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**Land west of Cotes Road  
Barrow upon Soar  
Leicestershire**

**Geophysical Survey**

Report no. 2568

January 2014

Client: CgMs Consulting



# Land west of Cotes Road Barrow upon Soar Leicestershire

## Geophysical Survey

### *Summary*

*A geophysical (magnetometer) survey covering 3 hectares was carried out on agricultural land west of Cotes Road, Barrow upon Soar, to inform the determination of an outline planning application for the proposed development of the site. Tentatively, a possible extraction pit has been interpreted within the west of the site and ridge and furrow cultivation has been identified throughout. However, no anomalies of obvious archaeological potential have been identified. Therefore, on the basis of the geophysical survey, the site is considered to be of low archaeological potential.*



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## Report Information

Client: CgMs Consulting  
Address: Units 20-22 Newark Beacon, Beacon Hill Office Park,  
Cafferata Way, Newark, Nottinghamshire, NG24 2TN  
Report Type: Geophysical Survey  
Location: Cotes Road, Barrow upon Soar  
County: Leicestershire  
Grid Reference: SK 568 184  
Period(s) of activity: -  
Report Number: 2568  
Project Number: 4183  
Site Code: CHB13  
OASIS ID: archaeol11-169471  
Planning Application No.:  
Museum Accession No.: n/a  
Date of fieldwork: January 2014  
Date of report: January 2014  
Project Management: Sam Harrison BSc MSc MifA  
Fieldwork: Sam Harrison  
Alexander Schmidt BA  
Report: David Harrison BA MSc MifA  
Illustrations: David Harrison  
Photography: Sam Harrison  
Research: n/a

Authorisation for  
distribution: \_\_\_\_\_



© Archaeological Services WYAS 2014  
PO Box 30, Nepshaw Lane South, Morley, Leeds  
LS27 0UG  
Telephone: 0113 383 7500.  
Email: [admin@aswyas.com](mailto:admin@aswyas.com)



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## 1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Myk Flitcroft of CgMs Consulting (The Client), to undertake a geophysical (magnetometer) survey of land west of Cotes Road, Barrow upon Soar, prior to the submission of a planning application for the proposed development of the site. The work was undertaken in accordance with a Project Design (Sykes 2014) supplied to and approved by the client, with guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (David *et al.* 2008). The survey was carried out on January 15th and January 16th 2014 in order to provide additional information on the archaeological potential of the site.

### Site location, topography and land-use

The Proposed Development Area (PDA) is situated on the north-western periphery of Barrow upon Soar, at Catsick Hill, Leicestershire, centred at SK 568 184 (see Fig. 1), and comprises a rectangular parcel of land which is subdivided into two fields (Field 1 and Field 2) covering 3.5ha. Field 2 is further subdivided by a series of horse paddocks along its south-eastern boundary. The site is bound to the north-east by Cotes Road, to the south-west by the Midland Main Line railway and by mixed residential and arable plots to the north-west and south-east (see Fig. 2). Topographically, the PDA is sited on a west-facing gradient, being at 61m above Ordnance Datum (aOD) at Cotes Road and 45m aOD the Midland Main Line railway. At the time of the survey Field 1 was overgrown and unsuitable for survey (see Plate 1 and Fig. 2) and Field 2 was under arable cultivation (see Plate 2) with horse paddocks along the south-eastern boundary (see Plates 3 and 4). A stable prevented any survey within the western corner of the site (see Fig. 2).

### Soils and geology

The underlying bedrock comprises mudstone which is classified in the Blue Anchor, Westbury, Cotham Member and Barnstone Member (interbedded limestone and mudstone). The mudstone is overlain by superficial deposits of Thrussington Member – Diamicton – poorly sorted sediment (e.g. sand and gravel) within a mud matrix (British Geological Survey 2014).

The soils are classified in the Dunnington Heath association, characterised as coarse and fine loams over clays with slowly permeable subsoils and slight seasonal waterlogging (Soil Survey of England and Wales 1983).

## 2 Archaeological Background

Barrow upon Soar is known to be rich in industrial archaeology with the town being linked to the production of lime since the medieval period. In recent years, archaeological evaluations

have identified a variety of kiln types, in-filled stone quarries and clay pits from the medieval through to the post-medieval periods. However, it is understood that there are no known heritage sites within the PDA.

