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WYAS

Wigginton Cottage Methane Plant
York

Geophysical Survey

May 2010

Report No. 2070

CLIENT

Greenpark Energy Limited

Wigginton Cottage Methane Production Plant
York

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 1 hectare was undertaken off Wigginton Road, north of York, in order to fulfil an archaeological condition attached to a planning application for the construction of a methane production plant and access track. No anomalies of obvious archaeological potential have been identified despite known archaeological settlement activity within 350m of the site, both to the north-west and south-east. On the basis of the geophysical survey the archaeological potential of the site is considered to be low although the possibility of encountering archaeological remains cannot be completely dismissed.

Report Information

Client:	Greenpark Energy Limited, First Floor, Norham House, 15 Walkergate, Berwick-Upon-Tweed, Northumberland, TD15 1DS
Report Type:	Geophysical Survey
Location:	Off Wigginton Road, York
County:	North Yorkshire
Grid Reference:	SE 54 562
Period(s) of activity represented:	None
Report Number:	2070
Project Number:	3568
Site Code:	WCY10
Planning Application No.:	09/00095/FUL
Museum Accession No.:	-
Date of fieldwork:	April 2010
Date of report:	May 2010
Project Management:	Alistair Webb BA MIfA
Fieldwork:	Alex Harrison BSc Ian Wilkins BSc
Report:	Alistair Webb
Illustrations:	Sam Harrison
Photography:	n/a
Research:	n/a
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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Euan Brown Planning Manager for Greenpark Energy Limited to undertake a geophysical (magnetometer) survey at the site of a methane production plant off Wigginton Road, York (see Fig. 1) which has been granted planning approval (09/00095/FUL) subject to the implementation of a scheme of archaeological works. Following consultation with John Oxley, Principal Archaeologist at City of York Council, it was determined that the first phase of this programme should comprise a geophysical survey of the production plant site and along the route of the proposed access track.

Site location and topography

The site, centred at SE 59478 56188, is located on the northern edge of York with Haxby to the north and New Earswick to the east. The main site is approximately 200m west of Wigginton Road (B1363) and 200m north-west of the A1237/B1363 roundabout. Wigginton Cottage is to the north and Moor Plantation immediately to the north-west (see Fig. 2). Hedged field boundaries delimit the site to the south and west with open fields under permanent pasture to all sides. The site was relatively flat at 16m above Ordnance Datum. The survey covered approximately 1 hectare including a 20m wide strip covering the route of the access track to the production site.

Soils, geology and land-use

The solid geology comprises Bunter and Kueper Sandstone overlain with drift deposits of warp and lacustrine clay with sands and gravels. The soils are classified in the Foggathorpe 2 1 soil association and are derived from glaciolacustrine clays. These soils are characterised as slowly permeable seasonally waterlogged stoneless clays and fine loams over clays.

The land was under permanent pasture at the time of survey.

2 Archaeological and Historical Background

The archaeological condition was attached due to the location of the site between two archaeological sites that have produced significant archaeological features and deposits dating to the Iron Age and Romano-British periods.

At Rawcliffe Moor, approximately 300m to the north-west, an Iron Age settlement site comprising hut circles enclosed by ditches was recorded whilst Iron Age/Romano-British settlement activity was also encountered during the construction of the roundabout at the A1237/B1363 junction.

3 Aims and Objectives

The general aim of the geophysical survey was to establish and clarify the potential for archaeological features within the development boundary.

Specifically the survey sought to provide information about the nature and possible interpretation of magnetic anomalies identified during the survey and thereby determine the likely extent, presence or absence of any buried archaeological remains within the development area. These aims were to be achieved by undertaking detailed (recorded) magnetometer survey across the whole of the development site and along the route of the access track.

4 Methodology

A Bartington Grad601 magnetic gradiometer was used to take readings at 0.25m intervals on zig-zag (east-west) 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. Detailed (recorded) survey allows the visualisation of weaker anomalies that may not have been readily identifiable by alternative evaluation techniques such as magnetometer (magnetic) scanning.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey mapping, is shown in Figure 1. Figure 2 shows the processed greyscale magnetometer data at a scale of 1:10000. The processed and 'raw' (unprocessed) magnetometer data from the survey, together with interpretations of the identified magnetic anomalies, are presented at a scale of 1:1000 in Figures 3, 4 and 5.

