Norfolk Boreas Offshore Wind Farm

Appendix 28.8

Archaeological Geophysical Survey Report (Substation area)

Environmental Statement

Volume 3

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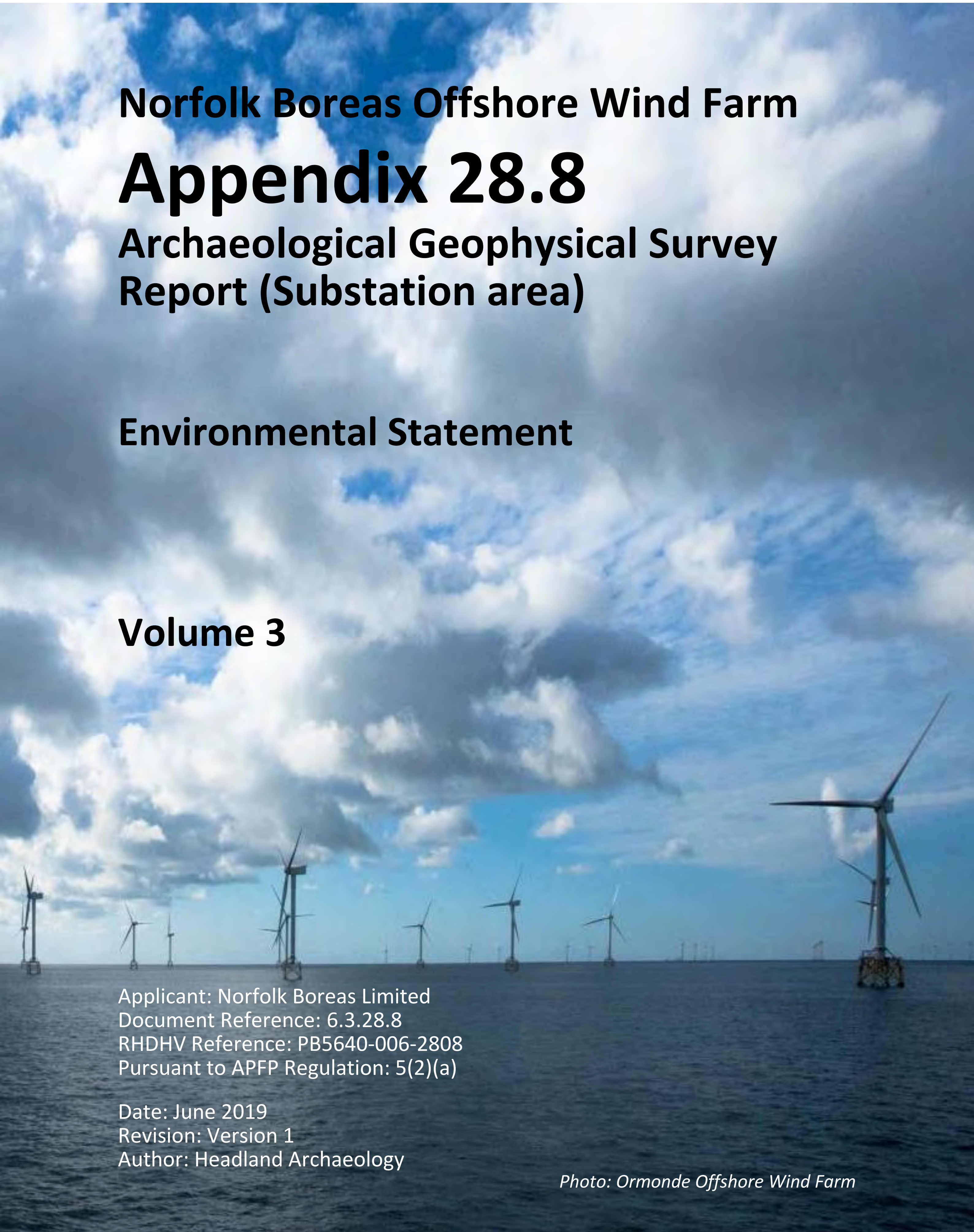

Photo: Ormonde Offshore Wind Farm

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NBOW18

NORFOLK BOREAS OFFSHORE WIND FARM ONSHORE SUBSTATION, NECTON, NORFOLK

GEOPHYSICAL SURVEY

commissioned by For Norfolk Boreas Ltd

May 2019

HEADLAND ARCHAEOLOGY

REGISTERED CIfA ORGANISATION

NORFOLK BOREAS OFFSHORE WIND FARM ONSHORE SUBSTATION, NECTON, NORFOLK

GEOPHYSICAL SURVEY

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PROJECT INFO:
HA Project Code **NBOW18** / NGR **TF 9001 1031** / Parish **Necton** / Local Authority **Norfolk** / OASIS Ref. **headland5-350212** / NHER Event No **ENF 145660**

PROJECT TEAM:
Project Manager **Sam Harrison** / Author **Krasimir Dyulgerski** / Fieldwork **Bethany Shenton, Krasimir Dyulgerski, Olivier Vansassenbrouck, Phoebe Utting, Richard McGregor Edwards, Ross Bishop** / Graphics **Beata Wieczorek-Oleksy, Bethany Shenton, Krasimir Dyulgerski, Olivier Vansassenbrouck**

Approved by **Sam Harrison** [redacted]..........................

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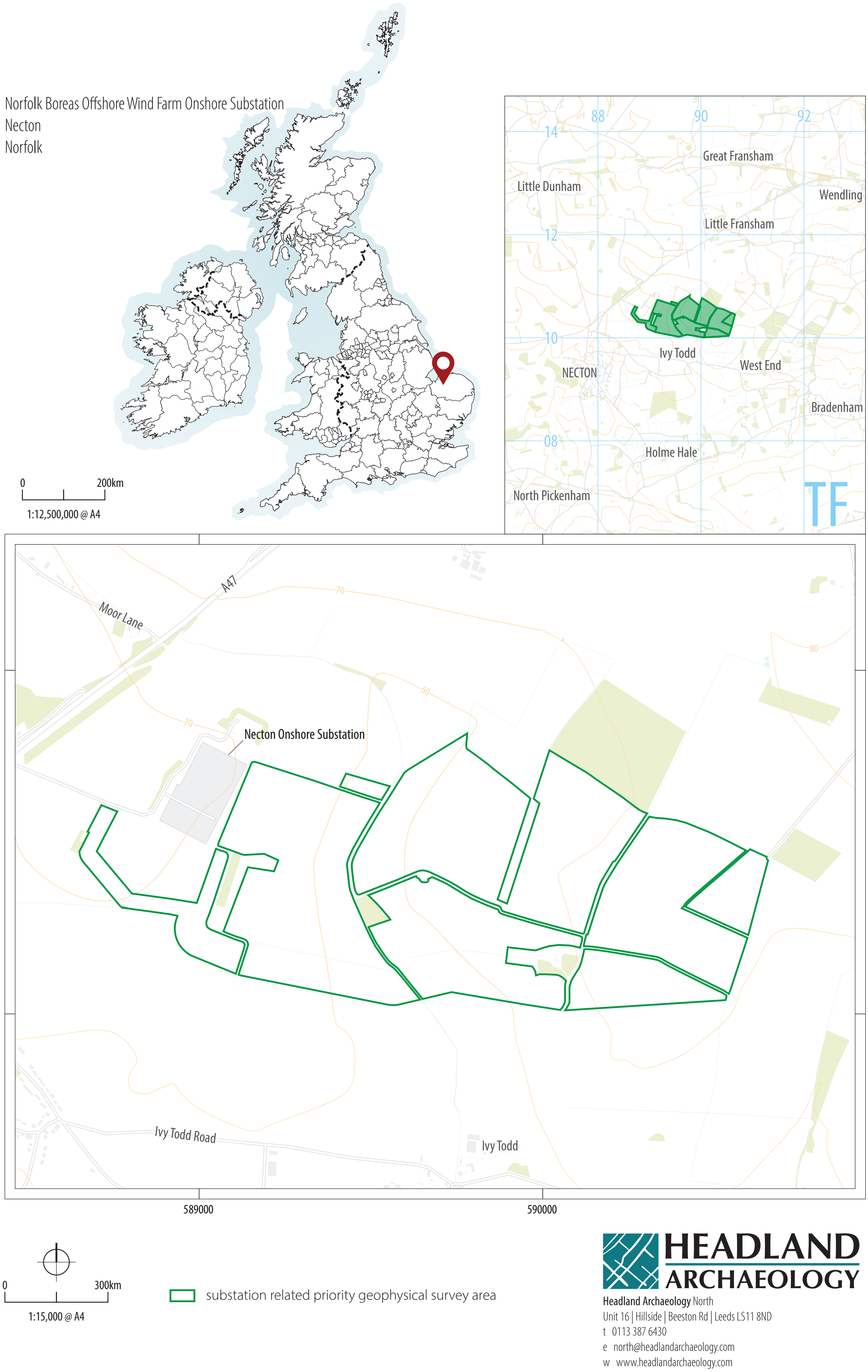
PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of a 96 hectare site immediately north-east of Necton, Norfolk, to provide information on the archaeological potential of the site, identified as a Substation Related Priority Geophysical Survey Area (SRPGSA), in order to assess the impact of potential future onshore substation infrastructure. The survey has identified two areas of archaeological activity (AAAs), in the central and western parts of the SRPGSA. In AAA2 the survey has corroborated the historic OS mapping and cropmark data identifying an undated moated site, whilst the ring-ditch in AAA1 was not previously known. The survey has also identified numerous linear anomalies caused by agricultural activity (ploughing, drainage and boundary removal), and discrete anomalies due to variation in the soils and superficial deposits. Overall, the survey has successfully evaluated the archaeological potential of the site, with AAA1 and AAA2 assessed as being of high potential and the remainder of the SRPGSA considered to be of low potential.

CONTENTS

LIST OF ILLUSTRATIONS



ILLUS 1 Site location

NORFOLK BOREAS OFFSHORE WIND FARM ONSHORE SUBSTATION, NECTON, NORFOLK

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Royal HaskoningDHV on behalf of Norfolk Boreas Ltd (the Client), to undertake a geophysical (magnetometer) survey on land north-east of Necton, Norfolk which is being proposed as the location for an onshore substation for the Norfolk Boreas Offshore Wind Farm. The survey was undertaken in order to assess the archaeological potential of the SRPGSA and therefore the impact of the proposed development on the historic environment.

The work was undertaken in accordance with a specification, including previously agreed Written Scheme of Investigation (WSI) (Royal HaskoningDHV 2018/2017), with guidance within the National Planning Policy Framework (MHCLG 2018) and in line with current best practice (Chartered Institute for Archaeologists 2016, Europae Archaeologia Consilium (EAC) 2016).

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The SRPGSA is comprised of a block of 13 arable fields bounded by Ivy Todd Road to the south and Necton National Grid Substation to the north-west, centred on NGR TF 9001 1031 (Illus 1).

All the land within the SRPGSA was in agricultural use at the time of survey (see Illus 2–9 inclusive) with all of the fields under arable cultivation (winter wheat and oilseed rape) apart from the northern ends of F6 and F8 which were under bird cover and unsuitable for survey (Illus 10).

The SRPGSA's topography is relatively flat, rising from 52m Above Ordnance Datum (AOD) in the centre of the site to 63m AOD at the western and eastern edges of the SRPGSA.

The survey was carried out between the 14th and 30th January 2019.

1.2 GEOLOGY AND SOILS

The bedrock geology across the SRPGSA comprises Lewes Nodular Chalk Formation, overlain by superficial deposits of diamicton (boulder clay). A band of alluvium (clay, silt and gravel) extends either side of a minor water course running north/south (see Illus 10) which divides the SRPGSA in half (NERC 2019).

The soils are classified in the Soilscape 8 association and are characterised as slightly acid, seasonally wet, loams and clays with impeded drainage (Cranfield University 2019).

2 ARCHAEOLOGICAL BACKGROUND

The Norfolk Historic Environment Record (NHER) identifies a single heritage asset within the SRPGSA; an undated moated site (NHER 4190) located in the eastern side of F3 and south-western corner of F8. There are no associated finds with this heritage asset and Ordnance Survey (OS) mapping confirms that the moat was levelled and backfilled after 1955. Cropmark data suggests the presence of former field boundaries within the SRPGSA and potentially the presence of other features associated with, or simply in proximity to,

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ILLUS 2 F11, looking north-east

the moated site. Two undated square enclosures (NHER 30851) are recorded south of F4, just outside the SRPGSA.

3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to gather sufficient information to enable an assessment to be made of the impact of the proposed development on any potential sub-surface archaeological remains within the SRPGSA and to inform further strategies as necessary.

Specifically, the aims were to:

- undertake an initial programme of targeted detailed magnetometry across those areas identified as Priority;
- to corroborate, identify and characterise sub-surface anomalies that may have an archaeological origin (including defining the spatial limits of already known or suspected heritage assets);
- to discount areas within the survey area that are found to have been subject to previous 'modern' disturbance, for example where the geophysical survey data indicate the presence of 'made' or previously heavily disturbed ground;
- provide an interpretation of all recorded geophysical anomalies in order to inform the design of a scheme-wide programme of archaeological evaluation trial trenching (in this instance this will be an initial informative stage of mitigation, post-consent); and
- to produce a comprehensive site archive and report that is compliant with all relevant standards, guidance and good practice.

