



**Graffitoe Farm
Hunmanby
North Yorkshire**

Geophysical Survey

November 2010

Report No. 2140

CLIENT
Mr B. Emmerson

Graffitoe Farm Hunmanby North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 4 hectares was carried out to the west of Graffitoe Farm, Hunmanby at the site of two proposed wind turbines. Whilst the survey results are dominated by anomalies caused by near-surface geological variation, two anomalies stand out due to their magnitude and clarity as being of potential archaeological interest, perhaps representing isolated pits. However, both anomalies are beyond the area that will be impacted by the development as currently proposed. Elsewhere, parallel linear trends have been detected adjacent to Graffitoe Farm that correspond to extant ridge and furrow earthworks. On the basis of the geophysical survey the site is considered to have a low archaeological potential.



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Report Information

Client: Mr B. Emmerson

Address: Graffitoe Farm, Bridlington Road, Hunmanby, Filey, North Yorkshire, YO14 9RS

Report Type: Geophysical survey

Location: Hunmanby

County: North Yorkshire

Grid Reference: TA 119 756

Period(s) of activity: represented None

Report Number: 2140

Project Number: 3660

Site Code: GFH10

Planning Application No.: Pre-determination (Outline)

Museum Accession No.: n/a

Date of fieldwork: November 2010

Date of report: November 2010

Project Management: Sam Harrison BSc MSc AIfA

Fieldwork: David Harrison BA MSc
Alex Harrison BSc

Report: David Harrison

Illustrations: David Harrison
Sam Harrison

Photography: David Harrison
Alex Harrison

Research: n/a

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PO Box 30, Nepshaw Lane South, Morley, Leeds LS27 0UG
Telephone: 0113 383 7500.
Email: admin@aswyas.com



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1 Introduction

Archaeological Services WYAS was commissioned by Henrietta Hopkins of Segen Limited on behalf of their client Mr Ben Emmerson to carry out a programme of non-intrusive geophysical (magnetometer) survey as part of pre-determination work to accompany a planning application for the proposed installation of two 11kw Gaia wind turbines. The survey was undertaken on November 1st and 2nd 2010.

Site location, topography and land use

The site is situated to the immediate west of Graffitoe Farm, Hunmanby, centred at TA 159 756 (see Fig. 1), and is bounded to the north by Hunmanby Road (C367), by Graffitoe Farm to the east and by open fields on all other sides. The survey area comprised two fields divided by an established field boundary orientated north-north-east/south-south-west, and was under short pasture at the time of survey (see plates).

Located towards the crest of a south-facing slope, the north of the site is situated at approximately 109m above Ordnance Datum (aOD) (see Fig. 2 - Ref. Obj. A), falling away to 107m aOD towards the southern survey boundary (see Fig. 2 - Ref. Obj. F).

Geology and soils

The solid geology comprises chalk of the Welton Chalk Formation which is overlain by superficial deposits of till and glaciofluvial drift. The soils are classified in the Hunstanton soil association which are characterised as deep, well-drained, loams.

2 Archaeological background

No archaeological sites are known within the proposed development area (PDA). However, a number of archaeological sites are recorded within the surrounding landscape. A linear earthwork is recorded within the English Heritage National Inventory (NMR ref. 81318) 166m west north-west of the PDA at Whyncrest. Two tumuli at Reighton are recorded as Scheduled Monuments. The first of these (Ref. NY848) is located 1.4km south-east of the PDA and is situated to the east of Reighton House. The second tumulus (Ref. NY847) is located 1.3km north-north-east of the PDA to the south-east of Moor Farm. A third scheduled monument is recorded 2.8km north-west of the PDA at Hunmanby Castle (Ref. 20531) and is thought to be a Norman motte and bailey fortress. Consequently the site is located in a landscape of known archaeological potential.

3 Aims, Methodology and Presentation

The general aim of the survey was to establish and clarify the potential for archaeological features as part of pre-determination evaluation works prior to the submission of a planning

application for a small two turbine wind scheme in the PDA. This information would then enable further, informed, decisions to be taken prior to the finalisation of the development proposals and in support of any planning application.

