



# Western Regional Trenchless Review

# 2018

**INSIDE SPOTLIGHT:**

**14th Annual WESTTT  
No-Dig Conference & Exhibition**  
September 17 & 18, 2018 | Scottsdale, AZ



FEATURING KEYNOTE SPEAKER

**Jim Thompson**

City Manager – City of Scottsdale

The official publication of the North American Society for Trenchless Technology

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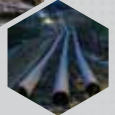
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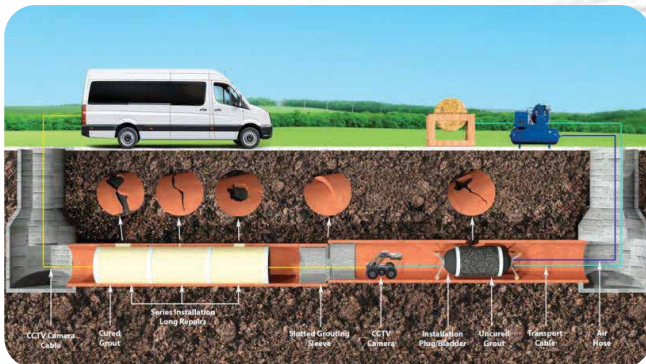
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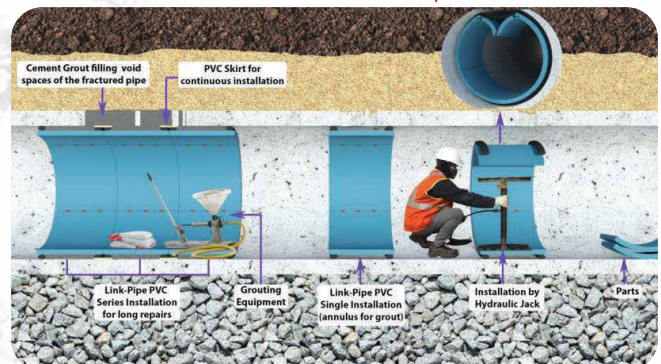
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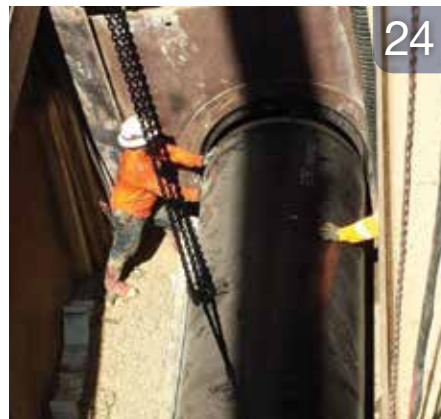
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Cover photo: Views near Eagle Peak of the Diablo Range in Contra Costa County.  
 © Yuval Helfman | Dreamstime



BRIAN AVON, P.E., CHAIRMAN, WESTT  
ASSOCIATE VICE PRESIDENT  
CAROLLO ENGINEERS

# Another Fantastic Year

This past year has been another fantastic one for WESTT. Our 2017 regional conference, held last October 16–17 in Walnut Creek, California, was the best attended conference and training we've hosted to date. We received positive feedback from the attendees and look forward to another great regional conference this year. In March, the WESTT region hosted NASTT's 2018 No-Dig Show at the Renaissance Hotel in Palm Springs, California. Our annual board meeting was well attended and many of our members volunteered to help our continued efforts. To celebrate having the NASTT's No-Dig Show back in our region, the WESTT Board of Directors hosted our second WESTT Member Reception, which was a fun evening of food, drinks, and networking. The Board was pleased to connect with so many new WESTT members. Thank you to everyone who attended, and a special thank you to Michelle Beason for organizing the event.

After a year of success with our newly formed committees, we added a new committee to improve Student Chapter involvement at our events and throughout the year. The committees and newly elected Chairs include:

- Mini No-Dig Conference Planning Committee – Lisa Arroyo, Chair
- Magazine Committee – Jennifer Glynn, Chair
- Nominations and Elections Committee – Tim Taylor, Chair
- Student Chapter Involvement Committee – Michelle Beason

In past years, as part of our ongoing efforts to provide value to WESTT members, we have sent NASTT publications to all WESTT members. To continue those efforts, the WESTT Board of Directors is planning to send

“After a year of success with our newly formed committees, we added a new committee to improve Student Chapter involvement at our events and throughout the year.”



The current WESTT Board of Directors and Officers. From left to right: Norm Joyal, Lisa Arroyo, Cindy Preuss, Tim Taylor, Jennifer Glynn, Michelle Beason, Brian Avon, Kate Wallin, and Jacque Jaques. Not pictured: Gayleen Darting and Mike Rocco.

out a new publication later this year. Special thanks to Cindy Preuss for making this happen.

I would like to thank the WESTT Board of Directors, committee chairs, and other member volunteers for their continued involvement. It is an honor to work with so many passionate individuals who share the goal of advancing the practice of trenchless technology through education, training, and research for public benefit. A special thank you to Lisa Arroyo as my Vice-Chair and

this year's Mini No-Dig Conference Chair. This year's event is scheduled for September 17–18 in Scottsdale, Arizona. We expect a good turnout and hope to see you there.

To stay connected and hear about upcoming events, visit our website ([westt.org](http://westt.org)) or LinkedIn account (WESTT NASTT). If you want to get involved in WESTT activities, please reach out to me or any of our Board members.

Thank you for your continued support of WESTT. ▼



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FRANK FIRSCHING  
NASTT CHAIR

# Our Regional Advocates

**H**ello fellow WESTT Members! As the year marches along we're looking forward to the continued growth of the trenchless industry and our Society. It was exciting to host NASTT's 2018 No-Dig Show right here in our region in Palm Springs. The conference was very successful on all accounts. The exhibit hall featured close to 190 exhibitors and we welcomed more than 2,000 attendees from all over the world who came to experience the world-class technical sessions and networking events that our Show is known for. NASTT's 17th Annual Educational Fund Auction was, once again, the trenchless social event of the year and we raised nearly \$100,000 for our educational programs! Thank you all for your generous support.

NASTT exists because of the dedication and support of our volunteers and our 11 regional chapters. Plans are

*"The JW Marriott Camelback conference center will be a perfect setting for a focused two days of trenchless education and networking."*

now underway for the 2019 conference. It is a very exciting time for the WESTT Chapter because Chapter Past Chair, Cindy Preuss of HydroScience Engineers, is also serving as the 2019 Program Committee Chair. This is a huge undertaking and I know that Cindy is up to the task!

Our No-Dig Show Program Committee members are volunteering their time and industry knowledge to peer-review the 2019 abstracts. These committee members ensure that the technical presentations are up to the

standards we are known for. Thank you to the WESTT Chapter Members who have volunteered for this important task this year: Sam Ariaratnam, Brian Avon, David Bennett, Glenn Boyce, Sam Brancheau, Anil Dean, Joshua Hampton, Dave Haug, Matthew Wallin, Jennifer Glynn, Rachel Maupin, and Cindy Preuss.

Each year this Chapter holds the Western Regional No-Dig Conference and this fall it is headed to Scottsdale, Arizona. The JW Marriott Camelback conference center will be a perfect setting for a focused two days of trenchless education and networking. Be sure to check the information in this issue for the details and join us September 17 for the conference and September 18 for NASTT's Good Practices Courses.

The North American Society for Trenchless Technology is a society for trenchless professionals. Our goal is to provide innovative and beneficial initiatives to our members. To do that, we need the involvement and feedback from our professional peers. If you are interested in more information, please visit our website at [nastt.org/volunteer](http://nastt.org/volunteer). There, you can view our committees and learn more about these great ways to stay active with the trenchless community and to have your voice heard.

Our continued growth relies on the grassroots involvement of our regional chapter advocates. Thank you again for your support and dedication to NASTT and the trenchless technology industry. ▼

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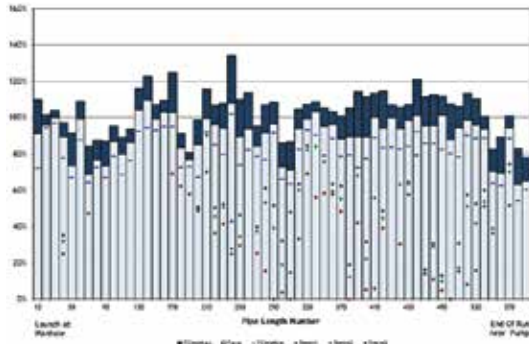
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# 14TH ANNUAL WESTERN REGIONAL No-Dig Conference, Exhibition, and Course



**Monday, September 17, 2018 7:30 AM through  
Tuesday, September 18, 2018 5:30 PM**  
(Pacific Time)

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The Western Society for Trenchless Technology (WESTT) is proud to present the 14th Annual Western Regional No-Dig Conference, Exhibition, and Course, Monday & Tuesday, September 17th & 18th, 2018 in Scottsdale, Arizona.

