United States Department of Agriculture
Natural Resources Conservation Service
11 Campus Boulevard Suite 200 Newtown Square, PA 19073

Subject: SOI -- Ground-Penetrating Radar Assistance **Date:** March 1, 2005

To: Theresa M. Chadwick
State Conservationist
USDA, NRCS
Federal Building
2 Madbury Road
Durham, NH 03824-2043

PURPOSE:
The purpose of this study was to use ground-penetrating radar (GPR) to characterize the thickness of organic soil materials and determine the composition of soil map units within peatlands located in Merrimack and Strafford counties, New Hampshire.

PARTICIPANTS:
Thomas Burke, Soil Scientist, USDA-NRCS, Lancaster, NH
Jim Doolittle, Research Soil Scientist, USDA-NRCS-NSSC, Newtown Square, PA
Karen Dudley, Soil Scientist, USDA-NRCS, Concord, NH
Don Keirstead, Soil Scientist, USDA-NRCS, Durham, NH
Don Richard, GIS Specialist, USDA-NRCS, Concord, NH
Kathy Swain, Soil Specialist Database, USDA-NRCS, Concord, NH

ACTIVITIES:
All field activities were completed during the period of 7 to 10 February 2005. Field work was abbreviated because of the advance of a severe "nor'easter" snow storm.

Observations:

1. Don Kierstead conducted all GPR surveys and interpreted the results. During the course of this study, Don received additional training on GPR field methods and data interpretation. I am very pleased with the progress that Don demonstrated this week.

2. The most suitable antenna for work in organic soils is the 70 MHz antenna. Unfortunately, this antenna was found to be defective and unusable for this study. In addition, because of relatively warm weather patterns, field conditions were marginal in most peatlands and most participants fell through the ice and got wet at one time or another. In order to evaluate the SIR-3000 system and 70 MHz antenna for soil survey investigations of peatlands, it is recommend that more extensive surveys be conducted next year under more favorable field conditions.

3. Although the number of sites was limited, peatlands developed in thin layers of outwash overlying finer-textured marine sediments (Bellamey River and Pierce Brook sites) have relatively thin layers of organic soil materials. Peatlands developed in kettles on till (Northfield, Dunbarton, Howard Brook, and Center Strafford sites) generally have thicker layers of organic soil materials.

4. In Strafford County, this limited study revealed no dominant pattern or appropriate soil to collectively rename areas that have been mapped as Fresh Water Marsh (Fa) and Muck and Peat (Mp).

5. All participants are commended for their enthusiasm and dedication in spite of rather difficult and demanding field conditions.

It was my pleasure to work in New Hampshire and with members of your fine staff.

With kind regards,

James A. Doolittle
Research Soil Scientist
National Soil Survey Center

cc:
R. Ahrens, Director, USDA-USDA, National Soil Survey Center, Federal Building, Room 152, 100 Centennial Mall North, Lincoln, NE 68508-3866
S. Hundley, State Soil Scientist, USDA-NRCS, Federal Building, 2 Madbury Road, Durham, NH 03824-2043
D. Hammer, National Leader for Soil Investigations, USDA-USDA, National Soil Survey Center, Federal Building, Room 152, 100 Centennial Mall North, Lincoln, NE 68508-3866
M. Golden, Director of Soils Survey Division, USDA-NRCS, Room 4250 South Building, 14th & Independence Ave. SW, Washington, DC 20250
B. Thompson, MO Team Leader, USDA-NRCS, 451 West Street, Amherst, MA 01002-2995
J. Turenne, Assistant State Soil Scientist, State, USDA-NRCS, 60 Quaker Lane, Suite 46, Warwick, RI 02886-0111
W. Tuttle, Soil Scientist (Geophysical), USDA-NRCS-NSSC, P.O. Box 974, Federal Building, Room 206, 207 West Main Street, Wilkesboro, NC 28697

STUDY SITES:

In Merrimack County, surveyed peatlands are in areas that have been mapped as *Greenwood and Ossippee soils, ponded* (map unit (M.U.) 97); *Greenwood mucky peat* (M.U. 295); or *Ossippee mucky peat* (M.U. 495). The Greenwood and Ossippee soils consist of very poorly drained soils formed in organic deposits. The Greenwood series is a member of the dysic, frigid Typic Haplohemists family and has organic soil layers greater than 51 inches thick. Ossippee soils have organic soil layers that range in thickness from 16 to 51 inches and underlain by loamy sediments. The Ossippee series is a member of the loamy, mixed, dysic, frigid Terric Haplohemists family. Sites located in Merrimack County included areas of map units 295 and 495 near Northfield and an area of map unit 97 near Dunbarton. These sites consist of kettle basins on glacial sluiceways.

In Strafford County, surveyed peatlands are in areas that had been mapped as: *Fresh Water Marsh* (Fa) and *Muck and Peat* (Mp). *Fresh Water Marsh* consists of very poorly drained soils that are composed of moderately decayed organic materials 16 to more than 51 inches thick. *Muck and Peat* are simply described as consisting of very poorly drained soils in depressions on outwash plains, terraces, glaciated uplands, and along the borders to lakes, ponds, and streams. In the Soil Data Mart, soils within these undifferentiated map units are classified as Borohemists (Fa) or Dysic Typic Borohemists (Mp). Based on further investigations, these undifferentiated map units will be assigned more appropriate names.

