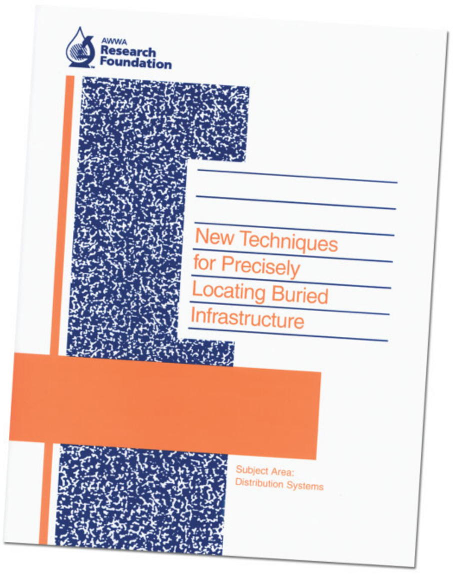

Study Recommends Methods for Locating PVC Pipes

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Focus on our nation's aging infrastructure in recent years has brought the issue of accurately locating buried structures to the forefront. As all utility engineers and contractors know only too well, hitting and rupturing an in-service buried line with a backhoe during construction can result in inordinate expenditures of manpower and resources, and inconvenience to customers. To address this issue and to prevent such mishaps from occurring, the American Water Works Association Research Foundation (AwwaRF) funded a study that culminated in their report, "New Techniques for Precisely Locating Buried Infrastructure." The report evaluates advances in technology and the accuracy of various devices in locating pipelines made of different materials, both metallic and non-metallic. Additionally, other goals of the report were to provide recommendations for specifications and guidance for improving existing technologies, and also to recommend the most appropriate technologies to utility companies with respect to accuracy, data quality, time, cost, and ease of use.

STANDARD PRACTICE FOR LOCATING PVC

PVC pipe's performance in the last three decades has satisfied its users immensely, raising its market share significantly higher than all other competing materials. Over the years, however, manufacturers of competing products have attempted to undermine the use PVC pipe by making the accusation that since it is not a metallic product, it cannot be easily located. Such allegations have always been without foundation, and the findings of this AwwaRF study further discredits any such assertion by identifying technologies that are 100% successful in locating buried PVC pipe. Historically, utilities have installed PVC pipe with an inexpensive metallic tracer wire, which is buried 1.5 to 2 feet below the ground surface and directly above the pipe. With the tracer in place, a metal detector can locate the buried wire and the PVC pipe directly below it. To use electronic scopes, a conductor can be buried with the pipe, which is then typically connected to a hydrant or a valve box. Metallic wire can be used as a tracer or a conductor; the American Gas Association (AGA) reports in their "Plastic Pipe Manual for Gas Service" that most companies have greater success with conductive systems (transmitter is physically connected to the tracer wire) than inductive ones (transmitter induces a signal onto the tracer wire).

STATE-OF-THE-ART TECHNOLOGIES EVALUATED

The human appetite for advancing technology has given rise to many other techniques for locating buried piping systems. The study initially surveyed all available technologies, listed below, and performed testing with the most promising three technologies: GPR, EM, and S&A.

1. Ground Penetrating Radar (GPR): This method involves the transmission of an electromagnetic pulse (like a seismograph) into the subsurface and producing a graphical image from the reflected wave. The imaging shows buried structures and other changes in the soil.

2. Electromagnetic (EM) Technologies: Involves sending "passive" and "active" signals and using a receiver to locate buried structures. It is also possible to calculate the relative depth to the target using this methodology.

3. Sonic and Acoustics (S&A) Technology: S&A equipment creates pressure waves or acoustic waves within pressurized pipes, which then travel within the pipes and radiate outward. A receiving device on the surface detects these waves and allows the user to locate the pipe.

4. Magnetometry (MAG) Technology: This technology makes use of spatial changes in the earth's natural magnetic field to locate ferrous metal objects. Simple handheld gradiometers are used for instrumentation.

5. Infrared (IR) Thermography: This type of locating is typically done for leaks, voids caused by erosion, poor backfills, etc. It measures temperature differences in shallow surface materials to provide thermal imaging. The method works best for pipelines carrying fluids (gases, water, sewer) at the same temperature as the ground.

