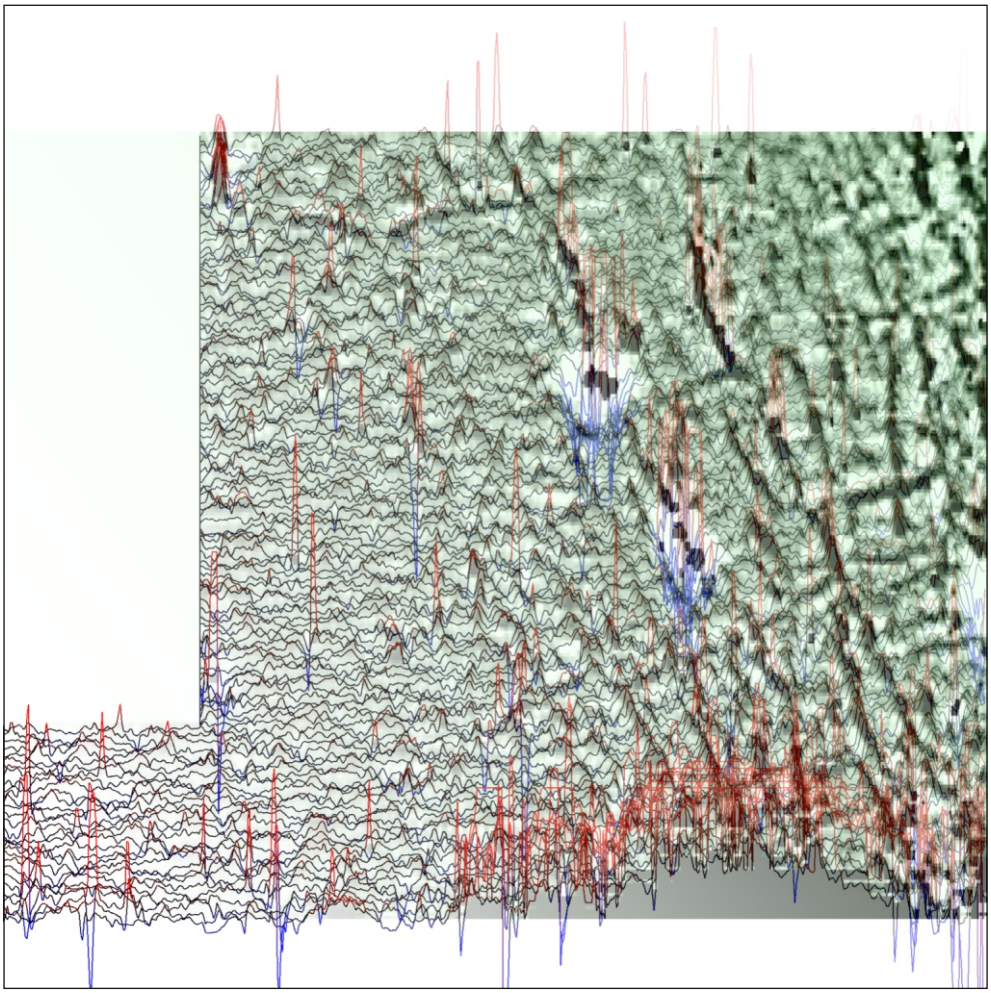
making sense of heritage

Mansfield Road
Clowne, Derbyshire

Detailed Gradiometer Survey Report



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May 2013

geoservices

Mansfield Road
Clowne, Derbyshire

Detailed Gradiometer Survey Report

Prepared for:
ECUS Ltd.
3 Blackburn Road
Sheffield
South Yorkshire
S61 2DW

On behalf of:
Gladedale South Yorkshire Ltd.
(t/a Ben Bailey Midlands)
Dale House
9 Tally's End
Barlborough
Chesterfield
S43 4WP

Prepared by:
Wessex Archaeology
Portway House
Old Sarum Park
Salisbury
SP4 6EB

www.wessexarch.co.uk

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* I = Internal Draft; E = External Draft; F = Final

Mansfield Road
Clowne, Derbyshire

Detailed Gradiometer Survey Report

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Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land off Mansfield Road in Clowne, Derbyshire. The project was commissioned by ECUS Ltd. on behalf of their client Ben Bailey Homes, with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of proposed development.

