United States Department of Agriculture | Soil Conservation Service | 160 East 7th Street Chester, PA 19013-6092

Subject: Ground-penetrating Radar (GPR) and Electromagnetic Induction (EM) Surveys in Pike, Centre, and Perry counties; September 16-19, 1991

Date: October 22, 1991

To: Richard N. Duncan
State Conservationist
Soil Conservation Service
Harrisburg, PA

Purpose:
To collect data with the ground-penetrating radar on the depth to bedrock within several soil map units in Pike County. In Centre and Perry counties, using electromagnetic induction methods, detected the presence and location of seepage from a constructed pond and established baseline surveys prior to the construction of a manure stacking area and storage pond.

Participants:
Tom Balthaser, District Conservationist, SCS, New Bloomfield, PA
Bruce Benton, Geologist, SCS, Harrisburg, PA
Jim Bistline, Soil Conservation Technician, SCS, New Bloomfield, PA
Tim Craul, Soil Scientist, SCS, Milford, PA
Jim Doolittle, Soil Specialist, SCS, Chester, PA
George Skowran, Civil Engineer, SCS, Lebanon, PA
Pete Vanderstappen, Ag. Engineer, SCS, State College, PA
Ed White, Soil Correlator, SCS, Harrisburg, PA

Activities:
Transects were conducted with the GPR in Pike County on 16 and 17 September 1991. Surveys of the Pennsylvania State Agricultural Progress Farm's pond and the Pennsylvania State manure stacking sites were completed on 18 September 1991. A baseline EM survey was completed of the Amos Hoover HDP lined manure storage pond on 19 September 1991.

Equipment:
The ground-penetrating radar unit is the Subsurface Interface Radar (SIR) System-8 manufactured by Geophysical Survey Systems, Inc. [1]. Components of the SIR System-8 used in this study were the model 4800 control unit, ADTEK SR 8004H graphic recorder, power distribution

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1. Use of trade names in this report is for identification purposes only and does not constitute endorsement.

unit, transmission cable (30 m), and the model 3110 (120 MHz) antenna. The system was powered by a 12-volt vehicular battery.

The electromagnetic induction meter used was the EM31 manufactured by GEONICS Limited. Measurements of conductivity are expressed as milliSiemens per meter (mS/m). With the EM31 meter in the horizontal dipole mode, the scanning depth is about 2.75 meters. With the EM31 meter in the vertical dipole mode, the scanning depth is about 5.5 meters. Measurements reflect the bulk conductivity averaged over a lateral distance of about 4 meters.

Results:
Geophysical tools provided a rapid, cost effective, and nondestructive method for quality assurance and site assessments. Compared with conventional methods these tools provide greater areal coverage per unit time and cost.

Data collected in Pike County will help to insure the accuracy of map unit descriptions and interpretations, and the validity of map unit names. The baseline EM surveys will provide vital data needed to assess the potential movements of water and contaminants from structures.

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

With kind regards.

James A. Doolittle
Soil Specialist

cc:
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Discussion:

Depth to Bedrock

Soil scientists recognize the need to acquire improved data on the depths to bedrock in upland soil map units. In many upland soils, coarse fragments restrict conventional surveying tools and results are inconclusive. The GPR has been recognized as an efficient tool for bedrock investigation.

Sites for radar transects were selected by the soil party leader prior to the arrival of the unit. Pike County contains large acreage of rugged, forested terrain. Because of the inaccessibility of the terrain, transect sites were located along forest trails which contained a minimum of cuts and fills. Transects were conducted across multiple units with observation sites located at 100 foot intervals along each traverse.

Sites traversed with the GPR included areas which had been mapped as Culver (coarse-loamy, mixed, mesic, Typic Fragiochrepts), DeKalb (loamy-skeletal, mixed, mesic Typic Dystrochrepts), Oquaga (loamy-skeletal, mixed, mesic Typic Dystrochrepts), Swartswood (coarse-loamy, mixed, mesic, Typic Fragiochrepts), and Wurtsboro (coarse-loamy, mixed, mesic, Typic Fragiochrepts) soils.

The depths to bedrock were estimated and recorded for each map unit on the radar profiles. All radar profiles have been returned to Tim Cruel. Tables 1 through 5 summarize the frequency of observation by soil depth classes for each map unit.

