

**Hunger Hill Farm,
Middleton St George,
Darlington, County
Durham**

**Geophysical Survey
Report**

Client: ELGIN ENERGY

AB Heritage Project No:10620

Date:20/10/2015

Hunger Hill Farm, Middleton St George, Darlington, Country Durham

Geophysical Survey Report

Client Elgin Energy
Project Number 10620
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1. NON TECHNICAL SUMMARY

- 1.1.1 AB Heritage Limited (herein AB Heritage) undertook a programme of geophysical survey over two phases between Wednesday the 15th to Friday the 17th of July, and Monday the 28th of September to Friday the 2nd of October 2015 at Hunger Hill Farm, County Durham, ahead of a proposed development.
- 1.1.2 The detailed magnetic geophysical survey concluded that there is a high potential for archaeological remains to occur within the site. In Field 4 several linear and rectangular features have been identified, which possibly relate to archaeological features based on their form.
- 1.1.3 Further archaeological investigation is recommended in the form of archaeological evaluation and will be required to determine the validity of these features. This is subject to the approval of the Local Planning Archaeologist.

2. INTRODUCTION

2.1 Project Background

- 2.1.1 AB Heritage has been asked to undertake a geophysical survey on behalf of Elgin energy, at Hunger Hill Farm, Middleton St George, Darlington, County Durham (NZ 32804 12969).
- 2.1.2 The purpose of this work is to identify any potential surviving archaeological remains.

2.2 Site Location & Description

- 2.2.1 The proposed development site (hereafter referred to as the site) is located at site centre point NZ 32804 12969 (Figure 1), c. 4.5km south-east from the centre of Darlington, and c.1km south of the A67.
- 2.2.2 The site boundaries are mostly hedge banks, some of which (the northern edge and south eastern corner) contain metallic fencing. Most of the southern and western sides of the site border on woodland. The northern edge runs along a railway bank, and the eastern side of the site cuts through two fields leaving an open edge; there are no buildings located within or alongside the site.
- 2.2.3 The site is currently used as Agricultural land with the majority of the site harrowed at the time of survey.

2.3 Geology & Topography

- 2.3.1 The overlying soils are slowly permeable seasonally wet but base-rich loamy and clayey soils (Cranfield Soil and Agrifood Industry 2015).
- 2.3.2 The bedrock consists of the Roxby formation which is a calcareous mudstone. Superficial deposits consist of Devensian Till (Diamicton) and Devensian Glaciofluvial deposits (sand and gravel). The Glaciofluvial deposits only run along the southern edge of the site, protruding between c. 20 to 70m into the site (BGS 2015).
- 2.3.3 These forms of geology are not likely to have an effect on the results of the geophysical survey.
- 2.3.4 The site covers c. 19.7 ha with an average height of c. 47m AOD. There is a variation of 10m in the height AOD (c. 40 to 50m), and the lowest point of the site is in the south-east corner and it rises towards the north.

3. AIMS & METHODOLOGY

3.1 Aims of Survey Works

3.1.1 Geophysical survey is a programme of non-intrusive archaeological work. The aims of this geophysical survey were to:

- Identify any geophysical anomalies of possible archaeological origin within the specified survey area;
- Accurately locate these anomalies and present the findings in map form; and
- Provide recommendations for any further archaeological work(s) necessary to contribute to the mitigation of the impacts of proposed development on these potential features.

3.2 Methodology of Survey Works Summary

Site Specific Information

3.2.1 A geophysical survey was undertaken covering an area of c. 19.7 hectares (ha) between the 15th to the 17th of July, and the 28th of September to 4th of October 2015.

3.2.2 The AB Heritage staff members who undertook the works were Glenn Rose (Senior Project Archaeologist), Tom Cloherty (Archaeological Technician), and Peter Bonvoisin (Archaeological Technician).

3.2.3 The weather conditions for the work were mainly dry and sunny throughout the survey; these conditions had no material impact upon the survey.

Equipment

3.2.4 The magnetic survey equipment used was two Bartington Grad-601 (fluxgate magnetometers). Please see Appendix A, which contains a detailed methodology for the works undertaken; however, briefly, Table 1, below, shows site specific information on how the magnetometer was set up:

Table 1: Setting Parameters of Magnetometer

Grid Size	30x30 metres
Data Capture Distances	1m x 0.25m
Sensors	2
Sensitivity	0.1nT

3.2.5 A Trimble GeoXR GPS was used to setup the geophysical survey. This has sub-centimetre accuracy suitable to this survey.

