magnitude surveys

Geophysical Survey Report

of

Wilstead, Bedfordshire

For

Nexus Heritage

On Behalf Of

Bloor Homes South Midlands Ltd

Magnitude Surveys Ref: MSTL145

October 2017

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a *c*. 10ha area of land at Cotton End Road, Wilstead, Bedfordshire. A fluxgate gradiometer survey was successfully completed and identified an area of possible archaeological activity towards the centre of the site; these responses may reflect enclosure boundaries or delineate former field systems. Outside of this, the geophysical results primarily agricultural activity, including the remnants of former ridge and furrow ploughing. The impact of modern activity is focused towards the southern end of site and along the site's western and eastern boundaries.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by Nexus Heritage on behalf Homes South Midlands Ltd to undertake a geophysical survey on a c.10ha area of land off Cotton End Road, Wilstead, Bedfordshire (TL 06664 43712).

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. The survey was carried out over two phases (see Figure 1 for phase extents). The first phase commenced on 19 June 2017 and took one day to complete. The second phase commenced 21 September 2017 and took two days to complete.

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 the northern edge of Wilstead, 6.2 km south of Bedford (Figure 1). The site was comprised of five survey areas, under use for agricultural, pasture and paddocks at the time of survey. Areas 1, 2 and 3, at the site's southern end, were surveyed during the first phase and Areas 4 and 5, to the north, were surveyed in the second phase. These survey areas are surrounded by hedges, farm equipment, tarmacked track and garden fences. Cotton End Road runs east-west to the south of the site with housing along this road bounding the southern edge of the site; fields bound the site to the north and east, while further housing bounds the west. A wooded area borders the southeast of Area 1 (Figure 2). Central to Areas 1, 2, and 3, was an area containing a number of garages, a stable block, a number of caravans, vehicles and scrap metal. An area of grass located south of the stable block was unsurveyable due to its small dimensions and the presence of tractors and cars in the area.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Flat, pasture field. Extant ridge and furrow was present in the north of the field.	The north, east and south boundary of the area were formed by hedges. The western boundary was divided between buildings in the south and hedges in the north.
2	Paddock, flat pasture. Overgrown vegetation covers more than half of the area which made the northern part of the paddock unsurveyable.	Inactive electric fences bordered the north of the paddocks, separating the overgrown area, and acted as the perimeter between the two paddocks to the west. Scrap metal, caravans and vehicles bounded the east, while wooden garden fences bounded the south.
3	Paddock, flat pasture.	Inactive electric fences acted as the perimeter between the two paddocks to the east, a wire fence bounded the west, a hedge bounded the north, and wooden garden fence to the south
4	Recently harvested field with flat ground. Extant ridge and furrow noted throughout the area.	Boundaries to north, south and east were formed by hedges. To the east the boundary was marked by garden fences, while to the south and east were agricultural equipment and tarmacked track, and to the north a leftover strip of maize crop encroached the survey area.
5	Recently harvested field with flat ground. An oak tree was located towards the centre of the field.	Boundaries to north, south and east were formed by hedges. To the east the boundary was marked by garden fences. A tarmacked track ran along the eastern perimeter and the southern end was encroached by a leftover strip of maize crop.

4.3. The underlying geology comprises undifferentiated Stewartby member and Weymouth member mudstones with superficial unsorted mud, sand and gravel drift deposits overlaying it in areas (British Geological Survey, 2017).

4.4. The soils consist of Lime-rich loamy and clayey soils with impeded drainage (Soilscapes, 2017).

5. Archaeological Background

5.1. The following section summarises the archaeological background of the site following a search of Heritage Gateway (2017) within a 1km radius. There are no scheduled monuments or listed buildings on the site, though a number are present within the limit of the medieval village of Wilstead where the site is located.

5.2. Evidence for prehistoric activity within the wider landscape of the site is limited. An undated feature (HER 7142) has been identified 1 km southwest of the site, comprising two rectangular ditched enclosures with one side formed by an existing pond, and an adjacent small mound. While these remain undated it is likely they are prehistoric in origin.

5.3. Roman evidence is limited, with no finds or features detected on the site. However, archaeological works in 2005 and 2007 uncovered evidence of former Roman occupation including pits, ditches and pottery 1 km northwest of the site (HER 18262).

5.4. Evidence for Medieval activity is recorded on the site and within the wider landscape. The southern boundary of the site extends to the northern limit of the medieval village of Wilstead (HER 17052). Ridge and furrow agricultural activity is visible in the northern section of Area 1, and has been confirmed through archaeological investigations in other locations around the village (HER 662). Approximately 800m northwest of the site is the deserted Medieval settlement of Duck End (HER 17053).

