ARCHAEOLOGICAL SERVICES WYAS

# Land at School House Farm
# Flixton
# North Yorkshire

## Geophysical Survey

Report no. 2508

August 2013

Client: MAP Archaeological Practice Ltd

REGISTERED ORGANISATION IfA

# Land at School House Farm
# Flixton
# North Yorkshire

## Geophysical Survey

*Summary*

*A geophysical (magnetometer) survey, covering 2 hectares of land was carried out at School House Farm, Flixton, to inform the submission of a planning application for the erection of two wind turbines. The survey has identified a circular anomaly, 10m in diameter, which is thought to locate a round barrow. Anomalies suggestive of a second barrow have been identified a short distance away. Possible ditches and numerous discrete anomalies, perhaps indicating pits have been identified throughout the site. On the basis of the geophysical survey the archaeological potential within the north of the site is moderate to high with a low to moderate potential towards the south.*

ARCHAEOLOGICAL
SERVICES
WYAS

## Report Information

| | |
|---|---|
| Client: | MAP Archaeological Practice Ltd |
| Address: | The Croft, East Street, Swinton, Malton, YO17 6SH |
| Report Type: | Geophysical Survey |
| County: | North Yorkshire |
| Grid Reference: | TA 047 799 |
| Period(s) of activity: | Prehistoric? |
| Report Number: | 2508 |
| Project Number: | 4119 |
| Site Code: | FLX13 |
| OASIS ID: | archaeol11- |
| Planning Application No.: | Pre-application |
| Museum Accession No.: | n/a |
| Date of fieldwork: | August 2013 |
| Date of report: | August 2013 |
| Project Management: | David Harrison BA MSc MIfA |
| Fieldwork: | James Lawton BSc MSc PIfA<br>Thomas Fildes BA |
| Report: | David Harrison |
| Illustrations: | Thomas Fildes and David Harrison |
| Photography: | Site Staff |
| Research: | n/a |

Authorisation for distribution: ---------------------------------------------------


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

# Contents

## List of Figures



## List of Plates

# 1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Sophie Coy of MAP Archaeological Practice, to undertake a geophysical (magnetometer) survey of land at School House Farm, Flixton, North Yorkshire (see Fig. 1), to inform the submission of a planning application for the siting of two wind turbines. The work was undertaken in accordance with a Project Design supplied to the Development Management Archaeologist at North Yorkshire County Council, with guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (David *et al* 2008). The survey was carried out on August 22nd 2013 to provide additional information on the archaeological resource of the site and to allow for the micro-siting of the proposed turbines.

### Site location, topography and land-use

The proposed turbine site is situated 650m to the east of the village of Flixton and 7km due west of Filey, North Yorkshire. It is located within a single field of permanent pasture (see Plates), 250m east of School House Farm (see Fig. 2), and is bound by open farmland on all sides. The site slopes gently from the south, at 32m above Ordnance Datum (aOD) towards the north at 26m aOD. The undulating topography is characterised by a probable palaeochannel which winds through the site from the south-east in a north-easterly direction before turning to cross the northern half of the field in a north-easterly direction. A 1 hectare block was surveyed centred upon each of the two proposed turbine sites, T1 and T2.

### Soils and geology

The underlying bedrock is mudstone of the Speeton Clay Formation. This is overlain in the north of the field by lacustrine deposits of clay, silt and sand, typically deposited in lake settings, whilst superficial deposits of sands and gravels occur within the south of the field (British Geological Survey 2013). The soils in the south of the field are classified in the Newport 1 association, characterised as well-drained sandy loams. Within the north of the field the soils are characterised as deep peat of the Adventurers' 1 association (Soil Survey of England and Wales 1983).

# 2 Archaeological Background

The proposed turbine site is located on the southern margins of Lake Flixton, a palaeolake at the eastern end of the Vale of Pickering. Twenty four early Mesolithic sites are known around the former lake shore and on its former islands, including the settlement site at Starr Carr (Scheduled Monument Ref. 1401425) which is located approximately 2km to the north-west (see Fig. 1). Recent archaeological investigations in the immediate vicinity of the proposed turbines have identified two Mesolithic sites, Flixton School Field and Flixton House Farm, within 150m of the northernmost turbine site (T2). Excavation of these sites has identified pits, stake-holes and possible heaths, whilst previous geophysical survey in the area has identified a number of circular anomalies of unknown origin (Taylor and Gray Jones, 2009).