Sites located in Strafford County included areas of *Fresh Water Marsh* near Barrington (Bellamey River site) and Stratford Center (Center Strafford Site) and *Muck and Peat* near Barrington (Pierce Brook site) and Rochester (Howard Brook sites). These sites consist of kettle basins on glacial sluiceways. The Bellamey River and Pierce Brook sites are underlain by a thin layer of outwash over finer-textured marine sediments. The Howard Brook and Center Strafford sites are underlain by till. The Howard Brook site will be remapped as either *Catden mucky peat* or *Timakwa muck*. The very deep, very poorly drained Catden soil has organic soil layers greater than 51 inches thick. Catden is a member of the euic, mesic Typic Haplosaprists. The very deep, very poorly drained Timakwa soil has organic soil layers that are 16 to 51 inches thick. Timakwa is a member of the sandy or sandy-skeletal, mixed, euic, mesic Terric Haplosaprists. The Center Strafford site will be remapped as *Greenwood and Ossippee soils, ponded* (M.U. 97)

MATERIALS AND METHODS

Equipment:

The radar unit is the TerraSIRch Subsurface Interface Radar (SIR) System-3000 (here after referred to as the SIR System-3000), manufactured by Geophysical Survey Systems, Inc.[1] The SIR System-3000 consists of a digital control unit (DC-3000) with keypad, SVGA video screen, and connector panel. A 10.8-volt lithium-ion rechargeable battery powers the system. The SIR System-3000 weighs about 9 lbs (4.1 kg) and is backpack portable. With an antenna, this system requires two people to operate. The use and operation of GPR are discussed by Daniels (2004). The 70, 200, and 400 MHz antennas were used in this study. It was later learned that the 70 MHz antenna was defective and unusable (GSSI has subsequently exchanged this antenna with another 70 MHz antenna).

The radar records contained in this report were processed with the RADAN for Windows (version 5.0) software program (Geophysical Survey Systems, Inc, 2003).[1] Processing included setting the initial pulse to time zero, color transformation, marker editing, distance normalization, signal stacking, migration, and range gain adjustments.

An Allegro field computer with the Trackmaker software (Geomar Software, Inc.) and a Garmin Global Positioning System Map 76 receiver (with a CSI Radio Beacon receiver, antenna, and accessories that are fitted into a backpack) were used to record position data.[1]

Field Methods:
Areas of organic soils are considered most crossable and suitable for GPR surveys in winter months when the upper part of the soil is frozen. Random traverses were conducted with the GPR across each study site. Along most traverse line, reference points were spaced at intervals of about 15 m. As the study was conducted through wooded areas, all traverses were completed with the GPR control unit carried in a backpack and the antenna carried or towed by hand. The 70 MHz antenna was carried by hand and held about 1 to 2 inches above the snow surface. This antenna is ideally suited to surveys conducted in forested, swamps. The 200 and 400 MHz antennas are 60 and 30 cm wide and must be pulled by hand along the surface. The wider width of the 200 MHz antenna resulted in the frequent entanglement of this device in the undergrowth and debris that typify swamps.

As the antenna passed each reference point, the operator impressed a dashed vertical line on the radar record. The location of reference point was obtained with the Garmin Global Positioning System Map 76 receiver. The receiver was operated in the station-to-station. All readings were obtained in the autonomous mode as signals from base stations (as near as Portsmouth, NH) were not receivable in the areas surveyed. The Latitude/Longitude coordinate systems were used. Horizontal datum is the North American 1983.

Integration of GPS with GIS:
The integration of global positioning system (GPS) and geographic information system (GIS) with GPR provides an effective means of presenting survey results in formats that are familiar to users. Figures 1 and 2 were prepared by the NRCS staff in New Hampshire and show the locations of reference points and radar traverse lines in the Dunbarton and Center Strafford sites, respectively. These images can help soil scientists summarize results and relate organic layer thicknesses to vegetation patterns and/or topographic features.

