Prime power-drives long

Recently, a challenging horizontal intersect below the Elizabeth River in Norfolk, Virginia, involved drilling two separate HDD bores, using a Paratrack II guidance system. The crossings run from Craney Island to Tanner's Point, a peninsula protruding from the western side of the Port of Virginia

THE Elizabeth River project was part of renovation works to upgrade an existing high-voltage power line crossing the river with the introduction of two additional, parallel lines.

Two parallel 200 mm (8 in) steel pipes were to be installed with a separation of 6.1 m (20 ft). Only the first of these is discussed in this article. The path of the pipeline was designed to roughly follow that of the existing line, a rather meandering route involving three large, horizontal bends at different points along the 2.2 km (7,300 ft)-long course, as shown in the plan view (see page opposite).

Dominion Energy commissioned the work and contracted it to UTEC Constructors Corporation, a specialist in underground electrical transmission systems. Initially a dredging solution was proposed for installation of the power lines but this was ruled out on environmental grounds relating to disposing the toxic material dredged from the channel bottom, as well as shipping channel regulations.

Port authorities would only permit closing the channel for a single period of eight hours during the project. It was considered too high a risk to attempt dredging two lines across a shipping channel nearly 610 m (2,000 ft) wide in such a short amount of time.

When the dredging option was ruled out, UTEC contracted Mears HDD LLC to complete the crossing with guidance provided by the ParaTrack-II magnetic guidance system.

Mears contacted Prime Horizontal Inc for the guidance of the intersect. Prime is a guidance company specialising in the planning and execution of HDD intersects. At the time of contact, Prime had successfully completed 18 such intersect projects.

PLANNING

Soil sample boreholes were taken over the length of the crossing's bore path. These samples showed that most of the ground consisted of soft alluvial sediments (sand silt and clay) with trace amounts of fine gravel and shell fragments. The composition was fairly consistent throughout the entire bore path although with varying degrees of firmness. The softest section was found beneath the shipping channel, even at a depth of 35 m (114 ft). This was lower than the planned bore path of 27.4 m (90 ft), and was also a pre-warning of potential steering problems.

Because of the tight turns and soft formations, it was necessary to compute the maximum forces that could be applied to the drill string in order to avoid buckling or breaking the drill pipe downhole. Because of these anticipated forces on the drill string while drilling, a conventional, HDD river crossing was ruled out in favour of the least risky method, the underground intersection of two independent boreholes drilled from each side of the river, called a horizontal intersect.

Based on the soil samples and planned geometry, it was also decided to attempt the intersection closer to Tanner's Point in the Port of Virginia, leaving the majority of the crossing to be drilled from Craney Island.

For the short side, the equipment used was an American Auger rig with a 140,000 lb pull strength; a class 2, 5.5 in drill pipe, and a shovel headed jetting assembly to give more aggressive action when steering the tight turns and soft sediments. For the long side, an American Auger rig with a 660,000 lb pull strength; the same drill pipe as on the short side and a $9^{7}/_{8}$ in drill bit.

RS232 radio modems were used to communicate data from the steering probe on the shorter side to the drill rig on the other side, where the steering engineers responsible for the intersect were able to process the relevant data in real time.

Two types of guidance systems were used to complete the crossing. The first, a standard ParaTrack-II system configured with surface and channel bottom AC guide wires, steered the pilot hole into the intersect zone. Divers were used to lay a cable along the surface of the river bed to a distance of 573 m (1,880 ft) on the Craney Island side and to 1,115 m (3,660 ft) on the Tanner's Point side. Guiding the longer side made use of the earth's magnetic field for 554 m (1,820 ft) before arriving at the intersect zone.

When the two boreholes were in proximity to each other, the magnetic guidance source was switched to the Passive Magnet Ranging System (PMRS), a rare earth magnet housed behind the drill bit to give a known magnetic signal that is measured by the ParaTrack-II sensor in the opposing drill string. The PMRS system gives a very accurate bearing and position, within centimetres, of the magnet relative to the sensor and this information is then used to steer the magnetic assembly into the path of the other drill string.

