Western Regional Trenchless Review

2023

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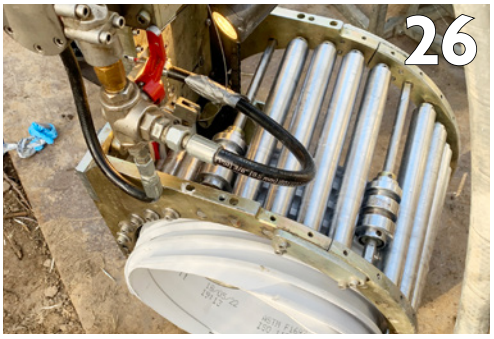

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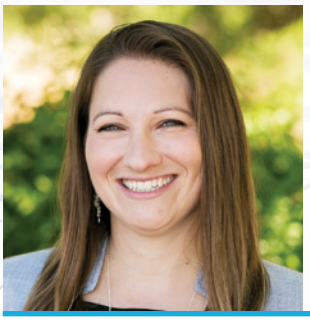

MESSAGE FROM THE WESTT CHAIR

Kate Wallin, Chair, WESTT

This past year, the WESTT Chapter Board of Directors (BOD) has been working hard to increase the focus on spreading education on trenchless technologies. We are very excited about our conference, exhibition, and course this November in gorgeous Oahu, Hawai`i. On Tuesday November 7, at the Japanese Cultural Center in Honolulu, WESTT will be presenting NASTT's two 4-hour courses: Introduction to New Installations and Introduction to Rehabilitation. We are proud of the technical expertise of the WESTT Board as four of the five course instructors are WESTT Board members! WESTT is fortunate to once again be partnering with the Hawaii Water Environment Association (HWEA) who will be hosting the 1.5 day technical conference and exhibition on November 8 and 9 at the stunning Ko`olau Ballroom. This conference is a great opportunity for networking and education and the venue can't be beat!

One key initiative that the board has prioritized is increasing coordination with the student chapters in our region at Arizona State University and at Cal Poly Pomona. We have designated student ambassadors who help the board understand the ongoing activities, structure, and overall goals of the student chapters. We have coordinated with Cal Poly Pomona to provide field site visits to active trenchless construction sites to provide real-world experience of a career in the trenchless field. We are also looking to provide brown-bag presentations to the students to highlight the variety of projects and careers that fall under the umbrella of trenchless construction.

The board is also reaching out to additional universities within our region to see where WESTT could provide valuable knowledge that is often not provided in a collegiate setting and to get more young engineers excited about trenchless! So far we have coordinated with both San Jose State and the University of California at Berkeley. We are always looking to widen our reach, so if you have contacts with Civil Engineering, Geotechnical Engineering, and/or Construction Management programs at universities in the Western region, we would love to have an introduction!

WESTT is currently accepting nominations for new board members through November 17, so keep an eye out for an email with details, or visit our website for election information. If you wish to get more involved in the organization, I encourage you to run. Even if you miss the nomination period there are other ways to get involved. The current board is filled with passionate individuals who work to advance the practice of Trenchless Technology through education, training, and research. I am truly honored to get to work with this very talented group of individuals. Interested parties should contact our Election Chair, Cindy Preuss, at **PreussCL@CDMSmith.com**.

I would like to thank the WESTT Board of Directors, committee chairs, and other member volunteers for their continued involvement. We have accomplished so much over the past few years, and I look forward to continuing to pursue our ambitious plans for the future of the chapter. It has been an honor to work with so many invested individuals who share the goal of advancing the practice of trenchless technology through education, training, and research for public benefit. To stay connected and hear about upcoming events, visit our website (**www.westt.org**) or find us on LinkedIn (WESTT NASTT). If you want to get involved in WESTT activities, I encourage you to please reach out to me or any of our Board members.

> *"Thank you for your continued support of WESTT."*

Thank you for your continued support of WESTT.

Kate Wallin

Kate Wallin, Chair, WESTT
Bennett Trenchless Engineers, LLP

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MESSAGE FROM NASTT CHAIR

Matthew Wallin, PE, NASTT Chair

The 17th Annual Western No-Dig Conference Heads Back to Hawaii!

Hello Western Chapter Members and Associates! Earlier this year we held the NASTT 2023 No-Dig Show in Portland, Oregon, which was a great success and a wonderful opportunity to see our industry friends and colleagues while we celebrated all things trenchless. And now we are excited to switch gears and look forward to the many upcoming Regional Chapter conferences this fall, including the 17th Annual Western No-Dig Conference! The conference will be held on November 7-9 in Honolulu, HI. On the first day of the conference, two 4-hour NASTT Good Practices Courses will be offered. The Intro to New Installation course covers new construction techniques such as microtunneling, HDD, pipe jacking, auger boring and pipe ramming. The Intro to Rehabilitation session provides an overview of the methods available to public works and sewer agencies to rehabilitate water, sewer, and gas systems without the need for excavation.

Registration for the second and third days of the conference includes an informative technical program of papers. Attendees will have several opportunities to interact with the many exhibitors during sponsored meals, breaks, and an evening reception. Visit **www.westt.org/education-and-events/upcoming-events** for all the details and registration.

In the coming months we have many additional events planned to bring the underground infrastructure community together. Our ever-popular NASTT Good Practices Courses are being held both virtually and in-person throughout the year. Visit **www.nastt.org/training/events** to find a course that fits your schedule.

> *Our industry is a steward of our precious natural resources.*

We are also already planning for the 2024 No-Dig Show which meets in Providence, Rhode Island next April. Providence is a great central location within the heavily populated northeast corridor, just a short drive or train ride from Boston, and within reasonable drive from Philadelphia, New York City, Hartford, and many other cities in between. Our Show motto is *Green Above, Green Below* as it is important that our industry is a steward of our precious natural resources, so we welcome the opportunity to provide a forum for learning about the latest in innovative trenchless products and services that help us all accomplish that lofty goal. Learn more about all the No-Dig Show has to offer at **www.nodigshow.com**.

If you have attended an NASTT event (national or regional) you probably left feeling excited and eager to get more involved. I ask that you consider getting engaged in one of the many NASTT committees that focus on a wide variety of topics. Some of our committees that are always looking for fresh ideas and new members are the Training and Publications Committee, the individual topic Good Practices Course Sub-Committees, the

Educational Fund Auction Committee, the No-Dig Show and No-Dig North Planning Committees and Technical Program Committees. There are many opportunities for you to consider where your professional expertise can be put to use through networking with other motivated volunteers. With education as our goal and a strong drive to provide valuable, accessible learning tools to our community, we are proud of our continued growth as both an organization and as an industry.

Our volunteers and committee members are what keep us moving in the right direction.

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

We look forward to seeing you at a regional or national conference or training event soon! And we hope you are planning to join us in Hawaii, November 7-9.

Matthew Wallin

Matthew Wallin, PE
NASTT Chair

WESTERN REGIONAL CHAPTER

ELECTED OFFICERS:

KATHRYN WALLIN – CHAIR
Bennett Trenchless Engineers

kate.wallin@bennetttrenchless.com

Kate has been involved with trenchless design since 2005 and has provided design and construction management services on trenchless new installation projects using horizontal directional drilling, microtunneling, pipe ramming, guided boring, and earth pressure balance pipe jacking. She is a contributing author on the 2023 revision of the Horizontal Directional Drilling Good Practices Guidelines. Kate serves as the Chair of WESTT Chapter Board of Directors, and volunteers on the NASTT Student Scholarship Award/Education Committee, the No-Dig Show Program Committee, and as a No-Dig session leader. Kate was honored to receive the NASTT Volunteer of the Year award in 2023.

MICHELLE BEASON, PE - VICE CHAIR
National Plant Services Inc.

mbeason@nationalplant.com

Michelle received a BS in Civil Engineering from Purdue University, and is a registered California PE with over 30 years of water and wastewater experience. She has worked as a Project Engineer for Black &Veatch, as an Asset Management Engineer with the East Bay Municipal Utility District, she owned her own Engineering & Construction firm for 5 years, and for the last 12 years has specialized in CCTV and multi-sensor inspections and trenchless rehabilitation of sewer, storm, and water assets. She is currently the Regional Manager for National Plant Services, Inc., covering the 12 Western States, including Hawaii and Alaska. Michelle is also active in many industry organizations. In addition to serving as a Board Member of WESTT, she is a Board Member of NASSCO, and is Chair of the NASSCO Infrastructure Assessment Committee which manages all revisions to NASSCO's PACP/MACP/LACP coding. She has led the effort over the last two years to update PACP/MACP/LACP, and Version 8 is set to be released this fall.

MIKE JAEGER – SECRETARY
Tanner Pacific, Inc.

mjaeger@tannerpacific.com

Mike is a Principal Co-Founder of Tanner Pacific, Inc., specializing in Construction Management of Water Resource Projects. Mike is the Chief Marketing Officer responsible for all Marketing and Business Development for the Company. He is a Professional Engineer with over 35 years of experience in public infrastructure project/construction management, as well as, over 10 years of Partnering Facilitation. Having spent his early professional years working for the Cities of Fremont and Palo Alto and at the Union Sanitary District, Mike worked on many different types of projects including, roadway improvements, building renovations, landfill closures and large wastewater treatment plant expansions, just to name a few.

Mike has managed many pipeline projects, totaling more than 30 miles of installed pipe. Ranging in size from 30 to 132 inches in diameter, these projects included many miles of open cut, microtunnel, HDD and pipe bursting to traverse under highways, active school sites, active rail lines and sensitive environmental habitats. One of the largest and longest projects included the LAVWMA pipeline stretching 16 miles from Pleasanton to the bay in San Leandro. This project had microtunnel crossings of freeways (4), sensitive creek habitat (2), a railroad crossing and a long stretch of continuous microtunnel (10,000 LF) at the end. Another was the West Sacramento Force Main as part of the Lower Northwest Interceptor Program. This project installed twin 60-inch diameter force mains with microtunnel of 2 railroad crossings, 1 freeway and high school property crossing and a 3 bore microtunnel under a major thoroughfare. It also included a 1,300 LF HDD crossing of a barge canal.

Mike has overseen several other pipeline projects that include microtunnel, HDD, pipe bursting and CIPP lining work, as well. Currently Mike is the Project Manager on a $206 Million Progressive Design Build Tunnel Project in Redwood City for Silicon Valley Clean Water. Mike grew up in the bay area in San Jose and Campbell, later attending and becoming a graduate of San Jose State University with a BS in Civil Engineering.

BOARD OF DIRECTORS & OFFICERS 2023-2024

ELECTED OFFICERS:

RACHEL MARTIN - TREASURER
McMillen Jacobs Associates

martin@mcmjac.com

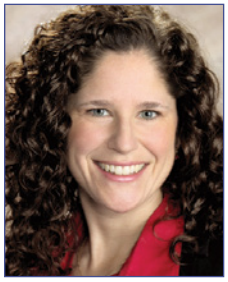
Rachel Martin has 20 years of experience in design and construction management on civil projects focused in the fields of water, wastewater, and hydropower. Her experience includes trenchless and tunnel design, development of contract drawings and specifications, construction management, design and constructability reviews, project controls, quality management, and cost estimating. Rachel has developed designs for microtunneling, pipe jacking, HDD, and sliplining projects throughout the US, Canada, and New Zealand.

BRIAN AVON – PAST CHAIR
Carollo Engineers

bavon@carollo.com

Brian Avon is a Vice President and Trenchless Practice Lead with Carollo Engineers, in Walnut Creek CA. He has more than 17 years of experience in design, preparing contract documents and cost estimates, and facilitating the acquisition of permits for pipeline projects. His work has included systems evaluation, development of rehabilitation/replacement improvements, construction, geotechnical engineering, and specialty inspection. Over the past 15 years most of Brian's projects have been trenchless focused.

DIRECTORS AT-LARGE:



JENNIFER GLYNN
Woodard & Curran Inc.

jglynn@woodardcurran.com

Jennifer Glynn is a Senior Technical Practice Lead and Senior Principal for Woodard & Curran out of their Sacramento, California office. Jen has over 27 years of experience in Project Management and Infrastructure Design, with an expertise in Condition Assessment and Trenchless Rehabilitation.
Jen has been authoring papers and presenting at conferences both domestically and internationally for the past 25 years. She was a founding member of WESTT and past Executive Board Member for NASTT and is currently an NASTT training course instructor for two classes: Introduction to Trenchless Rehabilitation and Pipe Bursting Good Practices. She is also a member of the AWWA Water Main Rehabilitation and Water Main CIPP Standards Committees.

JACQUIE JAQUES
Sekisui SPR Americas

jacquie.jaques@sekisui-spr.com

Jacquie Jaques is the Regional Manager for Sekisui SPR Americas for the Western US. Jacquie has over 25 years of industry experience working with manufacturers and contractors specializing in pipeline condition assessment and trenchless rehabilitation solutions.
She started her career working for a technical services company specializing pipeline cleaning and CCTV condition assessment. During that time, she worked with municipalities, FEMA and OES on post-earthquake pipeline condition assessment inspection that enabled agencies to obtain federal funding for projects. With a high demand for cost effective solutions to repair our infrastructure, she became involved with cutting edge trenchless technologies that could meet stringent industry design and performance standards.
Jacquie has been actively involved in numerous industry committees over her career. Early on, she was a member and recording secretary for the "Green Book Pipeline Rehabilitation Task Force" which evaluated new trenchless technologies that were germane to public works construction. This task group wrote the first Part 5

BOARD OF DIRECTORS & OFFICERS 2023-2024

DIRECTORS AT-LARGE:

JACQUIE JAQUES – CONT'D

of the "Green Book" "Pipeline System Rehabilitation". Jacquie is still active on the committee today and works with the subcommittee to ensure that the specifications are current and still relevant to public works construction. As a WESTT Board Member, she is the Education Liaison for the university members and conducts the outreach on behalf of the committee. Jacquie has also authored several industry papers and presented at national and regional conferences including NASTT, WESTT, Pipe Users Group and HWEA. She has also authored or contributed to several magazine articles including NASSCO and Trenchless Technology.

SASHA MESTETSKY
Central Contra Costa Sanitary District

smestets@centralsan.org

Sasha Mestetsky is a Senior Engineer in the Capital Projects Division at Central Contra Costa Sanitary District (Central San) located in Martinez, California. He manages Central San's Collection System Program with an annual fiscal budget of approximately $40 million. Sasha is responsible for the design and construction management of all sewer system replacement and renovation capital improvement projects. Most of these projects utilize various trenchless technologies.

Sasha has over 25 years of experience in design and construction of collection systems projects. He holds a Bachelor of Science degree in Civil Engineering from California State University, Sacramento and is a California-licensed Civil and Mechanical Engineer.

Sasha serves as the At-Large Representative of WESTT Chapter Board of Directors. He is a long time member of Water Environment Federation (WEF), North American Society for Trenchless Technology (NASTT), and Northern California Pipe Users Group (PUG). Sasha is passionate about everything trenchless, enjoys sharing his experiences, and actively promotes trenchless technology education.

DEVIN NAKAYAMA
Yogi Kwong Engineers, LLC

devin@yogikwong.com

Devin has over 20 years of geotechnical engineering experience, and has served as a geotechnical and trenchless engineer on projects requiring microtunneling, horizontal directional drilling, and guided bore methods, as well as shallow and deep foundations, rockfall mitigation, deep shaft excavations, soil stabilization, and shoreline protection. He is a professional civil engineer licensed in Hawaii and California, and obtained his Bachelor and Master's Degree in Civil Engineering from the University of Hawaii at Manoa. For the past 18 years, he has been at Yogi Kwong Engineers, a geotechnical engineering and construction management firm in Honolulu, Hawaii, where he worked his way from Project Engineer to Principal of the company. He has published and presented two papers on trenchless pipe installation at the North American Society of Trenchless Technology No-Dig conferences.

COMMITTEE CHAIRS:

Budget Committee:
Rachel Martin

Conference Committee:
Michelle Beason

Nominations and Elections Committee:
Cindy Preuss

Social Media Committee:
Greg Watanabe

Student Chapter Liaison:
Jacquie Jaques

WESTT Magazine Committee:
Devin Nakayama

BOARD OF DIRECTORS & OFFICERS 2023-2024

DIRECTORS AT-LARGE:

CINDY PREUSS – CDM Smith HydroScience Engineers

preusscl@cdmsmith.com

Cindy is a registered professional engineer and Qualified SWPPP Developer (QSD) and Practitioner (QSP). She brings 25 years of experience in planning, designing and managing large-scale public water and wastewater projects throughout the West. She has experience in all phases of the project life cycle, including bidding and construction. Early in her career, she worked on transportation, stormwater, and pipeline projects. Over time, she has honed her expertise in pipeline construction and trenchless technology applications of all sizes and functions.

Cindy is nationally recognized through her past active participation and leadership roles on various industry boards, including the North American Society for Trenchless Technology (NASTT), the Western Regional Society for Trenchless Technology (WESTT), and, more locally, the Northern California Pipe Users Group (Nor Cal PUG). Cindy currently serves on WESTT Board of Directors, the AWWA Water Main Rehabilitation Committee, and several national No-Dig conference committees. Cindy is also an instructor for NASTT's Trenchless 101 Good Practices Courses.

Outside of work, Cindy enjoys spending time with her family, relishes the outdoors, embraces adventure and travel, and has been labeled as a fish by most everyone that knows her.

GREG WATANABE GHD

greg.watanabe@ghd.com

Mr. Watanabe is a Civil Engineer registered in California, Hawaii, Idaho, Oregon, and Guam and has more than 20 years of engineering and construction experience largely focused on trenchless technologies for both rehabilitation and new installations of underground utilities. During this time, he has planned, assessed, and designed over 100-miles of pipelines up to 96-inches for public utility systems. His project experience includes the design and construction via horizontal auger boring, burst and insert, sliplining, HDD, point repairs, Thermal CIPP, Thermal PCIPP, and microtunneling.

