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Six Miles of Fusible PVC® Pipe Used to Rehabilitate Water Line in Rural Wyoming via Trenchless Construction

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1. ABSTRACT

For several years the primary waterline serving the Town of Cowley was a 6-inch Asbestos Cement (AC) pipeline. The pipeline originated in the Town of Deaver and ran along Highway 310 for nearly 6 miles to Cowley, with most of the alignment located in farm fields. Over time, leaks had become prevalent along the line, and significant amounts of water were being lost. For Cowley, located in the high desert, this leaky pipeline was wasting too much of a very precious resource for the area, and it needed to be replaced.

With an eye toward potential cost savings, the design engineer, Pryor Mountain Engineering, thoroughly researched and with utility's support, elected to bid a trenchless option that involved nearly three miles of pipe bursting and almost two miles of horizontal directional drilling (HDD). The Wyoming Water Development Commission, the agency that funded project, was open to hearing the feedback that Pryor Mountain Engineering had regarding newer installation technology and materials. HDD was required in wetlands areas and in other locations where the existing pipe depth was less than five feet.

The low bid utilized the alternate option of trenchless installation. This paper will review in greater depth why trenchless construction was selected as an alternative bid option in a rural application not normally associated with large scale trenchless work and the conventional reasons for alternate methods success. Design and construction challenges of replacing AC pipe using trenchless methods will also be discussed, as well as successes, including a single pull of 2,120 linear feet for pipe bursting installation.

2. INTRODUCTION

The town of Cowley sits at the northern tip of Wyoming. It was named in honor of Matthias F. Cowley, one of the Apostles of the Church of Latter-Day Saints. As a small town in Big Horn County, Cowley extends to a total area of 0.84 square miles - all land, and majority farm fields. The first group of pioneers to settle in the area arrived in 1900. This group of Mormon pioneers began the construction of the Sidon Canal which would bring water to the town from the Shoshone River. The canal was completed in 1904 and it stretched to over 30 miles long. By winter of 1900 there were approximately 18 log houses built in the area.

The first school opened in January of 1901 in a log house. This school consisted of 24-30 students. The first high school in Cowley, Big Horn Academy, was opened in September of 1910, and the first class to graduate was the class of 1912, with a total of 13 students. Later named Cowley School, Big Horn Academy eventually closed in 1983 due to declining student enrollment. There were a total of 6 students in the graduating class of 1983. Today, Cowley has an estimated population of less than 1,000. Public education in the town of Cowley is provided by Big Horn County School District #1. There are currently 250 students attending Rocky Mountain Elementary School, 136 students attending Rocky Mountain Middle School, and 188 students attending Rocky Mountain High School. While the population of Cowley isn't very sizeable (See Figure 1), reliable water service is nonetheless critical in the town's daily operation.

Figure 1. As of the census of 2010, there were 655 people, 229 households, and 169 families residing in the town of Cowley, WY.

For the past 50 years, the main waterline serving the town of Cowley was a 6-inch asbestos cement (AC) line. Constructed in 1962, this line reached a total of roughly 6 miles along Highway 310. Given the age of the AC line, leaks throughout the line were intensifying, and the town's primary source of water was failing. In most recent years, from 2007 on, there were roughly 2 to 3 major breaks that took place along the line per year. In addition, the breaks that occurred showed longitudinal cracks along the pipeline, which made pipe rehabilitation much more challenging and costly (See Figure 2). Once a section of cracked pipe was exposed, repairs would result in removing and replacing a larger section of pipe than initially planned. This resulted in unexpected incurred costs to the original project. Since the AC pipeline was evidently reaching the end of its lifespan, it was apparent that the line that served this high desert area needed to be replaced.

Figure 2. Longitudinal crack along the 6 inch AC pipe.

Consequently, in September of 2011, the Town of Cowley began the early stages of design on the West End Water Project. With the Wyoming Water Development Commission (WWDC) as funding agency, Pryor Mountain Engineering was selected to complete the design of the project.

3. PROJECT DESIGN

The existing AC waterline serving the town of Cowley originated in Deaver, Wyoming, a small town nearly seven miles west of Cowley, and stretched along the Highway 310. The majority of the land that surrounded the span of this pipeline was farm fields. Timing was an important factor, as it is almost impossible for construction to take place during the harsh winter season. As a result, construction was slated to begin near the start of crop season.

