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Slipline Method Used to Repair
a Leaking Pipeline Installed with HDD**

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1. ABSTRACT

Fairpoint Regional Utility System (Fairpoint) is a regional water supply entity located east of Pensacola, Florida in Southern Santa Rosa County. The utility is a wholesale provider of potable water to five water suppliers. The water supply system consists of seven sand-and-gravel aquifer supply wells and approximately 42 miles of water transmission mains.

A key segment of the transmission main is a 2,800-foot crossing under the East Bay. This section of the line was originally installed via directional drilling (HDD). In the spring of 2014, a major loss of water pressure occurred and it was determined that the leak was in the pipeline under East Bay. The pipeline had to be taken out of service until repairs could be accomplished. A video of the pipeline revealed a 13-foot longitudinal crack which, based on the original bore profile, was determined to be located 408 feet from the southern end of the alignment at a depth approximately 55 feet below the bottom of East Bay.

The project team evaluated methods to restore the failing pipeline and narrowed it down to the most reasonable option; a point repair of the failure area or a complete slipline of the 2,800-foot crossing using a new pipe. The slipline was chosen as the most cost effective and complete rehabilitation option. An HDD drill rig proofed the existing line and then installed the new pipeline with a fuse and pull method.

This paper outlines the design and evaluation process undertaken to renew the leaking pipeline. It will also review the construction results and outcome of the repair effort.

2. INTRODUCTION

In response to a growing statewide awareness of the importance of water, the Florida Legislature enacted the Water Resources Act of 1972. This Act represented a comprehensive approach to water management based on regional hydrological boundaries. Through the implementation of a Regional Water Supply Development Plan that was first published in 1982 and subsequently periodically updated, the coastal area of Santa Rosa County, Florida was deemed to be a Water Caution Area. The local area water providing utilities were required to explore alternative sources of potable waters either through surface water treatment or moving northward in the county where there was a more viable supply of potable ground water. The South Santa Rosa Utility System's primary supply of water is purchased from the Fairpoint Regional Utility System (FRUS), which was formed to develop and supply potable water to the coastal area of the county. FRUS is owned and operated by the City of Gulf Breeze, Midway Water System and Holley-Navarre Water System (See Figure 1). A fourth municipality receives water from FRUS but is not a member.



Figure 1. A vicinity map of the three entities that make up the Fairpoint Regional Utility System (FRUS) - City of Gulf Breeze, Midway Water System, and Holley-Navarre Water System,

A study completed in the late 90's evaluated surface water treatment and development of area ground water supplies. The most cost effective development of a regional water supply was to develop a wellfield approximately 20 miles from the coast and provide water to the member utilities through a transmission main between the wellfield and the points of delivery to the users. During the design phase of this project, it was apparent that the new transmission main installation would not be an easy one due to the length of the drill and its location under a large body of water.. [n1]The directional drill was selected to cross East Bay at a point where shorelines were approximately 2,000 linear feet apart. The design included the installation of a 30-inch DR 9 HDPE pipeline.

In 2004, installation of the pipeline under East Bay began. During the first drilling operation, the HDD driller was able to successfully complete the pilot hole bore just before sunset. They ceased operations until the next morning. When they returned to the jobsite, the plan was to enlarge the pilot hole with multiple reaming passes, however when all equipment was prepared, the crew could not get the drill rod to rotate. After attempts to free the rod failed, they elected to abandon the equipment in place and drill a new pilot hole. Once the contractor and FRUS selected a new location for the pipeline under East Bay, they successfully drilled and then successfully reamed the required bore hole. During the pipe installation, however, approximately 1,500 linear feet into pull-in, the swivel attached to the pull-head broke. Reasons for the swivel detachment are unknown, and after attempts to retrieve the pipe failed, the contractor decided to abandon the pipe. [n2] Determined to successfully install the pipe, the contractor drilled a third bore hole at a new location under the bay. The third attempt to complete the drill was accomplished with no major issues and the 30-inch DR 9 DIPS HDPE pipeline was subsequently placed into service in 2004. Figure 2 shows the final location of the of the HDPE waterline across the East Bay.