He is currently the Collaborative Delivery Leader for GHD's US West Water Market Sector covering California, Arizona, Oregon, Washington, Hawaii, Guam, and Saipan. In this role he oversees the pursuit and delivery of all water/wastewater design-build projects in the region. He is also GHD's managing Principal for GHD's NASTT No-Dig participation across North America.

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JOINT CONFERENCE:
WESTT 17th Annual Western Regional No-Dig Conference & HWEA 11th Biennial Collection System Conference

Honolulu and Kaneohe, Hawaii

Tuesday, November 7 – Thursday, November 9

All of the benefits of a national conference program in a smaller forum with a personalized touch! Come to Hawaii and learn about the latest in trenchless technology from experts in the field. Registration for the conference includes an informative one-day technical program and product exhibition area.

Conference Information

Earn valuable Continuing Education Units (CEU's)!

WESTT

WESTT (www.westt.org) is the Western regional chapter of the North American Society for Trenchless Technology (NASTT) (www.nastt.org), promoting education and development of Trenchless Technology for public benefit. WESTT is a non-profit organization established in 2004 and includes Arizona, California, Hawaii, Nevada, and New Mexico.

HWEA

HWEA (www.hwea.org) is the Hawai'i Water Environment Association, an organization of knowledgeable professionals dedicated to preserving and enhancing the water environment in the Pacific Island Region. HWEA is a member organization of the Water Environment Federation (WEF), and is incorporated as a tax exempt professional organization.

NASTT Good Practices Courses – November 7

These introductory courses are ideally suited for both newcomers to the industry and anyone who is interested in seeking a refresher course on trenchless technology methods. The New Installation course covers new construction techniques such as microtunneling, HDD, pipe jacking, auger boring and pipe ramming. The Rehabilitation session provides an overview of the methods available to public works and sewer agencies to rehabilitate water, sewer, and gas systems without the need for excavation.

HWEA/WESTT Conference Format – November 8 - 9

The first day of the conference will feature an informative, two-track technical program, with one track focused on trenchless construction. Technical sessions in the second half day of the conference will focus on maintenance and operations issues presented by local owners and operators. Attendees will have several opportunities to interact with exhibitors during sponsored meals, breaks, and a happy hour reception.

Attendees

The joint HWEA/WESTT conference and NASTT Good Practices Course are both useful to public officials, engineers, utility company personnel, designers, and contractors who are involved with constructing, rehabilitating, and managing underground utilities.

Attendee Registration

Register at: https://www.hwea.org/hweaevents/conference/2023-hwea-westt-collection-systems-conference
NASTT and HWEA members receive a discount for both the conference and course fees. Government Employees are eligible for discounted registration rates for both the conference and course.

NASTT Good Practices Courses

Tuesday, November 7
Japanese Cultural Center, Honolulu HI

NASTT's GOOD PRACTICES
INTRO TO NEW INSTALLATIONS
EST. 2002

The four-hour NASTT Introduction to New Installation Methods Good Practices Course is ideally suited for both newcomers to the industry and for anyone who is interested in seeking a refresher course on the trenchless technology methods that are used to install new utility pipelines. This course provides an overview of various trenchless construction methods and discusses the broad applications and limitations of each method. For each method, the presentation includes a discussion of achievable drive lengths, suitable pipe diameters, anticipated accuracy, required work areas, and appropriate ground conditions. The new construction techniques discussed include HDD, piercing, pipe ramming, auger boring, guided methods, pipe jacking, and microtunneling. For additional training, NASTT also provides a detailed eight-hour course on New Installation Methods Good Practices as well as an in-depth eight-hour HDD Good Practices course.

NASTT's GOOD PRACTICES
INTRO TO REHAB
EST. 2002

The four-hour NASTT Introduction to Trenchless Rehabilitation Good Practices Course is geared to consultants, municipalities, and contractors and gives a high-level overview of numerous trenchless methods commonly used in North America to rehabilitate existing pipe and conduit. This half day course covers Rehabilitation Project Planning (including pipe and manhole inspection technologies), Watermain Rehabilitation, and Sewer Rehabilitation and offers a brief introduction of technologies such as sliplining, panel lining, spiral wound lining, spray on lining, pipe bursting, cure-in-place lining, lateral lining, and manhole rehabilitation. This course is ideally suited for both newcomers to the industry and anyone who is interested in a refresher course and offers an excellent basis for basic understanding of different trenchless rehabilitation methods currently out in the marketplace. It can be augmented with other more in-depth eight-hour good practices courses offered by NASTT.

HWEA/WESTT JOINT CONFERENCE

Wednesday, November 8

Ko'olau Grand Ballrooms, Kaneohe HI

START TIME	TRACK 1 Location: Grand Ballroom	TRACK 2 Location: Mauka Room
8:00 a.m.	**REGISTRATION / WAKE-UP COFFEE & PASTRIES**	
8:30 a.m.	**OPENING SESSION AND KEYNOTE SPEAKERS (Grand Ballroom)** Ramzi Mansour, County of Hawaii Roger Babcock, City and County of Honolulu TBD, County of Maui	
10:00 a.m.	**NETWORKING BREAK**	
10:30 a.m.	**Dowsett Highlands Relief Sewer Project - Part 2** Jon Muraoka & Wei Chen - Fukunaga and Associates, Devin Nakayama - Yogi Kwong Engineers	**Building a Better Robot! Utilizing Creative Methods to Obtain High-Definition Video of Large Diameter RCP Pipelines** Jennifer Glynn - Woodard & Curran, Michelle Beason - National Plant Services, Inc.
11:00 a.m.	**Emergency 24" Sewer Line Repair Work - Lessons and Logistics** Kristopher Maile, Aqua Engineers	**Performance-Based Specifications for Sewer Inspection Leveraging AI & Cloud Technologies: Analysis of Productivity Increases and Accuracy Enhancements** Sara Dyer - SewerAI
11:30 a.m.	**LUNCHEON (Glass Ballroom)** **Introduction to NASTT** **Update on Hawaii Cesspool Conversions** Sina Pruder - State of Hawaii, Department of Health, Environmental Health Administration, Wastewater Division	
1:00 p.m.	**A Potential Solution to Hawaii's Cesspool Compliance - Small Diameter Pressure Sewer and Trenchless Technology** Bill Cagle - Orenco Systems Inc., Stuart Coleman - WAI	**Design Approach for Critical Transmission Pipeline in Highly Deformable Soils** Gus Cicala - East Bay Municipal Utility District, Justin Lianides - Mott MacDonald
1:30 p.m.	**Utilizing Public Engagement to Set the Stage for the Kalanianaole Highway Sewer Improvements Project** Jennifer Lim & Ian Endrina - The Limtiaco Consulting Group	**Assessing and Cleaning Siphons and Force Mains for the Largest WW Treatment Provider in the Rocky Mountain West** Gary Skipper & Mark Poppe - Brown and Caldwell
2:00 p.m.	**NETWORKING BREAK**	
2:30 p.m.	**The True Cost Benefit of Trenchless Specialty Inspectors (Cheap Insurance)** Brian Avon & Jon Marshall - Carollo Engineers	**It is Hard to be a Smart "Smart" City** Dave Belomy - ADS Environmental Services
3:00 p.m.	**The In(Take)s and Out(Fall)s of Trenchless Technologies** Jeff Maier - Garver	**Effective Results-based Wetwell Condition Assessment** Sean Hoss & Teigan Gulliver - HDR
3:30 p.m.	**Rehabilitation of Carolina Trunk Sewer in Portland, OR Using Sekisui PVC Spiral Wound Liner** Jacquie Jaques - Sekisui SPR Americas, Emily Neuhaus - City of Portland, Bureau of Environmental Services, Stan Kowalczyk - Brown and Caldwell	**15th and Wawona Stormwater Improvement Project in San Francisco, CA** Glenn M. Boyce - Delve Underground
4:00 p.m.	**PAU HANA - HAPPY HOUR**	

HWEA
Collection Systems Operations and Maintenance Session

HWEA
HAWAI'I WATER ENVIRONMENT ASSOCIATION
wef Member Association

Thursday, November 9
Ko'olau Grand Ballrooms, Kaneohe HI

START TIME	TRACK 1 Location: Grand Ballroom
8:00 a.m.	**Collection System Operation and Maintenance - Agency Organization Overviews** Collection System Operation and Maintenance Staff from City and County of Honolulu, County of Hawaii, and Aqua Engineers
8:45 a.m.	**History of CCH CSM** Who we are! What we do! Albert Kim - CCH CSM
9:15 a.m.	**CCH CSM Field Services** Maintenance, Cleaning, Spill Response, Pump Station Operation Shane Starr,Albert Kim, Alan Young - City and County of Honolulu, Collection System Maintenance
9:45 a.m.	**CCH CSM Analysis Branch** CCTV, Smoke Testing, Flow Monitoring, Lucity Tools Reid Ikemori, John Sadorra, Daniel Mahi - City and County of Honolulu, Collection System Maintenance
10:15 a.m.	**CCH CSM IDIQ Program** Program Overview, Work Order Development, Work Order Process Lance Manabe, Nikhil Khurana, Alec Toshi - City and County of Honolulu, Collection System Maintenance
10:45 a.m.	**Lessons Learned Forum Presentation and Q&A Panel** O&M Staff from City and County of Honolulu, County of Hawaii, and Aqua Engineers
11:30 a.m.	**Recruitment Forum** Positions and Vacancies at Each Agency O&M Staff from City and County of Honolulu, County of Hawaii, and Aqua Engineers
12:00 p.m.	**Lunch - Bentos** **Field Work Demonstrations in the Parking Lot** CCTV, Mechanical Cleaning, Vactor Truck O&M Staff from City and County of Honolulu, County of Hawaii, and Aqua Engineers

Hawai`i Water Environment Association (HWEA)

By: Aiko Fajardo, Aura Hawaii, LLC, HWEA Executive Director

Hawai'i, with its breathtaking landscapes, pristine beaches, and deep-rooted culture, is a paradise on Earth. Yet, one of the most fundamental challenges faced by the communities is the sustainable management of water resources and wastewater treatment.

Clean water is the lifeblood of any community, and in Hawaii, where residents rely on a delicate balance between freshwater and seawater, it's even more crucial. Access to clean water is a basic human right that needs to be safeguarded to ensure this right is upheld throughout the islands. The Hawaii Water Environment Association (HWEA) understands the importance of preserving this natural wonder for future generations. They actively participate in conservation efforts, such as shoreline restoration and water source protection, to safeguard Hawaii's unique environment.

The HWEA, formerly known as the Hawaii Water Pollution Control Association, is a non-profit organization, which was founded on August 9, 1962, in Honolulu, Hawaii. Currently, HWEA has a total membership of about 450 members that include civil and environmental engineers, planners, treatment plant and collection system operators and operations support staff, chemists, microbiologists, ecologists, regulators, public health officials, scientists, researchers, and educators.

HWEA is part of the national and international organization Water Environment Federation (WEF) with over 41,000 members in the water environment protection field. WEF's purpose and mission is to inspire the water community in pursuit of human and environmental well-being and their focus is on amplifying stories of water to grow, strengthen, and diversify the water community.

Photo 1: HWEA 2023-2024 Board of Directors from left to right, Jessica Agsalda (Secretary), Brandon Uejo (Vice President), Alicia Suzuki (Past President), Amanda Waki (Treasurer), Cari Ishida (President), and Audrey Haerle (WEF Delegate). Missing: Virgil Viernes (PWO Representative).

HWEA has an executive board comprised of seven officers: President; Vice-President; Treasurer; Secretary; Past President; Professional Wastewater Operator (PWO) Representative, and WEF Delegate. HWEA also retains a Delegate At-Large in the WEF House of Delegates. All positions require one year of service, except the PWO Representative and the Delegate, who serve for a 3-year term. HWEA has 16 specialty committees which are typically led by two co-chairs. The board and committees comprise of hard-working, dedicated volunteers who actively donate their time and resources to this invaluable organization.

HWEA was founded with a clear mission; to promote sustainable water management practices and protect Hawai'i's unique natural environment.

Recently, HWEA reevaluated their organization's strategic plan which refocuses their vision, mission, and positioning statements. HWEA's updated mission statement is to engage and educate the water community to improve the environment.

The critical objectives that will drive HWEA for the next few years are as follows:

- Provide a broad range of professional content and programming that is relevant and widely valued by the water sector.
- Enhance connection and collaboration for the development of innovative solutions.

Photo 2: Ko'olau Ballrooms Center, Kaneohe, Hawaii

- Be a visible and effective partner that increases public awareness of the value of water, water professionals, and resource recovery.
- Elevate the profile of water professionals to promote recruitment into the water sector by sharing the value, benefits, and versatility of the career.

HWEA's key strengths lies in its water professional's community-centered approach. HWEA collaborates closely with water professionals and the local communities, understanding their unique needs, and tailoring their programs and objectives accordingly. From remote communities on the Big Island to the urban areas in Oahu, HWEA's impact is felt across the entire state. HWEA engages in educational programs, hosts professional workshops, and facilitates partnerships that promote responsible water use and wastewater treatment.

One of HWEA's primary partnerships is with the Western Chapter of the North American Society for Trenchless Technology (WESTT). This year, HWEA and WESTT have teamed up again to provide the joint conference, the 11th Biennial Collection Systems Conference which will be held on November 8th and 9th, 2023, at the Koolau Ballrooms Center in Kaneohe, Hawaii. WESTT's Introduction to Trenchless Technology Course will be offered on November 7th, 2023, at the Japanese Cultural Center in Honolulu, Hawaii.

The HWEA/WESTT Collection Systems Conference will include a wide variety of topics related to wastewater collection systems and buried infrastructure with an emphasis on current collection system technologies, assessment, rehabilitation, and operations. Water professionals will gather to discuss the latest advancements, challenges, and innovations in this critical field, and will offer a unique platform for exchanging ideas and knowledge to promote more sustainable and efficient wastewater management practices. With a focus on sustainability, innovation, and collaboration, the conference will provide a platform for the exchange of ideas and best practices that will shape the future of wastewater collection systems.

As we face increasingly complex challenges in the realm of urban water management, events like these are crucial in driving progress and fostering a sustainable future for all. If you're interested in attending the conference, please visit the following website to register (**https://www.hwea.org/hweaevents/conference/2023-hwea-westt-collection-systems-conference**). It will be an exciting conference you won't want to miss!

While HWEA has made significate strides in helping to improve the water and wastewater operations and management, it is vital that the organization continues to have an active membership for continued growth to safeguard Hawaii's future. Please consider becoming a member of HWEA and volunteering your time to help raise awareness about the importance of clean water and responsible wastewater management. Every effort counts in ensuring that everyone has access to clean water and that the earth's natural beauty is preserved for generations to come.

For more information about HWEA or to get involved, please find us at: **https://www.hwea.org**.

A Remarkable Feat of Engineering:

The Highway 1 Culvert Installation Project

Highway 1 is known for its breathtaking views along the California coastline

By: Steven Gallyer, Pacific Boring

INTRODUCTION

In the rugged terrain near Lucia, California, on the iconic Highway 1, a remarkable engineering project recently unfolded. This endeavor involved the installation of 270 linear feet of 96-inch casing down a challenging hillside with a slope of -27 percent. The purpose of this mammoth casing was to serve as a culvert, replacing the failed infrastructure that had caused the road to wash out a few miles past Paul's Slide on Highway 1. Caltrans, California's Department of Transportation, took swift action to rebuild the road, opting for an innovative approach to ensure long-term stability and safety. Leading the charge was the experienced General Contractor, Papich, which contracted Pacific Boing, Inc. to perform cutting-edge techniques to execute this ambitious project.

Installing 270 LF of 96-inch casing down a challenging -27% slope was a formidable challenge

Working on such a precipitous incline required careful planning

Recovery of equipment at the base of the slope was a major challenge

THE NEED FOR A NEW CULVERT

Highway 1, known for its breathtaking views along the California coastline, faced a significant problem near Lucia. A failed culvert had led to the erosion and collapse of the road, shutting down a portion of Highway 1. The urgency of the situation prompted Caltrans to expedite the reconstruction of the road and implement a novel approach for the culvert installation.

THE TUNNEL SHIELD METHOD

To tackle the steep -27 percent gradient of the hillside and ensure the stability of the new culvert, Pacific Boring utilized an Akkerman Excavator Shield and 800-ton thrust frame. This method, known as pipejacking, allowed for precise and controlled excavation and casing placement. The tunnel shield acted as a protective barrier, enabling the excavator arm to work efficiently while preventing cave-ins and ensuring the safety of the crew.

> *"The most significant challenge was the steep -27% slope."*

Project demonstrated resilience, capability and creativity of California's engineering and construction industry

Project showcased public/private sector collaboration in completing complex infrastructure projects

Two heavy duty wreckers were used to winch the boring unit back up the slope

Failed culvert caused erosion and road collapse, shutting down a portion of Highway 1

CHALLENGES OVERCOME

Undoubtedly, the most significant challenge of this project was the steep slope. Working on such a precipitous incline required careful planning and execution to prevent accidents and maintain the integrity of the installation. Additionally, the recovery of the tunnel shield and equipment at the base of the slope posed another formidable challenge. To address this, two wreckers were employed, demonstrating the project team's adaptability and resourcefulness in overcoming obstacles.

THE COLLABORATIVE EFFORT

Caltrans, as the project owner, played a pivotal role in orchestrating this ambitious endeavor. Their commitment to public safety and efficient infrastructure restoration was evident throughout the project's lifecycle. Meanwhile, Papich & Pacific Boring, with a history of successful projects along Highway 1, brought their expertise and innovative techniques to the table. This collaborative effort between the public sector and private industry showcased the importance of cooperation in executing complex infrastructure projects.

