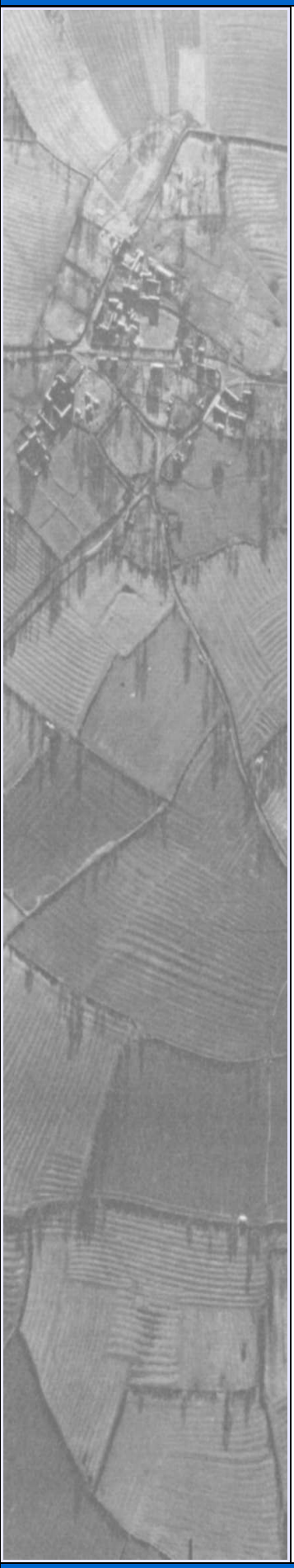

Land north of Green Lane
Chesterton
Oxfordshire

MAGNETOMETER SURVEY REPORT

for

CSa Environmental Planning

on behalf of

Taylor Wimpey UK Ltd

David Sabin and Kerry Donaldson

August 2014

Ref. no. 538

ARCHAEOLOGICAL SURVEYS LTD

Land north of Green Lane
Chesterton
Oxfordshire

Magnetometer Survey Report

for

CSa Environmental Planning

on behalf of

Taylor Wimpey UK Ltd

Fieldwork by David Sabin
Report by David Sabin BSc (Hons) MIFA and Kerry Donaldson BSc (Hons)

Survey date – 11th April 2014
Ordnance Survey Grid Reference – **SP 55800 21395**

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SUMMARY

A detailed magnetometer survey was undertaken within two land parcels at Chesterton, near Bicester in Oxfordshire. The results indicate the presence of cut features of archaeological potential in the form of a rectilinear enclosure and linear ditch. These extend across both survey areas, although the north eastern area contains widespread magnetic debris which may have obscured further weaker features. Several other linear and discrete anomalies have been located, and while these may relate to cut, ditch-like and pit-like features they are weak, fragmented and indistinct.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by CSa Environmental Planning on behalf of Taylor Wimpey UK Ltd, to undertake a magnetometer survey of an area of land at Chesterton, near Bicester, Oxfordshire. The site has been outlined for a proposed residential development and the survey forms part of an archaeological assessment of the site.

1.2 Survey objectives and techniques

1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation;* and Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations*. The work has been carried out to the Institute for Archaeologists (2011) *Standard and Guidance for Archaeological Geophysical Survey.*

1.3 Site location, description and survey conditions

1.3.1 The site is located on the western edge of Chesterton, near Bicester in Oxfordshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SP 55800 21395, see Figures 01 and 02.

1.3.2 The geophysical survey covers approximately 2.6ha within two land parcels. Area 1, forming the north eastern part of the site, contained short grazed grass, and Area 2 to the south west contained a rape crop at the time of survey.

1.3.3 The ground conditions across the site were generally considered to be

favourable for the collection of magnetometry data. However, large bonfires within Area 1 prevented survey across some small zones. The area also contained modern steel objects that are sources of strong magnetic disturbance.

Plate 1: Area 1 looking south east

Plate 2: Area 2 looking south east

1.4 Site history and archaeological potential

1.4.1 The site lies 100m north of the Roman road of Akeman Street which lead to the Roman town of Alchester, 1.2km to the south east. Other Roman finds have been located in the vicinity. During the medieval period it is likely that the site was under strip field cultivation. The northern part of the site (Area 1) contained allotment gardens in the 20th century. Given the proximity to Akeman Street, Alchester and Roman findspots there is potential for the survey to locate buried archaeological features. Evidence for cultivation, both as ridge and furrow and later allotments is also possible.

