United States Department of Agriculture
Soil Conservation Service

Chester, PA 19013
610-490-6042

Subject: Stratigraphic and Hydrogeologic Investigations using Ground-Penetrating Radar (GPR) of Buxton Woods, North Carolina; 11 to 15 July 1994.

Date: 28 July 1994

To: Horace Smith
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Purpose:
To assess the feasibility of using GPR to investigate and map stratigraphic layers within a surficial aquifer.

Participants:
Bill Anderson, Groundwater Hydrogeologist, NCDEHNB/DEM, Raleigh, NC
Jim Doolittle, Soil Specialist, SCS, Chester, PA
Dave Evans, Ass't. Professor of Hydrology, NCSU, Chapel Hill, NC
John Gagon, Resource Soil Scientist, SCS, Edenton, NC
Derek Lewis, Groundwater Hydrogeological Tech., NCDEHNB/DEM
Ted Mew, Senior Hydrogeologist, NCDEHNB/DEM, Raleigh, NC
Phillip Tant, Ass't. State Soil Scientist, SCS, Raleigh, NC
Kai-Ping Wang, Groundwater Modeler, NCDEHNB/DEM, Raleigh, NC

Activities:
On 11 July, a reconnaissance survey was conducted near Lizzie, North Carolina. This study was in support of a ground water recharge investigation and provided broad and rather general information concerning relic stream channels. Multiple traverses were completed with GPR in the Buxton area of Dare County during the period of 12 to 14 July 1994. This study provided stratigraphic information for a surficial aquifer proposed for well field development.

Equipment:
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 either a 12-volt vehicular or a deep-cycle, marine battery. The model 3110 (120 mHz) antenna with a model 705DA transceiver was used in this investigation. The unit was mounted in a 4WD vehicle or a litter.

Survey Procedures:
Calibration:
No calibration trials or verifications of the radar imagery were conducted at the Lizzie Site. The radar profiles provided researchers with superficial stratigraphic information.

In Dare County, as part of the calibration trials, metallic reflectors were buried at depths of 17 and 22 inches (43 and 56 cm). Based on the scaled depths to these reflector, the calculated dielectric constant of the relatively moist, sand deposits ranged from 18 to 20.

The velocity of propagation ranged from 0.220 to 0.234 ft/ns. Below the water table, the dielectric constant and the velocity of propagation were based on tabled values and assumed to be 30 and 0.333 ft/ns, respectively. [1].

During the coarse of the survey in the Buxton area, scanning times of 100, 200, and 300 nanoseconds (ns) were used. Assuming that the velocity of propagation are correct, the maximum observation depth would ranged from about 22 to 23 feet and about 44 to 47 feet with scanning times of 100 ns and 200 ns, respectively. These depths assume the absence of a water table and saturated conditions within the profile. Saturated soil conditions would reduce these observation depths.

Discussion:
Although GPR provided highly resolved images of the subsurface, depths of observation were more restricted than the depths of interest. Hydrogeologists from the Groundwater Section of the North Carolina Department of Environment, Health and Natural Resources were interested in the presence, depths to, and extent of semi-confining beds within the surficial aquifer. These beds, believed to be associated with a buried, relic headland, were either not recognize during the cursory field reviews of the radar profiles or below the maximum observation depths of the 120 mHz antenna. Ground-penetrating radar surveys provide no clear evidence of these semi-confining beds.

Ground-penetrating radar appears to be an appropriate tool for characterizing stratigraphic features within the upper 20 to 30 feet of high dune areas and the upper 5 to 20 feet of most inter-dune areas. Depths were restricted in inter-dunal areas, especially near drainage canals, and on storm-washed or -reworked deposits. In these areas, relatively higher concentrations of soluble salts were believed to have produced more rapid rates of signal attenuation and restricted profiling depths.

At both sites, the use of ground-penetrating radar allowed the rapid and economical collection of extensive and continuous subsurface data. Although observation depths were restricted, GPR technique provided valuable information on near-surface stratigraphic features. This information, especially when integrated with data gather from other sensors, geophysical techniques, and monitoring wells, may provide insight into the deeper-seated aspects of the Buxton and Lizzie sites.

Recommendations:
1. Each agency benefited from the contributions of the other. Cooperative efforts between the Groundwater Section of the North Carolina Department of Environment, Health and Natural Resources and the Soil Conservation Service are encouraged.

2. All radar profiles were studied and annotated in the field. These profiles were turn over to Bill Anderson (Groundwater Hydrogeologist,

1. Morey, R. M. 1974. Continuous sub-surface profiling by impulse radar. Proceeding of the Conference on Subsurface Exploration for Underground Excavation and Heavy Construction. Henniker, NH, August 11-16, 1974. (Amer. Soc. Civ. Eng.) pp. 213-232.

NCDEHNB/DEM, Raleigh, NC) for further analysis. If I can be of further assistance, please do not hesitate to ask. 3

With kind regards

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