United States Department of Agriculture

Soil Conservation Service

Northeast NTC
160 East 7th Street
Chester, PA 19013-6092
215-499-3960

Subject: SOI-Investigation; St. Louis Co. Date: 13 October 1989

To: Gary R. Nordstrom
State Conservationist
USDA-SCS
FCS Bldg., Suite 600
375 Jackson Street
St. Paul, MN 55101

Purpose:
To provide ground-penetrating radar (GPR) assistance to the progressive soil survey of St. Louis County for the purpose of determining the depth to bedrock within selected mapped soil delineations.

Principal Participants:
Stu Behling, Geologist, USFS, Duluth, MN
James Doolittle, Soil Specialist (GPR), Chester, PA
Jackie Haskin, Biologist, Univ. of Washington, Orr, MN
Jerry McCormick, Soil Scientist, SCS, Virginia, MN
Bill Nord, Soil Scientist, MAES, St. Paul, MN
Jerry Sharp, Party Leader, SCS, Virginia, MN

Activities:
The GPR unit arrived in Virginia, Minnesota, on the weekend of 23-24 September. Selected sites were traversed with the radar on 25 to 28 September. A backhoe was made available by the University of Minnesota and provided ground truth observations for the purpose of verifying and scaling the radar imagery on 26 to 29 September. The radar unit returned to Chester, Pennsylvania, on 28 and 29 September.

Discussion:
In many upland areas of St. Louis County it is difficult to examine soil profiles and determine the depth to bedrock with conventional soil survey tools (i.e. hand augers, tiling shovels, and mechanical probes). Rock fragments and irregular or weathered bedrock surfaces limit the effectiveness of surface probe techniques. In New England, GPR techniques have helped soil scientist determine the depth to bedrock and determine the composition of map units based on soil depth criteria (Doolittle et al., 1988 and Collins et

al., 1989)*. This study represents the first attempt to expand the concepts and methodology used by SCS in New England to determine the depth to bedrock into the Midwest.

Multiple transects were completed with the GPR near the towns of Buyck, Wahlsten, and Biwabik. Transects were flagged at 50 to 100 foot intervals. Additional, equally spaced observation points were marked on all radar profiles. Transects were conducted along trails having minimum cuts and fills. Radar profiles were scaled on the basis of known depths to bedrock (confirmed with the backhoe at several observation sites along transect lines).

Not all radar profiles were interpretable. The radar interpretations were confounded by images from coarse fragments in the soil; migmatites, vertical bedding planes, or fracturing in the bedrock; and irregular bedrock surfaces. Generally, the radar imagery was more distinct and interpretable in areas of high-grade metamorphism. In this study, thirteen of the twenty-one transects were interpretable and used. These transects are summarized in Table 1. This data should be reviewed by the soil survey party leader and a determination should be made as to the representativeness of the areas transected with the radar. Because of the limited nature of the radar survey, all representative landscape segments on which these map units may occur within St. Louis County have not been sampled and certain soil depth classes may be over- or underestimated.

Table 2 is the actual measurements (in inches) along each of the transect lines. This data may assist the correlation of these map units. All graphic profiles have been returned to Jerry Sharp under a separate cover.

This has been a learning experience. Results were most encouraging. I hope that the data collected during this brief visit is but the being of further data collection with the GPR in northern Minnesota.

James A. Doolittle
Soil Specialist (GPR)

cc:
A. Dornbusch, Jr., Director, SCS, MNTC, Lincoln, NE
D. Heil, State Soil Scientist, SCS, St. Paul, MN
E. Knox, National Leader, SCS, NSSL, National Soil Survey Center, Lincoln, NE
C. Olson, Suprv. Soil Scientist, SCS, NSSIS, NSSL, National Soil Survey Center, Lincoln, NE

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*Doolittle, J. A., R. A. Rebertus, G. B. Jordan, E. I. Swenson, and W. H. Taylor. 1988. Improving soil-landscape models by systematic sampling with ground-penetrating radar. Soil Surv. Horz.29(2):46-54.
Collins, M. E., J. A. Doolittle, and R. V. Rourke. 1989. Mapping depth to bedrock on a glaciated landscape with ground-penetrating radar. Soil Sci. Soc. Am. J. 53:(Nov-Dec Issue).