1.5 Geology and soils

1.5.1 The underlying geology is limestone from the Cornbrash Formation (BGS, 2014).

1.5.2 The overlying soil across the site is from the Aberford association and is a brown calcareous earth. It consists of a shallow, locally brashy, well drained, calcareous, fine loamy soil over limestone (Soil Survey of England and Wales, 1983).

1.5.3 Magnetometry carried out over similar geology and soil has produced good results. The site is, therefore, considered suitable for magnetic survey.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla,

which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers spaced 0.5m apart with readings recorded at 20 Hz. The gradiometers have a range of recording data between 0.1nT and 10,000nT. They are linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.2 Data are collected along a series of parallel survey transects wherever possible. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses.

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared and automatically compensated using SENSYS MAGNETO®DLMGPS software. As the data is collected at ±10000nT, it is clipped for display. Georeferenced data are then exported in ASCII format for further analysis and display using TerraSurveyor.

2.3.2 Appendix C contains specific information concerning the survey and data attributes and is derived directly from TerraSurveyor; this should be used in conjunction with information provided by Figure 02.

2.3.3 Only minimal processing is carried out in order to enhance the results of the survey for display. Raw data are always analysed, as processing can modify anomalies. The following schedule sets out the data and image processing used in this survey for the SENSYS MAGNETO data:

- clipping of the data at ±20nT for Area 1 and ±15nT for Area 2 to enhance low magnitude anomalies,
- zero median traverse is applied in order to balance readings along each traverse.

2.3.4 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within each survey area.

2.3.5 Reference should be made to Appendix B for further information on the specific processes carried out on the data. Appendix C metadata includes

details on the processing sequence used for each survey area.

2.3.6 The main form of data display prepared for this report is the 'processed' greyscale plot followed by an abstraction and interpretation plot. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.3.7 Data captured with the SENSYS MAGNETO cart-based system are resampled to a resolution of effectively 0.5m between tracks and 0.15m along each survey track. A TIFF file (OSGB36) is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing when using GIS or CAD software.

2.3.8 The raster images are combined with base mapping using ProgeCAD Professional 2014 and AutoCAD LT 2007, creating DWG file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. Quality can be compromised by rotation of graphics in order to allow the data to be orientated with respect to grid north; this is considered acceptable as the survey results are effectively georeferenced allowing relocation of features using GPS, resection method, etc.

2.3.9 A digital archive is produced with this report, see Appendix D below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of two survey areas covering approximately 2.6ha.

3.1.2 Magnetic anomalies located can be generally classified as positive linear and discrete positive responses of archaeological potential, positive and negative anomalies of an uncertain origin, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects.

3.2 Statement of data quality

3.2.1 Data are considered representative of the magnetic anomalies present within the site. Localised zones of magnetic disturbance caused by modern ferrous objects are present within Area 1. Widespread magnetic debris likely to be of modern origin is also present across much of Area 1. Both magnetic debris and disturbance have the potential to obscure more minor anomalies should they exist within the survey area.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross referencing to the abstraction and interpretation plot. CAD layer names are included to aid reference to associated digital files (.dwg/.dxf). Sub-headings are then used to group anomalies with similar characteristics for each survey area.

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with archaeological potential AS-ABST MAG POS LINEAR ARCHAEOLOGY AS-ABST MAG POS DISCRETE ARCHAEOLOGY 	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc..
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN 	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies with an agricultural origin AS-ABST MAG RIDGE AND FURROW 	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing.
Anomalies associated with magnetic debris AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR 	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, or hearths and may therefore be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin AS-ABST MAG DISTURBANCE 	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically and with hysteresis adjacent to strong magnetic sources.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 455818 221418, see Figures 03 & 04

Anomalies of archaeological potential

(1) – A positive linear anomaly extends across the width of the survey area and is a response to a cut feature which continues to the south west as anomaly (7).

