Edition" published in October 2021, by McGraw-Hill, up to 1.2 CEUs and 12 PDHs, wallet-size certification card, and a PDF copy of all presentations.

For more information or to register, contact CUIRE at 817-272-9177, *cuire@uta.edu*, or visit *uta.engineering/cuireschools*.

EVALUATION OF NUKOTE PP300 FOR IMPROVING HYDRAULIC CAPACITY OF WATER PIPES

Pipe aging and deterioration of water pipes are one of the most common issues in today's underground infrastructure systems. The trenchless technology renewal method of spray-applied pipe linings (SAPLs) is the fastest growing, most cost-effective, and versatile method utilized to restore and extend design life of older deteriorated pipes.

Nukote Coating Systems International (NCSI) is a leading provider of coating and liner products globally, involved in both the chemical formulation and robotic application equipment utilized. NCSI has a proprietary two-component liner product called Nukote PP300, which is used for the structural renewal of aged and deteriorated buried pipelines. It is very important to analyze hydraulic properties, such as the friction factor of the liner system, in addition to the structural capabilities since the liner installation decreases the dimension ratio (DR). NCSI, in collaboration with the Center for Underground Infrastructure Research and Education (CUIRE) at the University of Texas at Arlington, is analyzing the hydraulic properties of the liner system in addition to the structural properties of Nukote PP300 for both gravity and pressure applications. Consideration of the flow characteristics are as important as the structural capability for the pipeline networks and their renewal process.

In this research project, the hydraulic properties analysis will determine the effects of the liner system on the hydraulic flow of piping systems, including analyzing the friction factor at various flow rates and high Reynolds number, determining the improvement in the head (pressure) loss in the pipe and its effect to pumping requirements, the liner surface roughness of the will be closely determined with the use of a profilometer and verified with the test results. The end results of the analysis will show the degree that Nukote PP300 polymeric SAPL will improve the water flow characteristics and pumping requirements.

As shown in Figure 1, the theoretical analysis in advance of the field testing shows for both bare pipe and lined pipe, the head loss increases with increasing flow, however, the rate of head loss increase is less for the lined pipe compared with the bare pipe. For example, at 1,800 GPM, the head loss for the bare pipe is approximately 19.8 ft, and for the lined pipe is 18.3 ft with a difference of 1.5 ft or 7.5 percent reduction in head loss for the lined pipe. This head loss reduction is for 100 ft of small diameter carbon steel pipe and can be significant for larger diameters and longer lengths, allowing tremendous cost savings and energy use for pumping. This theoretical analysis helps to select proper flow rates in field testing for hydraulic parameters such as head loss, Reynold's number and roughness or friction factor.

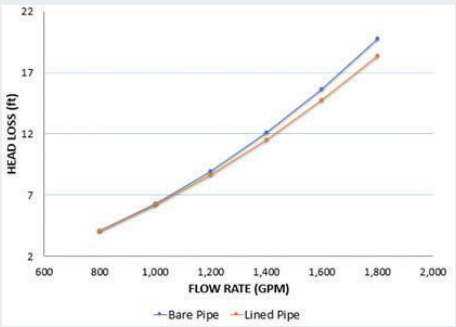
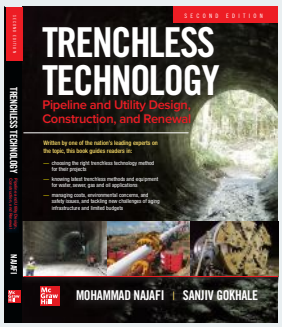


Figure 1 Head Loss Comparison- Bare vs. Lines Pipe

TRENCHLESS TEXTBOOK UPDATED



After two years of hard work and challenges, such as pandemic, Dr. Najafi and coauthors published the second edition of "Trenchless Technology: Pipeline and Utility Design, Construction, and Renewal" by McGraw-Hill Professional.

The book is a fully updated guide to no-dig engineering and trenchless technology, this thoroughly revised reference covers the latest techniques and materials for high-demand trenchless technology in underground projects. Written by recognized experts in the field, "Trenchless Technology: Pipeline and Utility Design, Construction, and Renewal, Second Edition" offers clear explanations of the full range of trenchless technologies and pertinent guidelines for design and construction.

Readers will get complete details on new tools, techniques, and analysis methods and discover how to choose between them. The information contained in this guide can save thousands of dollars in costs and weeks of surface disruptions. Authors would like to thank Dr. Ali Abolmaali, Chair of Civil Engineering Department at the University of Texas at Arlington, for his support of guidance throughout preparation of this book.

The book can be purchased at an introductory price of $125 at McGraw-Hill at *https://rb.gy/tfbzeg*, on Amazon at *https://rb.gy/8b6mfc* or other book sellers. Online resources are available to faculty who adopt this book for teaching.

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Feb. 3-4 | Arizona State University SkySong Center | Scottsdale, AZ

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Limited Seating Available

Earn CEUs

WHO SHOULD ATTEND?

