United States Department of Agriculture

Soil Conservation Service

Northeast NTC
160 E. 7th Street
Chester, PA 19013

Subject: SOI - Ground-Penetrating Radar (GPR), Field Assistance to Northern New Jersey, October 21-25, 1986

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To:
Joseph C. Branco
State Conservationists
Soil Conservation Service
Somerset, New Jersey

File Code: 430-5

PURPOSE

To continue field testing the ground-penetrating radar (GPR) on selected soils within Northern New Jersey.

PARTICIPANTS

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Equipment

The subsurface interface radar is the SIR System-8. This system consist of the model 4800 radar control unit, model SR-8004H graphic recorder, model DT-6000 digital tape recorder, and the model 30 program control unit. Although the 80, 120, and 30 MHz antennas were used at various times and under differing soil conditions, the 120 MHz antenna with the model 705DA transceiver, providing the best balance of image resolution and probing depths, was preferred.

Discussion

During this field investigation, the GPR was used as a tool for determining the composition of various map units. The first study site was in an area of Penn shaly silt loam, 2 to 6 percent slopes in Somerset County. The GPR effectively charted the upper contact of the shallow to moderately deep bedrock. However, maximum depth of consistent penetration was slightly less than four feet. Within the study area, the average depth to bedrock is 22.4 inches. Based on one transect, the composition

of the map unit is 45 percent Klinesville (loamy-skeletal, mixed, mesic Lithic Dystrochrepts), 45 percent Penn (fine-loamy, mixed, mesic Ultic Hapludalfs) and, 10 percent Lansdowne (fine, mixed, mesic Aquultic Hapludalfs) soils. Present map unit description of Penn shaly silt loam, 2 to 6 percent slopes (PnB) mentions inclusions of small areas of Klinesville, but not Lansdowne soils. Additional transects are needed to establish an estimate of the composition of this map unit at a higher level of confidence.

Two areas of Washington loam, 2 to 8 percent slopes, were investigated in Morris and Warren Counties. Washington (fine-loamy, mixed, mesic Ultic Hapludalfs) soils have increasing amounts of fragments of weathered limestone in the substratum. Depth to bedrock ranges from 5 to 20 feet and is variable over short distances. With microprocessing, the GPR provided a clear, continuous graphic profile of the underlying gravelly C horizon and/or bedrock.

In the Morris County Soil Survey Report, the Washington soil is described as having limestone fragments in the substratum. The amount of limestone fragments increases with increasing soil depth. Depth to limestone bedrock is described as being "at a depth of 6 to 10 feet." In a representative area of Washington loam, 2 to 8 percent slopes, near Long Valley (Morris County), the depth to the gravelly 2C horizon ranged from 16 to 48 inches and averaged 34 inches. Depth to jointed and fractured bedrock ranged from 41 to 74 inches and averaged 56 inches. In the studied area, 20 percent of the soils are very deep and 80 percent of the soils are deep over bedrock.

In Warren County, neither a contrasting gravelly C horizon or bedrock is described in the typical pedon of Washington soil. In a representative area of Washington loam, 3 to 8 percent slopes, near Stewartsville, the depth to the gravelly C horizon ranged from 17 to 64 inches and averagaed 48 inches. Bedrock was not discerned by the GPR within the upper 6 to 8 feet of the soils profiled. The depth to the gravelly C horizon varied as follows: within depths of 20 inches in 11 percent; within depths of 20 to 40 inches in 11 percent; within depths of 40 to 60 inches in 56 percent; and greater than 60 inches in 22 percent of the transected sites.

At the Warren County study area, the GPR failed to detect the argillic horizon of the Washington soil and the fragipan of an included area of Bartley (fine-loamy, mixed, mesic Typic Fragiudults) soil. Admittedly in some profiles the agrillic horizon and fragipan were weakly expressed, the clay bulge enlarged gradually with increasing depth, or the argillic horizon was too close to the surface for the 120 MHz antenna to detect.

Areas of Riverhead (coarse-loamy, mixed, mesic Typic Dystrochrepts) and Dunellon (coarse-loamy, mixed, mesic Typic Hapludults) soils were investigated with the GPR near Lake Tappan in northern Bergen County. The GPR provided clear and interpretable profiles of these soils. In an area of Dunellon soil, the GPR charted the depth to the argillic horizon, thickness of fill and outwash deposits. In an area of Riverhead soil the

GPR provided an exceptional cross-sectional profile of the underlying stratigraphy of the outwash. The GPR separated strata within the Riverhead soil on the basis of grain size, particle size distribution, and bulk density.

A nearly level summit area of Boonton (coarse-loamy, mixed, mesic Typic Fragiudalfs) soils was transected with the GPR on the Palisades near Alpine. The depth to, lateral extent, and variability of the argillic horizon and the underlying bedrock were clearly charted on the radar's graphic profile, but a fragipan was not observed. The argillic horizon appeared to be discontinuous: being segmented by rock fragments of shallow bedrock. The depth to bedrock averaged 25.8 inches and ranged from 14 to 63 inches. Along the transect, 25 percent of the soils were shallow, 62 percent of the soils were moderately deep, and 13 percent of the soils were very deep. The very deep soils within the study area are members of the Wethersfield (coarse-loamy, mixed, mesic Typic Dystrochrepts) series.

A second transect was conducted along a sideslope area at the Flat Rock Brook Nature Center in Englewood. Here, the colluvium was thick and the depth to bedrock was greater than 60 inches. Clearly, the two areas investigated along the Palisades in Bergen County need to be mapped as separate map units.

On Friday, an area of Freehold (fine-loamy, mixed mesic Typic Hapludults) soil was investigated near Freehold. The GPR provided a clear and interpretable profile of the major diagnostic subsurface horizons and distinguishing underlying strata.

Results

This study complements an earlier investigation (see my report of July 2, 1984) and confirms the wide potential of the GPR as a investigatory and quality control tool for soil survey operations in Northern New Jersey. Though restricted to depths of less than 4 feet in soils formed in materials weathered from shale and siltstone, the GPR can, in most areas, provide soil information to depths in excess of 6 feet. In most areas of Northern New Jersey, the GPR can be used to improve the quality of soils data and interpretations.

All graphic profiles have been returned to Carl Eby, State Soil Scientist, under a separate cover letter.

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cc:
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