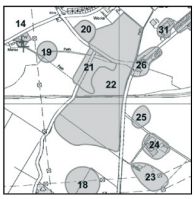
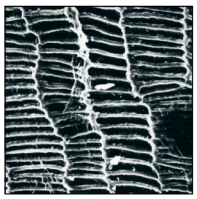
FCCP19










FLITWICK CEMETERY AND COUNTRY PARK, BEDFORDSHIRE

GEOPHYSICAL SURVEY

commissioned by Cemetery Development Services Ltd

November 2019

HEADLAND ARCHAEOLOGY

REGISTERED ORGANISATION CIfA

FLITWICK CEMETERY AND COUNTRY PARK, BEDFORDSHIRE

GEOPHYSICAL SURVEY

commissioned by Cemetery Development Services Ltd

November 2019

This report adheres to the quality standard of ISO 9001:2015

PROJECT INFO:

HA Project Code **FCCP19** / NGR **TL 04000 36301** / Parish **Flitwick** / Local Authority **Bedfordshire** / OASIS Ref. **headland5-374676**

PROJECT TEAM:

Project Manager **Sam Harrision** / Author **Nick Hannon** / Fieldwork **Olivier Vasassenbrouck, Ross Bishop** / Graphics **Beata Wieczorek-Oleksy, Nick Hannon, Rafael Maya Torcelly, Ross Bishop**

Approved by **Sam Harrision**

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HEADLAND ARCHAEOLOGY

part of the RSK Group

REGISTERED ORGANISATION CIfA

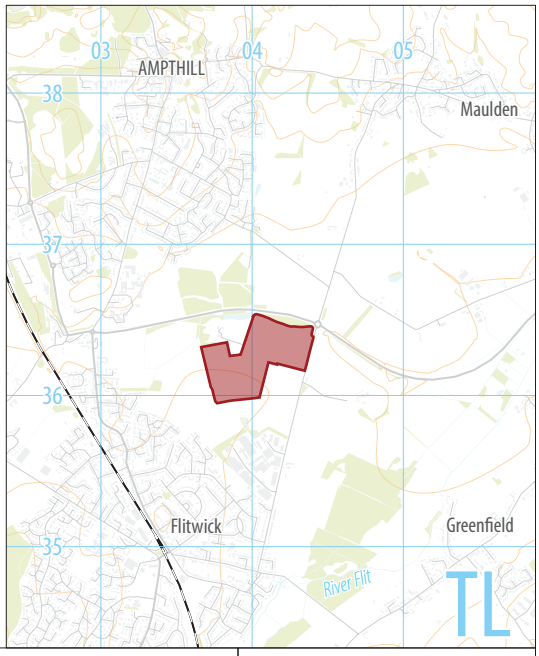
PROJECT SUMMARY

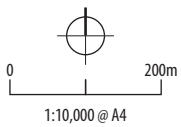
Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey, covering approximately 27 hectares north-east of Flitwick, Bedfordshire, to inform planning proposals relating to land west of Maulden Road and south of the A507. One localised area of archaeological activity (AAA) has been identified towards the west of the proposed development area (PDA). This comprises a small sub-square enclosure, within which is a probable ring ditch, with a possible second enclosure immediately to the west. Associated anomalies of possible archaeological origin are also identified in the immediate vicinity of the enclosures. Linear anomalies indicative of recent agricultural activity including former field boundaries, ridge and furrow and modern ploughing and field drains are located throughout the PDA. Anomalies locating four areas of former small-scale extraction are also identified. Based on the results of the geophysical survey the archaeological potential of the PDA is assessed as low but medium to high in the AAA.

CONTENTS

LIST OF ILLUSTRATIONS

Flitwick Cemetery and Country Park
Flitwick
Bedfordshire





proposed development area

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ILLUS 1 Site location

FLITWICK CEMETERY AND COUNTRY PARK, BEDFORDSHIRE

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Cemetery Development Services Ltd (the Client), to undertake a geophysical (magnetometer) survey on land north-east of Flitwick, Bedfordshire, to inform planning proposals relating to land west of Maulden Road and south of the A507, where a new cemetery is proposed. The survey was undertaken in order to assess the impact of the proposed development on the historic environment.

The work was undertaken in accordance with a Written Scheme of Investigation (WSI) (Dyulgerski 2019), with guidance within the Ministry of Housing, Communities and Local Government (MHCLG 2019) and in line with current best practice (Chartered Institute for Archaeologists 2014; Europae Archaeologia Consilium 2016).

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The PDA is an irregular shaped parcel of land covering an area of approximately 27 hectares located to the north-east of Flitwick (Illus 1) and centred on National Grid Reference (NGR) TL 04000 36301. It is bound to the north by the A507, the east by Maulden Road and the south and west by field boundaries. The PDA comprises a single field under arable cultivation (see Illus 2 and 3).

The PDA slopes down from the south, at approximately 75m Above Ordnance Datum (AOD), to the north, at approximately 61m AOD.

The survey was carried out on 20th and 21st August 2019.