3.3 Known Constraints

- 3.3.1 The known constraints within the survey area included an area of dense vegetation and woodland to the south of Field 3. This area was not surveyed due to the dense vegetation, a steep incline, and the lack of suitable access route into the field.



Plate 1: Looking south from the south edge of Field 3.

- 3.3.2 A number of utilities were also evident below and above ground in Field 4 of the site, which is evident in the survey results, these include a manhole cover and a couple of metallic features along the north edge of Field 4. .
- 3.3.3 Some of the field boundaries at the site contained metallic fences which affects the data c.1-2m from the boundary.

4. RESULTS & INTERPRETATIONS

4.1 Geophysical Survey Results

4.1.1 For the purposes of this detailed magnetic survey, the site was split into the four fields (Figure 1). Results for the geophysics data have been shown within Figure 2 and 3, with interpretations shown in Figures 4 and 5.

4.1.2 Below is a factual account of the results.

Possible Archaeology [GP 1]

Field 1 – A positive linear [GP 1] running on a rough north-south axis, c. 70m in length readings between 1.5 and 4.2 nanotesla (nT).

Field 2 – Shows a set of positive features [GP 1] of irregular shape, c. 90m at longest extent with readings between 2 to 3 nT.

Field 3 – Two areas of positive features [GP 1], c. 15 and 30m at longest extents with readings between 2 to 4 nT are present in the south-east corner.

Field 4 – A series positive linears [GP 1] run along a north-east to south-west axis, c. 110m at longest extent, with readings between 0.55 and 1.4nT. There are also two rectangular features made up of positive linears, c. 75m north to south, covering an area of c. 0.3 ha and readings of between 1.1 and 4.6 nT.

A set of sub-circular features are also located within Field 4 in the north west and south east. The largest located in the south east corner measuring up to c.40m in length with a reading of c. 0.5 to 1nt

Agricultural Features [GP 2]

Field 1 – Large areas of north-south aligned probable agricultural features [GP 2] spanning the length of the field, up to c. 140m with c. 3m gaps between the individual features.

Field 2 – Areas of possible agricultural features [GP 2] are visible running on an east-west axis and spanning the width of the field (up to c. 100m) in most places, with c. 3m gaps between the individual features.

Modern and Magnetic disturbances [GP 3 – 5]

Field 1 – A large area of magnetic disturbance [GP 4] surrounds a gas pipeline [GP 6] that runs roughly north-south, and continues into Field 4. Di-Polar anomalies [GP 3] appear more common in areas of agricultural activity [GP 2].

Field 2 – A small area of magnetic disturbance [GP 4] is evident in the north-east corner of the field; part of an area that is also present in Fields 3 and 4.

Field 3 – An area of magnetic disturbance [GP 4] is evident along the northern edge of the field; art of an area that is also present in Fields 2 and 4.

Field 4 – A large area of magnetic disturbance [GP 4] surrounds a gas pipeline [GP 6] that runs roughly north-south, continues into Field 1. A second area of magnetic disturbance [GP 4] is evident along part of the south-east edge of the field; part of an area that is also present

in Fields 2 and 3. A field boundary [GP 5] runs north to south following on from a current field boundary between Fields 2 and 3.

Utilities [GP 6]

A gas pipeline [GP 6] runs roughly north-south, continues into Field 4 running to a length of c.500m.

Also in the northern edge of the Field 4 there is some magnetic disturbance [GP 4] running across the majority of the site in two parallel linears.

Geology [GP 7]

Field 3 – Two features in the south-east corner of the field have been identified as geological features, c. 40m and 80m at the longest extents.

4.2 Geophysical Survey Interpretation

- 4.2.1 Interpretation of the results of geophysical survey is based on professional judgement as to the likely/probable cause of an anomaly or reading. For example, strong dipolar discrete anomalies of small size are often associated with ferrous debris or similarly magnetic debris. In addition, where a positive linear anomaly is recorded, which has a negative anomaly associated alongside either side of it, is often likely to relate to the line of a modern service.
- 4.2.2 GP numbers have been used to place interpretations into categories.