CONCLUSION

The Highway 1 Culvert Installation Project near Lucia, California, stands as a testament to the power of innovation, collaboration, and determination in the face of challenging terrain and infrastructure failures. Through the use of the tunnel shield method and pipejacking, the project team successfully installed a 270-linear-foot, 96-inch casing culvert at a steep -27 percent slope . This accomplishment not only restored a vital transportation artery but also demonstrated the resilience and capability of the engineering and construction industry in California. As travelers once again enjoy the scenic beauty of Highway 1, they can also appreciate the remarkable engineering feat that made it all possible.

ABOUT THE AUTHOR:

***Steven Gallyer**, Pacific Boring, Inc. started working for Pacific Boring 21 years ago out of High School. He worked in Pacific Boring's shop while attending Fresno State and earning his Bachelor of Science in Construction Management.*

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City of Los Angeles North Outfall Sewer Unit 30 Rehabilitation

Completion Anticipated Nearly One Year Ahead of Schedule

By: Joseph Vera, Mladen Buntich Construction

The North Outfall Sewer (NOS) Unit 30 is a 4540 linear foot stretch of non-circular sanitary sewer in the heart of the film district in the City of Los Angeles, California. Commissioned in 1928, the sewer ranges in size from 57 inches to 39 inches, with a 42-inch twin barrel siphon on the downstream end of the project. The entire alignment consists of reinforced concrete pipe. Due to age, significant deterioration, and four recent failures resulting in major roadway sinkholes, the project was greenlit and fast tracked for rehabilitation with reinforced polymer mortar pipe (RPMP). Mladen Buntich Construction (MBC) based in Upland, California were the successful bidders on the rehabilitation project and received the Notice to Proceed on December 19, 2022. MBC partnered with Channeline International out of Dubai, UAE to supply the RPMP.

Hurricane Hillary

In addition to the 4290 linear feet of rehabilitation with RPMP, the full project scope also includes 250 feet of 42-inch twin barrel rehabilitation by cured in place pipe (CIPP), approximately 2600 linear feet of 8-inch local sewer by open cut installation, 510 linear feet of 6-inch house connection laterals by open cut installation, 20 direct sewer connection laterals in various lengths ranging in size from 6 inches to 24 inches, 18 access structures on both the local sewer and main NOS, two encasement structures, and a significant amount of roadway and surface restoration.

The 42-inch twin barrel siphon traverses beneath the Tujunga Wash which is a tributary of the Los Angeles River. The barrels will be rehabilitated with ultraviolet cured Impreg liner out of Germany. The 8-inch local sewers are intended to replace the existing direct connections to the NOS that service the residences along the alignment. These will be replaced with 6-inch house connections connecting to the 7-phase 8-inch local sewer, which in turn will have one direct connection to the main NOS system in each phase. Both local sewers and house connections will consist of vitrified clay pipe. Of the 18 proposed access structures, 16 of those will be constructed on the local sewer alignments. The other two access structures will be constructed directly on the main NOS corresponding to the launch and receiving pit locations. The last two will be encasement structures with no access, also corresponding to launch and receiving pits on the NOS alignment.

MBC's construction methodology was to begin on the downstream end, and work upstream to the limits of the project. The first access pits were completed between late March and early April 2023. The furthest downstream pit, or pit number one was installed approximately 250 feet upstream of the upstream siphon barrel structure. From this pit MBC launched 57-inch non-circular RPMP downstream to the siphon structure. Installation upstream

> *The project has gone very well to date. Completion will be nearly one year ahead of schedule.*

Cleaning Mandrel

was one of the more challenging and unprecedented activities completed to date.

A vertical bend along the alignment exists approximately 30 feet upstream of the pit number one location. Between the beginning and end of the vertical curve, the NOS transitions in size from 57 inches to 48 inches. MBC launched approximately 150 feet of 48-inch non-circular pipe upstream through the vertical curve, and then installed a special RPMP transition reducer from 48 to 57 inches. The remainder of the launch was completed with approximately 65 feet of 57-inch pipe connected to the transition reducer. Pushing through the vertical curve eliminated the need for an additional pit to close the transition. It was not without risk but proved to be effective and significantly reduced public impact. The pipe was closed with a closure piece and rubber closure couplings in the center of the pit one after the upstream push. The pit was permanently closed with a no-access encasement structure. These activities were completed in late June 2023.

Cleaning Powertrain

Pit number two was installed 240 feet upstream of pit number one. It was intended as a receiving pit for RMPM from pit one, and as a launch pit for 48-inch RMPM to the termination point of phase one. Utilizing an Akkerman jacking frame, MBC installed 1175 linear feet of 48-inch FRP over a period of 6 hours. This stretch was relined in mid-June. The push terminated immediately downstream of a section of the NOS that had been previously lined as an emergency repair. This 115 linear foot section of the NOS traverses beneath a major roadway and separates phases one and two of the rehabilitation scope. Pit two will eventually be closed with an accessible structure with cast in place and precast elements. Construction is currently underway and expected to be completed by September 21, 2023.

To minimize the risk of another collapse, MBC immediately began preparations for phase two relining after completion of phase one. The process began with construction of pit number three which was identical in size and composition to pits one and two. Pit three was strategically located midway between the upstream and downstream limits of phase two and was intended for launching pipe in both directions. Launching to the phase two upstream limit required a push through the existing 57-inch NOS, and downstream through the 39-inch NOS to the phase two downstream limit.

Pit 3 Transition

Sewer Debris

The necessary activities in preparation of relining which were also completed prior phase one rehabilitation consisted of removal of the crown of the reinforced concrete NOS, cleaning, and mandrel proofing. Crown removal was completed by wall sawing at the spring line with supplemental saw cuts vertically around the circumference of the NOS. Once the crown was removed, the cleaning "sled" was pulled back and forth between the upstream and downstream limits of phases one and two. This was accomplished

Sliplining Process

with two 50,000-pound capacity line pull winches stationed at the upstream limits of phases one and two. Utilizing the same winches MBC pulled proofing mandrels conforming to the shape of each NOS stretch, but one inch greater in diameter. The logic of the increase in size was to confirm that the new liner pipe would successfully pass through. The proofing was completed successfully on all stretches in phases one and two.

One major event occurred compromising this process during phase two. Cleaning had been completed, and proofing had been unofficially completed as the contract requirement is to proof 24 hours prior to relining. MBC had not yet received the pipe to complete the lining but had confirmed the pipe would pass by pulling the proofing mandrels prior. Hurricane Hillary swept through Southern California between August 19 and 20, 2023. It created flash flooding conditions throughout the area, as well as record setting rainfall. This event significantly increased the flow level and velocity in the NOS. It is very likely that the system surcharged bringing debris from upstream of the Unit 30 limits into the system, as there was an extensive field that had settled into the NOS upon investigation after the hurricane. The stretches formerly prepared for relining had to be cleaned and proofed again. Once completed, MBC relined both 1300-foot phase two stretches each in a single day. Relining of the full NOS alignment with new RPMP was completed on September 8, 2023.

MBC did encounter a considerable challenge during the downstream installation. The NOS reduces in size from 57 inches to 39 inches in the center of pit three. The slope also transitions from 0.0017 percent in the 57-inch to 0.018 percent in the 39-inch. The flow velocity picks up significantly at this transition. The flow restriction combined with the increase in slope created more buoyancy than MBC had initially expected. No jacking forces were required to move the train downstream. Approximately 200 feet in, it was clear that a runaway pipe train effect was inevitable. MBC's solution was twofold: block the annular space to prevent flow from creating additional buoyancy allowing the pipe to settle on the invert, and restrain the pipe train to the jacking frame with a cable that had been clamped to the nose pipe. This proved very successful.

MBC is currently completing all outstanding activities in phase one to close out half of the project footprint and reduce public impact. Phase one will end with the completion of annulus grouting and surface restoration. The former activity will require extensive coordination, as the intent is to grout the entire alignment in a single lift from multiple injection points. MBC plans to construct a series of weirs at certain discharge and injection points to ballast the NOS with sufficient flow to prevent floatation. The ballast weirs will be constructed inside existing and proposed structures to backup flow into the stretch being grouted. This will be feasible in phase one as the slope of the NOS between the upstream and downstream ends is 0.0017 percent. This activity is scheduled to be completed in early October 2023.

Upon completion of phase one closeout, MBC will begin working on outstanding phase two activities. This will include completion of the remaining 8-inch local sewer lines, 6-inch local house connections, remaining direct connection NOS laterals, accessible and non-accessible structures, annulus grouting and surface restoration on phase two. The grouting procedure for the phase two downstream alignment is still a plan in progress. As mentioned previously the slope is

Sliplining

significant at 0.018 percent. The elevation difference between the injection and discharge points is approximately 15 feet. It is likely that this particular stretch will require multi-lift grouting.

The technical complexity of the project is not great, but there have been some challenges such as pushing through vertical bend and preventing the runaway pipe train. Some non-technical challenges encountered have been working within the limits of the City of Los Angeles. Restrictions are abundant, there are large number of agencies involved many of which are unfamiliar with rehabilitation work, and traffic is formidable. However, the project has gone very well to date, and MBC expects project completion in late Winter or early Spring of 2024. This will be nearly one year ahead of schedule.

ABOUT THE AUTHOR:

***Joseph Vera** has been specializing in large diameter sliplining rehabilitation since 2014. He has extensive knowledge pertaining to flow control, ground support, cleaning, sliplining, and annulus grouting. He has successfully overseen and directed rehabilitation projects in Houston, Toronto, Dallas, Detroit, Vancouver, and Los Angeles.*

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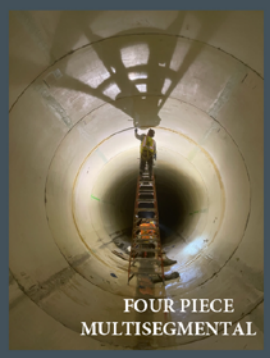

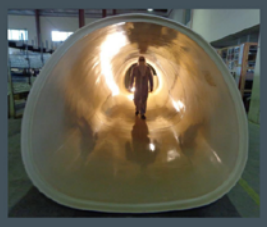

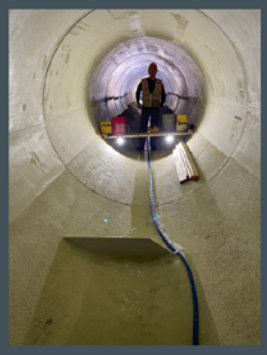

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Beyond the Ordinary

Beyond the Ordinary

Spinning & Winning: Spiral Wound Technology Saves Time & Money for the City of Farmington, New Mexico

East Sanitary Sewer Interceptor Phase III Rehab

By: Michael Rocco, AUI Inc.

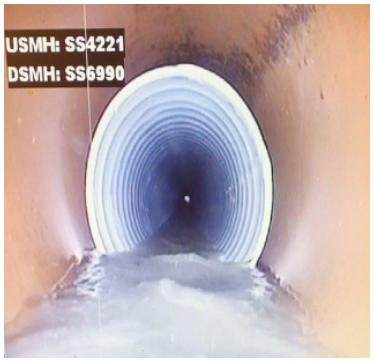
The City of Farmington, New Mexico is nestled in the four corners region of New Mexico, Arizona, Colorado, and Utah. Like cities throughout the Southwest, Farmington has an aging infrastructure. Sewer lines that were installed in the 1950s, 1960s and 1970s were far beyond their service life. The city was responding to frequent emergency repairs and decided a more comprehensive approach was needed. One of the projects that was identified was the East Sanitary Sewer Interceptor Phase III, an existing 21-inch Vitrified Clay Pipe (VCP) sewer interceptor line that was located in busy commercial areas of the city and ran towards a residential street. Due to concerns about disrupting businesses as well as residents during construction, the City of Farmington elected to use trenchless technologies and specified Sekisui's SPREX-PVC Spiral Wound Liners to rehabilitate 4,835 LF of 21-inch VCP. SPREX-PVC Spiral Wound liners offered many constructability advantages versus other trenchless methods. The liners can be installed via existing manholes, access chambers and all without access pits or site excavation. The liners can be installed in live flow typically without the need for by-passing. Additionally, there are no chemicals as part of the installation process, which was a key factor in this project due to the project location.

The project was competitively bid in October 2022 and AUI, Inc., headquartered in Albuquerque, NM was the low bidder. In addition to Spiral Wound Pipe rehabilitation, the project also included the trenchless rehabilitation of 24 existing 4-foot diameter manholes with Fiberglass Inserts.

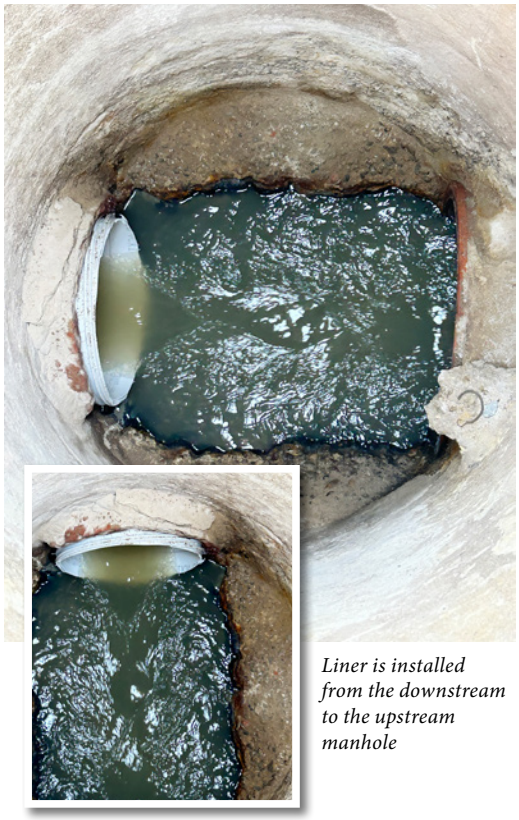
Winding machine spirals a PVC strip into the deteriorated pipeline

Winding machine is positioned at the base of the manhole

Typical compact set up above ground



Installed in live stream



Liner is installed from the downstream to the upstream manhole

Result is a custom, tight fit liner with consistent wall thickness restoring hydraulic capacity

> *Sewer service reconnections are an important function in the lining process.*

The first step in the SPREX-PVC Spiral Wound Liner installation was to clean and televise the sewers. AUI subcontracted Southwest Sewer to hydro jet and camera the existing 21-inch VCP line. Once the line is televised, the video is reviewed to verify the line has been sufficiently cleaned prior to liner installation. Some of the defects you are looking for in the video are offset joints and breaks in the pipe

Manhole collar and bench coated with Zebron

Form for manhole grout ring

NOV fiberglass insert

> *Trenchless methods used on this project resulted in considerable time and cost savings.*

as well as the location of existing sewer services. Sewer services can be robotically reinstated or reconnected by traditional open cut excavation depending on the project requirements. The location of the service connections are logged during the video inspection. The video gave exact footage from the existing manholes to where the service is tied into the existing line. If the existing line has an offset joint that is too severe to line through or the pipe is broken, they will be repaired by a traditional point repair. Fortunately, there were no offset joints or broken pipe that were required.

The next step in the lining process was to verify the condition of the shelves/benches before the winding equipment could be lowered into the chamber. If too narrow, the shelves/benches would need to be widened. This is usually accomplished by using a small jacking hammer, chipping out the shelves/bench, and removing the debris. After the liner is installed, the manhole shelves/benches are rebuilt to the original condition or improved to the soffit of the pipe.

Sewer service reconnections are an important function in the lining process. The existing VCP had ten 4-inch sewer services that needed to be reconnected. The existing sewer services were excavated and reconnected with a 4-inch Insert-A-Tee fitting. The Insert-A-Tee fitting is custom made to fit the contour of SPREX-PVC liner and had a PVC SDR 35 hub end that fits 4-inch SDR 35 standard PVC pipe. The services that were reconnected included 15 linear feet of new 4-inch sewer line and reattached to the existing 4-inch line which was usually cast iron or clay.

Sekisui's PVC SPR EX is a structural repair solution for 6 – 42-inch diameter pipelines. The process consists of a single strip of PVC profile which is fed from a spool above ground into the winding machine which is positioned at the base of the manhole or access chamber. The stationary winding equipment spirally winds the PVC profile strip into the deteriorated pipeline, initially at a diameter smaller than the host pipe. The profile forms a continuous liner by interlocking subsequent strips of profile which includes a primary and a secondary lock. The liner is installed from the downstream to the upstream manhole. Once the lining terminates at the upstream chamber, the liner is torsionally restrained and the operator will pull a wire to sever the secondary lock, which initiates the expansion process. The operator will then feed additional profile into the winding machine as the liner is being expanded. The result is a custom, tight fit liner with a consistent wall thickness that restores hydraulic capacity.

After the sewer line was rehabilitated, the next phase was to rehabilitate the existing 4-foot diameter manholes using 42-inch fiberglass inserts that fit inside the existing 48-inch concrete manholes. The 42-inch fiberglass inserts were manufactured by NOV Company and are a structural fiberglass liner to rehabilitate manholes. This construction process began with removing the first 3 to 4-foot of the cone section and/or flat top of the existing manhole. The existing

benches/shelves are rehabilitated and brought up to soffit using and approved calcium aluminate material for manhole applications. The new NOV 42-inch insert is then installed into the old concrete manhole, in a similar slip-line method. The annular space is then filled with flowable fill concrete, backfilled and a new 30-inch ring and cover was installed. The last process was to coat the newly rebuilt benches/shelves and the ring and cover collars with Zebron a polyurethane epoxy.

