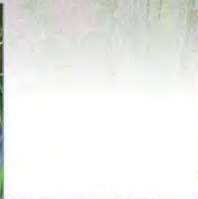
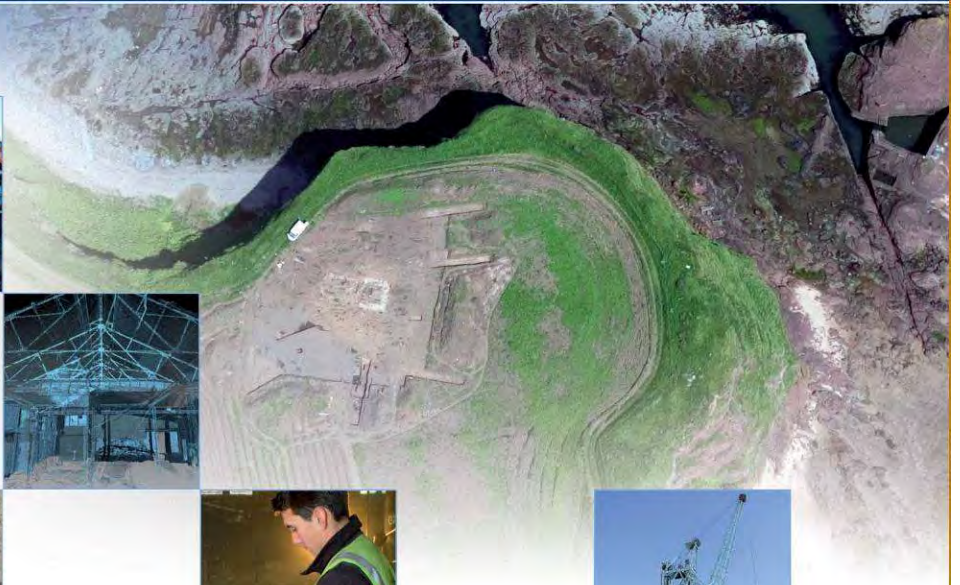


Heath Road Solar Farm, Bagworth, Leicestershire Archaeological Geophysical Survey

National Grid Reference: SK 45490 05883

AOC Project No: 40329

Date: 01 February 2024



AOC
Archaeology
Group

ARCHAEOLOGY

HERITAGE

CONSERVATION

Heath Road Solar Farm, Bagworth, Leicestershire:

Archaeological Geophysical Survey

On Behalf of:	DWD Planning 6 New Bridge Street London EC4V 6AB
National Grid Reference (NGR):	SK 45490 05883 (centre)
AOC Project No:	40329
OASIS ID	aocarcha1-519148
Prepared by:	Susan Ovenden and Robert Legg
Illustrations by:	Susan Ovenden
Date of survey:	28/08/2023 – 30/08/2023, 14/12/2023 - 15/12/2023
Surveyors:	Gabby Hart, Marguerite Hall, Reed Haywood, Victoria Huggett & Chris Sykes

This document has been prepared in accordance with AOC standard operating procedures.

Author: Susan Ovenden & Robert Legg Date: 01 February 2024

Quality Checked by: James Lawton Date: 01 February 2024

Report Stage: Final Draft v2 Date: 01 February 2024

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Non-Technical Summary

AOC Archaeology Group was commissioned by DWD to undertake an archaeological geophysical survey, using the magnetic gradiometry method to investigate the potential for buried archaeological remains prior to a proposed development at Heath Road, Leicestershire centred at NGR SK 45490 05883.

The proposed development area is located approximately 13km west of Leicester and situated across agricultural land to the north of Merrylees Road. The development area covers 28.1ha. The majority of this, 26ha, covers three arable fields, with the additional 2ha covering an existing road. A small area, 0.1ha, in the west could not be surveyed due to adverse ground conditions.

The results show an elevated level of background response. While some of this could be due to modern debris in the topsoil, it may be a product of the underlying geology. It is possible that weaker responses from archaeological deposits, if present, may be being masked by the elevated background response.

No anomalies indicative of probable or possible archaeology have been noted within the survey area.

Several linear trends, discrete areas of enhanced magnetism and scatters of isolated ferrous responses have been noted in all three fields. The origin of these is unclear, but they are most likely to be due to natural variations, agricultural activity, and modern debris in the topsoil.

Responses from former field boundaries, indicated on historic mapping, have been recorded across the survey area.

Weak parallel trends associated with modern agricultural activity have also been noted, along with anomalies consistent with the presence of ceramic drains.

Modern disturbance has been recorded along the field edges together with a high level of ferrous / fired responses throughout the survey area.

1 Introduction

- 1.1 AOC Archaeology Group was commissioned by DWD to undertake an archaeological geophysical survey using magnetic gradiometry of an area of land at Heath Road, Leicestershire. The survey was undertaken over two survey sessions, the first commenced on the 28 August 2023 and was completed on the 30 August 2023, and the second commenced on the 14 December 2023 and was completed on the 15 December 2023. This is part of a wider scheme of archaeological assessment in advance of proposed development of the site. The overall survey area was 26ha, of which approximately 1ha was unsuitable for survey due to hedges and bales in the centre of the survey area.
- 1.2 Archaeological geophysical survey uses non-intrusive and non-destructive techniques to determine the presence or absence of anomalies likely to be caused by archaeological features, structures or deposits, as far as is reasonably possible (ClfA, 2014). It is therefore a common component of the process of evaluating the impact of development on the historic environment. It is also a key tool in archaeological research as it is non-destructive and able to cover large areas, to allow below ground interventions to be appropriately targeted.
- 1.3 This survey was carried out to provide information on the presence, character and extent of potential buried archaeological remains within the proposed development area. The significance of any such remains can only be determined with reference to further information; as such this report may form part of an assessment of significance but cannot stand alone as such.

2 Survey Area Location and Description

- 2.1 The proposed development area (hereafter 'the survey area') is located on land at Heath Road, Bagworth, approximately 13km west of Leicester (NGR SK 45490 05883). The survey area is situated across agricultural land which is located to the north of Merrylees Road (see Figure 1).
- 2.2 The survey area covers 26ha across three fields, all of which were under stubble at the time of survey, (Figure 2). The ground level within the site is gently undulating and level, situated at around 133m above Ordnance Datum (aOD).
- 2.3 The recorded solid geology underlying the survey area consists of Edwalton Member bedrock; a mudstone formed in the Triassic Period approximately 237 – 228.4 million years ago (BGS, 2023). The superficial geology of the site predominantly belongs to the Oadby Member – Diamicton formed in the Quaternary Period approximately 480-423 thousand years ago (BGS, 2023). Glaciofluvial Mid Pleistocene sand and gravel deposits, - formed during the Quaternary period between 860 and 116 thousand years ago- are located in the southeast corner of the northern most area.
- 2.4 The soils within the survey area are classed as Brown soils which typically cover undulating lowlands with gentle and strong slopes (Scotland's Soils, 2023).
- 2.5 Gradiometer survey is suggested to provide a variable response over sedimentary rocks; for example the results can be good over certain sandstones and average over mudstones and the drift / alluvium deposits may also have an effect (David et al. 2008, 15).

3 Archaeological Background

- 3.1 The archaeological background below is drawn from the Cultural Heritage Assessment produced by AOC Archaeology (AOC, 2023)

Prehistoric (8,000 BC – AD 43)

- 3.2 No prehistoric remains or artefacts are recorded within the survey area.
- 3.3 There are two non-designated assets recorded within 1km from the Site, a ring ditch around 400m to the southeast that most probably represent the remains of a prehistoric barrow and three lithic artefacts; two fire cracked pebbles and a single flint flake that were found during fieldwalking within the vicinity of the ring ditch.
- 3.4 Taken together the ring ditch and the lithics suggest a concentration of prehistoric evidence, perhaps representing Bronze Age funerary practices, on the land to the northeast of the Site.

Romano-British (AD 43 – AD 410)

- 3.5 No Romano-British remains or artefacts are recorded within the survey area.
- 3.6 Evidence for Romano British activity within the 1km study area is limited to a Roman copper alloy trumpet brooch recorded in a field c.540m to the southwest of the survey area. This could possibly represent casual loss rather than physical archaeological deposition.

