NASTT SOUTH CENTRAL CHAPTER

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# TEXAS & OKLAHOMA TRENCHLESS REPORT 2024

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

2024

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# All Hands on Deck for the Record-Breaking 36-inch FPVC HDD

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As one of the fastest-growing cities in the United States, League City has consistently expanded its infrastructure to meet the demands of its burgeoning population and thriving economy. Over the decades, the city has evolved into a vibrant residential and commercial hub, attracting families, businesses, and tourists alike with its excellent schools, recreational amenities, and proximity to major metropolitan areas. As of the latest census data, League City boasts a diverse population of over 100,000 residents, making it one of the largest cities in the Greater Houston area.

Among its recent infrastructure projects, the League City 36-inch Water Transmission Main from State Highway 3 to South Shore Harbor Booster Pump Station is a testament to the city's commitment to sustainable development and resilient infrastructure. The key players involved in the successful installation of the waterline are as follows:

**OWNER:**
**League City**
**ENGINEER OF RECORD:**
**CDM Smith**
**TRENCHLESS SME:**
**CCI & Associates, Inc.**
**PRIME CONTRACTOR:**
**Reytec Construction Resources, Inc.**
**HDD CONTRACTOR:**
**TCH Underground**
**MATERIAL PROVIDER:**
**Underground Solutions**

The League City 36-inch water transmission main consists of approximately 17,470 feet of 36-inch pipe. As part of the 36-inch Water Transmission Main project, approximately 9,600 feet was installed via three (3) separate HDDs. Fusible PVC pipe was selected as the pipe material because of superior mechanical properties and high tensile strength which makes it well suited for long and deep HDD installations. This article focuses on design and construction considerations for the 4,567-LF drill (HDD 2) which is the longest 36-inch FPVC installation of its kind completed in the world to date. Prior to this project, the longest HDD for 36-inch FPVC was a 3,800 LF HDD in Ocean City, MD. For FPVC pipe sizes 30 inches and above, there have been four HDDs that have exceeded 3,000 LF. This project adds two HDDs to that list. The longest HDD FPVC pipe was a 7,658 LF 24-inch DR 18 HDD in Cape Coral, Florida.

***Figure 1: Tight Workspaces at the Entry***

HDD 2 measured roughly 4,554 feet in horizontal length and was drilled in a northeast-to-southwest drill direction. The HDD was installed at a depth of approximately 60 feet below Robinson Bayou and utilized entry and exit angles of 12.5 degrees and a vertical curve radius of 2,400 feet.

The entry point was located directly south of a nearby residential property line near the west side of Davis Road, while the exit point was located near the Dr. Ned and Fay Dudney Clear Creek Nature Center parking lot . The entry location was located directly west of Davis Road where the back end of the rig abutting the road. The contractor was able to stage all of the necessary equipment within a tight workspace to accommodate HRE 750 HDD rig. The exit point was staged within the park area where all pits and any other supporting equipment was setup to minimize disturbance and impact to the park and its facilities.

***Figure 2. Entry point near residential property line***

*Figure 3: Exit-Side Operations*

The HDD crossed beneath Robinson Bayou and several wetland areas on either side of the bayou and near the entry point, however, the entry and exit fell outside any wetland area. The available survey data revealed that the proposed HDD did not cross beneath any buried facilities or pipelines, however, it was parallel to an existing buried Kinder Morgan pipeline and a high voltage powerline through most of the drill path, at a southeasterly offset.

The pipe staging and pullback area was located behind the exit point and was bent to the northwest through an existing park entrance and followed Egret Bay Blvd (Highway 270). In order to stage the pipe in a single continuous section with no mid-fuses, the pipe was laid out along the shoulder and one lane of Hwy 270, which required approximately 3,600 feet of lane closure during pipe string staging, assembly and pullback operations. The pullback alignment incorporated a compound curve as the vertical overbend overlapped with with a horizontal curve which required complex engineering and stress considerations. In order to support the pipe through the overbend and horizontal curve, a total of eight (8) excavators were utilized which required careful coordination. Another (ninth) excavator also supported the tail end of the pipe as it was pulled along. A segment of guardrail was also requried to be removed to facilitate the continuous layout of the pipe as it passed through the park entrance and onto the highway. Another important consideration during the pullback was the manamgent of the ballast water that was used to control pipe bouyancey to reduce the drag in the borehole. The contractor chose to secure several tanks of ballast waster instead of relying of hyrdants as a source of water.

