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

Subject: Soil – Ground-Penetrating Radar (GPR) Field Assistance **Date:** 18 December 2000

To: Walter W. Douglas
State Conservationist
USDA-NRCS
1835 Assembly Street
Room 950
Columbia, South Carolina 29201

Purpose:
The purpose of this study was to use GPR to detect voids under a concrete spillway for the lake at Oconee State Park, Oconee County South Carolina.

Participants:
Kurt Becht, Chief of Conservation and Maintenance, SCPRT, Cola, SC
Brandon Burton, Conservation Technician, USDA-NRCS, Walhalla, SC
Brodie Davis, D-3 Maintenance, Oconee State Park, SCPRT, Cola, SC
Andrew Davis, Manager, Oconee State Park, SCPRT, Cola, SC
Gene Dobbins, Agricultural Engineer, USDA-NRCS, Greenville, SC
Jim Doolittle, Research Soil Scientist, USDA-NRCS, Newtown Square, PA

Activities:
All activities were completed on 8 December 2000.

Background:
The Civilian Conservation Corps constructed the spillway in the 1930's. The structure is believed to consist of a non-reinforced concrete slab. It has native rock masonry walls. The slab has been undermined at several locations and the outlet section has dropped about 6 to 8 inches. The State wishes to repair the structure and wishes to know the extent of the voids under the spillway.

Equipment:
The radar unit is the Subsurface Interface Radar (SIR) System-2000, manufactured by Geophysical Survey Systems, Inc.[1] Morey (1974), Doolittle (1987), and Daniels (1996) have discussed the use and operation of GPR. The SIR System-2 consists of a digital control unit (DC-2A) with keypad, VGA video screen, and connector panel. A 12-volt battery powered the system. This unit is backpack portable and, with an antenna, requires two people to operate. A 400 mHz antenna were used in this study. For this survey a scanning time of 40 nanoseconds, and a scanning rate was 32 scan/second were used. Hard copies of the radar data were printed in the field on a model T-104 and 608 printers.

Field Procedures:
Twelve survey lines were established spanning the length of the spillway. Each survey line crossed the spillway from one side to the other. Lines varied in length from about 14 to 20 feet. The lines were spaced at intervals of about 10 feet. Along each line survey points were marked on the spillway at intervals of 2 feet. The radar antenna was pulled along each of the survey lines. The GPR provides a continuous profile of the subsurface. As the radar antenna was pulled passed each survey point, the operator impressed a vertical mark on the radar record. The vertical marks identified the survey points. The survey points provide a horizontal scale and identify relative locations along each traverse line.

Results:
With a scanning time of 40 ns, high-resolution radar profiles were obtained with the 400 MHz antenna along the spillway. Radar profiles were printed and discussed in the field. Subsurface features identified on the radar profile included: the concrete pad with reinforced bars or mesh, several pipes, voids and possible fill materials. Several repetitive subsurface features with irregular

[1] Manufacturer's names are provided for specific information; use does not constitute endorsement.

expressions suggested voids or troughs filled with dissimilar materials. These features were pervasive and extend along most of the spillway. These features occur on several profiles, often in approximately the same locations. In addition, their trend conforms to the down slope axes of the spillway.

Ground-penetrating radar detects but does not identify subsurface features. As no ground-truth verification could be made at the time of this survey, results remain interpretative. Geophysical interpretations are considered preliminary estimates of site conditions. The results of all geophysical investigations are interpretive and do not substitute for direct soil coring. The use of geophysical methods can reduce excavation or the numbers of cores, directs their placement, and supplement their interpretations. Interpretations should be verified by ground-truth observations. As the locations of the subsurface anomalies that were detected with GPR are known, the South Carolina State Park Service can core at several points to verify the identity of these features and confirm the presence and extent of subsurface voids. All radar profiles were turned over to Kurt Becht. He will use these records to guide the placement and reduce the number of cores.

With kind regards,

James A. Doolittle
Research Soil Scientist

cc:

R. Ahrens, Director, USDA-NRCS, National Soil Survey Center, Federal Building, Room 152,100 Centennial Mall North, Lincoln, NE 68508-3866

G. Dobbins, Agricultural Engineer, USDA-NRCS, 301 University Ridge, Suite 4900, Greenville, SC 29601

E. Morrow, Assistant State Conservationist (O), USDA-NRCS, 1835 Assembly Street, Room 950, Columbia, South Carolina 29201

C. Olson, National Leader, Soil Investigation Staff, USDA-NRCS, National Soil Survey Center, Federal Building, Room 152,100 Centennial Mall North, Lincoln, NE 68508-3866

H. Smith, Director of Soils Survey Division, USDA-NRCS, Room 4250 South Building, 14th & Independence Ave. SW, Washington, DC 20250

H. Stephens, District Conservationist, USDA-NRCS, 301A West South Broad Street, Walhalla, SC 29691

B. Stuckey, State Soil Scientist, USDA-NRCS, 1835 Assembly Street, Room 950, Columbia, South Carolina 29201

References:

Daniels, D. J. 1996. Surface-Penetrating Radar. The Institute of Electrical Engineers, London, United Kingdom. 300 p.

Doolittle, J. A. 1987. Using ground-penetrating radar to increase the quality and efficiency of soil surveys. 11-32 pp. In: Reybold, W. U. and G. W. Peterson (eds.) Soil Survey Techniques, Soil Science Society of America. Special Publication No. 20. 98 p.

Morey, R. M. 1974. Continuous subsurface profiling by impulse radar. p. 212-232. *IN:* Proceedings, ASCE Engineering Foundation Conference on Subsurface Exploration for Underground Excavations and Heavy Construction, held at Henniker, New Hampshire. Aug. 11-16, 1974.