The geophysical survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the IfA (Gaffney *et al.* 2002). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the survey archive.

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.

5 Results and Discussion

'Iron spike' anomalies have been identified across the whole of the survey area. These anomalies are caused by ferrous material in the upper soil horizons and although they could be caused by archaeological artefacts they are more likely to be caused by modern ferrous debris introduced into the ploughsoil often as a consequence of manuring. Clusters of these ferrous anomalies can be seen at the eastern end of the access track corridor and on the western edge of the main survey area where they form areas of magnetic disturbance. These areas of magnetic disturbance are assumed to be due to the dumping of modern magnetic material and are not considered to be archaeologically significant.

Other ferrous responses along the field boundary forming the southern edge of the survey area and at the intersection of this boundary with the drain are also interpreted as being due to modern activity, probably the proximity of metal in the boundary fencing.

Also common across the whole of the survey area are other much weaker isolated positive anomalies which gives the data a speckled appearance. There is no pattern to the distribution of these anomalies and they have not been shown on the interpretation figure. These responses are possibly due to weakly magnetic, deeply buried, ferrous objects or more possibly due to geological variation within the soils and drift deposits. Again these anomalies are not considered to be archaeologically significant.

A single weak linear trend aligned north-west/south-east can be seen to the south-western corner of the survey area. No definite interpretation can be given but a modern cause, possibly a field drain, is considered likely.

Two anomalies where an enhanced magnetic responses can be seen on two or more consecutive X-Y trace plots have been identified and this criteria has been considered as possibly indicative of archaeological potential. Close to the northern boundary of the main survey area a broadly linear, north/south aligned anomaly, **A1**, can be seen. The enhanced response can be seen on at least seven successive traces (see Fig. 4). A much smaller anomaly, **A2**, can also be seen just to the east of the drain near the southern site boundary. However, both anomalies could equally easily also be caused by underlying geological or pedological variation and this interpretation is considered the most likely.

6 Conclusion

No anomalies of obvious archaeological potential have been identified by the geophysical survey. Two anomalies whose origin is uncertain but which could have archaeological potential have been identified but given the nature of the drift geology a natural origin is considered more likely. It should also be noted that the prevailing soils and geology are not necessarily particularly conducive to the identification of archaeological features by magnetometry and that it is considered possible that there could be underlying features, particularly shallow and/or narrow features such as ring gullies, that may not be detectable even under more favourable conditions. Nevertheless it is considered unlikely that the survey would have failed to identify any major settlement activity on this site if it were present. However, it is recognised that there may be shallow, truncated or discrete features present on this site that may not be detectable under the prevailing site conditions. This conclusion is reached based on the type of features and degree of preservation encountered on the two adjacent sites. Consequently on the basis of the geophysical survey the site is considered to have a low archaeological potential based on the survey results but that the proximity of known archaeological activity and the variability of the geology and soils means that it should not be assumed that the site has no archaeological potential.

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.

