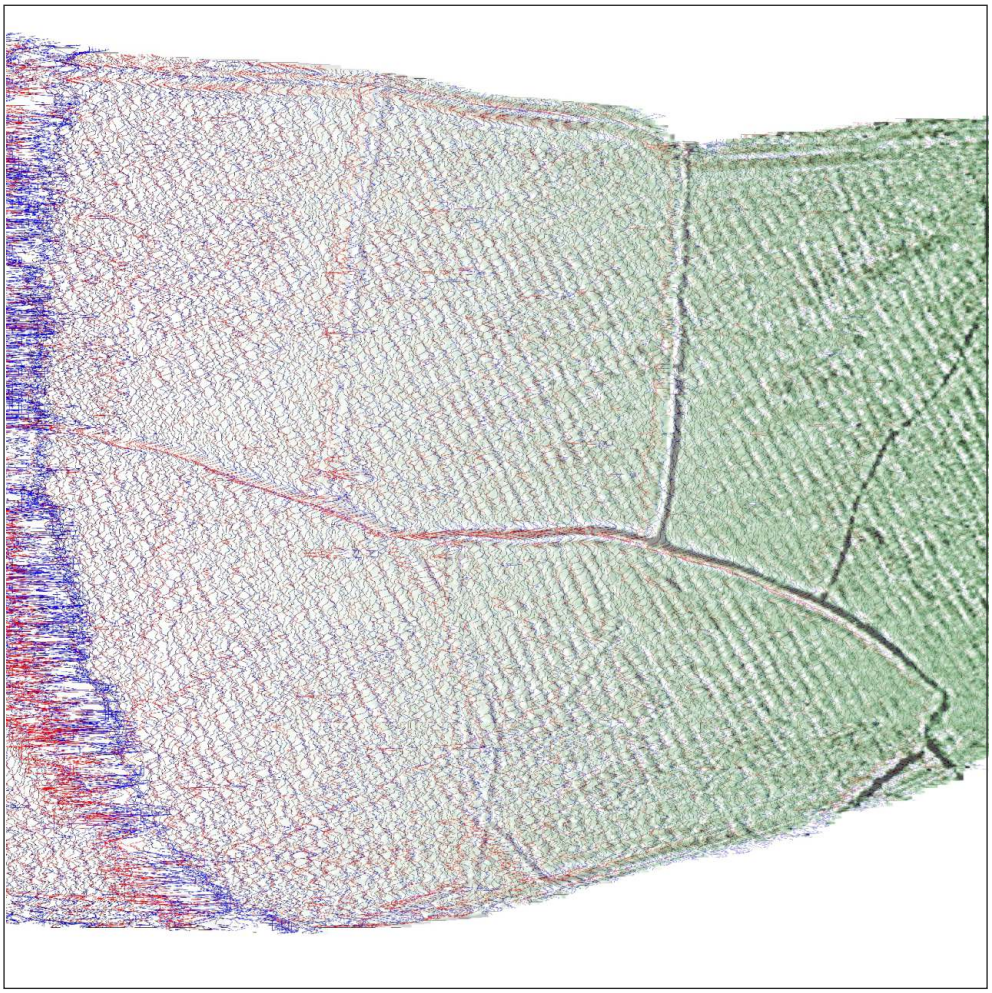
making sense of heritage

Land adjacent to Gover Farm St. Agnes, Cornwall

Detailed Gradiometer Survey Report



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geoservices

Land adjacent to Gover Farm
St. Agnes, Cornwall

Detailed Gradiometer Survey Report

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Land adjacent to Gover Farm
St. Agnes, Cornwall

Detailed Gradiometer Survey Report

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Summary

A detailed gradiometer survey was conducted over land close to Gover Farm, St Agnes, Cornwall. The project was commissioned by CgMs Consulting with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed development.