Table 2: Interpretation of Geophysical Anomalies

AB No	Appearance	Potential Cause
GP 1	Positive Linear Features	Possible Archaeology
GP 2	Positive equidistant linear features	Agricultural Activity / Ridge and Furrow
GP3	Di-polar Anomalies	Amorphous Magnetic Debris
GP 4	Area of strong negative and positive readings	Magnetic disturbance, caused by disturbed ground or nearby metallic objects
GP 5	Positive Linear	Known Field Boundary
GP 6	BI-Polar Anomaly	Gas Pipeline
GP 7	Low Positive Features	Geological Features

- 4.2.3 Features of possible archaeological origin [GP 1] have been identified within the geophysical survey, and are present across the site.
- 4.2.4 An area of high archaeological potential has been identified within Field 4 due to the positive rectangular and sub-circular features [GP 1]. The rectangular features in Field 4 are possible enclosures with surrounding archaeological potential.

- 4.2.5 Further possible archaeological features [**GP 1**] in the form of irregular shaped areas found in Fields 2 and 3 have strong positive readings. These features are likely to be associated with geological features based on their form, however based on the structure of the eastern feature in Field 2 at a 'right angle' could be suggestive of having an archaeological origin.
- 4.2.6 Positive parallel linears [**GP 2**] present in Fields 1 and 2 are likely due to agricultural activity on the site, while possibly indicating ridge and furrow. With more modern agricultural activity indicated by an amorphous pattern of Magnetic debris [**GP 3**]
- 4.2.7 The north to south orientated linear in Field 4 [**GP 5**] follows on from a field boundary in the field below and has been interpreted as a continuation of that boundary, and as a modern feature. The boundary is still visible in the 2001 Google earth images (Google Earth, 2015).
- 4.2.8 Low positive features [**GP 7**] have also been identified in Field 3, and are likely to relate to geological features. While a large Gas Pipeline has been identified running through the western side of the site, which makes it unlikely to see any archaeological feature due to magnetic disturbance from the utility.

5. CONCLUSION

- 5.1.1 A geophysical survey was undertaken by AB Heritage Limited at Hunger Hill Farm, taking place over 8 days between Wednesday 15th to Friday the 17th of July, and Monday the 28th September to Friday the 2nd of October 2015.
- 5.1.2 The purpose of this work was to understand the potential for any archaeological remains to survive within the site, and, where possible, identify the form, function and extent of any potential remains.
- 5.1.3 The geophysical survey identified possible archaeological features within the boundaries of the site, including possible field boundaries and enclosures.
- 5.1.4 Overall the potential for the presence of previously unknown archaeological features within the surveyed area is high, based on the results of the geophysical survey, especially in relation to Field 4 where there are possible enclosures.

6. FURTHER RECOMMENDATIONS

- 6.1.1 Based on the conclusion of this report it is recommend that further archaeological investigation takes place; in the form of an evaluation, with the main area of interest focusing on possible archaeological features identified with Field 4.

7. ARCHIVE

7.1.1 The Site Archive will contain the following, as a minimum:

Table 3: Site Archive Data

Archive	Format
Raw Geophysical Data files	XYZ and Text
Processed geophysical data files	JPEG, BMAP
Archaeological Interpretation	Shape Files ARC GIS
Final Report	PDF
Final Images	PDF

7.1.2 A physical and digital archive will be stored in a suitable format at AB Heritage Limited offices in Taunton, Somerset.

8. REFERENCES

BGS (British Geological Society) 2015. *Geology of Britain viewer*.
<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>.

IFA, 2011. Standard and Guidance for archaeological geophysical survey.

Jones, D.M. (ED) 2008. *Geophysical Survey in Archaeological Field Evaluation*. English Heritage.

Schmidt, A. 2002. *Geophysical Data in Archaeology: a Guide to Good Practice*. Oxford. Oxbow.

Cranfield Soil and Agrifood Industry, 2015. *Soilscapes viewer*,
<http://www.landis.org.uk/soilscapes/>

Google Earth, 2015. *Google Earth images from 2001*,
https://www.google.co.uk/intl/en_uk/earth/

Appendix 1 Technical Information on Geophysical Survey

FLUXAGTE MAGNETOMETRY SURVEY

The magnetic survey is carried out using a fluxgate gradiometer, which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field, whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

Survey equipment

The Bartington Grad 601-2 dual magnetic gradiometer is capable of surveying to an accuracy of 0.1 nanotesla (nT).

