

**UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE**

**CHESTER, PA 19013
610-490-6042**

**SUBJECT: Site Assessments with Electromagnetic Induction (EM) Techniques: Pennsylvania
December 14 1994** **DATE: 20 December 1994**

**To: Richard N. Duncan
State Conservationist
USDA-Natural Resources Conservation Service
Harrisburg, PA**

Purpose:

To use electromagnetic induction (EM) techniques to monitor selected agricultural-waste sites for potential groundwater contamination in Union and Schuylkill Counties, Pennsylvania.

Participants:

Bruce Benton, Geologist, NRCS, Harrisburg, PA
Mike Clark, District Engineer, Dauphin County Conservation District,
Dauphin, PA
Bill Deitrick, Nutrient Management Tech., Union County Conservation
District, Lewisburg, PA
Jim Doolittle, Soil Specialist, NRCS, Chester, PA
Andrew Hibbs, District Engineer, Union County Conservation District,
Lewisburg, PA
Margaret Thrasher, Soil Conservationist, NRCS, Pottsville, PA
John Zaginaylo, Area Engineer, NRCS, Bloomsburg, PA

Activities:

Two animal waste-holding sites were surveyed on 14 December 1994. These sites were located in Union and Schuylkill counties.

Equipment:

The electromagnetic induction meter was the EM31 manufactured by GEONICS Limited. The observation depth of the EM meter is dependent upon intercoil spacing, transmission frequency, and coil orientation relative to the ground surface. The EM31 meter scans depths of 0-2.75 meters in the horizontal and 0-6.0 meters in the vertical dipole mode.

Measurements of conductivity are expressed as milliSiemens per meter (mS/m). Two-dimensional plots of the EM data were prepared using SURFER software developed by Golden Software, Inc. A kriging algorithm with an octant search of data points was used to construct the grids. Resulting grid matrices were smoothed using a cubic spline technique.

Field Procedures:

Grids were established at each site. Generally, grids were established in a downslope direction of each waste-holding facility. The grid interval was 25 feet. Survey flags were inserted in the ground at each grid intersection. At each grid intersection, measurements were obtained with the EM31 meter in both the horizontal and vertical dipole modes. At the Union County site, all measurements were obtained with the meter at waist height (about 1 m above the ground surface). At the Schuylkill County site, all measurements were obtained with the meter on the ground surface.

Discussion:

Union County Site

The survey grid was established to the north and west of the manure storage pond and farm buildings. Figures 1 and 2 are two-dimensional plots of apparent conductivity measurements collected with the EM31 meter in the horizontal and vertical dipole orientations, respectively. The grid was located in an area of Hagerstown silt loam, 8 to 15 percent slopes, and Alvira silt loam, 3 to 8 percent slopes. Hagerstown and Alvira are members of the fine, mixed, mesic Typic Hapludults and the fine-loamy, mixed, mesic Aeric Fragiagults families, respectively. Background levels of apparent conductivity (as measured with the EM31 meter in the horizontal dipole orientation) were 12 to 14 mS/m and 16 to 18 mS/m for the Alvira and Hagerstown soils, respectively. A small stream was included in the survey area (see Figure 1 or 2).

In Figure 1, values of apparent conductivity are highest along the northwestern and western perimeter of the manure storage pond and near the north and northwest portions of an animal holding area and silo (the area which was not surveyed). A fairly broad zone of relatively high apparent conductivity values (> 16 mS/m) emanates and extends away from these facilities in a downslope direction (towards the north and northwest). Within this zone values of apparent conductivities decrease horizontally (in a downslope direction). These patterns suggest the possible concentrations of soluble salts from animal wastes in the upper part (0 to 2.75 m) of soils and their probable dissemination by runoff. As the zone of relatively high apparent conductivity appears to intercept the stream, the contamination of the stream by surface runoff is considered most probable.

