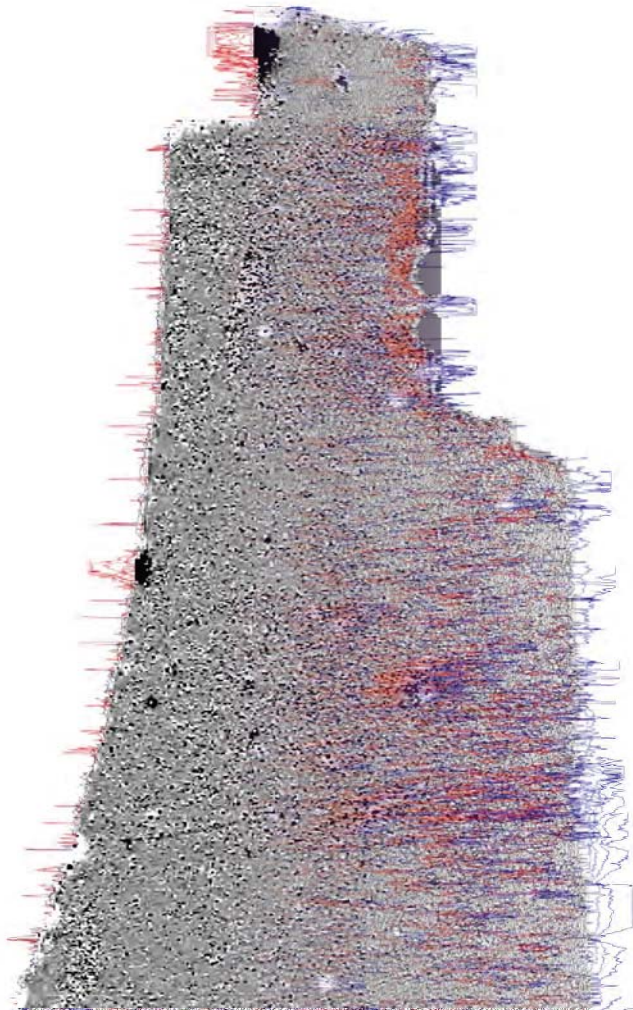


The West Midlands Rail Freight Interchange Order 201X
Technical Appendix 8.4 - Detailed Gradiometer Survey Report
Regulation 5(2)(a)
Wessex - September 2017



West-Midlands Interchange Staffordshire

Detailed Gradiometer Survey Report



Ref: 112702.02
September 2017



© Wessex Archaeology Ltd 2017, all rights reserved.

Portway House
Old Sarum Park
Salisbury
Wiltshire
SP4 6EB

www.wessexarch.co.uk

Wessex Archaeology Ltd is a Registered Charity no. 287786 (England & Wales) and SC042630 (Scotland)

Disclaimer

The material contained in this report was designed as an integral part of a report to an individual client and was prepared solely for the benefit of that client. The material contained in this report does not necessarily stand on its own and is not intended to nor should it be relied upon by any third party. To the fullest extent permitted by law Wessex Archaeology will not be liable by reason of breach of contract negligence or otherwise for any loss or damage (whether direct indirect or consequential) occasioned to any person acting or omitting to act or refraining from acting in reliance upon the material contained in this report arising from or connected with any error or omission in the material contained in the report. Loss or damage as referred to above shall be deemed to include, but is not limited to, any loss of profits or anticipated profits damage to reputation or goodwill loss of business or anticipated business damages costs expenses incurred or payable to any third party (in all cases whether direct indirect or consequential) or any other direct indirect or consequential loss or damage.

Document Information

Document title West Midlands Interchange, Staffordshire
Document subtitle Detailed Gradiometer Survey Report
Document reference 112702.02

Client name Ramboll-Environ
Address 8 The Wharf
Bridge Street
Birmingham
B1 2JS
United Kingdom

Site location Four Ashes
County Staffordshire
National grid reference 392294 309622 (SJ 92294 09622)
Statutory designations N/A

WA project name West Midlands Interchange, Staffordshire
WA project code 112702
Dates of fieldwork 05/06/2017 – 08/09/2017
Fieldwork directed by Chirs Hirst
Project management by Alexandra Grassam
Document compiled by Alexander Schmidt
Contributions from Nicholas Crabb
Graphics by Nancy Dixon

Quality Assurance

Issue and date	Status	Author	Approved by
1	25/09/2017	Version 1	AJS NLC
2	26/09/2017	Version 2	AJS/NLC AG
3	09/10/2017	Revision following comment	AR AG



Contents

Summary.....	iii
Acknowledgements.....	iv
1 INTRODUCTION	1
1.1 Project background	1
1.2 Scope of document	1
1.3 The Site	1
2 ARCHAEOLOGICAL BACKGROUND	2
2.1 Introduction.....	2
2.2 Summary of the known archaeological resource.....	2
2.3 Recent investigations within the Site	4
3 METHODOLOGY	4
3.1 Introduction.....	4
3.2 Aims and objectives	4
3.3 Fieldwork methodology	5
3.4 Data processing	5
4 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION.....	5
4.1 Introduction.....	5
4.2 Gradiometer survey results and interpretation	6
5 CONCLUSIONS	9
REFERENCES	10
Bibliography	10
Cartographic and documentary sources.....	10
Online resources.....	10
APPENDICES.....	11
Appendix 1: Survey Equipment and Data Processing	11
Appendix 2: Geophysical Interpretation	13
Appendix 3: OASIS form	14



List of Figures

- Figure 1** Site location and survey extents
- Figure 2** Gradiometer survey results: Greyscale plot - Area A
- Figure 3** Gradiometer survey results: XY Trace plot - Area A
- Figure 4** Gradiometer survey results: Interpretation - Area A
- Figure 5** Gradiometer survey results: Greyscale plot - Area B
- Figure 6** Gradiometer survey results: XY Trace plot - Area B
- Figure 7** Gradiometer survey results: Interpretation - Area B
- Figure 8** Gradiometer survey results: Greyscale plot - Area C
- Figure 9** Gradiometer survey results: XY Trace plot - Area C
- Figure 10** Gradiometer survey results: Interpretation - Area C
- Figure 11** Gradiometer survey results: Greyscale plot - Area D
- Figure 12** Gradiometer survey results: XY Trace plot - Area D
- Figure 13** Gradiometer survey results: Interpretation - Area D
- Figure 14** Gradiometer survey results: Greyscale plot - Area E
- Figure 15** Gradiometer survey results: XY Trace plot - Area E
- Figure 16** Gradiometer survey results: Interpretation - Area E
- Figure 17** Gradiometer survey results: Greyscale plot - Area I
- Figure 18** Gradiometer survey results: XY Trace plot - Area I
- Figure 19** Gradiometer survey results: Interpretation - Area I



Summary

A detailed gradiometer survey was conducted over land at the proposed site of the West Midlands Interchange, Staffordshire (centred on NGR 392294 309622). The project was commissioned by Ramboll-Environ with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features in support of an application for a Development Consent Order (DCO) for the development of the site as Strategic Rail Freight Interchange, to be submitted to the Secretary of State (SoS) via the Planning Inspectorate (PINS).

The majority of the site is primarily under arable cultivation consisting of numerous fields to the north of Four Ashes, Staffordshire. The proposed development area covers a total of 297 ha, of which 37 ha is detailed in this report. The surveyed areas were considered to be higher priority due to their proximity to cropmarks and other possible archaeological features (A – E and I).

The anomalies identified as being of archaeological interest are primarily pit and ditch-like features. However, a possible ring-ditch and two probable former field boundaries have also been identified. These features are predominantly located directly south of the A5/Watling Street, a Roman road, adjacent to the northern boundary of the site which will mostly contain green infrastructure. It is possible therefore that they may be associated with Roman activity in the area, however this is not clear based on these results alone.

Evidence for historic ridge and furrow ploughing has been clearly identified in Area D and Area I. Throughout the remainder of the areas, this is much less clear. Although there are numerous ploughing trends identifiable within the geophysical survey results, these are thought to be associated with modern agricultural practice. This suggests that the ridge and furrow features identified in LiDAR data have been significantly reduced by modern agricultural practice.

Evidence for field drains is apparent across many of the areas and a modern service has been identified in Area A and B. There are also some isolated increased magnetic responses which are thought to be associated with the infilling of the natural topography or superficial geological deposits. Additionally, two larger areas of increased magnetic response have been identified in Area E which relate to the use of green waste as a fertiliser.



Acknowledgements

Wessex Archaeology would like to thank Ramboll Environ for commissioning the geophysical survey. The assistance of Matt Royall and Rachel Naylor is gratefully acknowledged in this regard.

The fieldwork was carried out by Alexander Schmidt, Chris Hirst, Matt Tooke, Adam Fraser and Owen Jenkins. The data processing, interpretation and report were compiled and written by Alexander Schmidt. Illustrations were prepared by Nancy Dixon. The geophysical work was quality controlled by Nicholas Crabb and Alexandra Grassam managed the project on behalf of Wessex Archaeology.



West Midlands Interchange, Staffordshire

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Ramboll-Environ to carry out a geophysical survey at the site of the proposed West Midlands Interchange, Four Ashes, Staffordshire (hereafter “the Site”, centred on NGR 392294 309622) (**Figure 1**). The project was commissioned by Ramboll-Environ with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features in support of an application for a Development Consent Order (DCO) for the development of the site as Strategic Rail Freight Interchange, to be submitted to the Secretary of State (SoS) via the Planning Inspectorate (PINS). This study will form a technical appendix of an Environmental Statement (ES).

1.2 Scope of document

1.2.1 This report presents a brief description of the methodology followed by the detailed survey results and the archaeological interpretation of the geophysical data.

1.3 The Site

1.3.1 The Site, in its entirety, comprises 297 ha of relatively flat terrain, lying at approximately 95 m to 116 m aOD. Elevation is lowest in the Marsh Farm area on the western edge of the Site, from which point the terrain rises slowly eastwards towards the route of the M6.

1.3.2 It is bounded to the north by the A5 (Watling Street), to the east by the M6 and Stable Lane. It is also bound to the south by Straight Mile and a section of the Staffordshire and Worcestershire Canal, and to the west by the A449.

1.3.3 The majority of the Site is primarily under arable cultivation consisting of numerous fields enclosed by hedgerows. The Site contains Calf Heath Quarry and Calf Heath Woods, which together comprise an area of 52 ha which are not suitable for geophysical survey.

1.3.4 This report details the survey of the six areas, together covering 37 ha, allocated as being of high priority due to their proximity to cropmarks and other possible archaeological features (Areas A to E and I; **Figure 1**).

1.3.5 The solid geology varies slightly throughout the site. In the north-west and western edge of the Site the bedrock geology comprises sandstone of the Helsby formation. The remaining area comprises Wildmoor Sandstone (BGS 2017). Superficial geological deposits are recorded across the Site and are predominantly Glaciofluvial Deposits of sand and gravel. A band of Alluvium is also recorded heading from Marsh Farm in the west to the south of Calf Heath Quarry.

1.3.6 The soils underlying the Site are likely to consist of typical stagnogley soils of the 711n (Clifton) association (SSEW SE Sheet 3-2 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 ARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 An Archaeological Desk-Based Assessment (DBA) was undertaken by Wessex Archaeology (2017a). This examined the potential for the survival of buried archaeological remains within the development area and a 1 km Study Area. It used information provided by the Staffordshire Historic Environment Record (SHER) and the National Heritage List for England (NHLE). The following background is summarised from the DBA.

2.2 Summary of the known archaeological resource

2.2.1 There are no designated heritage assets within the Site, although there is a cluster of four Scheduled Monuments located approximately 750 m to the north-west of the Site. These are situated alongside the route of Watling Street (which in part forms the northern boundary of the Site), are all associated with the strong Roman presence in the area. They comprise Two Roman Camps north of Water Eaton (NHLE no. 1006097); a Roman Fort west of Eaton House (NHLE no. 1006098); a Roman camp at Kinvaston (NHLE no. 1006104) and the Site of *Pennocrucium*, east of Stretton Bridge (NHLE no. 1006121).

2.2.2 There are no listed buildings within the Site, but directly south of Watling Street, in between Area A and B, there are two Grade II listed properties at Gailey Wharf. These include Wharf Cottage (NHLE no. 1039205) and the Round House (NHLE no. 1188285). These are also located within the Staffordshire and Worcester Canal Conservation Area, which runs through the Site, although only very small sections are located within the survey area.

2.2.3 The earliest archaeological evidence within the Study Area is located within the Site. Cropmarks identified from aerial photographs indicate the presence of a ring ditch and linear feature (within Area I) which have been dated to the Neolithic period. Additionally, two barrows located approximately 400 m south of the Site, were noted by antiquarians in the 17th and 18th centuries. However, gravel quarrying in the area appears to have removed any remains.

2.2.4 Cropmarks identified from aerial photographs approximately 660 m north-west of the Site indicate an irregular enclosure containing two sub-circular enclosures and linear features thought to date to the Iron Age.

2.2.5 The wider Study Area contains evidence for significant occupation during the Romano-British period including the four previously mentioned Scheduled Monuments. This activity is clustered approximately 750 m north-west of the Site which is thought to be a strategic location and a nodal point in the Roman road system, with roads leaving Watling Street for Chester, Wroxeter, Greensforge, and perhaps Metchley. Three of the Scheduled Monuments relate to camps or forts constructed by the Roman military (NHLE no. 1006097; 1006098 and 1006104). The camps comprise rectangular or sub-rectangular enclosures which were used by Roman soldiers when on campaign or as practice camps. In addition, the remains of Roman settlement of *Pennocrucium* (NHLE no. 1006121) is also located in this area.

