NTEN19

A47 NORTH TUDDENHAM TO EASTON, NORFOLK

GEOPHYSICAL SURVEY

commissioned by Highways England Ltd

April 2020

HEADLAND ARCHAEOLOGY

REGISTERED CIfA ORGANISATION

A47 NORTH TUDDENHAM TO EASTON, NORFOLK

GEOPHYSICAL SURVEY

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PROJECT INFO:
HA Project Code **NTEN19** / NHES Event No. **ENF147209** / NGR **W edge: TG 0549 1366, E edge: TG 1332 1127** / Local Authority **Norfolk County Council** / OASIS Ref. **headland5-390894**

PROJECT TEAM:
Project Manager **Sam Harrison** / Author **Krasimir Dyulgerski** / Fieldwork **Krasimir Dyulgerski, Ben Tipton, Olivier Vansassenbrouck, Euan Hall, Richard McGregor Edwards** / Graphics **Ross Bishop, Krasimir Dyulgerski, Eleanor Winter, Julia Bastek-Michalska**

Approved by **Sam Harrison**

HEADLAND ARCHAEOLOGY
part of the RSK Group
REGISTERED ORGANISATION CIfA

PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey, covering 212 hectares of land along the proposed route of the A47 extension from North Tuddenham to Easton, Norfolk. The survey was undertaken in order to provide information on the archaeological potential of the Proposed Scheme and to inform the Environmental Statement (ES) submitted as part of the Development Consent Order (DCO). Across the Geophysical Survey Area (GSA), four areas of definite archaeological activity have been recorded, two of which were previously unknown. Alongside the areas of archaeological activity, the survey has identified a series of isolated discrete and ditch anomalies that could be considered to be of possible archaeological origin as well as 15 areas of extraction and 32 former boundaries. Overall, the survey corroborates the conclusions of the scoping report and expands upon it by identifying further areas of interest. The archaeological potential of the site is considered moderate to high in the areas of archaeological activity and low to medium across the remainder of the GSA.

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A47 NORTH TUDDENHAM TO EASTON, NORFOLK

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Sweco and GalifordTry (the Designer) on behalf of Highways England (the Client) to undertake a geophysical (magnetometer) survey along the A47 Improvement Programme (the Proposed Scheme) between North Tuddenham and Easton (Illus 1). The Proposed Scheme forms a section of dual carriageway, 9km in length, that is part of the main arterial highway route connecting Norwich and Great Yarmouth to the east.

The survey is required in order to provide information on the archaeological potential of the Proposed Scheme and to inform the Environmental Statement (ES) which will be submitted as part of the Development Consent Order (DCO) application being prepared by Highways England. The A47 trunk road forms an important part of the Strategic Road Network (SRN) and provides for a variety of local, medium and long-distance trips between the A1 and the eastern coastline. The Proposed Scheme will comprise the construction of new dual carriageway alongside the A47 between North Tuddenham and Easton. There will also be alterations to the local road network including the creation of on/off slip roads to connect to the new carriageway.

The survey was undertaken in accordance with the Geophysical Survey Scope (Sweco UK 2019), and in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016.

1.1 SITE LOCATION, LAND USE AND TOPOGRAPHY

The Geophysical Survey Area (GSA) covered 212 hectares of predominantly arable fields (F1–41), bordering the A47, which extend from Fox Lane in the west (TG 0549 1366) to Ringland Road (TG 1332 1127) in the east.

The extent of the GSA underwent slight revision during the period of the survey. This comprised the expansion of a four-hectare section south of F32 following analysis of cropmarks that suggested the presence of archaeological remains.

Most of the land within the GSA was suitable for survey. Exceptions included areas of bird cover around the periphery of some fields, fields F31 and F37 which were deep ploughed and F11 which was an established tree plantation.

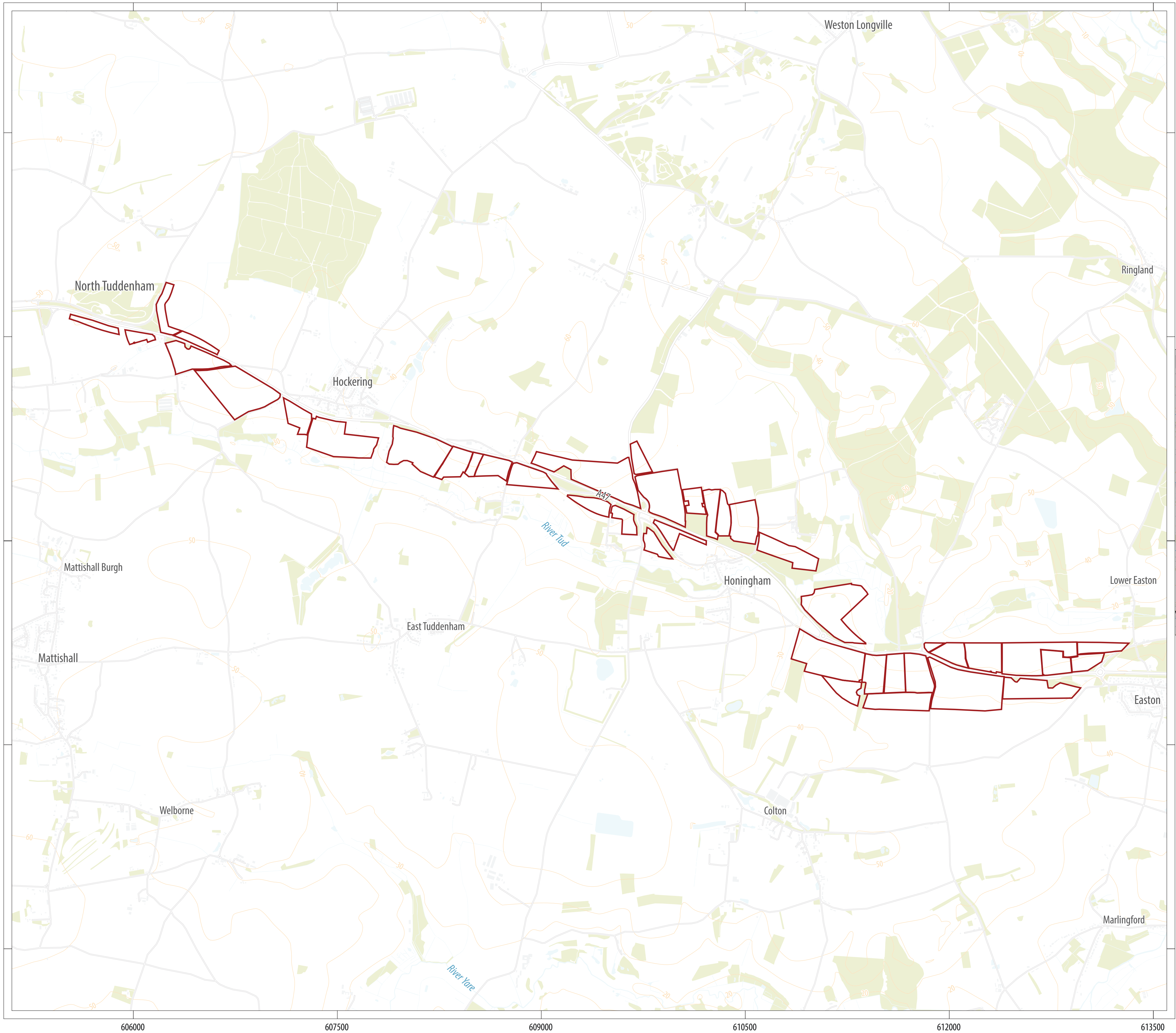
The land within the GSA is relatively flat ranging between 29m Above Ordinance Datum (AOD) and 37m AOD.

The survey was carried out in two phases. The first (main) phase was undertaken between 11th November and 18th December 2019 with the final three fields being surveyed on 17th and 18th February 2020 once cropping restraints were removed.

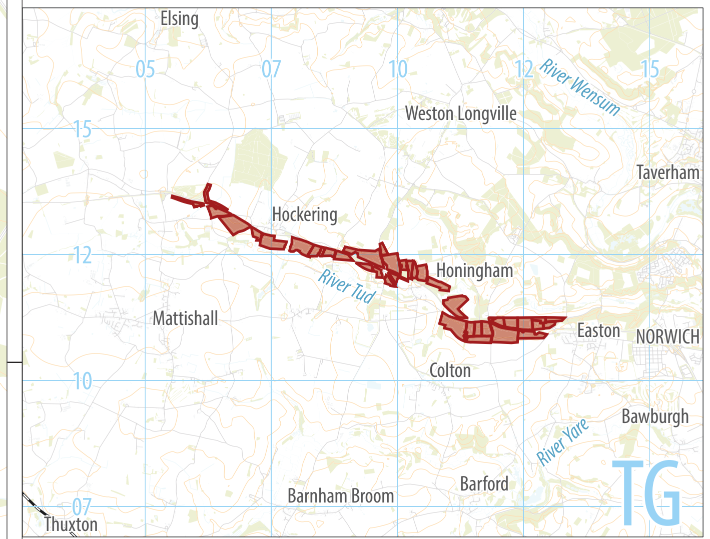
1.2 GEOLOGY AND SOILS

The underlying bedrock geology across the entire 9km length of the corridor comprises undifferentiated chalk formation (Lewes Nodular Chalk, Seaford Chalk, Culver Chalk and Portsdown Chalk formation) which is overlain across most of the GSA by superficial deposits of Lowestoft Formation (diamicton). Alluvium is recorded in the shallow valleys along the corridor as well as near lower elevation water channels where Sherringham Cliffs Formation (sand and gravel) (NERC 2020) is also present.

The soils are classified in the Soilscape 8 association which are characterised as slightly acid loamy and clayey soils with impeded drainage (Cranfield University 2020).



A47 Improvement Programme
North Tuddenham
Norfolk



HEADLAND ARCHAEOLOGY
Headland Archaeology Yorkshire & North
Unit 16 | Hillside | Beeston Rd | Leeds LS11 8ND
t 0113 387 6430
e yorkshireandnorth@headlandarchaeology.com
w www.headlandarchaeology.com

0
500m
1:30,000 @ A3

geophysical survey area

ILLUS 1 Site location (1:30,000)

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2 ARCHAEOLOGICAL BACKGROUND

The geophysical survey scoping report (Sweco UK 2019) records that there has been an evaluation of the Historic Environment Record (HER) undertaken on behalf of Highways England, which identified that there is a high potential for the presence of previously unknown archaeological remains dating from between the prehistoric period and Roman periods, within the scheme area.

Cropmark evidence from the National Mapping Programme (NMP) records possible Bronze Age structures on the eastern side of the GSA, a round barrow cropmark (NHER MNF59554) on the eastern side of F33 and possible ring ditches (NHER 12809) on the southern side of F32.

The GSA is located within 12km of the Roman town of *Venta Icenorum* and therefore falls within the Romano-British hinterland. The NMP has also recorded evidence of Roman period enclosures (NHER 53627 and NHER 53628) and ditches to the south of F34 and east of F26.

Later period structures have also been identified within the GSA. In F35 the NMP cropmark data has recorded a series of medieval tofts (NHER NMF28552) aligned along the river channel. At the easternmost end of the GSA in F41 a series of medieval and post-medieval land division ditches (NHER 54359) have been recorded.

Along with the larger scale features within the GSA the scoping report (Sweco UK 2019) has identified numerous artefacts. These spot finds range from flint tools and flakes, to sword fittings and coins. However, due to the wide dispersal of such finds across the landscape, they are not considered to be indicative of specific areas of archaeological activity or structures.

3 AIMS, METHODOLOGY AND PRESENTATION

The overall aim of the geophysical survey was to gather information to enable an assessment to be made of the density and extent of any sub-surface archaeological remains within the defined limits of the Proposed Scheme.

Specifically, the aims were to:

- locate and identify the nature and extent of any previously unknown archaeological features along the proposed corridor;
- establish whether any features associated with known archaeological remains can be traced within the current geophysical survey areas;
- establish whether any remains identified during previous geophysical surveys can be identified continuing into the current survey areas;
- establish, if possible, the condition of any archaeological deposits, particularly their level of preservation;
- identify any areas of modern disturbance; and
- 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. Features 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 archaeological sites can be obtained as buried features often producing reasonably characteristic anomaly shapes and strengths (Gaffney and 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 is programmed to take readings at a frequency of 10Hz (allowing for a 10–15cm sample interval) on roaming traverses 4m apart. These readings are stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system is 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 has been used to collect and export the data. Terrasurveyor V3.0.32.4 (DWConsulting) software has been used to process and present the data.

3.2 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:30,000. Survey condition photographs are shown on Illus 2 to Illus 7. Processed and interpreted data are shown on Illus 8 to Illus 13 inclusive at scales of 1:10,00. The data is presented and interpreted at a scale of 1:2,500 in Illus 14 to Illus 52 inclusive. This includes fully processed (greyscale) data, minimally processed data (XY traceplot) and accompanying interpretative plots. The data from the four AAA's are also presented at a larger scale (1:1,000) in Illus 53 to Illus 64 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 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 Geophysical Survey Scope (Sweco UK 2019), guidelines

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ILLUS 2 F4, looking north-west **ILLUS 3** F9, looking south-west

outlined by Historic England (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2014). All illustrations reproduced from Ordnance Survey mapping are 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

4.1 GENERAL

A variable magnetic background has been recorded throughout the GSA manifesting in the data as a plethora of discrete areas of magnetic enhancement. These are due to localised variations in the depth and composition of the soils and the superficial deposits from which they derive. Ground conditions were generally good across the GSA and the data quality is correspondingly good throughout.

The discontinuous nature of some of the anomalies which have been interpreted as of possible or probable archaeological origin demonstrates that detection of some soil-filled features may be hampered by either low magnetic contrast in the surrounding soils and/or the depth of the superficial deposits or differential degradation due to modern intensive farming practices. In these circumstances some discrete and low magnitude anomalies may not manifest in the data. The accurate interpretation is also hampered by the fact that such anomalies extend beyond the survey limits.

The anomalies identified by the survey fall into several categories but are broadly interpreted according to their origin, whether archaeological or non-archaeological.

The non-archaeological anomalies are described first and are categorised as being due to modern, agricultural, geological or quarrying activity.

Anomalies that are interpreted as of possible or probable archaeological origin are then described and discussed within the context of the four Areas of Archaeological Activity (AAA's) which have been identified across the GSA.

It should also be noted that not all the anomalies interpreted as of possible archaeological origin fall within AAA's. In these cases, the anomalies are typically linear or discrete and cannot be confidently interpreted as non-archaeological and which have therefore been ascribed a possible archaeological status.

4.2 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 resulting from manuring or tipping/infilling. Throughout the GSA there is no obvious clustering to these ferrous anomalies which might indicate an archaeological origin, although this cannot be guaranteed. Far more probable is that the 'spike' responses are likely caused by the random distribution of ferrous debris in the upper soil horizons.

Two high magnitude dipolar linear anomalies (SP1 and SP2) have been identified at the eastern edge of F13 and running a south-west/north-east alignment through F17, F18, F20 (Illus 23–34 inclusive). These anomalies are due to buried service pipes.

Near the northern boundary of F38 (Illus 7) and F34 the survey has identified two areas of high magnetic response. They are caused by the proximity of the magnetometer to high voltage pylons (Illus 47–49 inclusive).

Near the southern boundary of F32 (Illus 41–43 inclusive) the survey has detected a high magnitude bipolar linear anomaly on a north/south alignment. This anomaly is interpreted as having been caused by a lightning strike (a lightning induced remnant magnetic anomaly).

Magnetic disturbance around the periphery of fields is due to ferrous material within or close to adjacent boundaries and is of no archaeological interest unless specified otherwise.

4.3 GEOLOGICAL ANOMALIES

Discrete and curvilinear low magnitude anomalies are identified throughout the GSA. These are geological in origin and are caused by minor variations in the depth and composition of the topsoil (or the superficial deposits from which the upper soil horizons are derived), or the accumulation of topsoil along the breaks in, or bottom of, slopes.

4.4 AGRICULTURAL ANOMALIES

Analysis of historic cartographic sources (early edition Ordnance Survey maps) indicates that the pattern of land division throughout the GSA has undergone extensive change from the late 19th century up to the present day as boundaries have been removed to create larger fields. Overall, the survey has detected 32 (FB1–FB32) former field boundaries and four (PFB1–PFB4) possible field boundaries that appear to continue or terminate near recorded historic boundaries. Some of these former boundaries manifest in the data as linear anomalies (soil-filled ditches), or as linear alignments of ferrous anomalies, which are caused by modern debris within the fill of the ditch or which has accumulated along the former field margins.

The more closely spaced linear anomalies, aligned parallel with the extant field boundaries, are due to modern ploughing. Perhaps surprisingly, no anomalies have been identified which are caused by medieval and/or post-medieval ridge and furrow cultivation. This is presumably due to the intensive nature of the current agricultural regimes having removed any vestigial traces of older agricultural practices.

Linear trend anomalies have also been identified in F4, F8, F9 and F10. These anomalies are sometimes oblique to the surrounding field boundaries and/or arranged in a partial herring-bone pattern and are characteristic of field drains. A broad positive curvilinear anomaly is identified in the north-east corner of F16 (Illus 32–34 inclusive). This anomaly is interpreted as a drainage channel for the A47 to the north.

4.5 QUARRYING ANOMALIES

Fifteen amorphous localised areas of magnetic disturbance are identified throughout the GSA being most prevalent in the eastern half of the corridor. These anomalies are interpreted as being due to backfilled clay and gravel extraction pits. Many of these small-scale enterprises would have been designed to cater for a specific, local, purpose and hence short lived. Consequently, although some of these pits are recorded on historic mapping many more are not however, they are interpreted as areas of extraction due to the similarity of the magnetic response. The magnetic disturbance is caused by magnetic debris (brick, tile, iron etc) within the material used to infill the extraction pits.

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ILLUS 4 F11, looking east **ILLUS 5** F13, looking north-east **ILLUS 6** F20, looking south-west **ILLUS 7** F38, looking north-west

4.6 POSSIBLE 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 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 of non-archaeological origin.

Anomalies interpreted as being of possible archaeological origin are caused by soil-filled features such as pits or ditches or by spreads of magnetically enhanced material within the upper soil horizons. Whilst these anomalies do not manifest in any coherent archaeological pattern, they are either located near to areas of known archaeology, or cannot be satisfactorily interpreted as either modern, agricultural or geological in origin. On this basis, these anomalies are interpreted as potentially archaeological in origin.

The survey has identified positive ditch-like anomalies across the GSA (D1–D11). These anomalies are not in the same alignment with current or historic field boundaries and do not correspond to geological or agricultural anomalies. These anomalies are interpreted as truncated enclosures and field systems. However, due to the segmented nature of these anomalies a definite archaeological interepretation cannot be assigned.

Near the southern boundary of F32 the survey has identified five faint linear anomalies (D7–D11) that do not align with the existing field boundaries or lines of cultivation. Even though the anomalies have a weak magnetic signal they are considered to be of possible archaeological origin due to the presence of crop marks to the south of F32.

In F18 a series of discrete anomalies have been identified (Illlus 32–34). These anomalies do not have any obvious clustering however, due to their strong positive magnetic signal they are considered to be of possible archaeological origin. Nevertheless, this interpretation is tentative and a geological origin cannot be dismissed.

Four anomalies with a distinct magnetic response have been identified within the survey area, K1(see Illus 14–16), K2 and K3 (see Illus 26–28) and K4 (see Illus 46). Based on their proximity to areas of extraction and unique magnetic response a kiln interpretation has been attributed.

4.7 AREAS OF ARCHAEOLOGICAL ACTIVITY

Four distinct areas of archaeological activity (AAA) have been identified, which are discussed below.

AAA1 (Illus 53–55)

The survey has identified an irregular shaped enclosure (E1) in the north-west corner of F8. This enclosure, which has not been identified by the NMP, has well defined ditches on the eastern side while the western side is truncated by the contemporary field boundary. Within the enclosure and to the north, the survey has identified several anomalies. Due to the direct association with E1 these anomalies interpreted as of possible archaeological origin. To the south of E1, a double ditch anomaly, aligned in a south-west/north-east direction is identified. This anomaly is also interpreted as of possible archaeological origin. However, this interpretation is tentative given that this anomaly is on the same alignment as the extant access road to the nearby timber yard.

AAA2 (Illus 121–129)

AAA2 encompasses the north-western corner of F33 and western corners of F35 and F36. Within AAA2 a series of parallel ditches and a rectangular enclosure have been identified. The enclosure (E2) is truncated on its western side by the field boundary and an area of extraction (Q6).

On it eastern and southern side the survey has identified two breaks in the magnetic response which may indicate the location of entrances. Within the enclosure there are numerous discrete anomalies which could be interpreted either as pits or remnants of partition ditches. To the north of E2, three ditch anomalies (D12–D14) in an east/west alignment and one ditch (D15) in a north/south alignment perpendicular to D12–D14 have been detected. These anomalies identified in AAA2 correspond to a series of medieval tofts (NHER NMF28552) identified by the NMP.

AAA3 (Illus 59–61)

In AAA3 the survey has identified two positive ditch anomalies (D16 and D17). Ditch D17 is identified as a truncated rectangular shaped anomaly that does not align with the current or historic field boundaries. To the north-west is D16, which is in the same alignment as the northern part of D17, extends beyond F37 and into F36. These anomalies were not identified by the NMP and are interpreted as forming part of possible earlier field systems.

AAA4 (Illus 62–64)

AAA4 is situated at the easternmost end of the GSA. Within this area the survey has identified five ditch anomalies of varying length, shape and alignment (D18–D21). Numerous discrete and small ditch type anomalies are also identified and interpreted as of possible archaeological origin due to their proximity to D18–D21. The anomalies within AAA4 correspond to a series of medieval and post-medieval land division ditches (NHER 54359) recorded by the NMP. Unfortunately, the full extent these features cannot be identified due to the magnetic disturbance along the field edges.

