MAINTAINING A SLOPE OF JUST 0.20 PERCENT:

West Royster Creek Sewer Outfall Project

By: Steve Matheny P.E., Logan Clay Products LLC

As problems arise in older sewer systems, the challenges are becoming more and more common. A developed area with existing utilities, a need to maintain access to residences and businesses, mature trees and landscaping, and a need to replace and enlarge an existing collection line – these are some of the issues we are seeing more frequently. But the West Royster Creek Sewer Outfall project added a few extra challenges. One of the added challenges was the creek causing significant head-cutting near the existing pipeline.

The existing 12-inch main was originally placed in service in the 1970s prior to the annexation of the area by the city of Millington, TN. Since annexation, the city has invested in various stabilization efforts that proved to be short-term solutions. For the past ten years, the stream has been encroaching on the sewer main. The changes to the stream alignment have required that Millington provide short-term protection to the stream embankment in an effort to protect this sewer and the environment.

Available right of way was limited to the roadway in many parts of the project

"The average compression strength of this clay pipe is 18,000 psi."

- Tim Verner, P.E. Fisher & Arnold Engineers

Short (1-meter) VCP-J pipe lengths make the 8-foot shafts functional

They feared that this large stream would ultimately undercut the sewer. The line would need to be moved.

To further compound problems, the existing 12-inch sewer was not adequately sized to handle additional flows from new upstream development. Without additional capacity, new growth in the area would be stymied.

The lack of adequate room to install this new line between the existing high-density housing and the top of the creek bank required Fisher & Arnold engineers to explore alternative locations for the new sewer main with increased capacity. Installation using standard "open-cut" methods would be very disruptive to traffic patterns, existing utilities, and emergency access to the residents. Resurfacing the roadway would have also significantly impacted the final cost of the installation in this neighborhood consisting of fairly dense housing with sidewalks and mature trees on all lots. The best option was to install the new sewer within an existing roadway in an established neighborhood.

After eliminating an open-cut project from the methods under consideration, Tim Verner, P.E with Fisher and Arnold explored trenchless installation methods. The goal was to identify the best installation method to address all the challenges presented. Using trenchless methods would allow the contractor to excavate shafts at 300 to 400-foot intervals. Different technologies require different shaft sizes, and some require a permanent casing to be installed.

Verner evaluated three technologies that could accommodate 20-foot depths and a minimal slope (0.20 percent) to maintain flow for the gravity sewer:
- Jack and Bore
- Pipe Bursting
- Pilot Tube Method (PTM)

Jack and Bore would require large shafts (20 x 40-foot) and the installation of a permanent casing with the carrier pipe inside. Maintaining the required slope would require a larger casing to ensure the slope. The expense of the steel casing was a significant consideration.

Pipe Bursting would require large shafts to allow the final line to start at 20 feet below grade. To eliminate the traffic disruption this would cause, this pipe alignment would only replace the existing 12-inch sewer where it currently exists. Stabilization of the bank would become a major component of the project. Upsizing from 12-inch to 21-inch was determined to be beyond the practical limits of this technology given the challenges of this project.

PTM would allow limiting the size of shafts (8- to 12-foot in diameter) and the final installation would not require a permanent

The depth needed to tie in to the existing sewer was one of the challenges that made the Pilot Tube Method of guided boring the right choice for this project

casing. PTM is a 3-step process that installs Vitrified Clay Jacking Pipe (VCP-J) on grade and on target.

Accurate control of the line and the small footprint required, led to the selection of PTM for this project. It was deemed the best value for the community, minimizing disruption to the residents, impacts on existing utilities, and restoration at the conclusion of the project.

After doing due diligence on both the installation method and the pipe material, Verner commented, "This is not the clay pipe that got the bad reputation for being brittle. The average compression strength of this clay pipe is 18,000 psi."

In this neighborhood, the existing utilities included an 8-inch sanitary sewer, 36- and 18-inch storm drains, an 8-inch water main, and an 8-inch gas line. The depth of these utilities varied from just below the surface to 12 feet below grade.

Installation of the new pipeline would utilize just six access shafts at an average depth of 25 feet. The deepest shaft was 29 feet. Three of the shafts were round and 8 feet in diameter. The VCP-J pipe was ordered in one-meter lengths to make the smaller shafts practical. Memphis Road Boring (MRB), the contractor, was able to jack pipe in two directions from these shafts and in three directions from one shaft. Three of the shafts were used for reception only, and these shafts used 10 x 10-foot trench boxes. This arrangement lessened the impact on traffic circulation and maintained all existing services during construction. The ability to control the slope throughout the drive enabled MRB to achieve the specified 0.20 percent slope that minimized the required depth of the line.

The project was designed using PTM and went to bid in 2020. MRB had the winning bid of approximately $2.6 million. The work was awarded in December of 2020 and completed in 2021 on time and on budget.

The Akkerman Guided Boring Machine (GBM) 308 system used for this project can operate in an 8-foot diameter shaft and can jack up to 21-inch VCP-J. The GBM includes a digital theodolite with an integrated camera mounted independent of the jacking frame, a battery-powered LED illuminated target housed in the slant-faced steering head, and a computer monitor screen. This guidance system gives the operator a "real-time" view of the location and steering head orientation of the pilot tubes. This "real-time" view, together with the ability to continuously make adjustments during the entire pilot tube drive, results in pinpoint accuracy. In a three-step installation process, driving the pilot tube to the next shaft is step one.

In the second step, a reaming head attached to the final pilot tube and in front of temporary thrust casings, cuts and removes soils. Thrust (auger) casings advance the pilot tubes to the reception shaft where pilot tubes are removed (pilot tubes are reused on future projects). The spoils are transported by the auger to the jacking shaft for removal. The thrust casings are temporary casings that maintain

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the line while transporting any soils removed as the borehole is upsized from the four-inch pilot tube to approximately 11 inches.

Step three is installation of the carrier pipe. Taking advantage of the average compressive strength of VCP-J (18,000 psi) means that no casing is needed in the final installation. The pipe itself can resist the high jacking forces generated as the pipe is thrust through the ground, replacing the temporary casings and augers and eliminating the need for an external casing pipe. The carrier pipe is jacked with an additional power reaming head (PRH) in front of the pipe. The PRH matches the OD of the VCP-J and removes excess soils in the area between the 11-inch hole created in step 2 and OD of the carrier pipe. The VCP-J pipe pushes the thrust casing to the reception shaft where it is removed. With a PRH, the augers within the casings are reversed and soils are transported to the reception shaft.

The project is complete when the carrier pipe enters the reception shaft. These shafts then become manholes (access holes) when the contractor has completed the sanitary sewer runs. The accuracy of the installation method meant MRB was able to tie the new alignment into the existing system at existing access holes.

Tommy Sander, P.E, of MRB said, “This project went seamlessly. We were able to install both 21-inch and 12-inch VCP in the middle of the streets, through a residential area, without ‘open-cutting’ the roadway while maintaining the slope specified of just 0.2 percent. NO resident was affected by this operation – meaning residents were able to use their streets and driveways throughout this project.”

ABOUT THE AUTHOR:

Steve Matheny P.E. *is a sales engineer for Logan Clay Products. He is a Board Member for ASCE and has authored a number of papers and articles. He is currently consulting on multiple PTM projects. His bachelor’s and master’s degrees in civil engineering are both from Wayne State University. Steve is also a Board Member for the MSTT Chapter.*