Geophysical Survey Report

of

Land to East of Knebworth, Hertfordshire

For

WYG Environment Planning Transport Limited

On Behalf Of

Gladman Developments Ltd

Magnitude Surveys Ref: MSTL223

February 2018

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a *c*. 19ha area of land to the east of Knebworth, Hertfordshire. A fluxgate gradiometer survey was successfully completed and no anomalies of probable or possible archaeological origin have been identified. The geophysical results primarily reflect modern services, and natural variations in the superficial geology. Anomalous responses potentially indicative of historic quarry pits have been identified in the centre of the site, while the remnants of former field boundaries have been identified towards the south. An ambiguous linear anomaly has been classified as 'Undetermined' in origin.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by WYG Environment Planning Transport Limited (WYG) on behalf of Gladman Developments Ltd to undertake a geophysical survey on a *c*.19ha area of land east of Knebworth, Hertfordshire (centre TL 2556 2027).

1.2. The geophysical survey comprised hand-pulled, cart-mounted fluxgate gradiometer survey.

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, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.4. Survey was undertaken between 11-15 December 2017. Due to the treacherous nature of the site, not all of the survey could be completed during this time. A revisit was attempted at the end of the following week, but conditions had not improved in the intermediary time. On 23 January 2018, another revisit was made, and the ground conditions in all areas that were previously unsafe had improved sufficiently to allow survey to continue safely.

2. Quality Assurance

2.1. Project management, survey work, data processing and report production have been carried out by qualified and professional geophysicists to standards exceeding the current best practice (CIfA, 2014; David et al., 2008, Schmidt et al., 2015).

2.2. Magnitude Surveys is a corporate member of ISAP (International Society of Archaeological Prospection).

2.3. Director Graeme Attwood is a Member of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, as well as the Secretary of GeoSIG, the CIfA Geophysics Special Interest Group. Director Finnegan Pope-Carter is a Fellow of the London Geological Society, the chartered UK body for geophysicists and geologists, as well as a member of GeoSIG, the CIfA Geophysics Special Interest Group. Director Chrys Harris has a PhD in archaeological geophysics from the University of Bradford and is the Vice-Chair of the International Society for Archaeological Prospection.

2.4. All MS managers have postgraduate qualifications in archaeological geophysics. All MS field staff have relevant archaeology or geophysics degrees and supervisors have at least three years' field experience.

3. Objectives

3.1. The geophysical survey aimed to assess the subsurface archaeological potential of the survey area.

4. Geographic Background

4.1. The site is located on land approximately 650m due east of Knebworth rail station (Figure 1). Survey was undertaken over four distinct parcels of sloping arable land, totalling an area of *c*. 19ha (Figure 2).

4.1.1. Area 1 is situated within a section of a larger field. It is bounded to the west by housing at Bell Close and Oakfields Road, and by recreational sports fields. To the north, this area is bounded by a public footpath, to the east, by overhead power lines with the field continuing beyond, and to the south by Watton Road.

4.1.2. Area 2 is bounded to the west by housing and allotment gardens at St Martin's Road and Watton Road, to the north by Watton Road and a pumping station, and to the south and east by Old Lane.

4.1.3. Area 3 is bounded to the north and west by Old Lane, to the south by Swangley's Lane and to the northeast by Longdene House, the field continues to the south-east.

