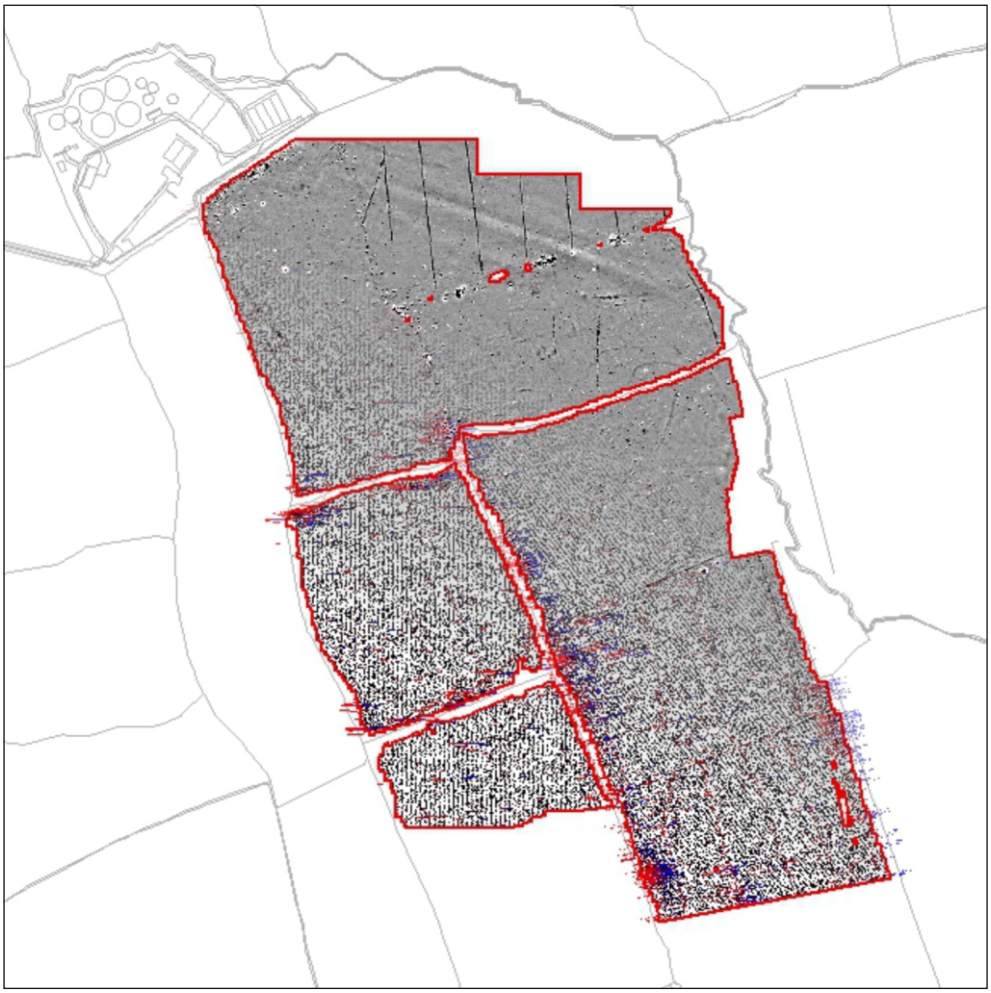
making sense of heritage

Outwood Solar Farm
Billericay, Essex

Detailed Gradiometer Survey Report



Ref: 102601.03
March 2014

geoservices

Outwood Solar Farm, Billericay, Essex

Detailed Gradiometer Survey Report

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March 2014

Report Ref. 102601.03

Quality Assurance

Project Code	102601	**Accession Code**		**Client Ref.**	
Planning Application Ref.		**Ordnance Survey (OS) national grid reference (NGR)**	570135 193800		

Version	Status*	Prepared by	Checked and Approved By	Approver's Signature	Date
v01	I	*JS/BCU*	*CB*		20/03/2014
File:	X:\PROJECTS\102601\Geophysics\Report\102601_Geophysics_Report_.docx				
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* I = Internal Draft; E = External Draft; F = Final

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Summary

A detailed gradiometer survey was conducted over land near Billericay, Essex, centred on NGR 570135 193800. The project was commissioned by MS Power Projects Ltd. with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of the proposed development of the site as a solar farm. The geophysical survey follows a Desk-Based Assessment (DBA) prepared by Wessex Archaeology.

