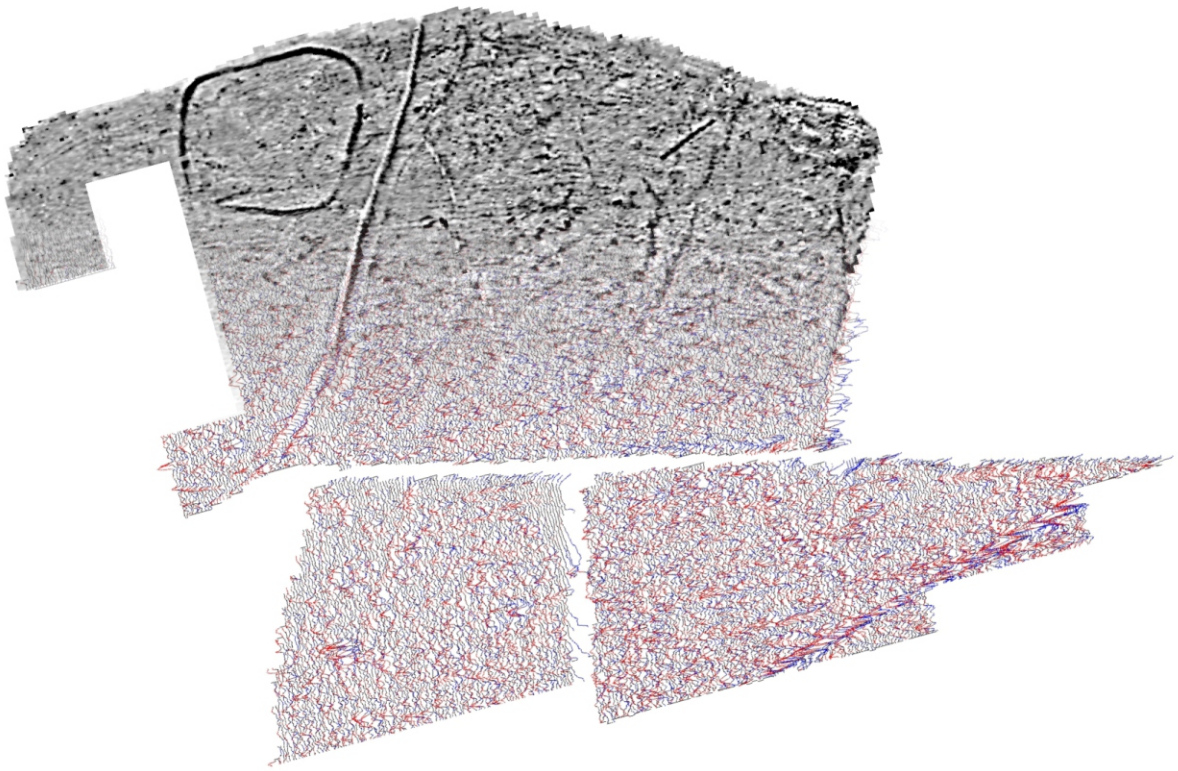
making sense of heritage

Coombeshead Farm, Diptford Devon

Detailed Gradiometer Survey Report



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geoservices

Coombeshead Farm, Diptford
Devon

Detailed Gradiometer Survey Report

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

Coombeshead Farm, Diptford
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Detailed Gradiometer Survey Report

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Summary

A detailed gradiometer survey was conducted over land near Coombeshead Farm, Diptford, Devon. The project was commissioned by AEE Renewables UK 12 Limited with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed development of a solar array.

The site comprises six fields to the southeast of Diptford, approximately 7.7km southwest of the centre of Totnes, and occupies an area of undulating land. The geophysical survey was undertaken between 21st and 29th October 2013 and covered c.15ha; it has demonstrated the presence of anomalies of likely, probable and possible archaeological interest within the survey area, along with former field boundaries, regions of increased magnetic response and at least one modern service.

Within the northernmost survey area, a sub-oval shaped enclosure is of primary interest; whilst it is not possible to date this anomaly through geophysics alone, it is considered likely to be of a relatively early date. Nearby, a former field boundary can be seen oriented NNE-SSE across the centre of the survey area, with fragmentary linear anomalies consistent with ditches appearing elsewhere. A modern service extends NE-SE across the southernmost limit of the northern survey area.

Within the southern survey area, numerous isolated ditch linear anomalies are visible, with occasional pit-like anomalies. Whilst some of these may be archaeological in origin, many are likely to relate to near-surface geological changes. Several linear anomalies have been identified, which are consistent with former field boundaries and other irregular anomalies that may possibly relate to an early field system.

The interpretation has been complicated by the strong background magnetic field associated with the local geology; this has resulted in a somewhat lowered confidence in the archaeological interpretation of some of the weaker anomalies, due to the possibility of a geological origin.