1.2 GEOLOGY AND SOILS

The underlying geology within the PDA is complex. There is a bipartite split in the bedrock between Woburn Sands Formation (sandstone) in the north of the site and, in the south of the site, West Walton and Ampthill Clay Formations (mudstone). Superficial deposits overlay the bedrock. Head (clay, silt, sand and gravel) covers the majority of the PDA with narrow bands of alluvium (clay, silt, sand, and gravel) on the lowest lying parts of the PDA along the northern edge of the PDA and glaciofluvial deposits (sands and gravels) at the southern end of the PDA (NERC 2019). The boundaries between the three types of superficial deposit are clearly distinguishable in the data (see below).

The soils are classified in the Soilscape 9 Association being characterised as lime-rich loamy and clayey soils with impeded drainage (Cranfield University 2019).

2 ARCHAEOLOGICAL BACKGROUND

Geophysical survey and trial trenching were conducted on a site bordering the PDA to the south-east of the PDA, off Maulden Road (Albion 2012). The trenching found no features or deposits of archaeological significance and confirmed that any anomalies identified by the geophysical survey were probably the result of farming activities and/or geological variation, such as ironstone outcropping within the soil. The principal features found by the trenching comprised two shallow parallel ditches, likely a post-medieval trackway.

ILLUS 2 Proposed Development Area, looking south-east

3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to provide sufficient information to establish the presence/absence, character and extent of any archaeological remains within the PDA. This will therefore enable an assessment to be made of the impact of the proposed development on any sub-surface archaeological remains, if present.

The specific archaeological objectives of the geophysical survey were:

- Gather sufficient information to inform the extent, condition, character and date (as far as circumstances permit) of any archaeological features and deposits within the survey area;
- to obtain information that will contribute to an evaluation of the significance of the scheme upon cultural heritage assets; and
- to prepare a report summarising the results of the survey.

3.1 MAGNETOMETER SURVEY

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney & Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Appendix 1.

The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid carrying frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10–15cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point.

MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Terrasurveyor V3.0.35.1 (DWConsulting) software was used to process and present the data.

3.2 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:10,000. Illus 2 and Illus 3 inclusive are site condition photographs. Illus 4 is a 1:2,500 survey location plan showing the direction of survey as GPS swaths and photograph locations. Illus 5 presents the data from the PDA as a greyscale plot at a scale of 1:2,500. Illus 6 presents the minimally processed data (XY traceplot), also at a scale of 1:2,500 whilst Illus 7 presents the interpretation again at a scale of 1:2,500.

ILLUS 3 Proposed Development Area, looking south

Illus 8, 9 and 10 presents AAA1 to the west of the PDA at a scale of 1:1,000 as a greyscale plot, as minimally processed data (XY traceplot), and the interpretation respectively.

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the site archive. Data processing details are presented in Appendix 4. A copy of the OASIS entry (Online Access to the Index of Archaeological Investigations) is reproduced in Appendix 5.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Dyulgerski 2019), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2014). All illustrations from Ordnance Survey (OS) mapping are reproduced with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The illustrations in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All illustrations are presented to most suitably display and interpret the data from this site based on the experience and knowledge of management and reporting staff.

4 RESULTS AND DISCUSSION (ILLUS 4 TO ILLUS 10)

The ground conditions were good across the PDA (see Illus 2 and Illus 3) and the overall data quality is good.

The magnetic background across the PDA varies with the change in superficial deposits. To the north and south of the PDA, on the alluvium and glaciofluvial deposits, the background is relatively homogenous but there is a much greater variation on the head across the centre of the site with numerous discrete areas of magnetic enhancement. These are caused by localised variations in the depth and composition of the soil. Against this background, linear and discrete anomalies of geological, agricultural, modern and archaeological nature have been identified. These anomalies are discussed below and cross-referenced to specific examples on the interpretive figures, where appropriate.

4.1 FERROUS AND MODERN ANOMALIES

Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris is common on most sites, often being present as a result of

manuring or tipping/infilling. Across the majority of the PDA these 'spikes' display no obvious clustering which might indicate an archaeological origin, far more probable is that the 'spike' responses are likely caused by the random distribution of ferrous debris in the upper soil horizons. However, running on a broadly east/west alignment, situated between PFB4 and Maulden Road is an alignment of 'spikes' each exhibiting a similar magnitude reading. Due to the relatively even spacing of these anomalies (approximately 8m apart) and their linear nature they have been interpreted as locating the continuation of the probable field drain/former boundary PFB2/3.

A large, irregular, high magnitude anomaly (Q1), approximately 80m by 35m and located on the southern extremity of the PDA, has been identified. This anomaly corresponds with the location of a former quarry or pond depicted on historic Ordnance Survey (OS) mapping. The disturbance is due to the magnetic properties of the material (brick, tile etc) used to infill the former feature. Three other similar areas of disturbance (Q2, Q3 and Q4) are identified although the locations of these anomalies do not correspond with any features on historic mapping. Nonetheless they are also interpreted as indicative of former small-scale extraction.

Magnetic disturbance around the field edges is due to ferrous material within, or adjacent to the boundaries and is of no archaeological interest.

