GEOPHYSICAL SURVEY REPORT

Land at East Hill, Chatham, Kent

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Abstract

Magnitude Surveys was commissioned to assess the subsurface potential of a c. 44ha area of land at East Hill, Chatham. A fluxgate gradiometer survey was successfully completed across the survey area and has detected anomalies related to historical and present-day agricultural practices, and natural variation in the soil and underlying geology. The survey has also identified modern interference in the form of magnetic haloes around field boundaries and power infrastructure, as well as a magnetically enhanced background resulting from dumped material on the site. Some anomalies have been classified as "Undetermined" because it has not been possible to definitively establish whether the anomaly is archaeological, agricultural, or natural in origin.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by RPS Consulting to undertake a geophysical survey over a c. 44ha area of land at Capstone Road, Chatham (TQ 77580 65335).

1.2. The geophysical survey comprised quad-towed GNSS-positioned fluxgate gradiometer survey. Magnetic survey is the standard primary geophysical method for archaeological applications in the UK due to its ability to detect a range of different features. The technique is particularly suited for detecting fired or magnetically enhanced features, such as ditches, pits, kilns, sunken featured buildings (SFBs) and industrial activity (David *et al*., 2008).

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David *et al*., 2008), the Chartered Institute for Archaeologists (CIfA, 2020) and the European Archaeological Council (Schmidt *et al.,* 2015).

1.4. It was conducted in line with a WSI produced by MS (Turner, 2022).

1.5. The survey commenced on 31/10/2022 and took 4.5 days to complete.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society for Archaeological Prospection).

2.2. The directors of MS are involved in cutting edge research and the development of guidance/policy. Specifically, Dr Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and is the Vice-Chair of the International Society for Archaeological Prospection (ISAP); Finnegan Pope-Carter has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member of GeoSIG (CIfA Geophysics Special Interest Group); Dr Paul Johnson has a PhD in archaeology from the University of Southampton, is a Fellow of the Society of Antiquaries of London and a Member of CIfA, has been a member of the ISAP Management Committee since 2015, and is currently the nominated representative for the EAA Archaeological Prospection Community to the board of the European Archaeological Association.

2.3. All MS managers, field and office staff have degree qualifications relevant to archaeology or geophysics and/or field experience.

3. Objectives

3.1. The objective of this geophysical survey is to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The survey area was located c. 3km south-east of Chatham (Figure 1). Gradiometer survey was undertaken across multiple fields under arable cultivation. The survey areas were encompassed by tree and hedge lines, with some metal gates and fencing, located near to main roads. Overhead cables and utility covers were also present in the survey area (Figure 2).

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Former arable field, left fallow, sloping west to north-east	Woodland and barbed wire fence surrounded the whole perimeter. Utility covers ran in a row from north to south through the centre of the Area. An access route was present in the north-western corner, one borehole in the east, and a metal gate in the north-eastern corner.
2	Undulating former arable field left fallow, sloping south to north	Hedgerow and trees ran around the majority of the area perimeter, with a tarmac road and raised verge around part of the western border. Boreholes were present in the southern end of the area, footpaths in the north and south, and overhead cables were present in the north.
3	Former arable field left fallow, sloping east to west	A Hedgerow and trees surrounded the perimeter at the west, south and some of the east, with tarmac path/road around the east edge of area.
4	Former arable field left fallow, sloping south to north with steep bank west to east	Hedgerow and trees surrounded most of the perimeter, in the north, west, south and some of the eastern border, with tarmac and a raised verge present with the rest of the eastern border. One borehole in the north, parking in the north-eastern corner along with a metal barrier and overhead cables present across the middle of the area.

4.3. The underlying geology comprises of Lewes Nodular Chalk bedrock formation, including chalk, Turonian, coniacian in Areas 1, 2 and 3 and Seaford Chalk formation in the west of Area 4. The superficial deposits include clay, silt, sand, and gravel in some of the west of Area 4 and south of Area 3, and some Head formation of clay, silt, sand and gravel in Area 1 (British Geological Survey, 2022).