(2) – A positive linear anomaly extends across the south eastern part of the survey area and links to the north eastern part of anomaly (7) seen in Area 2 to the south west.

(3) – A positive linear anomaly is located in the north western part of the survey area and appears to be a continuation of anomaly (8) within Area 2.

Anomalies with an uncertain origin

(4) – The survey area contains a number of weak and short positive linear anomalies. It is not clear if they relate to cut features, or if they have some association with the use of the site as allotment gardens.

Anomalies associated with magnetic debris

(5) – The survey area contains widespread magnetic debris. This obscures weak anomalies and is likely to be associated magnetically thermoremnant material incorporated into the topsoil during the use of of the site as allotments and possibly to more recent burnt material

Anomalies with a modern origin

(6) – Magnetic disturbance is a response to steel buildings and ferrous fencing.

3.5 List of anomalies - Area 2

Area centred on OS NGR 455775 221375, see Figures 03 & 04.

Anomalies of archaeological potential

(7) – Three sides of a positive rectilinear anomaly appear to form an enclosure that extends north eastwards as anomalies (1) and (2) in Area 1. The response is generally 2nT and there appears to be a partial extension at the western corner.

(8) – A discontinuous positive linear anomaly extends along the western part of the survey area. There appears to be a gap of 5.5m and then it continues north eastwards as anomaly (3) in Area 1. The response is generally 3-4nT and it

indicates a cut, linear feature, such as a boundary ditch.

Anomalies with an uncertain origin

(9) – Within the confines of anomaly (7) are a number of positive and negative linear anomalies and a possible positive curvilinear anomaly. Although these may relate to cut features, they are short and weak (<1nT) and lack a coherent morphology preventing confident interpretation.

(10) – Located close to the south eastern corner of the survey area is a broad positive linear anomaly with some associated negative response. As it is located close to the field boundary it is not clear if it relates to a cut feature, but this is possible.

(11) – A number of positive linear and rectilinear anomalies are located to the west of anomaly (8). They have a similar response to anomalies (9) and it is not possible to determine their origin.

(12) – A number of discrete positive responses have been located within the survey area. Although some lie within the confines of anomaly (7) is it not possible to determine if they relate to pit-like features with an anthropogenic or natural origin, but archaeology should be considered.

Anomalies with an agricultural origin

(13) – A series of parallel anomalies appear to relate to former ridge and furrow.

Anomalies associated with magnetic debris

(14) – Strong, discrete, dipolar anomalies are a response to ferrous and other magnetically thermoremnant objects within the topsoil.

4 CONCLUSION

4.1.1 The detailed magnetometer survey located a positive rectilinear anomaly that appears to relate to an enclosure feature that is present within both survey areas. A further linear ditch, with an apparent deliberate 5.5m gap, is located to the west of the enclosure. Several other linear and discrete anomalies have been located within the site, but these are generally very weak and indistinct and although they may relate to cut, ditch-like and pit-like features, their origin is uncertain.

4.1.2 Widespread magnetic debris with the north eastern part of the site (Area 1) is likely to have originated from its use as allotment gardens. The south western part of the site (Area 2) contains evidence of medieval cultivation in the form of ridge and furrow.

5 REFERENCES

British Geological Survey, 2014. *Geology of Britain viewer, 1:50 000 scale [online]* available from http://mapapps.bgs.ac.uk/geologyofbritain/home.html [accessed 21/7/2014].

English Heritage, 2008. *Geophysical survey in archaeological field evaluation. Research and Professional Service Guideline No.1.* 2nd ed. Swindon: English Heritage.

Institute for Archaeologists, 2002. *The use of Geophysical Techniques in Archaeological Evaluations*. IfA Paper No. 6. IfA, University of Reading.

Institute for Archaeologists, 2011. *Standard and Guidance for archaeological geophysical survey*. IfA, University of Reading.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 6 South East England.*

Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature. If no enhanced feature is present the field measured by both sensors will be similar and the difference close to zero.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between ±15nT and ±10nT often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise slight differences between the set-up and stability of gradiometer sensors and can remove striping. The process can remove archaeological features that run along a traverse so data analysis is also carried out prior its application.