L. Ratliff, National Leader, SCS, NSSQAS, National Soil Survey Center, Lincoln, NE
J. Sharp, Party Leader, SCS, Virginia, MN

Table 1
Map Unit Composition Based on GPR transects

Map Unit: 674B

Transect #	13a	13b	13c	Average
Soil Depth				
<10"	0%	15%	0%	**5%**
10-20"	0%	0%	0%	**0%**
20-40"	26%	30%	0%	**19%**
40-60"	53%	10%	42%	**35%**
>60"	21%	45%	58%	**41%**

Map Unit: 1343D

Transect #	5
Soil Depth	
<10"	0%
10-20"	21%
20-40"	79%
40-60"	0%
>60"	0%

Map Unit: 1988C

Transect #	1	2	4	7	11	Average
Soil Depth						
<10"	15%	0%	19%	6%	27%	**13%**
10-20"	30%	33%	33%	0%	27%	**25%**
20-40"	50%	61%	38%	12%	41%	**40%**
40-60"	5%	6%	9%	29%	5%	**11%**
>60"	0%	0%	0%	53%	0%	**11%**

Map Unit: 1988E

Transect #	3
Soil Depth	
<10"	0%
10-20"	14%
20-40"	62%
40-60"	10%
>60"	14%

Table 1 (continued)
Map Unit Composition Based on GPR transects

Map Unit: 1943D

Transect #	6
Soil Depth	
<10"	0%
10-20"	0%
20-40"	15%
40-60"	15%
>60"	70%

BEDROCK INVESTIGATION-ST. LOUIS COUNTY, MINN
ALL DEPTHS ARE TO BEDROCK & ARE IN INCHES

TRANSECT	1	2	3	4	5	6	7
MAP UNIT	1988C	1988C	1988E	1988C	1343D	1943D	1988C
	26	26	>60	22	17	33	118
	0	25	>60	23	19	49	132
	19	22	>60	12	31	54	47
	31	22	51	26	39	36	28
	12	20	45	43	31	37	45
	17	17	22	11	30	53	0
	28	14	25	39	22	72	36
	20	31	20	0	25	95	86
	20	22	30	25	20	138	95
	22	17	31	11	22	174	89
	16	14	19	15	25	>210	86
	26	19	28	20	30	>210	43
	8	26	30	20	33	>210	68
	25	19	30	22	33	>210	68
	16	20	31	50	23	193	86
	5	31	28	12	20	198	53
	11	30	20	17	16	160	59
	20	43	12	0	19	98	
	22		12	11	22	64	
	23		20	0		67	
			22	0			
AVERAGE:	18.4	23.2	31.2	18.0	25.1	118.1	67.0

TRANSECT	8	10	11	13a	13b	13c
MAP UNIT	1396E	674D	1988C	674B	674B	674B
	23	>220	39	41	20	68
	36	>220	37	59	25	75
	31	>220	31	54	25	58
	22	>220	34	22	20	82
	33	194	40	32	0	59
	25	90	30	31	0	48
	31	5	30	30	0	65
	12	17	36	31	23	68
	42	40	12	40	31	59
	20	96	23	70	57	82
	30	90	17	80	117	58
	26	128	6	40	116	62
	26	151	0	42	143	
	20	194	16	73	140	
	33	190	8	62	148	
	34	204	0	44	87	
	33	220	11	51	54	
	31	205	20	47	62	
	33	174	11	50	70	
	25	155	9		78	
		220	0			
			17			
AVERAGE:	28.3	154.9	19.4	47.3	60.8	65.3