5.5. An 1809 map marks “Dovehouse Close” implying the location of a former dovecote in the region of Areas 2 and 3 (HER 7144). This possible dovecote is referenced on Heritage Gateway (2017), though the 1809 mapping is not available for viewing, and no further evidence is available to substantiate this.

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 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. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient data 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 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. Multiple greyscales images at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 7). 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 5) and historic maps (Figure 6).

7.2.2. The fluxgate gradiometer survey has responded well to the environment of the survey area. A range of different types of responses were identified across the site, even towards the south, in Area 1, the overall background magnetic level is comparatively "noisy" due to an increased density of ferrous material.

7.2.3. Anomalies of possible archaeological origins were identified towards the centre of site, in Area 4, and may reflect the interrupted remains of field or enclosure boundaries. Weak trends located across Areas 1, 4, and 5 follow the alignment of extant ridge and furrow. Trends south of the possible ridge and furrow in Area 1 and across Area 5 may reflect the remnants of former field boundaries. Broad-scale and discrete ferrous responses have been detected across the site. These are concentrated around the modern structures at the south of site, and along the western boundary. The line of subterranean service line has been detected along the western boundary of Area 1. Minor natural variations in the background soils and superficial geology have been detected as well. These are particularly evident in Area 5, where superficial drift deposits of unsorted mud, sand and gravel are recorded (see Para 4.3).

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. **Possible Archaeology –** A series of linear anomalies in Area 3 are distinct from the surrounding ploughing trends and have been identified as possibly being archaeological in origin. This area of possible archaeological activity is comprised of truncated and broken up linear anomalies that form perpendicular and parallel configurations. These occur off a central ditch-like anomaly [**4a**] that runs on an NW-SE alignment. [**4a**] consists of an interrupted linear response c. 130m in length, which slightly to the north. The strength of this feature is stronger towards the south, then tapers off towards the north. This could be indicative of a 'habitation effect'; whereby soil filled anomalies demonstrate stronger magnetic enhancement closer to the centre of occupation or resulting from more intensive use and reuse (Aspinall *et al.* 2009, 144). Abutting [**4a**] at c.90° are several further linear anomalies [e.g. **4b**]; these responses also segmented. The segmentation of the anomalies indicates the features have been truncated or obscured by subsequent ploughing. However, the overall configuration of [**4a**] and [**4b**] can often be associated with field systems or enclosure boundaries.

7.3.2.2. **Ridge and Furrow –** Linear to curvilinear anomalies of weak strength, characteristic of cultivation activity, were noted in Areas 1, 4, and 5. Those in Areas 1 and 4 correspond well with the extant ridge and furrow noted at the time of survey. These systems were identified as having separations of c. 8m. The responses are more ephemeral in Area 5, but follow the alignment with ridge and furrow cropmarks visible in satellite imagery (Figure 5).

7.3.2.3. **Agricultural** – A trend running across the centre of Area 1, perpendicular to the ridge and furrow, is likely to be a former field boundary of relatively modern origin. Satellite imagery from 2002 and 2006 (Google Earth, 2017) shows a field boundary in approximately this location. Historic OS County Series and Plan mapping shows no such field boundary in this location dating from 1883 to 1990.

Area 5 is bisected into eastern and western segments by a curvilinear anomaly characterised mostly by weak responses [**5a**], but in places stronger ferrous responses. The anomaly is positioned close to the location of a field boundary identifiable within the 2nd edition OS map for the area (Figure 6). This boundary is identifiable in maps up until 1990. A further possible field boundary is

identifiable with a linear anomaly marked by weak responses and some ferrous responses [**5b**] and spread of ferrous and mixed material [**5c**]: these align approximately with a field boundary identifiable in the 2nd edition OS map (Figure 6). **5c** noticeably spreads approximately perpendicular to this field boundary, and with other ferrous spreads noted below may reflect another field boundary. However, no such boundary is notable either in the 2nd edition OS map or any subsequent maps.

7.3.2.4. **Service** – A broad expanse of magnetic disturbance runs along the western boundary of Area 1. The nature of the anomaly, a series of strong negative and positive responses, is typical of a magnetic response caused by subterranean services such as a pipeline

7.3.2.5. **Natural** – A strong circular response [**5d**] in Area 5 is positioned near an oak tree noted in the field and visible in satellite imagery of the area (Figure 5).