2.2.6 The route of Watling Street ran from the east coast of England, through the major settlements at London (*Londinium*) and St Albans (*Verulaium*), along the northern edge of

the Site to the settlement at Water Eaton (*Pennocrucium*) and on towards the major town at Wroxeter (*Viroconium Cornoviorum*). Three subsidiary roads are recorded to the west of the Site, which extend south from Watling Street and comprise the road from Crateford to Standeford Green, the road from *Pennocrucium* to Kingswood and the road from *Pennocrucium* to Greensford. Several features identified from cropmarks on aerial photographs are also noted as being potential Roman Roads including two sets of parallel linear cropmarks on a north-western alignment, located approximately 745 m north-west of the Site.

- 2.2.7 Aside from the Scheduled Monuments and roads, several findspots of Roman coins are recorded. This includes a complete silver Roman republican denarius minted in 82 BC which is recorded as having been found close to the southern boundary of Area E. There are also several findspots of Roman pottery are also documented within the wider Study Area.
- 2.2.8 Two settlements are recorded within the Study area that can trace their origins to the Anglo-Saxon period. Gailey, or *Gragelie*, is located close to the southern boundary of Area A and is recorded as having one villager in the Domesday Survey on 1086. The settlement at Rodbaston, or *Redbaldeson*, is located approximately 540 m north of the Site, and the earthwork remains of at least three house platforms have been identified. Other finds from the Anglo-Saxon period within the Study Area include two copper alloy strap ends, found approximately 250 m north of the Site while a copper alloy strap end and stirrup strap mount with an animal's head were recovered within the centre of Area J.
- 2.2.9 A series of upstanding earthworks located approximately 300 m south of the Site have been interpreted as the possible remains of a medieval moat. A rectangular feature located approximately 1 km north-west of the Site feature may be associated with a ploughed-out moat, although it is possible that these may in fact relate to the significant Roman occupation of this area.
- 2.2.10 There are numerous features within the Study Area relating to medieval agricultural practices which include areas of ridge and furrow and earthworks associated with former field boundaries and drainage systems. Other finds from the medieval period within the Study Area include several sherds of 11th to 14th century pottery located approximately 500 m west of the Site and an incomplete 14th century cast copper alloy horse harness suspension mount located approximately 785 m west of the Site.
- 2.2.11 Numerous isolated farms and farmsteads throughout the Study Area are dated to the Post-medieval period. There are also linear earthworks around 625 m south of the Site that have been identified from aerial photographs and are likely represent former post-medieval field systems.
- 2.2.12 Running through the centre of the Site on a roughly north-south orientation is the Staffordshire and Worcestershire Canal, which was constructed in 1772. The canal was designed by James Brindley, as part of his wider plan to link the cities of Hull, Bristol and Liverpool with waterways (gracesguide.co.uk 2016). A reservoir associated with the canal is located 175 m east of Area J.
- 2.2.13 During the 19th century The Grand Junction Railway was built and runs through the Site. Gailey Railway Station is located between two of the land parcels west of Gailey along the northern edge of the Site.



2.3 Recent investigations within the Site

- 2.3.1 A LiDAR data assessment (WA 2017b) was undertaken to establish the location of additional archaeological features present within the Site that are identifiable through the interrogation of LiDAR data-derived visualisations. This resulted in the identification of a number of features of archaeological potential across the Site, except for Calf Heath Wood where understorey and leaf litter may be masking the ground surface and in the Woodside Farm House area, where quarrying has appeared to remove any traces of possible archaeological activity.
- 2.3.2 Several of these features appear to represent the possible remains of ridge and furrow and other agricultural activity. Earlier land division, in the form of former field boundaries, is also a common feature across the Site. The cropmark features recorded in the Staffordshire Historic Environment Record are not visible in the LiDAR data, suggesting that subsequent agricultural activity in the area of the Site has removed any clear above-ground evidence

2.4 Recent investigations in the wider Study Area

- 2.4.1 A trial trench evaluation was carried out on land immediately to the west of the Site's western boundary, north of Vicarage Road, in March 2016. The evaluation found no significant archaeological remains (Oxford Archaeology South 2016).

3 METHODOLOGY

3.1 Introduction

- 3.1.1 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between the 5th June 2017 and the 8th of September 2017, with several phases of survey being undertaken between these dates to allow for the ground conditions on site. Field conditions at the time of the survey's being undertaken were generally good throughout the period of survey, although several delays were caused by the presence of crops on site. Of the 13 areas (Figure 1), those considered to be of the highest priority determined by information gathered during the DBA were selected for survey at this stage (Areas A-E and I).
- 3.1.2 Across the six surveyed areas, an overall coverage of 31.5 ha was achieved. Any reductions in survey area are the result of overgrowing hedgerows, inaccessible or private land, or areas previously deemed unsuitable for survey e.g. parcels of woodland.

3.2 Aims and objectives

- 3.2.1 The aims of the survey comprise the following:
- to conduct a detailed survey covering as much of the specified area as possible, allowing for artificial obstructions;
 - to clarify the presence/absence and extent of any buried archaeological remains within the site;
 - to determine the general nature of the remains present.



3.3 Fieldwork methodology

- 3.3.1 Individual survey grid nodes were established at 30 m x 30 m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02 m and therefore exceeds Historic England recommendations (2008).
- 3.3.2 The detailed gradiometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1 m between sensors. Data were collected at 0.25 m intervals along transects spaced 1 m apart with an effective sensitivity of 0.03 nT, in accordance with Historic England guidelines (Historic England 2008). Data were collected in the zigzag method.

3.4 Data processing

- 3.4.1 Data from the survey was subject to minimal data correction processes. These comprise a Zero Mean Traverse function (± 5 nT 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 throughout the survey area, with no interpolation applied.
- 3.4.2 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

4 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

4.1 Introduction

- 4.1.1 The detailed gradiometer survey has identified magnetic anomalies in each of the surveyed areas of the Site, along with anomalies associated with agricultural and a small amount of increased magnetic response. For ease of reference, each geophysical survey area is discussed individually in the following section. A brief description of the location, is provided, as well as specific reference to the ground coverage and conditions at the time of survey. Results are presented as a series of greyscale plots, XY plots and archaeological interpretations at a scale of 1:2000 (**Figures 2 to 19**). The data are displayed at -2 nT (white) to +3 nT (black) for the greyscale image and ± 25 nT at 25 nT per cm for the XY trace plots.
- 4.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4; 7; 10; 13; 16 and 19**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.
- 4.1.3 Numerous ferrous anomalies are visible throughout the dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.
- 4.1.4 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 present than have been identified through geophysical survey.
- 4.1.5 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.

4.2 Gradiometer survey results and interpretation

Area A

- 4.2.1 This area is spread across three fields and is in the north of the Site, directly south of the A5 and is also directly north of Area F. A total area measuring 6.3 ha was achieved, with only small areas not possible to cover due to the presence of trees within the fields and farm buildings and a wooded area in the north near Gailey Farm (**Figures 2 to 4**).
- 4.2.2 Within the most central of the three fields there are several anomalies that have been interpreted as possible archaeology. At **4000** there is an amorphous, irregularly shaped positive magnetic anomaly which measures 10 x 4 m. This is characterised by values measuring from +3 nT to +9 nT. On the northern edge of this there is also a negative response with values recorded in the order of 0 to -2 nT. It is possible that this may represent a large pit-like feature and the large size may suggest that is associated with an extraction pit. However, given the irregular shape of the feature it is equally possible that this may be a feature natural in origin.
- 4.2.3 45 m to the south-east of **4000** there is a small cluster of three sub-circular positive anomalies (**4001**). These have a magnitude of +3 nT to +6 nT and are relatively circular in plan, with a diameter measuring between 1.5 and 3 m. It is possible that these may be associated with possible pit-like features, although they may simply be associated with natural pitting in the underlying bedrock.
- 4.2.4 Traversing the north-western part of the central field in Area A is a very weak positive linear anomaly (c. +0.5 nT) at **4002**. This is orientated on a north-east to south-west alignment and extends for 35 m and is a maximum of 1 m wide. It is likely that this may represent a ditch-like feature or former field boundary. As this does not correspond with any feature visible in historic mapping for the area, and is also not visible in the LiDAR data, it is possible that it may be associated with an archaeological feature. However, it is possible that this may be associated with ploughing activity in the area.
- 4.2.5 In the most westerly field of Area A, there are several very weakly positive (< 0.5 nT) linear trends. Some of these are interpreted as evidence for ploughing, but those which are not aligned on the same orientation as the existing field boundaries are more difficult to provide specific interpretations for.

Area B

- 4.2.6 Area B covers a 3.8 ha area located 145 m east of Area A, and is directly east of Gailey Wharf. It comprises part of three fields and the westernmost field is bounded by a thin strip of woodland which prevented the collection of data (**Figures 5 to 7**).
- 4.2.7 In the north-western corner, there is a smaller irregularly shaped positive anomaly. This measures a maximum of 3.5 m in diameter and is represented by values around +3 to +6 nT. The amorphous form suggests that it is likely that this represents natural pitting in the underlying geology. However, due the proximity to Watling Street, which is directly north of the area, it is not possible to rule out a possible archaeological interpretation.
- 4.2.8 In the central of the three fields in Area B, and north-eastern corner of the western most field, there are a series of dipolar linear anomalies (**4004**). These cross the entire surveyed area on a NNE to SSW orientation. There are also several further similar linear

anomalies positioned roughly perpendicular to this and a further example on an east-west alignment. These are all characterised by moderately strong magnetic values up to +/- 20 nT and are associated with an orthogonal network of field drains.

- 4.2.9 In the south-east of Area B, a strong positive (+10 - +100 nT) magnetic response has been identified at **4004**. This is associated with a pylon located at the eastern edge of the field.
- 4.2.10 There are numerous weakly positive (< +0.5 nT) linear anomalies across Area B. These are situated on the same alignment as the current field boundaries (NNE – SSW) and are therefore interpreted as ploughing furrows.
- 4.2.11 Along the western edge of the central field there is a strong dipolar (+/- 100 nT) linear anomaly which likely associated with a modern service (**4006**). This likely turns towards a north-westerly trajectory heading across the north-eastern corner of the westernmost field in Area B.

Area C

- 4.2.12 To the east of the Calf heath reservoir and 180 m south-east of Area B is Area C. This is composed of a single field which is lined with a band of woodland and measures approximately 1.7 ha (**Figures 8 to 10**).
- 4.2.13 Along the western edge of the field there is a small area of increased magnetic response (**4007**). This measures a maximum of 45 x 20 m. Within this there is a small cluster of amorphous positive response which is interpreted as superficial geology. This area also corresponds with the edge of recorded Glaciofluvial deposits of sand and gravel in the area (BGS 2017).
- 4.2.14 At **4008** there is an arrangement of weakly positive and negative (+/- 1 nT) linear anomalies. These extend from an approximately north-south aligned response for c. 70 m, forming a 'herringbone' pattern. This type of response is indicative of a small area of field drains located on the western edge of Area C.

Area D

- 4.2.15 Area D is located south-east of the Calf heath reservoir and is directly west of the Watling street plantation, close to Junction 12 of the M6. It is separated into two fields by an extant field boundary and covers a total area of 6.1 ha (**Figures 11 to 13**).
- 4.2.16 In the centre of the western-most field a weakly positive (, +1 nT) sub-circular anomaly has been identified (**4009**). This measures approximately 5 m in diameter and is interpreted as possible archaeology. This corresponds with the location of a possible ring ditch identified from aerial photographs, however, the type of response encountered within the geophysical survey data is not consistent with such an interpretation. The sub circular form of the anomaly suggests that it is more likely to be associated with a large pit like feature. As such it is unlikely that there is a ring-ditch in this area, but further investigation would be required to investigate this further.
- 4.2.17 In the south-west portion of Area D, a negative (c. -1 nT) linear anomaly has been identified on a north-east to south-west alignment (**4010**). The anomaly traverses the entire field and measures approximately 140 m long and 2.5 m wide. This corresponds to a former field boundary identified on first edition OS mapping dating to 1890.

- 4.2.18 At **4011** and **4012**, there are several weakly positive (c. +0.5 nT) linear anomalies orientated on the same north-east to south-west alignment as 4010. These are regularly spaced between 7.5 m and 10 m apart and cover the entirety of both fields, although they are slightly stronger in the northern portion of the area. This is most likely associated with ridge and furrow ploughing and is corroborated by the LiDAR data, which also identifies blocks of features consistent with this. These features are commonly associated with medieval and earlier post-medieval agricultural activity.
- 4.2.19 There are numerous weakly positive linear anomalies which are orientated perpendicular to **4011** and **4012**. These are also parallel to the existing field boundaries and are therefore interpreted as evidence of more recent ploughing activity.

Area E

- 4.2.20 In the most north-westerly field of the Site is Area E. It covers a total area measuring 8.5 ha and is located directly west of Stafford road. The northern part of the site is adjacent to the route of Watling Street (**Figures 14 to 16**).
- 4.2.21 Directly south of the northern boundary of Area E, there is a fragmented, weakly positive curvilinear anomaly at **4013**. This has an internal diameter of approximately 15 m and measures characterised by magnetic values in the region of +0.5 to +1.5 nT. A possible interpretation of this feature is that it may relate to a possible ring-ditch. However, as this is incomplete and poorly defined within the geophysical survey results, further investigation would be required to elucidate this further.
- 4.2.22 Two large areas, covering almost the entirety of Area E, are characterised increased magnetic response (**4014** and **4015**). This response is most likely associated with the use of green waste as a fertiliser for the agricultural land. It is possible that this could be preventing the detection of more discrete archaeological anomalies in the area. However, if substantial archaeological remains were located within this area it is likely they would be identifiable within the survey results.
- 4.2.23 A weakly positive (+1 to +3 nT) linear anomaly has been identified at **4016**. across the southern portion of the increased magnetic response in Area E (**4007**). It is believed this linear anomaly corresponds to a known footpath identified across the area on historic mapping.

