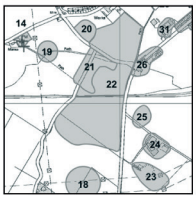
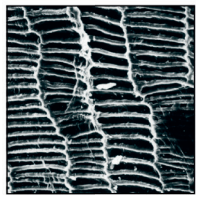
HSFH20








# HILFIELD SOLAR FARM, HERTFORDSHIRE

## GEOPHYSICAL SURVEY REPORT

commissioned by Elstree Green Limited

December 2020

HEADLAND ARCHAEOLOGY

REGISTERED ORGANISATION CIfA

# HILFIELD SOLAR FARM, HERTFORDSHIRE

## GEOPHYSICAL SURVEY REPORT

commissioned by Elstree Green Limited

December 2020



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

PROJECT INFO:

HA Project Code **HSFH20** / NGR **TQ 1499 9693 (west), TQ 1620 9802 (east)** / Parish **Elstree and Borehamwood Town Council** / Local Authority **Hertfordshire County Council** / OASIS Ref. **headland5-410836**

PROJECT TEAM:

Project Manager **David Harrison** / Author **Alistair Webb** / Fieldwork **Glyn Sheldrick, Michael Puntorno, Peter Heykoop, Richard McGregor-Edwards, Robbie House, Ross Bishop** / Graphics **Eleanor Winter, Olivier Vansassenbrouck**

Approved by **David Harrison** D Harrison .....

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part of the RSK Group

REGISTERED ORGANISATION CIfA

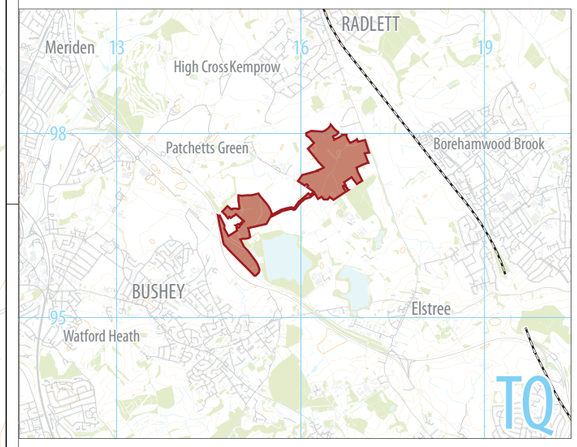
# PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey at a 130-hectare site north-west of Elstree, Hertfordshire to inform a planning application for a proposed solar farm and battery storage. Several fields were surveyed across the full extent of the site. In all locations the data was extremely disturbed due to the presence of 'green waste' in the plough soil. No anomalies of archaeological potential were identified. The extent and magnitude of the disturbance was such that no archaeological anomalies, if present, could be identified against the perturbed magnetic background. Consequently, following consultation and review it was agreed that continuing the survey would not help inform the application and was so abandoned.

# CONTENTS

# LIST OF ILLUSTRATIONS

Hilfield Solar Farm
Elstree
Hertfordshire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0
250m
1:12,500 @ A3

proposed development area

**ILLUS 1** Site location

# HILFIELD SOLAR FARM, HERTFORDSHIRE

## GEOPHYSICAL SURVEY REPORT

## 1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Elstree Green Limited to undertake a geophysical (magnetometer) survey on land north-east and west of Elstree Aerodrome, an area of 130 hectares, the site of a proposed solar farm and battery storage.

The results of the survey will inform future archaeological strategy at the site. The survey was undertaken to assess the impact of the scheme on the historic environment. It was undertaken in accordance with an Archaeological Written Scheme of Investigation (WSI) (Headland 2020), with guidance within the National Planning Policy Framework (MHCLG 2019) and in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016).

The surveys were carried out between September 18th 2020 and October 2nd 2020.

### 1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The proposed development area (PDA) comprised two irregularly sized blocks of land north-east and west of Elstree Aerodrome and north of Hilfield Park Reservoir, linked by a new access track (Illus 1). The western block, centred on TQ 1499 9693, comprised five fields (F1–F5) which are bound to the west by the M1 motorway, to the south by London Elstree Aerodrome, to the north-west by an electricity sub-station and to the east and the north by arable fields. The eastern block is centred on TQ 1620 9802 and is bound to the west by Aldenham Road, to the south by Butterfly Lane, to the east by Watling Street and to the north by arable farmland.

### 1.2 GEOLOGY AND SOILS

The bedrock geology comprises London Clay Formation. No superficial deposits are recorded (NERC 2020).

