



Photo courtesy of Eric E. Johnson/Konomark.

## **Imaging Contractor Finds Hidden Objects Below Bay Area Rail Stations**



Operators performed GPR imaging in station buildings and outdoor parking areas.



A total of 34 BART stations required some form of retrofit to protect passengers and staff in the event of a major earthquake.

**A**s part of a \$1.2-billion project to improve the resilience of a California rail system in the event of an earthquake, a series of retrofits are being made to parts of the 40-year-old system. However, various installations of utilities and additional structures over the years means there is an unknown number of objects hidden from view. To avoid damaging these objects during retrofits at three locations, a CSDA member was given the job of finding and recording their locations.

The original Bay Area Rapid Transit (BART) system was completed between 1972 and 1976 to serve commuters in the San Francisco Bay Area. Today, the system carries around 360,000 commuters every day and consists of 44 stations connected by 104 miles of track.



The blue lines indicate BART routes. Green lines indicate known earthquake fault lines.



**“The use of GPR allowed us to locate non-conductive lines and utilities not identifiable using the other scanning methods.”**



A recent U.S. Geological Survey statistical analysis concluded that the Bay Area is likely to be hit by a major earthquake sometime within the next 30 years. Because the BART system crosses over and runs close to several fault lines, it is also likely that a major seismic event will heavily impact the system. To safeguard the public's significant investment in the system and ensure their safety, BART initiated the Earthquake Safety Program. Portions of the original system—74 miles of track, 34 stations and various buildings and structures—are being upgraded by using the latest seismic standards to improve the structural integrity of BART facilities. The Program is scheduled for completion in 2018.

The retrofit project involves the core drilling of reinforced concrete slabs and structures for the installation of strengthening bolts and dowels, particularly concrete bent caps. Before this work could commence, however, several buried utility lines had to be identified and their positions mapped so that they would remain undamaged during these cutting tasks. The general contractor for the retrofits, Robert A. Bothman Inc. of San Jose, California, chose a specialist subcontractor that could offer scanning and imaging services—local CSDA member Safe2Core.

“The people at Robert A. Bothman were looking for someone that not only used more conventional scanning methods, like electromagnetic and radio detection, but also used imaging techniques with Ground Penetrating Radar (GPR),” said Antonio Guzman, owner of Safe2Core. “The use of GPR allowed us to locate non-conductive lines and utilities not identifiable using the other scanning methods.” In addition to the benefit of locating non-conductive utility lines, imaging with GPR offered a faster and more accurate way of collecting and displaying data than other methods. In general, the non-destructive testing and scanning of hidden objects in concrete is a better option than simply relying on outdated drawings or records to conduct cutting or breaking work.

Safe2Core's scanning tasks on the BART Earthquake Safety Program combined GPR and electromagnetic detection to correctly locate and identify all targets at two rail stations: Hayward and San Leandro. As part of a separate project on the BART system, the contractor also provided scanning and GPR imaging services at the Oakland station around the same time. The contractor was tasked with scanning 38 locations inside station buildings and outside on station car parks where the retrofits would be installed. While the specified areas measured just 100 square feet, operators scanned all station areas to locate and map utility lines between bent caps. This work was done in August 2013.

Scanning operators began by performing an electromagnetic inspection of the stations and verifying utility lines that were marked on “as built” drawings. Station operations were not to be interrupted by the work, so the contractor used cones and caution tape to keep rail users from entering scanning areas. Once complete, GPR equipment supplied by Geophysical Survey Systems, Inc. (GSSI) was set up with 1.6 MHz and 2.6 MHz antennas to inspect up to 16 inches deep in reinforced concrete. This allowed the operators to locate small utility lines that may otherwise have been obscured by steel reinforcement using larger antennas. It took two operators four days to complete the first phase of GPR imaging.

Next, the team from Safe2Core utilized a 400-MHz antenna to survey the specified areas of the three stations and locate objects positioned up to 5 feet deep. The use of different antennas was crucial for this project. Some interior areas of the three BART stations contained highly congested sections of utility runs, which rendered other utility location methods useless due to high levels of interference. GPR was the only technology that allowed operators to distinguish between the different types of lines and materials. This second phase was completed over three days at the Hayward, Oakland and San Leandro stations.



This form of non-destructive testing enabled station operations to continue as usual.

During the scanning and imaging work, Safe2Core encountered one main obstacle—the type of steel reinforcement used in the stations' concrete slabs. A 6-inch wire mesh was buried in the slabs, which created a lot of interference in the GPR wave because of its close spacing. Another difficult part of the work was accurately identifying a large quantity of utilities running at varying depths and several directions. The use of three different types of GPR antennas provided the imaging contractor with a solution to both of these issues. By using these three antennas, operators were able to divide the imaging work by depth ranges and obtain clearer images of all hidden objects.



The results of the scanning and imaging work will assist in the installation of strengthening devices on buildings and structures.





A 400-MHz antenna was used to locate and identify utilities buried up to 5 feet deep in reinforced concrete.

The team from Safe2Core completed all scanning and imaging tasks at the three BART stations over a seven-day period, covering around 80,000 square feet. Operators used a 1.6-MHz StructureScan Mini, a 2.6-MHz StructureScan HR and a SIR-3000 unit with a 400-MHz antenna, all from GSSI. Employees were provided with all standard items of personal protective equipment for the work.

"I am very satisfied with the outcome of this project. It shows how important the use of GPR is on utility locating projects," explained Guzman. "We were originally chosen to scan two stations in Hayward and San Leandro, but when the general contractor saw how well the work went we were given Oakland station as well. This is an ongoing project for the BART system, and it has been indicated that we will be offered more work in the future," he added. The scanning and imaging work was completed within budget and the specified time frame.

Because of the advancements in utility locating and GPR imaging, this CSDA member was able to seek out hidden objects easily and without disrupting important transport links in the San Francisco Bay Area. The BART Earthquake Safety Program remains on schedule for completion in 2018. The team from Safe2Core hopes to continue its scanning and imaging work before concrete core drilling techniques are used to install the station retrofits.

## COMPANY PROFILE

Safe2Core is based in San Jose, California and has been a CSDA member since 2012. The company has been in business for eight years, has 12 employees and eight trucks. Servicing the state of California and completing projects nationwide, Safe2Core offers the services of GPR imaging, utility location and core drilling.

## RESOURCES

### General Contractor:

Robert A. Bothman

### GPR Imaging Contractor:

Safe2Core

San Jose, California

**Phone:** 408-266-7050

**Email:** antonio@safe2core.com

**Website:** www.safe2core.com

**Methods Used:** GPR Scanning, Utility Location

REVIEW AND COMMENT ON THIS ARTICLE AT:  
[WWW.CONCRETEOPENINGS.COM/FORUM.CFM](http://WWW.CONCRETEOPENINGS.COM/FORUM.CFM)