ABSTRACT: East Bay Municipal Utility District (District) recently completed a $4 million Trenchless Technology Pilot Program. This paper addresses issues with which many water utilities struggle: limited resources and increasing costs of their infrastructure renewal programs. As part of this pilot, the District completed seven pipeline replacements using horizontal directional drilling (HDD), and eight using pipe bursting, totaling over three miles.

Pilot projects replaced mains using high-density polyethylene (HDPE) and fusible polyvinyl chloride (FPVC) pipes, including 1.7 miles using HDD and 1.3 miles using pipe bursting. The District completed Pipe bursting projects in two phases, with the first phase consisting of replacing 6- and 8-inch Cast Iron (CI) mains with equivalent size pipes, and the second phase consisting of upsizing CI pipes from 4- to 6 inches and from 6- to 8-inches.

Through the successful completion of these pilot projects, it was demonstrated that HDD and pipe bursting can often be less costly and result in fewer community impacts than open trench installations. This paper covers “lessons learned” during the pilot, including limitations of these technologies, and how the District plans to use HDD on a wider scale as part of its ongoing pipeline renewal program. While trenchless technologies cannot replace open trench, they can be a viable alternative for the routine replacement of water mains in paved streets.

1. INTRODUCTION

The East Bay Municipal Utility District (District) supplies water to approximately 1.4 million people in a 325-square mile area that extends from Crockett to the north, Hayward to the south, Walnut Creek to the east, and southeast through San Ramon. The water distribution system includes 122 pressure zones, composed of over 4,100 miles of distribution pipelines, 150 pumping plants, and 176 storage reservoirs.

In recent years, the cost of the District’s pipeline replacement projects has increased significantly. This rise in cost is primarily due to increases in material costs and more restrictive permit conditions, such as increases in paving restoration and traffic control requirements that are often required by permitting agencies to minimize community disruptions. Higher replacement costs have resulted in a reduction in the District’s rate of replacements and have put a strain on the District’s Capital Improvement Program budget. Results of District studies and predictive models indicate that to continue to maintain a stable leak rate, the District will eventually need to increase its pipeline replacement rate from approximately 8 miles per year (current rate) to approximately 20 miles or more per year. Given the challenges of managing its aging infrastructure in an era of limited public works funding, the District in 2007 started a Trenchless Technology Pilot Program to evaluate more economical pipe installation methods. The purpose of this program was to investigate other installation options to help reduce unit costs and improve efficiency of installation, with the ultimate goal of increasing the District’s pipeline replacement rate.

The District’s current practice is to install most of its new pipelines using primarily welded steel or polyvinyl chloride (PVC) pipe materials, using conventional open trench methods. This report explains how the pilot program was developed and compares the advantages, disadvantages, and costs of HDD and pipe bursting versus...
conventional open trench methods for the routine replacement of 6 and 8-inch water mains. This paper also discusses the District’s new guidelines and methods used to decide which pipelines are good candidates for replacement using trenchless technologies.

2. EBMUD PIPELINE INVENTORY, LEAK RATES, AND REPLACEMENT NEEDS

About 80 percent of the District’s distribution system consists of 6, 8, or 12-inch diameter pipelines, located mostly in paved streets and with cover depths typically ranging from approximately 36 to 42 inches. The remaining 20 percent consists primarily of pipes with diameters ranging from 16- to 48-inch. As shown on Figure 1, these pipes are comprised of four primary material types: steel, PVC, cast iron (CI), and asbestos-cement (AC). Some of the pipe in the system is over 90 years old with an average age of approximately 53 years. The average ages for the four primary pipe materials are 76 years for CI, 39 years for steel, 46 years for AC, and 19 years for PVC.

The AC and CI pipelines make up the highest percentages of pipe material in the system at 28% and 35% respectively and represent some of the oldest pipe. CI, AC and PVC dominate the smaller size pipe with 86 percent of the mileage of pipe having diameters less than or equal to 8 inches. Steel dominates the larger size pipe by constituting 82 percent of the mileage of pipe having diameters greater than 8 inches.

Figure 1. EBMUD Pipe Inventory
The District currently installs primarily steel and PVC material for both its new and replacement pipelines. PVC pipe installations started in the 1980s, and replaced AC pipe as an alternate to steel pipe.