4.4. The soils consist of shallow lime-rich soils over chalk or limestone across most of the survey area, apart from in the north of Area 4 where the soils consist of slightly loamy and clayey soils with impeded drainage (Soilscapes, 2022).

5. Archaeological Background

5.1. The archaeological background is set out in the desk based heritage assessment dated 28 February 2019.

6. Methodology

6.1. Data Collection

6.1.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey. Geophysical survey therefore comprised the magnetic method as described in the following section.

6.1.2. Geophysical prospection comprised the magnetic method as described in the following table.

6.1.3. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.1.4. The magnetic data were collected using MS' bespoke quad-towed cart system GNSS-positioned system.

6.1.4.1. MS' cart system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.4.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.1.4.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to the EAC and Historic England guidelines for 'minimally enhanced data' (see Section 3.8 in Schmidt *et al.*, 2015: 33 and Section IV.2 in David *et al.,* 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen *et al*. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.3. Data Visualisation and Interpretation

6.3.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 5, 8, 11, 14 & 17). XY trace plots visualise the magnitude and form of the geophysical response, aiding anomaly interpretation.

6.3.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historical maps, LiDAR data, and soil and geology maps. Google Earth (2022) was also consulted, to compare the results with recent land use.

6.3.3. Geodetic position of results – All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible, an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports, as well as reports from further work, in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in combination with historical maps and satellite imagery (Figures 18 & 19).

7.2.2. A fluxgate gradiometer survey was successfully completed across all the survey areas. Modern interference is present in the form of magnetic haloes around field boundaries and power infrastructure, as well as a magnetically enhanced background resulting from dumped material on the site; these may have masked any weaker anomalies if they were present.

7.2.3. The geophysical survey detected linear anomalies related to agricultural activity and are limited to old field boundaries that are visible on historical maps, which provides evidence of the region's prolonged agricultural use. Anomalies across the survey area are the result of natural variation in the underlying soil and geology. In some cases these present as discrete, sub-circular anomalies; these are likely the result of dissolution hollows within the underlying chalk, but could alternatively be the result of extraction pits.

7.2.4. No anomalies suggestive of significant archaeological features were identified, though archaeological origins cannot be ruled out for several anomalies classified as 'Undetermined'. The anomalies have limited context and lack any clear pattern or morphology to enable a confident interpretation. Nevertheless, an archaeological origin cannot be excluded.

7.3. Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Ferrous (Spike)** – Discrete dipolar anomalies are likely to be the result of isolated pieces of modern ferrous debris on or near the ground surface.

7.3.1.3. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentration of multiple discrete, dipolar anomalies usually resulting from highly magnetic material such as rubble containing ceramic building materials and ferrous rubbish.

7.3.1.4. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures, typically including fencing, pylons, vehicles, and service pipes, have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure weaker anomalies relating to nearby features, should they be present, often over a greater footprint than the structure causing them.

7.3.1.5. **Undetermined** – Anomalies are classified as Undetermined when the origin of the geophysical anomaly is ambiguous and there is no supporting contextual evidence to justify a more certain classification. These anomalies are likely to be the result of geological, pedological or agricultural processes, although an archaeological origin cannot be entirely ruled out. Undetermined anomalies are generally distinct from those caused by ferrous sources.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Agricultural (Weak/Strong)** – Linear anomalies in the north of Area 2, the centre of Area 3, and in the south of Area 4. These anomalies have been classified as agricultural, and all follow field boundaries marked on historical mapping. The two in the north of Area 2 run parallel to one another (Figure 20 & 21), both boundaries measure at c. 100m. The one in Area 3 has a straight profile with a slight curve at the northern most point, and measures at c. 130m in length. The three in the south of Area 4 have a straight profile and appear to align with part of the same field boundary as seen on historic mapping. The northern-most of these measures at c. 76m, the eastern feature at c. 65m, and the southern feature at c. 50m.