This program is for all levels of stakeholders within the utility pipeline industry including owners, regulators, contractors, and engineers.

For the past seven years, the HDD Academy has helped professional drillers and utility owners accomplish the impossible.

Main Event/Founding* Sponsors:

- Bentonite Performance Materials*
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- AEM - Association of Equipment Manufacturers
- DCA - Distribution Contractors Association
- NUCA - National Utility Contractors Association

Organized By:

- ASU Del E. Web School of Construction
- *Trenchless Technology*
- *North American Energy Pipelines*
- Benjamin Media, Inc.

Questions? Contact Hannah Stakolich at hstakolich@benjaminmedia.com or 440-465-9434.

STAYING SAFE WORKING IN THE WINTER

BY NATE HEALY

Each day, thousands of construction workers battle the elements — particularly snow, ice and cold weather — while making a living on the job. Working safely in these conditions requires focus and a strong commitment to safe working practices. Tasks that were "simple" in warmer months may now be more difficult due to freezing temperatures. Staying warm while working is only part of the battle; slip hazards, bulky clothing, and cold-related illnesses also come to the forefront while working in the winter months.

Slippery Work Surfaces

A typical construction work site has the potential for slip, trip and fall hazards. This is amplified in the winter in locations where temperatures dip below freezing. Snow and ice-covered walking and working surfaces must be addressed to prevent injuries. In theory, the solution for preventing slips caused by snow and ice is simple: remove the snow and ice. However, realistically we know this can be difficult to manage at each work location. Finding what works for each location will be the key to success. Some options include:

- Applying salt or other ice-melting applications to a variety of surfaces to help prevent and remove the buildup of snow and ice.
- Applying sand or other fine aggregate to working and walking surfaces to add traction and friction for employees, vehicles and mobile equipment.
- Building temporary heated structures to cover and surround common walking and working areas to avoid snow accumulation and hinder the formation of ice.
- Attaching specifically designed traction aids to a work boots and shoes.

Determining the best solution or preventative measure can only be decided by those working and by conducting a thorough Job Hazard Analysis (JHA) at your specific work location. Regardless of the preventative method chosen, as always, the focus should be placed on mitigating the hazards and keeping safety a priority in every facet of work performed.

Stay Warm, Stay Safe

Dressing appropriately for work activities and temperatures is something that those working in cold climates must perfect. The clothing you wear may have a direct impact on your safety while on the job. For example, if you wear too bulky of clothing you will not be able to move with ease, making your tasks more difficult and potentially more dangerous. If you replace your safety clothing (i.e. FRC) with warmer clothing, you are leaving yourself exposed to a potential injury.

It is recommended to dress in layers of close-fitting clothing. Layers can easily be added or removed as the temperatures and activities change throughout the day. Also, by wearing close-fitting layers, you avoid unnecessary entanglement hazards caused by over-sized and bulky outerwear. It is important to be able to perform your job safely while staying warm. Ensure all your PPE is still able to be worn and worn properly. Hard hats, safety-toed boots, protective gloves, and high-vis clothing must still be worn as required, regardless of temperatures outside. Do not sacrifice your safety because of additional clothing.

Staying warm may not always mean simply wearing more clothing. Adding warm-up breaks or temporary heating sources are good ways to keep your fingers and toes warm and prevent cold-related illnesses. Two of the most common concerns on the minds of those working in cold temperatures are frostbite and hypothermia. Keeping your extremities and core body temperature warm is critical to staying healthy.

Frostbite is an injury to the body caused by freezing body tissue. The most susceptible parts of the body are the extremities, such as fingers, toes, ear lobes or the tip of the nose. Symptoms include a loss of feeling in the extremity and a white or pale appearance. Medical attention is needed immediately for frostbite. The area should be SLOWLY re-warmed. Prevention of frostbite is always preferred over treatment of frostbite. Keep your extremities warm while working.

Hypothermia is abnormally low body temperature (below 95 F). Warning signs include uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness, and apparent exhaustion. Medical attention is needed immediately. If it is not available, begin warming the body SLOWLY. Much like frostbite, prevention is the best medicine. Wear proper clothing and keep dry while working to help keep a consistent body temperature.

With proper planning, working in cold or freezing environments safely is possible and is accomplished by thousands every day each winter. Focus on removing the slip hazards from our walking and working surfaces and dress appropriately to protect yourself while staying warm.

Nate Healy is senior director of health, safety and environment at Michels Corp. He has more than a decade of experience in the field and in leadership positions.