The WWDC was open to utilizing newer technology to install the new watermain, especially if it would reduce the overall installed cost of the project. Pryor Mountain Engineering considered replacing the 6-inch AC pipe via standard open trench or by pipe bursting methods. They immediately determined that open trench replacement would present several obstacles. The surrounding farm fields primarily consisted of cash crops of sugar beets and malt barley grain. Because construction would take place during crop season, the contractor would be responsible for loss of crop for the area farmers if the new pipe was installed via open trench. With the soil type of the farm fields consisting mostly of heavy clay, irrigation during crop season would reduce compaction of the soil, making excavation for open trench installation much more challenging. On the other hand, if the pipe were to be installed via pipe bursting, this would minimize disruption of the crops which would alleviate any additional costs to the contractor. The volume of soil excavation would be very minor and crops remain unaffected. In addition, the loose soils would provide optimal conditions for installation via pipe bursting. Due to these determining factors, it was decided that the majority of the new waterline would be installed by the pipe bursting method.

Due to some limitations with pipe bursting, it was determined that approximately 8,000 linear feet of the pipeline needed to be horizontally directional drilled (HDD). There were a number of drainage pipe crossings along the project alignment where pipe bursting was not feasible, and many wetlands areas along the project alignment where the existing pipe depth was less than five feet. These shallow areas required HDD replacement because of the possible risk of the pipe freezing during cold weather conditions. There was even one location, crossing Sage Creek, where the pipe was exposed and supported above ground. Even with insulation to protect the pipe, water had to run all winter to keep the pipe from freezing. Utilizing HDD installation methods would allow the new watermain to be installed below the frost line, which would protect the pipe from harsh winter temperatures in the future.

During the design phase of the project, Pryor Mountain Engineering not only considered current conditions, but future water needs as well. A regional 10-inch polyvinyl chloride (PVC) waterline exists that is currently connected to Deaver but not to Cowley. The new waterline was designed so that a loop system could eventually be installed at a

later date to connect it to the existing regional waterline. Although an 8-inch line would be sufficient to serve the area, and the demand for a larger line was not a vital factor, a 10-inch line would allow easy reconnection to the regional line. This was the main reason why a 10-inch pipe was chosen for this project. Pryor Mountain Engineering estimated that the total length of water main to be replaced was approximately 32,000 linear feet (see Figure 3).

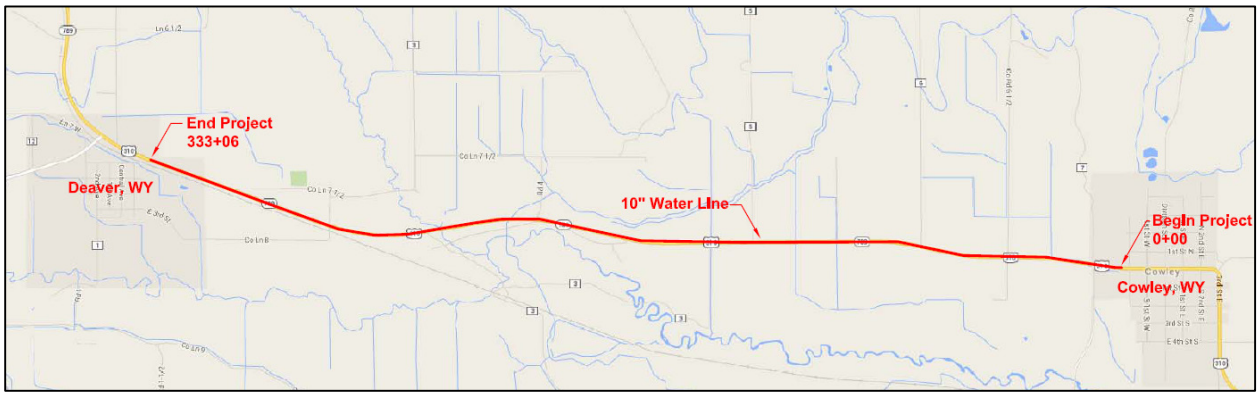

Figure 3. The proposed waterline started in Cowley, WY, and ended in Deaver, WY

Once the pipe size and length were determined, Pryor Mountain Engineering began looking into possible pipe materials for the new 10-inch waterline. The primary pipe choice was PVC, mainly because this was the product that was familiar to the town maintenance crew. The crew members were concerned that utilizing a different pipe material would require the purchase of new equipment. They were also worried that they would incur additional costs for crew training due to the new equipment requirements. In the end, Pryor Mountain Engineering specified both Fusible PVC® and HDPE pipe for the trenchless portions of this project. However, since the inside diameter had to equal that of the 10-inch regional waterline, the size of the proposed HDPE was increased to a 12-inch nominal diameter pipe (see Figure 4).

