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**Hillsborough County Dale Mabry Diversion Force Main and Reclaimed
Water Transmission Main Design-Build Project
Horizontal Directional Drill vs Open Cut Strategy**

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1. ABSTRACT

The Dale Mabry Diversion project is part of the Northwest Hillsborough Wastewater Consolidation Program, which will retire two aging wastewater plants and consolidate treatment at the Northwest Regional Water Reclamation Facility (NWRWRF). The program will improve wastewater service in northwest Hillsborough County, improve reliability, and save money for all County customers. An initial step of this program involved retiring the Dale Mabry Wastewater Treatment Plant (WWTP) and constructing a new pump station and six miles of 24 and 36-inch force main to convey wastewater to the NWRWRF for treatment and a new 20 and 24-inch reclaimed water main to return reclaimed water to the Dale Mabry service area. Westra Construction and their design partner, McKim & Creed, were contracted to design, permit, and construct the project utilizing a Design-build approach in 2015. Due to an alignment that traversed a major 6-lane road with numerous intersections/business entrances and environmental challenges, the team had to carefully weigh trenchless versus open-cut installation along the route during their initial response to the design-build solicitation. The final approach incorporated 16 horizontal directional drills, many in close proximity to each other within the road median to minimize traffic disruptions, provide separation from existing utilities including a 1,000-psi gas main, and to avoid impacts to bridge pilings, surface waters, and forested wetlands.

This paper will review the benefits of selecting trenchless technologies for pipe installation to minimize impacts within the project boundaries. It will also review the design-build method and its benefits over the traditional project approach.

2. INTRODUCTION

Hillsborough County Public Utilities Department (HCPUD) was formed in the 1970s when the Board of County Commissioners began to acquire franchises that provided water and wastewater service in unincorporated areas of the county. The county is located on Tampa Bay in the central gulf coast of Florida. The utility has two distinct service areas divided from the bay in the south to the county line in the north, and by the City of Tampa. Franchise acquisition led to the facilities being spread out over these two service areas.

The Dale Mabry Diversion project is located in the northwest service area which includes three regional wastewater treatment plants (WWTPs), one biosolids management facility, and one sub-regional WWTP. For years, the long-term plan for this service area was to retire the two older regional plants (Dale Mabry and River Oaks) and expand the much newer NWRWRF to accommodate flow from the other retired facilities.

The Dale Mabry WWTP is located in a residential area, sharing a fence with several neighborhoods. The River Oaks WWTP was in a rural area when it was originally built, but the area is now built out with commercial retail establishments immediately adjacent to it. The facilities are experiencing ever-increasing renewal and replacement costs, including degradation of large concrete structures. The newer facilities, including the NWRWRF, are located on larger tracts of land in rural areas.

When HCPUD determined that consolidation was the cost-effective path, the consolidation project was moved into the Capital Improvement Program (CIP) and Dale Mabry Diversion project began immediately. The utility initiated an aggressive three-part consolidation program. Funding for this program is on the order of a quarter billion dollars. This multi-part project included construction of a pumping station and associated force main to divert the entire plant flow to the NWRWRF, a reclaimed main to return reclaimed water to existing customers in the area, and demolition of the Dale Mabry WWTP. The second and largest project in the program is the expansion of the NWRWRF from a design flow of 12 million gallons per day (MGD) to 30 MGD. This project was awarded in June of 2016. Diversion of the River Oaks WWTP flow cannot be done until the NWRWRF is expanded. The River Oaks Diversion Project is expected to be awarded as this paper is being written.

The County selected Design-build (D/B) as the delivery method in an effort to deliver the program as quickly and efficiently as possible. As defined by the Design-Build Institute of America (DBIA), *Design-build (D/B) is a method of project delivery in which one entity-the design-build team- works under a single contract with the project owner to provide design and construction services.* This method of delivery allowed the utility to begin work on the design criteria package (DCP) almost immediately; offered opportunity for efficient and cost-effective design, construction and operation; provided optimal risk allocation, offer a competitive design selection; and allowed clear assignments of performance responsibilities to a single contracting entity. Because of the multiple and significant potential impacts to residents, public outreach was initiated while the DCP was being developed. Neighborhood groups and HOAs were contacted immediately and meetings were scheduled to discuss the project. HCPUD informed and sought input from residents in dealing with challenges such as construction along a main arterial roadway, multiple businesses and residential areas, a feeder road that impeded access, and impacts on rush hour traffic.