Coombeshead Farm, Diptford
Devon

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by AEE Renewables UK 12 Limited, and Wessex Archaeology is grateful to Tom Jones of AEE in this regard.

The fieldwork was directed by Clara Dickinson and assisted by Rachel Chester and Natalia Hunt. Ross Lefort processed and interpreted the geophysical data in addition to writing this report. The geophysical work was quality controlled by Ben Urmston. Illustrations were prepared by Linda Coleman. The project was managed on behalf of Wessex Archaeology by Damian De Rosa and Ben Urmston.

Coombeshead Farm, Diptford
Devon

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by AEE Renewables UK 12 Limited to carry out a geophysical survey of land at Coombeshead Farm, near Diptford, Devon (**Figure 1**), hereafter "the Site" (centred on NGR 275050, 055400). 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 Site Location, Topography, Soils and Geology

1.2.1 The Site is located approximately 2.5km southeast of Diptford and some 7.7km southwest of Totnes (**Figure 1**). Geophysical survey was carried out over all accessible areas of the Site, a total of c.15ha.

1.2.2 The Site comprises two survey areas covering six agricultural fields. The northern area is made up of three arable fields and one pasture field; it is bounded by a road and field boundaries to the west, north and east with the southern boundary defined by the limits defined by the client and a contour line (120m aOD). The southern survey area is made up of two fields (one arable and one pasture) with the survey extents defined by a road and field boundaries to the north, west and south; the eastern boundary is defined by a contour line (145m aOD).

1.2.3 The Site occupies an area defined by several small stream valleys. The northern survey area is located on a south facing slope with the elevation falling from c. 135m above Ordnance Datum (aOD) at the north to 120m aOD at the south. The southern survey area occupies an east facing slope close to the head of a spring. The height falls from c. 150m aOD at the western extent to 145m aOD at the eastern extent. There are several unnamed watercourses that flow past the Site to the east and into Ashwell Brook; this stream then flows into the River Harbourne further east.

1.2.4 The underlying solid geology is mapped as Middle Devonian slates across the whole Site (Ordnance Survey 1957). No superficial deposits are recorded although alluvial deposits may be present close by (Ordnance Survey 1977). The soils underlying the Site are likely to be typical brown earths of the 541n (Trusham) 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.

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 21st and 29th October 2013. Field conditions at the time of the survey were good, with firm ground under foot and little vegetation present on site.

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 (ZMT) function (±30nT 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. The multiply and deslope functions were used to correct minor inconsistencies in the data. These four steps were applied to all survey areas, with no interpolation applied. A wide ZMT threshold was applied to the data as the background geology proved to be very strongly magnetised and required a wide threshold to correctly process the data.

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 at least one modern service and two former field boundaries. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2000 (**Figures 2** to **7**). The data are displayed at -12nT (white) to +15nT (black) for the greyscale image and ±50nT at 200nT 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** 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 northern area contains the most interesting archaeological anomalies with a sub-oval shaped enclosure present at **4000**; this feature appears to represent a ditch with magnetic values ranging from +6nT to over +15nT at the strongest points. The interior of this enclosure does not appear to show many internal features and there are no more pit-like positive anomalies inside the enclosure than there are outside that might suggest occupation. This anomaly cannot be linked to any mapped features on early Ordnance Survey (OS) maps and is classed as archaeology as its curved shape may suggest an early date.

3.2.2 An isolated straight section of ditch is visible at **4001**; this anomaly is aligned roughly northeast to southwest with magnetic values over +15nT. Another weaker ditch-like anomaly is visible to the southwest and is aligned perpendicular to **4001**; it is not clear if the two are directly related. The stronger anomaly has been classed as archaeology with the weaker anomaly classed as probable archaeology.

3.2.3 Another isolated ditch-like anomaly is present at **4002** with magnetic values between +5nT and +15nT. The anomaly extends beyond the limits of the survey area and it is unclear what this feature may relate to; this anomaly has been classed as probable archaeology.

3.2.4 A former field boundary is present at **4003** and is present as a negative anomaly with flanking positive responses; this form is typical of field boundaries present in survey data collected by Wessex Archaeology elsewhere in Devon. This boundary also appears on early OS maps from the earliest available 1887 edition up to 1963 where it is no longer mapped (Ordnance Survey 1963 and 1887). This boundary has been classed as former field boundary but an early origin for this land division cannot be ruled out.

3.2.5 There are a number of linear and curvilinear positive anomalies running throughout the data; it is not clear whether these anomalies represent ditches or are some form of geological feature. The anomalies have a slightly irregular and diffuse form and as a result have been classed as possible archaeology to reflect these uncertainties in interpretation.