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 (National Marine Electronics Association) mode to ensure a high positional accuracy for each data point.

ILLUS 3 F5, looking west

MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Terrasurveyor V3.0.32.4 (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 1:15,000. Illus 2 to Illus 9 inclusive are site condition photographs. Illus 10 is a 1:7,500 survey location plan showing greyscale magnetometer data, cropmarks, geology, photograph locations and first edition OS mapping. Illus 11 presents the overall interpretative plot at a scale of 1:7,500. Large-scale, fully processed (greyscale) data, minimally processed data (XY traceplot) and accompanying interpretative plots are presented at a scale of 1:2,500 in Illus 12 to Illus 23 inclusive. Larger scale (1:1000) plots of the two areas of archaeological activity (AAAs) are presented in Illus 24 to Illus 29 inclusive.

Further technical information on the equipment used, data processing and magnetic survey methodology is provided 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 a specification, including previously agreed Written Scheme of Investigation (WSI) (Royal HaskoningDHV 2018/2017), guidelines outlined by Europae Archaeologia Consilium 2016 and by the Chartered Institute for Archaeologists (CIfA 2016). All illustrations from Ordnance Survey 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

The ground conditions were good throughout (see Illus 2–9 inclusive) and the overall data quality is good.

In the majority of the SRPGSA the survey has detected a relatively homogenous magnetic background which is characterised by discrete areas of magnetic enhancement. These are caused by localised variations in the depth and composition of the soil and superficial deposits. Against this background, numerous linear and discrete anomalies of a geological, agricultural and archaeological nature have been identified. These anomalies are discussed below and cross-referenced to specific examples on the interpretive figures, where appropriate.

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ILLUS 4 F8, looking north-west

4.1 FERROUS 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 consequence of manuring or tipping/infilling. There is no obvious clustering to these ferrous anomalies 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.

In F7 and F8 (see Illus 15–20 inclusive), three areas of high magnitude magnetic disturbance have been identified, Q1, Q2 and Q3. These anomalies locate small quarry pits recorded on the first edition OS mapping (Illus 10). The strong magnetic response is caused by the magnetic properties of the material used to backfill the former pits.

Across F5, F6, F11 and F13, broad areas of magnetic disturbance have been identified (see Illus 18–23 inclusive). These clusters of anomalies are centred around the former location of Lodge Farm (see Illus 10) and are likely caused by bricks and/or other fired material in the upper soil horizons resulting from the demolition of the farm and outbuildings.

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

Linear anomalies in the data are identified throughout the SRPGSA. All these anomalies are due to agricultural activity such as boundary removal, ploughing and drainage.

Parallel linear trend anomalies on differing alignments, but mostly parallel or orthogonal to the current field boundaries, have been identified in F1, F8 and F10 (see Illus 18–20 inclusive). These anomalies predominantly reflect the alignment of recent ploughing.

A series of linear anomalies identified in the majority of the fields (see Illus 15–23 inclusive), oblique to the extant field boundaries and exhibiting a 'speckled' appearance, are caused by field drains.

Analysis of the historic OS mapping (see Illus 10) indicates that the pattern of enclosure has substantially changed since 1888 with several former boundaries having been removed. These former boundaries manifest in the data as positive linear anomalies (see Illus 15–23 inclusive) which are caused by the magnetic contrast between the former (but now infilled) boundary ditch and the surrounding soils.

4.3 GEOLOGICAL ANOMALIES

Numerous low magnitude curvilinear and discrete anomalies are identified across the SRPGSA. These are likely due to the variation in the depth and composition of the soils and superficial deposits from which the soil is partly derived.

ILLUS 5 F8, looking north-east

4.4 ARCHAEOLOGICAL ANOMALIES

Unless specified all the linear anomalies described are likely to be due to soil filled cut features, such as ditches, forming clear patterns of enclosure and/or land division. Against a variable magnetic background, it is difficult to confidently discriminate between discrete anomalies which may be due to archaeological features, such as pits, which may be indicative of occupational activity, and those that are probably due to localised geological variation. For this reason, most of the discrete anomalies within enclosures have been ascribed a possible archaeological origin with those outside, except where the responses are particularly broad or high in magnitude, interpreted as being of non-archaeological origin.

Two areas of archaeological activity (AAAs) have been identified which are discussed below.

Area of Archaeological Activity 1 (AAA1 – Illus 24 to 26 inclusive) In AAA1, a single ring-ditch anomaly (RD1), with a diameter of 19m, has been identified adjacent to the eastern boundary of F1. The anomaly is truncated by a field drain running across its northern side. Discrete anomalies within the interior of the ring-ditch are interpreted as of possible archaeological origin, perhaps being due to former pits. This feature is possibly the ploughed down remains of a Bronze Age funerary monument (round barrow). Equally, a post mill of post-medieval origin may provide a similar signature within the data.

Area of Archaeological Activity 2 (AAA2 – Illus 27 to Illus 29 inclusive) In AAA2, the survey corroborates the historic OS mapping and the cropmark data in identifying a moated enclosure (E1) (NHER 4190). The anomaly has been identified in the eastern side of F3 and south-western corner of F8. The enclosure measures approximately 115m by 175m and is aligned broadly from north-west to south-east along its long axis. The enclosure is bisected by a minor water course which runs through the centre of the feature. The magnetic response from the infilled moat varies along its length with the highest responses recorded to the south-western corner where the magnitude suggests deliberate backfilling with a strongly magnetic material. Elsewhere it is particularly weaker, perhaps due to being primarily filled with alluvial material from the flooding of the watercourse. On the north-western corner of the enclosure the moat is defined by three distinct discrete anomalies which suggest the deposition of three separate dumps of magnetically enhanced material. Within the enclosure several discrete anomalies have been identified which may be due to internal features such as pits, demolition material and in situ structural remains. However due to the variable magnetic background and a lack of any clear pattern, these anomalies are considered to be of possible rather than definitive archaeological origin. No survey could be undertaken within an area of woodland in the south-east corner of the enclosure.

5 CONCLUSION

The survey has successfully evaluated the SRPGSA, advancing knowledge of its archaeological potential and providing evidence for two areas of archaeological activity. AAA2 was previously known, being shown on historic OS mapping, recorded on the Norfolk HER and also

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visible as a cropmark on aerial photographs. The ring-ditch in AAA1 was not previously known. The survey has also identified numerous discrete and linear anomalies of a geological and agricultural nature across the SRPGSA. Overall, the archaeological potential of the SRPGSA is considered high in the areas of definite archaeological potential (AAA1 and AAA2) and low in the remaining areas.

6 DISCUSSION

The magnetometer survey has identified a moderate level of magnetic variation across the SRPGSA and has identified numerous soil-filled features of varying origin. It is assessed that the survey provides a reliable indication of the extent of sub-surface deposits within the SRPGSA although some isolated features and/or areas of unenclosed settlement, if present, may not manifest as magnetic anomalies in the datasets. The survey has clearly identified the extents of the moated enclosure (NHER 4190) and has identified internal anomalies which may be due to internal features. Further geophysical investigation such as earth resistance survey and/or ground penetrating radar may provide clarity and definition of these internal anomalies. This area is, however, outside of the Norfolk Boreas red line boundary.

7 REFERENCES

Chartered Institute for Archaeologists (CIfA) 2016 ***Standard and guidance for archaeological geophysical survey*** (Reading) http://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_2.pdf accessed 14 February 2019

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6

7

ILLUS 6 F3, looking west **ILLUS 7** F1, looking west

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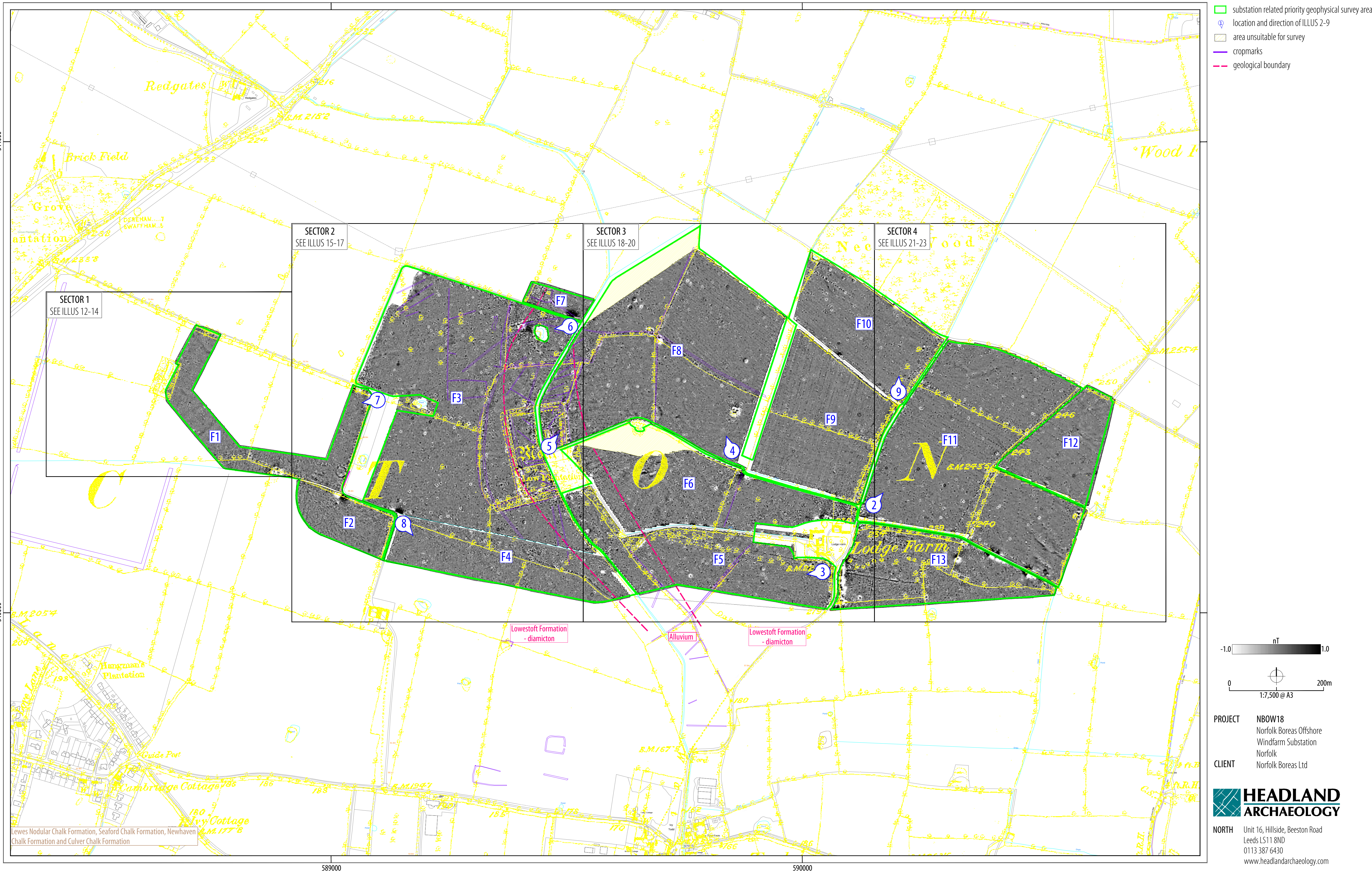
9