The County's project objectives listed in the Request for Proposals (RFP) included an overall positive experience for the communities involved, protection of the environmental, construction safety, and good neighbor attributes, among others. These objectives were embedded into the scoring of the proposals, which provided points for addressing criteria such as minimizing impacts to traffic and pedestrian circulation, maintaining business and residential access, reducing noise and vibrations, avoiding environmental impacts, and overall safety, as well as the traditional criteria of cost and schedule. The D/B team selected by the County for the solicited services consisted of Westra Construction Corp. and its design partner, McKim & Creed, Inc. The horizontal directional drills (HDDs) were sub-contracted to Centerline Directional Drilling Service, Inc.

The 6-mile alignment between the Dale Mabry WWTP and the NWRWRF was identified by the DCP and included four optional routes that could be utilized by the proposers in preparing their response to the RFP. After careful review, the alignment selected by the D/B team included the use of an existing utility corridor through County-owned property followed by installation of the pipelines within the median of Citrus Park Drive and Gunn Highway, and routed through selected residential streets to minimize impacts. This alignment included eight areas that challenged conventional open-cut pipeline installation and were good candidates for trenchless installations. The selected alignment and the challenging areas are shown in Figure 1. Each of these areas and their challenges and solutions are discussed below.

3. CHALLENGING AREAS

Area 1: Forested Wetlands

The first area identified along the alignment that presented a challenge was within the existing 75 ft wide utility corridor located on County property. The corridor included a 6-inch sludge line, 8-inch sludge line, 36-inch force main, 36-inch reclaimed water main, and 20-inch water main. Approximately 20 ft separated the water main from the other utilities, and it was within this corridor that the new installations were proposed. In addition to the tight construction constraint, a forested wetland had re-established itself across the corridor since the installation of the existing utilities. This crossing was approximately 940 ft in length. Open cut would require lengthy permitting and