Area I

- 4.2.24 Area I is 210 m south of Area E and is located directly west of Gravelly Farm and north of Gravelly Way. It covers a total area measuring 4.6 ha and occupies a single field (**Figures 17 to 19**).
- 4.2.25 At **4017** there is a weakly positive linear anomaly. This is aligned on an approximate north-west to south-east and measures 136 m in length and approximately 3 – 3.5 m wide. It is characterised by magnetic values from 0 to +2 nT, and is slightly poorly defined. This is most likely associated with a possible ditch-like feature and can also be identified on LiDAR data for the area, albeit very faintly. As this is aligned on the same orientation as the western field boundary of Area I, it is possible that this is associated with a previous land division in the area.
- 4.2.26 There are numerous weakly positive (c. + 0.5 nT) linear trends identified on the same alignment as **4017**, and these are most likely associated with ploughing activity. The LiDAR data for the area suggested that there may be evidence for ridge and furrow within this field on this north-west to south-east alignment, and it is possible that these are



associated with this. However, it is not possible to clearly distinguish this from more recent ploughing activity.

- 4.2.27 In the northern part of Area I, there are two areas of increased magnetic response at **4018** and **4019**. These are irregular in shape and have a maximum diameter of approximately 30 m. They are most likely representative of natural depressions in the landscape that have been subsequently backfilled with material and are not considered to be archaeological in origin.
- 4.2.28 At **4020**, there are a series of dipolar linear anomalies which are positioned in an orthogonal arrangement. These are predominantly located in southern part of Area I and are most likely associated with a network of ceramic field drains.
- 4.2.29 In the north-west corner of Area I there is strong positive response at **4021**. This is caused by a pylon which is located directly north of the survey area.

5 CONCLUSIONS

- 5.1.1 The detailed gradiometer survey has been successful in detecting a small number of anomalies that may be associated with archaeological remains. This includes possible pit and ditch-like features (**4000-4003**; **4009**), a possible ring-ditch (**4013**) and two probable former field boundaries (**4010** and **4017**). Many of these anomalies are located directly south of the A5/Watling Street, a Roman road, adjacent to the northern boundary of the site which will mostly contain green infrastructure. It is possible therefore that they may be associated with Roman activity in the area, however this is not clear based on these results alone.
- 5.1.2 In Area D, there was no evidence to suggest the presence of a ring-ditch that had been previously identified on aerial photographs. However, a large pit-like feature (**4009**) was identified in roughly the same location which may be of archaeological origin.
- 5.1.3 Evidence for historic ridge and furrow ploughing has been identified in Area D and Area I, which indicates these areas were used for agriculture during the medieval/post medieval periods. Throughout the remainder of the areas, this is much less clear. Although there are numerous ploughing trends identifiable within the geophysical survey results, these are thought to be associated with modern agricultural practice. This may suggest that the ridge and furrow features identified in the LiDAR data (WA 2017b) have been significantly reduced by modern agricultural practice.
- 5.1.4 Two significant areas of increased magnetic response have been identified in Area E which relate to the use of green waste as a fertiliser. Although it is possible that this could be preventing the identification of further potential archaeological features, these are likely to be relatively small in scale. Any large features would still be expected to be identifiable within the gradiometer survey results.
- 5.1.5 In addition, evidence for field drains is apparent across many of the areas and a modern service has been identified in Area A and B. There are also some isolated increased magnetic responses which are thought to be associated with the infilling of the natural topography (**4018**; **4019**) or superficial geological deposits (**4007**).



REFERENCES

Bibliography

- English Heritage, 2008. Geophysical Survey in Archaeological Field Evaluation. Research and Professional Service Guideline No 1. Swindon (2nd Edition)
- Garwood, P., 2011. The earlier prehistory of the west midlands. In Watt, S., (ed.). The Archaeology of the West Midlands: A Framework for Research. Oxford: Oxbow Books
- Oxford Archaeology South, 2016. Land off Gravelly Way, Four Ashes, Staffordshire. Archaeological Evaluation Report.
- Schmidt, A, Linford, P, Linford, N, David, A, Gaffney, C, Sarris, A and Fassbinder, J. 2015 Guidelines for the use of geophysics in archaeology: questions to ask and points to consider. EAC Guidelines 2, Belgium: European Archaeological Council.
- Wessex Archaeology 2017a. West Midlands Interchange Staffordshire Archaeological Desk-Based-Assessment
- Wessex Archaeology 2017b. West Midlands Interchange Staffordshire LiDAR Data Assessment

Cartographic and documentary sources

- Ordnance Survey 1983 Soil Survey of England and Wales Sheet 3, Soils of Midland and Western England. Southampton.

Online resources

- British Geological Survey Geology of Britain Viewer (accessed September 2017) <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>
- Grace's Guide to British Industrial History (accessed September 2017) https://www.gracesguide.co.uk/Main_Page
- Old Maps (accessed September 2017) <https://www.old-maps.co.uk/>
- Romanbritain.co.uk, 2016. Pennocrucium. (accessed September 2017) <http://roman-britain.co.uk/places/pennocrucium.html>



APPENDICES

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 ± 100 nT 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 Historic England (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 (English Heritage 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 Historic England (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.
- 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.
- 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.



Appendix 3: OASIS form

Project Details:

Project name		West-Midlands Interchange, Staffordshire			
Type of project		Detailed Gradiometer Survey (Field evaluation)			
Project description		<p>A detailed gradiometer survey was conducted over land at the proposed site of the West-Midlands Interchange, Staffordshire. The project was commissioned by Ramboll-Environ with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features in support an application for a Development Consent Order (DCO) for the development of the site as Strategic Rail Freight Interchange, to be submitted to the Secretary of State (SoS) via the Planning Inspectorate (PINS).. The majority of the site is primarily under arable cultivation consisting of numerous fields to the north of Four Ashes, Staffordshire. The proposed development area covers a total of 271 ha, of which 37 ha is detailed in this report.</p> <p>The anomalies identified as being of archaeological interest are primarily pit- and ditch-like features. However, a possible ring-ditch and two probable former field boundaries have also been identified. These features are predominantly located directly south of the Roman road known as Watling Street, which is adjacent to the northern boundary of the site along the current route of the A5. It is possible therefore that they may be associated with Roman activity in the area, however this is not clear based on these results alone. Evidence for historic ridge and furrow ploughing has been clearly identified in Area D and Area I. Throughout the remainder of the areas, this is much less clear. Although there are numerous ploughing trends identifiable within the geophysical survey results, these are thought to be associated with modern agricultural practice. This may suggest that the ridge and furrow features previously identified in LiDAR data are not well preserved and may have been significantly reduced by modern agricultural practice.</p>			
Project dates		Start: 05-06-2017		End: 08-09-2017	
Previous work		DBA, LiDAR Assessment			
Future work		Unknown			
Project Code:	112702	HER event no.	N/A	OASIS form ID:	wessexar1-296548
		NMR no.	N/A		
		SM no.	N/A		
Planning Application Ref.					
Site Status		N/A			
Land use		Arable			
Monument type		N/A	Period	N/A	

Project Location:

Site Address	Watling Street, Gailey, Staffordshire			Postcode	ST19 5PR
County	Staffordshire	District	Penkridge	Parish	Brewood and Coven / Penkridge
Study Area	37 ha	Height OD	100 – 105 m aOD	NGR	392294 309622

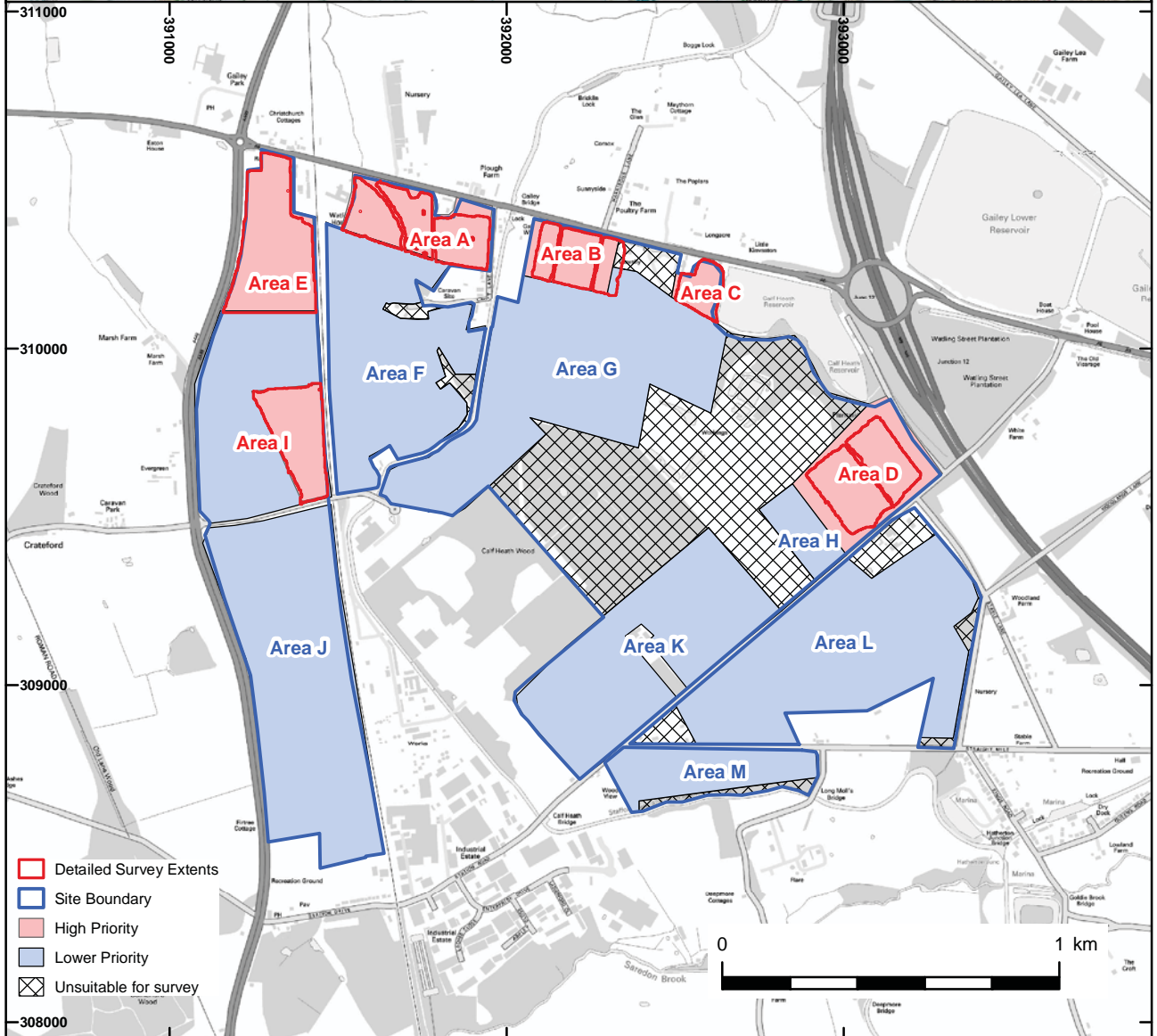
Project Creators:




Name of Organisation	Wessex Archaeology		
Project brief originator	Ramboll-Environ	Project design originator	WA
Project Manager	Alexandra Grassam	Project Supervisor	Chris Hirst
Sponsor or funding body		Type of Sponsor	

Project Archive and Bibliography:

Physical archive	N/A	Digital Archive	Geophysics, survey and report	Paper Archive	N/A
Report title	West-Midlands Interchange, Staffordshire			Date	25/09/2017
Author	Wessex Archaeology	Description	Unpublished report	Report ref.	112702.01



 Coordinate system: OSGB36 (OSTN15/OSGM15)	Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.			
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:18,000 @ A4	Illustrator:	ND
	Path:	X:\PROJECTS\112702\GIS\FigsMXD\2017_09_25		

Site location and survey extents

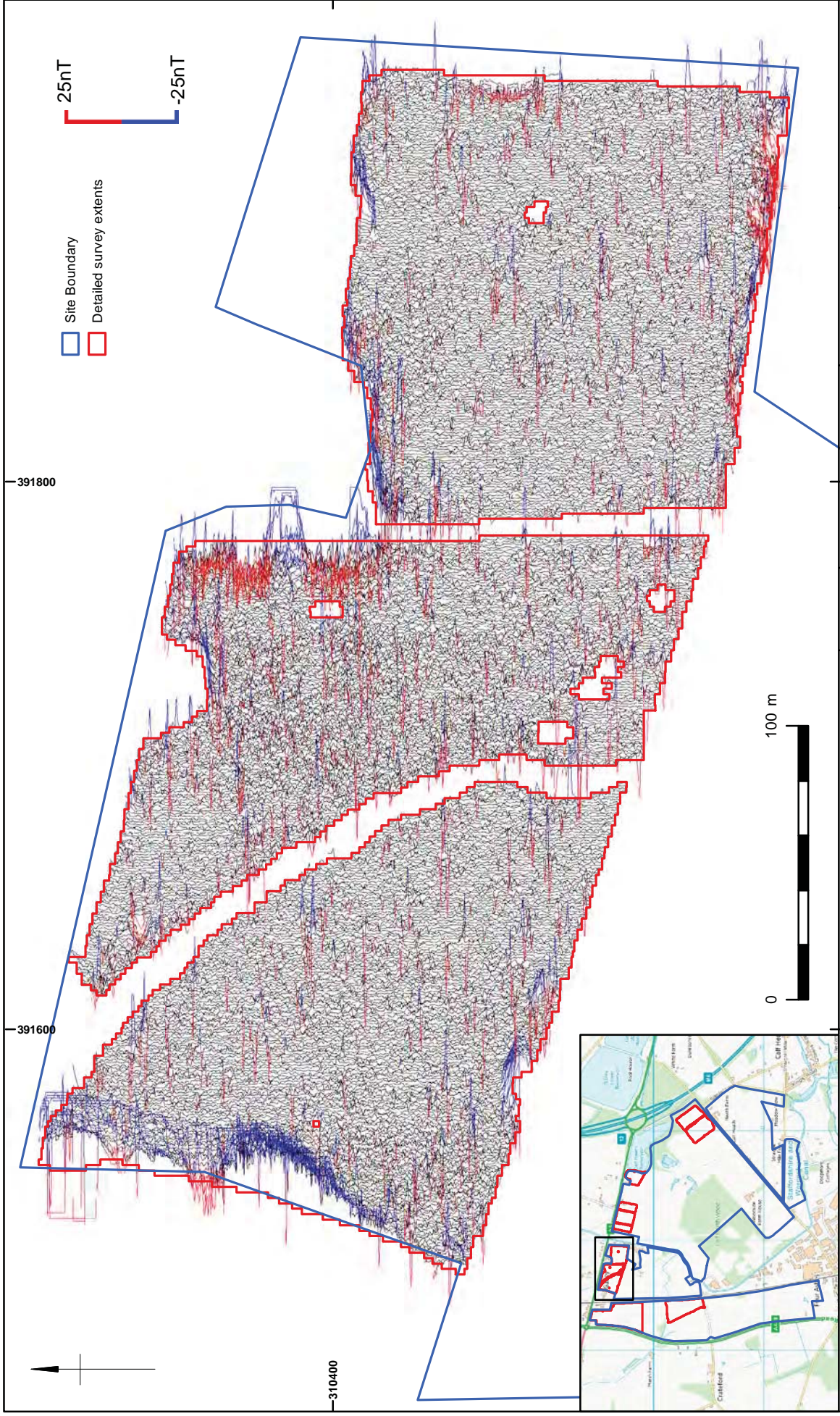
Figure 1



	Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		Coordinate system: OSGB36 (OSTN15/OSGM15)	
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:2000 @ A4	Illustrator:	ND
Path: X:\PROJECTS\112702\GIS\Figs\MXD\2017_09_25				

