LESSONS LEARNED ON CHALLENGING PTM PROJECT

Pilot Tube Method Effective Trenchless Option in Novi MI

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Novi is a growing area 25 miles northwest of Detroit. In one area of this community, there was an existing 20-year-old, six-inch force main that was functionally obsolete carrying the outflow from two separate pump stations. Multiple single grinders also fed into the one pipe resulting in regular failures of the force main. Replacement of the force main would have required significant capital investment for multiple new mains, limited future growth and continued to be a costly maintenance headache.

The project is designed to replace more than 1.5 miles of the existing force main. The new 12-inch diameter gravity sanitary sewer will separate the two force mains from two upstream pumping stations, ultimately delivering a lower lifecycle cost. The new increased capacity will also create the opportunity for current parcels (with existing septic systems) and future developments to tie into the municipality's gravity sewer.

This project area featured large parcels in a naturally beautiful surrounding with mature trees lining the roadway. The road is classified as a Natural Beauty Road by Oakland County, and there is an abundance of landscaping in the right-of-way with natural ponds throughout the project corridor. All these features were viewed as community assets that needed to be respected and protected. The mature trees and landscaping also created an extremely tight project corridor for operations.

To preserve the community assets while keeping costs down, a multi-method project plan was developed using both open-cut and trenchless installation methods. The new gravity sewer line would provide the expanded capacity needed to serve a growing population in the area while addressing the ongoing environmental, maintenance, and cost concerns that accompany lift stations, force mains, septic fields, and grinder pumps.

The bid documents allowed for the use of horizontal auger boring or, as an alternate, Pilot Tube Method of Guided Boring (PTM) for the trenchless runs. The contractor bidding PTM was the most competitive bid for the trenchless portion of the project.

The contractor elected to use PTM with Vitrified Clay Pipe (VCP) because of previous experience. Shaft construction and installation, including dewatering, using PTM was more economical than traditional jack and bore methods because of the reduced shaft size and the permanent pipe installation without an oversized carrier casing, on grade spacers, and grout.

Results of 18 soil borings in the 7,400-foot alignment were included with the plan documents. That was one bore approximately every 500 feet. Because the soil layers were roughly consistent, additional borings were deemed unnecessary. The borings indicated that on the east end of the project the soils were

Aerial view of the 9 Mile Road Sanitary Sewer Project area in Novi, MI

Nested cobbles from one run

Maximum cobble size that can be "digested"

"moist gray clay with some silt and traces of sand or gravel." This description was present in 14 of the original 18 borings. This was the area planned for trenchless installation.

On the west end of the project "gray sands" were in the profile of the installed pipe. This was the area planned for open cut installation where depth of sewer was less, the natural beauty designation was not present, and the foliage cover in the Right of Way (ROW) opened.

Dewatering was a key component of the project. The area has multiple wetlands and a high-water table. The dewatering narrative was written based upon the soil borings, geotechnical report, and site-specific review letter from the Michigan DEQ (now known as EGLE – Environment, Great Lakes & Energy). The review letter based on the original dewatering permit application included a limitation of two MGD (Million Gallons per Day) of discharge.

The dewatering plan was designed to limit pumping and stay below this maximum. The plan anticipated that the deep wells would lower the existing water table and allow the construction of temporary shafts over a period of two to three weeks. The expectation was that this would lower the water level to below the invert of the pipe for open cut trench construction. The deep wells were intended to eliminate water in the jacking shafts and the well points would lower the water-table to within six to ten feet of the top of pipe for the trenchless operations.

The PTM process based on the dewatering narrative should have allowed for operations to be conducted simultaneously with open cut operations because of the ability to tight sheet the shafts. The construction plan for this project was designed to take advantage of the precision of PTM installation with ongoing dewatering throughout the project. The plan anticipated pumping of 1 – 1.5 MGD in up to six deep wells and shaft pumps in the east end of the trenchless sections and 0.5 - 1 MGD from the well points in the open cut areas. After initial setup of four of the 14 planned dewatering wells, two MGD was immediately reached with the water table plateauing at six to twelve feet above the invert.

While the dewatering permit was reevaluated, the two MGD limit in the partial permit was used entirely for the well points in the open cut portion of the project. To stay within the two MGD limit, work began only in the open-cut area of the project while an application was made to expand the project's dewatering. The new permit allowed for up to 8 MGD. A larger header system was installed to allow trenchless installation to commence with an average of 5 MGD used to provide adequate dewatering.

On the first few runs, a 16-inch open face reamer head following the 5-inch pilot tube functioning as planned. The third run was the first indication of problems as ground water moved soils around the head and along the profile.