Specifically the aims were to provide information about the nature and possible interpretations of any magnetic anomalies identified during the survey and thereby determine the likely extent, presence or absence of any buried archaeological remains in and around the proposed locations of the turbines and cable routes. To achieve these aims two areas (Area A and Area B) covering 3.86 hectares were surveyed.

Magnetometer survey

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 Ordnance Survey map is shown in Figure 1. A large scale (1:2000) site location plan with processed greyscale magnetometer data and proposed turbine locations and cable routes is shown in Figure 2. The data are presented in greyscale and XY trace plot formats in Figure 3 and Figure 4 with an accompanying interpretation graphic included as Figure 5, all at a scale of 1:1000.

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

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).

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

The geophysical survey has identified broad magnetic fluctuations throughout the survey area, the vast majority of which are thought to indicate near-surface geological variation. Two high-magnitude anomalies have been identified in Area A which may be archaeological in nature, perhaps being caused by isolated pits. However, given the density of geological responses in the vicinity, an archaeological interpretation is considered tentative and in any case both anomalies are located outside the PDA and so would not be impacted under the current proposals.

The remaining anomalies are all interpreted as non-archaeological whose origins can be attributed to one of the following categories.

Ferrous Anomalies

Ferrous anomalies either as individual ‘spikes’ or more extensive areas of magnetic disturbance are typically caused by ferrous (magnetic) material, either on the ground surface or in the topsoil. Little importance is normally given to such anomalies unless there is any supporting evidence for an archaeological interpretation, as modern ferrous objects or material are common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the site iron spike anomalies are common and there is no obvious pattern or clustering to their distribution to suggest anything other than random ferrous debris.

Broader areas of magnetic disturbance at the easternmost perimeter of Area A and the perimeters of Area B are thought to be due to ferrous material within the adjacent field boundaries and to the close proximity of Graffitoe Farm and its outbuildings.

Geological Anomalies

The data in both Area A and Area B is dominated by the presence of numerous broad, irregular and predominantly high magnitude anomalies (areas of magnetic enhancement). These anomalies are interpreted as geological in origin and are thought to be due to near-surface variations in the composition of the heterogeneous glacial till superficial deposits.

Agricultural Anomalies

Parallel linear trends identified within Area B correspond to extant traces of former ridge and furrow cultivation which were observed during the course of the survey (see Plate 3). The characteristic striped effect is due to the contrast between the magnetic soil infill and the former furrows.

A faint linear trend anomaly parallel with the eastern edge of Area A corresponds with an extant rough path/trackway (see Plate 1 and Plate 2) and is of no archaeological interest.

5 Discussion and Conclusions

The survey has identified only two anomalies that are considered to have any archaeological potential and even this tentative interpretation is considered highly speculative. Both anomalies are also located outside the area that will be impacted under the current design proposals. On this basis it is not considered that any further archaeological work would be appropriate.

Across the remainder of the site irregular concentrations of anomalies can be seen to form sinuous and ill-defined alignments generally trending north-east/south-west but with no pattern or regularity that might suggest an anthropogenic origin. These anomalies are interpreted as geological in origin probably caused by glaciofluvial channels or scars in the superficial deposits. Anomalies of this magnitude and frequency may mask or obscure weaker, isolated responses of archaeological potential, if present, within the affected areas.

However, on the basis of the geophysical survey, the archaeological potential of the proposed development area 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.