4.1.4. Area 4 comprises the majority of a single field, bounded to the north by Knebworth Primary School playing fields, housing at Swangley's Lane and Swangley's Farm, to the east by Wellington Farm, to the south by a hedged boundary and further arable fields beyond, and to the west by housing at Haygarth.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Rolled, seeded soil with young crop seedlings. Soft, wet soil following snow melting and heavy rainfall. Sloped down from north to south.	Multiple raised water inspection covers were located across the survey area.The area was bounded to the east by overhead power lines. In December 2017, flat ground to the north and to the southwest of this area was found to be unsafe to survey due to the treacherous ground conditions created by the soft nature of the soil. This had been exacerbated by recent snowfall and heavy rain. By January 2018, conditions had improved sufficiently to allow survey to continue safely.
2	Rolled, seeded soil with young crop seedlings. Covered with a *c*. 3cm layer of snow at the time of survey. Sloped down gently from south to north.	A pumping station lay directly north of the area and was bounded by a bare metal fence. Overhead power lines followed the eastern boundary of the area.
3	Rolled, seeded soil with young crop seedlings. Covered with a *c*. 8cm layer of snow at the time of survey. Sloped down from southeast to northwest.	An electrical outbuilding was located in the southwest corner of the area. Overhead power lines followed the western boundary of the area.
4	Sloped down from southeast to northwest. Rolled ploughsoil with young crop seedlings, with a small area of rough meadow to the north. A small area along the southern boundary of the Area was occupied by earth mounds and could not safely be surveyed.	In December 2017, The combination of the steep topography and the soft nature of the soil, which had been exacerbated by recent snow and heavy rain, precluded survey during this phase of works. By January 2018, conditions had improved sufficiently to allow survey to continue safely.

4.3. The underlying geology across all four survey areas comprises Lewes formation chalk. Superficial deposits consist of glacial sands and gravels across the whole of Area 1, and most of Areas 2, 3 and 4. A *c*. 35m band of head deposits, aligned W-E are recorded across the north of Area 2, while there are no recorded superficial deposits in the centre of the area. The same head deposit is recorded across a small area in the southeast corner of Area 3. The south of Area 4 has no superficial deposits recorded other than a small area of glacial diamicton, *c*. 20m across (British Geological Survey, 2017).

4.4. The soils in Areas 2, 3 and 4 are described as slightly acid loamy and clayey soils with impeded drainage, and in Area 1 as freely draining, slightly acid loamy soils (Soilscapes, 2017).

5. Archaeological Background

5.1. The following summarises selected findings of an archaeological appraisal conducted by WYG, which examined records of heritage assets, archaeological events, historic mapping, aerial photography, and Historic Landscape Characterisation data within 1km of the survey areas (Farrar, 2017).

5.2. There is one heritage asset recorded within the survey areas, in Area 4. Two undated parallel linear earthworks, *c*. 20m apart and *c*. 100m long, were visible in aerial photographs taken in May 1980 and May 1990. They are also discernible in cropmarks from Google Earth satellite imagery captured in December 2000, though not in later imagery. These are no longer visible at the ground surface, and are presumed to have been ploughed out (Farrar, 2017: 11-13).

5.3. Archaeological investigations *c*. 600m north-east of Area 1 revealed successive deposits dating from the Late Neolithic to the Early Bronze Age, interpreted as a possible causewayed enclosure and later ritual timber structure.

5.4. Circular cropmarks discovered in aerial photographs *c*. 750m south-west of Area 4 have been interpreted as ploughed-out ring-ditches. Late Bronze Age to Early Iron Age pottery sherds found during trenching and fieldwalking give a possible date to these features. Excavation *c*. 700m east of Area 3 revealed a subdivided, irregular enclosure dated by pottery sherds to Late Iron Age/Early Roman period.

5.5. The route of the proposed Roman road 'Viatores' runs through the centre of Knebworth, to the west of site, aligned approximately NNW-SSE. Its position has not been confirmed by excavation.

5.6. Swangley's Farm, less than 100m from Areas 3 and 4, was recorded in historical documentation in 1278 as 'Sueninghele'. Archaeological evaluation *c*. 600m east of Area 3 found remnants of medieval field boundaries.

5.7. An 1845 tithe map depicts two intersecting field boundaries within Area 3, these are also visible in the 1884 Ordnance Survey 6-inch:1-mile map with the addition of a footpath. Similarly, several boundaries are identifiable from the 1884 OS map within Area 1 (of which one mature tree remains). In the 1899 revision, these field boundaries were no longer recorded, though the footpath in Area 3 was most recently included in OS mapping in 1925. An unnamed gravel or chalk pit within the west of Area 2 was recorded on the 1884 OS map, but was not present in the 1899 revision.