Medieval (AD 410 – AD 1066)

- 3.7 No Early Historic remains or artefacts are recorded within the survey area and evidence from the within the wider 1km study area is limited to a single sherd of a Stamford-ware cooking pot dating from 850-1250AD recovered c. 300m, to the northwest of the survey area. Stamford Ware was an early mass-produced glazed ceramic and was widely distributed both across Britain and overseas.
- 3.8 The Site is located within the parish of Newbold Verdon, Leicestershire immediately to the south of its boundary with the adjacent parish of Bagworth both of which were recorded at Domesday as falling within the hundred of Guthlaxton (Powell-Smith N.d). Domesday records Newbold as being in the ownership of the Crown but tenanted to Hugh of Grandmesnil who was granted extensive estates across Leicestershire following the Conquest (Powell- Smith N.d). Newbold had a recorded population of 3.5 households in 1086, putting it in the smallest 20% of settlements recorded in Domesday. Verdon was added to the parish name during the 13th century following a change in ownership and it is derived from the same French family name as Verdun.
- 3.9 No medieval remains or artefacts are recorded on the survey area and it is possible that settlement was nucleated within the village cores by the time of the Conquest.
- 3.10 The Scheduled moated site at Newbold Verdon Hall lies on the southwestern edge of the village around 50m to the southwest of the 2km Study Area. The moated area measures 90 by 100m overall and fragments of roof tile recovered during excavations there suggest the former presence of a manor house on the island that was defined by the moat.
- 3.11 A second Scheduled moat is located c. 1.6km to the southeast of the survey area, 440m southwest of Lindridge Fields Farm. It has external dimensions of approximately 105m northwest-southeast and 116m northeast-southwest and includes both inner and outer moat ditches. There is no visible evidence for the original access onto the moated island and it is thought that it was via a bridge.
- 3.12 No medieval remains or artefacts are recorded within 1km of the Site boundary.

Post medieval – Industrial Period (AD 1540 – 1901)

- 3.13 Early maps tend to be schematic and lacking in detail and often only record settlements at the county level. Saxton's 1583 Map of Leicestershire is in line with this, depicting both 'Bagworthe' and 'Newbold' as villages with churches but lacking any further detail.
- 3.14 The 1849 Tithe Map of the Township of Barlestone in the adjacent Parish of Market Bosworth shows Barlestone Lodge c. 750m to the west of the survey area. A map of Barlestone Estate from the 1870s shows the estate straddling the parish boundary between Market Bosworth and Newbold Verdon. The estate owned fields immediately to the west of Bagworth Road.
- 3.15 The 1885 Ordnance Survey records the survey area as seven agricultural fields bounded to the south by Merrylees Road and to the north, the west and the south by other fields. The map also records several non-designated assets within the area including Heath Farm and Desford Colliery. The HER records two post-medieval brick kilns, one east of Heath Farm Lodge to the north of the survey area, the other within Brick Kiln Field to the northeast of Heath Road.

Modern (1900 – present)

- 3.16 The 1901 and 1958-67 Ordnance Surveys both show the survey area unchanged since 1885 although changes within the wider area include the development of Desford Colliery to the north. The colliery commenced production in 1902 (ROLLR Ref No: L.662.182) its 218m shafts gave access to eleven coal seams, including the Lower Main Seam and a subsidiary mine Merry Lees was subsequently opened to the east of the Site. The colliery closed in 1984. The logs of boreholes that were sunk on the survey area by the colliery company in 1915 record that at least part of the Site lay within the landholding of Halifax Farm at that time.

4 Aims

- 4.1 The aim of the geophysical survey was to identify anomalies that suggest the presence of archaeological remains, in order to enhance the current understanding of the historical environment within the survey area.
- 4.2 Specifically, the aims of the gradiometer survey were:
- To locate, record and characterise any potential surviving sub-surface archaeological remains within the survey area;
 - To help determine the next stage of works as per the client's instruction;
 - To produce a comprehensive site archive (Appendix 1) and report

5 Methodology

- 5.1 The geophysical survey was undertaken over two sessions between 28/08/2023 and 30/08/2023, and 14/12/2023 and 15/12/2023.
- 5.2 All geophysical survey work was carried out in accordance with recommended good practice specified in the EAC guideline documents published by Historic England (Schmidt et al. 2016) and the Chartered Institute for Archaeologists Standard and Guidance for archaeological geophysical survey (2014).
- 5.3 Parameters and survey methods were selected that were suitable for the prospective aims of the survey and in accordance with recommended professional good practice (Schmidt et al. 2016).

- 5.4 Digital photographs of every survey parcel were taken before, during and after geophysical survey to show any changes to field conditions following the programme of works. The photos were downloaded and stored off site, and relevant examples are included as Plates 1 and 2 in this report.
- 5.5 The initial gradiometer survey was carried out using a Bartington Non-Magnetic Cart. The cart system utilises six Grad-01 fluxgate gradiometer sensors mounted upon a carbon fibre frame 1m apart, along with data logging equipment and batteries (see Appendix 2). Before each session of use, the cart system was balanced around a single set up point within the Site specifically chosen for being magnetically quiet. Balancing the machine around this point produces a more uniform dataset throughout and allows all data to be plotted with ease on the same palette.
- 5.6 Data was collected using zig-zag traverses alongside a constant stream of GPS data collected through a Trimble R10 GPS, enabling the collected data to be spatially georeferenced without the need for a pre-determined grid system. The data was logged on a laptop mounted to the cart using Geomar MLGrad601 software.
- 5.7 A total of 16.1ha were surveyed using the Bartington cart.
- 5.8 Care was also taken to attempt to avoid metal obstacles present within the survey area, such as metal objects within and adjacent to the survey area as gradiometer survey is affected by 'above-ground ferrous disturbance' and avoiding these improves the overall data quality and results obtained.
- 5.9 The data was downloaded from MLGrad601 and converted into a .xyz file in Geomar MultiGrad601 before being processed along with the GPS data in TerraSurveyor v64. The details of these processes can be found in Appendices 2 and 3.
- 5.10 The second gradiometer survey was carried out using a SENSYS MAGNETO® MXPDA ATV towed magnetometer cart system. The cart utilises 16 FGM650/3 total field gradiometer sensors mounted upon a frame along with data logging equipment (see Appendix 2). Batteries were located upon the ATV.
- 5.11 Data was collected using zig-zag traverses alongside a constant stream of GPS data collected through a Carlson BRx7 GPS, enabling the collected data to be spatially georeferenced without the need for a pre-determined grid system. The data and measured tracks were collected through the data acquisition unit MXPDA and visualised through SENSYS MonMX5.0 on a tablet PC mounted to the ATV.
- 5.12 A total of 8.5 ha was surveyed using the SENSYS cart.
- 5.13 Care was taken to attempt to avoid metal obstacles present within the survey area, such as metal objects within and adjacent to the survey area as gradiometer survey is affected by 'above-ground ferrous disturbance' and avoiding these improves the overall data quality and results obtained.
- 5.14 The data was exported from SENSYS MonMX5.0 in ASCII file format, uploaded to project folder on OneDrive, before being processed (compensated) using MAGNETO® 3.0 software. The details of these processed can be found in Appendices 2 and 3.
- 5.15 Interpretations of the data were created in ArcGIS Pro and the technical terminology used to describe the identified features can be found in Appendix 4.

6 Results and Interpretation

- 6.1 The magnetic gradiometer survey results have been visualised as greyscale plots and XY traces. An overview of the data is provided as a greyscale image in Figure 3 with an accompanying interpretation in Figure 4. The processed data are displayed at -1 nT to 2nT in Figures 5.1 to 5.4. Detailed interpretation of the data can be seen in Figures 6.4 to 6.4, and an individual characterisation of the numbered identified anomalies of interest is given below. Figures 7.1 to 7.4 shows minimally processed data plotted as XY traces at 50nT/cm at A3.
- 6.2 Appendix 4 contains a guide to the interpretation categories employed and the logic used to assign anomalies to specific classes, as well as a short discussion of how past human activity results in these anomalies, however some important points are noted below:
- 6.3 The classes have three sub-types (generally); anomalies (typically indicated by a solid colour polygon), spreads (a stippled polygon) and trends (a line with a colour matching the polygon colour). *Anomalies* refer to distinct changes in the survey data which suggest an abrupt boundary between materials below ground, such as a cut feature with a magnetically contrasting fill. *Spreads* of enhanced material refer to diffuse areas of altered magnetic contrast which suggest a localised spread of material with a magnetic contrast within the topsoil or ploughzone. Linear *trends* are less distinct and are typically visible as linear patterning in the overall texture of the data. A common example of these is the striping effect caused by recent ploughing.
- 6.4 Anomalies placed in the 'uncertain' class may have an archaeological origin, but other explanations are equally likely. Where any particular interpretation is *more* likely than others, the anomaly is assigned to that class.
- 6.5 The definite 'Archaeology' class is only used for anomalies with no other possible explanation, either due to their diagnostic characteristics or because they are corroborated by other sources such as previous interventions within the survey area. Anomalies with magnetic characteristics or morphologies that suggest an archaeological origin with generally be assigned to the 'Possible Archaeology' class.
- 6.6 The anomaly type 'ferrous spike' is assigned to strong dipolar anomalies which cover a small spatial area and have a characteristic appearance in the XY traces of the survey data. These are strongly likely to be of recent origin in the form of magnetic or ferrous debris within the topsoil; 'spikes' of other origin will be assigned to their appropriate classification.
- 6.7 A distinction is made between modern *disturbance* from strongly ferrous materials within or adjacent to the survey area, such as the strong dipolar 'halos' produced by services like gas mains, and spreads of material within the topsoil causing noise which is assumed to have a recent origin. Generally speaking, '*modern disturbance*' occurs at a distance from magnetic source, whereas *modern magnetic spreads/debris* are related to material directly at that location.
- 6.8 Generally, only anomalies (or groups thereof) of a likely archaeological or historical origin have been assigned an anomaly number on the interpretation figures. However, anomalies interpreted as resulting from other processes that are integral to the discussion of the results have also been assigned anomaly numbers.
- 6.9 The results show an elevated level of background response. While some of this could be due to modern debris in the topsoil, potentially due to the application of green waste, the higher background response may be a product of the underlying geology.