Sample interval and depth of scan

The magnetometer data is collected in 30mx30m grids at a resolution of 1m x 0.25m. This sample density is recommended for site evaluation (English Heritage, 2008). This equates to 3600 points per 30mx30m grid. The magnetometer has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects are buried within the site.

Data capture and processing

The readings are logged continually by the data logger during the survey, which is then downloaded on site to a site laptop. At the end of each job, data is transferred to the office PC's for processing and presentation.

This 'regular xy' data is then downloaded into specialist data processing software, at user defined sample intervals (in this case 1 m by 0.25 m). This is processed as standard magnetometer data.

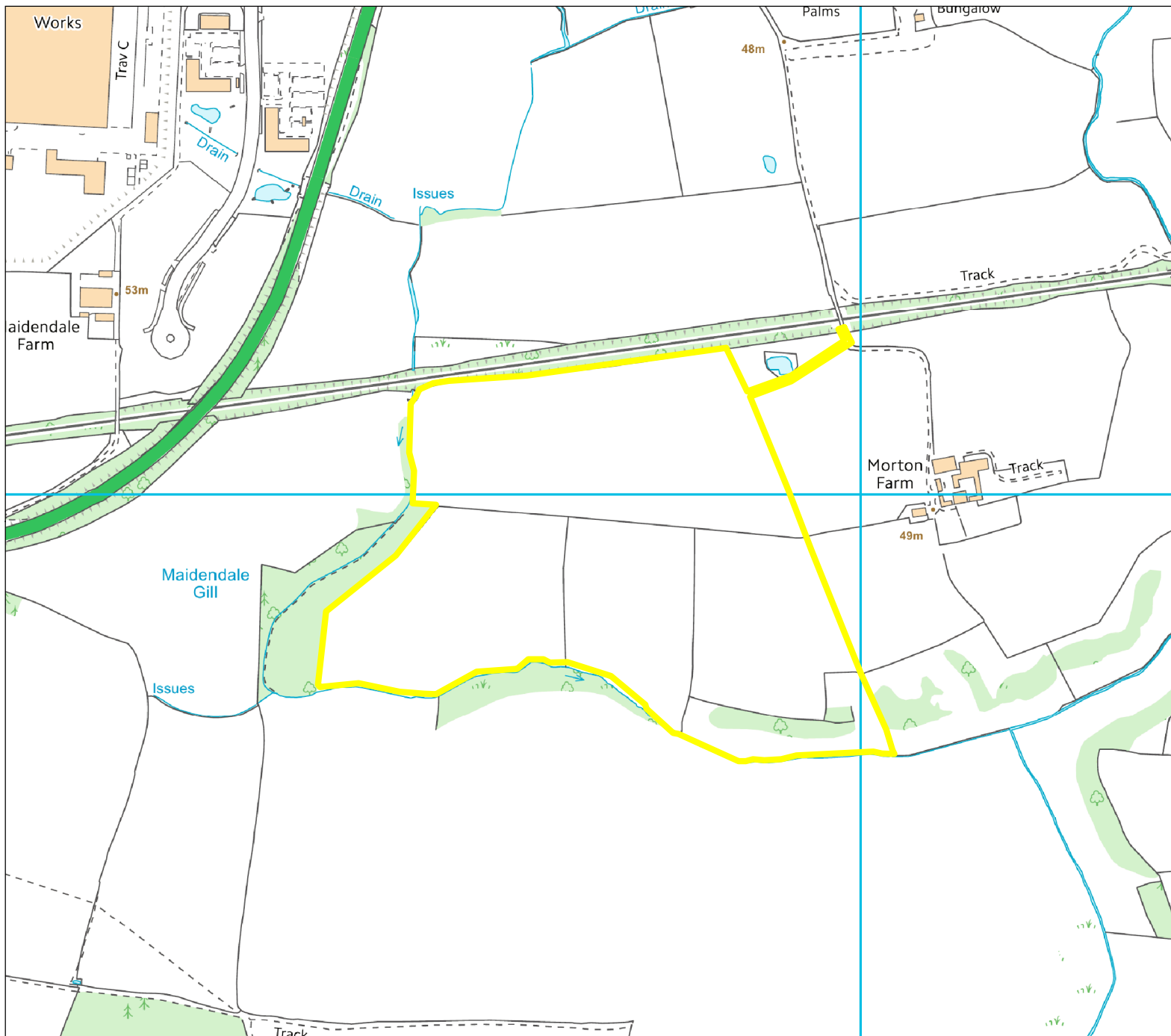
GPS METHODOLOGY

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to sub-cm accuracy, a far greater accuracy than a standard GPS unit. An RTK system uses a base station receiver and a number of mobile units (rovers). The base station takes measurements from satellites in view and then broadcasts them along with its known position to the rover receivers. The rover receiver also collects measurements from the satellites in view and processes them with the base station data. The rover then computes its location relative to the base.