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5 CONCLUSION

The survey has successfully evaluated 38 out of 41 fields further advancing knowledge of the archaeological potential of the GSA and providing evidence of four areas of definite archaeological activity, ranging from isolated ditches to enclosures and areas of settlement. Two of these areas (AAA2 and AAA4), were previously known through the presence of cropmarks, although to a lesser extent than has been identified by the geophysical survey. The two other areas (AAA1 and AAA3) were previously unknown. As well as the areas of definite archaeological activity the survey has identified a number of isolated discrete and ditch anomalies that could be considered to be of possible archaeological origin as well as 15 areas of extraction and 32 former field boundaries. Overall, the survey corroborates the conclusions of the scoping report and expands upon it by identifying further areas of interest. The archaeological potential of the site is considered moderate to high in the four areas of archaeological activity and low to medium across the remainder of the GSA.

6 REFERENCES

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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.

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,

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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.

APPENDIX 4 DATA PROCESSING

Digital, geo-referenced copies of the geophysical survey plans will be supplied with the report for inclusion in the Norfolk HER.

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. Data is also clipped to remove extreme values and to improve data contrast.

APPENDIX 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5–390894

PROJECT DETAILS	
Project name	A47 North Tuddenham to Easton, Norfolk
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey, covering 212 hectares of land along the proposed route of the A47 extension from North Tuddenham to Easton, Norfolk. The survey was undertaken in order to provide information on the archaeological potential of the Proposed Scheme and to inform the Environmental Statement (ES) submitted as part of the Development Consent Order (DCO). Across the Geophysical Survey Area (GSA), four areas of definite archaeological activity have been recorded, two of which were previously unknown. Alongside the areas of archaeological activity, the survey has identified a series of isolated discrete and ditch anomalies that could be considered to be of possible archaeological origin as well as 15 areas of extraction and 32 former boundaries. Overall, the survey corroborates the conclusions of the scoping report and expands upon it by identifying further areas of interest. The archaeological potential of the site is considered moderate to high in the areas of archaeological activity and low to medium across the remainder of the GSA.
Project dates	Start: 11.11.2019 end: 18.02.2020
Previous/future work	Yes / Yes
Any associated project reference codes	NTEN19 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Grassland Heathland 5 - 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	Road scheme (new and widening)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Lewes Nodular Chalk, Seaford Chalk, Culver Chalk and Portsdown Chalk formation
Drift geology (other)	Lowestoft Formation (diamicton)
Techniques	Magnetometry
PROJECT LOCATION	
Country	England
Site location	NORFOLK BRECKLAND NORTH TUDDENHAM A47 North Tuddenham to Easton, Norfolk
Study area	212 Hectares
Site coordinates	TG 0549 1366 52.681148444721 1.04030478995 52 40 52 N 001 02 25 E Point TG 1332 1127 52.656650936557 1.154418177098 52 39 23 N 001 09 15 E Point
PROJECT CREATORS	
Name of Organisation	Headland Archaeology
Project brief originator	RSK
Project design originator	Consultant
Project director/manager	Harrison, S
Project supervisor	Dyulgerski, K
Type of sponsor/funding body	Highways Agency

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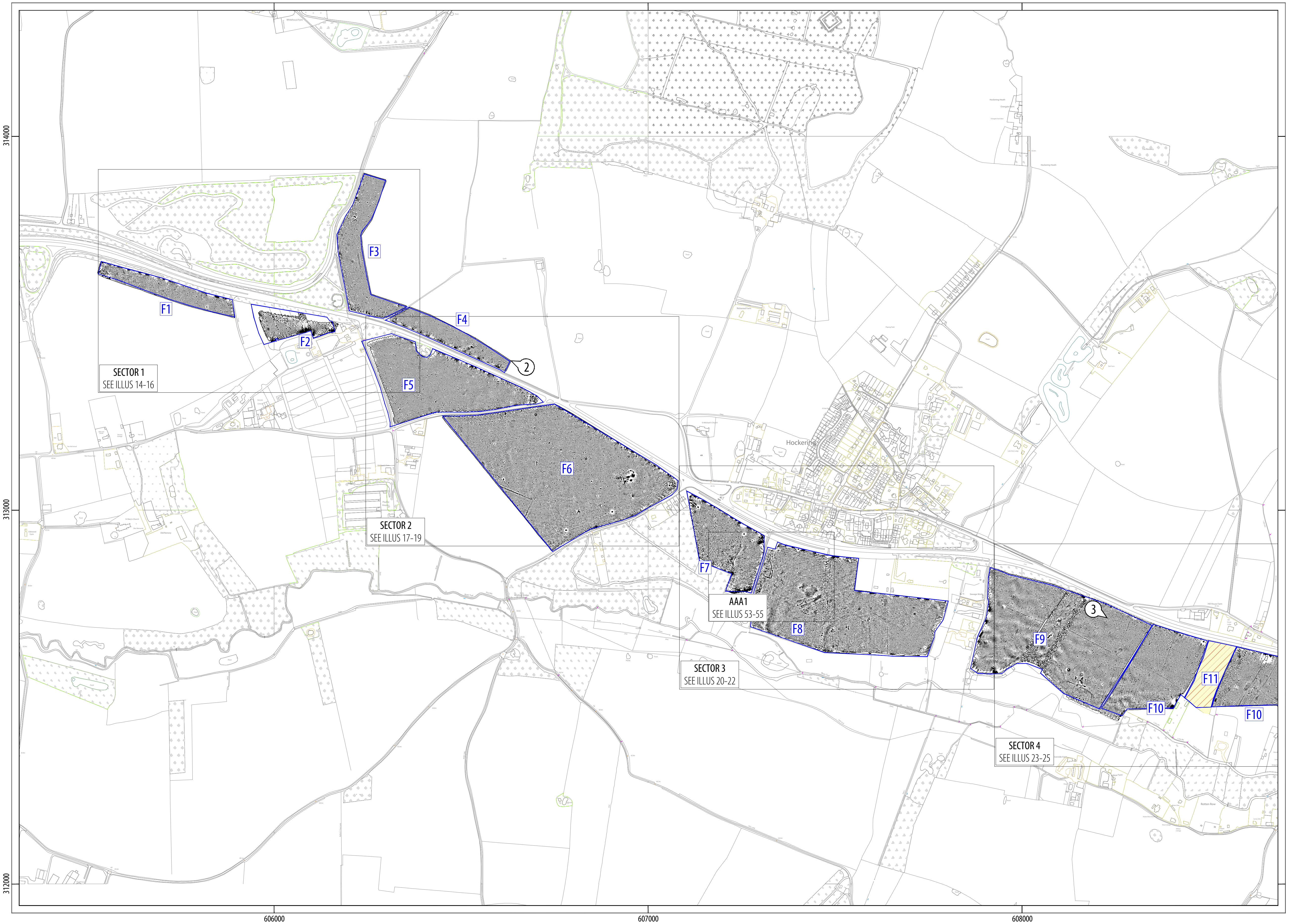
PROJECT ARCHIVES	
Physical Archive Exists?	No
Digital Archive recipient	In-house
Digital Contents	'other'
Digital Media available	'Geophysics', 'Images raster / digital photography', 'Images vector'
Paper Archive Exists?	No

PROJECT BIBLIOGRAPHY 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	A47 North Tuddenham to Easton, Norfolk: Geophysical Survey
Author(s)/Editor(s)	Dyulgerski, K
Other bibliographic details	NTEN19
Date	2020
Issuer or publisher	Headland Archaeology
Place of issue or publication	Edinburgh
Description	A4 Glue bound report and PDF/A
Entered by	Sam Harrison (sam.harrison@headlandarchaeology.com)
Entered on	2 April 2020



geophysical survey area

unsuitable for survey

location and direction of ILLUS 2-7

nT

-1.0 2.0

0 200m

1:10,000 @ A3

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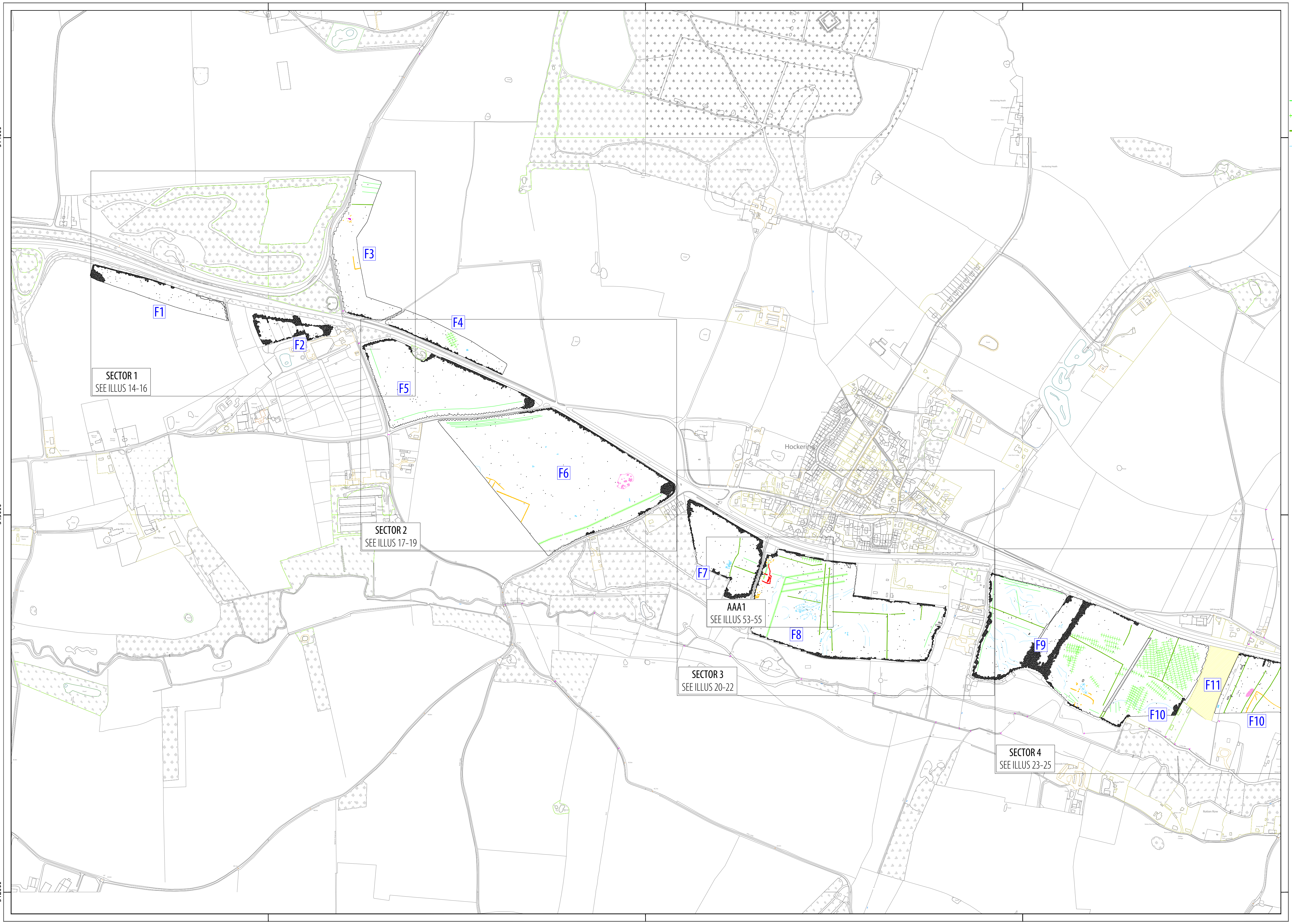
ILLUS 8 Processed greyscale magnetometer data; Western section



unsuitable for survey

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	quarrying
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	kiln/burning
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

0 200m
1:10,000 @ A3

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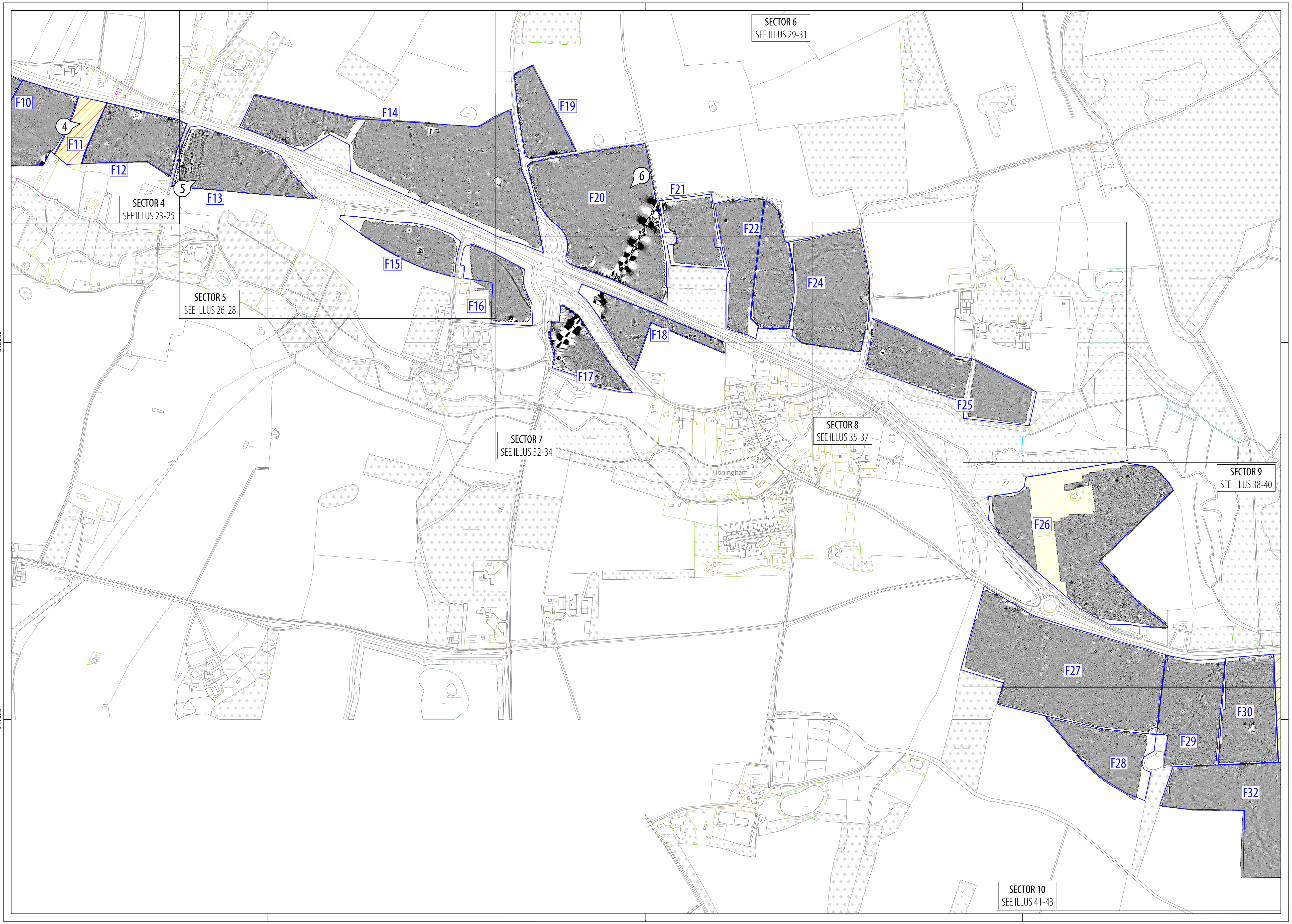
ILLUS 9 Interpretation of magnetometer data; Western section



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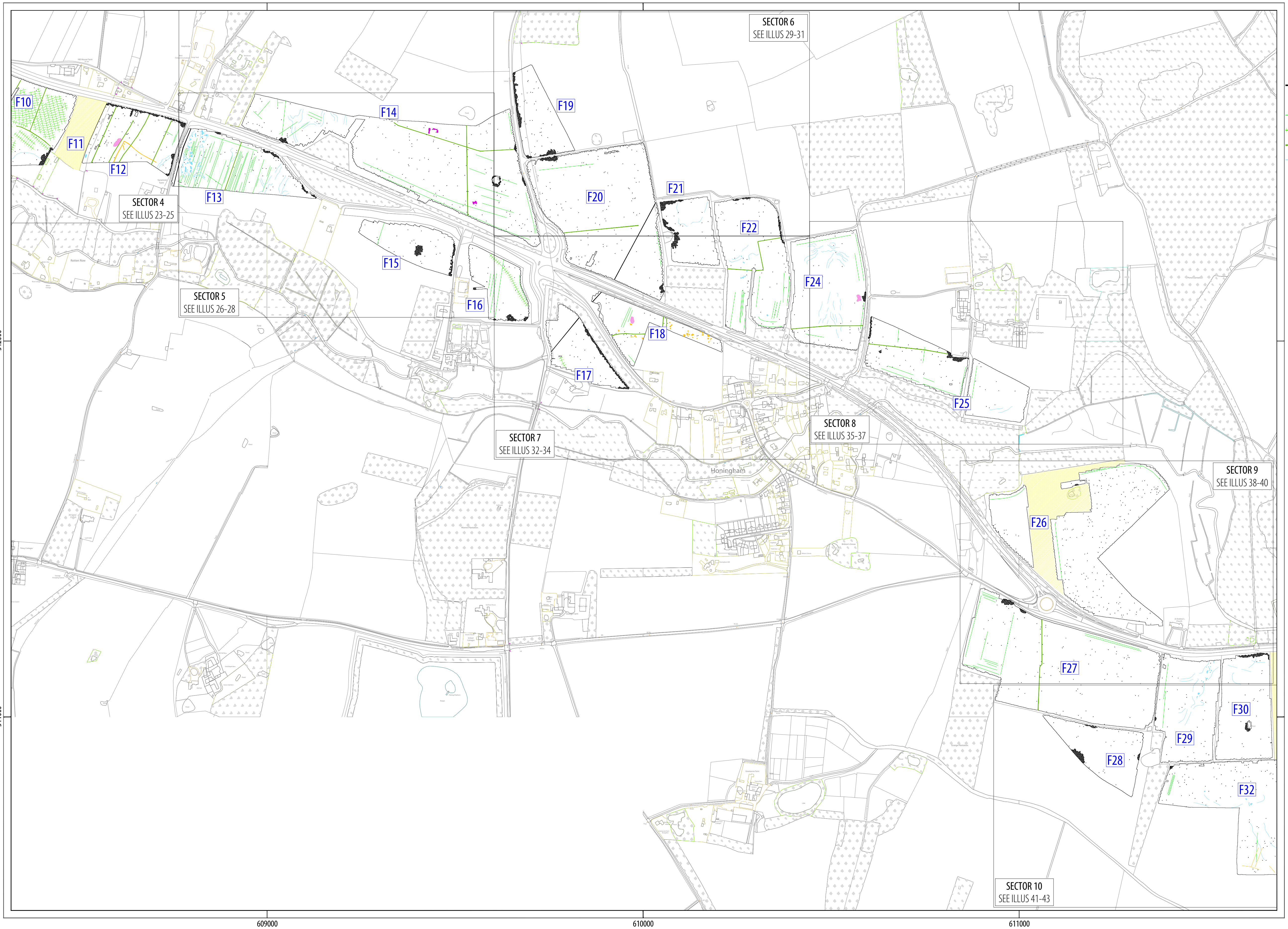
ILLUS 10 Processed greyscale magnetometer data; Central section



area unsuitable for survey

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
magnetic disturbance	quarrying
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	kiln/burning
magnetic enhancement	archaeology?