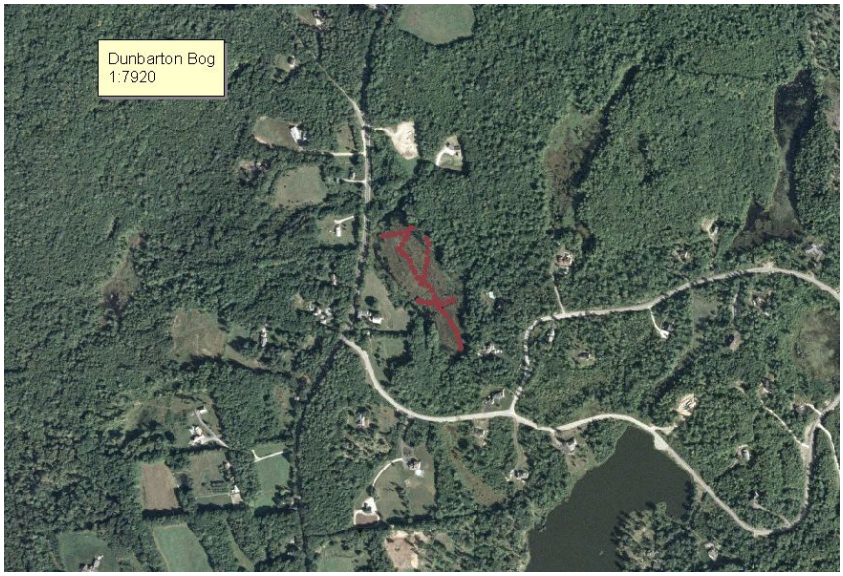

Figure 1. Location of reference points and traverse lines at the Dunbarton Site

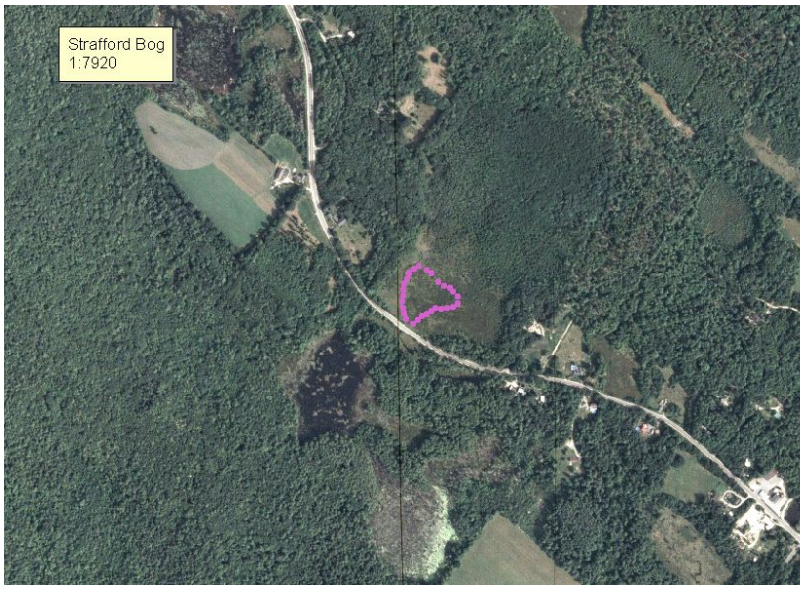

Figure 2. Location of reference points and traverse lines at the Center Strafford Site

Calibration of GPR:
Ground-penetrating radar measures the time it takes electromagnetic energy to travel from an antenna to an interface (i.e., organic/mineral contact, stratigraphic layer) and back. To convert travel time to depth requires knowledge of the velocity of pulse propagation. Several methods are available to determine the velocity of propagation. These methods include use of table values, common midpoint calibration, and calibration over a target of known depth. The last method is considered the most direct and accurate method to estimate propagation velocity (Conyers and Goodman, 1997). The procedure involves measuring the two-way travel time to a known reflector on the radar profile and calculating the propagation velocity with the following equation (after Daniels, 2004):

$$V = 2D/T \qquad [1]$$

Equation [1] describes the relationship of the average propagation velocity (V) to the depth (D) and two-way pulse travel time (T) to a reflector. At several reference points, the two-way radar pulse travel time was compared to the measured depth of the organic/mineral interface and used with equation [1] to estimate the velocity of propagation. The average velocity of propagation and the dielectric permittivity (E_r) were 0.036 m/ns and 69. This velocity of propagation was entered into the SIR System-3000 and used to compute the thickness of organic soil materials at each reference point displayed on radar records.

Interpretations:
A representative radar record is shown in Figure 3. This radar record was collected with the 200 MHz antenna at the Dunbarton site. Abrupt and strongly contrasting changes in water content makes the organic/mineral interface distinguishable on radar records. On this radar record, the organic/mineral interface forms a conspicuous reflector that varies in depth from about 1.8 to 3.0 m. At this site, rates of attenuation in the underlying mineral soil materials are considered moderately high and limit the penetration depth. The lower part of the radar record is plagued by high frequency noise (appears as *snow*) and has a low signal to noise ratio. Very little meaningful information is obtained below a depth of about 3.0 m. The high rates of signal attenuation were attributed principally to the concentration of

ion in the groundwater and/or the clay content of the underlying loamy till. The sharp hyperbolic patterns and inclined reflectors in the upper part of the radar record represents reflections from fractures or breaks in the ice surface.