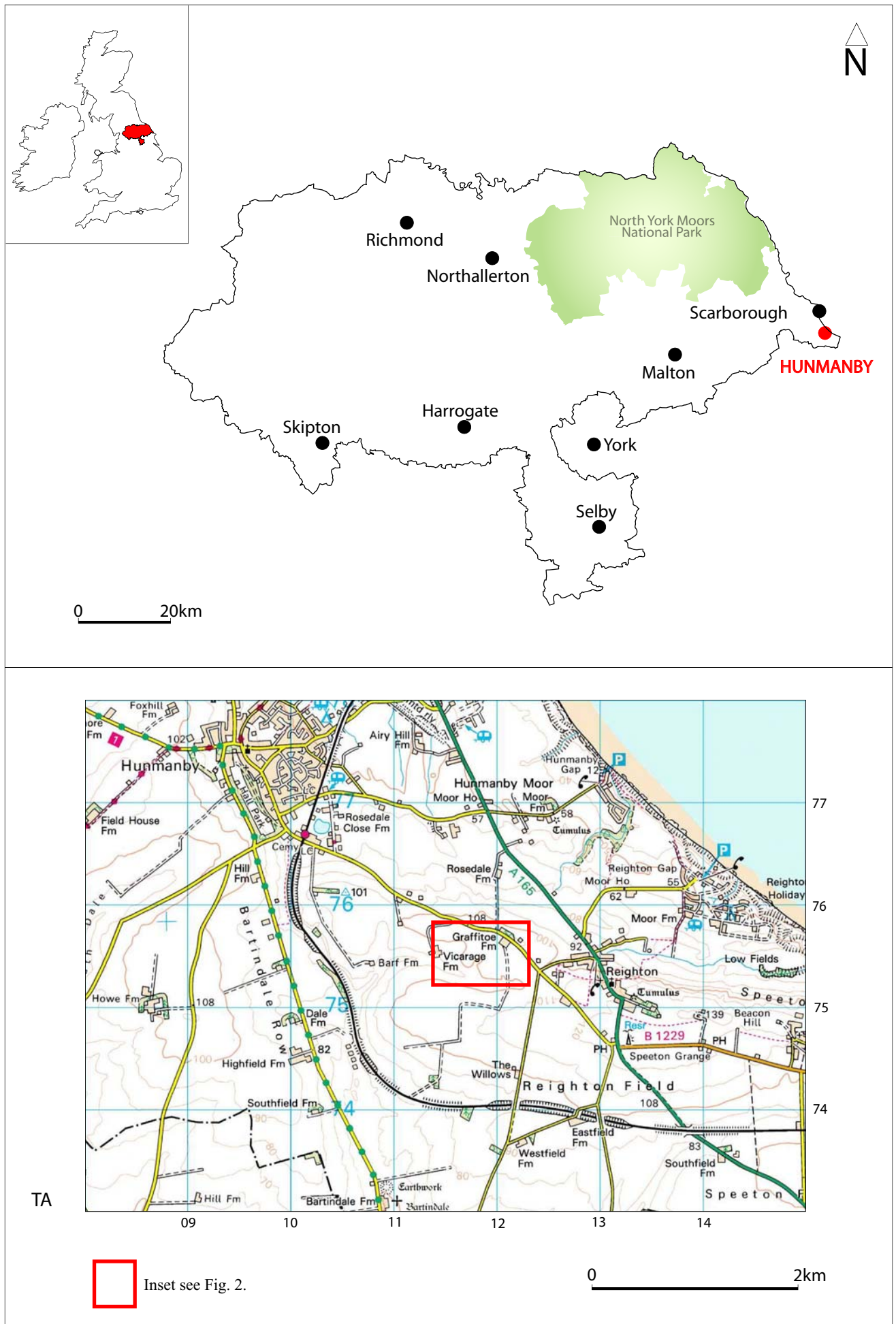


Fig. 1. Site location



Fig. 2. Site location showing processed geophysical (magnetometer) survey data (1:2000 @ A3)