CI pipes, virtually all of which the District installed prior to 1960, are currently responsible for 74 percent of the District’s average leaks. Older parts of the District’s distribution system, which have higher concentrations of CI pipe and, therefore higher leak rates, are shown in red on Figure 2.

A majority of the remaining leaks, approximately 17 percent, occur in AC pipe. Pipes having diameters less than 12 inches constitute 92 percent of the leaks.

The District’s pipeline replacement program primarily focuses on the replacement of 6- and 8-inch CI pipes. Results of a recent study, however, indicate that the District’s AC pipes may need replacing at a significantly higher rate to prevent a future increase in AC leak rate.

![Figure 2. Normalized Distribution of Yearly Leak Rate for EBMUD’s Service Area](image)

### 3. RE-EVALUATING STANDARDS AND REPLACEMENT TECHNOLOGIES

The District based its historical use of open trench construction methods in part on:

- the limited choice of standard pipe materials, namely welded steel and jointed PVC pipe, and
- the perception that trenchless technologies were not well suited for the replacement of relatively shallow water mains in paved streets.

Historically, the primary use of trenchless installations is for the replacement of sewer lines, which do not have the same outage constraints and are typically deeper than water mains, where potential for ground heave associated with the use of HDD or pipe bursting is less of a risk.

Traditionally, the District limited its use of HDD and pipe bursting for specialized applications such as replacement of mains located in steep or narrow right-of-ways, or mains crossing highways, railroads, or rivers, where open-trench installations are not feasible. However, in recent years, the development of new pressure pipe materials such as fusible PVC (FPVC), and the availability of additional high-density polyethylene (HDPE) fittings and mechanical repair methods have made the use of trenchless technologies for the installation of water mains more practical. These fusible materials, in combination with more stringent permit conditions such as increased traffic control and more extensive pavement restoration, have made the use of trenchless technologies more attractive not just for specialized applications, but also for the routine replacement of water mains in paved streets.
As part of an overall effort to reduce the unit costs of its main replacement program, the District developed a Trenchless Technology Pilot Program, which required new design guidelines, details, and specifications on the use of trenchless technologies. The District modified design standards to incorporate the use of FPVC and HDPE pipe materials, in addition to steel and jointed PVC, developed new standard drawings, details, and specifications to allow the use of these materials for trenchless installations, and increased its standard cover depth from approximately 3 to 4 feet for HDD installations, to reduce the risk for ground heave and frac-outs.

The District also performed an evaluation to estimate the number of locations where the use of trenchless installations would be feasible for the routine replacement of water mains on a wider scale. A Geographical Information System (GIS) analysis was performed to identify where favorable soil types (clayey soil) and slopes (< 5 percent) are located within the District’s service area. The results of this GIS analysis indicate that of all the District water mains that qualify for replacement under its program, approximately 40 percent fall within areas where trenchless installations may be a viable alternative (see highlighted areas on Figure 3). This result indicates that it may be feasible to design approximately 3 miles of replacement projects per year for installations using trenchless technologies, out of the current replacement rate of 8 miles per year. A step-by-step guideline was developed to streamline the HDD selection process during the design phase of a project, as discussed in more detail below.

4. PILOT PROGRAM

As discussed above, the District initiated the Trenchless Technology Pilot Program to investigate cost-effective alternatives to upgrading its pipeline distribution system. The primary goal of the pilot program was to evaluate the use and suitability of trenchless technologies as an alternative to open trench, in an effort to reduce construction costs. Other goals were to evaluate the use of trenchless construction as a way to reduce environmental impacts (e.g., paving, carbon footprint), community affects (e.g., dust, noise, traffic), and to assess the use of fusible pipe materials required for trenchless installations, such as FPVC and HDPE. The pilot program focused on the replacement of 6- and 8-inch mains in paved streets, which represents the bulk (~75 percent) of the distribution system and pipeline replacement candidates.

Program Description, Findings, and Recommendations

Table 1 lists the 15 projects included in the pilot program and the reasons behind their selection. Figure 3 shows the approximate locations of the pilot projects. The District completed these projects in the following two phases:

- **Phase 1, HDD**: District crews completed the first phase in May 2009, which included seven projects. District crews, with the exception of actual HDD operation and pipe pull, performed all of the work.

- **Phase 2, Pipe Bursting**: Due to concerns over ground heave, the District used contractors to implement this second phase, completed in September 2011 and included eight projects.