NASSCO NEWS

NASSCO
NATIONAL ASSOCIATION OF SEWER SERVICE COMPANIES

2470 Longstone Lane, Suite M, Marriottsville, MD 21104 | Phone: 410.442.PIPE (7473) | Email: info@nassco.org

As we enter 2022 with a new, fresh perspective, I am grateful to reflect on NASSCO's ability to make significant impact in 2021. In addition to the hard work of NASSCO committees and staff, much of the thanks goes to the essential services we provide in a critical industry. The ability of our members to maintain operations throughout the pandemic has, for the most part, increased demand for our services 18 months later. When other industries had to pause, our doors were open and provided those much-needed services to our communities. It would be incredibly difficult to find a NASSCO member that is not extremely busy. This is no coincidence. As we each work for the future of our individual business units, we are collectively moving the industry forward through a spirit of non-competitive cooperation for the greater good. Below are just a few NASSCO highlights from 2021, all designed to set standards for the assessment, maintenance and rehabilitation of underground infrastructure:

NASSCO's Webinar on CIPP and Styrene Emissions Attracts 1,000-plus Registrants!

On Nov. 4, NASSCO's Technical Advisory Council and Health and Safety Committee prepared a highly informative, industry-wide webinar titled "CIPP and Styrene Emissions: Best Practices." More than 1,000 industry professionals registered for this event, indicating the critical need to share objective, research-based information and guidance.

Moderated by NASSCO's Technical Advisory Council (TAC) Chair, Chris Garrett, P.E., the webinar event began with an overview of cured-in-place pipe (CIPP) by Lynn Osborn, P.E., a member of NASSCO'S TAC. Lynn's goal was to ensure all attendees had a basic understanding of the technology. Lynn also shared research studies commissioned by NASSCO to ensure we keep our workers and communities safe and specific guidelines and recommendations from the Trenchless Technology Center at Louisiana Tech (TTC).

Kaleel Rahaim, also a TAC member, shared a variety of new and emerging technologies for remediation and expressed the need for the solutions to be, first and foremost, effective, as well as economical, portable, and able to occupy a small footprint.

Dennis Pivin, CSP, CHST, CIT and Co-Chair of NASSCO's Health and Safety Committee, shared specific research findings, recommendations and PID requirements. His presentation included a basic understanding of styrene, which is found in common, everyday household items, and its relationship with CIPP and the acceptable styrene health limits as outlined by regulatory agencies and other organizations including ACGIH, EPA, NIOSH and OSHA.

The webinar may be viewed at *nassco.org/webinars* and we are grateful to our sponsors AOC, Applied Felts/MaxLiner/Ferratex, Brown and Caldwell, Granite Inliner and Jerry Weimer Consulting for making the webinar possible.

Supporting and Simplifying NASSCO Training and Education Programs

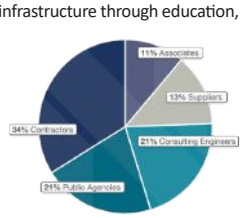
This summer NASSCO launched a new learning management system, The NASSCO Training Source. The NASSCO Training Source simplifies the student experience – the way students enroll in sessions, pay for courses, and how they manage PACP and ITCP certifications and view certificates.

Students can access training and certification courses via the training login page on *nassco.org*. Once there, students may search public course catalogs for upcoming sessions in the program of their choice. Students pay the course fee online and provide additional information upon enrollment including their shipping information, CEU requests, metric manual selection and more. Once enrolled, a manual will be ordered and shipped directly to the student, allowing time to become familiar with the materials prior to attending the session.

The NASSCO Training Source also provides a solid platform to expand NASSCO's vision: To increase awareness of aging underground infrastructure through education, technical resources and industry advocacy. Explore the NASSCO Training Source, view our new website and learn more at *nassco.org*.

NASSCO Membership Grows to Record Levels

Did you know that NASSCO members are a direct reflection of the entire underground infrastructure industry? Founded back in 1976 as a 501 c (6) trade association to represent contractors, the Bylaws still reflect that vision through its determination of Board of Directors representation. However, the membership base has now grown to reflect all segments of our industry including public agencies, consulting engineers, manufacturers and suppliers, as well as others aligned to our industry, identified as the Associate category. This membership category includes institutions of higher learning and trade media organizations. In total, our member organizations exceeded 600 this year and represents thousands of workers throughout North America.



NASSCO MEMBERS

Contact Pam Fulmer, NASSCO's Membership Liaison, at *membership@nassco.org* to join NASSCO, get connected with the right NASSCO Committee, request training discounts or learn more about our many industry-wide and member-only events.

NASSCO Announces Two New Grouting Specifications

After years of hard work from its Infiltration Control Grouting Committee (ICGC), NASSCO has published two new grouting specifications: Pipeline Packer Injection Pre-Rehabilitation Grouting V2.10. and Pipeline Packer Injection Capital Grouting.

First published in 2014, the Suggested Standard Specifications for Pressure Testing and Grouting of Sewer Joint, Laterals and Lateral Connections quickly became the choice grouting document for engineers and municipalities. Updated for 2021, that document has been enhanced and renamed Pipeline Packer Injection Pre-Rehabilitation Grouting. Available for contractors, engineers, and system owners to download for free at *nassco.org/resources/nassco-specification-guidelines*, Pipeline Packer Injection Pre-Rehabilitation Grouting addresses the needs to eliminate infiltration prior to installing other rehabilitation methods and the ability of chemical grouting to act as a complementary technology after installed.