During the pilot drilling operations, both drilling assemblies used a ParaTrack-II steering tool mounted behind the drill bit in non-magnetic drill collars. The assembly for the rig on the Craney Island side used the rare earth magnet from the PMRS system connected between the drill bit and the steering tool which was used for the close range measurements once the intersect was under way.

The 660,000 lb pullback HDD rig used on Craney Island in the Elizabeth River crossing

HDD intersect in Virginia

THE PILOT AND INTERSECT

The pilot hole was started on May 23, 2006. When the longer side (from Craney Island) had drilled out to 1,640 m (5,390 ft) and the shorter side (drilling from Tanner's Point) had drilled just under 600 m (1,970 ft), the two drilling assemblies were nearly overlapping, whereupon the guidance system was switched to the PMRS system to measure the distance between the two assemblies.

The operators completed the intersection on their first attempt. When they attempted to pass the magnet past the steering tool, the two opposing drill bits made contact. After a brief celebration, the Tanner's Point rig began to pull its drill pipe out of the ground while the Craney Island rig continued forward into the space left for it. To keep the drill bores from collapsing and to minimize pulling forces, a 304 mm (12 in) casing was run around the drill pipe from both entry points until the casing from the Tanner's Point side passed over the two touching drill bits. The following day the drill bit from the Craney Island rig came out of the ground on Tanner's Point. Overall the pilot hole took 19 days, an impressive feat given the length and complexity of the crossing.

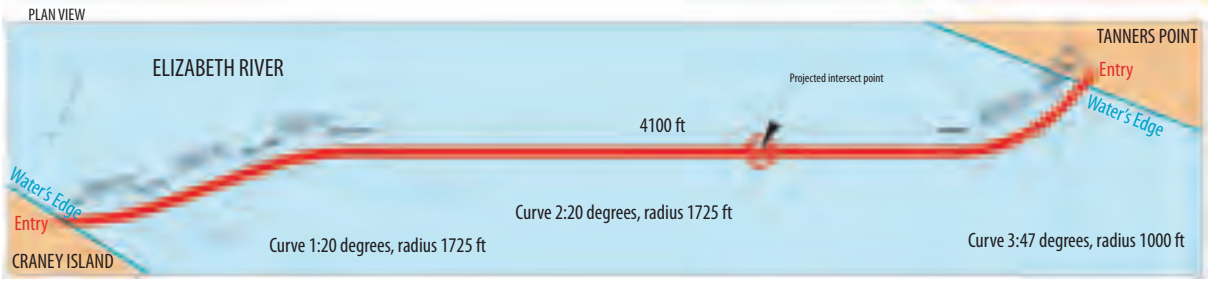
REAMING AND PIPE PULL

The reaming was completed using only one reaming pass. Due to space constraints, the pipe was welded and tested on the Craney Island site. Once the reaming was completed, the larger rig was moved from Craney Island to Tanners Point to begin the pipe pull.

The 200 mm (8 in) steel pipe was prepared for installation in two complete sections. Once the pipe was halfway in the ground, pulling operations halted briefly for the pipe to be welded. The operation finished in time for the July 4 celebrations.

SUMMARY

Given the size and complexity of the project, this first bore under the Elizabeth River has been very successful. It was completed on time and on budget, thanks mainly to the experience Mears Inc has in long bore HDD projects and the operational support given to them by UTEC Constructors Corporation. Thanks are also extended to Prime Horizontal for its unique experience in both long bore HDD and HDD intersect projects. Once again the boundaries for HDD projects have been extended that much further.



CAD drawing showing the plan view of the bore path. The three horizontal bends can be seen clearly. Also apparent from this drawing is the lack of land approach available before the bore paths enter under the river

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