Register today and enjoy all the benefits of a national conference program in a smaller forum with a personal touch! Come to sunny Scottsdale, Arizona, in the Phoenix area to learn about the latest in trenchless technology from experts in the field. Registration for the first day of the conference includes an informative technical program and product exhibition area.

On the second day of the conference, WESTT will offer attendees a NASTT Good Practices Course. Attendees may choose to participate in either or both days of the conference. For more information on course content and instructors, please visit [www.NASTT.org/training](http://www.NASTT.org/training).

### Conference Facility & Hotel Information

The conference facility is at the JW Marriott Camelback Inn Resort & Spa in Scottsdale, Arizona. Oasis-like casitas and suites feature balconies or patios with awe-inspiring views of lushly manicured grounds or the nearby mountains.

Check-in on or after Friday, September 14, 2018 and check-out on or before Tuesday, September 18, 2018: \$236 + taxes per room, per night. Reserve online at: <https://book.passkey.com/go/WESTTConference>.

### Conference Registrations:

Member Regular	\$250
Non-Member Regular	\$325
Municipal Regular	\$150

### Short Course Registrations:

Member Regular	\$400
Non-Member Regular	\$475
Government	\$250

### Agenda

**Technical Program and Product Exhibition**  
September 17, 2018 7:30 AM – 5:00 PM

**Monday Evening Networking Reception**  
Monday, September 17, 2018 5:00 PM – 7:30 PM

**NASTT Introduction to Trenchless Installation and Rehabilitation Course**  
Tuesday, September 18, 2018 7:30 AM – 5:00 PM

For questions about the program content or registration information, please see the event links available on the online registration page at [www.regonline.com/builder/site/?eventid=2349744](http://www.regonline.com/builder/site/?eventid=2349744), or contact Lisa Arroyo at (805) 564-5412 or [larroyo@santabarbaraca.gov](mailto:larroyo@santabarbaraca.gov), or Norman Joyal at (925) 705-4119 or [joyal@mcmjac.com](mailto:joyal@mcmjac.com).

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### Conference Planning Committee

A big thank you goes out to everyone who helped make this event possible, including Lisa Arroyo, 2018 Conference Chair (City of Santa Barbara). ▼

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**As we continue to deliver valuable information through the pages of this magazine, in a printed format that is appealing, reader-friendly and not lost in the proliferation of electronic messages that are bombarding our senses, we are also well aware of the need to be respectful of our environment. That is why we are committed to publishing the magazine in the most environmentally-friendly process possible. Here is what we mean:**

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- Within the pages of each issue, we actively encourage our readers to REUSE and RECYCLE.
- In order to reduce our carbon footprint on the planet, we utilize a carbon offset program in conjunction with any air travel we undertake related to our publishing responsibilities for the magazine.

***So enjoy this magazine...and KEEP THINKING GREEN.***



# Q&A with Jim Thompson, City Manager, City of Scottsdale

Keynote speaker at this year's Western Regional No-Dig Conference & Exhibition in Phoenix, AZ in September



Jim Thompson was appointed as Scottsdale City Manager in January 2017. Before that, Mr. Thompson served as the city manager of Casa Grande, Arizona; Bothell, Washington; and Bullhead City, Arizona. He has more than 30 years of experience as a city manager.

Mr. Thompson has also served on the Arizona State Personnel Board since 2004 and as an adjunct professor in Arizona State University's Department of Public Affairs since 2011.

Mr. Thompson has a bachelor's degree in accounting from Indiana University, a master's degree in business administration from Regis University, a PhD from La Salle University, and attended the Senior Executive Program at Harvard.

Please join us on Monday, September 16, 2018 for Jim's Keynote Address, beginning at 9:00 am.

## Jim, what will your keynote presentation focus on?

The overall activities and direction of Scottsdale related to any of the following:

- inspection and condition assessment,
- asset management,
- trenchless pipeline projects and pilot projects, design stats and case studies, and/or
- trenchless construction projects/pilot projects, construction stats & case studies.

## How are trenchless technologies relevant to you and your team at the City of Scottsdale?

Capital Project Management (CPM) uses trenchless technologies for construction in several instances to reduce construction congestion and to also minimize damage to facilities. A few examples of our use of trenchless technologies are:

- 1) Relining existing sanitary sewer systems. The City of Scottsdale has a regular program that inspects, identifies sections of failures, develops plans for the repair of the lines and then mobilizes Job Order Contract (JOC) crews

who specialize in pipe relining. This method of repair does not require the open cut of any roadways and provides virtually a brand-new sewer line.

- 2) Installation of a sewer forcemain across a golf course fairway that is within a FEMA Floodway. The directional bore for the installation of the sewer forcemain allowed for the construction to occur across the floodway, below the low scour line of the channel and did not create any damage to the golf course.
- 3) CPM utilized directional drilling to install 902 feet of a 30-inch HDPE waterline on Frank Lloyd Wright Boulevard at the Cactus intersection. Doing so allowed for a straight alignment and only minor intersection restrictions with no intersection shutdowns.

Scottsdale also uses trenchless technology in support of water and sewer infrastructure repair and replacement. Trenchless technology provides a means of repairing or replacing underground mains with minimal surface disruption at competitive cost with traditional trenching techniques. Scottsdale recently used this technology to repair an 18-inch sewer main in Shea Boulevard – a major transportation corridor – with minimal traffic disruption. Due to the complexity of the geography in the area, which included a small bridge structure, trenchless technology also proved to be the low-cost alternative.

## Is this your first time attending this event?

Yes.

## What connections do you hope to build or develop during your time at the show?

It's a good opportunity to network. ▼



## WESTT CHAPTER SUPPORTER SPOTLIGHT

# Dr. Samuel T. Ariaratnam

Ph.D., P.E., P.Eng., F.ASCE, F.CAE

- Senior Sustainability Scientist, Julie Ann Wrigley Global Institute of Sustainability
- Professor, School of Sustainable Engineering and the Built Environment, Ira A. Fulton Schools of Engineering
- Professor and Program Chair of Construction Engineering
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- Senior Sustainability Scientist, Global Institute of Sustainability
- Chair, American Society of Civil Engineers Pipelines Division
- Past Chairman, International Society for Trenchless Technology
- Vice Director, China-U.S. Joint Center for Trenchless Research & Development
- Guest Professor, Zhengzhou University
- Guest Professor, China University of Geosciences (Wuhan)



### Dr. Samuel T. Ariaratnam

is a Professor and Construction Engineering Program Chair in the School of Sustainable Engineering and the Built Environment at Arizona State University, in Tempe, AZ. His teaching and research interests are in the area of Underground Infrastructure Management and Rehabilitation, with a focus on trenchless engineering applications of horizontal directional drilling, trenchless pipe replacement, and underground utility asset management. He has published more

than 300 technical papers and reports, has co-authored eight textbooks, and is a co-holder of five patents. Ariaratnam has received multiple awards including the John O. Bickel and Arthur M. Wellington Awards from the American Society of Civil Engineers (ASCE) and the Young Civil Engineer Achievement Award from the University of Illinois. In 2006, he was named to the Phoenix Business Journal's "Forty under 40" list, and in 2012 was named the North American Trenchless Technology

Person of the Year. Ariaratnam received his Ph.D. in Civil Engineering from the University of Illinois at Urbana-Champaign and is a registered professional engineer in Arizona and Ontario (Canada).

Throughout the years, Ariaratnam has carried the message of trenchless technology all across the world. He has made his mark through his passionate service in trenchless academia, research, and leadership through professional associations. Ariaratnam has been involved with NASTT since the mid-1990s at all levels, including its student chapter where he has mentored and advised engineering students in the trenchless disciplines. He has also been instrumental in educating and mentoring industry professionals through his teaching of NASTT courses on HDD Good Practices and Pipe Bursting Good Practices.

In 1989, Ariaratnam earned a bachelor of applied science in civil engineering from the University of Waterloo. He went on to earn a master of science and a Ph.D. in civil engineering, specializing in construction engineering and management, in 1991 and 1994,

Throughout the years, Ariaratnam has carried the message of trenchless technology all across the world. He has made his mark through his passionate service in trenchless academia, research, and leadership through professional associations.

respectively, from the University of Illinois at Urbana-Campaign.

He then served as a visiting professor at the U.S. Air Force Academy in Colorado Springs, from 1995–96, giving him the opportunity to teach civil engineering. But it was an assistant professor position at the University of Alberta that started him on a road in trenchless technology. While at the University of Alberta, Ariaratnam initiated and headed up the trenchless technology research, focusing on directional drilling and pipe bursting. It was during this time that Ariaratnam began his affiliation with NASTT and became a founding member of its Northwest Regional Chapter.

A new opportunity brought Ariaratnam to the U.S. in 2001, with the chance to explore trenchless technology even further when he was recruited by Arizona State University (ASU) to join its Del E. Webb School of Construction. When Ariaratnam made the move to ASU, he also became a founding member of the Western Chapter of NASTT, in 2004. In 2015, he was elected as a Fellow of ASCE. Ariaratnam has lectured internationally in more than a dozen countries and has delivered keynote addresses at various technical conferences.