This trenchless project was located parallel to a busy main road in Farmington and private property which went through a swamp land area and included lots of trees. The City of Farmington's Parks and Recreation Department had to cut and trim some trees to make access for the equipment required for access to the manholes. Traditional open cut excavation would have been more costly and taken more time, due to dewatering, access, and surface restoration. The two trenchless methods used on this project resulted in considerable time and cost savings to the City of Farmington, NM.

PROJECT SUMMARY:

SPREX-PVC Liner installed	**4,835 LF**
NOV Fiberglass MH Liner installed	**24 EA**
Sewer Service Reconnected	**10 EA**

SPECIAL THANKS TO THE ENTIRE CREW AND FOLLOWING MANAGEMENT WHO MADE THIS TRENCHLESS PROJECT A SUCCESS:

Project Manager	**Wayne McCarthy**
Project Superintendent	**Archie Lucero III**
Project Foreman	**Jorge Miramontes**
Project Foreman	**Miguel Acosta**
Project Foreman	**Pedro Lares**
Sekisui Technical Support	**Joseph Dominguez**
Sekisui Technical Support	**Cyril Aibout**

ABOUT THE AUTHOR:

Michael Rocco has been employed with AUI, Inc., for over 32 years and works in the estimating, project management and marketing departments. His experience includes rehabilitation of water, storm sewer and sanitary sewer pipelines by Slip-lining, Pipe Bursting and Spiral Pipe Rehabilitation trenchless methods. Mike has well over 35 years' experience with various trenchless applications, and was a long-serving Director on the WESTT Chapter Board.

Trenchless Construction Keeps BART Running

BART Utilizes Trenchless Technologies to Maintain Operations during Critical Facilities Upgrades

By: Steve Donovan, P.E., Underground Solutions, Inc.

Trenchless technologies played a vital role in keeping San Francisco's Bay Area Rapid Transit System (BART) running during the construction of critical infrastructure at the Hayward Maintenance Complex (HMC). As one of BART's "Core Capacity Projects", the HMC project prioritized construction of a new maintenance yard on neighboring property and expanding the existing Hayward maintenance facility to create the new HMC that integrates a new train control system, the expanded yard, and increased train-holding capacity for BART's "Fleet of the Future". The HMC is critical infrastructure for BART and for the current and future Bay Area commuters. Completion of the HMC is considered so important to 'maintaining and expanding reliable operations,' BART provided its own design staff for the water distribution renewal design.

> *Conventional methods of construction would be very difficult, if not impossible.*

The Hayward maintenance yard water distribution upgrade was the last of three 'yard fire protection system upgrades' undertaken by BART. Designed to meet future maintenance demands for the new fleet and issued under the contract titled "Hayward Yard Fire Protection," the water system was considered a critical step in completing the HMC. One of the primary project constraints was that the existing maintenance facility would need to remain operational during construction, because existing train service could not be negatively impacted. For the water system, this was no easy task, as several portions of the distribution piping crossed under multiple tracks or ran parallel along a six-foot-wide corridor between active tracks. Conventional methods of construction would be very difficult, if not impossible due to the high third-rail voltage, track spacing, utilities crossing under active rails, and continuous 24/7 activity in the maintenance yard.

The existing maintenance facility water system was comprised of cast iron (CI) pipe foundered in the 1960s and Transite or asbestos-cement (AC) pipe from around the same period. Over the last decade, both pipe materials have exhibited an increasing rate of failures, especially in the 50+ year old CI pipe. The CI pipe was

Feasibility of construction in an active rail yard required trenchless methods

Many pipe bursting runs exceeded 600 feet under multiple BART tracks

believed to be experiencing corrosion related to stray currents associated with the third-rail train electrification system. While not suffering from galvanic corrosion, the AC pipe in the system had also served its useful life and was reportedly soft. Due to their proximity to the tracks and the risk of a failure impacting train service, the water system project was scheduled as a stand-alone project and assigned to BART engineers as a priority.

Having recently completed two other maintenance yard fire water systems, engineers at BART understood the challenging environment that the maintenance yard would create for a contractor installing a pipe system. Design considerations included:

- Corrosion resistance,
- Hydrocarbon permeation resistance,
- Connections to existing fittings,
- Restricted equipment access,
- Under rail pipeline alignments, and
- Construction in an active rail yard

Given these constraints, BART engineers understood that trenchless technologies may be required to accomplish the project.

In the fall of 2022, BART received bids for the "Hayward Yard Fire Protection" project. The project was awarded to Con-Quest Contractors out of Burlingame, CA. Having experience in rail track construction for BART and other urban rail providers, Con-Quest understood the permitting, restricted access, and enhanced safety requirements that working inside BART's Right-of-Way would require, especially when working at a maintenance yard with a third-rail energized to 1,000 volts DC.

In its approach to the work, Con-Quest identified pipe bursting as opposed to open cut construction as a more efficient means to replace sections of the pipe within a tight six-foot-wide corridor—an area between the third-rail and two sets of tracks. Portions of the waterline in this area were under six-foot-wide concrete access paths stretching between the rails. BART engineers embraced the alternate construction method as a reduction in the risk to rail service, provided line heaving did not occur. For the bursting construction, a Hammerhead HB125 Static Pipe Bursting machine (125 tons) was utilized for bursting longer runs (600+ feet) and an HB558 for shorter runs. Con-Quest started bursting the existing 8-inch pipe with a 12-inch head, but switched to an 8-inch head to minimize the risk of any surface heave and to rely more on the high pull forces allowed by the 8-inch DR

Pipe bursting was the most efficient method within a tight six-foot gap between tracks

Water lines were replaced with minimal impact on BART operations

14 Fusible PVC® pipe replacing the existing water mains. The cast iron pipe was effectively replaced with bursting runs that exceeded 600 feet in length.

Where encountered, the Transite pipe was also replaced by pipe bursting. Since BART has full control of its own Right of Way and does not anticipate future excavations for connections to the water main, the risk of a future exposure from the AC pipe burst spoils was considered manageably low. When the existing AC pipe was exposed in pits, even after bursting, Con-Quest followed all OSHA requirements concerning worker safety and the safe handling and disposal of AC pipe, including double bagging the material before it can be considered friable and providing an EPA tracking number to follow the waste to its proper disposal place. There were in effect no other alternatives to consider since it would have been prohibitive to BART operations to remove the old AC pipe. In areas of AC pipe encounters, BART maintained a record of the pipe location on the project record drawings.

For track crossings, BART engineers also repurposed the old 8-inch cast iron water pipe by using it as a casing for sliplining a new 6-inch DR 14 Fusible PVC® carrier pipe. The new pipe was cut into 22.5-foot sections and lowered into the sliplining pit, where it was fused before being pulled into the cast iron pipe. The in-pit fusion and sliplining succeeded in crossing under multiple tracks with only minimal excavations, and also allowed BART engineers to repurpose the old CI as casing pipe. Where sliplining was used, BART engineers required Con-Quest to run a proofing pig through the host pipe before converting it to an encasement pipe. Sliplining provided minimal impact compared to the possible alternative of a jack and bore installation.

Given the time and space constraints for working, trenchless methods using a fused monolithic pipe proved to be the only viable construction option for any installation spanning more than one track, especially considering the amount of temporary support and protection required.

This project was the last of three water distribution replacement efforts at BART's maintenance yards. The utilization of trenchless technologies allowed BART to replace their water lines with little impact to operations, even within a very congested environment. Trenchless methods also allowed BART to repurpose sections of the old water system by converting the pipe to casing under the rails. Accordingly, BART Engineers expressed their satisfaction with how trenchless technologies made the water system upgrades possible in the face of extreme challenges of space and rail proximity.

Trenchless methods overcame extreme challenges of space and rail proximity

ABOUT THE AUTHOR:

***Steve Donovan** is an Oregon registered professional civil and environmental engineer engaged as the Aegion Regional Sales Manager for Hawaii, South Pacific, California, Utah, and Oregon. Prior to joining Aegion, Steve worked with a directional drilling company managing large diameter pipeline installations throughout the United States. He has an MS in Environmental Engineering from UC Davis and a BS in Civil Engineering from Columbia University, NY.*

City of North Las Vegas Sanitary Sewer Main Rehabilitation

By: Kevin Seeman, Contech Engineered Solutions

Sewer Main Rehabilitation – Losee Road and Cheyenne Avenue

- Owner: City of North Las Vegas
- Engineer: Horrocks Engineers / Atkins
- Contractor: Las Vegas Paving

Technical Information:

- Product: A2™ Liner PVC
- Diameter: 15-inch
- Length: 6,300 LF

An aging sanitary sewer main in the City of North Las Vegas needed rehabilitation or replacement. As the project was located along the busy corridor of Losee Rd. and Cheyenne Ave, the city wanted a solution that would avoid any extended road closures and traffic disruptions and initially looked into a Cured-In-Place-Pipe (CIPP) solution.

This project was located amidst a very busy area with several commercial businesses and industrial plants nearby and required construction management (CM) techniques as outlined below:

1. Public outreach efforts.
2. Coordination with multiple agencies (NDOT, City of North Las Vegas and Clark County).
3. Schedule reviews to ensure contractor stays on schedule to not impact businesses.
4. Budget reviews due to the potential of quick-change orders to move the project along.
5. Document control – City of North Las Vegas utilizes Submittal Exchange.
6. Specialized inspection due to the project scope of CIPP lining of the existing sewer and sliplining sections.

The project engineer, Horrocks, was able to provide CM management services and inspection services that require the National Association of Sewer Service Companies (NASSCO) certifications.

> *Slipline made the project sustainable in many ways.*

The project contractor, Las Vegas Paving, submitted an approach that would successfully repair the existing sanitary sewer main while addressing some of the structural issues concerning utilizing a combination of CIPP and A2™ Liner PVC to slipline in larger sections. Slipline has not been used in Southern Nevada to date. This scope entailed the cutting of existing pipe, removing the top of the host pipe and installing new sewer pipe to be pushed up and down stream to existing manholes. This was done while maintaining live flow in the sewer system. As a result of the slipline approach, the project was completed well ahead of schedule.

Safety performance of the construction crew demonstrated awareness of the need for a good overall safety program during construction. The contractor submitted their basic safety plan; however, the safety items and performance were observed on the project as stated below:

1. Detailed coordination of traffic control was required to maintain lining through busy intersections with bypass pipes.
2. Working inside existing sewer manholes to provide a protective coating to limit the deterioration of concrete. Contractor had the required sniffing equipment to monitor fumes and vapors to keep personnel safe.
3. Equipment working within active roadways. Pre-activity meetings were held to discuss how equipment would work within the busy streets and to provide safe passage for pedestrians and vehicles.

Community relations were also important throughout this project as evidenced by efforts to minimize public inconvenience due to construction, safety precautions to protect lives and property, provision of observation areas, guided tours, and other means of improving relations between agency and the public.

> *"Bypass was not required as the pipe was installed in live sewer stream."*

The following items were accomplished to ensure good community relations:

1. Walking the project and meeting with each business owner and leaving them a copy of the scope of work and schedule of when construction would be close to their business. Also having them sign a sheet indicating they were notified of work activities.
2. Emails during the project to businesses.
3. Flyer during the project to businesses.
4. Meeting with agencies to publish public information notices as it affected I-15 Freeway traffic.
5. Weekly public outreach meetings with contractor to discuss any complaints or needs for businesses.

Special consideration was also given to any particular environmental concerns raised during the course of the project. This was a very important item on this project as it was a sewer rehabilitation scope. Sewer bypass plans had to be submitted and approved to line the host pipe in long lengths of up to 2,500 feet. Within that length pumps were needed to pump the existing flow into a main bypass line in an effort to do the CIPP operation. This plan had to be reviewed by all agencies in case there was a leak or failure of pumps on the project and what the emergency plan would be. Additionally, for the slip lining portion of the project, insertion pits had to be excavated to be able to cut the existing line and insert new line to be pushed up and down stream of said insertion pits. A plan had to be submitted and approved in case of a spill in the insertion pit.

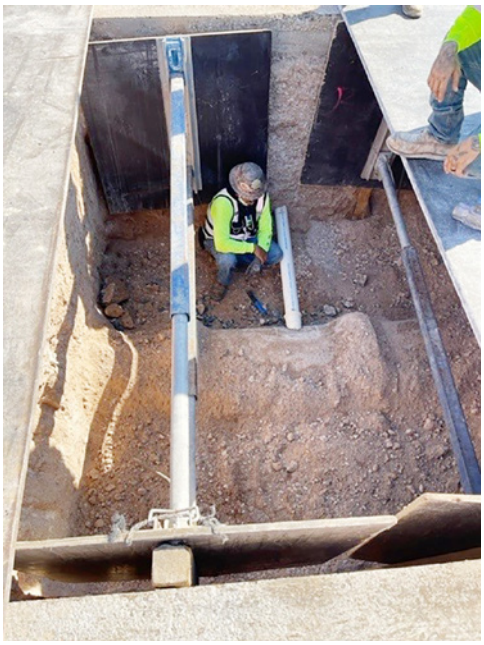
The selection of an A2™ Liner PVC product to slipline into the existing sanitary sewer system was extremely beneficial as the pipe could be installed in a live sewer system and bypass was not required. This was a tremendous cost savings to the city, and it ensured that no roadway closures would be needed during this part of the improvement project.

The entire project was completed without any issues. The rehabilitation of the aging sewer facilities with a combined CIPP and A2™ Liner PVC approach avoided the possibility of an open excavation along an extremely busy corridor of Losee Rd. and Cheyenne Ave. As this was a new scope in Southern Nevada with regards to the slipline sewer, this made it unusual, and it was accomplished with no issues.

Additional conditions deemed important to the public works agency, such as exceptional efforts to maintain quality control and, if value engineering is used, construction innovations as evidenced by time and/or money saving techniques developed and/or successfully utilized.

As the slipline was a new scope of work to City of North Las Vegas and the contractor, there were many items that had to be designed through partnering with the contractor, Horrocks, Atkins and City of North Las Vegas. The City of North Las Vegas was pleased with how the project was

Insertion pit shown before the removal of the top of the host pipe



Insertion pit during excavation

Insertion pit shown: A-2000™ PVC used to slipline the host pipe

managed and constructed with regards to this new scope.

As noted previously, in lieu of open excavation of the busy Losee Rd. and Cheyenne Ave. roadways, it was determined that a combined CIPP and A2™ Liner PVC slipline solution would be utilized. This made the project sustainable in many ways, noted below:

1. Saving of excavated materials to be hauled off.
2. Environmental concerns of having to dig up existing sewer and dispose of it.
3. Less fuel needed to construct the project due to CIPP and sliplining.
4. Less impact to traveling public because of not having to open excavate.

ABOUT THE AUTHOR:

***Kevin Seeman** is the Contech Sales Engineer for the central valley of California and Southern Nevada. With over 28 years of experience in the construction industry and nine specifically in manufacturing, Kevin has provided technical expertise to engineers, contractors, and owners in the storm sewer, sanitary sewer, and drainage markets. Kevin earned his B.S. degree in Business Management from the Grove City College. Kevin can be reached at kevin.seeman@conteches.com.*

Ductile Iron Pressure Pipe Condition a Mystery: Time to Inspect?

CPM PIPELINES

By: Chris MacDonald, CPM Pipelines

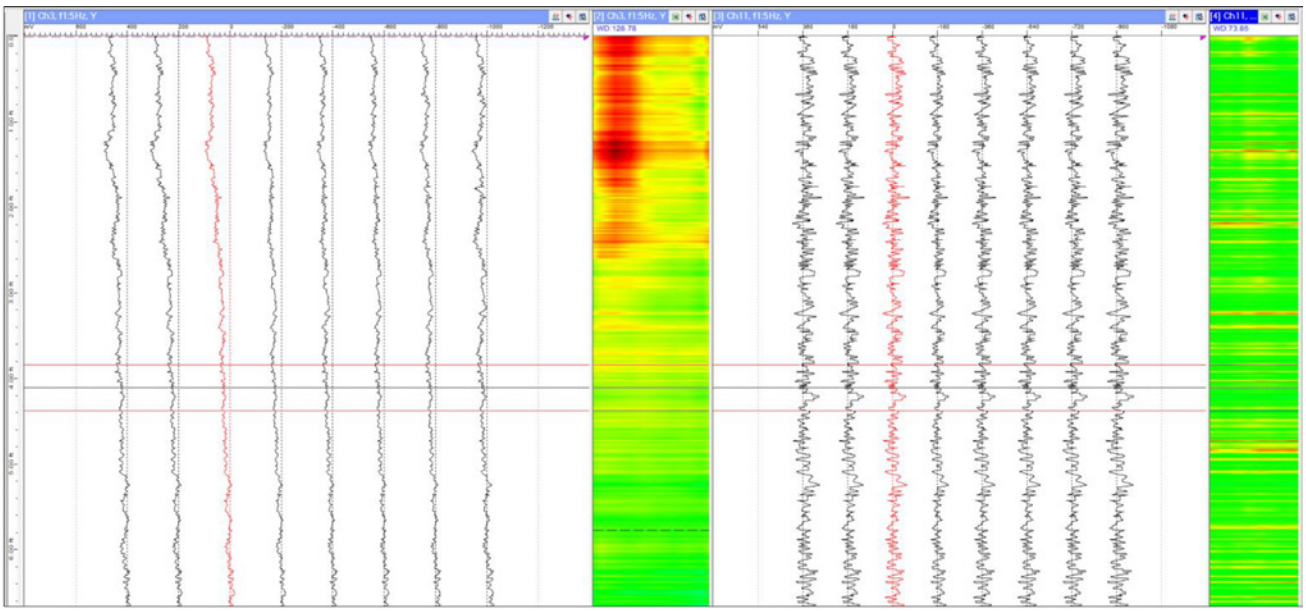
The primary challenge with any in-line inspection technology comes down to the unknown conditions and variables. When evaluating different options, understanding the value and limitations is critical in making decisions on which technology is best suited for the application. In all instances the purpose of the inspection is to obtain visibility of the system and determine where extreme degradation or damage has occurred to develop a management plan to repair, rehabilitate, or replace. Having inspection data as the cornerstone of the asset management plan ensures:

- Investments in infrastructure don't occur after failures.
- Investments in infrastructure are not premature.
- Investments are not excessive, and properly budgeted based on the remaining useful life.