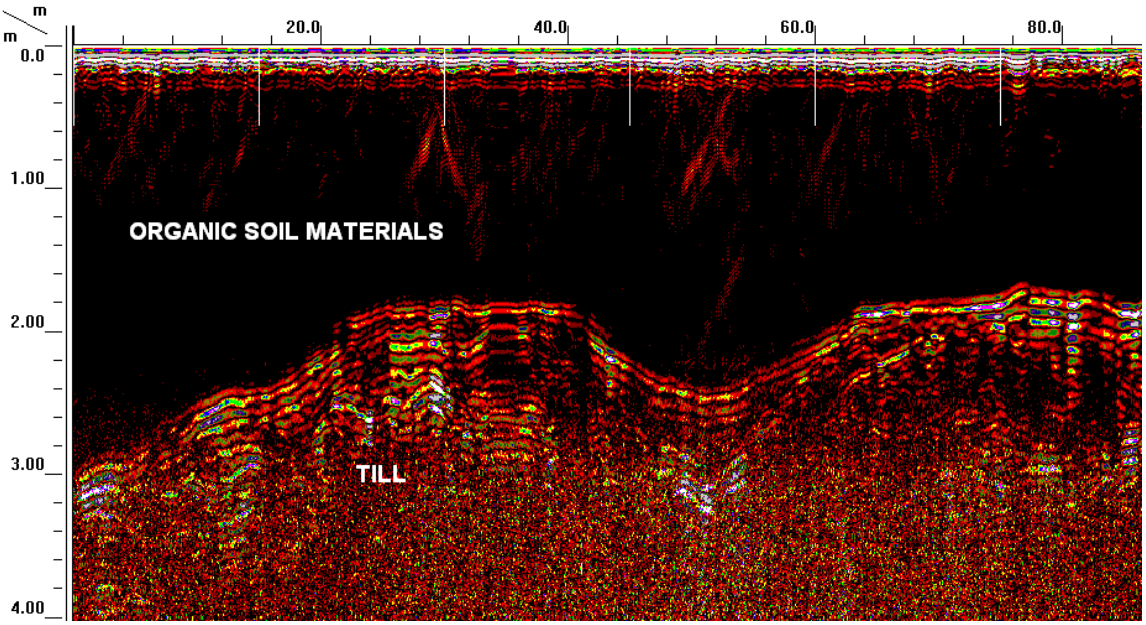

Figure 3. This radar record is from the Dunbarton site and an area of Greenwood soil.

Figure 4 is a representative radar record collected from the Northfield site. This radar record was also collected with the 200 MHz antenna. A green line has been used in Figure 4 to highlight the organic/mineral soil interface that marks the bottom of the basin. Compared with the radar record shown in Figure 3, the organic/mineral soil interface is more ambiguous and interpretative on the radar record shown in Figure 4. Rates of attenuation were high and soil heterogeneities were common within this site. As a consequence, the organic/mineral contact was more difficult to trace laterally across radar records obtained at the Northfield site.

Many of the traversed peatlands contained streams. During former periods and in response to catastrophic events within these watersheds, sediments were deposited on the organic soil materials. In the radar record shown in Figure 4, stratifications are evident within the organic soil materials. A sequence of low to high amplitude, wavy, planar reflectors form a rather thick, continuous zone within the organic soil materials shown in the radar record. These discontinuous reflectors represent deposits of mineral and organic/mineral alluvial materials. Near channels, these deposits are closer to the surface. These deposits affect the hydrology and classification of soils. Presently, a streams continues to meander across the Northfield site eroding the peat and depositing layers of over-washed mineral soil materials.

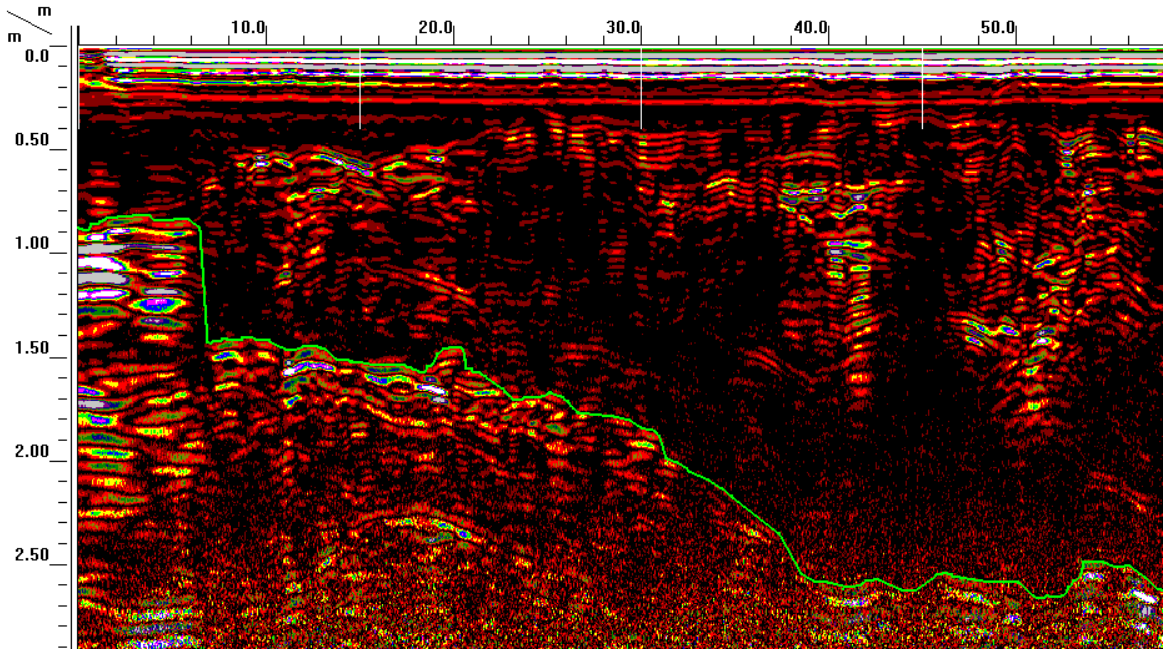

Figure 4. This radar record is from the Northfield site and an area of Ossippee soil.