7.3.2.2. **Dissolution/Extraction** – Several anomalies discrete anomalies are present across Areas 2 & 4; the anomalies range from c. 4m to 11m in size and are all sub-circular in shape. These anomalies are likely the result of dissolution hollows in the underlying chalk geology, though it is also possible that they result from extraction activity aimed at the chalk bedrock or at the sand and gravel superficial deposits.

8. Conclusions

8.1. A fluxgate gradiometer survey was successfully completed across the c. 44ha survey area. Modern interference is present in the form of magnetic haloes around field boundaries and power infrastructure, as well as a magnetically enhanced background resulting from dumped material on the site. These may have masked any weaker anomalies, if present.

8.2. Anomalies related to historical and modern agricultural use, including field boundaries that are also represented on historical mapping. Multiple anomalies have been classified as "Undetermined" because we have not been able to definitively determine whether the anomalies are the result of archaeological, agricultural, or natural in origin.

8.3. Natural variation in the underlying soil and geology has been identified, and in places may be the result of dissolution hollows in the underlying chalk; It is also possible that these represent extraction pits.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to any dictated time embargoes.

10. Copyright

10.1. Copyright and intellectual property pertaining to all reports, figures and datasets produced by Magnitude Services Ltd is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

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12. Project Metadata

MS Job Code	MSTQ1461
Project Name	Land at East Hill Chatham
Client	RPS Consulting Ltd
Grid Reference	TQ 77580 65335
Survey Techniques	Magnetometry
Survey Size (ha)	44ha (Magnetometry)
Survey Dates	31/10/2022 – 04/11/2022
Project Lead	Peter Turner BSc MSc
Project Officer	Peter Turner BSc MSc
HER Event No	TBC
OASIS No	TBC
S42 Licence No	N/A
Report Version	0.2

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	JLA	PT	22 November 2022
0.2	Update Following Review	CL, JLA	PT	24 November 2022

MSTQ1461 - Land at East Hill, Chatham
Figure 1 - Site Location
1:25,000 @ A4

N

0 0.5 1 km

Site Boundary

magnitude surveys

MSTQ1461 - Land at East Hill, Chatham
Figure 2 - Location of Survey Areas
1:10,000 @ A3

Survey Areas

N

0 250 500 750 m

magnitude surveys

MSTQ1461 - Land at East Hill, Chatham
Figure 3 - Magnetic Gradient (Areas 1, 2 & 3)
1:1,500 @ A3