The site comprises an irregular parcel of land of 23.9ha, situated within three arable fields. The eastern boundary of the Site follows the edge of the flood zone of a small tributary of the River Crouch, which is heavily tree lined; the southern boundary follows an arbitrary line dividing an open field, and the north-western boundary is largely open, with a number of trees seen singly or in small groups. The internal boundaries are a mixture of established hedgerows, sporadic tree lines and ditches. The Site is bounded on all sides by further agricultural land.

The gradiometer survey was successful in detecting anomalies of probable and possible archaeological interest, along with regions of increased magnetic response, ploughing trends, field drains and several former field boundaries.

The majority of anomalies of potential archaeological interest are located near the northeastern extent of the Site, comprising several linear and curvilinear anomalies. Whilst their origins are not entirely clear, it is possible that they represent parts of former field systems or enclosures.

Numerous isolated pit-like responses can be seen throughout the dataset and, although many of these are likely to be natural or agricultural in origin, it is not possible to rule out entirely an archaeological interpretation.

Field drains can be seen on a number of orientations and with a variety of construction techniques. Many of the stronger anomalies are consistent with backfilled trenches, whilst others are typical of ceramic drains.

The geophysical survey was undertaken between the 24th February and 4th March 2014.

Outwood Solar Farm, Billericay, Essex

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Acknowledgements

The detailed gradiometer survey was commissioned by MS Power Projects Ltd. The assistance of Chris Brake is gratefully acknowledged in this regard.

The fieldwork was directed by Clara Dickinson, Alistair Salisbury, Jen Smith and Rachel Williams. Jen Smith processed and interpreted the geophysical data, and wrote this report in conjunction with Ben Urmston. The geophysical work was quality controlled byPaul Baggaley. Illustrations were prepared by Richard Milwain. The project was managed on behalf of Wessex Archaeology by Caroline Budd.

Outwood Solar Farm, Billericay, Essex

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) was commissioned by MS Power Projects Ltd. to carry out a geophysical survey of land near Billericay, Essex (**Figure 1**), hereafter "the Site" (centred on NGR 570135 193800). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of proposed development at the Site.

1.1.2 A previous Desk-Based Assessment (WA 2014a) identified a high potential for medieval and post medieval archaeological remains to exist within the survey area, along with a moderate potential for Romano-British archaeology. The potential for remains from other periods were considered to be low in the case of prehistoric archaeology and unknown in the case of Saxon archaeology.

1.1.3 Following the completion of the DBA and in consultation with Essex County Council (ECC) acting as archaeological advisors to the Local Planning Authority (LPA) it was agreed that a geophysical survey was required to identify any previously unknown areas of archaeological activity, and better define the known archaeology at the Site.

1.1.4 Subsequently a Written Scheme of Investigation (WSI) WA 2014b) was prepared which set out the techniques and methodologies of the proposed geophysical survey. This document was submitted to and approved by GCC prior to the commencement of the survey.

1.2 Scope of Document

1.2.1 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data. In format and content it conforms with current best practice and to the guidance outlined in Management of Research Projects in the Historic Environment ('MoRPHE') (English Heritage 2009), the Institute for Archaeologists' Standards and Guidance for Archaeological Geophysical Survey (2011) and English Heritage's guidelines Geophysical Survey in Archaeological Field Evaluation (2008).

2 SITE DESCRIPTION

2.1 Location, topography and geology

2.1.1 The site is located in south Essex, approximately 1km to the south-east of Billericay and 4km to the north of Basildon.

2.1.2 The site comprises an irregular parcel of land of 23.9ha, situated within three arable fields. The eastern boundary of the Site follows the edge of the flood zone of a small tributary of the River Crouch, which is heavily tree lined; the southern boundary follows an arbitrary line dividing an open field, and the north-western boundary is largely open, with a number of trees seen singly or in small groups. The internal boundaries are a mixture of established hedgerows, sporadic tree lines and ditches. The Site is bounded on all sides by further agricultural land.

2.1.3 The site is situated on an east facing slope to the south of a ridge of high ground which runs north-east to south-west across the landscape. Within the Site the land rises gradually from an elevation of approximately 25m above Ordnance Datum (aOD) along the eastern boundary to 36m aOD at the western edge of the application area.

2.1.4 The underlying soils are mapped as pelo-stagnogley soils of the 712c (Windsor) association (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.

3 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

3.1 Previous work

3.1.1 The DBA undertaken by WA (2014a) did not identify any previous archaeological fieldwork within the Site or the wider study area. This was presumed to be related to the low rate of modern development in the area.