Results:
Although the number of sites was limited, peatlands developed in thin layers of glacial outwash overlying finer-textured marine sediments (Bellamey River and Pierce Brook sites) have relatively thin layers of organic soil materials. Peatlands developed in kettles on till (Northfield, Dunbarton, Howard Brook, and Center Strafford sites) have generally thicker layers of organic soil materials. At many of the investigated sites, modern and ancestral streams deposited overwash deposits of varying thicknesses within these basins resulting in areas of Histosols that are classified as members of *Terric* great group. In Strafford County, this study revealed no dominant pattern or appropriate soil to collectively rename areas that have been mapped as *Fresh Water Marsh* (Fa) and *Muck and Peat* (Mp).

Merrimack County:
Northfield site:

Based on interpretations made at 20 reference points in areas of *Ossippee mucky peat* (M.U. 495), the averaged thickness of the organic soil layers was about 60 cm, with a range of 31 to 148 cm. One half of these observations had organic soil layers between 45 and 68 cm thick. This peatland developed in a kettle formed in till on a glacial sluiceway. A stream meanders across this basin.

Based on interpretations made at 36 reference points in areas of *Greenwood mucky peat* (M.U. 295), the averaged thickness of the organic soil layers was about 82 cm, with a range of 57 to 114 cm. One half of these reference points had organic soil layers between 75 and 93 cm thick. This peatland developed in a kettle formed in till on a glacial sluiceway. A stream meanders across this basin. A depth class and taxonomic breakdown of these radar traverses are listed in Table 1.

Dunbarton site:

Based on interpretations made at 69 reference points in areas of *Greenwood and Ossippee soils, ponded* (M.U. 97), the averaged thickness of the organic soil layers was about 164 cm, with a range of 97 to 320 cm. One half of these reference points had organic soil layers between 136 and 181 cm thick. This peatland developed in a kettle formed in till on a glacial sluiceway. A stream meanders

across this basin. A depth class and taxonomic breakdown of these radar traverses are listed in Table 1.

Strafford County:

Bellamey River site:

Based on interpretations made at 24 reference points in areas of *Fresh Water Marsh* (Fa), the averaged thickness of the organic soil layers was about 57 cm, with a range of 40 to 100 cm. At one-half of the reference points, the thickness of the organic soil layers was between 45 and 63 cm thick. This site consists of a shallow kettle basin formed over in a thin layer of outwash that is underlain by marine sediments. A stream meanders across this basin. A depth class and taxonomic breakdown of these radar traverses are listed in Table 2.

Pierce Brook:

Because of a dense growth of alders and open water, this area was exceedingly difficult to survey. Based on interpretations made at 11 reference points in areas of *Muck and Peat* (Mp), the averaged thickness of the organic soil layers was about 130 cm, with a range of 105 to 174 cm. At one-half of the reference points, the thickness of the organic soil layers was between 119 and 136 cm thick. This site consists of a shallow kettle basin formed over in a thin layer of outwash that is underlain by marine sediments. A stream meanders across this basin. A depth class and taxonomic breakdown of these radar traverses are listed in Table 2.

Howard Brook site:

Based on interpretations made at 37 reference points in areas of *Muck and Peat* (Mp), the averaged thickness of the organic soil layers was about 306 cm, with a range of 76 to 372 cm. At one-half of the reference points, the thickness of the organic soil layers was between 246 and 370 cm. This site consists of a deep kettle formed in till. A stream meanders across this basin. The maximum depth of penetration with the 200 MHz antenna in this peatland was only 372 cm; at 19 reference points within this site, the thickness of organic soil layers exceeded 372 cm. As a consequence, the statistics reported here underestimate the thickness of organic materials within the peatland. A depth class and taxonomic breakdown of these radar traverses are listed in Table 2.

Center Strafford site:

Based on interpretations made at 29 reference points in areas of *Fresh Water Marsh* (Fa), the averaged thickness of the organic soil layers was about 252 cm, with a range of 112 to 420 cm. At one-half of the reference points, the thickness of the organic soil layers was between 180 and 325 cm thick. This site consists of a deep kettle formed in till. A stream meanders across this basin. A depth class and taxonomic breakdown of these radar traverses are listed in Table 2.

Data Display

Procedures are available to plot georeferenced GPR data onto aerial photographs using ArcView GIS. Figure 5 is an integrated example of the Dunbarton site. In this plot, distributions of organic soil by depth classes and the thickness of organic materials within the peatland are easily identified and related to surrounding landforms. This figure was graciously prepared by Jim Turenne, Assistant State Soil Scientist in Warwick, Rhode Island. Jim has recently developed procedures for rapidly producing similar plots of geo-referenced GPR data. These procedures will soon be added to his website at *http://nesoil.com/gpr/contours.htm*.

