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TRENCHLESS TECHNOLOGY 2018

OFFICIAL PUBLICATION OF THE MID ATLANTIC SOCIETY FOR TRENCHLESS TECHNOLOGY

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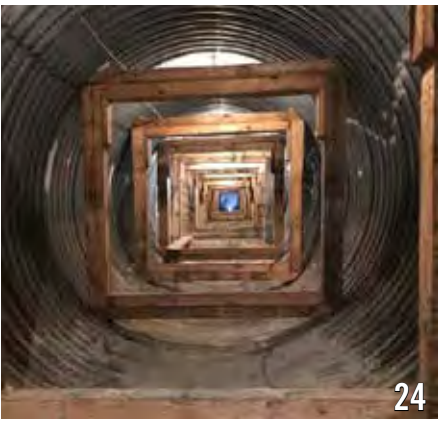

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NASTT MID ATLANTIC CHAPTER

MESSAGE FROM THE MASTT CHAIR

Richard Thomasson, P.E., MASTT Chair

We are pleased to produce our fourth publication of the Mid Atlantic Society for Trenchless Technology (MASTT) Journal. The MASTT was founded in 2004 as a Chapter of the North American Society for Trenchless Technology (NASTT), and serves the geographical region of Virginia, West Virginia, District of Columbia, Maryland, Delaware, Pennsylvania and New Jersey. This area has a huge population and many large municipalities, with water and wastewater systems 100 years old. There has been ongoing interest in trenchless technology throughout our region because of the older water and sewer systems needing rehabilitation or replacement.

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

The new service products and innovations for trenchless technology have been used by public and private infrastructure owners across the Mid Atlantic region. Educating and introducing new trenchless technologies and services, MASTT has conducted 27 seminars throughout the Mid Atlantic area. These seminars have been very informative and have introduced trenchless technology to many people over the last 13 years. More short courses using NASTT developed course materials will be implemented in the future.

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

"WE LOOK FORWARD TO YOUR COLLABORATION & PARTICIPATION"

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

Thank you,

Richard Thomasson
Chair, MASTT

MASTT SITE

GREETINGS FROM THE MASTT EXECUTIVE DIRECTOR

Leonard Ingram, Sr., PWAM Executive Director, MASTT

I want to take this opportunity to congratulate my friend Dr. Tom Iseley, P.E., PWAM, Louisiana Tech University (Trenchless Technology Center Founder) on being inducted into the NASTT Hall of Fame. Dr. Iseley was one of the original five founders of NASTT in 1990 and has been a stern supporter of the Society and MASTT ever since. Since the formation of MASTT in 2003, Dr. Iseley has always been an avid follower of the Chapter with his time, knowledge, excellent advice and attendance of our seminars. "Congratulation Dr. Iseley! A well-deserved honor".

As we continue with our "Trenchless Technology, SSES and Buried Asset Management" seminars please fine listed below the 2018 Proposed Seminar and Journal Publication Schedule for the Mid Atlantic, Midwest and Southeast Societies for Trenchless Technology. I am the Executive Director for each Society and would very much appreciate your participating with these seminars as an exhibitor, food sponsor and/or presenter. MASTT had a very successful "Trenchless Technology, SSES and Buried Asset Management" seminar in Richmond VA on May 17th & 18th, 2017 at the Hilton Richmond Downtown Hotel. The Guest Presenter was Ms. Susan Hamilton, Operations Manager, Department of Public Utilities, City of Richmond, with the presentation "Richmond's Trenchless Technology Program". ASCE Richmond Branch was the co-sponsor of the seminar. There was a lot of networking and learning.

MASTT had a "Trenchless Technology, SSES and Buried Asset Management" seminar in Philadelphia PA on November 28, 2017 at the Clarion Hotel & Convention Center, Essington, PA (Philadelphia, PA). Mr. Jeff Twardzik, Engineering Supervisor, Philadelphia Water Department (and Sewer) was the Guest Presenter with the presentation "Philadelphia's Trenchless Technology Program". ASCE Philadelphia Section was co-sponsor of the seminar. The networking and learning were terrific.

"THANKS FOR THE SUPPORT"

Thanks For The Support!

Leonard E. Ingram, Sr., PWAM
Executive Director, MASTT

MASTT SEMINAR

2018 PROPOSED SEMINAR AND JOURNAL PUBLICATION SCHEDULE:

SOCIETY	PROPOSEDED DATE	PROPOSED LOCATION	STATUS
SESTT SEMINAR	ATLANTA GA	MAY 9, 2018	CONDUCTED
MASTT JOURNAL	PUBLISH DATE	MAY 24, 2018	PUBLISHED
MASTT SEMINAR	PITTSBURGH PA	JULY 19, 2018	PROPOSED
MSTT SEMINAR	DES MOINES IA	AUGUST 15, 2018	PROPOSED
MSTT JOURNAL	PUBLISH DATE	SEPTEMBER 14, 2018	PROPOSED
MASTT SEMINAR	VIRGINIA BEACH VA	SEPTEMBER 26, 2018	PROPOSED
MSTT SEMINAR	MINNEAPOLIS/ST. PAUL MN	NOVEMBER 8, 2018	PROPOSED
SESTT JOURNAL	PUBLISH DATE	NOVEMBER 16, 2018	PROPOSED
SESTT SEMINAR	TAMPA FL	DECEMBER 12, 2018	PROPOSED

MESSAGE FROM NASTT CHAIR

Frank Firsching, NASTT Chair

Greetings Mid Atlantic Chapter Members!

NASTT's Regional Chapters are the foundation of our Society and our volunteers are the reason for our growth and success. Thank you for being a part of our organization and dedicating your careers to the trenchless industry.

We've just wrapped up another impressive conference as NASTT's 2018 No-Dig Show in Palm Springs, California was very successful on all accounts. The exhibit hall featured close to 190 exhibitors and we welcomed over 2,000 attendees from all over the world, who came to experience the world class technical sessions and networking events that our Show is known for. NASTT's 17th Annual Educational Fund Auction was, once again, the trenchless social event of the year and we were able to raise nearly $100,000 for our educational programs! Thank you all for your generous support.

NASTT exists because of the dedication and support of our volunteers and our 11 regional chapters. There are many Mid Atlantic Chapter Members that served on our No-Dig Show Program Committee and volunteered time in summer 2017 to peer-review the 2018 abstracts. These committee members ensured that the technical presentations were up to the standards we are known for: George Cowan, Paul Headland, Peter Oram, George Ragula, Camille Rubiez, Jim Shelton, Richard Thomasson and Dennis Walsh.

The Mid Atlantic Chapter is also home to some of our Session Leaders. Session Leaders are Program Committee members that have the added responsibility of managing a session of the technical program and working with the authors and presenters to facilitate excellent presentations. I would like to extent a special thank you to the Mid Atlantic Chapter Members that also served as Session Leaders at No Dig 2018: Paul Headland, Peter Oram, George Ragula, Richard Thomasson and Dennis Walsh.

NASTT's Educational Fund Auction Committee are another group of volunteers that work hard every year to help raise funds for our educational initiatives. In the past 17 years the auction has raised over $1.1 million! We raise funds in a variety of ways including our live and silent auctions and our Dream Vacation Raffle. This year's Auction Committee Chair and Vice Chair were both Mid-Atlantic members who are very dedicated to the cause. Many thanks for Auction Chair, Gregg Leslie of Xylem Dewatering Solutions and Vice Chair, Dennis Walsh of PSE&G. A huge thank you also goes out to George Ragula of PSE&G for selling nearly all the vacation raffle tickets once again. George is a ticket selling machine!

The North American Society for Trenchless Technology is a society for trenchless professionals. Our goal is to represent our industry and provide valuable initiatives. To do that, we need the involvement and feedback from our professional peers. If you are interested in more information, please visit our website at nastt.org/membership/volunteer. There you can view our committees and learn more about the many ways to stay involved with the trenchless community and to have your voice heard. Please consider becoming a volunteer – we would love to tap into your knowledge and skills.

NASTT continues to grow because of our Regional Chapter involvement and volunteers. Thank you again for your support of our society and the trenchless technology industry.

Frank Firsching

Frank Firsching
NASTT Chair

MEMBERSHIP IN NASTT

Molly Margosian, NASTT Membership Coordinator

All in the Family: NASTT is pleased to present new opportunities to join the NASTT Family!

Attention Students! *Available now:* Student Non-Affiliated Membership

NASTT proudly engages 18 official Student Chapters, and now we are branching out to all students throughout North America! The NASTT Student Non-Affiliated Membership ($50 USD per year) is available to any student actively enrolled full-time in a North American university that doesn't currently have an official Student Chapter on campus.

Overseas Opportunities! *Available now:* International Individual Membership.

The NASTT International Individual Membership ($250 USD per year) is available to any individual residing outside of North America.

Stay Engaged! *Available now:* Retiree Membership.

The NASTT Retiree Membership ($40 USD per year) is open to NASTT members after they retire from the industry.

Now that you're officially in the family, are you getting the most out of your NASTT membership?