During such a survey a Trimble GeoXR Differential Global Positioning System (dGPS), capable of Real Time Kinematic (RTK) is used to set out a nominal grid prior to the survey. This increases the accuracy and efficiency of the survey. The data is then downloaded from the unit on the day, using a USB stick.



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Legend
 Site Boundary

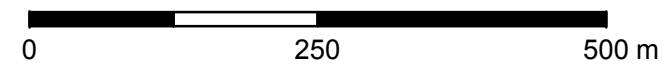


Figure 1: Site Location



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Drawn by: ZE Approved by: GR





- Legend**
-  Unsurveyable Area
 -  Site Boundary

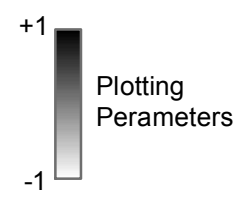
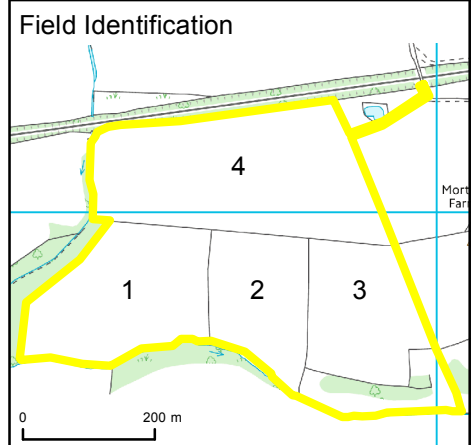
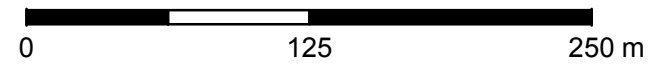