4.2 AGRICULTURAL ANOMALIES

Two low magnitude linear anomalies (FB1 and FB2), aligned north-north-west/south-south-east, have been identified towards the south of the PDA and interpreted as former field boundaries; both anomalies have been cross-referenced with first edition or later OS mapping and their locations correspond to mapped boundaries. Three other linear anomalies (PFB1, PFB2 and PFB3), have been identified. These are interpreted as possible former field boundaries although they are not recorded on the historic mapping. Alternatively, they may locate field drains (see below) – this is the lowest lying part of the PDA – and this is considered the most likely cause.

At the far west of the PDA are a series of parallel, slightly curving, linear trend anomalies spaced approximately 10m apart. These anomalies are aligned parallel with the former boundaries FB1 and FB2 (see above) and have been interpreted as indicative of ridge and furrow cultivation. The anomalies are caused by the magnetic contrast between the infilled furrows and former ridges.

Numerous parallel linear trend anomalies on varying alignments have been identified in the north-eastern part of the site, north of the possible former boundaries, PFB1 to 3 inclusive. This is the lowest lying part of the PDA and these anomalies are due to field drains.

Other disparate linear anomalies are due to recent ploughing or other agricultural activity.

4.3 GEOLOGICAL ANOMALIES

As described above the magnetic background varies depending on the underlying superficial deposits. The boundaries between the three bands of superficial material are visible by virtue of the change in the magnetic background. These interfaces are shown on the interpretation graphic (Illus 7) and is most noticeable along the boundary between the alluvium and head deposits where numerous broad areas of magnetic enhancement are also identified.

4.4 AREA OF ARCHAEOLOGICAL ACTIVITY – AAA1

A sub-square enclosure (E1) has been identified on the higher ground towards the west of the PDA measuring approximately 35m east/west by 30m north/south. Within it a circular anomaly is interpreted as a ring-ditch (RD1) measuring 10m in diameter at its western end. Discrete anomalies within or immediately outside the enclosure could be indicative of features such as pits.

Immediately abutting E1 to the west is a second possible enclosure (E2). The magnetic response from the ditches defining E2 are much weaker than in E1 but the enclosure is nevertheless interpreted as of possible archaeological origin.

Three linear ditch-type anomalies have been identified (D1 to D3) extending east from E1 with which they appear to broadly align although they of lower magnitude. These are also interpreted as of possible archaeological origin.

5 CONCLUSION

The survey has successfully evaluated the PDA identifying one area of definite archaeological activity on the higher ground to the south-west of the PDA. This comprises one, and possibly two, enclosures with possible internal features. Ditch type anomalies extend to the east of the enclosures. Other linear anomalies locate former field boundaries, field drains and post-medieval and modern ploughing. Based on the geophysical survey, the archaeological potential of the PDA is assessed as low but medium to high in the area of archaeological activity.

6 REFERENCES

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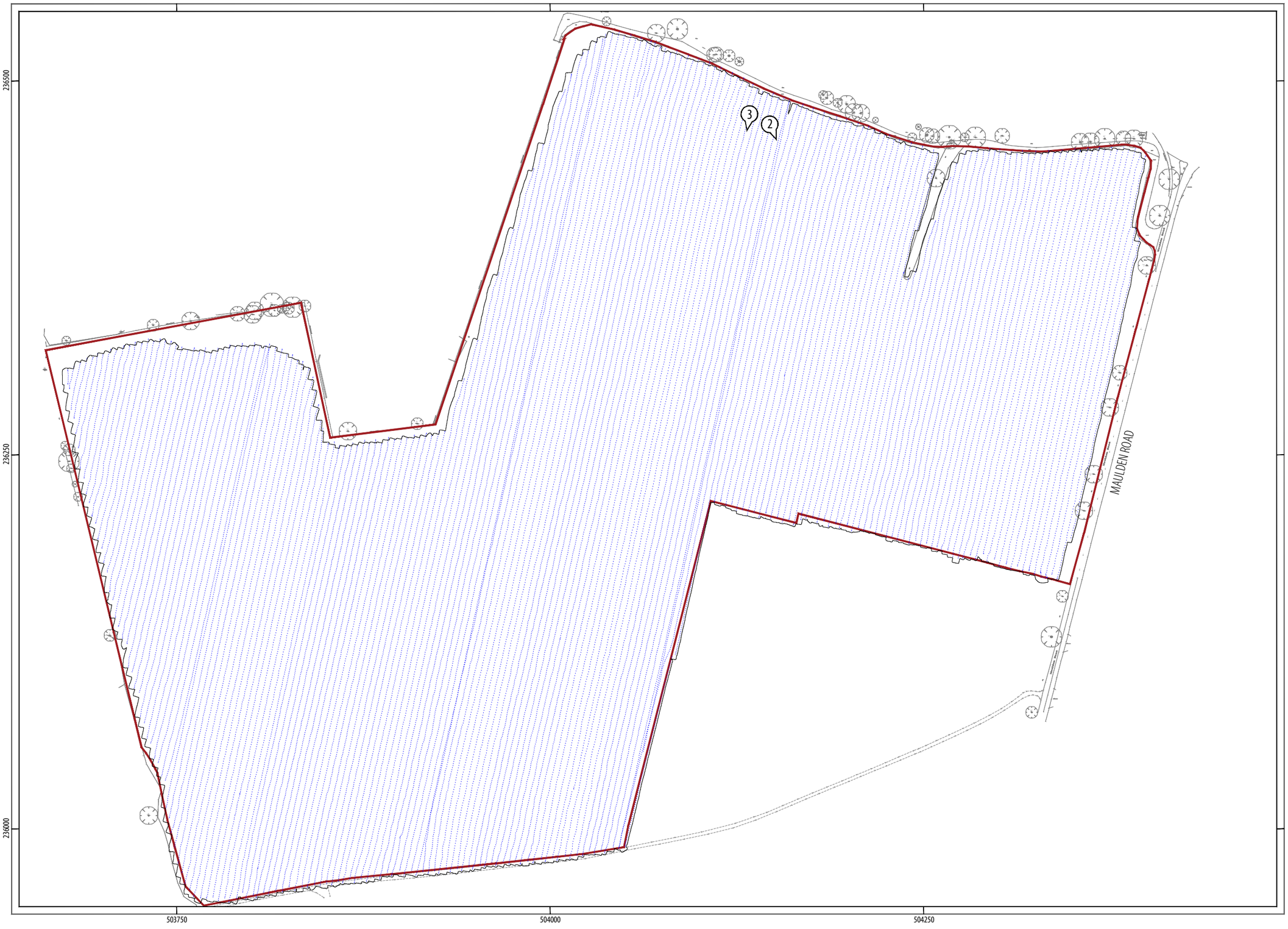