Archaeology

- 6.10 No responses indicating the presence of definite or probable archaeology have been identified within the data set.

Possible Archaeology

- 6.11 No responses indicating the presence of possible probable archaeology have been identified within the data set.

Unclear Origins

- 6.12 A sinuous zone of slightly elevated response [B1] has been detected in the east of Field B. The origin of this is unclear. It is most likely to have a natural origin, although a modern origin cannot be excluded.
- 6.13 Weak linear trends [A1], [B2] and [C1] have been noted in all three fields. The origin of these is unclear, but their weak nature and form suggest that are most likely to be associated with agricultural activity, although an archaeological origin cannot be wholly excluded.
- 6.14 Throughout both fields discrete areas of enhanced magnetism have been detected [A2], [B3] and [C2]. The origin of these is unclear. While an archaeological origin cannot be excluded, they are more likely to be due to natural variations or more deeply buried modern fired or ferrous material.
- 6.15 Two areas of scattered dipolar anomalies are located in the north of Area C [C3]. The dipolar magnetic signatures are likely to relate to debris, possibly ceramic drains damaged by ploughing, however, it is also possible these anomalies relate to superficial geological deposits.

Historical Features

- 6.16 Weak linear trends [A3], [B4], [C4], and associated areas of increased response, correspond with former field boundaries recorded on the 1st Ed OS map of 1888 (NLS, 2023).

Agricultural

- 6.17 Very weak parallel trends have been noted within all three fields and are associated with modern agricultural activity.
- 6.18 Linear alignments of magnetic dipoles in Area C are consistent with presence of ceramic drain pipes. Several of the anomalies are positioned in a herringbone formation along the length of the former field boundary.

Non – Archaeology

- 6.19 Zones of magnetic disturbance have been noted along the edges of the fields and are due to ferrous material within, and adjacent to, extant field boundaries.
- 6.20 Isolated ferrous responses have been noted throughout the survey area. These are likely to be due to modern ferrous / fired material in the in the topsoil.

7 Conclusion

- 7.1 No anomalies indicative of probable or possible archaeology have been noted within the survey area.
- 7.2 Several linear trends, discrete areas of enhanced magnetism, and scatters of dipolar anomalies have been noted in all three fields. The origin of these is unclear, but they are most likely to be due to natural variations, agricultural activity, and modern debris in the topsoil.
- 7.3 Responses from former field boundaries, indicated on historic mapping, have been recorded across the survey area. Weak parallel trends associated with modern agricultural activity have also been noted, along with anomalies consistent with the presence of drainage features.

- 7.4 Modern disturbance has been recorded along the field edges together with a high level of ferrous / fired responses throughout the survey area.
- 7.5 In assessing the results of the geophysical survey against the specific aims set out in Section 4;
- The survey has succeeded in locating, recording, and characterising surviving sub-surface remains within the survey area, though more remains may be present that are not suitable for detection through magnetic gradiometry due to the elevated level of background responses
 - The survey will help in determining the next stage of works as it has provided evidence that remains of an uncertain origin are most likely present on site, and has provided a number of targets for further investigation;
 - The survey has resulted in a comprehensive report and archive.

8 Statement of Indemnity

- 8.1 Although the results and interpretation detailed in this report have been produced as accurately as possible, it should be noted that the conclusions offered are a subjective assessment of collected data sets.
- 8.2 The success of a geophysical survey in identifying archaeological remains can be heavily influenced by several factors, including geology, seasonality, field conditions and the properties of the features being detected. Therefore, the geophysical interpretation may only reveal certain archaeological features and not produce a complete plan of all the archaeological remains within a survey area.

9 Archive Deposition

- 9.1 In accordance with professional standard practice an 'Online Access to the Index of archaeological investigations' ('OASIS') record will be completed for submission to the HER and Archaeological Data Service (ADS) (Appendix 2).
- 9.2 One digital and hard copy of the report and data will be submitted to the relevant Historic Environment Record (HER) at the Client's discretion.
- 9.3 A digital copy of the report and data will also be submitted to the ADS at the Client's discretion.

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*denotes a reference that occurs in Appendix 2 rather than the main body of this report.

11 Plates



Plate 1: Field A facing West.



Plate 2: Field B facing Southwest.



Plate 3: Field C facing Northwest.

12 Figures

HEATH ROAD SOLAR FARM, BAGWORTH:
ARCHAEOLOGICAL GEOPHYSICAL SURVEY

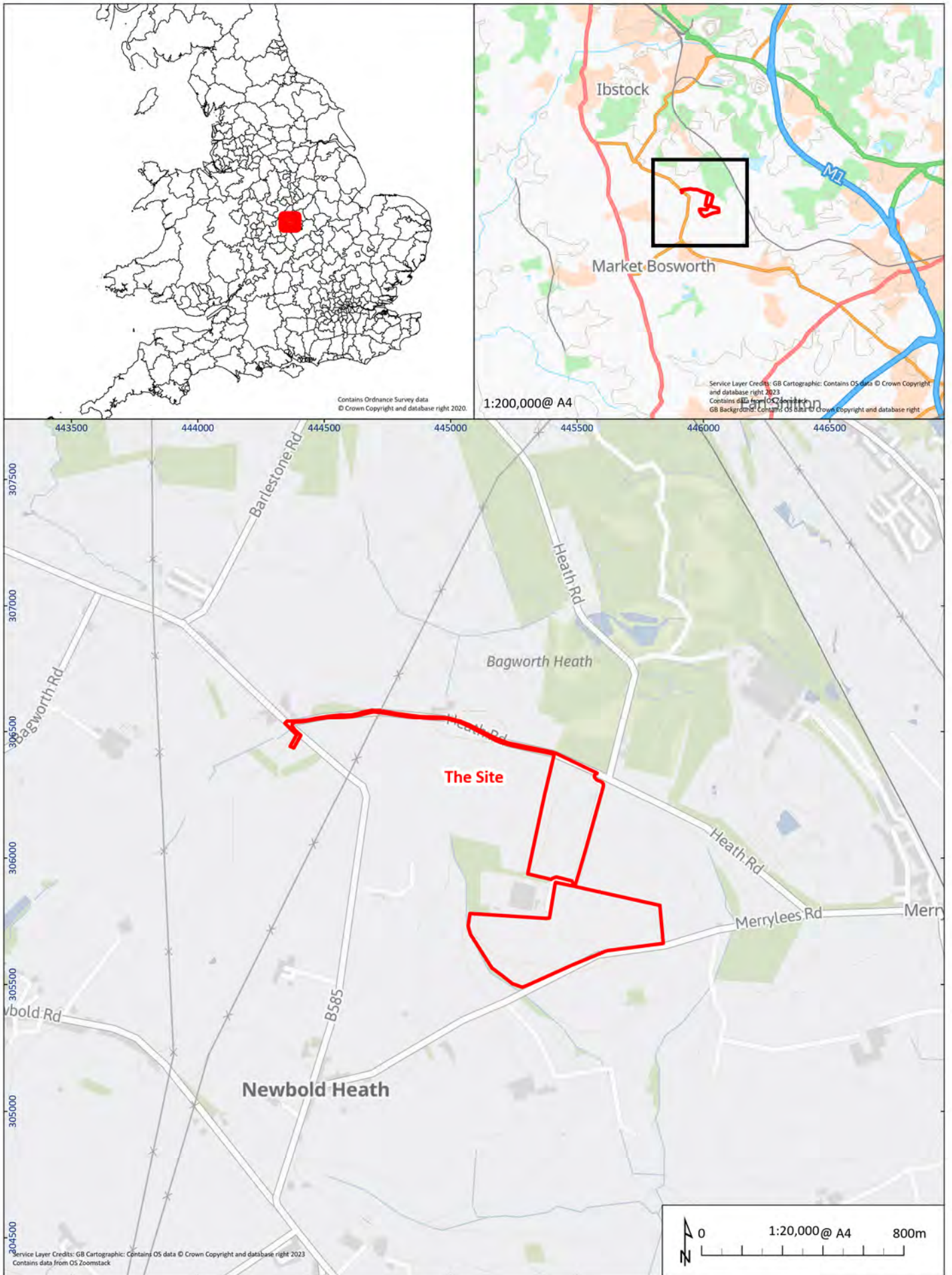


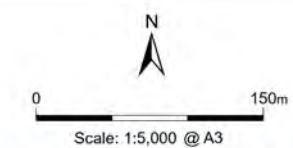
Figure 1: Site Location

05/40329/GEO/01/01



Figure
02

- Survey Areas**
- Red Line Boundary
 - Gradiometer Survey - Sensys Cart
 - Gradiometer Survey - Bartington Cart
 - Unsuitable