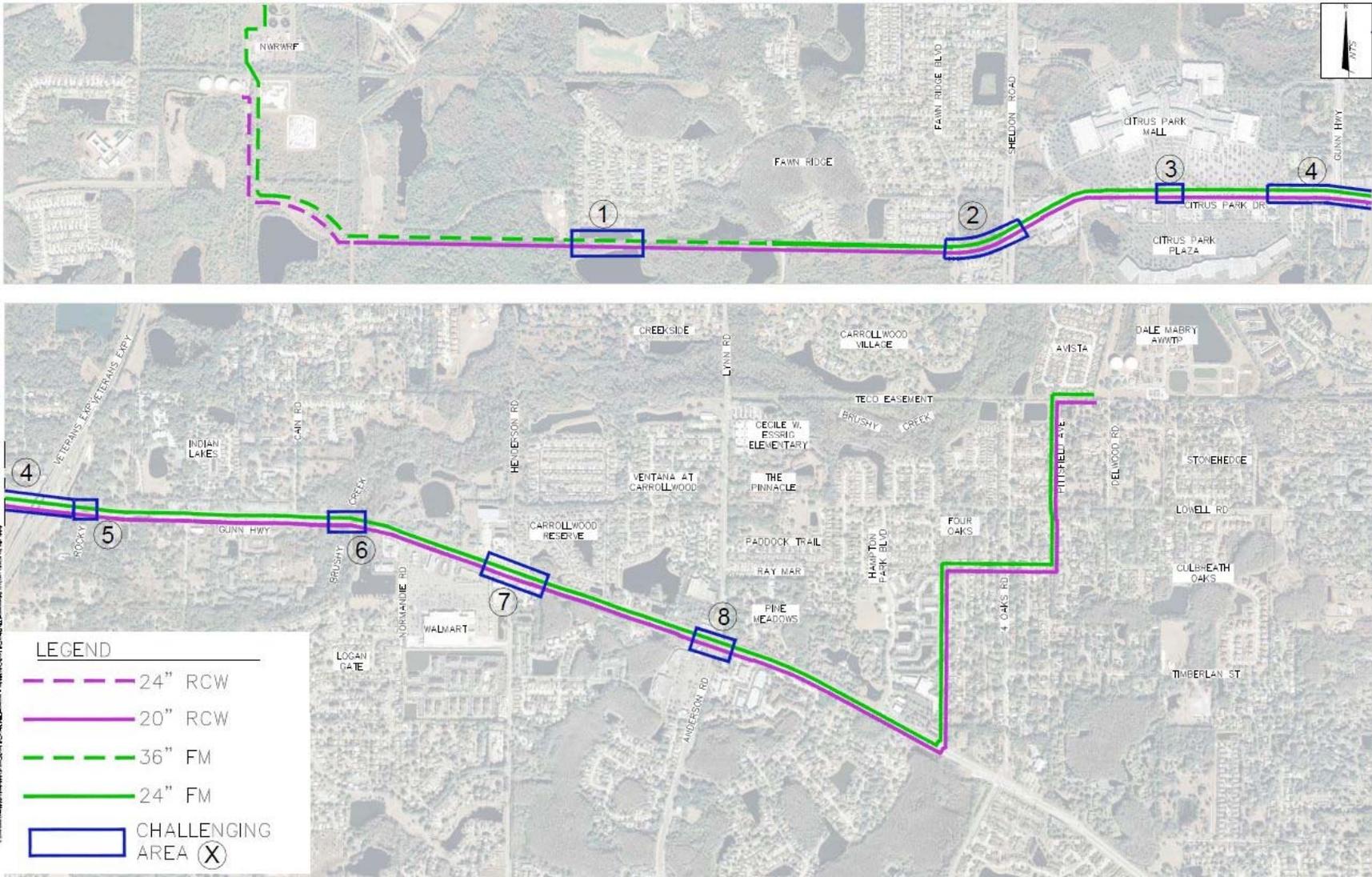


Figure 1: The Dale Mabry Diversion Alignment and Challenging Areas

mitigation requirements that would increase the cost and duration of the project. While the DCP did identify an alternative route around the utility corridor, it was determined that this would add approximately 1,100 linear ft to both pipelines. Further, this alignment included environmental challenges of its own and required close coordination with a new roadway under development. The D/B team selected to utilize HDD to cross the forested wetlands to mitigate environmental impacts, reduce permitting and scheduling delays, minimize the total length of pipe to be installed, and mitigate potential conflicts with the future roadway project. However, the D/B Team was faced with the following challenges; limited construction space between the existing utilities and the potential for hydrofractures and borehole collapse.