GPS swaths
location and direction of ILLUS 2-3
proposed development area

0 50m
1:2,500 @ A3

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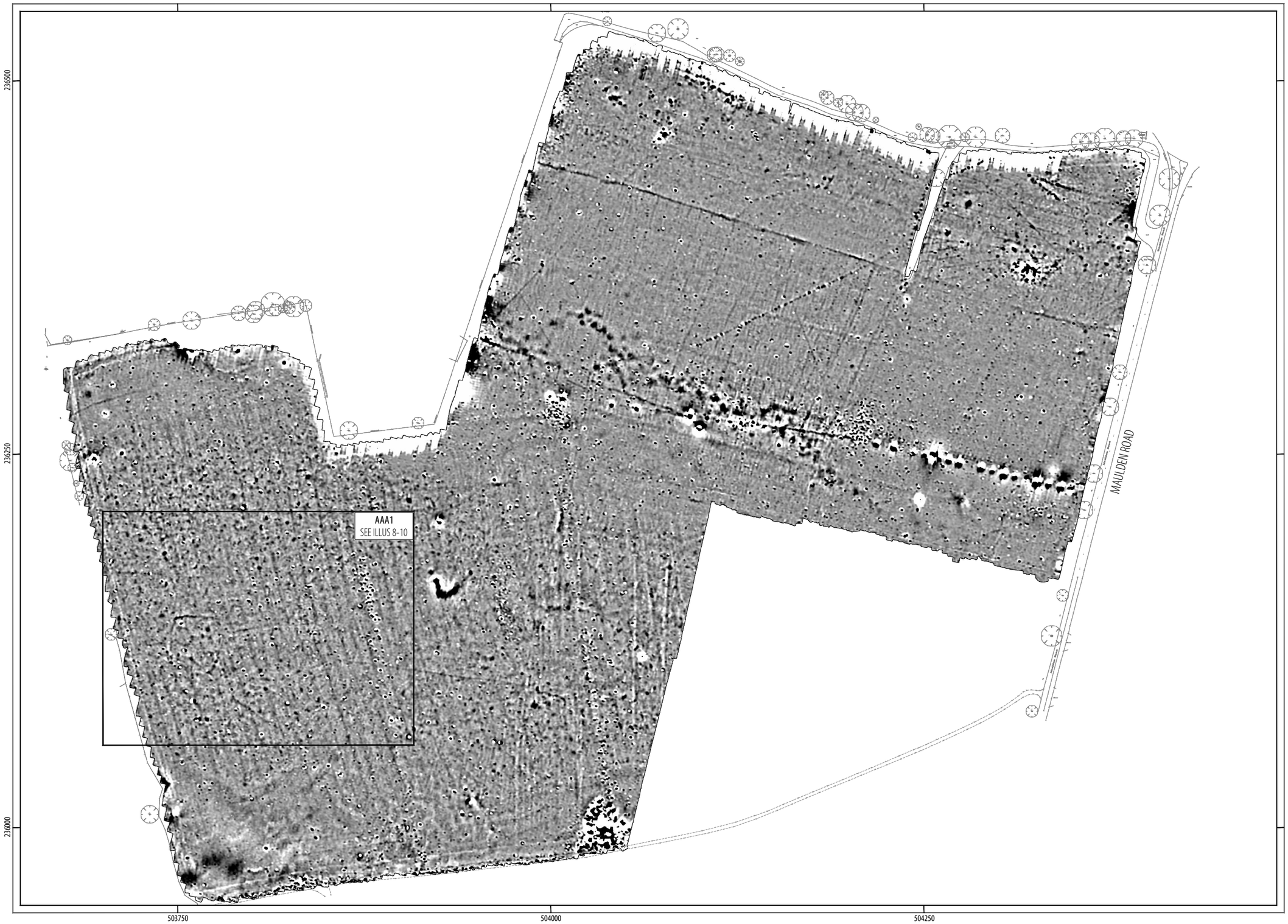
ILLUS 4 Survey area showing GPS swaths



