PARRIS ISLAND FORCE MAIN PROJECT CREATES RECORD HDD INSTALLATION FOR PLASTIC PIPE

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ABSTRACT: In September 2008, the Beaufort-Jasper Water and Sewer Authority (BJWSA) assumed ownership, operation, and maintenance responsibility for the water and wastewater systems at several local military facilities, including the Marine Corps Recruit Depot at Parris Island, SC. Due to the restrictive Beaufort River discharge requirements, the military wastewater plants at the Air Station and Parris Island needed to be eliminated and flows diverted to BJWSA’s state-of-the-art Port Royal Island, SC Water Reclamation Facility.

This operational change required the waste stream at Parris Island to be piped off of the island. But with extensive tidal marshland, and other traditional construction constraints present, the new sewer force main from Parris Island had to be installed under Archer’s Creek and the surrounding marsh via Horizontal Directional Drilling (HDD) methodology. Open cutting across the salt marsh would have been very difficult, even had it been possible to permit. BJWSA’s growing body of experience with long HDD installations and recent advances with the technology made drilling the only viable option. The Mears Group mobilized in October, 2009 and began the pilot bore. On December 2, 2009, 6,400 linear feet of fused 16” DR 18 FPVC® pipe was positioned on rollers and pulled into place to complete the crossing.

This paper will discuss all aspects of this 6,400 LF record breaking crossing, including the bore completion, staging and inserting that length of pipe, and working within the requirements of the military base, which made this project even more challenging.

1. INTRODUCTION

Very early on December 3, 2009, at the drill rig location on Jericho Island, the final drill rods, reamer, swivel and pipe pull head assembly emerged from the drilling fluid returns, pulling with it one end of a 6,400 linear foot (LF) string of fusible polyvinylchloride pipe (FPVC). The pipe emerged during the predawn hours to the applause of the small group of interested bystanders and a much larger number of tired workers (Shepherd, 2010). This Horizontal Directional Drill (HDD) pullback operation ended much like thousands of others – with the successful installation of a new pipeline between two points of difficult or perhaps impossible construction by traditional approach. This installation, however, was different in that it represented the longest single, uncased HDD installation of a thermoplastic pipe ever performed. What is perhaps more impressive is that the owner, design and
construction team that put this successful record-breaking installation together was the same team that performed the up-until-that-time record for the same type of installation back in 2007.

Less than three years after the record-setting 5,120 LF Secession Effluent Force Main (Secession) project was successfully installed under the Beaufort River, Beaufort Jasper Water & Sewer Authority (BJWSA), Mears Group, Inc. (Mears), Hussey, Gay, Bell & DeYoung (HGBD), and Underground Solutions, Inc. (UGSI) have set a new record for the longest known single continuous HDD pullback of thermoplastic pipe to date..

Figure 1. Successful completion of 6,400 LF HDD crossing, using 16” DR 18 FPVCP

2. PROJECT SET-UP

The BJWSA is a two county special purpose district located on the southeastern coast of South Carolina. BJWSA provides water and sewer services to approximately 125,000 people and has revenues in excess of $45M annually. Beaufort County’s geographic surface area is about 40% water and has more islands than any county on the east coast. Based on this type of topography, HDD is a practice that BJWSA has used numerous times and has gained experience and confidence in, along with the use FPVCP in HDD situations.

In September 2008, BJWSA assumed ownership, operation, and maintenance responsibility for the water and wastewater systems at several local military facilities, including the Marine Corps Recruit Depot (Depot) at Parris Island, SC. As part of the merger, all of the water and sewer utilities are undergoing upgrades and improvements. Due to restrictive Beaufort River discharge requirements, the military wastewater plants at the Air Station and Parris Island will be eliminated and flows will be diverted to the state-of-the-art Port Royal Island, SC Water Reclamation Facility. It was this need that started the Military Wastewater Consolidation Project to bring the wastewater flows
from the base back to the mainland and treatment. The new sewer force main from Parris Island would need to be installed under Archer’s Creek and the surrounding marsh, which became a real design challenge due to the fact that the narrow causeway linking the island and the mainland was off limits to construction activity. Direct bury options across the salt marsh would also have been very difficult, even had it been possible to permit the work. That left HDD as the main viable option – but it was shaping up to be a very long crossing.

BJWSA turned to a design team for this challenging crossing that had been there before. Only three years ago, BJWSA, Mears, HGBD, and UGSI teamed up to install the previous record setting long-distance HDD of thermoplastic pipe with a crossing of the Beaufort River. Early onsite consultations with representatives of HGBD, Mears, and UGSI helped to determine the feasibility of such a long crossing with FPVCP. However, the possibility of an intersect drill, staging that length of pipe, and working within the requirements of the military made this project challenging in addition to the sheer length of the crossing.