ILLUS 8 F4, looking south-east **ILLUS 9** F10, looking north



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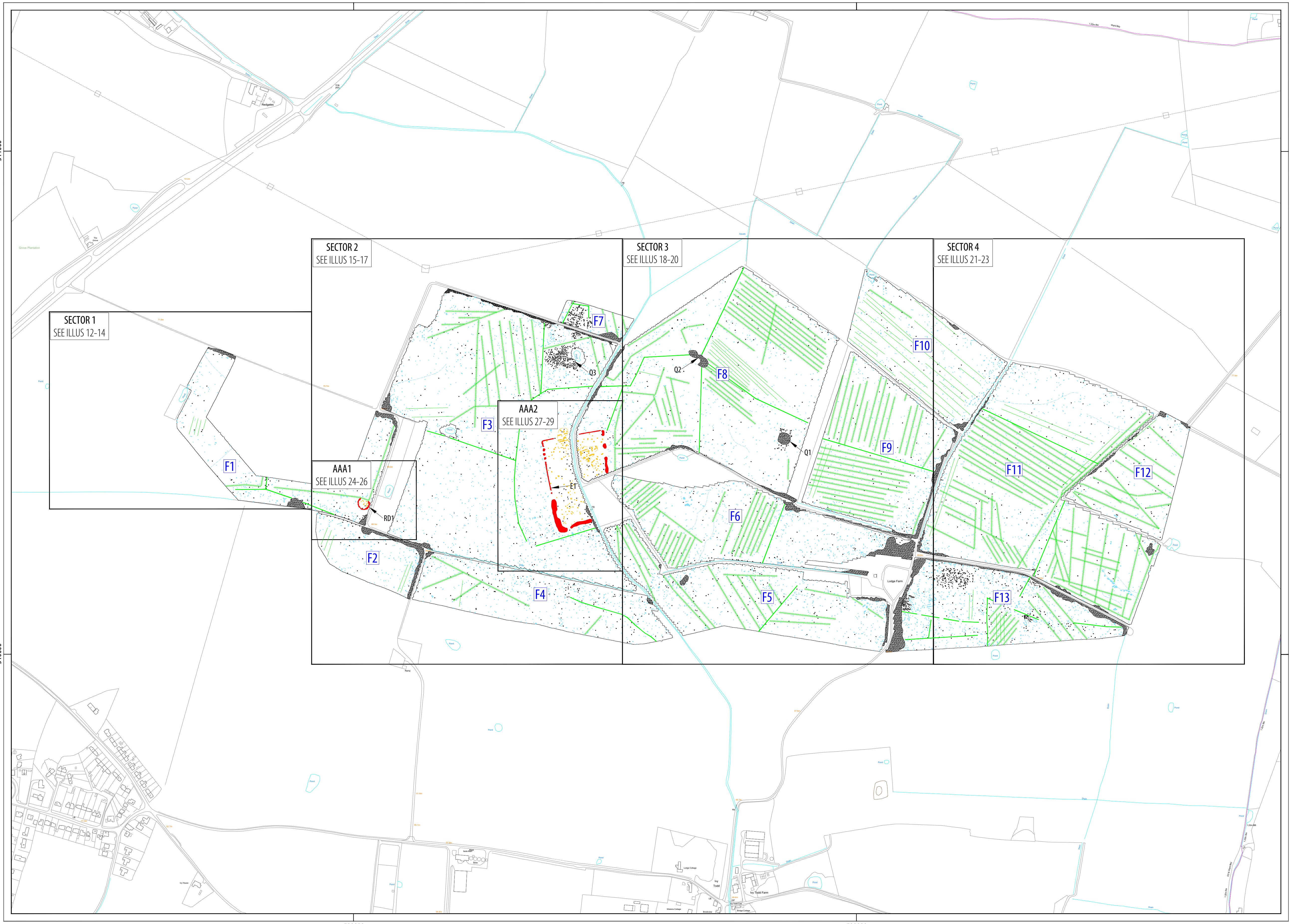
ILLUS 10 Processed greyscale magnetometer data showing cropmarks, geology,photograph locations and first edition OS mapping (1888-1913)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear	possible former boundary
linear trend	geology
magnetic enhancement	geology
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

Q quarry

RD ring-ditch

E enclosure

0 200m
1:7,500 @ A3

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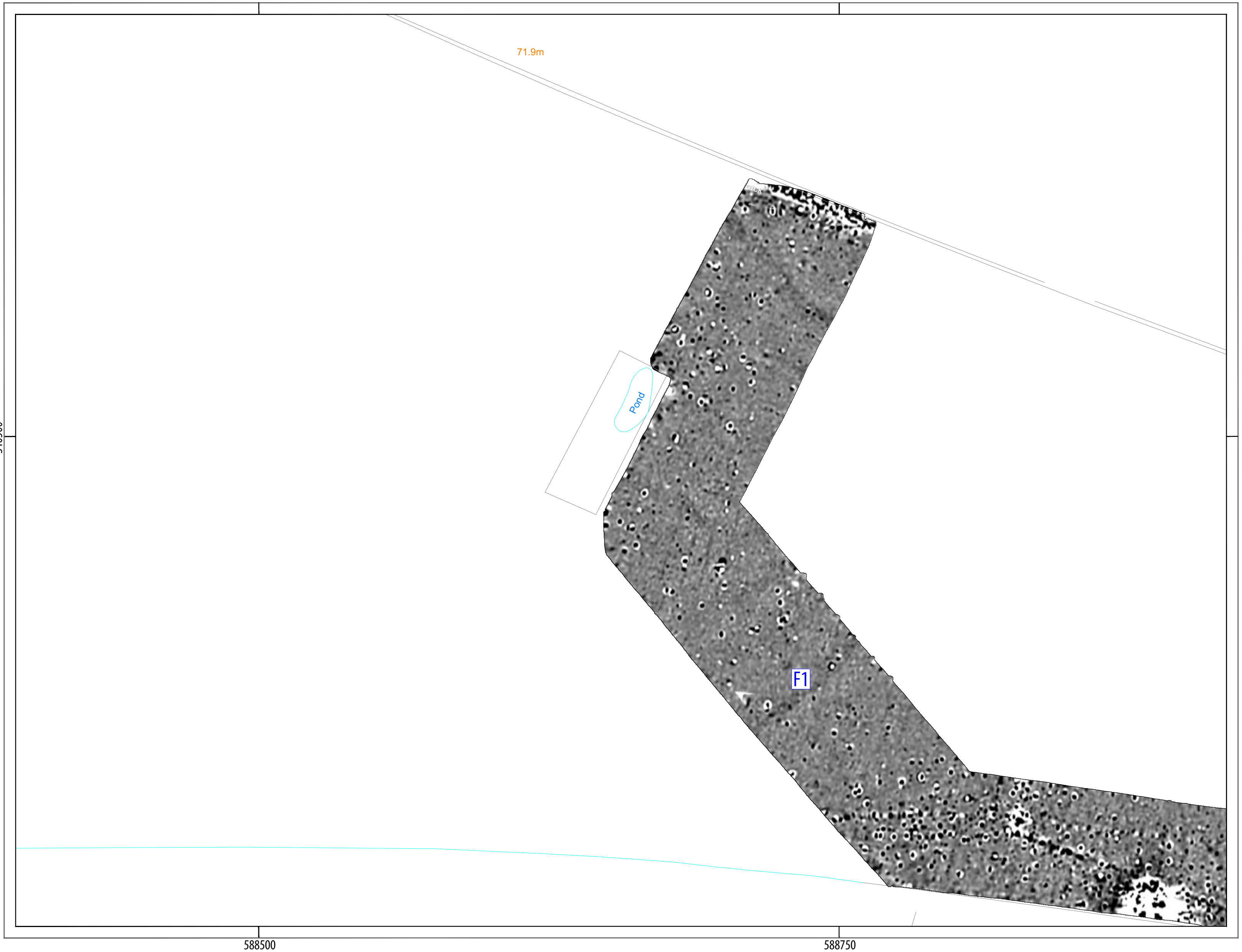
ILLUS 11 Interpretation of magnetometer data



nT
-1.0 1.0

0 50m
1:2,500 @ A4

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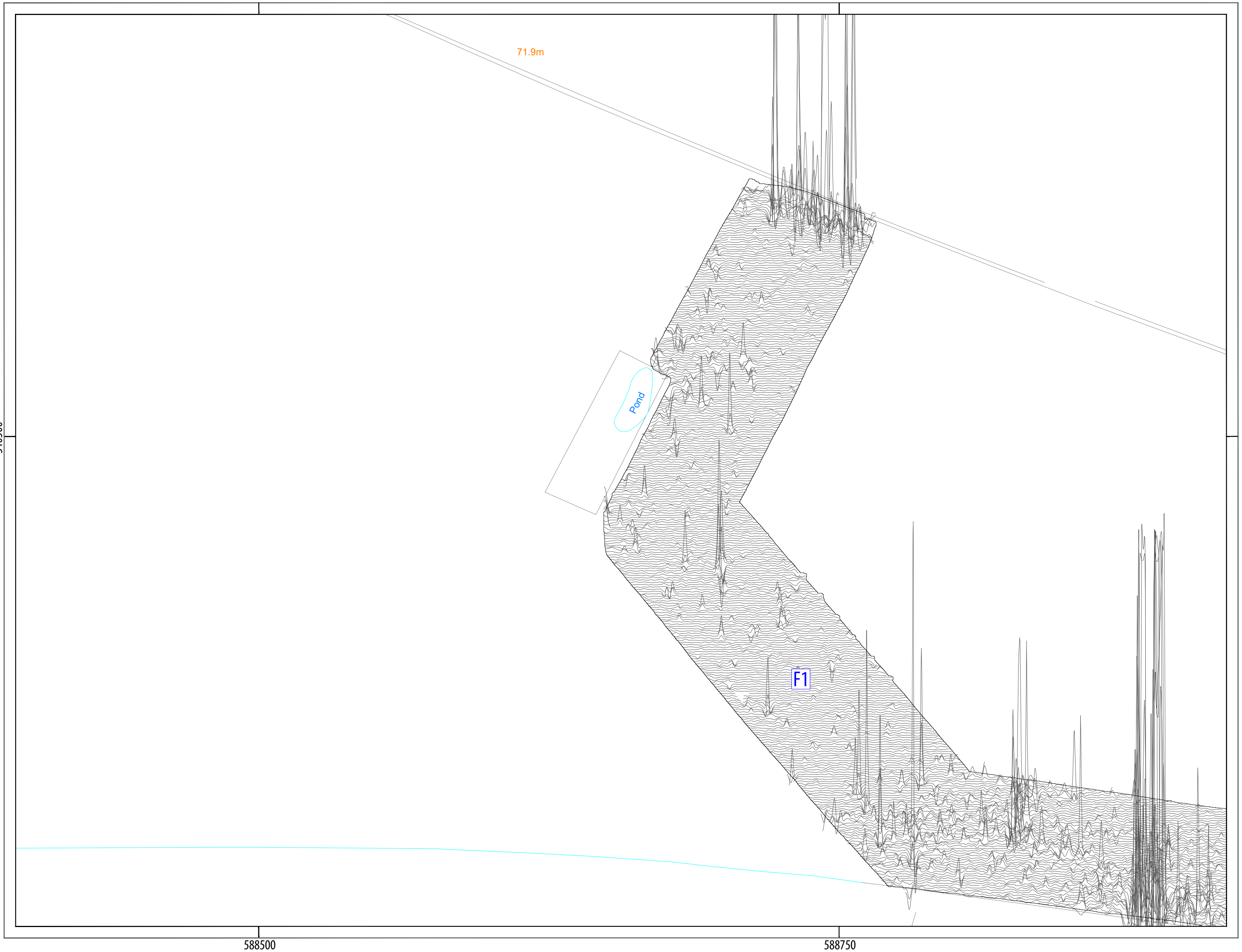
ILLUS 12 Processed greyscale magnetometer data; Sector 1



21.0nT/cm

0 50m

1:2,500 @ A4

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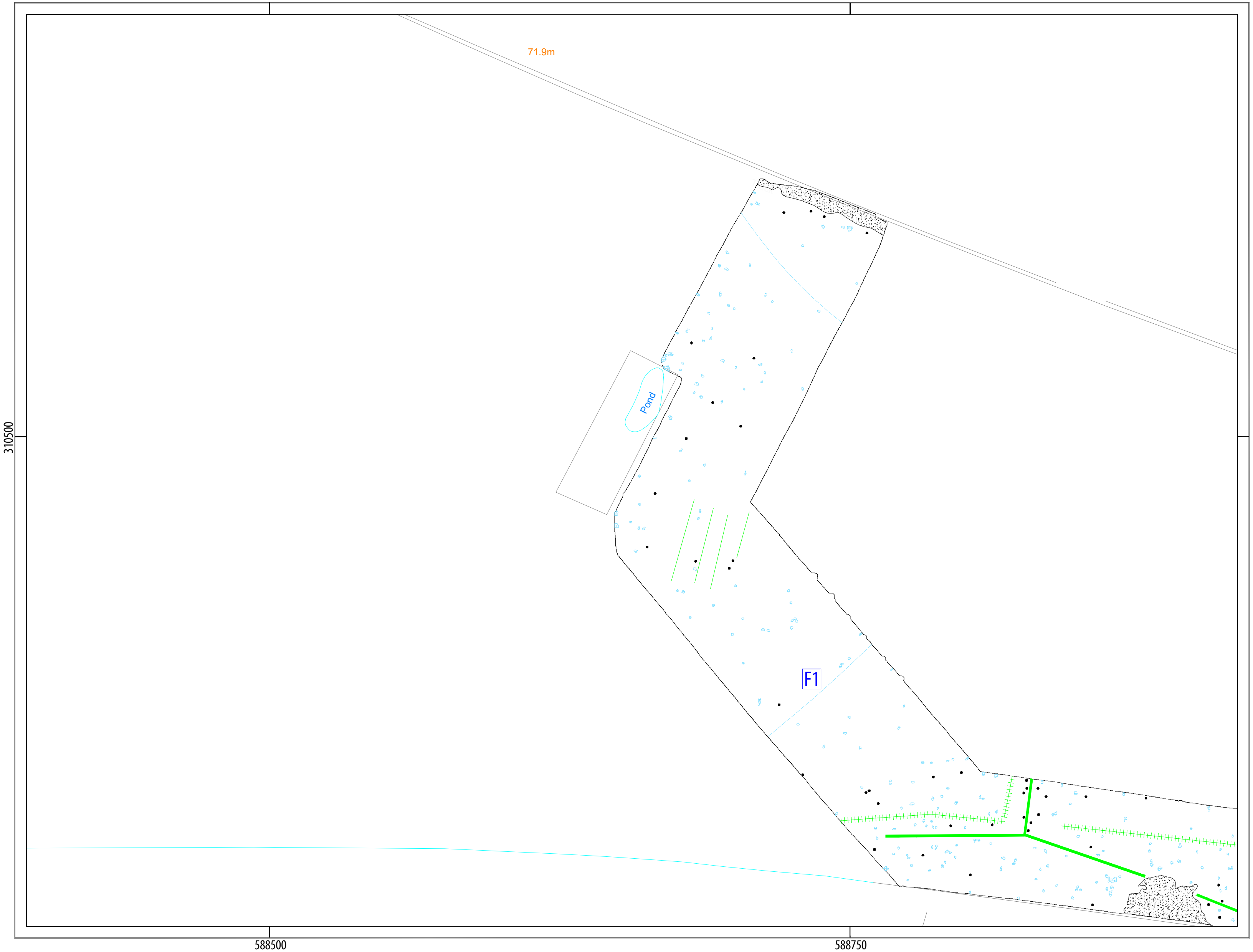
ILLUS 13 XY trace plot of minimally processed magnetometer data; Sector 1