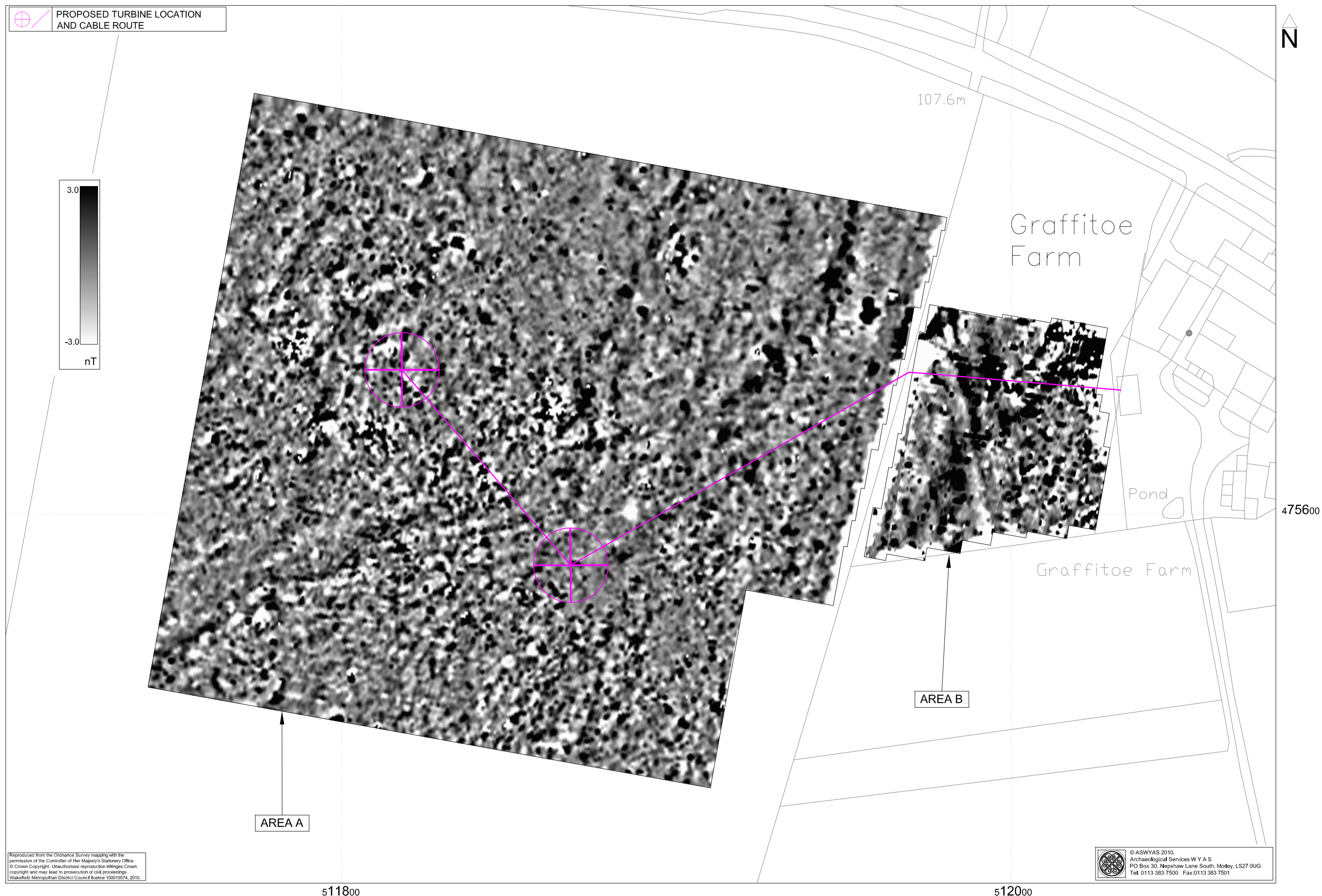


Fig. 3. Processed greyscale magnetometer data (1:1000 @ A3)

