United States Department of Agriculture
Natural Resources Conservation Service

160 East 7th Street
Chester, PA 19013

Subject: GPR Field Assistance, Warren and Sussex Counties, New Jersey; 6 & 7 March 1995

Date: 13 March 1995

To: Gail E. Updegraff
State Conservationist
USDA-NRCS
Somerset, New Jersey

Purpose:
To provide ground-penetrating radar (GPR) transect data on the depth to bedrock in various map units in Warren and Sussex Counties.

Principal Participants:
Jim Doolittle, Research Soil Scientist, NSSC, NRCS, Chester, PA
Shawn Finn, Asst. State Soil Scientist, NRCS, Somerset, NJ
David Kingsbury, Soil Scientist, NRCS, Annandale, NJ

Activities:
Ground-penetrating radar transects were conducted in delineated areas of several map units in Sussex and Warren Counties on 6 and 7 March. Several areas were made inaccessible to the radar vehicle because of wet field conditions.

Equipment and Survey Procedures:
The radar unit used in this study was the Subsurface Interface Radar (SIR) System-2 manufactured by Geophysical Survey Systems, Inc. The SIR System-2 consists of a digital control unit (DC-2) with keypad, VGA video screen, and connector panel. 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.

The velocity of signal propagation through the upper part of the soil was estimated to range from 0.242 to 0.244 ft/nanoseconds (ns). Scanning times of 90 or 110 nanoseconds were used. These scanning times provided maximum observation depths of about 11 to 13 feet, respectively.

All GPR transects were conducted in open fields or along access roads. The antenna was towed behind a 4WD vehicle at a speed of about 3 km/hr. At timed intervals, reference marks were impressed on the radar profiles. Though the GPR provides a continuous record of subsurface conditions, estimates of the depth to bedrock were restricted to these referenced or observation points.

Results:
Warren County
Several areas of Nassua (loamy-skeletal, mixed, mesic Lithic Dystrochrepts) and Washington (fine-loamy, mixed, mesic Ultic Hapludalfs) soils were traversed with GPR in Warren County. The interpretative quality of these profiles was generally poor. The underlying shale bedrock was weathered. Weathering weakens electromagnetic gradients across soil/bedrock

interfaces. High soil moisture contents further diluted the electromagnetic gradients across these interfaces. As a consequence, the soil/bedrock interface was poorly expressed and difficult to trace on most radar profiles. Under existing field conditions, no acceptable interpretation of the depths to bedrock in the traversed areas of Nassau and Washington soils was possible. It was suggested that improved radar interpretations could be achieved by returning to these sites at a drier time of the year.

An area of Edneyville gravelly loam, 8 to 15 percent slopes, was traversed with GPR. Edneyville is a member of the coarse-loamy, mixed, mesic Typic Dystrochrepts family. This deep soil formed in materials weathered from granitic gneiss bedrock. In this area of Edneyville soils, radar profiles were interpretable. The following table summarizes data from a GPR transect conducted in an area of Edneyville gravelly loam, 8 to 15 percent slopes. Data are expressed in terms of frequency of observation by soil depth. All depths are expressed in meters.

Table 1
Warren County, New Jersey

Map Unit	Obs.	SOIL DEPTH CLASSES (meters) 0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0
EeC	26	-	31%	38%	19%	8%	4%

Sussex County

Areas of Nassau-Rock outcrop complex, extremely stony (Ng); Bath gravelly loam, 15 to 25 percent slopes (BfD); and Rockaway very stony loam, 5 to 25 percent slopes (RpD), were traversed with GPR. Bath is a member of the coarse-loamy, mixed, mesic Typic Fragiochrepts family. Rockaway is a member of the coarse-loamy, mixed, mesic Typic Fragiudults family. The deep, well drained Bath and Rockaway soils formed in till.

Radar profiles collected in Sussex County were highly interpretable. The following table summarizes data from GPR transects conducted in Sussex County. Data are expressed in terms of frequency of observation by soil depth. All depths are expressed in meters.

Table 2
Sussex County, New Jersey

Map Unit	Obs.	SOIL DEPTH CLASSES (meters) 0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0
BfD	25	-	84%	16%	-	-	-
BfD	32	-	-	31%	47%	9%	13%
Ng	27	19%	81%	-	-	-	-
RpD	38	-	13%	24%	31%	29%	3%

Recommendations:

Ground-penetrating radar techniques can be used to extend the depth and increase the frequency of observation. For soil depth or bedrock investigations, GPR is faster and is less labor intensive than traditional soil survey methods. The use of GPR as a quality control tool for the soil survey updates in Sussex and Warren counties is recommended.

At the time of this study, wet soil and field conditions reduced the efficiency of radar operations.

With your approval, Dave Kingsbury and I will schedule additional days for GPR field work in Warren and Sussex counties. These field activities will provide data needed to characterize map unit composition and to improve map unit interpretations.

It was again my pleasure to work in your state and with members of your staff.

With kind regards.

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