Lunenburg Blockhouse Geophysical Survey
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Photo by Vanessa Smith

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Executive Summary

A geophysical survey was conducted on 19 October 2013 at Gallows Hill in Lunenburg. This grim toponym is somewhat of an archaism, for the site is better recognized today as the perch of the iconic Lunenburg Academy. Prior to the school's construction, this hilltop was military property, and historical mapping suggests elements of the town's early defenses were located here. It appears that our survey has located some of these early military features, revealing part of a large structure as well as a faint trace of what may be to be a palisade line associated with the town's original defensive circuit.

I would like to thank the Dr. Henry Cary for his support in carrying out this survey. Saint Mary's University students enrolled in ANTH4827, Advanced Landscape Archaeology, assisted in conducting the survey. They are: Allison Fraser, Don Cull, Samantha Grant, and David Jones. Brittany Houghton, Courtney Glen, Darius Pomeroy, and Vanessa Smith provided valuable assistance, while Duncan McNeill played an essential supporting role as electromagnetic pathfinder and mentor.

The intrepid surveyors (from L to R): Allison Fraser, Vanessa Smith, Darius Pomeroy, Courtney Glen, Brittany Houghton, Don Cull, Samantha Grant, and David Jones.

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THE PROJECT

Lunenburg was established in 1753 as part of a focused effort by British colonial authorities to refashion 'Acadia or Nova Scotia' - a marginal colony nominally gained through conquest in 1713 and populated largely by French and Aboriginal peoples - into a British colony with a loyal, Protestant population (Bell 1961; Plank 2001:122-39). The establishment of a substantial naval base and planned civilian settlement at Halifax in 1749 initiated this process, and the following year saw garrisons stationed at Grand-Pré (Fort Vieux Logis), Beaubassin (Fort Lawrence), and Pisiquid (Fort Edward), as well as the increased foot traffic of ranger companies in and around the settled places (Grenier 2008). Mi'kmaw warriors pushed back, and with the aid of the French government launched a series of punishing attacks on the most exposed British outposts. Their efforts compelled the proprietors of Lawrencetown to abandon their pickets and retreat to Halifax by 1757 (Shears 2013:41-42), and for a time even Dartmouth was tenuously held (Grenier 2008:150, 160-61). Lunenburg's early residents weathered the storm as best they could, their town plot resting behind a "fence of pickets, sharpened at the points, and securely fastened in the ground" (DesBrisay 1895:30) (Figure 1). The first and most important of these blockhouses stood on Gallows Hill (Bell 1961:420-29), though its precise location has been lost. The primary goal of our survey was to see if geophysics could shed any light on this problem.