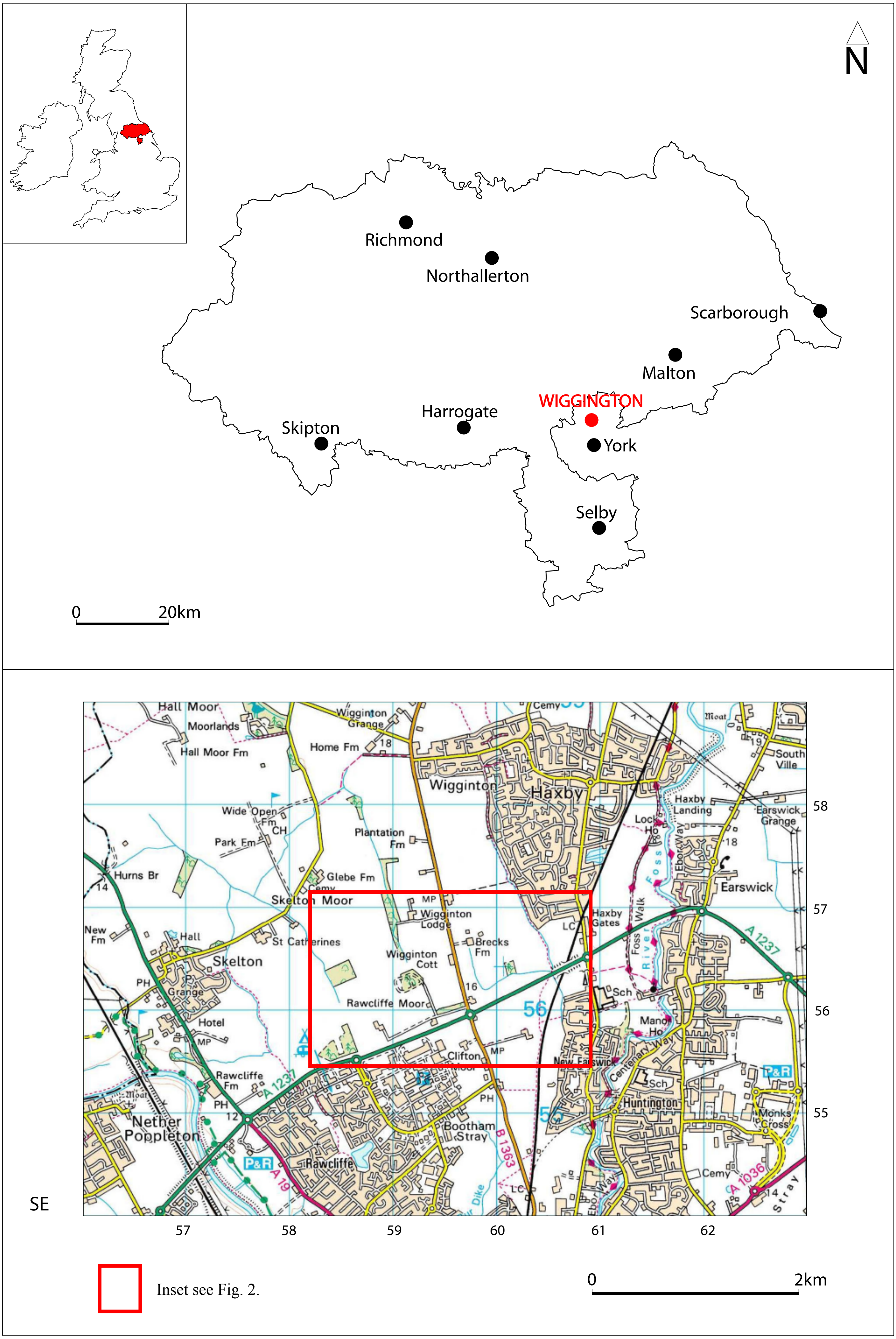

Fig. 1. Site location

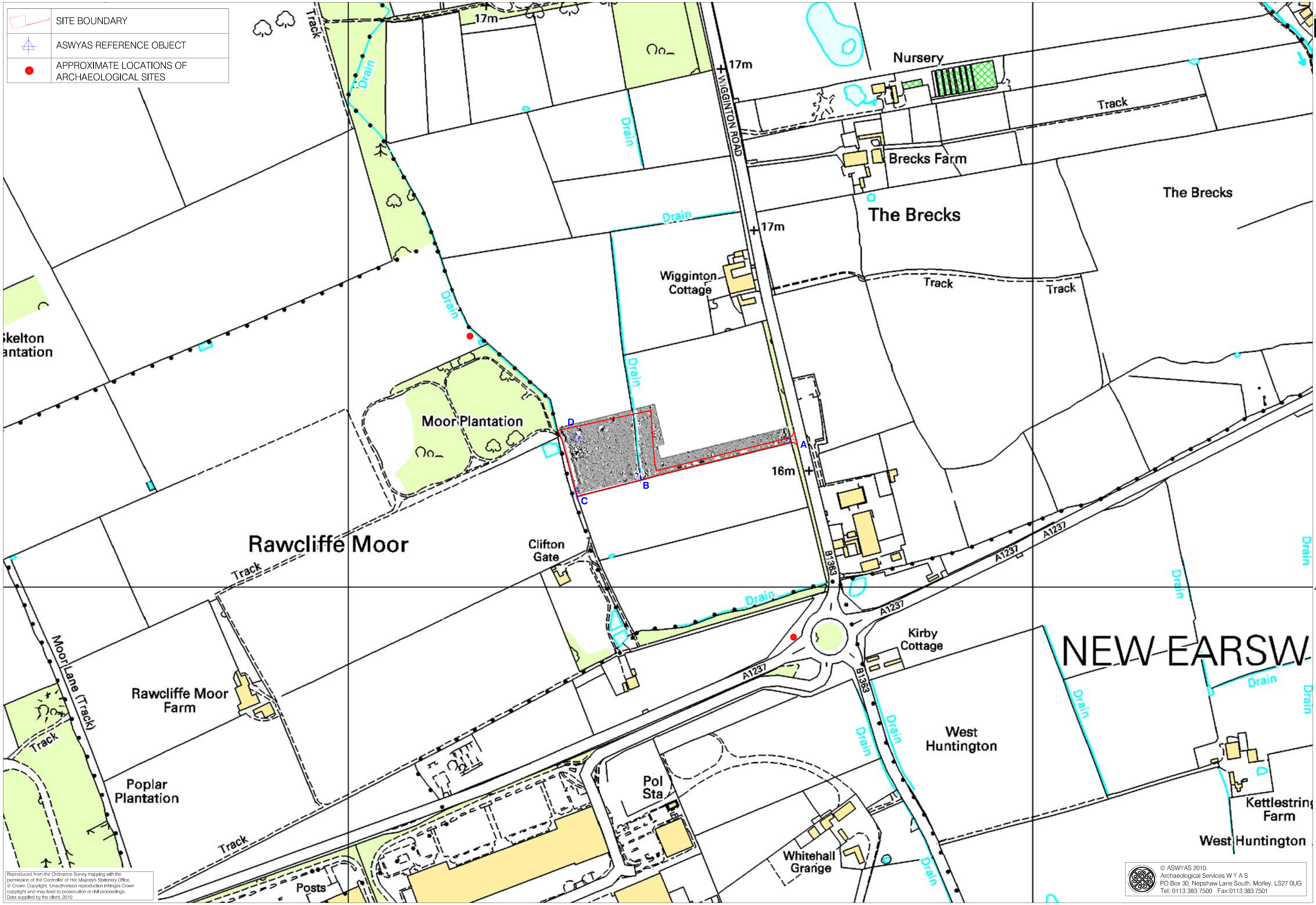

Fig. 2. Site location showing greyscale magnetometer data (1:5000 @ A3)