TESTING

AwwaRF contracted with Roy F. Weston, to perform the project. Weston teamed up with four water utilities (St. Louis County Water Company, MO; Philadelphia Suburban Water Company, PA; City of Coatesville Authority, PA; and East Bay Municipal Utility District, CA), two utility location and designation contractors (California Utility Surveys, CA; Utility Survey Corporation, NY), several technology developers/vendors (Radiodetection Corporation, NJ; Metrotech Corporation, CA; Geophysical Survey Systems, NH; Vermeer Manufacturing, IA; EMRAD, UK) and a university faculty member, Dr. Jay N. Meegoda of the New Jersey Institute of Technology, who served as an independent consultant.

Equipment was field-tested with the three following variable conditions at 80% of the sites:

- Asset Variables (e.g. Whether the material being detected is metallic or non-metallic)
- Soil Conditions (e.g. Whether the soil was electrically conductive, depending on the soil moisture content)
- Cultural interference (e.g. Whether there was interference from railroad tracks or high voltage electric lines)

Based on these variable conditions, as well as workshop discussions and field evaluations, the study recommended the applicability of each technology, summarized in Table 1. Applicable technologies are indicated by an 'X'.

CONCLUSION

The following conclusions were made about the effectiveness of the three technologies tested on PVC pipe:

- The performance of the S&A methods was 100% successful for PVC. (14 out of 14 trials were successful.)
- S&A technology was more accurate in locating PVC pipe than AC pipe.
- The S&A technologies tested were incapable of determining the depth of the pipes.
- GPR was only moderately effective in detecting PVC pipe (80%).
- GPR is very accurate in determining vertical depth.
- EM method is unsuitable for locating non-metallic pipes such as PVC.
- The two types of instruments used in the S&A method were the Radiodetection RD500 and TransOnde, and Vision Technology VT-2000 and TransOnde. A TransOnde is the trade name of the pressure valve that produces the acoustic signal by being hooked up to a fire hydrant, water meter box, or sprinkler head; this signal is then detected by the receiving unit.
- Absorptive soils, such as peat or loose loamy soils, attenuate the signals in the S&A system. Soil compaction and density play an important role in the ability of the system to transmit a signal and how it is attenuated.

The AwwaRF report clearly shows that PVC water pipe can be located with confidence, even if no tracer wire is installed with the pipe or even if there are no "as-built" plans available. Locating the buried PVC pipe fourteen out of fourteen times, under a wide range of conditions, demonstrates the precision of today's technology for locating buried plastic infrastructure. *Author's note: The S&A equipment can be purchased at a price of roughly $2,500.*

TABLE 1: TECHNOLOGY SELECTION SUMMARY*

Common Conditions				GPR	EM Locator		S&A	
	Asset. Material	General Soil Conditions			Active	Passive	High Pressure TransOnde	Medium/Low Pressure TransOnde
		Soil Moisture	Soil Conductivity					
Non-Metallic	PVC	Dry	Low	X			X	X
Non-Metallic	PVC	Wet	High	X			X	X
Non-Metallic	PVC, PE	Dry	Low	X			X	X
Non-Metallic	PVC, PE	Wet	High	X			X	X
Non-Metallic	AC	Dry	Low	X			X	X
Non-Metallic	AC	Wet	High	X			X	X
Non-Metallic	DI, CI, ST	Dry	Low	X	X	X		
Non-Metallic	DI, CI, ST	Wet	High		X	X		
Non-Metallic	DI, CI, ST	Dry	Low	X	X	X		
Non-Metallic	DI, CI, ST	Wet	High		X	X		
Non-Metallic	CI, CU, PB	Dry	Low	X	X	X		
Non-Metallic	CI, CU, PB	Wet	High		X	X	X	X

AC: Asbestos-Cement, CI: Cast Iron, CU: Copper, DI: Ductile Iron, PB: Lead, PE: Polyethylene, PVC: Polyvinyl Chloride, ST:Steel

X indicates recommended applicability of technology based on conditions

* Table modified from Figure 6.1, "New Techniques for Precisely Locating Buried Infrastructure", AwwaRF, 2001, p. 127