ARCHAEOLOGICAL SERVICES WYAS

Land west of Thetford Road
Watton
Norfolk

Geophysical Survey

Report no. 2539

November 2013

Client: NPS Archaeology

REGISTERED ORGANISATION IfA

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Watton
Norfolk

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Summary

A geophysical (magnetometer) survey was carried out on the southern periphery of Watton, Norfolk, to provide further information prior to the proposed development of the site. No obvious anomalies of archaeological potential have been identified by the survey although anomalies indicative of two parallel linear soil-filled ditches may be of archaeological interest, perhaps relating to a former field system. Elsewhere, anomalies due to geological variation, agricultural activity and service pipes have been recorded. On the basis of the survey the archaeological potential of the site is considered to be low.

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Report Information

Client:	NPS Archaeology
Address:	Scandic House, 85 Mountergate, Norwich, NR1 1PY
Report Type:	Geophysical Survey
County:	Norfolk
Grid Reference:	TF 917 001
Period(s) of activity:	?
Report Number:	2539
Project Number:	4146
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Planning Application No.:	
Museum Accession No.:	n/a
Date of fieldwork:	November 2013
Date of report:	November 2013
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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Nigel Page of NPS Archaeology, to undertake a geophysical (magnetometer) survey of land at Watton, Norfolk, to inform the planning process for a proposed development. The work was undertaken in accordance with a Project Design (Harrison 2013) supplied to and approved by the Client and Norfolk County Council, with guidance contained within the National Planning Policy Framework (NPPF 2012) and in line with current best practice (David *et al* 2008). The survey was carried out on November 12th and November 13th 2013 to provide additional information on the archaeological potential of the site.

Site location, topography and land-use

The market town of Watton is situated at the crossroads of the A1075 Dereham to Thetford toad and the B1108 Brandon to Norwich Road, approximately 40km west of Norwich (see Fig. 1). The proposed development area (PDA) is located to the west of Thetford Road, centred at TF 917 001. It is bound to the east by Thetford Road, to the west by the playing fields of Wayland Community High School, by residential properties fronting onto Churchill Close and Victoria Court to the north and by arable agricultural land to the south (see Fig. 2). The survey area comprised of a single field over 6.5 hectares and contained a recently harvested arable crop (see plates). The site is located on a gentle south-facing gradient at between 56m above Ordnance Datum (aOD) at the north of the PDA and 52m aOD to the south.

Soils and geology

The underlying bedrock comprises Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Culver Chalk Formation overlain by Lowestoft formation – Diamicton superficial deposits (British Geological Survey 2013). The soils in this area are classified in the Ollerton association, characterised as deep, permeable sandy and coarse loams (Soil Survey of England and Wales 1983).

2 Archaeological Background

No archaeological information on the site was available at the time of writing. However, it is understood that there are no known heritage assets within the site boundary.

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 of 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 of PDA was carried out, an area of 6.5 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 (1:4000) location plan displaying the processed magnetic data. Detailed data plots ('raw' and processed) and full interpretative figures are presented at a scale of 1:1250 in Figures 3, 4 and 5.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Trace plots of the 'raw' data and data repeatability plots are included in Appendix 3 and Appendix 4. Appendix 5 describes the composition and location of the site archive.

The survey methodology, report and any recommendations comply with the Project Design (Harrison 2013) and guidelines outlined by English Heritage (David *et al* 2008) and by the Institute for Archaeologists (IfA 2010). 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)

Numerous anomalies have been identified by the survey within a variable magnetic background. The anomalies 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.

Ferrous and Modern 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. 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.

The high magnitude linear dipolar anomaly, **A**, which skirts the eastern perimeter of the PDA locates the route of a buried service pipe. An open manhole which was fenced off at the time of the survey (see plates), manifests in the centre of the dataset as a broad area of magnetic disturbance, **B**. The linear trend, **C**, aligned east/west, to the west of the manhole, is likely to indicate a non-ferrous or deeply buried pipe or sewer. Areas of disturbance around the periphery of the PDA are either due to ferrous material forming part of, or incorporated into, the field boundary.

Agricultural Anomalies

Analysis of historical OS maps has shown that the division and layout of land within the PDA has altered little since the publication of the first edition OS map in 1883, albeit with the removal of two east/west aligned field boundaries. These former boundaries have not been detected by the geophysical survey. It is unclear whether the absence of anomalies in these locations reflects the low magnetic contrast between cut features (i.e. ditches) and the surrounding soils or the subsequent removal of the former boundaries by the plough.

A low magnitude linear trend, orientated north-west/south-east, is interpreted as a field drain. Elsewhere, numerous parallel linear trends have been identified throughout the PDA on a north-south alignment. These trends are caused by localised topographical variation resulting from modern cultivation ridges (see plates).

