United States Department of Agriculture **Chester, PA 19013**
Soil Conservation Service **610-490-6042**

Subject: Site Assessments using Electromagnetic Induction and Ground-Penetrating Radar Techniques; September 7 and 8, 1994

Date: 12 September 1994

To: Don W. Lake, Jr.
State Conservation Engineer
USDA - Soil Conservation Service
Syracuse, New York

Purpose:
To provide electromagnetic induction (EM) and ground-penetrating radar (GPR) field assistance. State Geologist received further training on the use of the EM31 meter.

Principal Participants:
Jim Doolittle, Soil Specialist, SCS, Chester, PA
Neil LeRoux, District Conservationist, SCS, Seneca Falls, NY
Doug Gillette, DEC Liaison, SCS, Avon, NY
Dave Sullivan, State Geologist, SCS, Syracuse, NY

Activities:
A reconnaissance EM survey was conducted at the Indian Hills development in Seneca County on 7 September 1994. An evaluation of the suitability of using GPR techniques to locate buried tiles was completed for Seneca Food Processing in Ontario County on 8 September 1994.

Equipment:
The electromagnetic induction meter used was the EM31 manufactured by Geonics Limited+. The depth of penetration is dependent upon the intercoil spacing, transmission frequency, and coil orientation relative to the ground surface. The EM31 meter integrates values of apparent conductivity over the upper 2.75 m in the horizontal dipole orientation, and over the upper 6.0 m in the vertical dipole orientation. Values of apparent conductivity are expressed in milliSiemens/meter (mS/m).

The radar unit used in this study was the Subsurface Interface Radar (SIR) System-8 manufactured by Geophysical Survey Systems, Inc. The system was powered by a 12-volt vehicular battery. The model 3110 (120 mHz) antenna with a model 705DA transceiver was used in this investigation.

+ Trade names have been used to provide specific information. Their mention does not constitute endorsement.

Discussion:

Indian Hills Housing Development, Fayette Township, Seneca County:

High levels of coliform have been detected in wells located in the area of County House Road, Miller Road, Marshall Road, and Route 96. The purpose of this investigation was to assess the potential of using EM techniques to chart the extent and to find the source(s) of this contamination.

The development is located principally in an area of Schoharie silt loam, 2 to 6 slopes and Schoharie silty clay loam, 0 to 2 percent slopes (Hutton, F. 1972)**. Schoharie is a member of the fine, illitic, mesic Typic Hapludalf family. These deep, well drained and moderately-well drained, high-lime soils formed in glacial lake sediments. The site was not representative of areas of Schoharie soils as limestone or shale bedrock was observed at the surface and in several shallow excavations.

A random walk with the EM31 meter was conducted through and around the periphery of the development. The purpose of this survey was to assess the site for general patterns in electromagnetic responses and to evaluate the suitability of the EM31 meter for detecting contaminants in the soil.

In general, electromagnetic responses were relatively low and invariable across the surveyed areas. Responses ranged from 7 to about 20 mS/m. As the soils were mapped as being deep and fine-textured, these values were surprisingly low. Shallower depths to resistive bedrock and/or the occurrence of coarser-textured soil materials are possible explanation for these low responses.

Responses were lower in swales and depressions, and higher on knolls and ridges. This relationship was believed to reflect shallower depths to the underlying, more resistive bedrock in swales and thicker soil depths on the higher-lying positions.

With the exception of road salts, no manifestations of surface or ground contamination were noted. Readings were 0 to 2 mS/m higher in cultivated fields than in adjoining forested or developed areas. This slight difference reflects variations in management, is considered insignificant (within normal observation errors), and can not be attributed solely to the dissemination of animal wastes on cultivated areas.

In a lawn inundate by runoff from cultivated areas, readings were similar to those observed in nearby, non-inundated areas. No patterns were apparent which could be attributed to the concentration of detectable levels of animal wastes.

Several readings were taken over a known septic tank drain-field. The drain field was located within the development. According to the landowner, the drain field was located above shale bedrock. Electromagnetic responses did not indicate the presence of the drain field. As responses did not disclose the presence of soil

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** Hutton, F. Z. 1972. Soil Survey of Seneca County, New York. USDA Soil Conservation Service. U.S. Government Printing Office, Washington, D. C. p. 143.

contamination, it was assumed that the concentration of wastes were low or waste products had been removed from the soil.

Spray Field for Seneca Food Processing, Ontario County:
The field is artificially drained by several systems of drainage tiles. These tills help to drain excess surface water from lower lying areas. To properly manage this spray field and to contain possible contaminants, the location and condition of these tiles must be known. The purpose of this investigation was to assess the potential of using GPR techniques to chart the locations of abandoned drainage tiles.

The spray field was located in an area of Berrien fine sandy loam, 0 to 6 percent slopes, and Alden silty clay loam, 0 to 1 percent slopes (Pearson and Cline, 1958)***. The Berrien series is no longer recognized and its use has been discontinued. The Berrien soil formed in deep to very deep lacustrine sands overlying finer-textured materials. The Alden soil is a member of the fine-loamy, mixed, nonacid, mesic Mollic Haplaquepts.

The large size of the field, and the small size and large number of drainage tiles made a detailed radar investigation impossible in the time allotted for this investigation. The suitability of using GPR techniques for this investigation was assessed. In areas of Berrien soils, the radar performed remarkably well with adequate depths of observation (estimated to be about 4 to 5 feet with a 50 nanosecond time window) and high resolution of subsurface features. The contact between the coarse- and finer-textured materials was evident and mappable across most transected areas. Several strata and numerous point reflectors were observed within the sands. As the radar detects but does not identify subsurface features, it was ambiguous whether point reflectors represented rock fragments or buried tile lines.

It appears feasible to use GPR techniques to locate buried tiles in areas of Berrien soil. With limited ground-truth verification, the tiles may be found to display unique and recognizable graphic signatures. If the drainage tiles have unique graphic signatures, they may be distinguished from rock fragments. Tiles may also be identified by the occurrence of similar graphic signatures, at comparable depths on three or more parallel radar transect lines. These reflectors should form a line that bisects the radar transect lines.

Results:
1. A reconnaissance survey with an EM31 meter at the Indian Hills Housing Development in Seneca County revealed no indication of surface or soil contamination from the adjoining cultivated areas. Although this was a preliminary and not a detailed investigation, no patterns of potential contaminants from cultivated areas were observed. Electromagnetic responses and patterns appear to reflect variations in

*** Pearson, C. S. and M. G. Cline. 1958. Soil Survey of Ontario and Yates Counties, New York. USDA Soil Conservation Service. U.S. Government Printing Office, Washington, D. C. p. 126.

the depth to bedrock, interference from cultural features (buried utility lines, houses, etc.), and the accumulation of road salts. As no indication of contaminants (other than road salts) were observed, waste products, if present within the depths of observation (0 to 6 m), are assumed to be concentrated at levels that are not detectable with EM techniques.

2. Ground-penetrating radar techniques may aid in the location of buried tile lines. In order to detect tile lines, areas should be systematically sampled using a 2 to 3 m grid interval. In order to justify field costs, the investigated areas should be of concern to management and of limited size.

3. An EM31 meter (serial number 8906013) has been loaned to Dave Sullivan for the period of 8 September to 2 December 1994. Dave has expressed interest in exploring the use of this technique at various sites and applications in New York.

It was my pleasure to work in New York and with Dave Sullivan.

With kind regards

J. A. Doolittle

James A. Doolittle
Soil Specialist

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