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**Land north of North Lane
Wheldrake
City of York**

Geophysical Survey

Report no. 2592

March 2014

Client: MAP Archaeological Practice



Land north of North Lane Wheldrake City of York

Geophysical Survey

Summary

A geophysical (magnetometer) survey was carried out on land north of North Lane, Wheldrake, in advance of the determination of a planning application for a proposed housing development. The survey has identified anomalies consistent with the 19th century agricultural landscape as depicted on historical Ordnance Survey mapping, including back-filled ponds, a former boundary and ridge and furrow cultivation. However, no anomalies of archaeological potential have been identified. Therefore, on the basis of the geophysical survey the archaeological potential of the site is considered to be low.



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Report Information

Client: MAP Archaeological Practice Limited
Address: The Croft, East Street, Swinton, Malton, YO17 6SH
Report Type: Geophysical Survey
Location: North Lane, Wheldrake
County: City of York
Grid Reference: SE 6766 4495
Period(s) of activity: post-medieval
Report Number: 2592
Project Number: 4219
Site Code: WHL14
OASIS ID: archaeol11-175766
Planning Application No.: Pre-application
Museum Accession No.: n/a
Date of fieldwork: March 2014
Date of report: March 2014
Project Management: David Harrison BA MSc MifA
Fieldwork: David Harrison
David Williams BA MifA
Report: David Harrison
Illustrations: David Harrison
Photography: David Harrison
Research: n/a

Authorisation for
distribution: -----



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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Sophie Coy of MAP Archaeological Practice Ltd (the Client), to undertake a geophysical (magnetometer) survey of land to the north of North Lane, Wheldrake (see Fig. 1), to inform the submission of a planning application for the proposed development of the site. The work was undertaken in accordance with guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (Institute for Archaeologists 2013; David *et al.* 2008). The survey was carried out on 6th March to provide additional information on the archaeological resource of the site.

Site location, topography and land-use

The Proposed Development Area (PDA) is situated on the north-western periphery of the village of Wheldrake, 11km south-east of York, centred at SE 6766 4495. The site comprises 3.2 hectares over six fields (F1 – F6) within a relic strip field system which extends north-west from North Lane, the southern site boundary. It is bound to the west by residential properties fronting onto Valley View and Derwent Drive, to the east by properties fronting onto The Cranbrooks and by open farmland to the north (see Fig. 2). Field 1 and Field 2 were cleared of overgrown vegetation prior to survey, although a pond within the south of Field 1 prevented any survey in this area (see Plates 1, 2 and 3). Field 3 was under pasture (see Plate 4). Field 4 contained a house and gardens and was unsuitable for survey. Field 5 was deemed unsuitable for survey due to the narrow width of the available area (see Plate 5 and Plate 6) and Field 6 contained overgrown vegetation (see Plate 5). In total, an area of 1.7 hectares was accessible for survey. The PDA is situated on level ground at approximately 12m above Ordnance Datum (aOD).

Soils and geology

The underlying bedrock comprises Sherwood Sandstone Group – sandstone overlain by clay, sand, silt and gravel superficial deposits which are recorded in the Elvington Glaciolacustrine Formation and the Escrick Moraine Member (British Geological Survey 2014). The soils in this area are classified in the Bishampton 1 association, being characterised as deep, fine loams with slowly permeable subsoils and slight seasonal waterlogging (Soil Survey of England and Wales 1983).

2 Archaeological Background

No information on the archaeological background of the site was available at the time of writing although it is understood that there are no known heritage assets within the PDA. However, several cropmarks and field systems of presumed Iron Age/Roman origin have been identified on aerial photographs within the wider landscape (Pastscape 2014).

3 Aims, Methodology and Presentation

The general objective of the geophysical survey was to provide information about the presence/absence, character, and extent of any archaeological remains identified within the specific area to be impacted by the proposed development and to help inform further strategies should they be required.