-1 nT 2

N

0 40 80 120 m

magnitude surveys

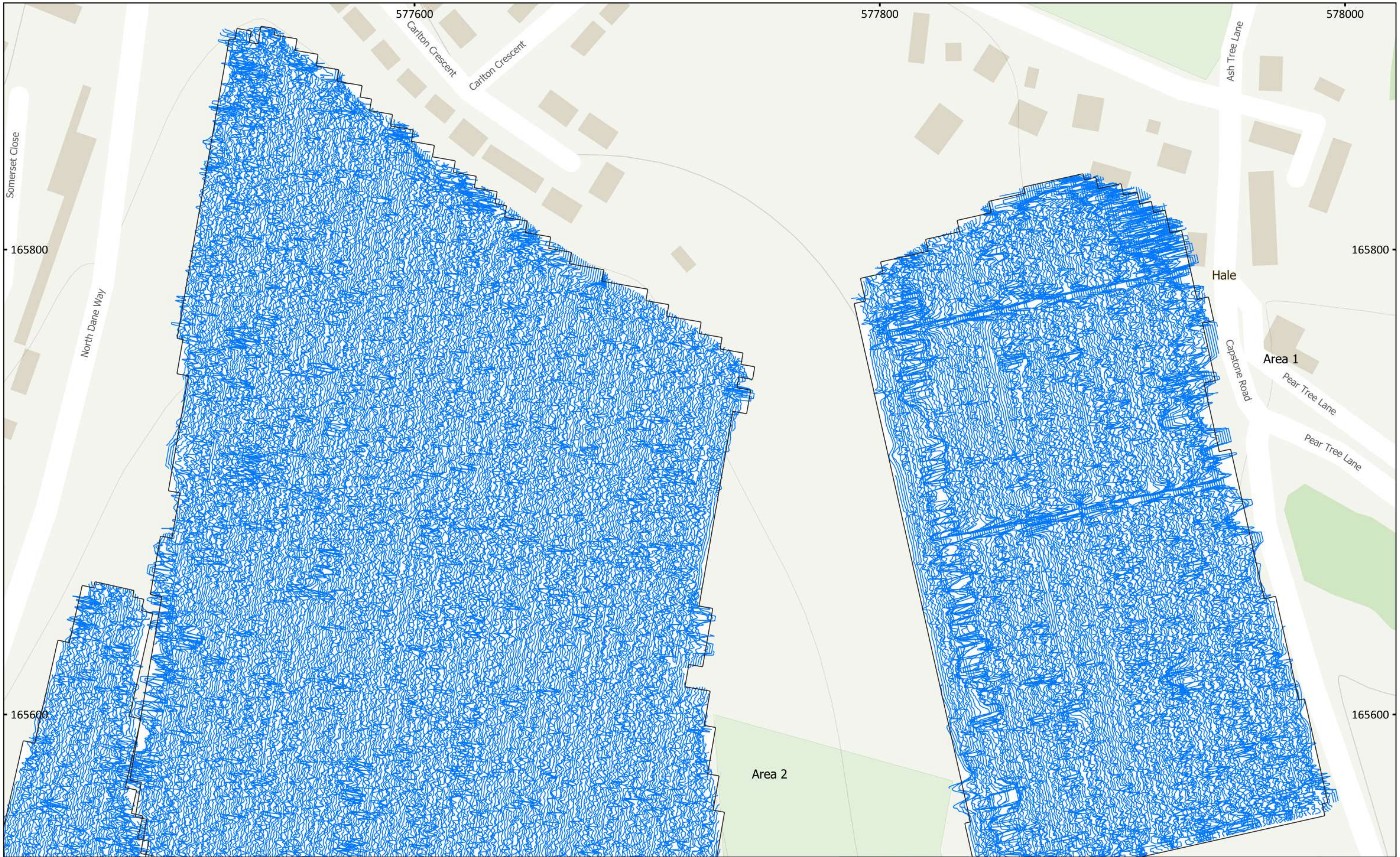
MSTQ1461 - Land at East Hill, Chatham
Figure 4 - Magnetic Interpretation (Areas 1, 2 & 3)
1:1,500 @ A3

Agricultural (Strong)
Agricultural (Weak)
Magnetic Disturbance
Ferrous/Debris (Spread)
Natural (Weak)
Dissolution/Extraction
Overhead Cables
Service
Ferrous (Spike)

N

0 50 100 150 m

magnitude surveys



MSTQ1461 - Land at East Hill, Chatham
Figure 5 - XY Trace Plot (Areas 1, 2 & 3)
30nT/cm at 1:1,500 @ A3

N

0 40 80 120 m

magnitude surveys

MSTQ1461 - Land at East Hill, Chatham
Figure 6 - Magnetic Gradient (Areas 1, 2 & 3)
1:1,500 @ A3

MSTQ1461 - Land at East Hill, Chatham
Figure 7 - Magnetic Interpretation (Areas 1, 2 & 3)
1:1,500 @ A3

- Agricultural (Weak)
- Magnetic Disturbance
- Ferrous/Debris (Spread)
- Natural (Spread)
- Natural (Weak)
- Undetermined (Strong)
- Undetermined (Weak)
- Dissolution/Extraction
- Service
- Ferrous (Spike)

N

0 50 100 150 m

magnitude surveys