Resources are available in New Hampshire and New England to prepare similar plots. These plots help NRCS fulfill the full potentials of modern technologies (GPR, GPS, & GIS) and are impressive and useful to our customers. Soil scientists and land use managers will find this visual imagery familiar and easy to comprehend and orientate.

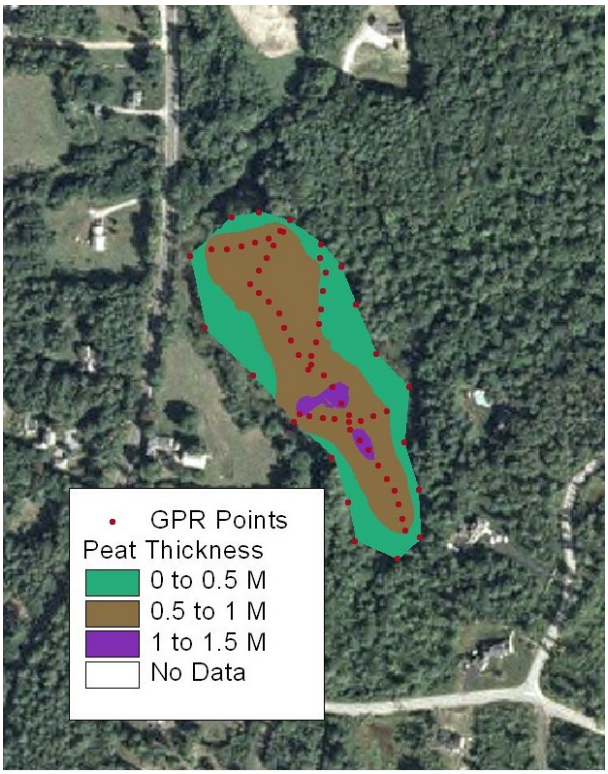

Figure 5. Contour map showing geo-referenced GPR data on the thickness of organic layer overlain on an aerial photograph of the Dunbarton site (mapped prepared using ArcView GIS by Jim Turenne, Assistant State Soil Scientists, Warwick, RI).

References

Conyers, L. B., and D. Goodman. 1997. Ground-penetrating Radar; An introduction for archaeologists. AltaMira Press, Walnut Creek, CA. 232 pp.

Daniels, D. J. 2004. Ground Penetrating Radar; 2nd Edition. The Institute of Electrical Engineers, London, United Kingdom.

Geophysical Survey Systems, Inc, 2003. RADAN for Windows Version 5.0; User's Manual. Manual MN43-162 Rev A. Geophysical Survey Systems, Inc., North Salem, New Hampshire.

Table 1

Frequency Distribution of Organic Soil Material Thickness by Soil Map Unit
Merrimack County
(All depths are in centimeters; "#" signifies number of observations)

Northfield Site

Areas of M.U. 495

Depth	#	Freq.	Great Group
0 to 40	1	0.05	
40 to 130	20	0.90	Terric
>130	1	0.05	Typic
SUM	22		

Areas of M.U. 295

Depth	#	Freq.	Great Group
0 to 40	0	0.00	
40 to 130	36	1.00	Terric
>130	0	0.00	Typic
SUM	36		

Dunbarton Site

Areas of M.U. 97

Depth	#	Freq.	Great Group
0 to 40	0	0.00	
40 to 130	12	0.20	Terric
>130	47	0.80	Typic
SUM	59		

Table 2
Frequency Distribution of Organic Soil Material Thickness by Soil Map Unit
Strafford County
(All depths are in centimeters; "#" signifies number of observations)

