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Emergency in El Paso – Frontera Force Main Replacement

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1. ABSTRACT

In El Paso, Texas various trenchless techniques were used in a design build emergency replacement of two existing sewer force mains. The sewer lines are the only connections that convey sewage from the west side of El Paso to the wastewater treatment facility via a lift station making this a critical component of the El Paso Water sewer system. When the sewer lines failed El Paso Water had to divert flow from the lift station into the Rio Grande to prevent backflowing sewage into residential neighborhoods. A combination of hand tunneling, jack & bore, internal carbon fiber wrapping, and sliplining of abandoned pipelines were used to complete the project while navigating through a heavily developed metropolitan area. The first phase of this project was completed in December 2021 with the open cut of Phase 2 starting March 2022.

2. INTRODUCTION

After four major leak repairs were required for the Frontera Force Main in three consecutive years, the El Paso Water Department (EPW) declared a state of emergency and began searching for a new permanent solution. The solution required the existing Frontera Force Main to either be rehabilitated, replaced, or a combination of both. To overcome the state of emergency, EPW contracted with Oscar Renda Contracting (ORC) as construction manager and hired Jacobs Engineering Group Inc. (Jacobs) as consulting engineer. EPW and Brierley Associates Corporation (Brierley) served as the engineers of record. During the preconstruction and design-build phase, the team identified key issues that would require unique solutions to overcome the challenges of this project.

Three key issues were determined as:

- Conflicts between rights-of-way, easements, and existing utilities
- Selection of the new sewer force main pipe material
- Hydraulic constraints based on the existing Frontera Lift Station

The team explored different trenchless installation technologies and the potential reuse of an abandoned 54-inch diameter prestressed concrete cylinder pipe (PCCP).

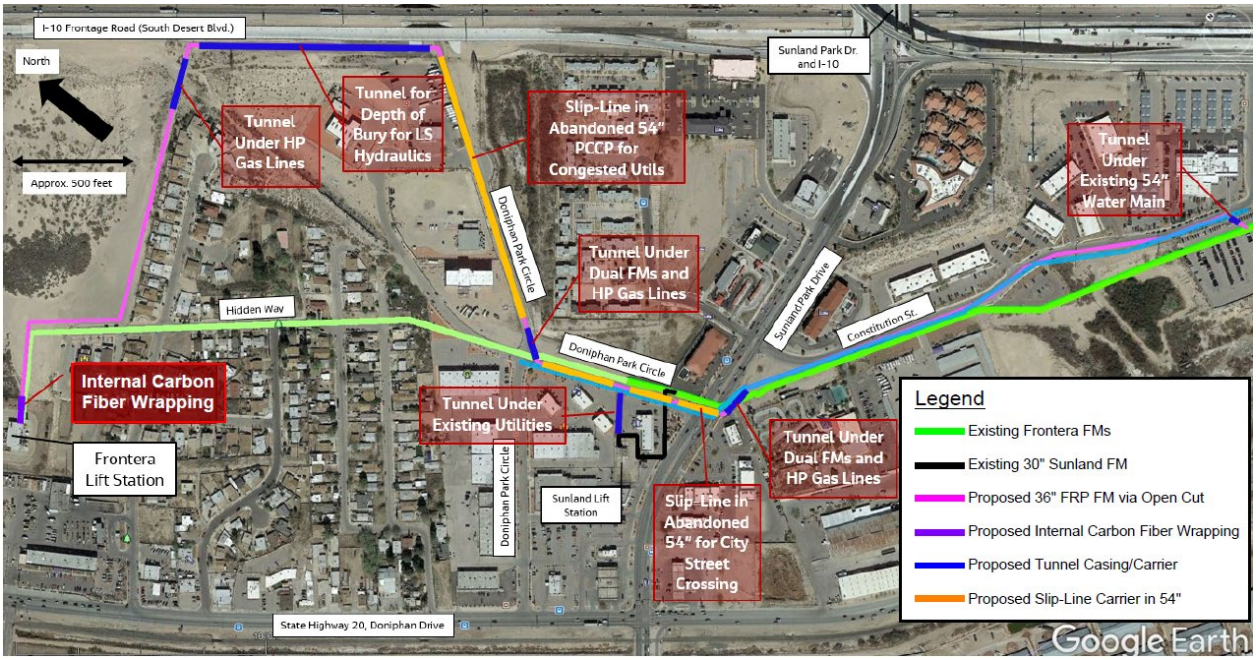

Figure 1. Layout of Phase 1 of the Frontera Force Main

The old Frontera Force Main was a nearly a 30 year old dual steel pipeline that included 30, 36, and 42-inch diameters. The pipeline is approximately 3.5 miles long, begins at the Frontera Lift Station and terminates at the John T. Hickerson Water Reclamation Facility. Based on system hydraulics, the team decided the first 6,000 linear feet should be replaced with 36-inch diameter pipe. EPW required that the new 36-inch diameter FRP be fully restrained. Engineers selected fiberglass reinforced pipe (FRP) by Thompson Pipe Group because of its high corrosion resistance to domestic sewer and soils, pressure capacity, restraining ability, and ease of joint installation.

Contractors used two restraint methods; keylock restrained joints and fiberglass laminations known as a butt wraps. The keylock joint was mechanically installed by inserting a nylon lock rod into grooves between the pipe spigot and coupling. This restraining joint system of the FRP pipe is unique in that the bell coupling adheres to both spigots mechanically, without steel, while maintaining chemical resistance. The butt wrap joint is a chemical bonding method that creates a monolithic continuous wall of pipe at the point of the weld lamination.


Figure 2. Two forms of restrained joints. Installation of a Key Lock with lock rod on the left. An internal butt wrap laminate joint on the right. Butt wraps can be performed both internally or externally.