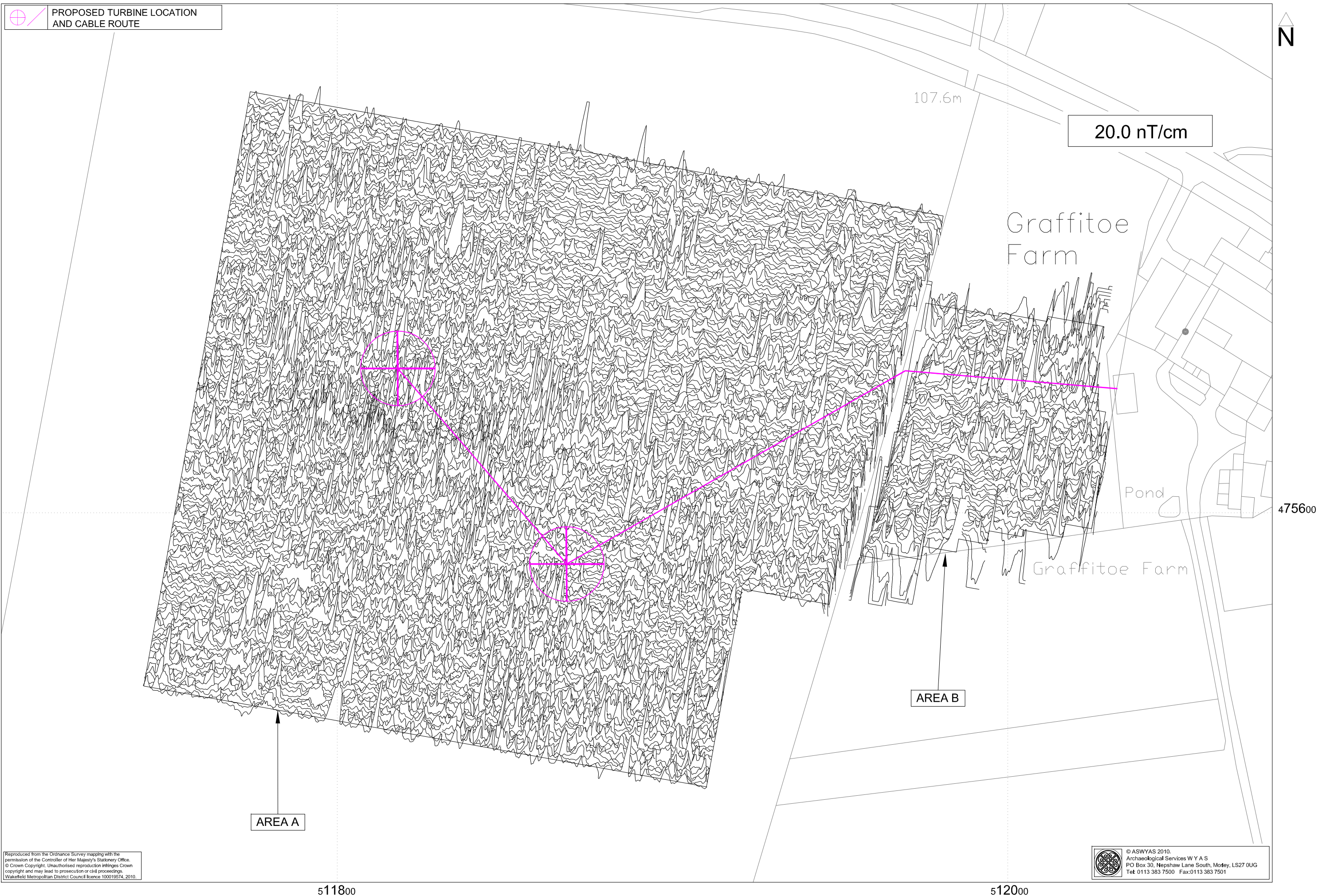


Fig. 4. XY Trace plot of unprocessed magnetometer data (1:1000 @ A3)