Appendix C – survey and data information

Area 1

COMPOSITE
Filename: J538-mag-Area 1-proc.xcp
Description: Imported as Composite from: J538-mag-Area 1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):
Northwest corner: 455724.862422094, 221508.439962376 m
Southeast corner: 455913.862422094, 221329.639962376 m
Direction of 1st Traverse: 90 deg
Collection Method: Parallel
Sensors: 1
Dummy Value: 32702

Source GPS Points: 248800

Dimensions
Composite Size (readings): 1260 x 1192
Survey Size (meters): 189 m x 179 m
Grid Size: 189 m x 179 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 22.10
Min: -22.00
Std Dev: 12.49
Mean: -0.07
Median: 0.46
Composite Area: 3.3793 ha
Surveyed Area: 0.79027 ha

Processes: 1
1 Base Layer

GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse: Threshold: 1.5 SDs
4 Clip from -20.00 to 20.00 nT

Area 2

COMPOSITE
Filename: J538-mag-Area2-proc.xcp
Description: Imported as Composite from: J538-mag-Area2.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):
Northwest corner: 455690.782989101, 221487.156167364 m
Southeast corner: 455879.332989101, 221279.556167364 m
Direction of 1st Traverse: 90 deg
Collection Method: Parallel
Sensors: 1
Dummy Value: 32702

Source GPS Points: 602300

Dimensions
Composite Size (readings): 1257 x 1384
Survey Size (meters): 189 m x 208 m
Grid Size: 189 m x 208 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 16.58
Min: -16.50
Std Dev: 5.31
Mean: 0.24
Median: 0.01
Composite Area: 3.9143 ha
Surveyed Area: 1.6151 ha

Processes: 1
1 Base Layer

GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse: Threshold: 1.5 SDs
4 Clip from -15.00 to 15.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire (see inside cover for address). Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

Surveys are reported on in hardcopy (recycled paper) using A4 for text and A3 for plots (all plots are scaled for A3).

Archaeological Surveys Ltd shall retain intellectual property rights for the materials and records created as part of this project. A non-exclusive, transferable, sub-licensable, perpetual, irrevocable and royalty-free licence shall be granted to the client in order for them to use, reproduce and enhance the reports, documentation, graphics and illustrations produced as part of this project for the purpose for which they were commissioned. Copyright licence will also be granted to the local authority for planning use and within in the Historic Environment Record for public dissemination upon instruction by the client. Archaeological Surveys Ltd shall retain the right to be identified as the author and originator of the material.

This report has been prepared using the following software on a Windows XP platform:

- TerraSurveyor version 3.0.23.0 (geophysical data analysis),
- SENSYS MAGNETO®ARCH version 1.00-04(geophysical data analysis),
- ProgeCAD Professional 2014 (report graphics),
- AutoCAD LT 2007 (report figures),
- OpenOffice.org 3.0.1 Writer (document text),
- PDF Creator version 0.9 (PDF archive).