For the remainder of the sewer line, Jacobs, Brierley, and ORC analyzed the alignment and planned the installation with a design build approach. The team performed an extensive nine-month utility investigation and determined the project required multiple trenchless and open cut installations. The trenchless sections were executed as slipline sections of 36” pipe on skids pulled through 54” pipe. Each end of the 54” tunnels would be met with access pits where pipe was joined with fittings. The open cuts were convenient where the depth of the installation was not an issue and utilities obstructions were not present. Furthermore, the investigation found a live 54-inch diameter water line near the 36” installation route which was avoided by sliplining. One of the benefits of the FRP material was that discrepancies between drawings and field slopes and angles could be accounted for by fabricating FRP fittings on site. The versatility of the product allowed the contractor to make specialty fittings at the job site and allow them to continue work without delay. This came into play especially during a time when the worlds distribution & supply network would cause delays in fabricating fittings at the manufacturing facility and delivering them to the job site.

Figure 3. A custom fitting made on site at an access pit where 2 tunnels meet. Making fittings like these on site proved very useful in design build situations.

To ensure that the abandoned 54” diameter water line was structurally sound to be used as a host pipe for the sliplining process, ORC hired Ground Penetrating Radar Systems Inc. (GPRS) to perform a condition assessment and survey of the pipeline. The condition assessment of the 54” abandoned water line produced CCTV video, grades, and elevations. The condition assessment and survey helped determine how much of the abandoned water line could be slip lined.

Analysis by ORC concluded the listed benefits of using the abandoned 54” water line for slipline installation:

- Eliminated open trench safety hazards
- Avoided disruption to traffic and repairs that would have to be done to the driveway
- Removed the need to encase the sewer force main in concrete along Doniphan Park Circle per EPW standards
- Reduced the risk of disrupting the live waterline nearby

Figure 4. ORC performing FRP pipe slipline installation.

Additional trenchless methods were utilized to reduced project costs and above-ground impacts. One such location was at the intersection of Doniphan Park Cir & Doniphan Park Cir, a loop intersection, where gas lines and a pair of 30” force mains intersect. Sliplining through the abandoned water line eliminated the painstaking job of excavating around the existing utilities and reduced the risk of disturbing those lines and dealing with the associated fallout.

Figure 5. Tee intersection fitting and blow off of 36” to 30” FRP sewer force main.

Two hand tunnels were planned totaling 1,042 linear feet. The reasoning for these two tunnels was to get underneath the Kinder Morgan Gas Lines and avoid having to remove and replace the abandoned 54" water line. Remove and replace in this area would have been extremely difficult with the overhead powerlines, the live 54" water line, and the extreme grade/elevation changes.

Along the I-10 Corridor a 750 linear foot tunnel was planned. Due to the of hydraulic head limitations of the Frontera Lift Station and the high ground elevation of the I-10 Corridor the depth of the new force main was approximately 49 feet to the top of casing at it's deepest. This tunnel was dug by hand and supported with tunnel liner plate to produce a 60' diameter tunnel to host the 36" FRP force main. Hand tunneling was the selected method of installation because of the overall length, soil conditions, and the accuracy that is needed. The FRP force main was installed by a combination of jacking the pipe and pulling it in place. After the pipe was in its final location the annular space was grouted.

The 750 linear foot hand tunnel was not the only tunnel on the project. A 300 linear foot hand tunnel as well as two auger bores were utilized to finish the work.

Figure 6. ORC hand tunneling operation. 30' diameter access pit on left. Hand tunneling shaft on right.

The biggest challenges were dealing with the unknowns. The discovery of the active 54-inch diameter live water line led the team to completely change the auger bore approach. The inaccurate record drawings of the existing force main led to many field adjustments to the pipe which was manufactured to the line drawings. Challenges were met by crews field fitting and adjusting pipe connections by cutting and butt wrapping the fiberglass pipe to adapt to the

changes. The table below provides a summary of all the trenchless techniques that ORC utilized to deliver the complex project.

Table 1. Summary Table of Project Highlights

Trenchless Method	Distance Executed	Material Used	Comments
Hand Tunneling	1042ft	60” steel liner plate	36” FPR carried in place
Sliplining	1502ft	36” FRP	755ft was the longest run inside abandoned 54” CMLC water line
Carbon Fiber Wrapping	400ft	Carbon Fiber	Wrapped existing 30” steel
Jack and bore	140ft	48” Steel Casing	Carried in place 30” FRP in casing
Jack and bore	77ft	54” Steel Casing	Carried in place 36” FRP in casing

3. CONCLUSION

This successful project was executed using several trenchless methods that enabled an accelerated schedule. The accelerated completion date was December 31st, 2021 three months earlier than the scheduled finish date of March 2022. Phase 2 of the project, approximately 5400’, is scheduled to last 10 months with open cut beginning in March of 2022. Phase 3 design will commence during Phase 2 construction. The FRP’s restrained joint system tripled the expected production rates. The trenchless methods helped navigate through the many existing utilities and prevented the need for road closures in heavily trafficked areas. Key occasions where trenchless construction was utilized were sliplining through an abandoned 54” water line to avoid open cut work parallel to a live 53” potable waterline, and a jack and bore to cross through a high pressure gas line easement that did not permit an open excavation. The non-corrosive nature and restraining capabilities of the FRP product was an essential material selection for the needs of EPW’s pressure sewer system.

Pipelines which require rehabilitation are more congested, technical, and challenging than ever before. It is important to know the various tools in the trenchless toolbox. The Frontera Force Main Project is a great example of all parties working together, utilizing the trenchless toolbox to facilitate rehabilitation in the most economical and least impactful approach.