3.2.6 There are a large number of trends spread across the data. Most are ploughing trends like **4004** but other curved examples such as **4005** may prove to be of archaeological significance. A modern service is present at **4006** but this will be discussed in more detail in the next section of the report.

3.2.7 The southern area contains no anomalies of definite archaeological interest, although several anomalies have been classed as probable archaeology. The western of the two fields contains clear ditch-like anomalies at **4007**, **4008** and **4009** in addition to numerous weaker less well-defined positive linear features such as **4010** and **4015**. These ditch-like anomalies form wide curving patterns across the field around **4007**, **4008** and **4010** and could either be regular patterns formed in the underlying geology or could be parts of a partially preserved earlier field system. These anomalies have been variously classed as probable archaeology and possible archaeology depending on magnetic values and regularity in form.

3.2.8 A broken line of bipolar anomalies is present at **4011** and **4012** that have been interpreted as increased magnetic response. This region corresponds to a footpath recorded on early OS maps that is present up until 1906 when it is no longer recorded (Ordnance Survey 1906). Another area of bipolar responses is present at **4013**; this corresponds with a modern track.

3.2.9 A curvilinear region of increased magnetic response is present at **4014**; this feature is considered to be agricultural given its alignment with modern field boundaries. The positive anomalies around **4015** are on a similar alignment and may also be related to an agricultural feature.

3.2.10 The next field to the east contains a clear ditch-like anomaly at **4016** and a more irregular example at **4017**. Like the linear and curvilinear features in the previous field it is not clear whether these anomalies represent fragments of an earlier field system or are geological features. These features have been variously classed as probable archaeology and possible archaeology depending on magnetic values and regularity in form.

3.2.11 Another former field boundary is present at **4018**; it appears on early OS mapping up until very recently (1963-1991 edition OS) suggesting it was removed in the last few decades (Ordnance Survey 1991).

3.2.12 There are more trends in these two fields, most represent ploughing scars but others such as those around **4019** may prove to be of archaeological significance.

3.2.13 There are a large number of small positive anomalies scattered throughout the data; given the strength of the underlying geology it is difficult to reliably recognise smaller pits from small geological features. Many of the sub-circular and sub-oval anomalies interpreted as possible archaeology may turn out to be of geological origin.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 There is at least one modern service located in the data at **4006**; this service appears to be a ferrous pipe running roughly northeast to southwest through the northern survey area and continues beyond the limits of the geophysical survey. This service is not visible in the southern survey area.

3.3.2 It is not clear from the geophysical data whether any of the services identified are in active use or not. Also 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 likely, probable and possible archaeological interest within the Site, in addition to regions of increased magnetic response and at least one modern service.

4.1.2 The data has revealed an enclosure along with some isolated ditch sections. There are more diffuse edged linear features running throughout the data; the interpretation of these features is unclear as they could represent archaeological features such as fragments of an earlier field system or could be regular looking geological features.

4.1.3 Some former field boundaries have been identified in the data; these features have not been interpreted as archaeology as the form of the anomaly and their presence on early OS maps suggests that they may be relatively modern. It is possible that these boundaries are set over earlier ones so their archaeological importance remains unknown.

4.1.4 Numerous anomalies can be seen within the greyscale plot, although it is difficult to discriminate between anomalies of geological and possibly archaeological origins. Whilst it is considered likely that significant archaeological remains would have produce

identifiable anomalies, such as those at the northern extent of the survey area, the confidence with which these anomalies have been interpreted is somewhat reduced by variations within the extremely strong background magnetic field caused by the local geology.

4.1.5 The relative dimensions of the modern services identified by the gradiometer survey are indicative of the strength of their magnetic response, which is dependent upon the materials used in their construction and the backfill of the service trenches. The physical dimensions of the services indicated may therefore differ from their magnetic extents in plan; it is assumed that the centreline of services is coincident with the centreline of their anomalies, however. Similarly, it is difficult to estimate the depth of burial of the services through gradiometer survey.

4.1.6 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. This is particularly true in this geological setting where the high and variable background magnetic values generated by the underlying geology have made the interpretation of small pit-like anomalies more difficult.

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.