nT
-2.0 3.0

0 50m
1:2,500 @ A3

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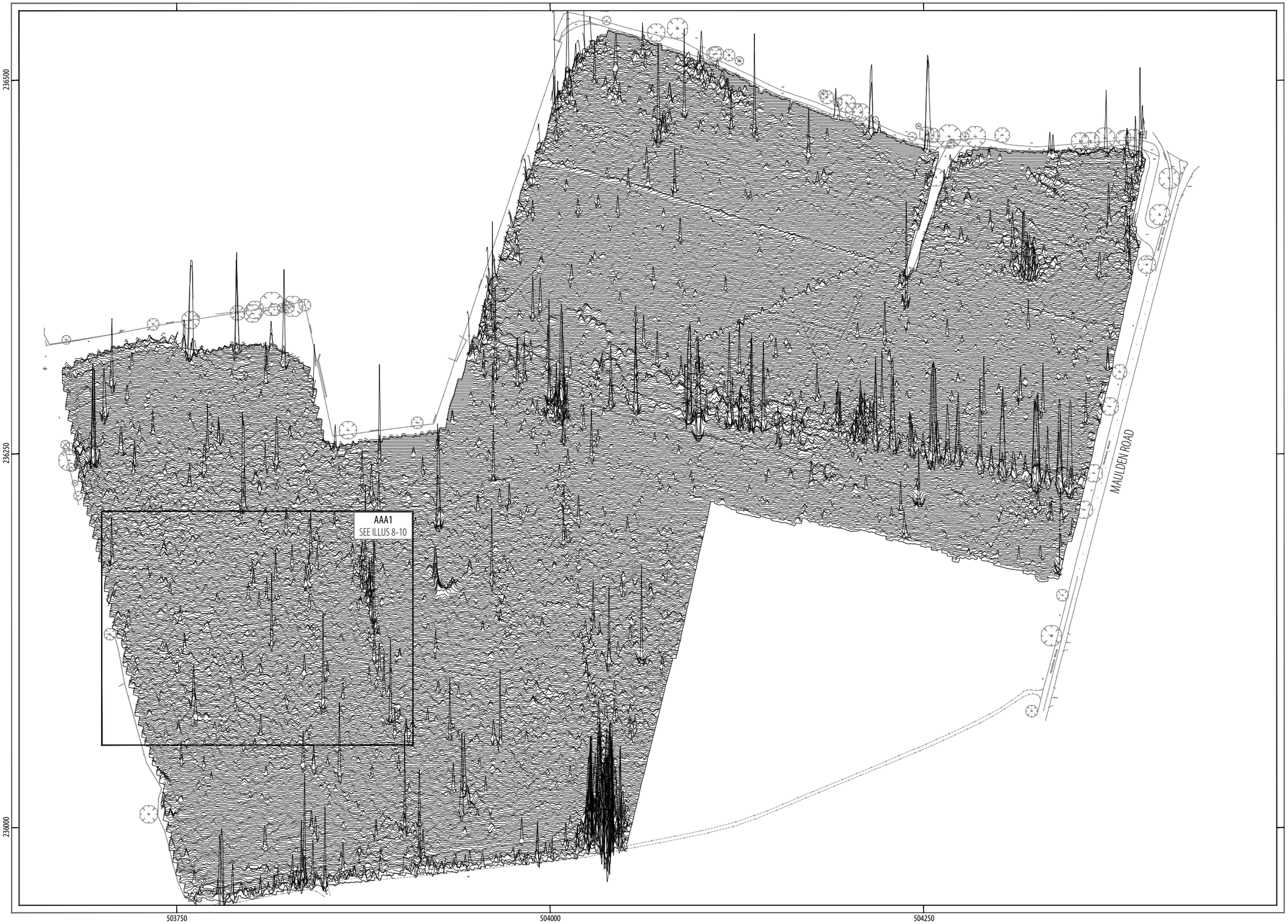
ILLUS 5 Processed greyscale magnetometer data



70.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 6 XY trace plot of minimally processed magnetometer data

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic enhancement	quarrying
linear trend	ridge and furrow
linear trend	agricultural
linear trend	field drain
linear	former field boundary?
linear	former field boundary
linear trend	geological boundary
magnetic enhancement	geology
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

D - ditch
E - enclosure
FB - former boundary
PFB - possible former boundary
Q - quarry
RD - ring ditch