In Figure 2, values of apparent conductivity are highest along the northwestern and western perimeter of the manure storage pond and near the north and northwest portions of an animal holding area and silo (the area which was not surveyed). A fairly broad zone of relatively high apparent conductivity values (> 20 mS/m) emanates and extends away from these facilities in a downslope direction (towards the north and northwest). Within this zone values of apparent conductivities decrease horizontally (away from the structures and in a downslope direction). These patterns suggest the possible concentrations of soluble salts from animal wastes in the lower part (2.75 to 6.0 m) of soils and their probable dissemination by seepage. As this zone of

relatively high apparent conductivity appears to intercepts the stream, the contamination of the stream by seepage is considered probable.

At most observation points, values of apparent conductivity increased with increasing observation depth (vertical > horizontal dipole orientation). As high conductivities are caused by high moisture, soluble salts or clay contents, it is assumed that one or more of these parameters increase with increasing soil depth. As the observed patterns emanate from the structures and slice across the topography with values often lower in the wettest or lower-lying portions of the landscape, the possibility of deep seepage of contaminants is suggested.

In Figure 2, three anomalous patterns of apparent conductivity values appear to the west of the manure storage area and to the southeast of the stream channel. These patterns are believed to be related to "cultural noise" associated with a small shed and dumped trash.

Schuylkill County Site

The survey grid was established to the east and north of a concrete waste-holding facility and to the east of several farm buildings. Figures 3 and 4 are two-dimensional plots of apparent conductivity measurements collected with the EM31 meter in the horizontal and vertical dipole orientations, respectively.

In Figure 3, values of apparent conductivity are highest around the perimeter of the waste-holding facility. The waste-holding facility was bordered by a chain-linked fence which was a source of unwanted "cultural noise." This noise interfered with and produced elevated EM responses. It is impossible to differentiate the effects caused by the metallic chain-linked fence and those produced by possible leakage of water and contaminants from the structure. The anomalous, circular pattern in the northeast portion of the site is believed to have been produced by a buried metallic object.

In Figure 4, values of apparent conductivity are highest around the perimeter of the waste-holding facility and in the northeast portion of the site. As with measurements taken in the horizontal dipole orientation (Figure 3), it is impossible to differentiate the effects caused by the perimeter chain-linked fence and those produced by possible leakage of water and contaminants from the structure.

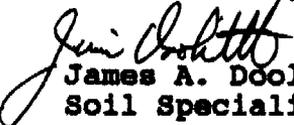
A buried utility line produced a linear pattern (line 150) in the eastern and elevated EM responses in the northeast portions of the site. The higher EM response recorded in the northeast portion of the grid occur in the area where the buried utility line bends towards the northwest. Generally, within this site, these undesired responses disrupted and masked patterns which may have been caused by changes in soil types or drainage.

Results from this survey are inconclusive. Because of interference from "cultural" features, no conspicuous patterns are apparent which suggest leakage of contaminants.

Results:

1. Results from the survey site in Union County suggest potential contamination of the soil from runoff (from animal holding areas) and seepage (from manure holding area). However, EM responses were also influenced by the earthen materials to the immediate west of the manure storage pond. These soil materials were disturbed and contained plant and animal wastes and metallic debris.
2. Results from the survey site in Schuylkill County were inconclusive. Because of excessive interference from a perimeter chain-linked fence and a buried utility line, no conspicuous patterns were apparent in the plots which would suggest the possible leakage of contaminants.
3. EM surveys provide interpretative maps of variations in apparent conductivity at selected sites. Ground truth verification is needed to confirm the nature and magnitude of inferences made from these maps.
4. It is my pleasure to provide continuing technical field assistance to your fine staff and the Conservation Districts of Pennsylvania.