7.3.2.6. **Undetermined** – The trends identified as "Undetermined" in the south of Area 1 consist of a series of small positive anomalies forming two linear trends. Given the relatively high background levels of magnetic 'noise' across the site, these could be a chance alignment of anomalies, however an agricultural, natural or modern origin cannot be ruled out

7.3.2.7. **Ferrous** – Broad scale ferrous responses are evident around the perimeter of all five survey areas. In Area 2 measurements have been severely affected by the presence of strongly magnetic objects to the east and south: scrap metal, vehicles and garden fences, which have 'swamped' magnetic responses in the small survey area. The southern, western and eastern perimeters of Area 4 and the western, northern and eastern boundaries of Area 5 are also marked by broad ferrous anomalies. These areas were notably located near to strongly magnetic objects such as farm equipment, fences, tarmacked tracks gates, and adjacent buildings.

Small, discrete dipolar anomalies and spreads of ferrous responses are common across the site. These are likely to be caused by small metallic objects on or near the ground surface, and are probably modern in origin. In Area 4 the two largest bipolar anomalies are located just north of the possible archaeological features orientated c.W-E. In Area 5 some of these anomalies are located near to or align with field boundaries identifiable in the 2nd edition OS map.

8. Conclusions

8.1. A fluxgate gradiometer survey has successfully been carried out in two phases across the site. Responses associated with potential archaeological archaeology have been identified along with numerous responses of agricultural, natural and modern origins.

8.2. Potential archaeological anomalies were identified in Area 4 and interpreted as possible field or enclosure boundaries. These anomalies are notably truncated by subsequent ploughing.

8.3. Agricultural activity is evident in Areas 1, 4, and 5 with weak, parallel linear anomalies that likely reflect ridge and furrow ploughing. Those responses in Areas 1 and 4 are well correlated with extant features. Further agricultural anomalies may reflect former field boundaries. A weak curvilinear anomaly in Area 5 was associated with a disused field boundary noted in 2nd edition OS map. A weak linear trend running NE-SW in Area 1 is aligned with a recent former field boundary visible on satellite imagery in 2002 and 2006 (Google Earth, 2017), though no evidence of this was visible on the ground surface at the time of survey.

8.4. Weak anomalies and spreads identified as being natural in origins were interpreted as representing superficial drift deposits of unsorted mud, sand and gravel. A stronger anomaly was associated with an oak tree identified in the field and Google Earth.

8.5. Two linear trends have been classified as "Undetermined" as a specific origin is ambiguous from the geophysical results alone. These anomalies are considered likely to reflect natural, modern, or agricultural processes.

8.6. Modern activity is identifiable with several ferrous anomalies scattered across both survey areas and towards their perimeters and subterranean service identified in Area 1. Several notably are located in close proximity and along disused field boundaries identifiable upon the 2nd edition OS survey map. Small scale, discrete anomalies are due to modern activity and the scattering of ferrous debris on or near the ground surface.