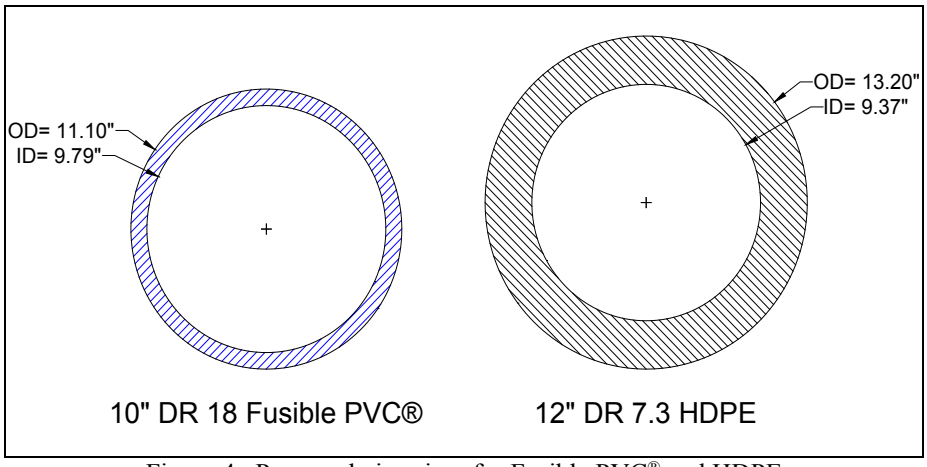

Figure 4. Proposed pipe sizes for Fusible PVC® and HDPE

Initially, High-Density Polyethylene (HDPE) pipe was the primary pipe material selection for the entire HDD portion of the project. Pryor Mountain Engineering believed that the bore angles under the crossings and wetlands were so sharp that HDPE was the only pipe material that could make the bends along the line. Contractors concluded that the bore angles could easily be extended so that the Fusible PVC® pipe could meet the minimum bend radius. Furthermore, reconnections back to the PVC pipe would be easier if Fusible PVC® pipe was used for the HDD sections. Connections from HDPE back to PVC would require more costly materials and additional labor for the crew. As a result, Fusible PVC® pipe was eventually added as an approved equal material to the HDPE.

Aside from the areas where pipe bursting and HDD were the best options, there were a few locations that presented realignment challenges as well as access/utility/depth challenges. For these areas, direct bury was the only option for the installation of the new water main.

In addition to deciding on the proposed material for the project, Pryor Mountain Engineering still had existing conditions to take into account. Because asbestos is historically known to cause health risks, the Wyoming Department of Environmental Quality (DEQ) was contacted to what the requirements were for the existing asbestos cement pipe, and what procedures needed to be followed for proper removal and disposal, if any. As long as the pipe was not exposed to the environment, the Wyoming DEQ stated that the pipe would not become friable, which made it okay that the pipe remained in the ground. Any pipe that was positively exposed needed to be disposed of properly at the landfill.

4. PROJECT BIDDING AND CONSTRUCTION

Once the design phase was completed and pipe materials were selected for the proposed water main, the West End Water Project was then advertised to prospective bidders. The bid form was fairly straightforward, presenting one bid item for the pipe bursting installation of 22,500 linear feet of potable water main, and one bid for the HDD installation of 8,200 linear feet of potable water main. There was also a bid item for the open trench installation of 2,600 linear feet of potable water main, where trenchless installation could not take place. For the pipe burst and HDD portions of the project, the pipe choices included 10-inch DR 18 Fusible PVC® pipe or 12-inch DR 7.3 HDPE pipe. The project bid in October of 2011 and was awarded to the lowest responsive bidder, Mountain View Building of Sheridan, Wyoming, who was responsible for the entirety of the pipe installation. Mountain View Building elected for Fusible PVC® pipe to be used for total footage of water main. Given the significant quantity of pipe to be fused, Mountain View Building elected to get its crews trained for PVC fusion by Underground Solutions, Inc.

Construction began in March of 2012, just after the winter season and at the start of crop season. Even though the winter season had come to an end, ambient temperatures were still low, which would nonetheless affect the cooling of pipe joints. In order to solve this issue, contractors positioned sheds along the project area to protect the pipe fusion process from the unsettling weather conditions (see Figure 5). Because the project area consisted of open farm fields, there was no concern of involving disturbance to passing cars or nearby business. The proposed waterline ran parallel to Highway 310, with a horizontal distance of approximately ¼ of a mile. So when it came to laying out the pipe before installation, and staging all other equipment, contractors mainly took into account the landowners and county roads closest to the project area, selecting vicinities that were the least intrusive. Fortunately, the nearby county roads that the proposed pipe crossed under were not disturbed because contractors were able to find pipe bursting pits around the roads, minimizing any type of excavation they would have had to do through the roads.

Figure 5. Fusion protection from Wyoming elements

The proposed water main alignment was one continuous pipeline. With no particular construction sequence required, Mountain View Building began pipe installation based on crew and equipment capacity. They started with pipe bursting segments, and were able to utilize a second crew to install the HDD segments at the same time. Once directional boring was completed, contractors were able to finish the open trench portion of the project while the pipe bursting was being finalized.