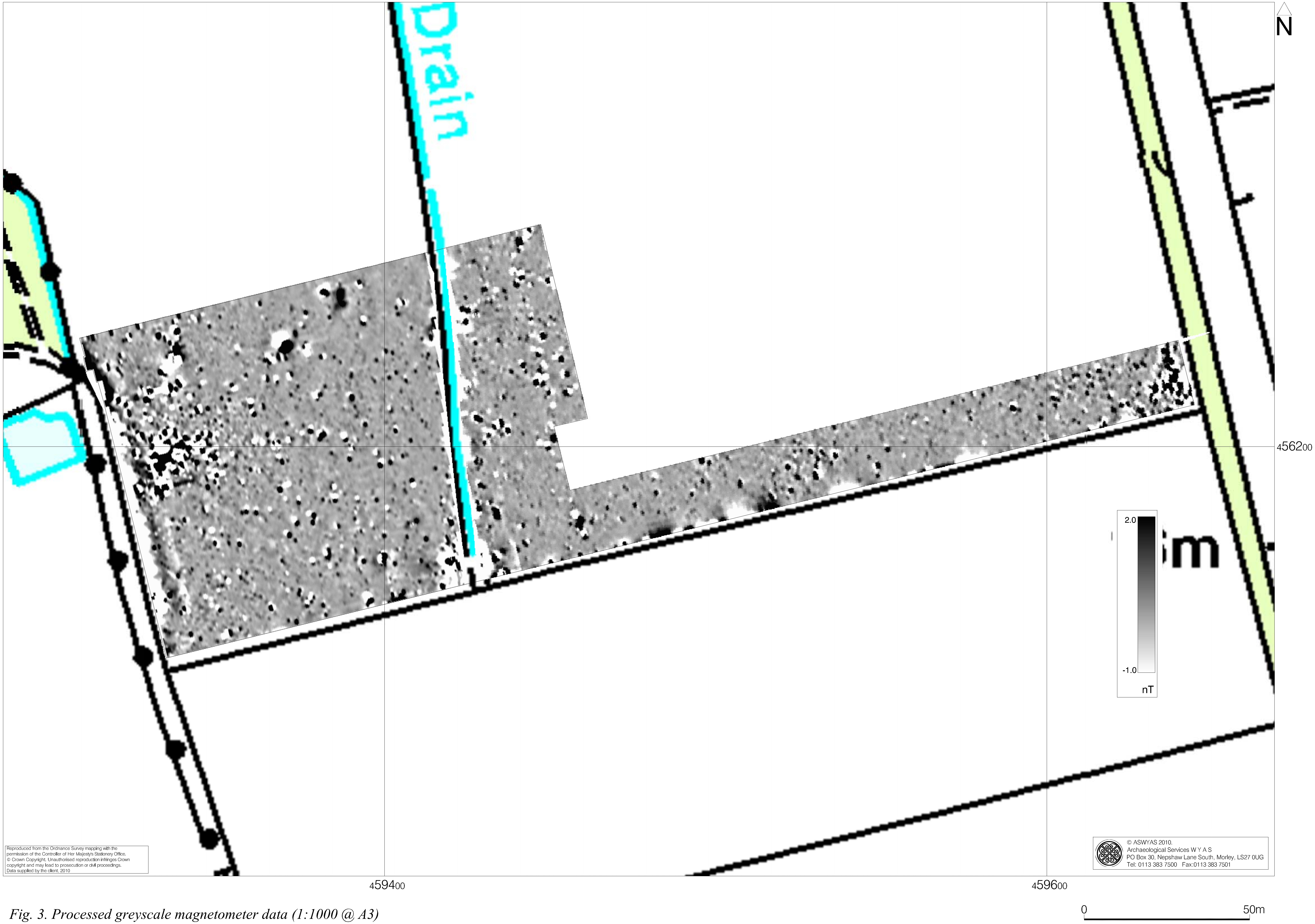

Fig. 3. Processed greyscale magnetometer data (1:1000 @ A3)