### **3 Aims, Methodology and Presentation**

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact on potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim a magnetometer survey covering all suitable parts of the PDA was carried out, an area of 3 hectares.

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

#### **Magnetometer survey**

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). Bartington Grad601 magnetic gradiometers were used during the survey, taking readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

#### **Reporting**

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 is a large scale (1:2500) location plan displaying the processed magnetic data. Detailed data plots ('raw' and processed) and full interpretative figures are presented at a scale of 1:1000 in Figures 3, 4 and 5 inclusive.

Further technical information on the equipment used, data processing and survey methodologies is given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the site archive.

The survey methodology, report and any recommendations comply with the Project Design (Sykes 2014) and guidelines outlined by English Heritage (David *et al* 2008) and by the

Institute for Archaeologists (IfA 2013). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

#### **4 Results and Discussion** (see Figs 3, 4 and 5 inclusive)

The anomalies identified by the survey fall into a number of different types and categories according to their origin and these are discussed below and cross-referenced to specific examples and locations within the site, if appropriate.

##### **Ferrous Anomalies**

Ferrous responses, either as individual 'spike' anomalies or more extensive areas of magnetic disturbance, are typically caused by modern ferrous (magnetic) debris, either on the ground surface or in the plough-soil, or are due to the proximity of magnetic material in field boundaries, buildings or other above ground features. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation as ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the PDA individual iron 'spike' anomalies are common but there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the soil.

High magnitude negative linear anomalies along the south-eastern boundary are caused by barbed-wire fencing enclosing a series of horse paddocks (see Plates 2, 3 and 4). Elsewhere, areas of disturbance around the periphery of the PDA are due to ferrous material forming part of, or incorporated into, the adjacent field boundaries.

##### **Agricultural Anomalies**

Historical mapping shows that the division and layout of fields within the PDA has altered little since the publication of the first edition map in 1884, albeit with the removal of one north-west/south-east aligned field boundary. This former boundary manifests in the data as a very faint linear trend, **A**, which is thought to be caused by a soil-filled ditch. A series of parallel, slightly sinuous, linear anomalies can be seen throughout the PDA on a north-east/south-west orientation. These anomalies are interpreted as being due to the medieval and post-medieval agricultural practice of ridge and furrow cultivation. The characteristic striped appearance to the data is a result of the magnetic contrast between the now soil-filled furrows and the former ridges. The former cultivation trends are orientated parallel with the field



boundaries as depicted on the first edition Ordnance Survey map and a post-medieval origin is likely.

### **Geological anomalies**

Aside from the linear trends discussed above, a low level of background magnetic variation is apparent throughout the PDA. Few discrete anomalies, characterised as localised areas of enhanced magnetic response, have been identified. Those that have are interpreted as geological in origin, being caused by variation in the composition of the soils and superficial deposits (sands and gravels) from which they derive. Within the west of the site, a single high magnitude broad and amorphous anomaly, **B**, may be of interest, perhaps being due to a former extraction pit. In recent years several medieval and post-medieval stone quarries and clay pits have been recorded within Barrow upon Soar, although none are known from within the immediate vicinity of the PDA. However, a geological origin, perhaps caused by a pocket of sand and/or gravel within the diamicton superficial deposits is also considered plausible.

## **5 Conclusions**

The majority of the anomalies identified by the survey are consistent with above-ground ferrous objects, such as perimeter fencing, and the 19th century agricultural landscape as depicted on the first edition Ordnance Survey map. One anomaly of interest has been identified within the west of the site, perhaps being caused by an in-filled extraction pit. However, this anomaly is likely to be of historical rather than archaeological potential. Therefore, on the basis of the geophysical survey, the archaeological potential of the site is considered to be low.

