ABSTRACT: The Consolidated Mutual Water Company (Consolidated), Lakewood, Colo., was established in 1926. Since that time, the number of water taps has increased from 136 to over 20,000. Currently the not-for-profit cooperative water utility serves a population of approximately 90,000 in a 26 square mile service area that includes Lakewood, Wheat Ridge and eastern Jefferson Counties. The utility maintains a network of pipeline totaling over 400 miles.

Now faced with aging infrastructure, Consolidated has undertaken a rehab and replacement program in order to continue to provide its customer with reliable, high-quality water. Rising costs associated with traditional open cut replacement methods have pushed the utility to look at trenchless pipe bursting for its infrastructure improvement program.

Since 2010, Consolidated has developed an impressive pipe bursting program, bursting, replacing and upsizing almost 100,000 lf feet of 4-, 6-, and 8-inch cast iron water main with Fusible PVC™ product pipe (FPVCP). The pipe bursting program is a model of efficiency and is able to achieve high levels of production.

1. INTRODUCTION

The Consolidated Mutual Water Company (Consolidated) distributes approximately 4 billion gallons of water annually to 90,000 residents. After building a state-of-the-art membrane treatment plant, Consolidated decided to improve the quality of distributed water further by modernizing their existing water main rehabilitation methods.

Consolidated's distribution system dates back as far as 1926 when the original company was formed from four smaller, well-based systems. Through decades of additions, expansions, and reorganizations, Consolidated has remained committed to providing the highest quality water to its customers through a reliable distribution system. Since the mid-50's, Consolidated has budgeted money annually for water main replacement and upgrades of other aging infrastructure. Consolidated has historically used the open-cut installation process in its water main replacement program. As the cost of open-cut installation continued to rise, including paved street restoration, Consolidated began evaluating alternative methods for water main replacement.

After evaluating and testing a variety of equipment, piping products, and installation methods, Consolidated decided to proceed with a static pipe bursting program beginning in April 2010, in a service area with antiquated and undersized lines.
2. STATIC PIPE BURSTING

While pneumatic pipe bursting has become a widely accepted and utilized trenchless pipe replacement method, bursting ductile iron and steel pipes has always been a limitation of the pneumatic method. The development of hydraulically operated static bursting systems with bladed rollers has provided an alternative to pneumatic pipe bursting that has become valuable in a wide range of pipe replacement situations. These static bursting systems are able to burst/split and replace ductile iron and steel pipes.

In the static process exit and launch pits are used in the same way they are for pneumatic bursting. First, the hydraulic bursting unit is positioned in the exit pit. Then the bursting rods are pushed through the host pipe and into the launch pit. Patented Quicklock bursting rods are linked not screwed together like traditional drill stems or other static systems. This system speeds the installation process as well as the breakdown procedure. The rods can be quickly removed one at a time at the exit pit as bursting is in operation. A flexible guide rod helps the bursting rods navigate through host pipe as shown in Figure 1.

![Figure 1. Typical static pipe bursting set up.](image)

The flexible guide rod allows the bursting rods to navigate the typical imperfections found on the inside of the host pipe such as sags, humps, dropped joints, debris and other obstacles. At the launch pit, the flexible guide rod is removed. The bladed rollers, bursting head, expander and new pipe are then attached as shown in Figures 2 and 3. The specially designed bladed rollers actually split the host pipe instead of ripping or tearing it.
Figure 2. Bursting configuration attached and pullback begins.

Figure 3. Host pipe is split and displaced, while new FPVCP is pulled into place.

The entire configuration is pulled back through the host pipe by the hydraulic bursting unit. The bladed rollers split the existing pipe, while the bursting head and expander displace the fragmented host pipe into the surrounding soil. The new pipe is pulled into place simultaneously.

Other pipe materials may be installed in certain situations. Potential pipe materials include: restrained joint ductile iron pipe, restrained joint PVC pipe, among others. Consolidated is trained and certified to fuse FPVCP and has been utilizing that particular product pipe for its program for the last three years.
3. HIGH PRODUCTION BURSTING

In order to achieve the results that Consolidated wanted from its bursting program, a system was developed that all projects can follow. This allowed crews to maximize efficiencies when performing specific tasks throughout the bursting process. Since its inception in 2010, over 100,000 ft of cast iron water main has been replaced with FPVCP through static pipe bursting in Consolidated’s system. The amount of footage is considerable and is a direct result of the company’s systematic, task-oriented approach to pipe bursting. Consolidated’s construction crews consist of the same 12 people. They have developed a rolling ~7-day pipe bursting schedule.