3.2 Archaeological Baseline

3.2.1 There is no recorded evidence of archaeological remains from any period within the Site. The historic landscape of the Site is described as medieval or Saxon in origin and is relatively well preserved in contrast to the wider area (WA 2014) though there is no direct evidence for this. Historic map regression demonstrates few historic changes to the arrangement of field boundaries.

3.2.2 Given the general lack of recorded archaeological remains within the Site and wider study area, the DBA noted the inherent uncertainty in attempting to define the potential for archaeological features within the Site. It was considered that any remains would be likely to be of local or regional importance for medieval/post-medieval and prehistoric/Romano-British archaeology respectively.

4 AIMS

4.1.1 The specific aims of the geophysical survey as defined by the WSI (WA 2014b) were to:

- Conduct a detailed gradiometer survey which covers as much of the specified area as possible, allowing for artificial obstructions;
- Clarify the presence/absence and extent of any detectable buried archaeological remains within the Site;
- Characterise any sites identified during the detailed survey;

- Produce a report which will present the results of the geophysical survey in sufficient detail to allow an informed decision to be made concerning the Site's archaeological potential.

5 METHODOLOGY

5.1.1 All work was conducted in accordance with the methodology set out within the WSI (WA 2014b) and within the guidelines and standards outlined in the Institute for Archaeologists' Standards and Guidance for Archaeological Geophysical Survey (2011) and English Heritage's guidelines Geophysical Survey in Archaeological Field Evaluation (2008).

5.1.2 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).

5.1.3 The geophysical survey was undertaken Wessex Archaeology's in-house geophysics team between the 24th February and 4th March 2014. Field conditions at the time of the survey were poor, with the survey area being heavily covered in dense brassica crop.

5.2 Method

5.2.1 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).

5.2.2 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.

5.2.3 Data from the survey were subject to minimal data correction processes. These comprise a zero mean traverse function (±5nT 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.

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

6 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

6.1 Introduction

6.1.1 The gradiometer survey has been successful in identifying anomalies of definite, probable and possible archaeological interest across the Site, along with regions of increased magnetic response, magnetic disturbance and ferrous responses, and a number of modern services. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2,000 (**Figures 2** to **7**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and 25nT per cm for the XY trace plots.

6.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figures 6** and **7)**. Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

6.1.3 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.

6.2 Gradiometer Survey Results and Interpretation

6.2.1 In general, the magnetic background across the site is relatively quiet. Near the northwestern extent of the survey, an orthogonal network of faint trends **4000** is apparent oriented NNW-SSE and ENE-WSW; the responses of these trends is consistent with ceramic field drains and it is likely that these relate to attempts to manage the drainage of the Site, although it is not possible to determine from what period these date.

6.2.2 Series of linear anomalies **4001** can be seen extending across the northern portion of the site; these are consistent with field drains, although their construction is clearly different from those seen at **4000**. The anomaly at **4001** bifurcates, although those further to the east appear as consistent linear anomalies.

6.2.3 A band of superficial geological responses **4002** extends NW-SE across the northern part of the field, with a number of faint trends indicating possible coherency within it. It is possible that it is associated with a near-surface feature such as a former channel.

6.2.4 Linear band of anomalies **4003** is oriented NE-SW across the Site and is coincident with a partially removed field boundary. Its western end, **4004**, currently terminates within the field, although similar anomalies to **4003** can be seen extending to the north and south.

6.2.5 Cluster of anomalies **4005** comprises curvilinear, linear and pit-like responses and these are considered to be of possible archaeological interest. The relative weakness of response makes their interpretation less conclusive and it is possible that these anomalies relate to agricultural features in the uppermost deposits, although this is considered unlikely.

6.2.6 Nearby to the east, better defined anomalies **4006** and **4007** are more easily visible. Their relatively strongly magnetised responses suggest that they are of probable archaeological interest. Whilst it is unclear whether they are related, it is possible that they represent part of a former field system.

6.2.7 To the south of the field boundary, linear anomaly **4008** is oriented NE-SW and it is possible that it is associated with **4007**, given the likely intersection under the existing boundary.

6.2.8 Parallel trends **4009** extend across the central part of the Site, although their origins are unclear. It is possible that they are either geological or agricultural in origin.

6.2.9 Linear anomalies **4010** are consistent with a former boundary dividing the field at this point.

6.2.10 In the field to the west, linear anomalies consistent with further field drains are visible, e.g. **4011**. It is interesting to note the difference in response, suggesting perhaps that some are backfilled trenches or ditches, whereas others are more typical of ceramic pipes. Ploughing trends are visible on a similar orientation and subtle textural changes across the southern portion of the field, **4012**, suggest near-surface geological changes.

