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## **Mandalay Channel Pedestrian Bridge Utilities Relocation Project Using Horizontal Directional Drilling**

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**ABSTRACT:** As part of the City's ongoing recreational program, the Clearwater East West Trail was designed to connect Clearwater Beach, on the Gulf of Mexico, to Tampa Bay at Safety Harbor. This 12-mile trail, when completed, will provide a safe, educational and independent pathway for pedestrians, bicyclist and skaters.

The Trail includes a new Cable Stayed Pedestrian Bridge over Mandalay Channel that will connect Clearwater Beach to the Memorial Causeway. Due to the location of the proposed drilled shafts of the bridges foundation support system, two existing City owned 12-inch potable water mains and a 4-inch natural gas main were found to be in conflict and would require relocating.

The project includes construction by horizontal directional drilling one 12-inch potable water main along with an 8-inch casing pipe in one bore and one 20-inch potable main along with a 4-inch communications conduit in a second bore. Each HDD bore is approximately 1000 feet in length.

A number of precautions were implemented to ensure a project that results in a quality product while ensuring the environmental safety of the surroundings. The project presents several intriguing challenges, most notably the logistics of installing multiple pipelines in a single pull-back operation under a water body and being adjacent to and below many existing utilities and structures.

This paper discusses a number of the issues unique to a HDD operation in a highly populated, environmentally sensitive community including the use of specific tracking devices by the contractor to ensure an accurate installation.

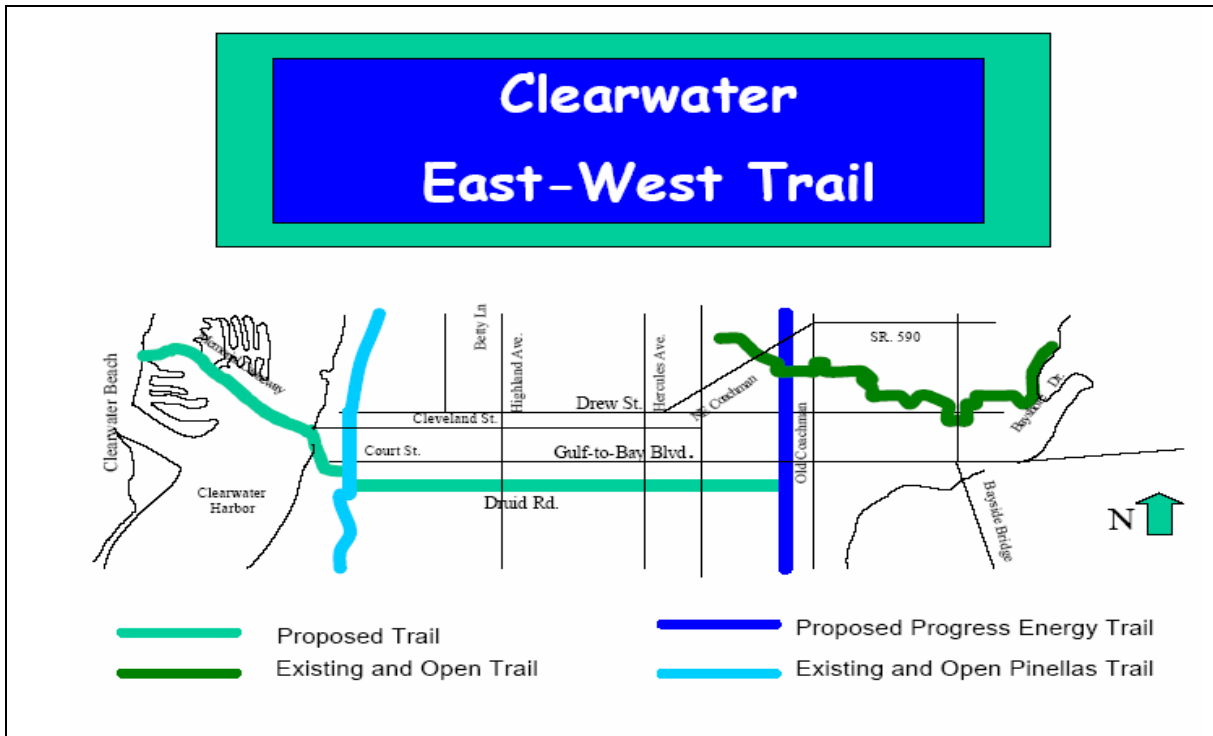
## **INTRODUCTION**

Pedestrians and bicycles currently cross the Mandalay channel highway bridge (FDOT Bridge #43) on two 5-foot wide open sidewalks (north & south sides of bridge) without safety railings or guard rails. Over 5,000 bicycles and pedestrians per week currently cross these two sidewalks. See Figure 1.



