BRISTOL COUNTY WATER AUTHORITY 2019 PVC SLIPLINING OF THE EAST BAY PIPELINE

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The Bristol County Water Authority (BCWA) provides water to approximately 50,000 customers in the Towns of Bristol, Barrington and Warren Rhode Island. The BCWA is a wholesale customer of the Providence Water Supply Board (PWSB). As such, BCWA receives 100 per cent of its supply from the PWSB through a conduit called the East Bay Pipeline. The East Bay pipeline was constructed between 1995-1998 through a series of contracts to address water quality and supply issues within the BCWA system. The East Bay Pipeline was constructed with two portions of the pipeline installed by means of horizontal directional drilling (HDD). The project addressed herein is associated with the longer of the HDD installations, a critical 4,300-foot crossing under the Providence River. This section of the transmission main was originally installed in 1998 by HDD though bedrock using a 24-inch welded steel main to a depth of approximately 170 feet below the river. At the time, it was the longest HDD to be attempted.

Critical 4,300-foot 24-inch welded steel main crossing under the Providence River originally installed in 1998 by HDD to a depth of approximately 170 feet in bedrock

In April of 2019, an alert was triggered resulting from a differential in two BCWA venturi meters located on either side of the Providence River. The differential in flow readings indicated that the East Bay Pipeline sprung a major leak, leaking approximately 400,000 gallons per day. Initial investigation efforts

THE EAST BAY PIPELINE IS THE SOLE CONDUIT SUPPLYING POTABLE WATER TO APPROXIMATELY 50,000 PEOPLE IN THE BCWA SYSTEM.

identified the leak to be on the west side of the Providence River in the Port of Providence parking lot, approximately 1,000 feet west of the Providence River shoreline. The leak arising within the Port of Providence offered a few challenges. The first being that the pipeline was the sole conduit which supplied potable water to approximately 50,000 people in the BCWA system. This meant the pipeline could not be easy isolated to accommodate the excavation work. However, even though the pipeline was leaking it was still functioning as the transmission main to the BCWA system. Another challenge was the location. The Port of Providence is a secure site with multiple documented environmental conditions, which a response would have to be take into consideration. This response would require coordination with multiple State regulatory agencies and the ongoing operations and security of the Port themselves. Given all of these conditions, BCWA reached out to Engineering Consultant BETA Group, Inc (BETA) as a partner to coordinate this effort and ultimately facilitate the repair of this critical water transmission main.

Based on the location of the active leak, it was believed that the pipe had likely sprung a leak at a failed welded joint beneath the parking lot. Since this main is the sole source of water supply for BCWA, repair efforts were going to have to be completed while keeping the main under pressure, actively leaking. To compound the repair efforts, the leak appeared to be where the existing transmission main had been installed by directional drilling methods. This meant that the main had to be located and excavated, to find the leak, all while the main was diving deep, at a 13 per cent slope at depths in excess of 10 feet. At this location, the main was within the water table, beneath mean sea level and subject to tidal fluctuations. The location is also a Rhode Island Department of Environmental Management (RIDEM) regulated site as it is a capped former municipal landfill. Due to this, construction efforts were going to require significant efforts to handle and control groundwater, tidally influenced groundwater and the actively leaking water main. This was not insignificant as all of this water had to be treated and discharged in accordance with applicable DEM discharge effluent limitations.

Two holes were found in the 24-inch steel pipe in bedrock approximately 170 feet beneath the surface of the Providence River

CCTV inspection of the main was critical to identifying the location and nature of the leak

Shortly after identifying the leak, BCWA coordinated with BETA to develop a Scope of Services with which to engage a Contractor. Ultimately, BCWA contracted with C.B. Utility Inc., to complete the emergency repair of the water main. Excavation work commenced in late April,

90- foot "Prover Piece" revealed an unanticipated issue as shreds of the host pipe's epoxy coating were sheared off during the pull and debris sucked into the PVC pipe