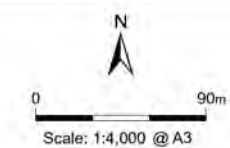
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 Checked by: JL Date: 25/01/2024
 Approved by: JL Date: 25/01/2024



Figure
03



Red Line Boundary



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Created by: SO Date: 25/01/2024

Checked by: JL Date: 25/01/2024

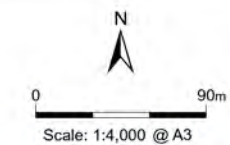
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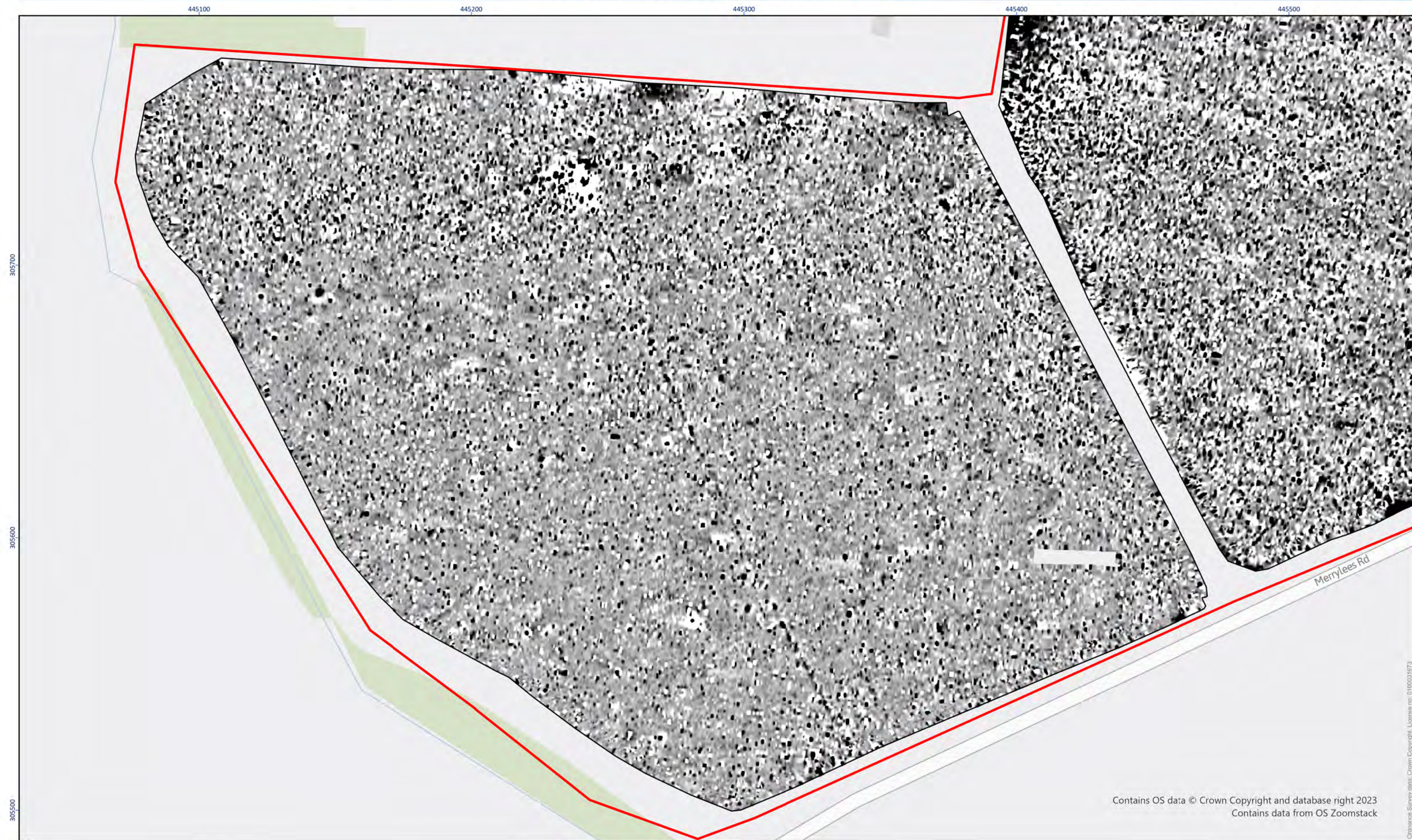
Overview of Interpretation

Figure
04

	Red Line Boundary		Spread (Unclear Origin)		Linear Trend (Historic Feature)		Linear Trend (Drainage)
	Spread (Historic Feature)		Spread (Magnetic Disturbance)		Linear Trend (Unclear Origin)		Linear Trend (Agricultural, Ploughing)
	Anomaly (Unclear Origin)		Anomaly (Ferrous/Iron Spike)				



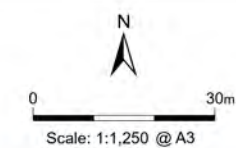
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Approved by: JL Date: 25/01/2024



Field A: Processed Gradiometer Data - Greyscale Image

Figure

5.1

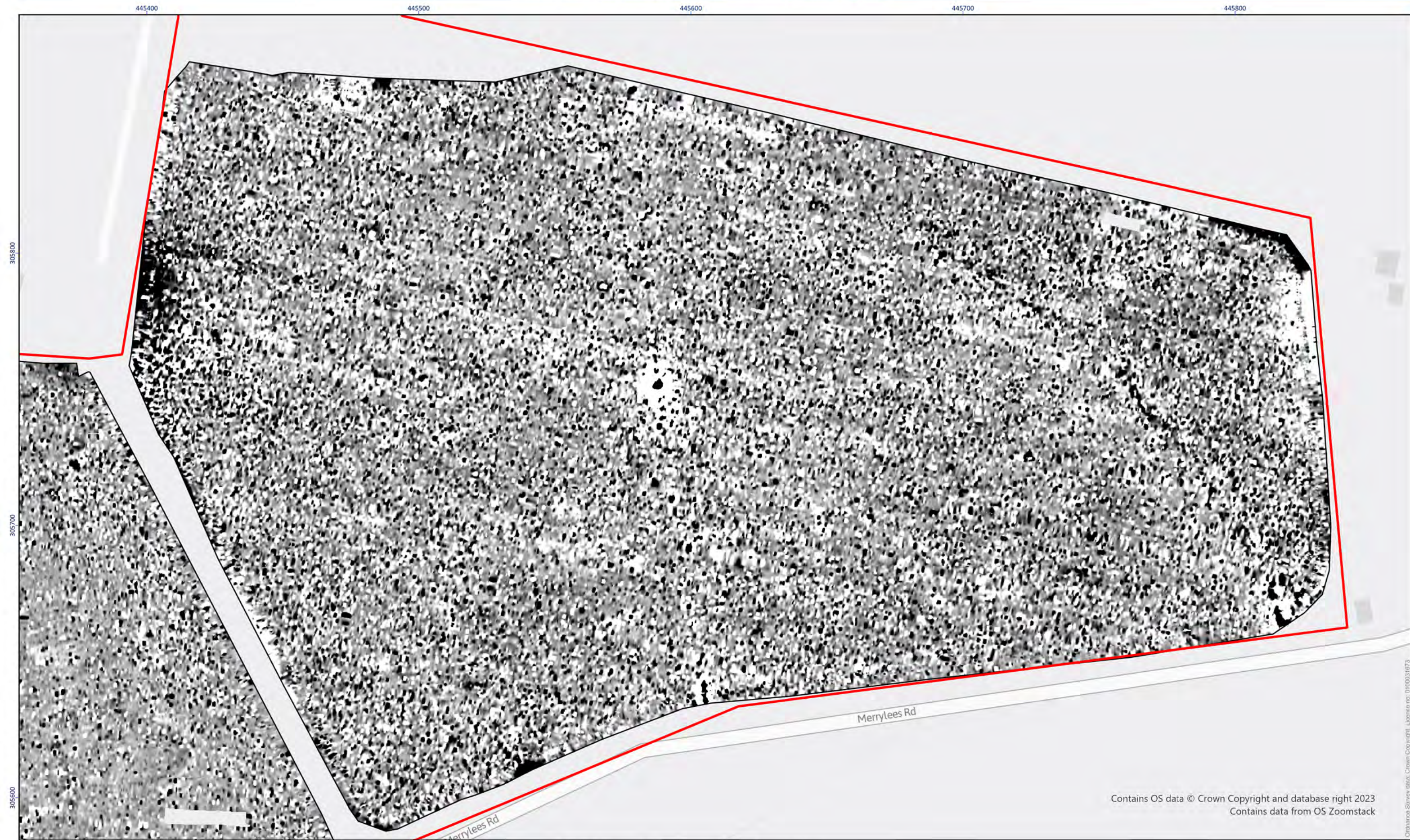

 Red Line Boundary


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Created by: SO Date: 25/01/2024