Specifically, the 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 1.0m 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. A large scale (1:3000) survey location plan is provided as Figure 2. The processed and minimally processed data, together with interpretation graphics of the survey results are presented in Figures 3, 4 and 5, at a scale of 1:1000.

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 archive.

The survey methodology, report and any recommendations comply with 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 Figures 3, 4 and 5)

Generally, the survey has recorded a low level of background variation across the PDA although broad areas of modern magnetic disturbance dominate the data across much of Field 1 and Field 2. Nevertheless, numerous anomalies have been identified which 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, where appropriate.

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 plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris or material is 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 a random background scatter of ferrous debris in the plough-soil.

Within the north of Field 1, the high magnitude north-east/south-west aligned linear anomaly, **A**, demarcates the route of a buried service pipe. Across the PDA, the broad areas of magnetic disturbance identified by the survey are thought to result from above-ground objects, such as localised areas of dumping and perimeter fencing. However, within this disturbance, two former ponds, **B** and **C**, manifest in the data as broad high magnitude anomalies. The ponds are depicted on the 1892 edition Ordnance Survey map and the responses result from the contrast between the material filling the ponds and the prevailing soils.

Agricultural Anomalies

Analysis of historical Ordnance Survey (OS) mapping indicates that the layout and division of fields across the survey area has undergone minimal alterations since the publication of the first edition OS map in 1851, with the removal of two boundaries to create wider strip fields. One of these former field boundaries has been identified within Field 1 as a clear north-west/south-east aligned linear anomaly, **D**. The anomaly is due to the contrast between the former boundary (soil-filled ditch) and the surrounding soils. A series of parallel, slightly sinuous trends have been identified throughout Field 2 and Field 3, orientated parallel with the existing field boundaries. These are characteristic of the medieval and post-medieval agricultural practice of ridge and furrow cultivation, evidence of which survives as low earthworks throughout Field 3. The characteristic striped appearance to the data in these fields is a result of the magnetic contrast between the now soil-filled furrows and the former ridges. Whilst this cultivation may be of local historical interest it is unlikely to be of any archaeological interest.

Geological Anomalies

Across all parts of the survey area discrete, low magnitude, anomalies (areas of magnetic enhancement) have been identified. Whilst any of these anomalies could be caused by an archaeological feature, such as a pit, the sheer number precludes an archaeological origin and they are therefore interpreted as being geological in nature, probably relating to variations in the depth and composition of the soils and superficial deposits from which they derive.

5 Conclusions

No anomalies of archaeological origin have been identified by the geophysical survey. Anomalies caused by former ponds, a former field boundary and ridge and furrow cultivation have been identified which are consistent with the former agricultural landscape as depicted on 19th century Ordnance Survey mapping. The only other anomalies identified are due to a service pipe, perimeter fencing and localised areas of dumping.

Therefore, on the basis of the geophysical survey, the archaeological potential of the site is assessed as being 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.