*The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.*

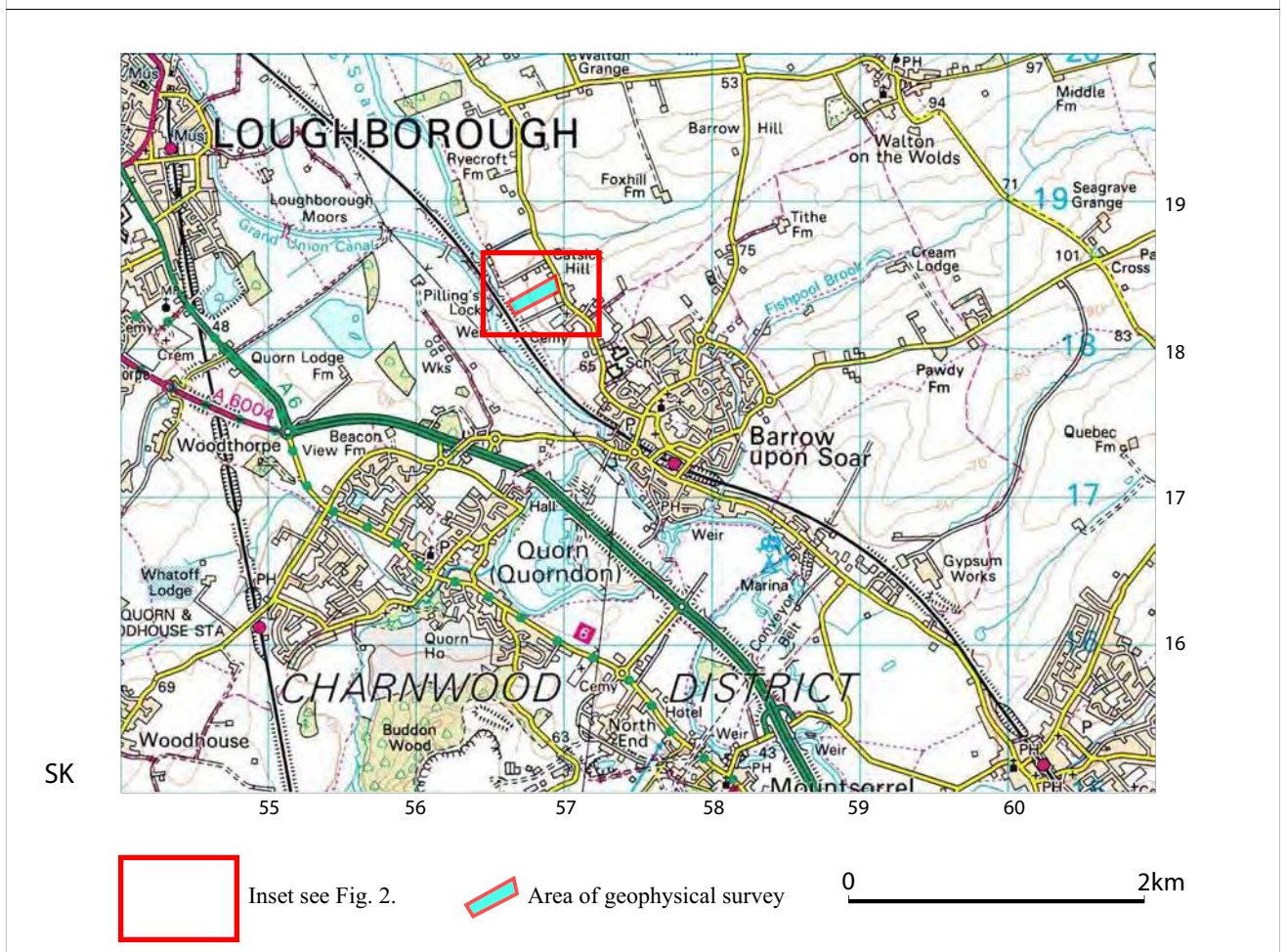
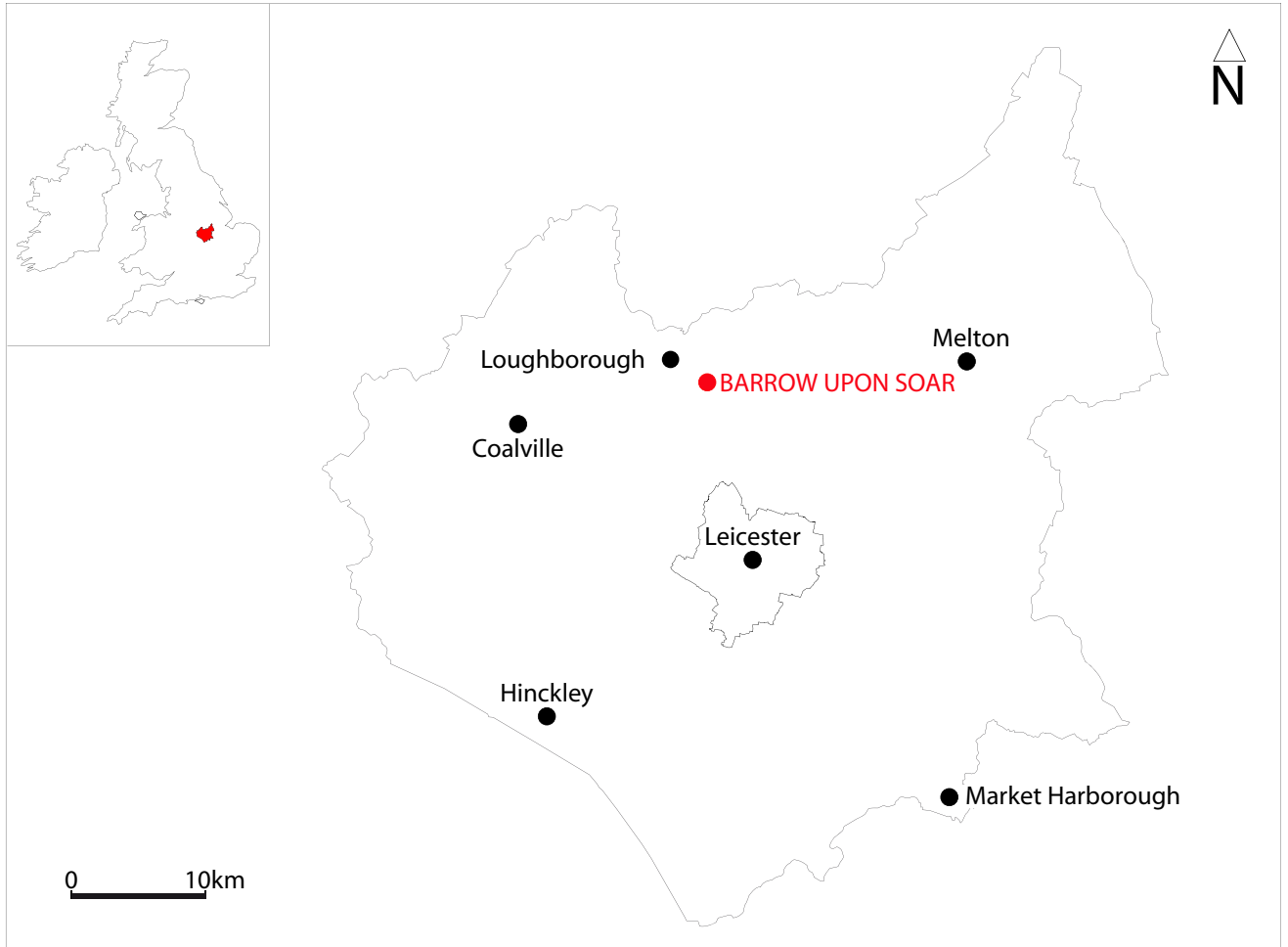