Prior to survey, therefore, the site was assessed as having a moderate to high potential for the presence of unrecorded features of archaeological potential, particularly from the prehistoric period.

## 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 the proposed turbine base on any potential archaeological remains and for mitigation proposals, if appropriate, to be recommended. To achieve this aim a magnetometer survey covering a 1 hectare block was carried out over each of the proposed turbine sites, T1 and T2.

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 (1:2000) survey location plan displaying the processed magnetic data and the proposed turbine sites. Detailed data plots ('raw' and processed) and full interpretative figures are presented at a scale of 1:1000 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. Appendix 3 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 (see Figs 3, 4 and 5)

Numerous anomalies have been identified throughout the two survey blocks. The anomalies survey 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 'spike' anomalies have been identified across the two survey blocks. These are caused by ferrous objects within the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation. Ferrous debris 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.

**Agricultural Anomalies**

Historical Ordnance Survey mapping shows that the current layout of fields within the site has remained unchanged since the publication of the first edition Ordnance Survey map in 1854.

Series of closely-spaced parallel linear trend anomalies, aligned north-south, have been identified throughout the surveyed areas. These are thought to be caused by modern ploughing.

**Geological Anomalies**

A winding band of discrete anomalies, **A**, has been identified reflecting the undulations in topography which were observed during fieldwork. These are thought to indicate localised pedological variations resulting from a silt-filled palaeochannel. Faint sinuous trends are also discernable which further accentuate these variations.

Elsewhere, small discrete anomalies, characterised as localised areas of enhanced magnetic response, have been identified across T1. These are likely to be caused by variations in the superficial deposits of sand and gravel.

**Possible Archaeological Anomalies**

A broad area of archaeological potential has been identified within T2, concentrated on slightly elevated ground and divided by the probable palaeochannel, **A**. The most obvious anomaly identified is a circular anomaly, **B**, measuring 10m in diameter, centred at TA 04671 80052. This is thought to indicate a soil-filled ditch enclosing a round barrow. Previous geophysical survey in the area has also recorded circular anomalies (Taylor and Gray Jones, 2009). To the north of this anomaly, a weaker curvilinear anomaly, **C**, may indicate a second barrow, although interpretation of this anomaly is less confident. Linear anomalies, **D** and **E**, are thought to indicate soil-filled ditches. The anomalies are fragmentary and form no clear archaeological pattern, but given the local context an archaeological origin is thought likely. Numerous discrete areas of magnetic enhancement have been ascribed a possible archaeological interpretation given their close proximity to these anomalies and, whilst they form no coherent pattern, it is possible that they may be caused by pits and burnt deposits. However, a geological interpretation for these discrete anomalies cannot be dismissed and it is possible that they are caused by localised variations in the superficial deposits of sand and gravel.

## 5 Discussion and Conclusions

The geophysical survey has identified a clear circular anomaly 23m to the north-west of the proposed site of T2. It is highly likely that this anomaly is archaeological in origin, probably being caused by a soil-filled ditch enclosing a barrow. Linear anomalies have been interpreted as being caused by soil-filled ditches. Given the close proximity of probable archaeological anomalies and the known Mesolithic sites in the wider landscape, numerous discrete areas of magnetic enhancement have also been ascribed a possible archaeological interpretation, possibly indicating pits and burnt deposits. It is notable that the majority of the possible archaeological anomalies are concentrated on slightly elevated ground defined by the winding nature of the former palaeochannel. It is also worth considering that, given the former wetland environment in the marginal lands of Lake Flixton, and the natural deposition of layers of silt, sand and alluvium deposits, some anomalies of archaeological potential, if present, may remain beyond the detection of the magnetometer.

Therefore, on the basis of the geophysical survey, the archaeological potential of the site of T1 is assessed as being low to moderate, whereas a moderate to high potential is attributed to the site of T2.