## Q&A with Dr. Samuel Ariaratnam

Since helping to found the WESTT Chapter in 2004, you've remained involved in different roles for about 14 years now. What changes and growth have you seen during this time period?

WESTT has really grown in terms of volunteer involvement of the membership since its inception. It is encouraging to see so many people from every state within WESTT spending their precious time volunteering in various capacities to help spread the benefits of adopting trenchless technologies. Early on, there were only a handful of people who spearheaded WESTT, but today we truly have one of the strongest NASTT Regional Chapters in terms of volunteerism.



I see a bright future for the trenchless industry as municipalities look to address their underground utility infrastructure networks with environmentally-friendly, minimally-intrusive technologies.



What are the best parts about being a WESTT supporter and about attending the Chapter's regional No-Dig event?

WESTT covers a large geographical area (Arizona, California, New Mexico, Nevada, and Hawaii), making it sometimes difficult for our members to get together face-to-face. The Annual Regional WESTT No-Dig event is an excellent venue to not only learn about trenchless activities in our region, but to also network with trenchless stakeholders. We also get together socially at the Annual NASTT No-Dig Show. I personally have made many lifelong friendships with members of WESTT, which I truly cherish.

Why are you so passionate about trenchless technologies and about educating others in the industry?

I have been involved in trenchless technologies since 1996 and joined NASTT in 1997. It is really a cutting-edge industry with many people from all areas of the construction industry involved. It is amazing to see the continual technological advancements in the trenchless industry. We are installing and rehabilitating larger diameter pipes, longer distances than in the past. I truly enjoy seeing our stakeholders expanding the boundaries of our industry. On a personal level, it makes me proud to see former students that I introduced to the trenchless industry now being actively involved in the industry as academics and practitioners. The only way that we are

going to continue to grow trenchless is through education, whether it be at a university, conference, or a brown bag presentation to a local municipality or utility. Education is the key! Today, we have two universities (Arizona State University and Cal Poly-Pomona) in our region with active NASTT Student Chapters. I hope that we can continue to add more universities to introduce and train the future civil and construction engineers in our industry.

What do you believe the future holds for the organization, as well as for the trenchless industry in general?

WESTT is a stable organization with a tremendous amount of volunteers to ensure a bright future. We will continue have new people volunteering for various roles within the Chapter. This year marks the 14th Annual WESTT No-Dig Conference. It's hard to believe that the Chapter has been going strong for so long! I still remember our first WESTT No-Dig Conference back in 2005 like it was yesterday. Where did the time go? I see a bright future for the trenchless industry as municipalities look to address their underground utility infrastructure networks with environmentally-friendly, minimally-intrusive technologies. Globally, I have seen tremendous growth in the trenchless industry, especially in megacities such as Beijing, Shanghai, and Sao Paulo with high-density urban centers where traditional open-cut is not an option due to the distress that surface disturbance would create. ▼

# Post-Disaster Trenchless Installation of Water Pipelines in Napa, California

Michael Hether, P.E., City of Napa, Napa, CA  
Jon Marshall, P.E., Carollo Engineers, Walnut Creek, California



## Abstract

On August 24, 2014, the largest earthquake (South Napa Earthquake) to hit the Bay Area since the Loma Prieta earthquake struck the City of Napa, causing extensive damage to Napa's water distribution system. Hundreds of water main leaks were immediately repaired within a week, but several leaks located beneath Highway 29 were not repairable and had to be isolated, reducing the City's ability to move water across the highway. To restore water service, the City abandoned the isolated leaks in place and installed new highway crossings using directionally drilled pipelines.

Three crossings were originally identified for the project, however during design development another leak beneath the highway was identified and isolated and a fourth trenchless crossing was added to the project. Soil conditions at each of the four crossings consist of artificial fill and Pleistocene-aged alluvium, consisting predominantly of medium stiff to stiff clays interlayered with lesser loose to medium dense sands and gravels. Each directional drill is approximately 500 linear feet with 16-inch fusible PVC casings and 12-inch fusible PVC carrier pipelines. Design challenges include a pipeline

alignment highly congested with existing utilities, a work area with residential and commercial businesses, and designing the pipeline beneath a planned large diameter microtunnel sewer pipeline that will be constructed shortly after the HDD installation. The project is funded through Federal Emergency Management Agency (FEMA) disaster mitigation funds, which created additional, unique challenges to implementing the project. This paper describes the geotechnical findings, design development, and administrative challenges to implementing a FEMA funded project.





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North American Society for Trenchless Technology (NASTT)  
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Palm Springs, California, March 25–29, 2018



### Introduction

The City of Napa is located in northern California, approximately 50 miles north of San Francisco and is nearby several active earthquake faults (see Figure 1). Napa's water system serves a population of approximately 80,000 people through 370 miles of transmission and distribution pipelines. On August 24, 2014 at 3:20 a.m. the 6.0 magnitude South Napa earthquake struck five miles south/southwest of Napa and seven miles below ground. Ground shaking was recorded at 0.80g in the City of Napa. Vertical ground deformation was recorded up to 10 centimeters (see Figure 2) and

horizontal deformation over one foot. This was the largest earthquake to hit the Bay Area since the Loma Prieta earthquake in 1989. The earthquake caused substantial damage to above-ground structures and more than 240 leaks were identified (see Figure 3). Luckily no damage occurred at the water treatment plants, pump stations, and dams and only one of the 12 storage tanks was damaged.

Several leaks were located beneath Highway 29 and because of their location beneath the highway, they were not repairable and left isolated. This resulted in limiting the City's ability to move water across the

highway, which is a natural physical barrier in the distribution system. The pipelines that crossed Highway 29 were originally installed when the highway was a two-lane road, compared to it currently being a four-lane expressway. To restore water service, the City decided to abandon the isolated leaking sections of pipelines in place and install new highway crossings using directionally drilled pipelines.

### The FEMA Public Assistance Process

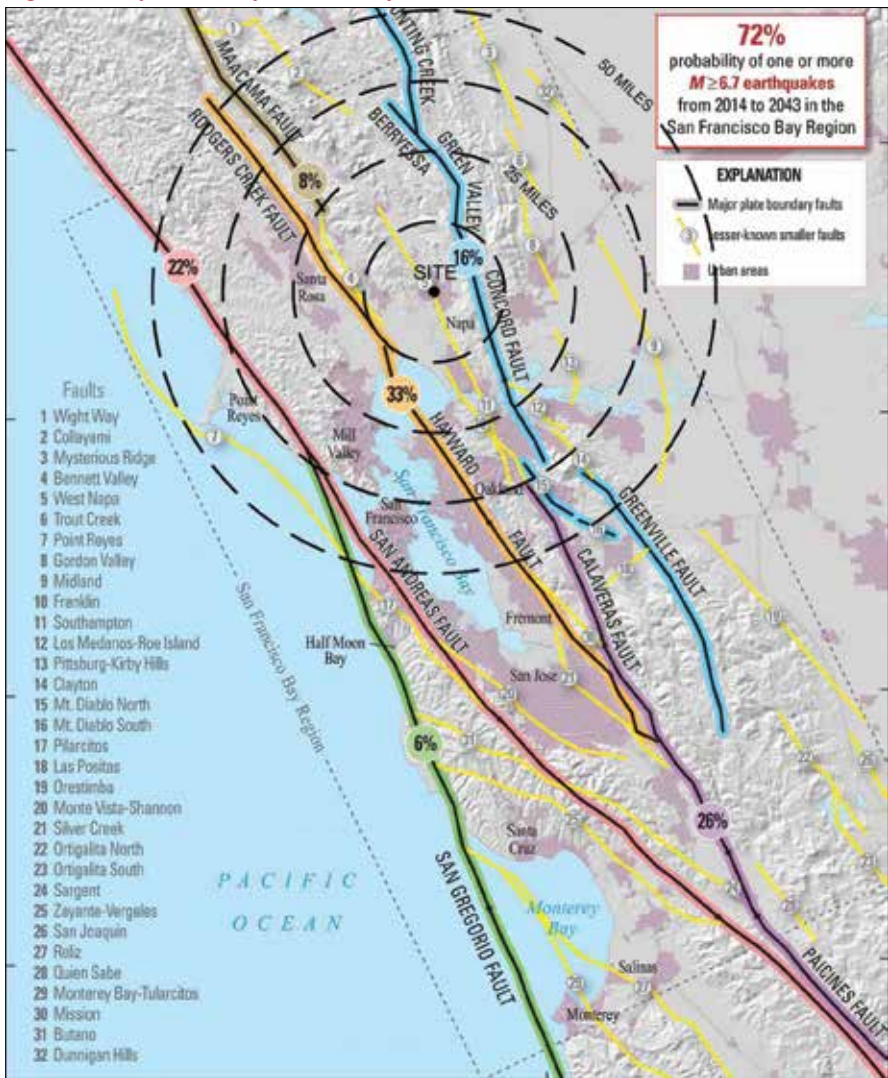
In a catastrophic disaster, and if the state's governor requests, federal resources may be mobilized through the U.S. Department of Homeland

Security’s Federal Emergency Management Agency (FEMA) for federal assistance to state or local governments to pay part of the costs of rebuilding a community’s damaged infrastructure. Federal assistance may include funding for debris removal, emergency protective measures and public services, repair or replacement of damaged public property, loans needed by communities for essential government functions, and grants for public schools. In California, FEMA coordinates with the California Office of Emergency Services (Cal OES) to implement the Public Assistance (PA) Grant Program.