Bellamey River Site
Areas of M.U. Fa

Depth	#	Freq.
0 to 40	2	0.08
40 to 130	22	0.92
>130	0	0.00
Sum	24	

Pierce Brook Site
Areas of M.U. Mp

Depth	#	Freq.
0 to 40	0	0.00
40 to 130	5	0.45
>130	6	0.55
Sum	11	

Howard Brook Site
Areas of M.U. Mp

Depth	#	Freq.
0 to 40	0	0.00
40 to 130	4	0.11
>130	33	0.89
Sum	37	

Center Strafford Site
Areas of M.U. Fa

Depth	#	Freq.
0 to 40	0	0.00
40 to 130	4	0.14
>130	25	0.86
Sum	29	

Appendix
Summary of GPR Transect Data on Thickness of Organics

NORTHFIELD SITE, MERRIMACK COUNTY

Longitude	Latitude	(m)	Map Unit
-71.5768	43.4113	0.89	495
-71.5768	43.4113	0.54	495
-71.5767	43.4113	0.42	495
-71.5767	43.4112	0.31	495
-71.5767	43.4112	0.44	495
-71.5766	43.4112	0.45	495
-71.5764	43.4110	0.58	495
-71.5764	43.4110	0.46	495
-71.5764	43.4110	0.43	495
-71.5764	43.4110	0.47	495
-71.5764	43.4109	0.45	495
-71.5765	43.4108	0.50	495
-71.5765	43.4108	0.50	495
-71.5765	43.4108	0.50	495
-71.5766	43.4106	1.48	495
-71.5766	43.4106	0.81	495
-71.5767	43.4106	0.68	495
-71.5767	43.4106	0.86	495
-71.5768	43.4105	0.53	495
-71.5769	43.4105	0.75	495
-71.5770	43.4105	0.67	495
-71.5770	43.4105	0.56	495
-71.5774	43.4104	0.68	295
-71.5775	43.4104	0.72	295
-71.5776	43.4104	0.77	295
-71.5776	43.4103	0.92	295
-71.5777	43.4103	0.93	295
-71.5779	43.4103	0.92	295
-71.5780	43.4103	1.00	295
-71.5781	43.4102	1.14	295
-71.5782	43.4102	1.03	295
-71.5783	43.4102	0.96	295
-71.5784	43.4102	0.96	295
-71.5785	43.4101	0.98	295
-71.5786	43.4101	0.76	295
-71.5788	43.4101	0.74	295
-71.5789	43.4101	0.90	295
-71.5790	43.4101	0.75	295
-71.5791	43.4100	0.71	295
-71.5792	43.4100	0.66	295
-71.5793	43.4099	0.57	295
-71.5794	43.4099	0.59	295
-71.5795	43.4099	0.76	295
-71.5797	43.4099	0.63	295
-71.5798	43.4098	0.68	295
-71.5799	43.4098	0.87	295
-71.5801	43.4098	0.92	295
-71.5789	43.4101	0.79	295
-71.5788	43.4100	0.79	295
-71.5787	43.4099	0.75	295
-71.5786	43.4099	0.75	295

NORTHFIELD SITE, MERRIMACK COUNTY

Longitude	Latitude	(m)	Map Unit
-71.5785	43.4098	0.75	295
-71.5783	43.4097	1.01	295
-71.5782	43.4096	1.01	295
-71.5781	43.4096	0.73	295
-71.5780	43.4095	0.84	295
-71.5779	43.4094	0.86	295
-71.5778	43.4093	0.79	295

DUNBARTON SITE, MERRIMACK COUNTY

Longitude	Latitude	(m)	Map Unit
-71.6149	43.0896	1.37	97
-71.6149	43.0895	1.26	97
-71.6149	43.0894	1.68	97
-71.6149	43.0892	1.82	97
-71.6149	43.0891	1.67	97
-71.6150	43.0890	1.70	97
-71.6150	43.0889	1.90	97
-71.6150	43.0888	1.95	97
-71.6151	43.0886	1.80	97
-71.6151	43.0885	1.34	97
-71.6151	43.0884	1.02	97
-71.6151	43.0884	0.98	97
-71.6150	43.0884	1.19	97
-71.6148	43.0884	1.47	97
-71.6147	43.0884	1.92	97
-71.6146	43.0884	1.72	97
-71.6144	43.0884	1.44	97
-71.6143	43.0884	1.60	97
-71.6142	43.0885	1.59	97
-71.6140	43.0885	0.97	97
-71.6139	43.0885	1.62	97
-71.6139	43.0885	1.27	97
-71.6139	43.0885	0.99	97
-71.6139	43.0884	1.54	97
-71.6140	43.0883	1.34	97
-71.6140	43.0882	1.66	97
-71.6141	43.0880	1.12	97
-71.6139	43.0875	1.12	97
-71.6140	43.0876	1.29	97
-71.6140	43.0877	1.63	97
-71.6141	43.0878	1.90	97
-71.6141	43.0879	1.98	97
-71.6142	43.0880	1.77	97
-71.6144	43.0881	1.75	97
-71.6145	43.0882	1.58	97

-71.6146	43.0883	1.55	97
-71.6146	43.0884	1.81	97
-71.6147	43.0885	2.06	97
-71.6148	43.0886	1.77	97
-71.6149	43.0887	1.73	97
-71.6150	43.0888	1.87	97

DUNBARTON SITE, MERRIMACK COUNTY

Longitude	Latitude	(m)	Map Unit
-71.6151	43.0889	1.79	97
-71.6152	43.0890	1.80	97
-71.6153	43.0891	2.13	97
-71.6154	43.0892	2.61	97
-71.6155	43.0893	2.85	97
-71.6156	43.0894	3.20	97
-71.6157	43.0894	2.25	97
-71.6156	43.0895	1.66	97
-71.6155	43.0896	1.59	97
-71.6154	43.0897	1.72	97
-71.6153	43.0898	1.33	97
-71.6154	43.0898	1.29	97
-71.6155	43.0898	1.43	97
-71.6156	43.0897	1.64	97
-71.6158	43.0897	1.49	97
-71.6159	43.0897	1.89	97
-71.6161	43.0897	1.50	97
-71.6163	43.0897	1.12	97