3. BACKGROUND ON PIPELINE FAILURE

On April 19, 2014, the operational staff of FRUS received notification of insufficient flow from the user furthest from the point where the transmission main split to the different users. This report was indicative of a water main break and operation department began tracing the pipeline back toward the source of the break or leak. The following day, a sand plume was observed approximately 200-feet from the south shoreline of East Bay where the directional drill had been completed. Through the isolation of valves, staff members were able to eliminate areas where no leaks were detected, and ultimately confirm that the leak was in the subaqueous pipeline.

Efforts were made to get a company to come in and video the pipeline under East Bay with a robotic camera, in order to identify the exact location of the leak. However this effort stalled due to either timing issues or conditions that were unreasonable. FRUS assembled an engineering team, a group of operators and pulled together two local contractors to help with the issues at hand. Two things had to be determined relatively quickly: 1) whether or not the pipeline was still intact, and 2) what exactly was causing the leak.

The best way to survey the pipeline for gross damage which would cause a leak of this magnitude would be to survey it with a camera, or CCTV. Utility Service Company was brought on board because they had pigging experience and there needed to be a way to get a cable through the pipeline so that a camera could be pulled through the alignment and control its orientation inside the pipe. The discussion leaned toward using system pressure to float something like an anchor buoy through the pipeline with some form of cable or rope attached. The immediate concern with this concept is whether the buoy would move past the point of the leak. Alternatives, such as pushing a drilling rod through the pipe, were discussed and left open in the event that a cable could not be pulled through the pipe.

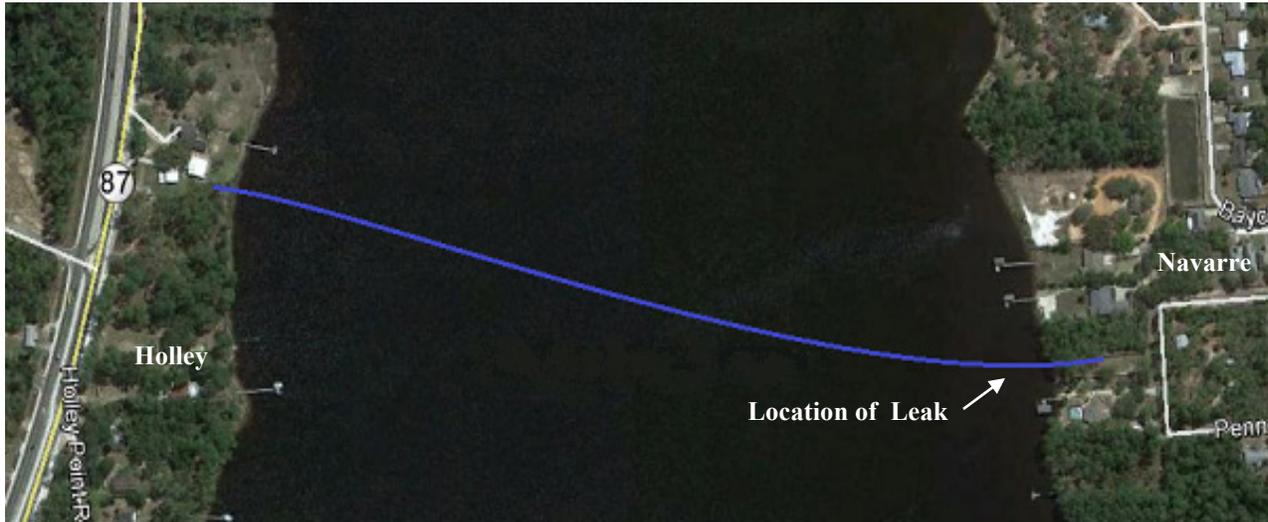


Figure 2. Aerial Photo of Project Area and Drawing of Alignment of Pipeline Crossing under East Bay

Griner Drilling was brought into the team because they had an underwater video camera with an umbilical cord long enough to cross the bay. However, the camera was not robotic and would need some means to move the unit through the pipeline with enough control to stop and evaluate any sections of interest. There was a discussion about mounting it in a cradle and Griner felt that their machine shop could fabricate a cradle that would support the camera while being pulled through the pipeline.

