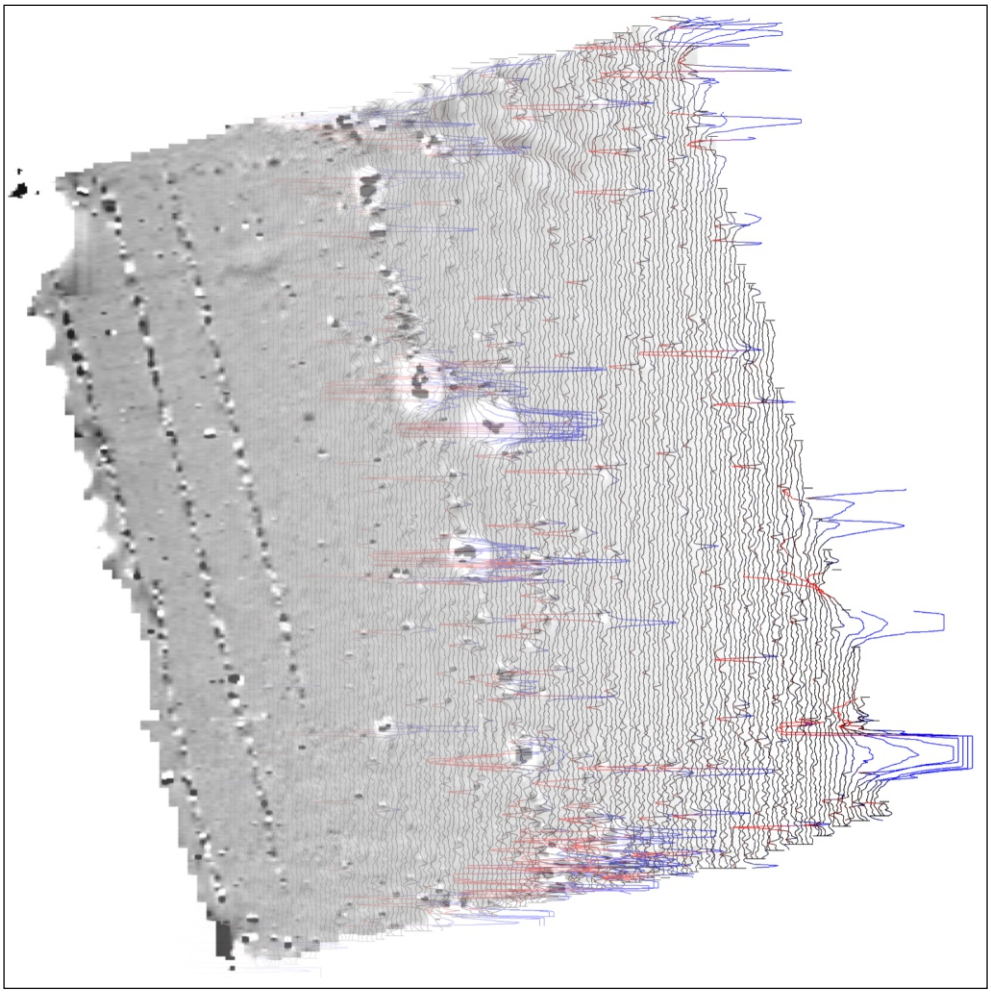
making sense of heritage

Cheddar Reservoir 2
Cheddar, Somerset

Detailed Gradiometer Survey Report Extension



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September 2013

geoservices

Cheddar Reservoir 2
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Detailed Gradiometer Survey Report Extension

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v01	I	*CD/RDL*	*BCU*		20/09/2013
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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 southwest of Cheddar, Somerset. The project was commissioned by Arup on behalf of their client Bristol Water with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of the proposed development of an additional reservoir.

The site comprises pasture and arable fields to the south of the existing Cheddar reservoir, approximately 2km southwest of Cheddar; the proposed scheme totals 9.4ha and gradiometer survey was undertaken over all accessible parts of the site. The site occupies largely flat land, sloping up towards the centre and eastern extents. The gradiometer survey has demonstrated the presence of anomalies of probable and possible archaeological interest within the survey area, along with regions of increased magnetic response, near-surface geological changes and several ferrous regions.

Former field systems can be seen through two areas with anomalies of probable archaeological interest; some of these responses may relate to a medieval stack stand. Elsewhere, linear anomalies and possible pit-like responses have been detected.

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Acknowledgements

The detailed gradiometer survey was commissioned by Arup on behalf of Bristol Water. The assistance of Phil Hodgson, Jim Keyte, Michelle Barker and other members of their team is gratefully acknowledged in this regard. Wessex Archaeology would also like to thank the landowners for granting access to the survey areas, and also Andrew Harris and Olly Squires of Integrale for providing site accommodation and liaising with landowners.