6.2.11 At the southwestern extent of the Site, the magnetic background is very quiet, e.g. **4013**, with very few anomalies of note. Several pit-like anomalies can be seen and, although an archaeological interpretation cannot be excluded, these are possibly agricultural or natural in origin.

6.2.12 Several large ferrous anomalies **4014** appear immediately south of the former boundary **4010** to the east of the centre of the Site. Whilst the function of these is not apparent, they are considered likely to relate to agriculture and therefore relatively modern in origin.

6.2.13 Elsewhere, the magnetic background is rather quiet, with another former boundary **4016** visible within the southeastern field. Further field drains extend to the north and south of this former feature.

7 CONCLUSION

7.1.1 The detailed gradiometer survey has been successful in detecting anomalies of probable and possible archaeological interest within the Site, in addition to regions of increased magnetic response.

7.1.2 The majority of anomalies of possible and probable archaeological interest are located near the northeastern extent of the Site. It is possible that they represent parts of a former field system or network of enclosures, although they are weakly magnetised and rather fragmentary. They are distributed within an approximately rectangular area measuring some 170m x 100m.

7.1.3 Elsewhere, isolated pit-like anomalies can be seen throughout the dataset, although little overall coherency is evident. Their responses are rarely diagnostic of archaeological features and the general lack of supporting evidence for such an interpretation indicates that at least some will be natural or agricultural in origin.

7.1.4 The field drains identified across the Site are largely oriented parallel with existing boundaries. It is therefore difficult to determine from what period they originated, and they do not appear to define any relict fields that have since been removed.

7.1.5 Weak ploughing trends and faint changes in the texture of the magnetic background demonstrate that it has been possible to detect ephemeral features through gradiometer survey. Whilst it should be noted that certain features may not produce strong magnetic anomalies, the successful identification of ploughing trends and other such subtle anomalies suggests that more substantial archaeological features would have produced measurable magnetic anomalies, should any have been present.

8 REFERENCES

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1, 2nd edition.

Soil Survey of England and Wales, 1983. *Sheet 6, Soils of South East England*. Ordnance Survey, Southampton.

Wessex Archaeology, 2014a. *Outwood Solar Farm, Billericay, Essex: Archaeological Desk-Based Assessment*. Client report 102600.01

Wessex Archaeology, 2014b. Outwood Solar Farm, Billericay, Essex: Written Scheme of Investigation for Geophysical Survey. Client report 102601.01

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.

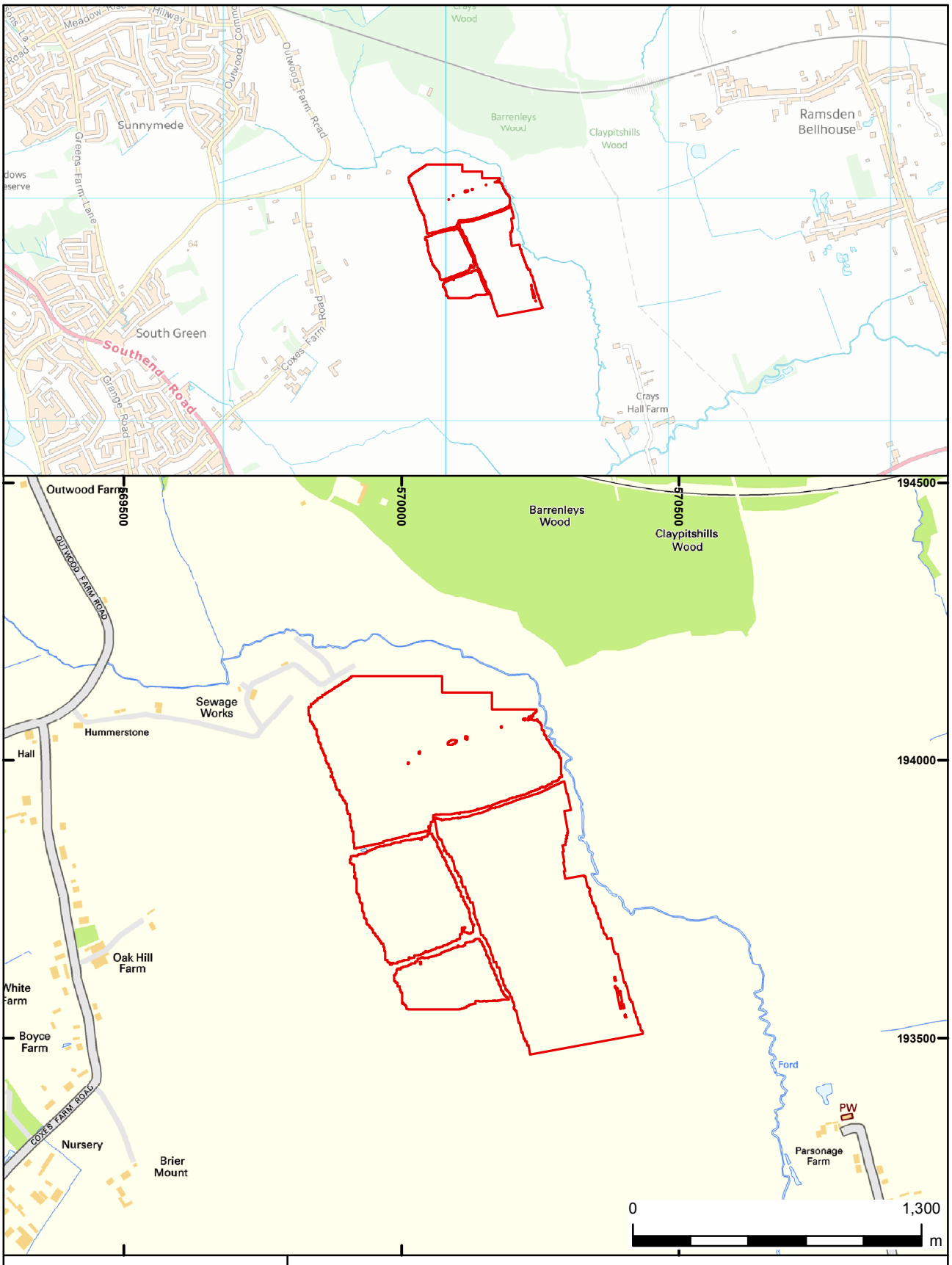
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided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