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

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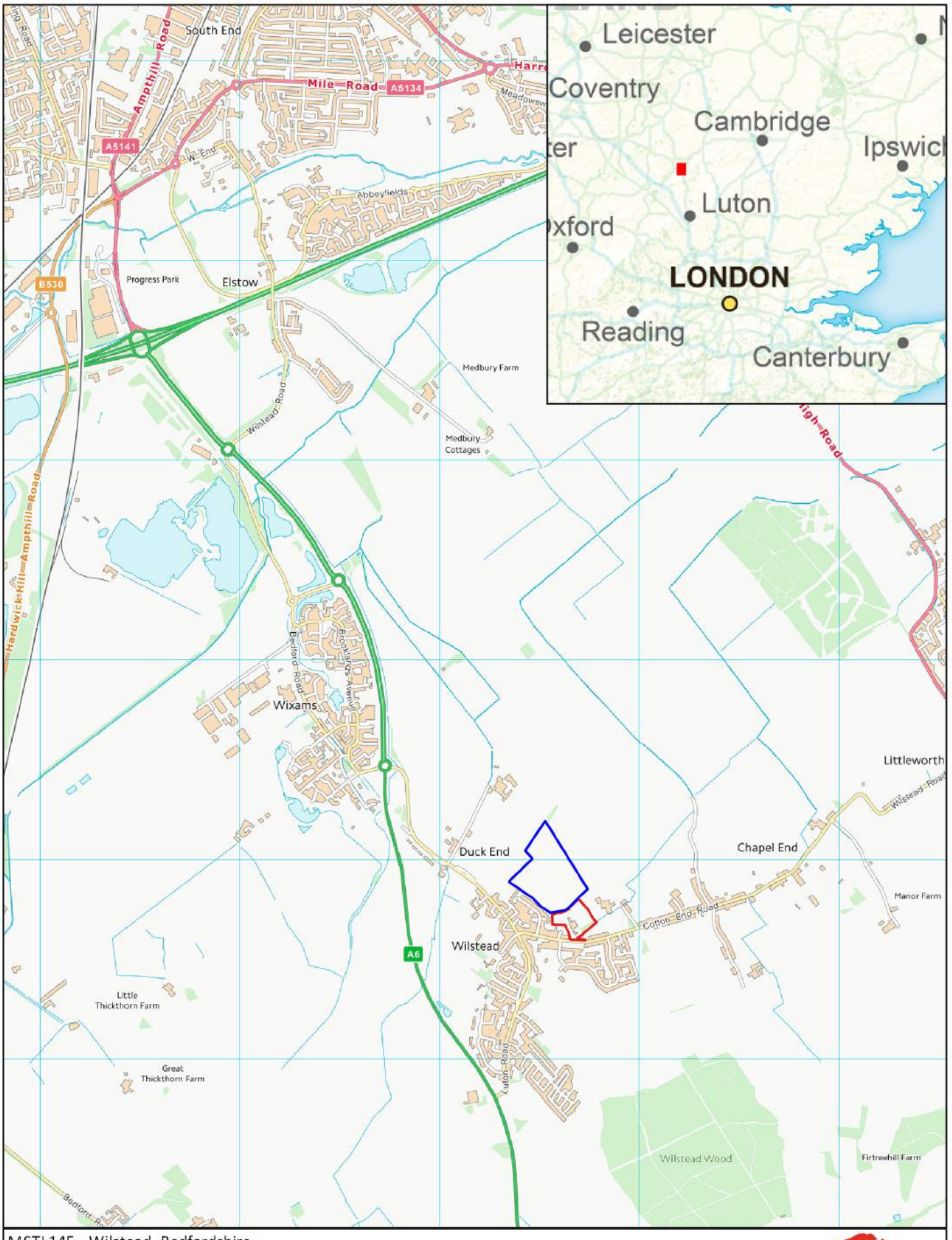


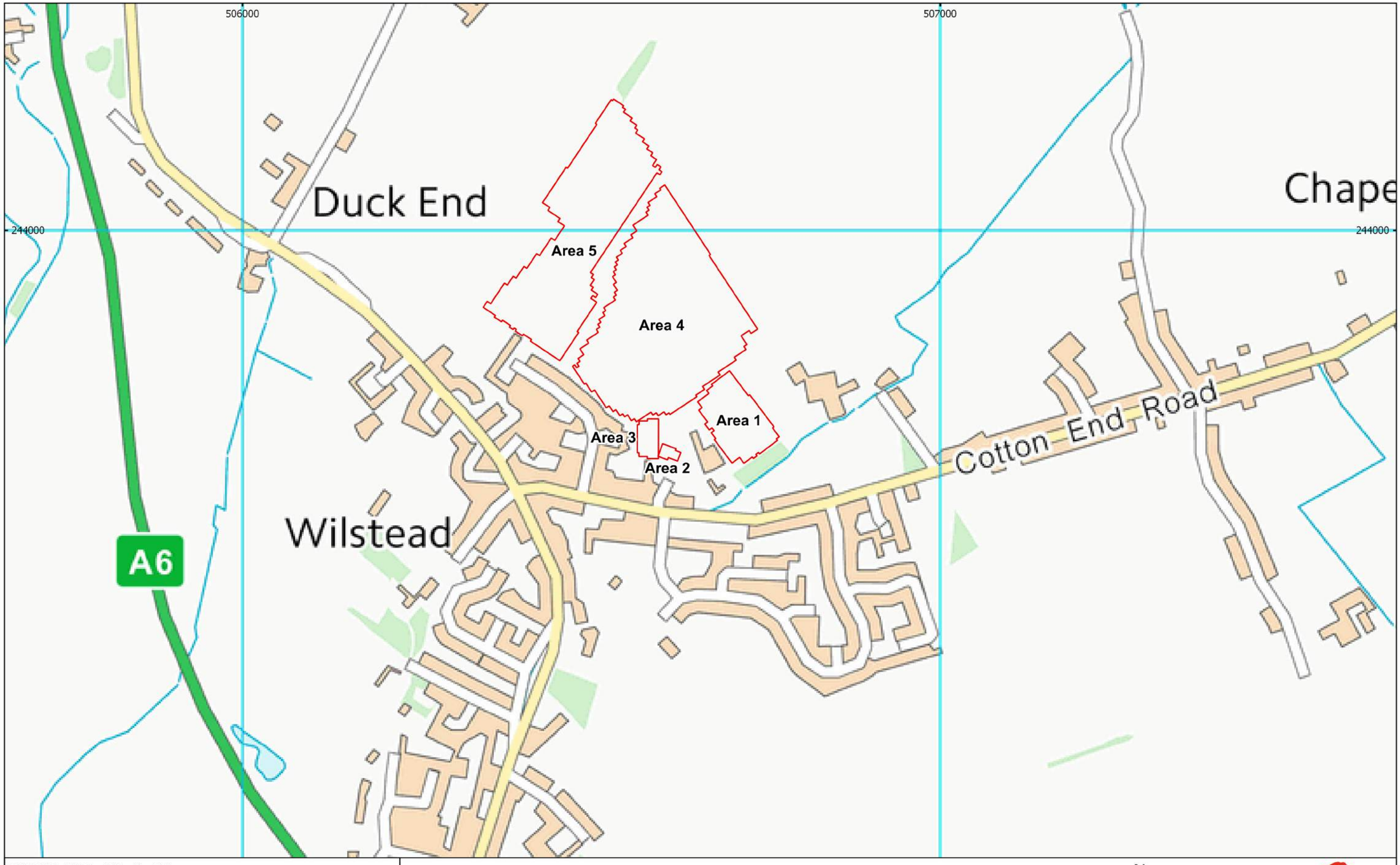
MSTL145 - Wilstead, Bedfordshire
Figure 1 - Site Location
1 : 25,000 @ A4