The second specification, Pipeline Packer Injection Capital Grouting, was developed by ICGC to address long term grouting means and methods that provide pipe stabilization by creating a pipe cradle-like stability in the bedding and a volumetrically significant, long-term, water seal outside the pipe. This will eliminate all groundwater and rainfall induced infiltration entering a defect or leaking joint. Installed per these new industry standards, it has an anticipated service life of 25 years or more.

In addition to online access, NASSCO is encouraging engineers and municipalities to download and print the 2021 specifications for use in their upcoming projects.

Pipeline Packer Capital Grouting Specification and Pipeline Packer Pre-Rehabilitation Grouting Specifications are available on the NASSCO website where you may also learn more about grouting by viewing ICGC's recently-released video titled "Grouting Technology."

Looking Forward to What's Ahead

As we have turned the corner in 2021, it is our wish that we all stay strong, steady and continue what is best for our industry, our workers and – most importantly – our communities. If you are not yet a member of NASSCO, please join us by visiting *nassco.org/join*. You will be welcomed and very much appreciated. If you are a member, we look forward to seeing you on committee calls and seeing you again in person at the 2022 NASSCO Annual Conference in Scottsdale, Arizona, April 6-8.

BUSINESS CARDS

AD INDEX

FORCE MAIN REHABILITATION WITH FRP

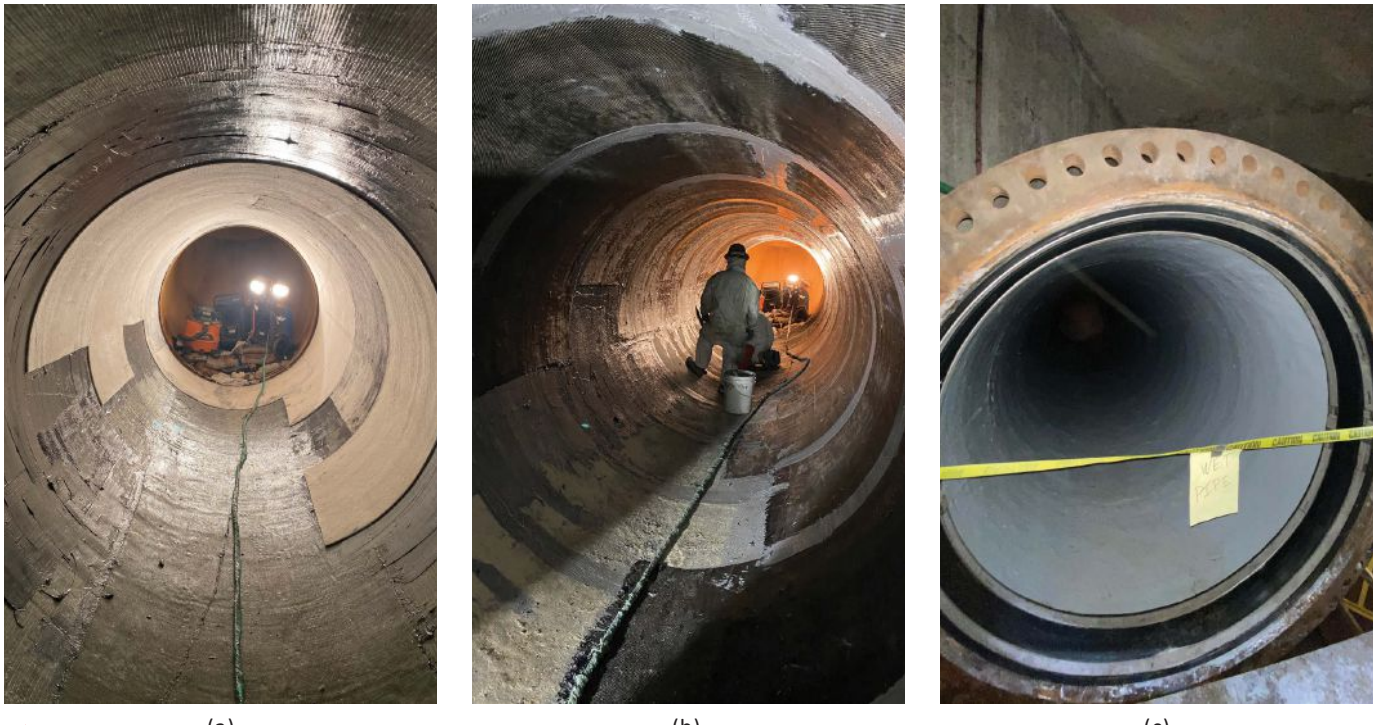
BY V. FIRAT SEVER

Carbon and glass fiber reinforced polymers (FRP) have been used for infrastructure for more than three decades, and applications in pipeline and other below ground infrastructure rehabilitation has gained momentum in recent years.