Checked by: JL Date: 25/01/2024

Approved by: JL Date: 25/01/2024



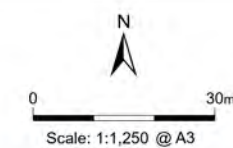
Contains OS data © Crown Copyright and database right 2023
Contains data from OS Zoomstack

Field B: Processed Gradiometer Data - Greyscale Image

Figure
5.2



 Red Line Boundary



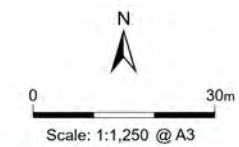
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Approved by: JL	Date: 25/01/2024



Field C south: Processed Gradiometer Data - Greyscale Image

Figure

5.3


 Red Line Boundary


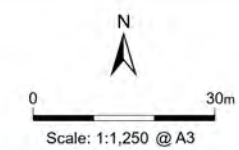
Drawing Number: 05/40329/GEO/5.3/01	
Created by: SO	Date: 25/01/2024
Checked by: JL	Date: 25/01/2024
Approved by: JL	Date: 25/01/2024



Field C north: Processed Gradiometer Data - Greyscale Image

Figure

5.4


 Red Line Boundary


Drawing Number: 05/40329/GEO/5.4/01

Created by: SO Date: 25/01/2024

Checked by: JL Date: 25/01/2024

Approved by: JL Date: 25/01/2024

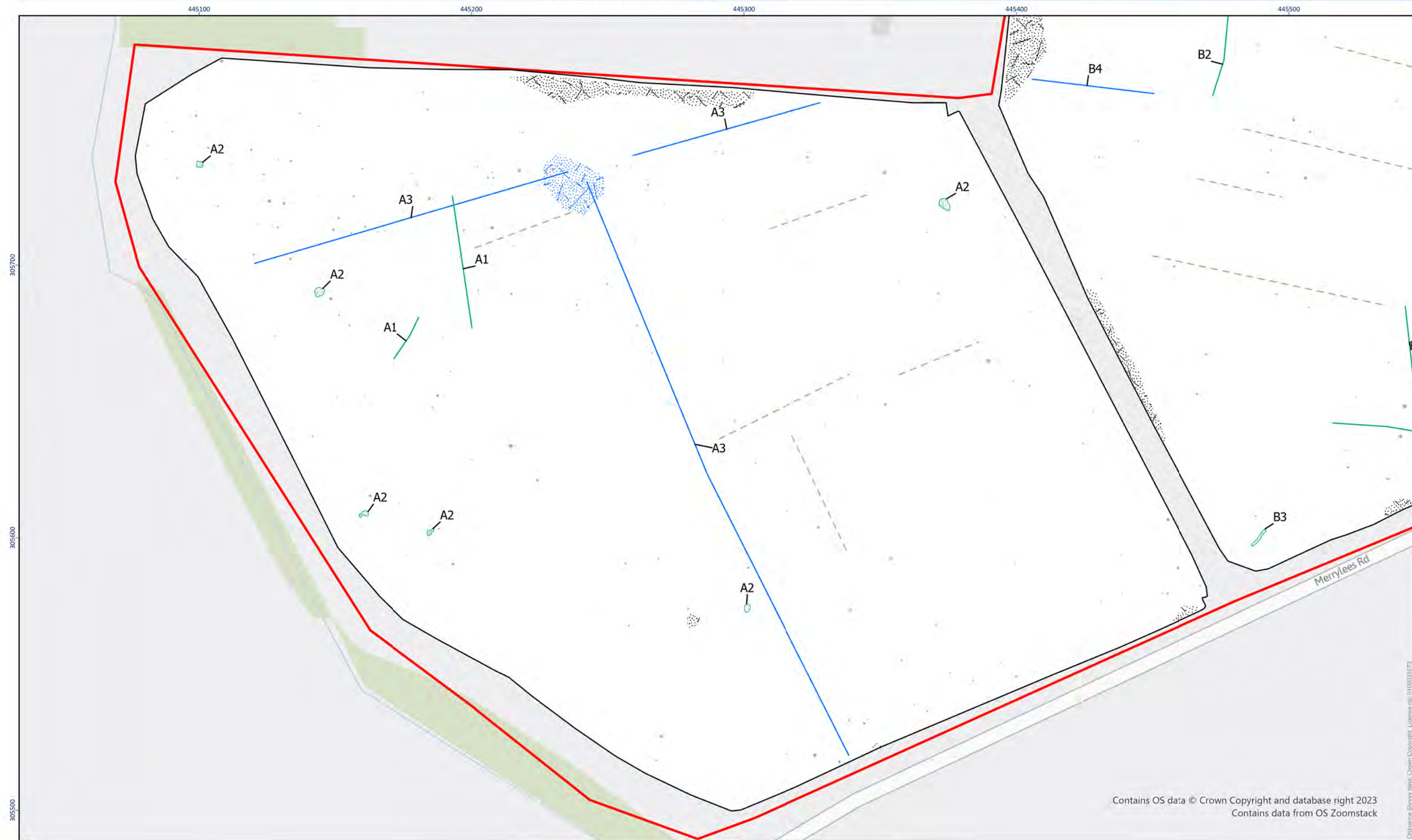


Figure
6.1

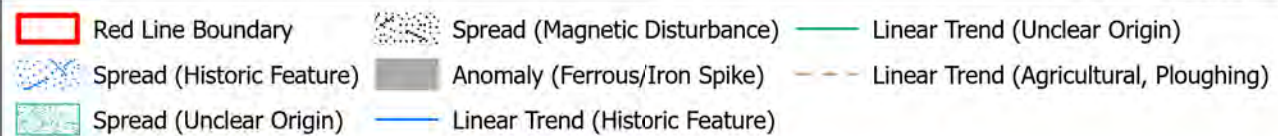
- | | | |
|---|---|---|
| █ Red Line Boundary | Spread (Magnetic Disturbance) | — Linear Trend (Unclear Origin) |
| Spread (Historic Feature) | Anomaly (Ferrous/Iron Spike) | — Linear Trend (Agricultural, Ploughing) |
| Spread (Unclear Origin) | — Linear Trend (Historic Feature) | |



Drawing Number: 05/40329/GEO/6.1/01	
Created by: SO	Date: 25/01/2024
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Approved by: JL	Date: 25/01/2024



Figure
6.2



Drawing Number: 05/40329/GEO/6.2/01	
Created by: SO	Date: 25/01/2024
Checked by: JL	Date: 25/01/2024
Approved by: JL	Date: 25/01/2024

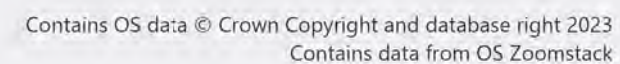
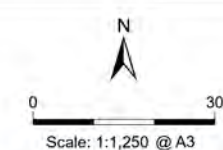
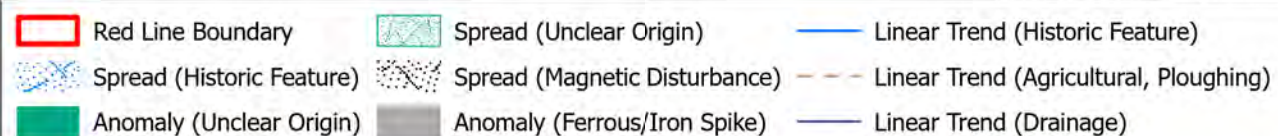


Figure 6.3



Drawing Number: 05/40329/GEO/6.3/01	
Created by: SO	Date: 25/01/2024
Checked by: JL	Date: 25/01/2024
Approved by: JL	Date: 25/01/2024