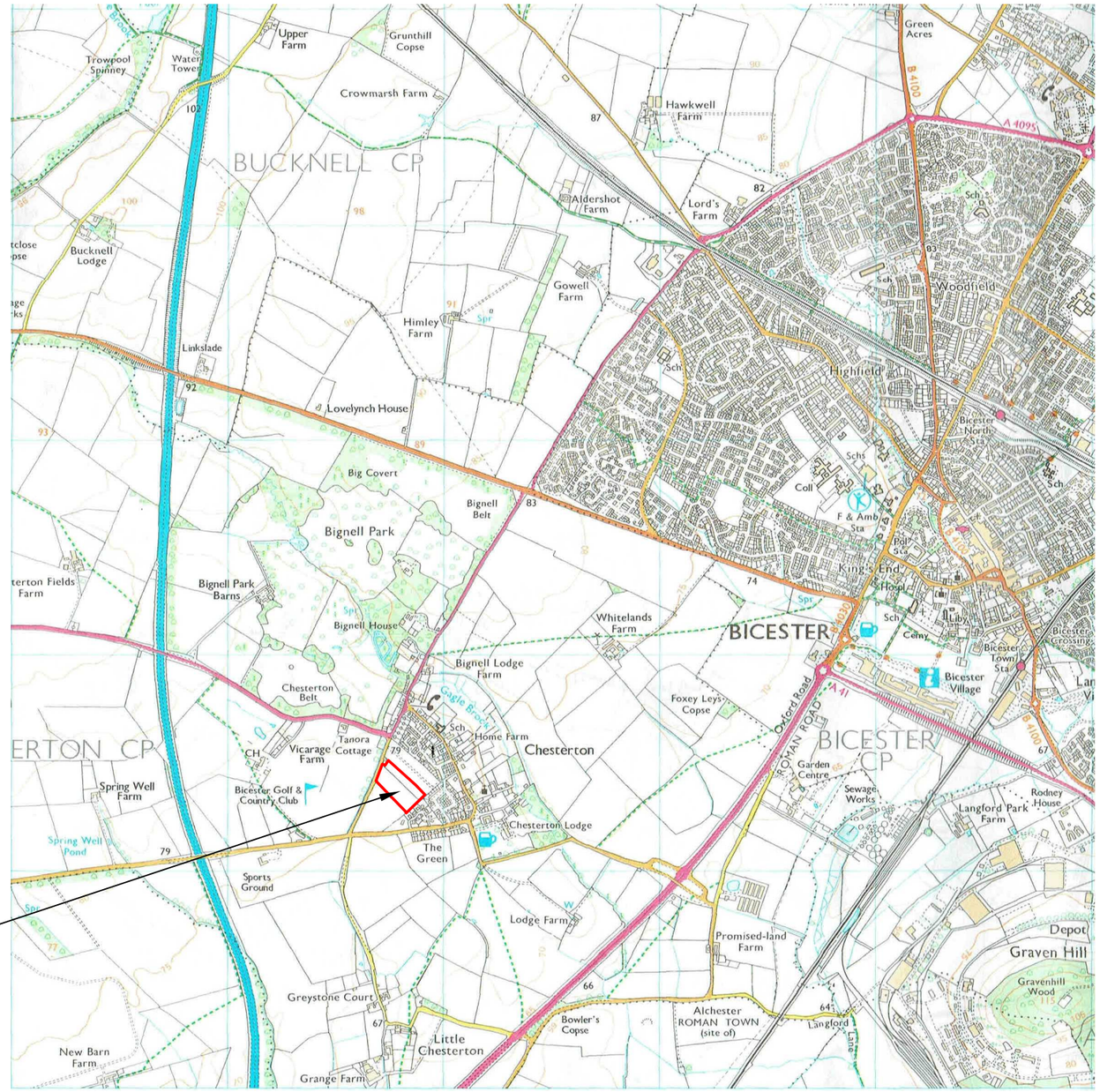
Digital data produced by the survey and report include the following files:

- TerraSurveyor grid and composite files for all geophysical data,
- CSV files for raw and processed composites,
- geophysical composite file graphics as Bitmap images,
- AutoCAD DWG files in 2000 and 2007 versions,
- report text as OpenOffice.org ODT file,
- report text as Word 2000 doc file,
- report text as rich text format (RTF),
- report text as PDF,
- PDFs of all figures.

