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**Osceola Parkway Turnpike Crossing in Orlando, FL – Unique HDD  
Application**

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**1. ABSTRACT**

In recent years the TOHO Water Authority (TOHO) has been acquiring and integrating privately owned water utility systems into their central regional water treatment and distribution system in Osceola County, Florida. As part of that system growth, TOHO found the need to apply redundancy to their rapidly expanding system with a 24-inch interconnect under the Florida Turnpike in Kissimmee, FL. The requirement to cross the Florida Turnpike's right-of-way added unique challenges and complexity to the design and construction process.

CPH, Inc. was retained by TOHO to provide engineering design services for this key crossing and after evaluation of alternatives the final design settled on a single horizontal directional drill (HDD) installation as the most practical solution. This HDD installation spanned nearly the entire length of the project with a total length of 1,400 LF.

The Florida Turnpike Enterprise required that the pipeline be encased under the entire Turnpike right-of-way. The hydraulic capacity requirements for the transmission main required that a 24-inch main be installed, and this in turn drove the required size of the casing, bore hole, and ultimately the depth required for the crossing. One key design component was selecting a casing pipe material that would need to handle soil loading of 40+ feet of depth under the Turnpike.

Andrew Sitework, LLC, was the general contractor and Accurate Drilling Systems (ADS) was the HDD sub-contractor. 30-inch DR 21 fusible polyvinylchloride pipe (FPVCP) was selected as the casing pipe material and the carrier pipe was 24" DR 18 FPVCP. The 30-inch casing pipe was installed and ballasted with water in a single insertion, which required one intermediate fusion joint to be performed during the installation process due to limited area available to string the pipe. The 24-inch carrier pipe was then inserted into the newly installed 30-inch casing pipe with an open pull head, so that it would self-ballast with water as it was inserted. This also required one intermediate fusion joint to be performed during the insertion.

This paper will discuss the details of the project design, the unique pipeline installation methodology and the final outcomes of the project. Specific project challenges from the perspective of the engineer will be addressed.

**2. INTRODUCTION**

The Toho Water Authority (TOHO) became the largest provider of water, wastewater and reclaimed water services in Osceola County, Florida in 2003. Today, TOHO currently serves approximately 73,000 water, 71,000 wastewater and 10,000 reclaimed water customers in Kissimmee, Poinciana and unincorporated areas of Osceola County, Florida. On its way to becoming the largest wet utility provider in Osceola County, TOHO obtained several water and wastewater treatment plants from privately owned utility companies. As part of these acquisitions, the existing

treatment, collection, and distribution schemes of the acquired systems would need to be modified in order to mesh with TOHO's systems. In some cases, this meant that some facilities could be decommissioned, and in other cases the existing facilities and systems needed to be upgraded. On the distribution side, redundancy and reliability was usually accommodated by making key interconnections between the older TOHO systems and the newly acquired ones. Such was the case for the recently acquired eastern service area, which is served by the aged Buena Ventura Lakes Water Treatment Plant (BVL WTP). TOHO looked to tie in this new service area with its western service area, which required a major pipeline project, albeit a short pipeline project, known as the Osceola Parkway/Turnpike Crossing Project.

Prior to this project, TOHO's water transmission and distribution systems had no interconnections across the Florida Turnpike along Osceola Parkway. TOHO's existing western service area included a 16-inch water main on the west side of the Turnpike and the newly acquired eastern service area had a 24-inch water main on the east side of the Turnpike. In order to provide the appropriate redundancy for the BLV WTP-based water supply in the eastern service area, a 24-inch interconnect was needed to connect these two service areas together.

### **3. DESIGN APPROACH**

#### *Design Background*

CPH, Inc. (CPH) was selected for the design services for the project. Several parameters of the design were predetermined for the interconnection project. The location of the project was already decided; with the connection points to be used on both sides of the Florida Turnpike already in place (see Figure 1). The appropriate transmission pipe size, a 24-inch nominal diameter, was also predetermined using TOHO's pre-existing hydraulic model for long term growth.

This initial predetermined project framework created several areas of concern that would need to be addressed in the design phase. The existing connection points and the project location in general meant that existing utilities, including larger storm water piping and conveyance, both paralleling and crossing the proposed alignment would need to be navigated. The available work areas on each side of the Turnpike, located adjacent to the busy Osceola Parkway, would be very limited. The presence of wetlands also added to the constrained work areas. Most significantly, the water main would have to cross the limited access right-of-way controlled by the Florida Turnpike Enterprise.