Graometer survey results: Greyscale plot - Area A

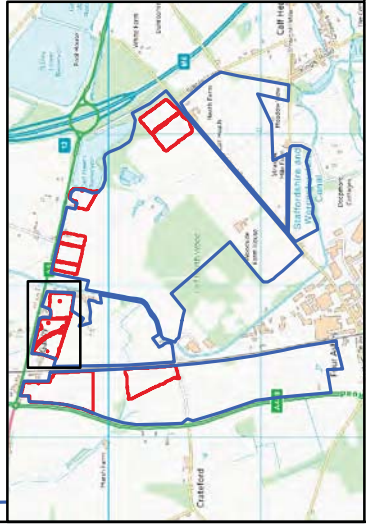
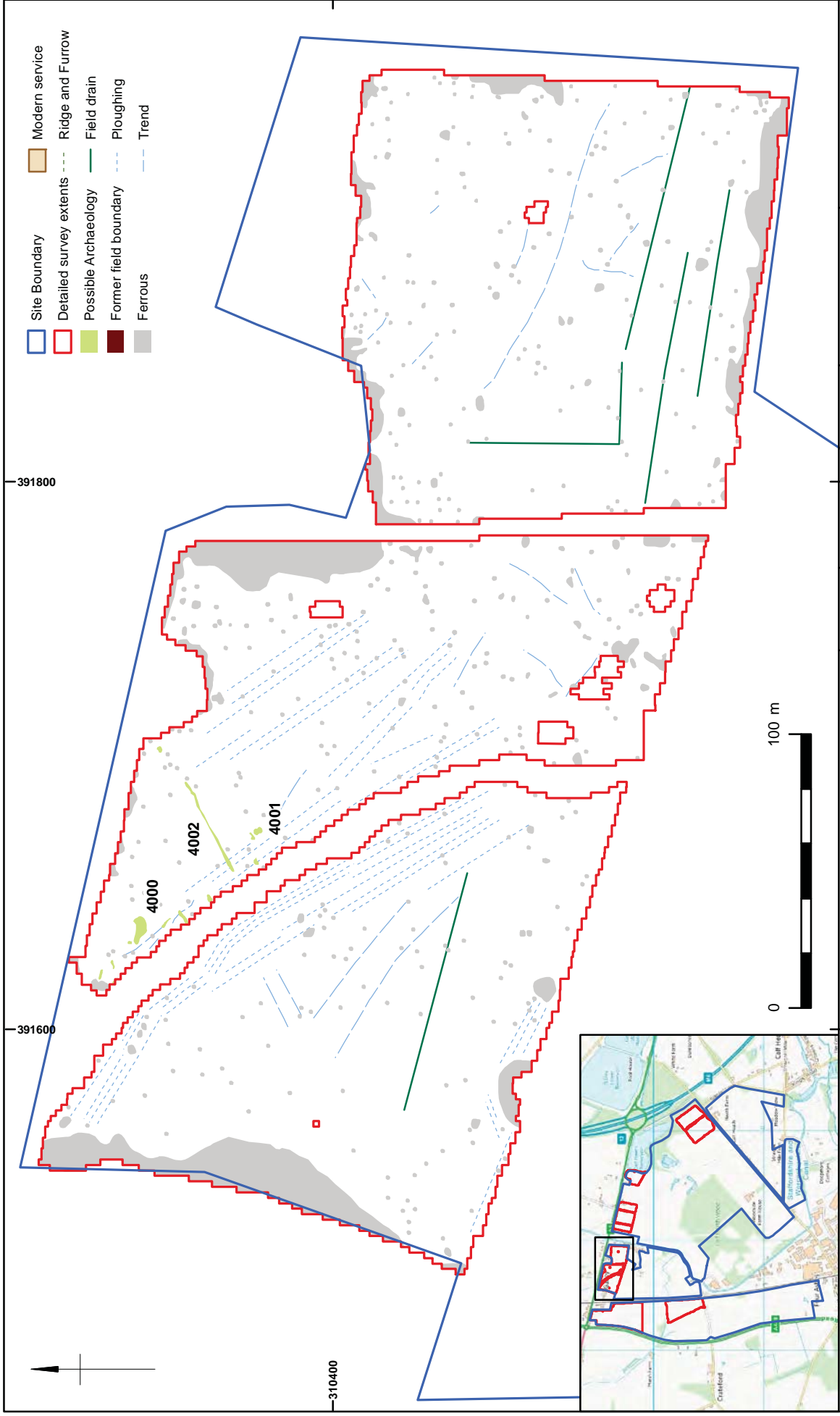
Figure 2



	Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		Coordinate system: OSGB36 (OSTN15/OSGM15)	
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:2000 @ A4	Illustrator:	ND
Path:		X:\PROJECTS\112702\GIS\Figs\MXD\2017_09_25		

Gradiometer survey results: XY-Trace - Area A

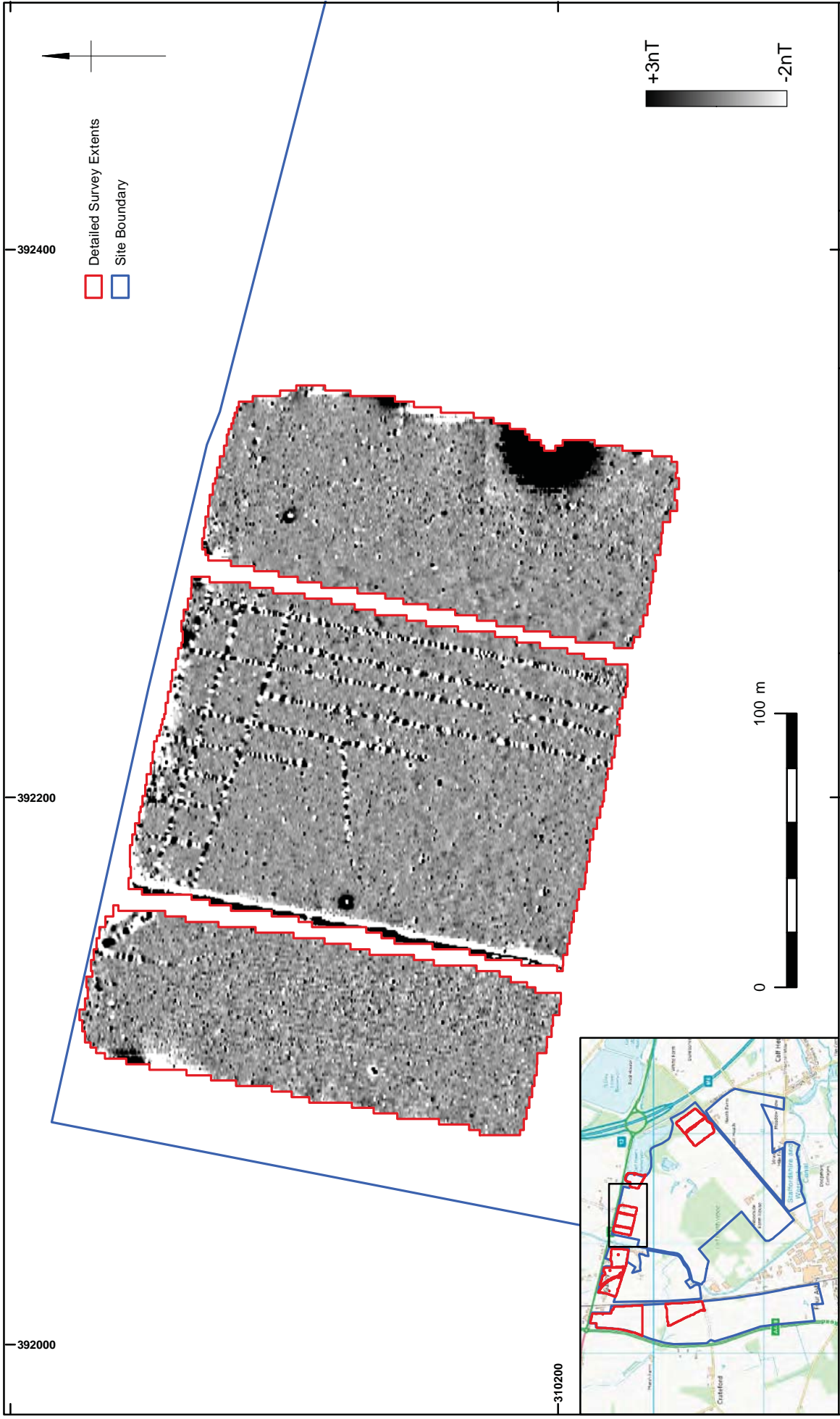
Figure 3



	Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		Coordinate system: OSGB36 (OSTN15/OSGM15)	
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:2000 @ A4	Illustrator:	ND
Path: X:\PROJECTS\112702\GIS\Figs\MXD\2017_09_25				

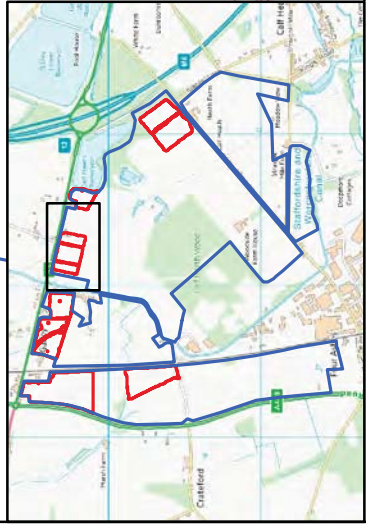
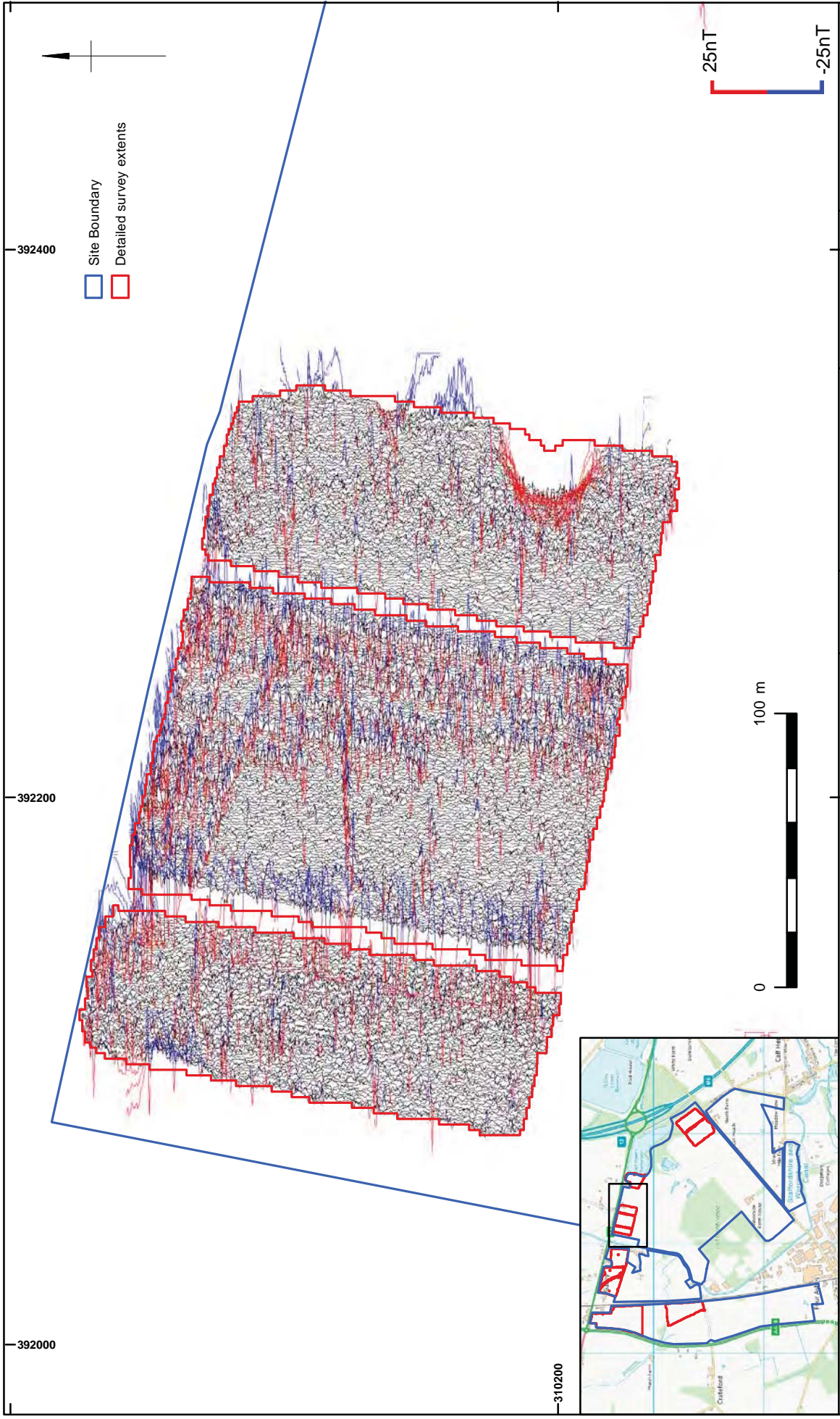
Gradiometer survey results: Interpretation - Area A