Table 1
Frequency of Observations of the Depths to Bedrock
Compiled from GPR Transects
in areas of
CuB - Culver extremely stony loam, 0 to 8 % slope

	Depth to Bedrock (in Inches)				
Transect #	0-10	10-20	20-40	40-60	>60
1	1	1	2	-	6
2	-	-	1	1	8
3	-	-	-	-	10
4	-	-	-		10

Table 2
Frequency of Observations of the Depths to Bedrock
Compiled from GPR Transects
in areas of
CuC - Culver extremely stony loam, 8 to 25 % slope

	Depth to Bedrock (in Inches)				
Transect #	0-10	10-20	20-40	40-60	>60
1	-	-	-	1	13

Table 3
Frequency of Observations of the Depths to Bedrock
Compiled from GPR Transects
in areas of
OED - Oquaga extremely stony loam, 12 to 30 % slope

	Depth to Bedrock (in Inches)				
Transect #	0-10	10-20	20-40	40-60	>60
1	1	3	4	-	-
2	1	5	4	-	-
3	1	6	1	2	-
4	2	4	4	-	-
5	1	5	4	-	-
6	-	4	1	1	-

Table 4
Frequency of Observations of the Depths to Bedrock
Compiled from GPR Transects
in areas of
SwB - Swartswood very stony loam, 0 to 12 % slope

	Depth to Bedrock (in Inches)				
Transect #	0-10	10-20	20-40	40-60	>60
1	-	-	1	1	8
2	1	-	5	3	1
3	-	-	-	1	6

Table 5
Frequency of Observations of the Depths to Bedrock
Compiled from GPR Transects
in areas of Map Units
DeD, SwD, and WuB

	Depth to Bedrock (in Inches)				
Map Unit	0-10	10-20	20-40	40-60	>60
DeD	-	-	1	1	3
DeD	1	4	-	1	-
SwD	-	-	-	5	5
WuB	-	1	1	3	1

Discussion:

EM Surveys

The enclosed contour plot (figures 1 to 6) summarizes the apparent conductivity of the upper 2.75 and 5.5 meters of the earthen materials within the study areas. The grid interval was 50 feet. The contour intervals for the computer generated plots were 2.0 mS/m (figures 1 and 2), 0.5 mS/m (figures 3 and 4), and 1.0 mS/m (figures 5 and 6).

Pennsylvania State Agricultural Progress Farm Pond:

Data from eighty-one observation points were used to construct figures 1 and 2. The location of the farm pond has been identified in each of these figures. Two anomalous patterns are evident in Figures 1 and 2. The elevated EM values near "B" reflect the presence of circular tile and pond drain lids, and pipes. Near "A" an anomalous pattern of slightly higher apparent conductivities is also evident. This pattern may be related to excess soil moisture and may identify the location of a seep. However, changes in soil type (increase clay content) may have caused this pattern. This inferences should be substantiated by ground-truth probings or a second EM survey to evaluate temporal variations in this pattern.

Pennsylvania State manure stacking sites

Data from forty-two observations sites were used to construct figures 3 and 4. A farm road is located at a slight (>80 feet) from the lower portion (x axis; 0 to 300 feet) of these figures. No apparent trends are evident or were expected as this site. The purpose of this survey was to provide baseline information which will be compared with data collected 2 to 3 years following the construction and use of the stacking site.

Amos Hoover HDP lined manure storage pond

Data from seventy-nine observations sites were used to construct figures 5 and 6. The survey covered an area which will be down-gradient of the proposed storage pond. Generally, values of apparent conductivity were higher on lower-lying slope positions and along drainageways. The purpose of this survey was to provide baseline data which will be compared with data collected 2 to 3 years following the construction and use of a manure storage pond.