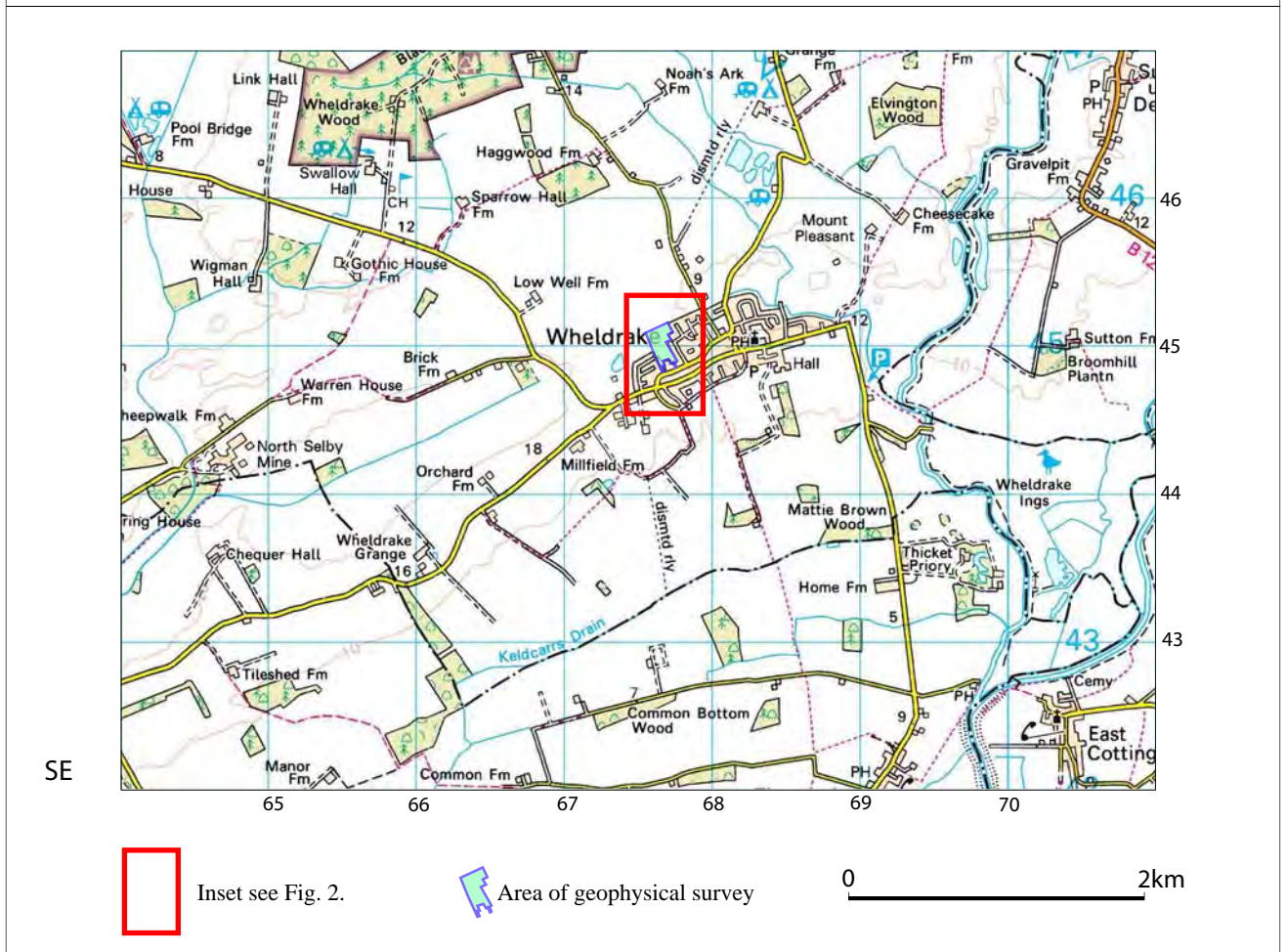
