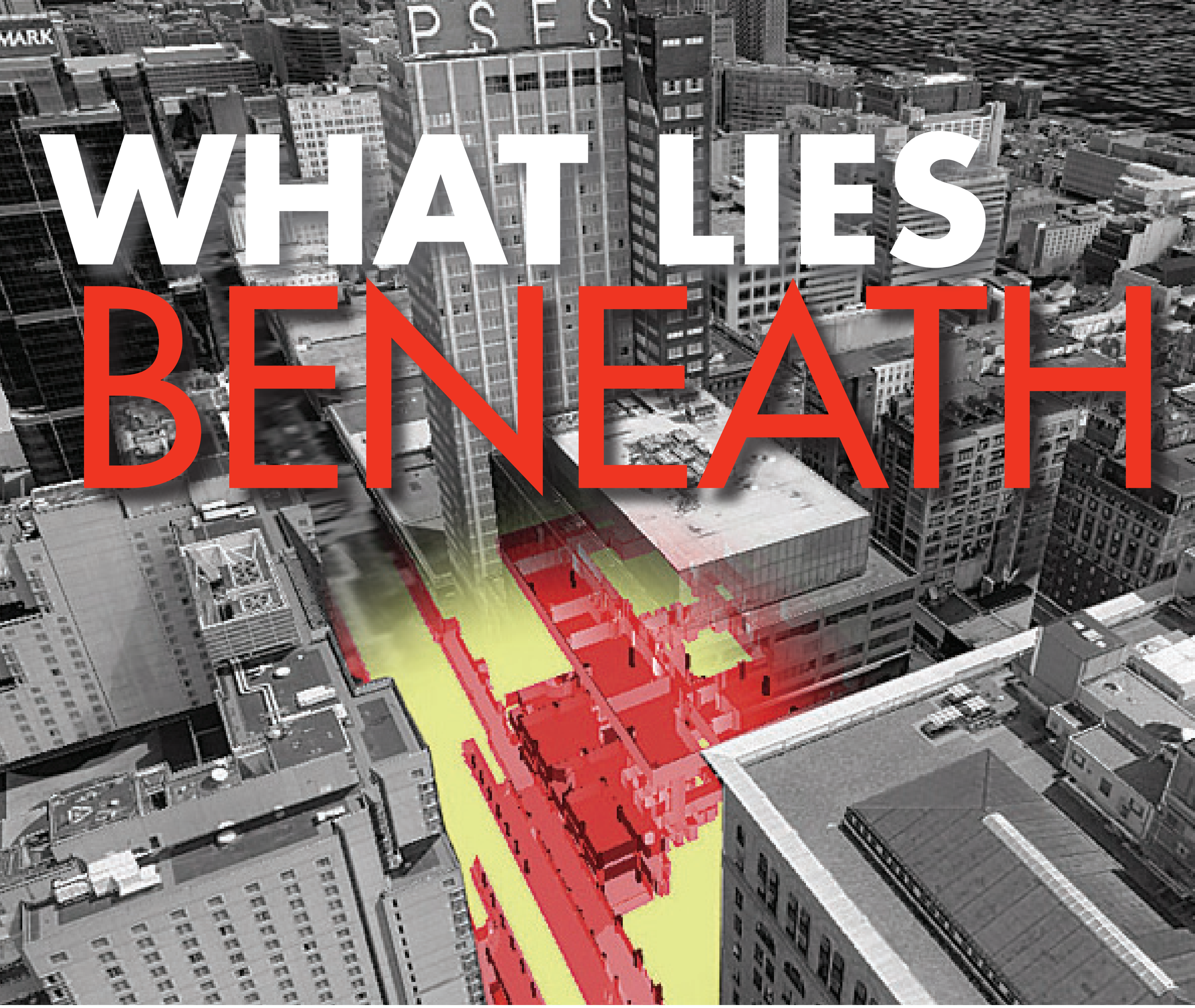
WHAT LIES BENEATH



Locating and managing the infrastructure that resides underground

BY MARK SMITH

Recently, on a horizontal directional drilling project in Southern California, it was determined that a pipeline was incorrectly installed and had to be removed. However, when the contractor vertically drilled to pump grout into the void, an 18-inch diameter sewer main was mistakenly struck. It was quickly determined that the existing as-built drawing and spatial information for the drilling location and the damaged pipeline were incorrect.