During CPH's permit determination process it was found that the following permits were required:

- Florida Department of Environmental Protection's (FDEP) "Application for a Specific Permit to Construct PWS Components,"
- Florida Department of Transportation's Utility Permit,
- Osceola County (County) Right-of-way Permit, and
- FDEP Environmental Resource Permit (FDEP ERP).

As part of this permit review process, it was discovered that the Florida Turnpike Permitting section would require encasement of the water main under the Turnpike's right-of-way. This encasement requirement would add another degree of difficulty to the project. Now, what started as a large diameter installation with the 24-inch water main, would increase with the larger casing required. Since the entirety of the project was basically crossing the Florida Turnpike Enterprise ROW, this meant that the casing pipe would now essentially dictate the design.

#### *Selection of an Installation Method*

Figure 1 shows the location of the major project constraints in terms of the site layout. From the western connection point of the project to the east, the topography included various drainage ditches, the exit and entrance ramps, as well as the main thoroughfare of the Turnpike, and a wetland system. These various crossings presented challenges with the existing topography, presenting large swings in elevation.



Figure 1. Characterization of the project layout in reference to the Florida Turnpike. The HDD installation took place along the blue alignment shown.

Certain sections of the crossing would not be able to be constructed with traditional methods, such as the Turnpike exit and entrance ramps and main roadway. In order to remove these issues, trenchless installation methods were evaluated. These were quickly narrowed to two options, one, to ‘jack and bore’ a casing pipe across the various obstacles, or two, to horizontally directionally drill (HDD) a casing pipe under the entire crossing. Due to the sheer number of drainage facilities, the groundwater withdrawal and treatment issues, and the constructability and access issues for jacking pits, the jack and bore method was quickly dismissed as a viable design approach. This left HDD as the viable alternative for the installation, and CPH’s design team focused exclusively on this alternative for the design and installation.

#### *HDD Design Specifics*

Alternate casing and carrier pipe sizes, such as breaking up the crossing into two or more pipelines were briefly considered, but not found to be as cost effective as one continuous casing and carrier pipe installation. A casing and carrier pipe would be required from connection point to connection point with some traditional direct bury pipe installation at the points of connection. In addition to crossing the Turnpike Right-of-way in one continuous HDD, wetland impacts on the east side of the project were eliminated thus leading to a FDEP ERP permit exemption in lieu of a complete permit.

The plan distance between the connection points was approximately 1,600 linear feet (LF) along a slightly curved path, approximating the road curvature of Osceola Parkway. Finding suitable locations for the entry and exit points for the HDD was a critical factor in the design. Installation requirements were weighed and based on the ability to set a drill rig to perform the HDD installation on one side of the Turnpike and to assemble the carrier and casing pipe on the other side. The drill rig location needed to be large and accessible enough to contain the specific drilling operations and required materials. On the insertion side, continuous pipe strings of approximately 1,400 LF for both the casing and the carrier pipe were required. Ideally, the pipe would be fused or assembled in one length and then installed in one continuous insertion.

Potential pipe fusing locations were reviewed on both sides of the project site, and each had its individual advantages and disadvantages. On the west side of the Florida Turnpike the pipe would need to be assembled so that it would cut across Bill Beck Boulevard as well as five business access points to a large shopping development. During pre-design review, this pipe fusing and layout alternative was not preferred by the County due to the potential closing of the business accesses. On the east side of the project, staging the pipe would require either

closing sidewalk access, or shutting down one of the travel lanes along Osceola Parkway. Additionally, during the pipe insertion activities, the pipe would need to be raised on aerial rollers to avoid closing the only access to two subdivisions at Coralwood Circle. Given the County's desire to keep the business accesses open on the western side of the project, they requested that the pipe fusion and staging be strung out on the east side of the project and that the travel lane be closed along Osceola Parkway. Understanding the difficulties with pipe layout on either side of the Turnpike, CPH's design team based the design on the County's desire for insertion on the east side of the project.