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear trend	agricultural
linear trend	field drain
linear	former field boundary
magnetic enhancement	geology

0 50m
1:2,500 @ A4

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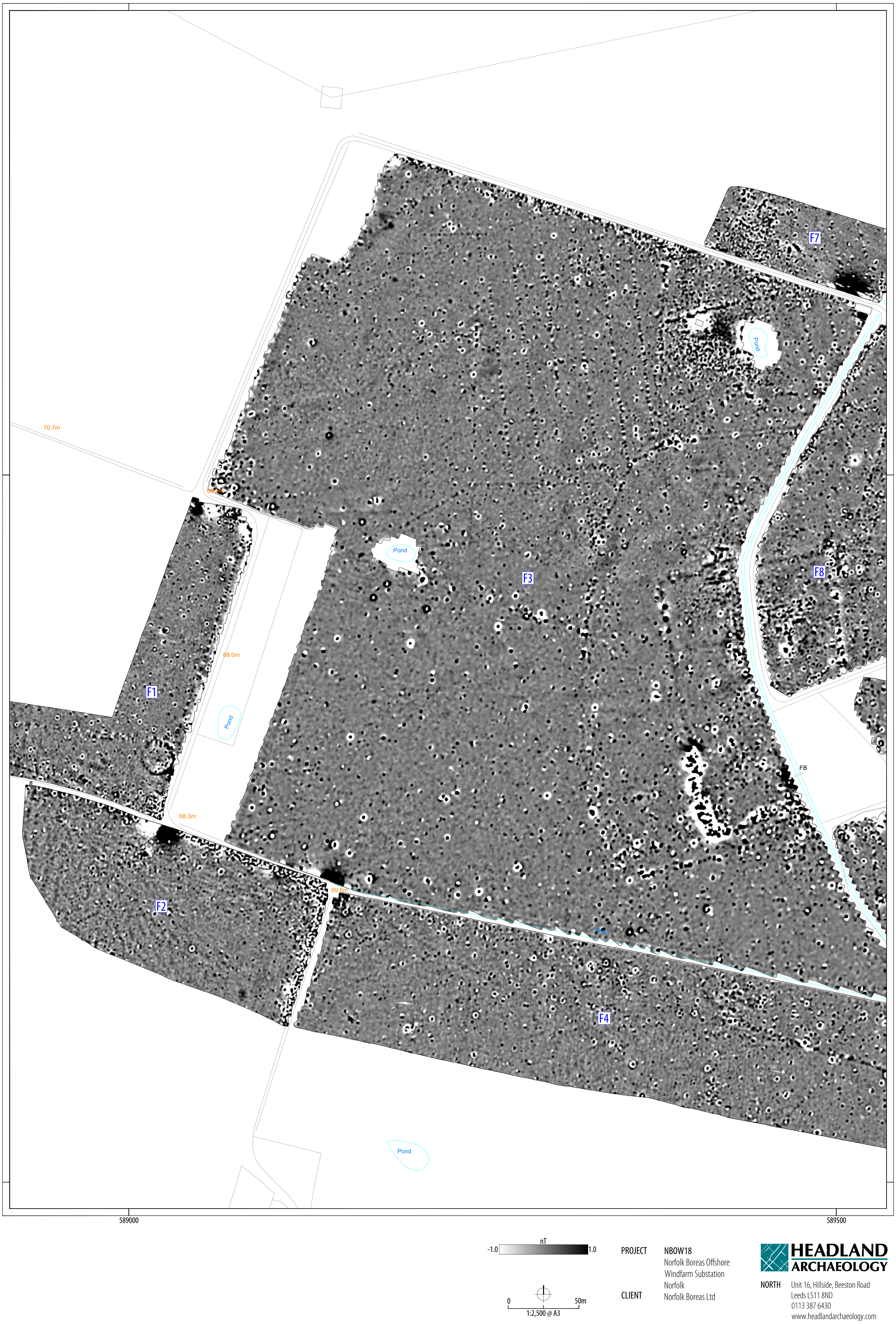
ILLUS 14 Interpretation of magnetometer data; Sector 1



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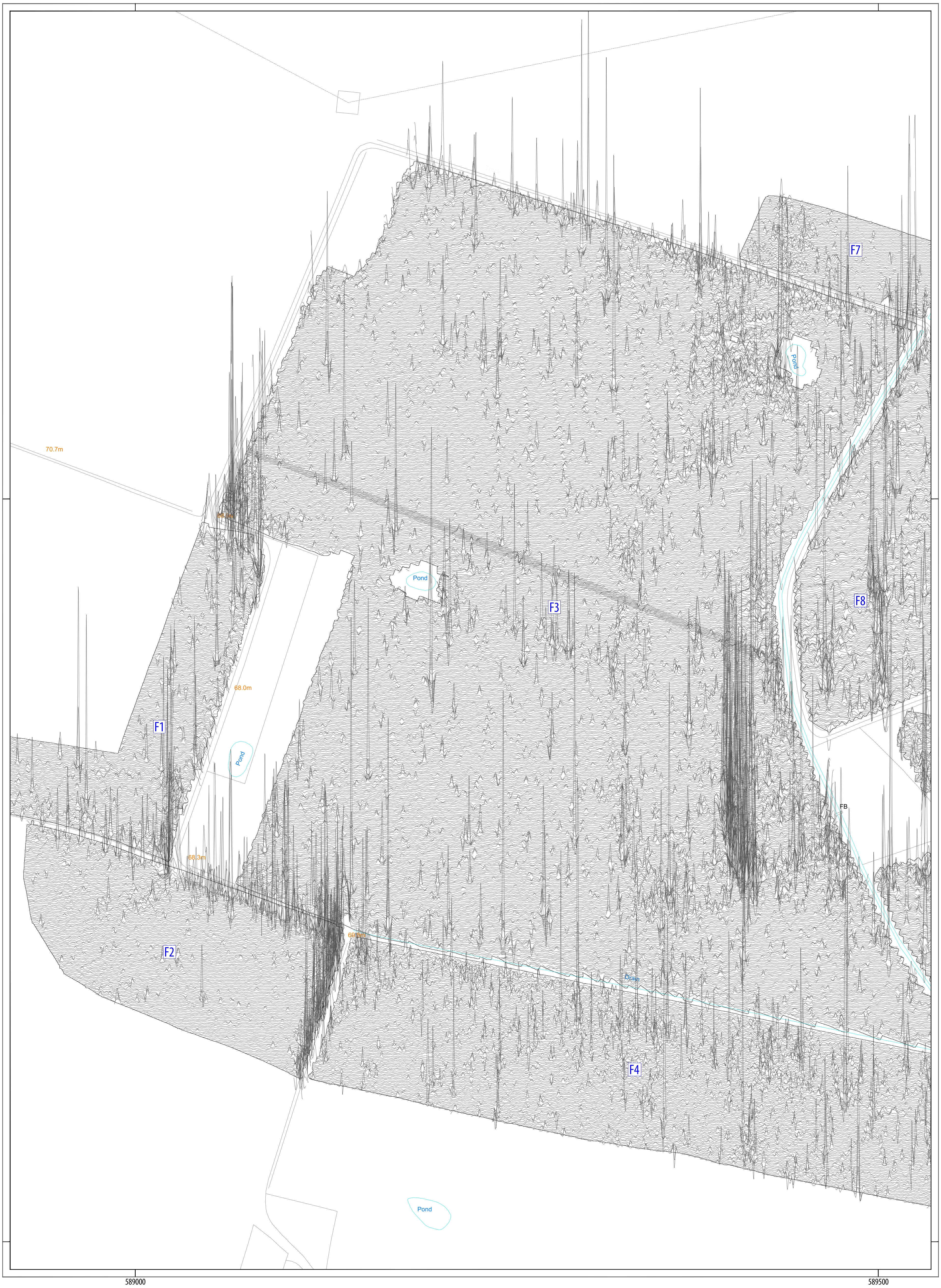
ILLUS 15 Processed greyscale magnetometer data; Sector 2



21.0nT/cm

0 50m

1:2,500 @ A3

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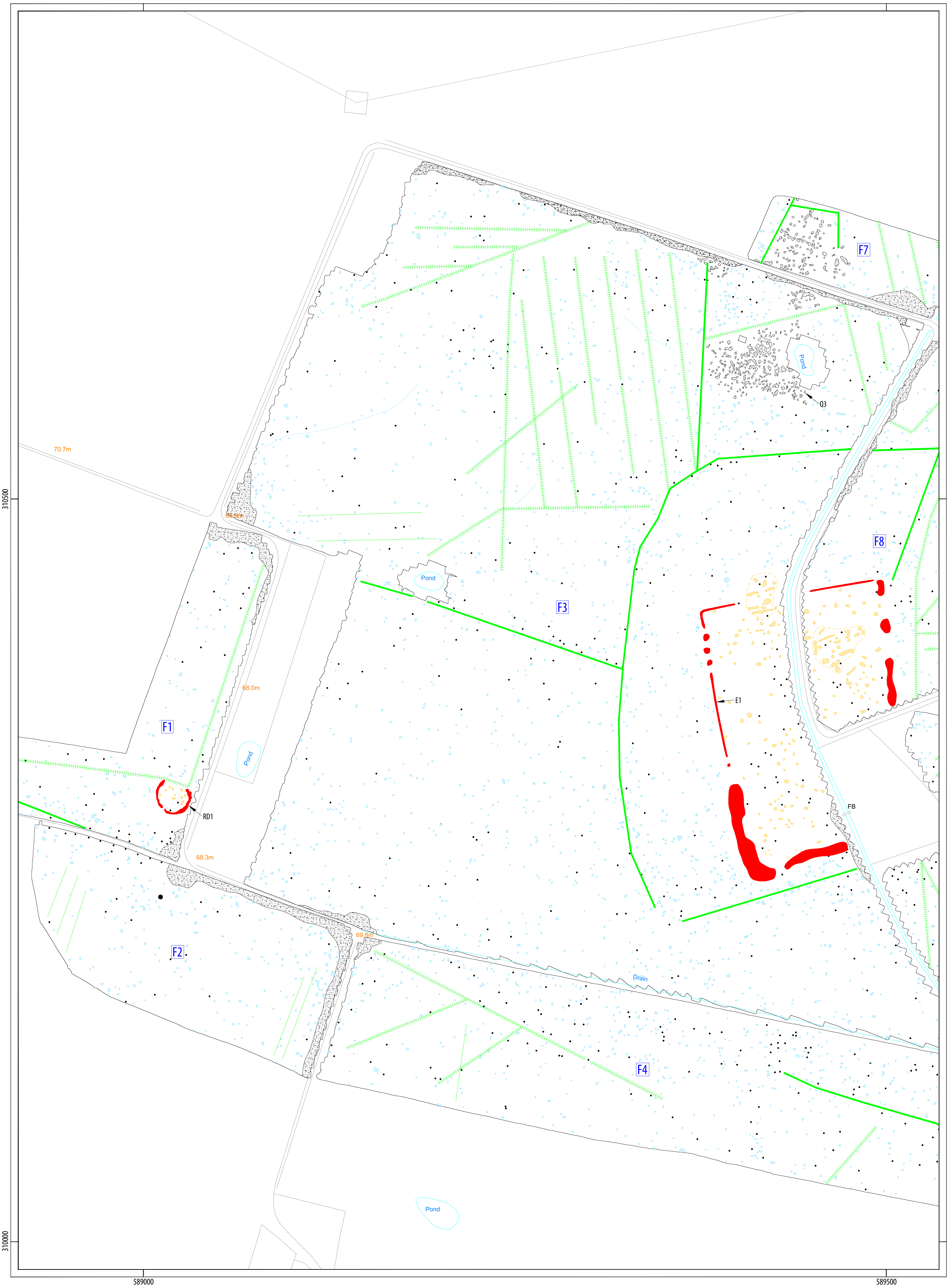
ILLUS 16 XY trace plot of minimally processed magnetometer data; Sector 2



