Engineering Innovations Emerge from Lining Challenges

A Complex Lining Project in Brooklyn's Gowanus Canal Led to Creative Solutions

By: Mario Carbone, Progressive Pipeline Management

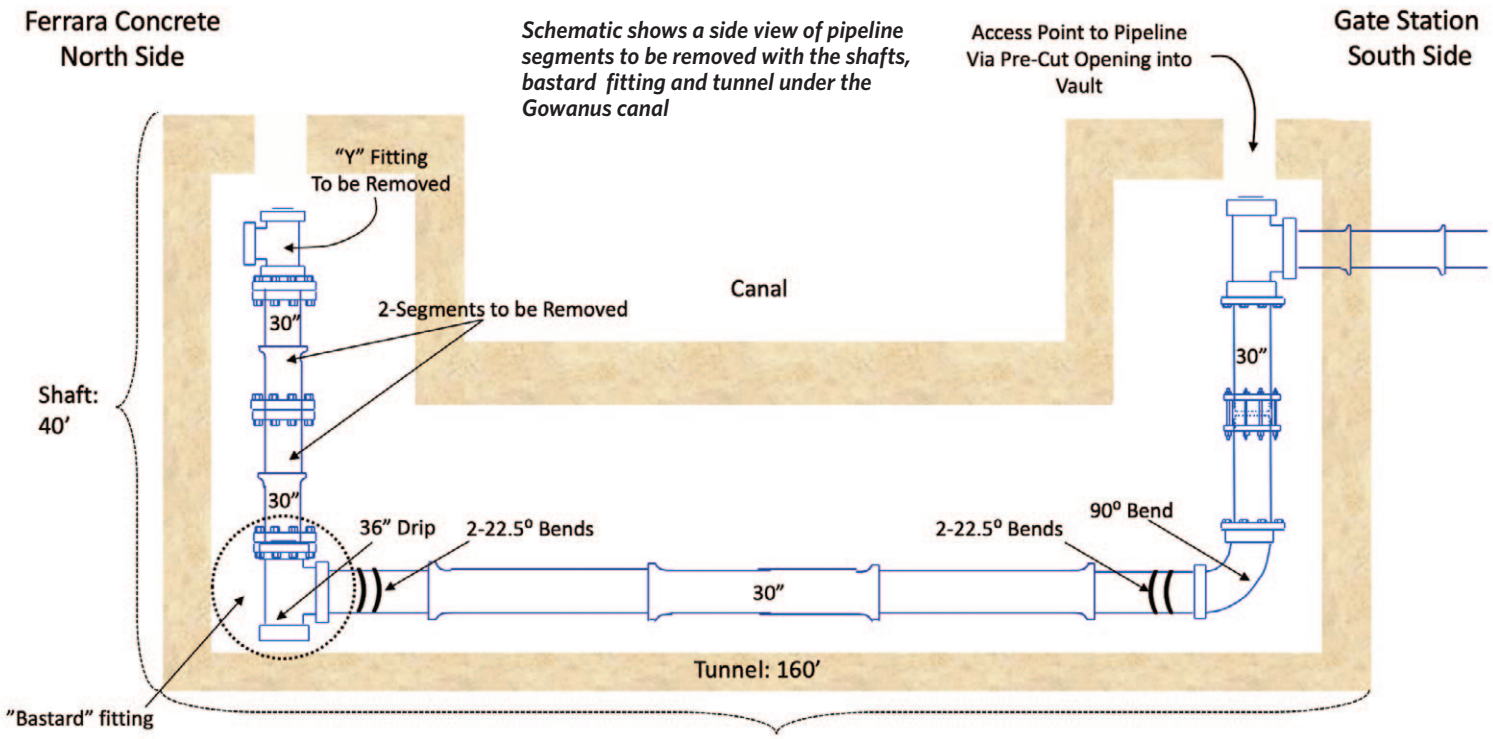
Since 2002, Progressive Pipeline Management has been installing the Starline® Cured-In-Place-Lining trenchless technology for natural gas main renewal. The trenchless pipeline renewal technology is proven to be an effective alternative to conventional replacement methods for cast iron and steel pipelines.

Cured-in-Place-Lining relies on engineering, whether it is a conventional lining application, or there are multiple complications. Rehabilitating natural gas pipelines requires a collaborative team with hands-on expertise of both natural gas and lining. Engineering innovation emerges from a need to solve a problem.

Every lining project, no matter how small or how complicated, requires up front engineering. Preparing the projects involves a knowledge of both gas procedures as well as lining applications. The two disciplines merge into a subject matter expertise and the ability to create new engineering processes. The 30-inch turnkey project in Brooklyn's Gowanus Canal challenged what we thought was possible. There were several times we wondered, can it be done? With the creative engineering and ingenuity of National Grid and Progressive Progressive Management, the challenges became a catalyst for multiple innovations.

CAN IT BE DONE?