Taking advantage of all NASTT has to offer? As your membership manager, I'm happy to guide you to resources so that you can fill your trenchless toolbox with up to date industry information, webinars, events, and so much more!

Did you know NASTT has the world's largest online trenchless library, filled with technical papers focusing on a wide variety of trenchless topics? All papers are all available for download to our members compliments of NASTT. We sell industry books too!

Does your organization exhibit at NASTT's No-Dig Show? Members can enjoy discounts on training and registration at our annual No-Dig Show.

Are you hiring or searching for a new position? Being a society member allows you to view and post career opportunities on the job board on nastt.org. This complimentary membership tool houses industry specific jobs and gives members the opportunity to search for potential jobs or post positions that are needing to be filled.

Are you interested in getting to know the next generation of trenchless champions? NASTT also offers membership to students! We are proud of our 18 NASTT Student Chapters and these student members are given the opportunity to attend the No-Dig show and learn about the trenchless world while networking with potential employers. Student chapters fulfill critical roles as not only volunteers at NASTT's No-Dig Show, but are the next generation of trenchless professionals.

Does your NASTT membership also make you a member of your Regional Chapter? Yes! Take the opportunity to work your local network and get involved with your Regional Chapter. Regional Chapters offer trainings and meetings, providing you the chance to expand your regional network. NASTT Regional Chapters encourage community outreach, and are a great tool to expand your knowledgebase and meet other individuals within your industry too!

But wait, there's so much more! NASTT offers a weekly eNewsletter, blog, archived webinars on trenchless topics, and committee and volunteer opportunities for you. Now that you know a little more about the NASTT family, join us! Visit nastt.org and get your membership started today!

Sincerely,

Molly Margosian

NASTT Membership Coordinator

MASTT BOARD OF DIRECTORS

Richard Thomasson – *Chair*

Richard O. Thomasson has over 49 years of experience working in the water and wastewater field. He has been closely involved with Trenchless Technology for nearly his entire career. While at the Washington Suburban Sanitary Commission he directed many uses of new trenchless technologies, retiring after 31 years as the Director of Construction. He has worked with Parsons Brinckerhoff for 8 years, and Arcadis for the past 10 years, continuing his involvement in numerous trenchless projects.

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

As a Founding Director and the very first Chair of the North American Society for Trenchless Technology (NASTT), Richard believes fully operational water and wastewater systems are crucial assets for a healthy growing nation. In 2016 Richard was inducted into the NASTT Hall of Fame.

Dennis Walsh – *Secretary*

Dennis M. Walsh, P.E. is a Senior Project Manager – Horizontal Directional Drilling for Public Service Electric & Gas in New Jersey. Dennis is a 1972 graduate of the University of Dayton, Ohio with a B.S. in Civil Engineering and a 2002 graduate of the Polytechnic University of New York with a M.S. in Technology. He retired from KeySpan Energy Company in 2005 after a 28 year career in the gas utility field with a background in engineering, operations, construction, Quality Assurance and HVAC. He led KeySpan's efforts to expand the use of trenchless technology in the early 1990's to decrease its main and service installation costs. Prior to joining PSE&G, he was a consulting engineer for various consultants in the natural gas industry.

Dennis is a member of the Society of Gas Operators, and a Board Member of the North American Society for Trenchless Technology. He is also on the NASTT No-Dig Show Committee. Throughout his career, he has designed numerous HDD installations for various utilities. When he is not involved in trenchless projects, Dennis enjoys traveling and playing golf.

Michael Delzingaro – *Vice Chair*

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

Michael has 28 years of experience in the water industry and a background in entrepreneurial-driven businesses.

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

Tom Wyatt – *Treasurer*

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

MID ATLANTIC SOCIETY FOR TRENCHLESS TECHNOLOGY – BOARD OF DIRECTORS 2018

2018 SEMINAR & JOURNAL SCHEDULE

MASTT - MID ATLANTIC SOCIETY FOR TRENCHLESS TECHNOLOGY
MSTT - MIDWEST SOCIETY FOR TRENCHLESS TECHNOLOGY
SESTT - SOUTHEAST SOCIETY FOR TRENCHLESS TECHNOLOGY

SOCIETY	PROPOSED DATE	PROPOSED LOCATION	STATUS
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SESTT SEMINAR	DECEMBER 12, 2018	TAMPA FL	PROPOSED

To Present, Exhibit and/ or Food Sponsorships please contact Leonard Ingram, PWAM, Executive Director at 888-817-3788 or leonard@engconco.com

For registration and updated information on the 2018 Trenchless Technology, SSES and Buried Asset Management Seminars and Trenchless Journals, please visit:

Mid Atlantic: www.mastt.org | Midwest: www.mstt.org | Southeast: www.sestt.org

LITTLE CUYAHOGA INTERCEPTOR SLIPLINE REPLACEMENT

Hard Pipe Slipline Solution Prevents Collapse

By: James W. Shelton, P.E., ARCADIS

1. ABSTRACT

This paper presents the evaluation and construction of the rehabilitation of the 87-inch and 75-inch diameter brick Little Cuyahoga Interceptor (LCI). The LCI was constructed in 1928 as the main combined interceptor for conveying sewage and stormwater from City of Akron (City) along the Little Cuyahoga River. Planned tunnel construction adjacent to 2,800 linear feet of the LCI was expected to impose loads and vibrations that might collapse the LCI. The City desired a solution that would prevent collapse, provide an additional 50 years of operating life, eliminated a near full pipe stage in one segment, maximize capacity of the LCI, and be constructed before initiation of tunnel construction.

Geotechnical investigations, internal multi-sensor inspections (video, virtual mandrel measurements, pipe ovality, protraction measurements, and in-situ slope measurement), site access evaluations along the Little Cuyahoga River and several tributary crossing, tributary sewer connection evaluations, included two river crossing tributary lines, bypass piping constraints, wetland permits, and dynamic hydraulic modeling were used to evaluate four replacement/lining approaches considered technically pragmatic:

1. Hard pipe sliplining
2. Cured in place pipe lining (CIPPL)
3. Same trench relay
4. Parallel trench relay

Conceptual cost evaluations indicated a 20 per cent range in costs between these alternatives. In the end, Akron selected hard pipe sliplining with an open cut replacement of the sagged segment. While the primary appeal was the ability to construct in the wet with limited bypass, in the end the contractor elected to install a significant bypass system. This paper focuses on the evaluation process and construction phase of this $8M project. The construction was completed in 2016.

2. PROJECT BACKGROUND

The LCI sewer was constructed in 1928 to provide additional capacity for a growing City of Akron. It is the main interceptor for conveying downtown and southern areas of the City sewer service area to the Main Outfall Sewer.

A planned Ohio Canal Interceptor Tunnel (OCIT) was scheduled for construction adjacent to the LCI west of Maple Street and south of the Ohio and Erie Canal Towpath Trail (Towpath) and LCI. Construction activities were expected to impose significant loads and subsurface vibrations adjacent to and above the LCI that could cause collapse of the LCI. It was necessary for this 89-year-old sewer to be structurally capable of handling construction loads anticipated during the OCIT construction activities, which were scheduled to begin in November 2014. The City also desired the LCI upstream of the OCIT construction zone be lined or replaced. Another issue involved a pipe sag in the LCI immediately west of the OCIT facilities construction zone. A reverse slope in the LCI results in near full pipe flow during dry weather flow and surcharged flow for typical year storm events. The City desired this construction feature be eliminated.

The project area was a 2,750 LF reach of the LCI beginning approximately 75 feet west of Howard Street at and extending downstream to the west and north. Refer to Figure 1, Project Overview.

Figure 1 – Project Overview

There are approximately 2,275 LF of 87-inch sewer, 475 LF of 75inch sewer, nine manholes, multiple connected collection and trunk lines, and seven mid-sewer taps, as shown in Figure 2.

Figure 2 – Plan View

Here, the LCI is a 75-inch and 87-inch round brick sewer. Figure 3 shows the typical cross section of the existing LCI.

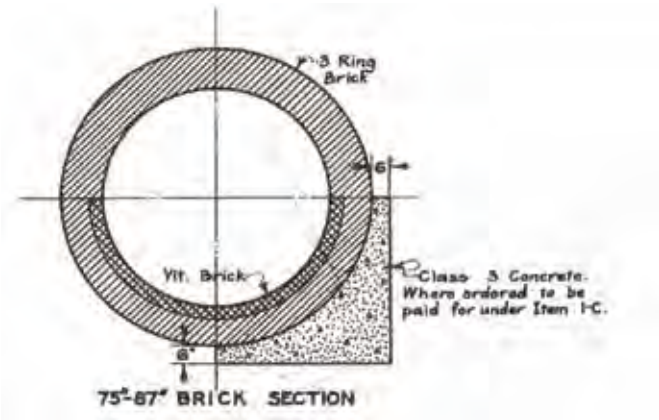

Figure 3 – Existing LCI Cross Section

Most of this reach of the LCI ran through the construction area of the planned OCIT projects. It parallels to the south the Little Cuyahoga River (LCR) and the historic Ohio & Erie Canal Towpath Trail, and is generally 10 to 100 feet off the river and approximately 10 to 30 feet off the Trail. It crosses the Towpath and Ohio Canal and continues along the LCR, with segments located within, and partially exposed in, the river bed.