Pull head needed to be watertight so a concrete plug was fused onto the first section of pulled PVC pipe

in the parking lot to identify and repair the water main. Four deep sump wells were installed to facilitate dewatering and groundwater control before the main was excavated in an attempt to locate and repair the leak. Groundwater control and treatment proved difficult as each high tide would kick up significant amounts of sediment which silted up the groundwater treatment system. The main was ultimately located at a depth of 14 feet deep. However, the main was observed to have no apparent defects and active significant flow was still entering the trench from the eastern limit of the excavation. As such, additional excavation work, progressing eastward and deeper, was completed in an attempt to locate the defect.

At this time, BCWA received word that there was a possible sink hole within a golf course on the other side of the Providence River. The sink hole was 4,300 feet away at an elevation of 60 feet higher than the Port of Providence side. Following subsequent testing of the water within the sink hole, it was determined that the water was consistent with potable water and directly related to the active leak. The leak was not in the Port of Providence parking lot, but rather somewhere beneath the Providence River at a significant depth, with potable water conveyed through the rock tunnel to both ends of the tunnel. A televised inspection of the main was critical to identifying the location and nature of the leak. This information would also be critical in evaluating possible repair options. Shortly thereafter, a 2-inch corporation stop was installed on the main in Port of Providence and the main inspected using Pure Technologies Sahara camera which allows for CCTV inspection of active water mains. The camera utilizes a parachute that pulls the camera and camera cable down the pipeline using the existing water system hydraulics to suspend the parachute and drag the apparatus through the pipeline. Inspection revealed two small holes on welds approximately 1,800 feet into the pipeline or roughly in the middle of the river crossing itself. The larger of the two holes is believed to be approximately 1-inch in diameter. At this location, the main is in bedrock approximately 170 feet beneath the surface of the Providence River. The plan was to complete an inspection of the entire crossing, approximately 5,000 feet, in an attempt to document all defects that could impact rehabilitation or repair efforts. Unfortunately, as the camera came up on the second hole, the parachute got propelled with the flow of water into the hole, lodged and ultimately damaged upon removal from the hole, thus preventing any additional inspection of the pipeline. Therefore, approximately 2,500 feet would go uninspected.

Once the break was pinpointed BCWA contracted with BETA to design the repair of the pipeline. With the leak holding a steady flow, the BCWA decided that the repair efforts would best be completed in the fall months when system demand would be lower and emergency interconnections could support the shutdown of the transmission main. The BCWA had installed a 16-inch emergency interconnection with the City of East Providence in 2016. This interconnection is not large enough to provide sufficient water supply to BCWA during peak flow during the summer months but would support work in a lower demand period. This seasonal constraint provided BETA approximately 1 month to complete

Fusing of PVC pipe segments was done at the golf course on the East Providence side of the river

the design of the repair and prepare construction documents.

BETA evaluated numerous pipeline rehabilitation options; multiple sliplining technologies and materials were evaluated based on their installation requirements, hydraulic capacity and overall costs. BETA ultimately recommended sliplining the existing water main with an 18-inch DR 18 Fusible PVC Pipe. The Fusible PVC pipe solution provided for the best possible water system hydraulics and met the significant pressure requirements due to the depth of the existing water main beneath the river. Due to the unknown condition of the remainder of the water main, the project was bid to include CCTV inspection of the entire main and the pulling of a 90-foot "prover" piece. The purpose of the "prover" piece was to evaluate the condition of the PVC pipe once pulled through the existing host pipe. This information would be used to evaluate if the pull resulted in any significant defects to the pipe, and if any adjustments would be required during the final pull. The job was designed and bid over the months of July and August in order to allow for construction to be completed in the fall. The pipe was pre-ordered by the Owner in order to avoid any lead time issues which would have prevented the pipe from being installed in the scheduled timeline.