**Figure 1 – Mandalay Channel**

As part of the City’s ongoing recreational program, the Clearwater East West-Trail was designed to connect Clearwater Beach on the Gulf of Mexico to Tampa Bay at Safety Harbor. This 12-mile trail would provide a safe, educational and independent pathway for pedestrians, bicyclists and skaters. This multiple-use trail will also serve as the linking trail between the Pinellas Trail and the proposed Florida Progress Trail. See Figure 2.



**Figure 2 – City of Clearwater East-West Trail**

This section of the East-West Trail along Memorial Causeway will connect downtown Clearwater at the Pinellas Trail to Clearwater Beach. This section consists of a multiple use path with two signature bridges that are currently being built. It is estimated that approximately 15,000 people a week will enjoy this connection after it is complete.

The Trail will include a new Cable Stayed Pedestrian Bridge over Mandalay Channel. Due to the location of the bridge's proposed drilled shafts for the foundation support system, two City owned 12-inch potable water mains and a 4-inch natural gas main will be in conflict and would require relocation.

Since the existing potable water mains and gas main had to be relocated to accommodate the new pedestrian bridge, the City desired to upgrade the potable water service and traffic communications on Clearwater Beach. Subsequently, the City decided that one 20-inch and one 12-inch water main would be constructed in lieu of the two 12-inch water mains. In addition, one 4-inch conduit will be constructed for traffic communications, and an 8-inch casing with a 4-inch carrier pipe would be constructed for the gas main.

**INSTALLATION METHODOLOGY**

HDD and microtunneling methods were reviewed as alternative installation methods. After careful review and consideration, the City and TBE determined that HDD was the installation method of choice since the HDD method would be a faster installation, required no casing pipe and would be least costly.

**ISSUES AND CONCERNS**

Successful horizontal bores result from a combination of careful planning and skillful execution. The more complex the bore, the more significant the planning stage becomes. During the planning stages of this project the following issues and concerns were addressed:

- Multiple Pipe Installation
- Permits
- Geotechnical Investigation
- Environmental and Other Considerations
- HDD Operation in A Highly Populated Area
- Tracking Devices for Accurate Installation
- Frackout and Mitigation Plan

## **MULTIPLE PIPE INSTALLATION**

Due to right of way constraints, numerous existing features in the immediate area such as mooring pilings for boats, existing utilities such as power, telephone, reclaimed water and potable water and the proposed drilled shafts for the cable stayed pedestrian bridge, it was decided that the proposed 20-inch potable water main and the 4-inch conduit for traffic communications, would be installed in one pull-back operation and the proposed 12-inch potable water main and the 8-inch casing with the 4-inch gas main carrier pipe would be installed in another separate pull-back operation.

## **PERMITS**

Permits for the project were obtained from the United States Army Corps of Engineers (USACOE) and the Pinellas County Health Department.

## **GEOTECHNICAL INVESTIGATION**

One Standard Penetration Test (SPT) boring 50 feet below existing grade was performed on land on each side of Mandalay Channel. In addition four SPT bores previously performed for the pedestrian bridge were used to evaluate the subsurface conditions.

Loss of circulation of drilling fluid occurred in four of the SPTs at varying depths. Based on the geotechnical investigations, steering response will be poor in the upper loose sands and soft clay and at the interface of the soil/limestone. In addition, filled or open cavities could be encountered that could adversely impact steering and circulation. The potential for encountering solution cavities and hard rock increased the risk of the bore. If the bore encountered open solution cavities, circulation could be lost and the drill pipe or product pipe may seize. If the bore encountered hard rock, line and grade control would be difficult to maintain, especially near the interface of the rock with the sand and clay soils. These factors increased the risks of the HDD operation.