There was nothing conventional about this project. The drawings showed a pipe configuration I had never seen. The 30-inch cast iron pipeline started above the ground and turned straight down 40 feet. It bended again, entered a tunnel for 200 feet, turned sharply with a 36-inch drip and up the other side of the canal. Access points to the pipe were extremely limited. The process of cleaning the pipe-



line's interior before lining had to be redesigned. The challenge of lifting the debris 40 feet to a vacuum truck, had to be overcome. A completely new approach to connecting the lining fitting to the pipe needed to be invented and engineered. Almost every lining standard and procedure would have to be redesigned, tested, and implemented.

After weeks of internal discussion within PPM's engineering group, we worked through options and recommendations with National Grid's engineers, pipeline and construction experts. Our collective expertise encompasses the best of rehabilitation technology, pipeline construction, gas engineering and distribution. Each scenario was considered and debated.

Even as we discussed possible solutions, I knew from experience to expect the unexpected. In lining, like chess, you can't see the challenges all at once. At best you see the next one or two moves. As each new challenge appeared, we would have to face it head on and then be ready for the next one.

THE BEST-LAID PLANS

After many weeks, we had a project design for the Gowanus Canal, on paper. When we got on site and entered the tunnel where the pipe travels under the Gowanus waterway, it was obvious that everything on paper needed to change. Although National Grid's drawings were accurate, what we found was much more complicated.

Separating or cutting the pipe segment to gain access to the pipe interior was our first challenge. The two 30-inch pipes were tightly packed within the old, brick walls. Conventional tooling wouldn't work to cut the pipe because of the limited surrounding spacing. No one wanted to disturb the bricks that were set in the 1890s.

The only way to preserve the brick tunnel was to disassemble the old cast iron vertical flanges and bring them out of the tunnel. We lifted the pipe segments out onto the ground intending to line them. Once the vertical cast iron flanges were removed, we realized it would not work to reassemble these flanges and put them back in place for lining. Under the weight of the 40 feet of 30-inch cast iron pipe, the gasket material that sealed the flanges had a strong possibility of leaking gas over time. I had seen it before. These flanges could not be lined. A different approach needed to be engineered to guarantee a leak free connection of the flanges.

THE ELEVATOR CONCEPT

We invented a solution to the potential leaking flanges with the innovation that is born from necessity. The new design consisted of an inflatable bladder or cylindrical balloon and a short segment of liner with impregnated adhesive that surrounded the bladder. The bladder with the liner was lowered into the pipe, until the bladder and liner made its way to the location of the flange. We observed the process on CCTV. The bladder was inflated and the wet adhesive liner pressed against the interior of the flange. This sealed liner would be secure for the next 100 years. The new approach, named the Elevator Concept, has become a useful tool for pipe access.

CONNECTING TO A VERTICAL PIPE

The pipe in this project was vertical; it started above ground and then sharply bent down 90 degrees. PPM had never lined a segment of pipe in a vertical downward application. How do we get a liner up into a piece of large diameter cast iron pipe when the lining process was designed to work on a piece of pipe that is horizontal in the ground? Lining equipment, pressure drums, pipe cleaning and CCTV equipment are all designed to recondition pipelines horizontally, the conventional direction of pipelines.

The cutting-edge build we designed had a bend on top of the vertical pipeline, eliminating the need to cut the pipe for access. This new "change in direction" fitting required more than just simple mounting. It had to be temporarily welded and anchored to a road steel plate. The road plate acted as thrust blocking, which stabilized the new fitting while it was bolted in place. The new fitting changed the profile from a vertical downward connection to a horizontal connection. We also had to design a way

The inflatable "bladder" designed to inflate inside the pipe segment, ensuring that the adhesive liner was flush with the pipe

The "change in direction" fitting redesigned the profile from a vertical downward connection to a horizontal connection

for it to be disconnected with ease after lining. The new fitting remained connected until the liner was cured and ready for pressure testing.

CHANGE IN DIAMETER

There was an old 36-inch drip within the 30-inch pipeline that became our next engineering challenge. When a "bastard" fitting is found, it is usually removed before the lining process can proceed. This bastard fitting could not be removed. Lining a 30-inch pipe that had a 36-inch fitting somewhere within the pipe segment was a big issue. Before the project could move forward, a solution to line the 36-inch bastard fitting needed to be engineered and tested.

Time for another innovation. Maybe the Elevator Concept that solved the problems on the vertical flanges could work. Rather than simply lowering the inflatable bladder and impregnated liner, we needed to traverse the horizontal piping. The bladder was too large for the 30-inch pipe because the bastard fitting was 36-inch in diameter. We used a new bladder that was collapsible. It traversed through the smaller diameter pipe with the liner to the position of the 36-inch fitting. The bladder was inflated and the liner cured, leaving behind the bonded liner.

The bladder engineering innovation solved the problem and made its way into our toolbox. Today, the bladder is used to reinforce bridge abutments. We pull the bladder into the corroded segment of the pipeline through the abutment wall. It had a carbon fiber sleeve wrapped around it. With the bladder inflated and the sleeve bonded inside the pipe, the segment was stronger than it ever was. The extension enabled access.