The advantages of these systems include high strength, corrosion resistance, light weight and the ability to be installed on essentially any type of structure, size and geometry. FRP liners can also be used to increase internal pressure and improve flexural and buckling capacity of deteriorated or non-deteriorated pipes. FRP liners essentially consist of carbon or glass reinforcing fabric that is saturated with an epoxy resin and then applied using the wet layup process to the prepared surfaces of the host pipe. Carbon fiber–reinforced polymers (CFRPs) are typically used for pressure pipelines. Glass fiber–reinforced polymers (GFRPs) are typically used as the first layer of material to contact any metallic substrate to provide a dielectric barrier between the metallic substrate and the CFRP materials, in addition to added strength to the FRP system.

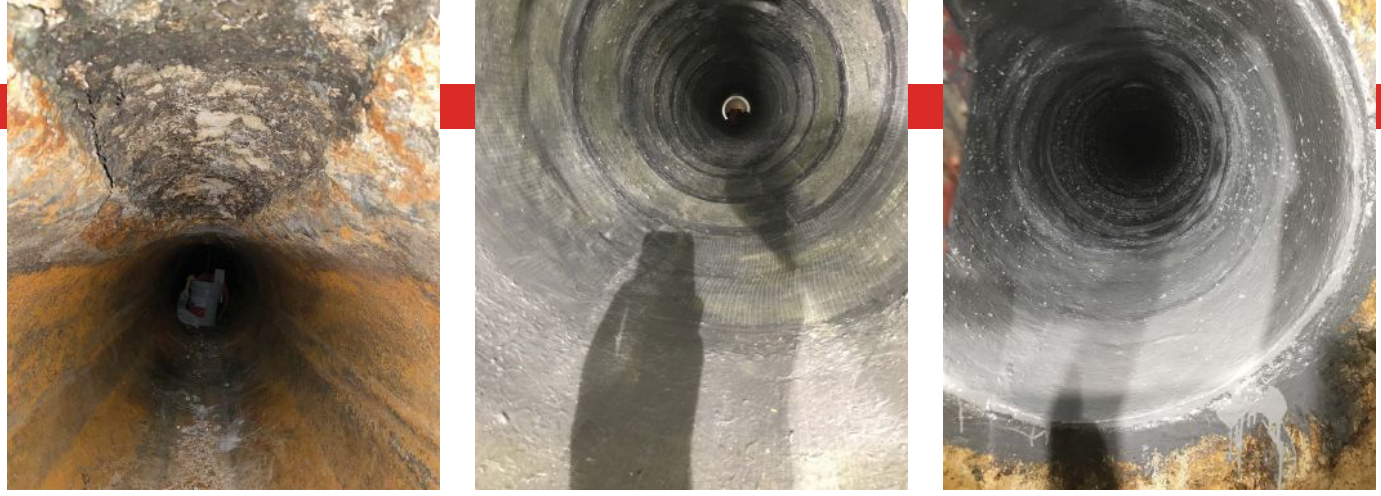
An FRP system can be installed internally or externally on a pressurized pipe. The upside of external wrapping is that the existing pipe can be renewed without any interruption to the service; the downside is if the pipe is corroding internally, external wrapping will not prevent it from progressing further. If such pipelines are exposed to direct sunlight, an ultraviolet radiation protection coating should be used. For internally lined systems, a corrosion and abrasion resistant top-coat (min 30 mils) is recommended to prevent any hydrogen sulfide induced corrosion as well as abrasion that could result from sand and other sediments transported particularly in a force main.

Alternatively, an FRP system can be prefabricated as pipe segments and installed with the sliplining method. While installation will be faster, this method may result in significant reduction in the host pipe diameter, and for most cases, will require the annular space between the host pipe and liner be filled with cementitious or polymeric grout. Another downside of sliplining is that it may require excavation of access pits to accommodate installation of the



(a) (b) (c)

Figure 1: Installation phase of a proprietary FRP composite system into the 84-in. sewage discharge force main. Shown here are (a) the 3D polymeric fabric being installed on top of fiberglass layer (with a tack-coat on top of the fiberglass), (b) the carbon fiber layer being installed on top of the 3D layer and (c) the finished product with the top-coat and dual-band compression seals at end terminations.



(a) (b) (c)

Figure 3: Low pressure iron pipe rehabilitation with GFRP depicted (a) before lining, (b) the dual-layer GFRP laminate as installed and (c) the finished product with the top-coat.

FRP pipe segments. Properly designed and installed FRP liners can completely restore a deteriorated host pipe and reset the service life for another 50 years or more.