The project was bid in August and awarded to Biszko Contracting Corp. of Fall River, MA. In September, after the peak summer months, the 16-inch diameter interconnection between BCWA and the City of East Providence was opened to provide BCWA water during the repair. The existing 24-inch steel water main was shut down and the repair commenced. Prior to completing the sliplining, the entirety of the pipeline was CCTV inspected to ensure that there were no other issues that would be prohibitive to the sliplining itself. The inspection revealed no obstructions or additional holes beyond the two previously identified and the repair moved forward.

Pipe staging and fusing of the PVC pipe segments occurred at the golf course on the East Providence side of the Providence River. The PVC was fused into 450-foot lengths, 10 sections of pipe, and air pressure tested to 5 psi to confirm that there were no issues with the fused

PVC pipe was pulled from the golf course side of the river to the Port of Providence side. Sliplining pull completed in 3 days

joints. Biszko's horizontal directional drilling (HDD) subcontractor, Hemlock Directional Boring Inc., setup their HDD rig within the Port of Providence. Once the driller had extended his steel drill rods 4,300 LF to the other side of the river, the 90-foot "Prover Piece" consisting of two 45-foot lengths of PVC pipe fused to together was pulled through the host pipe towards the Providence side of the river. The prover revealed only superficial scratches to the pipe exterior. However, the prover did reveal an unanticipated issue. Once the drill head was removed it was discovered that a significant amount of debris consisting of pulverized pieces of the existing steel pipe's epoxy liner had been ground off the pipe, kicked into suspension and sucked into the PVC pipe during the pull. A solution to this issue was required before completing the final pull, as this material would significantly complicate disinfection of the new water main should this happen during the sliplining operation.

In order to complete a pull of this length, the PVC pipe needed to be ballasted to reduce the overall pulling forces required to trip the PVC through the steel host pipe. Initially, the plan was to pull the PVC pipe with an open-faced drill head. This would have allowed for the PVC pipe to fill itself during the pull, essentially ballasting itself during the trip. Unfortunately, the epoxy observed within the prover piece after the pullback eliminated this as a possibility. Ballasting from the tail was the only alternative, but the pull head now had to be made watertight. Numerous options were quickly evaluated to determine what could provide this watertight connection while minimizing the risks of migration due to the significant pressures anticipated during the pull. There was concern with using an inflatable plug, as the anticipated pressures could deform

PVC was fused into 450-foot lengths, 10 sections of pipe in total

the plug, causing the plug to migrate away from the head, lodging itself within the pipe in an irretrievable location. Ultimately, BETA and BCWA decided to install a concrete plug behind the drill head. To install the concrete plug, a section of PVC pipe was inserted into the drill head and locked in with the drill head pins. The head was then placed vertically, and the PVC was filled with a 8-foot concrete plug, with the pins locking the concrete in. The drill head with concrete plug was then fused onto the first section of PVC pipe to be pulled.

The sliplining pull was completed over the course of 3 days. The pullback process consisted of pulling of each 450-foot length, then filling the installed length from the tail to ballast the PVC section within steel host pipe. Once the entire pipe was installed, it was successfully pressure tested to ensure continuity following the pullback and intermediate fused joints that were not subject to the initial test. Grouting of the annular space was completed on each side to stabilize the PVC and seal off the ends which was particularly important on the Port of Providence side as the location was within the tidal fluctuation zone. The PVC pipe was then transitioned to ductile iron and permanent connections to the existing steel main were completed. The main was then flushed, disinfected, sampled and returned to service. The project was completed on time and on budget.

The investigation, repair, and rehabilitation of the Providence River Crossing of the East Bay Pipeline offered some unique challenges for the BCWA, BETA and Contractors to overcome. From the environmental conditions, the length, the location and the many stakeholders, these challenges required careful planning and coordination to ensure the timeframe could be met and the project as a whole could be a success. Many hours were spent by all involved supporting this effort. The rehabilitation of this section of pipeline will serve the BCWA system for many years to provide a reliable source of supply to the BCWA system.

ABOUT THE AUTHORS:

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