There are several steps in the process to obtaining federal funding, all which must be followed. Below are the required steps, which are also shown in Figure 4.

1. A joint Preliminary Damage Assessment is conducted by FEMA, Cal OES, and local partners to determine losses and recovery needs.
2. The Governor requests federal assistance.
3. The President approves the request for federal disaster funding or FEMA informs the governor it has been denied. This decision process could take a few hours or several weeks.
4. Cal OES holds Applicants’ Briefings to provide a general overview of the Public Assistance (PA) program and describe the application process.
5. Applicants submit a Request for Public Assistance to Cal OES within 30 days of the date of the declaration.
6. Kick-off meetings for eligible applicants are held with FEMA, Cal OES, and the local partner to provide a more detailed review of the program and specific applicant needs.
7. The applicant submits a List of Projects to Cal OES.
8. Damaged sites are documented using a Subgrant Application (Project Worksheet).
9. Eligible Project Worksheets are obligated.
10. Funding is disbursed through Cal OES to the applicant as appropriate.
11. Applicants are required to provide quarterly status updates for each large project.
12. Applicants must submit time extension requests prior to the last approved project deadline.
13. Applicants complete construction of their projects and notify Cal OES.
14. Cal OES and FEMA complete a closeout of the application.

Figure 1: Project Vicinity and Nearby Faults



One of the biggest challenges with the federal funding process was changing the scope of the project. Repairs of these leaks were added to the federal funding list in early 2015. Three crossings were originally identified for the project; however, during design development in 2016 another leak beneath the highway was identified, isolated, and a fourth trenchless crossing was added to the project. While the leak was identified after the earthquake, it is thought to have been caused by from the earthquake. Modifying the overall project description caused a delay to the overall project of about a year. Reasons for the delay include justifying the earthquake as the cause of the leak and engaging FEMA staff, many of whom were tasked with hurricane and flooding relief efforts. In addition, because of the change in project description, the overall project was re-reviewed, which resulted in additional scrutiny and review of each crossing. Ultimately, FEMA approval was granted in November 2017.

### Regional Geology

Napa County lies within the Coast Ranges geomorphic province of California. The regional bedrock geology consists of complexly folded, faulted, and sheared sedimentary, igneous, and metamorphic rock of the Jurassic-Cretaceous age (65–190 million years ago) Franciscan Complex. Within central and northern California, the Franciscan rocks are locally overlain by a variety of Cretaceous and Tertiary-age sedimentary

Figure 2: Ground Deformation from the South Napa Earthquake

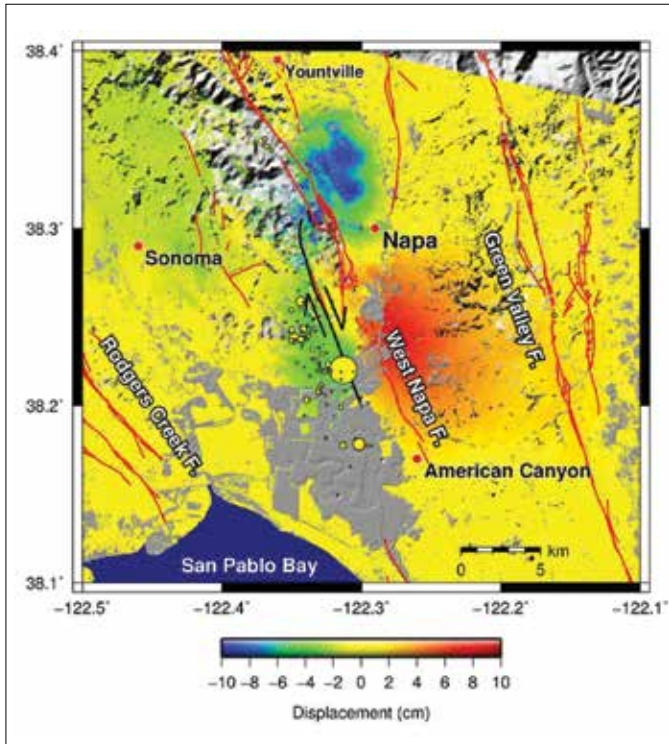
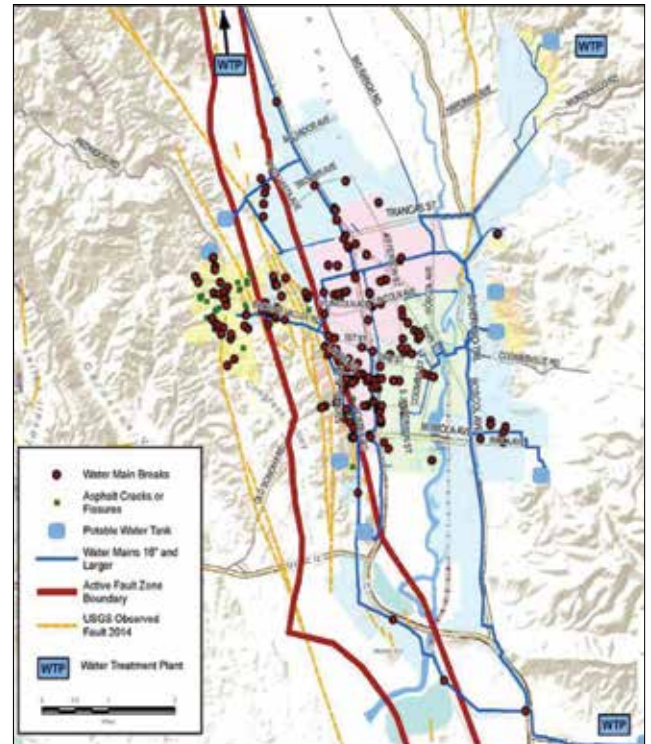


Figure 3: Earthquake Caused Water Pipeline Leaks



and volcanic rocks that have been deformed by episodes of folding and faulting. The youngest geologic units in the region are Quaternary-age (last 1.8 million years) sedimentary deposits. These unconsolidated deposits partially fill many of the valleys in the region.

The upper portions of the valleys contain loose deposits of rock fragments, sands and silts, that have migrated by gravity downslope from the adjacent hillsides to form the colluvial deposits along the lower slopes and upper edges of the valleys. The lower portions of the valleys have been filled with finer grained alluvial material over time through the sediment transport process during rainfall events.

Regional geologic mapping by the California Geological Survey indicates the project site is underlain by alluvial deposits of Pleistocene age (more than 11,700 years old). Alluvial deposits are generally composed of poorly sorted silt, sand and gravel deposited by streams and rivers, and can be in the forms of alluvial fans, stream terraces, and basin and channel deposits.

**Design of the Highway 29 Crossings**

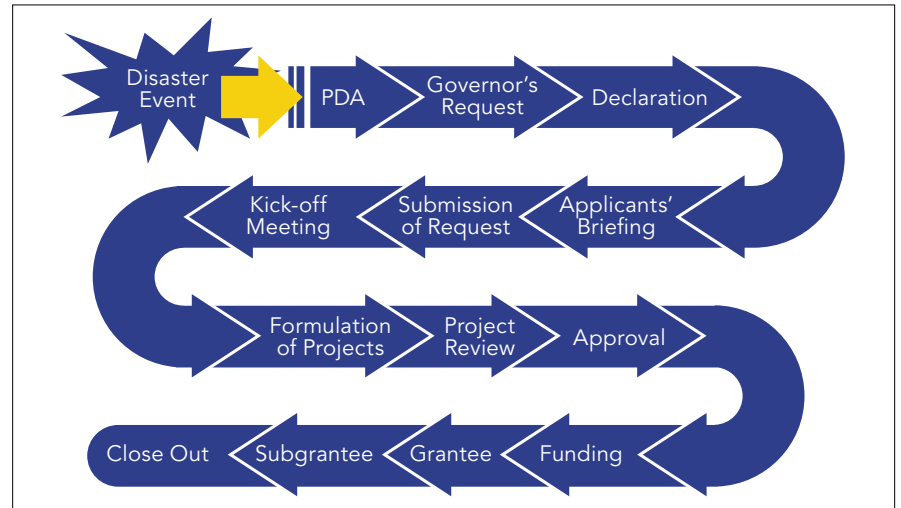
Based on two recent, successful City projects, surface impacts, site constraints, and owner preference, the

City decided that horizontal directional drilling using fusible PVC pipe was the preferred installation method and pipeline material (Figure 5). At each crossing, a 12-inch diameter pipeline is needed for hydraulic reasons.