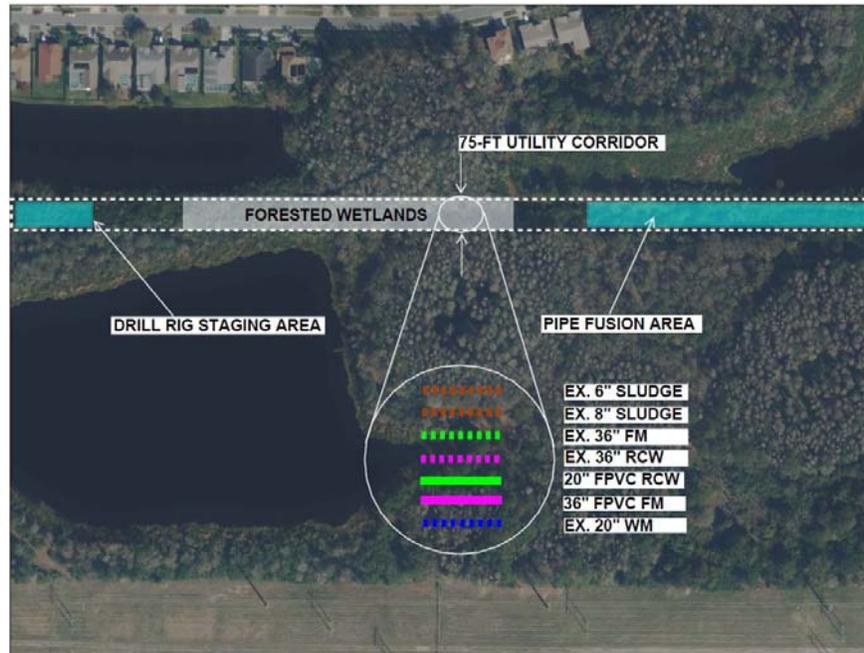


Figure 2: Forested wetlands within existing utility corridor

The limited space between the existing utilities (20 ft) was a concern for the D/B team. Per County utility separation requirements, the 36-inch force main and 20-inch reclaimed water main were required to be separated 5.5 ft from center to center. The D/B team elected to keep this distance in an effort to maximize the distance between the proposed drills, the existing 20-inch water main, and the 36-inch reclaimed water main. This was accomplished by designing the drills to be horizontally and vertically staggered by 60 ft and 12 ft respectively. For economic reasons, the smaller reclaimed water main was proposed to be the longer and deeper of the two drills.

Soil borings were taken on either side of the drills to a depth of 65 ft. The soils generally consisted of 25 to 45 ft of medium sandy soils (SP/SP-SM) followed by a 15 ft layer of very hard clay (CL/CH) atop hard clay (CL) with limestone fragments. A hydrofracture analysis was performed which indicated a minimum depth of 20 ft would be sufficient to minimize frac-outs from occurring within the forested wetland area. Taking this into consideration, the entry and exit pits were extended outward 150 ft from the forested wetlands to help shield them from frac-outs as well as potential bore-hole collapse.

The pilot bore for the reclaimed water main was drilled first. The pilot bore for the 36-inch force main did not occur until five months later, due to several schedule conflicts and rainy weather that made mobilization of the drill rig within the low lying utility corridor virtually impossible. While several small frac-outs occurred during the installation of the reclaimed water main, they were contained and manageable. However, during the reaming process for the shallower 36-inch force main, hydrofractures became more numerous. Drilling operations were ceased and the options to move forward were reviewed. The D/B team determined that some additional depth could be obtained within the original length of the drill, but the team did not want to jeopardize the previously installed reclaimed water main. It was determined that the best option was to lengthen and deepen the drill to an extent beyond that of the installed reclaimed water main. This option, however, would require additional 36-inch FPVC to be located and

delivered, but factory fabrication of the pipe was not feasible for such a small quantity. If unavailable, the D/B team would have to wait until a suitable order was placed for production. Fortunately, the required length of additional 36-inch FPVC pipe was located and made available for immediate shipment. After a short hiatus to allow for the delivery and fusion of the pipe, drilling operations resumed.

Another setback occurred when the bore-hole collapsed at the exit pit for a distance of approximately 60-ft. Concerned for the adjacent utilities, drilling operations were ceased. Sheeting was brought in and installed on both sides of the exit pit for approximately 100 ft to protect the existing utilities from being undermined. Drilling operations were restarted and continued 24 hours per day in two-12 hour shifts for the next 7 days. Both utilities were installed without further incident as shown in Table 1.

Table 1: Area 1 Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Sizes (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	14, 18, 24 & 36	1,250	44	01/18/16	01/26/16
Wastewater	36	DR21 FPVC	18, 24, 32, 36, 44 & 48	1,390	54	05/18/16	06/20/16

Area 2: Sheldon Road/Citrus Park Drive Intersection

The second challenging area along the alignment included the following three adjacent intersections:

- Utility corridor with Fawn Ridge Boulevard
- Utility corridor with Sheldon Road
- Sheldon Road/Citrus Park Drive

These three intersections occur within 1,500 ft of each other. They are heavily congested with large underground utilities, many within existing casings, as the utility corridor branches out and joins other utilities from the north, south and east. This made open-cut installation very challenging with excavation depths approaching 18 ft adjacent to roadways. Community impacts were also a concern to the D/B team considering Fawn Ridge Boulevard is the only means of access for more than 650 homes. Sheldon Road is a heavily traveled 4-lane road and Citrus Park Drive is a 6-lane road that provides regional access to the Citrus Park Mall, The Plaza at Citrus Park, and the Veterans Expressway. Additionally, the future roadway previously discussed was also proposed through this area. The available plans included provisions for stormwater inlets and conveyance systems that needed to be considered when designing the new 20-inch reclaimed water main and 24-inch force main. After careful review of the area, the D/B team determined that trenchless installation across these three intersections would eliminate utility conflicts, simplify maintenance of traffic (MOT), and greatly reduce restoration efforts.

