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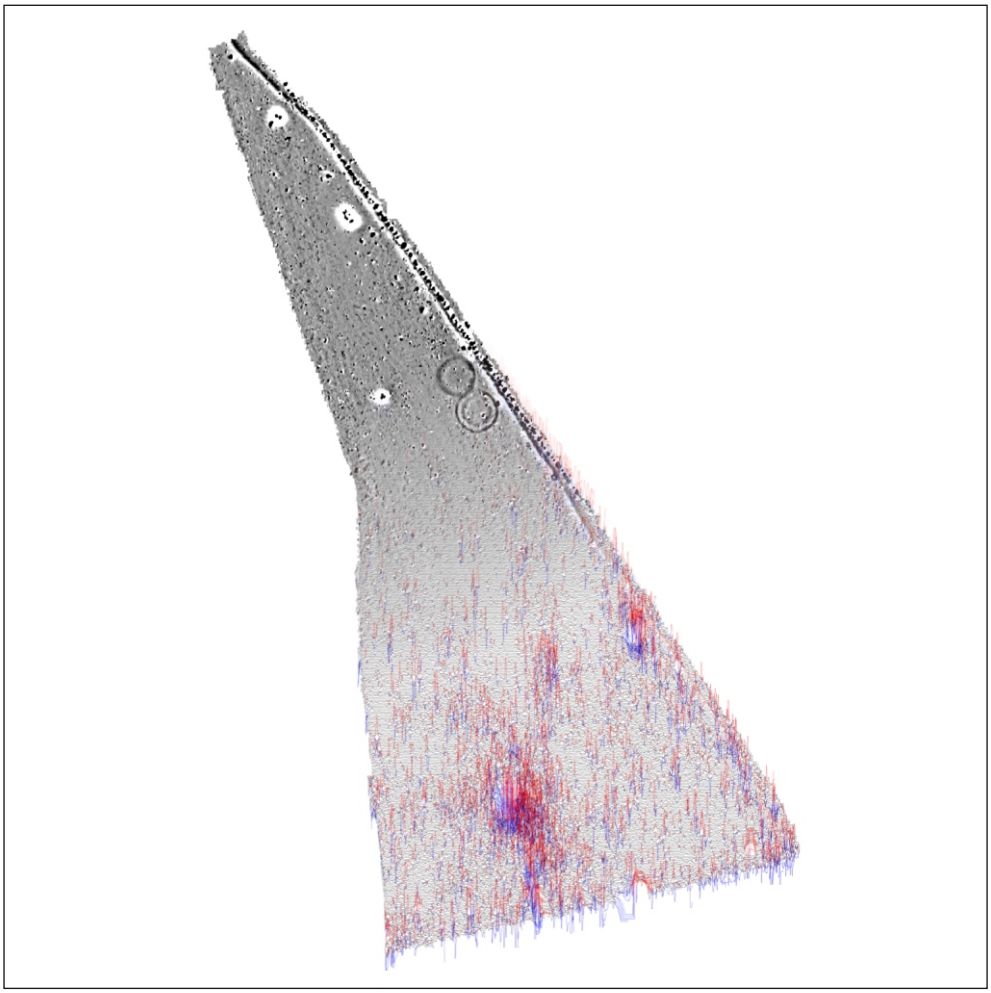
Army Rebasing: Bulford SFA South West Site Salisbury, Wiltshire

Detailed Gradiometer Survey Report



Ref: 104151.02
August 2014

geoservices

Army Rebasing: Bulford SFA South West Site, Salisbury, Wiltshire

Detailed Gradiometer Survey Report

Prepared for:
URS Infrastructure & Environment UK Limited
Scott House
Alencon Link
Basingstoke
Hampshire
RG21 7PP

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

www.wessexarch.co.uk

August 2014

Report Ref. 104151.02

Quality Assurance

Project Code	104151	**Accession Code**		**Client Ref.**	104151.02
Planning Application Ref.		**Ordnance Survey (OS) national grid reference (NGR)**	417450, 143525		

Version	Status*	Prepared by	Checked and Approved By	Approver's Signature	Date
v01	E	*GJS/RDL*	*PAB*		12/08/2014
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* I = Internal Draft; E = External Draft; F = Final

Army Rebasing: Bulford SFA South West Site, Salisbury, Wiltshire

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Contents

Figures

Army Rebasing: Bulford SFA South West Site, Salisbury, Wiltshire

Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land within the Salisbury Plain Training Area (SPTA), Salisbury, Wiltshire. The project was commissioned by URS Infrastructure & Environment UK Limited, on behalf of the defence Infrastructure Organisation (DIO) with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed housing development for Service Family Accommodation (SFA).