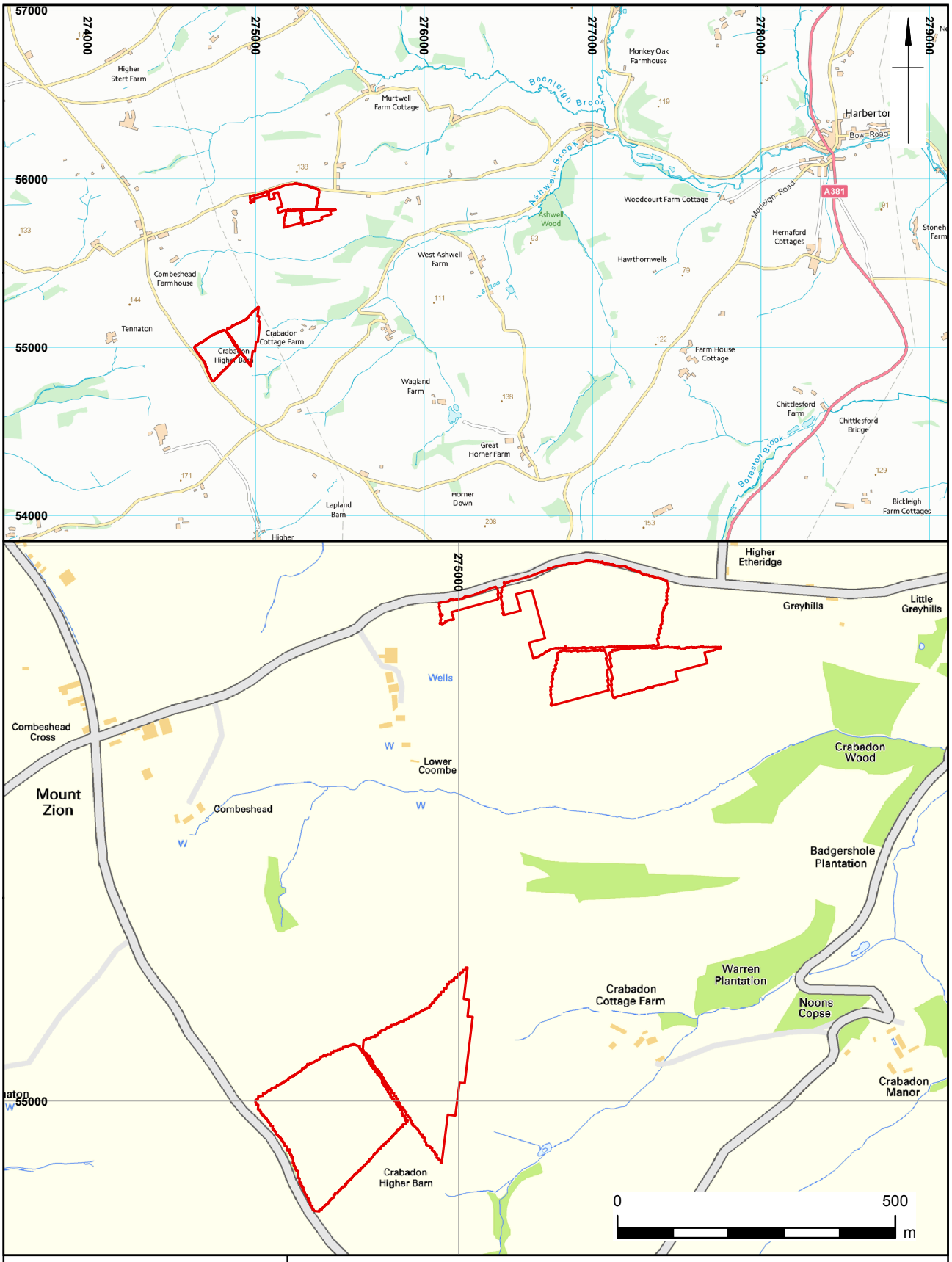
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided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