Fig. 1. Site location



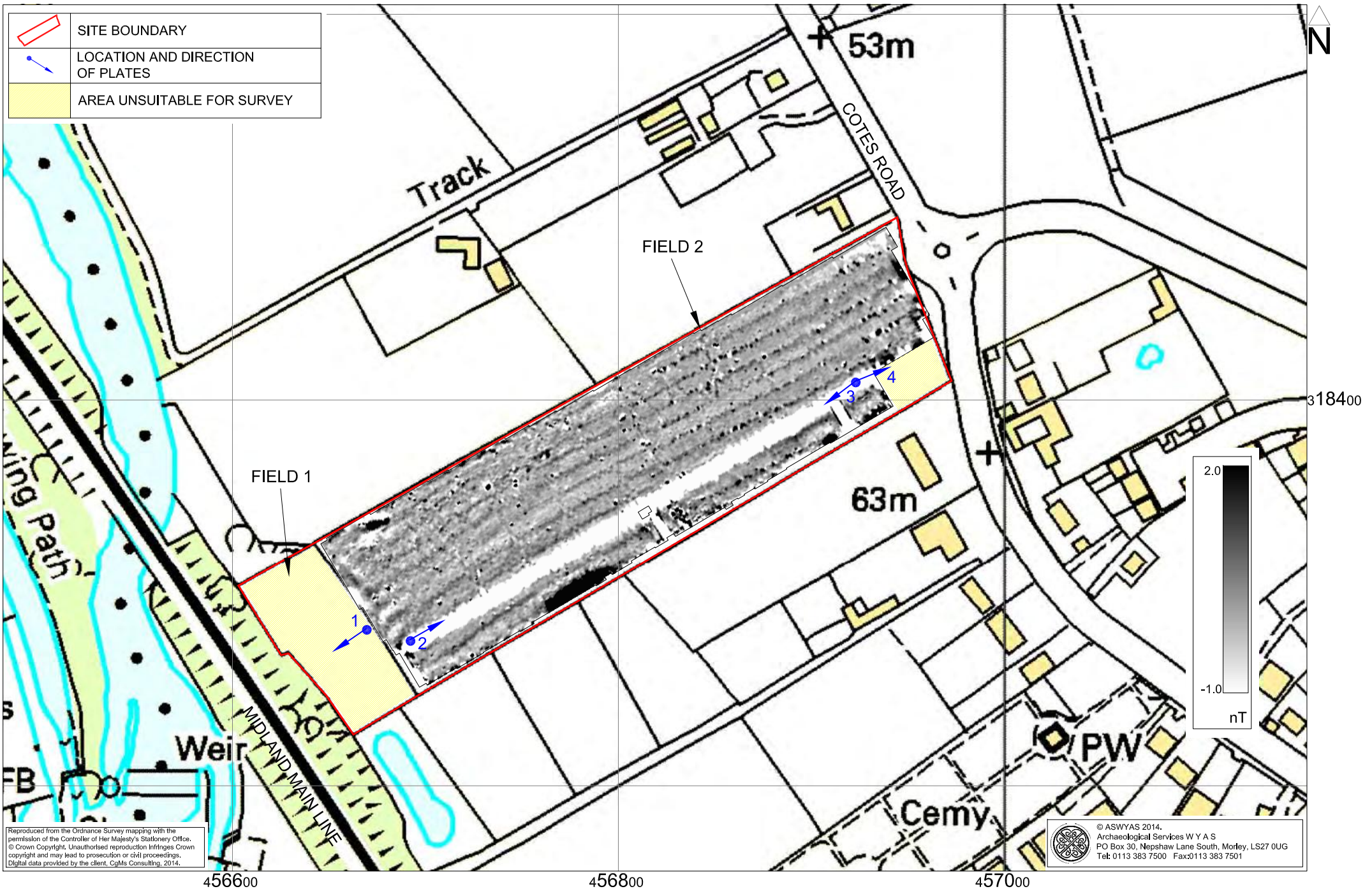


Fig. 2. Survey location showing greyscale magnetometer data (1:2500 @ A4)