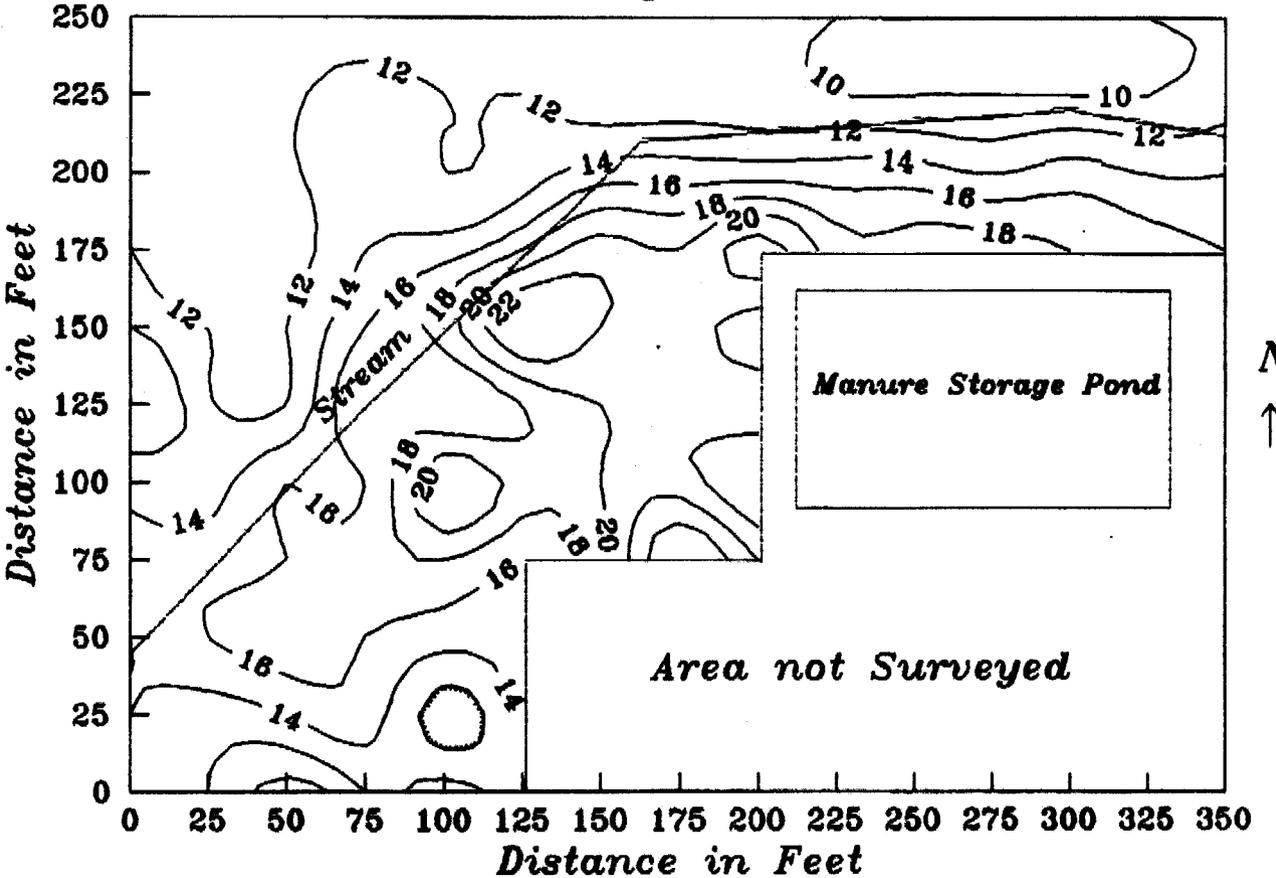
With kind regards.