Unfortunately, this scenario is far too prevalent. The fact is, there is no certainty when it comes to identifying the precise location, depth and condition of underground utilities. As proof of this statement, in the United States alone, on average one underground utility is impacted every day. The total annual cost to the national economy is estimated to be in the billions of dollars. With these astonishing facts in mind, how can we mitigate t=his looming liability? As with many of today's challenges, technology offers the solution.

Magnitude of the Network

Frequently, above ground infrastructure is rebuilt or changed over time, while the status and location of the existing underground infrastructure is forgotten or unknown. Therefore, there is a need for accurate underground mapping.

Knowing the exact locations of where existing underground infrastructure are—and where they are not—is a game-changer. It not only enables companies and developers to better manage their assets, it provides invaluable information that helps mitigate a company's risk from liability. Until recently, the technology did not exist to accurately locate and map all types of underground pipelines, conduits and cables in 3D, which includes length, width and depth measurements (x, y and z coordinates). However, a number of advances in sensing and gyroscopic technology have now made it possible to precisely map both the location and the depth of most underground and underwater assets in 3D.

According to Google, one integrated energy company in the Eastern United States owns 39,000 miles of easements containing underground transmission lines and 143,000 miles of easements containing overhead lines. While this information didn't provide the amount of publicly or privately-owned right of way in the U.S., it highlighted that the opportunities and problems associated with managing this critical network are massive.

Considering the Limitations

A widely-held yet mistaken belief in the underground pipeline management industry is that economical and accurate pipeline mapping is not possible today. In actuality, there are a significant number of technologies available. Unfortunately, there is no one technology for every type of underground mapping need, and each one has certain limitations.

The most commonly used tool for identifying the location of underground pipelines are handheld electromagnetic wands. These require the operator to slowly move the wand back and forth across the suspected metallic pipeline in the hopes of locating the "null," or high spot, indicating the top of the pipe. The operator then marks the spot with spray paint or a plastic flag. While this mode provides adequate positional information, it is not the most accurate way to determine depth. And because it is a slow and tedious process, it is considered a relatively expensive methodology. In addition, conventional electromagnetic technologies cannot be used for non-metallic pipelines.