The fieldwork was undertaken by Jennifer Smith and Clara Dickinson. Clara Dickinson processed the geophysical data and this was interpreted by Clara Dickinson and Ross Lefort. This report was written by Ross Lefort and Clara Dickinson. The geophysical work was quality controlled by Ben Urmston and Dr. Paul Baggaley. Illustrations were prepared by Linda Coleman. The project was managed on behalf of Wessex Archaeology by Nicholas Cooke.

Cheddar Reservoir 2
Cheddar, Somerset

Detailed Gradiometer Survey Report Extension

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) was commissioned by Arup on behalf of Bristol Water to carry out a geophysical survey of land southwest of Cheddar, Somerset (**Figure 1**), hereafter "the Site" (centred on NGR 344100 152700). The survey forms part of an on-going programme of archaeological and geophysical works being undertaken ahead of the proposed development of a new reservoir 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 of pasture fields some 2km southwest of the centre of Cheddar (**Figure 1**). Detailed gradiometer survey was undertaken over all accessible parts of the Site, which totalled 9.4 ha.

1.2.2 The Site occupies largely flat farmland, largely lying at around 10m above Ordnance Datum (aOD), sloping gently to 12m aOD towards the centre and east. The site is divided into two areas, the north-western area (NW) being bordered by the Stubbington Drove trackway to the north, the river Cheddar Yeo to the west, the Clay pits fishing ponds to the east and by pasture land to the south. The eastern area (E) is bordered by pastureland to the west, the B3151 to the east, residential areas to the north and a sewage treatment works to the south.

1.2.3 A desk-based assessment (DBA) was produced by WA prior to the survey, which identified a number of known archaeological sites within the reservoir scheme's boundary (WA 2012).Previous geophysical survey works have been undertaken within the proposed reservoir area by Wessex Archaeology in January 2013, in which 148ha was covered by gradiometer survey (WA 2013). This detected the presence of several previously unknown archaeological sites including several enclosure complexes and a duck decoy.

1.2.4 The soils underlying the Site are likely to comprise typical humic alluvial gleys of the 851a (Downholland 1) association to the north and northwest, stagnogleyic argillic brown earths of the 572d (Whimple 1) association towards the east and pelo-alluvial gleys of the 813e (Compton) association across the southern portion of the Site close to Cheddar Yeo (SSEW 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through gradiometer 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 1th July and 9th July 2013. Field conditions at the time of the survey were largely suitable, with the majority of the survey area under pasture; however geophysical survey was prevented in some areas due to tall crops of *Miscanthus giganteus* (elephant grass), and the presence of obstructions within the field.

2.2 Method

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

2.2.2 The gradiometer 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. In places, further data processing was undertaken to reduce the effect of periodic errors within the data resulting largely from ground conditions.

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 probable and possible archaeological interest across the Site. Regions of increased magnetic response, near-surface geological changes and a number of trends have also been detected.

3.1.2 Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2000 (**Figures 3** to **7**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale images. The XY trace plots are presented at ±25nT at 25nT per cm.

3.1.3 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figures 5** and **8**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.4 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 There are several linear spreads of increased magnetic response within **NW18**, around **4260**; these bipolar responses (black and white) are consistent with ceramic field drains. To the north east of this field around **4261** is an area of weak positive and negative anomalies interpreted as superficial geology.

3.2.2 There are several trends around **4262** in area **NW19** that do not follow the current field alignment. These may either prove to relate to former agricultural activity in this area or may be a product of the superficial geology recorded in this area. These anomalies have been interpreted as trends and can be seen oriented approximately northwest to southeast. These trends are located within a larger spread interpreted as superficial geology.

3.2.3 Field **NW20** has been split into two by a wide drainage ditch, which is on the same orientation as the present field boundaries in this area. Geological anomalies can again be seen running along the northern area of the field at **4263** and **4264**. Further curvilinear trends can be seen towards the north of the field. In the far southeast corner another change in the superficial geology has been identified.

3.2.4 An area of probable archaeological interest has also been identified in **NW21**, around **4265**, and is a group of clear negative linear anomalies. Two of the three linear sections form an L-shape and the third appears to be an offshoot from this. These responses are considered to represent ditches that either marked old field boundaries or served as drainage ditches within a field. These anomalies have been classed as probable archaeology as they may prove to be agricultural. There are a number of trends present in this field that may prove to be archaeological such as those around **4066** and **4068**.

3.2.5 Within area **NW21** the change in the geology can be again noted with two distinct spreads of negative and positive anomalies. The geology to the north, around **4266**, is similar to **4261** to **4264** with very weak positive and negative responses. The geology to the south of the field, around **4267**, by contrast is made up of much stronger positive and negative responses. Some of the responses within **4267** have been classed as either palaeochannels or anomalies of possible archaeological interest.