The soils are classified in the Soilscape 18 Association, characterised as slowly permeable, seasonally wet loams and clays (Cranfield University 2020).

## 2 ARCHAEOLOGICAL BACKGROUND

A preliminary assessment of the historic environment resource of the application site and its surroundings has been undertaken (Headland Archaeology 2020). This assessment included gathering baseline data on known heritage assets from the Hertfordshire Historic Environment Record and the National Heritage List and a review of Ordnance Survey mapping, LiDAR data and a site visit.

This initial review of the Hertfordshire HER data indicated that a Roman road (Watling Street) borders the PDA along part of its easternmost edge. Two later, two post-medieval roads are also noted as is an 18th century park which also partially was located within the PDA. A medieval moated site at Little Kendals Wood may also extend into the PDA although no earthworks are visible.

# 3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to provide enough information to establish the presence/absence, character and extent of any archaeological remains within the PDA. This would 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:

- to gather enough information to inform the extent, condition, character and date (as far as circumstances permit) of any archaeological features and deposits within the PDA;
- 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 V3.0.36.0 (DWConsulting) software was used to process and present the data.

## 3.2 REPORTING

A site location plan is included as Illus 1 with the greyscale data and interpretation graphically displayed in Illus 2 and Illus 3 at a scale of 1:10,000. The PDA is split into two sectors and the data displayed and interpreted at 1:5,000 in Illus 4 to Illus 7 inclusive.

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 included as 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 (Jacobs 2019), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (ClfA 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 display and interpret the data to best effect. The interpretations are based on the experience and knowledge of management and reporting staff.

# 4 RESULTS AND DISCUSSION

Ground conditions were very good throughout the PDA. However, the data is extremely magnetically perturbed throughout. This is due to the use of 'green waste' as a soil improver. Magnetic material within the green waste and the strongly magnetic compounds created during the decomposition process have led to a highly elevated magnetic background against which the much weaker responses from archaeological features, if present, have effectively been masked.

Anomalies or areas of anomalous response can still be identified against this magnetic background. However, these are all non-archaeological. These include high magnitude linear anomalies due to sub-surface pipes or overhead cables leading to/from the Electricity Distribution Station adjacent to the north-western corner of the PDA (F2, F14 and F15), the magnetic halo caused by the electricity pylons (F4 and F20) and the sub-surface footings of former pylons (adjacent to the current pylon in F4).

In the eastern half of F20 the massive magnetic disturbance is due to material used to infill a former quarry.

In F1 the area of elevated magnetic response on the southern side of Hilfield Brook is due to the deposition of alluvial material during episodes of flooding.

Two vague linear trends, also in F1, to the southern end locate former field boundaries.

# 5 CONCLUSION

In this instance the survey has not been able to successfully evaluate the site due to the presence of 'green waste' across the PDA. Consequently, no anomalies of possible or probable archaeological origin have been identified and hence the archaeological potential of the PDA remains unknown.

# 6 REFERENCES

Chartered Institute for Archaeologists (ClfA) 2014 ***Standard and guidance for archaeological geophysical survey*** (Reading) https://www.archaeologists.net/sites/default/files/ClfAS%26GGeophysics_3.pdf accessed 23 November 2020