3. PROJECT OBJECTIVES

The objectives for this project were to protect the LCI from damage or collapse during the OCIT construction, extend the useful life of the LCI in the project area by a minimum of 50 years, and eliminate the sag. These improvements needed to be completed without significant loss of the existing hydraulic capacity in this portion of the LCI or significant increase in hydraulic grade line (HGL) at the adjacent and upstream overflow racks during record storm event conditions. The existing LCI profile is shown in Figure 4.

Figure 4 – Existing LCI Profile

4. APPROACHES CONSIDERED

To meet the accelerated design schedule, four generalized LCI replacement/lining approaches were shortlisted for evaluation:

- Hard pipe sliplining
- Cured in place pipe lining (CIPPL)
- Same trench relay
- Parallel trench relay

5. SITE INVESTIGATIONS

Several investigations were completed to establish the Basis of Design for the project.

A geotechnical investigation revealed soils in the project area consist of poorly placed uncontrolled fill, with deeper layers of fine grain silts, silty sands, and sands at and below the invert of the existing LCI that are susceptible to erosion. A static groundwater table is found 13.0 to 18.0 feet below ground surface. Given these factors, new construction would require a braced sheeted retention system on both sides of the excavation along with a dewatering system.

Internal inspections of the LCI were performed on different occasions by RedZone Robotics (LIDAR and sonar). The RedZone inspection utilized a Multi-Sensor Responder platform to provide video, ovality, deflection, sediment, gas, and a virtual mandrel for evaluating sliplining and CIPPL options. No significant structural defects and only two protruding taps were found. Sediment was minimal, and infiltration levels judged as typical for a brick sewer. The pipe was nearly round, and was generally larger than its nominal diameter.

The RedZone inspection provided additional information regarding the sag that existed within a 470-foot length of the LCI centered on MH 303280. Slope measurements revealed that a 220-foot length within this reach had either a flat or a reverse slope. Despite this condition, no significant sediment deposition was found.

6. PERMITTING

A Surface Water Delineation was conducted, no areas were identified within the limits of work that exhibited all three wetland criteria; therefore, no areas were considered regulated wetlands by the U.S. Army Corps of Engineers (USACE).

The Ohio and Erie Canal, LCR, and an unnamed tributary to the LCR were identified within the limits of proposed project area. All three resources are tributary to the Cuyahoga River, which is a “traditionally navigable water”; therefore, all three water bodies

were considered jurisdictional by the USACE, and a Nationwide Permit 12 from USACE was required for any impacts associated with the project.

Other permits that were obtained or permitting factors that were evaluated included:

- Storm Water Pollution Prevention Plan
- Endangered or Threatened Species
- FEMA Floodplain
- Land Acquisitions, Temporary Construction Easements
- Existing Utility Conflicts

7. HYDRAULIC BASIS OF DESIGN

During dry weather, the LCI has peak dry weather flows of 51 MGD, velocities between 6 to 8 feet per second (fps), and velocities as high as 13 fps for steep segments. During a 0.5-inch rainfall event, peak flows in the LCI jump from 51 MGD to 211 MGD. During a 3.5-inch, 24-hour event (10-year storm), peak flows reach 277 MGD with velocities of 12 to 16 fps.

Several model runs were conducted to predict the impacts the different approaches would have on flow capacity and hydraulic grade line:

- Assuming a Manning's n coefficient of 0.014 for the existing pipe.
- Assuming a Manning's n coefficient of 0.016 for the existing pipe (assume brick surface is not as slick).
- Assuming a reduction of diameter of 4 inches less than existing (CIPPL) with a Manning's coefficient of 0.013.
- Replacing and increasing pipe diameters to 84 inches and 96 inches with a Manning's coefficient of 0.012.
- liplining using 66-inch and 78-inch pipes with a Manning's n coefficient of 0.012.

The model runs indicated there were no significant changes in dry weather or wet weather peak flow, or depth of flow, between any of the replacement/lining approaches under consideration.

8. BYPASS PUMPING BASIS OF DESIGN

The different approaches were evaluated based on assumed bypass pumping requirements. For all approaches where the bypass pumping system was needed to handle flows from possible rainfall events, the 3.5-inch rainfall event (10-year storm) was used. The 10-year storm event flows were expected to only be 10 per cent higher than a 6-month storm event (1-inch rain event).

CIPPL would require a full flow bypass for all lining shots. Due to the installation time of 1-2 weeks per shot, the bypass pumping system would need to be designed to handle flows expected during rain events. Predicted flows from the 10-year storm event were used to size the bypass system.

With dry weather flow depths of 25 per cent of the pipe, the hard pipe sliplining required little to no bypass. Some flow control would be needed during end seal and grouting work. Given that sliplining pushes take days to complete, the contractor needed to have a system or method in place to convey wet weather flows, which included possibly removing jacking equipment from pits and stopping installation work. The 10-year storm flow rates were provided to the contractor for planning purposes.

Same trench relay required a full flow bypass for the entire construction sequence. The 10-year storm was used to establish bypass requirements.

Parallel trench installation would only require bypass pumping during times of tie-ins of the existing LCI and crossing and connecting influent sewer lines. With connections only taking days to complete, the work could be done during dry weather, so the bypass requirements were dry weather flow plus a 20 per cent safety factor.

9. EVALUATION OF APPROACHES

It was determined that all four approaches were viable. A summary of key findings from the evaluation of approaches included the following:

Hydraulics

- Control structures upstream of the project area limited the maximum flow demand experienced by the LCI, regardless of storm event intensity or duration.
- A flow capacity increase in the project area had little impact on hydraulic grade lines upstream of the LCI (upstream of Howard Street).
- Sliplining, cured in place lining, and replacement all provided approximately the same hydraulic capacity as the existing LCI according to modeling performed.
- The sag changed the hydraulic grade line immediately upstream of the sag, but did not prevent the LCI from conveying peak hydraulic demand.

Bypass

- Dry weather flows varied little diurnally.
- The bulk of the flow came from two sources: LCI immediately upstream of the project area and the OCI.
- Storm flows significantly increased over base flows with minor storm events. A 0.5-inch rain storm flow is four times dry weather flow.
- Storm flows level out quickly in the LCI, regardless of storm intensity or duration, because of upstream flow control structures. A 0.5-inch event yields 211 MGD, while a 3.5-inch event yields 277 MGD.
- Bypass of the OCI across the Ohio Canal was needed while working near OCI's junction with the LCI. The top of the OCI needed to be removed and a wet-well constructed to support bypass.
- Bypass pipe would probably be routed along the south side of Towpath Trail. Dry weather flow (~50 MGD) could be easily accommodated, but wet weather flow, which would require approximately eight 36-inch pipes, would consume all (and likely more) of the trail's paved surface.
- Discharge of dry weather bypass flow could be accomplished by removing the cones from one or two manholes below the lining/replacement. Wet weather flows (277 MGD) required either an extension of some of the bypass pipe to further downstream manholes or construction of a discharge vault in the LCI.
- A 66-inch fiberglass reinforced polymer mortar pipe (FRPMP)

with an outside diameter (OD) of 69.2 inches could be sliplined into the 75-inch brick sewers. A 78-inch FRPMP with an OD of 81.6 inches could be sliplined into the 87-inch brick sewer. Approximately 450 CY of grout would be needed to fill the annular space in the segments upstream of the two sagged sections. Virtual mandrel data was sufficient to pre-order pipe. Based on discussion with the Hobas pipe manufacturer, the level of confidence with RedZone data was high, and virtual mandrel data was used to determine optimum stick lengths for a jacking schedule. The contractor would likely also pull sizing mandrels through the LCI prior to construction to verify RedZone data.

- Protruding taps should be cut flush prior to installation.
- Minimal to no LCI bypass was necessary to complete the sliplining. Some bypass proved desirable for grouting/end sealing.

Cured in Place Pipe Lining

- If unreinforced liners were used, liners would be approximately 1.5 inches thick. Reinforced liners would be approximately 1 inch thick.
- Full wet weather bypass would be required.

Open Cut

- Trenching for new pipe (existing trench or parallel trench) would require a braced sheeted retention system sheeted on both sides of the trench.
- Same trench relay would use existing concrete cradle, and required excavation only to the spring line and hence shallower sheeting than parallel construction.
- Full wet weather bypass would be required for same trench relay; dry weather bypass would be required for parallel.
- The dewatering system would likely consist of a multiple well point system. Additional soil and groundwater investigation during final design phase may be warranted.
- Existing high groundwater at the site may trigger special pipeline, manhole, and vault buoyancy countermeasures.

Sag

Elimination of the sag required pipe replacement between Station 3+00 and Station 6+00. See Figure 5 for the same trench replacement plan for the sag.