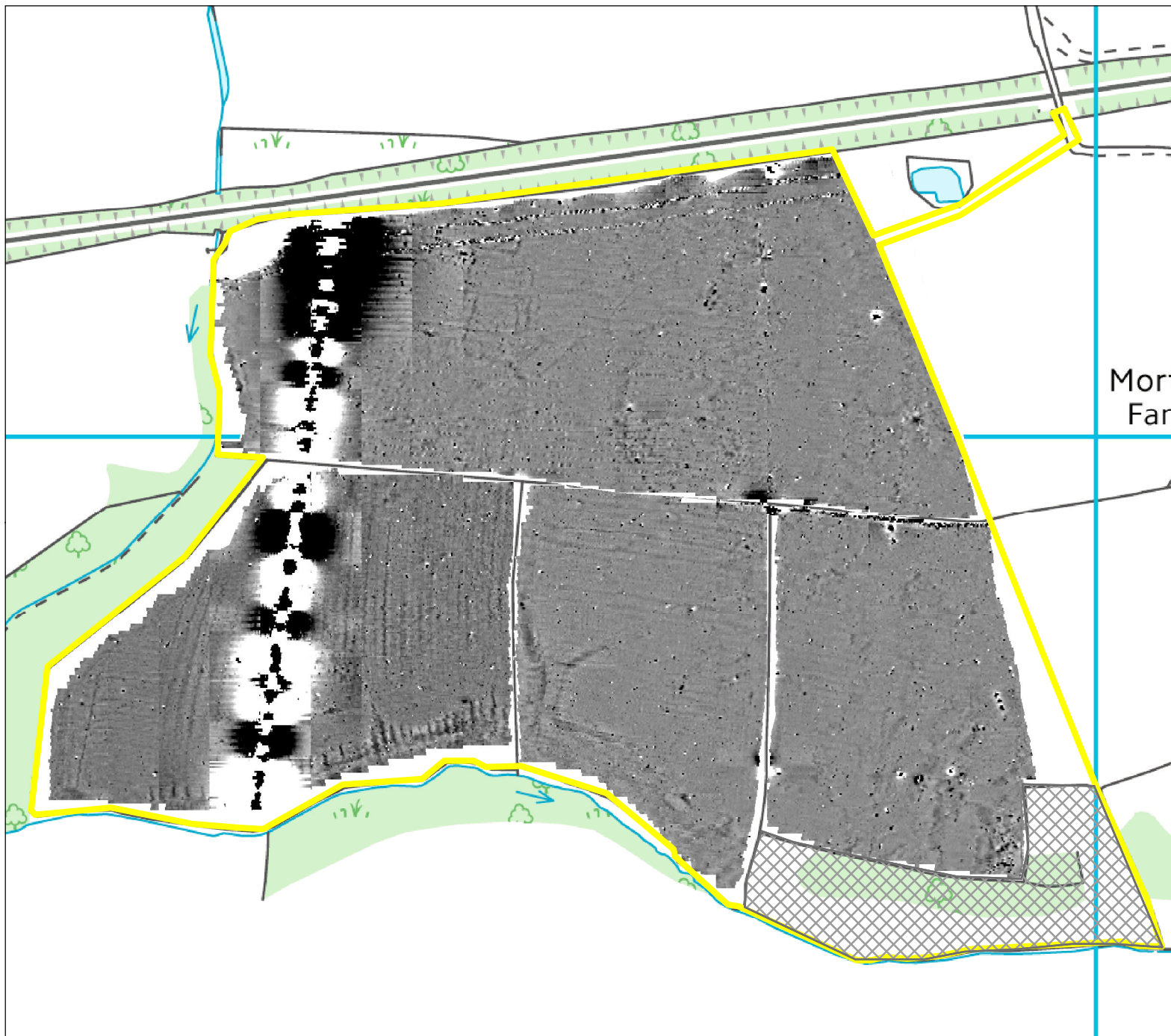
Figure 2: Raw Geophysical Data



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- Legend**
-  Unsurveyable Area
 -  Site Boundary

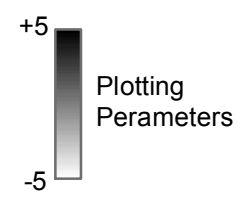
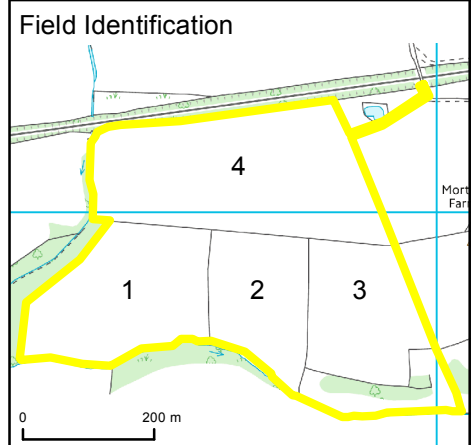
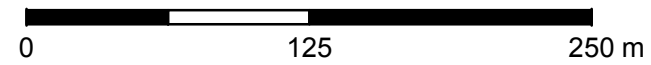