Previously, for the Secession project, BJWSA contracted with Mears directly for the work and used a daily rate with a fixed schedule in a risk sharing effort. In addition, BJWSA contracted directly with UGSI to provide the FPVCP and fusion services, also sharing the risk of the project on performance of the pipe material and fusion workmanship. This was a very successful project and a similar contract vehicle was instituted to complete the Parris Island project. Moving forward on a project of this magnitude with such a contract mechanism in place assures that all parties are motivated by a successful installation. This motivation then assures that teamwork, collaboration and coordination are highly prioritized in completing the project.

Figure 2 shows the overall layout of the crossing. This record-setting installation went from Horse Island shown in the middle of the figure to Jericho Island in the upper left-hand corner, crossing under Archer’s Creek between the two land masses. The primary drilling rig spread site was placed on Jericho Island. This site was chosen as the primary pulling site, because of the ability to string pipe along the causeway between Horse Island and Parris Island. A temporary road was built over the tidal mud flats to access Jericho Island and stage needed equipment and materials. The road was then removed upon completion of the project. The pipe fusion, fabrication, and stringing took place on Horse Island and stretched to Parris Island and the Depot. A secondary drilling rig spread site was
also staged on Horse Island. The secondary rig set up was for the intercept of the pilot hole, as well as readiness to be used as a tension rig for forward pre-reaming, if needed.

![Diagram of Archer's Creek HDD crossing](image)

Figure 3. Plan and Profile drawing of Archer’s Creek HDD crossing.

The bore crossing soil conditions were Pleistocene deposits of very weak clayey sands over Miocene medium dense to very dense cemented sands with shells and clayey sands. The relatively soft overburden of the salt marsh and flats necessitated care in drilling in order to avoid overpressuring the drilled hole. The calculated theoretical pullback load was estimated at 107,000 lbs assuming a fluid density of 12 pounds per gallon (ppg) in the drilled hole and that the pipeline would be pulled in a fully ballasted condition for the entire length of the installation. USGI’s published safe pull-load for the 16” DR 18 FPVC™ (DIPS) cross-section is 139,700 lbs, which includes a factor of safety of 2.5 compared to the yield of the joint and material. This factor of safety reflects the possibility of compounding stresses in an HDD installation; including bending and handling of the pipe during pull-in. USGI agreed to relax the allowable safe pull force maximum value for purposes of warranty on the pipe to 174,600 lbs solely for this project in light of Mears guarantee of care in laying out the pull-in arrangement and their monitoring of the pullback forces during the installation. This is one example of the risk sharing contracting that made a successful project outcome the focus of the risk and reward balance for the team members.

3. CONSTRUCTION PROCESS

Mears mobilized in October, 2009 with two drill rigs, prepared to use the intersect method to complete the pilot drill as described. The temporary road between Parris Island and Jericho Island was completed prior to mobilization. Mears’ 500,000 lb pull capacity rig was used as the primary rig and was set up on Jericho Island. Mears’ 140,000 lb pull capacity rig was used as the secondary rig and was set up on Horse Island. The pilot bore drilling was started from the Jericho Island, primary drilling rig site on October 15, 2009.
During the pilot bore process, in order to allow sufficient pressure to be applied on the pilot bore bit, 14” diameter steel casing was inserted over the drill pipe through the entry side curve. The pilot hole progressed and ultimately, the 6,400 LF pilot drill exited on target without requiring the use of intersect technology. No inadvertent returns occurred during the pilot bore process and the pilot hole was completed on October 24, 2009. The 14” casing was extracted after completion of the pilot bore.

The planned reaming process was to make a single forward pre-ream pass from Jericho Island to Horse Island. 26” and 34” diameter hole openers were both attached to the drill string in tandem and forward reaming from Jericho Island towards Horse Island started on October 26, 2009. Drilling fluid returns were maintained to the drill site at Jericho Island until the hole openers were approximately 3,300 feet into the crossing. At this point, some returns began to accumulate at the drilling site on Horse Island. From this point onward, returns circulated to both sides of the crossing through completion of the reaming activities. Pre-reaming activities were finished on November 27, 2009. A 26” diameter barrel reamer was passed through the crossing as a swab pass to clear cuttings and re-inject clean fluid between November 28 and 30, 2009, prior to pipe insertion.