Figure 4



	Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		Coordinate system: OSGB36 (OSTN15/OSGM15)	
	Date: 22/09/2017	Revision Number: 0		
	Scale: 1:2000 @ A4	Illustrator: ND		
	Path: Y:\PROJECTS\112702_Sheffield\GIS\Figs\MXD\Geophysics\2017_09_22			

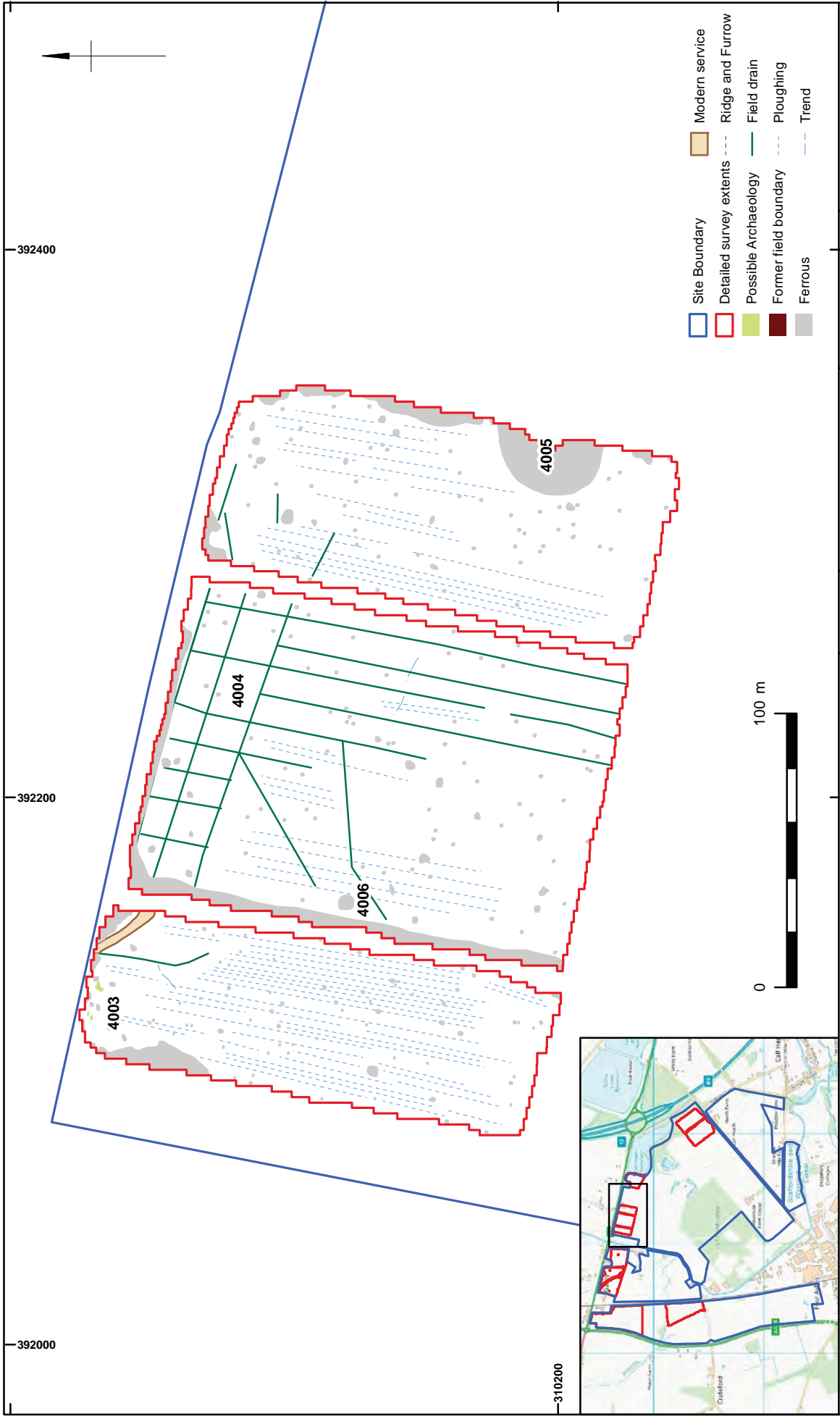
Gradiometer survey results: Greyscale plot - Area B



	Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.		Coordinate system: OSGB36 (OSTN15/OSGM15)	
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:2000 @ A4	Illustrator:	ND
	Path:	X:\PROJECTS\112702\GIS\Figs\MXD\2017_09_25		

Grafiometer survey results: XY-Trace - Area B

Figure 6



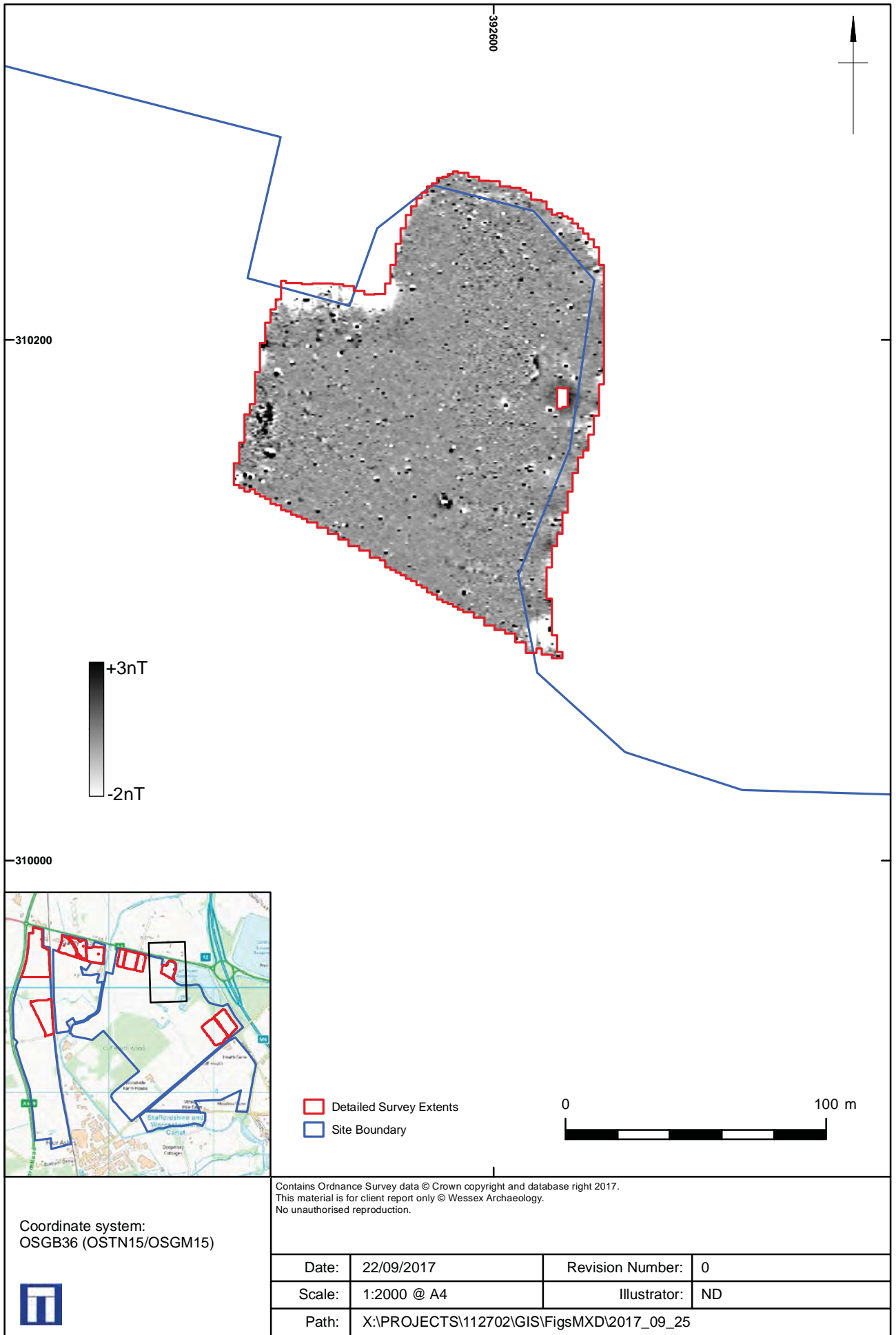
Contains Ordnance Survey data © Crown copyright and database right 2017.
 This material is for client report only © Wessex Archaeology.
 No unauthorised reproduction.

Coordinate system:
 OSGB36 (OSTN15/OSGM15)

Date:	22/09/2017	Revision Number:	0
Scale:	1:2000 @ A4	Illustrator:	ND
Path:	Y:\PROJECTS\112702_Sheffield\GIS\Figs\MXD\Geophysics\2017_09_22		

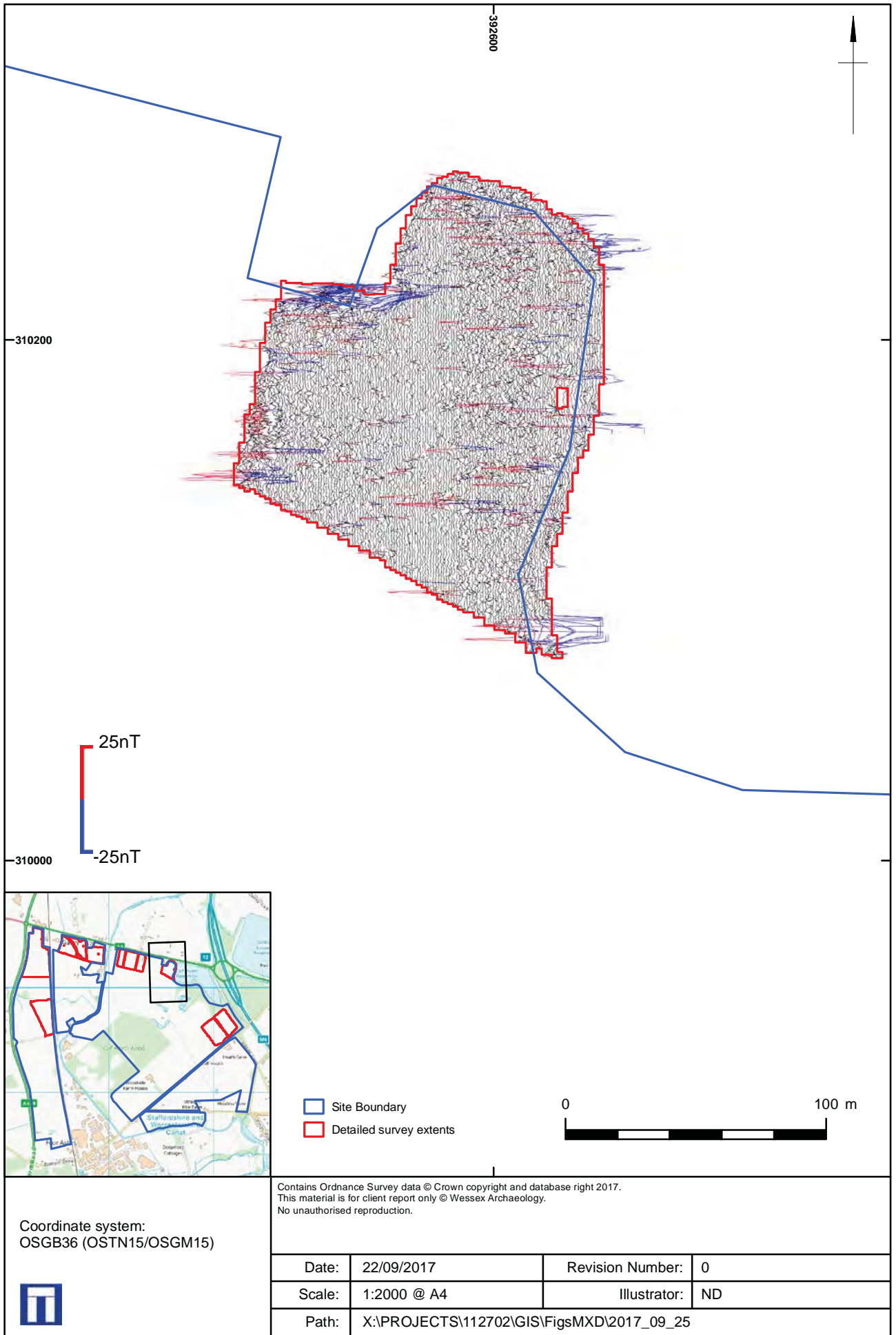
Gradiometer survey results: Interpretation - Area B