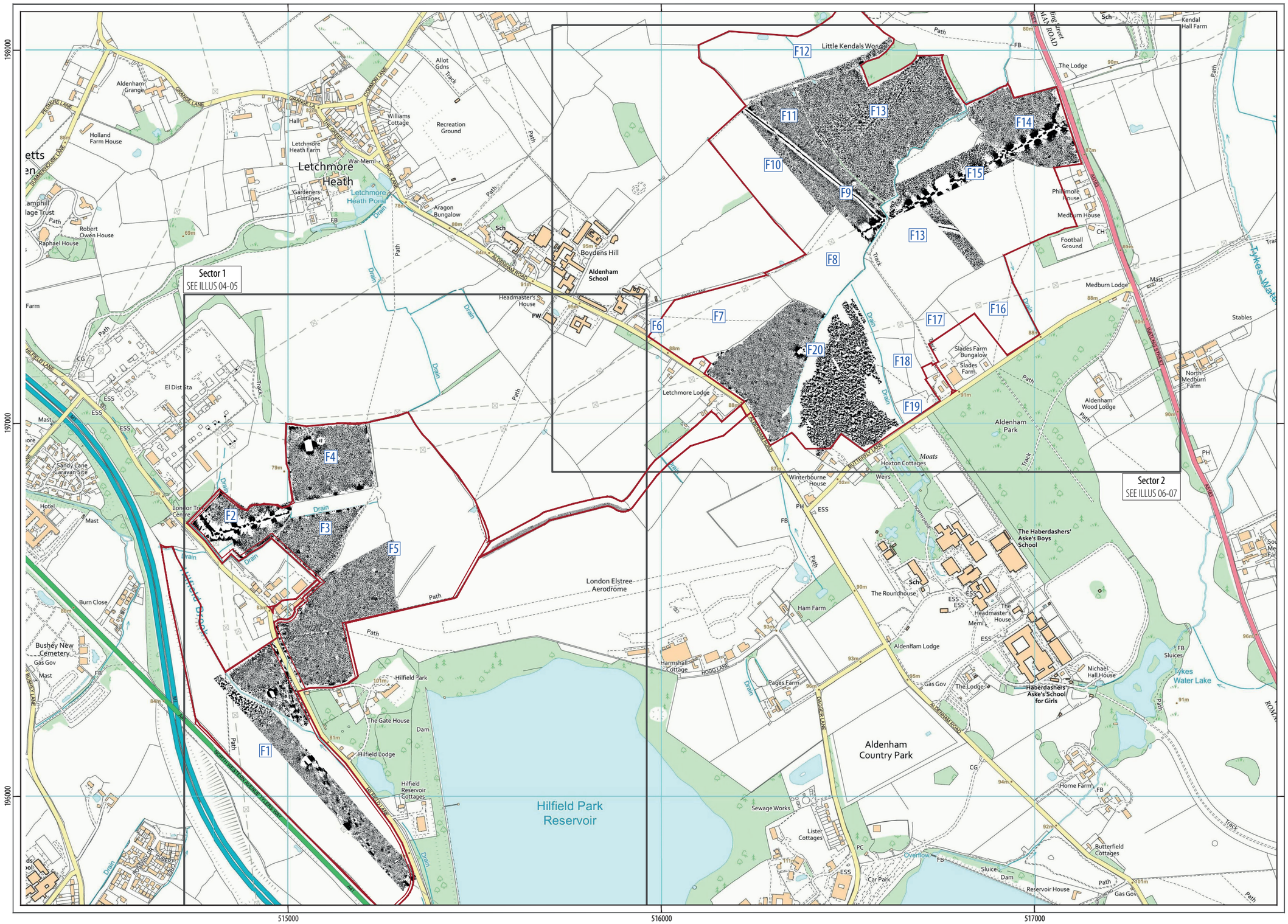
Natural Environment Research Council (NERC) 2018 ***British Geological Survey*** http://www.bgs.ac.uk/ accessed 23 November 2020

Europae Archaeologia Consillium (EAC) 2016 ***EAC Guidelines for the Use of Geophysics in Archaeology: Question to Ask and Points to Consider*** (Namur, Belgium) https://www.europae-archaeologiae-consilium.org/eac-guidlines accessed 23 November 2020

Gaffney C & Gater J 2003 ***Revealing the Buried Past: Geophysics for Archaeologists*** Stroud

Headland Archaeology 2020 ***Hilfield Solar Farm, Hertfordshire: Written Scheme of Investigation for Geophysical Survey*** [unpublished client report]

Ministry of Housing, Communities and Local Government (MHCLG) 2019 ***National Planning Policy Framework*** https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf accessed 23 November 2020