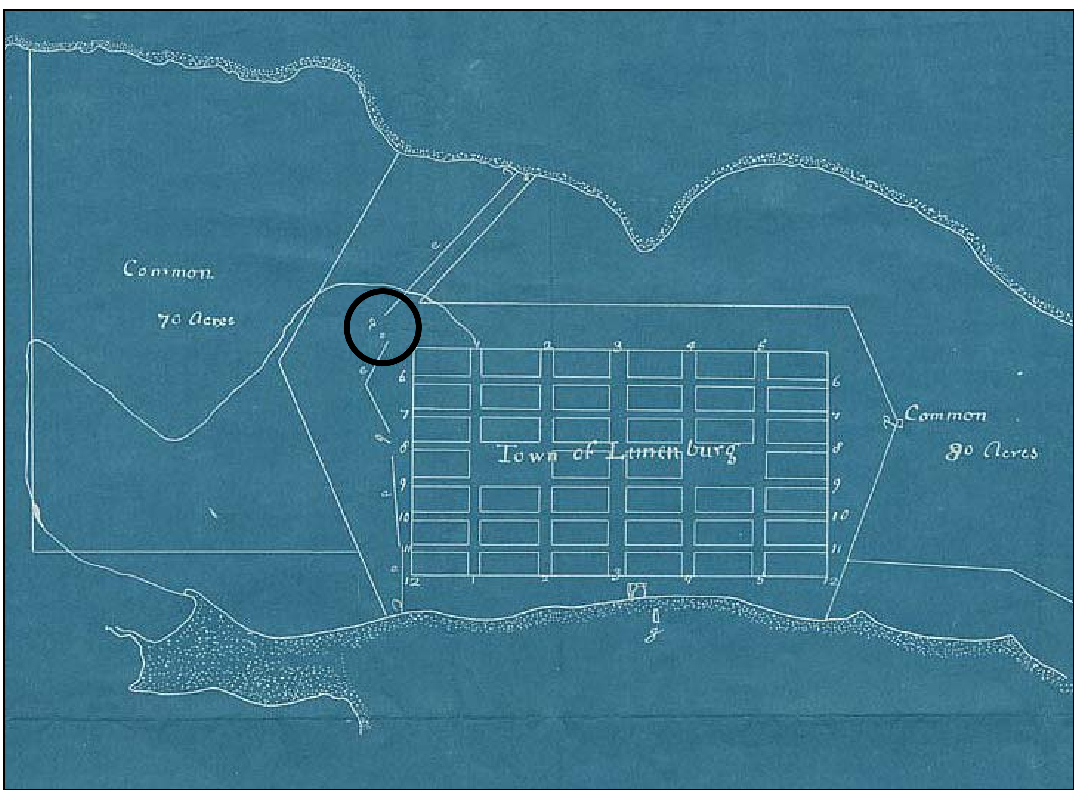

Figure 1: Map of Lunenburg's early defensive features drawn ca. 1770. The Gallows Hill area - the modern Lunenburg Academy property - is circled. The letter (a) in the map's legend reads: "A pentagon Fort with a blockhouse and Barracks." The solid lines extending from this fort are marked as "picket Lines." SOURCE: Nova Scotia Archives (NSA) F/239 Lunenburg ca. 1770 (according to Bell (1961:428) perhaps 1753).

METHODOLOGY

Our geophysical surveys employed the EM38B, a ground conductivity and magnetic susceptibility meter manufactured by the Canadian firm, Geonics Limited. The instrument, which is powered by a 9V battery, contains a transmitter coil that generates a low-frequency electromagnetic field (the primary field). This field induces a secondary field in the ground, which is in turn measured by a receiver coil (Clay 2006:82; McNeill 2012). The strength of the secondary field relative to the primary field allows inferences to be drawn concerning the nature of the soil and its constituents (for a more detailed discussion, see Clark 1996; Dalan 2006; McNeill 1980).

The EM38B is a particularly versatile instrument because it collects two types of data simultaneously: a quadrature phase response (conductivity), measured in millisiemens per metre (mS/m), and an inphase response (magnetic susceptibility), measured in parts per thousand (ppt) (Gater and Gaffney 2006:43). Soil conductivity is a function of several variables, not the least of which is moisture, which in turn may be taken as a proxy for soil porosity and, consequently, the presence or absence of buried archaeological features. Assuming they are filled with loosely-compacted topsoil, back-filled pits or ditches may exhibit higher conductivity than the surrounding soils, while on the other hand buried stone features stand out as exhibiting lower relative conductivity. Magnetic susceptibility is also a function of many variables, among which we have found the presence of iron oxides and chemical changes associated with burning (the LeBorgne effect) to be particularly important (Clark 1996:99-101; McNeill 2013:1-3). The presence of mafic rock in colonial-era architecture in Kings County has made the EM38B the preferred instrument for detecting ploughed-out house sites in that part of Nova Scotia (Fowler 2006).

In vertical dipole mode (coils perpendicular to the ground) the EM38B effectively detects magnetic susceptibility to a depth of 50cm (Dalan 2008:4), which encompasses the plough zone as well as anything preserved immediately beneath, and conductivity to a maximum depth of 1.5m (Clay 2006:83), but most effectively to less than 1m (Dalan 2006:177). This depth of measurement is generally sufficient to detect the sorts of near-surface archaeological deposits commonly found in Nova Scotia.

Archaeogeophysical survey methodologies have been well-developed internationally (Clark 1996; Clay 2006; Dalan 2006; English Heritage 2008; Gater and Gaffney 2006) as well as locally (Fowler 2006; McNeill 2013; McNeill and Fowler 2013). In this instance we conducted the survey on 19 October, 2013. It was a sunny and warm day, with temperatures reaching 16 degrees Celsius in the afternoon. The shape of the Academy building and the presence of scaffolding behind the building prompted us to conduct the survey in three separate squares, which we labelled A, B, and C (Figure 2). Each survey was conducted at 1m line intervals in zigzag transects with the zero line (x co-ordinate) running along the northernmost edge of the survey grid.