***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.***

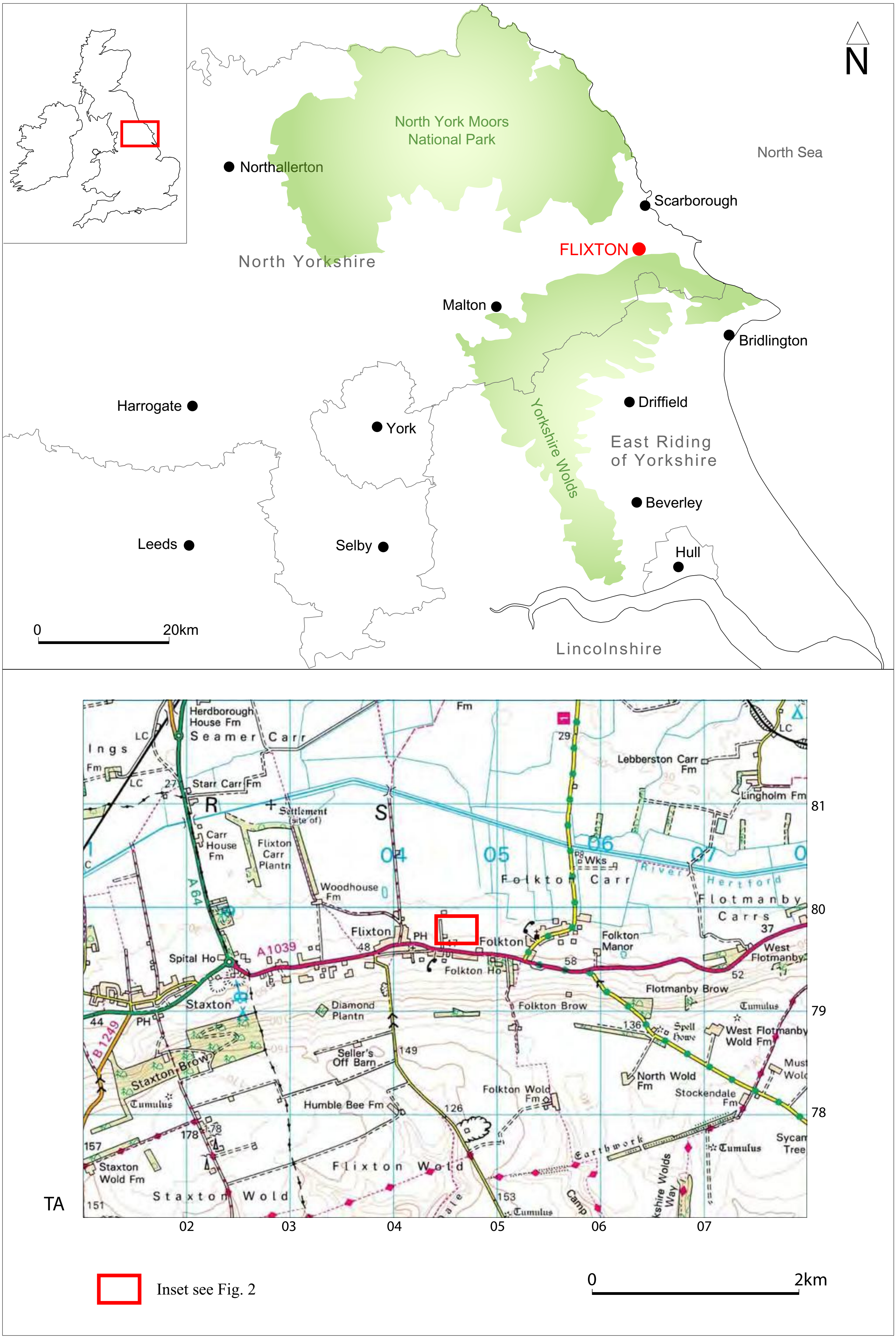


*Fig. 1. Site location*


*Fig. 2. Survey location showing greyscale magnetometer data and proposed turbine sites (1:2000 @ A4)*