The District used both FPVC and HDPE pipe materials for the pilot. The District evaluated the use of HDD for the first phase of the pilot program because it allows the existing water main to remain in service while installing the replacement main, similar to the District’s typical open trench installations. The District evaluated pipe bursting as the second phase of its pilot, due to concerns over ground heave and because it requires installation of a temporary aboveground main, to maintain uninterrupted water service to customers.
Figure 3. Favorable Trenchless Installation Areas
Table 1. Summary of Trenchless Pilot Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>Reasons Behind Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase 1 – HDD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Diablo Drive, Oakland</td>
<td>300’ 6” HDPE</td>
<td>Minimize paving repairs, one service, bedrock</td>
</tr>
<tr>
<td>2 Marina Boulevard., San Leandro</td>
<td>1,275’ 8” HDPE</td>
<td>Stringent pavement replacement conditions by City (full lane paving), relatively few services</td>
</tr>
<tr>
<td>3 O’Connor Drive, Lafayette</td>
<td>1,030’ 8” HDPE</td>
<td>Minimize paving repairs, relatively few services</td>
</tr>
<tr>
<td>4 19th Street, San Pablo</td>
<td>1,380 8” HDPE</td>
<td>Limited services because school on one side of street</td>
</tr>
<tr>
<td>5 Thornton Street, San Leandro</td>
<td>490’ 8” HDPE</td>
<td>Straight alignment, stringent pavement conditions</td>
</tr>
<tr>
<td>6 Grayon Road, Pleasant Hill</td>
<td>226’ 8” HDPE</td>
<td>Crossing of busy, 4-lane intersection (Taylor Blvd)</td>
</tr>
<tr>
<td>7 Hampton Road, Hayward</td>
<td>4,300’ 8” FPVC</td>
<td>Straight alignment, 6’ cover due to roadway cuts and sewer laterals</td>
</tr>
<tr>
<td><strong>Phase 2 – Pipe Bursting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Las Aromas, Orinda</td>
<td>510’ 10” HDPE</td>
<td>Narrow 10’ R/W, steep side yard fences &amp; paths, no services</td>
</tr>
<tr>
<td>2 Calvert Court, Oakland</td>
<td>920’ 8” HDPE</td>
<td>Steep R/W w/difficult access, two services, heavily vegetated canyon</td>
</tr>
<tr>
<td>3 Pershing Drive, San Leandro</td>
<td>565’ 6” FPVC</td>
<td>No services, stringent paving conditions (full lane for open cut)</td>
</tr>
<tr>
<td>4 Hidden Valley Road, Lafayette</td>
<td>670’ 8” HDPE</td>
<td>Limited number of services, high PCI index (4-ft T-cuts required)</td>
</tr>
<tr>
<td>5 Curtis Street, Berkeley</td>
<td>1,235’ 6” FPVC</td>
<td>Limited services due to school on one side of street</td>
</tr>
<tr>
<td>6 Burkhart Avenue, San Leandro</td>
<td>535’ 8” FPVC</td>
<td>Stringent pavement conditions, upsize of 6” CI pipe</td>
</tr>
<tr>
<td>7 Gaynor Avenue, Richmond</td>
<td>1,240’ 6” FPVC</td>
<td>Linear alignment, replacement of 4” CI pipe (upsize)</td>
</tr>
<tr>
<td>8 Grayson Road, Pleasant Hill</td>
<td>985’ 8” HDPE</td>
<td>Major arterial with high traffic upsize of 6” CI pipe</td>
</tr>
</tbody>
</table>

**Phase 1 – HDD**

As summarized in Table 1, the District completed seven HDD pilot projects in phase 1. Figure 4 is an example of one of the HDD pilot projects. Typically, the HDD projects were drilled intersection to intersection, strategically locating pits at interconnection points.

Upon completion of the first four projects, the District compared HDD projects with similar open trench “partner” projects. The District completed a triple bottom line analysis to consider the financial, environmental, and social/community factors of HDD versus open cut. Results of this analysis indicated that HDD
projects, on average, have a unit cost that is approximately 20 percent lower than their open-trench “partner” projects under certain site conditions. The District based this cost analysis on the pilot projects which is a relatively small sampling of projects, and costs may vary significantly depending on actual site conditions. The environmental and social factors (i.e., community impacts) were less for HDD than for open trench construction.