PROJECT HSFH20
Hilfield Solar Farm
Elstree
Hertfordshire

CLIENT Aardvark EM Limited

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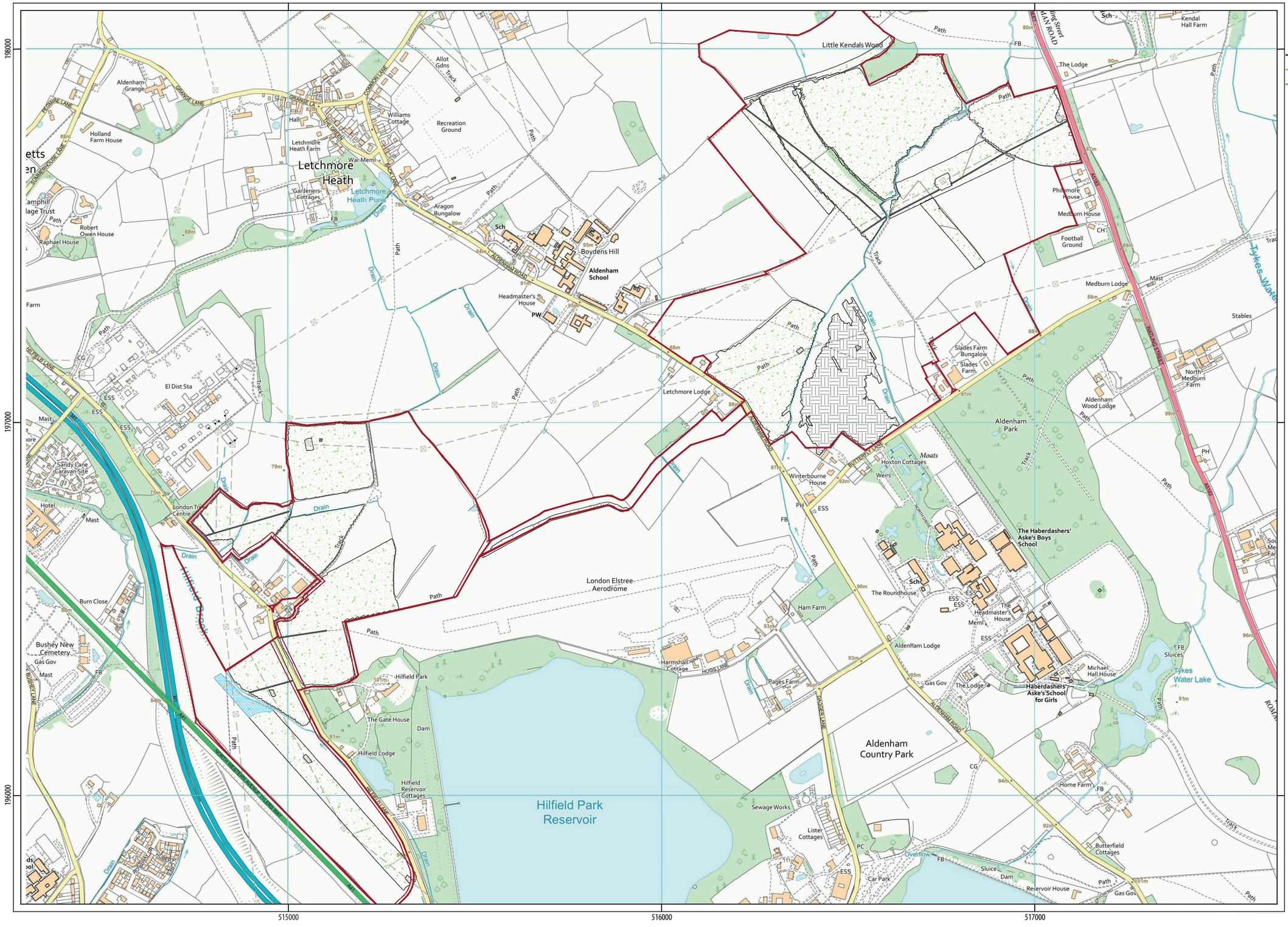
**ILLUS 2** Greyscale plot of processed magnetometer data