6. Methodology

6.1. Data Collection

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

6.1.2. 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

6.1.3. The magnetic data were collected using MS' bespoke hand-pulled and quad-towed cart system.

6.1.3.1. MS' cart system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a Hemisphere S321 GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The Hemisphere S321 GNSS Smart Antenna is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.1.3.2. 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.

6.1.3.3. Rows of temporary sight markers were established in each survey area to guide the surveyor and ensure full coverage with the cart.

6.2. Data Processing

6.2.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see sect 4.2 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 upper and/or 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 greyscales images at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figures 8). XY trace plots visualise the magnitude and form of the geophysical response, aiding in 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, historic maps, LiDAR data, and soil and geology maps. Google Earth (2017) was consulted as well, to compare the results with recent land usages.

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 of further work in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in consideration with satellite imagery (Figure 6), historic maps (Figure 7) and XY Trace Plots (Figure 8).

7.2.2. The fluxgate gradiometer survey has responded sufficiently to the survey area's environment, although the superficial changes within the geology and soils has produced an enhanced magnetic background, particularly in the northern half of site. The small, discrete responses scattered across the site are characteristic of superficial deposits. Concentrated areas of these deposits have been categorised as "Natural (Spread)". It is conceivable some of these responses have an anthropogenic origin; however, these would appear indistinguishable in the magnetic results from those responses produced by natural geology. Furthermore, there are no anomalies identified in the results to date that have been classified as archaeological in origin.

7.2.3. Prominent services and associated inspection covers have been detected crossing the entire site. The largest of these is likely related to the pumping station located in the centre north of Area 2. The magnetic strength of these features is such that they create a large 'halo', this response will mask any archaeological anomalies should they be present. Anomalies associated with historic quarrying and former agricultural activity have also been identified in Areas 2 and 3. A distinct broad, linear anomaly has been identified as 'Undetermined' due to the ambiguous nature of its response.

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. **Undetermined** – Anomalies are classified as Undetermined when the anomaly origin is ambiguous through the geophysical results and there is no supporting or correlative evidence to warrant 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 not ferrous in nature.

7.3.1.3. **Ferrous (Discrete/Spread)** – Discrete ferrous-like, dipolar anomalies are likely to be the result of modern metallic disturbance on or near the ground surface. A ferrous spread refers to a concentrated deposition of these discrete, dipolar anomalies. Broad dipolar ferrous responses from modern metallic features, such as fences, gates, neighbouring buildings and services, may mask any weaker underlying archaeological anomalies should they be present.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Agricultural (Trend) –** In Area 3, a linear trend of discrete ferrous-like anomalies is collocated with a boundary recorded on the 1845 tithe map, later visible as a line of trees in the 1884 Ordnance Survey map (See 5.7). In the north of Area 4, a linear anomaly between an area of arable land and an area of meadow corresponds with a boundary marked in a 1950 Ordnance Survey Map separating the two fields (Farrar 2017: 55). Given the strongly positive nature of the anomaly, this boundary was probably characterised as a ditch which has since been filled. Also in Area 4, a spread of ferrous-like anomalies along the north-east boundary of the field corresponds with a tractor path between Swangley's Farm and the field adjacently south of Area 4. In Area 1, a series of weak, parallel linear responses at the southern end of the field correlate with modern tractor movement (Figure 6).

7.3.2.2. **Modern/Industrial (Spread) –** Within the west of Area 2, several small areas of increased magnetic response have been identified. These correspond with a small un-named chalk or gravel pit marked on the 1884 Ordnance survey map, which were not recorded in the following 1899 revision or subsequent editions (see sect 5.7). These spreads may indicate the presence of quarry waste or fill material, although a more modern origin, like the spreads of material in Area 1 (see 7.2.2) would produce a similar response.

