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**Folly Beach Installs Unique Single Directional Drill  
With Multiple Material, Size, and Use Pipelines**

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**1. ABSTRACT**

When the South Carolina Department of Transportation decided to replace two bridges leading to Folly Beach, officials notified the local utilities that their pipelines and conduits would not be allowed to be suspended from the new bridges as they had been on the previous bridges. The existing bridges, spanning Folly Creek and Folly River, held a wastewater force main, communication conduits and gas mains that would need to be replaced and relocated under the two waterways. Horizontal directional drilling (HDD) methodology was quickly viewed as the easiest and most feasible means of construction to accomplish this task.

The City of Folly Beach chose BP Barber (now URS Corporation) to begin investigations and design an HDD crossing for the 8-inch wastewater force main. Soon thereafter, both AT&T and South Carolina Electric and Gas (SCE&G) inquired about performing a joint HDD project to install the three 4-inch conduits and a 6-inch steel gas main, respectively. URS had primary responsibility to the City of Folly Beach, but were involved in drafting agreements on design, inspection and cost sharing between the three entities. URS designed a bundled HDD with all five pipes being installed in a single pull – and this turned out to be the easy part. Negotiating the cost to share labor and equipment on a pro-rated basis, yet allow for material separately, was the true challenge.

This paper will review the design and construction highlights of this challenging multi-pipe, multi-use HDD installation.

**2. INTRODUCTION**

As a part of a state wide capital improvements plan, South Carolina Department of Transportation (SCDOT) decided to replace two bridges located on SC Route 171, Folly Road, which leads to the City of Folly Beach. The bridges cross Folly Creek and Folly River and provide the only means of vehicular access to the City of Folly Beach. Figure 1 depicts the location of the Folly Creek and Folly River bridge crossings. As a result of the roadway project, the City of Folly Beach and other utility providers were notified that there would be existing utility impacts which would require relocation of existing facilities.

The City of Folly Beach is located on Folly Island, a 6-mile long barrier island located on the Atlantic seaboard approximately 15 minutes south of historical Charleston South Carolina. With a population of about 2,300 people, and referred to by locals as the “Edge of America,” the city is a beach community comprised mainly of residential dwellings, a few historic sites, and a small commercial area with several restaurants, shops and hotels. With respect to existing utilities, the City of Folly Beach owns and maintains their own water and sewer system and works in conjunction with the James Island Public Service District (James Island) to operate several sanitary sewer lift stations. The City receives potable water from Charleston Water System and discharges wastewater to the City of Charleston’s Plum Island wastewater treatment plant, through existing James Island infrastructure. The City of Folly Beach also receives electric and natural gas service from South Carolina Electric and Gas (SCE&G) and communications service from AT&T.



Figure 1. General location and scope of project is shown, including two separate bore locations spanning Folly Creek and Folly River.

In the existing condition, several utilities were attached to the SCDOT bridges to be demolished and replaced, including the City of Folly Beach’s sewer force main, natural gas mains owned by SCE&G and communications

conduits owned by AT&T. Due to revisions in SCDOT's utility accommodation policy, new utilities were not permitted to be attached to SCDOT bridges forcing each utility owner to relocate their utilities in accordance with state and local construction regulations. This meant that each utility owner needed to secure their own utility corridor and construction means and methods to relocate their facilities across two waterways approximately half a mile each. Additionally, scheduling requirements were set by SCDOT to complete the relocations due to the poor condition of the existing bridges and the high priority for their replacement. While SCDOT could not sever existing utilities, they would be forced to set weight restrictions on the existing bridges which would have a negative impact on the Folly Beach community to receive commercial services.

After identifying the need to relocate the existing utilities and challenges ahead, the City of Folly Beach selected URS Corporation (formerly BP Barber) to evaluate relocation options, prepare design drawings, procure permits, obtain right of way, prepare contract documents and to administer bid and award of the construction contract. Concurrently, SCE&G and AT&T were evaluating utility relocation options with their own in-house engineering groups.