Archaeological Surveys Ltd

Geophysical Survey
Land north of Green Lane
Chesterton
Oxfordshire

Map of survey area



● Survey location

Site centred on OS NGR
SP 55800 21395

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0m 500m 1000m

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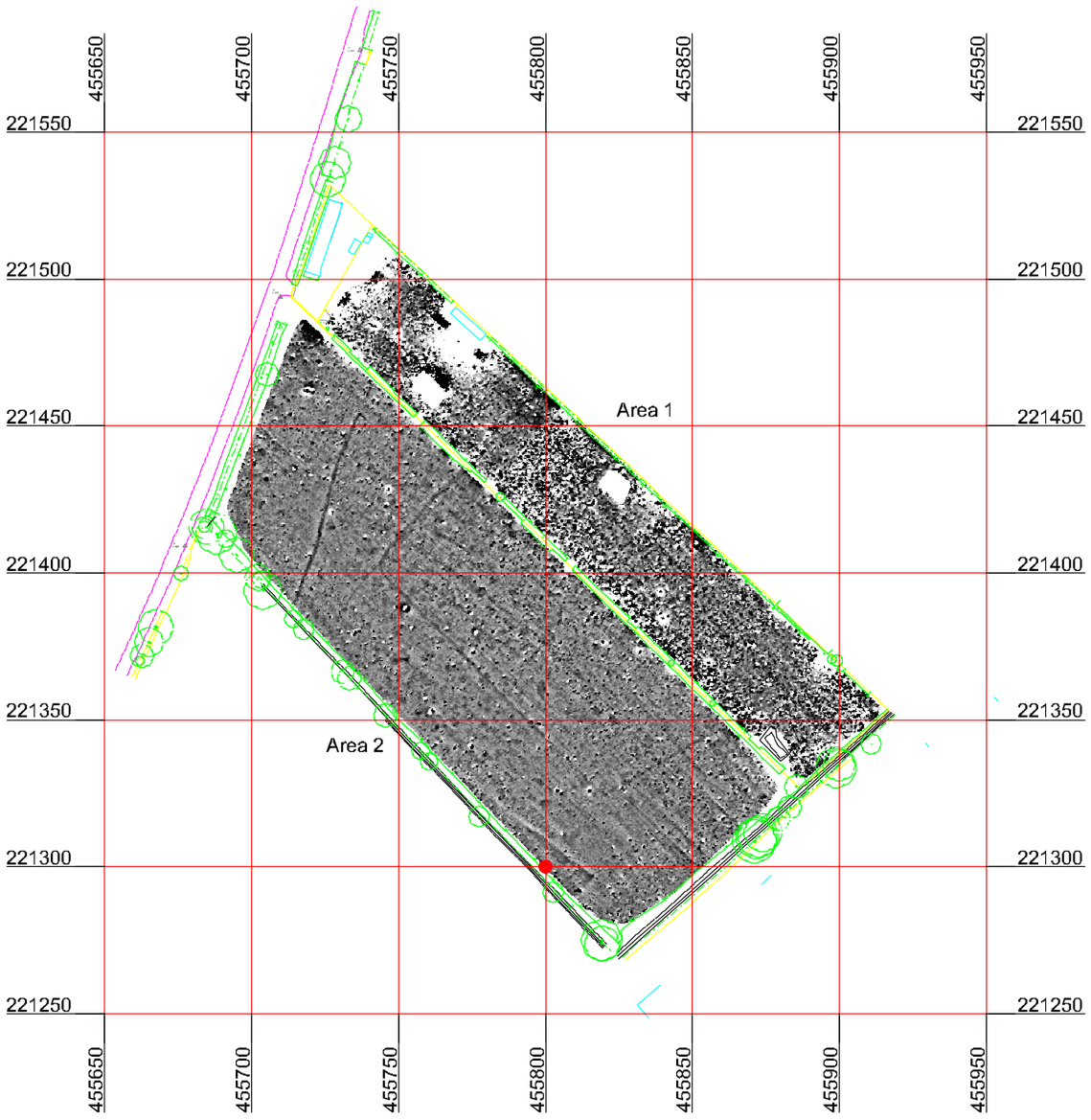
FIG 01