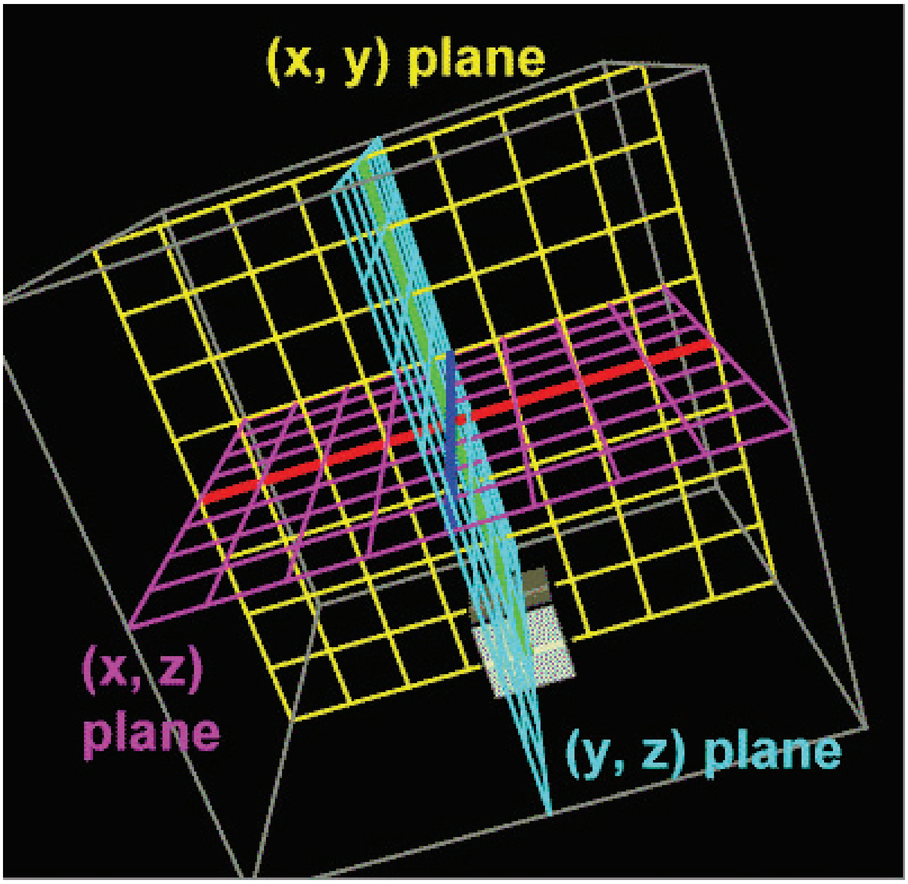
Another technology often utilized in mapping underground pipelines is Ground Penetrating Radar (GPR). While GPR has many benefits in locating both metallic and non-metallic pipelines, obtaining the precise depth is difficult at best. GPR results are also severely limited by soil conditions and the size of the pipeline to be mapped.

Addressing the Earth's Curvature

The majority of mapping data available today still uses 2D imaging. These 2D images are problematic because they are essentially a flattening of the earth that doesn't take into account its curvature. The result is a distorted and inaccurate determination of the exact location of a pipeline or utility. Yet, despite its limitations in establishing only the length and width of the infrastructure location, it is still widely used.

To accurately account for the curvature of the earth, Geospatial Corporation uses a methodology known as "ground-truthing," which works to eliminate any distortions and ensure accuracy within four inches of the location. In addition, we utilize technologies and vectors to establish the depth of the infrastructure as well, resulting in truly 3-Dimensional coordinates of the location. An array of other technologies, are also available including immersion technologies, new electromagnetic sensors that can be attached to an all-terrain vehicle or fixed-wing aircraft, a combined set of sensors using infrared, LiDAR, microwave technologies and vacuum excavation. The right combination enables the mapping of any type of pipeline or conduit, metallic or non-metallic, for any underground infrastructure within a reasonable budget.

In the not-so-distant future, electromagnetic sensors attached to drones will be able to map significant types of underground infrastructure. The Federal Aviation Administration has given limited permission for commercial drones to be used for this purpose on a case-by-case



New technology works to accurately locate and map all types of underground pipelines, conduits and cables in 3D, including length, width and depth.

basis. However, regulations are needed before drones or unmanned aerial systems can be universally used for commercial applications.

A Strategic Focus on Deliverables

Before the mapping specialists can identify which technology or set of technologies will achieve the desired results, we conduct a comprehensive evaluation. In creating an effective asset mapping and management plan, we use a four-fold methodology that starts with clearly defining the client's specific goals. Understanding the level of detail required and the accuracy of the deliverables will help us determine the most applicable technologies to use. We collect as much data as possible from the client, as this will be used to pinpoint an approximate location, ascertain the materials used to construct the lines and improve the overall organization and productivity of the locating team. Even though much of the original documentation is what was designed—and not necessarily what was actually constructed—this data still serves an important purpose.

The second step involves assessing and understanding the conditions and parameters of the project. We work to envision every conceivable scenario. For example, does the project necessitate that we map at night due to heavy traffic or a difficult location? Does the line span a river or lake, therefore requiring immersion technologies? Which municipalities, local, state or federal governments may be involved, if any? We also evaluate the existing soil conditions, as well as the potential effects that certain factors can have on various technologies. For instance, the presence of clay, iron oxide and dissolved metallic ions may interfere with certain tools, making the use of other technologies necessary and preferred. If the soil is problematic, then GPR cannot be used and a different technology must be utilized instead. Or, if the line is actually non-metallic conduit for an electric company, then we may implement a proprietary mapping device.