3.2.6 The ditches with negative responses observed in the previous field appear to continue into **NW22** at **4269**; this ditch is considered to be part of the same anomaly and has been classified probable archaeology. There are several linear and curvilinear repeating bipolar anomalies around **4270**; these responses are termed increased magnetic response and are considered likely to represent ceramic field drains.

3.2.7 The two distinct areas of superficial geology continue into this field at **4271** and **4272** with a possible channel observed within **4271**. There are several trends of possible archaeological significance around **4272** along with a dense concentration of ferrous anomalies.

3.2.8 Field **E12** has two weakly positive linear anomalies running roughly northwest to southeast through the field at **4273** and **4274**, which are considered likely to represent ditches. They are interrupted in places along their length which may be a reflection of their preservation or the composition of their fills. Both ditches have been classed as probable

archaeology as an agricultural interpretation is also possible for these anomalies. There are ceramic field drains present in this field that can be seen as linear regions of increased magnetic response such as at **4275**. There are several trends of possible archaeological significance such as those around **4276**.

3.2.9 There is very little of archaeological significance within **E13**; the only anomalies present are linear and curvilinear trends at **4278** and an irregular shaped spread of increased magnetic response around **4279** that may prove to be of archaeological interest.

3.2.10 The only other anomalies of possible interest, common to all the fields discussed above, are scatters of small sub-circular and sub-oval shaped positive anomalies. These anomalies may represent anything from archaeological features such as pits and postholes to natural variations in the geological background. They are classed as possible archaeology as there is no significant patterning in their spatial distribution to allow a more conclusive interpretation. The other anomalies common to all fields are the agricultural trends. These linear anomalies are considered to represent ploughing scars and most are considered to be fairly modern given their alignment with the present field system; some such as those around **4265** may prove to be earlier.

4 CONCLUSION

4.1.1 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, geological changes and ploughing trends.

4.1.2 A couple of responses have been identified in the geophysical data that may prove to be of interest. The anomalies around **4265** and **4269** are located close to a record of a medieval stack stand and field boundaries noted in the DBA (WA 2012). The two ditches at **4273** and **4274** may also prove to be of archaeological interest.

4.1.3 Anomalies relating to recent agricultural practices have been detected across all of the survey areas. These responses include ploughing trends, ceramic field drains, ferrous and ceramic debris and possibly some earlier field boundaries.

4.1.4 Some regions of superficial geology have been identified in the data; some of this is very weak such as at **4262** whereas other regions are much stronger as at **4271**. It is possible that the stronger geology may mask archaeological features that are present in these areas.

5 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 5, South West England*. Ordnance Survey, Southampton.

Wessex Archaeology, 2012. *Cheddar Reservoir 2, Cheddar, Somerset: Archaeological Desk-Based Assessment*. Unpublished report 86060.01

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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)
- Periodic Filter – This function is used to reduce or remove the amplitude of regular, periodic features present in the data. This is most commonly used to correct for operator error during the collection of data;
- Low Pass Filter – The low pass filter can be used to remove small scale, high frequency spatial detail. It is used to supress noise in the data to enhance larger and weaker anomalies;
- Add – The add function simply involves adding or subtracting data values to a selected area of the 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:

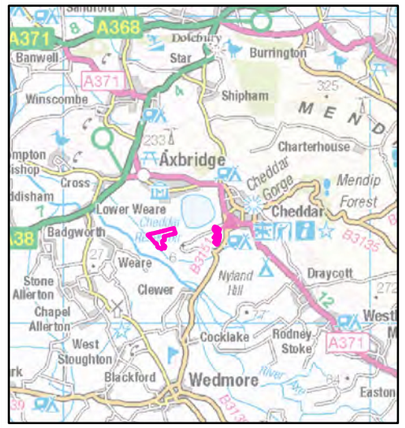
- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernible pattern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