The length of pipe that was installed via pipe bursting methods totaled roughly 16,000 linear feet. For the most part, fusion, layout, and installation were all accomplished successfully with no major setbacks. The soil conditions that once posed a concern for the contractors actually turned out to be an advantage for the crew. Because of the bentonite clay present in the area during crop season, this created a more lubricated enclosure for the pipe during pipe bursting pull-in. With most of the soil conditions remaining consistent throughout the project, the pipe burst installation for the most part was unproblematic. The last section of pipe that was burst turned out to be the most time consuming. Contractors noticed an increase in the pressure of the pipe bursting machine, which meant that the soil conditions in that area were not the same as that of the rest of the project. Because the soil was more compacted in this area, the pipe bursting installation took a little longer than expected. Another minor obstacle the crew faced during installation was that one of the fusion machines kept pausing, causing more delay in the project. Since the issues that took place during construction were so minor and minimal, time management was not a huge factor for contractors, as they stayed persistently ahead of schedule. One major breakthrough that Mountain View Building experienced during pull-in was a new record length for pipe bursting, with a measurement of 2,120 linear feet. With the actual pull-in lasting 3 to 4 hours, the total length of time, including set up and reconnection, took a total of 12 hours to complete, from start to finish. Figure 6 below illustrates the pipe burst rods being inserted into the existing pipe, and Figure 7 shows the 10-inch pull head on the Fusible PVC® pipe next to the 6-inch asbestos cement pipe.

Figure 6. Insertion of pipe burst rods

Figure 7. Pull head on 10-in Fusible PVC® pipe next to 6-inch Asbestos Cement pipe

While pipe bursting was taking place, another crew was appointed to complete the HDD segments of the project. Some of the HDD pipe sections were modified from the original design plans so that Fusible PVC® would be allowed to reach the minimum allowable radius. Figure 8 below shows the layout of the new pipe just before the HDD installation. Drill and reconnection of the pipe was completed with no drawbacks.

Once the crew finished the HDD portion, the open trench sections of the project went underway as the pipe bursting installation continued. Because the open trench sections did not take very long, contractors decided to install more pipe via open trench using the equipment and manpower they had readily available, as the pipe burst installation was coming to an end.

During construction, the water service along the project still had to be taken into account. For the pipe sections on the east and west side of the project that were not being installed, the contractor was able to backfeed the waterline from Deaver, on the west side of the project, using the existing regional water system. As each section of pipe was completed, pressure tested, and disinfected, the section was then turned on from Cowley, the east side of the project. For the new pipe that was being installed, contractors had the ability to run a temporary line.

Because the majority of the project area consisted of farm fields, the biggest obstacle that contractors faced was having to deal with the existing soil, which during the crop season can be irregular and possibly unstable. Since they had decided that most of the pipeline be installed via trenchless applications, disruption of the crops was not a concern for them.

Figure 8. Pipe strung out in beet fields

Minimal AC pipe was exposed and contractors disposed of the pipe at the landfill per the Wyoming DEQ's disposal protocol. Once all of the pipe was installed, pressure testing was performed on the entire new waterline. The pipe passed pressure testing of 150 psi in July of 2012, and went online shortly thereafter. With a new water service in place and in full working order, the town of Cowley was able to continue on with its daily operations.

5. CONCLUSION

Despite the project duration occurring during the farmers' most vital time of the year, the water main was installed and was working successfully by August 2012 with no major setbacks. Contractors finished way ahead of schedule, as the project wasn't expected to be completed until October. The crop season provided a nice advantage for Mountain View Building, since the irrigation of the crops created less compacted soil, which made the pipe bursting and HDD installations effortless. Using Fusible PVC® pipe for the new water main not only allowed for uncomplicated installation, but it also allowed easy connection to pipelines in the future, which the town of Cowley is looking forward to.

In addition to great design work by Pryor Mountain Engineering, its communication with the Wyoming Water Development Commission with reference to installation options and cost effectiveness for the project, the new waterline was installed using minimal costs and minimal disruptions to the environment and its daily operations. Communication with the Wyoming Department of Environmental Quality also assisted with contractors staying prepared even before construction began.

Mountain View Building arranged a team of contractors who were all trained to fuse PVC pipe. The experienced gained through training as well as the arrangement of crews chosen for each installation, the pipe was installed utilizing all manpower and equipment as they were readily available. Both HDD and pipe bursting installation took place, and when HDD was completed, the crew immediately began the open trench portions of the project. This tenacity of the crew resulted in early completion, which consequently lead to significant cost savings to the Wyoming Water Development Commission.

6. REFERENCES

The Official Website of Cowley Wyoming. Retrieved from http://cowleywyoming.com/

Pryor Mountain Engineering (2012) – Contract Documents and Specifications for West End Water Project #PME-010806, Town of Cowley, WY.