The Site comprises two arable fields on the southeast edge of Bulford and on the southwest edge of Bulford Camp, approximately 2.8km northeast of Amesbury. The Site is located on the northwest facing slope of the valley of the Nine Mile River, a tributary of the Avon, with a dry valley running along the northeast side of the Site. The gradiometer survey covered 13.4ha and has demonstrated the presence of anomalies of likely, probable and possible archaeological interest along with ploughing, some trends of uncertain origin and two modern services.

The geophysical data revealed two adjoining circular features which are very likely to archaeological in origin. Both are recorded from aerial photographic evidence as undated ring ditches. A number of weak, circular and sub-circular positive anomalies are possibly archaeological and could represent pits but many may turn out to be natural features such as tree throws. A ditch is identified running parallel to the current northern field boundary but it is unclear whether this feature is archaeological or agricultural.

The survey was undertaken between 18th and 23rd July 2014.

Army Rebasing: Bulford SFA South West Site, Salisbury, Wiltshire

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by URS Infrastructure & Environment UK Limited. The assistance of Robert Beaumont and Colin Bush is gratefully acknowledged in this regard.

The fieldwork was undertaken by Rachel Chester, Patrick Dresch, Alistair Salisbury, Laura Andrews, Jen Smith and Ross Lefort. Ross Lefort processed the geophysical data which was interpreted by Genevieve Shaw who also wrote this report. The geophysical work was quality controlled by Ross Lefort and Dr. Paul Baggaley. Illustrations were prepared by Ross Lefort and Karen Nichols. The project was managed on behalf of Wessex Archaeology by Paul Baggaley.

Army Rebasing: Bulford SFA South West Site, Salisbury, Wiltshire

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by URS Infrastructure & Environment UK Limited, on behalf of the Defence Infrastructure Organisation (DIO), to carry out a geophysical survey on land within the Salisbury Plain Training Area (SPTA), Wiltshire (**Figure 1**), hereafter "the Site" (centred on NGR 417450, 143525). The survey forms part of an ongoing programme of archaeological works being undertaken in advance of the proposed development of Service Family Accommodation (SFA).

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 and Topography

1.2.1 The survey area comprises two arable fields on the southeast edge of Bulford and on the southwest edge of Bulford Camp. The survey area is located approximately 2.8km northeast of Amesbury and 13.9km NNE of the centre of Salisbury (**Figure 1**).

1.2.2 The Site is located on the northwest facing slope of the valley of the Nine Mile River with a dry valley running along the northeast side of the survey area. The land at the south lies at a height of around 100m aOD and slopes downwards towards the northwest and northeast with the lowest part of the Site at a height of around 85m aOD. The size of the survey area totals 14.7ha of which a total of 13.4ha were surveyed. Some obstacles at the western end of the survey area reduced the area that could be collected.

1.3 Soils and Geology

1.3.1 The bedrock geology under the Site is recorded as Seaford chalk formation that dates to the Cretaceous period. The superficial deposits recorded at the Site are limited to head deposits (clay, silt, sand and gravel) recorded in the dry valley nearby (BGS).

1.3.2 The soils underlying most of the Site are likely to be a mix of typical brown calcareous earths of the 511f (Coombe 1) association and brown rendzinas of the 343h (Andover 1) 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 Grad 601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (English Heritage 2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between 18th and 23rd July 2014. Field conditions at the time of the survey were variable, with parts of the survey area either under silage crop or within an overgrown former paintball range.

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 a few anomalies of likely, probable and possible archaeological interest across the Site, along with two modern services. Results are presented as a series of greyscale and XY plots, with corresponding archaeological interpretations, at a scale of 1:1500 (**Figures 2** to **7**); an overall interpretation figure has been produced at a scale of 1:2500 (**Figure 8**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 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 (**Figures 4**, **7** and **8**). 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 most significant anomalies are two adjoining circular positive magnetic anomalies north of **4000**; the first is a single ring ditch and the second is two concentric ring ditches. Both ring ditches lie close to the northern boundary of the Site at the highest point. They are interpreted as ditches and their magnetic response varies between +1.5nT and +5nT. The outer ring ditch of the concentric double ditched anomaly exhibits the stronger magnetic responses of all the observed ring ditches. There are some weakly positive pit-like anomalies close to and within these ring-ditches; these have been interpreted as either probable or possible archaeology according to their magnetic values.