343000
344000
345000
154000
153000
152000
NW 18
NW 20
NW 22
NW 21
NW 19
E 12
E 13
0
1
km



The Site

Survey Extents

Proposed reservoir

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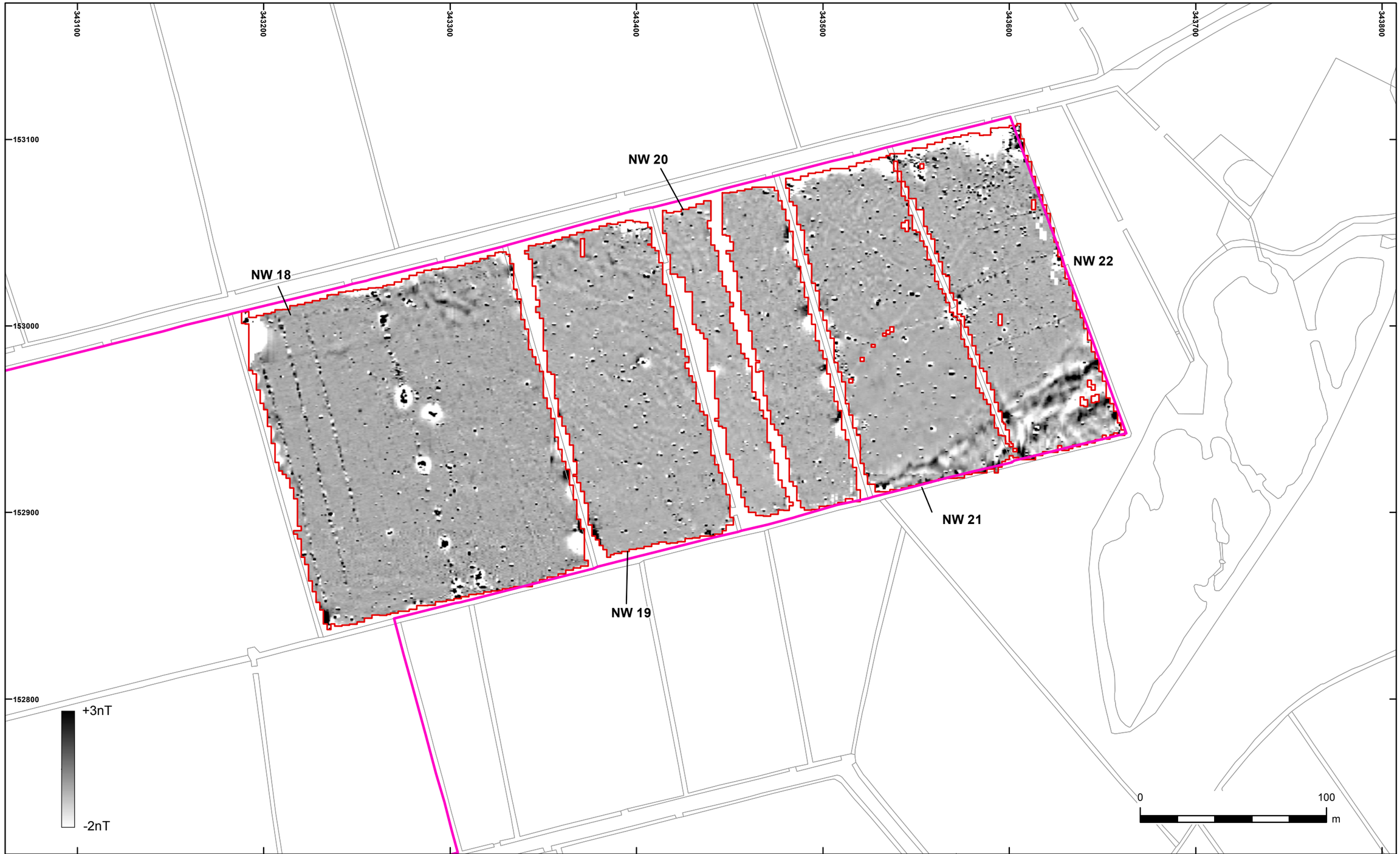
Site Location