Figure 5 – Same Trench Replacement at Sag

Concept level costs were developed for the four approaches as shown in Table 1 below. While Arcadis recommended an open competition with all four approaches available to the contracting community, Akron preferred a more restricted procurement. A design workshop was held where the City elected a design based on the sliplining approach, with same trench replacement of the sag. Table 1 presents the matrix of approach evaluation.

Table 1 - Approach evaluation Matrix

	Approach			
	Sliplining (SL)	Cured-in-Place Pipe Lining (CIPPL)	Same Trench Replacement (STR)	Parallel Trench Replacement (PTR)
Change in Flow Capacity	NC	NC	NC	NC
Change in HGL	NC	< 4"	NC	NC
Bypass Pumping • Construction • Tributary	 DWF DWF	 10-yr 10-yr	 10-yr 10-yr	 DWF 1.2 x DWF
Cost (Class 4 Estimate)	$5.73M	$7.67M	$12.98M	$12.34M
Onsite Schedule (Months after NTP)	7 months	8 months	11 months	10 months
General Risk	• Localized Ovality • Difficult Jacking Location	• Inversion Failure • Premature Resin Kick • Lifts & Wrinkles • Design Storm Event/River Flooding	• Geotechnical / Water • Basin Proximity / Incursion • Sheet pile driving damage to existing LCI	• Geotechnical / Water • Basin Proximity / Incursion • Sheet pile driving damage to existing LCI

HGL = Hydraulic Grade Line; based on Model Results
NC = Negligible Change
NA = Not Applicable
DWF = Dry Weather Flow
10-yr = 10-year Storm Event Flow

10. DESIGN COMPONENTS

Due to the high velocities within the LCI, all pipe materials used were HOBAS pipe.

During the design phase, multiple delivery methods were evaluated including Construction Manager at Risk, Design Build, and Progressive Design Build. The City elected to produce this project using the traditional Design-Bid-Build process in order to maintain a high level of control over the design work.

11. BID PHASE

The City received four bids for this contract. The engineer's estimate was valued at $6,472,340 and the four bids ranged from $5,667,400 to $7,849,000. A summary of the bid tab results is shown below in Table 2.

Table 2 - Bid Prices (by Totals)

Bid Item	Engineer's Estimate	Bidder 1	Bidder 2	Bidder 3	Bidder 4
Bypass Pumping (LS)	$ 1,235,600	$ 1,200,000	$ 1,460,000	$ 1,950,000	$ 540,000
78" CCFRPM (2,280 LF)	$ 4,104,000	$ 3,534,000	$ 3,135,000	$ 4,674,000	$ 5,415,000
66" CCFRPM (445 LF)	$ 903,350	$ 734,250	$ 656,375	$ 745,375	$ 1,068,000
Other Remaining Bid Items	$ 229,390	$ 199,150	$ 742,375	$ 375,850	$ 826,000
Total	$ 6,472,340	$ 5,667,400	$ 5,993,750	$ 7,745,225	$ 7,849,000

Based on the bids received, the project resulted in an average price of $2,080/LF of pipe installed for the low bidder, with bypass pumping accounting for about $440/LF of pipe installed (or 21 per cent of the overall cost). A summary of the bid tab results by linear foot is shown below in Table 3.

Table 3 – Bid Prices (by Linear Foot Prices)

Bid Item	Engineer's Estimate	Bidder 1	Bidder 2	Bidder 3	Bidder 4
Bypass Pumping (LF)	$ 453	$ 440	$ 536	$ 716	$ 198
78" CCFRPM (LF)	$ 1,800	$ 1,550	$ 1,375	$ 2,050	$ 2,375
66" CCFRPM (LF)	$ 2,030	$ 1,650	$ 1,475	$ 1,675	$ 2,400

The Contractor for this work was Kenmore Construction of Akron, OH.

12. CONSTRUCTION

Bypass Pumping

During the design phase, it was determined that most of the sliplining work could be performed without bypassing dry weather flows. However, during the construction phase, the contractor elected to install a bypass system to work in nearly dry pipe conditions for much of the construction. Figure 6 shows the configuration and setup of upstream primary bypass pumping system.

Figure 6 – Bypass Pump Setup

Figure 7 – Bypass Piping Crossing Under Howard Street Bridge

Bypass Piping Layout

The majority of the LCI runs parallel to the LCR and crosses tributaries such as the Ohio Canal. While laying out the bypass pumping discharge pumping, the Contractor utilized crossings including under bridges and built concrete supports to bridge the discharge piping over stream crossings. Figure 7 and 8 show examples of bypass discharge pumping locations.

Figure 8 – Bypass Piping Crossing Ohio Canal near LCR

Trench Protection

Due to the nature of the soil and groundwater conditions, a braced timber shoring system was installed to protect the LCI during excavation for bypass pits and jacking and receiving stations. Due to the groundwater table levels of 13-18 feet below ground surface, dewatering systems were installed to resist hydrostatic pressures and promote soil stability within the excavated areas. Figure 9 shows an example of the timber shoring system.

Figure 9 – Trench Shoring and Protection

Sliplining

The LCI was excavated at key locations over the pipe to install inserting/jacking pits for pushing the HOBAS jacking pipe into the existing pipe. Jacking pits were excavated just below the spring line. Platforms were constructed on each side of the pipe as a laydown area for materials and equipment before removal of the brick crowns. Ladders were used to enter and exit the pits.
All LCI host pipes were mandrelled to confirm pipe clear diameter and turn length as shown in Figure 10.

Figure 10 – Pipe Mandrel

Sliplining pipes were pushed in place and/or pulled using a winch. Figure 11 shows the typical placement of the sliplining pipe.

Figure 11 – Sliplining Pipe Placement

Figure 12 – Sliplining Pipe After Annular Space Grouting

Annular Space Grouting

After the sliplined pipe was placed, annular spaces were tremie grouted in lifts/stages to prevent pipe flotation and the end seals were installed. Figure 12 shows a typical annular space after grouting.

Pipe Closing

After the sliplined pipe was placed and secured, the coupling pipes were inserted as shown in Figure 13.

Figure 13 – Coupling to Sliplined Pipe After Annular Space Grouting

ABOUT THE AUTHOR:

***James W. Shelton, P.E.**, is National Technical Director for ARCADIS focusing on condition assessment, rehabilitation, construction management, capacity assurance, and operations. He has a degree in Chemical Engineering from University of Pennsylvania, is a licensed water and sewer contractor, and holds Professional Engineering licenses in Civil Engineering in 11 states.*

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By: Mike Young, Underground Magnetics

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This is an exciting year for Underground Magnetics. We are building a new engineering and assemble facility in Iowa. Some very exciting new products will be unveiled soon and as always, software updates are free!

ABOUT THE AUTHOR:

Mike Young, *President, Underground Magnetics Inc. has a thirty year history in the HDD industry, owning and working for many of the well- known drill rig manufacturers and HDD guidance system producers. Mike is still helping innovate new products for the HDD industry today.*

RICHMOND SEMINAR MAY 17 - 18, 2017:

GUEST PRESENTATION

"Richmond's Trenchless Technology Program"
Ms Susan Hamilton, Operations Manager,
Dept. of Public Utilities, City of Richmond

PRESENTATIONS

Welcome Address and "Liquid Assets" Overview Video,
Leonard Ingram, PWAM, MASTT Executive Director

Overview of Trenchless Technology & NASTT Education Efforts,
Richard Thomasson, P. E., ARCADIS US, Inc.
and MASTT Chairman

Structural Upgrade of Large Diameter Pressure Pipelines,
Anna Pridmore, Structural Technologies

Consent Decree Sewer Design & Construction,
Richard Thomasson, P. E., ARCADIS US, Inc.

GeoSpray Geopolymer Mortar for MH & Pipe Rehab,
Scott Navia, P.E., Milliken Infrastructure Solutions, LLC

Multi Sensor Inspection,
Ed Diggs, Pipeline Inspection Partners Corp.

BAMI-I Asset Management Training Initiatives,
Richard Thomasson, P. E., Vice Chairman, BAMI-I

Bypass Pumping and Monitoring,
Hunter Powell, Xylem, Inc.

Quality Air Vacuum Excavation,
Charles Bell, Vacmasters

UV CIPP,
Mike Hoffmaster, Pleasants Construction

Pilot Tube Microtunneling,
Troy Stokes, Akkerman Inc.