Once all of the available information is assembled and evaluated, the third step is making the final determination as to precisely which technologies will be the best fit for the project. More importantly, it is at this stage when we can specify exactly how, where and when each technology is to be used to precisely locate, map and collect data regarding the underground infrastructure.

Then, managing the data is the final step. Once the infrastructure data is collected, it needs to be digitally stored and securely maintained. For this purpose, a GIS infrastructure mapping software application was designed around the Google Maps API and Google Maps Engine, providing reliable content, security and mobility. Using the GeoUnderground™ application, data can be imported and exported to and from AutoCAD® drawings, ESRI® shape files, geo-referenced video and photos, enabling users to securely view, edit and share 3D coordinates of buried pipelines. The mobile, cloud-based application allows users to access the data from a laptop, phone or tablet.

Oil and Gas Applications

When mapping oil and gas underground infrastructure, the project may require locating all crossing lines, valve fittings and other prominent features. This may be a requirement in order to address all current regulations and developments, including natural gas shale plays, green energy initiatives and technical advancements.

In one particular case, a project required us to map ten miles of natural gas pipelines during winter weather conditions. Despite the extreme weather, we were able to map the underground portion of the pipelines in ten days using an electromagnetic tool with embedded GPS on an all-terrain vehicle. All the collected data was transferred to our in-house GeoUnderground application.

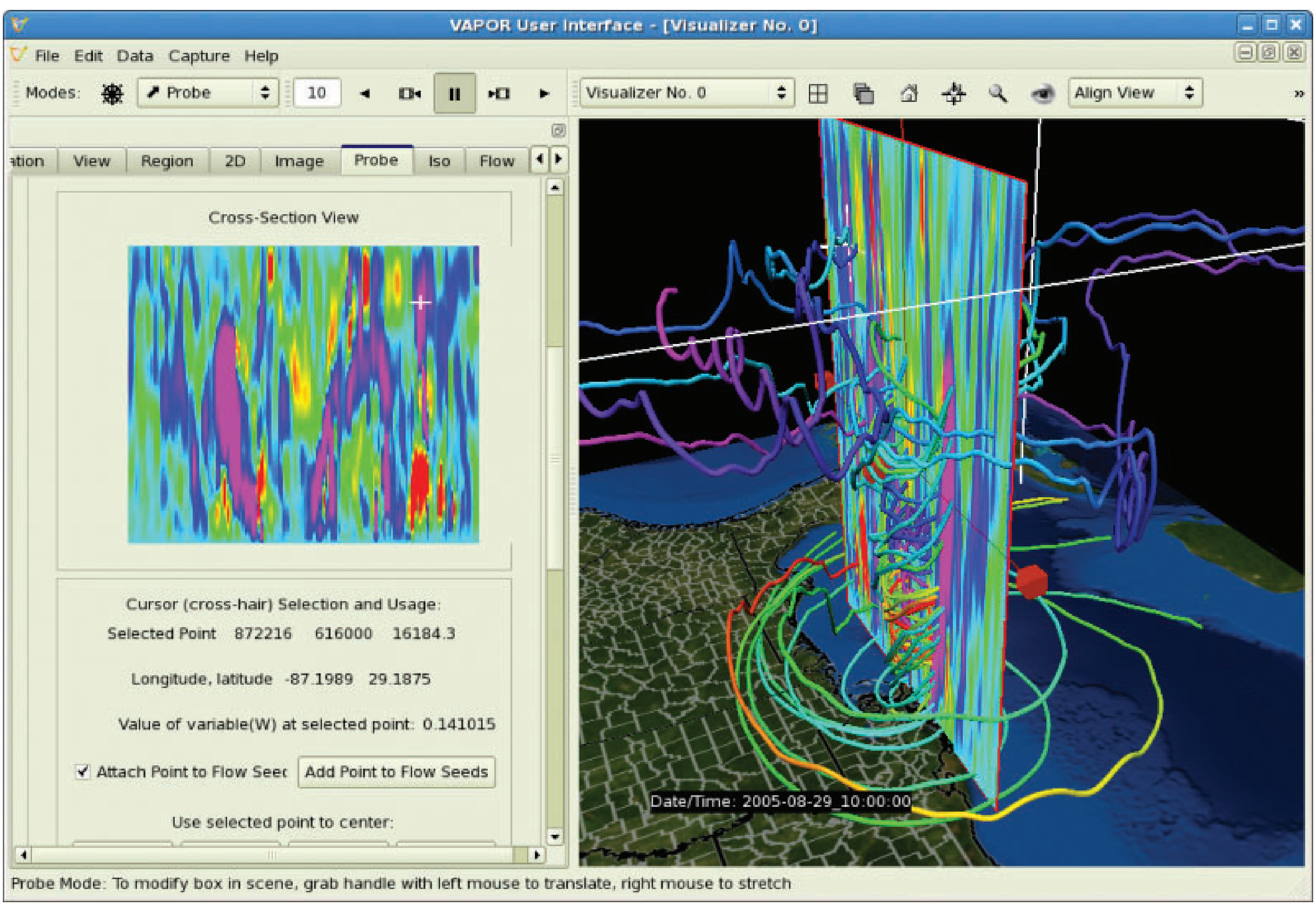
For another project involving natural gas pipelines, we were called in to confirm the coordinates of the pipelines for a highway expansion project. The area included a highly congested series of highways, and knowing the exact location was essential to the safety of the workers, as well as thousands of nearby residents. The gas line was temporarily taken out of service and spliced in two places to enable our mapping specialists to utilize GeoSpatial's Smart Probe® Inline Mapping Device. This enabled the mapping to be done in proximity to the heavily trafficked highways at depths exceeding 21 feet, a task that would have been impossible to map with other known technologies.