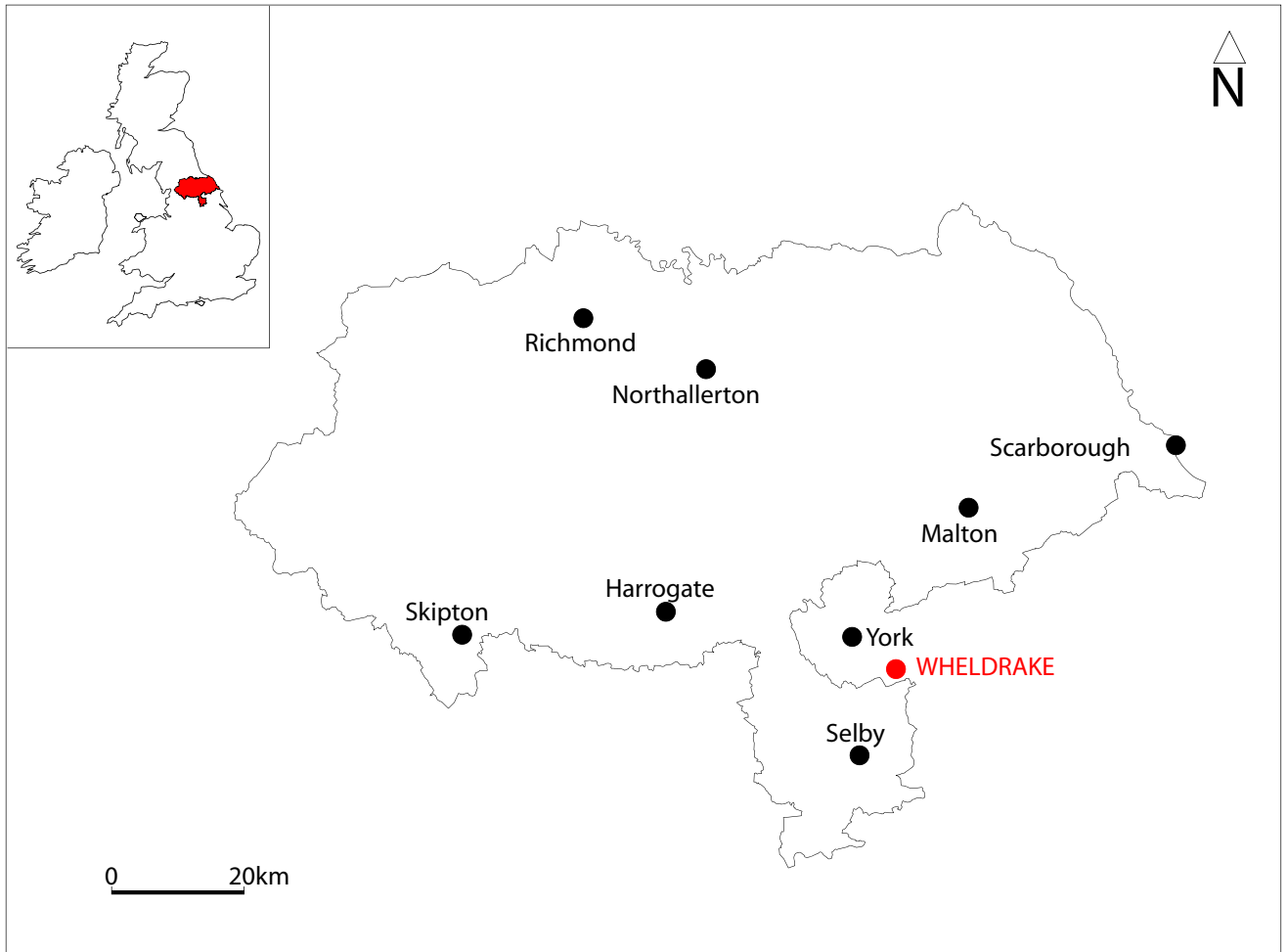