Following evaluation of several options for utility relocation including an aerial crossing, requesting a waiver from SCDOT policy to attach to their bridge structure or trenchless unground relocation, URS provided the City of Folly Beach with a recommendation to replace their force main at both locations via horizontal directional drilling (HDD). Based on previous experience, site constraints and similar successful projects completed by URS in the area, URS felt HDD was a viable option. Based on cost estimates prepared by URS, HDD was the economical choice.

As a part of the bridge replacement process, SCDOT recognized that close coordination between all utility owners and SCDOT was essential to the success of the overall project. Early into the design phase, SCDOT held a coordination meeting which included all parties involved at which time URS presented a plan to relocated sewer facilities by HDD on the east side of both bridge replacements. At this time, SCE&G and AT&T approached the City of Folly Beach and URS to discuss the potential for a joint relocation project due to extreme construction area limitations as well as potential cost saving benefits. The idea of installing all utilities (sewer, gas, conduits) in a single borehole was talked over and shortly thereafter, SCE&G and AT&T entered into agreements with URS to evaluate the joint installation.

### **3. PIPE DESIGN AND INVESTIGATION**

Understanding site constraints and determining HDD entry and exit points was a critical first step in the pipe design and analysis. Several HDD horizontal alignments were considered for each crossing in which several key considerations were assessed. These critical items included the location of the future SCDOT bridges, the location of soil stabilization construction areas related to the bridge construction, including soil mixing zones and spoil excavation areas, the location of environmentally sensitive areas, construction work and laydown requirements, and the location of existing utilities for tie-in with the proposed HDD alignment. The main objective was to avoid all areas to conflict with future construction while minimizing the length of the HDD alignment and providing the appropriate connections to the existing utilities. The HDD horizontal alignment analysis resulted in a 2,805 LF crossing at Folly River and a 2,382 LF crossing at Folly Creek, both to be installed in dedicated easements adjacent to future SCDOT right of way.

Following the horizontal alignment alternatives analysis, equipment staging and laydown areas were assessed. At Folly River, the City of Folly Beach Park was selected on the south end of the alignment to stage drilling operations due limited pipe laydown areas on the island as well limited working areas on the north end of the alignment in the Folly Road right of way, which is a wetland or marsh area within 15-feet of the roadway shoulders. Pipe laydown considerations narrowed down options for operations at Folly Creek and it was decided to locate the HDD drilling equipment on the north side of the alignment so both Folly River and Folly Creek crossings could share the same laydown area. This concept would allow both installations to utilize a common set of temporary laydown culverts and sleeves, while maintaining traffic to all intersecting roadways from Folly Road.

Lastly, setting the vertical alignment for each installation would provide the final data required to complete the pipe design and material selection for each trenchless crossing. URS set the vertical profile for each crossing with the use of topographic data of each waterway channel as well as critical geotechnical data provided by SCDOT. Several soil borings were completed by SCDOT at each waterway crossing to depths of 120-feet, which indicated

the depth of water, sand zones and the location of the Cooper marl zone. The location of the Cooper marl zone drove the depth of the HDD vertical alignment to where stiffer soils exist that help maintain the bore hole opening between the reaming and pullback stages. After determining existing subsurface conditions, ultimate pipe depths were set to be 20-feet into the Cooper marl zone, resulting in a final installation depth of 75-feet below sea level at Folly River and 85-feet below sea level at Folly Creek. Entry and exit angles were not a critical consideration for the vertical alignments and were set at 10° for initial calculations. Figures 2 & 3 depict the vertical alignments for each crossing.