Due to the geometry of the alignment, the drills required a horizontal curve radius of approximately 1,200 ft. Typically this would not cause worry, but the fact that the D/B team had to perform twin drills 15 ft apart – a distance dictated by the available work area within the median- created a challenge. Fortunately, the D/B team was able to keep the horizontal curve separate from the vertical curve, thus simplifying the drill by keeping it two-dimensional. Also, the drill on the inside of the horizontal curve was completed first to reduce the risk of interference from the second drill in case steering issues caused by soft soils came into play.

To reduce project complaints, the drill rig was located away from the residential area and positioned within the median of Citrus Park Drive. This setup also worked well for pipe fusion which occurred along the long stretch of County-owned property leading to the Fawn Ridge Water Treatment Plant.

The work zone for the entry pit encompassed the full median width and the inside travel lane in each direction. A specific MOT plan was developed for the “T” intersection of Sheldon Road and Citrus Park Drive that expanded on the Florida Department of Transportation (FDOT) requirements. Since the drilling equipment could not be set up out of the clear zone- it had to be 4 ft beyond the back of curb for this situation- jersey barriers were required to protect both the traveling public and the work space. Both utilities were successfully installed during the final weeks of October 2015 to the lengths and depths shown in Table 2.

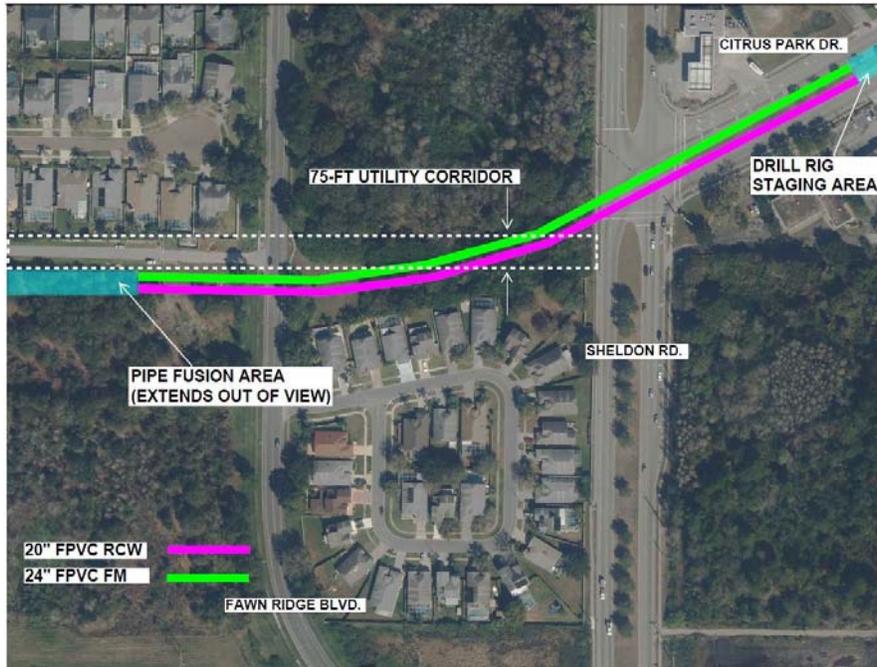


Figure 3: Drill alignment across Fawn Ridge Boulevard, Sheldon Road and Citrus Park Drive

Table 2: Area 2 Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Size (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	12, 18, 26 & 32	1,509	50	10/14/15	10/23/15
Wastewater	24	DR18 FPVC	18, 24, 32 & 36	1,436	50	09/29/15	10/13/15