Rehab Of Underground Structures,
Jerry Trevino, Protective Liner Systems

Guided Boring Using Pilot Tube,
Steve Matheny, Logan Clay Products

Underground Gyroscopic Mapping Tool,
Mac McGarry, CUES

Structural Polyurethane I & I Grouting,
Kirk Roberts, CJ Geo / Concrete Jack

Preventing SSO's With Chemical Root Control and Grease Control,
Hunter Dance, Douglas Products

Spiral Wound Pipeline Rehab For Gravity & Storm Water,
Chris Lind, Sekisui SPR Americas LLC

Advancement In Locating Technologies,
Mark Norris, Eastcom Associates

Crabtree and Upper Pigeon Interceptor Tunnels Project,
Mike Wanhatalo, Bradshaw Construction

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MASTT Executive Director Leonard Ingram believes the seminar programs are essential in fulfilling the MASTT mission to promote the growth of trenchless technology in the Mid Atlantic:

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Ms Susan Hamilton, Operations Manager, Dept. of Public Utilities, outlines City of Richmond Trenchless Technology program

For information dates and locations of the proposed 2018 MASTT Trenchless Technology, SSES and Buried Asset Management seminars planned for the Mid Atlantic, visit:

www.mastt.org

PHILADELPHIA SEMINAR NOVEMBER 28, 2017:

GUEST PRESENTATION

"Philadelphia's Trenchless Program"
Mr Jeff Twardzik, Engineering Supervisor, Philadelphia Water Department & Sewer

PRESENTATIONS

Welcome Address and "Liquid Assets" Overview Video,
MASTT Executive Director

Buried Asset Management Institute – International (BAMI-I) Certification Program,
Leonard Ingram, PWAM, BAMI-I Treasurer

Consent Decree Sewer Design & Construction,
Richard Thomasson, P. E., ARCADIS US, Inc.

Internal Joint Seals - Where, When, How,
Jeremy Keininger, Miller Pipeline Corporation

Guided Boring Using Pilot Tubes - Methodology and Case Studies,
Steve Matheny, P.E., Logan Clay Products

Tips and Tricks for Bypass Pumping,
Patrick Witt, Rain For Rent

Underground Gyroscopic Mapping Tool,
Mac McGarry, CUES

Over The Hole CIPP Installation in Downtown Baltimore,
Bob Stier, SAK

Fold and Form PVC Liners for Culvert Rehabilitation,
David Ohayon, IPEX USA LLC

Inspection Tools for Determining Remaining Useful Life,
Ed Diggs, Pipeline Inspection Partners Corp., PPIC (Purveyor of Cues High Technologies)

MID ATLANTIC CHAPTER

GERMANTOWN ROAD CULVERT RELINE: GAITHERSBURG, MARYLAND

Tunnel Liner Plate Solution Most Viable Option

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

Host pipe stabilized with box beam frames to temporarily address structural concerns

Tunnel Liner Plate provided a safe working environment as workers progressed through the length of the structure

In 2015, Montgomery County, Maryland identified a culvert under Germantown Road that was severely deteriorated and in need of repair or replacement. The existing 96-inch culvert was located under 26 feet of cover and included a major modular block retaining wall situated over the upstream end. The depth of cover and the retaining wall, combined with the fact that the road above was heavily trafficked and difficult to detour made a replacement solution highly problematic. There were also several utilities passing through the fill above the culvert. Notwithstanding the excessive capital expense required, a normal replacement approach would have been highly disruptive to local residents and commuters.

Once a reline solution was determined to be the most viable option, the initial challenge was to determine if the culvert truly could be relined. The total lineal footage was 470 feet with a 3-degree vertical elbow located 102 feet from the outlet end. It was also critical that the hydraulics checked, including the appropriate passage of the design flows, while a manageable level of outlet velocities was attained. The county decided the best solution was to engage an outside engineer to design and detail a full reline solution. The county also determined a competitive bid approach would provide the most economical construction cost after learning that relining techniques for culverts of this size had become widely known to area contractors.

Ultimately, the consulting engineer, The Wilson T. Ballard Company, decided the best design approach would be a

"WE ARE VERY PLEASED WITH THE OUTCOME OF THIS PROJECT. THE FINAL SOLUTION WAS HIGHLY EFFECTIVE."

– Brian E. Copley, P.E., Montgomery County DOT

relining solution that incorporated an 84-inch diameter, 12 gage, aluminized type 2 (ALT2) spiral rib corrugated metal pipe (CMP). This solution would provide the desired Manning's "n" of 0.012 while also extending the service life of the existing host pipe by an estimated 100 years. Aluminum coated steel for CMP was introduced in the mid-1980s and has proven to provide an extensive service life improvement compared to galvanized steel for CMP. This improvement is commonly a factor of three times longer when in the appropriate environment.

During the project scoping and evaluation process, representatives from Contech Engineered Solutions visited the site to help assess the existing culvert conditions. Timber supports were aged and appeared to have been installed during the original construction. This caused some concern as they suspected that the soil prism above the pipe could be variable from a soil arching standpoint. The corroded invert also showed full corrosion failure resulting in inward, rotational movement of the side wall which meant that an applied coating was out of the question and that movement or shifting of the host pipe was possible. Either way, a fully structural rehabilitation method was needed.

The low bidder for the project, Concrete General Inc., Gaithersburg, MD, mobilized its crew and began the preliminary work to prepare the host pipe for relining. During this initial site preparation, a 20 foot long section of the existing culvert shifted downward. Workers were inside that section at the time and the soil arch sheared. As a result of this unfortunate movement in the culvert, the safety of the workers inside of the structure became a much higher risk, and the selected 84-inch pipe would no longer cleanly fit into the host pipe.

At this point, the County needed to reconsider the viable options at their disposal. Given the previously mentioned design considerations, open cut was still out of the question. Instead, they decided

Individual sections were assembled inside the host pipe; 5 plates for each pipe ring

Blocking between Tunnel Liner Plate and host pipe ensured worker safety and provided uplift resistance during grouting

to stabilize the pipe with invert paving and box beam frames to temporarily address the structural concerns, allowing them time to determine another reline option.

After some consideration, they selected Aluminum Tunnel Liner Plate manufactured by Contech Engineered Solutions as the best option. Tunnel Liner Plate offered several advantages over other options. The individual sections can be assembled inside the host pipe and would allow for tunneling through the host pipe if needed. It also provided a safe working environment for the workers as they progressed through the length of the structure. The structural design of the new Tunnel Liner Plate pipe adhered to the AASHTO LRFD design methodology for tunnel liners. The aluminum alloy material is extremely durable. It features a marine grade, 5052 aluminum alloy that has been used in tough culvert environments since the mid-1960s. The heaviest plate weighed only 19 pounds which allowed for easy handling and assembly and quick hand tunneling within the culvert. Each section of Tunnel Liner Plate is 18 inches width, along the centerline of the new pipe. The new pipe rings were made up by five individual plates that feature high efficiency longitudinal seams with offsets in the plate ends. The staggered bolt pattern in the longitudinal seams provided an efficient transfer of bending loads around the ring.

As part of this revised construction plan, exploratory holes were drilled into the host pipe to allow for assessment of supporting backfill which aided in determining when the timber box strutting could be removed. If voids were found, a "U" shaped cut allowed for the host wall to be opened up at the time of the liner plate assembly. These openings were located at the top of the voids and allowed the grout to fill the voids during the liner grouting process.

During the assembly of the Aluminum Tunnel Liner Plate, staging was conducted in a solid area of the host pipe where supports could be removed well ahead of the assembly at this location. Placement of blocking between the Tunnel Liner Plate and the host pipe allowed for immediate transfer of loads to keep the workers safe. The blocking provided uplift resistance during grouting as well. Grout was pumped through the new pipe wall through 2-inch diameter ports utilizing a three-lift grouting plan with a highly viscous, standard grout mix consisting of cement, water, sand and a plasticizer. It had a fluid unit weight of 125 pounds per cubic foot.

Even with the change to a different design, the County was extremely pleased with the outcome in what otherwise would have been a very costly and time-consuming replacement project. Brian E. Copley, P.E. of the Montgomery County DOT, stated, "We are very pleased with the outcome of this project. The unfortunate movement of the host pipe during construction caused a shift in our approach, but the final solution was highly effective."

ABOUT THE AUTHOR:

Hugh B. Mickel, P.E *is the Director of Reline Technologies for Contech Engineered Solutions. He has been with Contech for over 30 years and has 23 years of direct experience relining drainage and sewer pipes, culverts and small bridges. Much of this reline experience was gained while living in Massachusetts and serving as Region Engineer covering New York, Pennsylvania, New Jersey and New England. Hugh holds a B.S. in Civil Engineering from Purdue University and has been a registered Professional Engineer since 1990.*

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Section of 36-inch abandoned cast iron pipe