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

ABBREVIATIONS

Q quarry

RD ring-ditch

E enclosure

0 50m

1:2,500 @ A3

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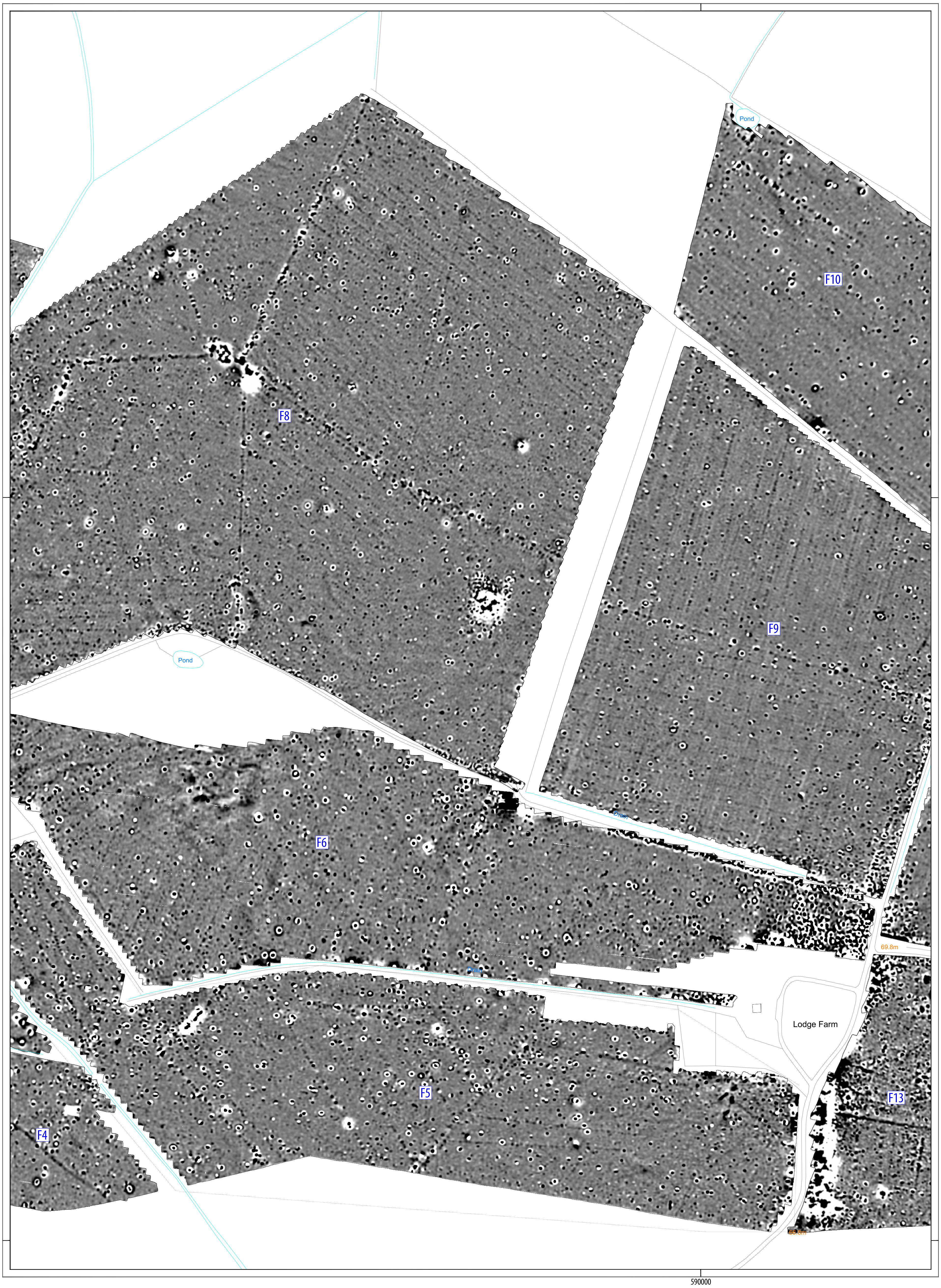
ILLUS 17 Interpretation of magnetometer data; Sector 2



nT
-1.0 1.0

0 50m
1:2,500 @ A3

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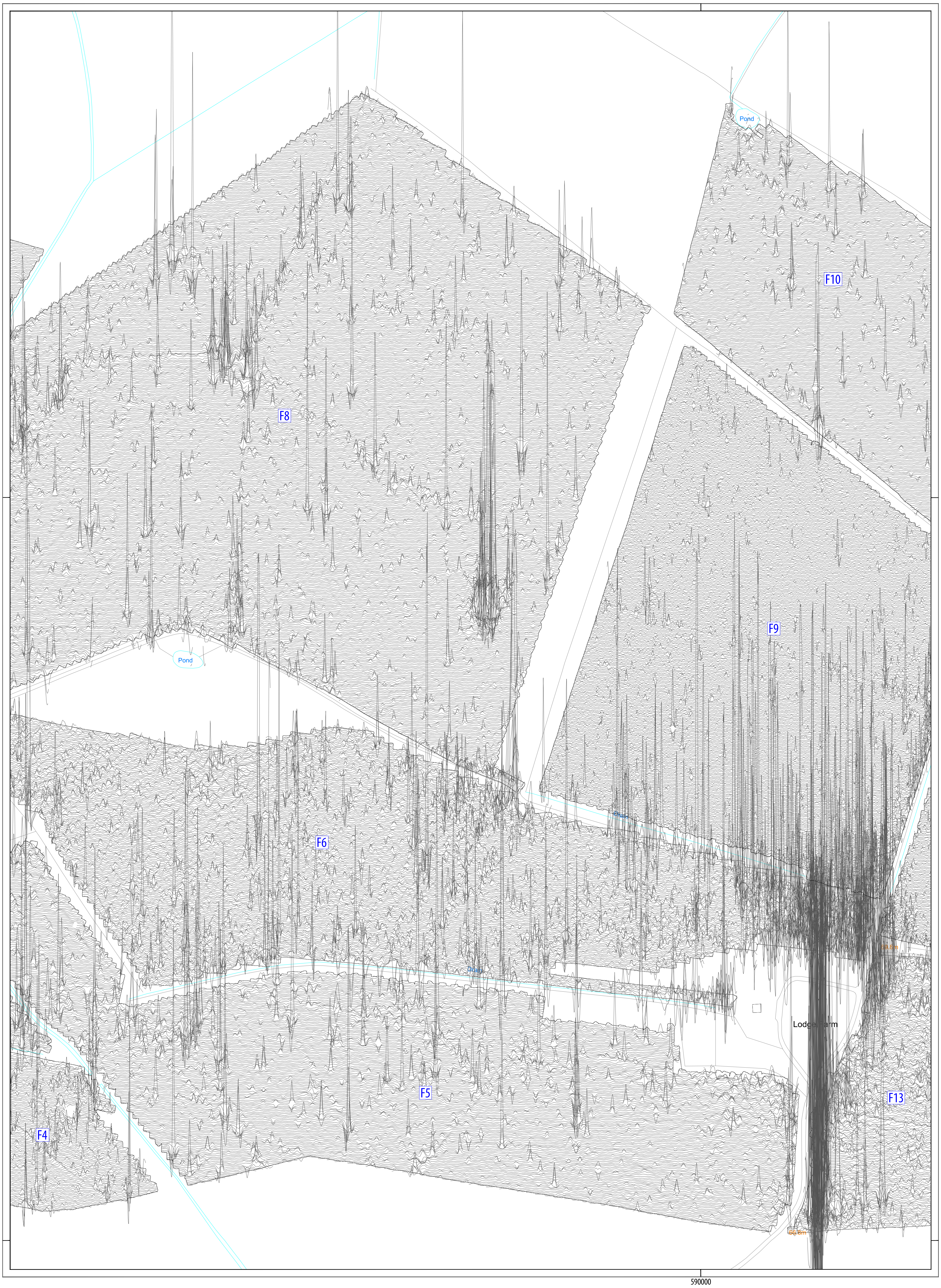
ILLUS 18 Processed greyscale magnetometer data; Sector 3



21.0nT/cm

0 50m
1:2,500 @ A3

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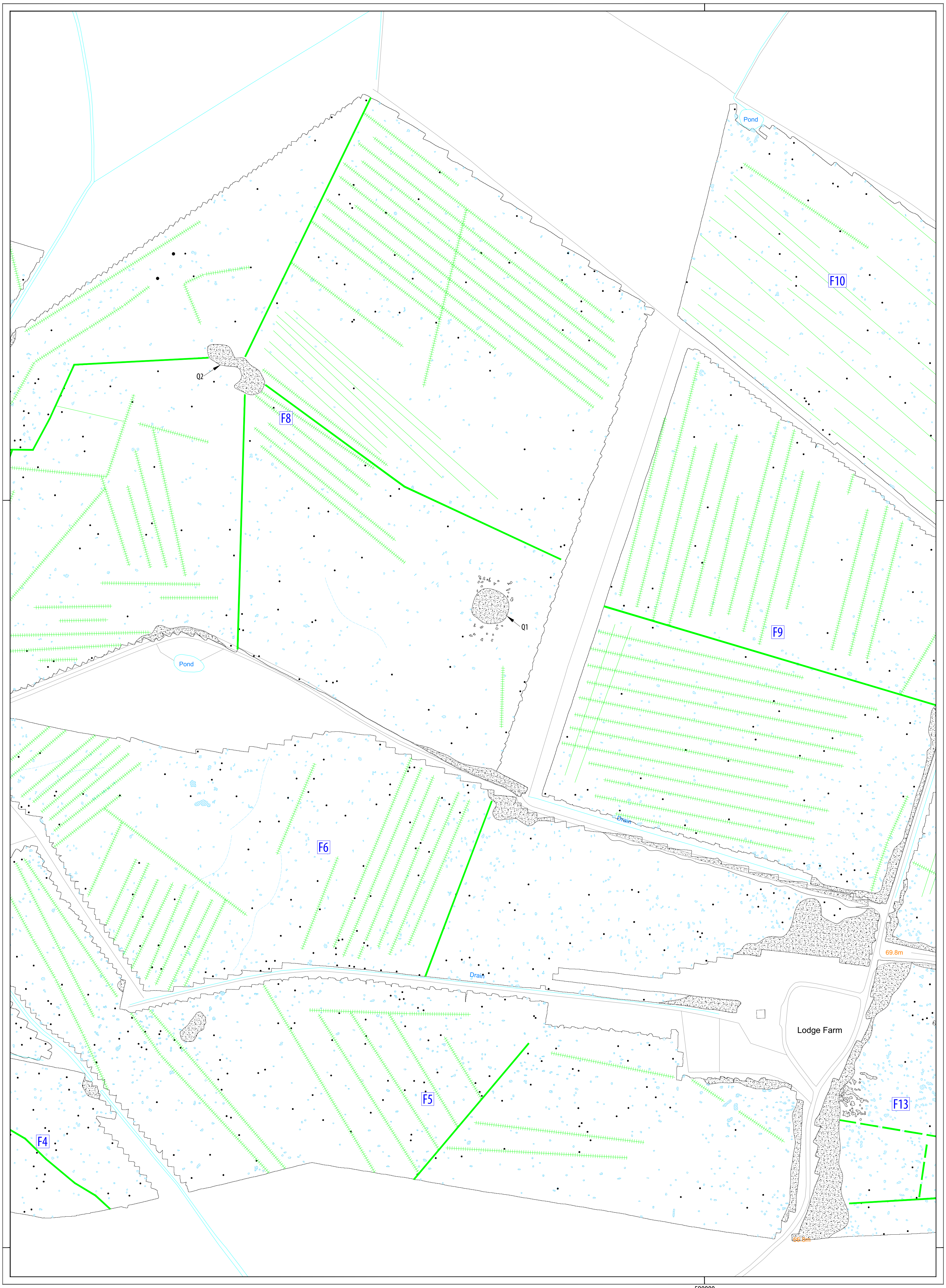
ILLUS 19 XY trace plot of minimally processed magnetometer data; Sector 3