3.2.2 These two anomalies are visible as cropmarks on aerial photographs and satellite imagery and are recorded in the Wiltshire HER as undated ring ditches (HER No: MWI12245 & MWI12246). They are classified as undated ring ditches as they could be the remains of ploughed our round barrows, round houses, or of modern features such as searchlight or gun emplacements. The Site is located just to the north of an area containing numerous barrows of various types and on Beacon Hill to the southeast there is a cemetery of 70 or more bowl barrows with associated burials and cremations. Considering the lack of ferrous responses associated with these features it is more likely that the two ring ditches are ploughed out prehistoric barrows rather than military installations.

3.2.3 A ditch runs parallel along the northern edge of the Site at **4001** and **4003** with strong magnetic values over +3nT. It is unclear whether this feature represents a ditch that served an agricultural function or is associated with the former railway that ran past the northern edge of the Site. Due to this uncertainty this feature has been interpreted as possible archaeology. This feature is interrupted by a modern service at **4007**.

3.2.4 There are numerous small sub-oval shaped positive anomalies scattered across the dataset such as the example north of **4002**. They have magnetic values ranging from +1nT to +2.5nT and could either be small archaeological features or are natural hollows. Previous experience working in this geology has shown many such features to be natural tree throws whereas a few others turn out to be pits; it is simply not possible to confidently tell the difference from geophysical data alone. All of these anomalies have been classed as possible archaeology to reflect this uncertainty.

3.2.5 There is a large concentration of ferrous around **4004** that is likely to be related to the spreading of modern debris; the large ferrous object in the centre of this spread may be related to a large buried ferrous object.

3.2.6 There are several spreads of increased magnetic response spread across the data; most are related to high concentrations of ferrous but others such as around **4005** may be related to geological variations.

3.2.7 A long linear positive anomaly runs across the middle of the survey area south of the large ferrous response at **4004** and has been classed as agricultural. This feature cannot be confidently linked to a former field boundary through historic mapping but its alignment suggests it served an agricultural function.

3.2.8 The remaining anomalies detected in all the areas include very small positive anomalies of possible archaeological interest and weak linear trends of uncertain origin. It is unclear whether these features indicate the presence of archaeological features or are of modern or geological in origin.

3.3 Gradiometer Survey Results and Interpretation: Modern Services

3.3.1 Two modern services have been identified at **4006** and **4007**; both are considered to represent pipes with **4006** possibly related to agricultural use as it appears to terminate in the middle of the field.

3.3.2 It is not clear from the geophysical data whether the services identified are in active use. It should also be noted that gradiometer survey may not detect 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 archaeology as well as ploughing and agricultural trends, a large amount of ferrous and two modern services.

4.1.2 The most interesting anomalies are two ring-shaped ditches identified in the Bulford survey area at **4000**. These are already recorded in the Wiltshire HER as undated ring ditches from aerial photography evidence and they are possibly the remains of ploughed out round barrows; there is a barrow cemetery to the south of the survey area.

4.1.3 A ditch runs parallel to the current field boundary between **4001** and **4003** and is either agricultural in origin, could be associated with a former railway embankment or 1960s woodland plantation both recorded on previous Ordnance Survey mapping.

4.1.4 The remaining anomalies detected appear to be agricultural in origin mainly in the form of ploughing trends and a possible ditch associated with agricultural activity in this field.

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.

5 REFERENCES

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5.2 Cartographic Sources

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Ordnance Survey, 1901. *Wiltshire,* 1:2500.

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Ordnance Survey, 1937-1939. *Wiltshire,* 1:2500.

Ordnance Survey, 1961. *Wiltshire,* 1:2500.

Ordnance Survey, 1971. *Wiltshire,* 1:2500.

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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 four main categories: archaeological, modern, agricultural and uncertain origin/geological.