BELLAMEY RIVER SITE, STRAFFORD COUNTY

Longitude	Latitude	(m)	Map Unit
-70.9828	43.1961	0.56	Fa
-70.9828	43.1961	0.53	Fa
-70.9827	43.1962	0.62	Fa
-70.9827	43.1964	0.60	Fa
-70.9827	43.1967	0.56	Fa
-70.9826	43.1968	0.75	Fa
-70.9825	43.1968	0.65	Fa
-70.9824	43.1969	0.64	Fa
-70.9823	43.1970	0.98	Fa
-70.9822	43.1971	1.00	Fa
-70.9821	43.1971	0.67	Fa
-70.9820	43.1972	0.40	Fa
-70.9821	43.1973	0.43	Fa
-70.9821	43.1974	0.61	Fa
-70.9822	43.1974	0.42	Fa
-70.9821	43.1975	0.48	Fa
-70.9820	43.1976	0.40	Fa
-70.9818	43.1977	0.45	Fa
-70.9817	43.1977	0.54	Fa
-70.9817	43.1979	0.54	Fa
-70.9816	43.1980	0.54	Fa
-70.9815	43.1981	0.54	Fa
-70.9814	43.1981	0.45	Fa
-70.9813	43.1981	0.43	Fa

PIERCE BROOK SITE, STRAFFORD COUNTY

Longitude	Latitude	(m)	Map Unit
-70.9996	43.1800	1.33	Mp
-70.9995	43.1801	1.35	Mp
-70.9994	43.1801	1.43	Mp
-70.9993	43.1801	1.23	Mp
-70.9992	43.1802	1.36	Mp
-70.9991	43.1801	1.32	Mp

PIERCE BROOK SITE, STRAFFORD COUNTY

Longitude	Latitude	(m)	Map Unit
-70.9988	43.1801	1.21	Mp
-70.9987	43.1800	1.17	Mp
-70.9986	43.1800	1.05	Mp
-70.9985	43.1799	1.12	Mp
-70.9984	43.1798	1.74	Mp

HOWARD BROOK SITE, STRAFFORD COUNTY

Longitude	Latitude	(m)	Map Unit
-70.9996	43.1800	2.18	Mp
-70.9995	43.1801	3.30	Mp
-70.9994	43.1801	3.70	Mp
-70.9993	43.1801	3.70	Mp
-70.9992	43.1802	3.70	Mp
-70.9991	43.1801	2.76	Mp
-70.9988	43.1801	2.09	Mp
-70.9987	43.1800	2.25	Mp
-71.0234	43.2919	2.82	Mp
-71.0234	43.2920	3.70	Mp
-71.0234	43.2920	3.70	Mp
-71.0235	43.2921	3.70	Mp
-71.0235	43.2922	3.70	Mp
-71.0235	43.2923	3.70	Mp
-71.0235	43.2924	3.70	Mp
-71.0236	43.2924	3.70	Mp
-71.0237	43.2924	3.70	Mp
-71.0239	43.2924	3.70	Mp
-71.0240	43.2923	3.70	Mp
-71.0241	43.2923	3.70	Mp
-71.0242	43.2922	3.70	Mp
-71.0244	43.2922	3.70	Mp
-71.0251	43.2927	3.72	Mp
-71.0251	43.2928	3.48	Mp
-71.0252	43.2929	3.07	Mp
-71.0252	43.2930	2.13	Mp
-71.0253	43.2930	0.82	Mp
-71.0254	43.2929	1.25	Mp
-71.0255	43.2929	1.38	Mp
-71.0256	43.2927	0.76	Mp
-71.0257	43.2927	1.29	Mp
-71.0258	43.2926	2.46	Mp
-71.0260	43.2925	3.41	Mp
-71.0261	43.2924	3.61	Mp
-71.0262	43.2923	3.70	Mp
-71.0263	43.2922	3.70	Mp
-71.0264	43.2922	3.70	Mp

CENTER STRAFFORD SITE, STRAFFORD COUNTY

Longitude	Latitude	(m)	Map Unit
-71.1455	43.2801	1.12	Fa

-71.1454	43.2802	1.21	Fa
-71.1453	43.2803	1.23	Fa
-71.1452	43.2803	1.18	Fa
-71.1450	43.2804	1.69	Fa
-71.1449	43.2804	1.91	Fa

CENTER STRAFFORD SITE, STRAFFORD COUNTY

Longitude	Latitude	(m)	Map Unit
-71.1448	43.2805	2.18	Fa
-71.1446	43.2805	2.90	Fa
-71.1445	43.2805	3.01	Fa
-71.1443	43.2805	3.74	Fa
-71.1443	43.2806	3.18	Fa
-71.1444	43.2807	3.25	Fa
-71.1445	43.2808	3.50	Fa
-71.1446	43.2809	3.32	Fa
-71.1447	43.2809	4.20	Fa
-71.1449	43.2810	3.84	Fa
-71.1451	43.2811	3.37	Fa
-71.1452	43.2812	3.60	Fa
-71.1454	43.2813	2.99	Fa
-71.1455	43.2812	2.39	Fa
-71.1456	43.2811	1.80	Fa

Longitude	Latitude	(m)	Map Unit
-71.1457	43.2810	2.17	Fa
-71.1458	43.2809	2.12	Fa
-71.1458	43.2808	1.74	Fa
-71.1458	43.2807	1.97	Fa
-71.1458	43.2806	2.86	Fa
-71.1458	43.2805	2.85	Fa
-71.1457	43.2804	2.07	Fa
-71.1457	43.2802	1.67	Fa