Geological Anomalies

Throughout the survey area discrete anomalies, characterised as localised areas of enhanced magnetic response, have been identified. These anomalies are interpreted as geological in origin being caused by variation in the composition of the soils and superficial deposits from which they derive.

Archaeological? Anomalies

Two parallel, fragmented, linear anomalies, **D** and **E**, can be seen within the north-east of the PDA. These possibly indicate soil-filled ditches. The anomalies are aligned north-west/south-east, on a similar orientation to the historical and existing division of land to the east of the PDA (see Fig. 2). This raises the possibility that these anomalies may relate to a former field system pre-dating the first edition OS map. However the discontinuous nature of the anomalies makes a confident interpretation difficult. Is it plausible that the anomalies are due to field drains. Equally, an archaeological origin for the probable ditches can not be discounted. On balance, and given the absence of any clear archaeological pattern, an agricultural explanation seems more likely.

5 Conclusions

The geophysical survey has not identified any obvious anomalies of archaeological potential within the PDA, although two parallel linear anomalies within the north-west of the site may indicate ditches which might be of archaeological interest. No clear archaeological pattern is discernable within the data. It is notable however, that two former field boundaries have not been detected by the survey, suggesting that there is a low magnetic susceptibility in the prevailing soils and diamicton superficial deposits. Therefore, some weaker archaeological anomalies, if present, may remain beyond the detection of the magnetometer. Nevertheless, on the basis of the geophysical survey, the archaeological potential of the site is assessed as being low.

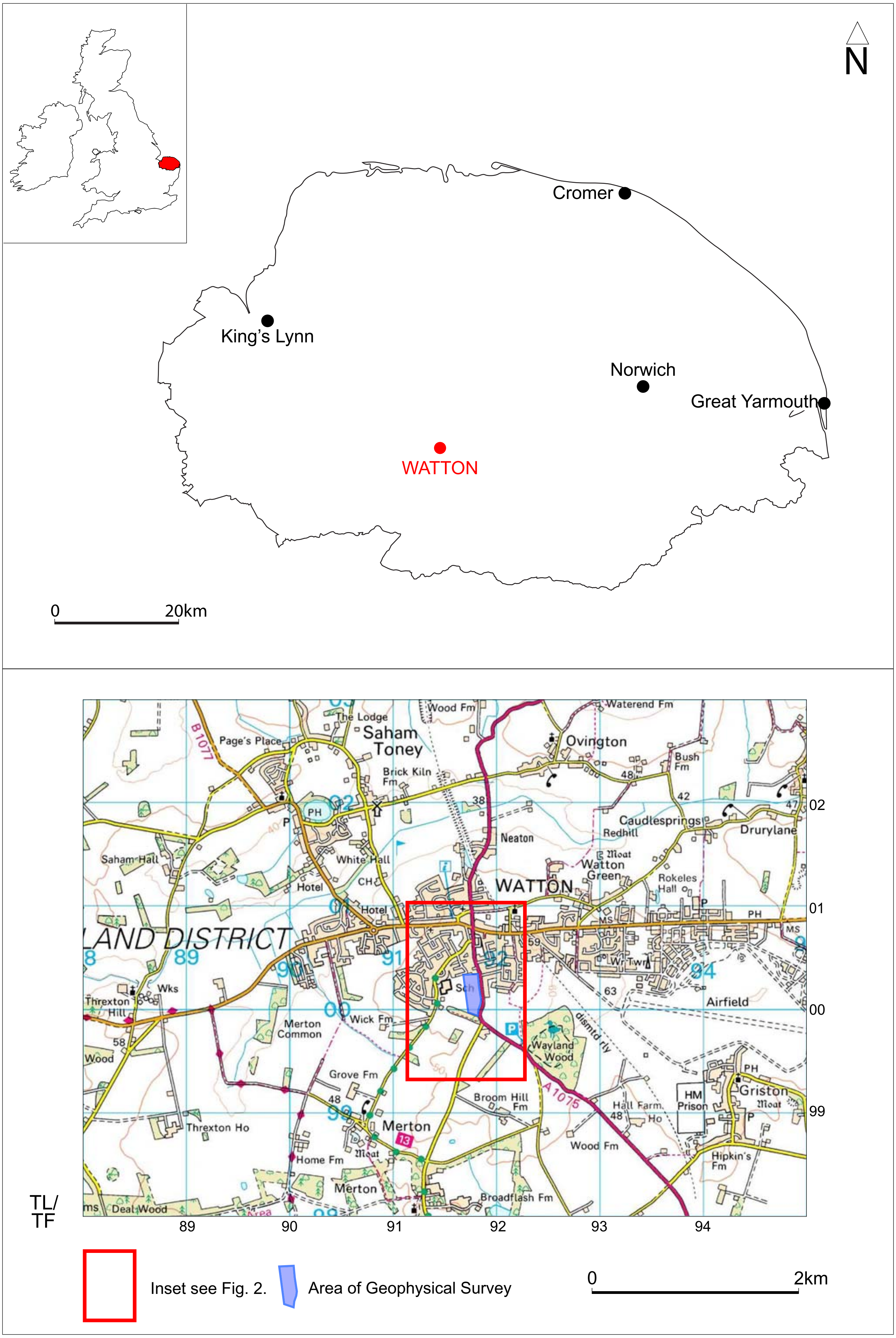


Fig. 1. Site location

Fig. 2. Site location showing greyscale magnetometer data (1:4000 @ A3)