> *Measurements from ultrasonic technology are absolute.*

Options for evaluating the condition of cement lined ductile iron pipe are electromagnetic or multi-sensor with ultrasound-based sensor technology on board. When considering electromagnetic technology, the limitations and benefits are well covered in the AWWA M77 manual of practice for condition assessment. While electromagnetic technology can deliver valuable defect detection, many factors can influence the signals and deliverables.

For decades electromagnetics have been used through various platforms to deliver wall condition data. The signals are compared to historical data, often not calibrated to the actual pipe that's undergoing inspection. These signals are interpreted by software, or highly skilled analyst to determine a level of degradation in the location where the indication has occurred. The results are subjective and can be skewed by outside factors such as stray current, and resolution. Due to the interpretation of the data, the actual degradation is often less than reported. However, these limitations are not reasons to



Electromagnetics have been used for decades to deliver wall condition data

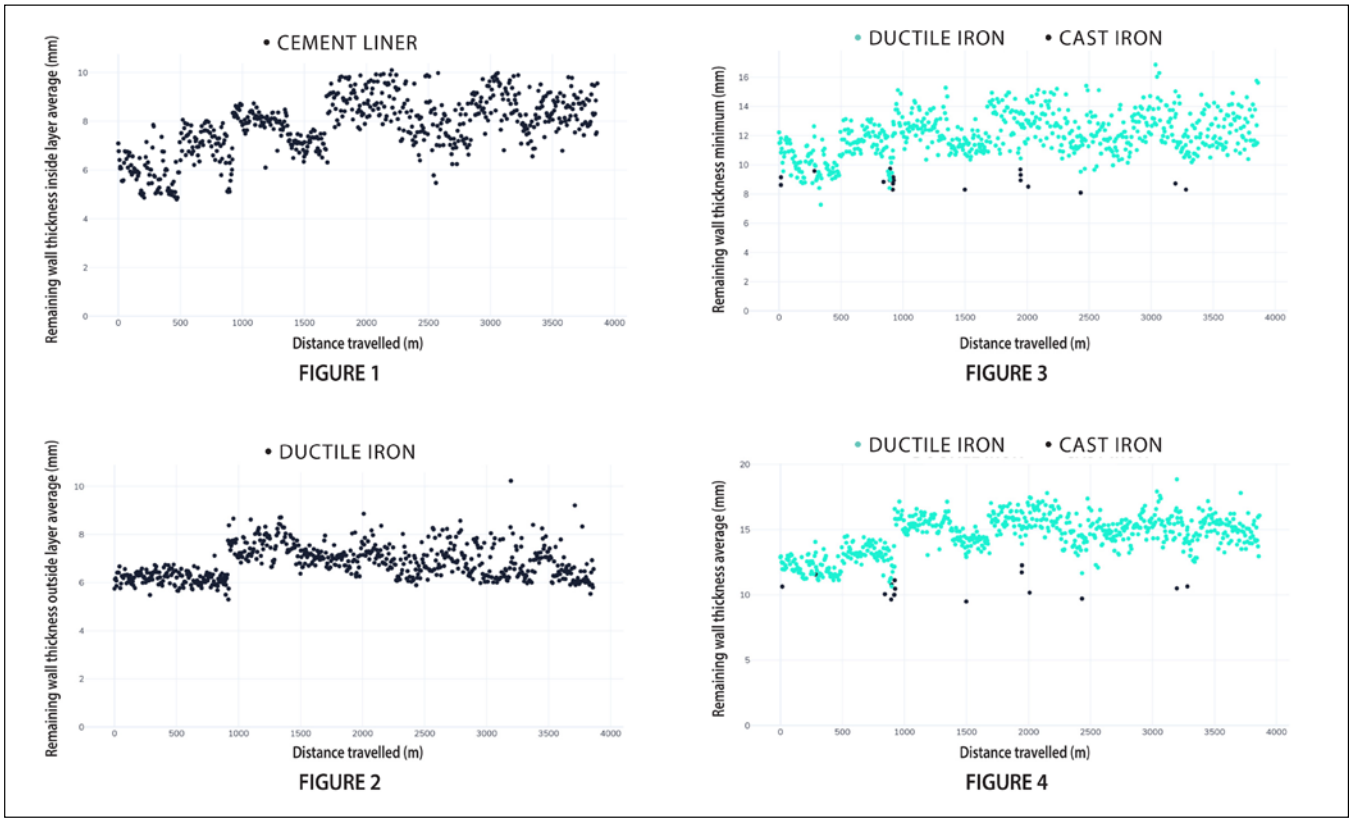
discontinue utilizing electromagnetics, as it has been historically proven to help provide necessary data required to focus renewal efforts.

Acquaint's Acquairus in-line inspection tool with multi-sensor technology provides precision ultrasonic measurements on a platform capable of deployment in line with minimal to no system shutdown. The technology is easily deployed through a wye or tee connection, either existing or installed for the purpose of inspection. The soft foam pig deployment system is used for swabbing the pipe, is very forgiving, allows navigation of complex geometry, and introduces minimal risk to the system as it requires a small pressure differential of 3-5psi required to travel successfully through the pipeline.

Ultrasonic technology has some limitations, however compared to electromagnetics, the measurements are absolute. Depending on the footage inspected and sensor array, millions of data points are collected to provide average thickness and minimum measurements across a segment of pipe. The measurement accuracy when detecting wall thicknesses through a single layer is 0.5mm. Through multiple layers, as in the case of cement lined ductile iron, accuracy is 1mm. Much like electromagnetics, ultrasonic technology coverage will not be 100 percent. Analysts have found when comparing the technologies, value of data is high, and the likelihood of locating the areas in the worst condition is also very high.

The Acquarius tool is equipped with multiple sensors including ultrasonic (UT), inertial measurement unit (IMU), magnetic field wave (MFW) and hydrophones that collect UT data in combination with other measurements to gain a better overall understanding of the pipeline's condition. For example, cement lining missing from the interior of a pipe wall, is very visible through UT measurements, even if the metallic pipe wall is in good condition in the same area. As the liner may have recently failed, this is an area of concern, and will require repair or monitoring. If the liner is tightly bonded to the pipe wall, and thickness is similar there will be inner and outer wall reflections that will point to external corrosion occurring on the ductile iron pipe. If liners are missing indications will be highly accurate and reflect the precise measurements of

Acquaint's Acquairus in-line inspection tool with multi-sensor technology can be deployed in line with minimal to no system shutdown



Ductile Iron Graphs – Figures 1 – 4 show average and minimum ductile iron wall thickness throughout the pipe alignment

the ductile iron layer. Liner that has dis-bonded from the pipe wall, but still intact, will also be reported. This data is critical to understanding the threat associated with the anomaly. Details reported will show the average and minimum lining thickness, as well as the average and minimum ductile iron wall thickness throughout the pipe alignment. Shown in the Ductile Iron Graphs, Figures 1-4.

Clients often question whether every minor defect will be picked up when using the various available technologies and techniques. The answer across the board is no. The most severe areas of corrosion will be detected. Based on CPM Pipelines' experience, these locations are unchecked for many years, and are broad in reach before a failure occurs.

Acquaint's Acquarius in-line inspection technology yields results and data in a single run that provide a valuable roadmap to create a proactive asset management plan. In addition to the information collected related to thickness of the liner and pipe material, additional information is logged. The on board IMU collects data related to joint deflection both vertically and horizontally, gaps at the joints, that could indicate a pipe was assembled incorrectly or is pushing apart from thrust forces. The data helps to calibrate and locate the defects indicated by the UT circumferentially, which is important when analyzing the cause of the corrosion or erosion in the pipe wall. The hydrophones detect active leaks, while the UT sensors detect gas pockets. In addition, the multi-sensor nature of the technology collects data related to the pipeline hydraulic profile, pressure, debris in the pipe, and delivers sub meter accuracy (within 1.5 feet), and XYZ mapping that allows for highly accurate location results. Deliverables can be downloaded to the clients' GIS system.

The combination of ultrasound, inertial measurement unit, hydrophones, and magnetic field wave technologies in a single inspection run, yields results and data collected that provide a valuable roadmap to efficiently managing and maintaining critical pipeline assets. This is what truly sets the Acquarius tool apart from other electromagnetic technologies that collect wall defects without additional data to quantify the results obtained.

ABOUT THE AUTHOR:

***Chris MacDonald** is President of CPM Pipelines, and has 25 years' experience providing specification and design support for consultants and clients throughout the U.S. on water and wastewater projects.CPM Pipelines provides innovative pressure pipe inspection technologies and trenchless rehabilitation driven by a proactive asset management program to eliminate disruptive failures and budget for rehabilitation.Recent partnerships include Acquaint from the Netherlands and BulletLiner System® by Asoe for trenchless pipe rehabilitation.*

What to Do When Your As-Builts are Not As-Found!

By: Mary Neher, Bennett Trenchless Engineers
Joshua Hampton, Pacific Gas and Electric
Sean Dearborn, Pacific Gas and Electric
Brian Avon, Carollo Engineers

INTRODUCTION

In 2011 Pacific Gas and Electric (PG&E) began a massive hydrostatic testing program to assess the condition of a portion of their high pressure natural gas distribution pipelines. As part of this program it was determined that Line 153, a 30-inch diameter pipeline which runs through the cities of Newark and Fremont in California's San Francisco Bay Area, needed to be evaluated. Even without testing, however, one section of Line 153 was identified for replacement in order to minimize safety risks and operations and maintenance issues: the above ground crossing of Interstate Highway 880 (I-880) on the border between the two cities.

Figure 1. Photo of the 30-inch diameter high pressure natural gas line aerial crossing of I-880

Line 153 was constructed in 1949, prior to the construction of I-880, close to a set of Union Pacific Railroad (UPRR) tracks. When Caltrans constructed I-880 in the 1960s they chose to route the freeway under the existing railroad tracks and high pressure gas line. This resulted in the surface of the freeway being located approximately 20 feet below the surrounding ground and an approximately 220-foot aerial span of 30-inch diameter steel gas line with a single support in the center of the freeway with two supports on the engineered slope of 880 (as shown in Figure 1). Thus, to eliminate the exposed gas pipe and the risk of pipeline exposure from potential traffic accidents, PG&E began the process of designing a new, below-grade crossing of the freeway.

In 2014, Gas Transmission Services (GTS) completed a routing study and alternatives analysis that identified six potential options that would meet the goal of eliminating the risk of traffic accidents impacting the pipeline. These alternatives included hanging a new pipe on the UPRR bridge, constructing a pedestrian bridge and hanging the pipe from that, as well as four trenchless options which included both microtunneling and HDD alignments for crossing I-880. In order to meet the desired construction schedule, HDD was recommended as the preferred alternative.

PG&E requested that Bennett Trenchless Engineers (BTE) evaluate the feasibility of the HDD crossing recommended in the GTS Alternatives Analysis report. After analyzing a variety of factors including the anticipated geotechnical conditions, settlement and hydrofracture risks, pullback load and pipe stress analyses, available work areas and pipe laydown areas, existing utilities, and other improvements and structures; BTE concluded that the proposed HDD crossing of I-880 was not feasible. Upon reaching this conclusion, BTE devised and evaluated several microtunneled alternatives to overcome the deficiencies identified with the HDD crossing. After discussions with PG&E, the contractor, and Golder Associates, a preferred microtunneled alternative was selected. There were numerous project constraints that affected the trenchless design including congested work areas, a railroad crossing, a flood canal crossing (at grade and in a siphon beneath the freeway), a below grade eight lane highway, two aquifers (one of them artesian), and a hard construction tie-in deadline.

Due to the risk and complexity of the project the design was heavily scrutinized and every known obstacle was thoroughly

vetted. Unfortunately, designers can only account for what they know, and after six days of smooth construction the crew hit an unknown obstruction. This paper discusses the routing analysis, design, and construction phases of this project. Included is a thorough discussion of how the project team and the contractor coordinated the dig-up to find and remove the obstruction. The paper will also discuss some additional construction impacts that were caused by the dig-up itself.

> *Engineers, contractors, and owners need to be able to trust in as-builts.*

SITE AND GEOTECHNICAL CONDITIONS

The trenchless crossing of I-880 was located in a densely developed area, shown in Figure 2. In this area, I-880 ran roughly northwest-southeast. A set of two UPRR tracks crossed above the freeway approximately 125 feet north of the existing Line 153 at a slightly skew angle running northeast-southwest. The area north of the UPRR tracks and west of the freeway (lower left corner of Figure 2) was primarily residential and contained a mixture of single family homes and apartment buildings. South of the UPRR tracks and west of the freeway (lower right corner of Figure 2) was a business park containing a variety of commercial ventures including a cross fit gym, sign shop, archery supply store, and others. In addition, the Alameda County Flood Control Channel runs parallel to I-880 along the northern edge of the business park. The area east of the freeway and south of the UPRR tracks was commercial (upper right side of Figure 2). Businesses in the area included a manufacturing facility, utility contractor, and rental car lot.

Figure 2. Aerial view of the project location

In addition to the surface features and typical existing utilities in the residential area including water, sewer, and the 30-inch PG&E gas line and valves, there were several significant existing underground features. These underground features, which were primarily associated with the Caltrans operations, include the Alameda Flood Control Channel siphon crossing of I-880, which is located just south of the UPRR crossing; a dewatering system associated with the below grade portion of I-880; a retaining wall with foundation elements on the west side of I-880 that was built in association with the dewatering system pump station; and a system of storm drains in the center and on the shoulders of I-880. Figure 3 shows the locations of the critical underground and surface features. As-builts of the facilities were provided by Caltrans. The dewatering assets were all located north of the proposed of the alignment and were isolated to the area just around the pumping station. The microtunnel would cross under the edge of the retaining structure, however, Caltrans had this portion of the retaining structure foundation identified as a shallow spread footing. The retaining wall directly in front of the pumping station was constructed using drilled piles reinforced with I-beams.

The geotechnical investigation for the trenchless crossing of I-880 was performed in two stages. An initial investigation, consisting of two borings, was performed by Kleinfelder in 2013. These two borings were located near the ends of the proposed HDD crossing and are shown on Figure 5. As the feasibility evaluation progressed, supplemental borings were recommended to provide information relevant to evaluating the microtunneling alternatives. Specifically, a boring was recommended at or near each proposed shaft location with two monitoring wells recommended to evaluate groundwater elevations and fluctuations. The supplemental investigation, which included three new borings, was completed by Golder in 2015. The locations of the Golder borings are shown on Figure 5. Figure 4 shows the geotechnical conditions interpreted from the Golder borings. The geotechnical conditions encountered by the Golder borings were consistent with the conditions encountered by the earlier Kleinfelder borings.

Generally, the anticipated geotechnical conditions consisted of an upper clay layer, extending 18 to 23 feet below the ground surface underlain by a 5 to 8-foot thick upper aquifer consisting of loose to medium dense poorly grade sand to silty sand. Below the upper aquifer was a 17 to 19-foot thick layer of firm to stiff lean clay and below that was the lower aquifer which consisted of medium dense to dense well-graded sand with varying amounts of gravel and poorly graded sand to silty sand to the maximum depths of the borings.

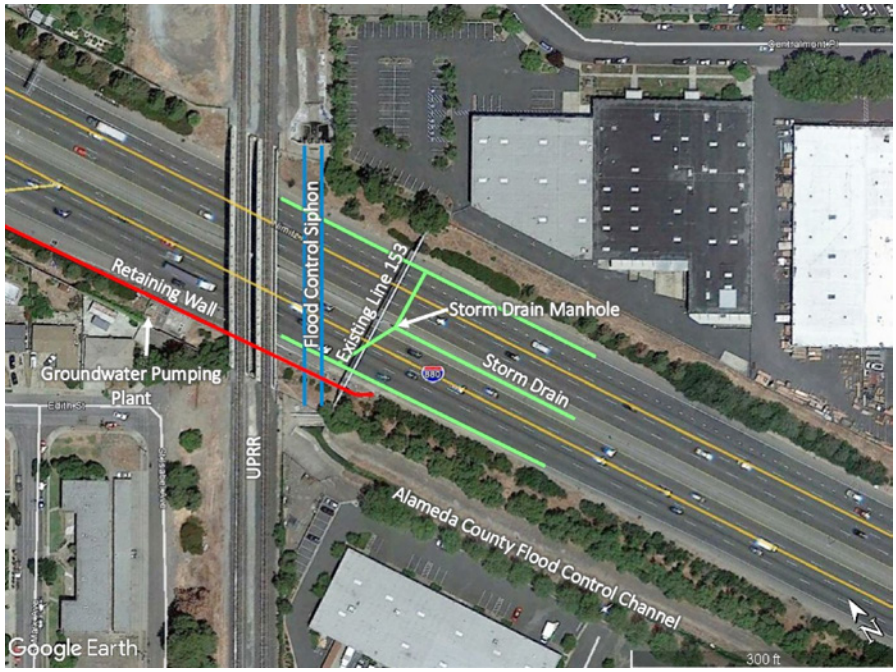


Figure 3. Existing underground features in the vicinity of the trenchless crossing

ALIGNMENT ALTERNATIVES AND SELECTED DESIGN

Two primary HDD alignment alternatives were analyzed as part of the feasibility analysis, both of which are shown by Figure 5. The first, proposed by GTS, was approximately 1,100 feet long and had a minimum clearance of approximately 12 feet from the centerline of the bore to the surface of I-880. Settlement and hydrofracture calculations performed during the feasibility analysis showed that this was not sufficient clearance to adequately protect the Caltrans facilities and other critical surface features. The second alternative was an approximately 1,370-foot crossing that was lengthened and deepened to provide adequate clearance from I-880, the UPRR tracks, and the Alameda County Flood Control Channel while still maintaining installation pipe stresses at acceptable limits.

