

Marking the spot

RFID markers and GPS technology support Virginia DOT roadway construction.

By Darlene North

Project

Widening of Lee Highway and Gallows Road, Washington, D.C.

Participants

The Virginia Department of Transportation
Virginia Utility Protection Service

Product application

The RFID electronic marking system, a product of 3M Track and Trace Solutions, uses digital technology to provide accurate locating of buried infrastructure and site-specific data.



The Northern Virginia District of the Virginia Department of Transportation (VDOT) has established a pilot program for identifying, relocating, and marking buried utility infrastructure in preparation for highway construction. This process uses a radio frequency identification (RFID) system incorporated in buried electronic markers. The program is expected to cut VDOT project risks by reducing the safety hazards, delays, and costs commonly associated with buried utilities and highway construction.

VDOT creates master utility relocation plans that record both horizontal and vertical information of the entire buried infrastructure installed during utility relocation operations within the footprint of a future highway project, said Matt McLaughlin, the VDOT district utility construction engineer responsible for overseeing construction of relocated utilities related to roadway construction in the Northern Virginia District.

“Buried utilities are critical to many public services, and VDOT is taking

Utility information is transmitted through a laptop computer to each portable locating device prior to burial. 3M Dynatel EMS 1400 Series iD ball markers can distinguish between seven utility frequencies and between adjacent markers of the same frequency.

a lead in protecting these high-value assets during the highway construction operation,” McLaughlin said. “A \$70 million reconstruction project that is currently under way at Virginia Route 29 and Gallows Road near the Capital Beltway in suburban Washington, D.C., calls for widening both Lee Highway and Gallows Road from four lanes to five and six lanes divided, with a 28-foot median.

“Utility relocation work associated with this roadway project is substantial, with every utility interest represented, including gas, telephone, power, CATV, two water authorities, sanitary sewer, and 13 separate fiber-optic companies, so the accuracy of the relocated facilities will have a significant impact to the project. This utility installation effort will magnify the intensity of utility locates in an area that is already congested with pipes and cables. Relocation is presently under way and

will take approximately 2-1/2 years to complete. Subsequent excavation and construction phases are scheduled to begin in December 2010 with a two-year completion timeline,” he added.

McLaughlin noted that the density of utilities within the project area poses considerable challenges with regard to utility safety, delays to the traveling public, construction delays, and higher project costs. The average distance between pipe crossings along this 60-foot-wide roadway is only 3 feet, and more crossings are being added in the relocation process. These crossings need to be clear of grade cuts, drainage crossings, traffic signals, and other construction elements.

The VDOT spokesman explained that there is typically very little delay between the utility relocation process and earth moving. Existing records can be used to locate, mark, and avoid long-standing utilities, but excavation con-

PROJECT CASE STUDY

costs are even greater. Not to mention the cost of the repair, possible evacuations, and personal injury or loss of life. Upon examination, we determined that RFID marking will help protect the buried infrastructure by increasing locate accuracy and enhanc[ing] public safety, as well as reduc[ing] or eliminat[ing] a major cause of costly project delays.”

Marking relocated utilities

As the relocation contractors install the underground facilities, they provide elevations and program data for the marked points where the RFID tags will be installed. The VDOT inspector, using the template form provided by 3M, records this information into a laptop computer. The VDOT team received input from each utility to be recorded onto RFID markers. This was done to convey information that is important for the current highway project as well as for future private and public projects. The information is transmitted to the portable locating device through the laptop computer, which VDOT uses to program a marker ball for each specific location (see Figure 1).

Once programmed, balls are dropped into the backfill material of the trench at a selected, pre-recorded depth (generally 3 to 4 feet below grade), taking future grade changes into account. After backfilling, VDOT takes GPS readings at each site and will include these marker coordinates in the

master GIS database, along with the rest of the data stored on each marker.

This stored data includes a unique 10-digit serial number, as well as the utility owner, item description (gas, water, CATV, et cetera), item details (valve, splice, service tap, horizontal or vertical change in direction, et cetera), placement date, depth below grade, orientation, elevation, and information about adjacent items (for example, a pipe or cable lies below). VDOT developed a compressed code for this purpose that fits within the available 256-bit RFID marker memory capacity and is useful across utility categories. VDOT also worked with 3M to modify templates to maximize the amount of information that can be programmed into RFID marker balls.

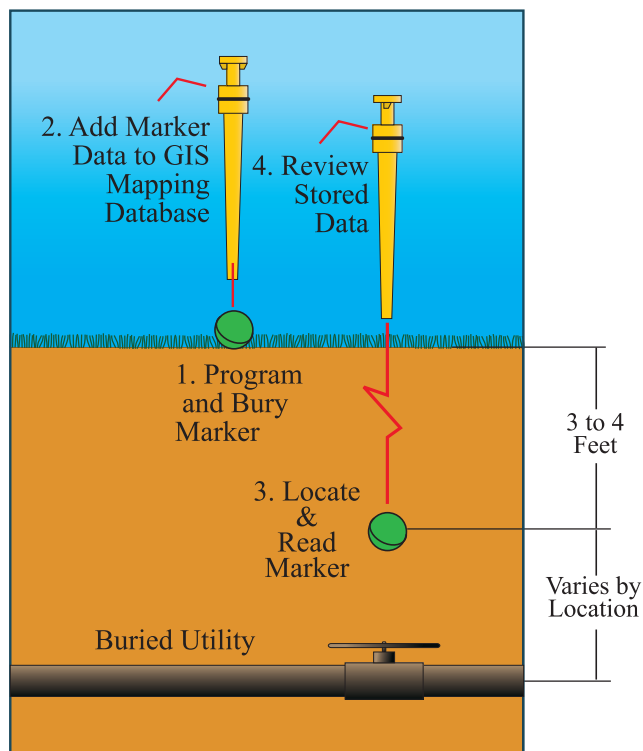
VDOT is managing RFID marker programming for the utility relocation phase, and assembles marker data for immediate entry in a master GIS mapping database to be delivered to the utility companies. Daily data entry means that mapping details are regularly updated and quickly accessible to stakeholders. The distributed record consists of a PDF file with all GIS data including pop-ups for each marker position that list programmed data and GPS coordinates. The utility companies can view programmed marker information on the computer screen by merely placing the cursor at a specific map location.