0 200m
1:10,000 @ A3

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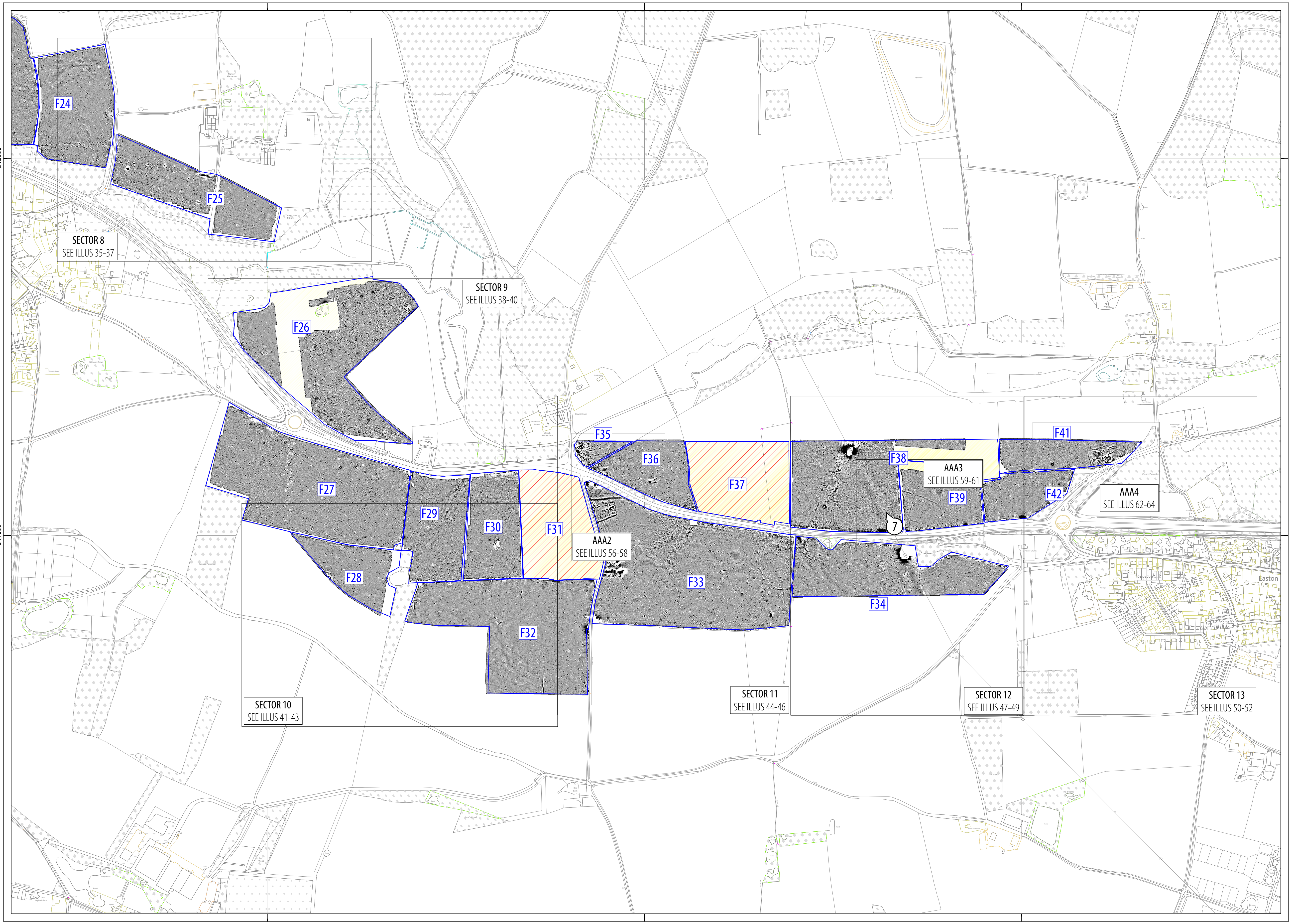
ILLUS 11 Interpretation magnetometer data; Central section



ILLUS 12 Processed greyscale magnetometer data; Eastern section

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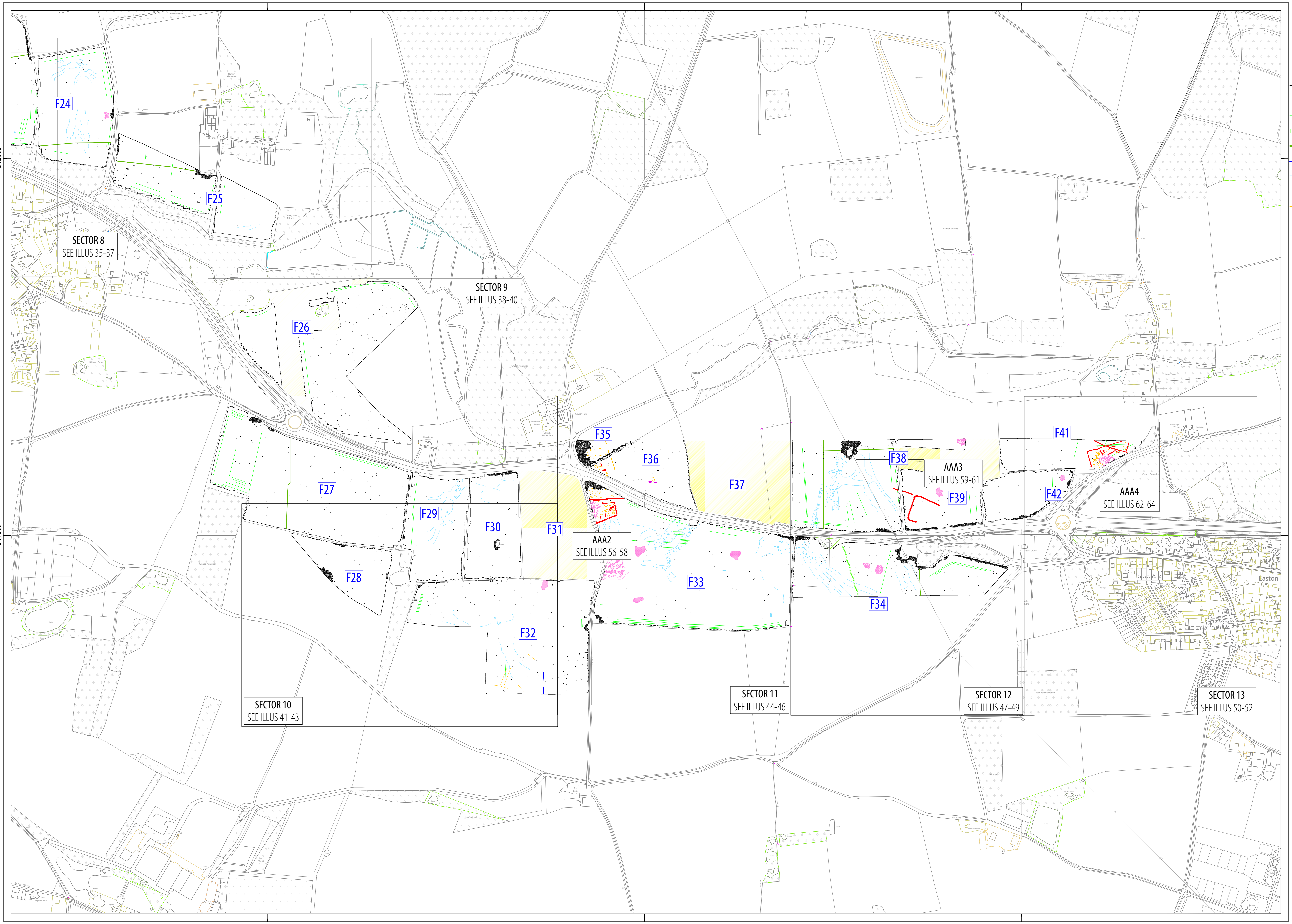

area unsuitable for survey

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
magnetic disturbance	quarrying
linear trend	agricultural
linear trend	field drain
linear	former field boundary
magnetic enhancement	LIRM
linear trend	geological variation
magnetic enhancement	geology
linear trend	archaeology?
magnetic enhancement	kiln/burning
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

0 200m
1:10,000 @ A3

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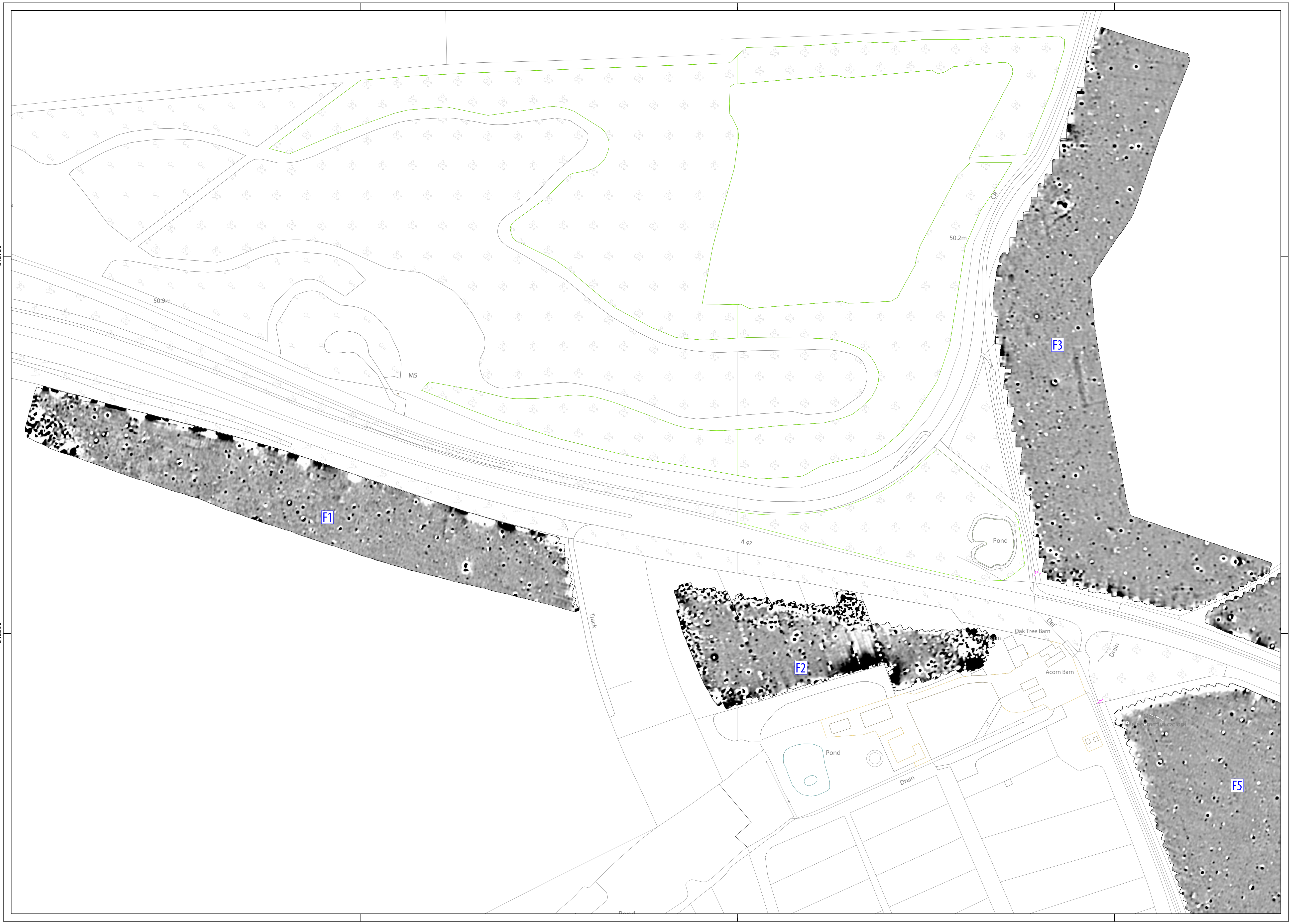
ILLUS 13 Interpretation of magnetometer data; Eastern section



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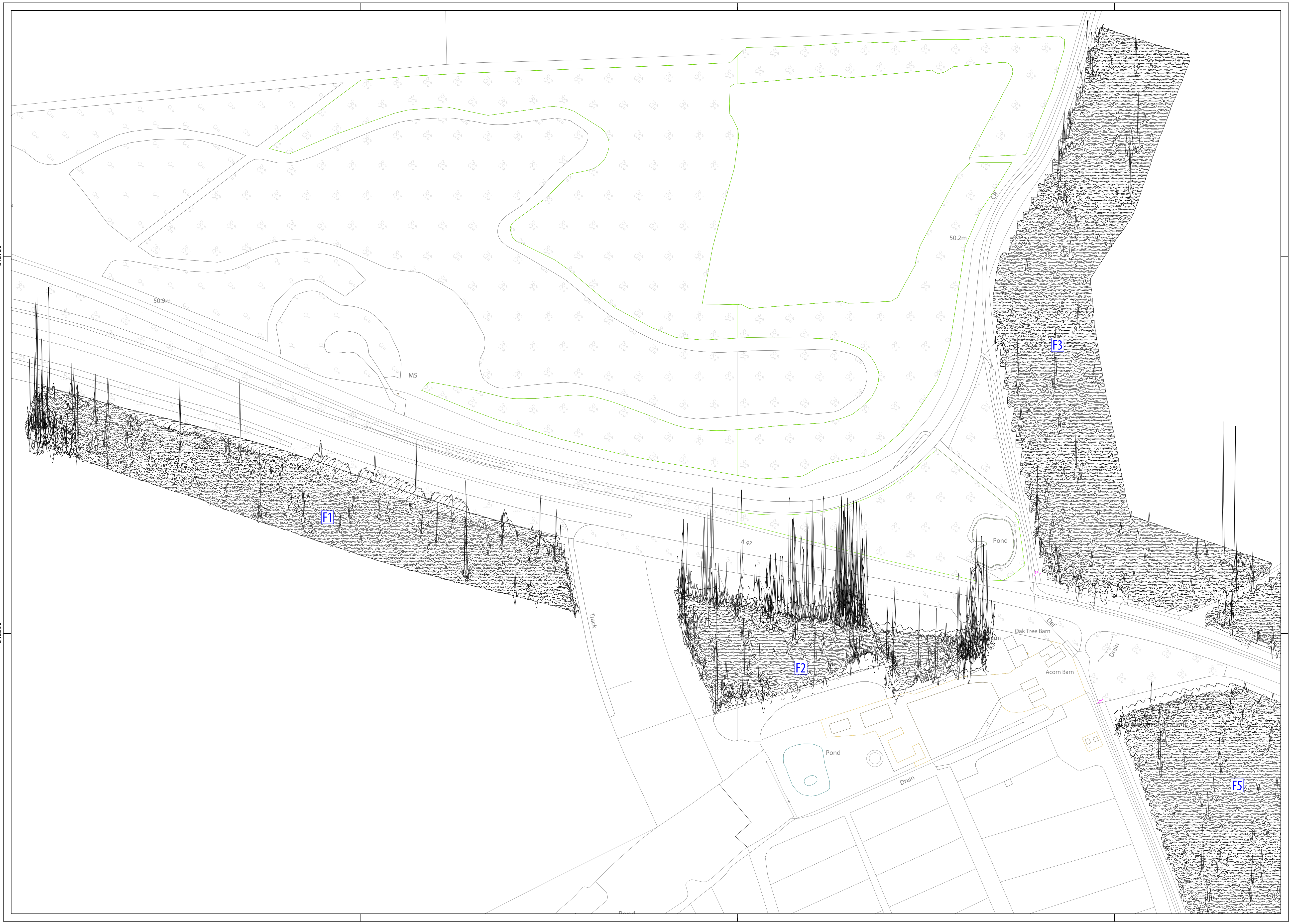
ILLUS 14 Processed greyscale magnetometer data; Sector 1



43.0nT/cm

0 50m

1:2,500 @ A3

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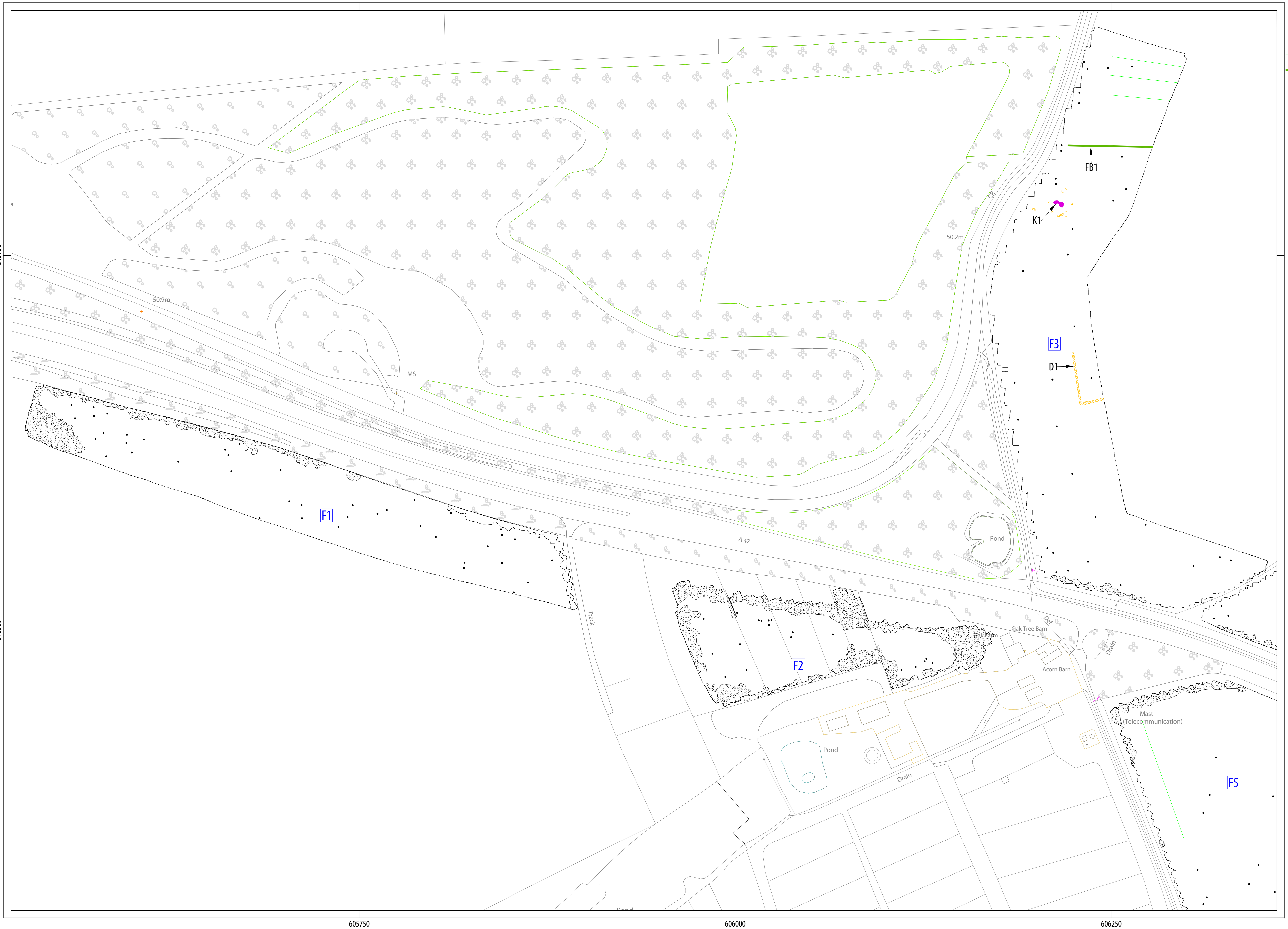
ILLUS 15 XY trace plot of minimally processed magnetometer data; Sector 1



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear trend	agricultural
linear	former field boundary
magnetic enhancement	kiln/burning
magnetic enhancement	archaeology?

ABBREVIATIONS

D ditch
FB field boundary
K kiln/area of burning

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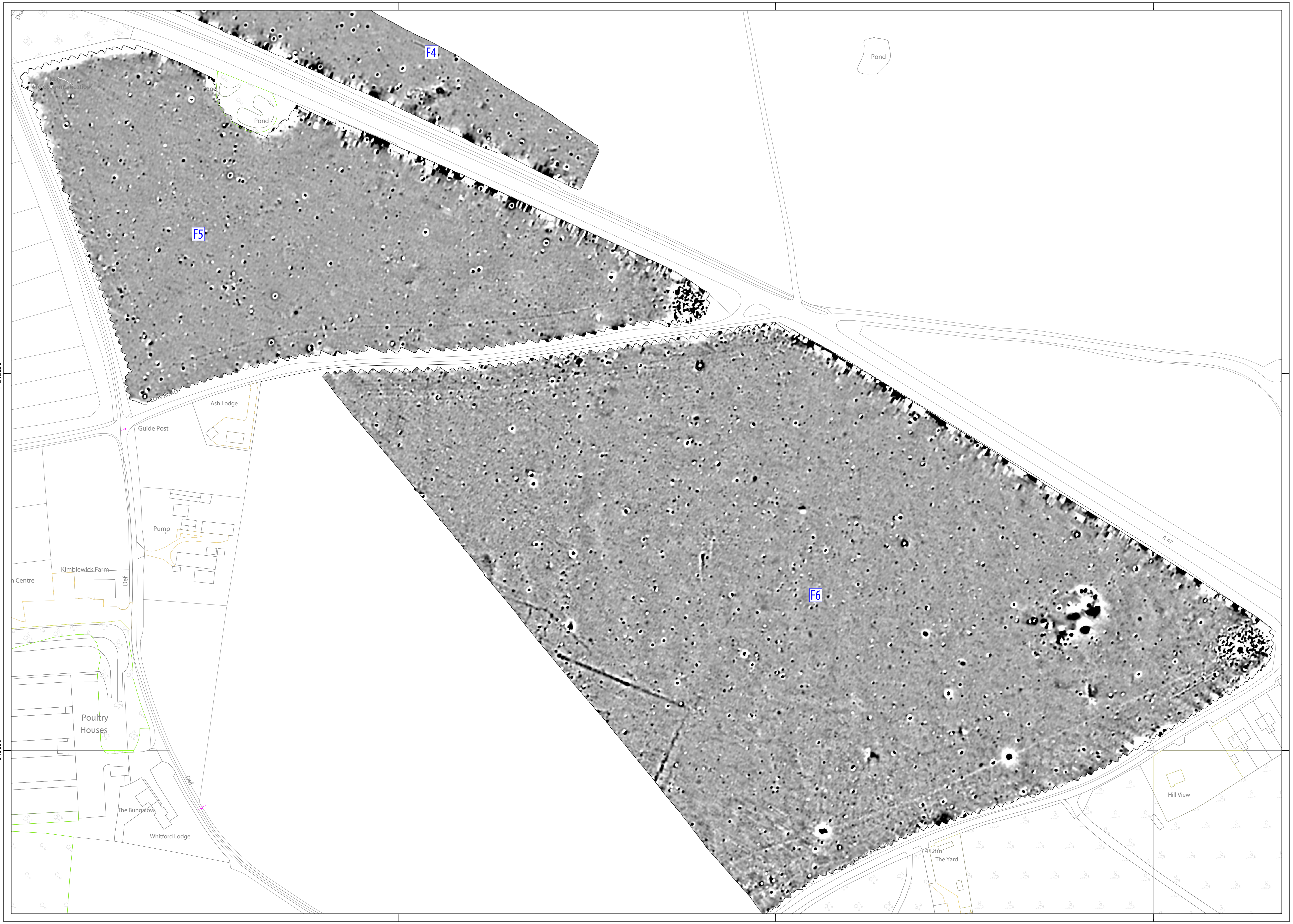
ILLUS 16 Interpretation of magnetometer data; Sector 1