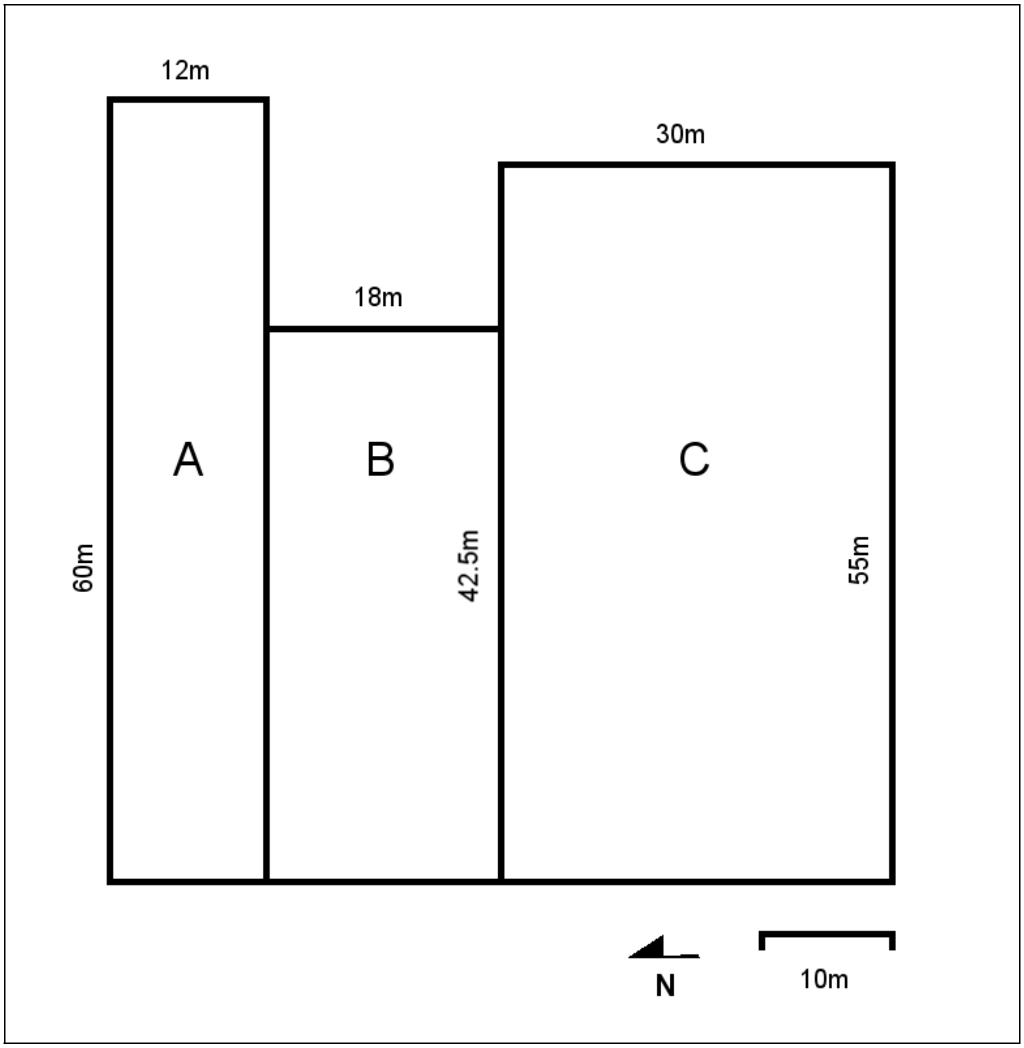

Figure 2: Plan of survey grids in relation to the Lunenburg Academy Building.

Following each survey, data were transferred from the Allegro logger and processed with DAT38BW (version 2.03) software by Geonics Ltd. (Figure 7) and Surfer 8 software by Golden Software Inc. Both procedures are described in detail elsewhere (Geonics Limited 2002; Golden Software Inc. 2002), and is outlined as follows:

1. The raw data is converted from .P38 (logger) format to .B38 (processing) format.

2. Using DAT38BW software, survey geometry is corrected, converted to 50m scale, and zero levels of inphase data are corrected for thermal drift.