The site comprises an arable field to the west of Mansfield Road, approximately 600m south of Clowne and some 2.7 km southwest of junction 30 of the M1 motorway. The site lies at the western extent of a broad plateau, with the land falling away to the west of the survey areas, and had been ploughing prior to the survey. The gradiometer survey covered 5.6 ha and has demonstrated the presence of anomalies of definite, probable and possible archaeological interest within the survey area, along with regions of near-surface geological changes and numerous trends, many of which are associated with ploughing.

A network of anomalies of definite and probable archaeological interest can be seen across the central and southern portions of the site. Whilst the interrupted nature and variations in magnetic contrast have made the interpretation less confident, it is considered likely that these anomalies indicate a complex of former fields or enclosures. Whilst it has not been possible to determine the function of these anomalies, it is thought that settlement activity would have produced detectable anomalies characteristic of occupation, such as dense clusters of pits.

Numerous linear and pit-like anomalies can be seen on similar orientations to the probable enclosures, although their interpretation is made less certain by the presence of strong ploughing trends on similar alignments. The reason for the strong enhancement of these agricultural trends is not clear, although it is likely that near-surface geological deposits have been disturbed through ploughing, leading to some of the linear responses seen. Whilst some of these anomalies will be geological or agricultural in origin, an archaeological interpretation, whilst tentative, cannot be discounted entirely.

Several regions of responses typical of near-surface geological changes have been identified, along with magnetic disturbance associated with the properties along Mansfield Road and farm buildings adjacent to the survey area.

Mansfield Road
Clowne, Derbyshire

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by ECUS Ltd. on behalf of their client Ben Bailey Homes. The assistance of Paul White is gratefully acknowledged in this regard.

The fieldwork was directed by Chris Breeden and assisted by Phil Roberts. Ben Urmston 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 Dr. Paul Baggaley.

Mansfield Road
Clowne, Derbyshire

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by ECUS Ltd., on behalf of their client Ben Bailey Homes, to carry out a geophysical survey of land off Mansfield Road, Clowne in Derbyshire (**Figure 1**), hereafter "the Site" (centred on NGR 448878 374837). 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 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 arable fields to the west of Mansfield Road, some 600m south of the centre of Clowne and some 2.7 km southeast of M1 junction 30 (**Figure 1**); the fields lie to the west and north of Sterry House and High Ash Farms. Detailed gradiometer survey was undertaken over all accessible parts of the Site, a total of 5.6 ha.

1.2.2 The Site lies at the western edge of a broad plateau at around 150m above Ordnance Datum (aOD), with the land markedly falling away to the west of the survey area. The survey area was bordered to the east by houses along Mansfield Road, High Ash Farm to the south and by arable fields to the west and north.

1.2.3 The solid geology underlying the Site is likely to comprise Dolomitic limestones overlain by head deposits of sands, gravels and clays. 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 from 29th April to 1st May 2013. Field conditions at the time of the survey were reasonable, with the survey area having been ploughed prior to the survey. This is not considered to have affected data quality significantly.

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 (±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.

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 definite, probable and possible archaeological interest across the Site, along with linear trends and regions of superficial geological responses. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2,000 (**Figures 2** and **3**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT 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 (**Figure 4**). 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 At the northwestern extent of the survey area, linear anomaly **4000** is only weakly defined from the magnetic background and is oriented NE-SW; it appears to fork towards the north. It is possible that this anomaly relates to a former field boundary.

3.2.2 Linear anomaly **4001** is oriented NNW-SSE, parallel with strong ploughing trends. Whilst it is possible that **4001** is associated with an agricultural feature, such as a ploughing headland or former boundary, it is conceivable that it represents geological material being ploughed to the surface.

3.2.3 Towards the centre of the northern field, cluster of pit-like anomalies **4002** may be of some archaeological interest. Given the lack of coherent distribution and the presence of strong ploughing trends, it is possible that these responses are geological or agricultural in origin.

3.2.4 Linear and pit-like anomalies **4003** are similar in character to those at **4002**, although somewhat better defined from the magnetic background. They appear more densely clustered towards the field boundary to the south.

3.2.5 At the northeastern extent of the northernmost field, weakly negative responses **4004** are consistent with near-surface geological changes. Whilst similar responses can be seen elsewhere, this region is the best defined cluster of such anomalies within this survey area. A region of magnetic disturbance lies in close proximity to the eastern boundary and is associated with the properties on Mansfield Road.