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0 50m
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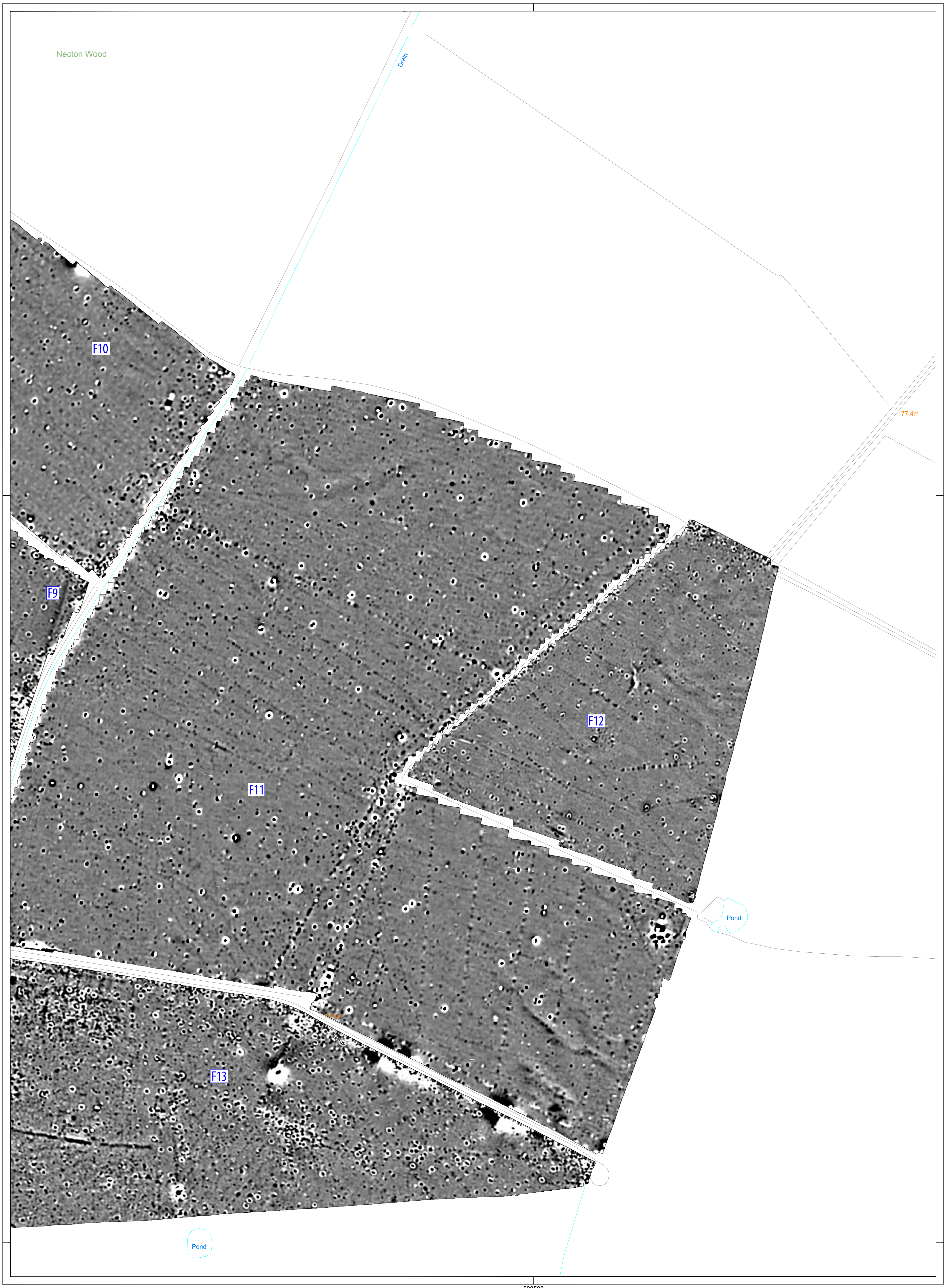
ILLUS 20 Interpretation of magnetometer data; Sector 3



-1.0 nT 1.0

0 50m
1:2,500 @ A3

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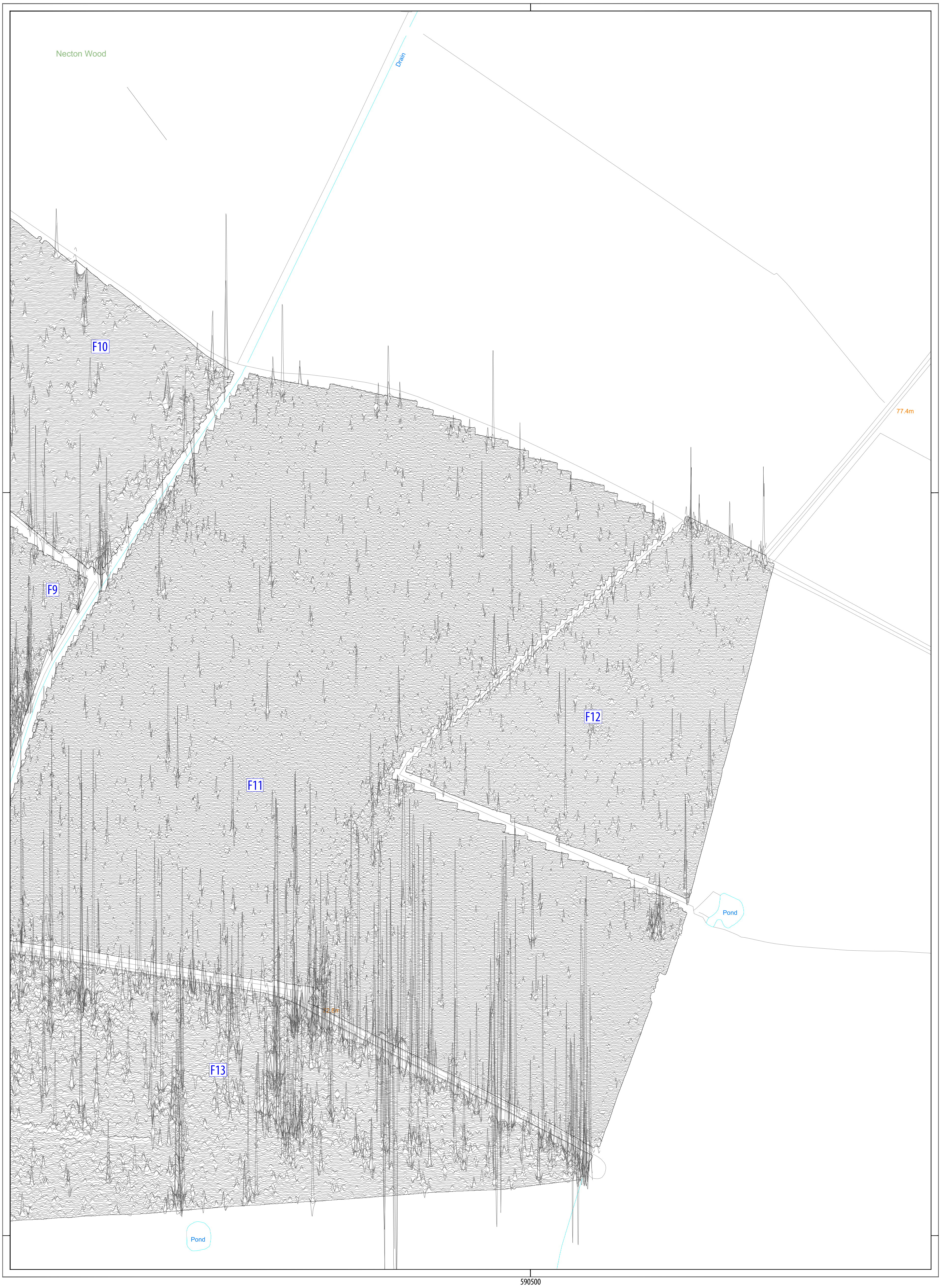
ILLUS 21 Processed greyscale magnetometer data; Sector 4



21.0nT/cm

0 50m
1:2,500 @ A3

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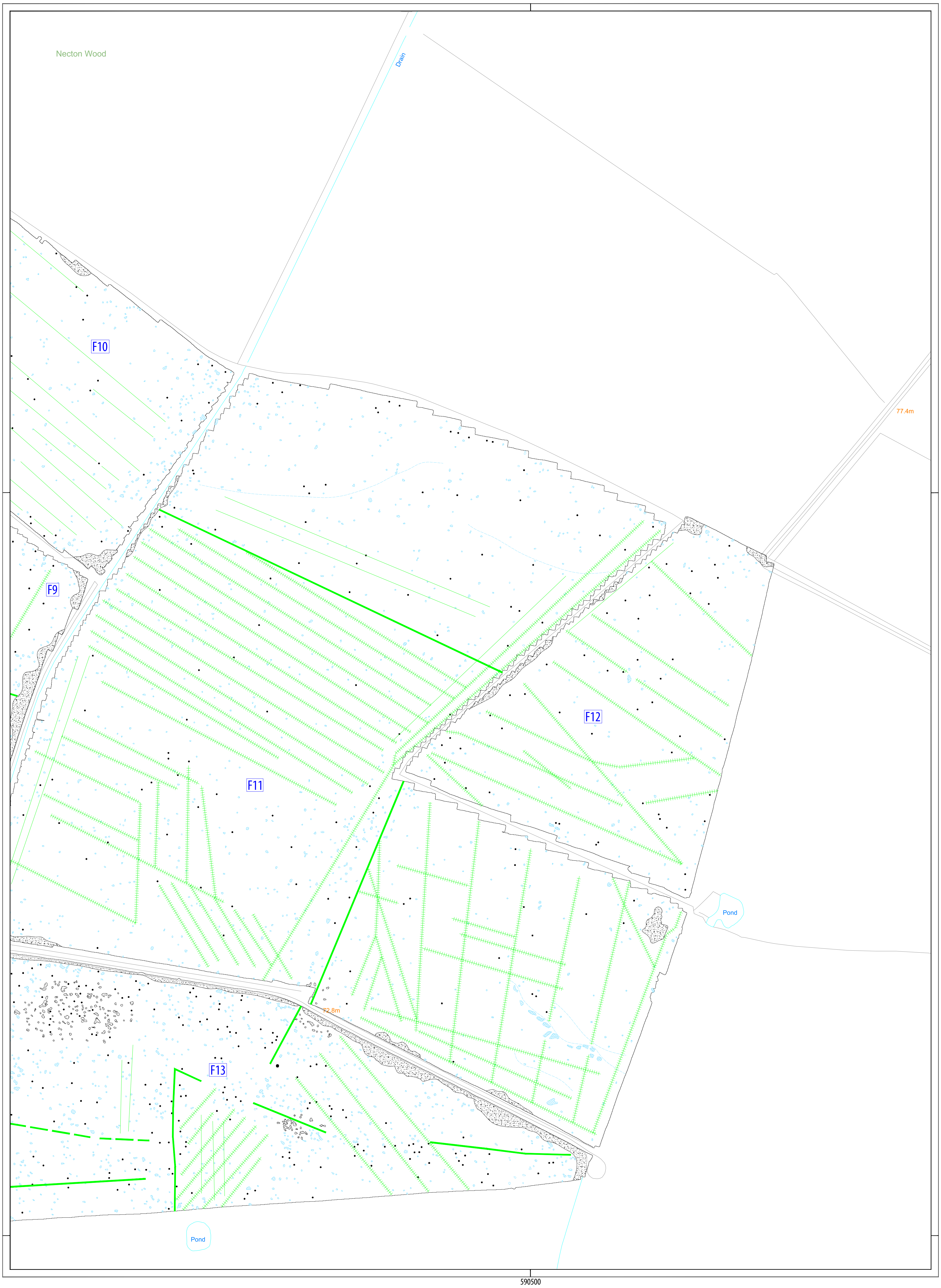
ILLUS 22 XY trace plot of minimally processed magnetometer data; Sector 4



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear	possible former boundary