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Site location and survey extents

Figure 1

569800
570000
570200
570400
194000
193800
+3nT
-2nT
0
100
m
Survey Extents

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Greyscale (north)

Figure 2

570000

570200

570400

193800

193600

+3nT

-2nT

0

100

m

Survey Extents

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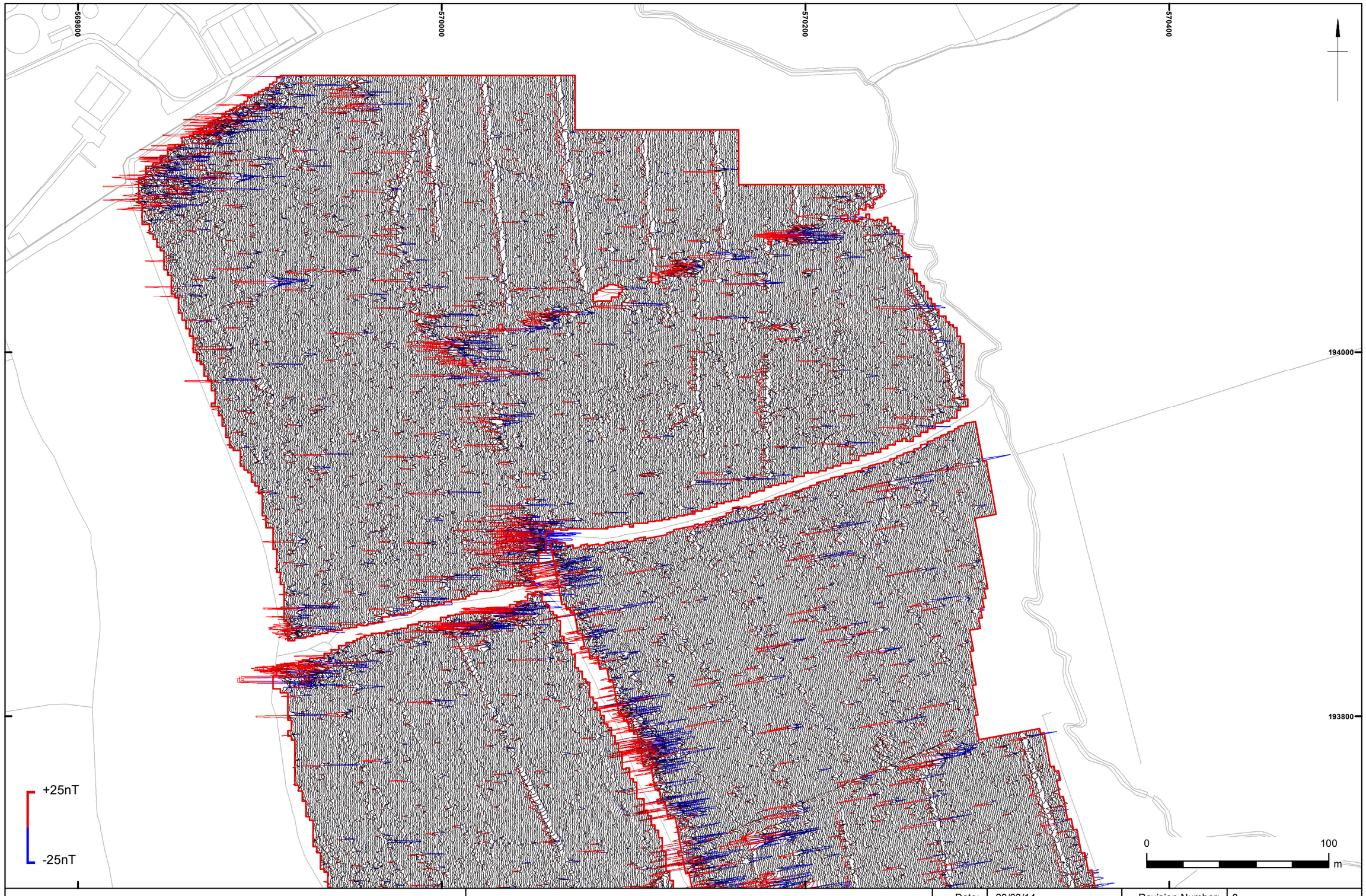
Greyscale (south)