James A. Doolittle
Soil Specialist

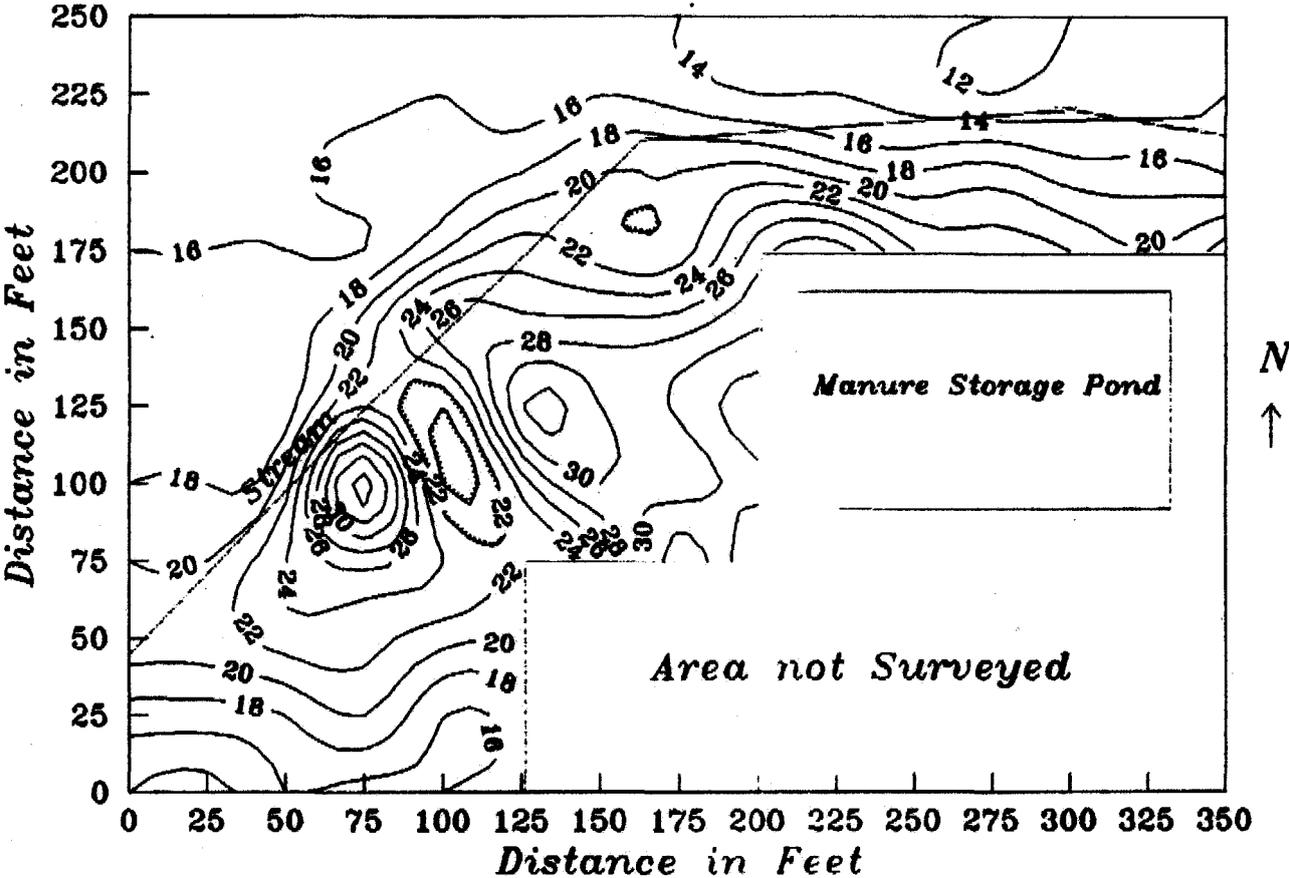
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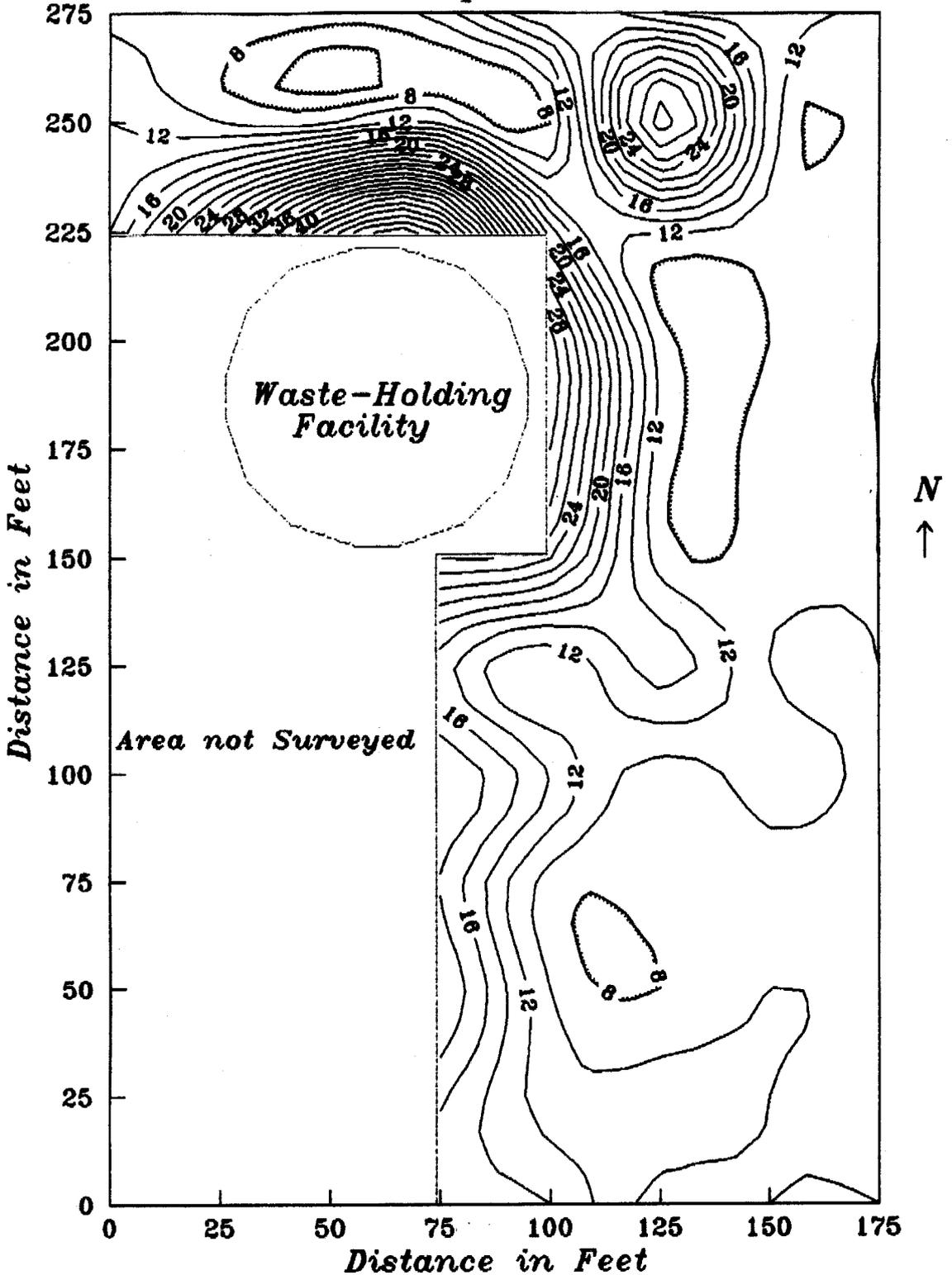
UNION COUNTY SITE
EM31 Survey
Horizontal Dipole Orientation



UNION COUNTY SITE EM31 Survey Vertical Dipole Orientation



SCHUYLKILL COUNTY SITE
EM31 Survey
Horizontal Dipole Orientation



SCHUYLKILL COUNTY SITE
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