The site conditions and project constraints posed many challenges to the HDD installation for the 36-inch DR21 FPVC pipe. The length, depth, and pipe OD of the HDD installation, when coupled with the challenging geotechnical conditions such as loose sloughing sands and soft swell-prone clays, posed major stress concerns for the pipe installation. For plastic pipe HDD installations (HDPE, MDPE, FPVC, etc.), due to relatively low modulus of elasticity in comparison to steel, selecting an appropriate depth of cover which satisfies factor of safety against hydraulic fracture to the formation while also providing sufficient factor of safety against collapse of the pipe due to external pressures can be a balancing

*Figure 4: HDD Pipe Staging along Egret Bay Blvd.*

act. The DR 21 FPCV was able to provide sufficient strength and stiffness to withstand the tensile and hoop stresses from the roughly 60-foot deep installation while also meeting the hydraulic capacity requirements for the project (afforded by a lower wall thickness). To further reduce the risk of potential pipe damage during an installation of this scale, the engineering team and contractors teamed up to develop contingency measures and best practices to follow which included maintaining a clean and open bore, utilizing buoyancy control, and monitoring of pull forces and torque during pullback.

A stress analysis was also required for the pipe pullback operations to ensure that the pipe would not become overstressed and that equipment would not be overloaded during lifting and maneuvering. A minimum allowable combined overbend radius was calculated to be 800 feet, therefore a horizontal radius of 1,100 feet and vertical overbend radius of 1,200 feet was chosen which produced a compound radius of 810 feet. The horizontal curve was chosen to be as tight as practical to allow the pipe to be laid out onto the highway while minimizing footprint within the lanes of traffic while the overbend was chosen to minimize above ground supporting requirements.

## *The longest 36-inch FPVC installation of its kind completed in the world to date.*

A hydraulic fracture analysis was completed for the HDD installation to model the downhole pressure during the pilot hole phase of construction and compared with the expected fracture pressure of the geologic formations above the drill path.. The driller used a 2009 HRE 750 drill rig with a 12 ¼-inch jetting assembly and 5 ½-inch drill pipe for the installation of HDD 2. Due to stress restrictions of the 36-inch FPVC pipe, the installation was limited to a maximum of roughly 60 feet deep. Challenging geotechnical conditions such a loose poorly graded sands and soft fat clays provided limited overburden strength at this depth to confine the drilling fluid pressures generated during the pilot hole. However, utilizing the pressure curves generated by the engineering team and following best drilling practices such as limiting pump pressures, maintaining circulation, and controlling drilling fluid properties, the HDD contractor was able to successfully install the pilot hole without impact to any major environmental feature along the drill path during installation.

HDD 2 was successfully installed and pressure tested in November of 2023. The 36-inch League City Horizontal Directional Drilling project achieved remarkable success through meticulous planning

and the collaborative efforts of all stakeholders Key to its success was a thorough understanding of site conditions and proactive planning for risks inherent to Horizontal Directional Drilling (HDD). The planning process encompassed comprehensive input from all stakeholders, ensuring a unified approach and effective mitigation strategies. This coordinated effort not only facilitated smooth project execution but also underscored the critical role of strategic planning in complex infrastructure projects.

*Figure 5. Minimal footprint along the highway*

## ABOUT THE AUTHORS:


**Gunnar Busch**, P.E., is the Trenchless Engineering Lead for CCI & Associates, Inc. Gunnar has managed and designed trenchless engineering projects throughout the United States, Mexico, and South America. Among these projects are a number of high-profile oil & gas, electrical, and municipal pipeline installations and replacements including onshore, offshore, and landfall installations. Gunnar holds a B.S. in Civil Engineering from McNeese State University and is a Licensed Professional Engineer in 15 states.

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