The site comprises three arable fields to the northeast of Gover Farm, approximately 2.6km south of St. Agnes. The site occupies the southwest facing slope of a hill and the gradiometer survey covered 17.2ha and has demonstrated the presence of anomalies of likely, probable and possible archaeological interest within the survey area, along with regions of increased magnetic response, numerous former field boundaries and a disused and dismantled railway.

At least three phases of field system are visible in the geophysical data along with probable enclosures and small cut features of probable archaeological interest. There is a wide spread of geological responses towards the east that may obscure other archaeological features.

The geophysical survey was undertaken between the 30th September and the 4th October 2013.

Land adjacent to Gover Farm
St. Agnes, Cornwall

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by CgMs Consulting. The assistance of Matthew Smith is gratefully acknowledged in this regard.

The fieldwork was directed by Jennifer Smith and assisted by Angus Forshaw and Rachel Williams. Ross Lefort processed and interpreted the geophysical data in addition to writing this report. The geophysical work was quality controlled by Dr. Paul Baggaley. Illustrations were prepared by Linda Coleman. The project was managed on behalf of Wessex Archaeology by Paul Baggaley.

Land adjacent to Gover Farm St. Agnes, Cornwall

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by CgMs Consulting to carry out a geophysical survey of land adjacent to Gover Farm, near St. Agnes, Cornwall (**Figure 1**), hereafter "the Site" (centred on NGR 172425, 048200). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of proposed development at the Site.

1.1.2 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

1.1.3 A Desk-Based Assessment (DBA) was carried out by CgMs Consulting that revealed there are a number of heritage assets close to the survey area. Bronze Age remains in particular are well-represented in the vicinity of the site (CgMs 2013). The results of this DBA will be referred to where relevant in the interpretation of the geophysical data.

1.1.4 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 The Site

1.2.1 The survey area comprises three arable fields close to Gover Farm, near Mount Hawke, some 2.6km south of the centre of St. Agnes (**Figure 1**). Detailed gradiometer survey was undertaken over all accessible parts of the Site, a total of 17.2ha.

1.2.2 The Site occupies the southwest facing slope of a hill surrounded by minor watercourses; the land slopes from over 150m above Ordnance Datum (aOD) at the northeast corner to 125m aOD at the southwest corner of the site. A small watercourse flows past the southern extents of the survey area and flows west before emptying into the ocean at Porth Towan. The survey extents are defined by the surrounding field boundaries.

1.2.3 The solid geology on Site is recorded as probably Devonian with sandstone and limestone expected; it is possible that intrusive igneous dykes are present close by (Ordnance Survey 1957). No Quaternary deposits are recorded close to the survey area (Ordnance Survey 1977). The soils underlying most of the Site are likely to be typical brown earths of the 541k (Denbigh 2) association with typical brown podzolic soils of the 611c (Manod) association to the south, close to the small watercourse (SSEW 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between the 30th September and the 4th October 2013. Field conditions at the time of the survey were variable, with soft ground under foot in places; none of these issues had any serious impact on the quality of the collected data.

2.2 Method

2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02m and therefore exceeds English Heritage recommendations (2008).

2.2.2 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag method.

2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±15nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey areas, with no interpolation applied.

2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The gradiometer survey has been successful in identifying anomalies of likely, probable and possible archaeological interest across the Site, along with former field boundaries and a disused and dismantled railway. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:1500 (**Figures 2** to **7**). The data are displayed at -6nT (white) to +9nT (black) for the greyscale image and ±50nT at 50nT per cm for the XY trace plots.

3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figures 4** and **7**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

3.2.1 The greatest concentration of archaeological features is located towards the western end of the survey area with small rectilinear and curving enclosures present around **4000** and **4001** in the southwest corner of the survey area. These enclosures are defined by strong positive anomalies with magnetic values in excess of +6nT and they are considered to represent ditches. These features have been classed as archaeology although their date is uncertain.