Caltrans requires a casing, so an 18-inch diameter casing was originally anticipated. However, after discussions with the pipeline manufacturer, a 16-inch diameter casing was selected with the weld beads removed from the interior of the casing pipe and exterior of the carrier pipe.

The Caltrans encroachment permit for the water main undercrossings (Caltrans Encroachment Permits, Guidelines and Specifications for Trenchless Technology Projects, January 2015 and Chapter 600, Section 623, January 2009 of the Caltrans Encroachment Permits Manual) requires a casing for the pressurized 12-inch water mains. The casings will be 16 inches in diameter. The Caltrans Encroachment Permit Manual (Section 623.2) recommends a minimum depth of cover for a 16-inch HDD pipeline

Figure 4: The FEMA Public Assistance Process



installation of 10 feet. However, in order to minimize systemic settlement and hydrofracture risks a minimum depth of cover on the order of 20 feet has been recommended and used in project design.

Given a minimum design depth of cover of 20 feet and the Caltrans easement widths described above the total HDD installation lengths will be on the order of 350 to 520 feet long (to accommodate entry and exit angles, radius of vertical curves, existing utilities, and tangent lengths under the

highway). The 12-inch water mains and 16-inch casing pipelines will consist of fusible PVC.

Subsurface soil conditions at the four Highway 29 undercrossings predominantly consist of medium stiff to stiff fine-grained, cohesive soils (silts and clays) with lesser interbedded coarse-grained, non-cohesive soils (sands and gravels). These soil conditions are conducive to HDD construction and are consistent with the soil conditions from the City’s 2013 project as discussed above.

Clean open graded gravels, cobbles, or boulders were not encountered in the project geotechnical investigation. In the absence of such high risk (and sometimes fatal flaw) soil conditions, geotechnical conditions will not control HDD bore path design. The design of the four undercrossings bore paths was governed by:

- a minimum depth of cover beneath Highway 29 of 20 feet (to control hydrofracture and limit systemic settlement);
- A minimum depth of 10 feet below all Caltrans right-of-way;
- A Caltrans required skew angle of less than 30 degrees from normal;
- existing utility clearances;
- minimum bending radius for HDD drill rods (typically, radius in feet = 100 x rod diameter in inches);
- allowable minimum bending radius for the 16-inch C905, DR18 PVC casings of 363 feet;
- appropriate HDD rig set-up and equipment area; and
- appropriate pipeline fusion and laydown area.

Two crossing locations include both a horizontal and vertical curve. While efforts were made to avoid these compound curves, the limited project space and other constraints necessitated them. The following equation, from the HDD Best Practices Manual, was used to derive the actual curve (combined horizontal and vertical curve):

$$\sqrt{\frac{(R_A^2 \times R_B^2)}{(R_A^2 + R_B^2)}}$$

Constructing a compound curve directional drill was a concern during design development. To address this concern, the pilot bore steering operator was required to have previously completed installation of a compound curve drill. An interesting design note is the installation of the Old Sonoma Road crossing, which is located beneath a planned 36-inch diameter microtunnel installation of a sanitary sewer pipeline. Properties used to calculate formation limit and drilling fluid pressures are summarized in Table 1.

ASTM F1962 methods were used to estimate pulling loads and to confirm pipe stresses would be within acceptable limits during installation. A maximum pulling force of 14,700 pounds was estimated to be required

Figure 5: Locations of 4 HDD Installations Across Highway 29

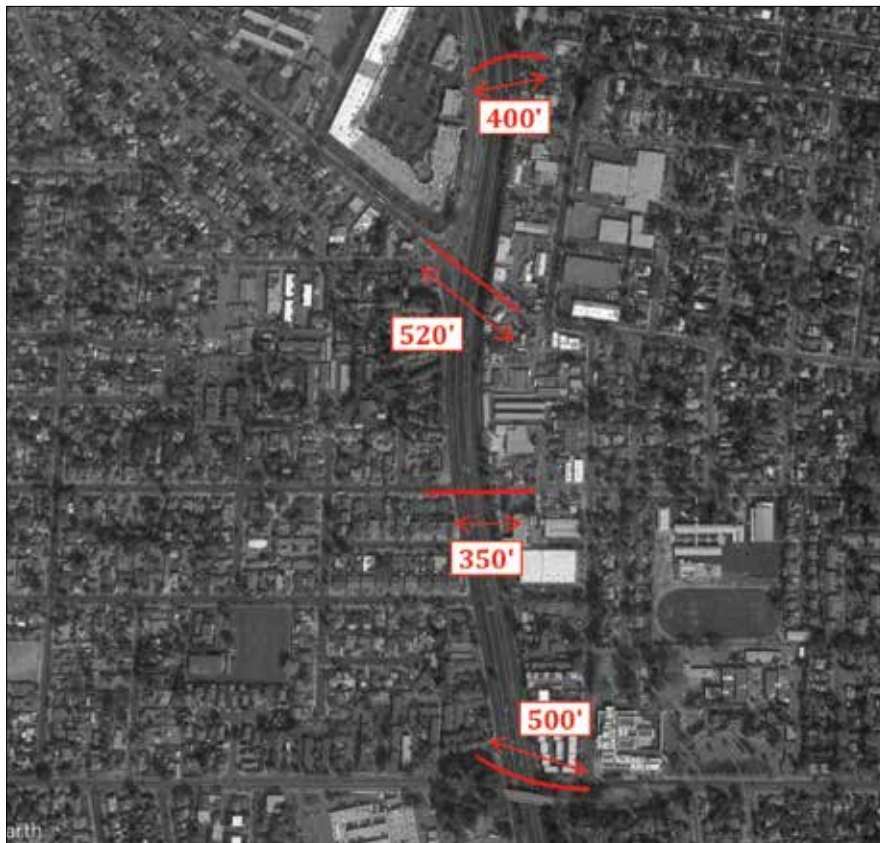


Table 1: Preliminary Design Formation Limit and Drilling Fluid Pressure Properties

	Properties	Values
<b>Drilling Fluid and Drill Pipe Properties</b>	Pilot Borehole Diameter	9.9 inches
	Drill Pipe Diameter	5.5 inches
	Drilling Fluid Unit Weight	11 lbs/gallon
	Drilling Fluid Viscosity	50 centipoise
	Flow Rate of Drilling Fluid at Drill Bit	29 pounds/100 ft <sup>2</sup>
<b>Soil Bore path Properties</b>	Unit Weight	100-110 lbs/ft <sup>3</sup>
	Friction Angle	34-38 degrees
	Cohesion	0-90 lbs/ft <sup>2</sup>
	Shear Modulus	1,500-5,000 ksf

for pipe pullback, which included a safety factor of 2.0 to account for possible deviations from idealized conditions (e.g., from sloughing, design bore path deviations, and stoppages), and assuming the pipeline will be fully ballasted with water during pullback within a drilling fluid having a specific gravity of 1.5.

The project was scheduled for construction in spring/summer 2018.

**Summary**

The City of Napa was rocked by a 6.0 earthquake in 2014. The City of Napa Highway 29 Water Main Replacement Project is an emergency replacement of critical water infrastructure that was damaged by the earthquake through the design of four HDD installations beneath Highway 29 that will “reconnect” water service across the freeway. The design includes a 12-inch diameter fusible PVC carrier pipe and fusible PVC casing. Two of the four crossings include compound horizontal and vertical curves, which were unavoidable. The project is funded through Federal Emergency Management Agency (FEMA) disaster mitigation funds, which created additional, unique challenges to implementing the project such as obtaining approval to modify the project description due to damage discovered subsequent to the original request for aid. The biggest recommendation for other agencies in similar situations is to not change the project description with FEMA once it has been set.

**Acknowledgments**

We would like to acknowledge Tyler Grossheim at Carollo Engineers, Inc., Dana Stockom-Smith at the City of Napa, Dave Mathy at DCM Consulting, Eric Debanian with Miller Pacific Engineering Group, and Jim O’Toole with ESA. We thank James P. Murphy, Trenchless Lead at Universal Pegasus International for his review comments on an earlier draft of this paper.

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# Successful Open Shield Pipe Jacking through Reservoir Embankment

Marshall P. McLeod, P.E., East Bay Municipal Utility District, Oakland, CA  
Evan Wheeler, Pipe Jacking Trenchless, Inc., San Bernardino, CA







Courtesy of:  
North American Society for Trenchless Technology (NASTT)  
**NASTT's 2018 No-Dig Show**  
**Palm Springs, California, March 25–29, 2018**



### Abstract

East Bay Municipal Utility District (EBMUD) has recently completed construction of two new pipelines for storm water and reservoir overflow drain water as part of the South Reservoir Replacement Project in Castro Valley, California. An open shield machine with cutting wheel was utilized to pipe jack two 50-inch diameter steel casing pipes through the former open-cut reservoir embankment. The two drives through rock and soil were 440 linear feet and 160 linear feet long. 24-inch and 36-inch (HDPE DR-17) carrier pipes were installed in the casing pipes and connected to the existing storm drain system. The tight tolerances for line/grade and favorable geotechnical conditions led to the specification of open-shield pipe jacking during the design phase after evaluation of other installation methods. Challenges during the design and construction phase included limited space for receiving shaft construction and TBM retrieval on the edge of the EBMUD property adjacent to residential property. Ground conditions for the tunnel bore mainly consisted of rhyolite varying greatly in strength, hardness, and weathering. This paper provides an overview of the project, compares design estimates and actual conditions during construction, and highlights the collaborative efforts that made the project a success.