FIGURE 1

EM31(H) SURVEY OF THE PENN STATE AG. PROGRESS FARM POND

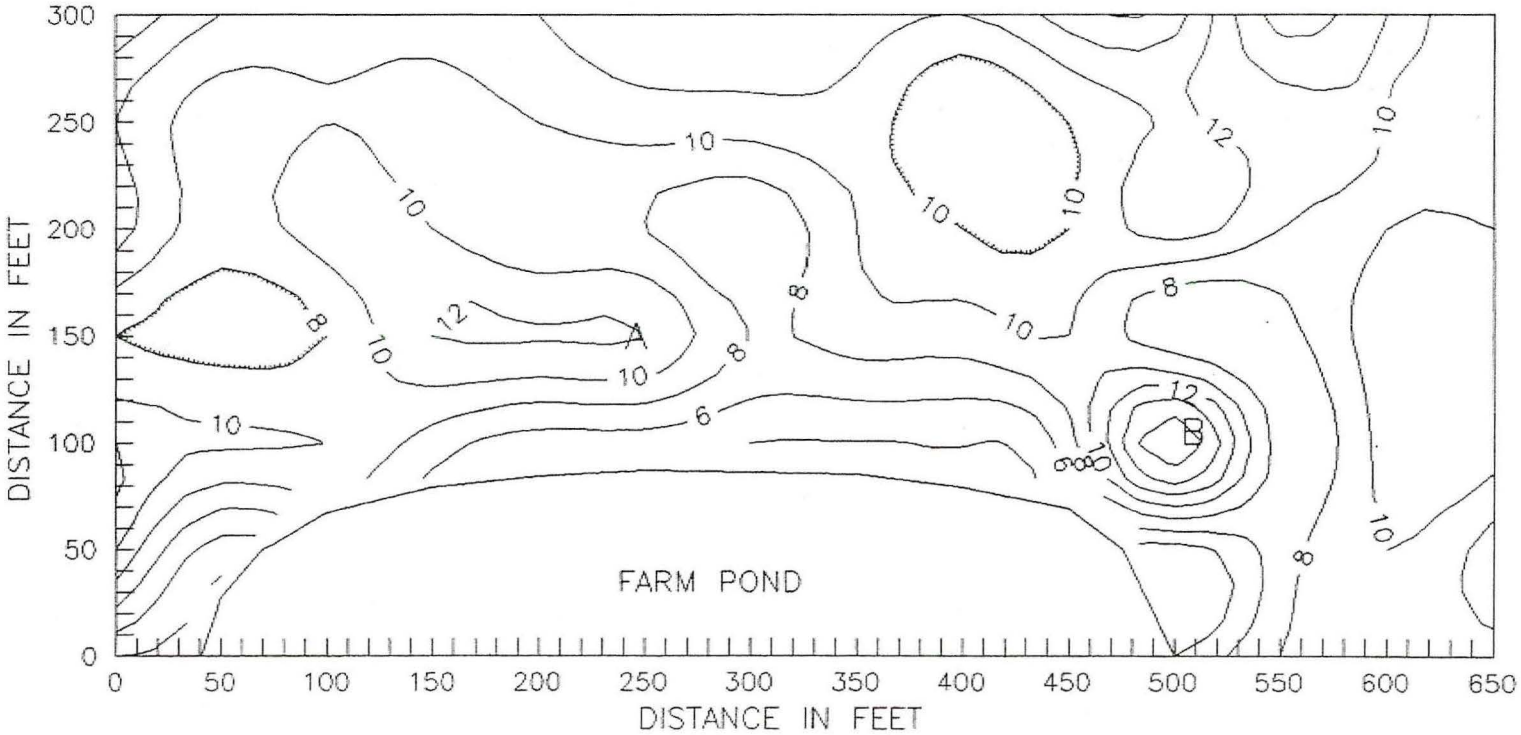
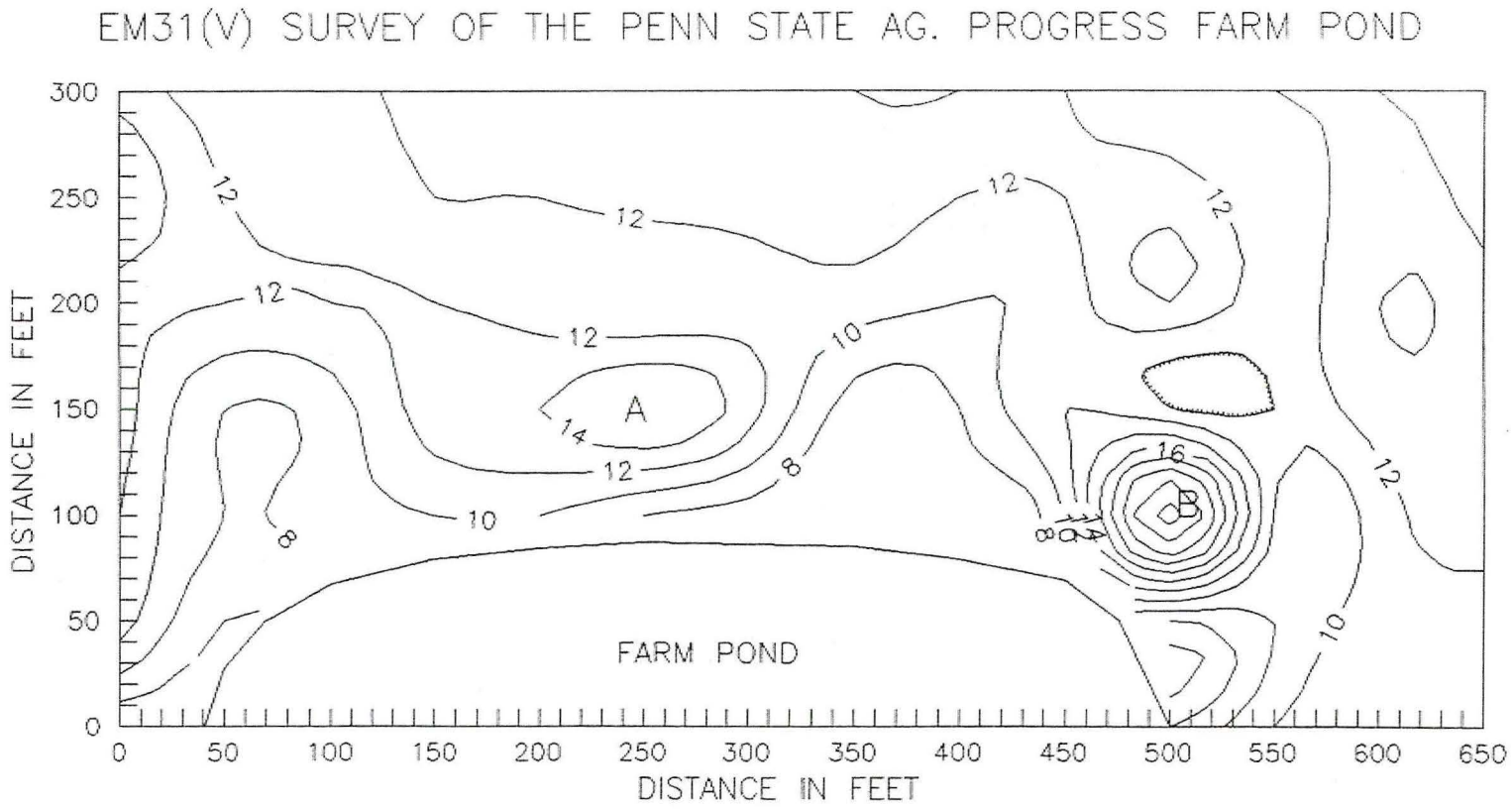