During construction, there were several constraints imposed by the military at the Depot in regards to its operations. First, the construction schedule was limited based on the Depot’s schedule. This included a transportation moratorium on graduation days. Additionally, the Depot’s weigh station, which is located on Horse Island was to remain open during construction and then had limited durations on which it could be closed, leading to pipe pullback blackout dates, since the weigh station had to be closed during the pipe insertion process. Careful coordination was also required with the Depot when construction personnel entered the marsh and creek areas for work activities, since those areas were used for military exercises including the use of live firearms.
The pipeline was fused and strung in two sections between October 15 and November 9, 2009 and was completed two days ahead of schedule. One section was 5,600 feet long and the other shorter section was 800 feet long. The two sections were created because there was not enough room available to string the entire length without cutting of access to critical Depot operations at the weight station. After the swab pass had been completed at the tail end of the drilling operations, the shorter section of pipeline was pulled across the Depot’s weigh station and attached to the longer section. This activity as well as the entire pipe installation process required the closure of the Depot’s weigh station, thus was carefully coordinated in regards to schedule. The full prefabricated pipeline was subjected to a short, two hour, low pressure air test to verify integrity and assure that no damage or vandalism had been sustained by the pipeline during the assembly stage of the project.

4. PIPE INSTALLATION

On December 1, 2009, the completely assembled and air-tested 6,400 length of fused 16” DR 18 FPVCP was positioned on rollers and pulled into place with an excavator. The pull head was then connected to the drill stem to begin the process of pulling the pipe from Horse Island, under Archer’s Creek, onto Jericho Island.
The pipe was positioned on the rollers to limit sag in the line with a spacing of 36 feet between the rollers. High quality rollers, well maintained and greased, also limited the amount of pull force that would be required as the pipe began insertion while at grade. In order to assure proper support for the pipe, as well as to minimize the effect of pipe weight and friction on the pull forces encountered during the insertion, rollers were adjusted and other support mechanisms were used. The alignment was also tended to by the installation crew as insertion progressed to assure that rollers maintained a solid support for the pipeline and that the pipeline was never in danger of falling off of the rollers or jumping the guide systems in place. Figure 7 shows two of the methods used to assure that the pipe alignment was maintained. A roller is adjusted to provide a reactive force, taking into consideration the horizontal bend being negotiated at this location near the Depot weight station. Also shown is the pipe tailing effort, which tended to the back of the alignment, guiding the tail end of the pipe string so that it did not wander off the rollers as well as assuring that the end was not damaged as rollers were cleared during the insertion.
After approximately 440 feet of the pipeline had been pulled into the crossing, a 3” diameter polyethylene water fill line (can be seen in Figure 7) that had been pre-installed within the pipeline was connected to a hydrant at the backside of the pipeline and water was introduced into the pipeline to help ballast it in the slurry filled bore hole. As the pullback progressed, ballast water was metered and dumped into that portion of the pipeline that was in the bore hole. Ballasting the pipe with clean water offsets the buoyancy force that pushes the pipe upward in the bore hole, due to the difference in effective density of the pipe cross-section compared to the drilling fluid slurry. This upward force is the largest contributor of pull force to a given installation during pipe insertion because of the friction that is created with the pipe on the top of the borehole. Thanks to the measures taken to reduce friction both above and below the surface, pullback was completed with a maximum pull force realized, as measured at the drilling rig, of 80,000 lbs. This was well below the adjusted, as well as listed, safe allowable pull forces for the FPVCP pipe section, as well as the estimated pull force per the installation design. The insertion took 17 hours to complete after it had commenced – completing the HDD operation and overall project on schedule.

After completion of the crossing, a four hour hydrostatic pressure test of 150 psi, representative of 150% of the working pressure for the pipeline was undertaken to verify its integrity. When the rest of the construction of the main line is completed in the future, the new force main will tie-in the flow from the Parris Island facilities to the Port Royal Water Reclamation Plant.

5. SUMMARY

In December, 2009, a 6,400 LF record-breaking HDD installation was completed with 16” DR 18 FPVCP – the longest uncased HDD installation of a thermoplastic pipe section ever known to be installed. Faith in the design and construction team, as well as diligent investigations during design and responsible care during construction, provided the confidence required for product selection and construction method utilized. Challenges on the project included geology and bore completion, fusing, stringing, staging and inserting such a long length of pipe, and working within the requirements of the Depot military base. Equitable risk-sharing on the project allowed for economically feasible installation with all parties sharing in the risk and success of the project. This risk-sharing contractual mechanism encouraged teamwork and resulted in the completion of a very difficult project on schedule and within budget.

5. REFERENCES