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 modern category is used for anomalies that are presumed to be relatively modern in date:

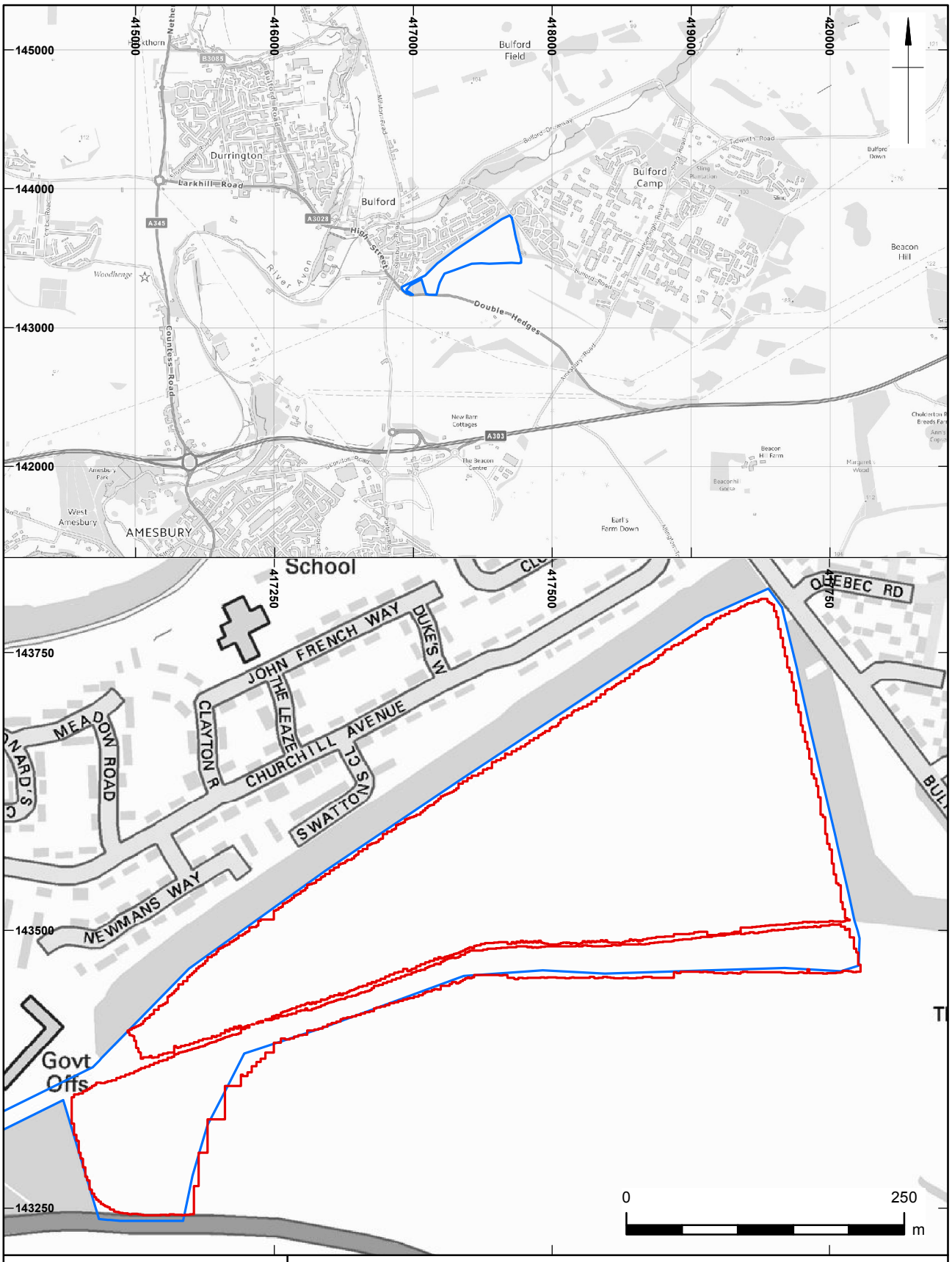
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.
- Modern service – used for responses considered relating to cables and pipes; most are composed of ferrous/ceramic material although services made from non-magnetic material can sometimes be observed.