Day 1
After locates are done a temporary service line is installed that can be easily assembled and disassembled as it is moved from one block to the next. Consolidated crews are moving the temporary lines, keeping one to two blocks ahead of the street that is being burst that week. When a street block ready for bursting, crews locate and dig up the service connections and move them over to the temporary line.

Day 2
Crews dig pull pit and pipe entrance pits, then set the 800G Grundoburst machine in and push rods out and attach to the new replacement FPVCP and pull it back. Most of the bursting runs are ~500 to 700 feet long.

Day 3
On day three, crews again push rods out from the center pit in the opposite direction and again pull pipe back.

Day 4
Next, valves, and hydrants are installed and crews flush and pressure test the line and do the bacteria test. Consolidated performs bacteria testing in house. This provides a definite timesaving, as the sample is hand carried to the plant and tested, eliminating downtime. When the test results come back, crews can proceed with moving the service connections back over to the new main.

Day 5-6
On days 5 and 6, crews complete all connections, backfill holes and prepare the street for the asphalt contractor to come in and patch the excavations. This is the only part of the process that is subcontracted out.

Day 7
While all of the above is being done, two crewmembers are constantly fusing pipe for future runs. Temporary lines are being moved ahead as sections of bursting are completed. Crews move the temporary lines one to two blocks ahead so that they are ready when bursting operations begin on the next section of street.

For a typical bursting project, crews onsite will begin by fusing a predetermined length of FPVCP. Consolidated selected FPVCP as the replacement pipe based on its corrosion resistance, ease of connection, and its ability to upsize old cast iron distribution lines while minimizing soil displacement due to its smaller pipe outer diameter compared to other replacement pipe options. See Figure 4 for a typical pipe fusion set up for FPVCP.
Figure 4. Crews staging and fusing the Fusible PVC product pipe.

At the same time the FPVCP is being fused for a bursting run, temporary water service is installed at the location of the installation. The existing services are disconnected and residents are provided water through the temporary service (See Figure 5).
Figure 5. Temporary water services established for area residents along the project street.

Pit construction begins after temporary water service is established and the existing water main is prepped for bursting (See Figure 6).
Bursting operations are now ready to get underway. The FPVCP string is moved into position (See Figure 7).
A bursting head with blades specifically designed for bursting cast iron pipe is then attached to the FPVCP. Also attached in this configuration is the first segment of bursting rod (see Figure 8). Crews at this point have placed the hydraulically powered bursting unit in the exit pit and rodded the host pipe with the bursting rods.
The bursting head configuration is lowered into the launch pit and connected to the bursting rods. At this point the actual bursting process can begin as the entire configuration is pulled into and through the host pipe (see Figure 9). At the exit pit bursting rods are removed from the string, one by one, as they are pulled back.
After the pullback is complete, crews begin commission and testing of the newly installed FPVCP waterline. As this being done, the beginning steps of the next bursting section are already underway, ensuring a quick transition from one project section to the next.

In addition to the structured bursting schedule, Consolidated takes the time to improve efficiency by color coding the temporary service taps and having them precut and on the trailer. Identifying and precutting significantly speeds up the installation of temporary water services. Consolidated also uses a combination expander and FPVCP pull head design. This one-piece option allows for a quick attachment of the pipe to the machine and again when the individual bursts are done, it is quick to disconnect from the pipe in the receiving pit.
Production was so successful during year one, Consolidated decided to increase production and purchased a second bursting unit. Now, while bursting is underway with the first unit, the second is being set up for the next run. The same 12 people have nearly doubled production by adding another pipe bursting unit.

4. CONCLUSION

The Consolidated Mutual Water Company has developed a significant and extremely efficient pipe bursting program to replace its deteriorating and undersized cast iron water main system. The use of static pipe bursting in conjunction with FPVCP has proven highly effective. The first and biggest factor in the success of Consolidated’s pipe bursting program is that there is complete and total support from the top down for the entire process. This is essential in any successful program but even more so with a private utility or public utility self-performing the work in-house. The systematic approach that Consolidated has taken with its bursting program can serve as a model for other utilities.

5. REFERENCES

Botteicher, Richard (Bo). (2011) – Consolidated Mutual Water Employs Large Scale Pipe Bursting Program To Rehabilitate Potable Water Piping, North American Society for Trenchless Technology (NASTT), No-Dig Show 2011