In addition to the triple bottom line analysis, the District compared the productivity of HDD projects to similar open trench projects. The results of this analysis indicate that HDD projects have similar production rates as open trench projects. However, when factoring in paving durations, HDD is more productive (requires less time) than open trench installations.

Given the estimated average cost savings of 20 percent associated with HDD projects, the District originally anticipated that production rates for HDD projects would be significantly higher than open trench. However, the District attributes this apparent discrepancy to the fact that, even with similar production rates and therefore similar labor costs, the overall construction cost for HDD projects is lower because of significantly lower excavation and pavement restoration quantities associated with trenchless projects. Excavation, backfill, and paving costs (and therefore materials and trucking costs) account for a significant portion of the total construction cost of open trench projects, and HDD projects require only a fraction of the excavation/backfill/pavement quantities.

In summary, the District estimates that production rates and cost savings associated with the use of HDD will improve further over time, making HDD both faster and less costly than open trench under certain site conditions.

Other advantages of HDD include minimal spoils, ground disturbance, site maintenance and clean up, surface distribution, and reduced construction time and impacts. Challenges or disadvantages associated with HDD include utility location being more critical, drilling fluid disposal, specialized crews and equipment required, and pipe material limitations. However, the District could overcome these challenges, particularly in light of the cost benefits. Based on the results of the pilot projects, other challenges include potential for ground heaving/frac-outs under certain soil/roadway conditions, and the increased cover depth that is required to avoid existing utilities and reduce potential for heave and frac-outs (i.e. about 4 feet instead of 3 for open trench), which may result in higher future maintenance costs.

Despite these challenges and disadvantages, the District’s pilot demonstrated that HDD offers many benefits and can be economically advantageous. Based on the initial results of the pilot, HDD proved to be a feasible alternative to open trench for the routine replacement of water mains even in paved streets. As discussed above, optimal conditions for HDD include sites with clayey soil, gentle grades (<5% slope), streets with relatively few existing utilities, and relatively straight horizontal and vertical alignments.

Phase 2 – Pipe Bursting

The District implemented its pipe bursting pilot projects in two separate phases, Phase 2A and 2B, because of the higher risk of ground heave associated with the upsizing projects in Phase 2B. Phase 2A included three size-on-size replacements of 6- and 8-inch cast iron mains. Phase 2B consisted of upsizing one 4-inch cast iron main to a 6-inch main, and two 6-inch cast iron mains to 8-inch diameter mains (Figure 5).

The District selected the first two pipe bursting projects listed in Table 1 because of limited site access (i.e., hand excavation), where the use of conventional open trench methods would result in prohibitive costs. These two projects represent site conditions ideally suited for pipe bursting (i.e. no other feasible options, right-of-ways that eliminate concerns about ground heave, and few to no services). The three size-on-size replacements under Phase 2A of the Pilot Program did not result in ground heave and proved to be viable applications of pipe bursting in paved streets. Two of the three upsize replacements under Phase 2B of the Pilot Program resulted in some minor pavement cracking, in limited sections where the existing mains had cover depths ranging between 29 to 35-inches.

Since pipe bursting requires using the alignment of the existing pipeline, some preliminary work is required prior to bursting the pipe. A major step is the set-up and transfer of services to a temporary, aboveground line (Figure 6) so customers continue to receive the same level of service during the construction of the project. The temporary line set-up is time intensive, requiring a long lead-time to install, transfer services, and bring the temporary main into
service after water quality testing. The temporary by-pass line is typically set up in the gutter, which results in some impacts to street parking and customer’s driveway access for the duration of the project.

For the pipe-bursting pilot, the District selected water main segments between valves to limit customer outages and easily isolate the burst section. However, since the water mains being burst were cast iron with leaded joints, the projects required the construction of reverse anchors (Figure 7) to resist in-line thrust on the existing valves prior to removing a section of the main to be burst. The construction of the anchors represents additional work required prior to the bursting process, also adding to the cost and project duration. In situations where valve spacing would result in too significant of an outage, installation of new valves were required, which also added to the cost/duration of the set-up process.

Despite these challenges/limitations, a cost analysis indicates that pipe bursting is cost competitive with open trench, under certain site conditions, for the replacement of water mains in paved streets, and resulted in a significant cost savings in right-of-ways with difficult access conditions.

The pilot results concluded that ideal pipe bursting projects include those in steep right-of-ways with limited access, and size-on-size pipe replacements projects located in paved streets with no services (i.e., cast iron mains where potential for ground heave due to shallow cover is low and where there is no need for a temporary line).