The objective of an FRP design is to ensure the FRP liner will remain functional when subjected to service loads over its design life and have the necessary strength, reliability, and durability. The available design references include ACI 440 , AWWA C305 ASME PCC2 /Part 4, and the recent guideline specification published by NASSCO. While some design equations are provided in these standards, guidelines, as well as in technical papers on FRP design, particularly, semi-structural rehabilitation can be complex and may require computational modeling with the finite element method as well as testing for loading conditions on different FRP configurations. Stress concentrations are possible at seams, joints, cracks and other surface irregularities.

Case studies on two force mains and one low pressure sewage process pipe rehabilitation with FRP are discussed briefly below.

(a) (b)

Figure 2: Structural rehabilitation of a 48-in. sewage discharge force main with a patented FRP composite system. Shown here are (a) 10-ft long prefab pipe segments and (b) branch connection sealing upon installation.

84-in. Pump Station Discharge Pipe Renewal

This project was comprised of fully structural rehabilitation of an 84-in. steel discharge pipe at the North East Sewage Pump Station (NESP) in Detroit, owned and operated by Oakland-Macomb Interceptor Drain Drainage District (OMIDDD). The design factored in an internal pressure of 15 psi and external (hydrostatic) pressure of 17 psi. The low internal pressure could be met with a single layer of carbon fiber laminate. Nevertheless, a dual layer glass fiber and a proprietary 3D polymeric fabric layer was used to serve as a dielectric barrier between steel and carbon fiber, improve impermeability, and achieve the ring stiffness needed for external load. The project was completed as planned with some additional effort to stop leaks by chemical grout injection through the invert of the pipe.

48-in. Pump Station Discharge Pipe Renewal

A patented prefab FRP system with glass, carbon, and proprietary 3D layers was installed for a fully structural rehabilitation of a 48-in. sewage discharge pipe at the Avalon Pump Station in Los Angeles County, California. The prefab FRP liner was designed to take the external loads (groundwater pressure) and 30 psi of internal pressure. The outside diameter of the FRP liner was 47-in. leaving a 1-in. total annular space. The installation was done with the sliplining method and the annular space was filled with epoxy grout by tubular injection.

30-in. Low-Pressure Pipe Renewal at Water Reclamation Facility

The third example project is from the Village Creek Water Reclamation Facility in Fort Worth, Texas. A process pipe conveying thickened raw sewage at low pressure was lined with a dual-layer GFRP to prevent corrosion, abrasion, and restore structural capacity. The pipe is in a gallery with limited access, thereby making any large equipment unfeasible for use to install a lining system. The GFRP system was installed with no special equipment and by person-entry. Some patching with quick setting cementitious grout was carried out in addition to the sand blasting the surface prior to installation of the GFRP system. The GFRP liner was finished with a corrosion and abrasion resistant top-coat (epoxy based).

V. Firat Sever, PhD, P.E. is the Pipeline Division manager at QuakeWrap Inc. and a member of the NASSCO Pressure Pipe Committee.

CHERNE INDUSTRIES

The newly redesigned Cherne I-Series Test-Ball Plugs from Cherne Industries, are the most innovative pneumatic plugs available for the underground/waterworks market. Lightweight, short and flexible, Cherne I-Series plugs deliver state-of-the-art solutions for a variety of applications: blocking and bypassing flow; installing new pipes and junction boxes or repairing old ones; and installing or repairing utility holes. Available in eight expansion ranges, from 6 to 24 in., Cherne I-Series Test-Ball Plugs meet U.S. and international industrial and municipal needs for engineers and contractors. The plugs offer industry-leading quality and durability, featuring robotic, mechanical bonding of aluminum end plates to the plugs' premium natural rubber to eliminate chemical bonding failures. Cherne I-Series Test-Ball Plugs provide improved performance and safety through optimized design and superior back pressure (maximum: 15 psi; inflation pressure: 45 psi). For more information, visit *oatey.com*.

ENVIROSIGHT

Need deeper insights into pipe condition? Envirosight's laser profiler uses a laser ring attachment to capture geometric profiles of pipes 6 in. to 27 in. in diameter. WinCan software transforms these scans into 3D models that identify potential defects and structural anomalies. Laser profiling is ideal for – confirming proper pipe installation, gauging remaining pipe life, planning pipe relining, monitoring erosion or corrosion and identifying pipe defects. Designed with accessibility in mind, the attachment snaps onto the ROVVER X camera (RCX90) in seconds, no tools required. Check out laser profiling's ring leader by scheduling a free demo today. For more information, visit *envirosight.com*.

HAMMERHEAD TRENCHLESS

The HydroBurst 100XTR by HammerHead Trenchless gives operators the ability to take on a wide range of sewer, water and gas line replacement jobs with just one machine. The unit's 100-ton capability is rated for up to 16 in. in diameter, yet it is compact enough for use on pipe down to 4 in. A combination of industry-first and industry-proven features mean operators can confidently bid and complete a wider range of jobs faster, efficiently and productively. The HydroBurst 100XTR comes with an easy-to-learn, easy-to-use radio remote control. Freeing operators from the pit allows them to position themselves for the best view of a bursting operation and increases workspace in the pit for rod handlers. Its lightweight, heat-treated alloy rods feature an API-style joint that resists buckling under the greater thrust loads required by longer burst runs, sweeping bends, and encrusted and collapsed lines. Used in combination with specialized tooling, operators can burst the toughest steel and ductile steel pipes. In average soil conditions, a 400-ft job takes little more than two hours to complete from rod payout to pipe pullback. For more information, visit *hammerheadtrenchless.com*.