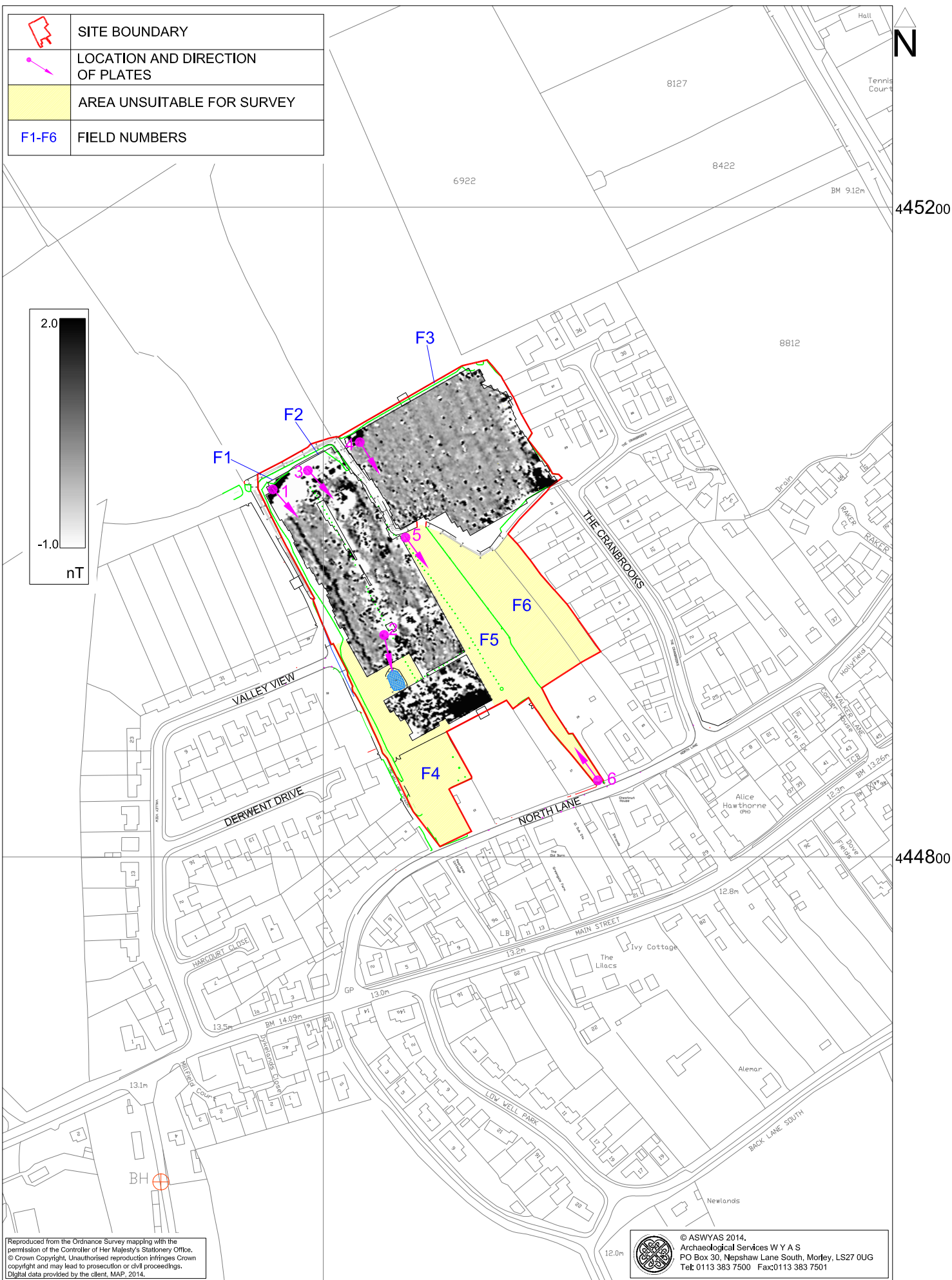