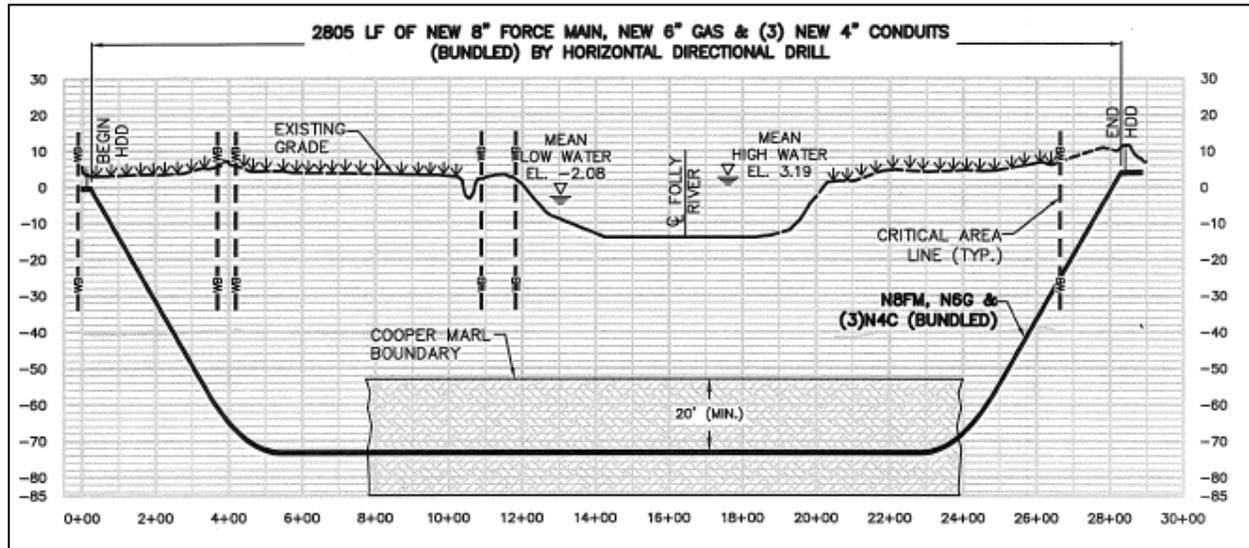


Figure 2. Folly River vertical alignment for the HDD bore.

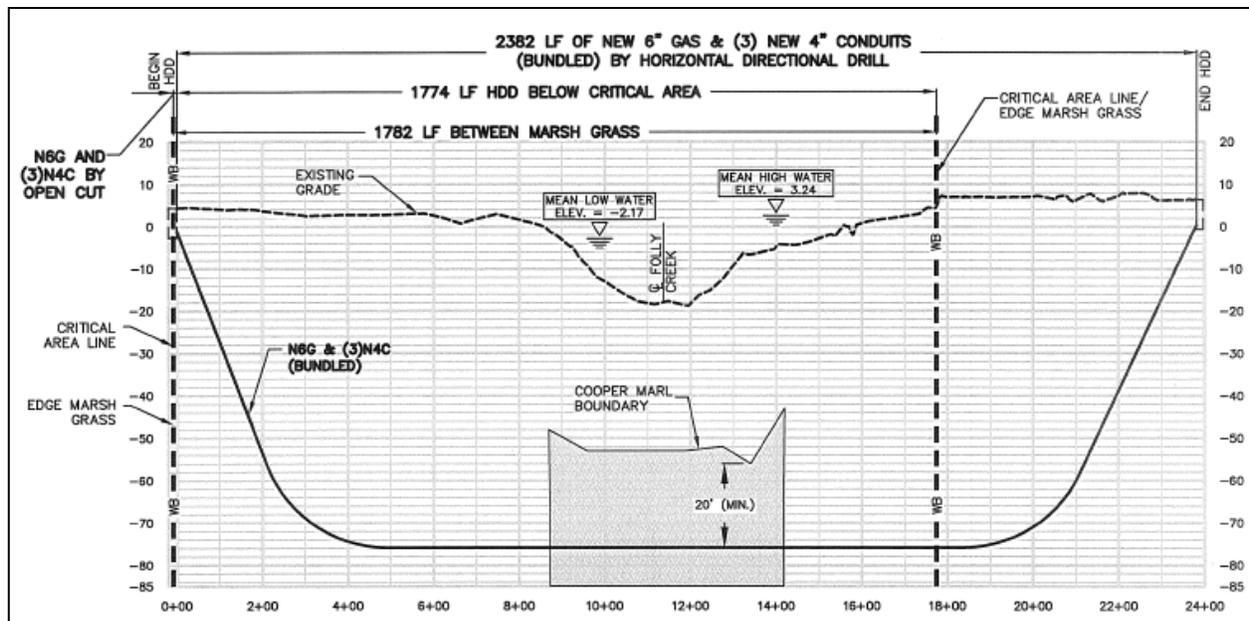


Figure 3. Folly Creek vertical alignment for the HDD bore.