3.2.6 At the northwestern extent of the central field, rectilinear anomalies **4005** lie on a different orientation from the ploughing trends and are considered to be of probable archaeological interest. Their form in plan is consistent with a former field system or part of a network of enclosures.

3.2.7 Similarly well-defined linear anomalies **4006** appear to the east of **4005**, although their alignment is similar to that of the strong ploughing trends seen throughout this survey area. More coherent anomalies have been interpreted as being of probable archaeological interest, and more fragmentary and weakly contrasting responses as possible archaeological in origin. Rectilinear anomaly **4007** is of probable archaeological interest, given its form in plan, and may be associated with **4005**.

3.2.8 Towards the eastern extent of the central field, short linear and pit-like anomalies **4008** can be seen as a relatively tightly distributed cluster. Their orientation is similar to that of the ploughing trends, although an archaeological interpretation cannot be discounted entirely, and it is possible that they are agricultural or geological in origin. Anomalies **4008** lie within a region of apparent geological responses, typified by weakly negative regions within the dataset.

3.2.9 To the south of **4005**, rectilinear and pit-like anomalies **4009** and **4010** appear to form a continuation of **4005**. They exhibit weak contrast with the magnetic background, however, making the interpretation of their archaeological origins more tentative.

3.2.10 At the southwestern extent of the central survey area, ditch **4011** is oriented N-S, with further linear anomalies of varying magnetic contrast appearing close by to the east. Ditch **4011** appears to extend beyond the boundary into the southernmost field (**4012**).

3.2.11 Strong magnetic disturbance can be seen along the northern and eastern boundaries, associated with the construction of the boundaries and the properties along Mansfield Road.

3.2.12 At the northwestern extent of the southernmost field, curvilinear anomaly **4012** is likely to represent a continuation of **4011** to the north. Its response appears to be interrupted to the southeast, although it is not clear whether this break is deliberate or the result of later truncation. Immediately to the east, rectilinear anomalies **4013** appear on a similar orientation, although no relationship can be demonstrated between them and **4012**; their somewhat weaker response and interrupted nature has somewhat reduced the confidence in their interpretation and they are considered to be of probable archaeological interest.

3.2.13 A complex of rectilinear anomalies can be seen across the eastern portion of the southernmost field, extending south and east from **4014**. The most clearly defined of these have been interpreted as being of probable archaeological interest; other linear anomalies that exhibit less contrast or appear on the same orientation as the ploughing

trends have been interpreted as being of possible archaeological interest reflecting the lower confidence with which they can be interpreted. Whilst not all of these anomalies are expected to be archaeological in origin, it cannot be determined conclusively which are the result of geological or agricultural processes.

3.2.14 Two regions of magnetic disturbance can be seen near the centre of the field, and are likely to indicate buried debris or backfilled hollows. The southernmost of the two, **4015**, is relatively coherent and appears on a similar NW-SE orientation as elements of **4014**; it is therefore possible that it represents a continuation of the probable field system or enclosures although backfilled with magnetic debris.

3.2.15 The complex of linear anomalies becomes noticeably less dense towards the west, with two linear anomalies **4016** marking the apparent extent of these responses. It is not clear whether this is a result of a change in geology or whether the probable enclosures or former fields did not extend further than this point. A similar region of quieter magnetic background **4017** appears to the south of the complex, although a number of linear trends may indicate continuations of some of these anomalies.

3.2.16 Towards the southwestern extent of the southernmost survey area, the magnetic background is somewhat mottled (**4018**), although these responses are not definitively geological in origin. A region of strong magnetic disturbance appears along the southern boundary, associated with the farm buildings to the south of the survey area.

3.2.17 Strong ploughing trends on a NNW-SSE orientation can be seen throughout the dataset, with further ploughing trends oriented approximately E-W. It is likely that some truncation through ploughing will have occurred and localised enhancements of the magnetic background can be seen across the Site. Other linear and curvilinear trends have been identified, although their origins are unclear and it is possible that they relate to near-surface geological changes or chance alignments in the data.

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 superficial geological changes and numerous linear trends.