The agricultural category is used for the following:

- Former field boundaries – used for ditch sections that correspond to the position of boundaries marked on earlier mapping.
- Agricultural ditches – used for ditch sections that are aligned parallel to existing boundaries and former field boundaries that are not considered to be of archaeological significance.
- Ridge and furrow – used for broad and diffuse linear anomalies that are considered to indicate areas of former ridge and furrow.
- Ploughing – used for well-defined narrow linear responses, usually aligned parallel to existing field boundaries.
- Drainage – used to define the course of ceramic field drains that are visible in the data as a series of repeating bipolar (black and white) responses.

The uncertain origin/geological 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.
- Superficial geology – used for diffuse edged spreads considered to relate to shallow geological deposits. They can be distinguished as areas of positive, negative or broad bipolar (positive and negative) anomalies.



Site location and detailed survey extents

Figure 1

Detailed Survey Extents

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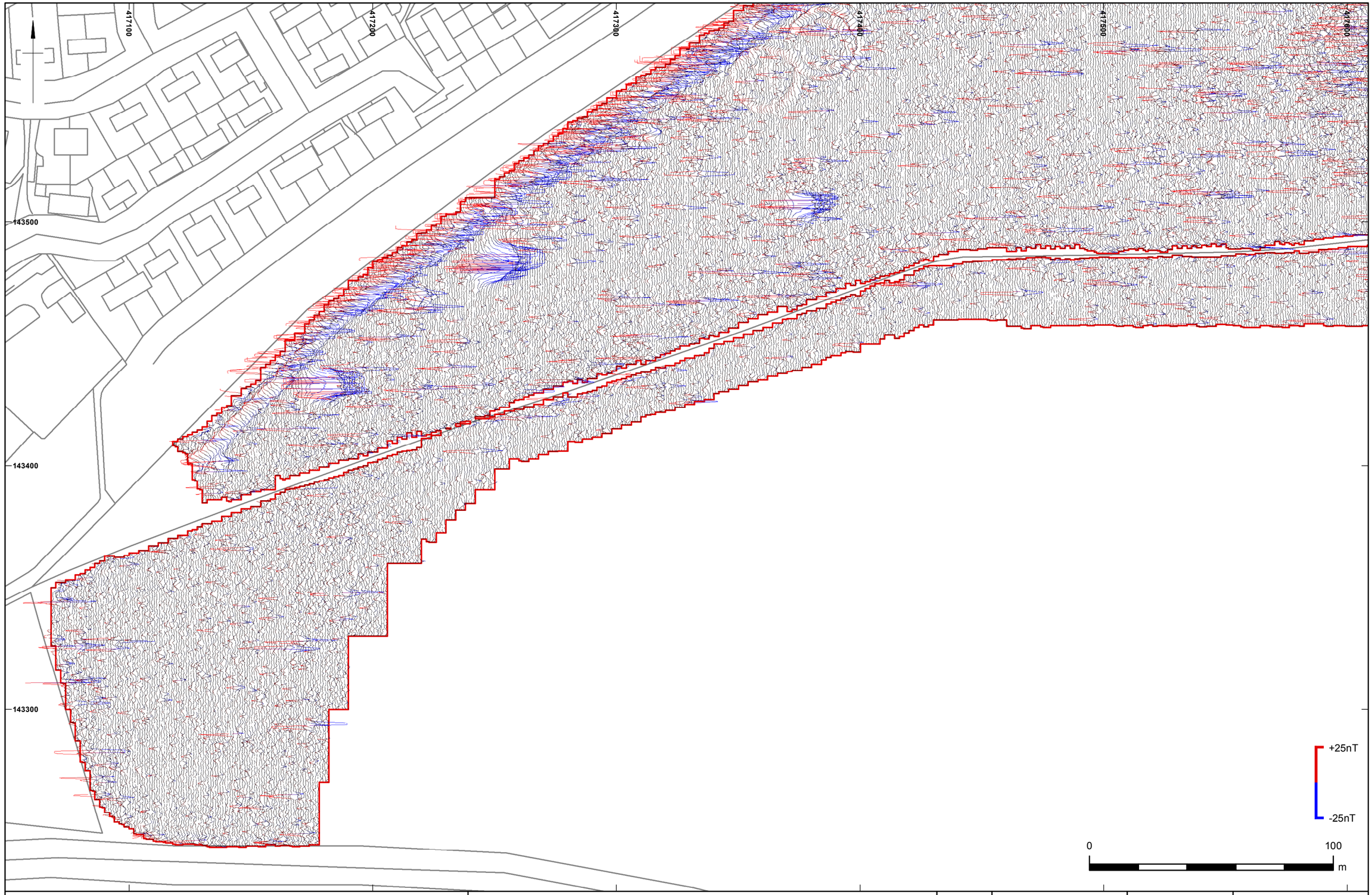
Greyscale plot: southwest