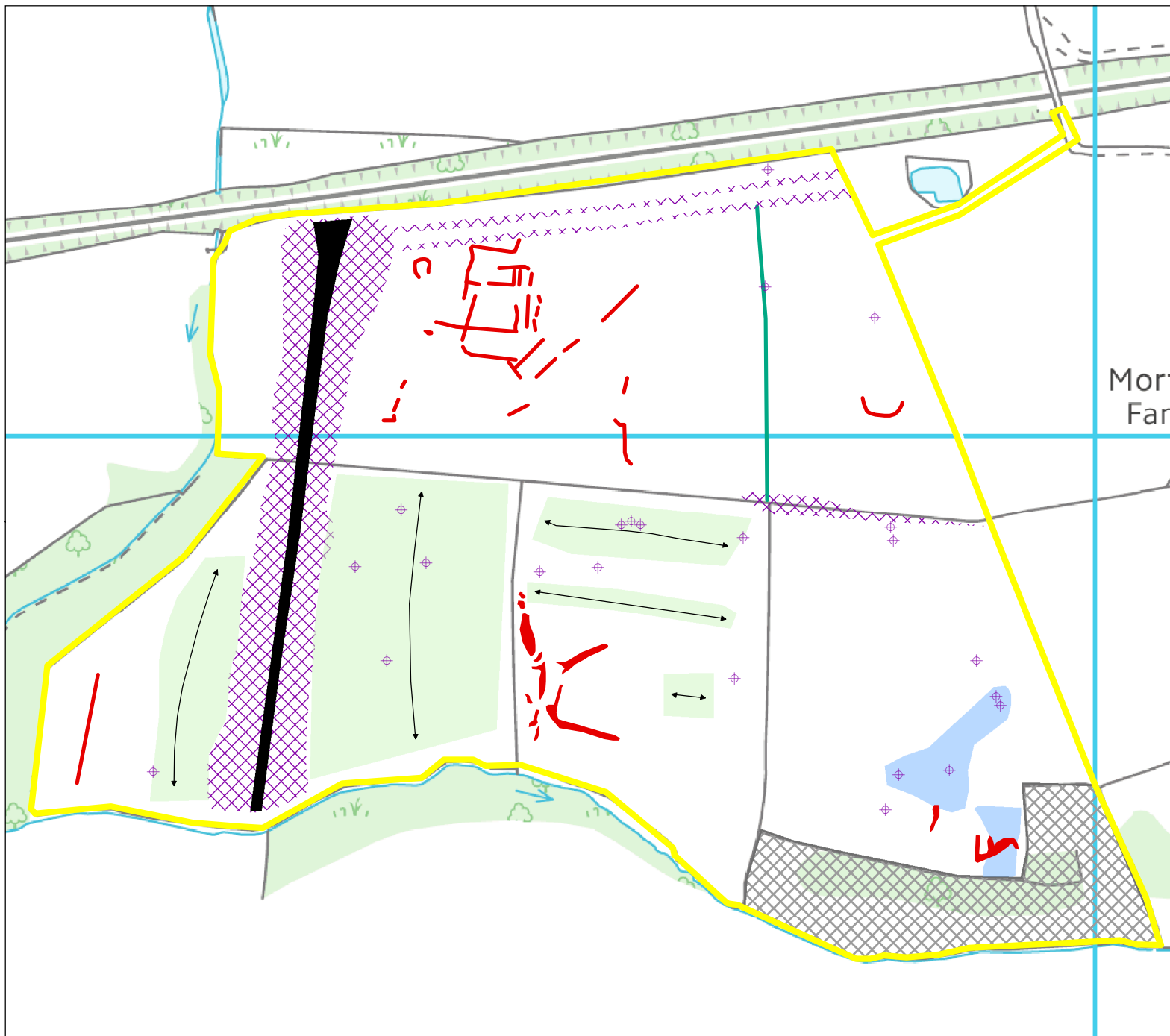
Figure 3: Processed Geophysical Data

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- Legend**
- Possible Archaeology [GP1]
 - Agricultural Features [GP2]
 - Di-Polar Anomalies [GP3]
 - Magnetic Disturbance [GP4]
 - Field Boundary [GP5]
 - Gas Pipeline [GP6]
 - Geological Features [GP7]
 - Unsurveyable Area
 - Site Boundary