Area 3: Citrus Park Mall/The Plaza at Citrus Park

Early on, *Westfield Citrus Park Mall* and *The Plaza at Citrus Park* were recognized as large stake holders in the project. Both are heavily traveled shopping destinations located north and south of Citrus Park Drive respectively. Due to the anticipated traffic increase during the holiday season, the D/B team established in the proposal that construction within this area would not occur during the holiday season, between Thanksgiving and New Year’s Day. The shopping area is provided with three entrances; the main entrance is signalized and the other two are not. The D/B team correctly assumed that the median crossovers at the un-signalized entrances could be crossed using open-cut installation if the other two entrances remained opened. It was also anticipated that the main entrance would not be allowed to close. As such, trenchless installation was the only solution for this crossing. The length of the trenchless installation however, was carefully weighed by the D/B team.

The main entrance itself is only 200 ft wide. However, there are four left turn lanes (two eastbound and two westbound) that approached the intersection for a length of 270 ft. The D/B team preferred to eliminate impacts to the left turn lanes. Further, as a safety measure, the D/B team preferred to maintain a depth of 10 times the borehole diameter beneath active roadways. As such, the D/B team determined the trenchless crossing would need to span at least 1,000 ft to accommodate these conditions. Although the crossing was relatively straightforward, challenges included a County-owned 24-inch water main and Florida Gas Transmission’s (FGT) 14-inch, 1,000-psi gas main that paralleled the project’s pipeline alignment.

The gas main was located in the middle of the median and the water main was located along the south edge of the median. The HDD design separated the drills by 20 ft, placing the force main alignment 10 ft north of the gas main. The reclaimed water main alignment was 10 ft south of the gas main and approximately 5 ft north of the water main. After an aerial review of the area, the D/B team selected to position the drill rig on the west side of the entrance to take advantage of 1,200 ft of uninterrupted median length on the east side of the drill which provided an ideal area to fuse the pipe without impacting traffic.



Figure 4: Mobilization of drill rig and supporting equipment within the median of Citrus Park Drive

The D/B team held meetings with FGT early during the design phase to discuss the design, proposed construction equipment, and safety requirements. Further, FGT provided safety training with the construction crews and was onsite during all construction activities proximate to the gas main.

The drills across the main entrance to the Citrus Park Mall and The Plaza at Citrus Park were successfully completed in April 2016 as shown in Table 3.

Table 3: Area 3 Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Size (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	18, 26 & 32	1,074	40	04/19/16	04/22/16
Wastewater	24	DR18 FPVC	18, 26 & 36	1,074	40	04/25/16	04/29/16

Area 4: Gunn Highway/Veterans Expressway

This area was identified as a major thoroughfare for regional commuters due to the interconnection of Citrus Park Drive, Gunn Highway, and the Veterans Expressway. Minimizing vehicular impacts in this area was paramount to the County and essential to minimizing project complaints. The Veterans Expressway was undergoing a widening project which would last the duration of the Dale Mabry Diversion project's construction. This added schedule constraints, the need for maintenance of traffic coordination, and required additional efforts to maintain clear community notification between the two projects. Similar to Area 3, this area was identified in the D/B team's proposal to be free of construction during the holiday season.

To minimize vehicular impacts and simplify the coordination with the Expressway expansion, the D/B team proposed twin drills from the west side of Gunn Highway to the east side of the Veterans Expressway totaling 1,874 ft. Due to the length of the drills, it was preferred to install the pipeline well below the top of limestone bedrock at a depth of approximately 70 ft. Like Area 3, the drills were separated by 20 ft and centered 10 ft on either side of the gas main at the west end. Moving eastward, the gas main shifts to the north, out of the alignment, allowing the two drills to be brought to within 10 ft of each other. This positioned them for the next installation beneath Rocky Creek (Area 5).

The D/B team opted to use the uninterrupted median length of 1,204 ft between the eastern mall entrance and the main entrance to safely fuse the pipes and placed the drill rig to the east. This required the pullback be performed in two sections (1,204 ft and 670 ft) and an intermediate fuse during insertion. This was preferred to reversing the operations, which would require supporting the fused pipes across the adjacent 100 ft wide Brushy Creek and closing a median cross over that provided the only access to a large assisted living facility.