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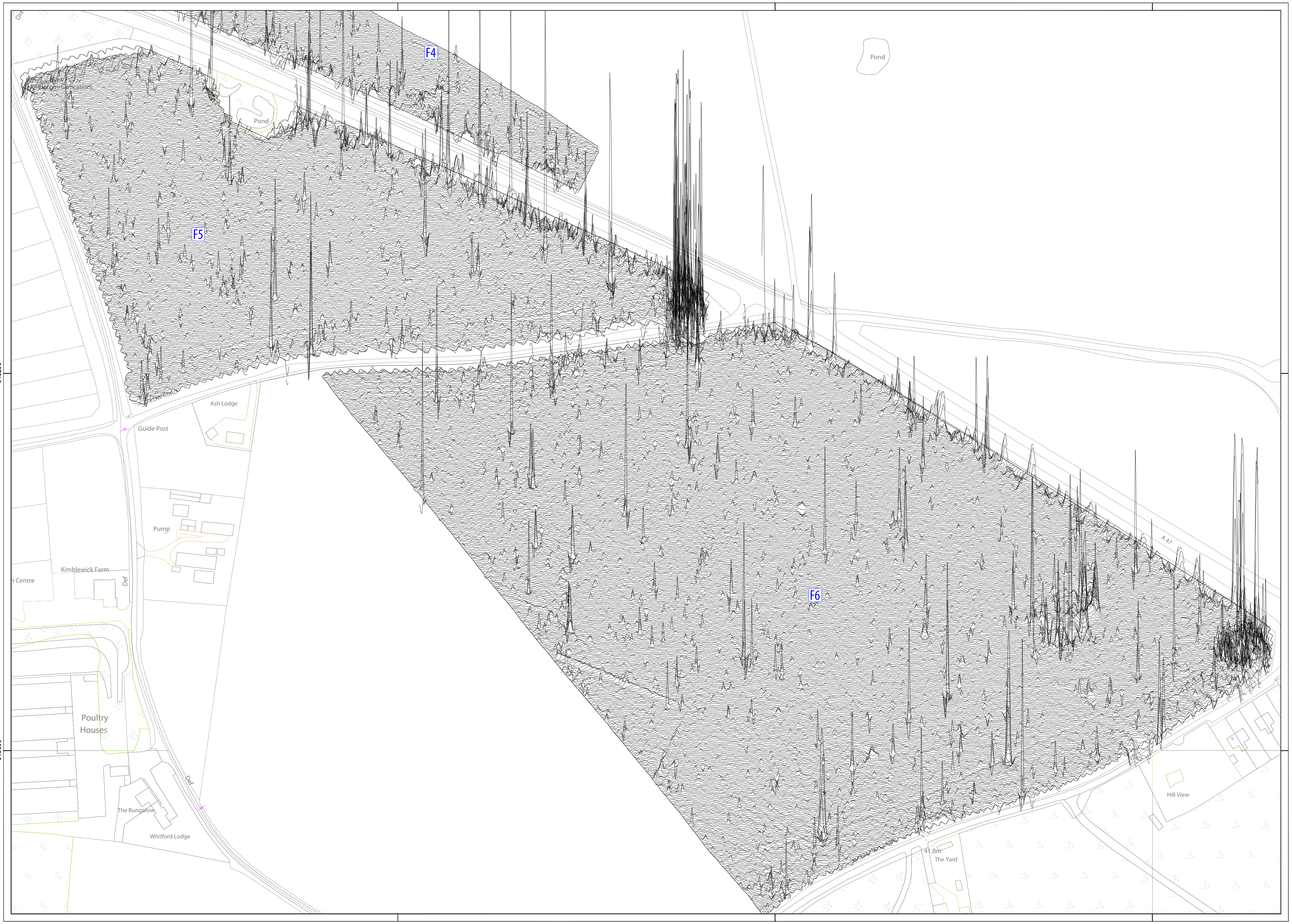
ILLUS 17 Processed greyscale magnetometer data; Sector 2



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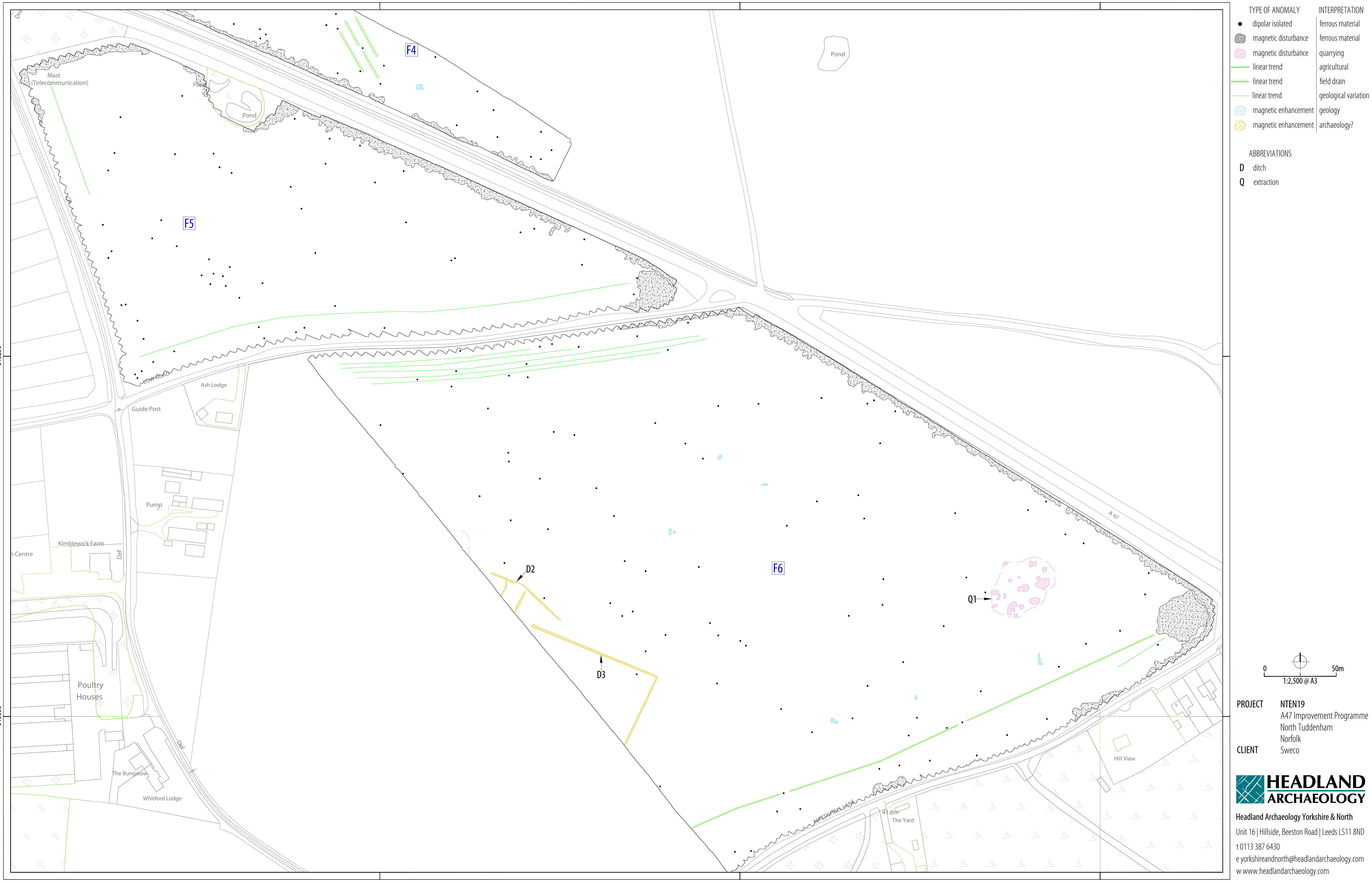
ILLUS 18 XY trace plot of minimally processed magnetometer data; Sector 2



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ILLUS 19 Interpretation of magnetometer data; Sector 2

nT

-1.0 2.0

0 50m

1:2,500 @ A3

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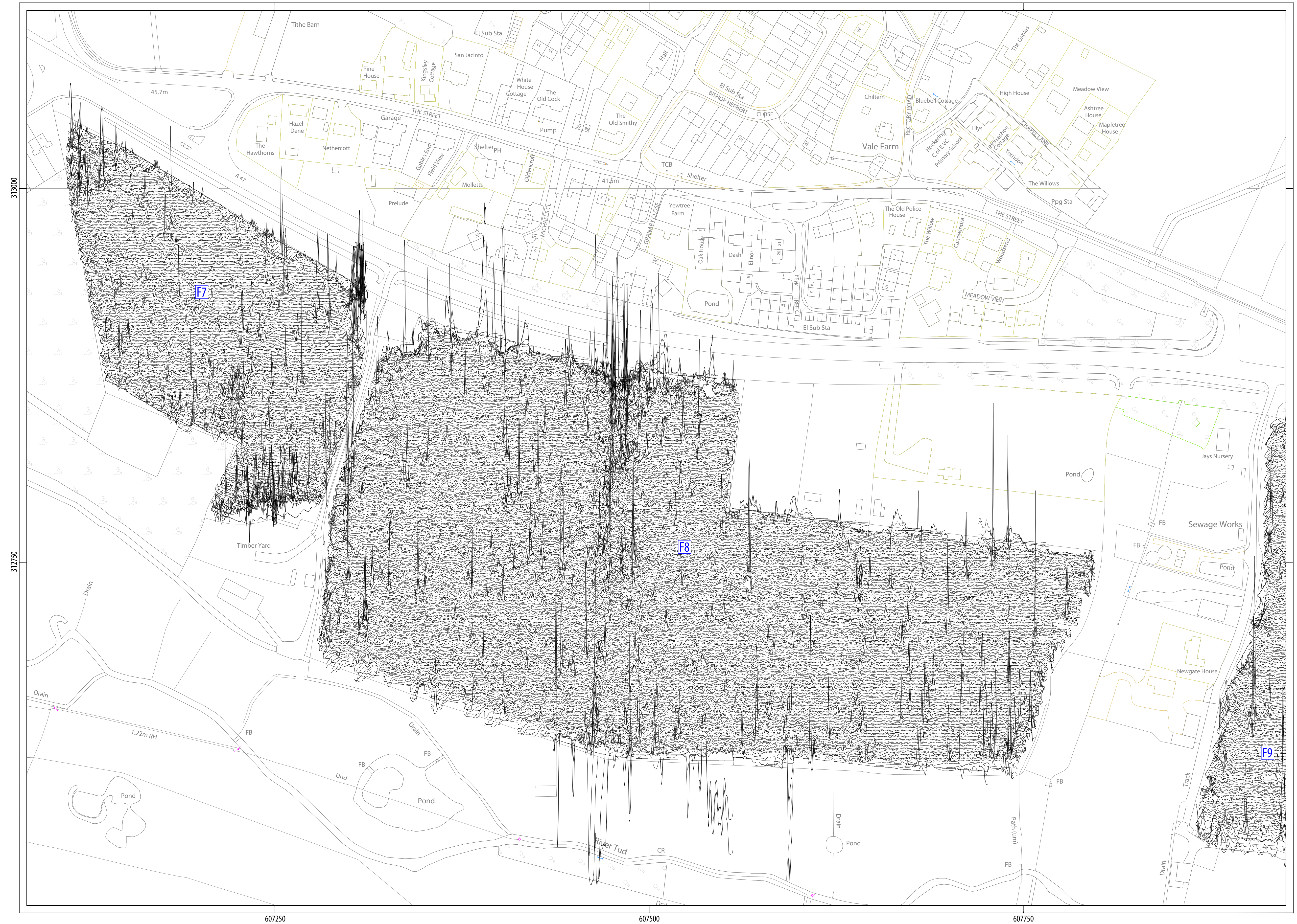
ILLUS 20 Processed greyscale magnetometer data; Sector 3



46.0nT/cm

0 50m

1:2,500 @ A3

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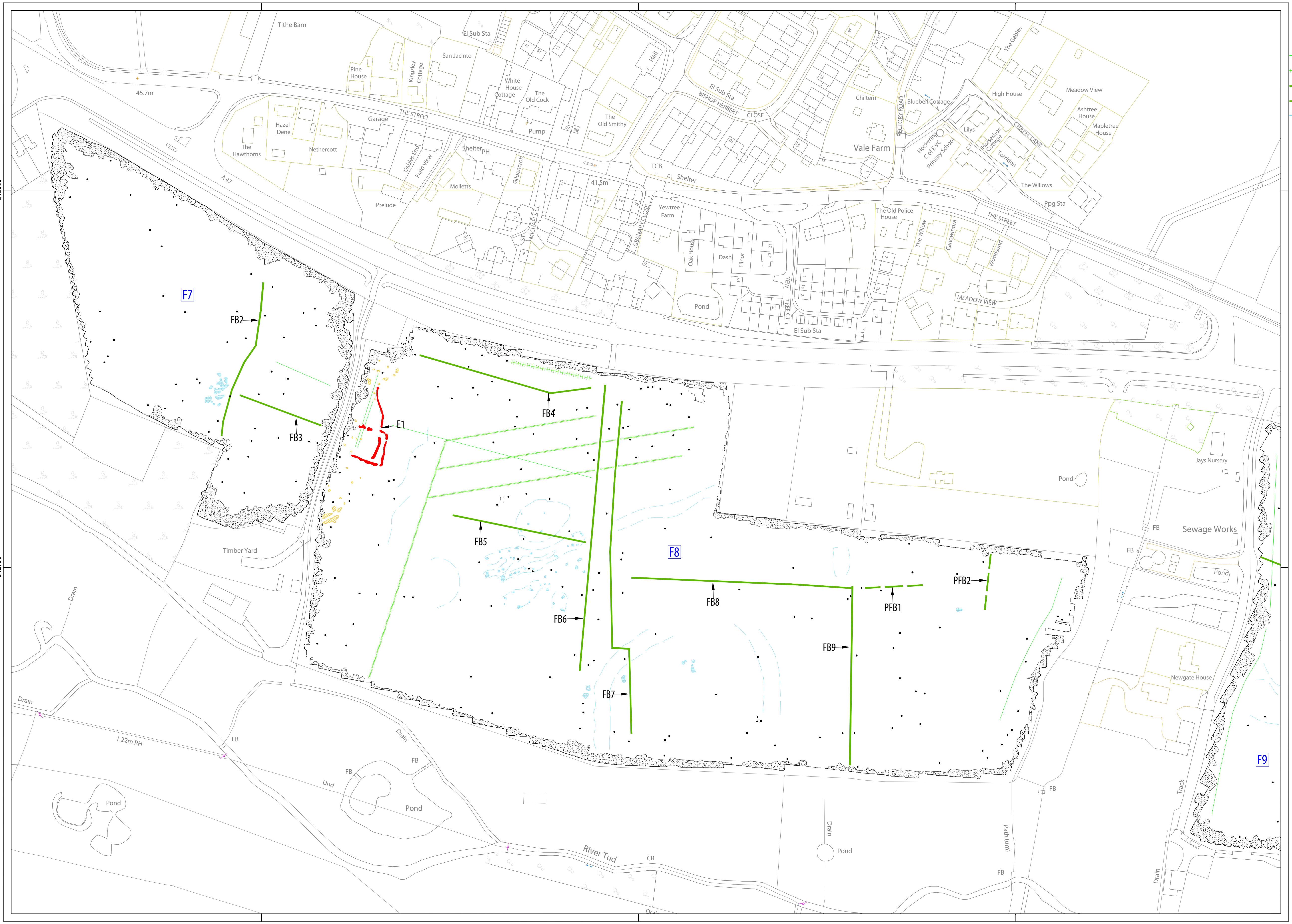
ILLUS 21 XY trace plot of minimally processed magnetometer data; Sector 3



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

ABBREVIATIONS

E enclosure
FB field boundary
PFB field boundary

0 50m
1:2,500 @ A3

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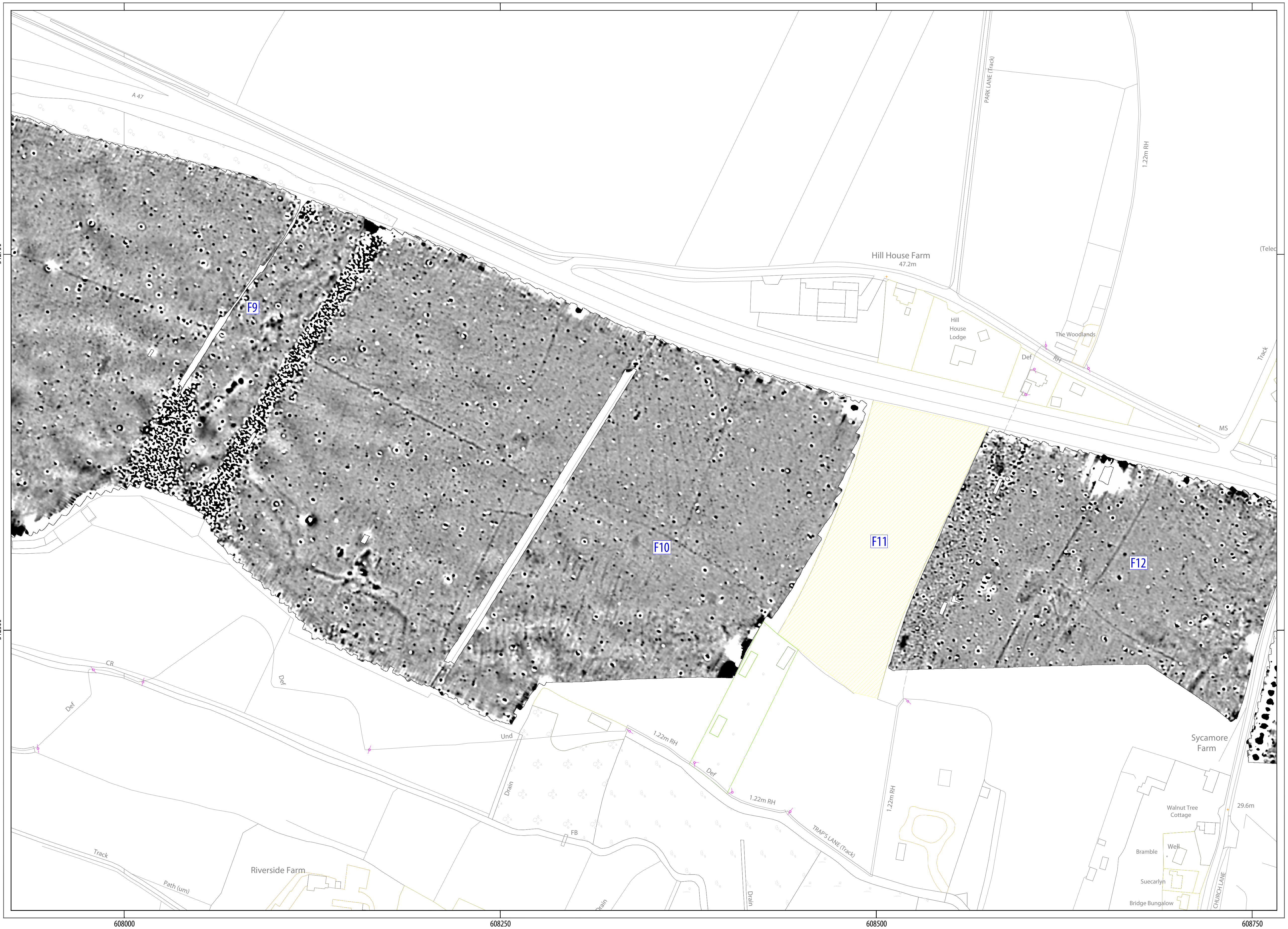
ILLUS 22 Interpretation of magnetometer data; Sector 3