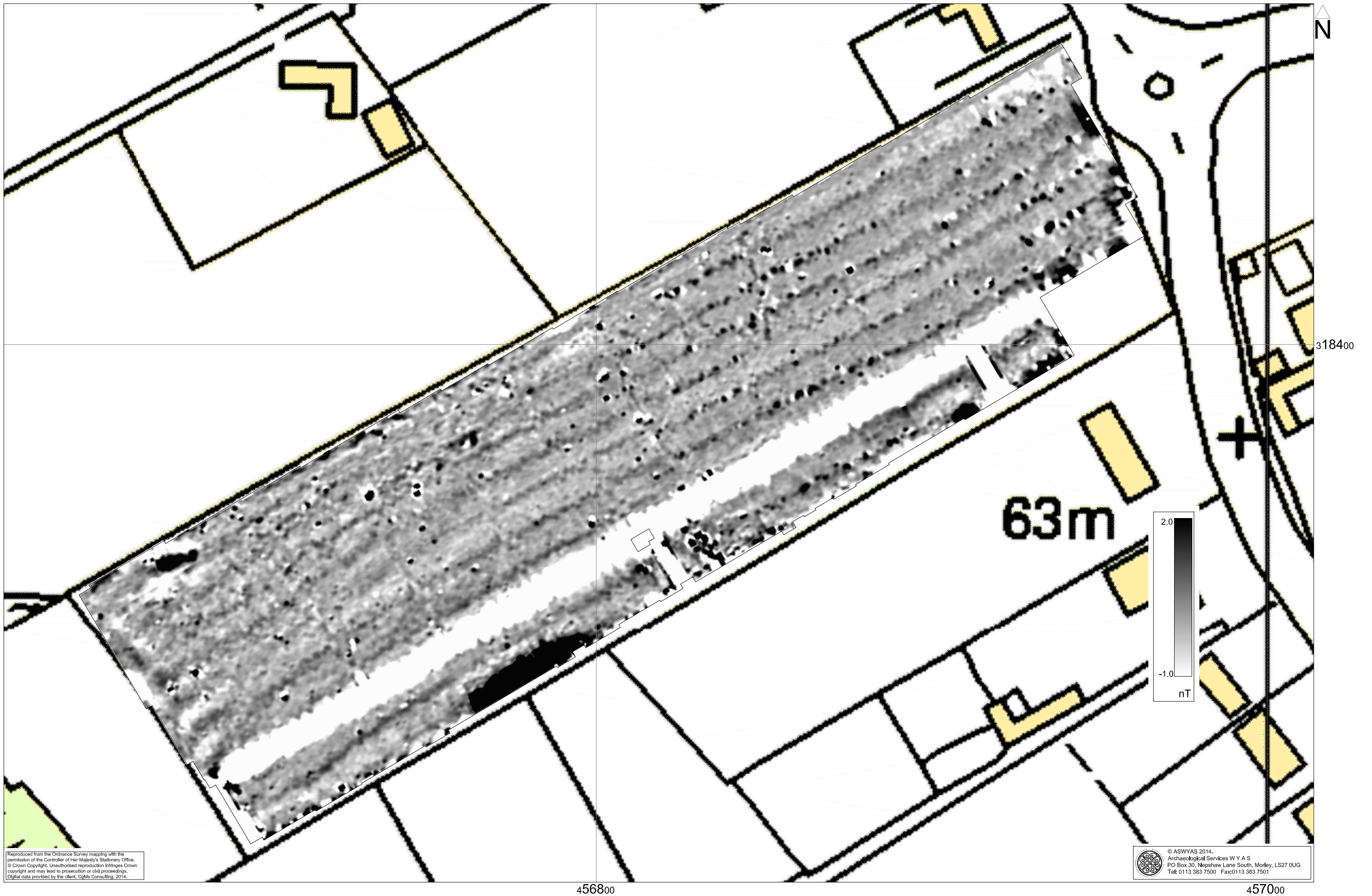


Fig. 3. Processed greyscale magnetometer data (1:1000 @ A3)

