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

Subject: EM-34 Survey at the Gervais Farm near North Enosburg, Vermont **Date:** 7 August 1991

To: John C. Titchner
State Conservationist
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Purpose:
To conduct additional studies of the holding capacity of the animal waste storage facility at the Gervais Farm using electromagnetic induction (EM) methods.

Participants:
Robb Allen, Civil Engineer, SCS, Winooski, VT
Kim Doolittle, Volunteer, Earth Team, Chester, PA
Jim Doolittle, Soil Specialist, SCS, Chester, PA
Dick Fisher, State Design Engineer, SCS, Winooski, VT
Jon Hebert, Engineering Aide, SCS, Winooski, VT
Norm Smith, Civil Engineer, SCS, Winooski, VT

Activities:
A grid was established across the study area and a survey of apparent conductivity was conducted using the EM34 terrain conductivity meter on 9 and 10 July 1991.

Equipment:
A GEONICS EM34-3 terrain conductivity meter with an intercoil spacing of 20 meters was used in this study. Measurements were taken at each grid intersect in the horizontal dipole mode. Compared with the vertical dipole mode, this configuration of the EM34-3 meter is relatively insensitive to coil misalignment. With the EM34-3 meter, the horizontal dipole mode provided a scanning depth of about 15 meters[1]. All measurements were expressed in milliSiemens per meter (mS/m). Measurements reflect the bulk conductivity averaged over a lateral distance of about 20 meters and a vertical distance of about 15 meters.

Survey Area:
Three hub lines (established during the November 1990 survey) were located in the field and used to re-establish the grid. The area surveyed with the EM34-3 was restricted to the portion of the original grid located down-slope from the lagoon. This provided a 1050 by 850 to 900 foot survey area. The grid interval was maintained at 50 feet. The survey area covered about

1. McNeill, J. D. 1980. Electromagnetic terrain conductivity measurements at low induction numbers. GEONICS Ltd. Technical Note TN-6. Mississauga, Ontario, Canada. pp. 15.

20 acres and consisted of 363 equally spaced observation points.

The surface layers were not uniformly moist at the time of the survey. Wet soil conditions were encountered in swales, seeps and along drainageways. Drier soil conditions occurred on most convex surfaces. Slight (<1 mS/m) variations in EM measurements were observed between these wetter and drier areas.

Interference from charged electrical fences and utility lines was observed. Electrical interference produced either pulsating EM meter readings or divergent values when the coils were reorientated by 90°. Orientating the EM coils at a distance and parallel with the utility lines reduced interference. When interference was observed at an observation point, measurements were excluded from this study (four sites).

Discussion:
Measurements obtained with the EM34-3 meter were higher than those obtained with the EM 31 in November 1990. This difference is believed to have been caused principally by differences in soil temperatures between the November (air temperature @ 0° C.) and the July (air temperature @ 23° C.) survey dates. The conductivity of soils is temperature dependent. As observed by McNeill [2], the conductivity of a solution will change about 2% per degree difference centigrade. Furthermore, McNeill noted that this relation applies equally well to ground conductivities over the normal range of ambient soil temperatures.

The enclosed contour plot of the study area summarizes the apparent conductivity of the upper 15 meters of the earthen materials. The contour interval is 1.0 mS/m. Generally, apparent conductivity values increase with decreasing elevation (towards the north). As noted in the report of 7 December 1990, this pattern reflects the transition from coarse-loamy tills to moderately-fine and fine textured glaciolacustrine sediments. In addition, this pattern is believed to reflect, in part, a general deepening of soils over bedrock. Drainageways and seep areas having saturated soil conditions had slightly higher apparent conductivities than drier convex surfaces.

A pattern of higher apparent conductivities adjacent to the lagoon suggest possible seepage. With the exception of the northeast corner, a zone of relatively high (>3 mS/m) apparent conductivity values surrounds the lagoon. While relatively high, 3 mS/m is an exceedingly low value of apparent conductivity. These elevated values are believed to reflect the higher clay content and deeper depths to bedrock within the embankment materials, and the possible seepage of contaminants from the lagoon. As measured over a depth of

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2. McNeill, J. D. 1980. Electrical conductivity of soils and rocks. GEONICS Ltd. Technical Note TN-5. Mississauga, Ontario, Canada. pp. 22.

about 15 meters with the EM34-3 meter, the maximum extent of this area away from the lagoon is about 80 feet. Compared with measurements taken earlier with the EM31 meter (scanning depth of 5.5 meters) the zone of higher apparent conductivities which surrounds the lagoon becomes more restricted with increasing depth scanned. No evidence of extensive seepage from the lagoon is evident within the upper 15 meters.

The southeast portion of the study site is dominated by a large area having apparent conductivity values greater than 2 mS/m. Located within this zone are the lagoon and the former manure stacking area reported in the Field Office Baseline Data Sheet of January 1986. These features, as well as wetter soil conditions and/or greater depths to bedrock may have produced these slightly higher values of apparent conductivity. However, this area is confined by a belt of exceedingly low (1 to 2 mS/m) values which extends in a broad arch from the extreme southwest corner to the southeast portion of the study area. As no "plume" of higher apparent conductivity values breaches this belt, it must be inferred that, within the upper 15 meters of the profile, any potential contaminants emanating from the lagoon has been restricted to the upper sideslope positions adjacent to the structure.

In the enclosed contour plot, an isolated, bow-tie shaped zone of apparent conductivity values greater than 3 mS/m is apparent immediately downslope from the lagoon. This anomaly is located about a livestock watering tank. Because dairy cattle congregate here, this area receives a heavy dosage of animal wastes which will increase the apparent conductivity of the soils.

Results:

1. Spatial patterns of apparent conductivity values revealed by the EM34-3 meter suggest that dissolved salts are not migrating beyond the footprint of the embankment of the animal waste storage facility (lagoon). This area became more restricted as deeper depths (2.75, 5.5, 15 meters) were profiled with the EM31 and EM34-3 meters.

2. The EM34-3 meter revealed no evidence of a hydraulic connection by subsurface waters between the Gervais animal waste storage facility (lagoon) and the Longe Spring.

It was again my pleasure to assist your fine staff. Their assistance in the field was greatly appreciated. With kind regards.

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Soil Specialist

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EM34(H) SURVEY AT THE GERVAIS FARM