Utility Service successfully passed the anchor buoy through the existing pipeline and very little sand was observed ahead of the buoy when it exited. A 1/16" steel cable was pulled through the pipe behind the buoy. Using the cable, Griner Drilling pulled a larger diameter nylon rope through the pipe, a line that would hold against greater pulling pressures. At 408-feet into the camera pull, a fracture in the pipe wall was discovered. The longitudinal fracture was traced and observed for approximately 13 feet and was located between thermal butt-fusion joints used to assemble the pipe (See Figures 3 and 4). With no internal pressure on the pipeline except the static head of water in the line, no infiltration was observed of existing surrounding soil or debris coming [n3] into the pipeline from the exterior of the line. At the point of the leak, the depth of the bay to the surface of the ocean floor, or mudline, [n4] was approximately 15 feet, and the pipeline was located 65 feet below the mudline for a total of 80 feet of cover over the area of the failure.

FRUS and the assembled team decided that there were three proposed solutions to repair the leak in the pipeline. First, they could attempt some sort of point repair at the specific location of the failure. Second, they could slipline another pipe into the entire East Bay crossing of existing pipeline originally installed by HDD. Or third, they could abandon the existing line and attempt yet another HDD crossing of the bay. It was decided that sliplining the entire pipe in lieu of a point repair or total replacement was the best option, given the circumstances. Since the cause of the failure could not be determined as being from an outside source or material failure, a point repair could entail having to excavate to the location of the failure, which was simply not an option. Replacing the pipeline with a new pipe installation would have been the ideal choice in terms of gaining the full asset back, however, it would require the most money and time. FRUS wanted to move forward with the quickest and most economical repair.

During this time frame, the engineering team spent numerous hours in contact with companies experienced in point repairs, sliplining and directional drilling so the most feasible repair solution could be recommended. As the staff worked diligently to get the issue repaired as quickly as possible, FRUS had to rely on Escambia County Utility Authority (ECUA) for the required water supply until the water main was restored to service.



Figure 3. Freeze frame of the video inspection showing the fracture roughly at its midway point.



Figure 4. Freeze frame of the video inspection showing one end of the fracture.

4. SELECTION OF REPAIR AND/OR REPLACEMENT METHOD

On May 16th, an advertisement was placed in a local newspaper seeking proposals from interested firms who could provide point repairs or sliplining of the entire pipeline. A bid form was never generated, in anticipation that bidders would propose a range of methods as to how the issues with the existing pipeline could be resolved. No proposers submitted on point repairs because of the length of the crack in the pipe. It was pointed out that point repairs usually

occur in 3-foot sections and companies contacted had not done more than three consecutive sections. There were no guarantees that the repairs would be successful or how long they would last.

Three proposals were received in response to the advertisement. United Pipeline submitted their quote for sliplining a 23-inch outer diameter HDPE pipe through the existing pipe but assumed no warranty for successful completion. Their total project value included an estimate of \$10,000 to \$15,000 for time and materials per day, with 7 to 10 days of work to complete the pipe installation, in addition to \$30,000 for mobilization and demobilization. TB Landmark of Jacksonville, Florida proposed a total project value of \$685,000 to slipline a 20-inch DR 18 DIPS fusible polyvinylchloride pipe (FPVCP) through the existing pipeline. Boan Construction submitted a proposal to complete an entirely new directional drill for \$1,559,272.

The FRUS Board of Directors reviewed the three proposals for the repair of the existing pipe across East Bay. After careful evaluation of each proposal, the Board decided to award the project to the lowest responsive bidder, United Pipeline. The methodology behind this attempt to repair the pipeline was to use a chain and winch to pull a 23-inch outside diameter HDPE pipeline through the existing 24-inch inside diameter HDPE pipeline that had failed. Due to restrictions on each side of the bay, the pipe pulling operations have to be completed in a pull-fuse-pull-fuse manor until the operation was completed. This meant that the new sliplined pipe would be assembled, 40 or 45 feet at a time with thermal butt-fusion joints, as it was inserted.

Construction commenced right away and the site was prepared and equipment was set up for the project. At approximately 600-feet into the pull-fuse-pull operation it was observed that high pressures were being required to move the pipeline after a fusing procedure. The movement of the pipe was described as a jerky, erratic motion. At one stage in the fuse-pull operation, a lot of pressure was required by the winch before the pipe would start moving, and it would jump once it began to move again. There was enough concern with United Pipeline in continuing to try and perform the installation, that they stopped progress and removed the 600 feet of pipe that had been installed. It was theorized that many slight bends in the existing pipe were causing too much friction for the smaller pipe to move through or that the inner diameter of the existing pipe contained variations that were having the same effect.