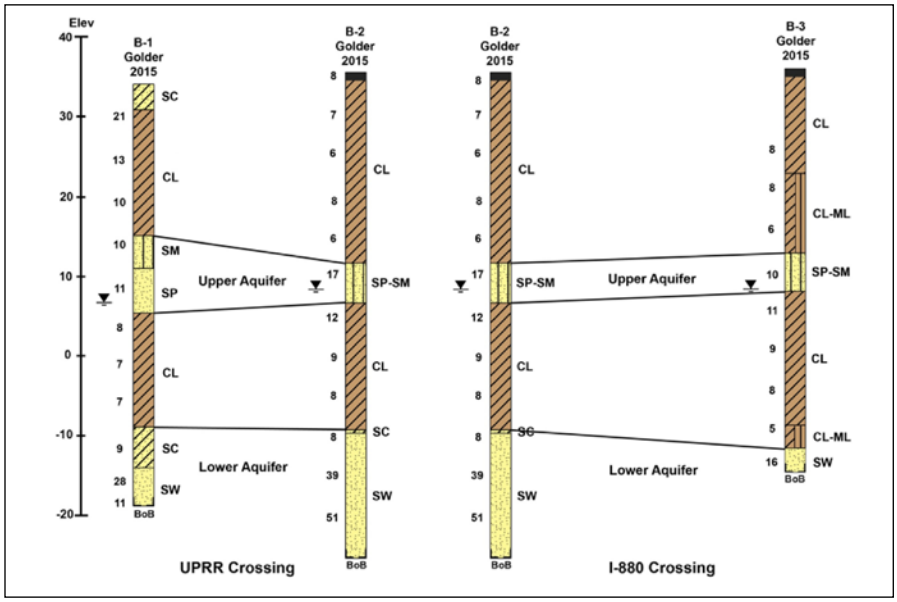


Figure 4. Geotechnical profile interpreted from Golder borings

Unfortunately, the technical drilling challenges and settlement and hydrofracture risks, which were mitigated or resolved by the second alignment alternative, were not the only challenges that needed to be overcome. The logistical issues related to available work areas and the impacts on businesses and residents were far more challenging. On the west side of the freeway, there was marginally adequate work area to set up the HDD rig and support operations. Overhead electric lines, businesses and closely spaced residences, and a lack of sufficient straight work area, however, would have prevented this side of the crossing from being used as pipe fabrication and lay down. On the east side of the freeway, there was approximately 400 feet of pipe fabrication and laydown area identified for the original, 1,100-foot crossing. To extend the laydown area any further would have required closing Central Avenue, a busy thoroughfare that crossed I-880; blocking numerous residential driveways; and use of multiple pipe segments that would result in several intermediate welds during pullback. The 1,370-foot long alternative identified as necessary to reduce settlement and hydrofracture risks further exacerbated the problems with the inadequate layout area by requiring more pipe to complete the crossing while simultaneously reducing the layout length that would not require street closures or driveways being blocked from approximately 400 feet to approximately 265 feet.

It was concluded that the amount of time required to fabricate the complete pipe string or make the intermediate welds would be unacceptably long and could not be appreciably reduced. To accomplish the installation a major street and many driveways would have to be blocked for a long period of time, numerous intermediate welds would have to be made which would result in unacceptably high risk of the pipe becoming stuck or the bore collapsing and causing settlement damage to the freeway, or some combination of the two. In addition, there were no alternative pipe layout areas on either side of the freeway which could resolve the disruption time and severity, even if the bore alignment

was changed. Another concern was that the preferred HDD alignment was at a significant skew angle to I-880 (Caltrans prefers crossings which are perpendicular or near-perpendicular to its facilities). There was concern that, even if the other logistical issues were resolved, Caltrans would not grant a waiver of its permit conditions if an alternative which complied with existing permitting requirements could not be devised. Due to this potential impact on the project schedule and the inadequate pipe layout area, the HDD crossing was deemed fatally flawed and not feasible.

Once HDD was eliminated as a feasible trenchless installation method for the I-880 crossing, attention turned to devising a pipe jacking solution. Due to the depth of the freeway below grade and the presence of two aquifers, one under artesian pressure, microtunneling was selected as the clear choice for the crossing of I-880. During the feasibility analysis, four microtunnel crossings of I-880 were considered. The first two alignment alternatives, shown in Figure 5, each consisted of two microtunneled drives: one parallel to I-880 and the other crossing at a skew angle to reach the approximate exit point of the original HDD alignment.

> *Final success of this project truly comes down to the entire project team!*

After discussions with PG&E and the Contractor, two additional pipe jacking alternatives were developed. The third was a single microtunneled drive that crossed both the UPRR tracks and I-880. The fourth alternative consisted of two drives, a short drive to cross the UPRR tracks and a longer drive to cross I-880. After analyzing the settlement risks, relative costs, and site constraints, alternatives 1 and 2 were eliminated. Alternative 3 initially looked promising, but after some research and investigation it was determined that the siphon under I-880 containing flows from the Alameda County Flood Control Channel was deeper than anticipated. To cross the siphon with sufficient clearance to avoid the risk of settlement damage would have required the trenchless crossing penetrate the lower aquifer, which would have dramatically increased the risks associated with the crossing and the cost of building the jacking and reception shafts. Alternative 3 was therefore eliminated from consideration and pipe jacking alternative 4 was selected as the preferred option.

Pipe jacking alterative 4 consisted of two drives: an approximately 130-foot shallow drive perpendicular to the UPRR tracks and a deeper, approximately 350-foot drive below I-880. The two drives required a total of three shafts: a shallow jacking shaft on the north side of the railroad tracks for the short crossing, a joint reception/jacking shaft south of the railroad tracks

and west of I-880, and a deep reception shaft on the east side of I-880. An invert elevation of 22.5 feet was selected for the UPRR track crossing, which resulted in approximately 11 feet of cover between the crown of the new pipeline and the ground surface. The short drive was located above the groundwater elevation and both aquifers so the allowable construction methods were auger boring, guided boring, and microtunneling. The specifications also allowed the jacking shaft for the short drive to be constructed using nonwatertight methods.

As mentioned previously, due to the depth of the freeway, groundwater elevation, and two aquifers, microtunneling was determined to be the only feasible trenchless method for the longer drive. Selection of the microtunnel drive invert elevation was challenging as there were several factors that had to be balanced: the pipeline had to have sufficient clearance to mitigate the risk of settlement damage to I-880 and existing storm drains while avoiding the risk of encountering the lower aquifer which could have resulted in problems for the trenchless construction and permitting issues. An invert elevation of 0.5 feet was selected for the pipeline which resulted in approximately 15 feet of clearance between the crown of the 30-inch diameter pipe and the road, approximately 8 feet of clearance between the crown of the gas line and the invert of the existing storm drains, and approximately 10 feet of clearance between the pipe invert and the anticipated location of the top of the artesian lower aquifer.

There were several additional design considerations that had to be addressed with the selected trenchless alternative. One set of issues that the design team looked at had to do with the installation of the gas product pipe. For corrosion management reasons, PG&E does not typically install their transmission pipelines in casings. However, on a previous PG&E project there was an issue with the microtunneling machine veering significantly off of line and grade while attempting to direct jack the gas product pipe. Direct jacking the gas product pipe also has the downside of being a time-consuming process as each product pipe joint has to be welded, x-rayed, and coated. For a 30-inch pipe, this process could take as much as an 8-hour shift per weld. To address all of these issues, the design team specified the Contractor use a sacrificial casing while tunneling and then displace the sacrificial casing with the product pipe. Each product pipe weld would still take many hours, but the Contractor could demobilize the microtunneling machine and most of the support equipment, leaving just what was necessary to run the jacking frame to push the product pipe.

Figure 5. HDD and microtunnel alignment alternatives identified during the feasibility analyses

Several design issues were tied to the shaft sizing and shaft construction method. Alameda County Water District (ACWD) has strict permitting conditions in this area in order to avoid cross-contamination between the two aquifers. As a result, the allowable shaft construction methods for the two deep shafts were restricted to cutter soil mixing (CSM) and secant piles. Sizing and positioning of the shafts was also a challenge because the shafts needed to be sized to accommodate the trenchless construction activities as well as construction of the gas pipe risers at angles that would allow a smart pig to be run through them while maintaining adequate clearance from the excavations to nearby buildings and other site features such as the existing 30-inch diameter Line 153 pipeline. There were also restrictions on where the microtunnel drive could be located to avoid the existing gas pipeline support in the center of the freeway,

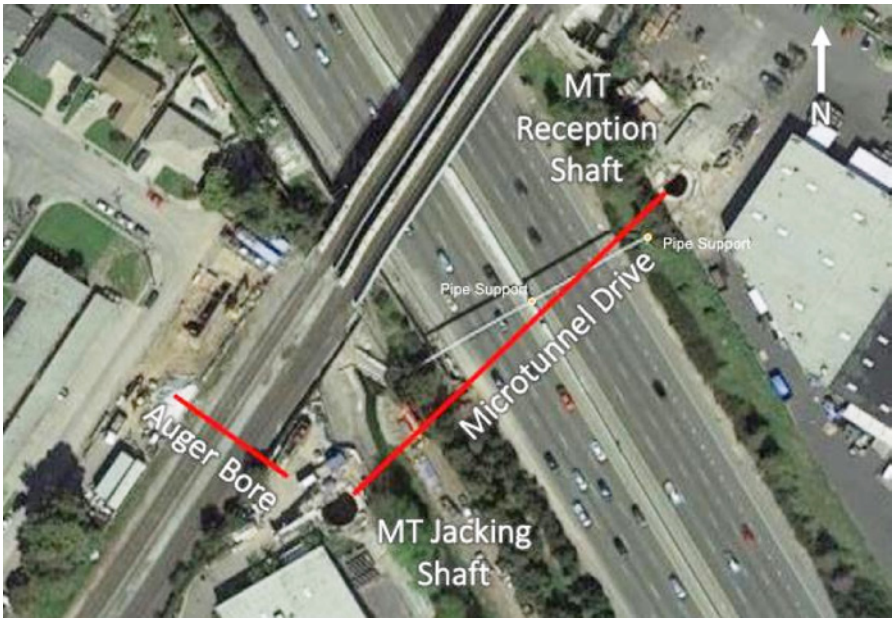


Figure 6. Aerial photograph showing the location of the shafts, microtunnel drive, and auger bore drive

the existing gas pipeline on the east side of I-880, the flood canal, and the storm drains and storm drain manhole in the center of I-880. The design team allowed a maximum jacking shaft excavation size of 40 feet by 40 feet and maximum reception shaft excavation size of 40 feet by 30 feet, and left the selection of the final shaft size to the Contractor.

The final alignment and shaft locations are shown in Figure 6. The alignment threaded the needle between the supports for the existing pipe while maintaining adequate clearance between the shaft excavations and buildings/site features. As a result, the microtunnel drive passed beneath the edge of the Caltrans retaining wall and a storm drain manhole. These existing features were of significant concern as they could result in an unsuccessful microtunneling drive. The design team therefore obtained as-built documents from Caltrans and dedicated a significant amount of time to determining the as-built location and foundation type of the retaining wall as well as the invert elevation of the storm drain manhole. There was not much information available about the construction of the storm drain manhole, but the storm drains were dipped and it was determined that the foundation of the manhole construction would have to be at least 7 feet thick for the microtunneling machine to strike it. As this was highly unlikely (it would be highly unusual for this type of construction in this area), the risk of striking or damaging this feature was deemed low. Based on the as-built drawings that were obtained, it was determined that the retaining wall foundation was a spread footing and that there would be sufficient clearance between it and the microtunnel that the risk of striking or damaging it would be very low.

Unfortunately, as we will discuss in more depth, the retaining wall as-builts did not actually reflect what was constructed which led to a significant problem during the trenchless construction.

Figure 7. Photos of the pieces of metal found in the spoils coming off of the separation plant

START OF CONSTRUCTION

Shaft construction began in early December 2016 when Malcom Drilling started installing the two CSM wall shafts. The launch shaft was to be 30 feet in inside diameter with the reception shaft being 20 feet. Both shafts would have floors constructed out of eight-foot diameter jet grout columns. It was necessary to jet grout the shaft floor prior to excavation in order to keep water from the lower aquifer from flooding the shaft. The jet grout plugs for the launch and reception shafts were approximately 18 and 13 feet thick respectively. While the launch shaft was installed without issue, an abandoned utility was struck during the installation of the reception shaft. The abandoned line was removed, capped and then construction continued after an observed holiday.

After the jet grouting and CSM walls were completed the shafts were excavated. By jet grouting the slab, the only water that needed to be disposed of was from the saturated soil inside the shaft. The bottom of the shaft was cleaned and a smooth working slab was poured. Vadnais Trenchless (a subsidiary of Primoris Services Corporation, PSC) mobilized to the site in late January of 2017. After troubleshooting to resolve an issue with a booster pump and a new light source in the head that was creating glare on some of the gauges, Vadnais launched the 30-inch microtunneling machine (MTBM) on February 1, 2017.

On the first day of tunneling, they successfully buried the machine and set the first section of sacrificial Permalok casing. They had some difficulty fully engaging the gasketed joint between the MTBM and the casing because there was not much frictional resistance along the bore and they did not want to push the face of the MTBM into the clay, as this could result in challenges when they resumed tunneling. They therefore spent a portion of the day welding temporary connections between the machine and the jacking frame. This enabled them to close the gap in the joint by the end of the day. Tunneling resumed the following day and Vadnais successfully installed the first 20-foot section of casing at an advance rate of approximately 0.75 inches per minute. On the third day of tunneling Vadnais spent some additional time dealing with the lighting inside the machine. At this point in the tunnel their solution to the glare problem they encountered at the start, diffusing some of the light with a welding shield, resulted in not enough light to see the gauges. A crew member went into the tunnel and was able to make some small holes in the welding shield and remedy the problem. After this was resolved, tunneling of casing joint two proceeded smoothly at an advance rate of approximately 1.5 inches per minute. In the afternoon a small leak occurred in one of the slurry lines running along the northern fence

of the site. Some slurry flowed under the fence and a small amount entered the Alameda County Flood Control Channel. The Contractor documented the spill, notified the appropriate people, and cleaned up the slurry before leaving the site. The following two days of tunneling proceeded smoothly. Each day Vadnais installed a joint and a half of Permalok (30 feet of total production per day) at an advance rate of approximately 1.5 inches per minute.

After six overall smooth days of tunneling, a significant problem occurred on February 7, the sixth day of tunneling. Setup of the sixth section of Permalok casing was completed and tunneling resumed around 8:50. At 11:10, with the MTBM head located approximately 126 feet from the face of the jacking pit, torque abruptly spiked to over 100 percent of capacity (the machine had been running consistently at 60 percent torque) and the machine rolled 13 degrees. Shortly thereafter, angular gravel and coarse sand started coming off of the separation plant, which was a departure from the consistent clay soils that had been encountered up to this point. Vadnais continued attempting to advance, alternating the rotation direction of the head between clockwise and counterclockwise to keep the machine roll between 10 degrees in either direction. After 10 minutes, earth pressure on the face dropped to practically nothing until, once every approximately 10 seconds, it would spike to over 10 tons per square meter.

Vadnais stopped tunneling and notified the construction team and PG&E of the sudden change in tunneling conditions. It was determined that the MTBM was approximately 9 feet short of the freeway and 11 feet short of the first storm drain that crossed the alignment. The surface features that were present near the location of the tunnel face were the toe of the embankment and the retaining wall on the southwest side of the freeway. With this in mind, after a discussion with the construction team, Vadnais was directed to continue tunneling but to proceed with caution. Tunneling resumed for just over ten minutes. At this time, several small pieces of metal an inch or less long (shown in Figure 7) were found in the spoils coming off of the separation plant. Vadnais shut down and notified PG&E of the situation.

DIG UP AND REMOVAL OF OBSTRUCTION

After measurements were taken, it was clear that the mictrotunneling head was located directly behind the retaining wall. Either the retaining wall was deeper than the as-builts had indicated or something was buried under the wall. Discussions quickly developed into how to get down to the head to find out what was in front of the machine. Teams worked in parallel to get access to perform night work on the shoulder of Highway 880, design an excavation plan, and initiate discussions with Caltrans Engineering.

As the microtunnel alignment was designed between two aquifers, groundwater management was going to be a challenge during the dig up operations. ACWD was closely consulted throughout this project and recognized that the project was in an emergency situation. Therefore, ACWD allowed the team to proceed with the excavation under the existing permits.

Due to ongoing construction activities on Highway 880 near the project site and Caltrans policies regarding multiple active projects within a certain distance of each other on the same highway, access to the location above the MTBM was limited. However, in mid-February a crew was able to go out with a vacuum excavator at night to begin an exploratory excavation on the back side of the retaining wall. The plan was to follow the back side of the wall and find the depth of the shallow footing to confirm the as-builts and locate what was struck. From this investigation it was determined that the MTBM had encountered an I-beam poured into the retaining structure. After confirming that the as-builts showed a shallow spread footing, an engineer at Caltrans, not originally part of the Caltrans permit review team, recalled that indeed piles were driven for the full length of the retaining structure and that the as-builts were incorrect.