area unsuitable for survey

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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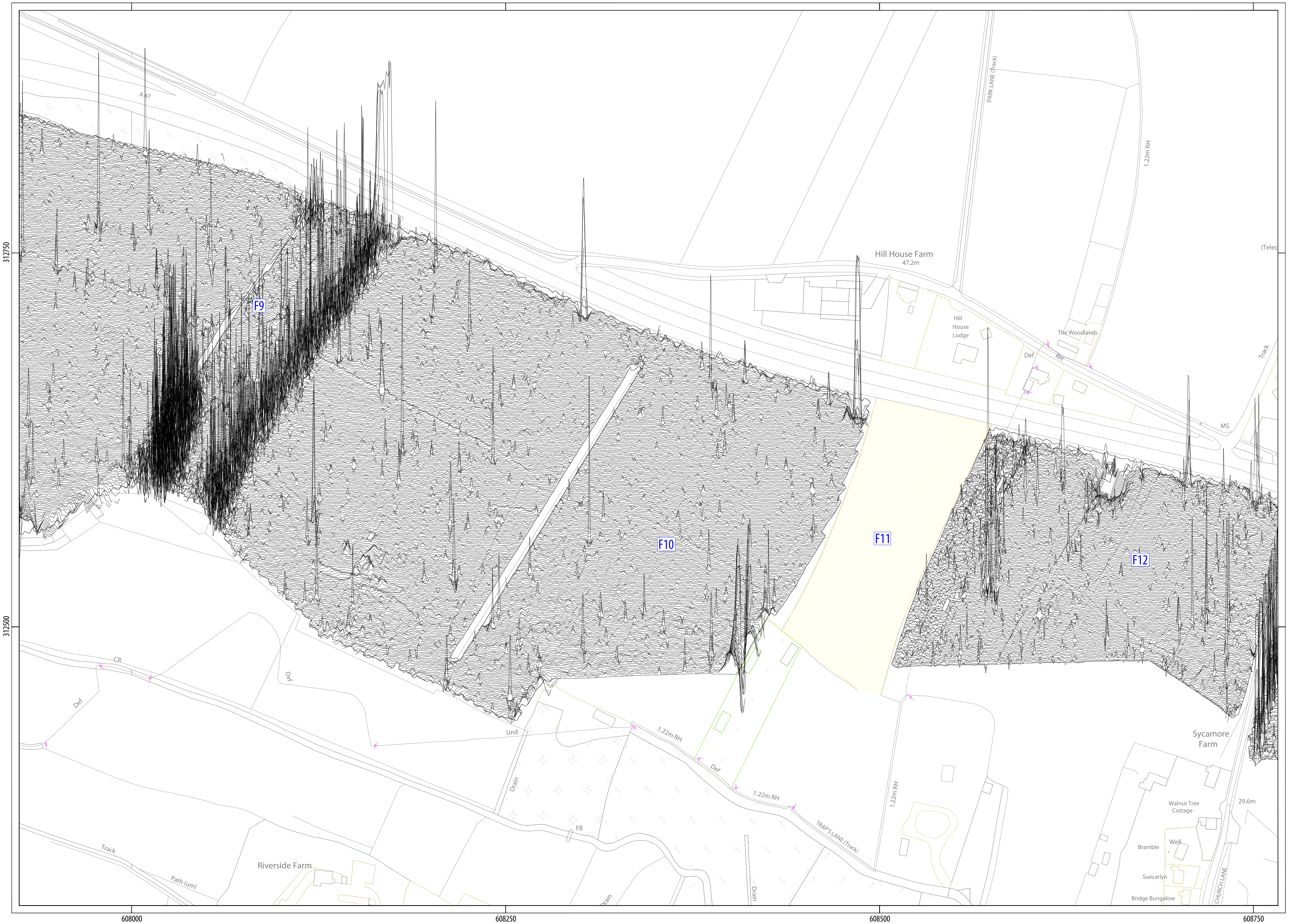
ILLUS 23 Processed greyscale magnetometer data; Sector 4



area unsuitable for survey

43.0nT/cm

0 50m

1:2,500 @ A3

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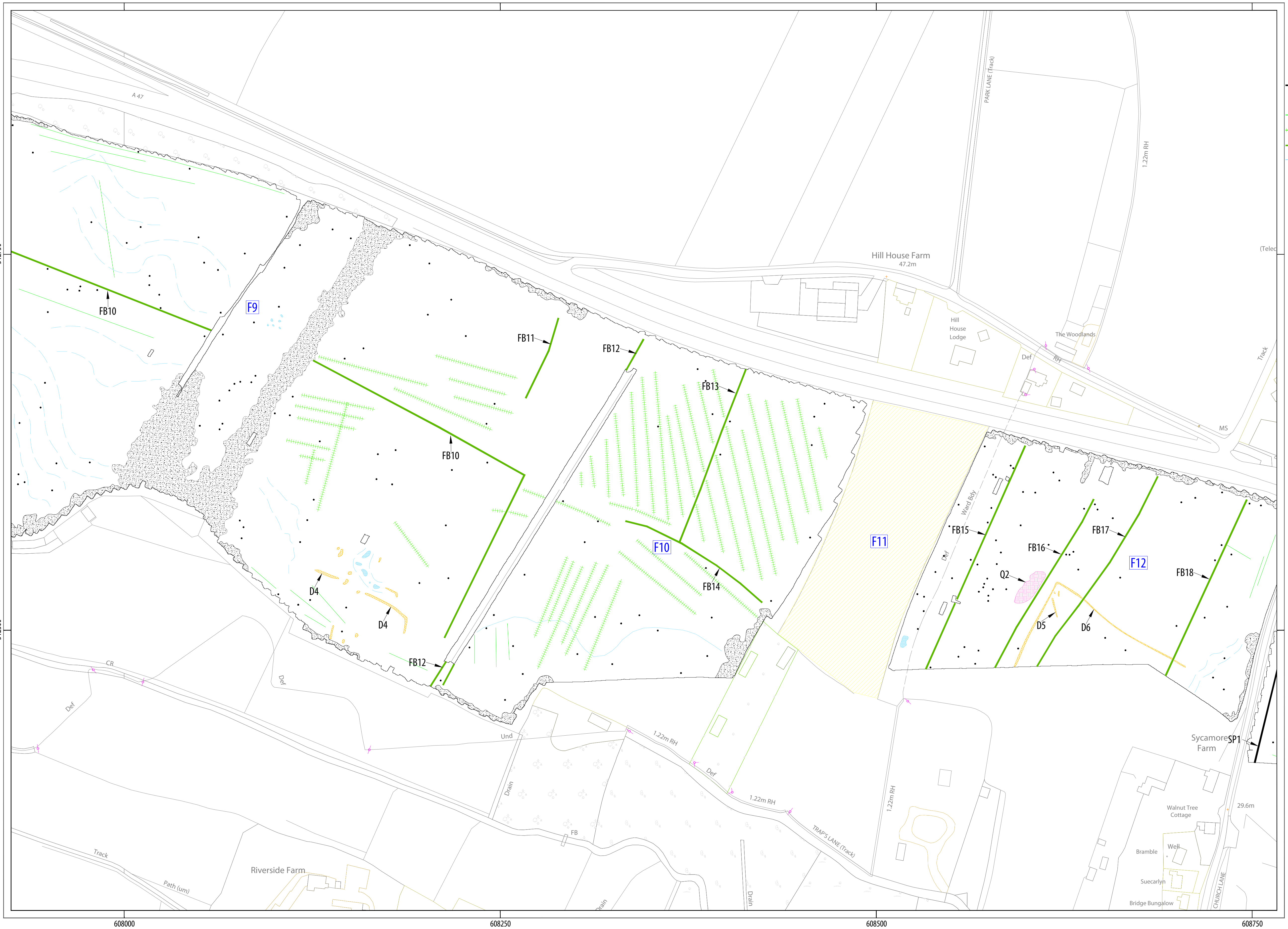
ILLUS 24 XY trace plot of minimally processed magnetometer data; Sector 4



	TYPE OF ANOMALY	INTERPRETATION
	area unsuitable for survey	
	dipolar isolated	ferrous material
	magnetic disturbance	ferrous material
	dipolar linear	service pipe
	magnetic disturbance	quarrying
	linear trend	agricultural
	linear trend	field drain
	linear	former field boundary
	linear trend	geological variation
	magnetic enhancement	geology
	magnetic enhancement	archaeology?

ABBREVIATIONS

- E enclosure
- FB field boundary
- SP service pipe
- Q extraction

0 50m
1:2,500 @ A3

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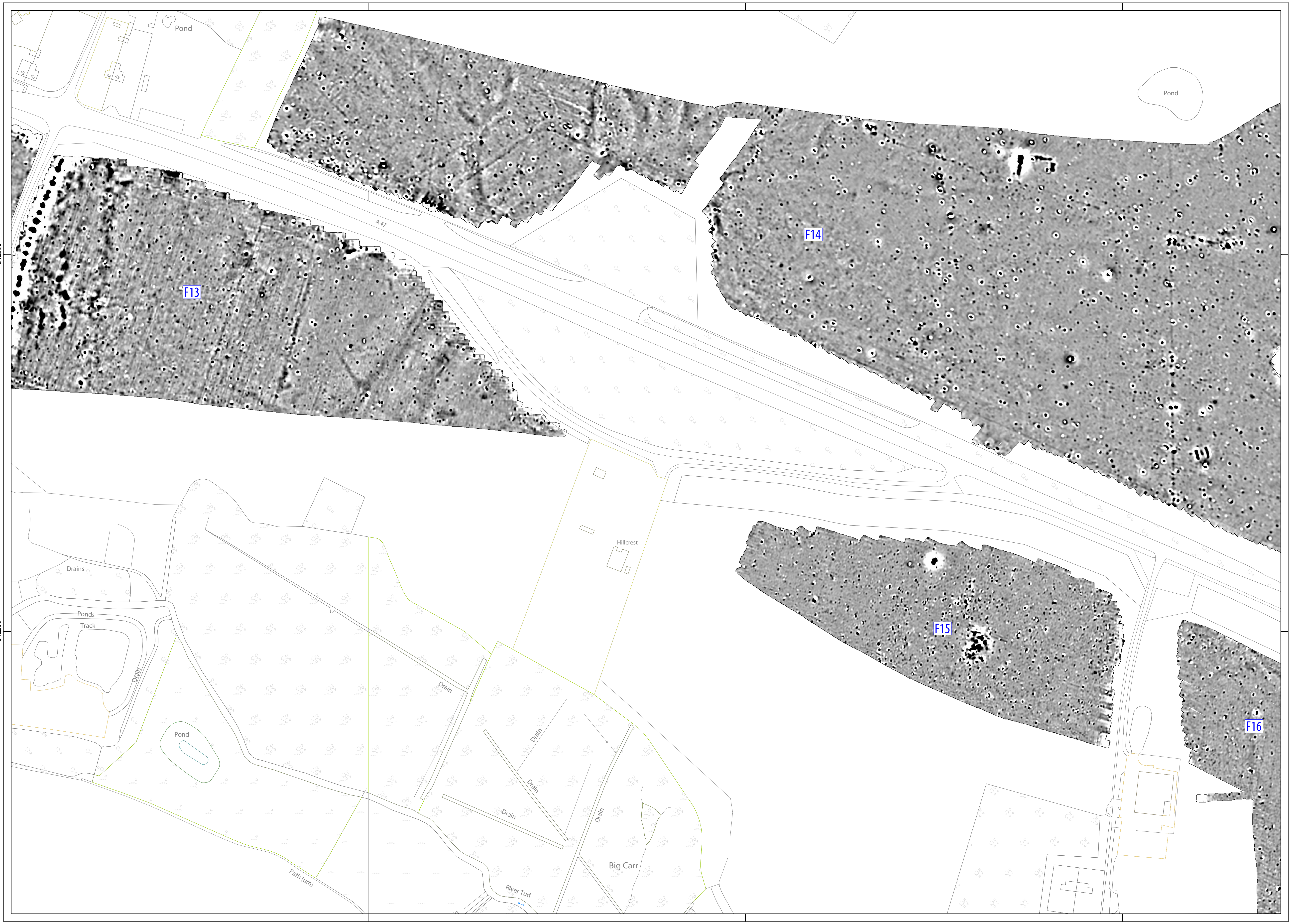
ILLUS 25 Interpretation of magnetometer data; Sector 4



nT

-1.0 2.0

0 50m

1:2,500 @ A3

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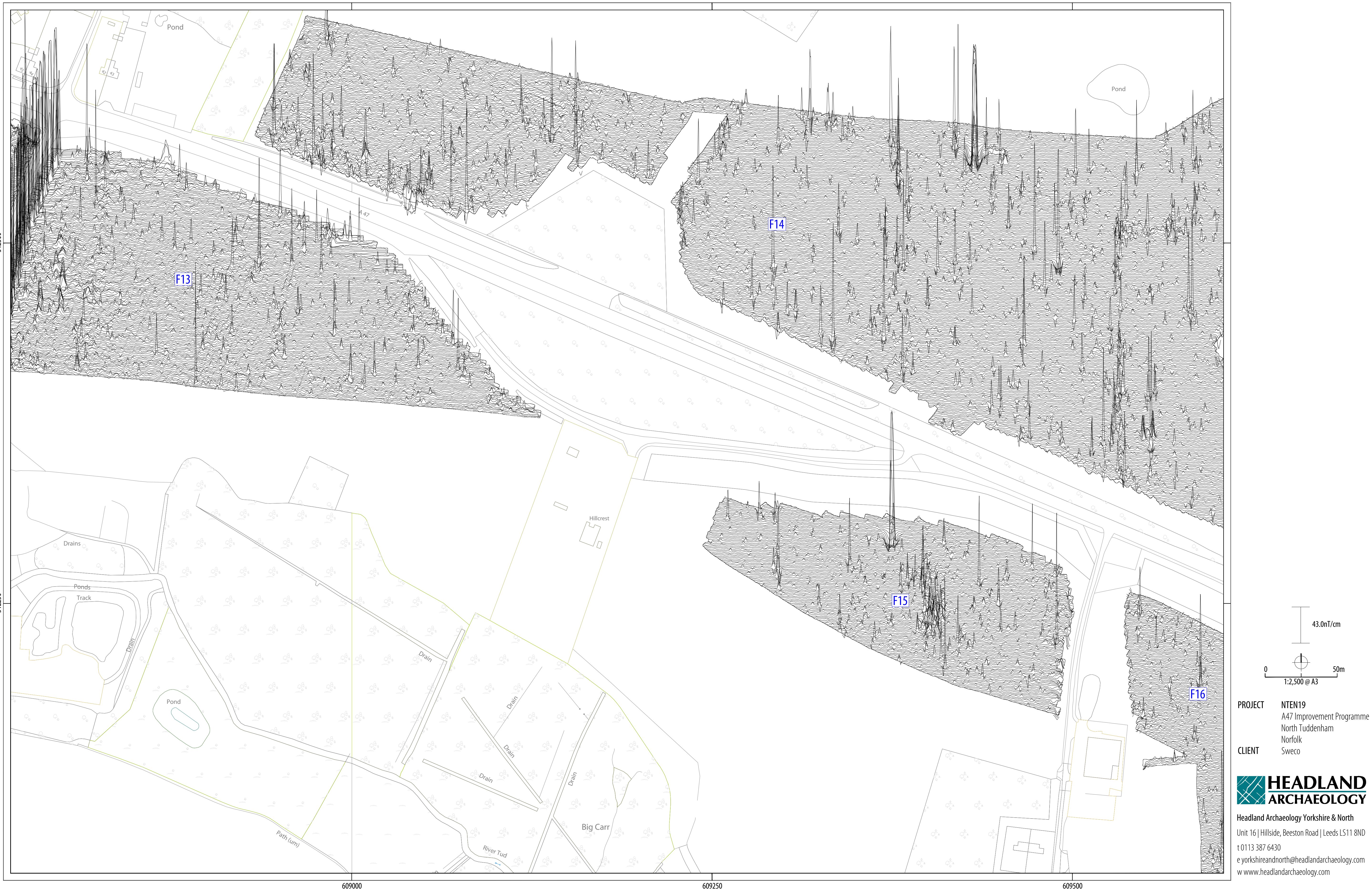
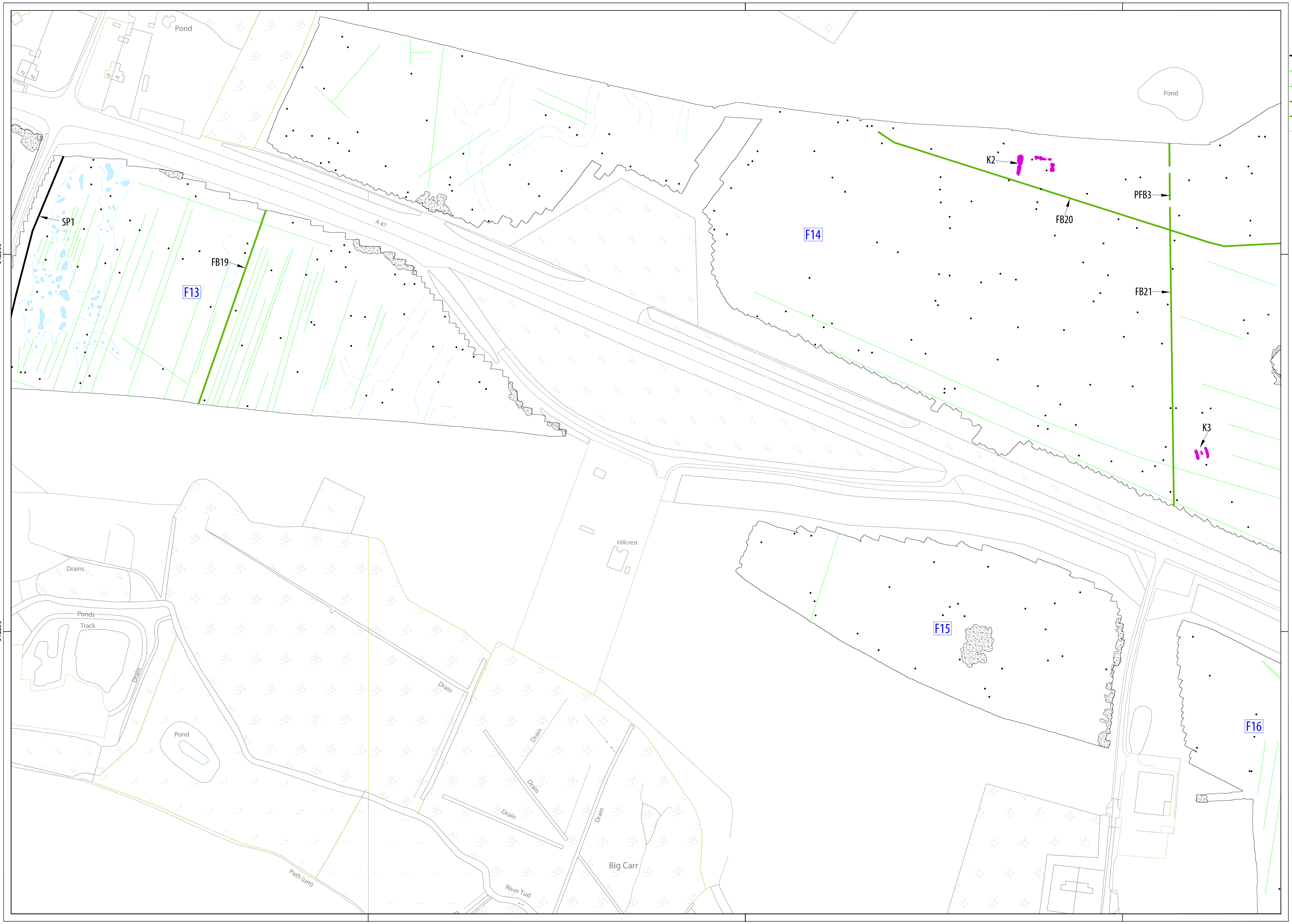
ILLUS 26 Processed greyscale magnetometer data; Sector 5



ILLUS 27 XY trace plot of minimally processed magnetometer data; Sector 5



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear	former field boundary?
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	kiln/burning

ABBREVIATIONS

- FB field boundary
- PFB possible field boundary
- SP service pipe
- K kiln/area of burning