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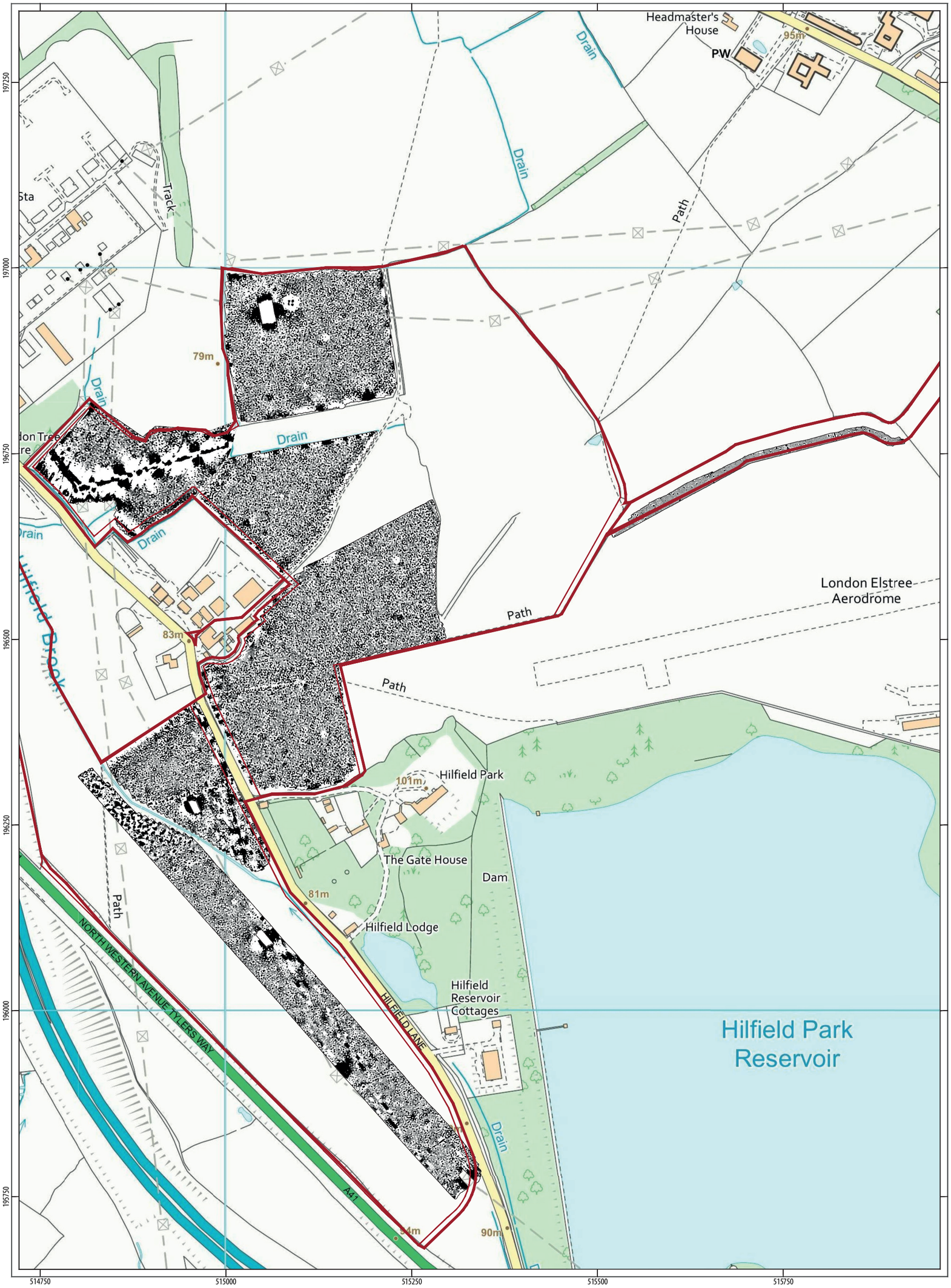
**ILLUS 3** Interpretation of magnetometer data

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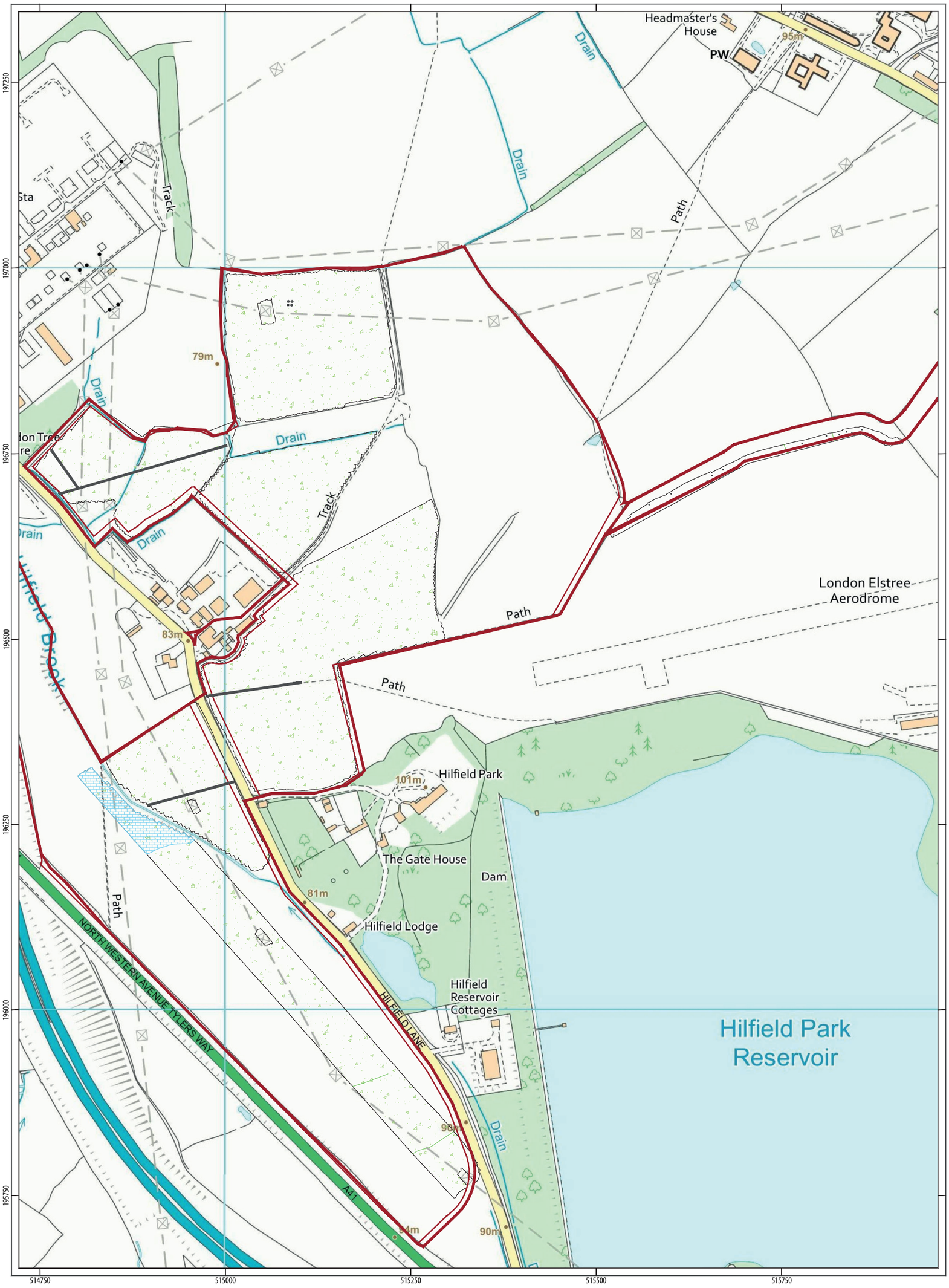
**ILLUS 4** Greyscale plot of processed magnetometer data; Sector 1