The challenges with this drill included length, location beneath active roadway, and proximity to the 14-inch gas main. For Area 4, a magnetic tracking system along with a second independent verification of the bore hole path, was utilized. During its use with the pilot bore, the system received interference from heavy vehicular traffic and from the adjacent gas main's cathodic protection system. This was mitigated by continuing the pilot bore at nighttime to reduce traffic volume and by coordinating with FGT who temporarily suspended the protection system. To avoid a second mobilization of the tracking system, both pilot bores were completed prior to the reaming passes and ultimately the pipe pullback, and the drilling contractor left the 5.5-inch drill rods installed for the first drill in place while the second pilot hole was completed.

During the pullback of the 18-inch reamer for the 24-inch force main, a subsidence in the asphalt was noticed approximately 120-ft in front of the entry pit. Fortunately, this was located within a closed portion of the westbound left turn lane onto the Veterans Expressway. However, for safety, the MOT was modified to divert traffic farther

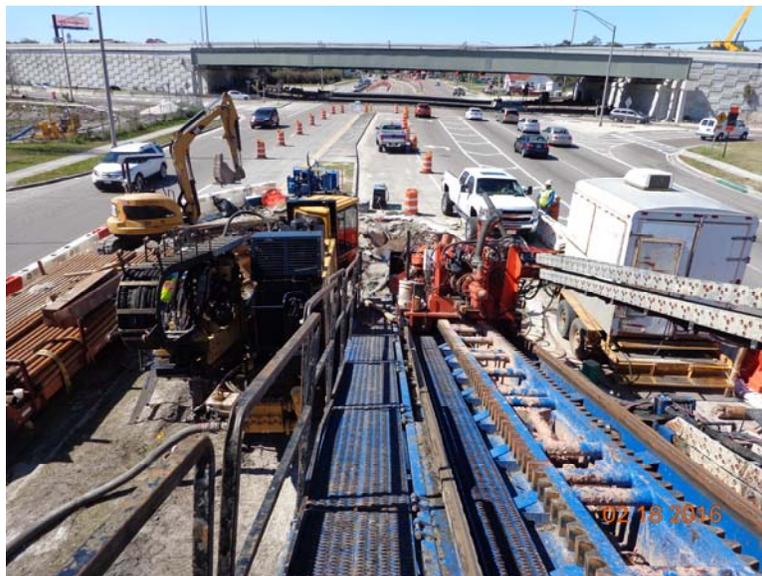


Figure 5: The two drill rigs used to drill the parallel 1,874 LF pilot bores under the Veterans Expressway

away from the depression. Drilling operations were stopped, and the D/B team's geotechnical professionals performed a geophysical investigation using ground penetrating radar (GPR). The GPR survey identified a semi-elliptical anomaly beneath the depression with an area of approximately 140 sq ft. Subsequently, two standard penetration tests (SPT) were performed within the anomaly to a depth of 60 ft. The tests showed a very weak layer of soils resting just above the limestone indicating the depression had formed from soil consolidation. A grouting injection plan was developed and implemented to stabilize the subsurface conditions. A total of 40 yd³ of 300 psi grout was injected and after 48 hours of cure time, the HDD resumed. No further settlement of the area was observed. Both utilities were installed without further incident as shown in Table 4.

Table 4: Area 4 Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Size (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	12, 18, 26 & 32	1,874	85	02/18/16	03/23/16
Wastewater	24	DR18 FPVC	18, 24, 32 & 36	1,874	75	02/12/16	03/14/16

Areas 5 & 6: Rocky Creek and Brushy Creek

Both Rocky Creek and Brushy Creek are approximately 100 ft wide and 15 ft deep. Separate east and west bound bridges convey traffic across the creek and are separated by approximately 35 ft. While the County would allow aerial installations of the pipelines, the D/B team preferred to eliminate any permanent surface water impacts resulting from the installation of piles or other means to support the pipe. This minimized permitting requirements and schedule delays. Further, the condition of the bridges and their ability to support additional loads were unknown during the development of the D/B team's proposal.