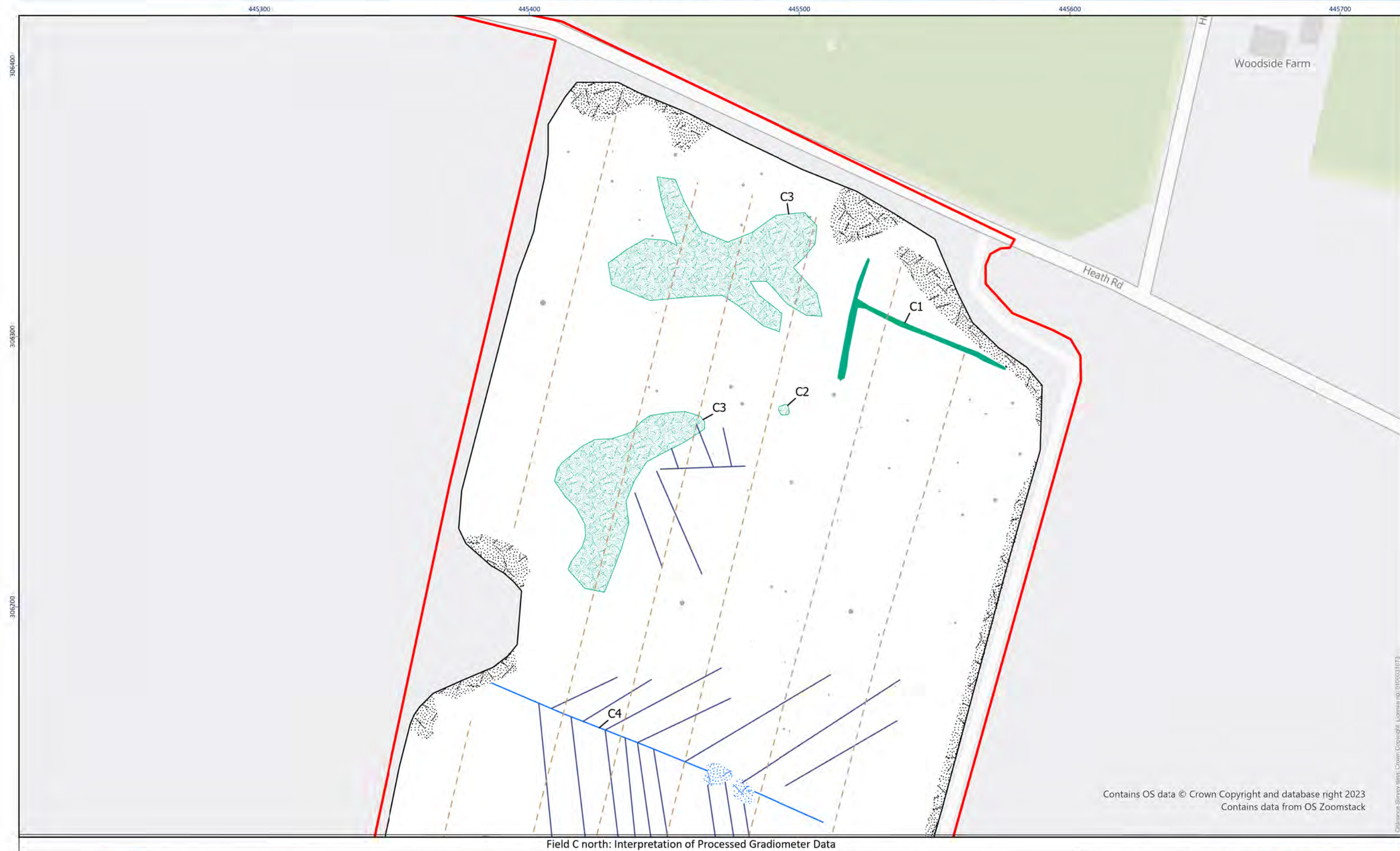
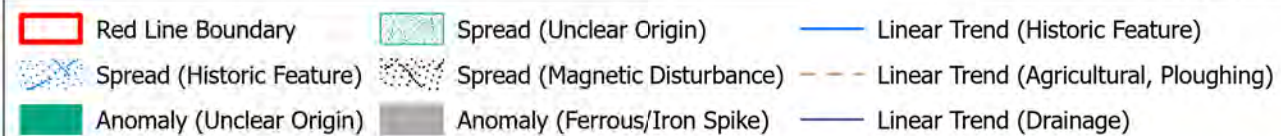
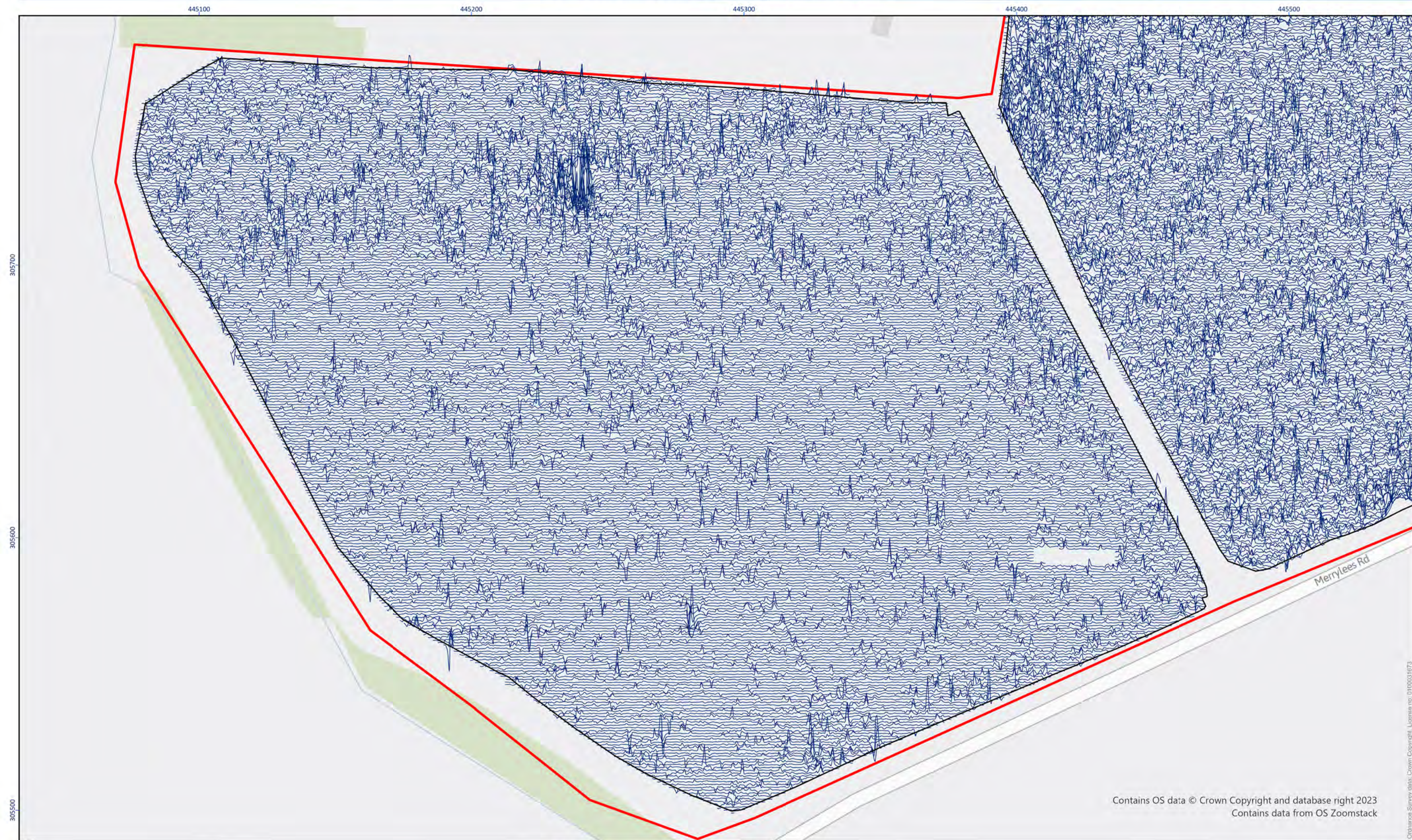


Figure
6.4



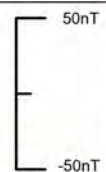
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Created by: SO	Date: 25/01/2024
Checked by: JL	Date: 25/01/2024
Approved by: JL	Date: 25/01/2024



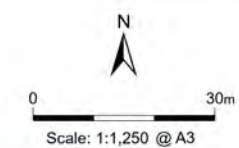
Field A: Minimally Processed Gradiometer Data - XY Trace

Figure

7.1



Red Line Boundary



Drawing Number: 05/40329/GEO/7.1/01

Created by: SO Date: 25/01/2024

Checked by: JL Date: 25/01/2024

Approved by: JL Date: 25/01/2024

445400

445500

445600

445700

445800

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Field B: Minimally Processed Gradiometer Data - XY Trace