Proposed development area

| TYPE OF ANOMALY | INTERPRETATION |
|---|---|
| dipolar isolated | ferrous material |
| dipolar linear | service pipe |
| linear | former field boundary |
| linear trend | agricultural |
| magnetic enhancement | green waste |
| magnetic enhancement | geology |

0 100m
1:5,000 @ A3

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Elstree
Hertfordshire

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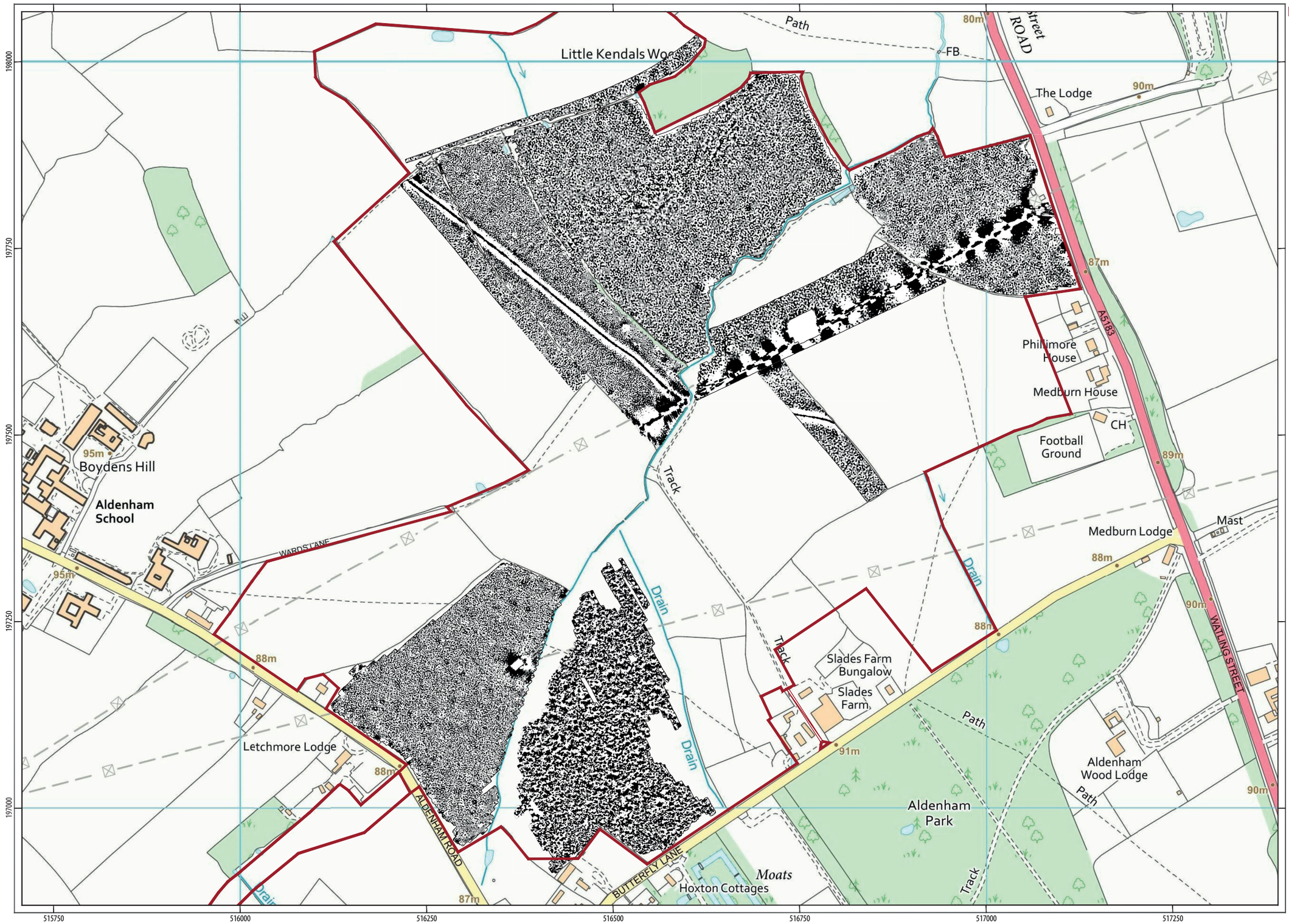
**ILLUS 5** Interpretation of magnetometer data; Sector 1