Figure 7



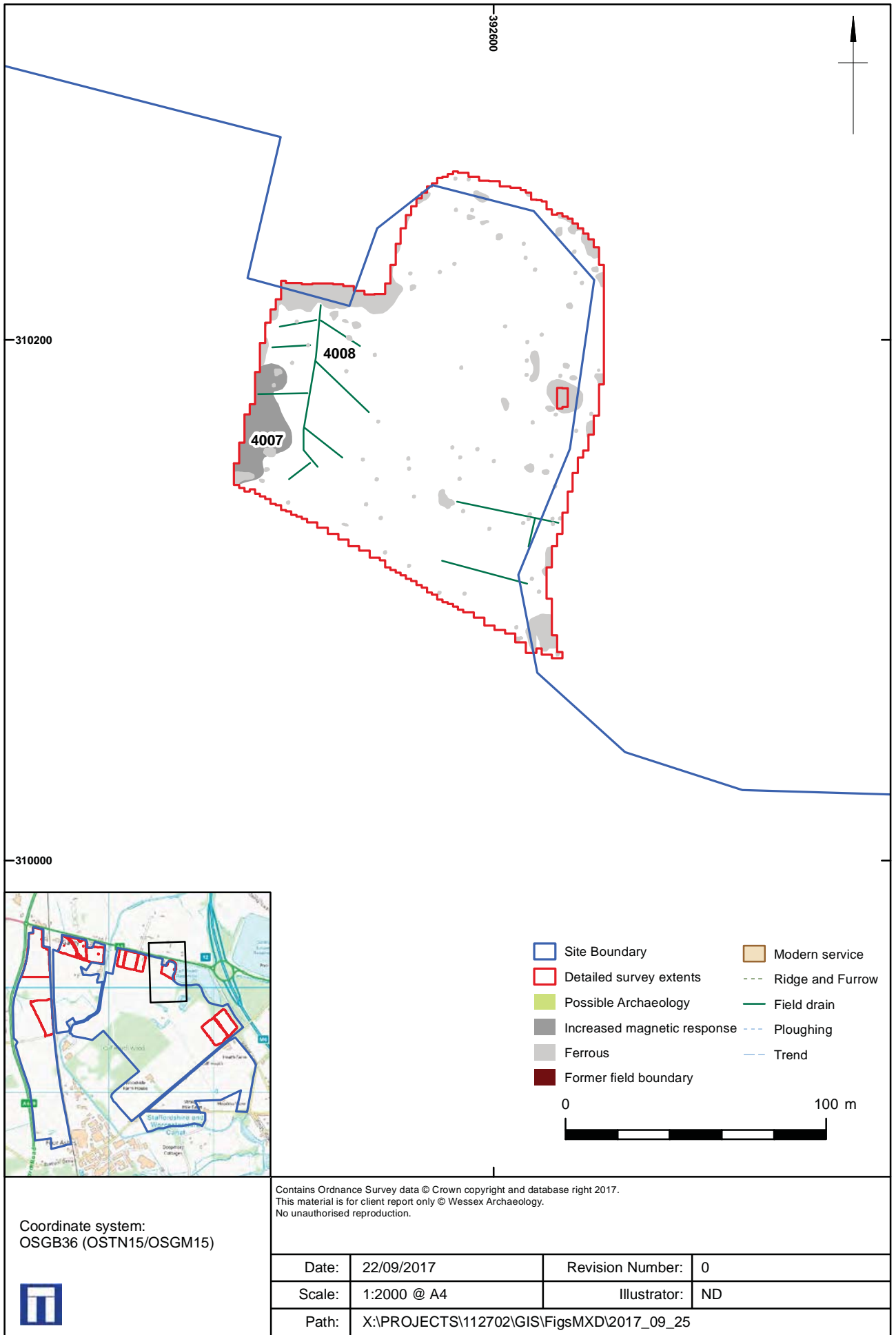
Gradiometer survey results: Greyscale plot - Area C

Figure 8



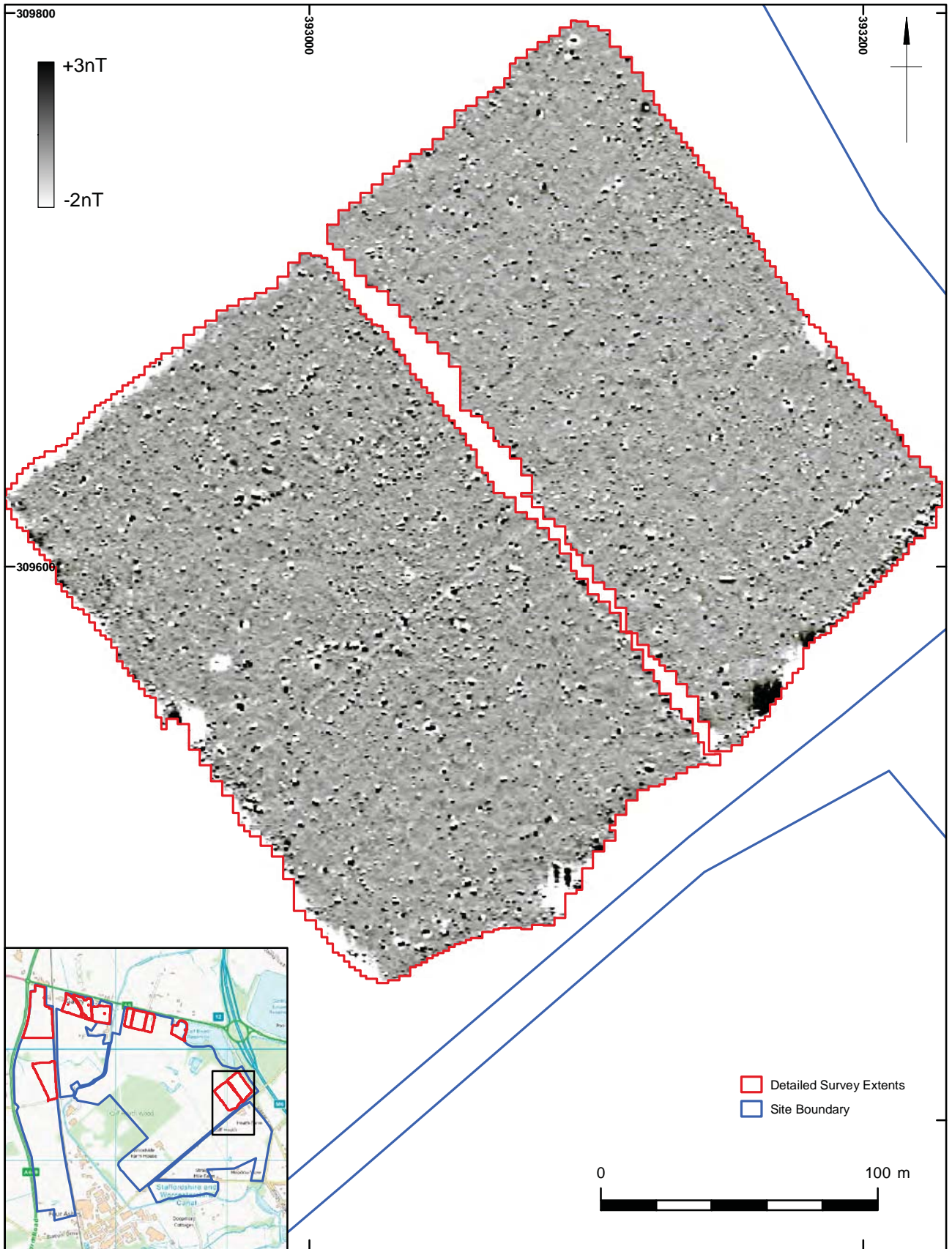
Gradiometer survey results: XY-Trace - Area C


Figure 9



Gradiometer survey results: Interpretation - Area C

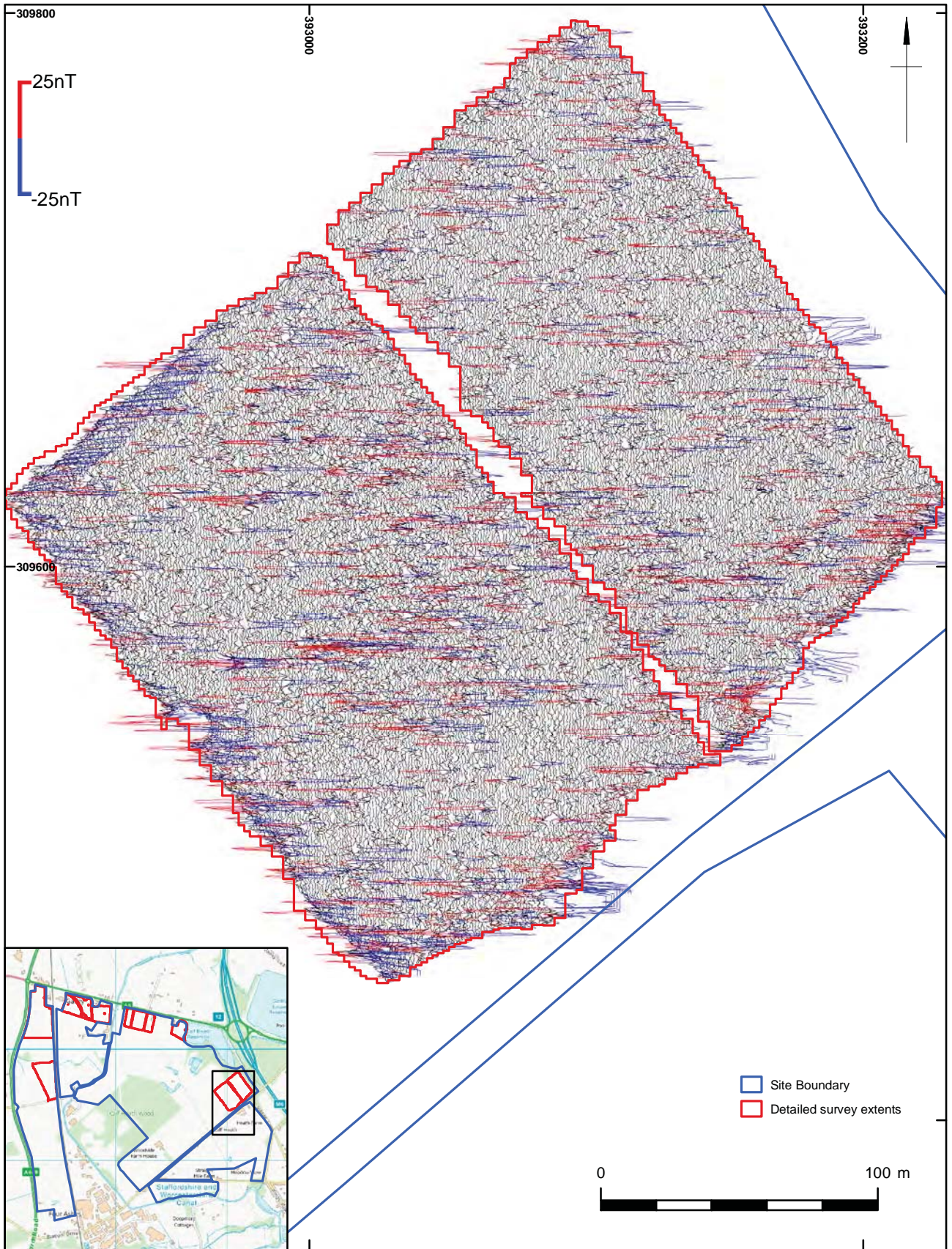
Figure 10




<p>Coordinate system: OSGB36 (OSTN15/OSGM15)</p> 	<p>Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.</p>			
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:2000 @ A4	Illustrator:	ND
	Path:	X:\PROJECTS\112702\GIS\FigsMXD\2017_09_25		

