RESOURCE NOTES

NO. 4 DATE 04/30/99

CARTOGRAPHY/ MAPPING SCIENCES

FIRE

FORESTRY

GIS AND GPS

HAZARDOUS MATERIALS

HUMAN/SOCIAL/ HISTORICAL

HYDROLOGY

NEPA COMPLIANCE

OTHERS

PUBLIC AFFAIRS

RANGE

RECREATION/ INTERPRETATION/ VISUAL RESOURCES

RIPARIAN

SOILS/GEOLOGY

THREATENED & ENDANGERED SPECIES

WILDLIFE BIOLOGY

LIBRARIES/RECORDS MANAGEMENT

CADASTRAL/ LAND RECORDS

BLM's Surface Geophysical Capabilities

By Brent Lewis, Geologist, BLM National Applied Resource Sciences Center (NARSC)

As a result of the closure of the Bureau of Mines, the National Applied Resource Sciences Center (NARSC) acquired a variety of portable surface geophysical equipment and over the past year, has implemented several seismic and resistivity surveys to characterize geologic settings. These studies have been in support of environmental issues; however, similar approaches can be implemented for assessing mineral deposits or acid mine drainage issues, the latter being extensively evaluated and published by the Environmental Protection Agency (EPA No. 530-R-95 013a). The surface geophysical methods within NARSC vary but generally consist of electrical resistivity, seismic, and electromagnetics. The type(s) to use is dependent upon the survey. Surface geophysical methods provide a non-intrusive, cost-effective means of acquiring subsurface geological information. Such information may encompass lithologic composition, stratigraphic depths and thicknesses, groundwater properties, or properties of the aquifer. This Resource Note discusses electrical resistivity, whereas other geophysical methods will be addressed in future Resource Notes.

Geologic information can be inferred from geoelectrical properties of rock and sediment and the spatial distribution of these properties, both can be acquired by direct current electrical resistivity. In simple terms, this method involves the application of an electrical current to the ground via two source electrodes with the potential difference created at the ground surface being measured between two receiving electrodes. The effective depth of a "sounding" is increased by sequentially increasing the distance between these electrodes. The further the distance, the thicker the vertical interval in which the bulk of the current flows. Recorded resistivity values can be considered the weighted average of the resistivity of all the beds down to the deepest bed detected. Differences in resistivity values occur when changes in subsurface conditions are encountered. These changes are geoelectric boundaries and typically correspond to changes in either lithologic composition, formation porosity (such as an increase in fracturing), and/or changes in groundwater chemistry. Clearly, the current prefers to flow in a bed of lower resistivity, such as clay; conversely, the more sand and gravel, the greater the resistive properties.

Depending upon objectives, a resistivity survey may be employed via several techniques or a combination of techniques, the most common being Vertical Electrical Sounding (VES) and horizontal profiling. The VES technique is analogous to electrical drilling because the result is a one-dimensional interpretation of the subsurface, similar in profile to a common drill log. This technique typically involves the correlation of multiple sample locations to produce geoelectric cross-sections from which the general stratigraphy and structural setting are identified. Horizontal profiling provides a two-dimensional profile of the subsurface, similar to viewing the wall of an excavated trench. This technique is typically used when greater detail is needed. Effective depths of any investigation can be customized to achieve specific objectives, however, based upon the in-house NARSC equipment, survey depths as great as 250 feet are readily achieved.

Two case studies are provided in the figures as examples of resistivity capabilities. The survey at the Sunrise Mountain Landfill in Las Vegas, Nevada, consisted of 15 VES profiles, i.e., electrical drill logs. The objective of this survey was to characterize the local stratigraphy and geological structure, e.g., faulting, in order to design a groundwater monitoring well network. Geological information from each VES (Figure 1A is an example of a single VES data set) was correlated to produce geologic cross-sections. An example of a cross-section developed through the correlation of six VES locations is provided in Figure 1B. In addition to the stratigraphic information, this survey identified several fracture zones and a nearby fault which greatly affect the strategies behind the placement of groundwater monitoring wells.