Figure 2



Detailed Survey Extents

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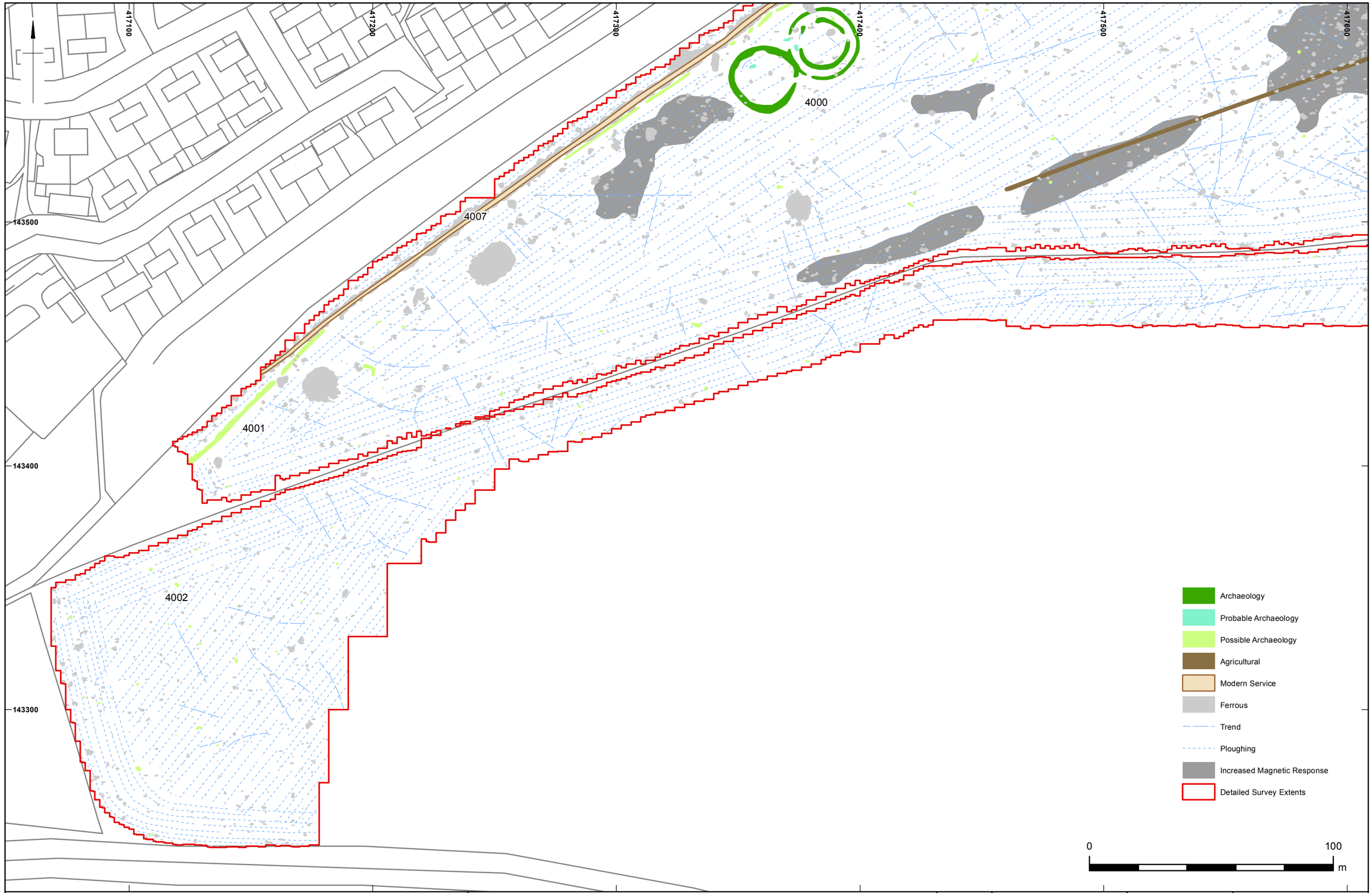
XY trace plot: southwest