Caltrans agreed to allow PG&E to remove the section of I-beam impeding the installation of the new gas pipeline and a larger excavation plan was designed. Caltrans also agreed to allow PG&E and ARB to perform their night work until the obstruction could be removed.

On Febuary 25, 2017 the contractor began excavating and lowering a large reinforced vault. Additional sheet-piles were eventually driven around the I-beam to increase the size of excavation. Due to the amount of groundwater encountered, the lowering of the box and the overall excavation process was slow. However, on Saturday March 11 the Contractor exposed the front half of the machine. That next week the obstruction was cut out of the way and the shaft was backfilled with slurry.

COMPLETION OF TRENCHLESS CONSTRUCTION

Microtunneling operations resumed on March 16. On that day, Vadnais installed approximately 30 feet of casing (the remainder of casing six, all of casing seven, and a portion of casing eight). At the end of the day, they had a slurry valve malfunction at the face which they addressed by refilling the hydraulic oil reservoir for the valves the following day. Unfortunately, after installing the remainder of casing eight and a portion of casing nine, they continued having problems with the valve and so only achieved a total of 14 feet of production on March 17. So, on the following day they created a slurry bypass circuit in the jacking shaft to work around the problems with the valve and continued tunneling. (The problematic valve could not be accessed or repaired while the MTBM was underground.) When they resumed tunneling casing nine, slurry traveled back through the annular space and was able to reach the surface through the backfilled emergency excavation at the toe of the embankment. Slurry entered the storm drain on the shoulder of I-880 and got into the canal siphon. The construction team cleaned up the spill and Vadnais was able to finish installation of casing nine with no further slurry releases.

At this time, PG&E was becoming increasingly concerned about meeting the hard schedule deadline for tie-in of

the new line. This tie-in requirement was due to an allowed clearance on the line that all parties involved were trying to coordinate. After discussions with the design and construction teams and PG&E, the decision was made to begin installation of the product pipe behind sacrificial Permalok casing nine. With nine sacrificial casings installed, it was felt that the steering issues encountered on the previous PG&E microtunneling project had been adequately mitigated. Even if the product pipe were to be significantly less than straight, there would still be enough flexibility in the sacrificial casings to allow for steering response. PSC and Vadnais therefore welded a short transition section to the front of the first section of gas product pipe and, on March 18th installed it in the pipe jacking string.

Vadnais began installing the first section of gas product pipe at 12:50 on March 18 and immediately saw slurry returns at the ground surface on the shoulder of I-880. The slurry returns occurred at the same location as the morning when they occurred during installation of casing nine. After cleaning the spill and a discussion with the construction team, Vadnais re-attempted to advance the first section of gas product pipe. This time they made several changes to their tunneling start-up sequence which resulted in no additional slurry loss to the surface. At the end of the day, a total of 208 feet of pipe was installed. When they attempted to resume tunneling the following day, however, they once again had a problem with losing slurry. There was no spill at the ground surface this time, but the separation plant operator reported that they lost slurry from the separation plant tank and workers monitoring the rescue operation reported water making its way into the excavation. There was no vac truck on site at the time to clean up or assist with containing a spill that could impact the freeway, so Vadnais shut down for the day without advancing the tunnel.

The following morning, with a vac truck staged and ready to clean up any inadvertent returns, Vadnais once again attempted to resume tunneling. Initially they struggled to maintain circulation, but after some additional adjustments they were able to successfully install the second section of gas product pipe with no problems. Over the next five days, Vadnais installed six additional sections of gas product pipe. Tunneling operations proceeded smoothly and the only reason that production rates were not higher was that it took approximately eight hours to weld, inspect, and coat each gas product pipe. Vadnais and ARB coordinated closely to enable the welding and tunneling crews to switch at appropriate times so that installation would proceed as quickly as possible. On March 29, the MTBM reached the soilcrete wall of the reception shaft at the end of gas product pipe nine, 346 feet from the face of the jacking shaft. The MTBM was pushed out of the exit seal and successfully retrieved on March 30.

Vadnais resumed installing the remaining product pipe and the project was completed in time for the original tie-in.

CONCLUSIONS

This project proves that even with a complete geotechnical report, a thorough routing analysis, and using the correct trenchless installation method for the anticipated conditions, you cannot design for the unknown. We were ultimately able to find the obstruction and, as it turns out, the I-beam was visible just below the ground surface but engineers, contractors, and owners need to be able to trust in as-builts. Correcting these drawings could have saved money, time, and a great deal of effort by all parties involved.

With all that said, the final success of this project truly comes down to the entire project team. Owner, contractor, and engineers all working together to find the problem, put together a plan, and then put that plan into action. Without everyone working together as a team this problem would not have been solved in the time that it was and, with trenchless projects, time can be your worst enemy.

ACKNOWLEDGEMENTS

The authors would like to thank Malcolm Drilling, ARB, and the Vadnais for their efforts to make this project a success.

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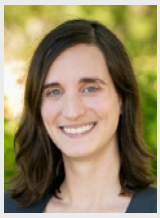

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***Pacific Gas and Electric Company**, incorporated in California in 1905, is one of the largest combined natural gas and electric energy companies in the United States. Based in Oakland, the company is a subsidiary of PG&E Corporation. The company provides natural gas and electric service to approximately 16 million people throughout northern and central California.*

Tech Lesson for Silicon Valley:

Cratus, Inc. Brings Leading Pipe Bursting Technology to Palo Alto

By: TT Technologies

The City of Palo Alto is considered the birthplace of Silicon Valley. The much-heralded area has been responsible for some of the most impactful technological advancements in history. But while technology of that sort amazes the general public, most would rather not consider the technology being used to update the infrastructure underground, specifically the sanitary sewer. That technology, trenchless technology, has been one of the most important advancements in the underground construction industry and has changed the way utility contractors approach projects. For a recent sanitary sewer upgrade project in Palo Alto, it was trenchless pipe bursting that was making an impact.

Utility contractor Cratus, Inc, San Francisco, CA was selected to take on the multi-facetted project. The project included the replacement of approximately 10,000 feet of Vitrified Clay (VCP) sanitary sewer mains of varying diameter, along with the replacement of 28 manholes and 150 existing city-owned sewer service laterals and cleanouts. The VCP was specified to be replaced with High Density Polyethylene (HDPE), which made it a prime candidate for pipe bursting.

Liam Finnegan, President of Cratus, said his company has a significant amount of pipe bursting experience and was well prepared for this type of project. Finnegan said, "We focus on all utility work, underground sewer, water. We don't really do much else. We don't do any concrete work. Sewer and water are what we primarily do. We've done quite a bit of pipe bursting."

> *Pipe bursting was a good option for this particular project.*
> *- George Mallakis, Regional Manager, TT Technologies*

With the amount of pipe bursting slated for the project, high production pneumatic bursting equipment was chosen for a majority of the project. Pipe bursting specialist George Mallakis from trenchless equipment manufacturer TT Technologies, Aurora, Ill., explained that pneumatic pipe bursting has been a workhorse in the industry since the 1980s. He said, "Pneumatic pipe bursting really put the method on the map beginning over 40 years ago. Contractors have been able to burst and replace literally thousands of miles of pipe with pneumatic pipe bursting. And it was a good option for this particular project."

For the Palo Alto sanitary sewer replacement project, a reversible PCG180 pneumatic hammer, along with an RW10 10-ton constant-tension, variable speed Grundowinch and reversible boom, from TT Technologies was used.

CRATUS, INC., QUALITY FOCUSED CONTRACTOR

Cratus is a high-quality utility contractor where safety is a top priority. The company emphasizes safety training, toolbox talks, observation programs, and job hazard analyses to prevent incidents from even occurring. And they make sure the right people are positioned to ensure safe operations. Finnegan said, "We operate with a superintendent and foremen and then inside that lead men in the crews, especially the pipe bursting. There are lead men on the mainline pipe bursting then on the

Cratus crews used a special reversible boom (pictured) for the pneumatic pipe bursting portion of the project. The boom creates additional space for detaching the busting tool from the winch cable in the manhole

backend we have lead men on paving and restoration backfill crews. We do toolbox meetings once a week. Our foremen go through a certain topic. We do the training as often as we need to keep everybody up to date if something changes."

ON THE JOB

The largest portion of the project was nearly 7,000 feet of 6- and 8-inch VCP to 8-inch HDPE, followed by smaller sections of 8-, 10- and 12-inch VCP to 10-inch HDPE and 10-inch VCP to 12inch HDPE. Finnegan said "We fused all the HDPE pipe on site, for each run. There was very limited space to fuse some days. We had to do a separate fuse on the day of the pull, which delayed us. The city also has its own certification process for pipe fusing that we needed to go through."

For most of the project the mains ranged from 6 to 10 feet deep with some sections as deep as 12 feet. Bursting runs averaged 350 feet with most running manhole to manhole. For traffic control, Cratus crews took the center lane of the roadway and pushed the traffic to each side.

According to Mallakis, the pneumatic bursting system was ideal for this project. He said, "The straight barrel tool worked well bursting manhole to manhole. Straight barrel bursting tools, like the 7-inch diameter PCG 180, use a front expander. This is a different configuration than your standard rear expander system. The front expander adds versatility to this style of tool when entering manholes you do not want to remove and replace. The straight barrel tools can be reversed automatically with a lever located on the in-line lubricator.

"So, once you complete a bursting run and enter the manhole, the winch cable can be detached from the tool and be reversed out through the newly installed pipe. This is extremely helpful when bursting into a manhole from a pit. Removing the tool through the manhole is usually not possible because of space limitations, but reversing it out to the launch pit solves that problem."

For pneumatic pipe bursting, the bursting tool is guided through the existing pipe with a constant-tension, variable speed winch. Mallakis explained,

> *"The most challenging part was crossing so many utilities. We had a lot of potholes."*
>
> *- Liam Finnegan, President, Cratus Inc.*

"The winch is specifically designed for pipe bursting and other underground construction applications. The constant-tension, variable speed aspect allows the winch to adjust for conditions that affect line speed during the pipe bursting operations providing for constant and consistent pulling force. Cratus also has

For a 700-foot section of 15-inch VCP to 18-inch HDPE, the Cratus crew utilized a Grundoburst 1250G static pipe bursting system from TT Technologies

The 700-foot section of main was in an area near businesses and homes. The static system provided a quieter option than the large pneumatic hammer for that area

one of our specially designed reversible booms on this project, which creates more space to detach the tool from the winch cable and back itself out. The Cratus crews were very efficient and productive."

While the bursting runs went smoothly on the Palo Alto project, getting to the point where bursting could begin proved challenging and contributed to some long days on the work site. Finnegan explained, "One of the biggest issues with the project was the number of adjacent utilities. We had to excavate quite a bit because Palo Alto has many utilities that are underground. All the electrical in the area and basically everything else. They don't have many poles in that city or overhead utilities of any kind. So, we had a lot of potholes. That was probably the most challenging part, crossing so many utilities.

"Then, by the time you do an active bypass on that system, 6-inch hoses on 6-inch pump, put in temporary piping, get the new pipe into position, get down, get it shackled down and get moving, I don't know what time in the day we started pulling, but in the end, it's a 12-hour day."

For a 700-foot section of 15-inch VCP to 18-inch HDPE, the Cratus crew utilized a different approach to pipe bursting. Mallakis said, "For the larger diameter pipe we brought in a static pipe bursting

The Cratus crew proved proficient with both the pneumatic and static pipe bursting systems, successfully replacing over 10,000 feet of sewer main for the city of Palo Alto

> *Residents benefit from pipe bursting through lower costs, less disruption, and lower carbon emissions.*
>
> *- George Mallakis, Regional Manager, TT Technologies*

system, the Grundoburst 1250G. This gave Cratus the opportunity to expand their pipe bursting resume and, with the proximity of both businesses and homes at that location, the static operation is much quieter than the larger pneumatic hammer. We also used special tooling that helped with connecting and disconnecting in a highly efficient manner."

For the static bursting process, instead of a winch guiding a pneumatic tool through the host pipe to break it apart, a hydraulically powered bursting unit uses static pull force to pull quick lock rods and the expander through the host pipe while pulling in the new pipe at the same time.

Mallakis said, "Static pipe bursting is very versatile and popular because you have the ability to pipe burst a wide range of existing pipe materials and install a wide range of new product pipe materials in addition to HDPE. Pneumatic pipe bursting is still a high production method and widely used especially in gravity sewer, but static pipe bursting has become a more common alternative especially in water and pressure pipes."

Finnegan said, "That was our first time using the Grundoburst static rod system. We wanted to use it in the past, but didn't have the suitable project. We only did one pull. It was more like a test for us. I liked it. Once you got the pipe ready to go and if you have long runs, that machine is a beast, you know what I mean? That's how I would describe it. But it was very smooth."

Mallakis said, "Cratus' ability to plan well and bring the best people and equipment to the job made this project a success. The City of Palo Alto and their residents benefit from pipe bursting being specified and used instead of traditional open cut replacement through lower costs, less disruption, and lower carbon emissions to get the job done."

ABOUT TT TECHNOLOGIES:

TT TECHNOLOGIES

For more than 45 years, TT Technologies has been the worldwide leader in trenchless technology. Each year, more trenchless sewer, water, gas and electric rehabilitation and replacement projects are successfully completed with trenchless equipment from TT Technologies than any other. TT Technologies is the leader in trenchless!

History and Development of Geonex Horizontal Hammer Boring Systems

By: Paul Wilkinson, Kilduff Underground Engineering, Inc. (KUE)
Kimmo Juvani, Geonex Inc, (GEO)

Effective solutions for installing small diameter tunnels through, solid rock, broken rock and difficult soft ground are pretty thin on the ground however they do exist, and we discuss here the development of Horizontal Hammer Boring (HHB) technology in Scandinavia over the last 30 years.

Scandinavian ground conditions can be extremely onerous requiring utilities to be installed through hard rock and soft ground littered with boulders that has forced contractors to think out of the box to find reliable cost-effective solutions to install underground ducts.

Pneumatic hammer well drilling technology from the 50s commonly referred to as Down-The-Hole (DTH) hammers provided a solution. Driven by compressed air the hammer mechanism has a fairly simple rapidly reciprocating piston arrangement that percussively strikes a drill head assembly 2 to 10 times per second to generate massive percussive impact energy that disintegrates and drives through the ground. Exhaust air from the piston is directed through the drill head to flush spoil cuttings to the surface.

> *In 2019 the Geonex system received NASTT's Innovative Product of the Year Award.*

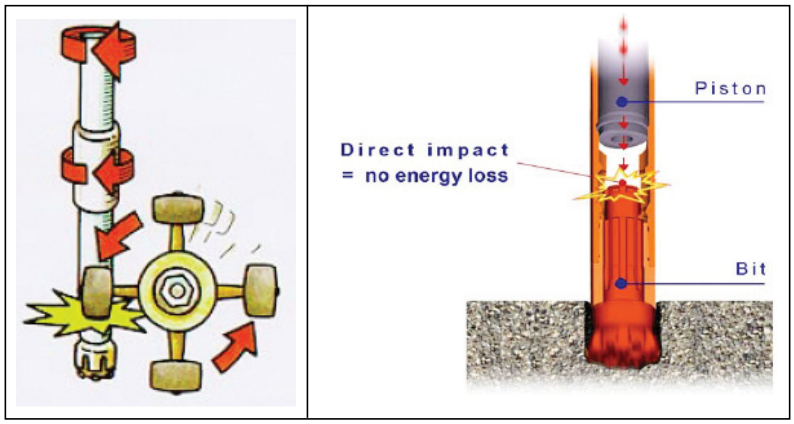
Pentti Juvani, father to sons Kai and Kimmo from Boreal Star Oy, a family-owned Finnish contracting company, adopted DTH technology in 1993 and converted hammers to run horizontally on their homemade rigs that when put to work also demonstrated the ability of the percussive energy to pull attached casing strings through the ground, providing cost saving benefits of not requiring shafts with thrust walls to pipe jack casings through the ground.

Boreal Star's initial small-scale enterprise expanded rapidly with the company transitioning to being a solely HHB

business by 1997. The company was sold in 2006 but Kimmo Juvani remained to be heavily involved in HHB contracting to 2011 registering an achievement record of more than 10,000 bores extending to 650,000 feet in the ground!

Reliable cost-effective solutions to install underground ducts through solid rock, broken rock and difficult soft ground

Pentti Juvani, father to sons Kai and Kimmo from Boreal Star Oy, a family-owned Finnish contracting company



Rapidly reciprocating piston arrangement percussively strikes drill head assembly 2-10 times per second to generate massive percussive impact energy

Having mastered HHB contracting, Kimmo's attention moved to and refocused on developing, designing, and manufacturing state of the art plug and play HHB equipment that could be offered to the Scandinavian and world-wide trenchless market.

By 2012 the concept for 1) A pneumatically powered horizontal hammer that uses exhaust air and augers to return excavated spoil down the casing 2) A hydraulically powered rig with a rotary drive unit to guide casings and drive the augers 3) A system controlling power pack unit, had been devised and the company Geonex Oy was founded.

Designs were finalized, and supply chains formed allowing for production and sale of the first HZR 400 system in 2013.