0 50m
1:2,500 @ A3

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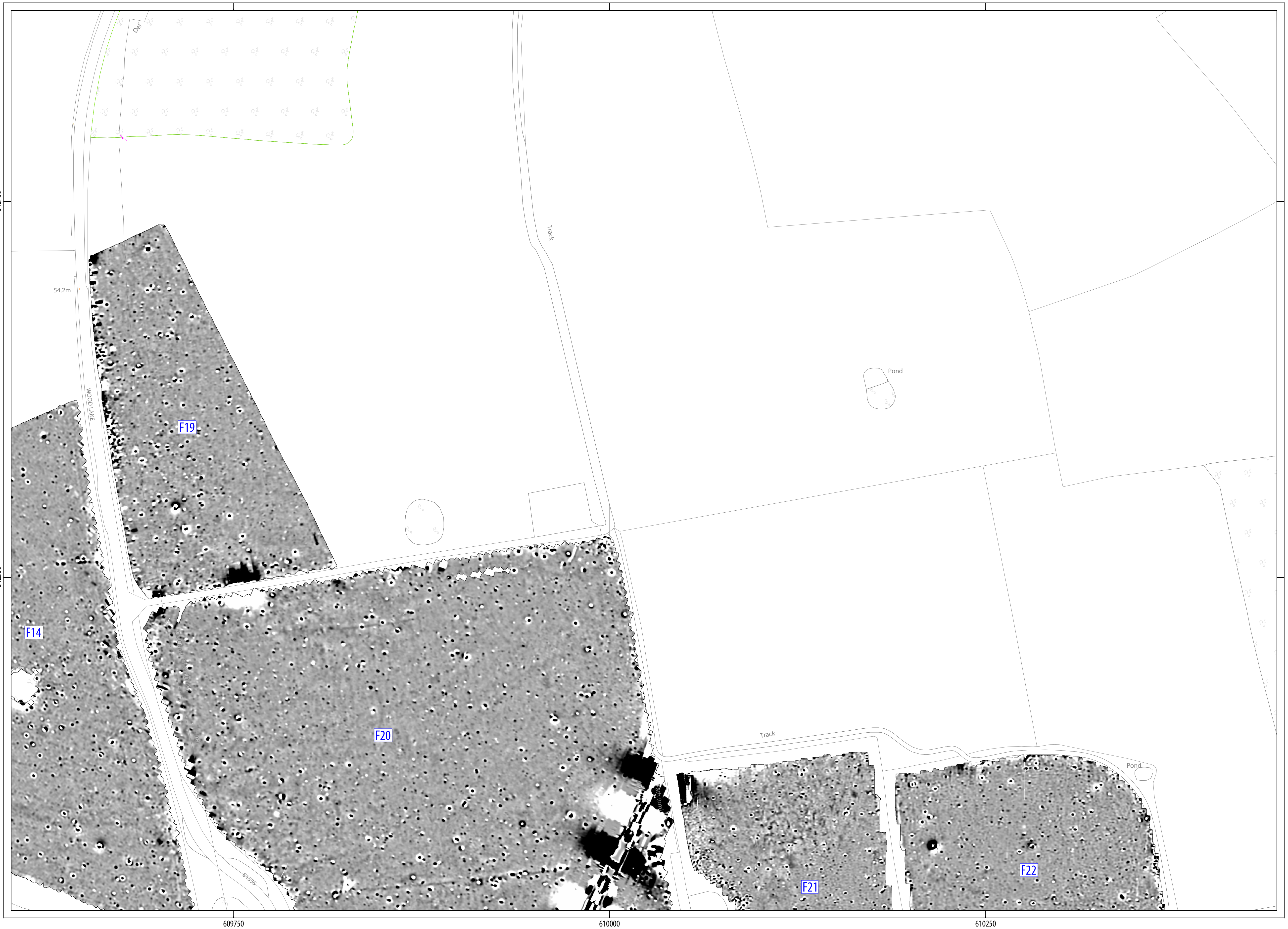
ILLUS 28 Interpretation of magnetometer data; Sector 5



nT
-1.0 2.0

0 50m
1:2,500 @ A3

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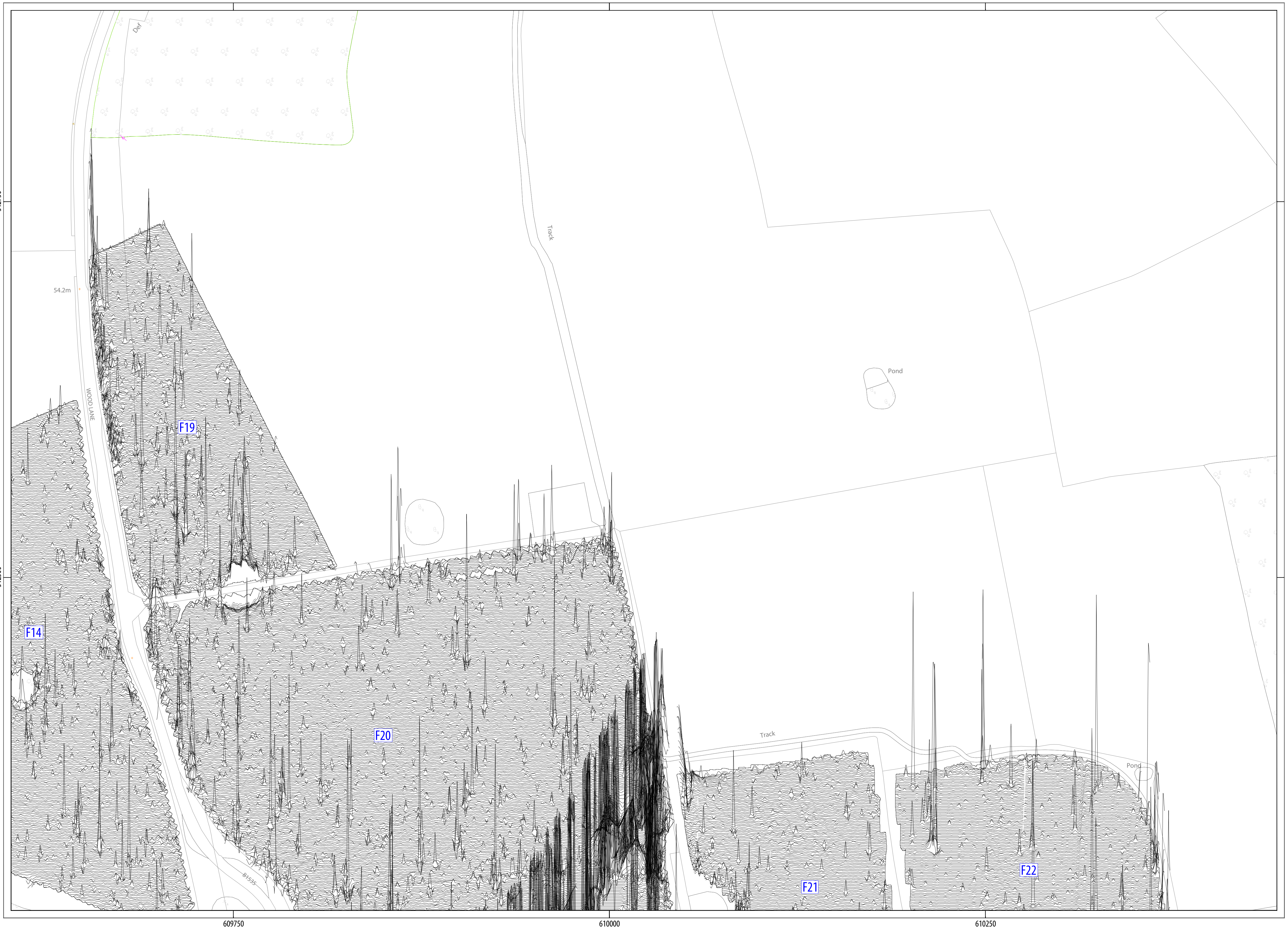
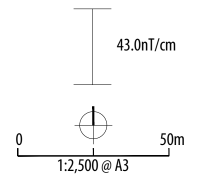
ILLUS 29 Processed greyscale magnetometer data; Sector 6





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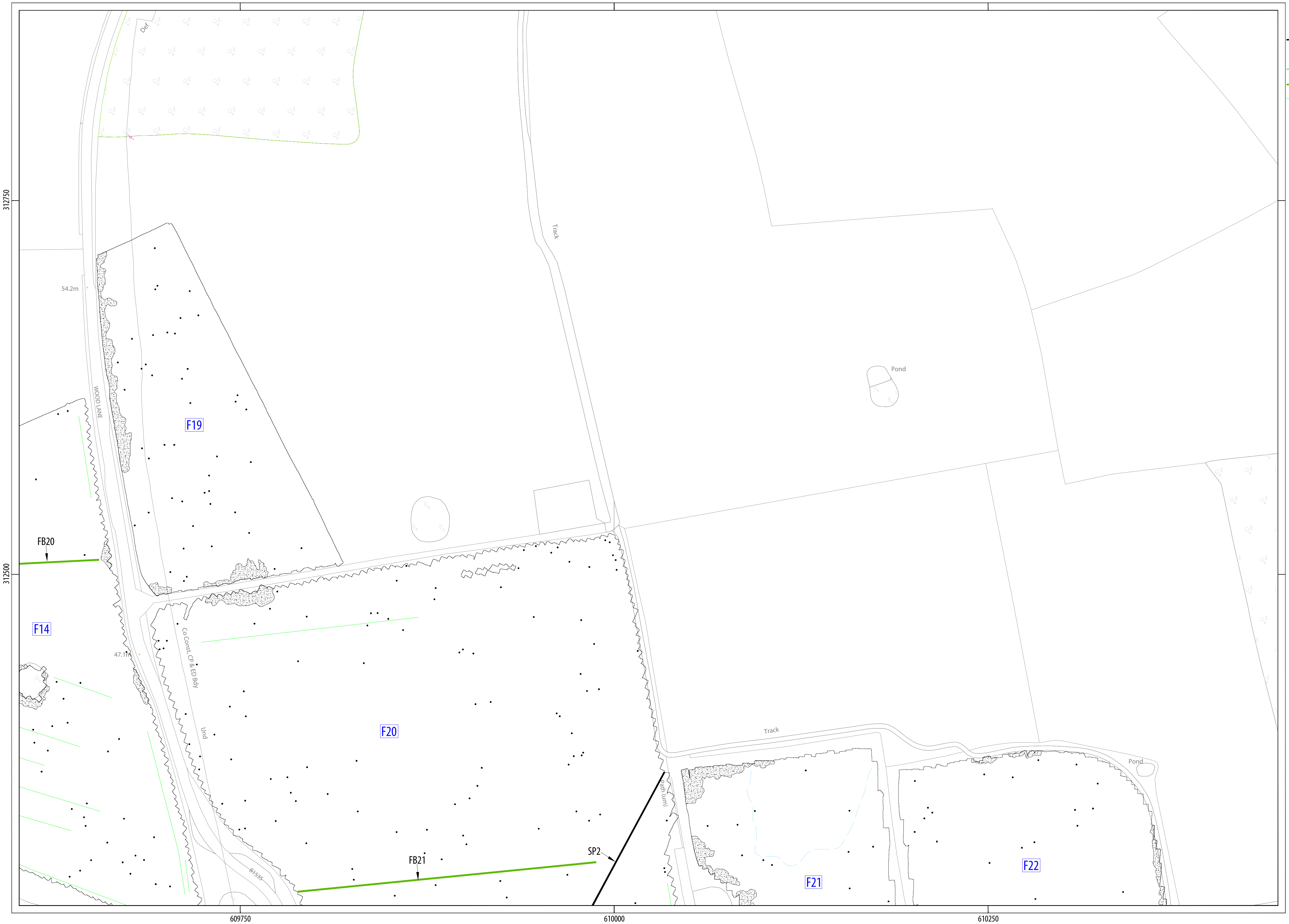
ILLUS 30 XY trace plot of minimally processed magnetometer data; Sector 6



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
dipolar linear	service pipe
magnetic disturbance	ferrous material
linear trend	agricultural
linear	former field boundary
linear trend	geological variation

ABBREVIATIONS

FB field boundary
SP service pipe

0 50m
1:2,500 @ A3

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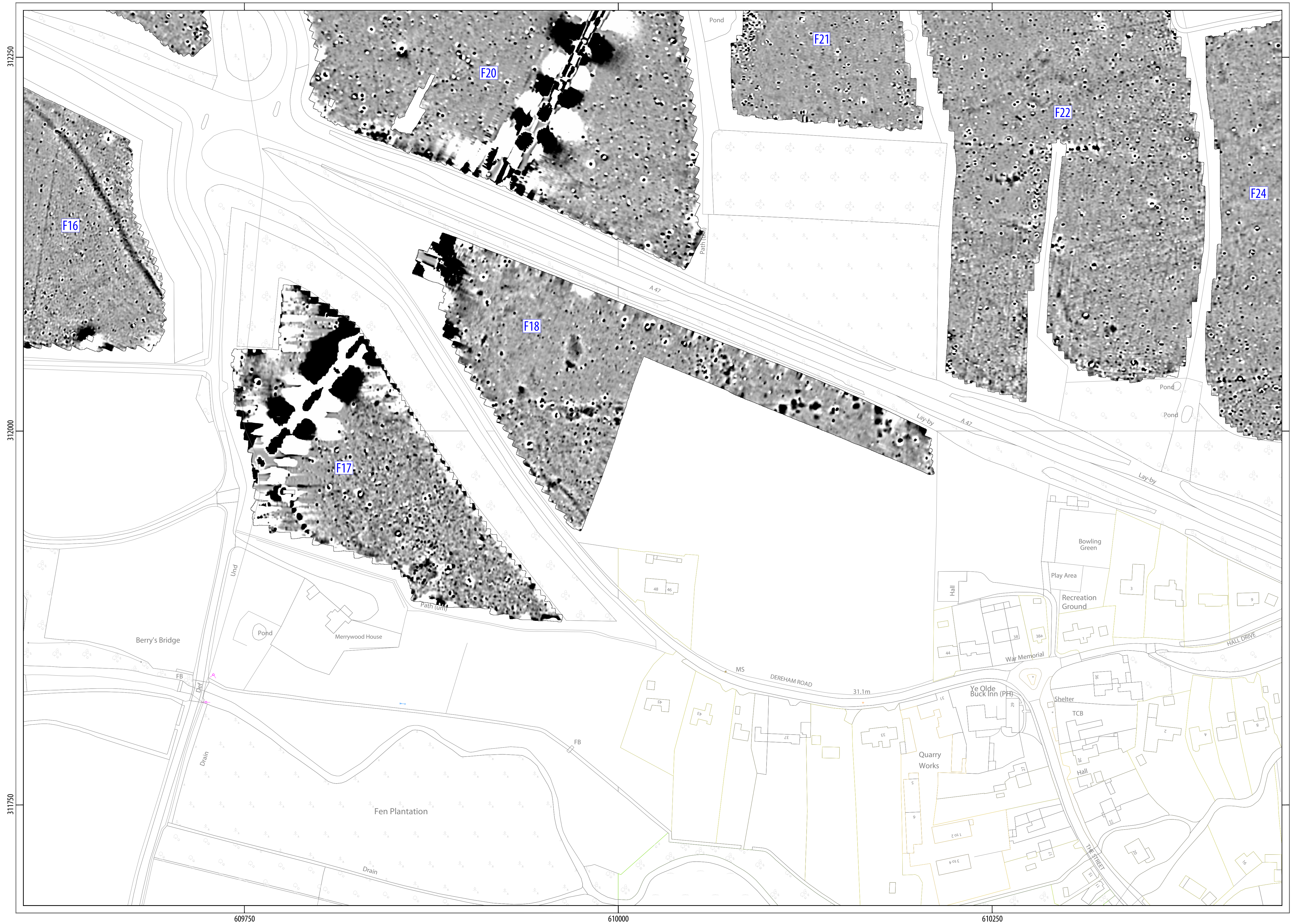
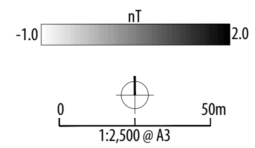
ILLUS 31 Interpretation of magnetometer data; Sector 6





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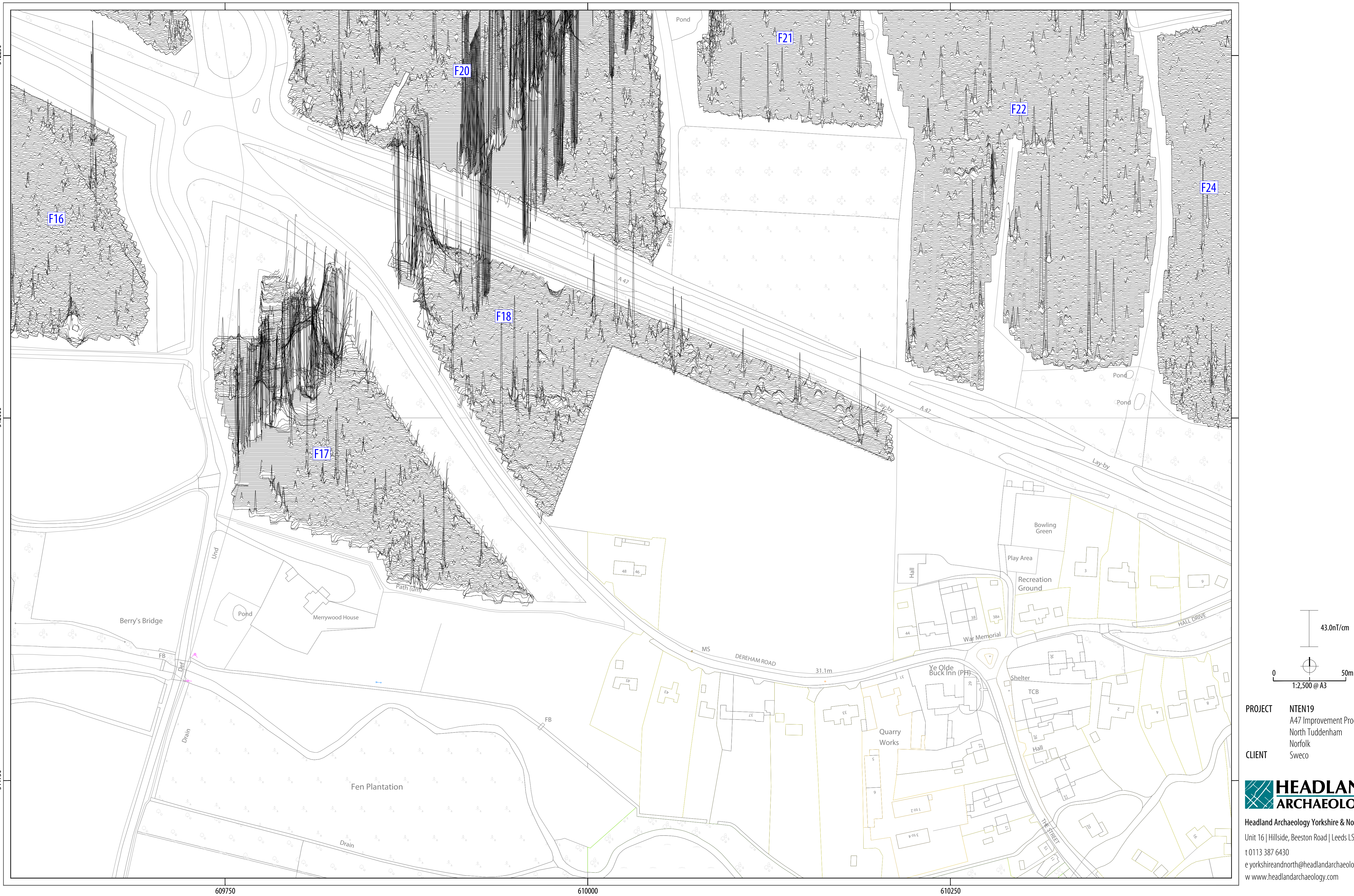
ILLUS 32 Processed greyscale magnetometer data; Sector 7



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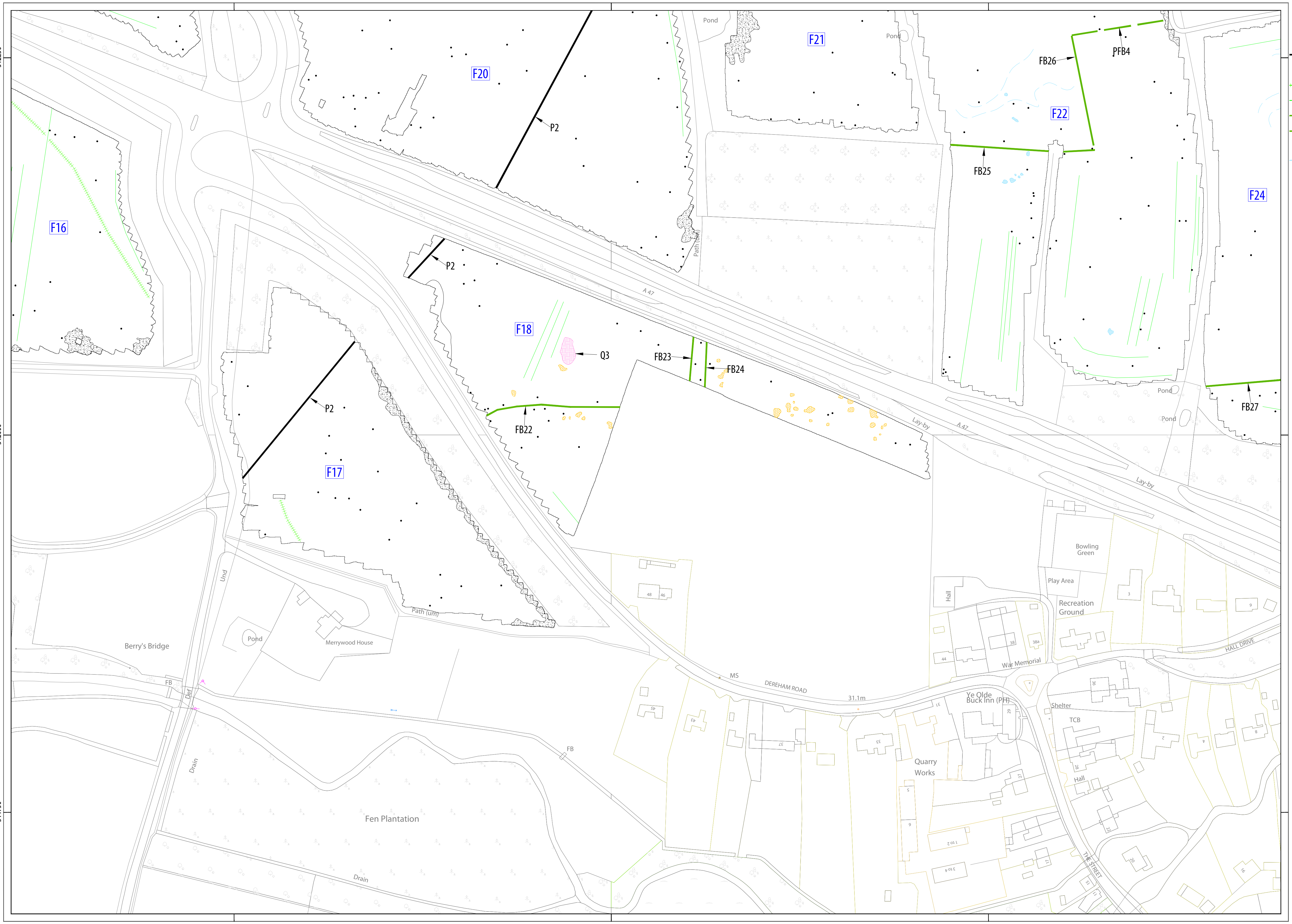
ILLUS 33 XY trace plot of minimally processed magnetometer data; Sector 7



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

ABBREVIATIONS

- FB field boundary
- SP service pipe
- PFB possible field boundary
- Q extraction

0 50m
1:2,500 @ A3

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ILLUS 34 Interpretation of magnetometer data; Sector 7

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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ILLUS 35 Processed greyscale magnetometer data; Sector 8

