Land south of Mawson Green Lane
Sykehouse
Doncaster
South Yorkshire

Geophysical Survey

September 2006

Report No. 1584

Carter Jonas LLP

Land south of Mawson Green Lane

Sykehouse

Doncaster

South Yorkshire

Walkover and Geophysical Survey

Contents

Summary

A geophysical (magnetometer) survey covering 4 hectares undertaken at Mawson Green Lane, Sykehouse has not revealed any anomalies indicative of probable archaeological activity. Numerous 'iron spike' anomalies have been identified that are indicative of modern activity on the site. Given the prevailing soils and geology it is not clear whether the geophysical evidence reliably indicates the real level of archaeological activity that may be present on this site.

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Archaeological Services WYAS

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1. *Introduction and Archaeological Background*

1.1 Archaeological Services WYAS was commissioned by Ms Kate Broadbank of Carter Jonas LLP on behalf their client Mr Ray Lane to undertake a walkover and geophysical (magnetometer) survey of an area of land to the east of Mawson Green Lane, Sykehouse (see Fig. 1) in advance of the proposed creation of fishing ponds.

1.2 The survey area, centred at SE 6465 1725, covered 4 hectares and comprised a single field of rough pasture recently in use as a horse paddock, south of the junction of March Hill Lane and Mawson Green Lane (see Fig. 2). No problems were encountered during the surveys although dense patches of weeds prohibited survey in small pockets, primarily in the south-east corner of the site. The walkover survey was carried out on September 7th 2006 with the geophysical survey undertaken two weeks later on September 19th and 20th 2006.

1.3 The site is situated in a flat low lying area (less than 10m Above Ordnance Datum) known as the Humberhead levels, effectively forming a southern extension to the Vale of York. The local geology comprises 25 foot Vale of York glacio-lacustrine drift deposits of silts and clays over Permo-Triassic Bunter sandstone. These are overlain by soils classified in the Foggathorpe 2 soil association that are prone to seasonal waterlogging. Indeed the field is bounded by Sykehouse Main Drain to the north, Mawson Green Lane Drain to the west and another unnamed drain to the south.

1.4 Until very recently there was virtually no archaeological information for the local area, predominantly because Sykehouse lies in the centre of an area notoriously unproductive in the detection of cropmark sites. However, archaeological excavation in advance of flood alleviation works undertaken by the Environment Agency in 2002 at Topham Farm, approximately 2.5km west of the current site (see Fig. 1), revealed part of a Late Iron Age and Romano-British enclosed settlement, probably dating between the 1st century BC and the early 3rd century AD. Significant assemblages of Late Iron Age and Roman pottery were also recovered making this site a notable discovery in an area of previously unrealised potential. Significantly a magnetometer survey undertaken of the whole site had not identified any of the archaeological features subsequently identified following topsoil stripping. The evidence from the excavation suggested that this was due to the similarity of the fills with the surrounding natural clay; even during excavation it was extremely difficult to distinguish the edges of features.

1.5 Closer to the current site is Warren Hall immediately to the east (see Fig. 1). This medieval moated site is a scheduled ancient monument and is rare in its preservation with two islands and timbers of a bridge still *in situ*. Ridge and furrow earthworks are found extensively within the Sykehouse area.

1.6 As a consequence the South Yorkshire Archaeology Service advised that an archaeological field evaluation should be carried out in advance of the proposed development. The walkover and geophysical survey forms the first phase of this evaluation.

2. Methodology and Presentation

2.1 The general aims of the survey were to obtain information that would contribute to an evaluation of the archaeological significance of the proposed scheme. This information would then enable further evaluation and/or mitigation measures to be designed in advance of the proposed development. In order to achieve these objectives Roy Sykes from the South Yorkshire Archaeology Service advised that detailed magnetometer survey be undertaken across those parts of the site that will be affected by the proposed development.

2.2 More specifically the aims of the survey were to:-

- determine the presence or absence of buried archaeological remains in the defined survey area;
- clarify the extent and layout of any remains;
- provide information about the nature and possible interpretation of any geophysical anomalies identified by the survey.

2.3 The walkover survey consisted of a rapid walkover to identify any surviving earthworks. A detailed earthwork survey was not required at this stage of the evaluation.