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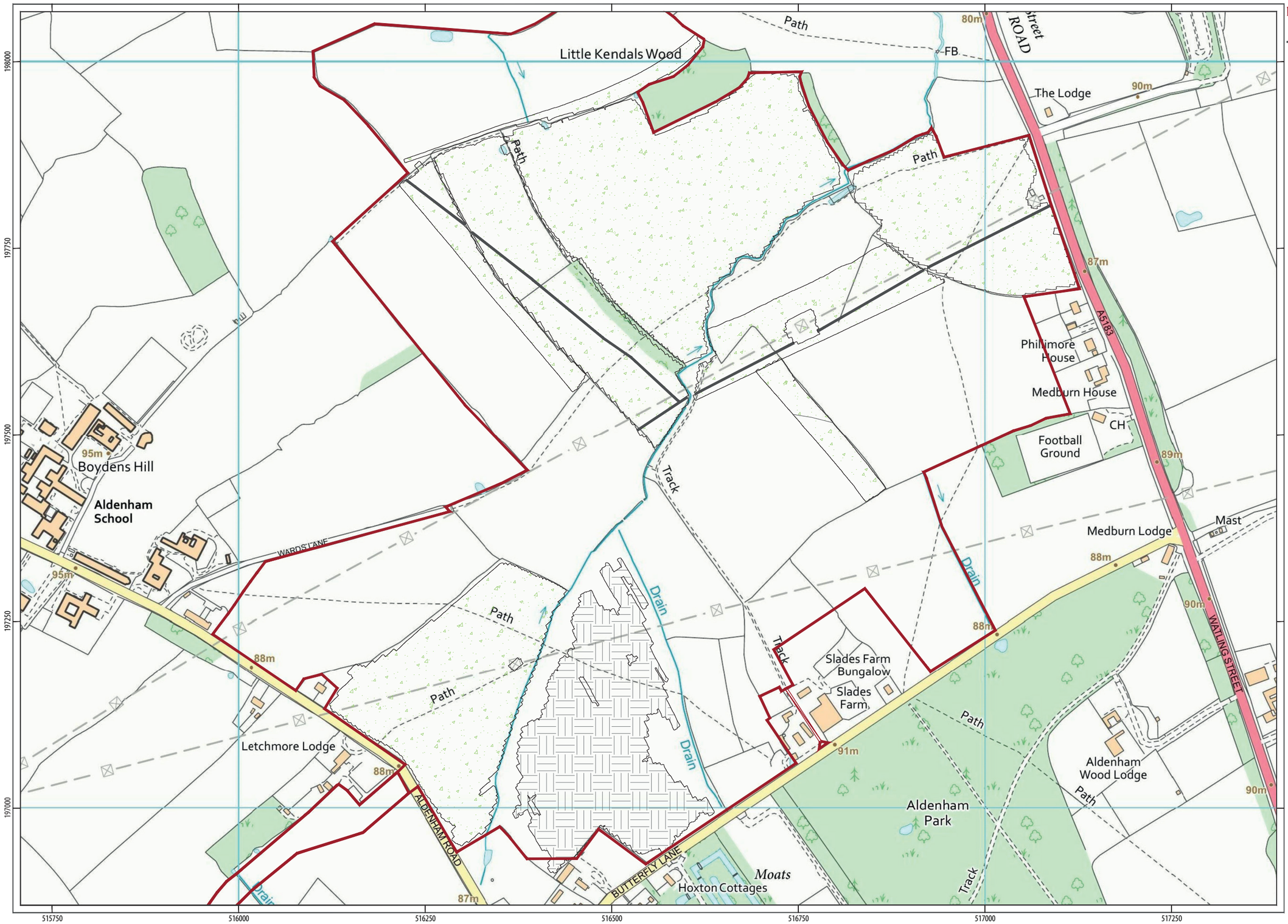
**ILLUS 6** Greyscale plot of processed magnetometer data; Sector 2