3. Using DAT38BW software, separate XYZ files (.dat format) are created for inphase and quad phase datasets.

4. Using Surfer 8 software, the separate XYZ files are gridded and plotted to produce 2D maps of the survey results.

RESULTS

The survey results were impressive, and revealed a great deal of unexpected subterranean evidence, including three large, linear structures and one very considerable susceptibility anomaly which may be the remains of a large building. Quad phase (conductivity) and inphase (magnetic susceptibility) data are described separately.

Conductivity

The dominant features of the conductivity data (Figure 3) are likely fairly recent in origin. There are areas of high conductivity associated with the rear wall of the Lunenburg Academy building running from co-ordinates (4,60) to (12,60), as well as a strong response at the light pole centered at approximately (54,46). This much was expected. The unexpected feature was the large, linear, highly conductive response extending diagonally across survey grid A from co-ordinates (0,20) to (12,43). This may be some kind of buried pipe. It is interesting to note that the area east of this anomaly exhibits higher overall conductivity than the area west of it, which causes one to speculate whether this feature marks a change in soil type or hydrology. Beyond this, only spot anomalies (perhaps isoThe overall conductivity values are consistent with what we would expect in a predominantly loamy soil (Clay 2006:83).

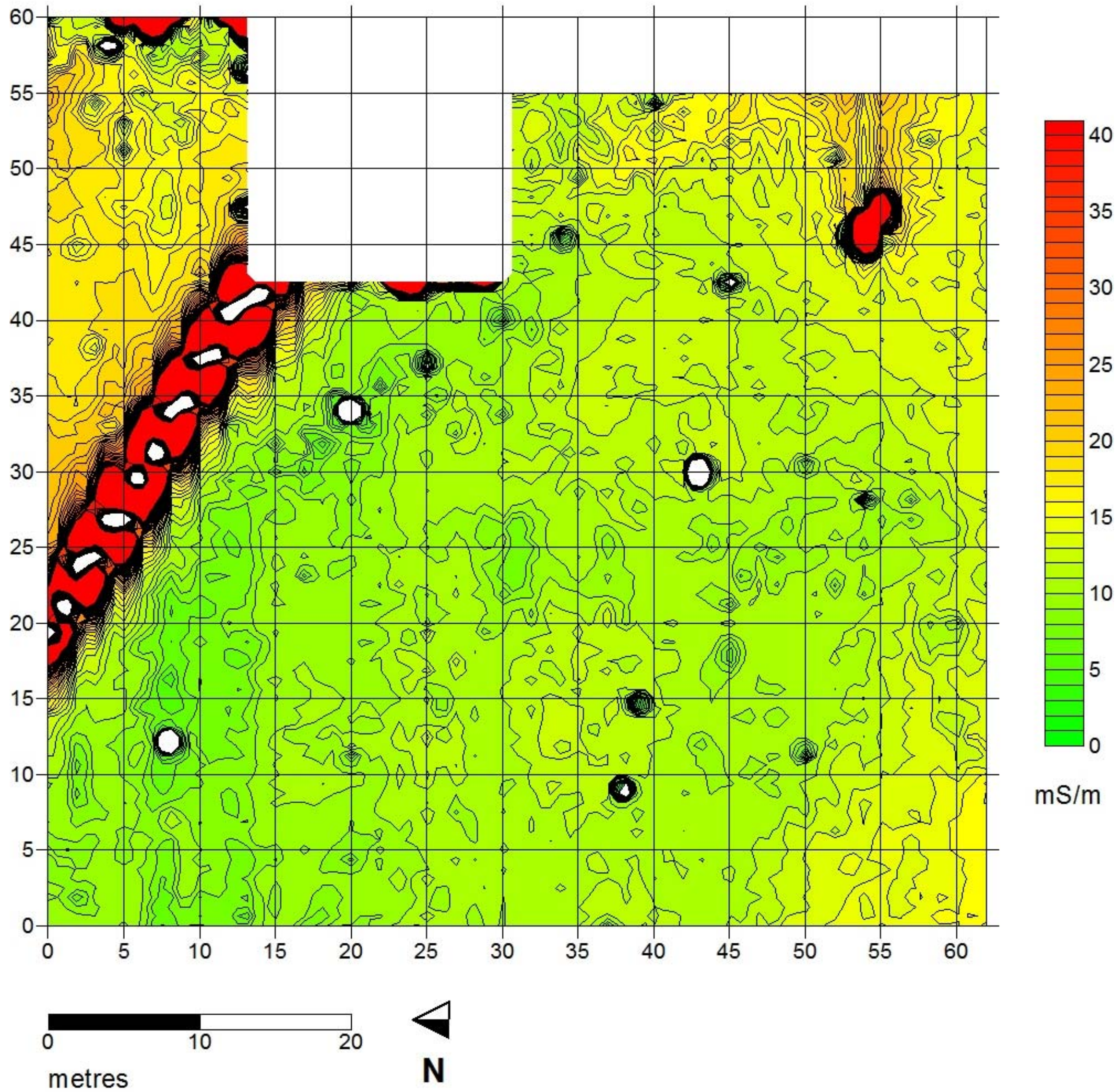

Figure 3: Contour plot of conductivity data. The anomalies shown here appear to be of recent origin.

Magnetic susceptibility

The inphase results were surprisingly illuminating, and the details they contain require some finessing to be fully appreciated. To begin, the most prominent anomalies readily reveal themselves in a standard contour plot (Figure 4). For this plot I have rendered background magnetic susceptibility values (below .2 parts per thousand) in grey, which allows the most anomalous areas to really stand out. At the east end of the survey, an extended zone of high magnetic susceptibility appears to be associated with the Lunenburg Academy building and its driveway. This anomaly is more intense at the east end of grid A because our survey here abutted the building, whereas the east of grid B abutted a pile of metal staging and scaffolding, while the east end of grid C ended several metres from the rear wall of the Academy. The light pole evident in the conductivity data is likewise very clearly visible here (54,46).