Figure 3



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Interpretation: southwest

Figure 4

Detailed Survey Extents

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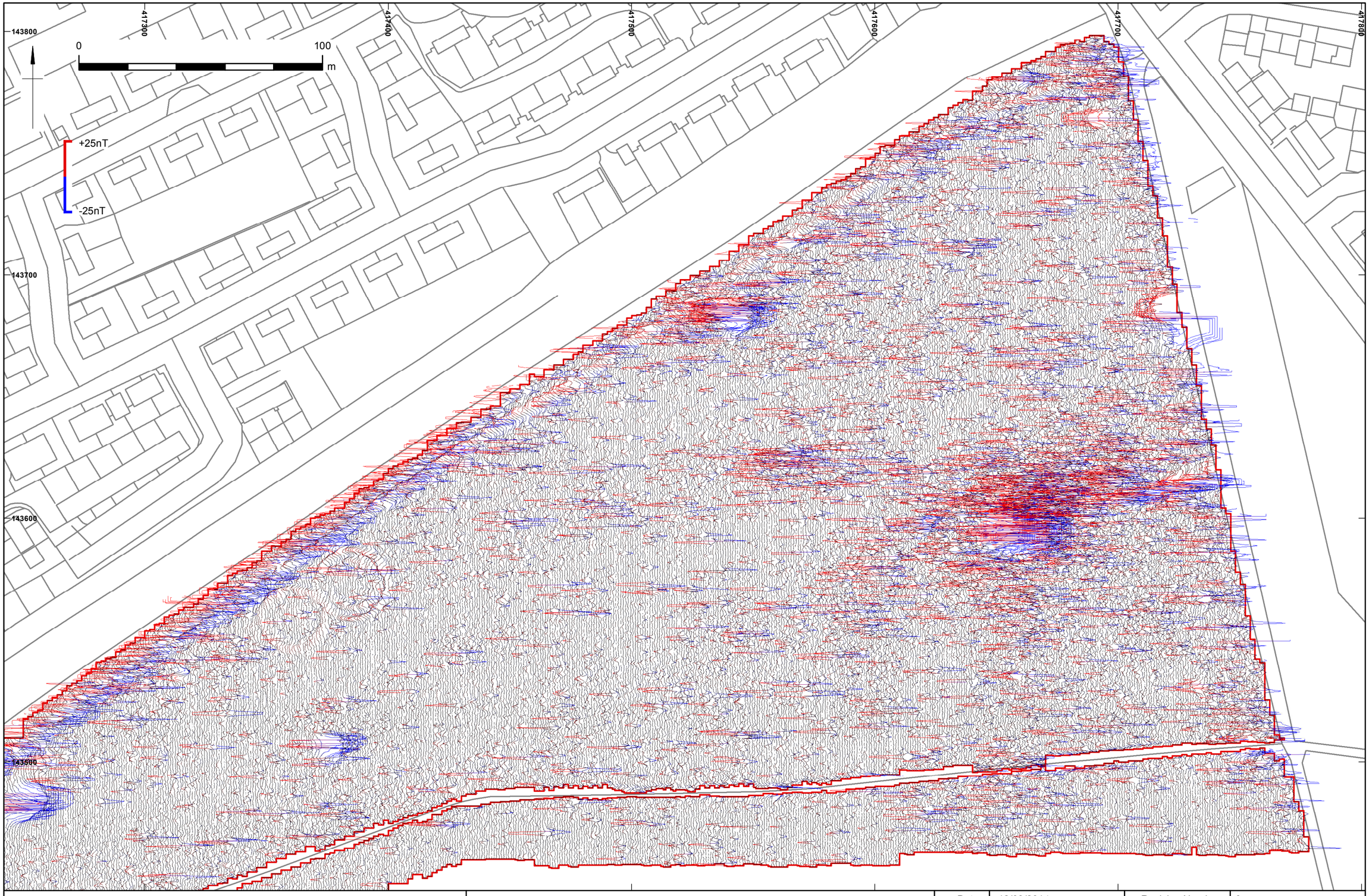
Greyscale: northeast