AN UNEXPECTED ENEMY — CONDENSATION

Just when we thought the pipe related issues were solved, another unanticipated challenge showed up. It was summer of 2020. In Brooklyn NY it was hot, with ambient temperatures in the 80°F range. Within the tunnel, under the Gowanus waterway, the temperature was a cool 40°F. While a relief from the summer heat, the tunnel temperature created a big problem for cleaning the interior of the pipe. The temperature change from a warm, damp 80°F degree to the cool, dry 40°F within the pipeline created a significant amount of condensation.

Tunnel underneath Gowanus dates back to the 1880s. Note the detailed brickwork on the walls.

To line properly, a pipeline needs to be dry, clean, smooth, and free of debris. When cleaning to prepare for lining, a sandblaster travels inside the pipe while the guzzler truck pulls the sand and the debris out. Fresh, warm, damp air goes into the cool dry pipe using a guzzler truck. Normally this is never an issue, because both ends of the pipe are in the same temperature environment. Here, pulling warm damp outside air into the cool dry pipe underground created a significant amount of condensation to the point where it was "raining" inside the pipe. The sand turned into mud.

After a day of racking our brains, we had an idea. What if we pull the cold air from the tunnel into the pipe and then out into the atmosphere. We introduced a system using a compressor to draw the moisture out of the pipe. Before pulling the warm, damp air into the guzzler, it was sent into a large air dryer. This avoided additional moisture causing a condensation headache. The next time outside and inside temperatures are different, we have another tool in our toolbox to combat unwanted condensation.

"Lining the Gowanus Tunnel pipeline was one of the most complex projects our department faced. ... Teamwork, PPM's engineering and expertise were invaluable to the success of this job."

Up to the final lining preparations, we had to innovate by rigging a cherry picker to hold and lift equipment in and out of the tunnel.

It only took a day to line 200 feet of the pipeline. The liner was installed down the shaft, across the tunnel and back up the vertical on the other side of the canal.

This project was unusual, and nerve-wracking. We faced each new challenge with our collective experience engineering gas infrastructure and lining applications. At every meeting with National Grid, we

made sure they understood that we were trying things for the very first time. I said, 'I'm willing to try if you're willing to try.' And they always were.

With the skills, time in the field and the willingness to try new solutions, we can overcome any lining challenge. Afterwards, we look back and say it was fun.

Bill Howe, the National Grid Project Manager said it the best.

"Lining the Gowanus Tunnel pipeline was one of the most complex projects our department faced. It started with identifying the existing conditions of the cast iron pipe, installed back in the 1920's. The lining process involved a challenging inversion through the vertical section in the access shaft, and complex custom fittings to align to the existing pipe. Teamwork, PPM's engineering and expertise were invaluable to the success of this job."

PPM PROGRESSIVE PIPELINE MANAGEMENT
THE INFRASTRUCTURE RENEWAL SPECIALISTS

Progressive Pipeline Management (PPM) is a NJ-based, full-service contractor that has been committed to improving the safety and longevity of pipeline infrastructure for more than 22 years. PPM offers the latest trenchless robotics and technologies to perform condition assessments and renew aging, damaged or leaking underground infrastructure, including pipelines of all types and sizes. The Starline® Cured-In-Place-Lining (CIPL) technology is the only approved liner for natural gas pipelines and adds 100 years of new service life to the existing pipe while eliminating methane leaks and emissions. This innovative and green solution has been installed in over 1 million feet of gas mains in 20 states.

ABOUT THE AUTHOR:

Mario Carbone, Chief Operating Officer leads PPM's key projects and spearheads the testing of new technologies and robotics. He spent thirty-two years in design, maintenance and construction with Brooklyn Union Gas/KeySpan Energy and ten years as the senior manager for gas research and development with KeySpan Energy. Mario holds three gas pipeline industry patents for new technologies in gas pipeline purging, live gas polychlorinated biphenyls (PCBs) pipeline sampling, and live service pipeline transfer without interruption. In addition to his expertise in Starline® CIPL, engineering and managing field operations, Mario is versed in current regulations for corrosion and pipeline environmental procedures. His inventiveness to overcome challenges led PPM to win the Trenchless Technology Project of the Year multiple times.

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Two of PPM's six Starline® cured-in-place-lining inversion drums for lining mains from 12 – 48 inches. "Kong" is on the left and "King Ghidorah" on the right.

EQUIPMENT ENGINEERED FOR CURED-IN-PLACE-LINING

PPM has invested heavily in developing a fleet of equipment that enables it to maximize productivity and sustainability. Starline Cured-in-Place Lining (CIPL) uses a process that inserts a liner that cures ambiently and adheres to the host pipe, adding 100 years to the life of the pipe.

40,000 cf dust collectors from Rapid Prep are ideal for cleaning large diameter pipelines. They save time and are highly efficient.

The 30-inch spin blaster is used for sandblasting. It can clean mains from 16 – 48 inches.

ARIES LETS CCTV robotic camera inspects mainlines and laterals prior to and after lining.