The current protocol requires underground utilities to install RFID markers on relocated facilities every 50 feet for metallic pipes and every 25 feet for non-metallic pipes. Markers also are placed at points of horizontal and vertical direction change, critical utility crossings, appurtenances that are important to the utility, service connections, and abandoned facilities.

McLaughlin reported that Virginia utilities are responding positively to the RFID underground marking technology with some already adopting it for general work as well. He expects that this common underground database will enhance the partnership between VDOT, the utility companies, VUPS, and the State Corporate Commission, and improve working relationships among all of the stakeholders based upon mutual interest.

“Our GPS/RFID pilot program confirmed the usefulness of RFID markers to help improve both the accuracy and efficiency of locating underground utilities and minimize the potential for costly damage,” McLaughlin concluded. “We anticipate great benefits in public safety, highway construction safety and efficiency, as well as the timeliness and accuracy of GIS mapping as a result of adopting this technology.” ■

Figure 1: RFID marker balls are programmed just before placement. VDOT records GPS coordinates for each location for inclusion in the master mapping database.



Darlene North is a product manager for 3M Track and Trace Solutions. She has 15 years of experience in the application of underground marking and remote locating and test technologies in utility applications. She can be contacted at ddnorth@3m.com.

tractors also need to know the precise location of infrastructure elements that have been moved or abandoned during the relocation operation without having to wait an extended period for the utility database to be updated.

Since utility relocation requirements for the Route 29/Gallows Road project are complex and the construction schedule is compressed, McLaughlin and his team recently conducted a search for new utility locating, marking, and record-keeping alternatives.

He reported that early in the planning phase, the VDOT team of construction managers and inspectors consulted with the Virginia Utility Protection Service (VUPS), the state's one-call authority, to discuss the viability of GPS tracking as an aid to this project. It was clear that GPS could be an important general asset for utility mapping and offered the possibility of converting information currently in VDOT language, which uses station numbers and offsets, to a universal language of GPS that establishes latitude and longitude coordinates that will be useful to the utilities, he said. While GPS offered sub-meter accuracy in support of satellite-based virtual mapping, a primary physical marking and locating method with greater precision would also be needed.

At that time, VUPS representatives told VDOT representatives about a relatively new marking and locating tool known as RFID, which uses buried markers that are placed adjacent to underground utilities and deliver locating accuracy measured in inches. These waterproof buried devices can be found easily from the surface using a portable marker locating device.

RFID technology

The RFID electronic marking system, a product of 3M Track and Trace Solutions, uses digital technology to provide accurate locating of buried infrastructure and site-specific data. A portable, hand-held device is used to program and later find electronic mark-

ers by transmitting a utility-specific radio frequency signal into the ground.

An interrogating signal from the marker locator is reflected back from the marker to give an exact and unambiguous indication of position. This digital response includes stored details including a unique marker identification number, the owner of the underground component, its function (splice, valve, service tee, direction change, et cetera), and its depth/elevation below the surface. RFID markers require no power source apart from the signal transmitted by the locator.

Conventional utility-tracing devices give only an approximation of utility position and depth, and when there are high voltage lines overhead, a high water table, or other pipes or metal objects in close proximity, it can be very difficult to pinpoint and accurately identify specific buried facilities. Interference and false marking are ongoing problems with standard locators, particularly in a congested underground setting such as the Route 29/Gallows Road site.

Electronic marking provides an accurate and reliable means for point location that is not affected by soil conditions, nearby utilities, or temperature extremes normally found underground. Unlike conventional passive markers, the RFID system can differentiate marked underground components, distinguishing between utilities and even between the facilities of multiple utilities with adjacent buried markers tuned to the same frequency.

Project planning

"Our VDOT team conducted a GPS/RFID pilot program to confirm the viability of this marking technology for roadway construction — a process that included programming and placing markers for each utility category," McLaughlin said. "We were able to confirm that a buried marker leads the locating technician directly to an exact spot and dependably distinguishes between side-by-side utilities without subjective interpretation."



A portable, hand-held device is used to program and later find electronic markers by transmitting a utility-specific radio frequency signal into the ground.

The projected budget for the Virginia roadway project is approximately \$70 million, including relocation of water lines, private utilities, and highway improvements, McLaughlin noted. The VDOT team determined that about 600 RFID marker balls would suffice to pinpoint and identify the relocated utilities at a cost of \$15 per marker, or about \$10,000 in total including installation costs. VDOT purchased RFID locators for the project and assigned each utility with the responsibility to provide markers for their own facilities.

This pilot program has evolved and the same concept is being applied to an interchange project in Gainesville as well as other smaller projects within the northern Virginia area. Implementation of this pilot program created a partnership between VDOT and the utility companies that increases the accuracy of underground locates, enhances public safety, and saves tax-payer dollars on claims as well as time extensions.

"It costs upward of \$1,000 per hour to put an excavator on hold while a buried utility question is resolved," McLaughlin said, "and in the case of a damage incident, the safety implications as well as police, fire, and rescue