Figure 1



The Site

Survey Extents

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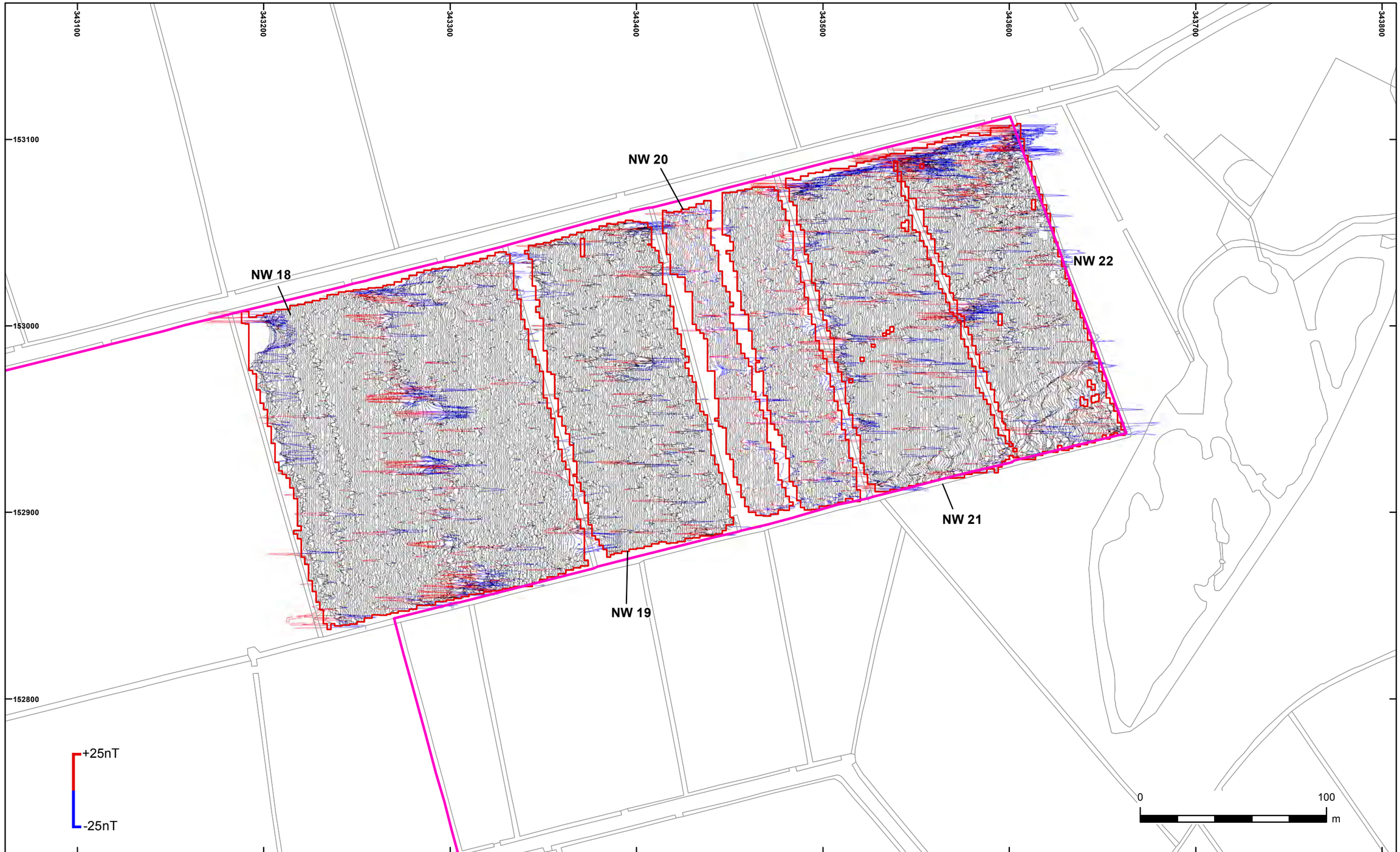
North-western Extension Region: Greyscale images

Figure 2



The Site

Survey Extents

Date:	18/09/13	Revision Number:	0
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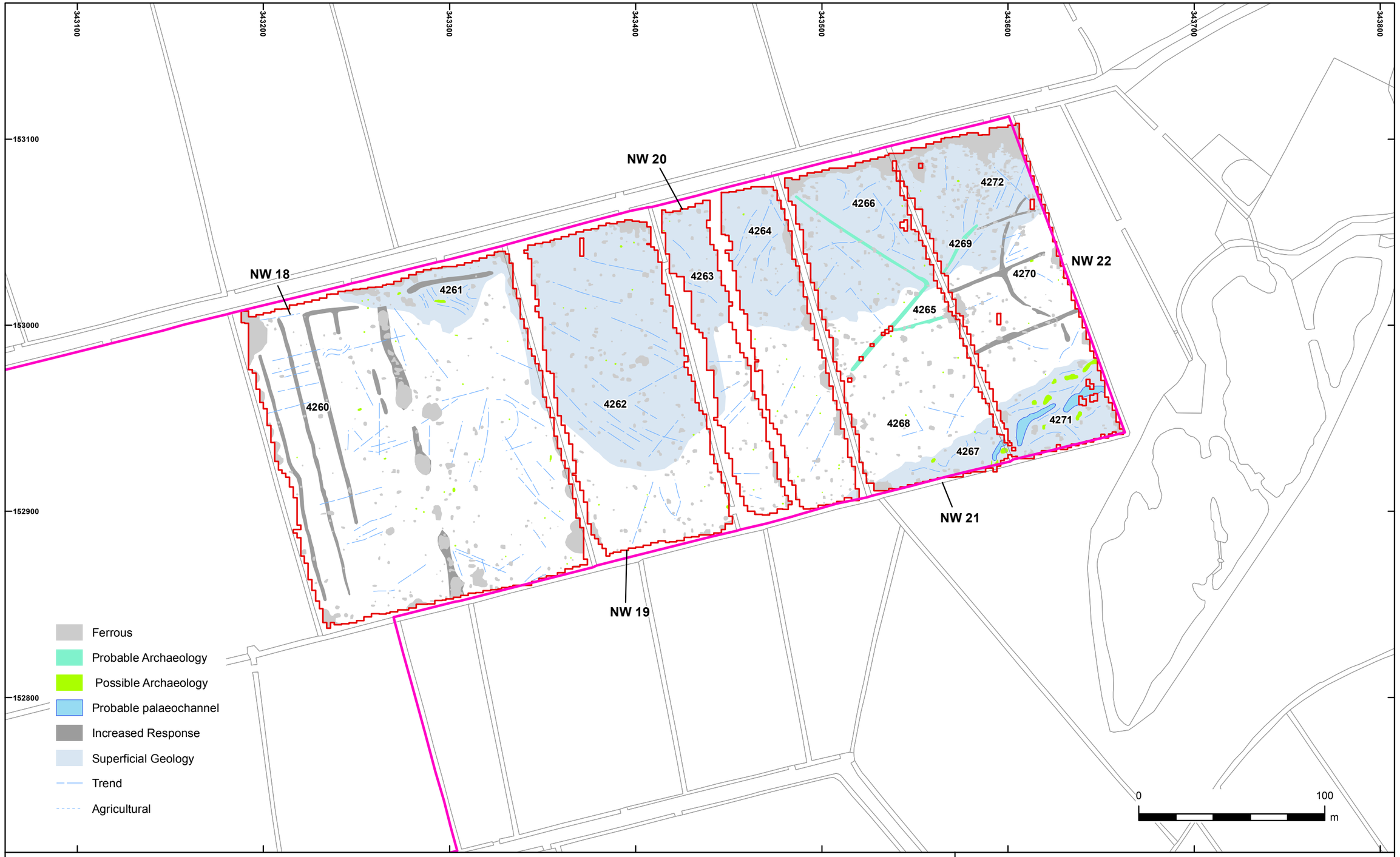
North-western Extension Region: XY trace