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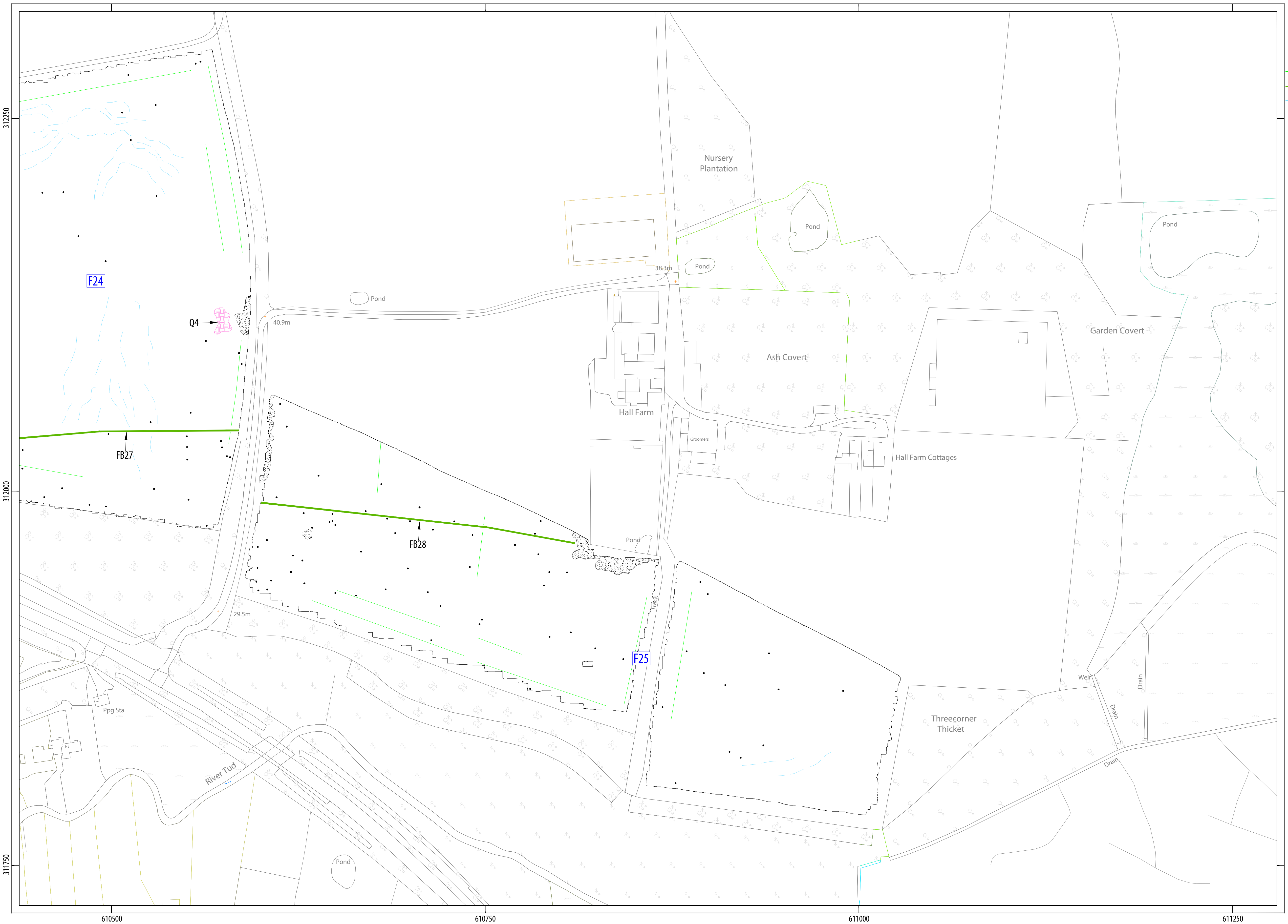
ILLUS 36 XY trace plot of minimally processed magnetometer data; Sector 8



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	quarrying
linear trend	agricultural
linear	former field boundary
linear trend	geological variation

ABBREVIATIONS

FB field boundary

Q extraction

0 50m

1:2,500 @ A3

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t 0113 387 6430

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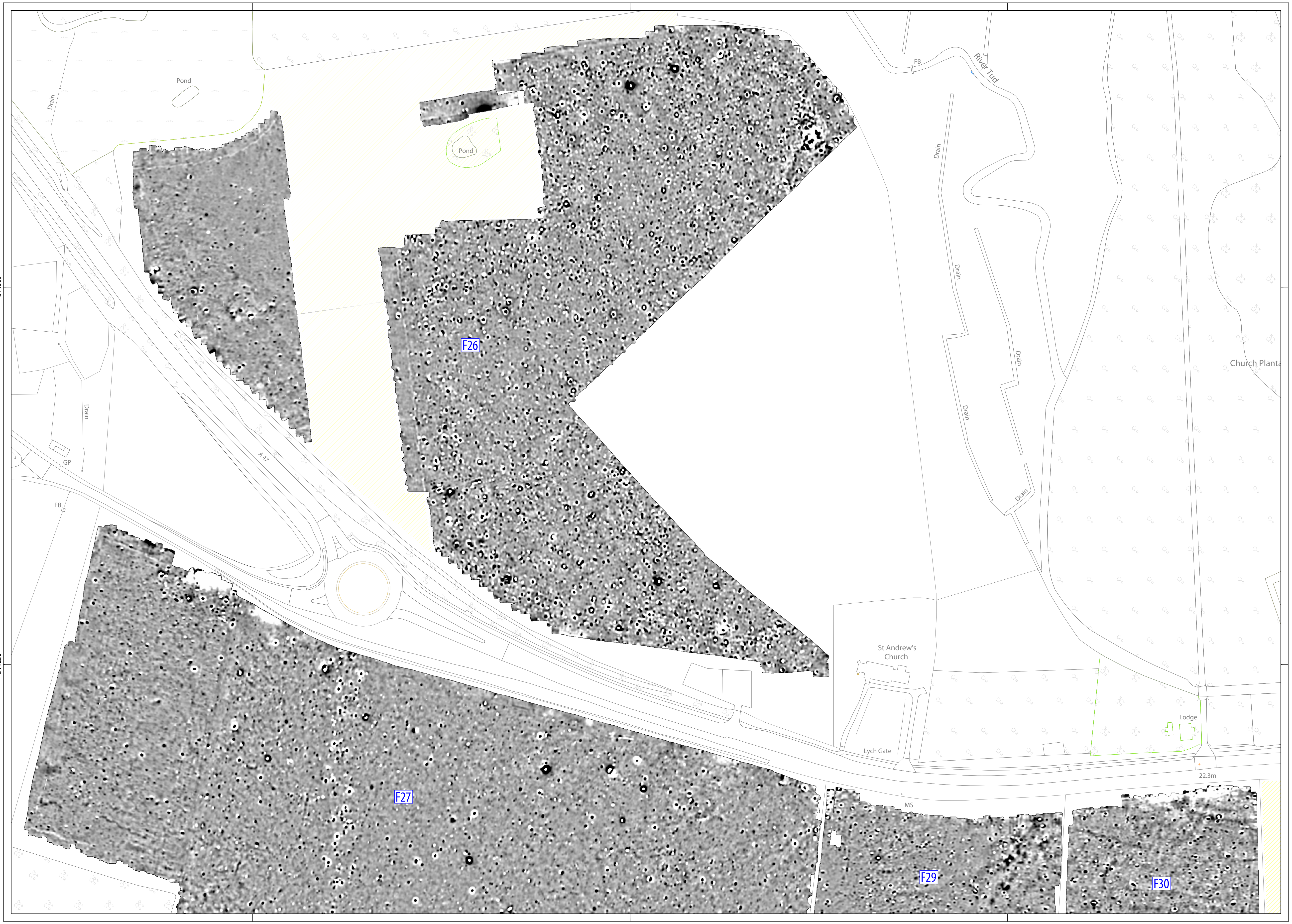
ILLUS 37 Interpretation of magnetometer data; Sector 8



area unsuitable for survey

nT

-1.0 2.0

0 50m

1:2,500 @ A3

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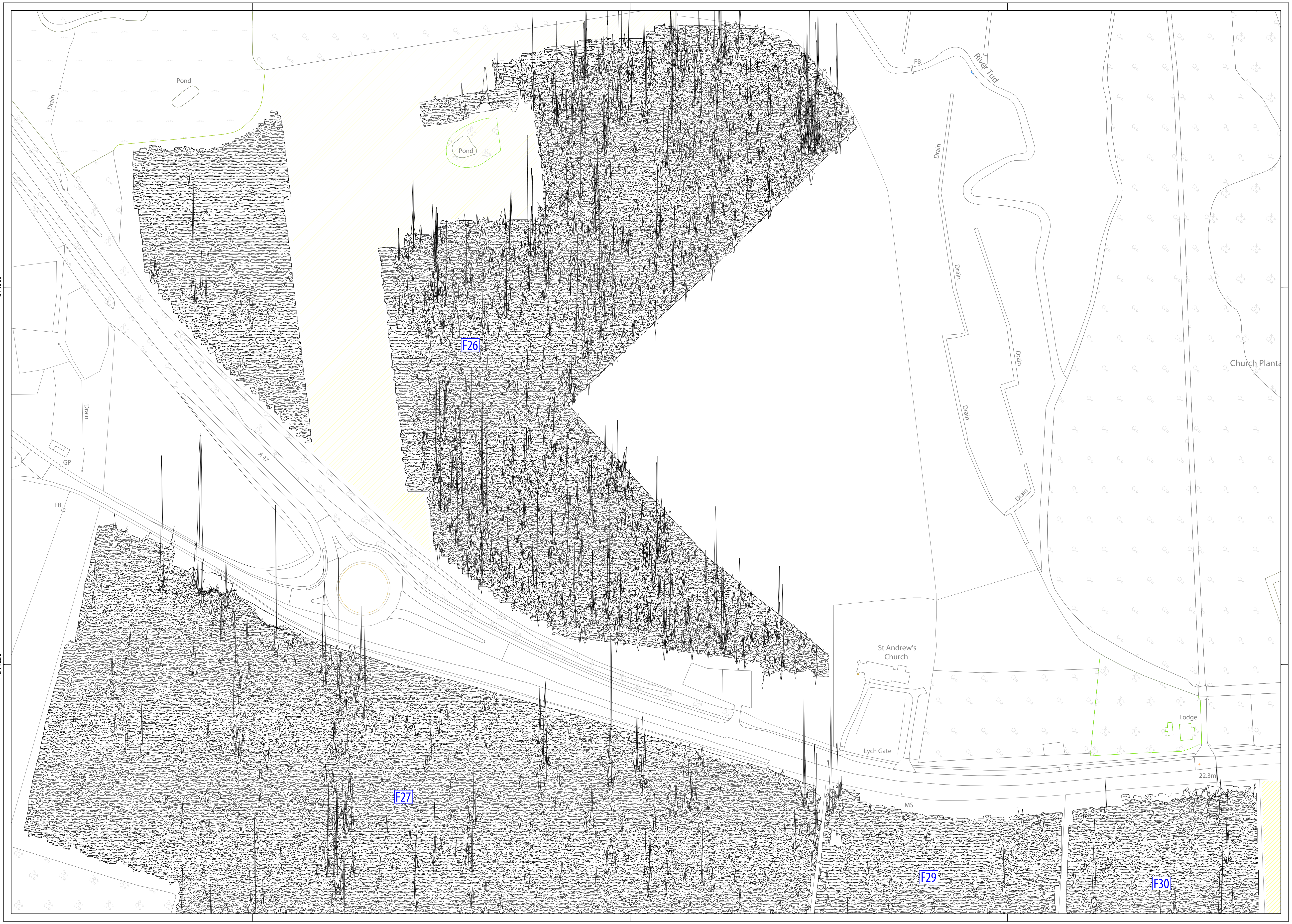
ILLUS 38 Processed greyscale magnetometer data; Sector 9



area unsuitable for survey

43.0nT/cm

0 50m

1:2,500 @ A3

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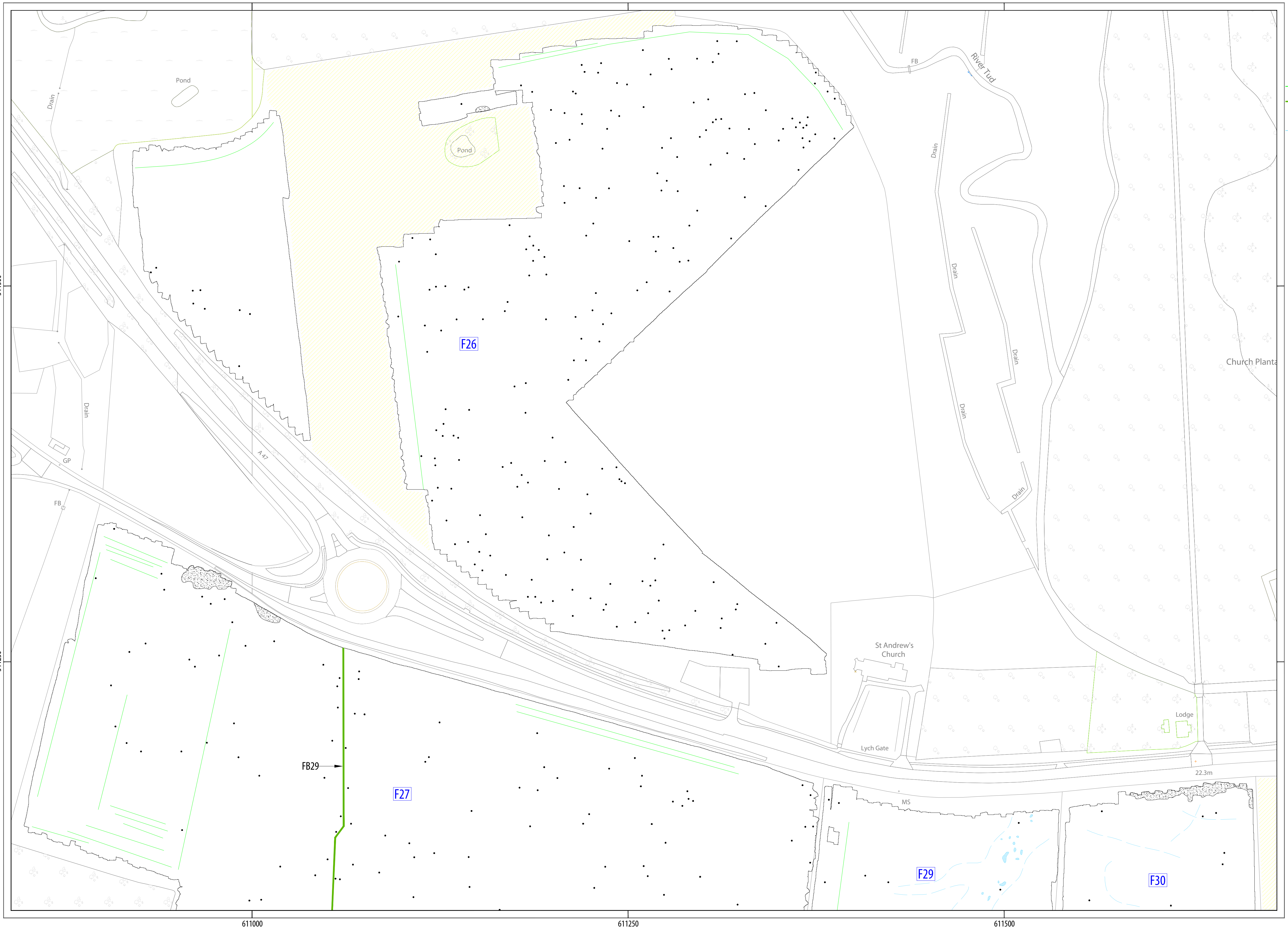
ILLUS 39 XY trace plot of minimally processed magnetometer data; Sector 9



area unsuitable for survey

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

ABBREVIATIONS

FB field boundary

0 50m
1:2,500 @ A3

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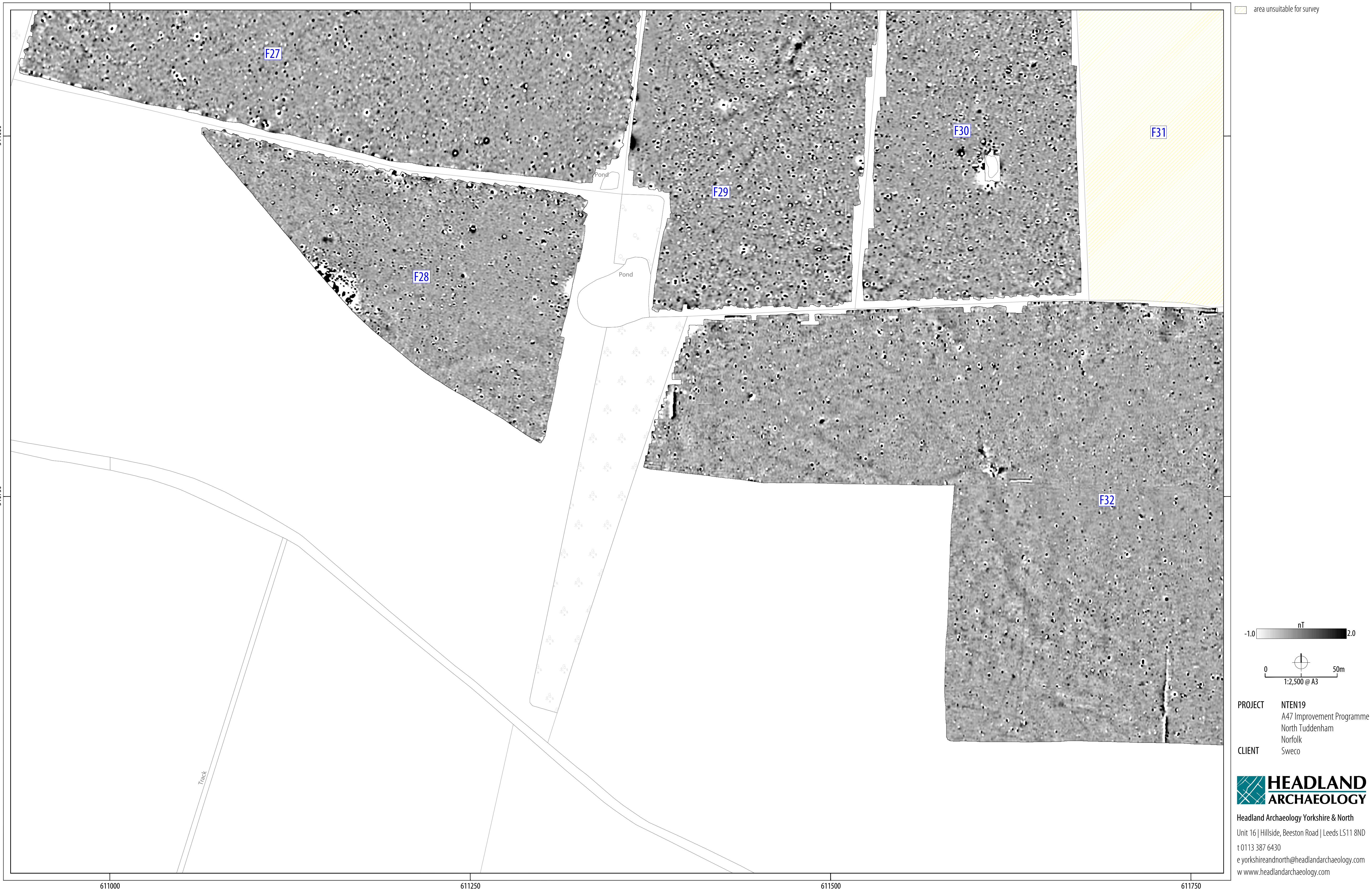
ILLUS 40 Interpretation of magnetometer data; Sector 9