Each of these installations involved a unique combination of different utility applications, which meant that URS had to work with several different entities as part of each the design. The pipe bundle to be directionally drilled under Folly River included an 8-inch force main, three, 4-inch communication conduits, and a 6-inch gas line. The pipe bundle under Folly Creek included only the three 4-inch communication conduits and the 6-inch gas line (see Figure 4). SCE&G hired a subcontractor for the design and testing of the steel gas line, but wanted to include the line into the same bore installation as the other utilities. The bundle was designed so that all of the pipes in the

bundle were to be placed in a single drilled hole by joining them to a common pulling head and installing them as a bundle.

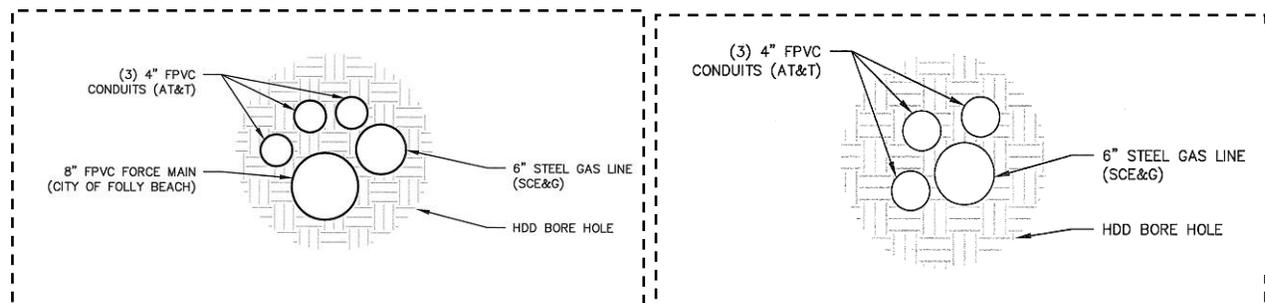


Figure 4. Bundle arrangements for each bore. The Folly River crossing is shown on the left and the Folly Creek crossing is shown on the right.

Due to the 2,800 foot length of the Folly River crossing, the selection of pipe material used for AT&T's conduits became the initial topic of discussion. The usual conduit material used for this application would be restrained joint PVC or butt-fused high density polyethylene (HDPE). However, concerns with tensile capability and elasticity with these pipe materials created too much risk with such a long HDD installation. The pipe selected would need to provide the strength and stiffness required for pullback and post-installation operations. Once investigations were completed, it was determined that the most rational choice for the conduits would be fusible polyvinylchloride pipe (FPVCP). The same material was also chosen for the 8-inch force main.

The pipe material selection for the force main and conduits was based on the operational and most importantly, installation loading for the project and application. PVC pipe, and particularly FPVCP, has greater stiffness and tensile capacity on a material property and joint basis compared to other thermoplastics. Having sufficient stiffness resists the potential soil loading for the long term operation of the non-pressure conduits. FPVCP's material and butt-fusion joint tensile capacity compared favorably to the expected installation stresses that would be encountered during installation. The recommended safe allowable pull forces of the 4-inch and 8-inch FPVCP pipes are 13,400 lbs and 47,700 lbs, respectively. Estimated pull forces were calculated along the drill section at the four critical locations for the FPVCP pipelines and compared to the allowable values to assure they would be capable of making the crossing. It was determined that the allowable pull forces for the FPVCP force main and conduits exceeded the estimated installation loads. One additional design consideration was the size of borehole required. The use of FPVCP compared to other thermoplastic pipe options required a smaller borehole size due to wall thickness requirements for operational and installation loading. This meant smaller outer diameter pipes could be used with FPVCP and this reduced the overall size of the borehole ream required.