Figure

7.2

50nT
-50nT

Red Line Boundary

N
0 30m
Scale: 1:1,250 @ A3

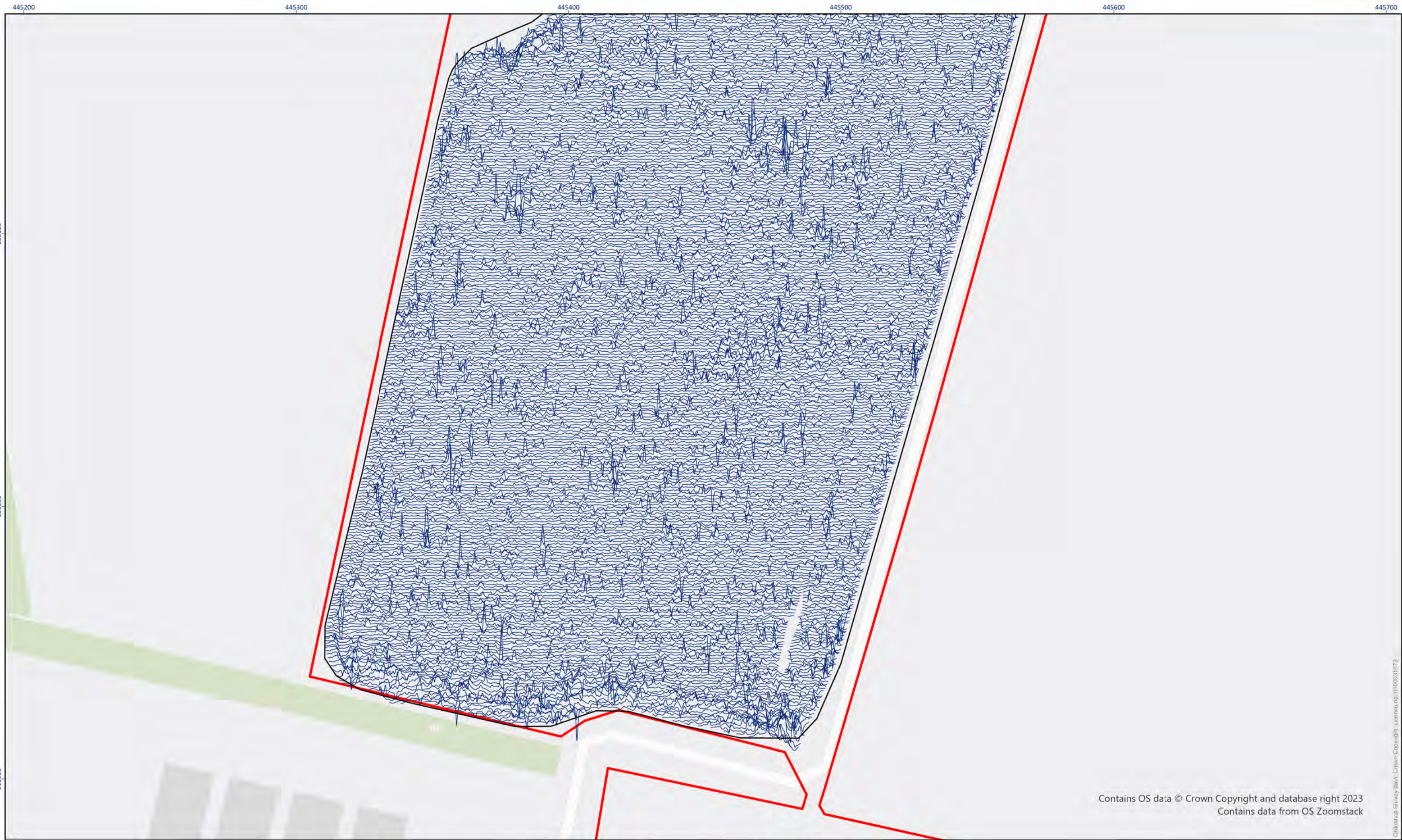
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Created by: SO Date: 25/01/2024

Checked by: JL Date: 25/01/2024

Approved by: JL Date: 25/01/2024

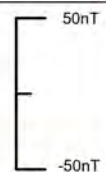
AOC
Archaeology
Group



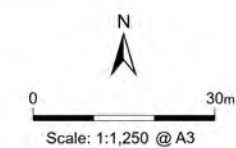
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Field C south: Minimally Processed Gradiometer Data - XY Trace

Figure
7.3



 Red Line Boundary



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Created by: SO	Date: 25/01/2024
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Approved by: JL	Date: 25/01/2024





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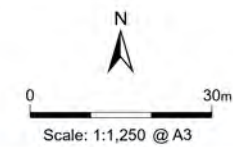
Field C north: Minimally Processed Gradiometer Data - XY Trace

Figure

7.4



 Red Line Boundary



Drawing Number: 05/40329/GEO/7.4/01	
Created by: SO	Date: 25/01/2024
Checked by: JL	Date: 25/01/2024
Approved by: JL	Date: 25/01/2024



Appendix 1: Survey Metadata

Oasis ID: aocarcha1-519148

Field	Description
Surveying Company	AOC Archaeology Group
Data collection staff	Gabby Hart, Marguerite Hall, Reed Haywood, Victoria Huggett and Chris Sykes
Client	DWD
Site name	Heath Road, Bagworth,
County	Leicestershire
NGR	SK 45490 05883
Land use/ field condition	Arable - stubble
Duration	28/08/2023 – 30/08/2023; 14/12/2023 – 15/12/2023
Weather	Overcast
Survey type	Gradiometer Survey
Instrumentation	Bartington cart survey: Bartington Non-Magnetic Cart, two Bartington Grad 601-2, Trimble R10 GNSS System Sensys cart survey: Sensys MXPDA cart, sixteen FGM650/3 sensors, Carlson BRx7 GNSS System
Area covered	24.6ha
Download software	MLGrad601, SENSYS MonMX
Processing software	TerraSurveyor
Visualisation software	ArcGIS Pro
Geology	Edwalton Member mudstone sedimentary bedrock overlain by Oadby Member – Diamicton (BGS, 2024)
Soils	Brown Soils (Soilscapes2024)
Scheduled Ancient Monument	No
Known archaeology on site	None
Historical documentation/ mapping on site	None
Report title	Heath Road Solar Farm, Bagworth, Leicestershire: Archaeological Geophysical Survey
Project number	40329
Report Author	Susan Ovenden & Robert Legg
Quality Checked by	James Lawton

Appendix 2: Archaeological Prospection Techniques, Instrumentation and Software Utilised

Gradiometer Survey

Gradiometer surveys measure small changes in the earth's magnetic field. Archaeological materials and activity can be detected by identifying changes to the magnetic values caused by the presence of weakly magnetised iron oxides in the soil (Aspinall et al., 2008, 23; Sharma, 1997, 105). Human habitation often causes alterations to the magnetic properties of the soils and sediments present in the area (Aspinall et al, 2008, 21). There are two physical transformations that produce a significant contrast between the magnetic properties of archaeological features and the surrounding soil: the enhancement of magnetic susceptibility and thermoremanent magnetization (Aspinall et al., 2008, 21; Heron and Gaffney 1987, 72).

Ditches and pits can be easily detected through gradiometer survey as the topsoil within and around settlements generally has a greater magnetisation than the subsoil; caused by human activity. This enhanced material accumulates in cut features such as ditches and pits. Areas of burning or materials which have been subjected to heat commonly also have high magnetic signatures, such as hearths, kilns, fired clay and mudbricks (Clark 1996, 65; Lowe and Fogel 2010, 24).

It should be noted that negative anomalies can also be useful for characterising archaeological features. If the buried remains are composed of a material with a lower magnetisation compared to the surrounding soil, the feature in question displaying a negative signature. For example, stone- built structures that are composed of sedimentary rocks are frequently non-magnetic and so will appear as negative features within the dataset if the local soils and sediments are at all magnetised.

Ferrous objects – i.e. iron and its alloys - are strongly magnetic and are typically detected as high-value peaks in gradiometer survey data; small (in spatial terms) spikes are generally assumed to derive from ferrous material of recent origin (e.g. stray bits of farm equipment) in the topsoil, though archaeological sources cannot be ruled out. Broader dipolar anomalies and those with diagnostic characteristics of form will be assigned to other classifications based on their character, which might include archaeology, burning, modern ferrous or uncertain.

Although gradiometer surveys have been successfully carried out in all areas of the United Kingdom, the effectiveness of the technique is lessened in areas with complex geology, particularly where igneous and metamorphic bedrock is present or there are layers of alluvium or till between the surface and the layers of interest. All magnetic geophysical surveys must therefore take the effects of background geological and geomorphological conditions into account.

AOC Archaeology's cart-based surveys are carried out using a Bartington Non-Magnetic Cart. The cart enables multiple traverses of data to be collected at the same time, increasing the speed at which surveys may be carried out and offers the benefits of reduced random measurement noise and rapid area coverage (Schmidt et al 2015, 60-62, David et al. 2008, 21).

The cart uses a configuration of four Grad-01-1000L sensors mounted upon a carbon fibre frame along with two DL601 dataloggers and one BC601 battery cassette. The sensors are normally positioned at 1m intervals on a horizontal bar, with the datalogger taking readings every 12.5cm along each traverse, though this can be altered to increase / reduce resolution if required. The data is georeferenced via a Trimble R10 Real Time Kinematic (RTK) VRS Now GNSS GPS which streams data throughout survey and allows the data to be recorded relative to a WGS1984 UTM coordinate system.