Fig. 1. Site location



467600

Fig. 2. Site location showing greyscale magnetometer data (1:3000 @ A3)

0 100m

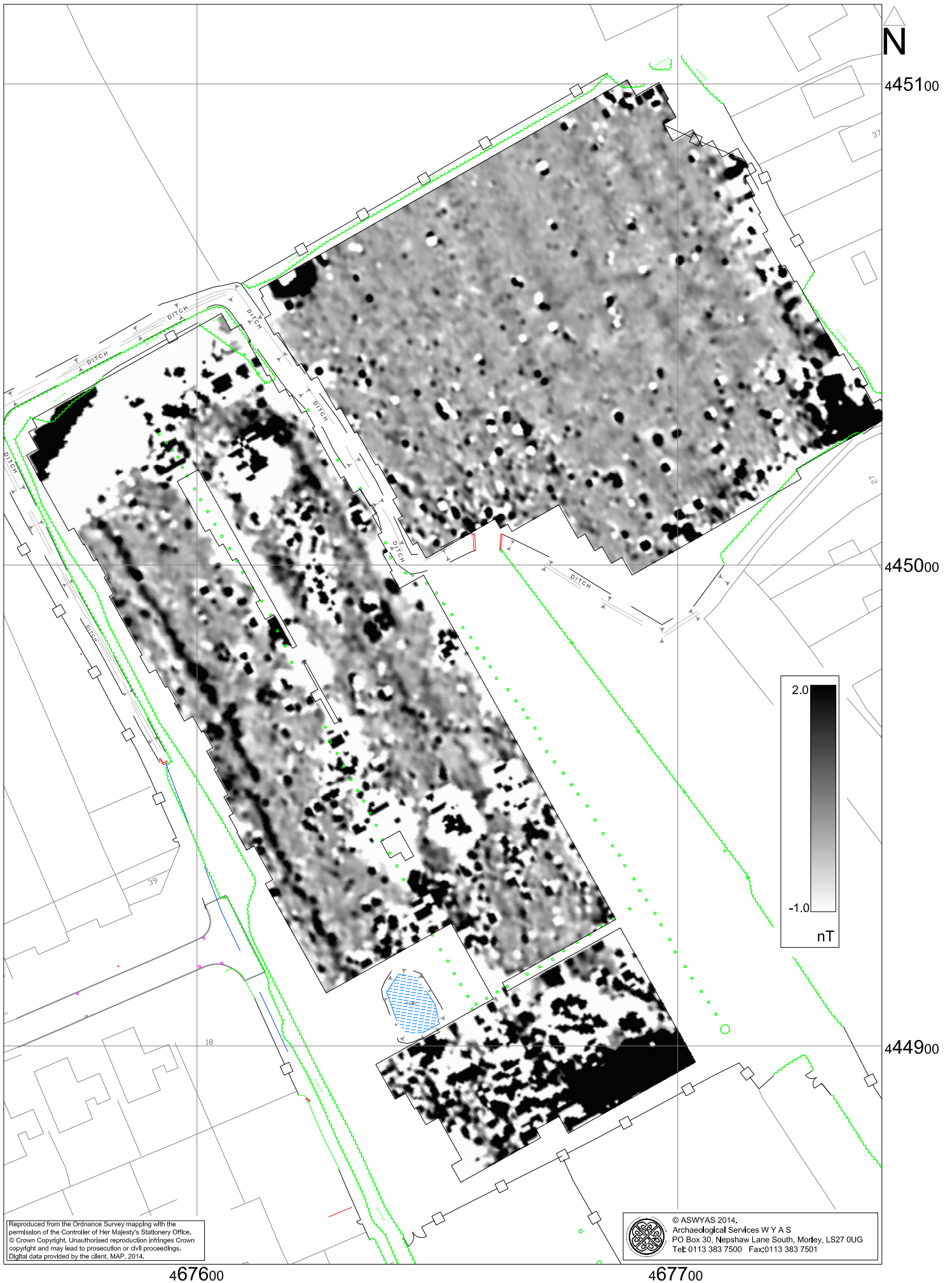


Fig. 3. Processed greyscale magnetometer data (1:1000 @ A3)