Figure 3



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North-western Extension Region: Interpretation

Figure 4

344800
344900
345000
345100
345200
153100
153000
152900
152800
152700
152600
E 12
E 13
+3nT
-2nT
0
100
m
The Site
Survey Extents

Date:	18/09/13	Revision Number:	0
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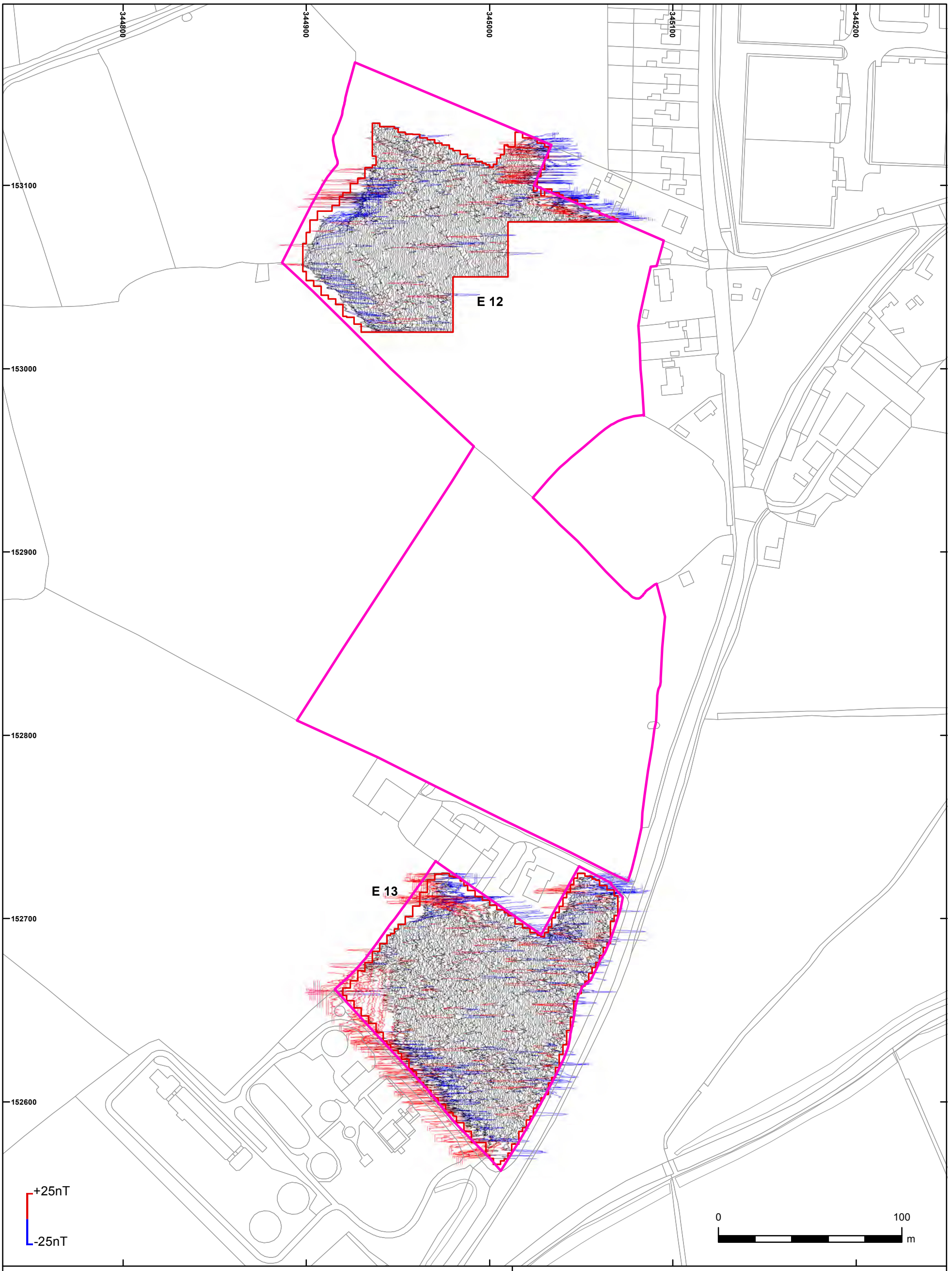
Eastern Extension Region: Greyscale images