FIGURE 2


EM31(V) SURVEY OF THE PENN STATE AG. PROGRESS FARM POND
DISTANCE IN FEET
DISTANCE IN FEET
FARM POND
A
B
0
50
100
150
200
250
300
350
400
450
500
550
600
650
8
10
12
14
16

Figu-re 3

EM31(H) SURVEY OF PENN STATE MANURE STACKING SITE

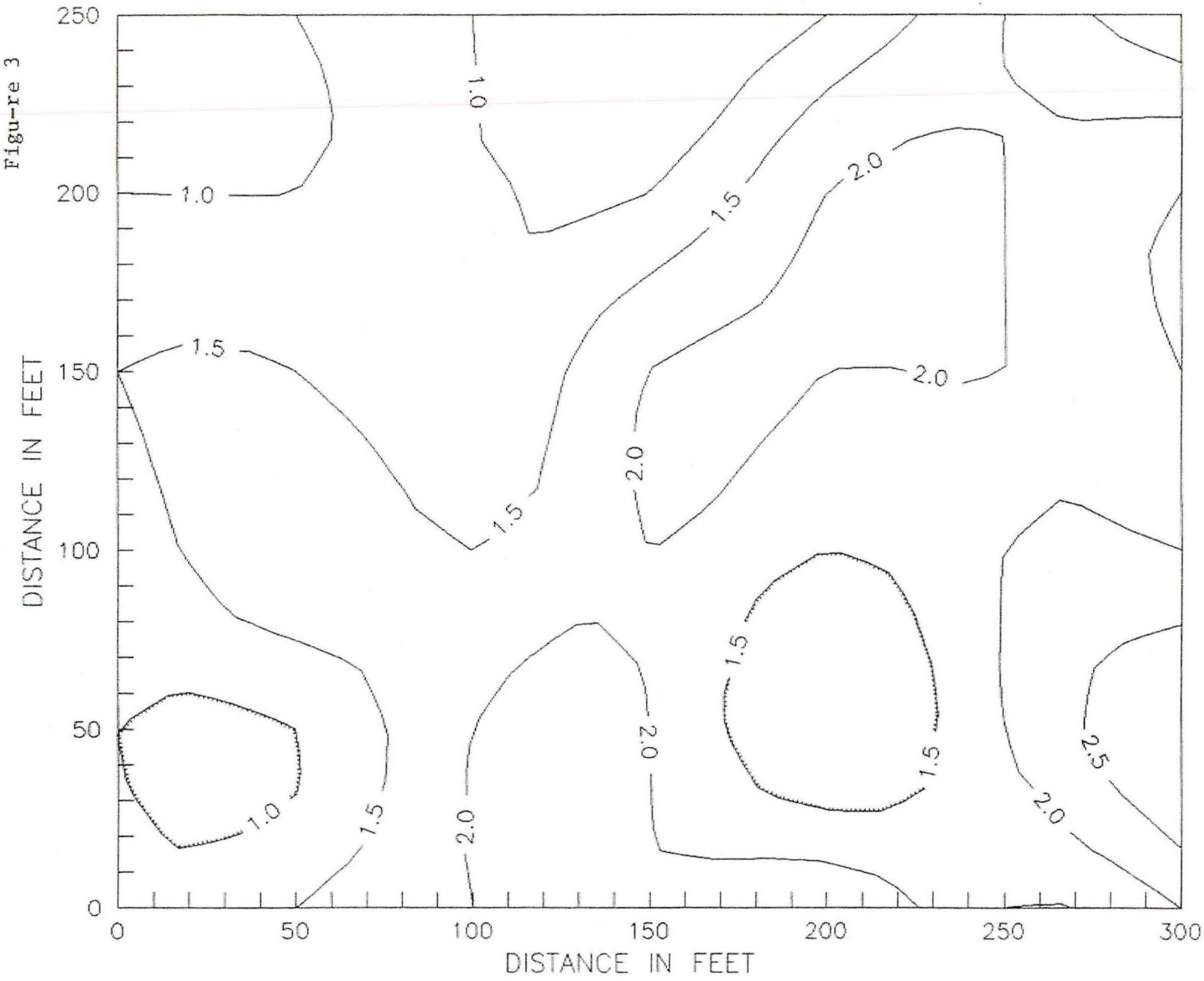
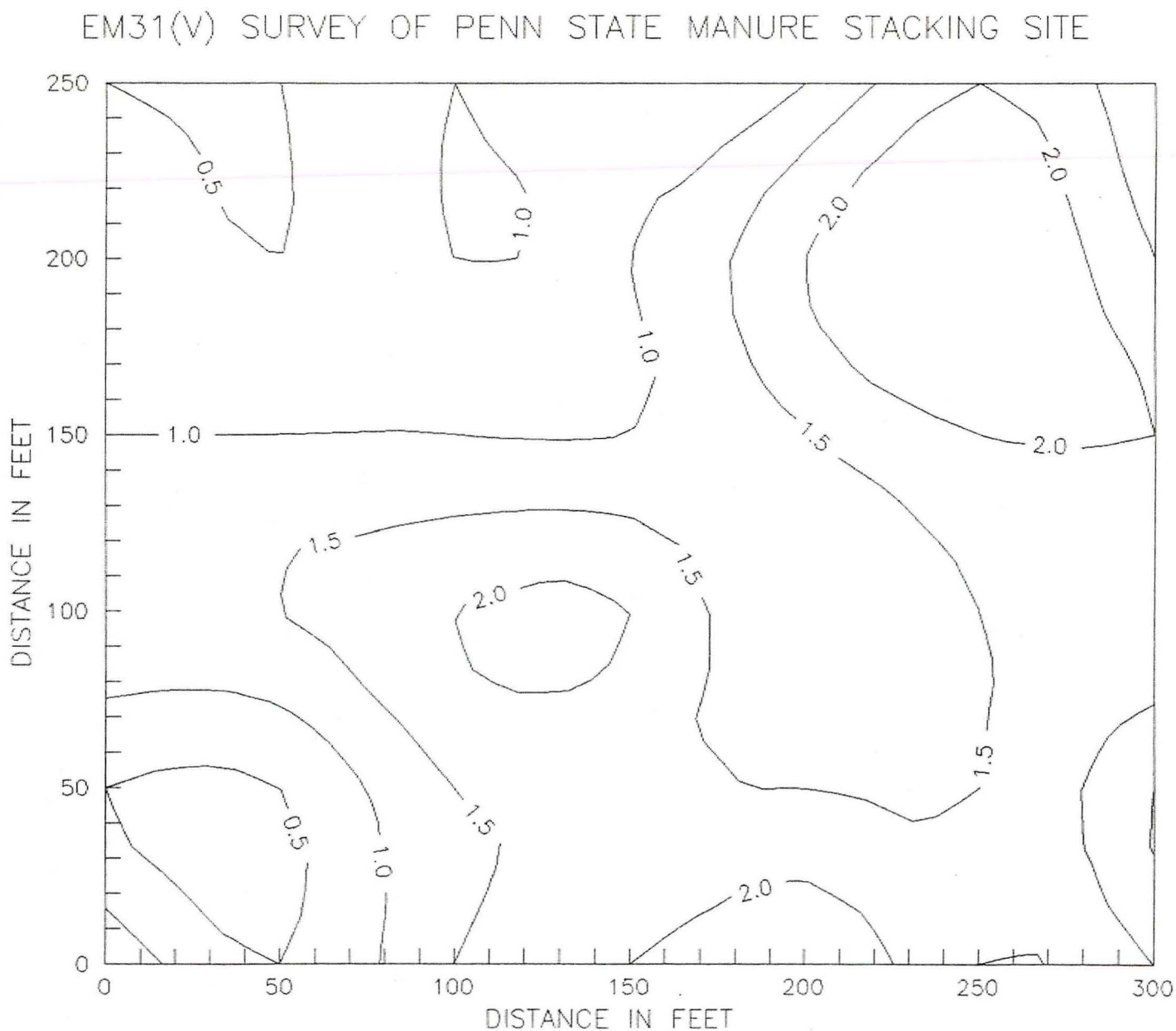