0 100m

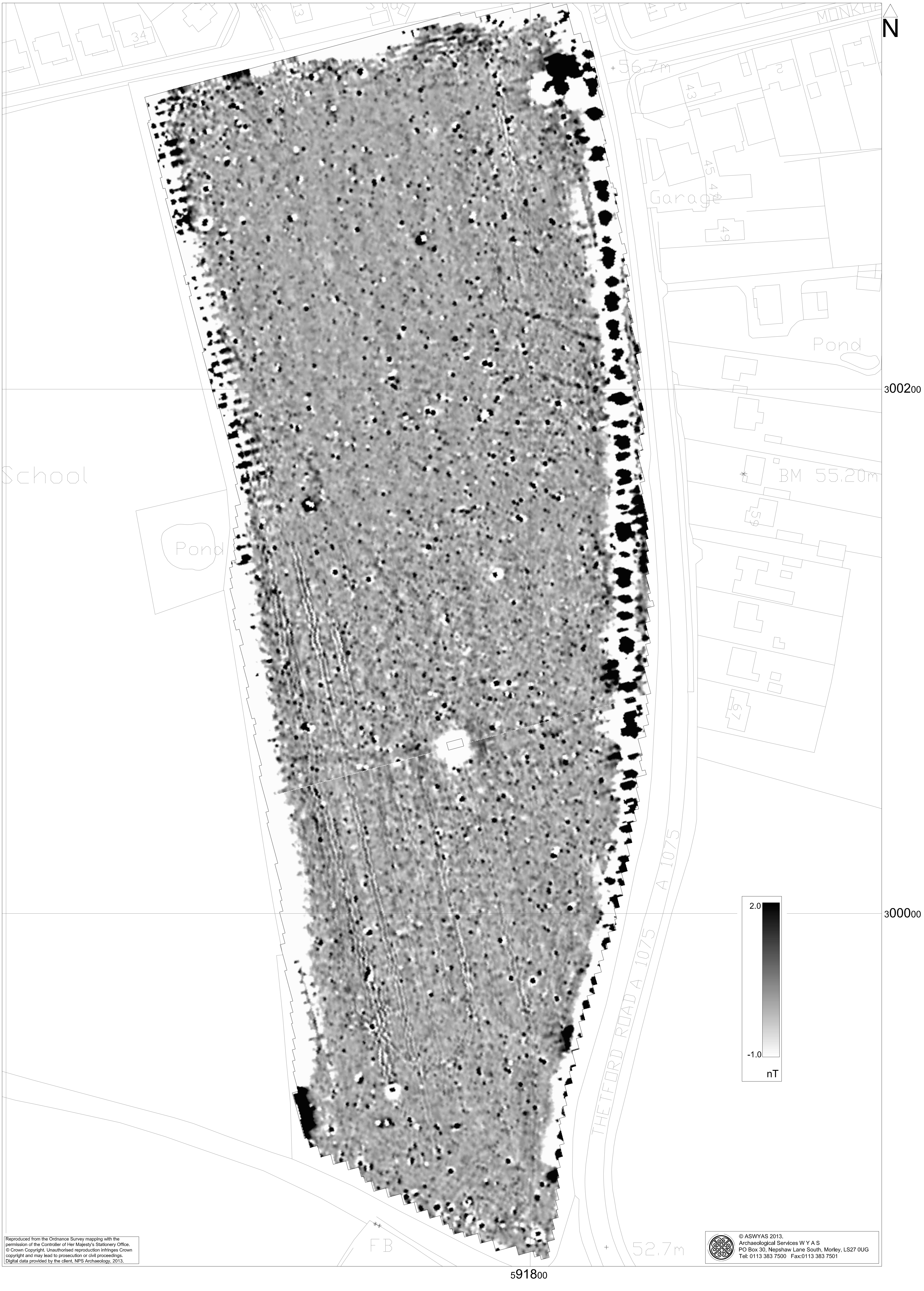


Fig. 3. Processed greyscale magnetometer data (1:1250 @ A3)

Fig. 4. XY trace plot of minimally processed magnetometer data (1:1250 @ A3)