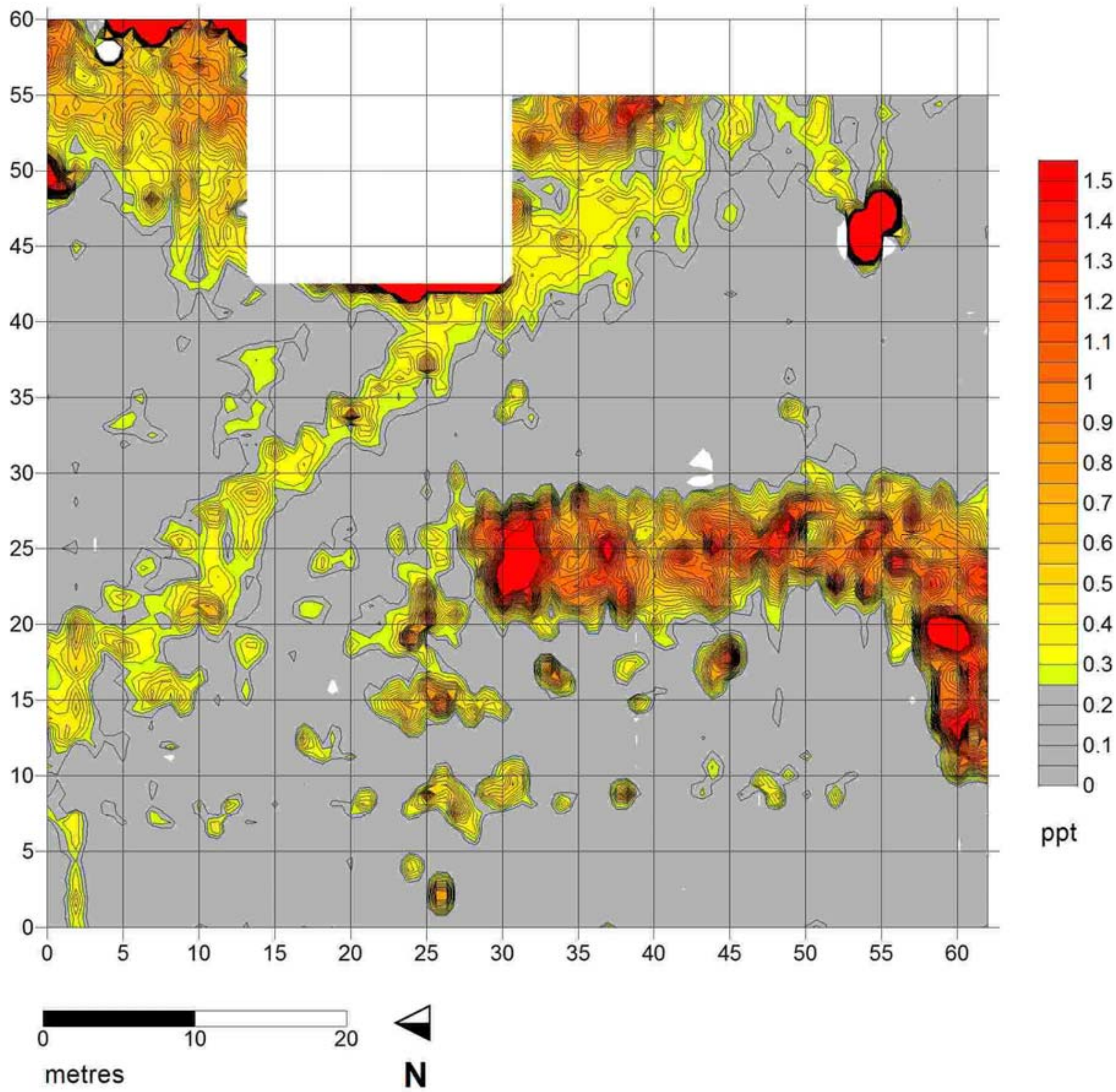

Figure 4: Inphase (magnetic susceptibility) results displayed as a contour map. Several unexpected features have appeared.

So much for the expected. Next, we have a substantial linear susceptibility anomaly extending across grids A and B from co-ordinates (0,15) to (47,55). It is important to observe that this feature is not the intense linear anomaly that we observed in the conductivity data, which actually runs east of this one. The former does not find significant expression in the magnetic susceptibility data, nor does the linear magnetic anomaly stand out in the conductivity channel.

The real surprise in this dataset is the massive susceptibility anomaly beginning near the south end of grid B and dominating grid C. It measures approximately 9m wide and extends for over 30m before continuing off the southern edge of grid C. The somewhat jagged edges of east and west sides of this anomaly are likely a function of the staggering effect in the data resulting from our zigzag survey geometry (Clay 2006:89-90). In reality, therefore, the archaeological features responsible for this anomaly probably has sharper boundaries than this geophysical plot would suggest.

The final anomalous feature of the magnetic susceptibility data is better appreciated with an orthographic projection (Figure 5), which allows for a more nuanced depiction of subtle variations in the data as well as a greater appreciation of overall variations in the response than the contour plot. In this instance, it allows us to see a faint linear feature running north-south across each of our three survey grids, from co-ordinates (0,7) to (60,8). Intriguingly, very large susceptibility anomaly discussed above seems to halt where it meets this linear anomaly, which suggests contemporaneity.