Figure 4


EM31(V) SURVEY OF PENN STATE MANURE STACKING SITE
DISTANCE IN FEET
DISTANCE IN FEET
0
50
100
150
200
250
300
0.5
1.0
1.5
2.0

FIGURE

EM31(H) SURVEY OF SITE OF HOOVER'S HPD LINED STORAGE POND

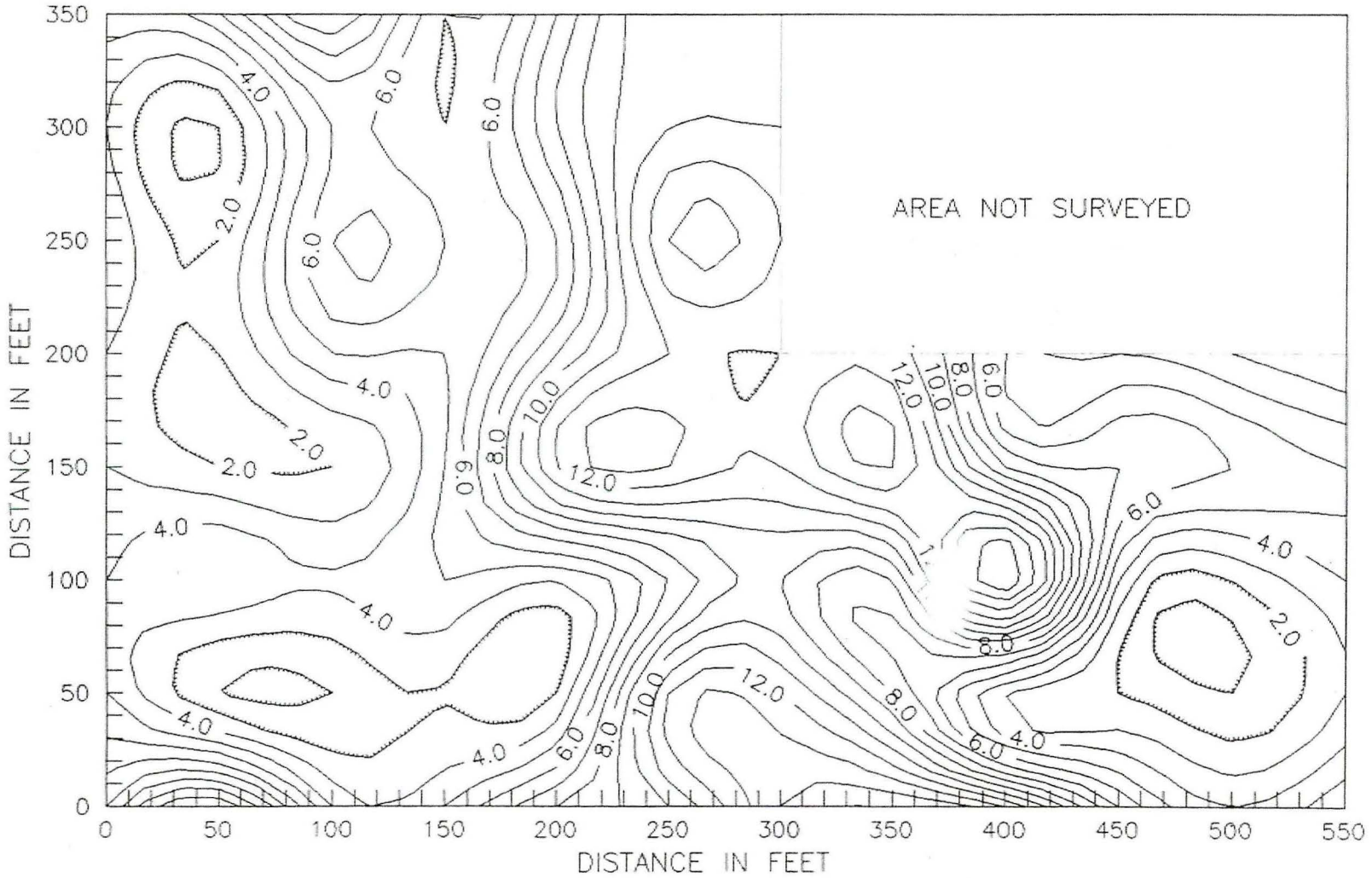
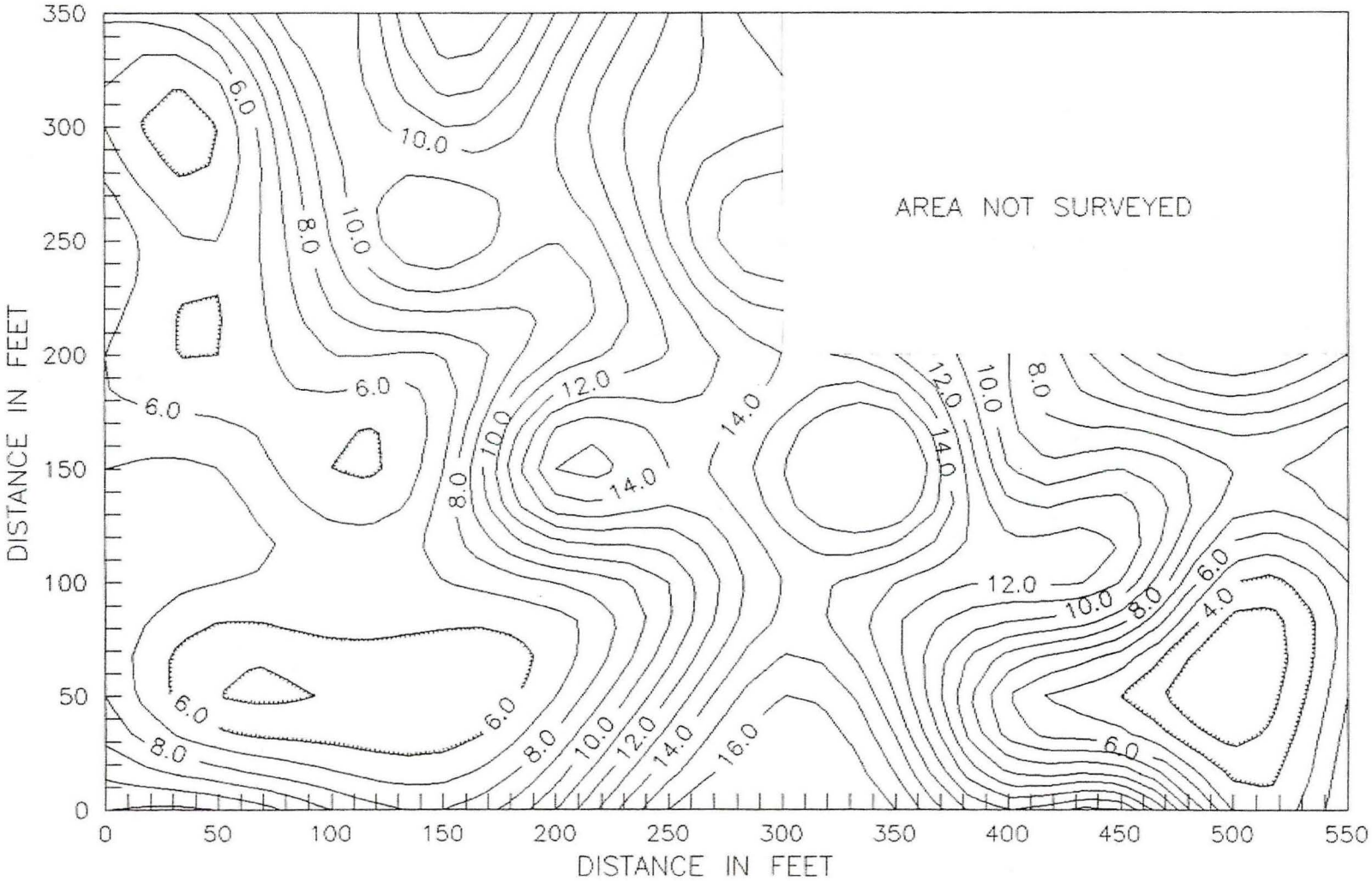
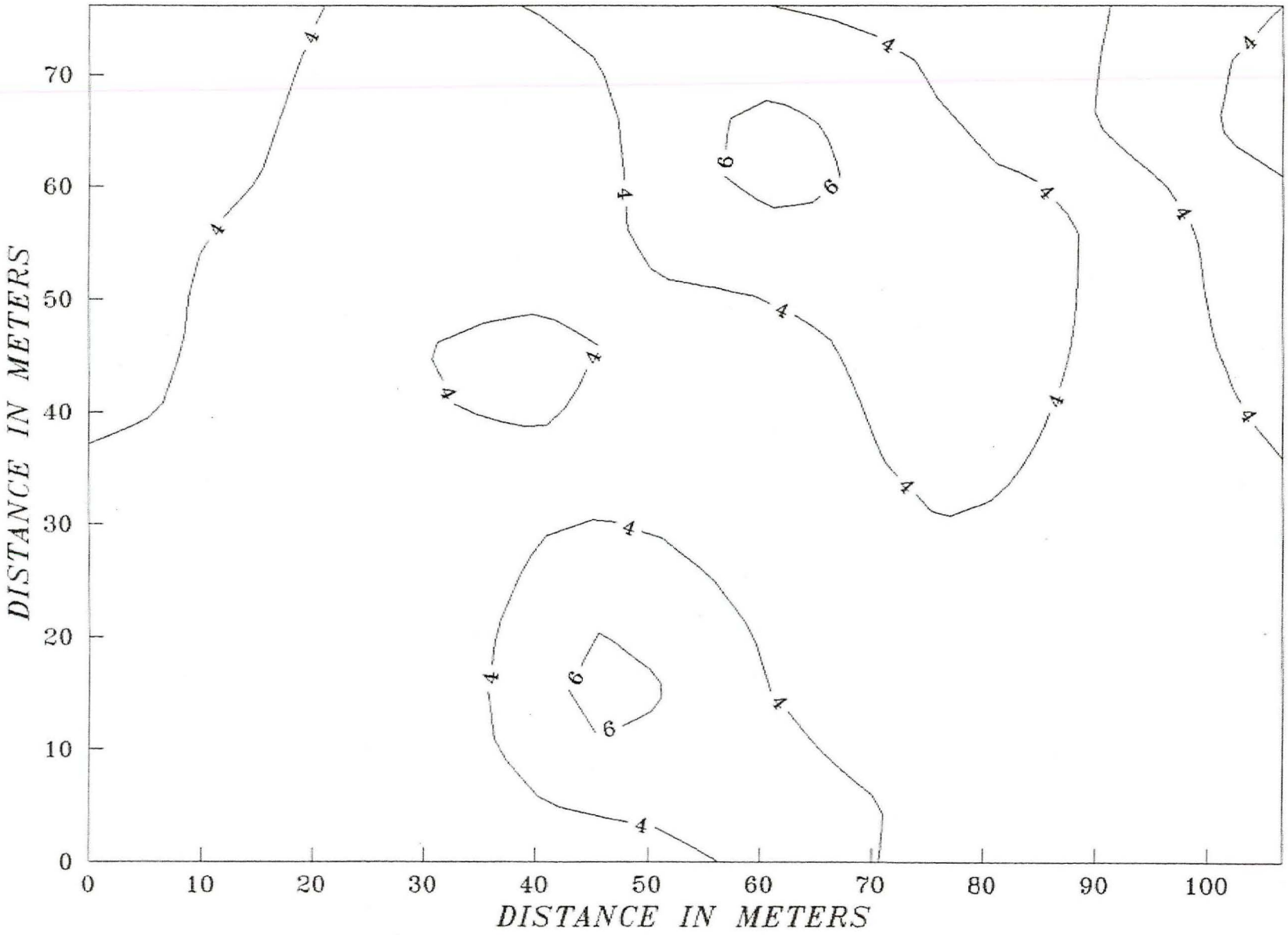


FIGURE 6

EM31(V) SURVEY OF SITE OF HOOVER'S HPD LINED STORAGE POND



SOIL MICROBIAL ENHANCEMENT PROJECT

Figure 9

LACKAWANNA COUNTY DEMONSTRATION SITE 2
EM38 SURVEY
VERTICAL DIPOLE ORIENTATION