Further designs to create four systems to cover casing installation in the range of 5.5 to 48 inches were completed by 2017:

a) HZR 220 + PP 180HA for casings 5.5-to-8.625-inch,
b) HZR 400 + PP 90 for casings 6.625 to 16-inch,
c) HZR 610 + PP 180 for casings 10.75 to 28-inch &
d) HZR 1200 + PP180 for 24 to 48-inch casings

> *It is also being unusually used to excavate catacomb graves in Israel.*

2019 NASTT Innovative Product of the Year Award

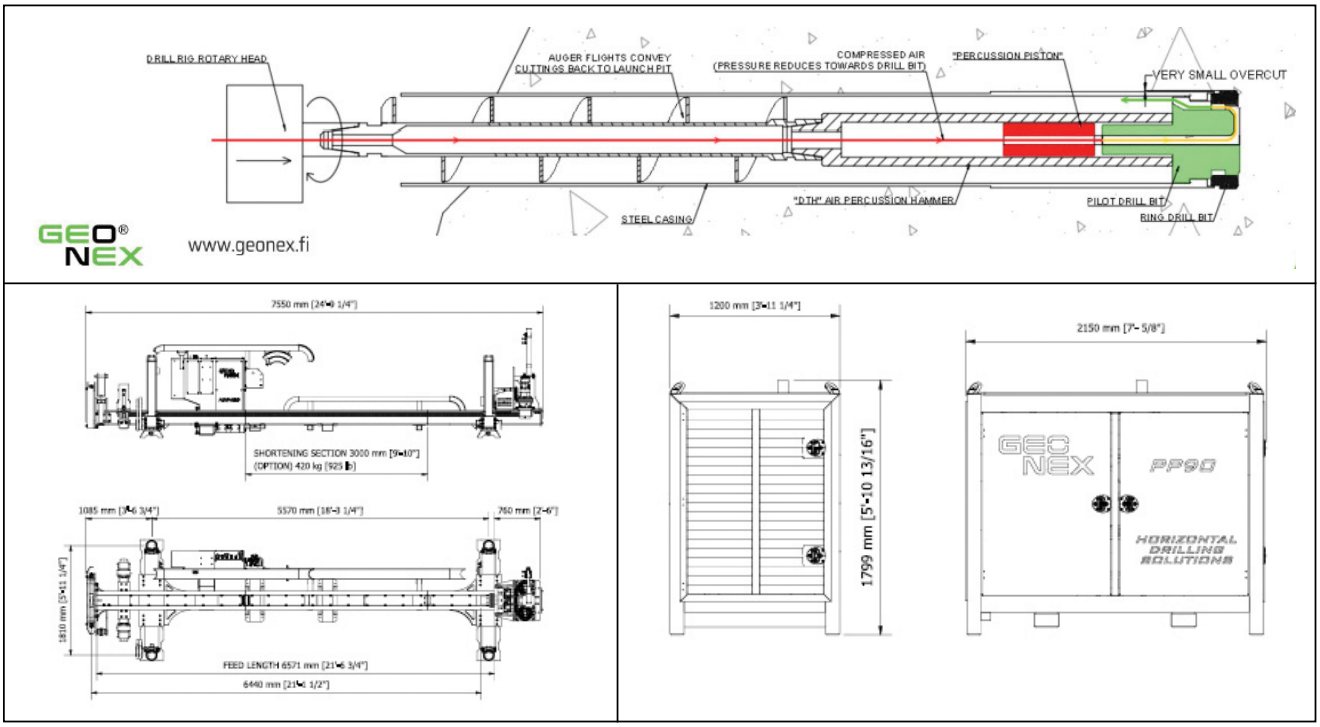
Key system benefits include the ability to operate in all ground with the same cutter head. Installation rates of 7 feet per hour through hard rock and 20 feet per hour in mixed ground with boulders that are reliable and fast. Control via a wireless light-weight hand portable control unit, allows the operator to be safely positioned remote from the rig, where required. Low set up costs, due to self-propulsion of the hammer shafts are not always required, which in turn allows for economical use of long 40-foot casing elements. Access for recovery is only required for removal of the ring bit and the short starter casing. Labor requirements are also low, typically systems up to 24-inch can be manned with three workers, with one being a coded welder. For 30-inch and above, it is recommended to have two welders, taking the total crew requirement to four workers. With remotely activated hydraulic legs for lateral and height adjustment rigs can be set up and ready to bore in half a day shift. All in all, a reliably robust efficient solution that can install 300-foot long bores within a week. The equipment is almost completely retractable, only leaving behind the peripheral cutter bit and starter casing allowing blind hole bores such as starter and receiving casings for horizontally drilled crossings to be undertaken.

Cased bores are limited to approximately 330 to 500 feet in length. Active steering is currently not available however when launched and correctly operated accuracy of approx. 0.5 percent over bore lengths is achieved. It is important to monitor that the hammer assembly and lead casing are installed on the designed alignment and use the hydraulically adjustable legs of the rig to make as required adjustments. Impact forces generated by the hammer disturb ground at the excavation face that trend to slight downward movement of the hammer along the bore. The "Rule of Thumb" is, the harder, denser, or better load bearing the ground the better the accuracy. Operators also need to adjust hammer impact frequency to suit project conditions and / or changed project conditions, higher than required frequency will induce greater downward movement trends.

Uncased open hole bores in competent rock can extend 1000 to 1500 feet and have the ability to be steered via the initial 6-inch pilot bore using sonde detection equipment for guidance.

In 2019 the Geonex system received NASTT's Innovative Product of the Year Award and to date over 50 Geonex systems have been sold to Finland, Sweden, Norway, Israel, Switzerland, Austria, USA, Canada, Germany, Spain &

In Norway bores mainly run through strong to extremely strong 50,000+ psi unconfined compressive strength rock



By 2012 the concept had been finalized, with sale of the first HZR 400 system in 2013

> *Customers are moving to purchase additional units after delivery of the first.*

Portugal. Scandinavia remains the most popular market where HHB is used for around 80 percent of 5.5-inch to 48-inch cased trenchless crossings < 500 feet in length, most bores are installed through terrain with frequent boulders. In Norway bores mainly run through strong to extremely strong 50,000+ psi unconfined compressive strength rock. In Switzerland the versatility of the system has been recognized and Geonex has been nominated for projects to minimize the risk of bore failure due to unforeseen natural ground conditions, it is also being unusually used to excavate catacomb graves in Israel.

The equipment from Finland is gaining traction and acquiring a reputation of "once used or seen never forgotten". Orders are being placed without work in-hand and customers are moving to purchase additional units after delivery of the first.

For Kimmo, supported by Tuomas Lassheikki and an ever-increasing work team product development is not over. Whilst writing the article a trial has been undertaken in Finland with an actively steerable 8-inch guided pilot casing that is to be reported under separate cover as is the factory test and field trial using mechanically interlocked steel casings that can offer an alternative to site butt joint welding of casings.

DTH and HHB hammers are not new to market, but the cleverly adapted Geonex package certainly is and offers ease of market entry to customers. For engineers and contractors, it puts on the table a "go to solution" for the installation of small diameter tunnels in the "rock and the hard places".

ABOUT THE AUTHORS:

***Paul Wilkinson** is a Senior Consultant who has been associated with Kilduff Underground Engineering (KUE) from its onset in 2014 and brings 31 years of Microtunnelling experience to the company. Formerly serving as General Manager for Iseki Euro Paul has personally overseen the installation of over 120 KM of micro tunnel, on over 200 projects in 27 countries.*

***Kimmo Juvani** is the CEO / President of the Geonex Group. Kimmo has nearly 30 year career working with Horizontal Hammer Boring. He started as CEO of trenchless contracting company solely working with HHB in Scandinavia. Later in 2012 Kimmo transferred from contracting to manufacturing of Geonex Horizontal Hammer Boring solutions as CEO / President of Geonex Group. Kimmo holds records in HHB contracting of over 10,000 holes and 200,000m.*

HDPE Electrofusion Pipe Joints

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

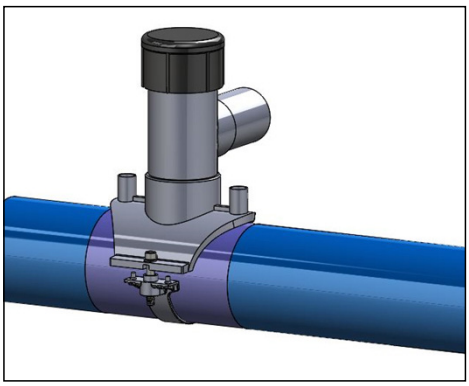
High-density polyethylene (HDPE) pipe has been used for municipal and industrial water applications for almost 50 years. HDPE's heat-fused joints create a leak-free, self-restrained, monolithic pipe structure. The fused joint will also eliminate infiltration into the pipe and exfiltration into the environment.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

Heat fusion can be used to join sections of HDPE pipe, including high-performing PE 4710 pipe, while electrofusion is used to add couplings, tapping tees, branch saddles and other fittings. Proven to be an extremely reliable joining system, an electrofusion joint is heated internally, either by a conductor at the interface of the joint or by a conductive polymer. Heat is created as an electric current is applied to the conductive material in the fitting.

TYPICAL ELECTROFUSION JOINT

All heat fusion joining methods require that there is no water flowing or standing in the pipe that can reach the fusion surfaces. Flowing water in contact with the fusion surfaces during the assembly or fusion cycle must be avoided as it can cause voids as the moisture turns into expanding steam during the fusion process. PE squeeze-off tools can be used to control the flow of water in cases where a valve is not present or will not shut off completely - refer to ASTM F1041.

Electrofusion fittings can be installed in ambient temperatures as recommended by the manufacturer.



Saddle Electrofusion

A typical qualified temperature range for installation is 14°F minimum to 113°F maximum. Contact the fitting manufacturer to verify.

Improper pipe preparation is overwhelmingly the leading cause of unsuccessful electrofusion joint. The goal of pipe peeling is to remove a thin layer of the outer pipe surface to expose clean virgin material beneath.

Pipe surfaces exhibit surface oxidation from the extrusion process, transportation, and outdoor exposure. This oxidation acts as a physical barrier and therefore those surfaces cannot be heat fused. Simply roughing the pipe surface is not sufficient. In order to achieve fusion, this layer must be removed. Even new pipe must be properly peeled before a fusion will be successful.

An adequate minimum amount of material that must be removed is just seven one-thousandths of an inch (.007") – approximately the same thickness as two sheets of ordinary paper.

Sandpaper, Emory cloth, or other abrasives should ***never*** be used to prepare a pipe surface for electrofusion. The only tools are those that are specifically designed for electrofusion peeling, which can peel the pipe surface to a controlled depth. Types of scrapers that are not recommended are "hand scrapers" such as wood rasps and metal files.

"Witness" marks should be made on the pipe surface prior to peeling with a permanent marker, such as a Sharpie® marker, which dries fast and contains no oils.

Avoid all possible recontamination of the prepared surface. This includes handling or even touching the peeled pipe surface or the inside of the coupling as body oils and other contaminates can affect fusion joint performance. If the surfaces become contaminated, clean thoroughly with a clean, lint-free towel and a minimum 90 percent concentration of alcohol isopropyl and allow to dry before assembling. Do not use alcohol with any additives other than water.

Gouges deeper than 10 percent of the pipe wall thickness require that the pipe section be cut out and replaced to maintain the maximum pressure rating of the pipe.

> *"Pipe preparation is among the most important aspects of making a sound electrofusion joint."*

Electrofusion in Pit

The *MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe (MAB-01-2022)* guide has been updated by the Municipal Advisory Board (MAB) and is available as a free download from the MAB website:
www.plasticpipe.org/MABPUBS

ABOUT PPI:

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

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A Novel Composite for Large Diameter Pipeline Renewal

By: V. Firat Sever, PhD, PE, F. ASCE, QuakeWrap

Designing, manufacturing, and installing supersize pipes (10 feet and above in diameter) has its unique challenges in comparison with smaller pipes. This challenge is to an extent that often almost entirely different methods need to be implemented at all levels when undertaking such projects. Starting with manufacturing, many of the conventional and assembly line production with common materials do not typically go larger than 10 feet.

A high strength, low weight composite FRP design was originated at QuakeWrap more than 10 years ago particularly for large diameter pipeline renewal or new construction. The FRP sandwich structure initially utilized a "mini I-beam" core layer (aka 3D fabric) for improved ring stiffness (Ehsani, 2017). This composite system was labeled as StifPipe® and patented by QuakeWrap/Mo Ehsani. Then it was further enhanced with stiffness factors as high as 90, by replacing the original mini I-beam with a proprietary, polymeric fabric than can absorb approximately 3.5 times more resin (epoxy) than the much thinner (40 mils on average) carbon fiber fabric. The end product is a resin rich, light weight, high strength pipe taking the best of the worlds of carbon fiber's tensile strength and the ring stiffness provided mainly by the core fabric in an economical way. Additionally, dual layer (with a woven and chopped mat) glass fiber reinforced polymer (GFRP) layers are used for enhanced strength, corrosion/abrasion resistance, and water tightness.

The first application of it dates back to 2012 in a pump station discharge pipe in Avalon, CA. The diameter and length of each pipe segment are custom made. As such, a 47-inch OD pipe was used for sliplining the 48-inch ID pump station

Figure 1. The record breaking, 16-foot FRP composite pipes being unloaded at the job site for installation

Figure 2. Fully-structural repair with the FRP composite system in a 100-foot deep tunnel in Minneapolis, MN

discharge pipe in Avalon to minimize the annular space thereby maintaining the hydraulic capacity. (Often times the hydraulic capacity is improved despite the reduction in cross-section due to the smoother surface of this pipe in comparison with the existing pipe.) This first application was followed by a number of similar sliplining projects in the USA and abroad. The StifPipe® system can be prefab and installed by sliplining (or direct bury for new construction) or applied cured-in-place with the wet layup method similar to the conventional applications of carbon fiber reinforced polymer (CFRP) liners. The most notable and largest ones took place in Minneapolis, Minnesota (12 ft.) (Figure 2) and Detroit, Michigan (16-ft); the latter is likely the largest of its kind ever made (Figure 1). The joints for the prefab pipes/liners can be a bell and spigot or FRP couplings. The latter is a cured-in-place method, as such for sliplining applications with live flow, bell and spigot joints are preferred (Figure 3).

For pipe sizes greater than 8 feet in diameter a rotating mandrel (on a motor) will be needed due to the difficulty in manual wrapping of FRP layers. Additionally, a mandrel in constant rotation eliminates the risk of slumping of the resin until a sufficient cure is achieved.

The relatively easy manufacturing process makes it possible to build temporary facilities for manufacturing at or in the vicinity of the project site. This localized production approach saves substantially on the transportation cost. In fact, it is not even physically possible to transport pipes of colossal size along certain routes due to bridge clearance and permitting issues. Additionally, localized manufacturing enables a project team and owner to closely monitor the overall process and troubleshoot any discrepancies on the spot without causing any significant delays that could take place with returned shipments of finished products.

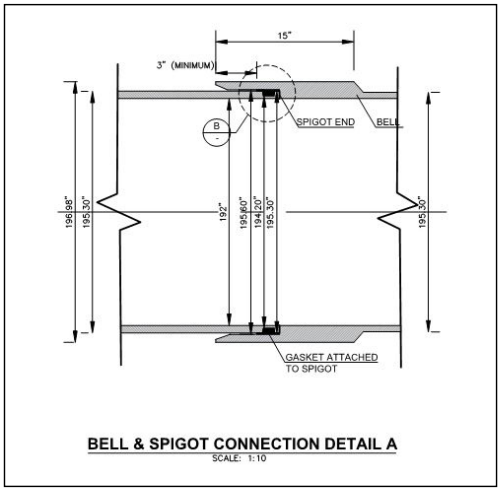

Figure 3. Bell and spigot joint detail for 16-foot ID FRP composite pipe

Quality Assurance/Control (QA/QC) is a vital part of on-site manufacturing. Any apparent defects observed (such as kinks in the FRP fabric, delamination among the layers, etc.) are noted and those exceeding the tolerances indicated in the technical specification are addressed, typically by cutting and removing the FRP laminate in the defective area and then replacing with FRP patches per the design.

To detect any unapparent defects in between FRP layers, a novel scanning technique for sensing damage initiation and progression was developed by QuakeWrap with its partner. This structural health monitoring is done by using linear and nonlinear ultrasonic techniques (Figure 4). For real time testing, complex signal processing tools are used to detect anomalies in a composite structure. The process is conducted with an improved and robust mobile testing instrument, which provides more reliable and consistent results and can monitor the damage progression over a wide range of damages including any delaminations and voids.

Due to the use of ultra-high strength materials such as carbon fiber, the pipe's weight is a fraction of other materials of equivalent strength. For instance, the 16-foot ID pipe weighs only about 500 lb/ft with 2-inch wall thickness. A fully-structural 3-foot diameter pipe would weigh approximately 50 lb/ft and a short segment can be lifted by a person. Because of this such light weight of the carbon fiber reinforced composite pipe system, it can be installed without the need for a jacking equipment and can even be placed and moved in a trench by manual labor for sizes up to 6 feet in diameter.

Use of ultra-high strength materials do indeed provide an opportunity to make pipes of colossal size as monolithic segments. Success highly depends on a good design, robust manufacturing process, and a well-planned transportation and installation by experienced professionals. Using the pipe system described in this article, it is possible to make such pipes at or in the vicinity of the project site. A comprehensive quality assurance plan with a thorough inspection protocol from the beginning to the end of the project is pivotal in addressing any unforeseen discrepancies along the process.

Figure 4. UT inspection on the 16-foot pipe with customized wave algorithms

ABOUT THE AUTHOR:

***Dr. Firat Sever** has approximately 20 years of experience mainly in underground infrastructure spanning a wide variety of projects including small/large conventional, design/build, and high-profile international research projects. His expertise in trenchless pipeline rehabilitation as well as new pipeline design has resulted in more than 20 peer-reviewed publications and a number of presentations at local, national, and international conferences. He currently spends the majority of his time in design, R&D, and marketing of QuakeWrap's pipeline solutions.*

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