The gradiometer data is collected through Geomar MLGrad601 software on a laptop in real-time during the survey. The data is downloaded and converted into a .xyz file in Geomar MultiGrad601 before being processed along with the GPS data in TerraSurveyor v3.0.34.10 (see Appendix 3 for a summary of the processes used in Geoplot to create final data plots).

Appendix 3: Summary of Data Processing

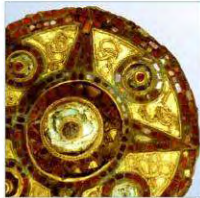
Process	Effect
Clip	Limits data values to within a specified range
De-spike	Removes small spatial scale exceptionally high readings in the data. In resistivity survey, these can be caused by poor contact of the mobile probes with the ground. In gradiometer survey, these can be caused by highly magnetic items such as buried modern ferrous objects.
De-stagger	Corrects a misalignment of data when the survey is conducted in a zig-zag traverse pattern.
Discard Overlap (TerraSurveyor)	Removes datapoints which occur too closely together and can cause digital artefacts in the data which are caused by the overlapping of parallel traverses.
Edge Match	Counteracts edge effects in grid composites by subtracting the difference between mean values in the two lines either side of the grid edge from one of the grids.
Filter (MAGNETO)	Much like a zero mean traverse, it resets the median value of each point to zero, in order to address the effect of striping in the data and counteract edge effects. In MAGNETO the individual values take into account the value of all uncorrected points within a certain distance to create its own median.
GPS Filter (MAGNETO)	Used to either remove or reduce the appearance of constant and reoccurring features that are not consistent with the GPS signal in use by the cart system.
High pass filter	Removes low-frequency, large spatial scale variance in order to remove background trends in the data, such as variations in geology.
Interpolate	Increases the resolution of a survey by interpolating new values between surveyed data points, creating a smoother overall effect.
Low Pass filter	Uses a Gaussian filter to remove high-frequency, small spatial scale variance, typically for smoothing the data.
Periodic Filter	Used to either remove or reduce the appearance of constant and reoccurring features that distort other anomalies, such as recent plough lines.
Remove Turns (TerraSurveyor)	Uses analysis of the direction of travel derived from the GNSS data to break continuous streams of data into individual traverses.
Zero Mean Grid	Resets the mean value of each grid to zero, in order to counteract grid edge discontinuities in composite assemblies.
Zero Mean Traverse	Resets the mean value of each traverse to zero, in order to address the effect of striping in the data and counteract edge effects.

Processing Steps

Bartington & Sensys Cart survey	
Process	Extent
Base Settings	Interval 0.13m, Track Radius 1.00m
Remove Turns	Threshold Angle 90°, Cut Length 5m
Discard Overlap	Threshold Distance 0.4m, Minimum Track 5, Newest
Despike	Mean Diameter 3 Threshold 12
Destripe	Mean Traverse SD 1.5
Clip	-30/30

Appendix 4: Technical Terminology

Type of Anomaly	Description of Type/Class and rationale for interpretation
Anomaly	Usually linear / curvilinear / rectilinear / discrete anomalies characterised by a sharp-edged increase or decrease in values compared to the magnetic background. Some interpretation classes may have more gradual transitions in magnetic character- this is used as part of the classification process.
Spread	Spreads of enhanced material refer to diffuse areas of altered magnetic character, which suggest a localised spread of material with a magnetic contrast within the topsoil or ploughzone or a generalised enhancement of the magnetic properties over a specific area.. These anomalies do not have the high dipolar response characteristic of ferrous material anomaly unless specifically classified as a spread of ferrous debris.
Linear Trend	Linear trends are less distinct and are typically visible as linear patterning in the overall texture of the data. A common example of these is the striping effect caused by recent ploughing.
Class of Anomaly	Description
Probable Archaeology	Interpretation is supported by the presence of known archaeological remains or by other forms of evidence such as HER records, LiDAR data or cropmarks identified through aerial photography. OR the data contains diagnostic anomalies in terms of character or morphology which allow a secure interpretation. Anomalies typically have well defined edges with abrupt transitions indicative of cut features with magnetically enhanced fills, such as ditches. Discrete anomalies will be checked on XY traces for their magnetic character; discrete anomalies in this class likely to be cut features such as pits; anomalies indicating high temperature processes will alternatively classified as 'burned area' - see below. Ferrous material creates distinct 'spikes' and is classified as such.
Possible Archaeology	Anomalies are interpreted as likely to have an archaeological origin, though other explanations are also possible, but less likely. Anomalies typically have well defined edges with abrupt transitions indicative of cut features with magnetically enhanced fills, such as ditches. Discrete anomalies checked on XY traces; discrete anomalies in this class likely to be cut features such as pits; anomalies indicating high temperature processes classified as 'burned area' - see below.
Burned Area	An anomaly with a form on the XY trace plot that is characteristic of high temperature activity such as a kiln or hearth. Should be considered as possible archaeology and should be assigned an anomaly number if a more specific interpretation is possible based on the anomaly characteristics (for example, a clear kiln) so that this can be discussed in text.
Historical Features	Features observed on historical mapping that correspond with anomalies in the data. Linear anomalies caused by removed field boundaries often exhibit distinct characteristics related to the removal process. Areas of enhanced magnetism in this class could relate to former buildings, trackways, quarries or ponds and their nature should be clarified with the use of anomaly numbers and discussion in the results section.
Unclear Origin	These anomalies are (often) magnetically weak and discontinuous or isolated making their context difficult to ascertain. OR they are indistinct for other reasons such as magnetic disturbance in their vicinity. Anomalies in this category have no more likely explanation than another, so whilst an archaeological origin is possible, an agricultural, geological, or modern origin is also equally likely.
Agricultural	Anomalies associated with agricultural activity, either historical (unless shown on a map, then classed as a historical feature) or modern. Usually, this interpretation is arrived at due to on the ground observations of (for example) ploughing, access tracks and the like, or from observation of recent aerial images of the survey area. Recent ploughing is shown as a dashed line and Ridge and Furrow ploughing is shown as a solid line.
Ridge and Furrow / Rig and Furrow	A series of regular linear or slightly curvilinear anomalies which are broad and usually have diffuse edges, either composed of an increased or decreased magnetic response compared to background values. Wide regular spacing between the anomalies is consistent with that of a ridge and furrow / rig and furrow ploughing regime, and the regime may also have a degree of sinuosity characteristic of certain types of ridge and furrow cultivation. Often, multiple directions will be present, with distinct headlands in between. The pattern might follow the general landscape organisation, or it may radically differ from it, depending on the local sequence of inclosure. The anomalies often present as a positive 'ridge' anomaly adjacent to a negative 'furrow' anomaly.
Ploughing Trends	A series of regular linear anomalies or changes in the texture of the survey data, either composed of an increased or decreased magnetic response compared to background values. Anomalies seen parallel to field edges are representative of headlands caused by ploughing.
Drains	A series of magnetic linear anomalies (often with a characteristic alternating positive-negative pattern, which indicates a ceramic drain) of an indeterminate date, usually with a regular dendritic or herringbone patterning which reflects the topography of the survey area.
Geology / Natural	An area of enhanced magnetism that is composed of irregular (usually) weak increases or decreases in magnetic values, frequently with gradual transitions in character, compared with background readings. These are likely to indicate natural variations in soil composition or reflect variations in the bedrock or superficial geology. In areas where former water courses were present, paleochannels may present as distinct curving and banded or braided linear anomalies.
Service	Strong linear anomalies often composed of contrasting high positive and negative dipolar values, with a halo of magnetic disturbance extending from the causative body. Such anomalies are characteristic of below-ground services.
Magnetic Disturbance	A zone of strong magnetic response (usually alternating between positive and negative with abrupt transitions) that has been caused by modern infrastructure or ferrous material within or adjacent to the survey area, such as metallic boundary fencing, gateways. The magnetic haloes around services and changes in the background texture of the data resulting from overhead power lines also fall into this class. These haloes are strong enough to obscure other anomalies (including those of possible archaeological interest) in the area they affect.
Ferrous Anomalies / Ferrous (iron spikes) and ferrous or debris spreads	A response caused by ferrous materials on the ground surface or within the subsoil, which causes a strong but localised dipolar response in the data. These generally represent modern material often re-deposited during manuring, rubbish at field edges and spreads of debris or building material used to surface tracks or left behind following demolition. Distinct from magnetic disturbance, these anomalies relate to material at their spatial location, rather than an effect occurring at a distance from the material responsible.
Free Category for custom use	A category which may be employed to denote specifically identified anomalies related to known past activity within the area, for example those definitely associated with a former airfield, or mapped former mineral extraction.



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