3.2.2 Further away from these probable enclosures are series of curving positive ditch-like anomalies such as those at **4002**, **4003**, **4004**, **4005**, **4006**, **4007**, **4008** and **4009**. They all have positive values but they vary in strength from close to 0nT to over +6nT; this variation is possibly a reflection of their state of preservation as some ditches are interrupted by ploughing lines which may indicate plough damage. These ditches are considered to represent field boundaries and from their layout it appears as though there may be at least three phases represented. The third phase of field boundary is considered to be the most recent and these are classed as former field boundaries that are discussed in more detail below (3.2.9). Three phases are suspected to be present as some crossing ditches such as those around **4007** and **4024** create very small enclosed areas that seem too small to represent fields or any kind of settlement enclosure. These ditches are considered to be archaeological given their irregular form although their original date is unclear. They have been variously classed as likely, probable and possible archaeology based on shape, magnetic strength and orientation. The main east-west curvilinear ditch at **4006** is represented on tithe maps and early Ordnance Survey (OS) maps in the DBA and is classed as a former field boundary; however its shape in plan suggests earlier origins than the other features classed as former field boundaries and may therefore prove to be archaeological.

3.2.3 There are a number of more isolated positive ditch-like anomalies such as short linear ditch-like anomalies at **4010** and **4013**; these ditches may form part of the field systems described above.

3.2.4 There are some more isolated groups of positive anomalies including a small D-shaped enclosure at **4011** that is interpreted as probable archaeology and a group of positive pit-like anomalies around **4012** also interpreted as probable archaeology. There is also a peculiar m-shaped positive anomaly at **4014** that may prove to be archaeological; as its form is a little irregular it has been interpreted as possible archaeology.

3.2.5 There are far fewer archaeological features to the east, it is unclear whether this is due to a lack of magnetic contrast due to geological responses in this area or a product of a lack of features cut into this area of higher ground. There are a few regular shaped positive anomalies including a small L-shaped positive anomaly at **4015** and a pit-like response at **4016**; both of these features are classed as probable archaeology. The remaining features at this eastern end of the survey area are a series of irregular shaped positive anomalies such as those around **4017** that are interpreted as possible archaeology as there is a possibility that they may prove to be geological features.

3.2.6 There are numerous linear and curvilinear trends visible in the geophysical data, most of these are ploughing trends such as those around **4018**, **4019** and **4020** but some others may prove to be archaeological. The trends considered to be of greater significance include L-shaped and curving trends such as those around **4021**; it is unclear what features these anomalies could correspond to but they are likely to be very small and ephemeral features.

3.2.7 There are several concentrated spreads of bipolar and dipolar responses (black and white) such as the example at **4022**. These spreads are often located close to field edges and are considered to be spreads of modern debris including metallic and ceramic debris. Some of these spreads may prove to be archaeological however with concentrations of artefacts creating these dipolar and bipolar responses.

3.2.8 The remaining anomalies of possible archaeological interest are a series of small sub-oval and sub-circular positive anomalies. They are classed as possible archaeology as there is no significant patterning in their spatial distribution.

3.2.9 There are a number of linear former field boundaries at **4023**, **4024**, **4025**, **4026**, **4027** and **4028**. They have negative values with flanking positive regions and are typical of responses observed from former field boundaries across Devon and Cornwall that are often formed by stone walls flanked by ditches. These features are not classed as archaeology as it is suspected that they are relatively modern given their regular layout and their presence on early maps. A distinction is made in the interpretation figure to show this likely difference in date and construction method.

3.2.10 A disused and dismantled railway is present as a broad ferrous spread at **4029**; this feature is not classed as archaeology simply as the identity of the feature is already known. This broad ferrous response will mask any archaeology that may lie underneath.