0 40m



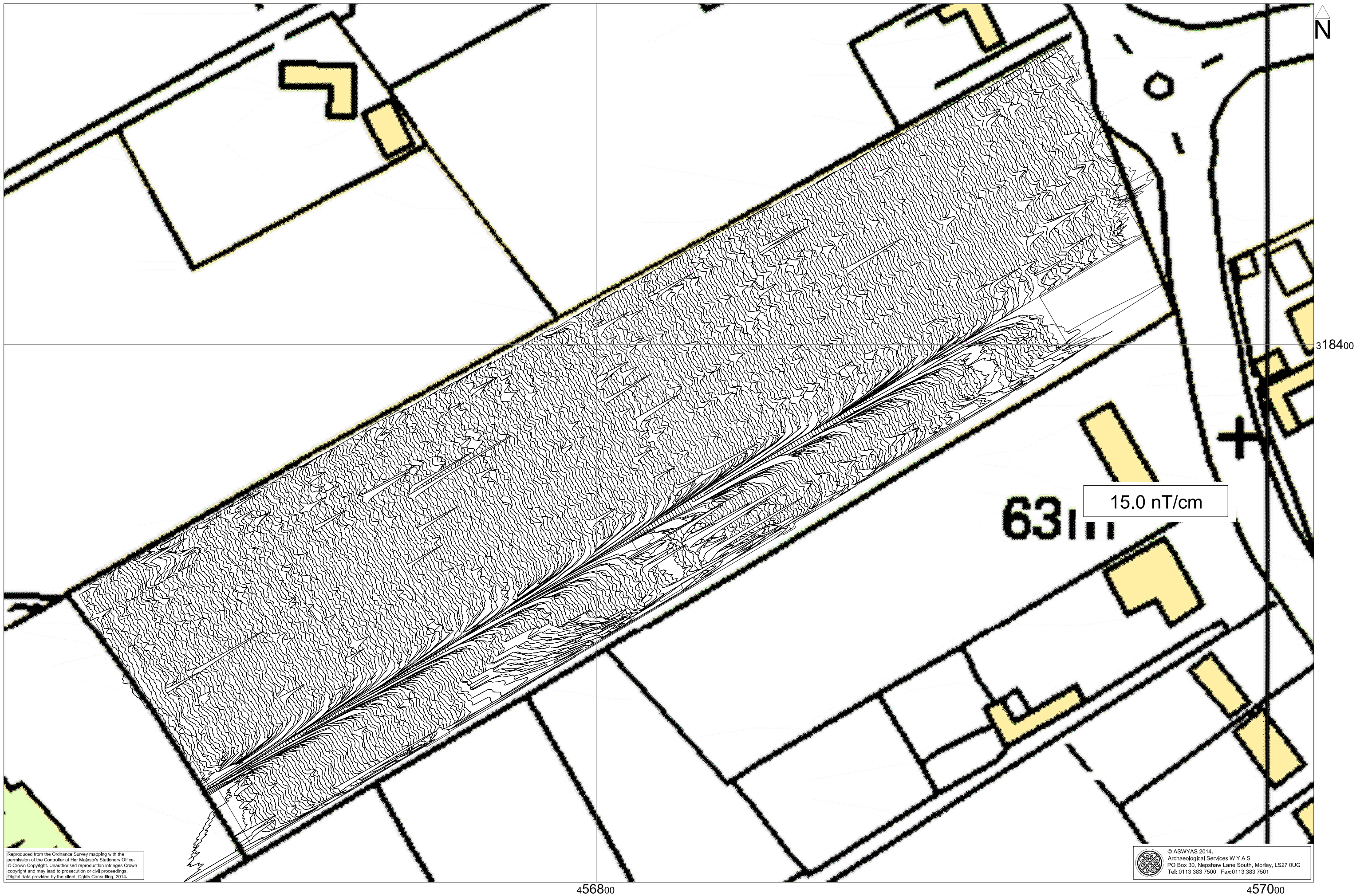


Fig. 4. XY trace plot of minimally processed magnetometer data (1:1000 @ A3)





Fig. 5. Interpretation of magnetometer data (1:1000 @ A3)





*Plate 1. View of area unsuitable for survey, looking south-west*



*Plate 2. General view of survey area, looking north-east*



*Plate 3. View of horse paddocks, looking south-west*



*Plate 4. View of horse paddocks, looking north-east*

## **Appendix 1: Magnetic survey - technical information**

### **Magnetic Susceptibility and Soil Magnetism**

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough. An advantage of magnetic susceptibility over magnetometry is that a certain amount of occupational activity will cause the same proportional change in susceptibility, however weakly magnetic is the soil, and so does not depend on the magnetic contrast between the topsoil and deeper layers. Susceptibility survey is therefore able to detect areas of occupation even in the absence of cut features. On the other hand susceptibility survey is more vulnerable to the masking effects of layers of colluvium and alluvium as the technique, using the Bartington system, can generally only measure variation in the first 0.15m of ploughsoil.

### **Types of Magnetic Anomaly**

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.



It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

#### *Isolated dipolar anomalies (iron spikes)*

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

#### *Areas of magnetic disturbance*

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

#### *Linear trend*

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

#### *Areas of magnetic enhancement/positive isolated anomalies*

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

#### *Linear and curvilinear anomalies*

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

### **Methodology: Magnetic Susceptibility Survey**

There are two methods of measuring the magnetic susceptibility of a soil sample. The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility. This method results in a bulk value that is not necessarily fully representative of the constituent components of the sample. For field surveys a Bartington MS2 meter with MS2D field loop is used due to its speed and simplicity. The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility. However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken. Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes. This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred.

### **Methodology: Gradiometer Survey**

There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as *magnetic scanning* and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10m apart. The instrument logger is not used and there is therefore no data collection. Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a 'negative' scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as *detailed survey* and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square

grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

### **Data Processing and Presentation**

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is 'raw' with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked' plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

## **Appendix 2: Survey location information**

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better than 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

*Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.*

### **Appendix 3: Geophysical archive**

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Leicestershire and Rutland Historic Environment Record).

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