Gradiometer survey results: Greyscale plot - Area D

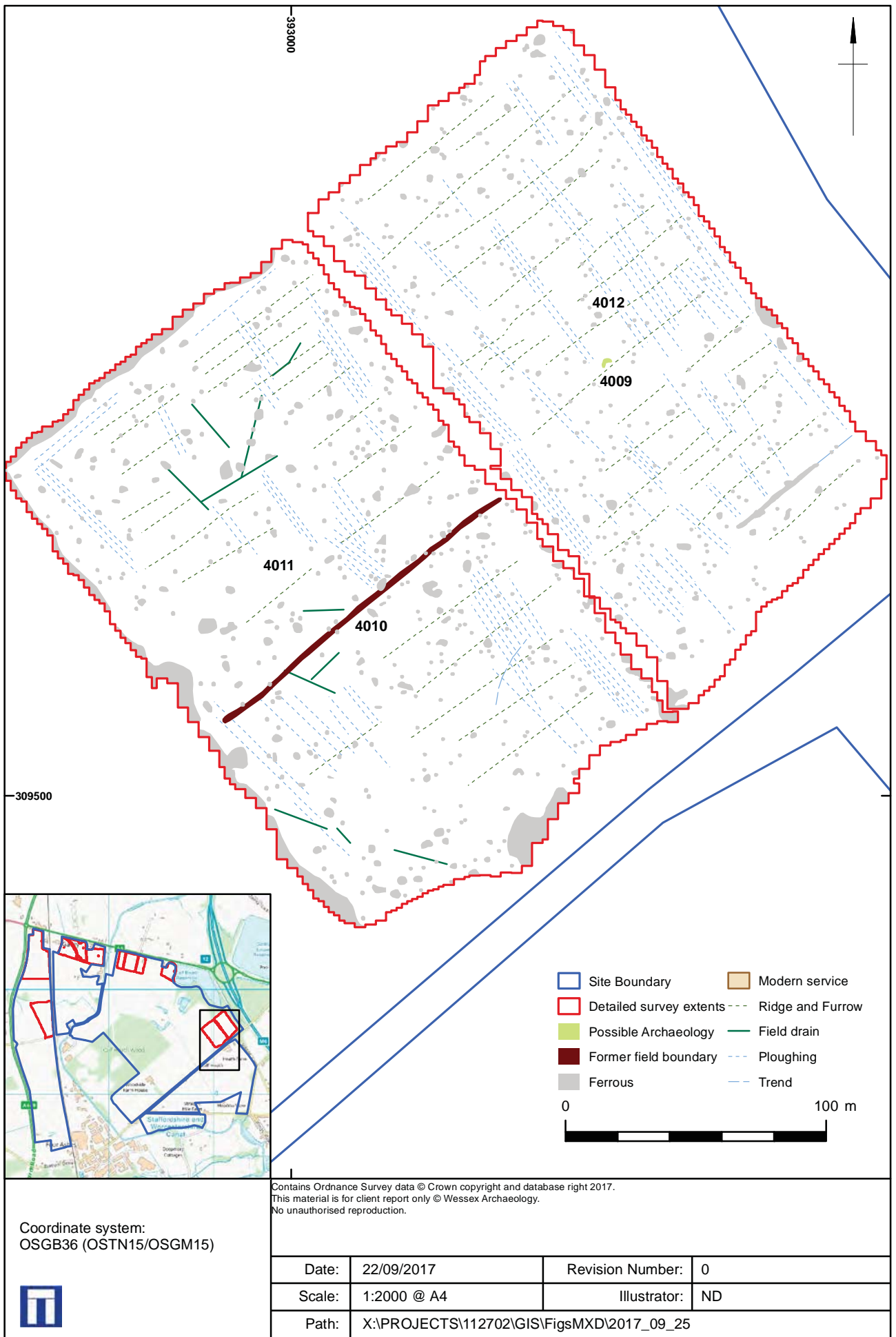
Figure 11



<p>Coordinate system: OSGB36 (OSTN15/OSGM15)</p> 	<p>Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.</p>			
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:2000 @ A4	Illustrator:	ND
	Path:	X:\PROJECTS\112702\GIS\FigsMXD\2017_09_25		

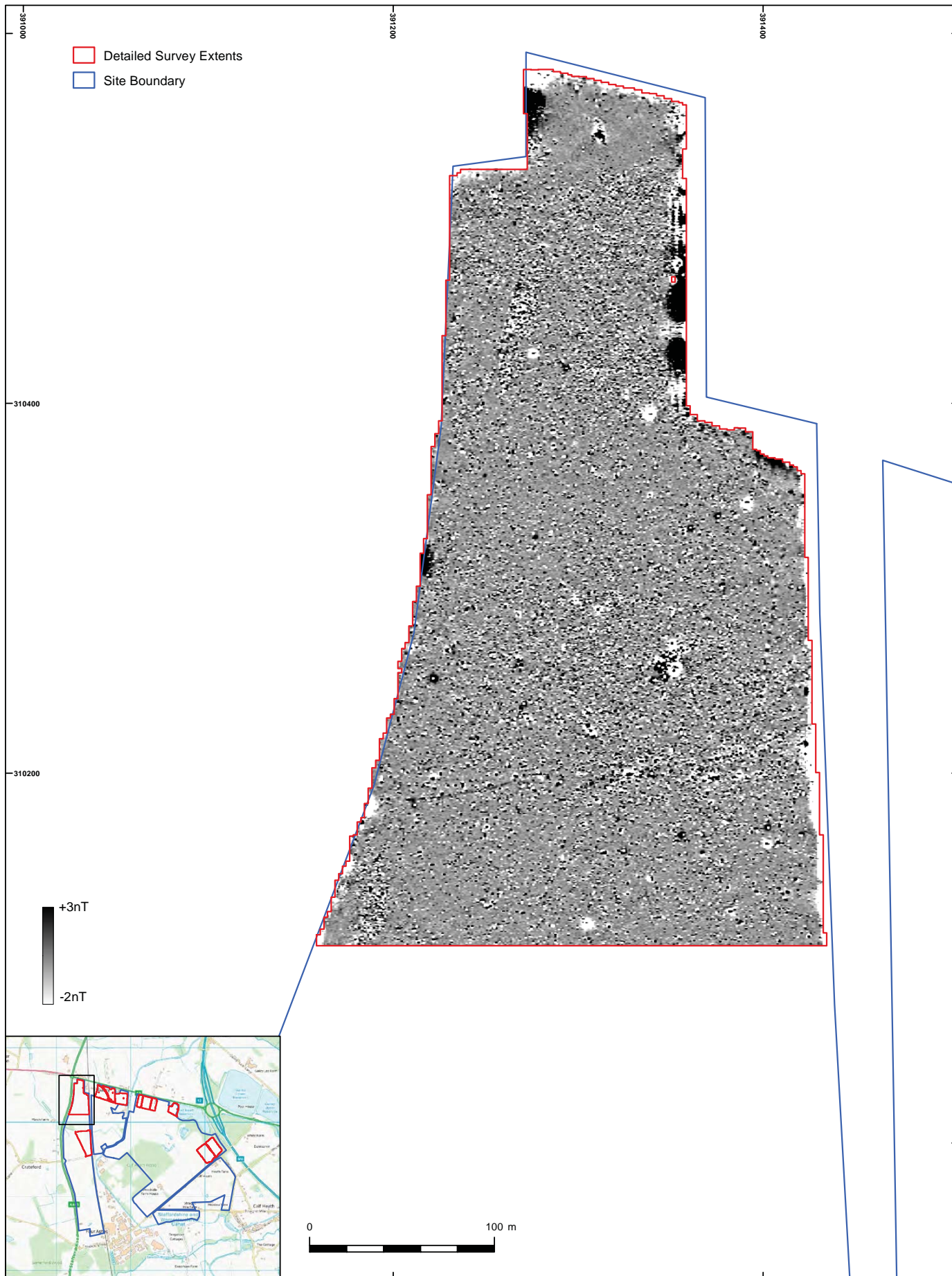
Gradiometer survey results: XY-Trace - Area D

Figure 12



Greyscale survey results: Interpretation - Area D

Figure 13



Coordinate system:
OSGB36 (OSTN15/OSGM15)

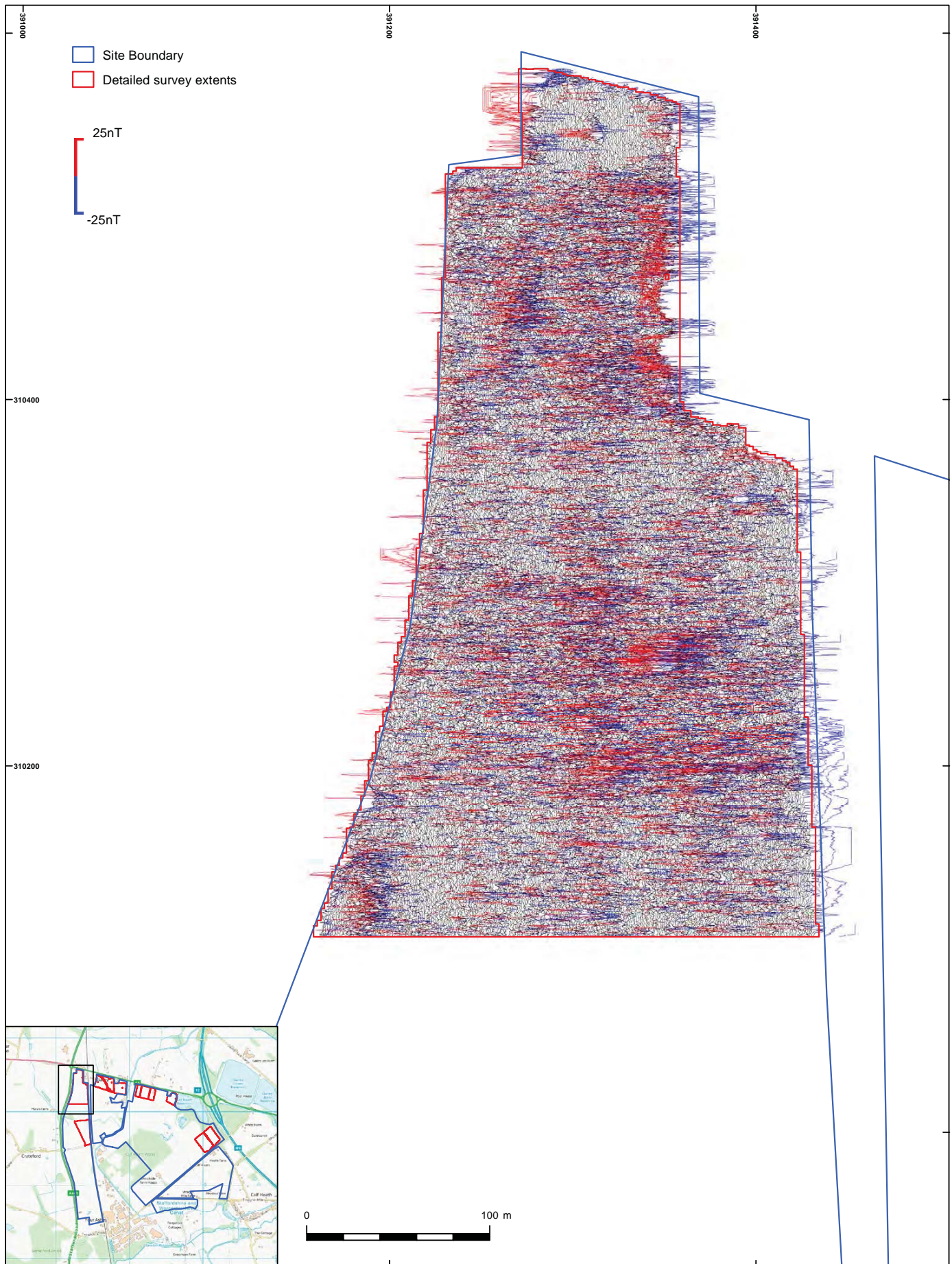


Contains Ordnance Survey data © Crown copyright and database right 2017.
This material is for client report only © Wessex Archaeology.
No unauthorised reproduction.

Date:	22/09/2017	Revision Number:	0
Scale:	1:2000 @ A3	Illustrator:	ND
Path:	X:\PROJECTS\112702\GIS\Figs\MXD\2017_09_25		

Gradiometer survey results: Greyscale plot - Area E

Figure 14



Coordinate system:
OSGB36 (OSTN15/OSGM15)

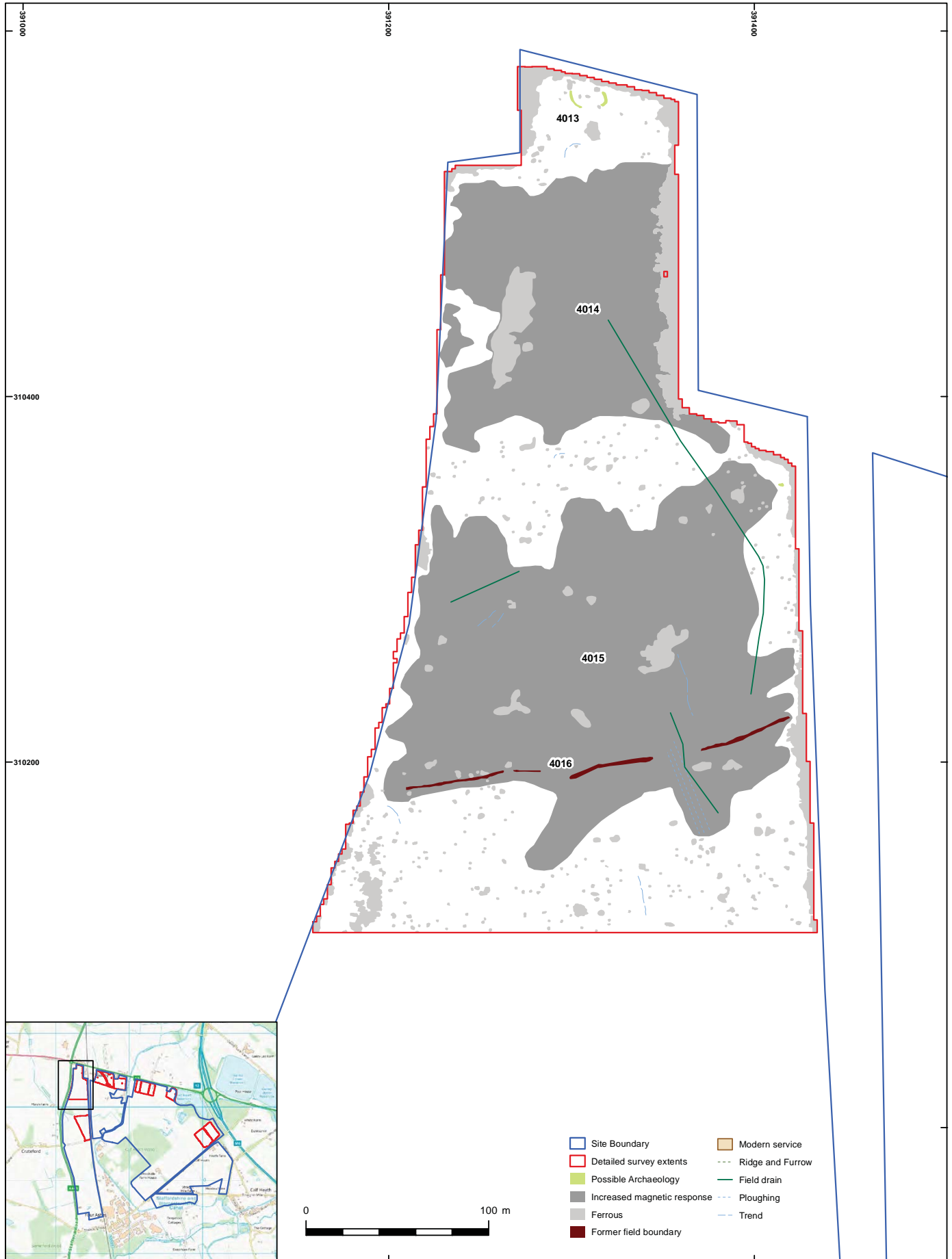


Contains Ordnance Survey data © Crown copyright and database right 2017.
This material is for client report only © Wessex Archaeology.
No unauthorised reproduction.