OVERCOMING CHALLENGES KEY TO WORLD RECORD 36-INCH CIPL GAS MAIN RENEWAL

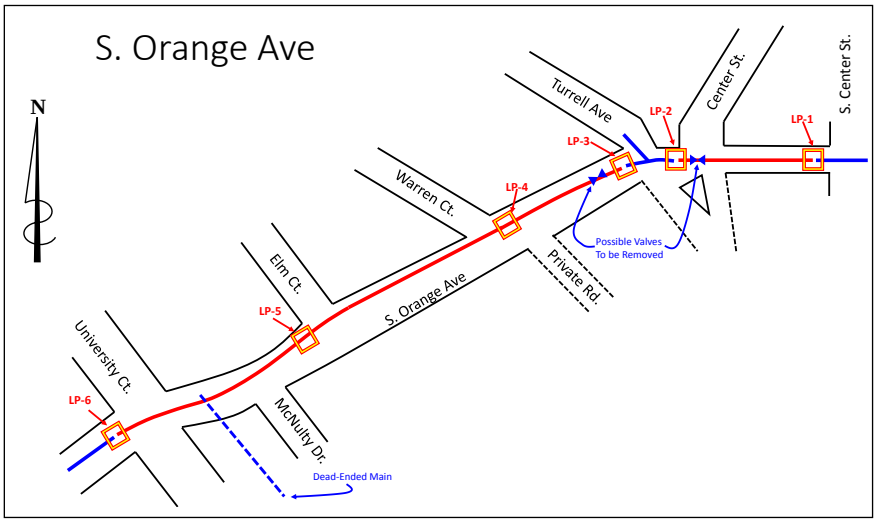
World Record Diameter Gas Main Relined in South Orange, NJ

By: George Ragula, Public Service Electric & Gas

South Orange Avenue is a major urban thoroughfare running through the Seton Hall University campus and into a nearby popular park. I was there on a late November day last year. The sun glistened on orange and yellow leaves and there was a chill in the air. I watched as pedestrians descended again on the crosswalks hustling to class and meetings. Traffic was again back to normal. It was an unlikely setting for the World Record 36-inch Gas Main Reline we had achieved only a week before. I breathed a sigh of relief and thought back on the design process and the challenges we faced during construction which led ultimately to our World Record achievement.

This large diameter feeder main reline was one of the most demanding projects of my 40-year career. Running under this section of South Orange Ave. was a 2,000 LF stretch of 36-inch cast iron gas main pipe originally installed in the fifties. With increasing deterioration over the years a lot of short term sporadic emergency work had been done on this section of cast iron pipe, however a long term permanent solution for this critical feeder main had not yet been formulated. There were now a total of 15 known joint leaks pinpointed along this section so it was critical immediate action be taken to implement a comprehensive long term solution.

Ultimately, the best and most effective long term solution we found required a Cured-In-Place-Liner (CIPL) renewal of this 2,000 LF section of 36-inch cast iron gas main – a new world record as the largest diameter CIPL project ever done on a gas main! This challenging undertaking required innovation, calculated risks and occasional round the clock shifts to complete. It was made possible by the exceptional work and expertise provided by the dedicated teams at Public Service Electric & Gas (PSE&G), Progressive Pipeline Management (PPM) and Karl Weiss Technologies GmbH. The outcome of our teamwork was a successful permanent renewal of the feeder main using trenchless technology and a new world record set for the largest diameter gas main renewed with CIPL!



South Orange Avenue 36-inch feeder main alignment

WITH SUCH AN UNPRECEDENTED SIZE DIAMETER OF PIPE TO BE LINED, A DETAILED GAME PLAN WAS CRITICAL, AND CONSIDERABLE TIME WAS INVESTED INTO PLANNING AND COORDINATING OUR APPROACH.

DECISION TO LINE: JUNE/2017 – SEPTEMBER/2017

Buried at an average depth of 4 feet under the fresh pavement surface of South Orange Ave., the 36-inch high pressure main was embedded amongst a congestion of subsurface utilities including telephone, water, multiple sewer lines, storm drains, cable, and electric. There was also a 12-inch low pressure gas main running parallel under the same street. Finding a clear alignment to relocate the main through this complex subsurface environment was therefore impossible, so replacement of the cast iron pipe was out of the question.

We considered our options. Often the easiest and most cost effective solution is to insert a much smaller diameter higher pressure plastic pipe within the host pipe. However, this was not a viable option as the 36-inch cast iron pipe was already running at 15 psig and we didn't have any 60 psig systems nearby to use as a source to maintain current volume through the smaller diameter plastic.

Another option was to excavate and encapsulate all the leaking joints over a period of time. There were already 15 known joints that leaked and it was only a matter of time before all of the cast iron pipe joints would need to be repaired. Spaced at eighteen foot intervals encapsulating all the joints along the busy South Orange Ave. corridor, was deemed impractical, cost prohibitive, with the likelihood of major negative impacts on traffic flow and the surrounding community. We concluded that the only viable and cost effective approach which guaranteed minimal disruption was trenchless renewal of the pipe using CIPL. Because it was the summertime, it was feasible to use the adjacent low pressure main as a relay to maintain service to customers as construction proceeded.

In June 2017 the decision was finalized to renew the 2000 LF section of the 36-inch cast iron main with Starline® Cured in Place Lining. For expertise in lining gas mains, all roads lead to the team of highly skilled infrastructure specialists at Progressive Pipeline Management (PPM). Since 2002, PPM have been the sole contractors in North America, exclusively licensed to install Starline® CIPL for natural gas main renewal applications. The Starline® product was originally developed by Karl Weiss Technologies GmbH, a German company with extensive experience in natural gas liner applications. The Starline® liner has undergone ten years and $14M worth of testing with PHMSA, Cornell University, and NYSEARCH. This independent testing of the liner in live pressurized pipe has determined a 100+ year's lifespan for the product. There are no other liners available for use in the gas industry that are backed with the same pedigree and extensive testing protocol.

Custom pig fabricated to remove stranded grit

With such an unprecedented size diameter of pipe to be lined, a detailed game plan was critical, and considerable time was invested into planning and coordinating our approach. There was significant lead time needed for the liner, materials, pipe, valves and related equipment to be manufactured and shipped. We calculated the length of liner required and determined there would be six access pits requiring excavation to install four separate liner segments varying in length from 260LF to 650LF. A specially designed custom inversion drum also needed to be manufactured and shipped from Germany.

Since this was the first installation of CIPL for such a large diameter of gas main, we felt it was important to have onsite technical support from the liner manufacturer in Germany. Karl Weiss Technologies GmbH sent Holger Turloff, a technician deeply experienced

Project Team: Public Service Electric & Gas, Progressive Pipeline Management and Karl Weiss Technologies GmbH

in lining large diameter gas mains. His help was invaluable in directing and training the crews through their first time working with the equipment necessary for installing this record-setting large diameter liner.

Based upon approximately a week for installation of each of the four liner segments, it was going to be a major challenge to meet a gas-in date of November 1/2017 so that this critical 36-inch feed main was back online before the cold weather hit. There were additional complications, delays and challenges which arose during the pre-construction and construction phases.

PRE-INSTALLATION: SEPTEMBER/2017 – OCTOBER/2017

From prior experience renewing cast iron gas mains, we knew there would be challenges, some known, and many unknown. We solved one of them in the planning phase, averting a potential failure of the liner material, by designing a reinforced four-ply polymer carbon fiber patch to bridge a four inch tap hole in the pipe. This patch concept was adapted from the circumferential structural reinforcement sleeve made of carbon fiber or steel that we occasionally use to bridge gaps in pressure pipe before lining (see NASTT-NE Journal Fall/2017 pp38-40).

The onsite preparations began with abandoning the 2000 LF section of main to be lined. There were two dead ended lateral mains that needed to have back feed relays installed first, before we could take the 36-inch cast iron pipe out of service. Excavations were done in locations on the 36-inch main where lateral feeds were disconnected, services were transferred and valves were replaced. These became our lining excavations. On the whole project overall, 5 old deteriorated valves were replaced with four new ones. Provisions for temporary relay feeds were put into place in the locations where the valves were being replaced.

Once excavation of the pits was underway, we knew there would be required adjustments and unforeseen circumstances related to equipment or the site. Lining four segments demanded we juggle multiple priorities with sites and equipment at the same time. Before cleaning of the pipe section commenced, a pre-clean CCTV inspection was run on each of the four segments to confirm the pipeline geometries, check for anomalies and protrusions, and assess overall internal conditions of the host pipe.

CHALLENGE: STRANDED GRIT IN SEGMENT TWO

To prepare the pipe for lining, sandblasted grit was used to clean the interior pipe wall down to white metal to ensure a tight bond between liner and host pipe. Based upon our previous experience doing sandblast cleaning and vacuum removal in large diameter mains, we thought the suction generated by an equivalent of five vacuum units would be more than sufficient to remove the debris and residual grit material from each of the four segments post-cleaning.

Due to the sequencing of access pit

Liner wet out involves mixing two-part chemicals

Starline® Cured in Place Liner coming off the drum guided as it enters the host pipe

excavations, Segment Two was cleaned first. However post-cleaning inspection revealed there was still roughly a 150 foot length of stranded grit material remaining in the pipe after the vacuum removal process was complete. Two more vacuum sources were added the next day to bring the total to seven vacuum units, along with a special fitting to increase suction. Even after an entire extra day was spent using seven vac sources, there were still piles of grit left behind in the pipe. A conventional pig didn't work to push the grit out either.

Time to innovate. We fabricated a custom pig with rollers and a tethered hold back. The rollers centered the pig into the pipe reducing the area into a small annular space. This drastically increased the suction velocity in the areas between the pipe's interior surface and pig. With vacuum source at one end we would slowly pull the pig back towards the other end against the airflow, moving it over the areas where grit had accumulated. We used CCTV to monitor the pig's position and confirm grit removal. It took us another day using this innovative process to successfully remove all the stranded grit.