Comparison of HDD with Pipe Bursting and Recommendations for Implementation

To compare both of these trenchless technologies, the District conducted several workshops with internal stakeholders to develop options for the long-term implementation of trenchless technologies. Based on these workshops and results of the pilot projects discussed above, the District decided to focus on the use of HDD as its main alternative installation method for the replacement of mains in paved streets. The District will still consider pipe bursting on a case-by-case basis, particularly for the replacement of mains in inaccessible right of ways, and for size-on-size replacements of 6- or 8-inch cast iron mains with few or no services. The District based its decision to focus on this technology on the following comparison between HDD and pipe bursting:

- HDD installation is more similar to open trench, in that it includes a new parallel pipeline.
- HDD and pipe bursting installations have similar excavation areas.
- Pipe bursting typically requires a more extensive set-up process, including an above-grade temporary bypass line that adds to the project construction duration and community impacts.
- Regulations restrict the pipe bursting of AC pipe.
- While all of the HDD pilot projects were successful, some of the Phase 2B pipe-bursting pilot projects had mixed results, with some pavement cracking observed on the upsizing pilot projects where the cover depth was 36-inches or less. Since most of the District’s main replacements require upsizing, and many of the District’s existing cast iron mains only have 36 inches of cover or slightly less, District staff does not recommend the use of pipe bursting as a routine replacement method.
As part of a formal full-scale program, the District developed and is currently implementing design guidelines to assist in determining which projects are best suited for the use of HDD. The following summarizes these step-by-step HDD pipeline design guidelines:

1. Complete site survey and prepare base drawings, showing all existing utilities.
2. Determine if project falls within a location conducive to HDD (areas highlighted in yellow on Figure 3).
3. Conduct a site visit to assess if site conditions meet criteria outlined below, and to identify any other unusual site conditions. Select sites with:
   - Relatively few existing utilities (i.e. residential neighborhoods, not urban areas)
   - Relatively straight alignments (both horizontally and vertically)
   - Streets in which a relatively constant cover depth of 4 feet can be maintained for majority of the alignment (i.e. vertical alignments with relatively few offset returns)
   - Horizontal alignments that can maintain approximately 5 feet of separation from adjacent parallel utilities (10 feet from sewers and high priority utilities, such as large diameter gas lines)
   - Streets with no or relatively few high priority utility crossings; or site that can accommodate open trench installations for limited sections where high priority utility crossings are required (i.e. design critical crossing locations as entrance/exit pits)
4. Avoid using HDD when the following site conditions are encountered:
   - Sites with parallel high priority utility within 10 feet of proposed pipeline alignment (see above)
   - Sites where a minimum cover of 4-feet cannot be maintained (see above)
   - Site with contaminated soils (i.e. soils that preclude the use of HDPE pipe)
   - Curvy streets and urban areas with high utility congestion
5. Select projects that are 1,000 feet or greater in length, or select sites where projects can be clustered in a particular geographical area, to eliminate multiple mobilizations/demobilizations
6. Use engineering judgment when making final decision on which installation method should be used
7. Prior to starting detailed design, meet with construction staff to review selected HDD candidates to confirm that HDD is the preferred method of installation for a particular site

5. CONCLUSIONS

The District’s pilot program included a total of 8 HDD and 7 pipe bursting pilot projects completed in various site conditions within the District’s service area. Results indicate that while both of these trenchless methods can work well for the replacement of mains in paved streets, where site conditions include relatively few existing utilities, clayey soil, and straight alignments, the use of HDD provides more benefits and is more adaptable to different site conditions (i.e., upsizing, bedrock, etc.), and is therefore being implemented as the primary trenchless method at the District. The District will consider pipe bursting projects on a case-by-case basis, when certain specific site conditions exist such as no services and right-of-ways with restricted access.

As shown on Figure 3 a majority of sites suitable for HDD installations are located in the western portion of the District’s service area, in cities such as San Leandro, Berkeley, San Pablo, and Richmond. This is because these areas have a higher concentration of cast iron pipes, which result in a majority of the District’s leaks and are therefore the focus of the replacement program, and where site conditions are favorable to HDD (i.e. clayey soils and relatively level terrain, allowing for straight pipe alignments).