Figure 5



The Site

Survey Extents

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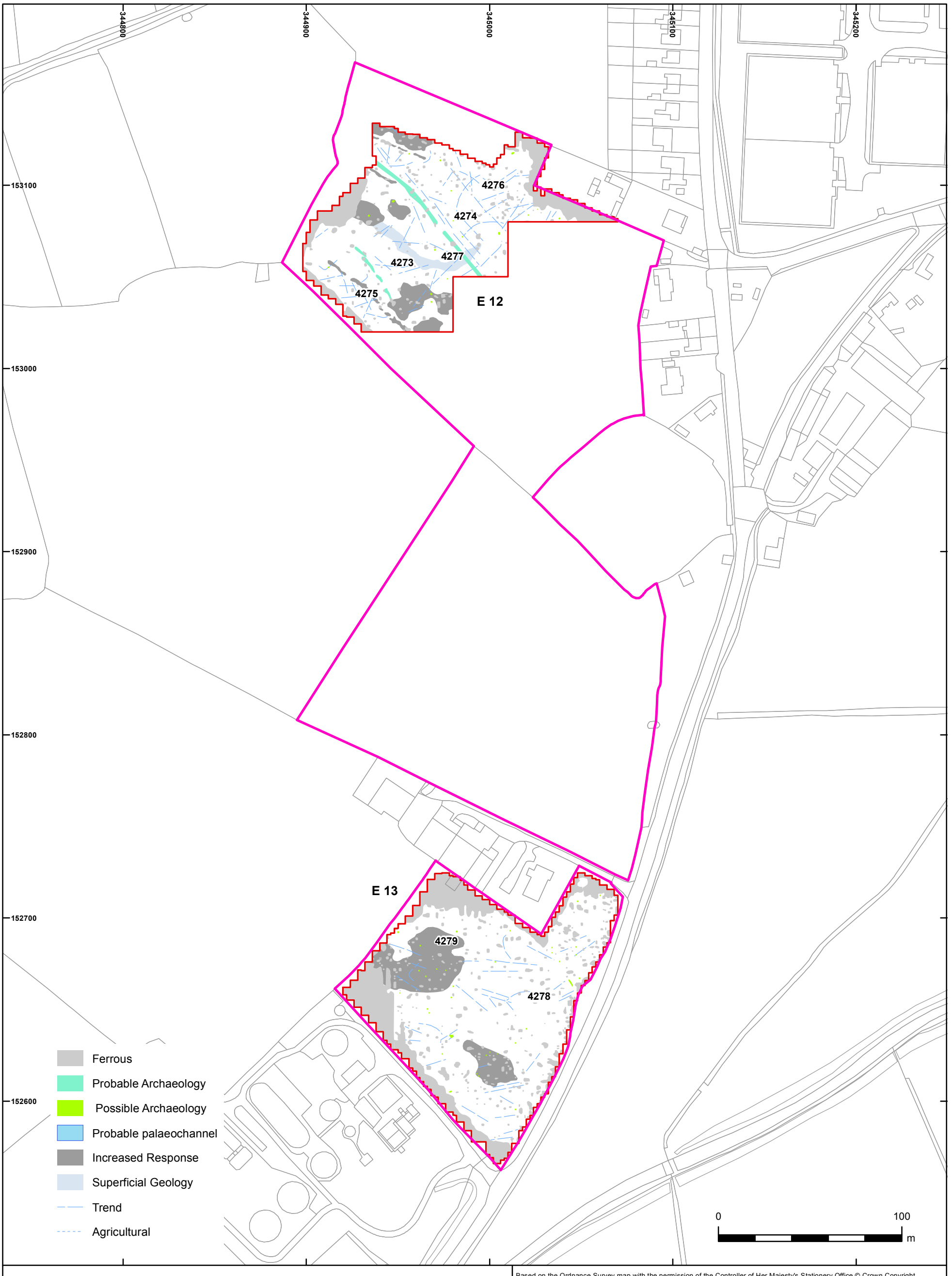
Eastern Extension Region: XY trace