It was known, however, that the bridges were constructed on battered piles. Following award of the project, the D/B team was able to obtain record drawings of the bridges. The drawings suggested that piles extended 40 to 50 ft to the top of the limestone, and the piles on the inside of the bridges, where the drills were proposed, were slanted 14 degrees toward each other. The challenge was to install the pipelines deep enough to safeguard against hydrofracture into the creek but shallow enough to provide separation from the battered piles to avoid damaging them, impacting their load bearing capacity, and to prevent them from becoming a pathway for drilling fluid to reach the creek.



Figure 6: Pullback of 24-inch FPVC FM under Rocky Creek

The final design included drill alignments that were separated from each other by 10 ft, separated from the piles by 10 ft, and installed to a depth of 35 ft. All four pipelines were successfully installed as indicated in Tables 5 and 6.

Table 5: Area 5 (Rocky Creek) Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Size (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	18, 26 & 32	504	35	01/08/16	01/12/16
Wastewater	24	DR18 FPVC	18, 26 & 36	504	30	01/05/16	01/07/16

Table 6: Area 6 (Brushy Creek) Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Size (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	18, 26 & 32	495	40	11/11/15	11/13/15
Wastewater	24	DR18 FPVC	14, 26 & 36	495	40	11/02/15	11/10/15

Areas 7 & 8: Henderson Road and Lynn Turner Road

Henderson and Lynn Turner roads are heavily traveled roads that intersect Gunn Highway approximately 2,600 ft apart. Both roads connect the surrounding neighborhoods to the east-west corridor provided by Gunn Highway and include large commercial properties at their intersection with the project corridor. These roads were identified by the D/B team to be crossed using trenchless technologies to minimize community impacts and reduce project complaints.

The directional drills across Henderson and Lynn Turner roads were conducted within the middle of Gunn Highway and extended beyond the intersection to allow the left turn lanes to remain in service during when drilling operation commenced. Pipe fusion was performed within the median, although one median cross over had to be closed for the HDD across Lynn Turner Road.

Other than the tight construction constraints associated with conducting two drills within the 30-ft median of a 4-lane road, these two drills were essentially straight forward and without any additional challenges. During the pullback of the 24-inch force main, however, a hydrofracture occurred under a median cross over and extended within a travel lane. The lane was quickly closed and the drilling fluid was contained. The road was restored and re-opened to traffic the next day. Tables 7 and 8 show the drilling lengths and depths that were performed for these crossings.



Figure 7: Pipe fusion and low pressure leak testing within Gunn Highway median.

Table 7: Area 7 (Henderson Road) Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Size (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	12, 18, 26 & 32	577	38	10/27/16	10/30/15
Wastewater	24	DR18 FPVC	14, 18, 26, 32 & 36	532	40	10/21/16	10/26/15

Table 8: Area 8 (Lynn Turner Road) Drill Characteristics

Utility Service	Dia. (inches)	Material	Reamer Size (inches)	Length (feet)	Max. Depth (feet)	Begin Date	End Date
Reclaimed	20	DR18 FPVC	18, 24 & 32	920	45	02/05/16	02/10/16
Wastewater	24	DR18 FPVC	18, 24 & 36	920	45	01/28/16	02/04/16

4. CONCLUSIONS

The Dale Mabry Diversion project successfully utilized trenchless installations to meet many of the County's objectives on the first design-build project of the Northwest Hillsborough Wastewater Consolidation Program. Through the execution of 16 HDDs that installed over 11,000 LF of 20-, 24- and 36-inch C-905 FPVC pipe, the D/B team minimized community impacts by maintaining full access to the Citrus Park Mall and The Plaza at Citrus Park, avoided environmental impacts by drilling beneath the forested wetlands and surface waters, elevated project safety by moving the work zone outside of busy intersections, and limit project complaints by executing the drill plan with consideration to good neighbor attributes. The design-build delivery method provided the County with a \$26 million project that was designed, permitted and constructed in less than two years and optimized creativity, flexibility, and teamwork to quickly identify and resolve problems to meet the County's end goal objectives.