TYPE OF ANOMALY	INTERPRETATION
linear trend	geology
magnetic enhancement	geology

0 50m
1:2,500 @ A3

NORTH

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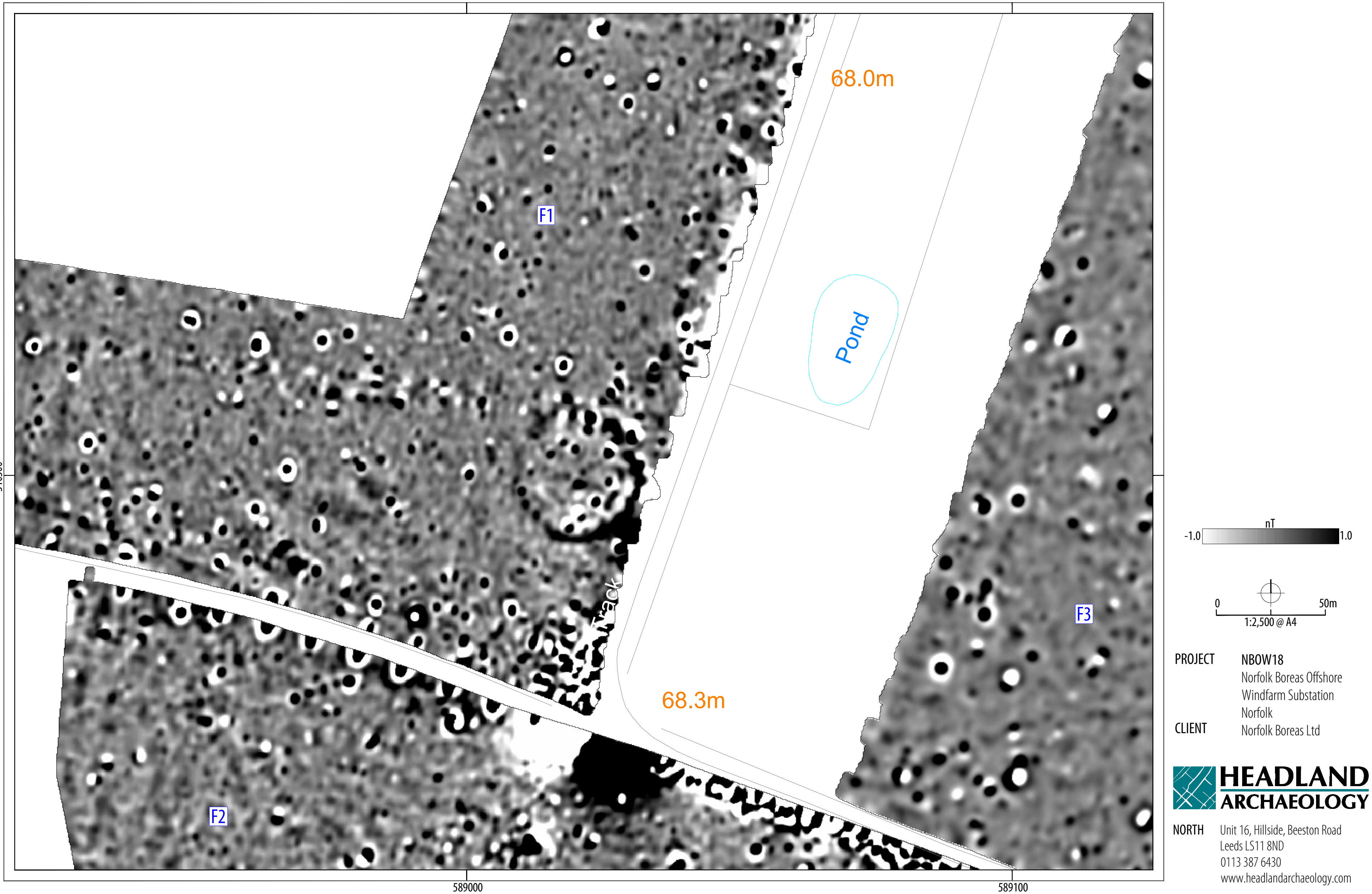
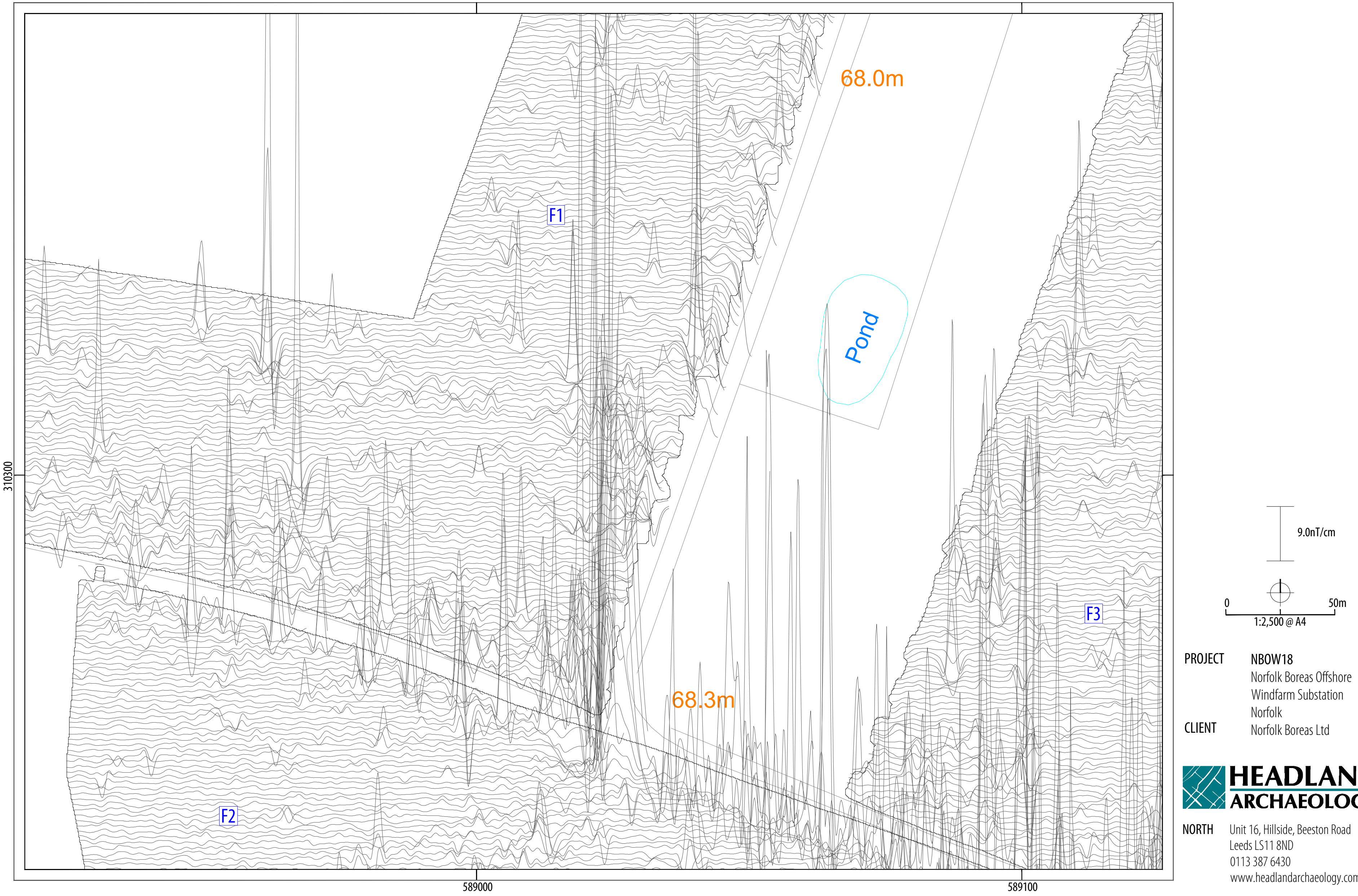
ILLUS 23 Interpretation of magnetometer data; Sector 4



ILLUS 24 Processed greyscale magnetometer data; AAA1



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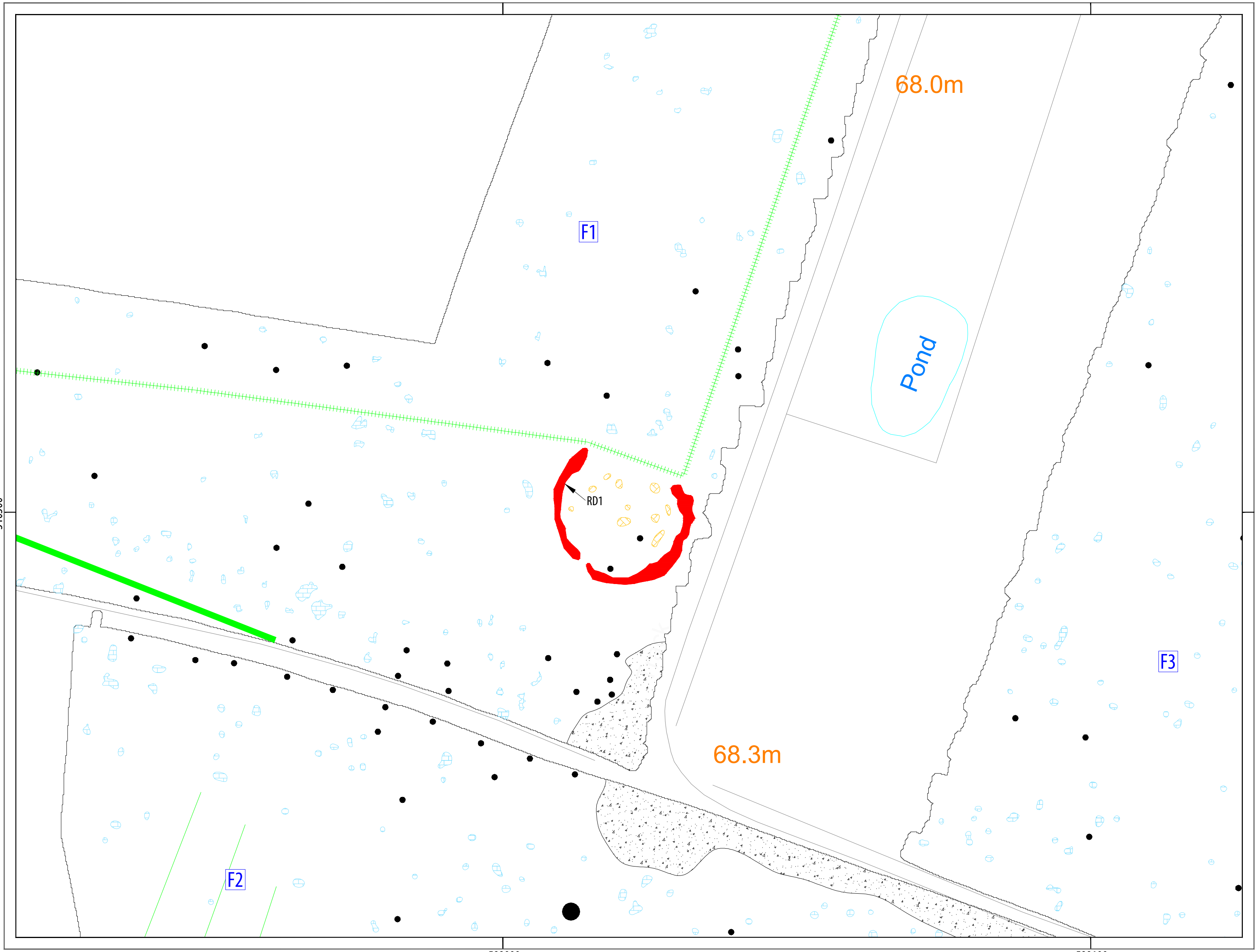
ILLUS 25 XY trace plot of minimally processed magnetometer data; AAA1



TYPE OF ANOMALY | INTERPRETATION
dipolar isolated | ferrous material
magnetic disturbance | ferrous material
linear trend | field drain
linear | former field boundary
magnetic enhancement | geology
magnetic enhancement | archaeology?
magnetic enhancement | archaeology

ABBREVIATIONS
RD ring-ditch

0 50m
1:2,500 @ A4

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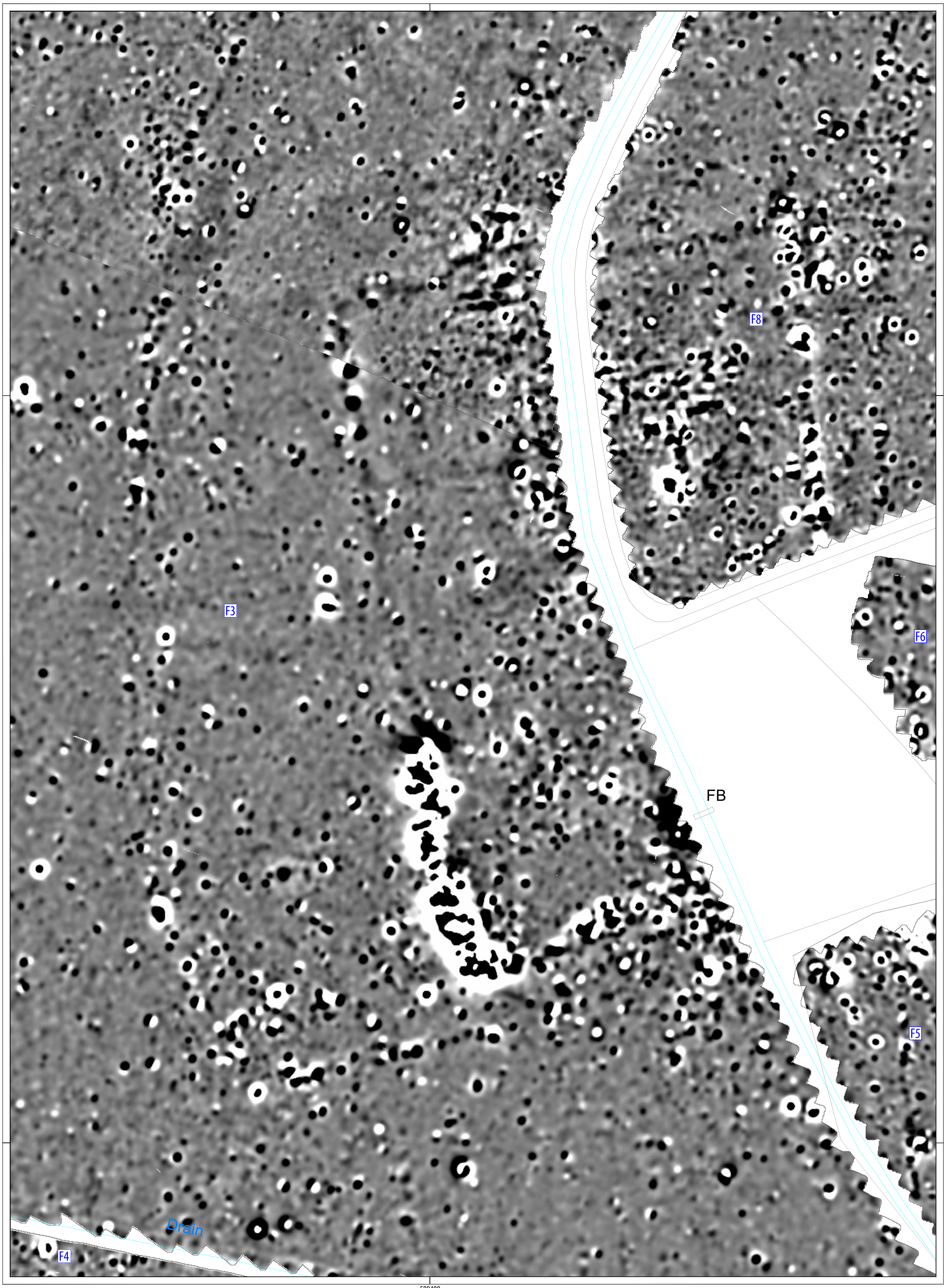
ILLUS 26 Interpretation of magnetometer data; AAA1