### Introduction

The East Bay Municipal Utility District (EBMUD) is a major metropolitan water district located near San Francisco, California, serving 1.4 million people. The 50-MG South Reservoir earthen embankment dam and reservoir was built in 1956. Water quality issues due to lack of turn-over and roof stability concerns led to the reservoir being taken out of service in 2007 and the roof and concrete liner were demolished in 2015. A 9-MG prestressed concrete tank, valve vault, and associated piping and appurtenances are currently being constructed as a replacement within the existing reservoir embankment. The earth embankment dam was originally designed as a large rectangular shape with the inlet outlet pipeline, storm drainage pipeline and overflow pipeline located at different sides of the site. The earth dam crest is about 75 feet high with a perimeter of about 2,400 feet. The embankment was breached to provide an access road and to construct a new 42-inch welded steel inlet/outlet pipeline. Breaching of the dam also fulfilled a project goal of removing the site from the jurisdiction of the State of California, Division of Dam Safety requirements. Unfortunately, the new access road was on the opposite side of the site from the existing storm drain system, making the design of gravity flow service for site drainage and reservoir overflow challenging. The new tank layout required a 24-inch storm drain pipeline on the north side and a 36-inch reservoir overflow pipeline on the south side. The elevations did not allow for gravity flow installation of the pipelines in the access road. See Figure 1 for the site plan. Different alternatives were considered and, ultimately, open shield pipe jacking was specified and successfully utilized to install the two pipelines, avoiding expensive 60-foot open cuts through the original reservoir embankment.

### Design Considerations

The design was completed in 2013, but due to funding issues, the project was not bid for construction until the fall of 2016. The bid documents required two 48-inch steel casing pipelines be installed by open shield pipe jacking. One drive was 440 feet long with a 24-inch HDPE carrier pipe grouted in place to serve as the site storm drainage pipeline. The other drive was 160 feet long with a 36-inch HDPE carrier pipe

grouted in place to serve as the new tank overflow pipeline. This section describes design process by which open shield pipe jacking was selected as the preferred installation method for the two gravity flow pipelines.

### Hydraulic Considerations

Analysis of the potential existing storm water discharge locations in the vicinity of the site led the design team to the decision to maintain two separate

discharge locations for the site storm water pipeline (24-inch) and the new tank overflow discharge pipeline (36-inch). Hydraulic modeling of the existing storm drain system indicated that they could not be combined. Hydraulic modeling was performed to determine the required inside diameters and slope of the pipelines to provide gravity flow regime throughout the new and existing system. The line and grade tolerance given to the pipeline design team was +/- 2 inches.

Figure 1. South Reservoir New Drain Alignments Through Existing Earth Embankment Dam.



Figure 2. Open Face TBM.



### Subsurface Conditions

Based on the geologic studies prior to and during construction (Marliave, 1953), South Reservoir is located in late Jurassic volcanic bedrock. The volcanic bedrock in the location of the two pipeline alignments is composed of highly fractured Leona Rhyolite Formation (Dibblee, 1980). Based on the existing boring logs and two new boreholes drilled during the design phase, the dam embankment consists of a layer of engineered fill at the dam crest and downstream slope surface, ranging from 12 feet at the crest to six feet near the embankment toe. Underlying the engineered fill layer is the native soil layer consisting of very dense clayey sand. Underlying the soil layer is the very deeply weathered rock, rhyolite. The pipeline installation elevations are primarily located in the weathered rhyolite material. For the 24-inch storm drain alignment on the Northeast embankment toe area, a 5-foot-thick layer of fat clay and 10-foot-thick layer of lean clay were also identified. The rock quality designation (RQD) of the local rock formation at the project site was classified as very poor (EBMUD, 2013). No laboratory tests were performed on the recovered rock samples because they were weathered and highly fractured.

Two standpipe or open-well type piezometers were installed to monitor water levels for the alignments, one inside the reservoir footprint and the other at the northeastern toe of the dam embankment. Based on the monthly piezometric readings that were monitored for three years, groundwater was not anticipated within the tunnel horizon for the 36-inch overflow pipeline. Depending on the year, month, and annual precipitation, there was groundwater potential within the Northeast embankment toe area on the downstream end of the 24-inch storm drain alignment.

**Environmental Considerations**

The proposed trenchless alignments were within EBMUD property, so traffic and other agencies' existing utilities were not a concern. The construction sequencing was important in order to facilitate the tank construction component of the project. Construction activities, such as noise, vibration, and traffic, were identified in the Environmental Impact Report (EIR) and appropriate mitigations were included in the contract documents. For the general contractor, spoil management was a challenge due to the requirement in the EIR to limit truck traffic to the site and place excavated material on-site, raising the grade of the former reservoir bottom. Staging excavated materials while concurrently constructing the large tank foundation required careful sequencing to maximize efficiency. Limits on tree removal were also an EIR requirement.

**Alternatives Analysis**

During the design, three options were considered for installation of the two gravity pipelines:

1. Open-trench excavation,
2. Horizontal auger boring (HAB),
3. Open shield pipe jacking.

Open shield pipe jacking was selected due to the low cost estimate and the ability to achieve the line and grade control that the hydraulic design required. Open trench excavation cost estimates were the most expensive and required more tree removal. HAB was considered for the shorter drive, but ruled out due to concerns about achieving the line and grade tolerances.

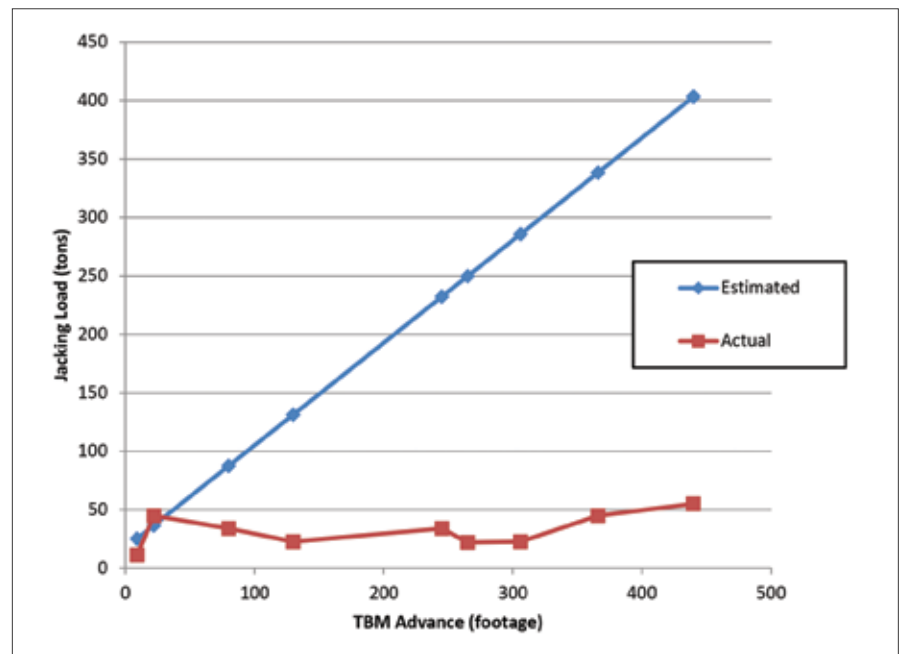
**Summary of the Trenchless Design**

Open shield pipe jacking was specified for both drives. The specification required a fully articulated open face TBM with a guidance system. The line and grade tolerances for the casing pipe installation were 1.0 inch for both drives. The jacking pipe casing was specified as welded steel pipe and minimum 0.5 inch thick. Bentonite lubrication and contact grouting was required. Table 1 summarizes the drives. The carrier pipes were designed as fully butt-fused HDPE (DR 17) with casing spacers. The annular space was required to be filled with Low Density Cellular Concrete (LDCC).

Table 1. Key Design Criteria.

Pipeline	Site Drainage	Tank Overflow
Contract Designation	Line A	Line B
Drive Length (ft)	440	160
Max Height of Embankment (ft)	60	40
Upstream Shaft Depth (ft)	24	15
Groundwater Potential	Yes	No

Figure 3. Line A Maximum Estimated Jacking Loads and the Actual Observed Jacking Loads During Installation.



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Figure 4. Line B Breakthrough Near Existing 24-Inch Overflow Pipe.



Figure 5. Line B TBM Shield and Cutterhead Being Retrieved From Excavation.