0 50m
1:2,500 @ A3

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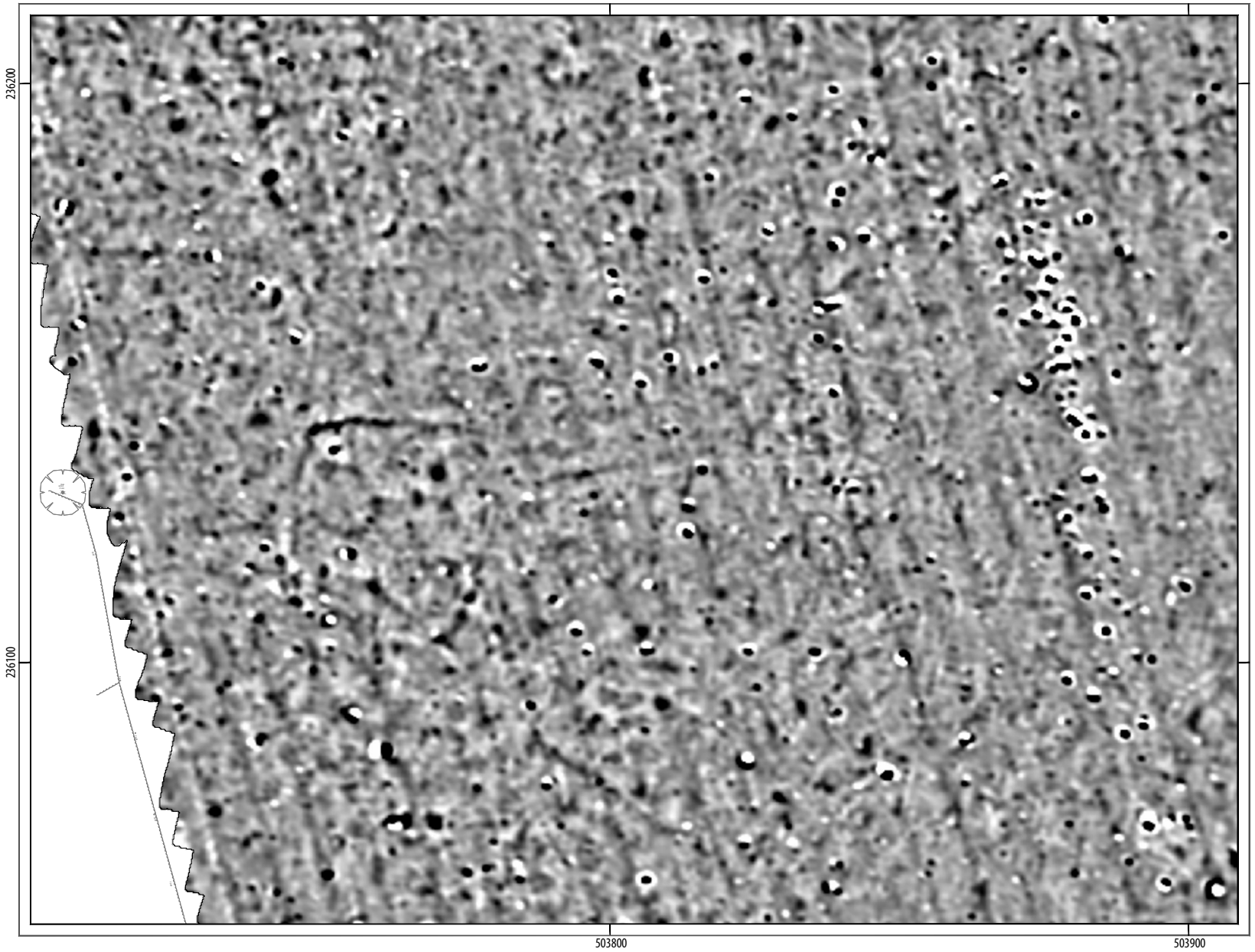
ILLUS 7 Interpretation of magnetometer data