3.2.11 As is mentioned above there is a broad region of geological responses towards the east of the survey area that are apparent as a concentration of bipolar responses. This region may be masking archaeological features.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 There are no modern services located in the data although there is a disused and dismantled railway visible in the data at **4029**. Gradiometer data will not be able to locate and identify all services present on site. This report and accompanying illustrations should not be used as the sole source for service locations and appropriate equipment (e.g. CAT and Genny) should be used to confirm the location of buried services before any trenches are opened on site.

4 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of definite, probable and possible archaeological interest within the Site, in addition to regions of increased magnetic response, several former field boundaries and a dismantled railway.

4.1.2 The data has revealed probable enclosures to the southwest of the survey area, extending beyond the limits of the survey area along with a field system with at least three phases of field boundary visible (including fairly recent ones). In addition to these field systems there are numerous small anomalies that may prove to be of significance such as the features at **4011** and **4012**. It is unclear what date these field systems belong to but some geophysical anomalies may relate to known archaeology in the vicinity of the survey area (CgMs 2013).

4.1.3 The data suggests that plough damage has taken place in parts of these fields with some fragmentary ditch sections visible in the data supporting this. The former railway running through the site may also have impacted on the buried remains.

4.1.4 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey. It is also the case that strongly magnetised regions, such as certain geological formations, can mask weaker archaeological features. This is possible towards the eastern end of the Site where a large spread of geological anomalies coincides with the area with fewest archaeological remains. There may be more archaeological features on site than were detected in this geophysical data.

5 REFERENCES

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APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (2008) for characterisation surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into two main categories: archaeological and unidentified responses.

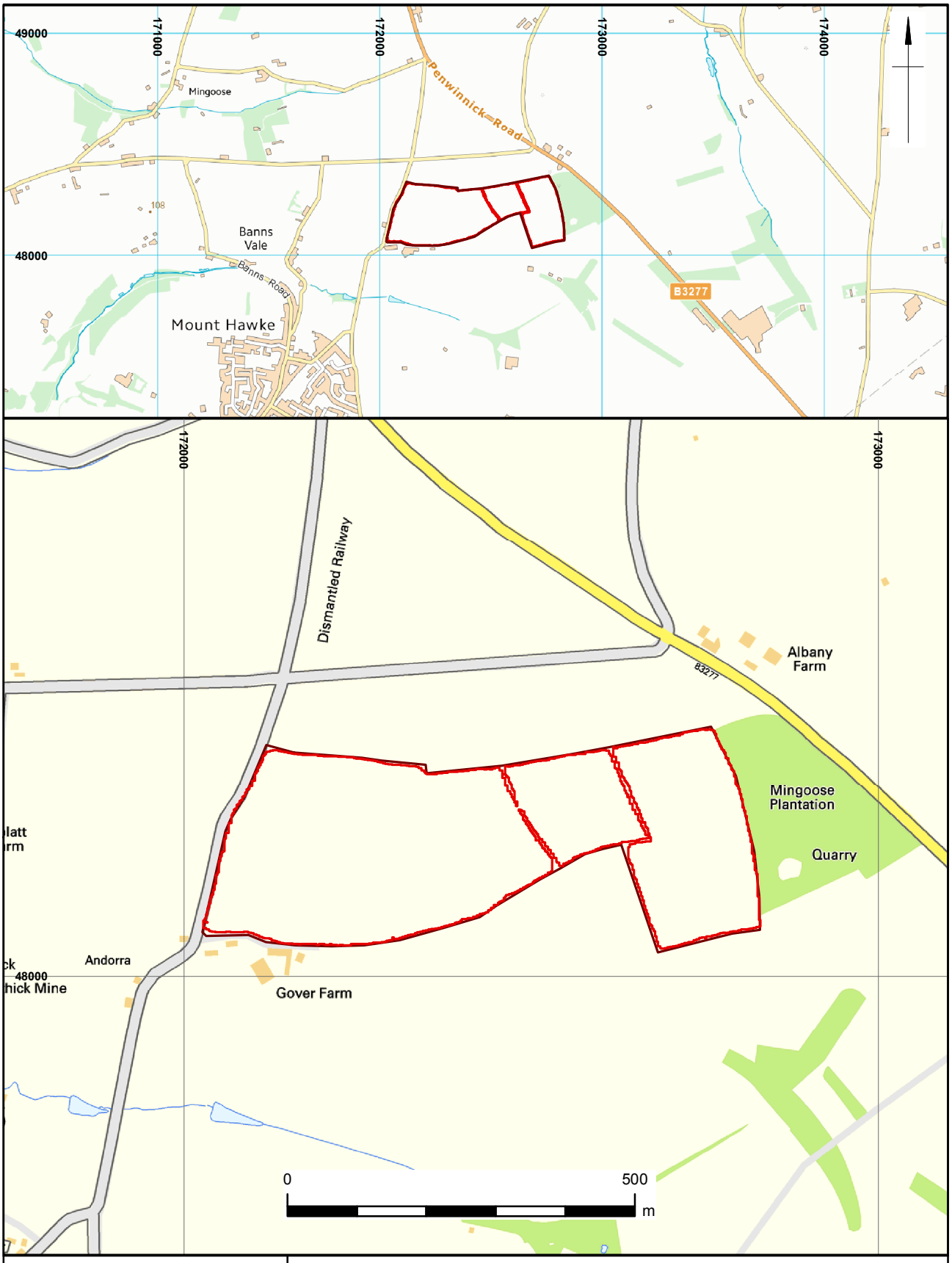
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