MCELROY

McElroy's newest line of fusion machines builds on the TracStar's rugged, self-contained tracked vehicle while adding industry changing technology for an improved user experience. The use of intelligent software has improved the machine systems to allow three levels of operator control, ranging from manual to fully automatic. It's all powered by the

new FusionGuide Control System. Other advancements include a Controlled Area Network (CAN) bus system for better machine diagnostics, smart keypads to guide users through the processes, and updated paddle levers for precise carriage control. The new control system was designed with the user in mind. It provides information, from user prompts and system status to built-in service reminders and troubleshooting information, all at the operator's fingertips. The iSeries machines feature a redesigned cowling that gives the operator the capability to fuse large tees and elbows without removing the carriage from the vehicle. This latest innovation is designed to simplify the fusion process. Available in 630i, 900i and 1200i. For more information, visit *mcelroy.com*.

TERRAMAC

Terramac, a leading manufacturer of rubber tracked crawler carriers, is well known for producing versatile equipment solutions with low ground pressure for traversing the slick and rugged landscapes encountered on remote utility jobsites. These multi-purpose utility carriers come in various sizes and feature frame extensions as well as various hydraulic pump drive configurations allowing support equipment to be mounted to its chassis. Featured here is the Terramac RT14U with an exclusive Supervac vacuum excavation system. For more information, visit *terramac.com*.

TT TECHNOLOGIES

TT Technologies Grundodrill 5X represents the most advanced directional drill rig in its class. The unit features a Tier 4F, 56hp Kohler engine, a single push button stake down system and independent front and rear lift. An all-weather 7-in. touchscreen display delivers real-time bore data and operational performance. The unit offers 11,000 lbs (48 Kn) of thrust and pullback and 1,200 lbf/ft (1,627 Nm) of torque. For more information, visit *tttechnologies.com*.

VERMEER

The Vermeer MX300, is now available in a diesel-powered model. The MX300D mixing system is equipped with a Caterpillar 3-cylinder 24.7-hp (18.4-kW) diesel engine to power two pumps for a two-tank mixing system. This design delivers a constant supply of fluid to the drill by moving fluids between tanks. After one tank is empty, HDD crews can begin mixing to replenish the fluid supply without impacting fluid pressure to the drill. The MX300D uses a single hopper and venturi and is paired with narrow rectangular tanks that allow many customizable mounting configurations. The mixing system's compact footprint and ability to support two tanks with one engine give crews more room on the truck or trailer to carry mixing additives to the job. Like the gas-powered MX300 mixing system, each pump on the new MX300D can produce up to 350 gallons per minute (1,324.9 L/min) of flow and can be paired with 750-gallon (2,839.1-L) or 1,000-gallon (3,785.4-L) tanks. The tanks are designed with a tapered bottom to help prevent additives from settling, building up and assisting with efficient drainage. For more information, visit *vermeer.com*.

PREMIER PIPE USA™ PROUDLY PRESENTS S.B. LINER

Premier Pipe USA™ S.B Liner is a groundbreaking proprietary styrene barrier coated product, which is named after our Premier Pipe founder, Mr. Simon Baylis. He was a proven engineer and a benchmark leader of our industry for many years. Simon was a great mind and lining expert. That is why it is an honor to name our first styrene barrier system after Simon Baylis who also played a role in the development of the S.B Liner.

S.B. Liner is a state-of-the-art technology that is an all polyester felt tube or polyester and fiberglass infused tube then is coated with our proprietary styrene barrier, this coating is applied by a flat die extrusion process. Our Premier Pipe USA™ S.B. Liner is then saturated in our own wet out with our standard polyester and vinyl ester resins. It is then taken to the job site to be inverted in the host line and then either steam or hot water cured to our current recommendations. Our Premier Pipe USA™ S.B. Liner with our proprietary styrene barrier can also be saturated with our specialty formulated UV resin, can be installed via inversion or drag-in, and cured using UV light as an option. Any questions a jobsite has, S.B. Liner can be the answer.

We feel that we now have a tested S.B. Liner system that meets our goals and standards, and this starts with our special proprietary styrene barrier technology which prevents permeation of the styrene and allows us to cook out the encapsulated styrene. This state-of-the-art styrene barrier coating makes styrene detection on a jobsite virtually untraceable. S.B. coating is designed for stretch so lateral location is never a problem. We feel very confident our Premier Pipe USA™ S.B. Liners can and will "dimple" laterals in a steam, hot water, or UV inversion.