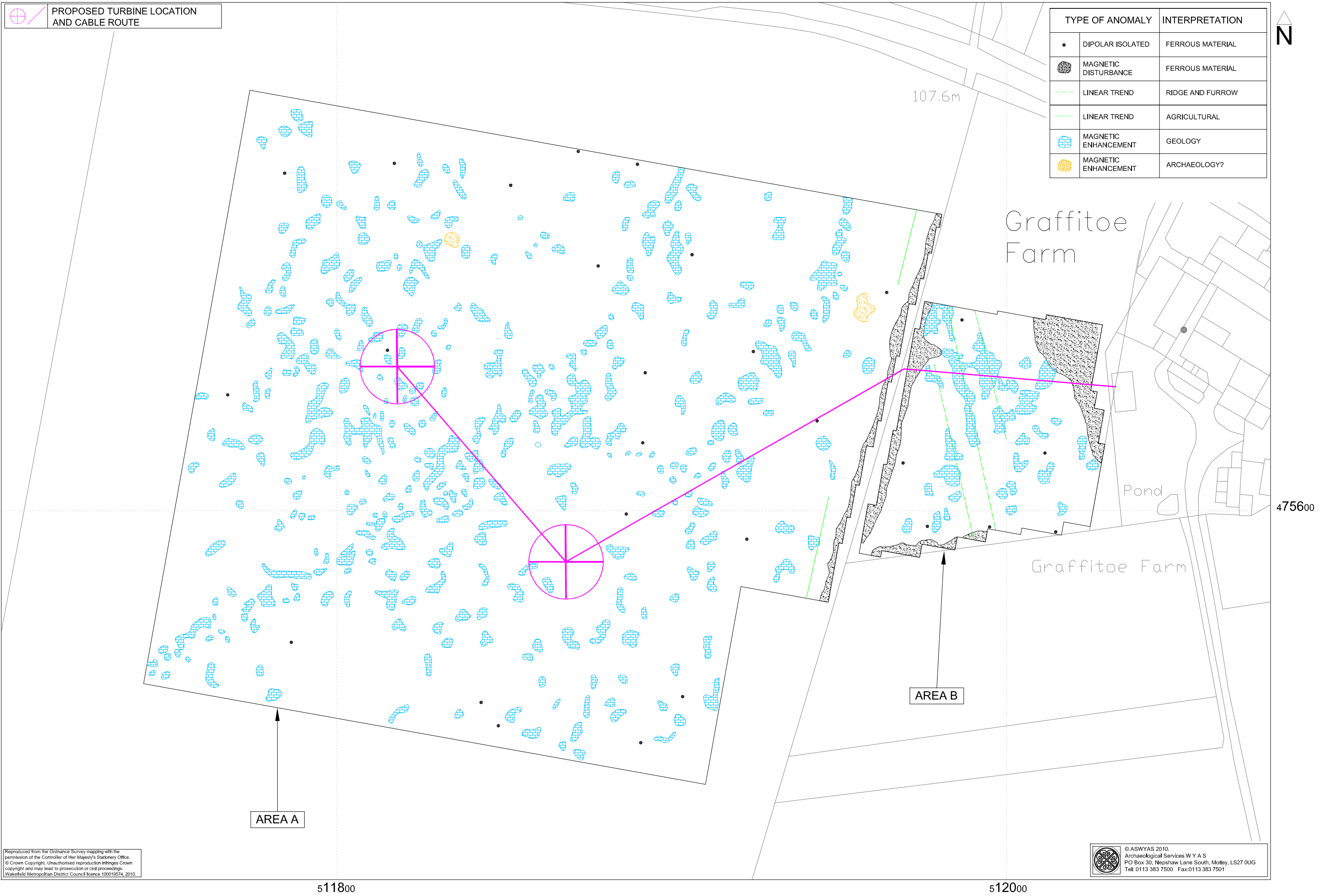


Fig. 5. Interpretation of magnetometer data (1:1000 @ A3)

025m



Plate 1. General shot of survey Area A; looking south-south-west



Plate 2. General shot of survey Area A; looking west



Plate 3. General shot of survey Area B showing ridge and furrow earthworks; 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 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 the survey grid relative to these markers is better than 0.05m. The survey grids were then superimposed onto a map base provided by the client as a 'best fit' to produce the displayed block locations. Overall there was a good correlation between the local survey and the digital map base and it is estimated that the average 'best fit' error is better than $\pm 1.5\text{m}$. However, it should be noted that Ordnance Survey co-ordinates for 1:2500 map data have an error of $\pm 1.9\text{m}$ at 95% confidence. This potential error must be considered if co-ordinates are measured off for relocation purposes.

Station	Easting	Northing	Elevation (aOD)
A	511832.4910	475759.0660	108.658m
B	511983.1110	475732.9510	108.001m
C	512003.6750	475661.2570	108.800m
D	512032.3590	475625.1620	109.114m
E	512002.9860	475591.6220	107.507m
F	511950.8290	475585.9650	106.845m

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.
- 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 Historic Environment Record).

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