2.4 Detailed magnetometer survey employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later downloaded to computer for processing and interpretation. A Bartington Grad601 magnetic gradiometer was used during the survey with readings being taken at 0.25m intervals on zig-zag traverses 1m apart within 20m by 20m grids. The readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation using Geoplot 3 software. Detailed survey allows the visualisation of weaker anomalies that may not have been identifiable by less rigorous evaluation techniques such as magnetic scanning or magnetic susceptibility survey.

2.5 The survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David 1995) and by the IFA (Gaffney, Gater and Ovenden 2002). All figures reproduced from Ordnance Survey mapping are done so with the permission of the controller of Her Majesty's Stationery Office. © Crown copyright.

2.6 A general site location plan, incorporating the 1:50000 Ordnance Survey mapping, is shown in Figure 1. Figure 2 shows the processed magnetometer data superimposed onto a digital map base at a scale of 1:4000. The processed (greyscale) and unprocessed (XY trace plot) data, together with an accompanying interpretation plot, are presented at a scale of 1:1000 in Figures 3, 4 and 5.

2.7 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 site 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.

3. Results

3.1 Walkover Survey

3.1.1 The field is rectangular in shape, and is used for rough pasture, with areas of nettles and thicker vegetation, and is bounded on all sides by hedge lines containing mature oak trees. The site and surrounding land is cut across by numerous artificial drainage channels, such as the Sykehouse Main Drain and the Mawson Green Lane Drain which run along the north and west sides of the site respectively. The field pattern surrounding the study area is typical of late 18^{th} or early 19^{th} century drainage and enclosure, which can be seen throughout the Humberhead Levels. The proposed development area is crossed west to east by a series of low ridges, about 8m apart that might be caused by the degraded remnants of ridge and furrow ploughing. However, the linearity of the ridges and the fact that they are constrained within the field boundaries could suggest that the ridges reflect the line of field drains. There are no further archaeological features visible on the surface within the proposed development area.

3.2 Magnetometer Survey

3.2.1 Numerous isolated dipolar anomalies ('iron spikes' - see Appendix 1) have been identified across the site. These anomalies are indicative of ferrous objects or other magnetic material in the topsoil/subsoil and, although archaeological artefacts may cause them, they are more often caused by modern cultural debris that has been introduced into the topsoil often as a consequence of manuring. In this case the number of these anomalies suggests that the field has previously been under arable cultivation. However, there is no obvious clustering and consequently the anomalies are not considered to be archaeologically significant.

3.2.2 Apart from an area of ferrous disturbance on the eastern site boundary, also considered not to be archaeologically significant, the only other anomalies are the three parallel linear trend anomalies that have been identified 50m apart on a north-south alignment. These anomalies are due to field drains.

4. Discussions and Conclusions

4.1 At Topham Farm the failure to identify the underlying features was attributed to the similarity between the material filling the cut features (ditches, gullys, pits etc) and the surrounding natural deposits. For magnetometer survey to identify infilled archaeological features there has to be measurable difference in the magnetic susceptibility between the fill of the archaeological feature and the surrounding natural deposits. Without this contrast it is very difficult to be confident of the validity of the results.

4.2 On this site no features or anomalies of probable or even possible archaeological significance have been identified by either the walkover survey or the geophysical survey, other than the possible low earthworks that might be the result of ridge and furrow ploughing. However, because of the discrepancy between the results of the geophysical survey and the level of archaeology later revealed at the Topham site (where exactly the same geological and pedological conditions pertain as on this site) it is not clear whether the absence of archaeological anomalies here is a true indication of a lack of archaeology. Therefore the ‘negative’ result should be treated with a degree of caution.

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.

Bibliography

David, A., 1995. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines* No. 1. English Heritage