The seven vac sources were effective by themselves at removing the residual grit from pipe Segments One, Three and Four. Finally, post cleaning CCTV confirmed each segment was clean and ready for the liner installation phase. We retired the custom pig.

LINER INSTALLATION: OCTOBER/2017 – NOVEMBER/2017

Segments of CIPL 36" Cast Iron Pipe	Feet	Days to Complete
One	650	7 days
Two	565	26 days
Three	450	6 days
Four	260	3 days

Lining began October 9th and was completed November 19th. Note the length of time required to complete Segment Two.

For each of the four segments, the host pipe ends were prepared at the entry and exit pits. This involved placing a crib under the host pipe entry point with a T bar to help center the liner into the

Liner entering host pipe after going through inversion cone

pipe. On the receiving end an end catch fitting was used to stop the liner. After we prepared the host pipe ends for each segment, the pipe was ready for liner installation.

The liner wet-out was done by mixing two-part epoxy resin in predetermined quantities based on diameter and length of each segment to be lined. The mixed resin was poured into the open end of the liner. Securing the liner tail properly was a critical step that prevented resin from leaking out once the liner was loaded up with epoxy. For this large diameter we prepared the tail for each segment with special adhesive tape before attaching the liner with 4 bolts to the retention belt that pulls the liner into the pressure drum. While being loaded into the pressure drum the liner was pulled through pre-set rollers gapped to wet-out or spread the epoxy inside the entire length needed for the planned inversion.

Connection of the tail to the retention belt was critical for control of the liner once it was pressurized and while inverting under air pressure. A twenty to thirty foot section of tail remained un-inverted inside of the liner while it cured with positive pressure maintained for two to three days. Once cured and deflated, the catch on the receiving end was removed and the tail pulled out. On the inversion end the cured liner was cut and separated from the pressure drum and on both ends the liner was cut flush to the end of the host pipe. Each segment was then ready for the post-lining CCTV inspection.

CHALLENGE: DELAMINATION AT ENTRY

On smaller diameter lining projects, the inversion cone is placed in the entry pit, next to the host pipe. With a large diameter liner like this, the inversion cone is placed on the pressure drum above ground, about 20 to 30 feet away from the host pipe. Doing this keeps the entry pits to a reasonably sized excavation, saving money and reducing the carbon footprint.

However, when the inversion cone is above ground, it is difficult to optimize the liner entry angle into the host pipe, the pit entry angle, and the position of the liner at the inversion cone and still have the liner be perfectly centered into the host pipe. For each segment, the T-bar and cribbing helped guide the liner into the host pipe, but the liner entry angles caused a minimal liner liftoff or local delamination at the immediate entry point.

After the liner was cured and the ends cut flush, we found that there was a very slight crescent-shaped piece at the entry end that was dis-bonded for a couple of inches at the end point where the liner entered the host pipe. We successfully repaired this minor issue on each of the four segments using epoxy and a mechanical retention band. The band held the liner in place while the local epoxy repair cured.

CHALLENGE: LINER CHAFE

These same liner entry angles also increased chafing from the retention belt which caused minor leaks on the exposed portion of the liner outside of the host pipe. The retention belt secures the tail thereby controlling installation speed and providing the capability to retract the liner. When we completed the inversion on Segment One, we used an eight-inch wide retention belt. At a few points along the liner there was too much friction between the belt and liner causing chafing and minor leaks. To prevent this liner chafe issue for Segments Two, Three and Four, we switched to a four-inch belt and doubled the lubrication.

THE BIG CHALLENGE: SEGMENT TWO

As the chart above shows, Segment Two took much more time than the other three segments taking a total of 26 days to complete. First, as noted above, delays were caused as we grappled with removing the piles of stranded grit in this segment that were left behind after cleaning. While the grit issue was being resolved, we were able to maintain schedule by moving ahead with lining Segments Three and Four. By then, we had already learned how to effectively handle the minor delamination and retention belt chafing issues notes above.

On Wednesday October 25 we were still on schedule to meet the November 1st gas-in date. That day, during the final liner installation on Segment Two, we were only 15 feet away from the catch end when one of the tail bolts failed and tore a hole in the liner due to the considerable forces at this large diameter. This meant we could no longer maintain positive pressure and complete the liner installation on Segment Two. Fortunately the retention belt was still attached to the tail with the 3 remaining bolts. We worked around the clock to retract the liner and remove it from the pipe.

It being late October, with outdoor temperatures rapidly dropping, there was substantial pressure on us to get the 36-inch feeder main back into service as soon as possible. Now, with the liner failure in Segment Two, meeting the scheduled November 1 gas-in date was impossible.

We had to make a quick decision, and ensure it was the correct one. Would it be better to simply gas-in the entire 2000LF section and allow the leaks to continue in Segment Two? Or would it be more optimal to relay Segment Two, and look at attempting to line the segment again in Spring/2018? Neither of these options were desirable or cost effective.

Instead, we were elated when Karl Weiss Technologies GmbH agreed to manufacture an emergency replacement liner. They had it delivered to us and through Customs in record time. The new liner order was placed on Friday, October 27 and was received by us on Monday, November 13 – an incredible turnaround time of two-and-a-half weeks!

Working round the clock, the replacement liner was successfully installed into Segment Two on Tuesday, November 14 – a mere 24 hours after it had been delivered! This time round, we modified the tail bolt design to six bolts to be extra cautious, and there were no further problems. After four days of ambient curing, the final CCTV inspection was on Sunday, November 19. The results were excellent. A 25 psig pressure test confirmed the integrity of the line. We gassed-in on Monday, November 20, in time for the cold Northeastern winter fast approaching. Thirty-six inch diameter – a new World Record for the largest gas main ever relined.

With a permanent solution in place, and a new World Record under our belts, we won't have issues out there with the feeder main under South Orange Avenue for years to come. Most importantly, we gassed-in in time for the winter months, so our valued customers were not adversely affected. Successfully, achieving our world record for the largest diameter CIPL ever completed on a gas main required teamwork, true grit and a lot of preparation to persevere through the inevitable challenges.

ABOUT THE AUTHOR:

George Ragula *is the Distribution Technology Manager at Public Service Electric & Gas (PSE&G) with over 40 years of experience in gas industry engineering, operations, construction, research/development/deployment and management.*

George is a noted authority on trenchless applications for the gas industry having spent 31 years specifically focused on trenchless. He received his B.S. in Mechanical Engineering from Polytechnic Institute of Brooklyn in New York. George is a past Chair of NASTT and serves on the NASTT No-Dig Show Program Committee. He also teaches several NASTT courses on various trenchless technology topics, including CIPL for the Gas Industry.

BAMI-I UPDATE

By: The Trenchless Technology Center (TTC)

On May 16 – 19, 2017, TTC in partnership with BAMI-I, conducted a 4 day "Asset Management Training for Water Infrastructure", Certification of Training in Asset Management (CTAM) session in Columbus, OH. The program was conducted in response to a request received by the TTC from Ms. Deb Martin, WSOS Community Action Development Director.

Headquartered in Fremont, Ohio WSOS Community Action serves as the regional management entity in Ohio and Michigan for the Great Lakes Rural Community Assistance Program (RCAP), which assists small rural communities in developing and maintaining infrastructure for drinking water, wastewater treatment, and other community services, thereby improving rural quality of life. Formed in 1980, the Great Lakes RCAP encompasses Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, and Wisconsin. BAMI-I President Dr. Tom Iseley gave a lecture on the CTAM program during the RCAP National Conference held April 23 – 26, 2018 in New Orleans.

CTAM is offered as 4 online courses and per request in classroom format. More than 1000 individuals from 15 countries have enrolled in the CTAM program. There are three levels of certification available – Certificates of Completion, the Associate Water Asset Manager (AWAM) and Professional Water Asset Manager (PWAM) designations. To date 108 AWAM and 12 PWAM certifications have been awarded.

The Buried Asset Management Institute - International (BAMI-I) is a non-profit corporation whose main purpose is to educate and assist those who have an interest in applying best buried asset management practices to extend the life and efficiency of their assets. Although BAMI-I has been mainly focused on water and wastewater systems, the principles of asset management apply to all different types of buried assets including for instance gas distribution pipes, electric cables.

BAMI-I launched the first CTAM course (CTAM 100) in 2010. The CTAM 100 course provides a comprehensive introduction to Asset Management principles and concepts with special emphasis on their application to "buried assets" associated with water and sewer systems. The initial success of the CTAM 100 course created awareness of the need to broaden its scope and provide more detailed training in an expanded sphere of utility system concerns. This led to the release in 2013 of the CTAM 200 course level, which focused on the specifics of how to develop an Asset Management Plan. In July and August 2015, BAMI-I released the CTAM 300 and CTAM 400 course levels respectively. CTAM 300 & 400 focus on the ongoing management of the Asset Management Plan, as well as the financial aspects of funding Asset Management Plans.