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

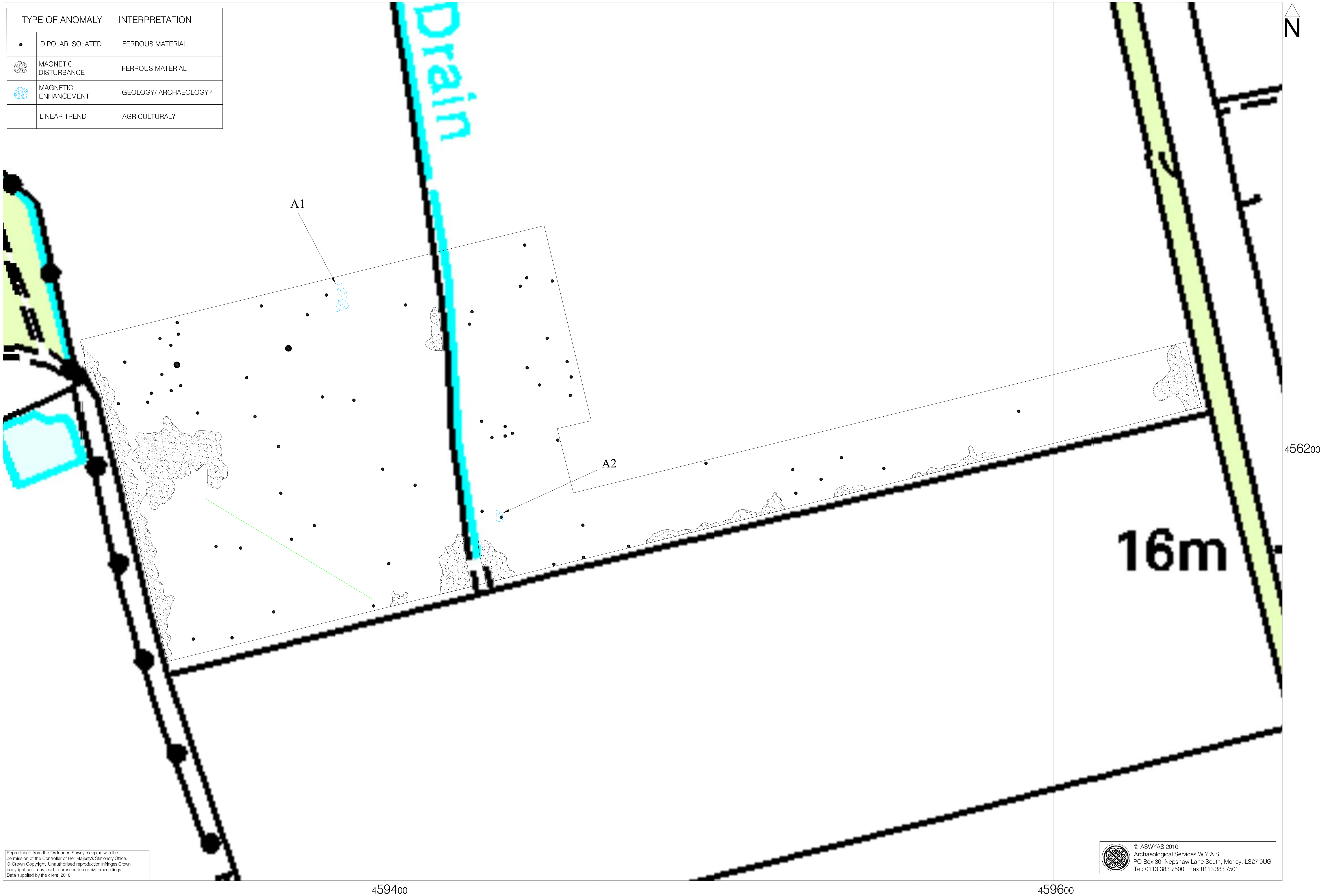

Fig. 5. Interpretation of magnetometer data (1:1000 @ A3)

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. Less magnetic material such as masonry or plastic service pipes that intrude into the topsoil may give a negative magnetic response relative to the background level.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

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. Such negative anomalies are often very faint and are commonly caused by modern, non-ferrous, features such as plastic water pipes. Infilled natural features may also appear as negative anomalies on some geological substrates.

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. An agricultural origin, either ploughing or land drains is 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 it not necessarily fully representative of the constituent components of the sample. 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 then 0.01m. The locations of the temporary reference points left on site are shown on Figure 2 and the Ordnance Survey grid co-ordinates tabulated below. The internal accuracy of these markers 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.

Station	**Easting**	**Northing**
A	459645.0243	456215.8581
B	459426.4970	456161.0870
C	459333.0956	456136.4987
D	459332.0229	456216.9047

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party or for the removal of any of the survey reference points.

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 2007) files.
- 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 relevant Sites and Monument Record Office).

Bibliography

David, A., N. Linford, P. Linford and L. Martin, 2008. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines (2nd edition)* English Heritage

Gaffney, C., Gater, J. and Ovenden, S. 2002. *The Use of Geophysical Techniques in Archaeological Evaluations*. IFA Technical Paper No. 6