## **ENVIRONMENTAL AND OTHER CONSIDERATIONS**

Because of the heavily populated, environmentally sensitive location and required permitting, the contract documents require the selected contractor to submit the following documentation for review:

- Noise Reduction Program
- Solids Control and Drilling Procedures
- Pipe Fusion, Hydrostatic Testing and Pigging Procedures
- Contingency Plan Including Contractor's Proposed Response(s) to the Following Potential Occurrences:
  - Loss of returns/loss of circulation of drilling fluid
  - Hydrofracture
  - Obstruction encountered during drilling
  - Broken drill pipe
  - Product pipe collapse

The Clearwater Marina area on Clearwater Beach is in the vicinity of the proposed HDD project. This area has experienced groundwater petroleum contamination. In the past, gasoline fueling stations were present on the marina site where underground storage tanks and/or lines could have leaked and caused petroleum impacts to soil and groundwater. Existing ground water monitoring wells on the site were sampled and analyzed. Two wells, located south of the HDD alignment, showed the presence of petroleum contamination. To verify the extent of the contamination plume and to determine if the proposed area of construction for the utility relocation had soil and/or groundwater contamination impacts, additional sampling and testing were performed in the alignment of the proposed pipelines. Five direct push borings and fourteen hand auger borings were installed to facilitate the collection of eight discreet groundwater samples and five soil samples which were collected up to depths of 30 feet below land surface.

Except for a low level petroleum impact at a boring close to the existing monitoring wells, no contaminated groundwater impacts or contaminated soil impacts were encountered that ran along the proposed HDD alignments and in the proposed trench areas.

Being a highly populated beach community and popular tourist area, contingency plans had to be developed for continued potable water supply in case the existing pipelines are damaged during pull-back or tie-in operations. Options reviewed were to install above ground temporary water lines in advance of HDD operations, perform one HDD operation and all associated piping prior to the other HDD operation or see if potable demands and fire flow demands could be met by temporarily connecting to the Pinellas County water system south of the project near Sand Key. The final decision was to stage the HDD operations so one drill and all associated piping was completed and in service prior to the other drill being performed.

### PIPE DESIGN

Alternative alignments and profiles were evaluated by TBE Group, Inc. during pipe design. The final profile is shown in Figure 3.

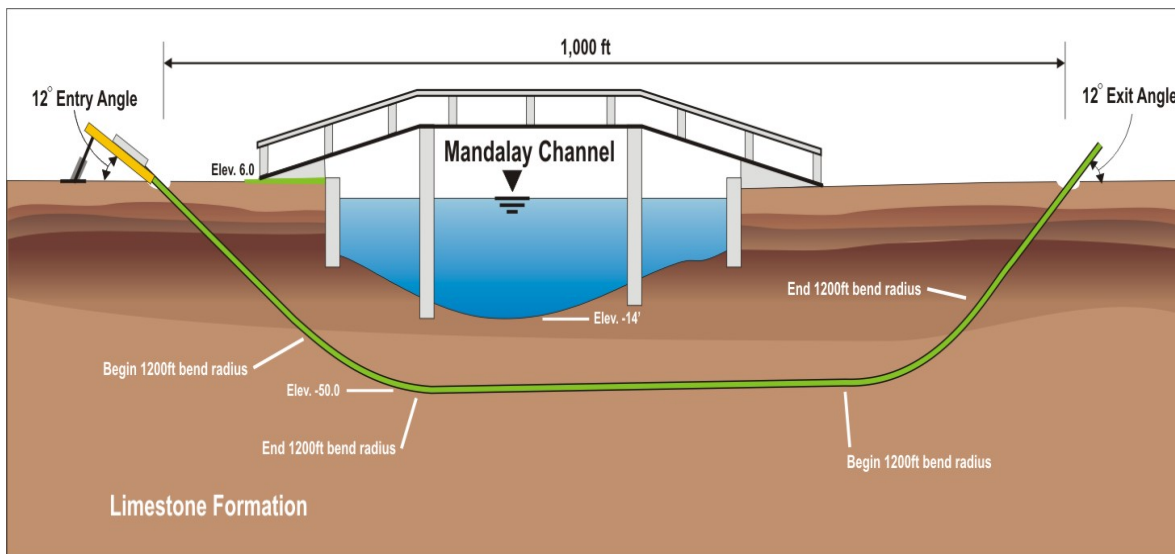


Figure 3 – Profile Under Mandalay Channel

The final profile was chosen based on the feasible entry and exit angles and establishing the depth to keep the majority of the steering operations in the limestone. The characteristics of the final profile are shown in Table 1.