0 40m



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

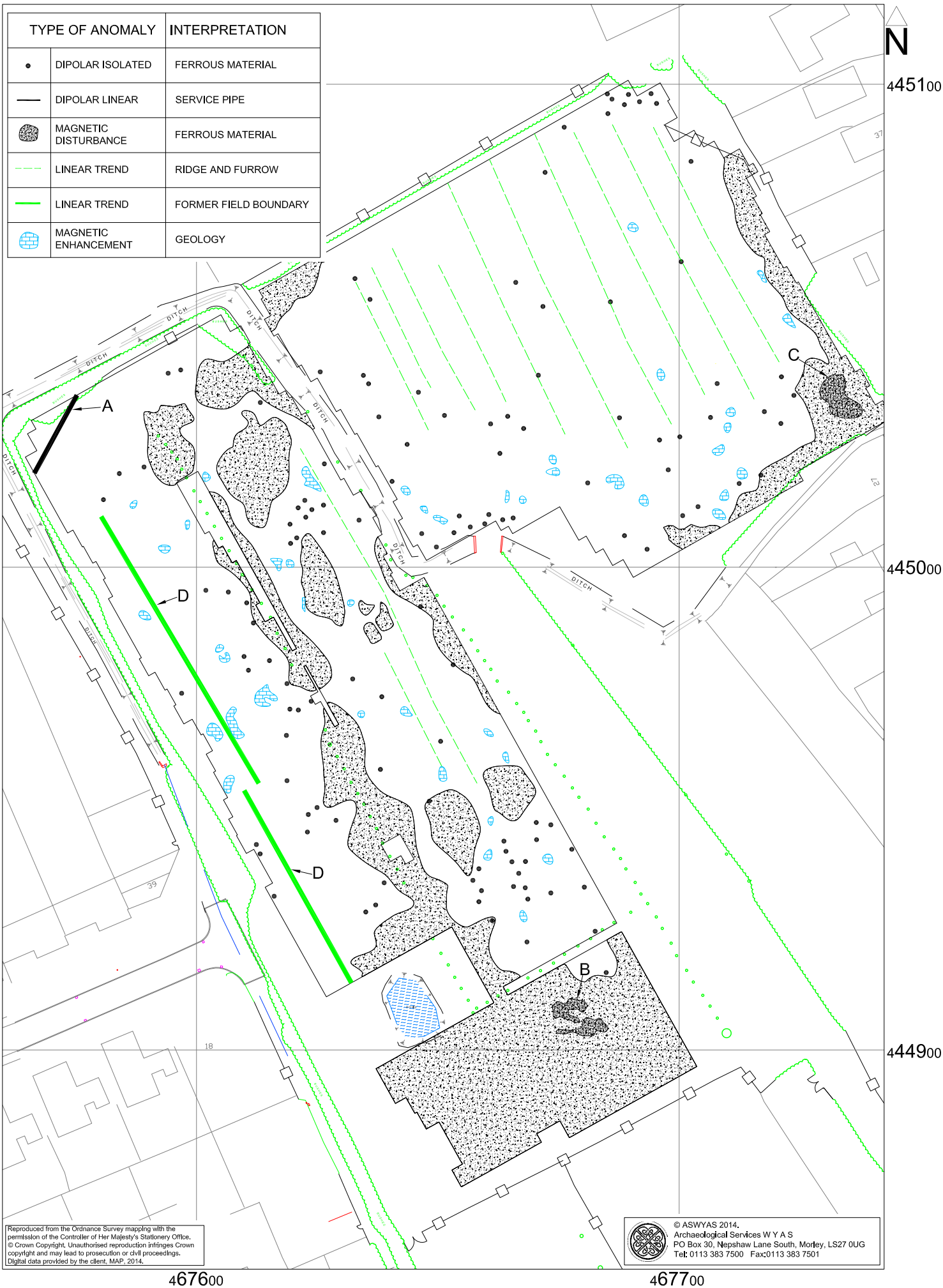


Fig. 5. Interpretation of magnetometer data (1:1000 @ A3)

0 40m



Plate 1. General view of Field 1, looking south-east



Plate 2. View of pond within the south of Field 1, looking south



Plate 3. General view of Field 2, looking south-east



Plate 4. General view of Field 3, looking south-east



Plate 5. General view of Field 5 and Field 6, looking south-east



Plate 6. View of site access at south of Field 5, looking north-west

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 0.5m 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 dual frequency Global Positioning System (GPS) with two Rovers (Trimble 5800 models) working in real-time kinetic mode. The accuracy of such equipment was better than 0.02m. 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 for relocation purposes.

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 City of York Historic Environment Record).

Bibliography

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