This setback stalled the project while working through negotiations to settle the contract with United Pipeline. While considering their options to find a way to return the pipeline to service, a company was hired to run a smart-pig through the pipeline to determine the ovality of the pipe. This resulted in a report that highlighted at least eight areas where the inside diameter of the pipe was less than 23-inches. The smallest of these was 22.69-inches. And, oddly enough, the initial attempt to repair the pipe had already passed this point. These points were determined to be thermal butt-fusion joint beads protruding into the pipe inner diameter. These beads are typical of the thermal butt-fusion process were left there as a matter of standard practice. Discussions followed and the United Pipeline indicated that they could come back on site but that they would have to use a smaller diameter HDPE pipe in order to be able to complete the installation. This smaller pipe section would reduce the inner diameter to 18-inches or less. The proposed loss in the system hydraulics due to this smaller pipe size was not acceptable to FRUS.

Once the contract closeout between FRUS and United Pipeline was completed, the attention was then shifted towards TB Landmark, the second lowest bidder. TB Landmark, had also proposed to slipline the existing pipe, but had chosen to use FPVCP as the slipline pipe material instead of HDPE. With an outside diameter of 21.60 inches, the new pipe would be small enough to handle the variations of alignment in the existing pipe. Also, with an inside diameter of 19.08 inches, the 20-inch DR 18 FPVCP was the best option to obtain the largest possible flow area for the given situation.

5. CONSTRUCTION

As part of the construction proposal, it was agreed that TB Landmark would first pull a 90-foot “proof” piece of representative pipe throughout the existing line to validate the alignment of the casing pipe and make sure there were not any significant variations in the alignment that would interfere with the installation. This would provide some assurance that the slipline would be feasible, and help to ease the uncertainty that everyone felt toward the installation. Due to time and funding constraints, TB Landmark elected against pulling the proof piece, but instead, opted to push a 22-inch rod ball through the existing 30-inch line to accomplish the same goal. A horizontal direction drill rig was brought to the jobsite and set up on the North end of the bore alignment to push the rod ball

through. Once the rod ball was pushed through and no concerns were raised regarding the inside diameter of the pipe, the contractor was ready to begin the slipline process the following day.

2,800 feet of 20-inch DR 18 DIPS FPVCP was shipped to the jobsite and construction began in February 2015. An internal pull-head was used to connect the drill stem to the FPVCP. An internal pull-head was used to deal with the small fixed clearance between the inside diameter of the existing pipe and outside diameter of the new pipe (see Figure 5). Starting from the South side of East Bay near Clarke Street, the 20-inch FPVCP was fused together and pulled into the existing pipe using a fuse and pull assembly operation (see Figures 6 and 7).



Figure 5. Internal pull-head attached to 20-inch FPVCP, shown here exiting the host pipe.



Figure 6. 20-inch FPVCP water main entering existing 30-inch DR 9 DIPS HDPE water main during slipline operation.



Figure 7. Fuse-and-pull operation and initial slipline insertion of Fusible PVC® Pipe

Once the entire 2,800 feet of pipe was installed, the new waterline was flushed and pressure testing was performed at 150 psi for two hours. Following the successful completion of the pressure test, the line was disinfected and cleared for use. Utility Services Company of Gulf Breeze, Florida made the final connections and tie-ins to place the transmission main back into service. With a new water service in place, FRUS was able to continue on with daily operations and no longer had to rely on shared water service.

6. CONCLUSIONS

The East Bay crossing is one of the critical links in the Fairpoint Regional Utility System and when it developed a leak and needed to be repaired or replaced, it represented a challenge unlike anything they had ever dealt with before. The process to find a solution presented several challenges, not only in terms of the engineering and construction, but also in terms of failed attempts and contract negotiations and settlement. Ultimately, a solution was found and implemented that allowed FRUS to continue operating their system. This solution utilized a smaller FPVCP pipeline that was sliplined into the existing 30-inch HDPE pipeline and assembled as the insertion took place. Although faced with these obstacles, they were eventually able to restore their water supply with a new waterline while maximizing the transmission main's hydraulic capacity in the most cost effective manner possible. Although the contractor who ultimately completed the project successfully was not the contractor that was initially chosen, TB Landmark was able to slipline the entire 2,800 feet of 20-inch FPVCP with no major complications to restore service.

7. REFERENCES

The Official Website of the City of Gulf Breeze. Retrieved from <http://cityofgulfbreeze.us/>