<b>CHARACTERISTICS OF THE PROFILE</b>	
Entry angle	<b>12 degrees</b>
Bend radius	<b>1,200 feet</b>
Maximum depth	<b>55 feet</b>
Exit angle	<b>12 degrees</b>
Total pipe length	<b>1000 feet</b>

**Table 1**

For the profile detailed above, pullback calculations were performed for DR 11 and DR 9 to determine the minimum pipe wall thickness. For both cases, the evaluations were performed for pulling back the pipe empty and full of water. The calculations were performed using guidelines developed by the American Gas Association (J. D. Hair and Associates, et. al., 1995). Although DR 11 was found to be acceptable to safely withstand estimated pullback forces with the pipe full of water, DR 9 was specified.

### **TRACKING SYSTEM**

Due to the right-of-way constraints, numerous existing features, existing utilities and the proposed drill shafts for the pedestrian bridge foundation support system, it is crucial that the HDD installations be accurate. Bore tracking and guidance are less accurate beneath water than beneath land. To accurately locate and guide the bore, specifications will require the use of a wireline steering system with TruTracker.

Basic components of a wireline steering tool include a downhole probe placed inside a nonmagnetic drill collar near the drill bit, wire connecting the probe to an interface unit on the drill rig, readout box, and computer and printer at the driller's station.

The probe's accelerometer measures gravity and resolves the tool's vertical-horizontal inclination. A magnetometer measures the earth's magnetic field and dip angle to resolve the tool's relationship to magnetic north. Information is transmitted to the interface unit that connects to a laptop computer and printer. The readout box provides the driller with constant updates of drill head roll, pitch and direction. Wireline systems usually are used with a Tensor TruTracker surface grid system – special software and wire coil placed along the line of the drill path. TruTracker provides a method of verifying that data from the wireline system are not being affected by magnetic forces or other interference and will provide an accurate alignment of the drill path.

### **PIPE INSTALLATION**

The Tru-Tracker tracking system will be set up on the west side of Mandalay Channel (entry-point) and at the exit-point. A wireline tracking system will be installed across Mandalay Channel from the entry point to the exit point.

During the pilot hole drilling, data will be collected at 30-foot intervals from an electronic device giving magnetic azimuth for left/right of the baseline and the vertical depth. The steering device will be located in the head of the pilot bit.

Pressurized slurry will be used to advance the drillhead.

Once the pilot holes are completed, the holes will be enlarged to accommodate both HDPE pipes.

The entire length of all HDPE pipelines will be butt fused together and laid out. The pipelines will be pressure tested prior to pullback. Following pressure testing, the pipelines will be attached to the drill pipe, reamer and breakaway swivel and pulled back continuously in one segment through the drilling mud along the reamed drill path. The pipes will be filled with water prior to pullback to aid in controlling the buoyant forces and to keep the pullback forces below the safe pullback capacity of the HDPE pipe.

Once the pipelines are installed, a hard pig slightly smaller than the inside diameter of each HDPE pipe will be passed through the pipelines to verify roundness.

## **SUMMARY**

As part of the City's ongoing recreational program, the Clearwater East-West Trail was designed to connect Clearwater Beach, on the Gulf of Mexico, to Tampa Bay at Safety Harbor. This 12-mile trail would provide a safe, educational and independent pathway for pedestrians, bicyclists and skaters.

The Trail included a new Cable Stayed Pedestrian Bridge over Mandalay Channel which would connect Clearwater Beach to the Memorial Causeway. Due to the construction of the drilled shafts for the foundation support system for the pedestrian bridge, two city owned 12-inch potable water mains and a 4-inch natural gas main would be in conflict and would require relocating.

It was determined that the most effective and least disruptive method for constructing the replacement pipelines would be by the HDD technique. The new pipelines will be constructed of HDPE, DR 9 pipe with a maximum depth of approximately 55 feet below the channel bottom in the existing limestone strata.

The project will include construction by horizontal directional drilling one 12-inch potable water main along with an 8-inch casing pipe in one bore and one 20-inch potable main along with a 4-inch communications conduit in a second bore. Each HDD bore will be approximately 1,000 feet in length.

Permits obtained for the project included Pinellas County Health Department and USACOE permits.

## **REFERENCES**

1. Bennett/Staheli Engineers, April 19, 2004, Technical Memorandum, Mandalay Channel HDD Review, Clearwater, FL
2. Driggers Engineering Services Incorporated, April 9, 2004. Report of the Test Borings, Subaqueous Crossing, Mandalay Bridge, Clearwater, Florida.
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4. City of Clearwater, Florida.