Finally, services such as water pipes are marked where they have been identified.



The Site

Survey Extents

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Path:	X:\PROJECTS\101470\GIS\FigsMXD		

Site location and survey extents

Figure 1

172100
172200
172300
172400
172500

48300
48200
48100

+9nT
-6nT

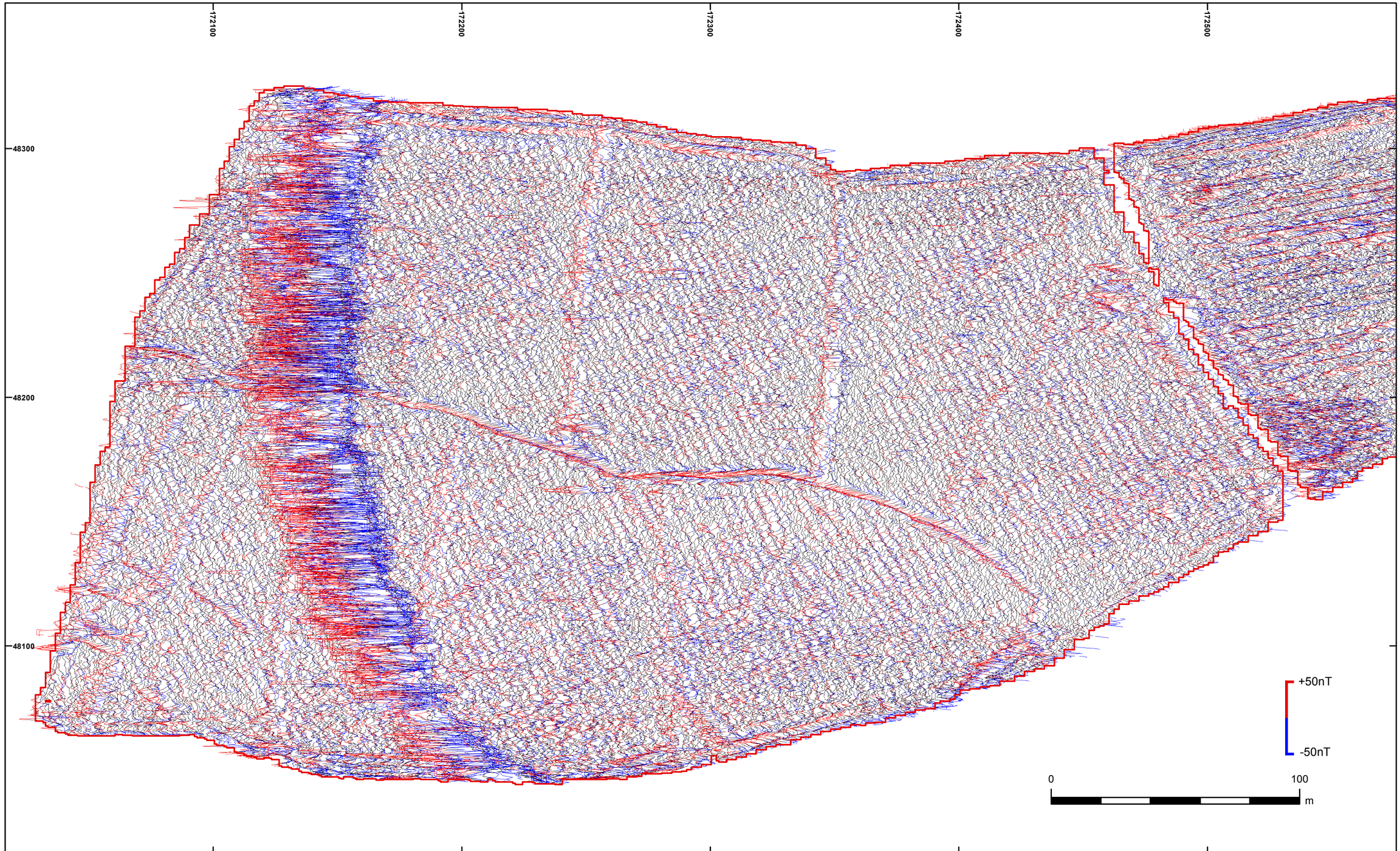
0
100
m

Survey Extents

Date:	18/10/13	Revision Number:	0
Scale:	1:1500 at A3	Illustrator:	LJC
Path:	X:\PROJECTS\101470\GIS\FigsMXD		

Greyscale, west

Figure 2



Survey Extents

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Scale:	1:1500 at A3	Illustrator:	LJC
Path:	X:\PROJECTS\101470\GIS\FigsMXD		

XY trace plot, west

Figure 3

172100
172200
172300
172400
172500
48300
48200
48100
4018
4019
4005
4021
4025
4013
4026
4012
4009
4002
4029
4022
4006
4008
4023
4001
4024
4000
4014
4004
4007
4003
4011
0
100
m

Survey Extents
Disused Railway
Ferrous
Archaeology
Probable Archaeology
Possible Archaeology
Former Field Boundary
Trend
Ploughing
Increased Magnetic Response
Superficial Geology

Date:	22/10/13	Revision Number:	0
Scale:	1:1500 at A3	Illustrator:	LJC
Path:	X:\PROJECTS\101470\GIS\FigsMXD\Fig04		

Interpretation, west

Figure 4

172400
172500
172600
172700
172800
172900
48300
48200
48100
+9nT
-6nT
0
100
m
Survey Extents

Date:	18/10/13	Revision Number:	0
Scale:	1:1500 at A3	Illustrator:	LJC
Path:	X:\PROJECTS\101470\GIS\FigsMXD		