Figure 3



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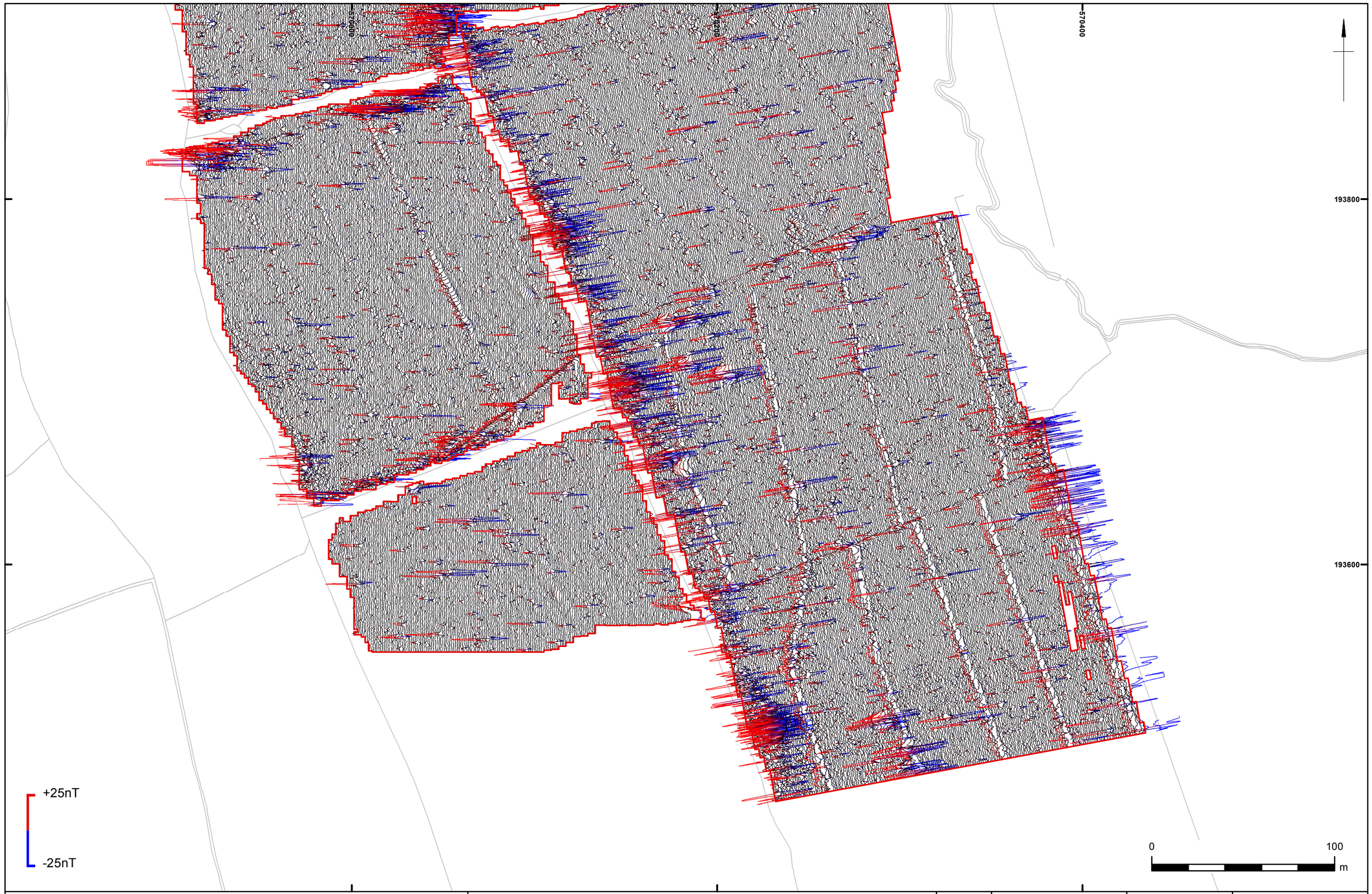
XY trace (north)