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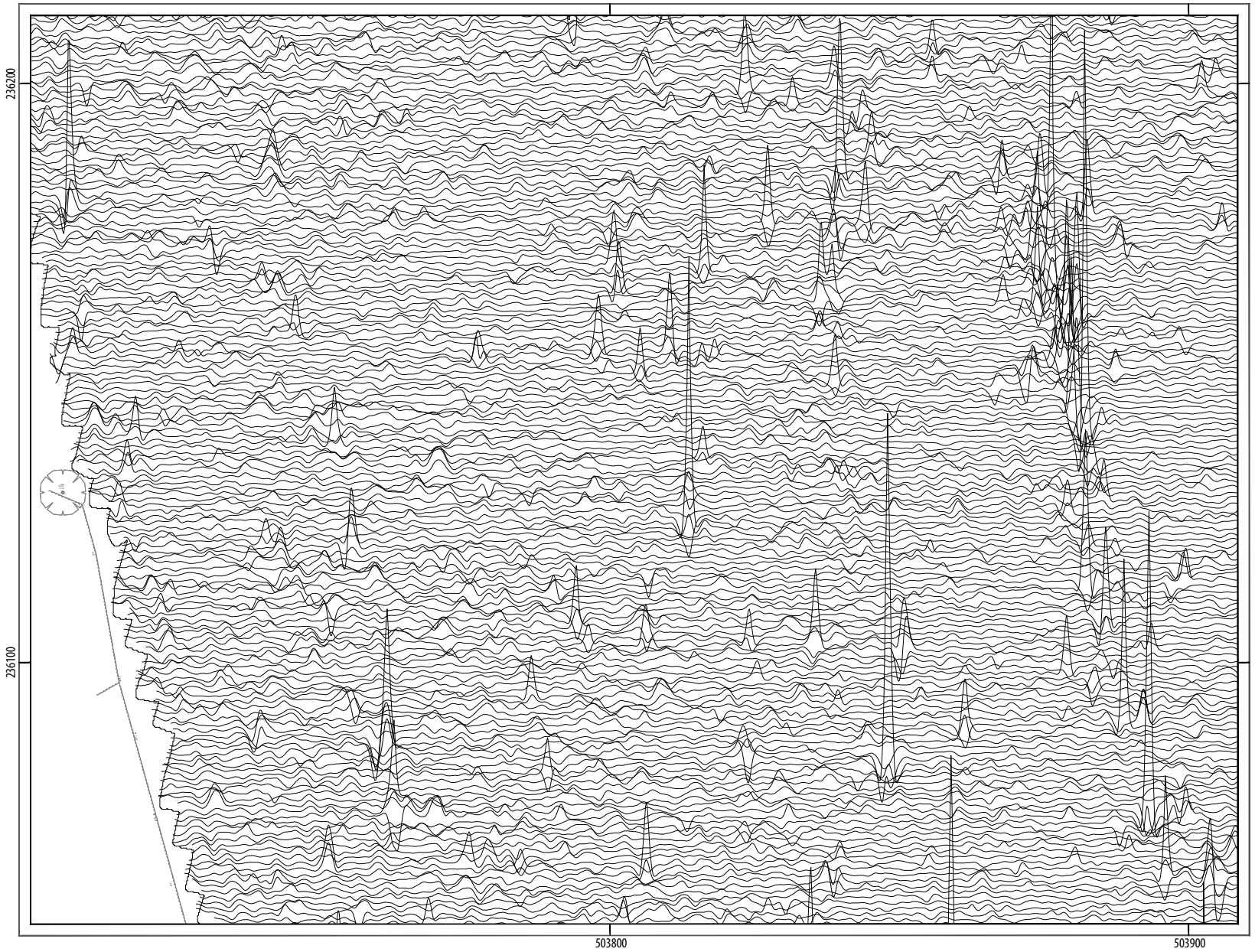
ILLUS 8 Processed greyscale magnetometer data; AAA1



28.0nT/cm

0 25m

1:1,000 @ A4

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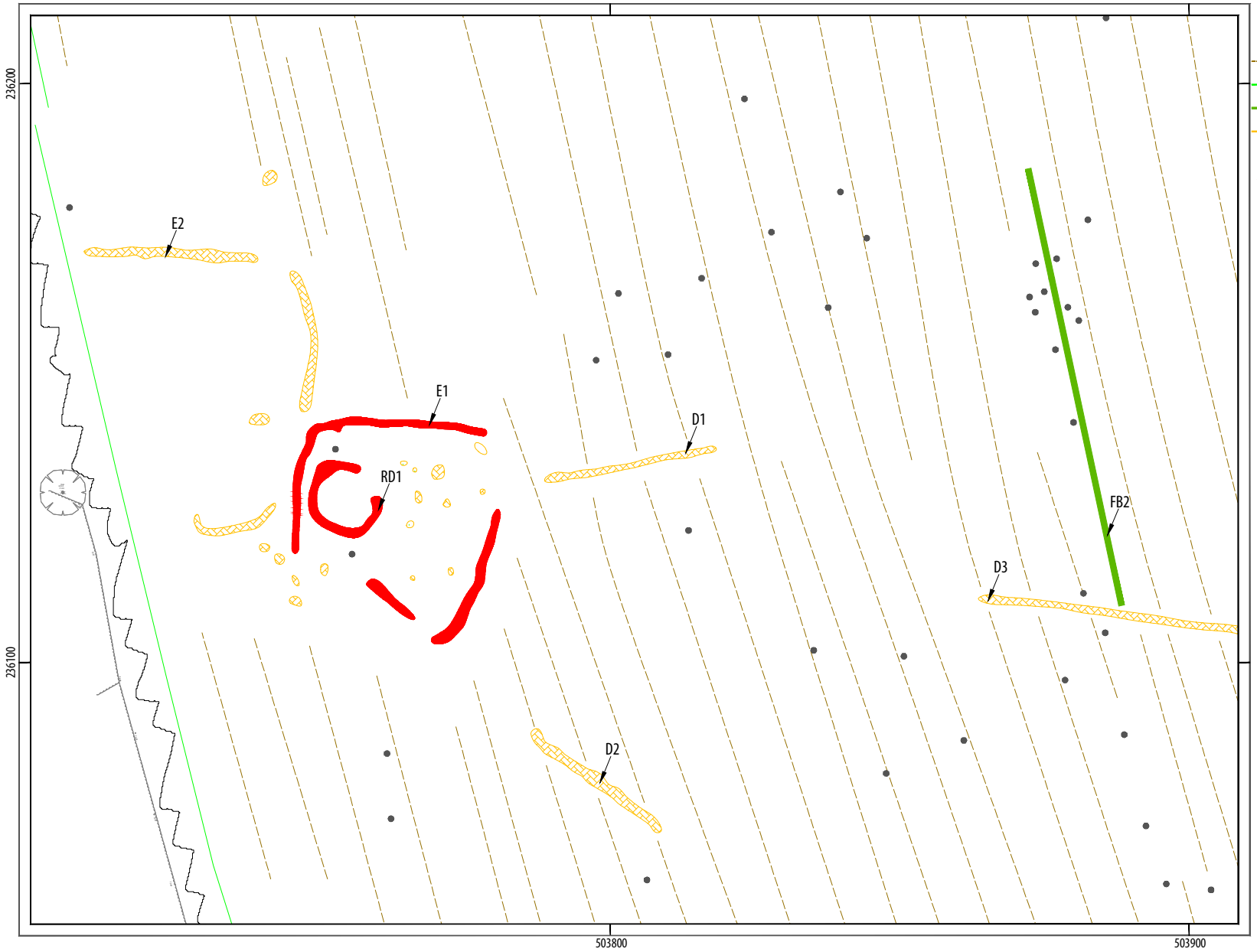
ILLUS 9 XY trace plot of minimally processed magnetometer data; AAA1