Archaeological Surveys Ltd

Geophysical Survey
Land north of Green Lane
Chesterton
Oxfordshire

Referencing information

Referencing grid to OSGB36 datum at 50m intervals

Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

● 456800 221300

SCALE 1:2000

0m 20 40 60 80 100m

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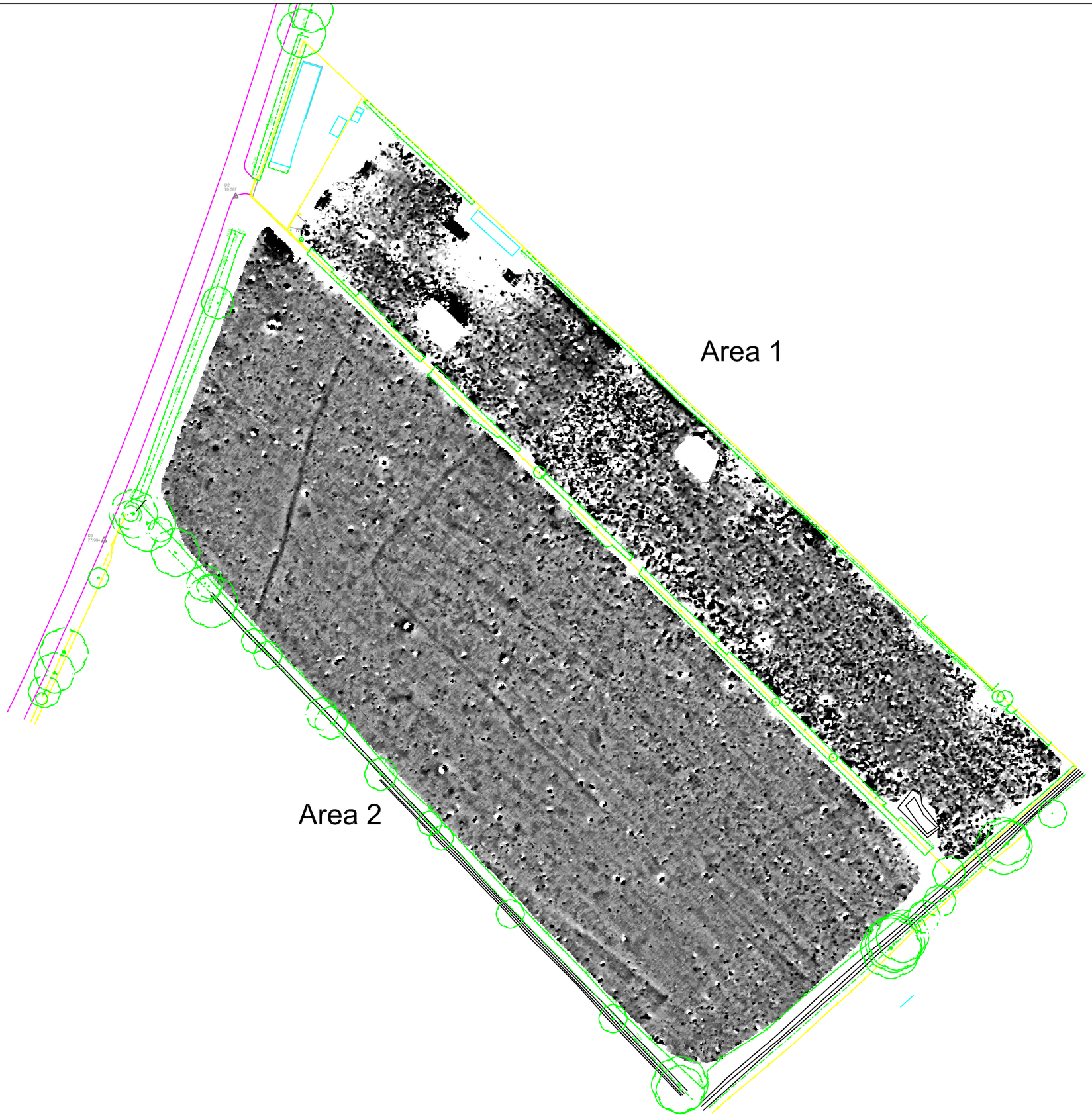
FIG 02



N

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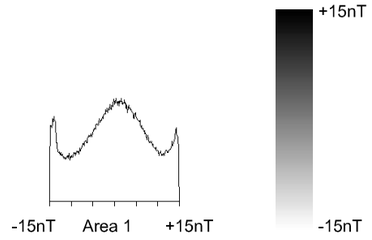
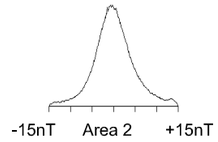
Geophysical Survey
Land north of Green Lane
Chesterton
Oxfordshire

Greyscale plot of minimally processed magnetometer data





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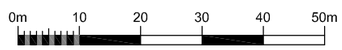

SCALE TRUE AT A3

FIG 04

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Geophysical Survey
Land north of Green Lane
Chesterton
Oxfordshire

Abstraction and interpretation of magnetometer anomalies

- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Negative linear anomaly - material of low magnetic susceptibility
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

N

Area 1

Area 2

1 2 3 4 5 6 7 8 9 10 11 12 13 14

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 04