Phase 1 Phase 2

N

0 0.5 1 km

magnitude surveys



MSTL145 - Wilstead, Bedfordshire
Figure 2 - Location of Survey Areas
1:5000 @ A3

N

0 100 200 300 m

magnitude surveys

MSTL145 - Wilstead, Bedfordshire
Figure 4 - Magnetic Greyscale
1:2500 @ A3

-1 nT 2

N

0 50 100 150 m

magnitude surveys

506100 506200 506300 506400 506500 506600 506700 506800 506900 507000

244200 244100 244000 243900 243800 243700

Duck End

Area 5

5b

5c

5d

5a

Area 4

4b

4a

Area 1

Area 3

Area 2

MSTL145 - Wilstead, Bedfordshire
Figure 4 - Magnetic Interpretation
1:2500 @ A3

Archaeology Possible (Strong)
Archaeology Possible (Weak)
Archaeology Probable (Trend)
Agricultural (Spread)
Agricultural (Trend)
Ridge and Furrow (Trend)
Natural (Strong)
Natural (Spread)
Undetermined (Weak)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service
Undetermined (Trend)

N

0 50 100 150 m

magnitude surveys

506100 506200 506300 506400 506500 506600 506700 506800 506900 507000

244200 244100 244000 243900 243800 243700

Area 5

5b

5c

5d

5a

Area 4

4b

4a

Area 1

Area 3

Area 2

MSTL145 - Wilstead, Bedfordshire
Figure 5 - Magnetic Interpretation Over Satellite Imagery
1:2500@ A3

Archaeology Possible (Strong)
Archaeology Possible (Weak)
Archaeology Probable (Trend)
Agricultural (Spread)
Agricultural (Trend)
Ridge and Furrow (Trend)
Natural (Strong)
Natural (Spread)
Undetermined (Weak)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service
Undetermined (Trend)

N

0 50 100 150 m

magnitude surveys

506100 506200 506300 506400 506500 506600 506700 506800 506900 507000

244200 244100 244000 243900 243800 243700

Duck End

Duckend Farm

WILSHA

Area 5

5b

5c

5d

5a

Area 4

4b

4a

Area 1

Area 3

Area 2

B.M. 126·1

Inn

Red Lion Inn

Manor Farm

W Chap.

119

MSTL145 - Wilstead, Bedfordshire
Figure 6 - Magnetic Interpretation Over Historic Mapping
1:2500 @ A3

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

Archaeology Possible (Strong)
Archaeology Possible (Weak)
Archaeology Probable (Trend)
Agricultural (Spread)
Agricultural (Trend)
Ridge and Furrow (Trend)
Natural (Strong)
Natural (Spread)
Undetermined (Weak)
Ferrous (Dipolar)
Ferrous (Spread)/Magnetic Disturbance
Service
Undetermined (Trend)

N

0 50 100 150 m

magnitude surveys

506100 506200 506300 506400 506500 506600 506700 506800 506900 507000

244200 244100 244000 243900 243800 243700

Duck End

Area 5

Area 4

Area 1

Area 3

Area 2

MSTL145 - Wilstead, Bedfordshire
Figure 7 - XY Trace Plot
50nT/cm at 1:750 @ A3

N

0 50 100 150 m

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