4.1.2 The majority of anomalies considered to be of definite and probable archaeological interest are located within the central and southern parts of the Site and appear to form a network of co-axial fields or enclosures. Conclusive interpretation has been hampered by the strong ploughing trends seen throughout; the anomalies have been classified according to the magnitude of their magnetic responses, their coherency and form in plan. Therefore only one anomaly (**4012**) has been interpreted as being of definite archaeological interest, with other anomalies of probable archaeological interest sharing a similar orientation to the ploughing trends.

4.1.3 Should the system of enclosures prove to be archaeological in origin and represent a series of associated features, the complex of probable archaeological anomalies would measure some 230m N-S by at least 175m E-W. It is not clear from the geophysical survey what the function of these enclosures was, should they prove to be archaeological; however, it is considered likely that dense clusters of pits and other evidence of settlement activity would have been detectable, given the responses of other apparently similar anomalies across the Site.

5 REFERENCES

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

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.

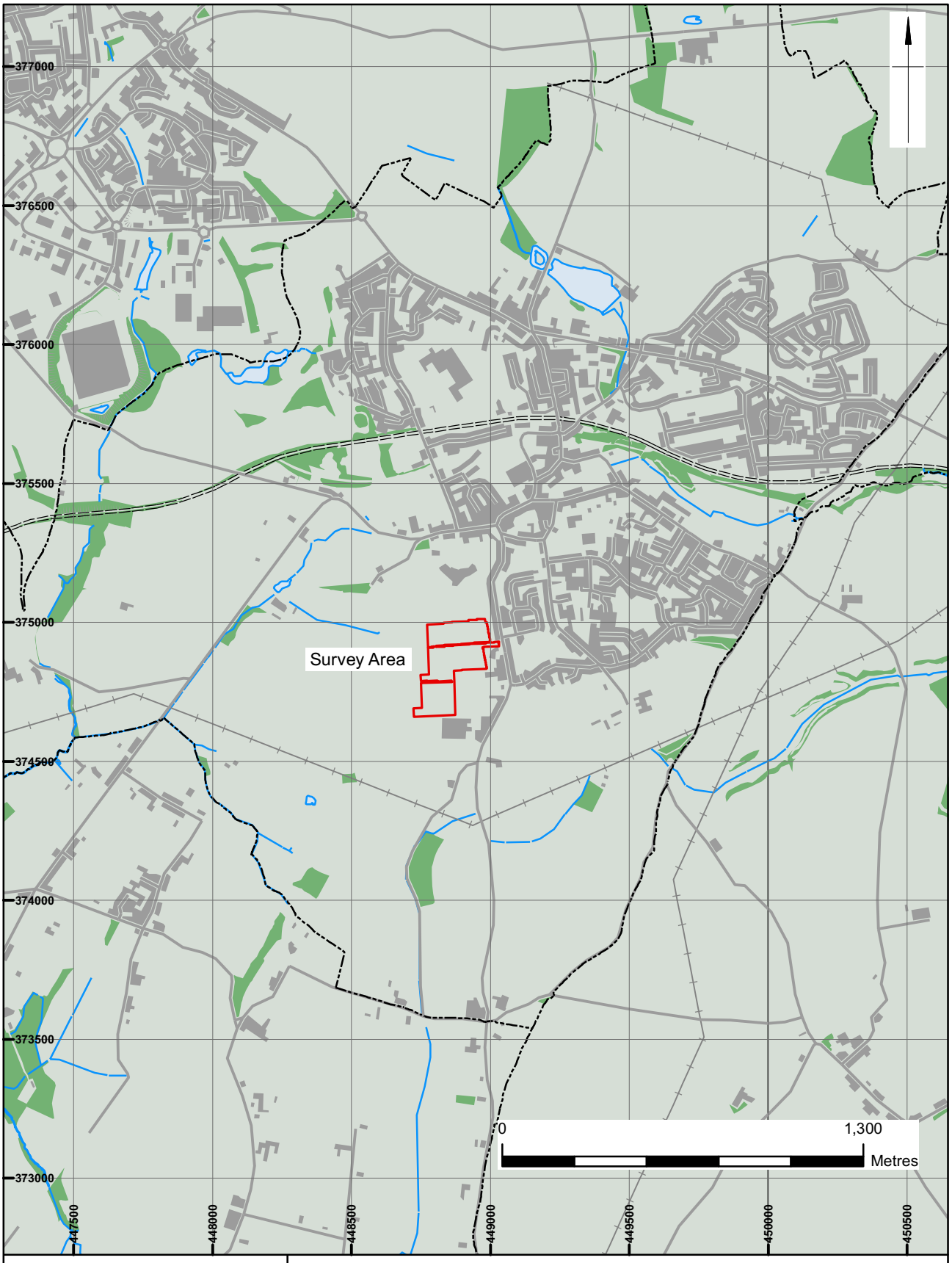
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided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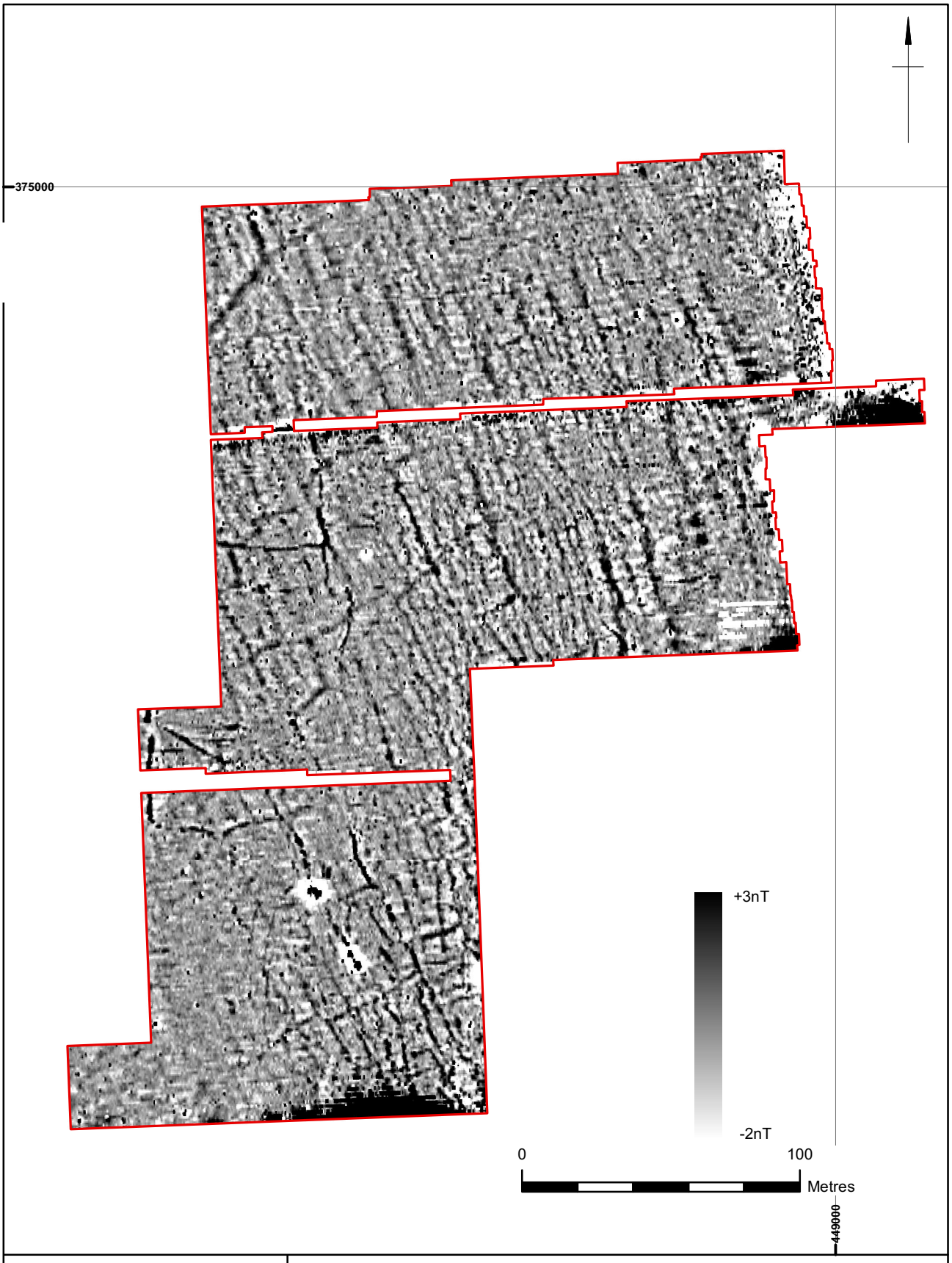
Site location and survey extents