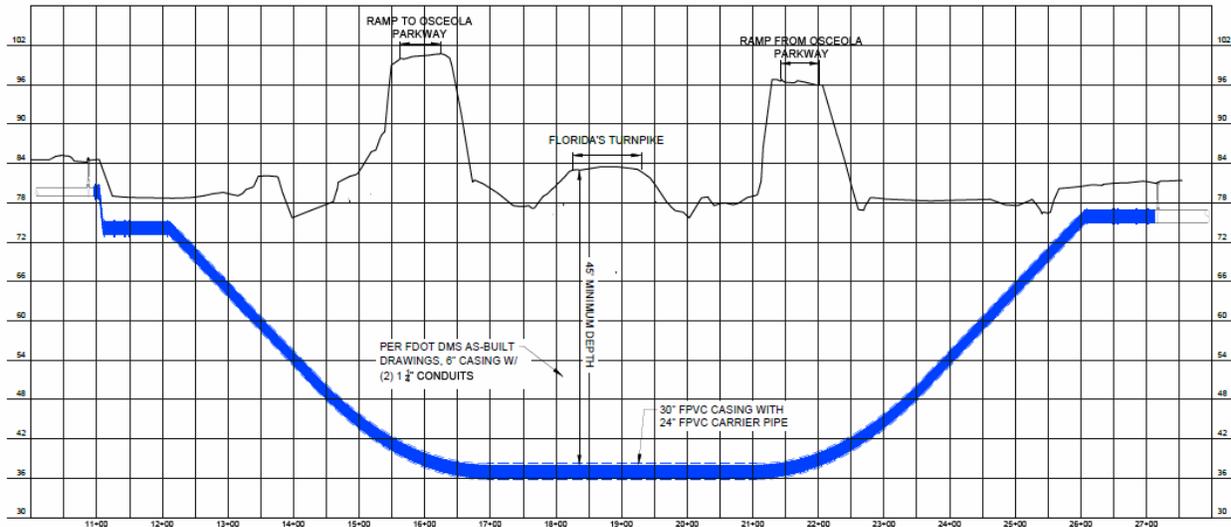


Figure 2. General characterization of the profile for the HDD and pipeline for the project. Note the elevated ramps for the interchange and location of existing casing and conduits.

With most other project constraints settled, the bore plan and profile along with applicable pipe materials were the final major design elements to be determined. The connection points of the alignment were already predetermined, so the horizontal alignment was only adjusted to avoid existing lighting and electrical transmission poles that were in conflict and assure a direct alignment across the Turnpike. The vertical profile would have to take into account the requirements of the road crossing as well as the existing utility locations (see Figure 2). "As-built" information on utilities in the area showed fiber optic lines that were as deep as 35 feet across the proposed bore path. The vertical alignment could attempt to thread through the existing utilities and maintain a certain amount of clearance from them. The other option was to go deeper and make sure that the alignment crossed under everything. According to the Florida Department of Transportation (FDOT) Utility Accommodation Manual, directionally drilled pipe must be installed to a depth at least ten times the reaming head diameter below the roadway, or it must be installed below a geologically confining layer (FDOT UAM, 2010). The geotechnical evaluation of this area found depths of sandy-clayey soils but could not establish a set confining layer. Due to the existing fiber optic conduits and the FDOT guidance it was decided to go deeper with the installation at an approximate depth of 45-ft for the crossing. This would provide at least 10 foot separation from other utilities known to be crossing the path of the bore and maintain the minimum cover requirement for FDOT.

Along with the alignment layout and depth constraints considered, CPH's design team needed to evaluate pipe materials that would be applicable for both the casing and carrier pipe installation. In order to achieve the required design specifications for the casing pipe, HDD installation loading as well as long term loading on the installation needed to be considered. A thermoplastic pipe material would be preferred to a metallic pipe due to long term corrosion concerns. Thermoplastic pipe wall thickness would need to be selected to assure that the pipe would have adequate pull force capacity for the installation, would have adequate buckling capacity for the short term critical collapse loading from the drilling slurry, and would have adequate ring strength for the long term soil loading on the pipe. The alignment considered, in particular the depth, meant that long term loading would be one of the most critical parameters to assure that the casing pipe would not over-deflect during the design life of the installation. The carrier pipe, designed to be inserted after the initial casing pipe installation was complete, would need to be designed for the operational loading of the water main application, which was dictated by the required internal pressures of the system. Critically, the pipe material selected needed to be capable of HDD installation, meaning

that the joining method for the pipe would be capable of tensile loading as well as capable of bending to follow the curvilinear alignment of the bore path.