7.3.2.3. **Undetermined (Weak) –** To the north of the extraction pit in Area 2, a weak, positive linear anomaly has been detected, aligned approximately NW-SE—perpendicular to the gradient of the land. The response of the feature appears to be impacted by the ferrous halo from the service. The morphology of the anomaly can be representative of a soiled filled feature, such a ditch, or broad natural changes. No corresponding field boundary or recorded feature is identifiable in historic mapping. Therefore, an 'Undetermined' classification has been ascribed.

7.3.2.4. **Natural –** A number of weak areas of magnetic enhancement have been identified within the survey areas, including a branching linear anomaly in Area 4. These are most likely the result of natural variation in superficial geology and soils; in this context, the deposition of sand and gravel material by glacial and fluvioglacial processes or the dissolution of chalk.

8. Conclusions

8.1. The fluxgate gradiometer survey has responded sufficiently to the environment of the survey area. Natural changes in the soil and superficial geology have produced a more enhanced natural background. However, responses weak and strong in magnitude have been identified against the natural background. The remnants of former field boundaries have been identified as well as a group of anomalies which have been detected in an area of small scale historic quarrying. The impact of modern activity is evident throughout the site as well, primarily demonstrated by subterranean services. Modern ploughing trends have been detected as well. An ambiguous linear response has been classified as 'Undetermined' in the absence of further evidence to warrant a more specific classification.

8.2. No anomalies have been classified as archaeological in origin. The cropmark in Area 4 (see 5.2) has not been identified within the magnetic data. It is possible that sub-surface features exist here, but have not been magnetically enhanced, or are masked by deep overlying natural deposits. In the absence of additional data or contextual information, no further interpretation can be made in this report.

8.3. A weak linear anomaly in Area 3, and a strong linear anomaly in Area 4, are the only instances of Post-Medieval land enclosure being identified in the data and supported by historic mapping. A second boundary in Area 3 that is visible in historic mapping has likely been obscured by the water main that follows the same approximate position and alignment. Other boundaries marked on historic mapping in Area 1 (Farrar 2017: 53) may not have been detected with the selected survey method, as they were most likely characterised by trees and hedges. This is supported by the use of tree symbols on the historic maps, and extant mature trees in the field (Farrar 2017: 25).

8.4. Several modern services as well as inspection covers have also been detected within the results of the survey. Broad ferrous responses around the perimeter of the field are the result of magnetic strength of adjacent modern features.

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 all reports to the ADS Grey Literature Library subject to any time embargo dictated by the client.

9.3. Whenever possible, MS has a policy of making data available to view in easy to use forms on its website. This can benefit the client by making all of their reports available in a single repository, while also being a useful resource for research. Should a client wish to impose a time embargo on the availability of data, this can be achieved in discussion with MS.

10. Copyright

10.1. Copyright and the 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

British Geological Survey, 2017. Geology of Britain. [Knebworth, Hertfordshire]. [http://mapapps.bgs.ac.uk/geologyofbritain/home.html/]. [Accessed 18/12/2017].

Chartered Institute for Archaeologists, 2014. Standards and guidance for archaeological geophysical survey. CIfA.

David, A., Linford, N., Linford, P. and Martin, L., 2008. Geophysical survey in archaeological field evaluation: research and professional services guidelines (2nd edition). Historic England.

Farrar, D., October 2017. Land to East of Knebworth: Archaeological Appraisal. Revision 1. WYG Environment Planning Transport Limited, Leeds.