ILLUS 27 Processed greyscale magnetometer data; AAA2

nT
-1.0 1.0

0 25m
1:1,000 @ A3

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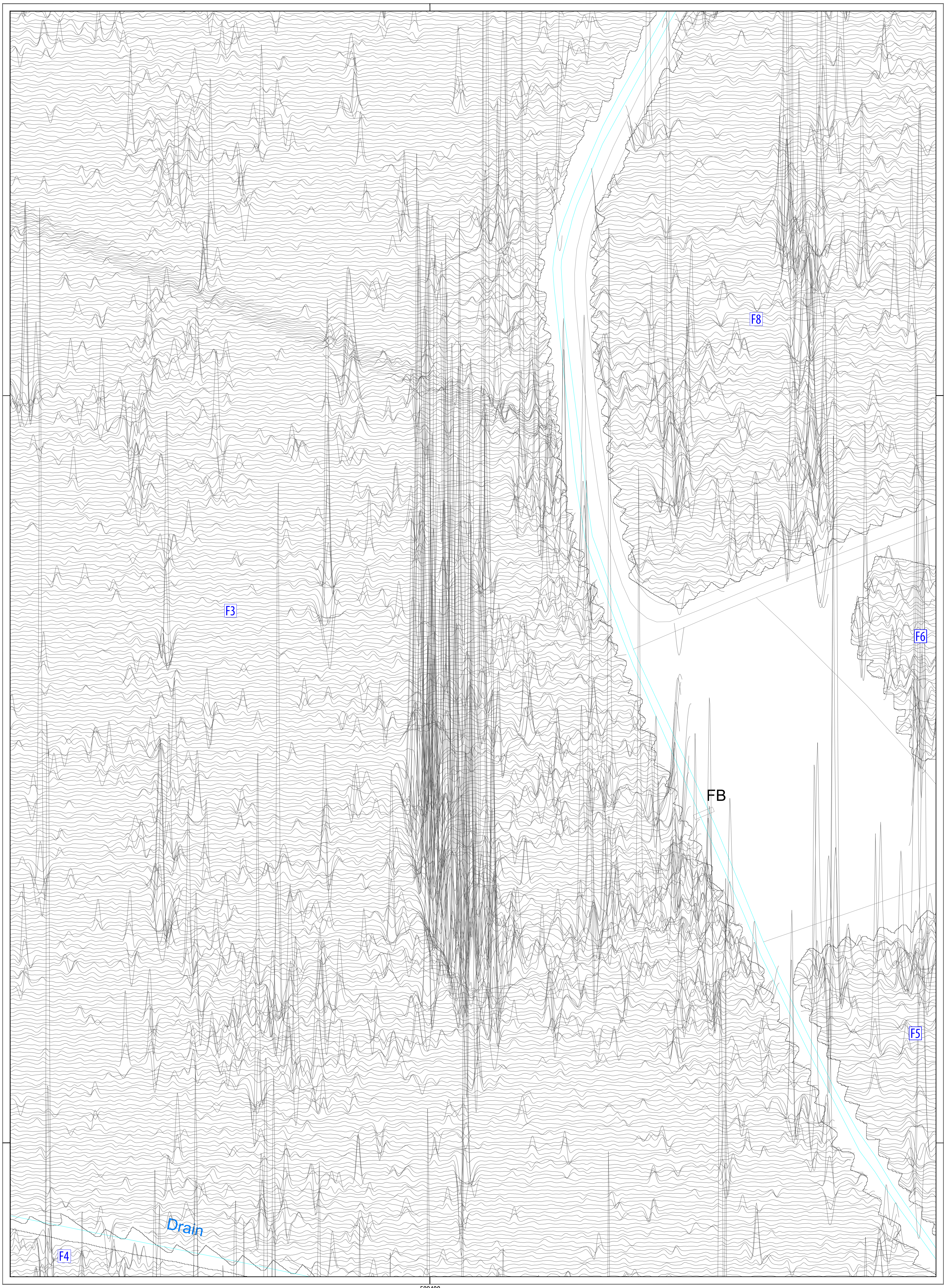

ILLUS 28 XY trace plot of minimally processed magnetometer data; AAA2

9.0nT/cm

0 25m
1:1,000 @ A3

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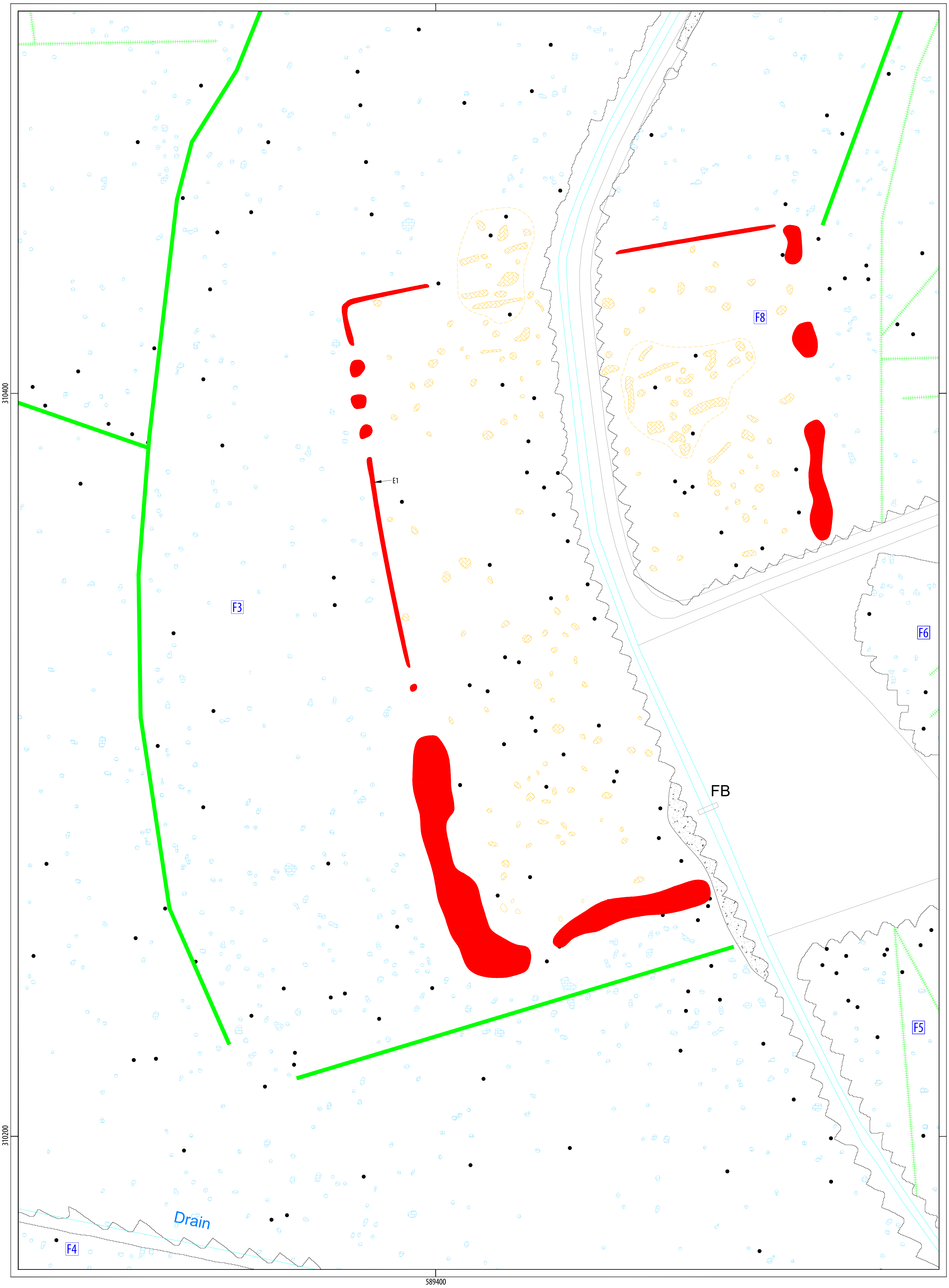

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear trend	field drain
linear	former field boundary

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	geology
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

E enclosure

0 25m
1:1,000 @ A3

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ILLUS 29 Interpretation of magnetometer data; AAA2

8 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.

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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 associated 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.

In addition to including a copy of the geophysical survey results and reporting (as available at the time) within the DCO application submission documents, copies of the final geophysical survey report will be supplied separately to the NHER. This will consist of one unbound hard copy and a PDF/A on CD upon the completion of the survey, and following relevant internal reviews and Norfolk Boreas Ltd. sign off, as well as any external review by NCC HES, as applicable.

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

Headland Archaeology will make their work accessible to the wider research community by submitting digital data and copies of the report online to OASIS (Online Access to the Index of Archaeological Investigations) at - http://www.oasis.ac.uk/, upon approval by Norfolk Boreas Ltd

OASIS ID: headland5-350212

PROJECT DETAILS	
Project name	Norfolk Boreas Offshore Wind Farm, Onshore Substation, Necton, Norfolk
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of a 96 hectare site immediately north-east of Necton, Norfolk, to provide information on the archaeological potential of the site, identified as a Substation Related Priority Geophysical Survey Area (SRPGSA), in order to assess the impact of potential future onshore substation infrastructure. The survey has identified two areas of archaeological activity (AAAs), in the central and western parts of the SRPGSA. In AAA2 the survey has corroborated the historic OS mapping and cropmark data identifying an undated moated site, whilst the ring-ditch in AAA1 was not previously known. The survey has also identified numerous linear anomalies caused by agricultural activity (ploughing, drainage and boundary removal), and discrete anomalies due to variation in the soils and superficial deposits. Overall, the survey has successfully evaluated the archaeological potential of the site, with AAA1 and AAA2 assessed as being of high potential and the remainder of the SRPGSA considered to be of low potential.
Project dates	Start: 14-01-2019 End: 30-01-2019
Previous/future work	Not known / Not known
Any associated project reference codes	NBOW - Contracting Unit No.
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N/A None
Significant Finds	N/A None
Methods & techniques	"Geophysical Survey"
Development type	Wind farm developments
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Lewes Nodular Chalk Formation
Drift geology (other)	diamicton (boulder clay)
Techniques	Magnetometry

PROJECT LOCATION	
Country	England
Site location	NORFOLK BRECKLAND NECTON Norfolk Boreas Offshore Wind Farm Onshore Substation, Necton, Norfolk
Study area	96 Hectares
Site coordinates	TF 9001 1031 52.656744185704 0.809652351102 52 39 24 N 000 48 34 E Point

PROJECT CREATORS	
Name of Organisation	Headland Archaeology
Project brief originator	Consultant
Project design originator	Consultant

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Project director/manager	Harrison, S
Project supervisor	Dyulgerski, K.
Type of sponsor/funding body	Developer
PROJECT ARCHIVES	
Physical Archive Exists?	No
Digital Archive recipient	In house
Digital Contents	"other"
Digital Media available	"GIS","Geophysics","Images raster / digital photography","Images vector","Spreadsheets"
Paper Archive recipient	in house
Paper Contents	"other"
Paper Media available	"Report"
PROJECT BIBLIOGRAPHY 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	Norfolk Boreas Offshore Wind Farm Onshore Substation, Necton, Norfolk: Geophysical Survey
Author(s)/Editor(s)	Dyulgerski, K.
Other bibliographic details	NBOW
Date	2019
Issuer or publisher	Headland Archaeology
Place of issue or publication	Edinburgh
Description	A4 glue bound report
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Entered on	30 April 2019

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