Industrial Revolution

Every home that is built is a representation of compromises made between different and often competing goals: comfort, convenience, durability, energy consumption, maintenance, construction costs, appearance, strength, community acceptance, and resale value. Consumers and developers tend to make tradeoffs among these goals with incomplete information which increases risks and slows the process of innovation in the housing industry. The slowing of innovation, in turn, negatively affects productivity, quality, performance, and value. This department piece features a few promising improvements to the U.S. housing stock, illustrating how advancements in housing technologies can play a vital role in transforming the industry in important ways. If you have an idea for a future department feature, please send your diagram or photograph, along with a few well-chosen words, to michael.j.early@hud.gov.

Trenchless Technology: A New Way to Install and Renew Utilities

Mike Blanford
U.S. Department of Housing and Urban Development

The views expressed in this article are those of the author and do not represent the official positions or policies of the Office of Policy Development and Research, the U.S. Department of Housing and Urban Development, or the U.S. Government.

Abstract

Installing effective utilities infrastructure is an essential practice that enables, sustains, and enhances the living conditions in communities. Utilities that support housing include water supply, sewers/stormwater management, electrical grids, fuel for heating and cooking, and telecommunications. Housing would not be as useful without the necessary utilities to support it. The trenchless industry offers new technologies that help mitigate the cost, enhance safety, limit effects, and speed the installation of utilities. In this article, we discuss how this invention supports the goal of promoting resiliency without sacrificing affordability.

Introduction

Innovative housing needs utilities. Identifying cost-effective strategies for installing those utilities increases affordability and value for homebuyers, as a greater portion of the construction cost can be focused on the home. Rather than attempting to "go cheap" on infrastructure, an approach that will likely prove to be a false economy, approaches that minimize the overall construction and restoration costs merit consideration. The trenchless method offers an alternative, new way to install utilities. As the name implies, a traditional trench may no longer be needed to install underground utilities. The trenchless method offers a number of advantages, possibly including reduced overall cost, improved safety, and increased speed of installation.

Trenchless methods can be applied to a wide range of utility types. Wet utilities, such as water, sanitary sewer, and storm sewer are common, as well as other underground utilities, including natural gas, electric, and telecommunications. Trenchless approaches also can be used to restore aging infrastructure, thus enhancing the vitality of the surrounding community. Trenchless methods may enable communities to reduce the effects of moving electrical utilities underground, reducing or preventing power outages in areas with trees.

The North American Society for Trenchless Technology (NASTT) defines trenchless technology as "a family of construction techniques for installing or rehabilitating underground infrastructure with minimal disruption to surface traffic, businesses, and residents. Also includes technologies for inspection, leak location, and leak detection with minimal disruption and minimal excavation from the ground surface" (NASTT, n.d.).

The most popular trenchless technologies for housing infrastructure are Horizontal Directional Drilling, Microtunneling, Horizontal Auger Boring, Pipe Ramming, and Lining. The following exhibit provides a description of these technologies.

Exhibit 1

Popular Trenchless Technologies for Housing Infrastructure

Trenchless Method	Description
Horizontal Directional Drilling	A steerable system for the installation of pipes, conduits, and cables in a shallow arc using drilling equipment from the surface. This method is typically used for large scale crossings of features, such as rivers, sensitive areas, roadways, and other critical infrastructure.
Microtunneling	A trenchless construction method for installing pipelines using a small unmanned tunnel boring machine. The piping is used to push the microtunneling boring machine to the end of the pipe run.
Horizontal Auger Boring	A method of forming a bore from a launch pit to a reception pit, by means of a rotating cutting head. While some excavation is necessary, it can be sited to avoid disruptions or excessive costs. This method may have limited steering capability but might be more economical for short and straight drives compared to other methods.
Pipe Ramming	A percussion hammer is used to force a strong (steel) pipe through the ground, essentially using the force of the hammer to drive the pipe.
Lining	A liner is installed in an existing water or sewer pipe to reduce leakage and improve flow.

Exhibit 2

Microtunneling Boring Machine

Photo courtesy the National Utility Contractors Association

Exhibit 3

Horizontal Directional Drilling Machine

Photo courtesy the National Utility Contractors Association

Exhibit 4

Liner in a Cast Iron Pipe

Photo courtesy the National Utility Contractors Association

Cost Mitigation

New infrastructure projects can often affect other community activities or installed infrastructure. Significant costs may be incurred in an effort to mitigate those impacts. Consider the traffic patterns in your community when a new building project near a major intersection needs to install a trench for a new sewer line. The costs of working at night (a typical approach to reduce traffic impacts), traffic control, worker protection (while trenching), and the necessary roadway repairs must ultimately be borne by the owner or developer. Costs such as roadway repair do not contribute directly to the actual construction project. For an owner or developer on a fixed budget, those secondary costs may necessitate cost reductions on some more tangible portion of the project.

Additionally, roadway repairs are rarely as durable as the original construction. Repairs can, hence, lead to accelerated deterioration of the roadway, which increases costs for the community. While the costs of using trenchless methods may be initially higher than other approaches, when the full cost of the project is considered, the potential for avoiding many of the trenching and related secondary costs may tilt the decision to use trenchless technology.