Proposed development area

| TYPE OF ANOMALY | INTERPRETATION |
|---|---|
| dipolar linear | service pipe |
| magnetic enhancement | green waste |
| magnetic enhancement | landfill |

0 25m
1:1,000 @ A3

| | |
|---|---|
| PROJECT | HSFH20<br>Hilfield Solar Farm<br>Elstree<br>Hertfordshire |
| CLIENT | Aardvark EM Limited |

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**ILLUS 7** Interpretation of magnetometer data; Sector 2

# 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 current 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 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 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 OASIS DATA COLLECTION FORM: ENGLAND

## *OASIS ID: headland5-410836*

| | |
|---|---|
| **PROJECT DETAILS** | |
| Project name | 410836Hilfield Solar Farm, Hertfordshire |
| Short description of the project | Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey at a 123-hectare site north-west of Elstree, Hertfordshire to inform a planning application for a proposed solar farm. Several fields were surveyed across the full extent of the site. In all locations the data was extremely disturbed due to the presence of 'green waste' in the plough soil. No anomalies of archaeological potential were identified. The extent and magnitude of the disturbance was such that no archaeological anomalies, if present, could be identified against the perturbed magnetic background. Consequently, following consultation and review it was agreed that continuing the survey would not help inform the application and was so abandoned. |
| Project dates | Start: 18-09-2020 End: 02-10-2020 |
| Previous/future work | Not known / Not known |
| Any associated project reference codes | HSFH20 – Sitecode |
| Type of project | Field evaluation |
| Site status | None |
| Current Land use | Cultivated Land 4 – Character Undetermined |
| Monument type | N/A |
| Monument type | N/A |
| Significant Finds | N/A |
| Significant Finds | N/A |
| Methods & techniques | "Geophysical Survey" |
| Development type | Solar Farm |
| Prompt | National Planning Policy Framework – NPPF |
| Position in the planning process | Pre-application |
| Solid geology | London Clay |
| Drift geology | Unknown |
| Techniques | Magnetometry |
| **PROJECT LOCATION** | |
| Country | England |
| Site location | Hertfordshire, Hertsmere, Elstree And Borehamwood, Hilfield Solar Farm, Hertfordshire |
| Study area | 123 Hectares |
| Site coordinates | TQ 1620 9802 51.668450071495 -0.319536772123 51 40 06 N 000 19 10 W Point |
| Site coordinates | TQ 1499 9693 51.658902039787 -0.337386331576 51 39 32 N 000 20 14 W Point |
| **PROJECT CREATORS** | |
| Name of Organisation | Headland Archaeology |
| Project brief originator | Headland Archaeology |
| Project design originator | Headland Archaeology |
| Project director/manager | Alistair Webb |
| Project supervisor | Peter Heykoop |
| Type of sponsor/funding body | Developer |

| **PROJECT ARCHIVES** | |
|---|---|
| Physical Archive Exists? | No |
| Digital Archive recipient | Headland Archaeology |
| 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 | Hilfield Solar Farm, Hertfordshire: Geophysical Survey |
| Author(s)/Editor(s) | Alistair Webb |
| Other bibliographic details | HSFH20 |
| Date | 2020 |
| Issuer or publisher | Headland Archaeology |
| Place of issue or publication | Edinburgh |
| Description | A4 Glue bound report |
| | |
| Entered by | Sam Harrison (sam.harrison@headlandarchaeology.com) |
| Entered on | 15 December 2020 |

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