### Construction

The trenchless subcontractor on the project was Pipe Jacking Trenchless, Inc. (PJT), a subsidiary of Primoris Services Corporation. PJT elected to utilize an open face TBM manufactured by Pipe Jacking Unlimited with 52-inch outside diameter (OD) cut with 50.5-inch OD Permalok steel casing, 0.5-inch wall thickness, for the casing pipe installation. Muck removal was by means of muck buckets loaded by a belt conveyor. Figure 2 is a photo of the TBM cutterhead. The jacking shaft included an entry seal and three-inch thick jacking thrust plate.

The geotechnical boring logs indicated the material in the tunnel zone would likely provide a stable bore, however, the rhyolite layer was very weathered and the overlaying clayey sand soil layer contact depth was not well defined for the downstream ends of both alignments. Therefore, conservative soil parameters were used in the jacking load calculations. However, the bore was stable for the entire tunnel alignment and with the bentonite lubrication, the maximum observed jacking load was only 55 tons. See Figure 3 for a chart of the estimated versus actual jacking load over the length of the longest drive, Line A.

As anticipated, no groundwater was encountered for Line B. However, groundwater was encountered on Line A and at a higher elevation in the tunnel horizon than anticipated. Once encountered, the stable borehole enabled the groundwater to follow the TBM for rest of the downward sloping drive. The presence of water did not affect the constructability of the pipeline, but it did slow down the production rate due to additional muck bucket trips in and out of the tunnel and cleaning up the sloppy mess below the conveyor belt.

### Changes During Construction

In general, the contractor constructed the pipelines as per the design documents. Some of the changes are highlighted below.

#### Drive Direction

The contractor requested to reverse the direction of the drive for Line A. The Line A drive was oriented in the design drawing to drive uphill due to the potential for groundwater. The downstream shaft area had limited space, but was accessible to the street and to the reservoir site by a narrow

access road. The request was approved because the upstream end of the drive was much better suited as a drive shaft and the contractor demonstrated they were prepared to deal with any potential groundwater challenges.

The Line B drive was already oriented in the design drawing to drive downhill because groundwater was not anticipated and site of the downstream end of the drive had very limited space and access. The District owns a narrow right of way to access the site, but residents had gradually encroached on the land over the years with some minor landscaping and improvements. Legally, it was accessible with small equipment for TBM retrieval, but not ideal for public relations.

### Receiving Shafts

One of the unique developments of this project is that the traditionally shored receiving shafts were constructed as open excavations. The geotechnical investigation did not include boring at the downstream shaft locations. It was assumed that the native soil layer overlaying the rhyolite layer would need to be supported to provide safe removal of the TBM. Contractor site investigations after the NTP showed that the native soil layer was only a few feet thick, and the required invert elevations of the casing pipes were also very shallow on the downstream ends of the drives with cover ranging approximately six to eight feet. Therefore, the contractor's request was approved to dig out the TBM and layback the soil material at 1:1 slope. There were no District structures in the vicinity of the receiving shaft areas, and the residential homes were downhill from the sites. There was no risk of settlement damage. See Figure 4 for a photo of the Line B TBM completing the drive into the receiving site excavation.

The challenges that arose at the receiving shaft sites mainly occurred at Line B. During the design phase, it was assumed that the contractor would utilize the District's pave right of way to access the shaft site for TBM removal. However, the contractor did not want risk problems with the resident whose property was adjacent to the right of way. The contractor elected to separate the TBM at the articulation joint to remove the TBM in two pieces by carrying up the embankment to the dam crest. See Figure 5 for a photo of the Line B TBM retrieval operations

Figure 6. Pushing on a Joint for Casing Pipe in the Jacking Frame at Line A.



in progress. The contractor excavated the Line B retrieval area prior to completion of the drive in order to avoid hitting the existing reservoir overflow pipeline. This existing welded steel pipe was cut out of the way prior to retrieval of the TBM.

### Casing Pipe

The casing pipe was specified as 0.5-inch minimum butt-welded straight seam steel pipe. The contractor request was approved to utilize Permalok in order to speed up the jacking time and eliminate the need for welding and welding inspection. See Figure 6 for a photo of the Permalok pipe being pushed together in the Line A jacking shaft.

### Conclusions

This unique project will benefit other owners and operators with earth dam reservoirs. This case study highlighted the need to carefully analyze the ground conditions and site constraints before selecting the trenchless installation methodology. Specific and well defined specifications resulted in competitive bid prices and construction of a reliable trenchless installation. Open shield pipe jacking method is not applicable to all situations, but was clearly the best methodology for installing the two gravity drains through the dam embankment. The engineering staff and contractor worked collaboratively

to identify potential problems and develop cost-effective solutions. This project highlights the importance of open communication regarding contract documents and implementation of changes. Knowledgeable engineering staff and a highly experienced contractor also contributed to the project's success, having concluded without any change orders or differing site conditions claims.

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# HOW REHAB... PIPE REHAB... IS RENEWING THE INFRASTRUCTURE *of Las Vegas*

## ABSTRACT

Established in 1954, the Las Vegas Valley Water District (LVVWD) delivers reliable, quality water – tested and treated in state-of-the-art facilities – to more than 1.5 million people. While the LVVWD’s distribution system is relatively young compared to other municipalities across the United States, some sections of the LVVWD’s 6,500-mile underground pipeline network require rehabilitation to ensure the long-term reliability of those assets.

The LVVWD’s forward-thinking engineering, maintenance, and asset management teams proactively collect field data on infrastructure assets to prioritize maintenance, repair, and replacement activities. Utilizing leak detection information and pipeline breakage history, the LVVWD prioritized two pipeline rehabilitation projects that included an 8-inch ductile iron pipeline (DIP) with detected leaks located under a major freeway and a 16-inch polyvinyl chloride (PVC) reclaimed water pipeline with a history of failures located in a residential neighborhood. Both rehabilitation projects presented unique challenges. While the 8-inch DIP pipeline could be taken out of service due to system redundancy, the pipeline was buried under a busy freeway that could not be shut down to accommodate the rehabilitation work. Conversely, the 16-inch diameter PVC reclaimed water line had to remain in service as it supplied water to a number of golf courses for irrigation.

After lengthy research and evaluation of several rehabilitation techniques and technologies, the LVVWD determined that Primus Line’s pull-in-place polyethylene lined and coated Kevlar liner product met the needs for both pipelines. Chief among its advantages was the product’s ability to traverse 45-degree bends while maintaining pressure above 150 psi; the material was a finished product when it arrived on-site; and LVVWD’s in-house Distribution crews could install the product without specialized equipment or training.



Highway 215 Map



Reclaimed Water Line Map

The LVVWD completed work on the two pipelines in spring 2017, beginning with the rehabilitation of 450 feet of 8-inch pipe under the freeway. While there were only two access portals needed for this installation, the logistics and communication between them created unique challenges.

“The fact it was leaking under the highway posed a significant challenge,” said LVVWD Senior Maintenance Engineer Ryan Benner. “The only access points were on either side, but we couldn’t shut down the highway.”

A logistical challenge for LVVWD crews involved commercial buildings and a concrete drainage canal on the west side of the freeway, which necessitated the work be accomplished within a small footprint. While the four 45-degree bends necessary to complete the task would typically pose problems for most rehabilitation technologies, the pull in place polyethylene Kevlar liner simplified the installation.

Conducted a month later, rehabilitation of the 16-inch reclaimed water pipeline, while in a quiet residential area, required five access portals for installation of about 1,700 feet of liner. With pulls through vertical and horizontal bends, as well as an installation with two 45-degree bends and 1,200 feet between portals, this rehabilitation project highlighted the unique capabilities of the lining product.

*“The open trench dig-and-replace evaluation in the golf community was deemed cost prohibitive as it would involve enormous outlays for materials, adjusting adjacent utilities, and asphalt and concrete replacement.”*

The LVVWD crews completed this project in about a month, from the start of excavation to backfill and paving of the access portals.

Overall, and despite some challenges, the LVVWD was pleased with the installation of the pipe rehabilitation lining product and was extremely satisfied with its own field maintenance staff’s ability to do the work in-house. The LVVWD anticipates completing additional pipeline rehabilitation projects in the near term.

### INTRODUCTION

The LVVWD is continuously evaluating and using innovative technologies and equipment to prolong the life of their water distribution system and minimize costs, social, and economic impact within the community. With the proactive asset management program, which completes leak detection surveys throughout the system, they consistently identify pipelines that need repair or replacement. In 2016, the LVVWD found two specific pipelines that needed renewal. Because of their alignments and locations, removal and replacement of these pipelines were deemed infeasible. The LVVWD then evaluated several rehabilitation technologies with an eye toward their ability to allow access portals to be more than 1,000 feet apart, navigate 45-degree bends, provide at least 150 psi operating pressure, and be a potable water solution. After due diligence, the LVVWD selected a polyethylene-lined and coated Kevlar material (Primus Line) that met or exceeded all the design criteria laid out by its internal engineering staff. One element the LVVWD did not include in the criteria but proved to be an added advantage, was that the LVVWD’s Distribution maintenance crews could install the entire lining system and termination fittings in-house.