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

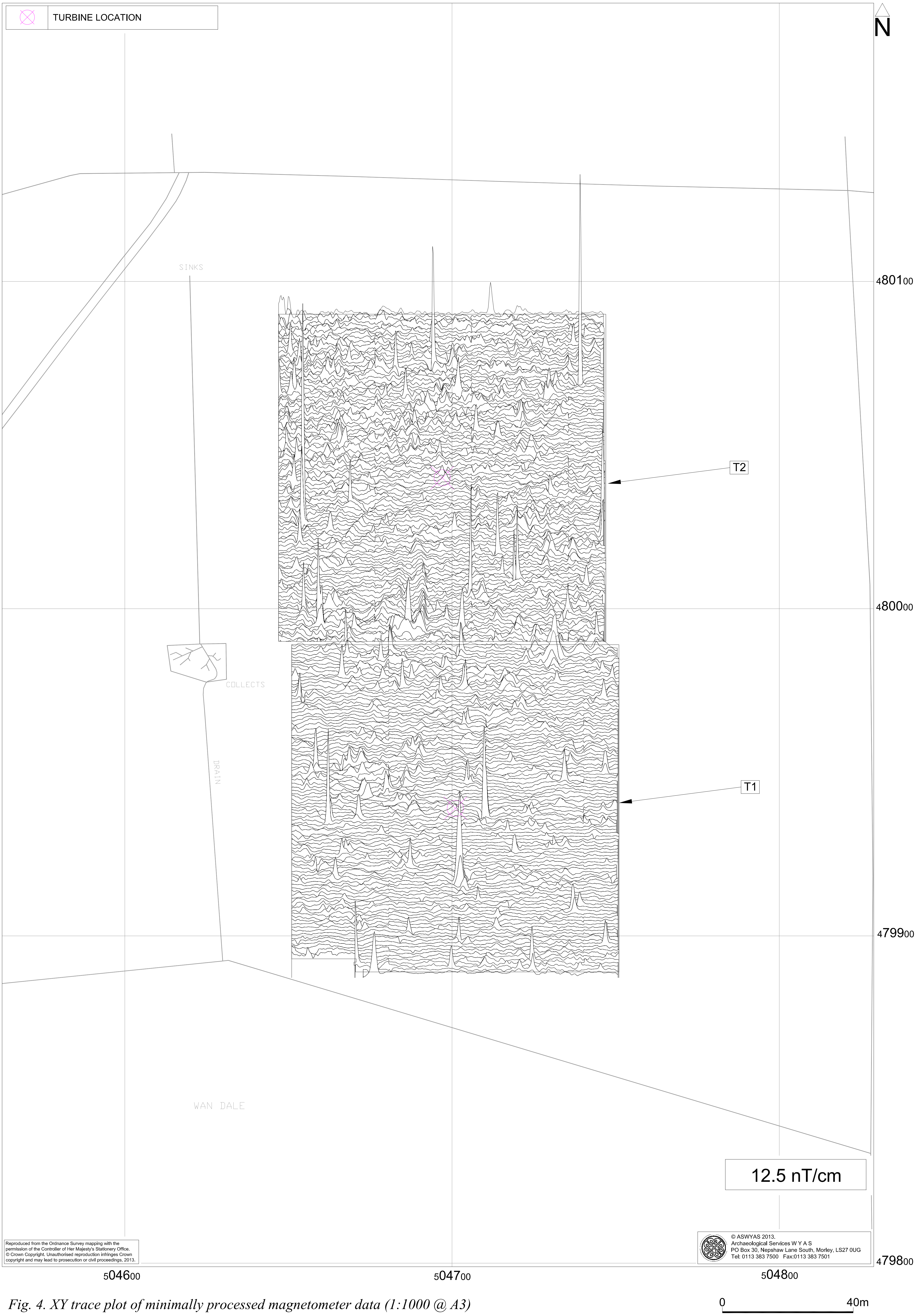


*Fig. 4. XY trace plot of minimally processed magnetometer data (1:1000 @ A3)*


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

*Plate 1. General view of survey area, Turbine 1, looking south*

*Plate 2. General view of survey area, Turbine 2, looking south-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 plough-soil.

### 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.

## 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: 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 North Yorkshire Historic Environment Record).

## Bibliography


British Geological Survey, 2013. www.bgs.ac.uk/discoveringGeology/geology OfBritain/viewer.html . (Viewed August 29th 2013)

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

Harrison, D. 2013. *Land at School House Farm, Filey Road, Flixton, North Yorkshire; Geophysical Survey Project Design* Unpublished ASWYAS Document

Institute for Archaeologists, 2010. *Standard and Guidance for archaeological geophysical survey.* IfA

Soil Survey of England and Wales, 1983. *Soil Survey of England and Wales: Soils of Northern England*, Sheet 1

Taylor, B. and Gray Jones, A. 2009. Definitely a pit, possibly a house? Recent excavations at Flixton School House Farm in the Vale of Pickering. *Mesolithic Miscellany* 20 (2): 21-26.