Greyscale, east

Figure 5

172400
172500
172600
172700
172800
172900
48300
48200
48100
+50nT
-50nT
0
100
m

Survey Extents

Date:	18/10/13	Revision Number:	0
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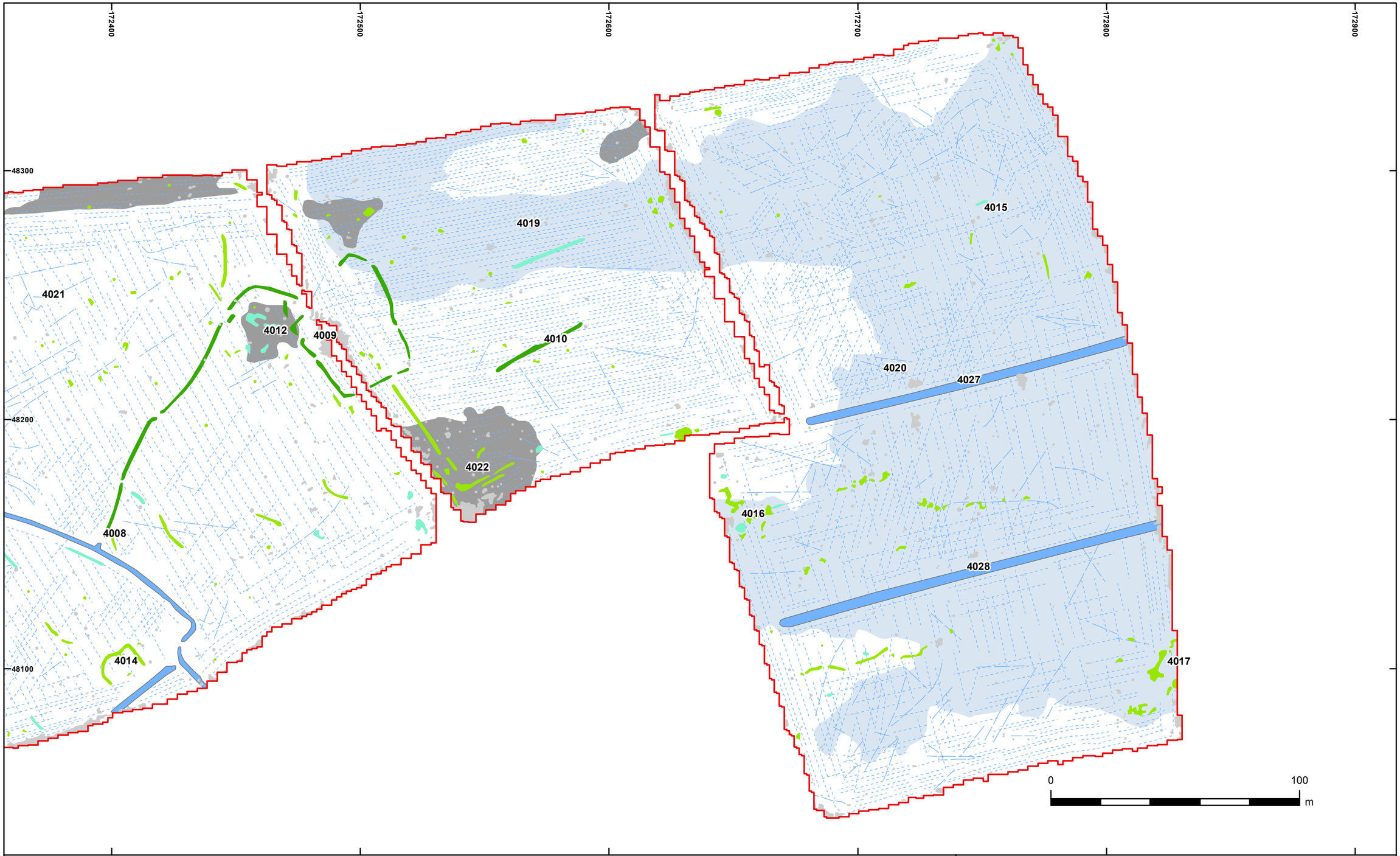
XY trace plot, east

Figure 6



Survey Extents
Disused Railway
Ferrous
Archaeology
Probable Archaeology
Possible Archaeology
Former Field Boundary
Trend
Ploughing
Increased Magnetic Response
Superficial Geology

Date:	22/10/13	Revision Number:	0
Scale:	1:1500 at A3	Illustrator:	LJC
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Interpretation, east

Figure 7

wessex archaeology

salisbury rochester sheffield edinburgh

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