Detailed Survey Extents

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Site location plan

Figure 1

Detailed Survey Extents

+15nT

-12nT

0 100 m

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Revision Number:	0
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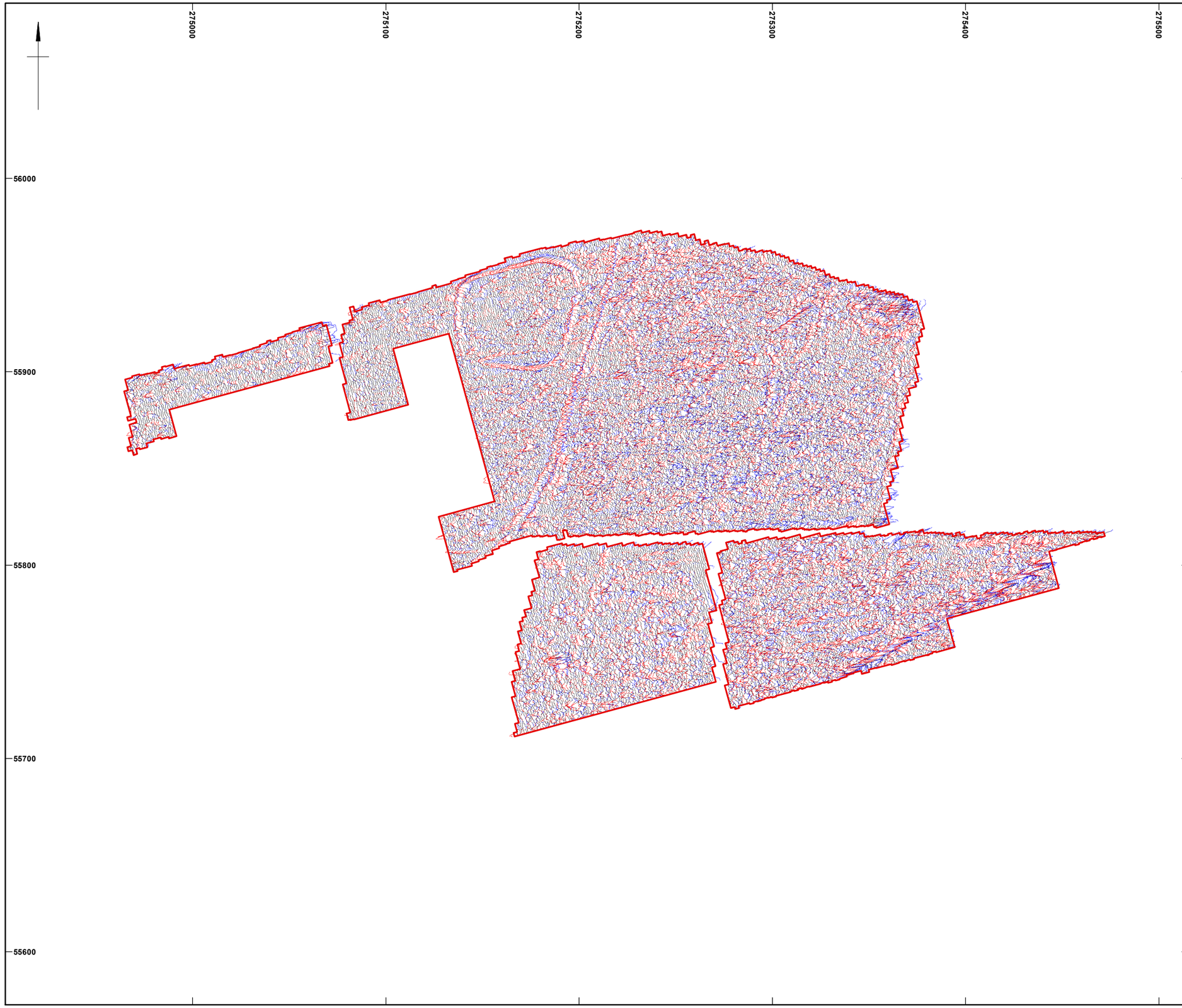
Greyscale; northern area

Figure 2



Detailed Survey Extents

+50nT

-50nT

0 100 m

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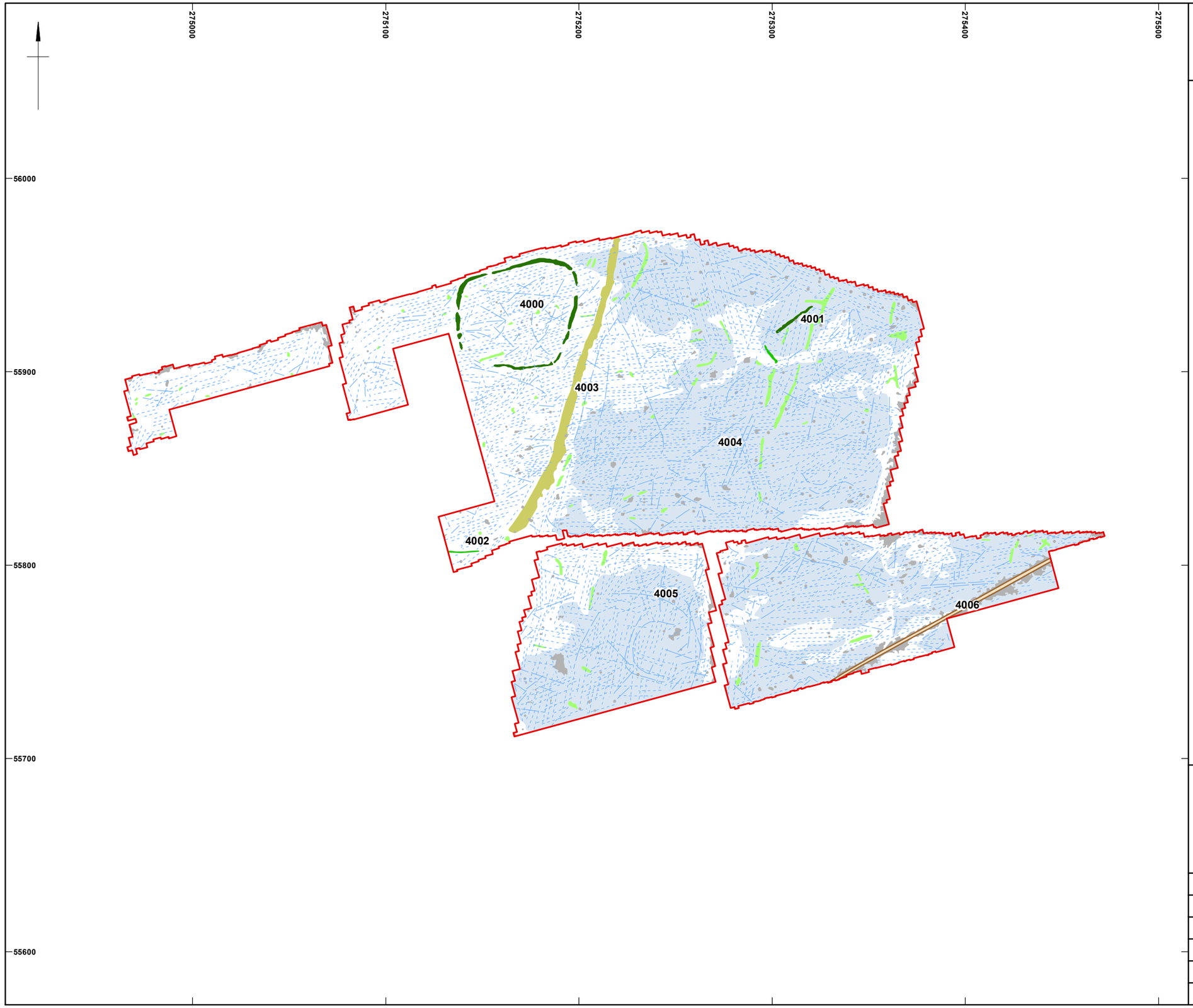
XY trace; northern area