Figure 1



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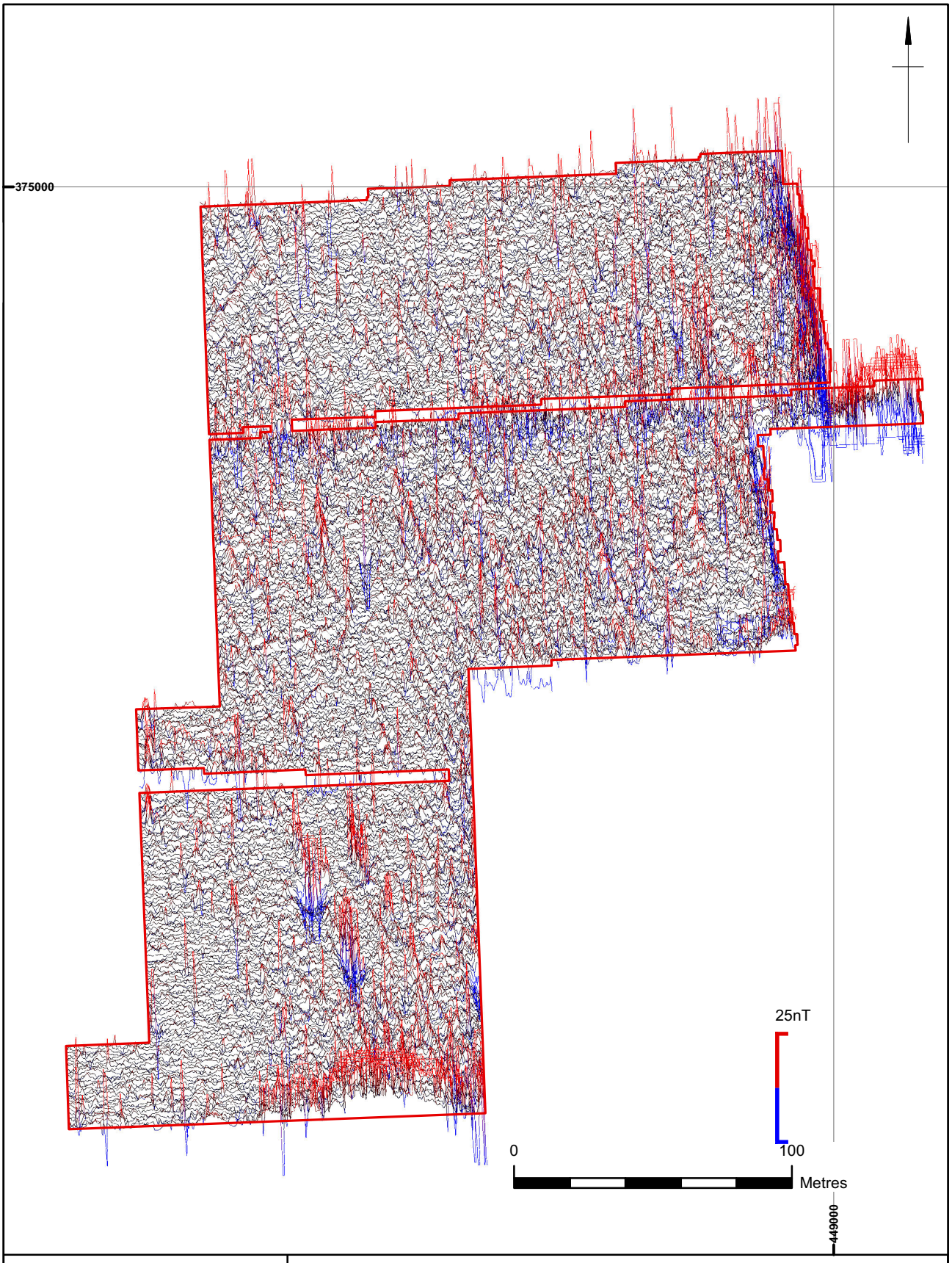
Greyscale