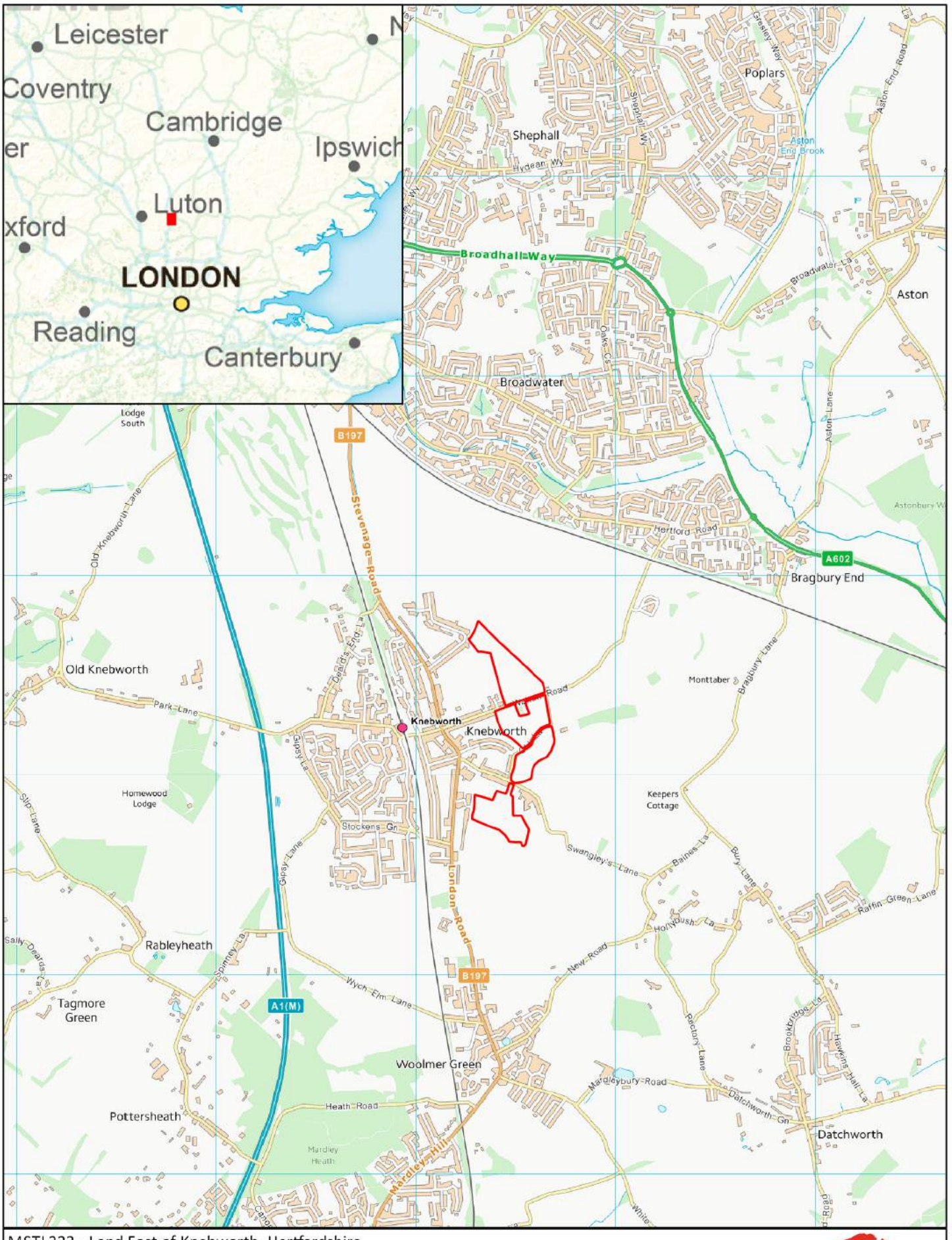
Google Earth, 2017. Google Earth Pro V 7.1.7.2606. 51®51'45.56N, 0®10'45.45W. Eye alt 1000m. ©2017 Google.

Olsen, N., Toffner-Clausen, L., Sabaka, T.J., Brauer, P., Merayo, J.M.G., Jorgensen, J.L., Leger, J.M., Nielsen, O.V., Primdahl, F., and Risbo, T., 2003. Calibration of the Orsted vector magnetometer. *Earth Planets Space* 55: 11-18.

Schmidt, A. and Ernenwein, E., 2013. Guide to good practice: geophysical data in archaeology. 2nd ed., Oxbow Books, Oxford.

Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A. and Fassbinder, J., 2015. Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2. European Archaeological Council: Belgium.

Soilscapes, 2017. [Knebworth, Hertfordshire]. Cranfield University, National Soil Resources Institute [http://landis.org.uk]. [Accessed 18/12/2017].



MSTL223 - Land East of Knebworth, Hertfordshire
Figure 1 - Site Location
1 : 25,000 @ A4

Site Boundary

N

0 0.5 1 km

magnitude surveys

MSTL223 - Land East of Knebworth, Hertfordshire
Figure 2 - Location of Survey Areas
1:5000 @ A3

Survey Extents

N

0 100 200 300 m

magnitude surveys

219600
219800
220000
220200
220400
220600
525200
525400
525600
525800
Area 4
Area 3
Area 2
Area 1
MSTL223 - Land East of Knebworth, Hertfordshire
Figure 3 - Magnetic Gradient
1:3000 @ A3

-2 nT 3
N
0 50 100 150 m
magnitude surveys

219600
219800
220000
220200
220400
220600
525200
525400
525600
525800
Area 4
Area 3
Area 2
Area 1
MSTL223 - Land East of Knebworth, Hertfordshire
Figure 4 - Magnetic Total Field - Lower Sensor
1:3000 @ A3

48,995 nT 49,010
N
0 50 100 150 m
magnitude surveys

MSTL223 - Land East of Knebworth, Hertfordshire
Figure 5 - Magnetic Interpretation
1:3000 @ A3

- Agricultural (Strong)
- Ferrous (Dipolar)
- Ferrous (Spread)/Magnetic Disturbance
- Natural (Spread)
- Natural (Strong)
- Natural (Weak)
- Undetermined (Strong)
- Undetermined (Weak)
- Industrial/Modern (Spread)
- Industrial/Modern
- Agricultural (Trend)
- Natural (Trend)
- Service
- Survey Extent

N

0 50 100 150 m

magnitude surveys

MSTL223 - Land East of Knebworth, Hertfordshire
Figure 6 - Magnetic Interpretation Over Satellite Imagery
1:3000 @ A3

- Agricultural (Strong)
- Ferrous (Dipolar)
- Ferrous (Spread)/Magnetic Disturbance
- Natural (Spread)
- Natural (Strong)
- Natural (Weak)
- Undetermined (Strong)
- Undetermined (Weak)
- Industrial/Modern (Spread)
- Industrial/Modern
- Agricultural (Trend)
- Natural (Trend)
- Service
- Survey Extent

N

0 50 100 150 m

magnitude surveys

219600 219800 220000 220200 220400 220600

525200 525400 525600 525800

Pullin's Spring

Warwick Lodge

Pelham Lodge

Hopground Spring

Stevenage 3
London 28

Roundwood Cottages

Swangley Farm

Area 1

Area 2

Area 3

Area 4

MSTL223 - Land East of Knebworth, Hertfordshire
Figure 7 - Magnetic Interpretation Over Historic Maps
1:3000 @ A3

Contains historic maps: Ordnance Survey, 6" 2nd edition c. 1882-1913 © National Library of Scotland

- Agricultural (Strong)
- Ferrous (Dipolar)
- Ferrous (Spread)/Magnetic Disturbance
- Natural (Spread)
- Natural (Strong)
- Natural (Weak)
- Undetermined (Strong)
- Undetermined (Weak)
- Industrial/Modern (Spread)
- Industrial/Modern
- Agricultural (Trend)
- Natural (Trend)
- Service
- Survey Extent

N

0 50 100 150 m

magnitude surveys

219600
219800
220000
220200
220400
220600
525200
525400
525600
525800
Area 4
Area 3
Area 2
Area 1
MSTL223 - Land East of Knebworth, Hertfordshire
Figure 8 - XY Trace Plot
60nT/cm at 1:3000 @ A3

N
0
50
100
150 m
magnitude surveys