0 50m

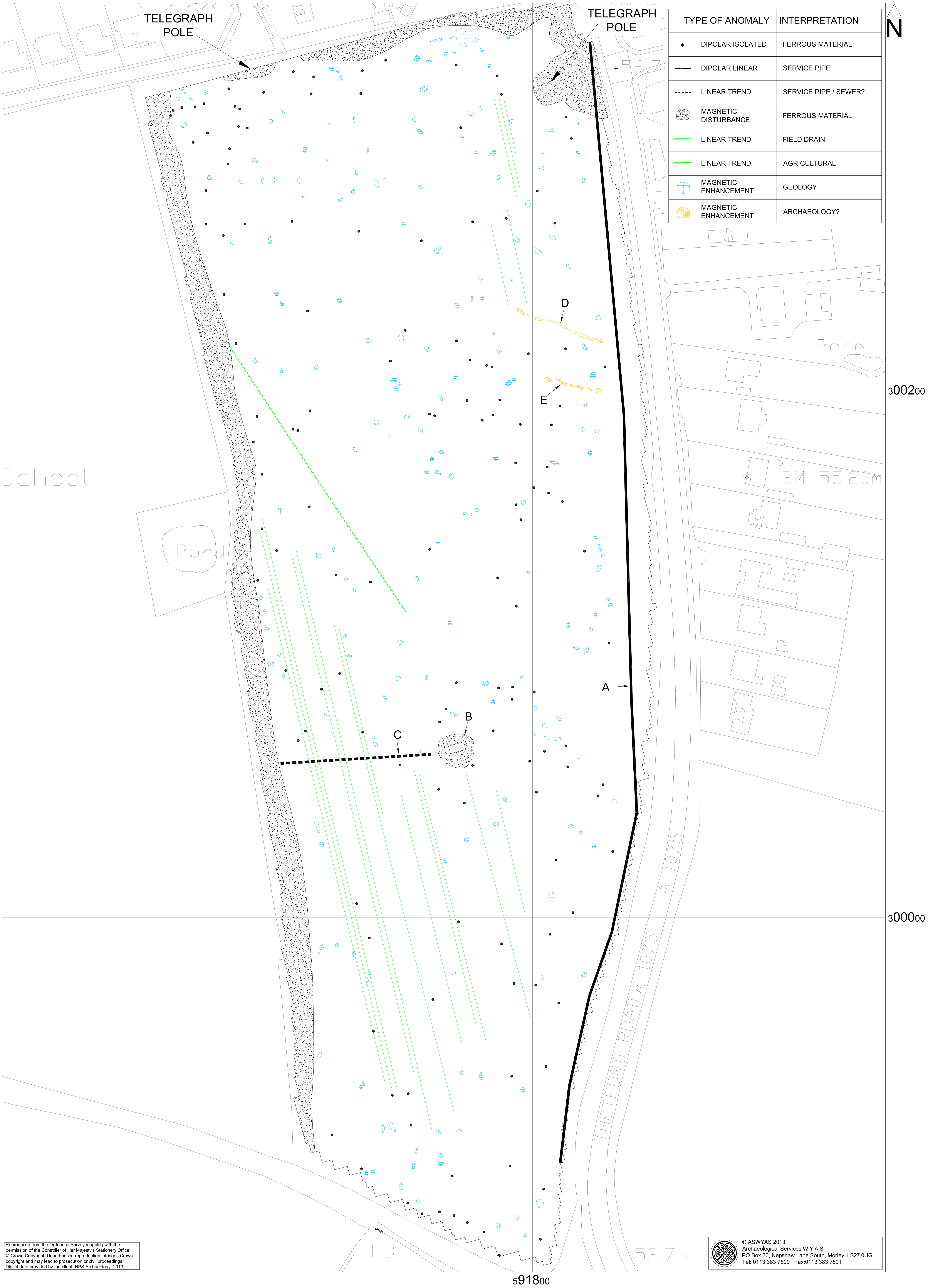


Fig. 5. Interpretation of magnetometer data (1:1250 @ A3)

0 50m

Plate 1. General view of survey area, looking north

Plate 2. General view of survey area, looking north

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 it 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.

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.

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 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: Raw XY trace plot data

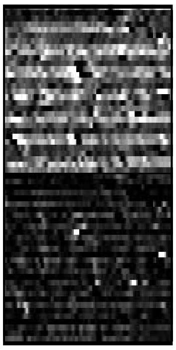
Raw XY trace plot of magnetometer data (1:1250 @ A3)

0 50m

Appendix 4: Data repeatability

Data Repeatability

JOB NUMBER	4146	SITE CODE	ZWN13	JOB NAME	Land west of Thetford Road, Watton



13/11/2013 Grid surveyed at 09:00 and 15:15

Appendix 5: 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 Norfolk Historic Environment Record).

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