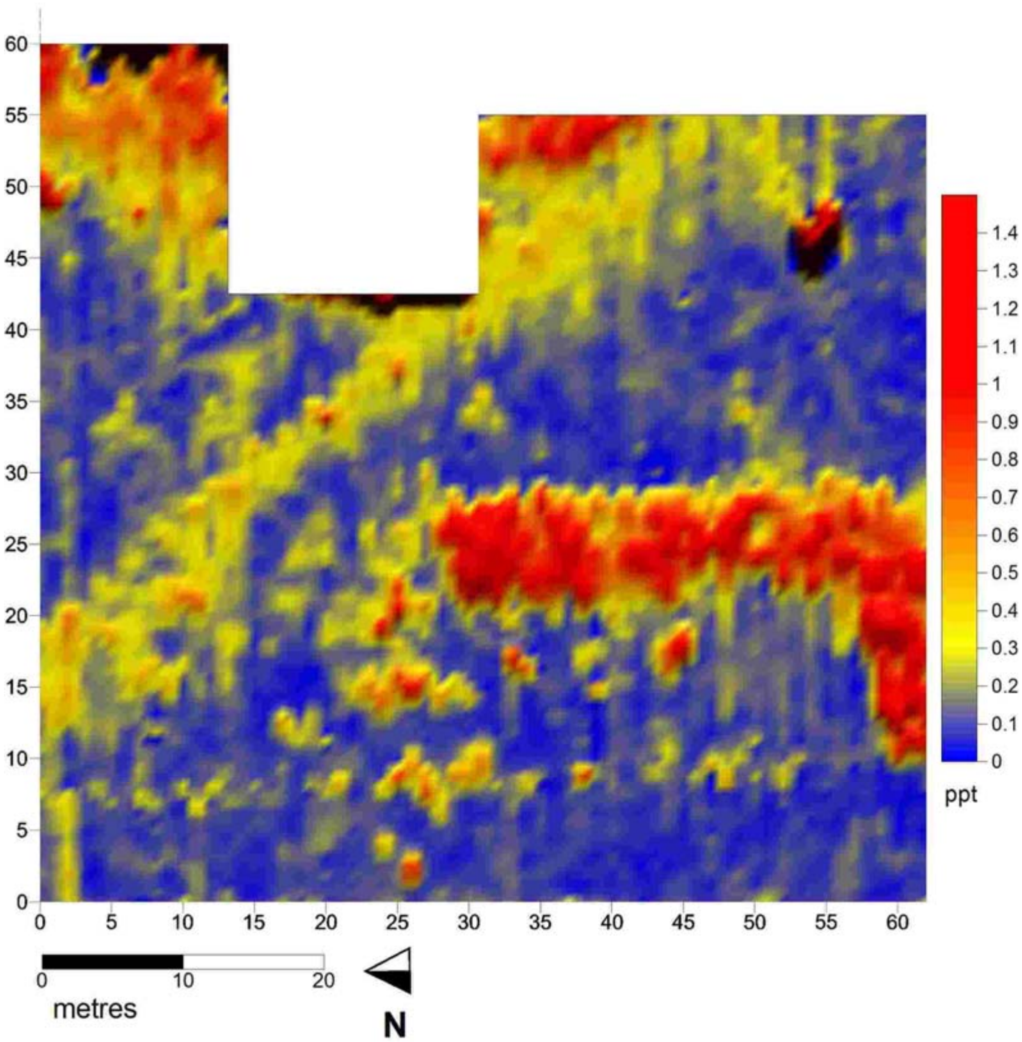

Figure 5: Magnetic susceptibility data displayed in an orthographic projection. Note the subtle linear feature running across the bottom of the survey plot.

Physical Status of the Site

The site is currently municipal property associated with the Lunenburg Academy, which is both a municipally and provincially registered heritage property. There is no likelihood that development pressure will exert a significant toll on these potential archaeological features in the near future. Nevertheless, it may arise that infrastructure upgrades may introduce earth-moving activities, and as such it seems prudent to alert municipal planning authorities and other stakeholders as to the results of our work.

Site Significance

It is difficult to assess the significance of most of these features without additional geophysical investigation followed by a program of archaeological ground-truthing. The massive susceptibility anomaly and the thin, linear susceptibility anomaly abutting it seem to predate any memory of architecture in this area. It seems reasonable to suspect that they may relate to the mid-18th century military occupation on this hilltop, but resolving this question requires additional information.

Assessment of Results

Overall, for a prospection survey conducted as part of an undergraduate class, this survey has revealed a number of very interesting results. As we have noted in previous surveys, the magnetic susceptibility data are generally more informative than the conductivity data, but there is certainly value in being able to compare the two. The large, linear conductivity anomaly depicted in Figure 3 finds no