Fusible polyvinylchloride pipe (FPVCP) and high density polyethylene (HDPE) pipe were evaluated for the casing and carrier applications. The casing pipe wall thickness and thus the overall pipe selection based on this requirement would dictate the design. Deflections were calculated using a full prism load at the deeper locations along the alignment and appropriate equation of ASTM F1962 (ASTM F1962, 2012). Full prism loading was assumed to maintain a conservative design result due to the critical nature of the installation and long term use of the pipeline. The results of the casing wall thickness calculation meant that a 30-inch DR 21 (pressure class 200 psi) FPVCP could be used for the casing, with a 24-inch DR 18 (pressure class 235 psi) FPVCP used for the carrier pipe to meet the flow and pressure requirements of the intertie pipeline. HDPE pipe ended up not being applicable for this project due to the fact that in order to maintain the pressure class and flow area required, the carrier pipe would need to be upsized from a 24-inch nominal pipe to a 30-inch nominal pipe. This in turn drove the casing pipe size larger to at least a 42-inch pipe depending on the wall thickness required, and that would then lead to a much larger reaming size required for the HDD, upwards of a 54-inch pass or more. All of this results in much larger pipe required, and a deeper installation to meet the requirements of FDOT on crossing depth relative to reaming size required. Although HDPE is a common material for HDD applications, it was determined that it would not be a feasible alternative for this installation.

Finally, a review of the estimated tensile forces expected for the 30-inch FPVCP showed that the pipe was capable of the design installation stresses for the HDD insertion. The 24-inch FPVCP carrier would also be adequate for the slipline insertion into the casing pipe once installed, as well as the operating design life of the intertie pipeline application.

#### 4. CONSTRUCTION

The project was publically bid following the design and permitting phase and was awarded to Andrew Sitework, LLC who teamed with ADS to perform the HDD. After project was awarded, ADS submitted a proposal to change the drill rig and pipe insertion orientation for the installation, essentially switching the pipe insertion side from the east, as designed, to the west. The change was proposed due to construction related layout and work logistics to facilitate an easier project completion. As previously determined, both orientations of pipe insertion and drill rig layout had their challenges. Specifically, using the west side of the alignment for the pipe insertion would require one intermediate fusion joint to be performed during the insertion of both the casing and carrier pipes. It would also require County and Florida Turnpike notifications as well as the approved use of privately owned properties and acquiescence of multiple businesses that would experience an access blockage of three entrance ways to a local shopping area (See Figure 3).



Figure 3. Pipe fusion and laydown area as proposed and then utilized by Andrew Sitework. Two lengths of 30-inch FPVCP and two lengths of 24-inch FPVCP were staged as shown. During the insertion of each pipe, one intermediate fusion joint was performed to create a single length of each pipe. Bill Beck Boulevard, shown on the right side of the picture was closed temporarily during the insertion and intermediate fusion activities.



Figure 4. The drill rig operation site is shown in this schematic, based on the revised location proposal and actual location used by Andrew Sitework and the driller, ADS. This is located on the east side of the crossing. Note the location of the sound barrier used to mitigate potential noise issues at the revised drilling location.

The original design and construction documents considered the assembly of one continuous fused section of pipe on the east side of the alignment as a more conservative approach to reduce the risks associated with intermediate fusion procedures as well as minimize blockages of entrance ways to local businesses. CPH’s design team was not opposed to a reversal of the drill rig and pipe stringing staging areas; however, it would require additional risk and the necessary approvals and accommodations to those impacted authorities and business owners. Andrew Sitework went through the necessary processes of contacting local business and property owners and providing the necessary approval documentation to allow for access and road closures. The design team also required that Andrew Sitework provide a secondary fusion machine to be on site should any issues occur during intermediate fusion procedures. Also, due to possible noise issues with the relocated drilling rig site, the design team requested a temporary wall be built along the back of the eastern work site to block the construction noise from the new drill rig location (See Figure 4). Once the County agreed to the temporary closure of Bill Beck Boulevard during pipe insertion activities, the design team and Andrew Sitework finalized the remaining details of the critical operations locations switch. Pipe was fused and staged along Osceola Parkway on the east side of the crossing as shown in Figure 5. While one access point was closed during construction, no businesses were obstructed. Bill Beck Blvd. was closed for two nights, one for the 30-inch installation, and one for the 24-inch installation.



Figure 5. Fusion and staging of the 30-inch FPVCP casing pipe along Osceola Parkway.

Following notice to proceed, the 30-inch FPVCP casing pipe was delivered to the site and fused into two sections of continuous pipe over a 14 day period. During the pipe fusion process ADS also began to mobilize to the site with their American Auger 440T drill rig, drilling fluid recycling, and other support equipment. Once the drilling equipment was assembled, the pilot hole was drilled without issue. Three reaming passes were made starting with a 24-inch, proceeding to a 36-inch, and then finishing with a 42-inch for the final ream. There were no issues with utility conflicts or strikes during the drilling operations, aided by the design team's efforts in locating the existing infrastructure in the area and also the final alignment depth chosen for the crossing. Underground Solutions, Inc., the pipe supplier, and ADS coordinated both the borehole and pipe fusion to be completed at approximately the same time.