TYPE OF ANOMALY | INTERPRETATION

- dipolar isolated — ferrous material
- linear trend — ridge and furrow
- linear trend — agricultural
- linear — former field boundary
- linear trend — archaeology?
- magnetic enhancement — archaeology?
- magnetic enhancement — archaeology

ABBREVIATIONS

D - ditch
E - enclosure
FB - former boundary
RD - ring ditch

0 25m
1:1,000 @ A4

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ILLUS 10 Interpretation of magnetometer data; AAA1

7 APPENDICES

APPENDIX 1 MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

Iron makes up about 6% of the earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

Types of magnetic anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes) These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Lightning-induced remnant magnetisation (LIRM) LIRM anomalies are thought to be caused in the near surface soil horizons by the flow of an electrical currents associated with lightning strikes. These observed anomalies have a strong bipolar signal which decreases with distance from the spike point and often appear as linear or radial in shape.

Linear trend This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

APPENDIX 2 SURVEY LOCATION INFORMATION

An initial survey base station was established using a Trimble VRS differential Global Positioning System (dGPS). The magnetometer data was georeferenced using a Trimble RTK differential Global Positioning System (Trimble R8s model).

Temporary sight markers were laid out using a Trimble VRS differential Global Positioning System (Trimble R8s model) to guide the operator and ensure full coverage. The accuracy of this dGPS equipment is better than 0.01m.

The survey data were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

APPENDIX 3 APPENDIX 3 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associate world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

APPENDIX 4 APPENDIX 4 DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift and any other artificial data.

A high pass filter has been applied to the greyscale plots to remove low frequency anomalies (relating to survey tracks and modern agricultural features) in order to maximise the clarity and interpretability of the archaeological anomalies.

The data has also been clipped to remove extreme values and to improve data contrast.

APPENDIX 5 APPENDIX 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5-374676

PROJECT DETAILS	
Project name	Flitwick Cemetery and Country Park, Flitwick,
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey, covering approximately 27 hectares north-east of Flitwick, Bedfordshire, to inform planning proposals relating to land west of Maulden Road and south of the A507. One localised area of archaeological activity (AAA) has been identified towards the west of the proposed development area (PDA). This comprises a small sub-square enclosure, within which is a probable ring ditch, with a possible second enclosure immediately to the west. Associated anomalies of possible archaeological origin are also identified in the immediate vicinity of the enclosures. Linear anomalies indicative of recent agricultural activity including former field boundaries, ridge and furrow and modern ploughing and field drains are located throughout the PDA. Anomalies locating four areas of former small-scale extraction are also identified. Based on the results of the geophysical survey the archaeological potential of the PDA is assessed as low but medium to high in the AAA.
Project dates	Start: 19-08-2019 End: 21-08-2019
Previous/future work	Yes / Not known
Any associated project reference codes	FCCP19 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	None
Monument type	None
Significant Finds	None
Significant Finds	None
Methods & techniques	"Geophysical Survey"
Development type	Amenity area (e.g. public open space)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Woburn Sands Formation (sandstone) in the north of the site and, in the south of the site, West Walton and Ampthill Clay Formations (mudstone).
Drift geology (other)	Head and Alluvium
Techniques	Magnetometry

PROJECT LOCATION	
Country	England
Site location	Bedfordshire Mid Bedfordshire Flitwick Flitwick Cemetery and Country Park
Study area	27 Hectares
Site coordinates	TL 04000 36301 52.014946956992 -0.484387616413 52 00 53 N 000 29 03 W Polygon

PROJECT CREATORS	
Name of Organisation	Headland Archaeology
Project brief originator	Consultant
Project design originator	Headland Archaeology
Project director/manager	Harrison, S
Project supervisor	Dyulgerski, K.
Type of sponsor/funding body	County Council

PROJECT ARCHIVES	
Physical Archive Exists?	No
Digital Archive recipient	In house
Digital Contents	"other"
Digital Media available	"Geophysics","Images raster / digital photography","Images vector"
Paper Archive Exists?	No

PROJECT BIBLIOGRAPHY 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	Flitwick Cemetery and Country Park, Bedfordshire: Geophysical Survey
Author(s)/Editor(s)	Hannon, N.
Other bibliographic details	FCCP19
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