Municipal Water and Wastewater

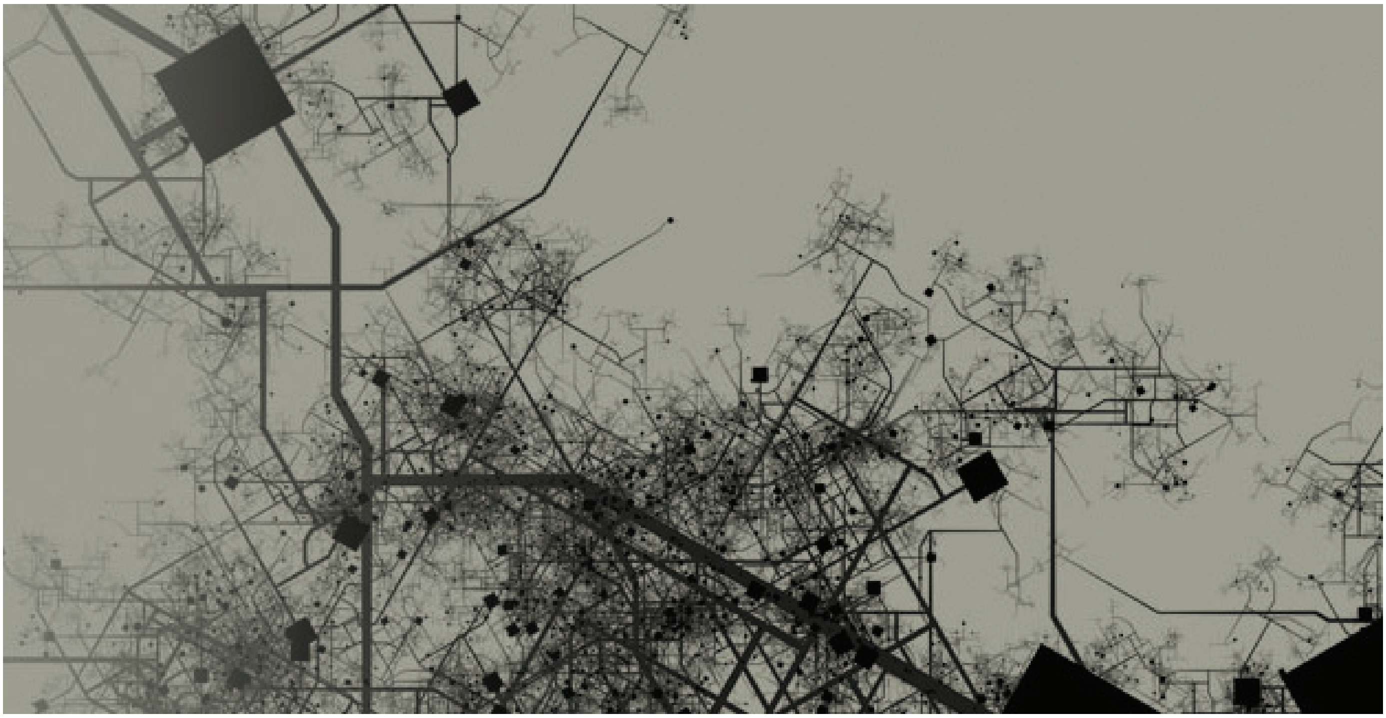
For municipal governments to manage their costs and mitigate adverse impacts, accurate assessments of water and sewer pipeline mapping work to ensure safe water and sanitary systems. For one unique project, a 38-inch pipeline in a drinking water reservoir was fully submerged at a depth of 60 feet. The pipeline was untraceable by conventional means, so to perform this underwater task, we utilized a smart probe mapping device in conjunction with a specialized carrier that could be hand-propelled by a team of hard-hat scuba divers. The work was successfully performed from a barge in the reservoir.

Electric Transmission

Accurate mapping is necessary for installing and maintaining conduits and cables for electric transmission and distribution companies. For these projects,



Smart probes allow mapping specialists to obtain data in heavily trafficked areas and at depths exceeding 21 feet.



When mapping under bodies of water, Geospatial's Smart Probe Inline Mapping system works to identify both metallic and non-metallic conduits and pipelines.

we provide detailed bending radius and joint integrity data, which is critical for the safe installation of sophisticated high-voltage electrical distribution conduits. With telecom and fiber optics, our team is able to map, analyze and manage conduits as small as one-inch in diameter in vast underground networks.

Using a mobile, cloud-based application, users can securely view, edit and share data from a laptop, phone or tablet.