The second case study (Figure 2) utilized the “horizontal profiling” technique. This survey was implemented at the old Granby Landfill near Granby, Colorado. The objective of this survey was to identify local stratigraphy, particularly the depth to impermeable bedrock. This required the ability to distinguish between weathered and unweathered shale [Pierre Formation]. The depth of a groundwater monitoring well was to be completed to the depth of unweathered bedrock. Resistivity results suggested this depth to vary from 24 to 34 feet across the site. Based upon the drill logs obtained after the survey, depth to impermeable bedrock was determined to range from 26 to 32 feet. Supplementary information obtained from this survey was the varied soil types of a nearby wetland.

The in-house resistivity capabilities of NARSC provide an opportunity to acquire subsurface geologic information quickly and cost-effectively. The examples provided are for environmental groundwater objectives; however, other uses may include mineral assessments, abandoned mine investigations, and archeological surveys for buried foundations or pits. If you would like more information about resistivity or the other geophysical methods now available within BLM, contact Brent Lewis at 303-236-0550 or e-mail B1Lewis@sc.blm.gov.

National Applied Resource Sciences Center

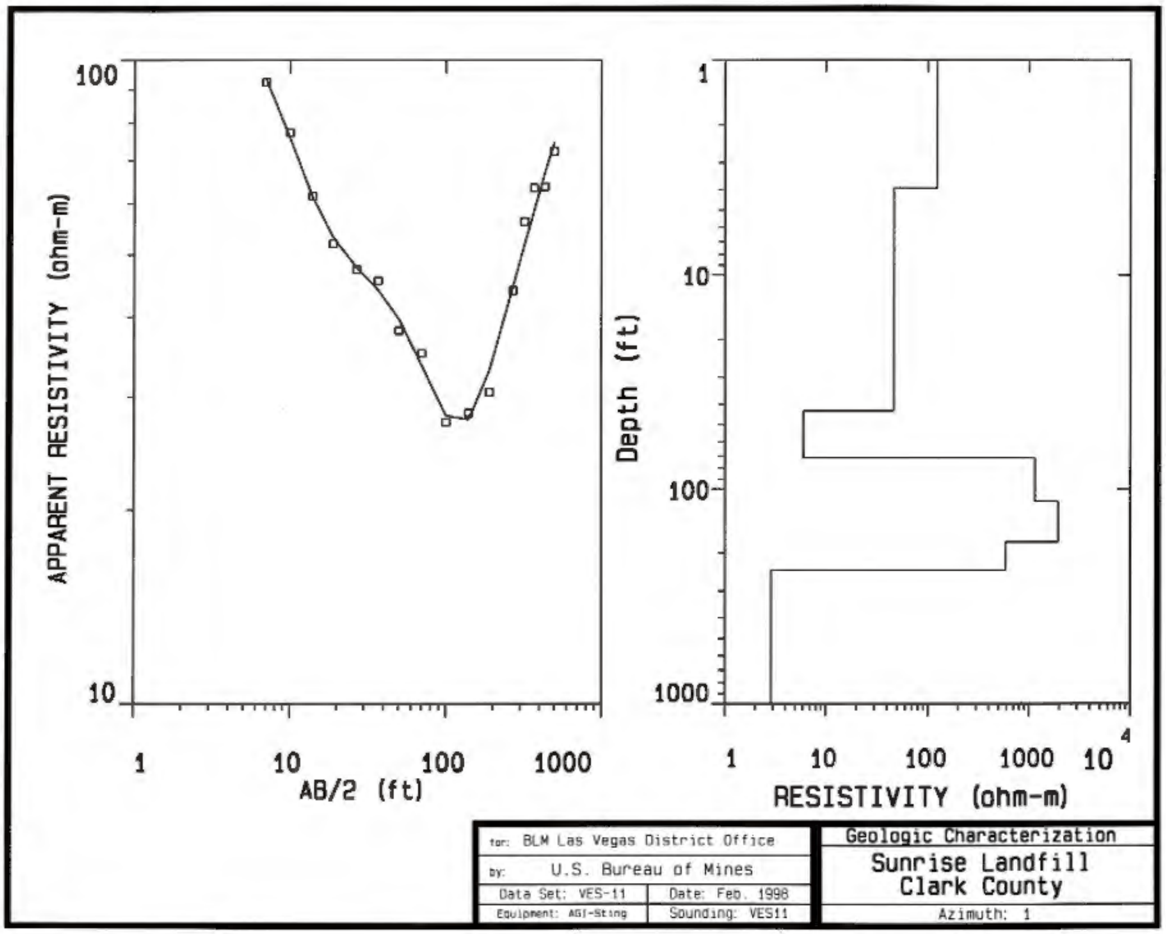

Figure 1A. A single VES dataset; illustrating the distribution of the data and depth model.

