



## Project Experience - Groundwater

### ***Apple Valley and Lenwood-Hinkley Groundwater Remedial Investigations, California***

#### ***Client:***

IT Corporation

County of San Bernardino, Solid Waste Management  
Department

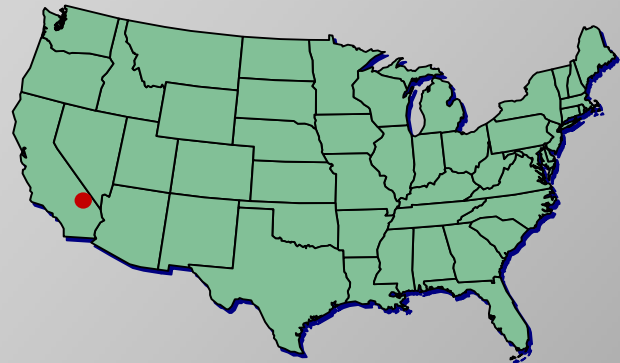
#### ***Project Description***

We conducted surface and borehole geophysical surveys as part of groundwater remedial investigations at the Apple Valley and Lenwood-Hinkley Sanitary Landfills. The objectives of the Apple Valley geophysical surveys were to map bedrock topography and determine the location of faults and fracture zones near the site. The objectives of the Lenwood-Hinkley geophysical surveys were to delineate a known regional fault and determine the location(s) of other suspected faults and fracture zones in the area. The survey results from each site were needed to determine the affect of the underlying geologic structure on the local hydrogeologic environment in support of monitoring well placement.

#### ***Work Performed***

The geophysical work conducted at these remote desert locations utilized high-resolution seismic refraction, vertical electrical sounding (VES) and dipole-dipole resistivity profiling, time-domain EM sounding (TDEM), controlled source audiofrequency magnetotellurics (CSAMT), gravity and magnetic profiling, and geophysical well-logging techniques.

At each site, VES's were conducted first using an Abem SAS 2000 booster transmitter and Abem Terrameter Model 300B receiver to determine



depth to bedrock in the site vicinity and aid in the design of the seismic refraction surveys. High-resolution seismic refraction surveys, using a 24-channel EG&G Geometrics ES2401 seismograph, 14-hertz geophones with a station spacing of 30 feet, and an EG&G Geometrics Dynasource (vacuum-assisted weight drop) as the seismic source, were conducted in the areas adjacent to



**Seismic refraction survey using a 24-channel Geometrics seismograph and Dynasource vacuum-accelerated weight drop as the energy source**

Apple Valley Landfill to map bedrock topography, specifically bedrock valleys. At Lenwood-Hinkley Landfill, seismic refraction work was conducted to locate and map a normal fault thought to control groundwater flow.

CSAMT and gravity techniques were used at Apple Valley Landfill to map low resistivity zones, indicative of faulting or fracture zones and to aid

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with interpreting the other geophysical data. At Lenwood-Hinkley Landfill, dipole-dipole resistivity and magnetic profiling, and TDEM soundings complimented the seismic refraction survey results.



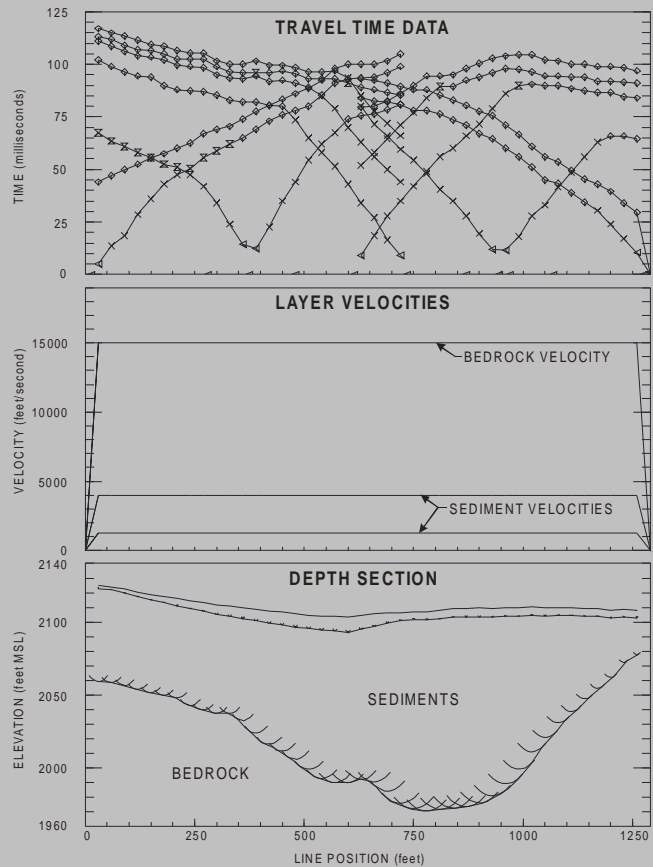
Time-domain electromagnetic survey using a Geonics EM47 ProTEM system

### Analysis and Results

The geophysical survey data results from each site were successful in accomplishing the project objectives. Interpretation of the geophysical data indicated the orientation of the subsurface bedrock valley and local subsurface bedrock topography, and revealed that a zone of highly fractured bedrock exists beneath the landfill, which causes an increase in local hydraulic conductivity and, therefore, groundwater migration.

Following the geophysical data interpretation, several monitoring wells were installed at both landfills and monitored for groundwater quality and landfill gas in the vadose zone. The chemistry of those samples indicated the wells were installed in suitable locations to determine the lateral and vertical extent of contaminant migration in relation to the sites and that no additional downgradient monitoring wells were required.

1-D inverse modeled results from TDEM sounding at Lenwood-Hinkley Landfill



From Top to Bottom: Seismic Refraction "first arrival" data, velocity model, and interpretation from Apple Valley Landfill