Date:	22/09/2017	Revision Number:	0
Scale:	1:2000 @ A3	Illustrator:	ND
Path:	X:\PROJECTS\112702\GIS\FigsMXD\2017_09_25		

Gradiometer survey results: XY-Trace - Area E

Figure 15

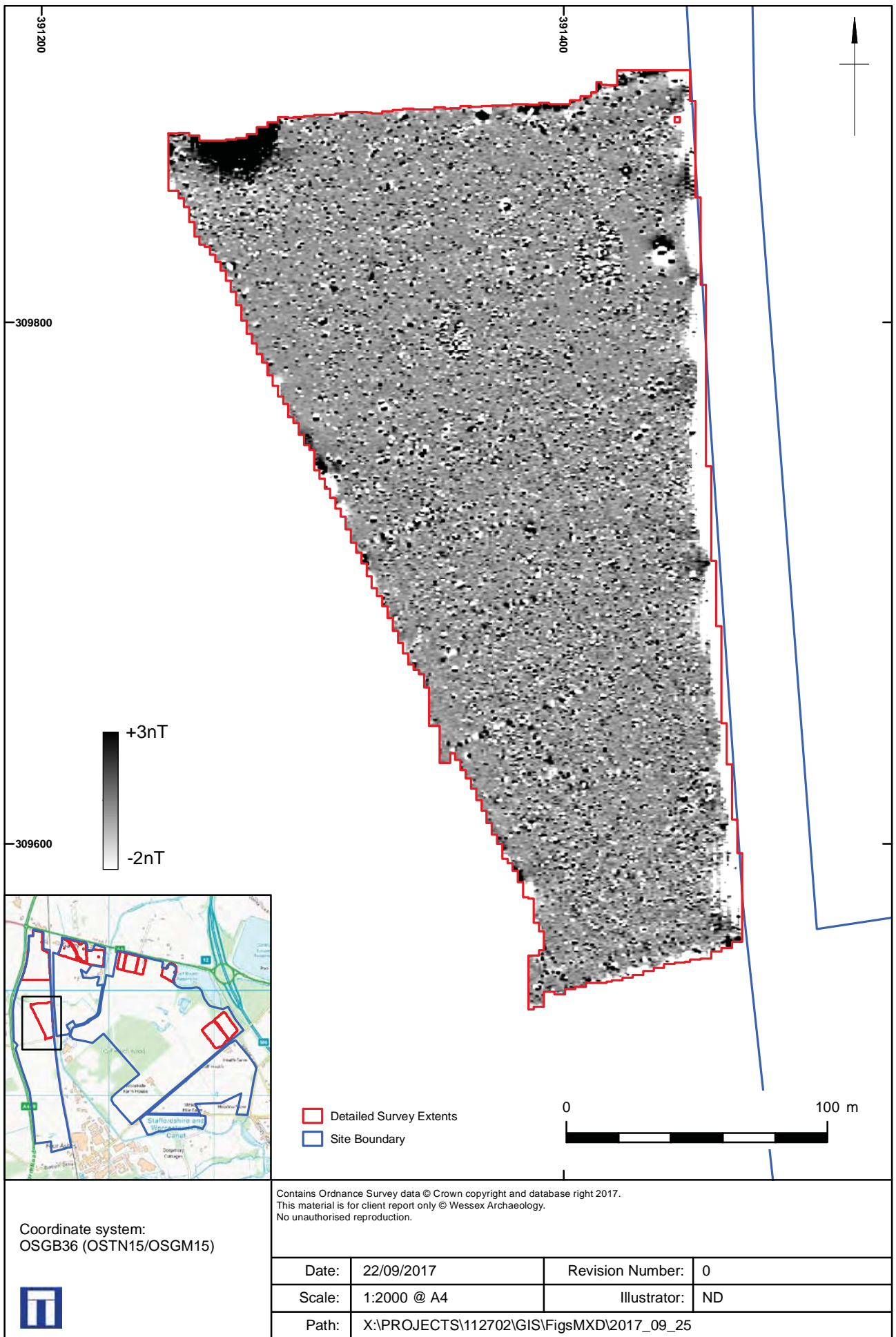


Coordinate system:
OSGB36 (OSTN15/OSGM15)



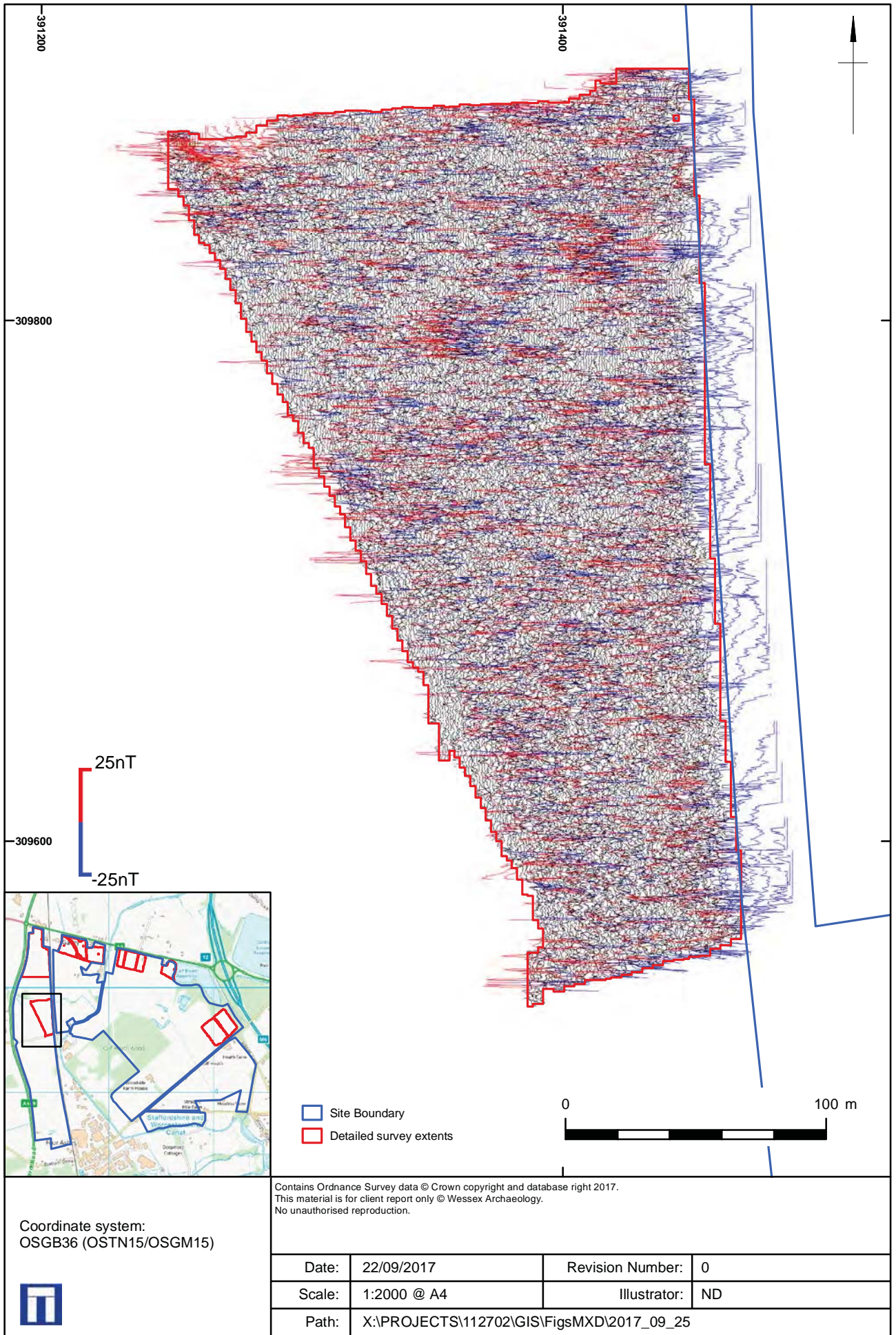
Contains Ordnance Survey data © Crown copyright and database right 2017.
This material is for client report only © Wessex Archaeology.
No unauthorised reproduction.

Date:	22/09/2017	Revision Number:	0
Scale:	1:2000 @ A3	Illustrator:	ND
Path:	X:\PROJECTS\112702\GIS\Figs\MXD\2017_09_25		



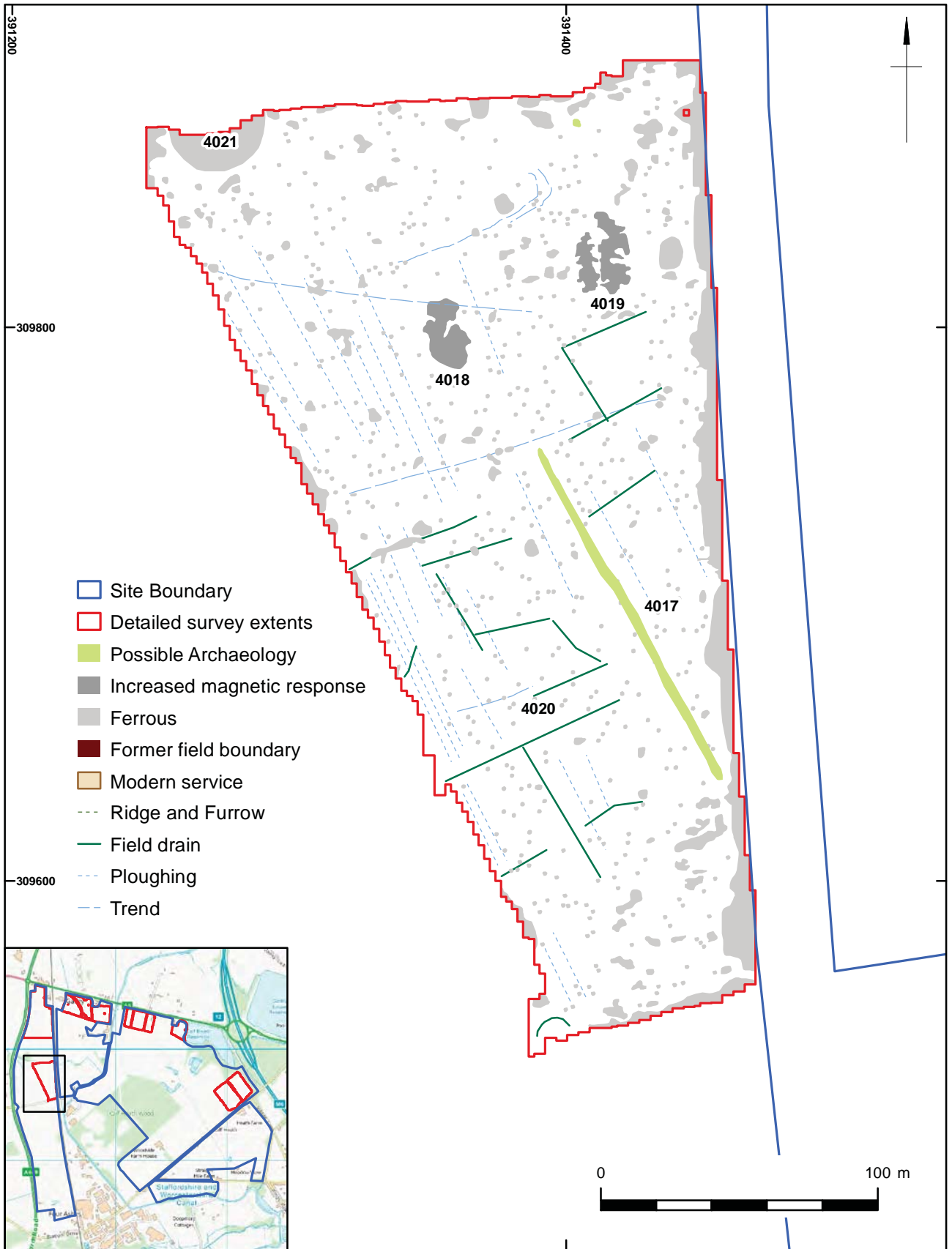
Gradiometer survey results: Greyscale plot - Area I

Figure 17

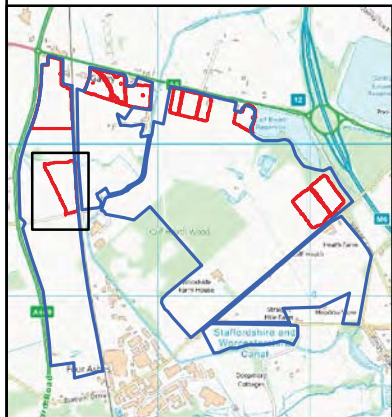


Gradiometer survey results: Greyscale plot - Area I

Figure 18



- Site Boundary
- Detailed survey extents
- Possible Archaeology
- Increased magnetic response
- Ferrous
- Former field boundary
- Modern service
- Ridge and Furrow
- Field drain
- Ploughing
- Trend



Coordinate system: OSGB36 (OSTN15/OSGM15)	Contains Ordnance Survey data © Crown copyright and database right 2017. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.			
	Date:	22/09/2017	Revision Number:	0
	Scale:	1:2000 @ A4	Illustrator:	ND
	Path:	X:\PROJECTS\112702\GIS\FigsMXD\2017_09_25		

Gradiometer survey results: Interpretation - Area I

Figure 19



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



FS 606559