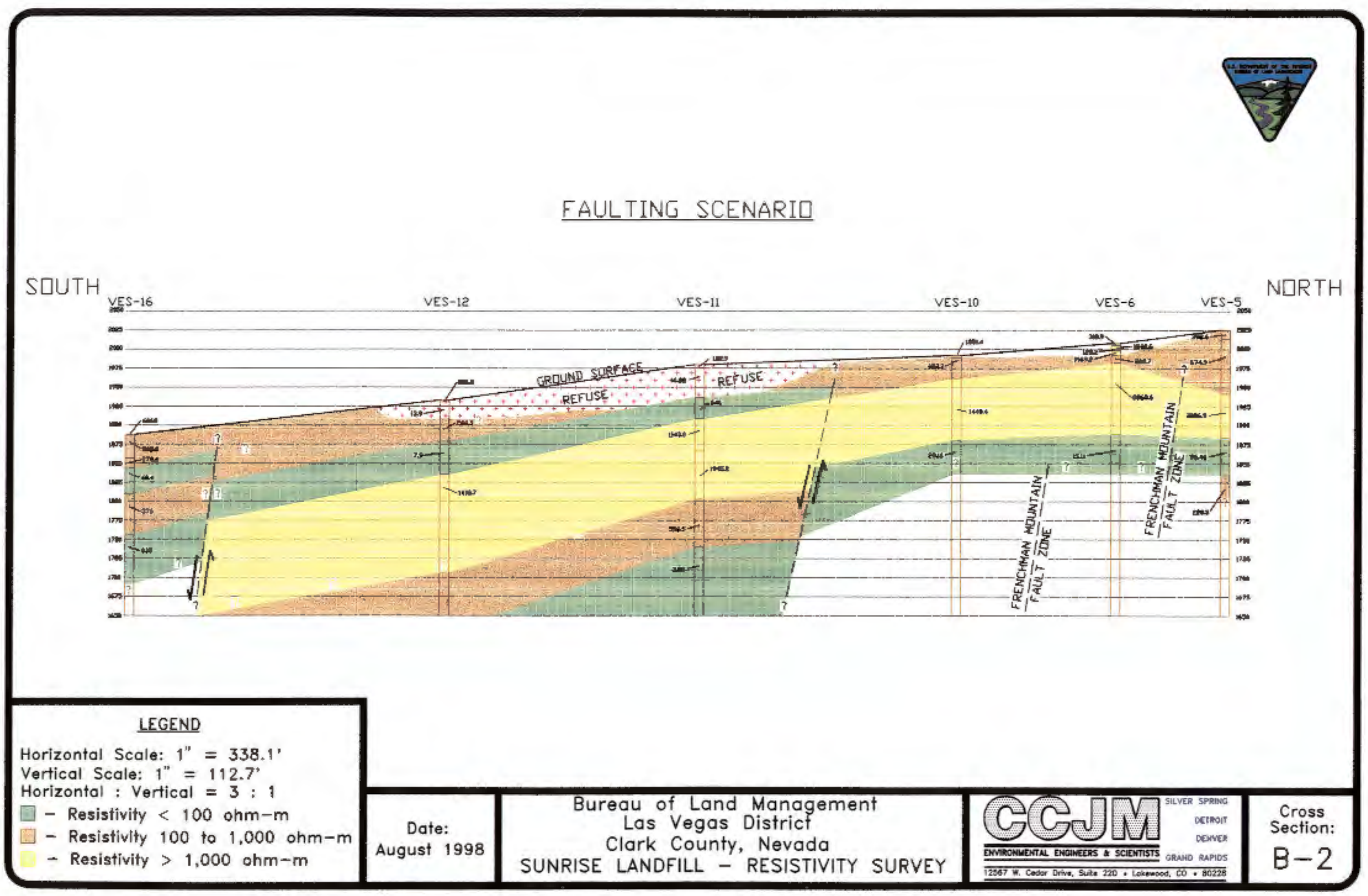

Figure 1B. Geologic cross section developed from the correlation of six VES locations.