Figure 3



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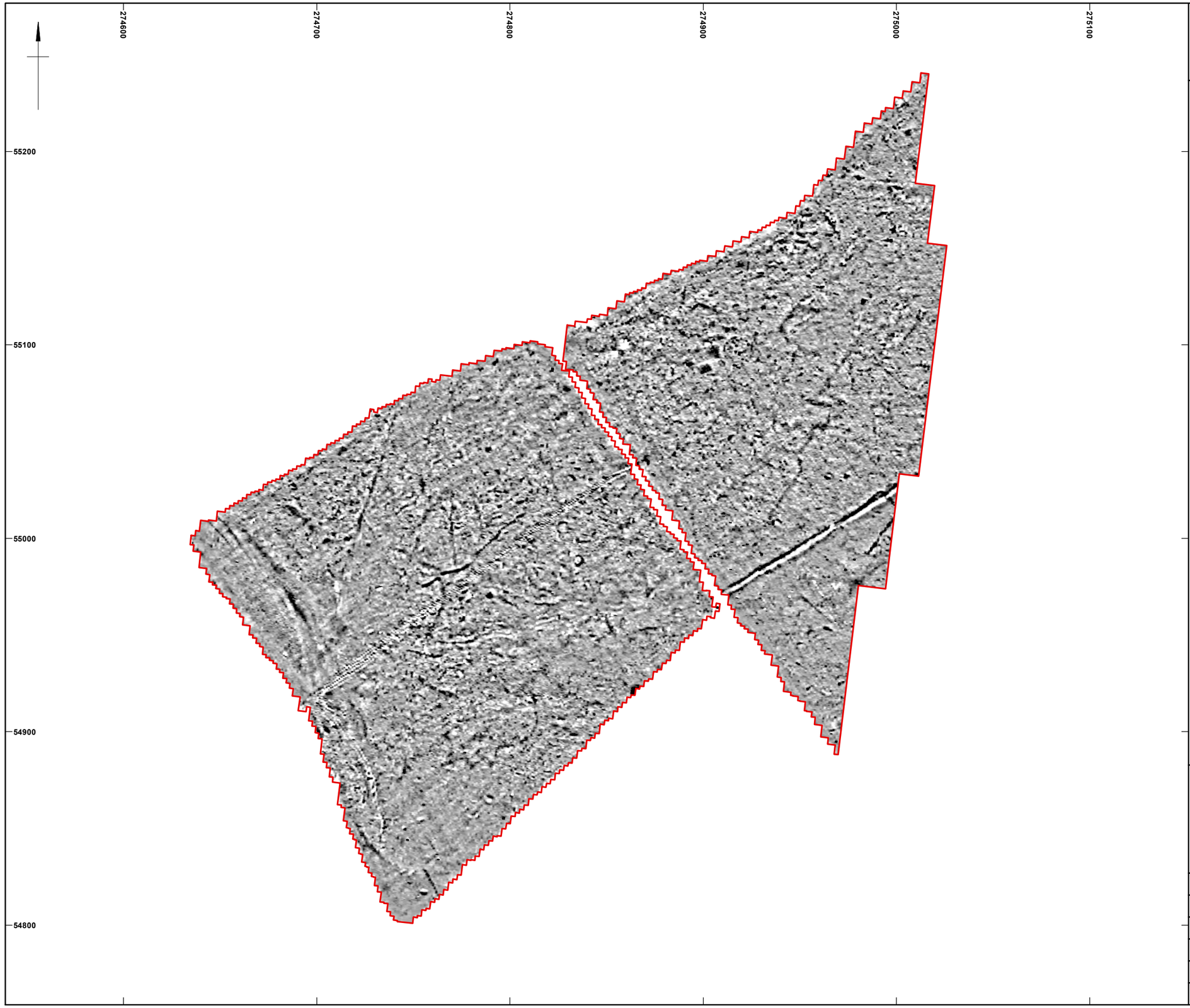
Interpretation; northern area