### OVERVIEW

The two pipelines renewed during the project both serve as distribution pipelines in the LVVWD system, but each have different end users. The 8-inch ductile iron pipe was a potable water pipeline that conveys potable drinking water at 80 psi and required renewals due to leaks detected under a section of a major freeway. This pipe had four vertical 45-degree bends in its alignment, with access points excavated about 450 feet apart outside of the roadway and pedestrian areas of the alignment.

The second project consisted of rehabilitating 2,200 feet of a 16-inch PVC pipeline that conveys reclaimed water at up to 160 psi. The pipeline included multiple vertical and



horizontal 45-degree bends and one 90-degree bend, which was challenging, and required five access portals throughout the alignment. The pipeline had experienced multiple line breaks in recent years, causing emergency repairs and damage to private property.

### PROJECT DETAILS

The LVVWD Asset Management and Distribution staff collaborated to evaluate, select, and execute the installation of the polyethylene-lined and coated Kevlar rehabilitation material. The LVVWD team selected the location of the portals to minimize the amount of surface restoration, limit traffic control needs, and provide adequate working space for the installation of the lining system. The access portals were from four to 20 feet deep, with one benched back and the other six requiring trench boxes. The operations crews tasked with the installation included staff who are typically responsible for emergency repairs and leaks, as well as meter and hydrant installations.

Procurement of the material – including the lining system, termination fittings, and equipment needed for the installation – entailed 12 weeks lead time due to manufacturing and sea freight delivery from Germany. The LVVWD also rented a pulling winch and used a Vactor truck to prepare the ductile iron pipeline. The PVC pipe required no preparation for lining as it had no tuberculation. Construction Product Marketing (CPM) provided factory installation support and a CCTV camera for the pre-lining inspection.

### 8-INCH LINING INSTALLATION

LVVWD crews installed the 8-inch lining system over a two-week period in March 2017. Portal development was completed in the first week, and the liner installation the following week. Portal 1 was located next to a commercial property and was the most difficult excavation and shoring due to the depth of the pipe, as well as the constrained work area bordered by a commercial property and a concrete drainage channel adjacent to the highway. Portal 2 was located behind a sound wall of the opposite side of I-215 in an area where open cut and benched trench was made easier due to the shallow depth of the pipe and surrounding undeveloped property.

Prior to installing the lining, LVVWD crews completed a CCTV inspection on the pipe. Because attempts to pull scraper pigs through the pipe were unsuccessful due to the 45-degree bends, crews brought in a Vactor truck to hydro clean the pipeline of any tuberculation. A foam pig was pulled through the pipe to confirm it was free of sharp edges prior to pulling the liner into place.

Crews pulled the folded and taped liner into the host pipe using a pulling winch, which needed only 2,000 lbs. of force and was completed in 30 minutes. Once in place, the liner was expanded using 7.5 psi of air pressure. The liner was left pressurized with air overnight to ensure it was holding pressure.

The following day, LVVWD crews installed the termination fittings supplied by the lining manufacturer with tools supplied with the material and hand tools the crews typically use. They then installed blind flanges on the termination fittings to allow a 100-psi pressure test of the liner system. Chlorine was flushed through the pipe and bacteriological tests were completed to ensure it was sanitary.



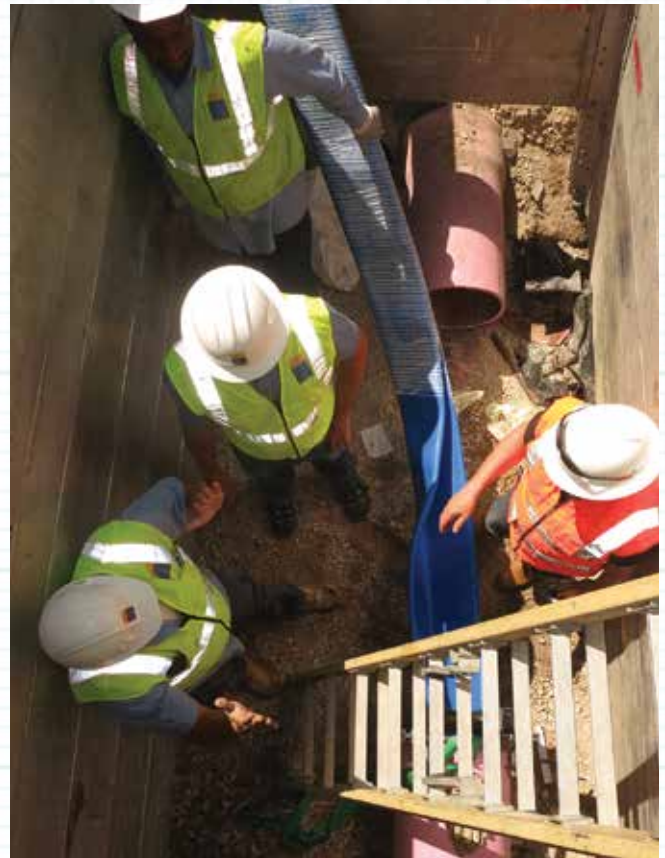
*Crews Prep the Pipeline at Portal 1 for Liner Install at Highway Location*



*Crews Prepare to Pig the Pipeline for Line Installation at Highway Location*



*Crews Install 8-Inch Terminal Fitting at Portal 2 Highway*



*Crews Coordinate Strategy for Liner Installation on Reclaimed Line*



*Crews Guide the Liner into Place for Installation on Reclaimed Line*



*Reclaimed Pipe Liner Installation*

“The hardest part was getting the winch cable from one side of the highway to the other,” Benner said. “We made a launch, placed it in the pipe, turned on the water, and let the water push it through to the other side.”

Benner said the LVVWD crews “did a great job” that resulted in minimal shut-downs during the course of the work. He also said the project served as a great test case for the 16-inch reclaimed water pipeline rehabilitation project.

### 16-INCH LINING INSTALLATION

The LVVWD completed the 16-inch rehabilitation in April 2017. The work was scheduled and coordinated when the seasonal water demands at the golf course were low.

To ensure continued service to the golf course while the rehabilitation work occurred, crews installed a bypass line to provide temporary delivery of potable water for the golf course’s irrigation purposes.

The five portals were strategically placed to minimize traffic control while still allowing residents access to their homes.

Because the pipe was PVC and did not have tuberculation on the walls, minimal preparation was needed. Also, there were a few 45-degree bends that were traversed, which were inspected with a CCTV camera prior to installation.

“Because this was a bigger pipe, we could use CCTV tractors to pull the cable through from one end to the other,” Benner said.

Crews pulled soft pigs through the pipe to ensure there were no sharp edges prior to installing the liner. The project entailed four separate pulls of the liner to rehabilitate the

*“Crews pulled the folded and taped liner into the host pipe using a pulling winch, which needed only 2,000 lbs. of force and was completed in 30 minutes.”*

2,200 feet of existing pipe, with the longest installation between Portal 2 and Portal 3, which had two 45-degree bends at the end of the installation. The pulling winch required approximately 2,500 lbs. of force to pull this section over a 90-minute period.

Like the work done on the 8-inch pipe under the freeway, crews installed pipe plugs on the end of the liner sections and used 7.5 psi of air to break the tape and expand the liner

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section. These stayed in place overnight to ensure the liner was free of leaks. After installing the liner, the LVVWD crews installed medium pressure termination fittings provided by the liner manufacturer; each termination fitting required about three hours to complete.

Crews then placed blind flanges on the pipe and completed a 120-psi hydrostatic test. The LVVWD crews then used flange coupling adaptors and DIP cut-to-fit spools

connecting the liner section to the downstream and upstream sections of pipe.

Because this was a reclaimed pipeline, bacteriological testing was not required.

“We were able to rehab this pipeline with minimal impacts on the neighborhood,” Benner said, adding that the work would have taken several months if it had been trenched. “We didn’t have to trench 2,000 feet of pipe, and we completed the work using in-house crews for about a third of what we would have had to pay a third-party contractor. Our crews can dig holes and cut pipe with the best of them.”

*“The LVVWD crews completed this project in about a month, from the start of excavation to backfill and paving of the access portals.”*

### CONCLUSION

The LVVWD undertook a thorough review and evaluation process to select and install a lining system to rehabilitate 8-inch and 16-inch sections of pipe, extending the useful service life of these underground assets.

The open trench dig-and-replace evaluation in the golf community was deemed cost prohibitive as it would involve enormous outlays for materials, adjusting adjacent utilities, and asphalt and concrete replacement. Residential impacts also prevented open cut as an option.

Primus Line’s polyethylene lined and coated Kevlar product met or exceeded all the design parameters that were identified for the rehabilitation and allowed LVVWD crews for the installation to be completed by LVVWD Asset Management and Distribution staff. The product proved cost-effective, with minimal social, economic, and environmental impacts, and it will provide 50 or more years of service for this critical segment of the LVVWD’s water distribution system. ▼

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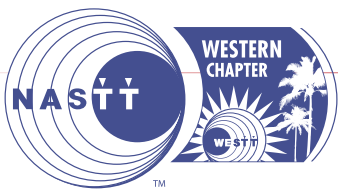
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