The District’s pilot projects indicate that HDD and pipe bursting, under certain site conditions, result in significantly lower unit costs and fewer overall impacts when compared to open trench. HDD and pipe bursting are viable alternatives to open trench, even for the installation of water mains in paved streets, and utility owners should consider them as part of their “tool box” of options for water main renewals. Discussions of other factors associated with the District’s use of HDD are below.

Financial Factors

The average unit cost of HDD projects is approximately 20 percent lower than the cost of open trench projects. The increased use of HDD should therefore result in a reduction in the unit cost of the District’s pipe replacement program. Actual cost savings will depend on how many HDD installations the District can complete and actual site conditions. Assuming District crews install approximately two miles of HDD projects in a year, and assuming an
average cost saving of 20 percent, the overall cost saving to the District’s pipeline replacement program should be approximately $400,000. As District crews become more familiar and efficient with the use of HDD, the percent of savings should increase.

Initially, The District will offset some of the estimated cost savings by training District crews on the fusing of HDPE pipe. The use of HDD may also result in higher future maintenance costs, due to an increase in the cover depth required for HDD projects. Installations of HDD projects will have a cover depth of approximately 48 inches, to reduce the potential for frac-outs, which is approximately 6 to 12-inches deeper than the normal cover depth used for open trench installations. The increased cover depth may require additional shoring when performing future maintenance activities, and may result in additional utility conflicts. Also, when the District uses HDPE for future HDD installations, the repair time required for this type of pipe is typically longer and the repair parts are more costly than for other standard District pipe materials such as PVC and steel. The District will have to stock HDPE pipe materials for the maintenance and repair of such installations.

**HDD Challenges/Limitations and Next Steps**

The results of the pilot projects confirmed that HDD is a viable pipeline installation method under certain site conditions, including those in suitable slope and soil conditions and paved streets with relatively few existing utilities and services. HDD is also a viable method at sites with difficult excavation conditions (e.g., bedrock). While these site conditions are present in a number of locations, actual site specific conditions may, in some cases, turn out to be less than optimal and reduce the benefits of HDD such that it may be preferable for District crews to use open-trench methods instead. District crews will make the final determination on which method of installation to use, even on projects designed for HDD installations.

Another challenge associated with HDD is the containment and disposal of drilling fluids. For some of the HDD pilot projects, District crews assisted in the handling of the drilling mud, including collection and disposal. For some of the pilot projects, the method of disposal included spreading and drying out the drilling fluids at a District-owned trench spoils disposal site, and mixing the dried out mud with trench spoils. This disposal method may preclude the use of HDD during the rainy season unless drilling fluids are disposed of at a commercial landfill, at an additional cost to the project. The District will re-assess the use of HDD in one or two years, after completion of a number of additional projects.

Results of the District’s GIS analyses, shown on Figure 3, indicate that it may be feasible to design approximately 3 miles of HDD projects per year, out of the current replacement rate of 8 miles per year. However, to allow District crews time to train and transition to using more HDD, the decision was made to initially design 1 to 2 miles of replacement mains in Fiscal Year 2013 for installation using the HDD methods. Once the full-scale program is up and running, in one or two years, the District will adjust the number of HDD designs depending on the actual number of HDD projects completed by District crews. Next steps required to implement HDD projects are listed below.

- Select HDD candidates, using new guidelines, and complete designs of 1-2 miles of HDD projects.
- Determine the most efficient crew complement required for different phases of HDD installations.
- Determine the feasibility of developing a dedicated trenchless crew, or if HDD projects should be spread around all of the pipeline crews.
- Determine if District forces will strictly perform HDD in the summer months, giving any disposed drilling slurry the opportunity to dry out at District trench spoil sites, or if the District will perform HDD projects year-round and the slurry collected and disposed of by a subcontractor.
- Develop best management practices (BMPs) for HDD projects. This may include the adjustment of crew sizes to complement the subcontractor based on site-specific HDD projects, and developing the most efficient methods for working with an HDD subcontractor (i.e., optimize workflow by staggering construction activities over multiple blocks, to utilize inherent “down times” for other activities).
- Complete the installation of about 1-2 miles of mains using HDD within the next 12 months.

The main goal for these projects will be to assess the long-term applicability of HDD installations as a part of the District’s overall Infrastructure Renewal Program. Based on the success of these additional projects, the District will determine the number of projects that should be designed and constructed using HDD on a routine basis.