Given that the pipe sizes and materials in the bundle vary, the final design concern involved the distribution of pull forces among all of the pipes. URS worked closely with SCE&G to make sure pull force requirements were met for the steel pipe and that the bundle installation would not inadvertently overload any single pipe.

As the design of the new pipelines was underway, communication among the various parties involved played a key role in the outcome of construction. The force main on Folly Creek was owned by James Island, who signed an agreement with SCDOT to handle the force main in conjunction with the construction of the new bridge across the creek. Consequently, another material other than FPVCP was selected for this particular force main. Although the contractor who was awarded the HDD sections was not responsible for this particular pipeline of the project, coordination with SCDOT was still critical – to shut the pump stations down and to monitor them during tie-ins. The pipe bundle that included the 4-inch conduits and 6-inch steel gas line for Folly Creek was installed first, followed by the separate HDD force main installation by SCDOT. Due to the limited area allowed for the underground pipes, both entities had to work during the setup process to assure that the new pipelines would not interfere with each other during installation. The minimum clearance between the two drills was set at 10 feet of horizontal and 20 feet of vertical separation, which was maintained throughout the installation. Through careful execution and open communication between the parties, both pipelines were installed successfully with no setbacks.



Figure 5. Corrugated conduit sleeves used to support the separate strings of pipe at the bridge location of the laydown area for the crossings. There were three separate sleeves used for each of the utilities, with one housing the multiple AT&T conduits.

Given a limited amount of space for laydown operations, preparation for construction took place primarily in the area between Folly Creek and Folly River. There is a small tributary that branches off Folly Beach and runs beneath SC Route 171, causing a small interruption within the laydown area. Figure 5 illustrates corrugated pipe sections connected to the roadway above this tributary. The SCDOT would not allow pipe rollers on the bridge itself, so the contractor used ties to support the corrugated pipe on the bridge. These corrugated pipes were used as temporary sleeves during construction. This design allowed the contractors to lay out complete pipe lengths prior to pullback operations. This laydown area was used for both Folly River and Folly Creek laydown operations.

Since the HDD bundle involved a number of utility pipes, there was a great deal of interaction between the entities involved. With all utilities sharing a bore hole, URS was hired to overlook a lot of the design work and investigations on the bundle pull. According to URS, the design of five pipes as a single HDD bundle was the easy part, but evaluating and allocating the cost for labor and equipment for each utility was the challenge. They had to negotiate the cost among all utilities by means of a prorated system, where all entities were in agreement.

## 5. BIDDING AND CONSTRUCTION

With the material selection finalized for each application, the project design documents were completed and the project was advertised to prospective bidders. Chandler Construction was the low bidding contractor and given the award for the Folly Creek and Folly River crossings, which were bid out as one project. Chandler was responsible for the entirety of the project work, except for the handling of the SCE&G 6-inch steel gas line prior to drilling of the HDD bore hole and post-drill tie-in connections to the existing gas utilities. Environmental Crossings, Inc. (ECI) was awarded a subcontract to perform the drilling at both bridge locations. While having previous experience using FPVCP in a multiple pipe, bundled HDD installation, this project was ECI's first opportunity to perform a multiple pipe, bundled installation using different pipe materials in the same bundle.

Set up for the construction process consisted of fusion and laydown of pipe along SC Route 171 between the new bridge locations at Folly Creek and Folly River. Chandler Construction assisted Underground Solutions, Inc. (UGSI), who supplied the FPVCP, with the fusion of the 8-inch force main and 4-inch conduits. Debeading of the internal joint seam or bead resulting from the fusion process was required for the 4-inch conduits. As part of the quality control process, each debeaded 4-inch joint was required to pass a mandrel test to confirm the internal diameter (ID) of the pipe as well as complete bead removal. Each test was recorded. Figure 6 shows an image of the mandrel used to test each forty (40) foot section of pipe after the debeading operations had taken place.