Figure 4



Detailed Survey Extents

+15nT

-12nT

0 100 m

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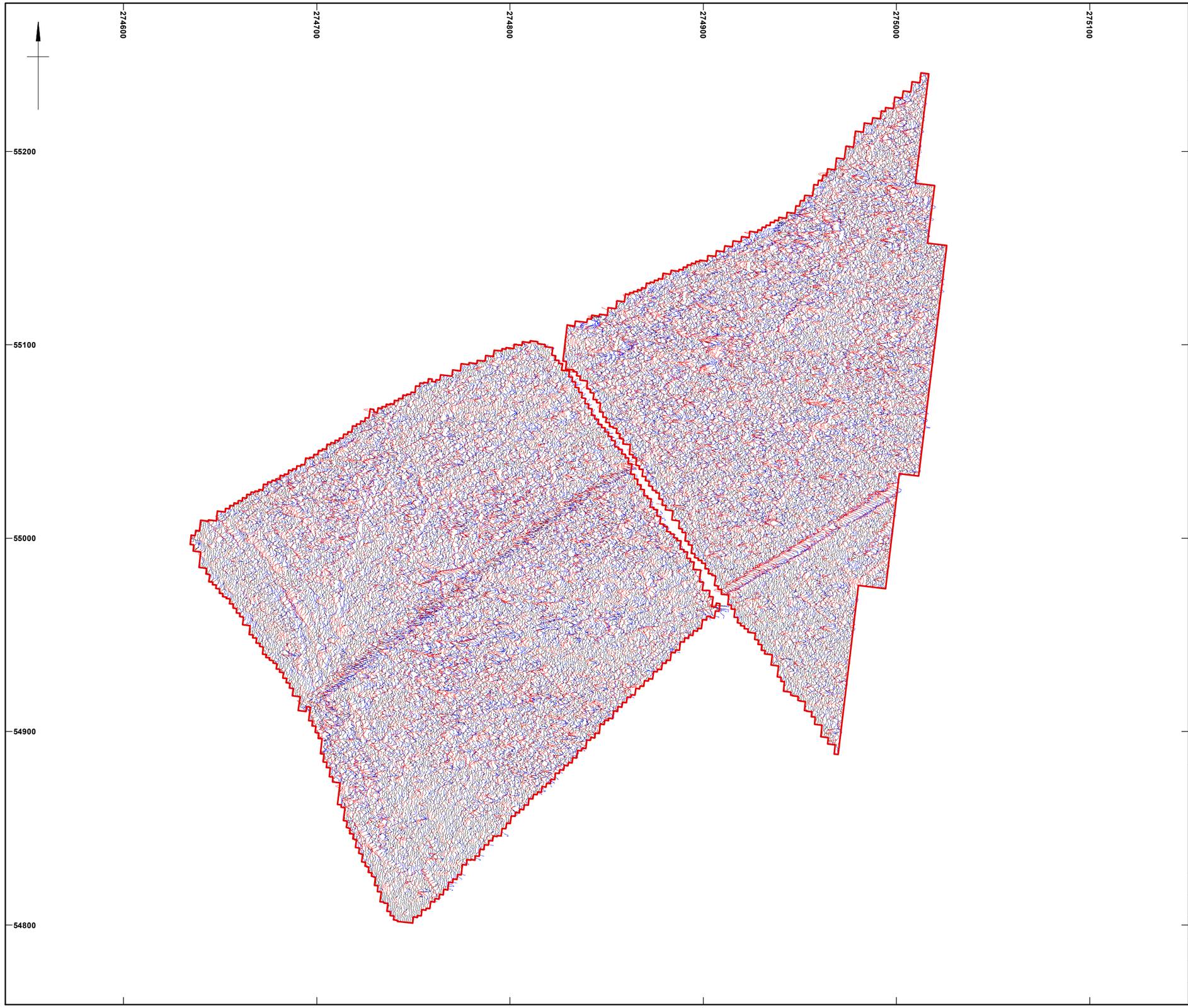
Greyscale; southern area