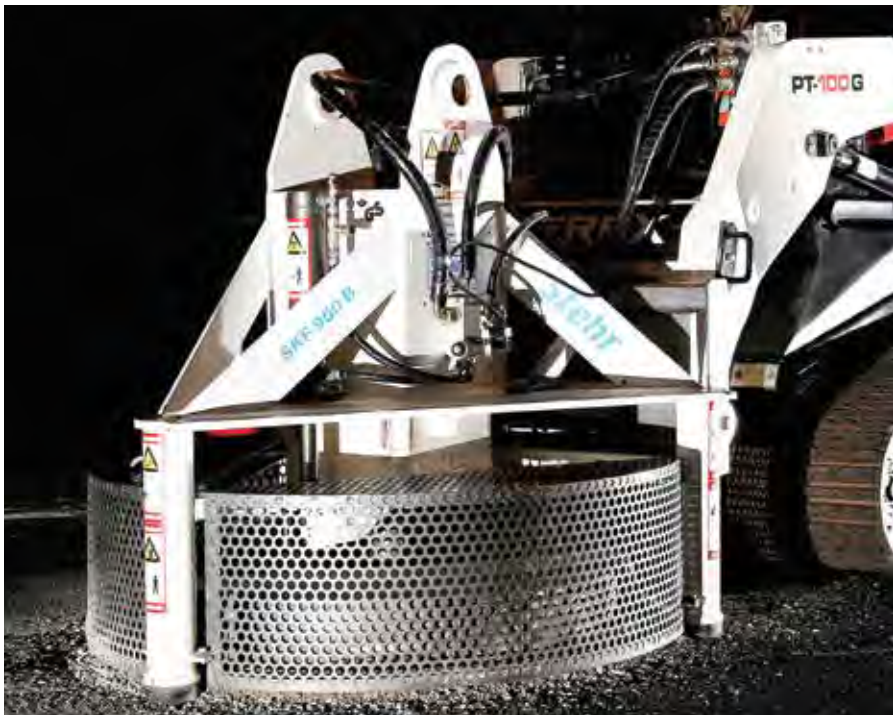
For more information, and application requirements, please visit http://bami-i.com or contact Dr. Tom Iseley: dtiseley@latech.edu.

The Trenchless Technology Center (TTC): *is an industry/university/government research center at Louisiana Tech University. It has world-class research and testing facilities at the National Trenchless Technology Research Facility (NTTRF) in South Campus at Louisiana Tech. The TTC was established by Dr. Tom Iseley in 1989. It was created to promote research, development and technology transfer in the trenchless technology industry. For over 28 years TTC has served as a global leader for the development of technologies influencing almost every aspect of trenchless construction methods.*

"... THE PRINCIPLES OF ASSET MANAGEMENT APPLY TO ALL DIFFERENT TYPES OF BURIED ASSETS INCLUDING WATER AND WASTEWATER SYSTEMS, GAS DISTRIBUTION PIPES, ELECTRIC CABLES."

CUTTING CORNERS AND MAKING THE GRADE

By: Jerry Trevino, Protective Liner Systems, Inc.



The Stehr manhole cutter, develops 8000 to 9000 ft-lbs of torque

Manholes are located in roads, outfalls by creeks and rivers, in private yards, swamps and just about anywhere the sewer collection systems runs through to end up at its final journey, the waste water treating facility. The location of manholes does not affect people as negatively as much as the deteriorating or failed manhole pads on roads. Everyone has experienced driving their cars over steel plates and on very bumpy manhole covers and pads. In many cases drivers avoid driving over uneven manhole adjustment pads to avoid damaging their vehicles' suspension or to avoid the risk of a vehicular mishap.

For many years, we encountered damaged manhole chimneys located in roads. The leveling materials inclusive of bricks and mortar eventually fatigues and fails. Some manholes were previously internally rehabilitated only to find that over time, the chimney portion of the manholes located in roads had been impacted by vehicular traffic, from wear and tear of the road surface. This was primarily due to the poor quality of construction and materials that were used during the adjustment to grade after road repaving. In all cases, the manhole castings and lids had been adjusted vertically to grade in order to approximate the level of the adjoining street surface. In almost all cases, the manhole castings were encased in a square or rectangular concrete pad. In most cases, the concrete pad was damaged, cracked, and uneven.

While manhole adjustment pads look good for a few months, many fail prematurely and they disrupt traffic both while being adjusted, and after they break and fail.

CUTTING THE CORNERS

Approximately 15 years ago we worked with a company from Colorado to introduce to the manhole industry a new method for adjusting manholes located in roads. By using a circular core cutter and coring the streets to a minimum of 11 inches deep, we drastically changed the quality, aesthetics and longevity of the manhole pads by via this process.

A circular cut core removes the potential concentrated stresses that are developed in the corners of square cut pads thus "cutting corners". It also has other advantages.

Paved roads are resurfaced every 7 to 15 years. The frequency of repaving varies and is dependent on many factors and conditions inclusive of funding, weather and traffic conditions. In the process, the top layer asphalt is removed via an asphalt milling machine. The milling machines mill or grind off the asphalt to a certain depth and convey the tailings onto a conveyor and then into dump trucks. The top of the manhole frame castings and covers, along with other utilities, may be in the path of the milling machines. Should the milling machine's grinding drums encounter a manhole frame casting and cover, it tears up a lot of carbide teeth, teeth holders, and it may also damage the drum. In the past, the milling machines would mill around the manhole castings and pad, then later grind the area around the manholes with smaller grinders. When the asphalt is applied, many manhole covers were asphalted over which making impossible to access the sewer at those points of entry. In addition, the manholes would be difficult to locate.

About 12 years ago we introduced the idea of lowering the manholes pads before milling. Using a skid steer attachment, we cored the manhole pads, remove the castings, shims and other leveling materials

Often the concrete pad is damaged, cracked, and uneven

A circular cut core removes potential concentrated stresses and has many other advantages

Many concrete pads can fail prematurely and disrupt traffic

including wood, rocks, and at times squashed beer cans. We placed a steel plate over the opening, then placed low strength concrete on top of the plate to grade. After the milling and asphalt paving was complete, we would locate the buried manhole, re-core the street again, install a new manhole ring and cover to grade.

MAKING THE GRADE

Placing the manhole castings to grade with minimal impact on the road surface requires a lot of attention to detail. It involves placing a concrete pad with high strength fast setting concrete and designing the manhole pad so that the weight and impact of traffic is not solely received by the manhole chimney and walls but more supported by the ground surrounding the manhole. The new pad will also serve as a new chimney seal and prevent infiltration and inflow into the manhole. These are some of the extra benefits achieved by this manhole adjustment method.

This process provides a higher quality level of manhole rehabilitation, which facilitates better trenchless repair and rehabilitation approaches.

AVAILABLE EQUIPMENT

After introducing this manhole core cutter, other companies have offered similar and different equipment to core or cut the manhole pads. These type of cutter can cut through asphalt readily, however take a much longer time to cut through concrete. There are some sensitivities to consider in selecting a manhole cutter such as:

- **Safety.** The cutter should have a built in safety guard so that workers do not come in contact with the rotating cutting blade or core saw.

- **Core cutter attachment.** The cutting of the asphalt or concrete requires a skid steer tractor. In the case of the Stehr cutter, it develops 8000 to 9000 ft-lbs of torque. Therefore, a 10,000 pound dual hydraulic flow skid steer works more effectively.

- **Stability.** The cutter must stable enough to cut through asphalt independently without requiring the cutter blade to support and center itself to the existing manhole chimney or frame casting. Centering the cutter to the manhole damages the manhole.

- **Wear Parts.** Determine the cost of the sacrificial wear parts. In some cutters only the cutting carbide teeth wear out. In some machines the entire cutting blades wear out.

- **Long term investment.**

ABOUT THE AUTHOR:

Jerry Trevino *is President of Protective Liner Systems, Inc., specializing in infrastructure rehabilitation since 1984. As longtime SESTT Chairman, Jerry strongly believes that Trenchless Technologies offer numerous methods to maintain and upgrade aging infrastructure.*

2019 NASTT's NO-DIG SHOW

March 17-21, 2019 | Chicago, Illinois

CALL for Abstracts

Submissions Deadline: June 30, 2018

The North American Society for Trenchless Technology (NASTT) is now accepting abstracts for its 2019 No-Dig Show in Chicago, Illinois at the Donald E. Stephens Convention Center on March 17-21, 2019. Prospective authors are invited to submit a 250-word abstract outlining the scope of their paper and the principal points of benefit to the trenchless industry. **The abstracts must be submitted electronically at NASTT's website by June 30, 2018: nastt.org/no-dig-show.**

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

Potable Water and Pressure Systems
- Pipeline Inspection, Locating, and Condition Assessment
- Pipe Rehabilitation
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- Emerging Technologies
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Wastewater, Storm water, and Non-pressure Systems
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- Manhole Rehabilitation
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Energy Pipeline Systems
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Questions? Please contact:

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