Figure 6



The Site

Survey Extents

Date:	18/09/13	Revision Number:	0
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Eastern Extension Region: Interpretation

Figure 7

153000

152000

344000

0 200 m

The Site
Survey Extents
Previous Detail Survey Extents
Ferrous
Archaeology
Probable Archaeology
Possible Archaeology
Trend
Agricultural
Probable palaeochannel
Increased Response
Superficial Geology
Modern Service

Date:	18/09/13	Revision Number:	0
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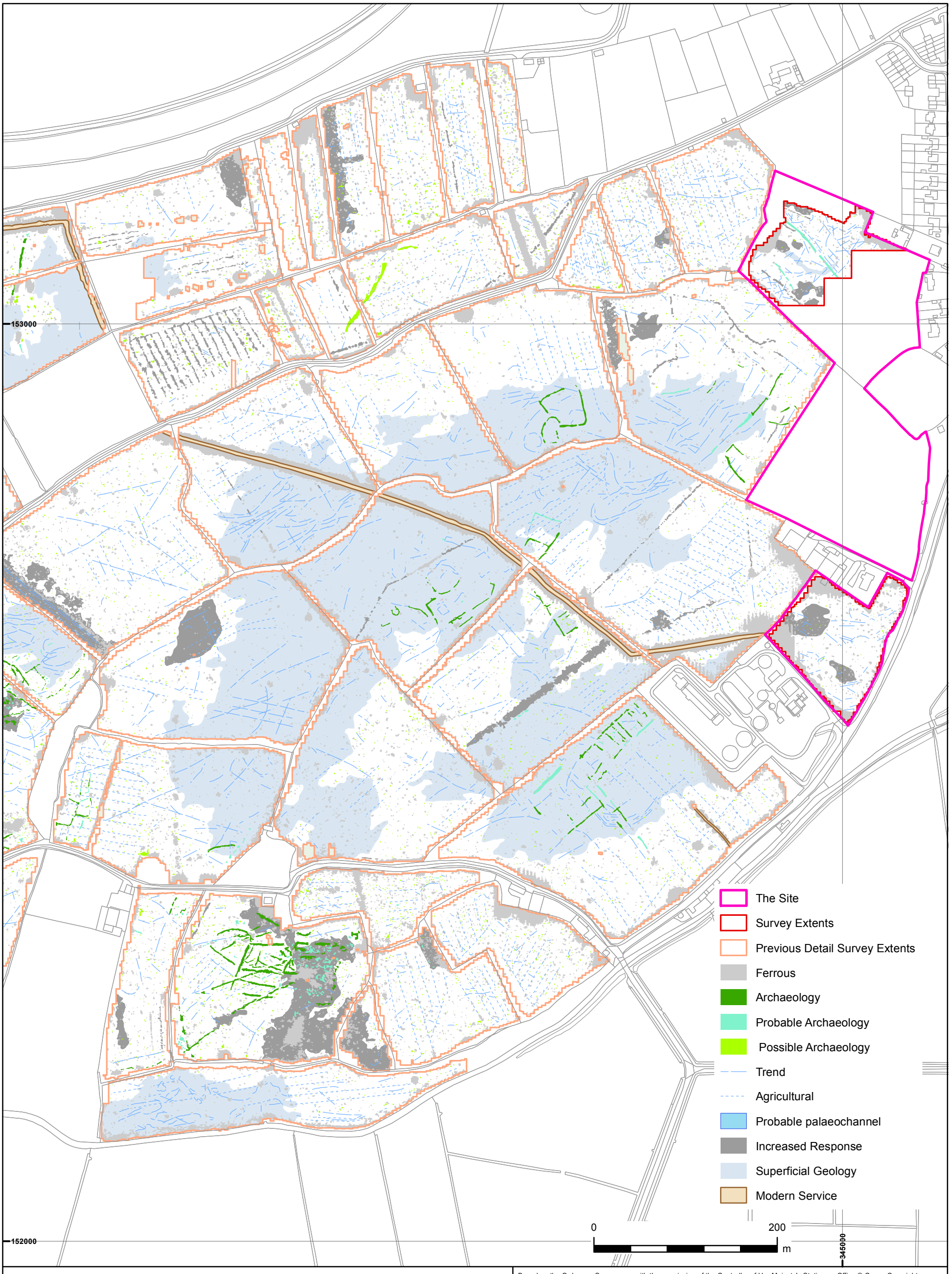
All interpretation data, western half of scheme

Figure 8



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All interpretation data, eastern half of scheme

Figure 9

wessex archaeology

salisbury rochester sheffield edinburgh

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