Figure 5



Detailed Survey Extents

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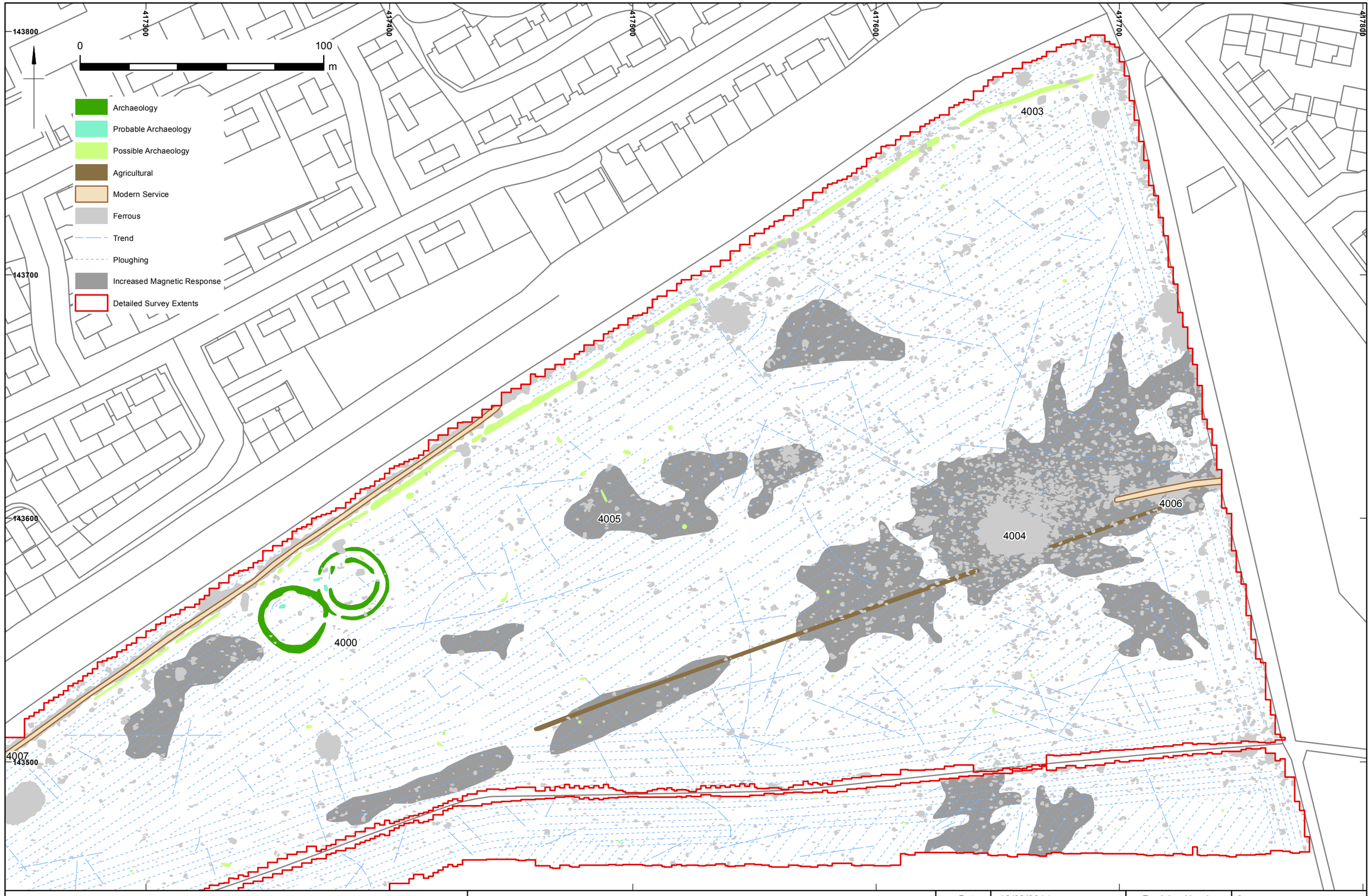
XY trace: northeast

Figure 6



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Interpretation: northeast

Figure 7

417000
417250
417500
417750
143750
143500
143250
4000
4001
4002
4003
4004
4005
4006
4007
Archaeology
Probable Archaeology
Possible Archaeology
Agricultural
Modern Service
Ferrous
Trend
Ploughing
Increased Magnetic Response
Detailed Survey Extents
0
100
m

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Overall interpretation

Figure 8

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