Our S.B. Liner needs no special equipment or special training. CIPP crews can take Premier Pipe USA™ S.B. Liner and install it using everyday standard procedures. Premier Pipe USA™ has been working on S.B. Liner for over 5 years and will continue to push the boundaries of styrene barrier lining systems.

S.B. Liner is available through our trusted group of installers, Michels Pipe Services, Insight Pipe Contracting, and Am-Liner East.

These ToxiRAE Pro meters were all placed inside a refrigerated unit full of wetout SB Liners for 15 minutes with the doors shut. Then pulled out and these were the readings.

***All events are current as of Jan. 4. Please check the event's website for updates.**

2022

****BLUE COLOR DENOTES NOTABLE EVENTS****

FEBRUARY

3-4 **HDD Academy**
Scottsdale, Arizona
Web: hddacademy.com

17-22 DCA's 61st Annual Convention
Phoenix, Arizona
Web: dcaweb.org/page/convention

21-24 2022 WWETT Show
Indianapolis, Indiana
Web: wwettshow.com

22-26 PLCA'S 74th Annual Convention
Phoenix, Arizona
Web: plca.org

MARCH

1-3 Global Excavation Safety Conference
Phoenix, Arizona
Web: globalexcavationsafetyconference.com

4-9 PCCA 77th Annual Convention
Scottsdale, Arizona
Web: pccaweb.org

9-12 ASCE Construction Institute (CI) and Construction Research Council (CRC) Joint Conference 2022
Arlington, Virginia
Web: cisummit-crc.asce.org

28-30 DCA's Annual Safety Congress
Austin, Texas
Web: dcaweb.org/page/safetycongress

APRIL

10-14 2022 NASTT No-Dig Show
Minneapolis, Minnesota
Web: nodigshow.com

11-13 DCA & AGA Workshop
Chicago, Illinois
Web: dcaweb.org/page/dcaaga

12-13 Risk Management in Underground Construction
Atlanta, Georgia
Web: undergroundriskmanagement.com

24-26 2022 *Trenchless Technology* Road Show
Kelowna, British Columbia, Canada
Web: catttrenchlessroadshow.ca

27-29 28th Annual Microtunneling Short Course
Scottsdale, Arizona
Web: microtunnelingshortcourse.com

MAY

2-6 Pipe Line Contractors Association of Canada (PLCAC) 68th Annual Convention
Maui, Hawaii
Web: pipeline.ca

4, 8, 18 & 25 Water Asset Management Conference Online Virtual Event
Web: waterassetmgmt.com

30-June 3 IFAT 2022
München, Germany
Web: ifat.de

JULY

18-21 DCA 2022 Mid Year Meeting
Coeur d'Alene, Idaho
Web: dcaweb.org/page/midyearmeeting

31-Aug. 3 UESI Pipelines 2022 Conference
Indianapolis, Indiana
Web: pipelinesconference.org

AUGUST

17-18 Water Finance Conference
Washington D.C.
Web: waterfinanceconference.com

SEPTEMBER

19-23 IPLOCA 2022 Convention
Prague, Czech Republic
Web: iploca.com

OCTOBER

17-19 2022 No-Dig North
Toronto, Ontario, Canada
Web: nodignorth.ca

24-30 Bauma 2022
München, Germany
Web: bauma.de







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- Design-Build and Alternative Delivery
- Geotechnical Baseline Reports
- Legal and Insurance Issues
- Design Risk
- Case Studies
- Instrumentation and Monitoring

Supporting Organizations:

- **Distribution Contractors Association**
- **NASBP - National Association of Surety Bond Producers**
- **Dispute Resolution Board Foundation**

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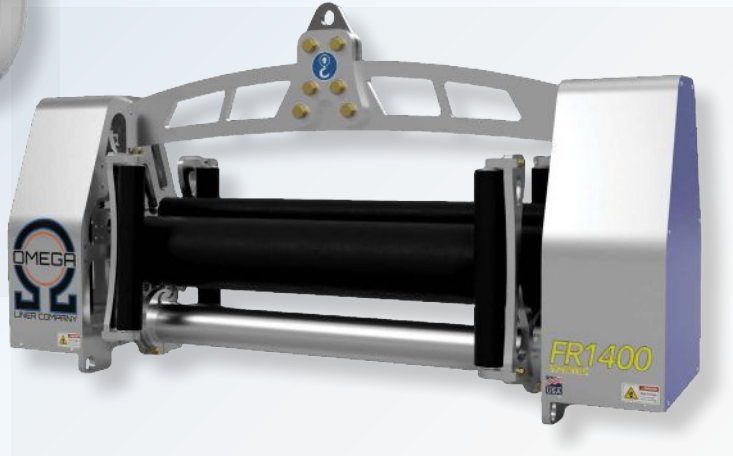
- Custom Cans and Hardware
- Engineering Support
- UV Service & Support
- Truck & Equipment Rental
- RealPower Generator Systems



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