For one project, a riverbed was going to be dredged to enable larger vessels to travel the waterway. However, there was a submerged conduit spanning the river channel and only rudimentary positioning information was available. In this case, the river and the conduit were not very deep, so we were able to effectively and accurately create 3D spatial map coordinates of the entire segment of pipe without the need for divers or underwater inspection. Following this mapping, an affiliate contractor utilized a metal-loss tool on the conduit to ascertain its condition. This data was then combined with the digital mapping data to allow x, y and z correlation to any existing weakened areas of the conduit.

In Summary

Owners and operators of the world's aging infrastructure are faced with increasingly stringent demands to manage their assets in an efficient and responsible manner. Granted, there is no one technology or a silver bullet that will provide 3D mapping of every infrastructure for every industry.

That is why it is crucial to have a strategic process in place that starts with assessing the situation and conditions of the area before determining which technology or combination of technologies to apply. As technological advances continue to progress, so will the feature-rich GIS management applications and the safety and security of our underground space. ✪

References

"Accelerating World-Wide Initiatives to Map Underground Utilities" by Geoff Zeiss

"The Infrastructure Crisis" by Robert L. Reid

Mark is the Chairman and CEO of GeoSpatial Corporation and has 30 years of experience in the infrastructure industry. Visit www.geospatialcorporation.com