SCE&G chose to hire a separate subcontractor to handle multiple responsibilities for the 6-inch steel gas line prior to pull-in of the bundled utilities. This work included the design and thickness specification for the 6-inch line, supply of the pipe and handling to the jobsite, as well as electrical resistance welding (ERW) and pressure testing of the joints on site. Although the work performed was separate from the scope of the contract awarded to Chandler, coordination was required between SCE&G and Chandler for onsite and laydown operations. Once the steel pipe

segment was complete in terms of welding and pressure testing, Chandler took over the responsibility of successfully installing the gas line in the bundled directional drill. Also included in the SCE&G scope of work post HDD installation, as a quality control measure, was the testing of discontinuities in the applied exterior coating. These tests located several holidays along the length of the steel gas line, which were spot repaired to prevent corrosion at the point of discontinuity.



Figure 6. Pipe mandrel used to confirm the internal diameter of the pipe after debanding.

After the completion of the pre-drill site work ECI proceeded with the directional drilling procedures to create the required bore hole for installation. After the pilot hole was drilled along the designed alignment, a series of reaming passes were used to expand the pilot hole to the appropriate diameter for the bundle installation. ECI chose to station the drill rig on Folly Island, to the east of Folly River, for the longer of the two directional drills. Pullback began from the laydown area to the west of Little Oak Island Drive and terminated to the east with tie-in connections made to existing utilities at the intersection of Center Street and Indian Avenue on Folly Island. The 2,805 foot drill was a multiple pipe, bundled installation consisting of three, 4-inch FPVCP AT&T communication conduits, one, 6-inch welded steel SCE&G gas line, and one, 8-inch FPVCP sewer force main, property of the City of Folly Beach. Figure 7 shows the bundled arrangement during the insertion process for the Folly River crossing. Upon successful installation of the pipe bundle, Chandler performed the tie-ins to the sewer system for the City of Folly Beach while AT&T and SCE&G subcontracted the work for connections to the existing communication conduits and gas lines, separately.

For the Folly Creek installation, drill rigs were stationed on the western side of Folly Creek, with pullback of pipe initiating from the east side of the creek and connecting to new 4-inch conduits and a 6-inch gas line installed using direct bury methods to the west. The direct bury portion occurred across SC Route 17, tying into existing utilities on the southwestern side of the highway. The shorter of the two directional drills, the Folly Creek bore consisted of 2,382 feet of three, 4-inch FPVCP AT&T conduits as well as one, 6-inch welded steel SCE&G gas line. Chandler was also responsible for installing mule tape lines through each of the 4-inch AT&T conduits at both site locations upon completion of the bundled pulls to act as pulling mechanisms for later installation of inner ducts. AT&T chose to run fiber optic cables and a copper wire through two of the ducts, leaving the third vacant for future needs. Upon completion of the pipe pull-in, AT&T subcontracted the tie-ins for the communication conduits and SCE&G self-performed connections for the gas main.



Figure 7. Pipe bundle set up shown as the Folly River crossing is beginning. From left to right are the three AT&T conduits, the sewer force main, and the gas main.

After the installation of the communication conduits and gas line were complete, SCDOT installed a new 8-inch sewer force main for James Island in a separate drill in conjunction with construction of the new bridge across Folly Creek. Coordination between the James Island and the City of Folly Beach was required for the shutting down of pump stations during the new force main tie-in, and connections were made to complete the systems.

## 6. CONCLUSION

The two completed bores at the Folly River and Folly Creek locations proved to be a milestone project for all entities involved. Early communication and involvement between utilities at the beginning of the project allowed for methodical planning during the pipe staging and layout phases of the project. In addition, efficient coordination of the entities involved during construction paved the way for the success of a bundled pull application that would benefit multiple owners.

## 7. REFERENCES

*The Official Website of Folly Beach.* Retrieved from <http://www.cityoffollybeach.com/>

BP Barber (2011) – Contract Documents and Specifications for Utility Improvements for AT&T, City of Folly Beach and SCE&G, Folly River and Folly Creek Utility Relocations, Folly Beach, SC