Figure 4



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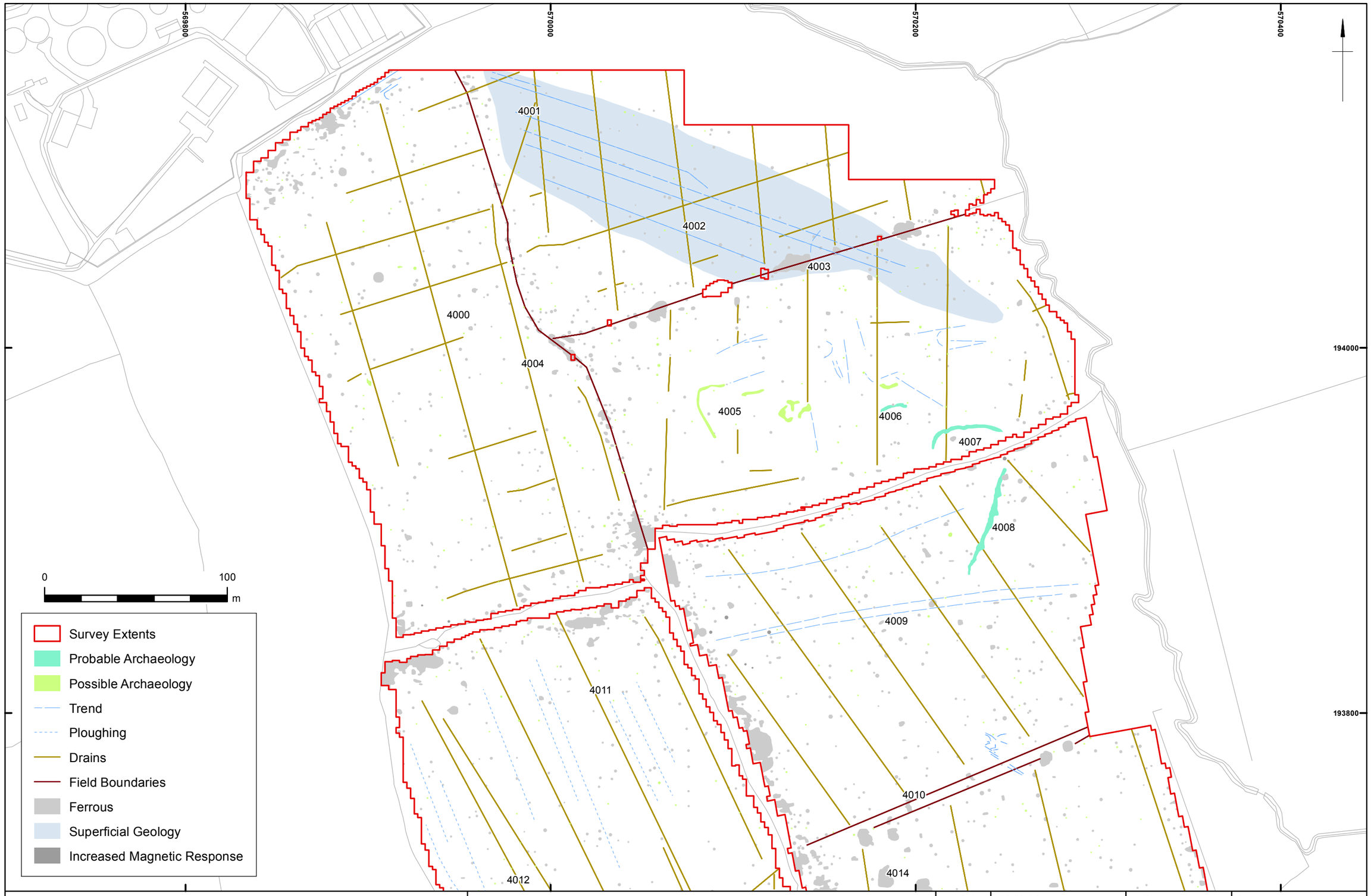
XY trace (south)