As run three progressed, it became clear that a more aggressive solution would be needed. Multiple variations in the soils were encountered. The clay layer varied in depth, drifting up and down intermittently in the boring profile creating a mixed face condition where sand would change to clay and back again, sometimes multiple times in the same run. Along the interface between the clay and sand layers throughout the project was a nested cobble layer that varied from 6 inches up to three-feet-thick with heavy percentages of coarse sand (up to 40 percent in two areas).

The clay would slow open face reamer heads. The sand would cause sediment migration along the bore profile where ground water wasn't fully controlled. The nested cobbles (3 to 12 inches) would stop the pilot tube or boring heads, causing considerable delays. Pauses in auger rotation and "slamming" of the casings permitted the swivel bearing cutter head to accept the smaller

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Mincon rock hammer pilot head

cobbles and grind them up in the front chamber, allowing them to be transported back to the jacking shaft.

The switch to a swivel bearing cutter head and chamber started to achieve results. However, the high groundwater also moved soils along the alignment in the coarse sand area. Temporary casings were replaced with permanent welded casings; however, a shear break created a misalignment. Ultimately that run had to have a 36-inch heavy-walled casing hammered in around the 16-inch casings to restore the design slope across the offset alignment. The casing was pulled out using an Akkerman Guided Boring Machine (GBM). After the 36-inch casing was cleaned and profiled, the carrier pipe was installed on grade, and the annulus was grouted.

After ten additional soil borings to clearly identify geotechnical conditions along the alignment of the remaining ten planned runs (MH ten down to existing), and with the larger dewatering system in place, PTM installation resumed with a swivel bearing cutter head. The method was successful from MH 10 to MH 5.

When the second area of course sand was encountered in the area of MH 5, Akkerman manufactured fittings for the pilot tube system to use the rock tooling provided by Mincon. This allowed continued use of the pilot tube optical guidance while also adding a directional drill sonde to verify the alignment and elevation when the optics were clouded by the dust and vibration of the rock hammer pilot head. The new fittings allowed precise drilling from MH 5 to 4 through the nested cobble, coarse sands, and a high-water table.

The inability to get a pilot tube from 3 to 4, resulted in an additional shaft 3B. After the installation of the pilot tubes from MH 3B to 4 with the Mincon rock hammer, DVM Utilities provided a 16-inch plate reamer leading a 16-inch casing that was unsuccessful in achieving line and grade through the nested cobble layer. Ultimately a 30-inch hammered casing swallowed the 16-inch welded casing and the 12-inch sewer was installed and grouted using profile spacers to maintain grade inside the casing.

The last five runs of the project profile drifted between clay, sand, and the nested cobble layer with fluctuations occurring, sometimes in intervals of less than 50 feet. The pilot tube achieved line and grade followed by a welded 16-inch heavy wall casing for successful installation through the mixed face condition. The pilot tube was changed out for 4.5-inch diameter rock drilling rods, then power auger reamed with 16-inch welded casing following. This proceeded until rock or nested cobbles stopped the operation. The augers were removed, and a hammer drove the 16-inch assembly following the rods to the next pit. From MH 3B to 3, the 16-inch casing was jacked out with 12-inch VCP. In the remaining runs, the jacking pressures exceeded 220 tons and the 16-inch casing is being left in place and CIPP lined.

With ten trenchless runs completed, and run 11 and 12 currently in progress, the largest, most important lesson learned has been teamwork! It may seem that you've heard that one before, but the importance cannot be overstated. Clear, consistent communication was an important element in making a team that held together in the face of adversity.

Don't push the boundaries. For any trenchless installation, the guidelines for geotechnical evaluations provided in ASCE MOP 133 should be viewed as conservative, but advisable. The additional soil borings called for in the standard, may or may not

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have unveiled the challenges before manpower and equipment were on-site, but the chances of uncovering issues would have been increased.

NO-DIG VCP Jacking pipe is the most-common choice for any PTM project. In this case, VCP's high compression strength (18,000 psi) and greater jacking pressures (78 tons with a 2.5 Factor of Safety) were fully exploited.

Experience & expertise cannot be over-valued. The members of this team, from the city and the design engineer to the contractors and equipment manufacturers all brought something to the table when it was time to problem-solve. When additional expertise was needed, each member of the team brought their resources to the table to grow the team on an as-needed basis. Applying the lessons learned from various other projects allowed the contractor to maximize the use of its GBM to solve problems in many ways.

The bottom line is: You never know when or how a project will surprise you. Make sure all the members of the team will partner with you to find solutions!

ABOUT THE AUTHORS:

Steve Matheny P.E. *joined Logan Clay Products LLC as a business development engineer in 2016 after more than 30 years in the field, working for municipalities and manufacturers. Steve is currently consulting on multiple projects throughout the Midwest & East Coast. Many of those projects will employ the Pilot Tube Method for installation. Steve's Bachelors and Masters degrees in Civil Engineering are both from Wayne State University.*

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