Exhibit 5

The Two-stage Process in the Horizontal Directional Drilling Under a River

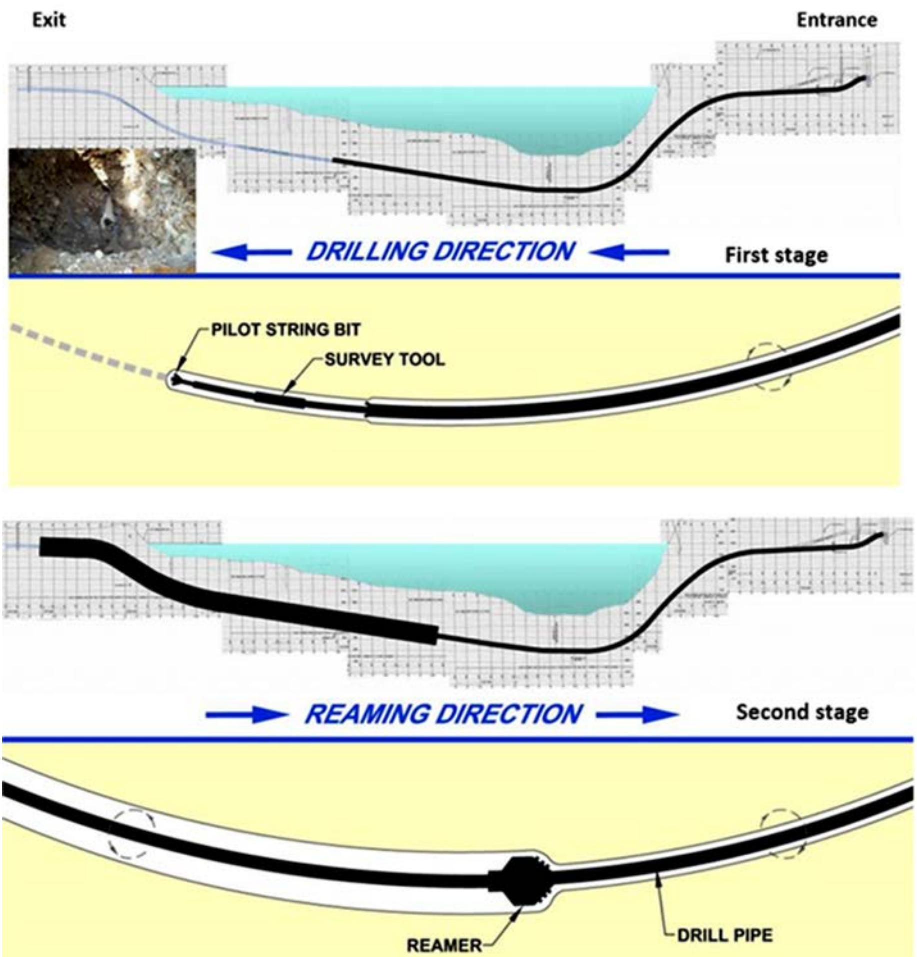

Image courtesy Brian Dorwart

Enhanced Safety

Trenching presents significant safety risks to the workers and the public. The Occupational Safety and Health Administration (OSHA) notes that "cave-ins pose the greatest risk and are much more likely than other excavation related accidents to result in worker fatalities. Other potential hazards include falls, falling loads, hazardous atmospheres, and incidents involving mobile equipment. Trench collapses cause dozens of fatalities and hundreds of injuries each year" (OSHA, n.d.). While any construction project has risks, avoiding those that are known is always a good strategy. Removing the need for a trench greatly reduces the safety hazards to the utility crew and the public.

Community Impacts

As we stated earlier, construction in a community is naturally disruptive. The disruption can complicate the process of infill development despite the many benefits of building in existing neighborhoods. The incorporation of trenchless technologies reduces the negative impacts to the neighborhood, however, while providing modern infrastructure for the new home.

In areas that are environmentally, culturally, or otherwise significant, trenchless technologies may permit construction with fewer effects to these important areas. Imagine a scenario where a homeowner desires to renovate or replace a home on a lot with mature landscaping. Trenching for the utilities might damage that landscaping, which could affect the entire neighborhood. Replacing mature landscaping after that damage is typically quite expensive.

Installation Speed

There are a number of factors that contribute to the pace of utility installation when using trenchless technologies. First, and foremost, is the type of trenchless technology being employed. The utility application also merits consideration, such as the pipe size and bore length, the site soil conditions, and the directional drilling tolerances. The speed of installation for trenchless technologies versus trenched is most notable when the project requires minimal effects to existing construction. In this case, trenchless technologies are the preferred method.

Conclusion

Trenchless technologies should be considered for utility installation because these technologies can provide cost savings, enhanced safety, reduced community impacts, and speedy installation. This is especially true for infill development, where upgrading utilities may cause significant damage to the landscaping, sidewalks, or roadways. Trenchless technologies can help to avoid the damage, minimizing the costs of installation as well as maintaining positive relationships between the developer and the neighboring community.

Acknowledgments

The author would like to thank Dana Bres (HUD) and Anne Luzier (NUCA) for reviewing this article and their thoughtful comments.

Author

Mike Blanford is a Research Engineer at the U.S. Department of Housing and Urban Development.

Additional Resources

North American Society for Trenchless Technology (NASTT)
NASTT is an engineering society. NASTT's mission is to advance trenchless technology by technical information dissemination, research and development, education, and training.
http://www.nastt.org/

Trenchless Technology Center (TTC)
The TTC is a Center of Excellence for trenchless technology at Louisiana Tech University. TTC conducts research and development, education, and technology transfer.
https://www.latech.edu/research-enterprise/centers-of-excellence/trenchless-technology-center/

National Utility Contractors Association (NUCA)
NUCA is a trade association for utility construction and excavation industry in the United States. NUCA's membership uses both trenchless and trenched utility installation technologies.
https://www.nuca.com/

References

North American Society for Trenchless Technology (NASTT). n.d. "Glossary of Trenchless Terms." https://www.nastt.org/resources/glossary/.

Occupational Safety and Health Administration (OSHA). n.d. "OSHA FactSheet Trenching and Excavation Safety." https://www.osha.gov/Publications/trench_excavation_fs.html.