Figure 5



Detailed Survey Extents

+50nT

-50nT

0 100 m

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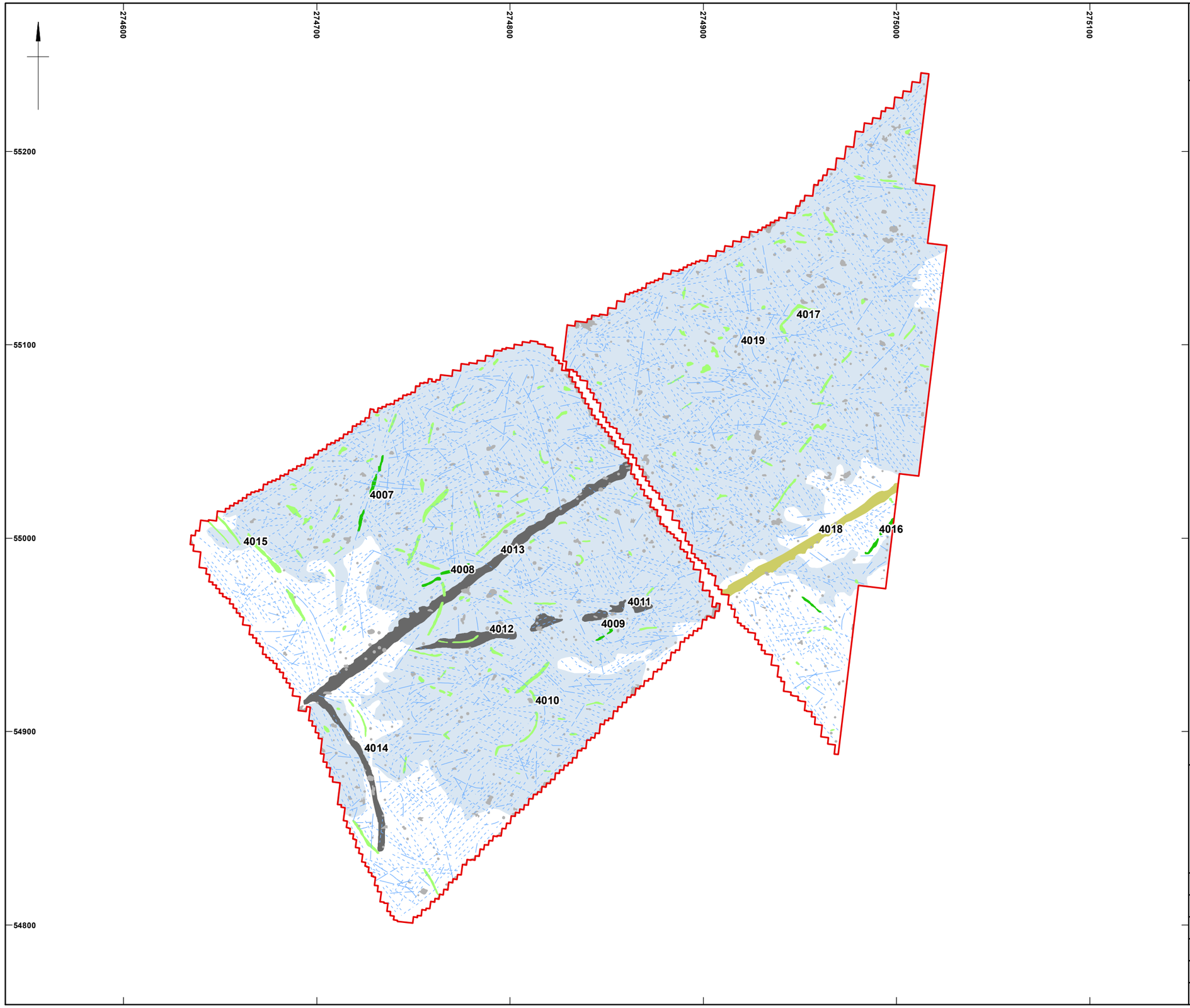
XY trace; southern area

Figure 6



Detailed Survey Extents
Ploughing
Trend
Modern Service
Ferrous
Archaeology
Probable Archaeology
Possible Archaeology
Increased Magnetic Response
Former Field Boundary
Superficial Geology

0 100 m

Date:	21/11/13
Revision Number:	0
Scale:	1:2000 at A3
Illustrator:	LJC
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Interpretation; southern area

Figure 7

wessex archaeology

salisbury rochester sheffield edinburgh

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