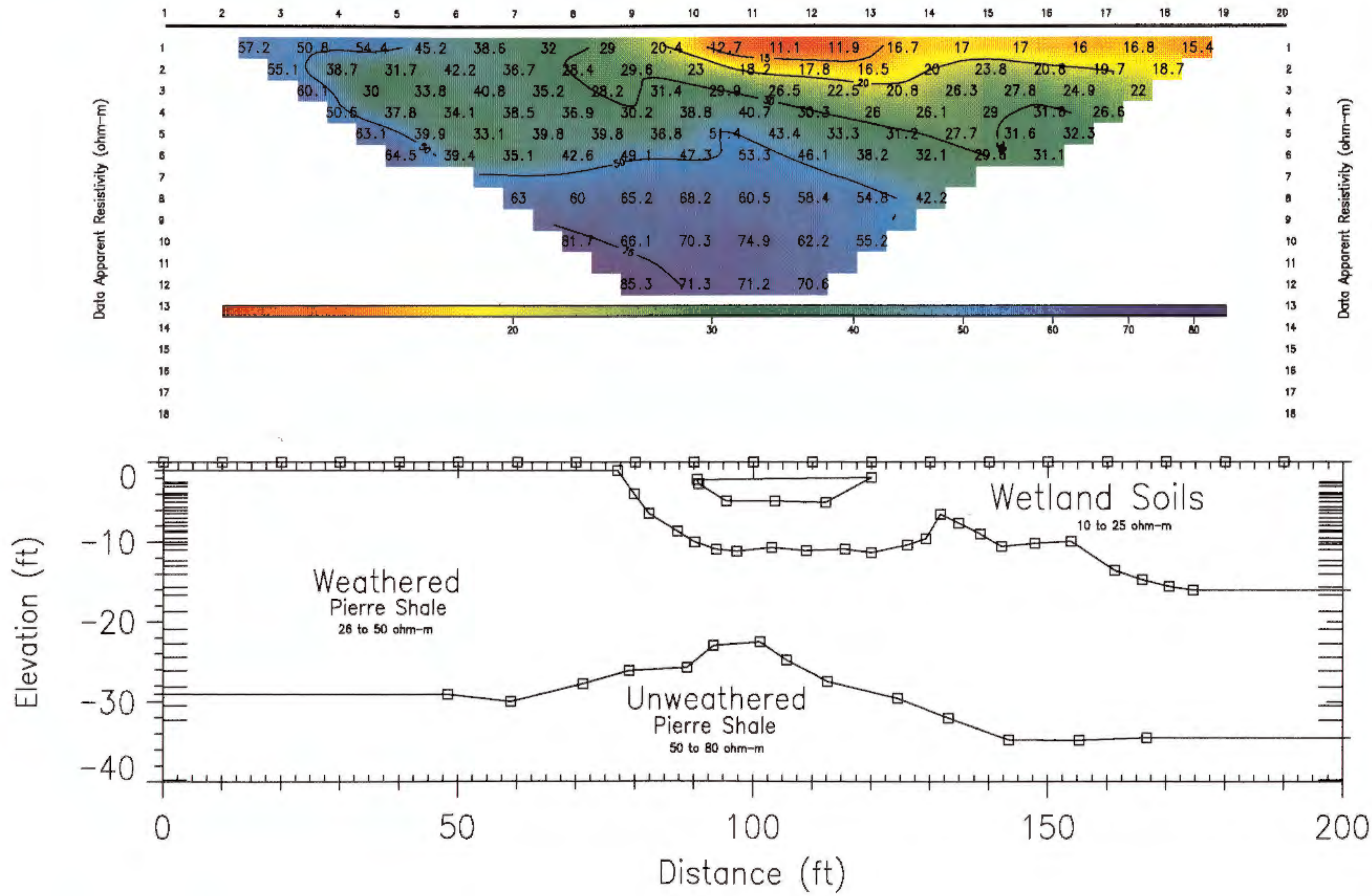

Figure 2. An example of Horizontal Profiling.

BLM Kremmling Area Office		Groundwater Investigation
Bureau of Land Management		Old Granby Landfill Grand
DATA SET: GSWIFT2	DATE: 98-10-14	
Array: Dipole-Dipole	a-Spacing: 10.0	Grid (X x Z): 125 x 47