Figure 6. Insertion of the 30-inch casing pipe into the HDD alignment. Note the fusion machine on the left-hand side of the picture showing where the intermediate fusion joints were performed during pull in at Bill Beck Boulevard, which was temporarily closed.

ADS chose to ballast the casing pipe with water during installation to minimize the buoyant forces within the pipe section as it was installed. The buoyant forces created by the less dense pipe and any ballast used being pulled through a more dense drilling slurry as the pipe is inserted, forces the pipe to the top of the borehole. As the pipe rubs against the top of the bore hole, the frictional resistance generated produces the largest contributor to pull forces on FPVCP when it is installed. Ballasting the pipe with clean water reduces these buoyant forces, thus reducing the overall pull forces required for the pipe installation. Ballasting also reduces the potential for critical collapse of the pipe section during installation due to the weight of the drilling slurry on the exterior of the pipe section, by providing a static head of water on the inside of the pipe as well. Using this method of ballasting the required pull force to install the casing was estimated to be around 75,000 lbs. The casing pipe insertion began at approximately 11:15 am and the first section was pulled without issue (See Figure 6). The intermediate fusion joint was delayed slightly due to some rain, but was eventually completed by about 2:00 PM in the afternoon. The second phase of the installation was then completed by 11:00 PM that evening. The estimated pull back forces, based on the drilling rig hydraulics reached as high as 100,000 lbs – slightly over the calculated loading. This ultimate tensile load was well within the allowable limits of the 30-inch DR 21 FPVCP which has an allowable pull force load rating of 408,500 lbs. The only issue encountered during the insertion of the 30-inch casing pipe was the presence of clayey soils on the drilling fluid returns that caused the hydraulic trash pumps in the receiving pit to clog. In essence, this slowed down the insertion operation, but presented no significant issues to the installation and was easily addressed by the contractor. The casing pipe was fitted with end caps and tested in place at 65 psi with no loss of pressure during a 2 hour test. This test was used to verify the integrity of the installed casing to assure it would be adequate to function as a casing for the carrier pipe installation.



Figure 7. Insertion of the 24-inch carrier pipe into the previously installed 30-inch casing pipe.

After the casing pipe had been installed, Underground Solutions, Inc. fused the 24-inch FPVCP carrier pipe within a 14 day period in the same location and orientation as the 30-inch casing pipe was staged. ADS demobilized from the site during this time and Andrew Sitework brought in a smaller drill rig, a Ditch Witch 3020, to pull the carrier pipe into the installed casing pipe. The casing pipe had been ballasted during installation and pressure tested afterward with clean water. The 24-inch carrier pipe was fitted with a pulling head that included flow-through cavities on the nose cone, which would allow the carrier pipe to accept the water filling the casing pipe during its insertion. This meant that the carrier pipe would in effect be ballasted as well during its installation. The installation of the 24-inch carrier pipe was completed without issue in about 6 hours (see Figure 7). The required pullback force during the casing installation was only 12,000 lbs, according to the drill rig hydraulic system and observations of the installation. After carrier pipe installation, end seals were fixed on both sides ends of the casing to the carrier pipe. The required connection locations were assembled by direct bury methods and installed using ductile iron pipe and fittings. The completed system up to the connection points was then pressure tested at 150 psi for two hours. No

leakage or drop in pressure was observed, and the installation was commissioned into the eastern and western service area systems.

## **5. CONCLUSIONS**

The project was a success in terms of the overall goals and objectives of the design and construction team and is operating as designed. The contractor and pipe supplier worked hand and in hand with the design team to ensure the success of the project. In the end, approximately 1,400 LF of 24-inch FPVCP carrier pipe and 30-inch FPVCP casing pipe was successfully installed at a depth of 45 feet below the Florida Turnpike by means of horizontal directional drilling. Issues with existing utilities and site restrictions or problem areas were minimized due to significant upfront coordination, thorough survey, and utility locates. Coordinating with local permitting agencies early in the design process allowed for a smooth transition from design to construction. Additionally, a team approach to the construction, which included the design team, pipe supplier, and contractor, was key to successfully tackling the challenges of this very difficult project site.

## **6. REFERENCES**

ASTM F1962 (2012) – Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings, ASTM International, May 1, 2011.

FDOT UAM (2010), “Florida Department of Transportation 2010 UAM Utility Accommodation Manual,” Topic 710-020-001-g. August, 2010.