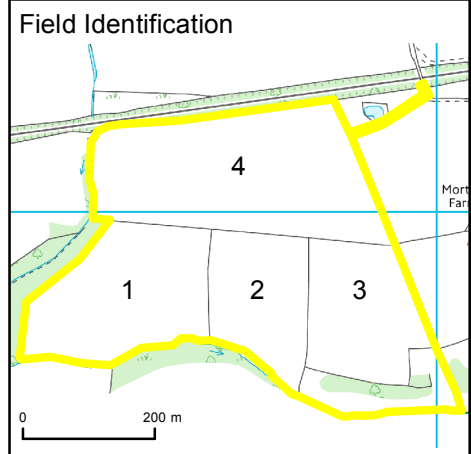
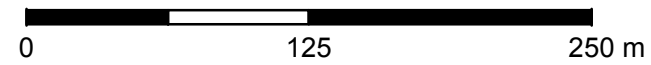
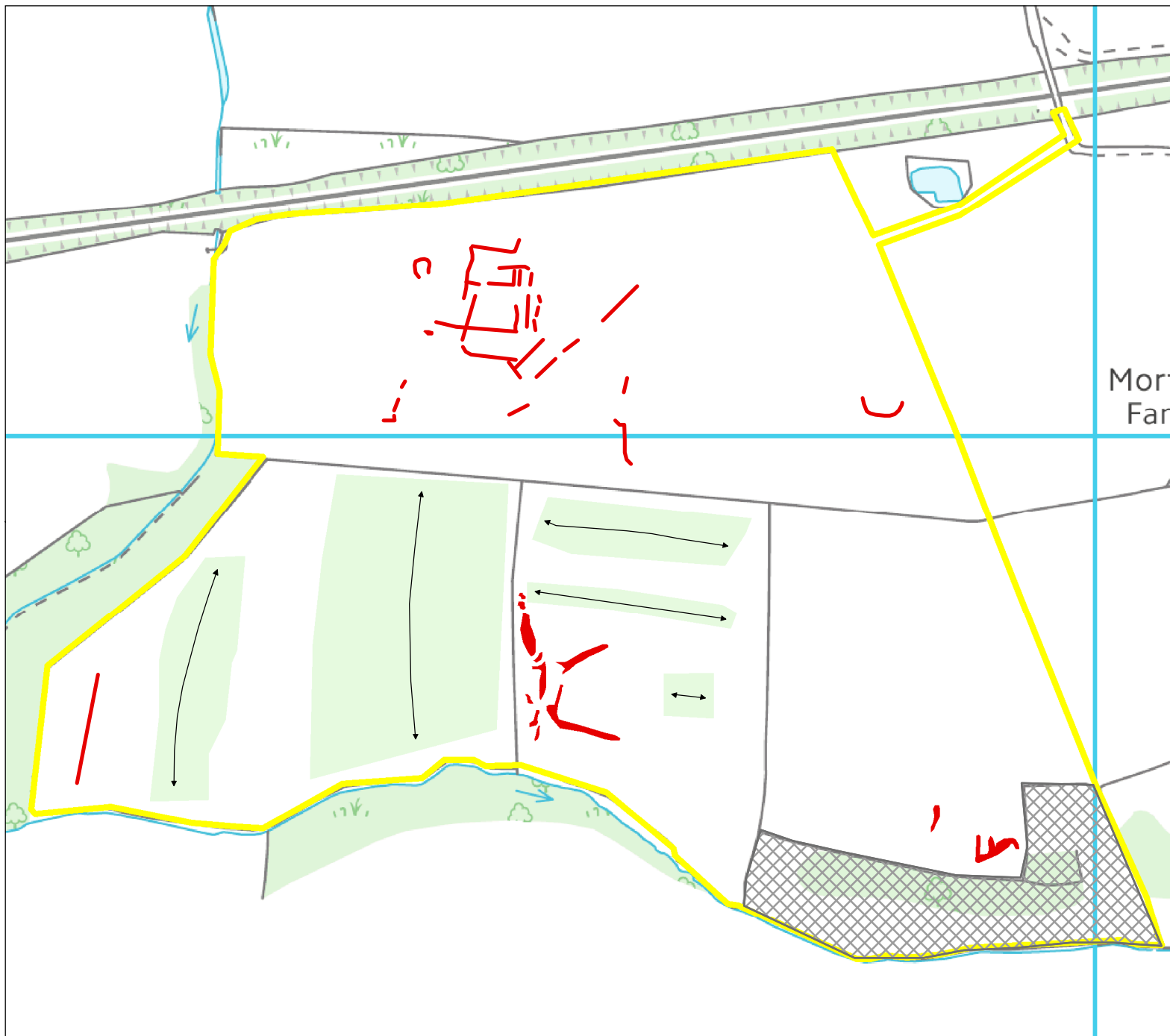


Figure 4: Interpretation of Geophysical Survey Data

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- Legend**
- Possible Archaeology [GP1]
 - Agricultural Features [GP2]
 - Unsurveyable Area
 - Site Boundary

Field Identification

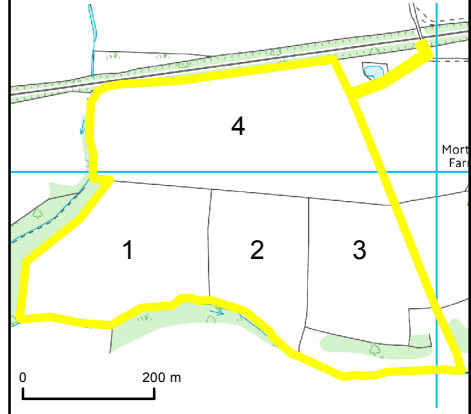


Figure 5: Interpretation of Possible Archaeological Features

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