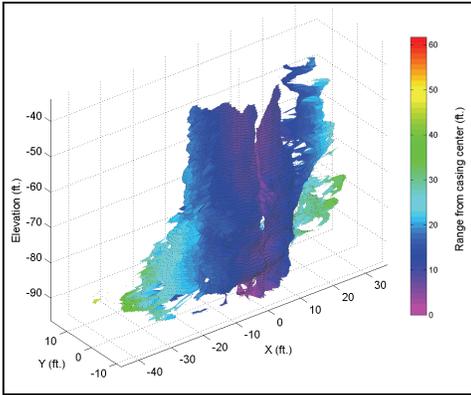


# PROJECT PROFILE

## FOUNDATION DESIGNS FOR CEMENT PLANT STRUCTURES IN KARST TERRAIN

D'Appolonia provided geotechnical engineering and construction phase support for the \$400-million expansion to a cement plant in northeastern West Virginia. The plant expansion included 12 large, heavily-loaded structures including a 410-foot-high Pre-Heater Tower, an 1,800-square-foot Raw Mill, a 73,000-square-foot Raw Material storage dome, and 7 silos varying from 90 to 200 feet in height.



*3D image of subsurface void created through laser mapping.*

The project site is underlain by karst terrain resulting from solutioned limestone bedrock characterized by subsurface caves, air- and clay-filled voids, large variations in the top of bedrock

elevation, and sinkholes. Due to the greatly varying nature of the site's subsurface characteristics, D'Appolonia evaluated foundation systems for the different structures independently. For cost effectiveness and constructability considerations, different

approaches were adopted for individual structures. Where the depth to competent rock was shallow, as for the Raw Material Storage dome, the near surface soils were over-excavated to the top of rock and replaced with compacted engineered fill consisting of crushed rock from on site. Where small voids or broken rock existed at shallow depths (less than 33 feet) compaction grouting was employed to fill and bind the rock layers together.

D'Appolonia conducted sonar and laser mapping of large voids that were encountered beneath one of the silos to establish the extent. The existing voids were filled with 1,400 cubic yards of



*Micropile installation for Finish Mill foundation.*

concrete. For the majority of the large, heavily loaded structures, high capacity micropile deep foundations were designed. To improve rock quality, Low-mobility grout was injected at pile locations where broken rock and cavities existed, and pile load tests confirmed the design adequacy of the load carrying capacity for representative pile/rock conditions.

Although the site presented significant geotechnical challenges, the design approach and the combination of investigative technologies, ground improvement and construction operations provided the flexibility required to address the various subsurface conditions.



*Aerial view of \$400 million cement plant expansion.*