comparable expression in the susceptibility data, which causes one to speculate as to its source. Although it is almost certainly a modern feature, examining it archaeologically may be justified in order to better understand the EM38B's responses. Beyond this, the conductivity data are not particularly noteworthy.

The intense linear magnetic susceptibility anomaly running approximately northwest to southeast across our survey area is too wide and of too great a magnitude to have resulted from a palisade trench. Subsequent investigations have revealed that the instrument is likely picking up the remnants of an old road here (Figure 6).

Assigning identities to the remainder of our likely pre-modern susceptibility anomalies is tricky. According to DesBrisay, the blockhouse complex on Gallows Hill was called the Star-Fort, owing to "the shape of the fence by which it was enclosed" (1895:33). Theoretically, the EM38B should be able to pick up evidence of buildings, ditching, and perhaps even palisade lines associated with this fort, and we may have done so. What is required now is to complete the survey by extending the grid to the south, and to introduce test excavation units in select areas to identify what it is the instrument is seeing. Perhaps we will have an opportunity to return to the site later in 2014.

Figure 6: Aerial photograph of Lunenburg depicting the path of a road that formerly ran across the lot behind the Lunenburg Academy. This is almost certainly the source of one of our magnetic susceptibility anomalies. SOURCE: Detail of NSA Nova Scotia Information Service no. 19575 / negative no. 19575.

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