Figure 5



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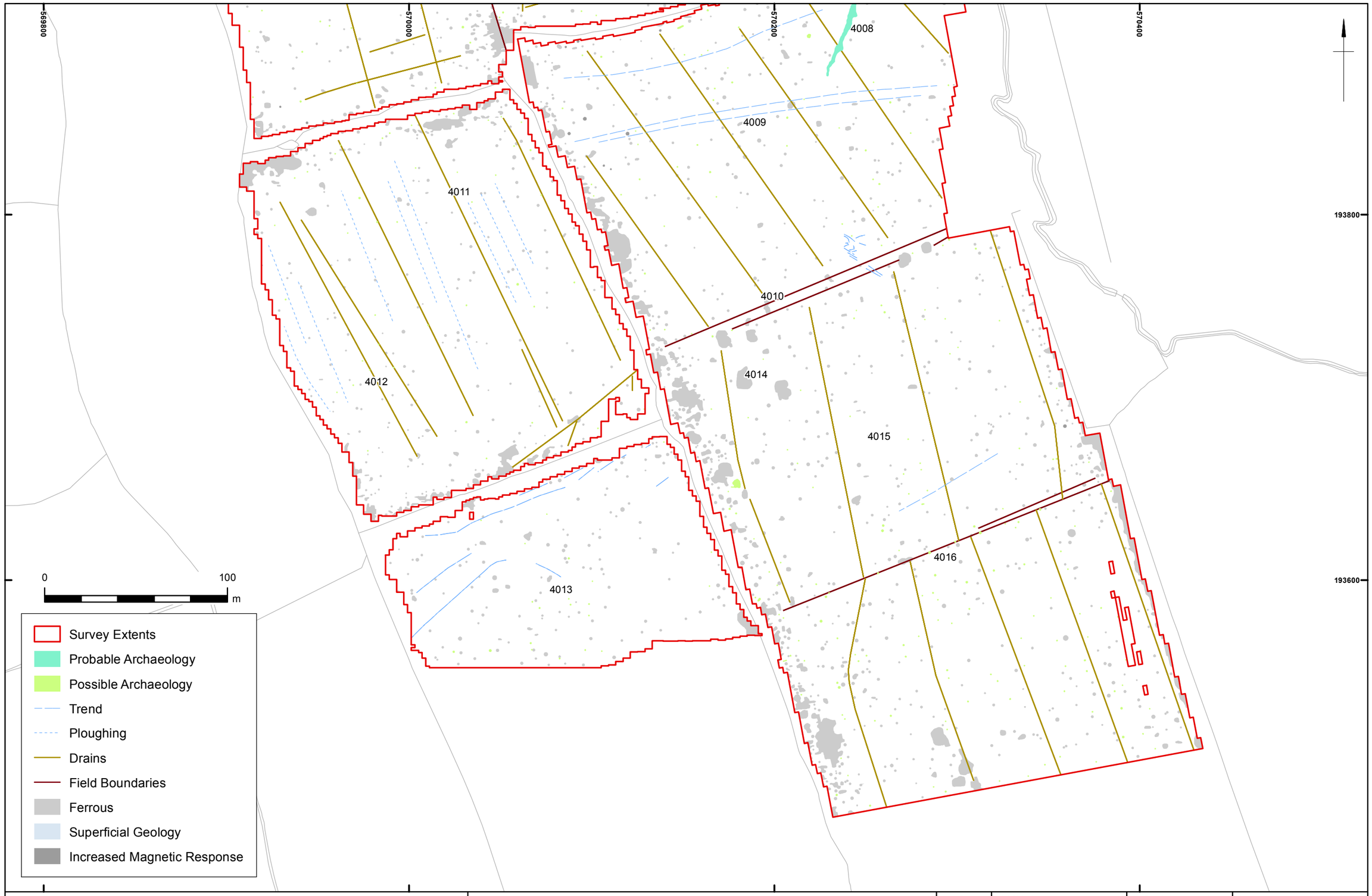
Interpretation (north)

Figure 6



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Interpretation (south)

Figure 7

wessex archaeology

salisbury rochester sheffield edinburgh

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