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

Acknowledgements

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Figures

Appendices

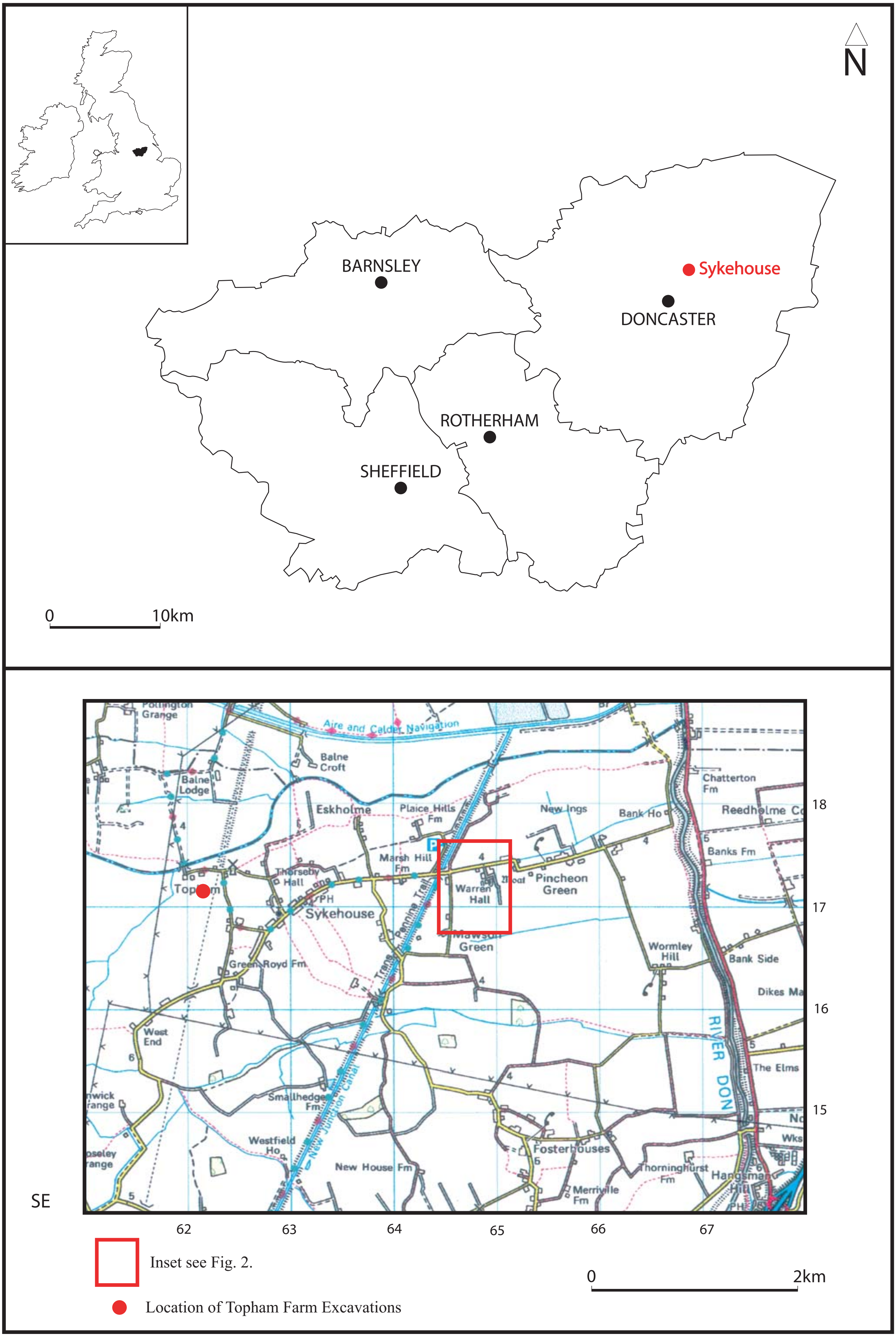

Fig. 1. Site location

Fig. 2. Site location showing greyscale magnetometer data (1:4000 @ A4)

0 200m

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

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

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

0 25m

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 haematite. 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 negative results from magnetic scanning should be checked with at least a sample detailed magnetic survey in order to validate a negative scanning result (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 0.5m or 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 20m by 20m 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 1600 readings were obtained for each 20m by 20m 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 Geodimeter 600s total station theodolite and tied in to the corners of buildings and other permanent landscape features and to temporary reference points (survey marker stakes) that were established and left in place following completion of the fieldwork for accurate geo-referencing. The locations of the temporary reference points 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 ±1.5m. However, it should be noted that Ordnance Survey co-ordinates for 1:2500 map data have an error of ±1.9m at 95% confidence. This potential error must be considered if co-ordinates are measured off for relocation purposes.

Station	Easting	Northing
A	464667.631	417111.646
B	464761.298	417164.026
C	464733.333	417314.203

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 (Word 2000), and graphics files (Adobe Illustrator, CorelDraw6 and AutoCAD 2000) 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 will 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).