Figure 2



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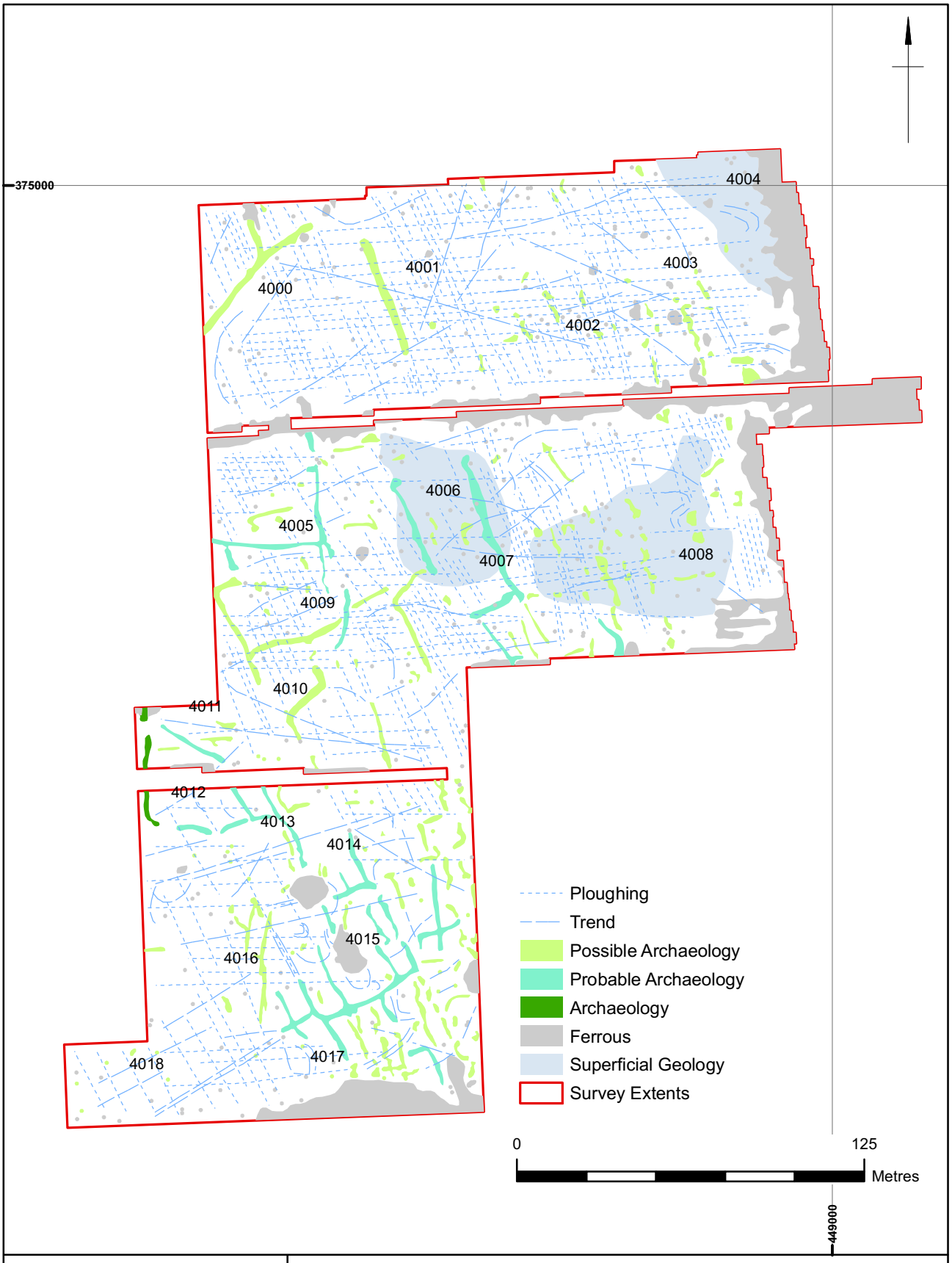
XY Trace

Figure 3



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Interpretation

Figure 4

wessex archaeology

salisbury rochester sheffield edinburgh

Wessex Archaeology Ltd registered office Portway House, Old Sarum Park, Salisbury, Wiltshire SP4 6EB
Tel: 01722 326867 Fax: 01722 337562 info@wessexarch.co.uk www.wessexarch.co.uk