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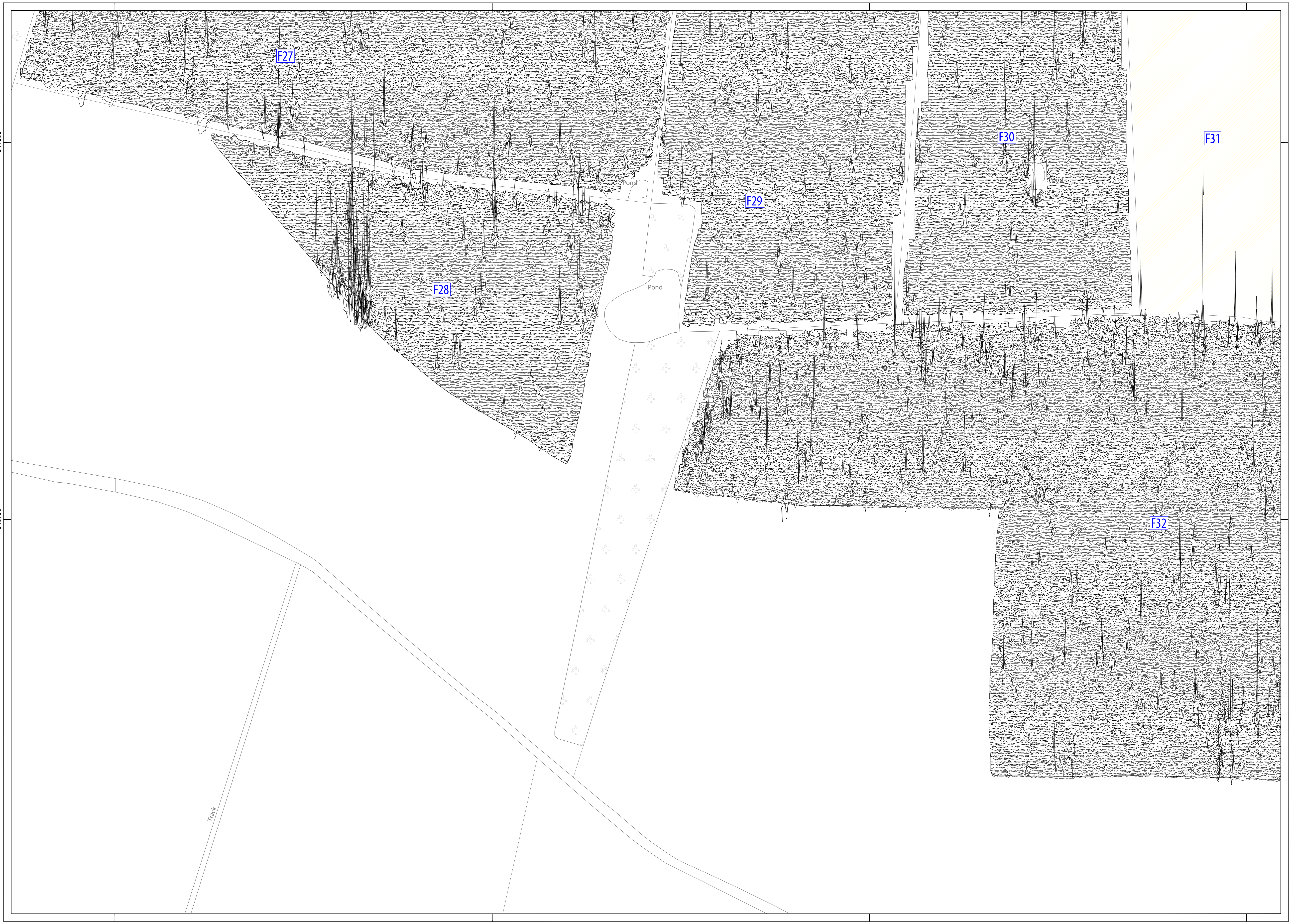
ILLUS 41 Processed greyscale magnetometer data; Sector 10



area unsuitable for survey

43.0nT/cm

0 50m
1:2,500 @ A3

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t 0113 387 6430
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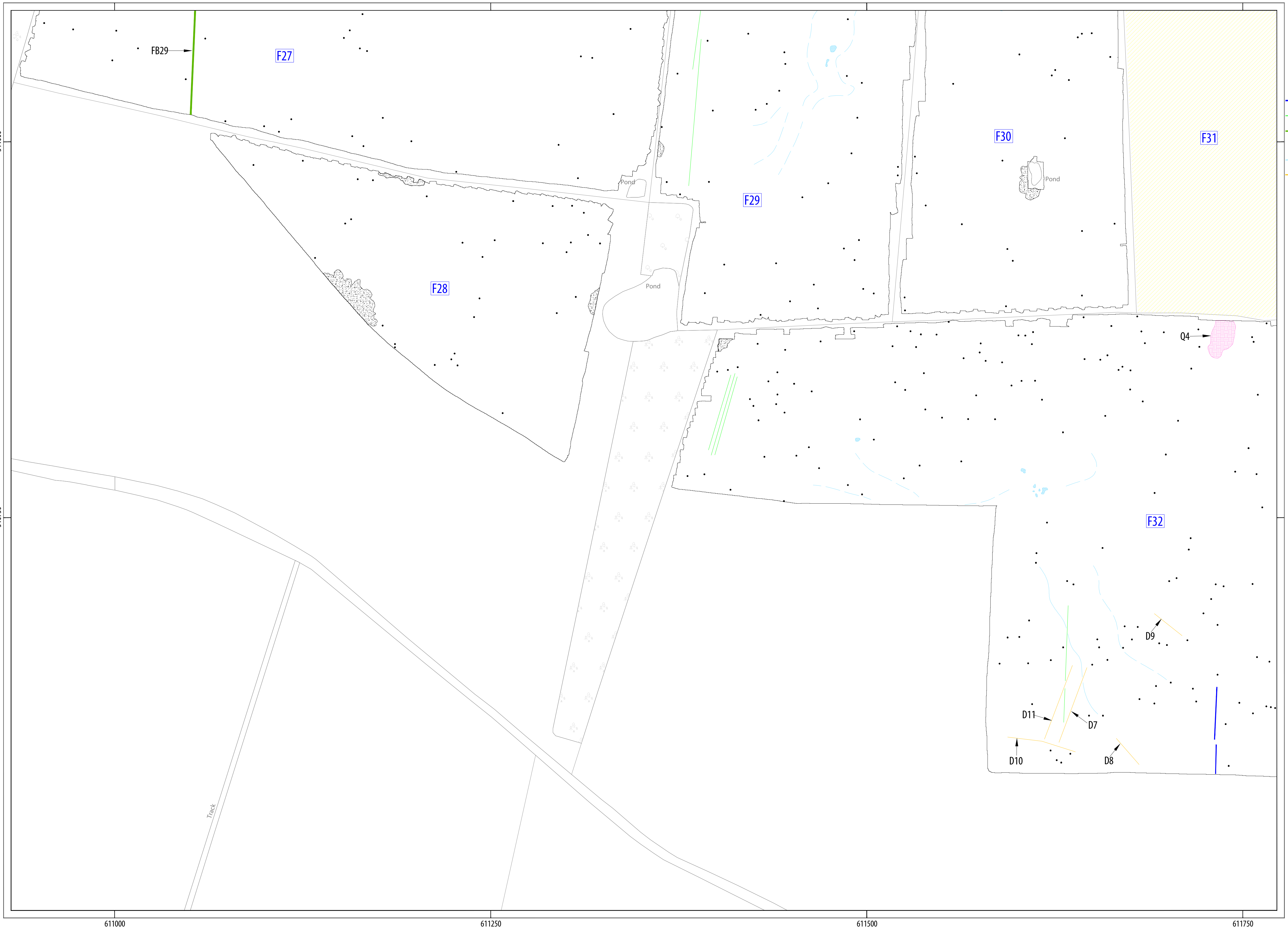
ILLUS 42 XY trace plot of minimally processed magnetometer data; Sector 10



area unsuitable for survey

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

ABBREVIATIONS

D ditch
FB field boundary
Q extraction

0 50m
1:2,500 @ A3

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t 0113 387 6430
e yorkshireandnorth@headlandarchaeology.com
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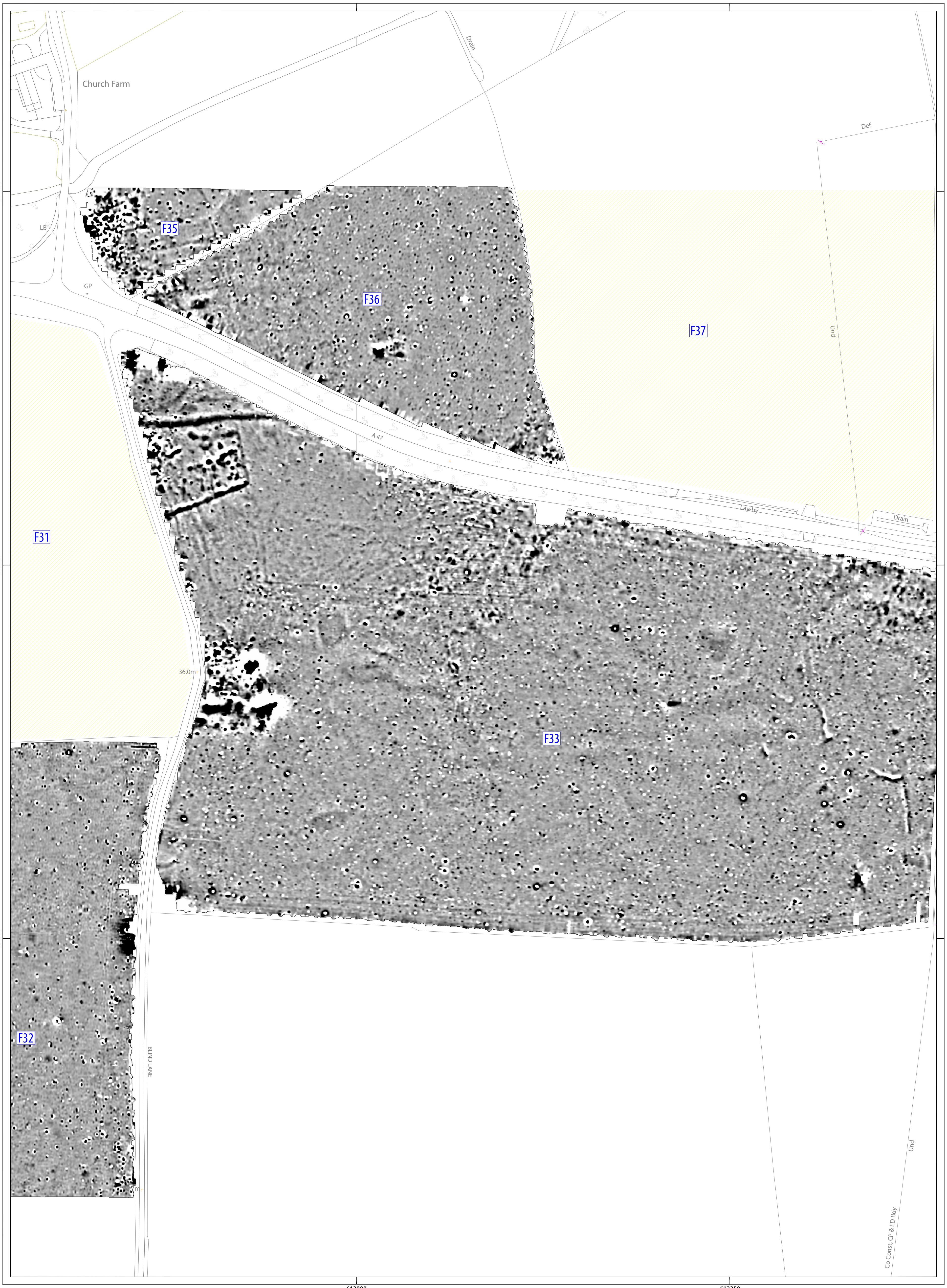
ILLUS 43 Interpretation of magnetometer data; Sector 10



area unsuitable for survey

32.0nT/cm

0 50m

1:2,500 @ A3

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t 0113 387 6430
e yorkshireandnorth@headlandarchaeology.com
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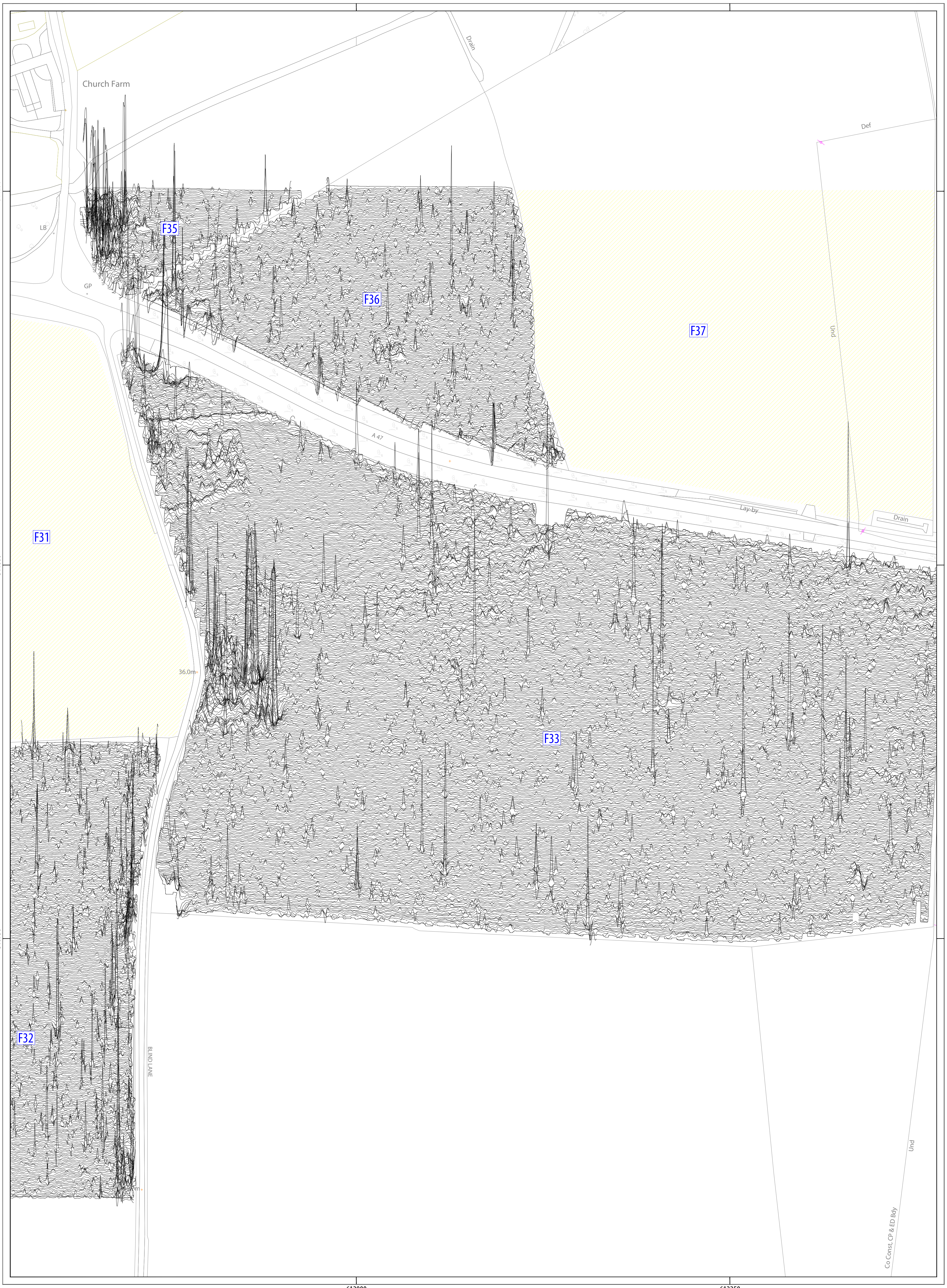
ILLUS 44 Processed greyscale magnetometer data, Sector 11



area unsuitable for survey

43.0nT/cm

0 50m

1:2,500 @ A3

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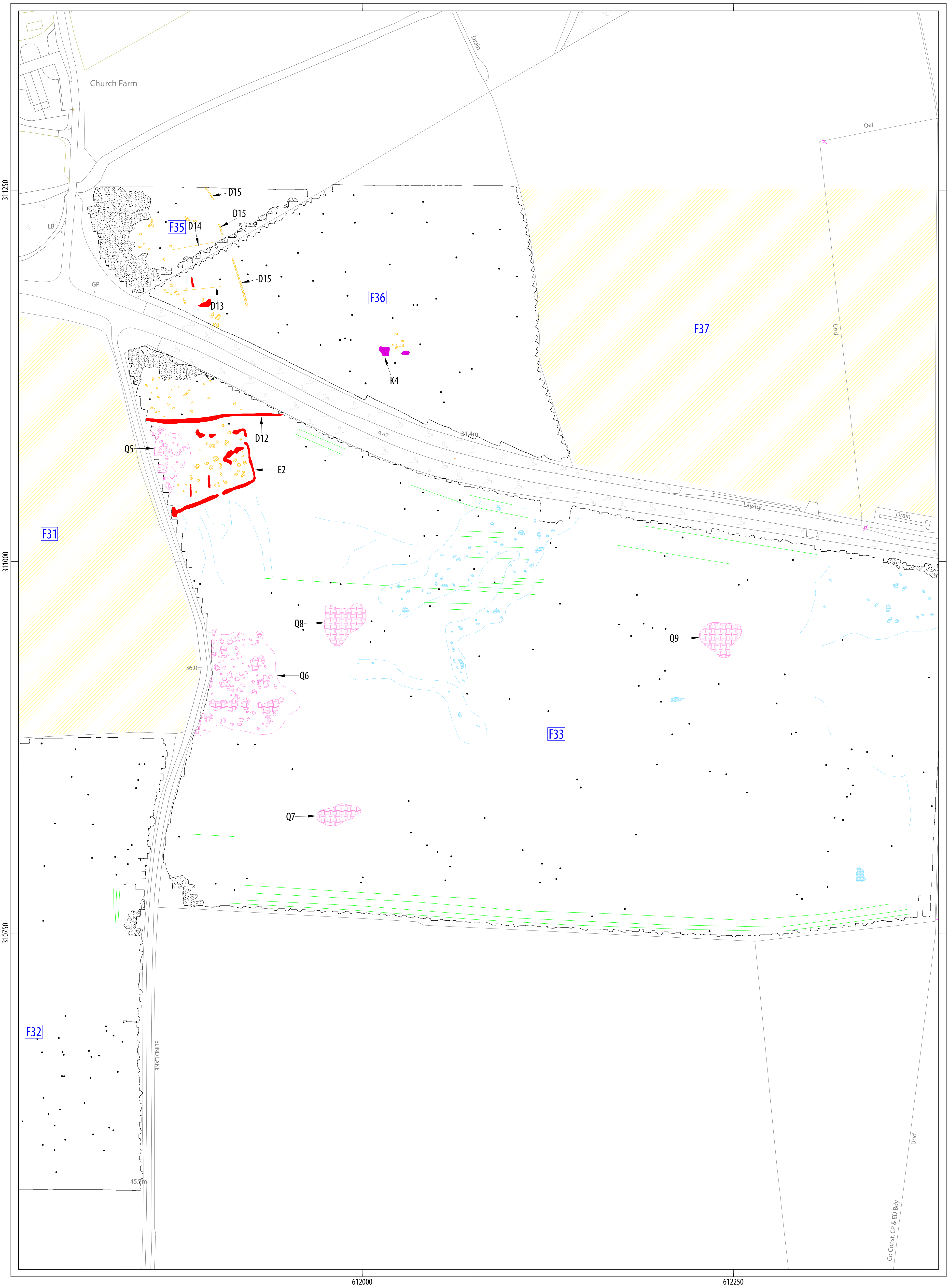
ILLUS 45 XY trace plot of minimally processed magnetometer data, Sector 11



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	quarrying
linear trend	agricultural
linear trend	geological variation
magnetic enhancement	geology

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	kiln/burning
linear trend	archaeology?
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

- D ditch
- E enclosure
- Q extraction
- K kiln/area of burning
- area unsuitable for survey

0 50m
1:2,500 @ A3

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e yorkshireandnorth@headlandarchaeology.com
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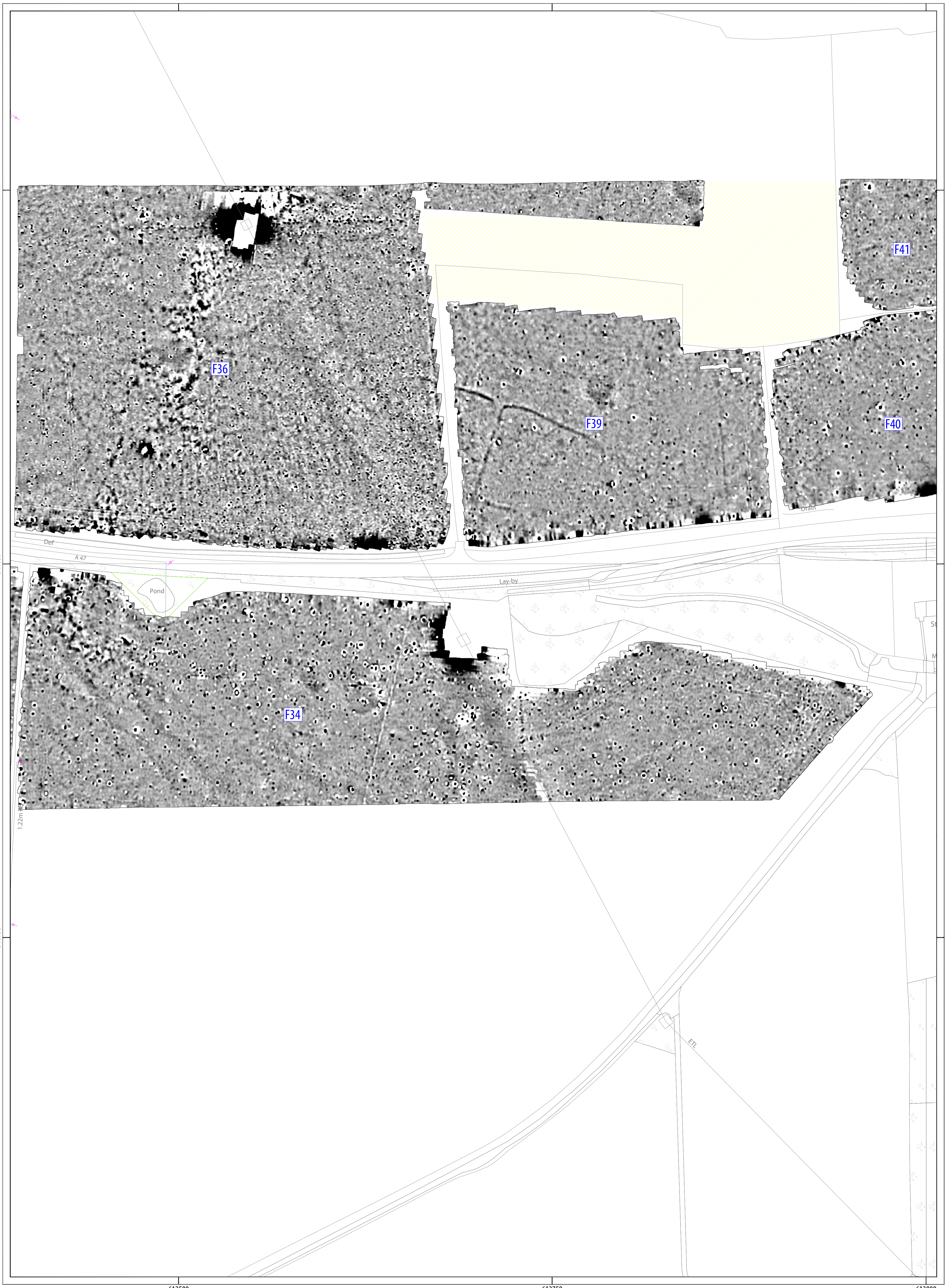
ILLUS 46 Interpretation of magnetometer data, Sector 11



area unsuitable for survey

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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t 0113 387 6430
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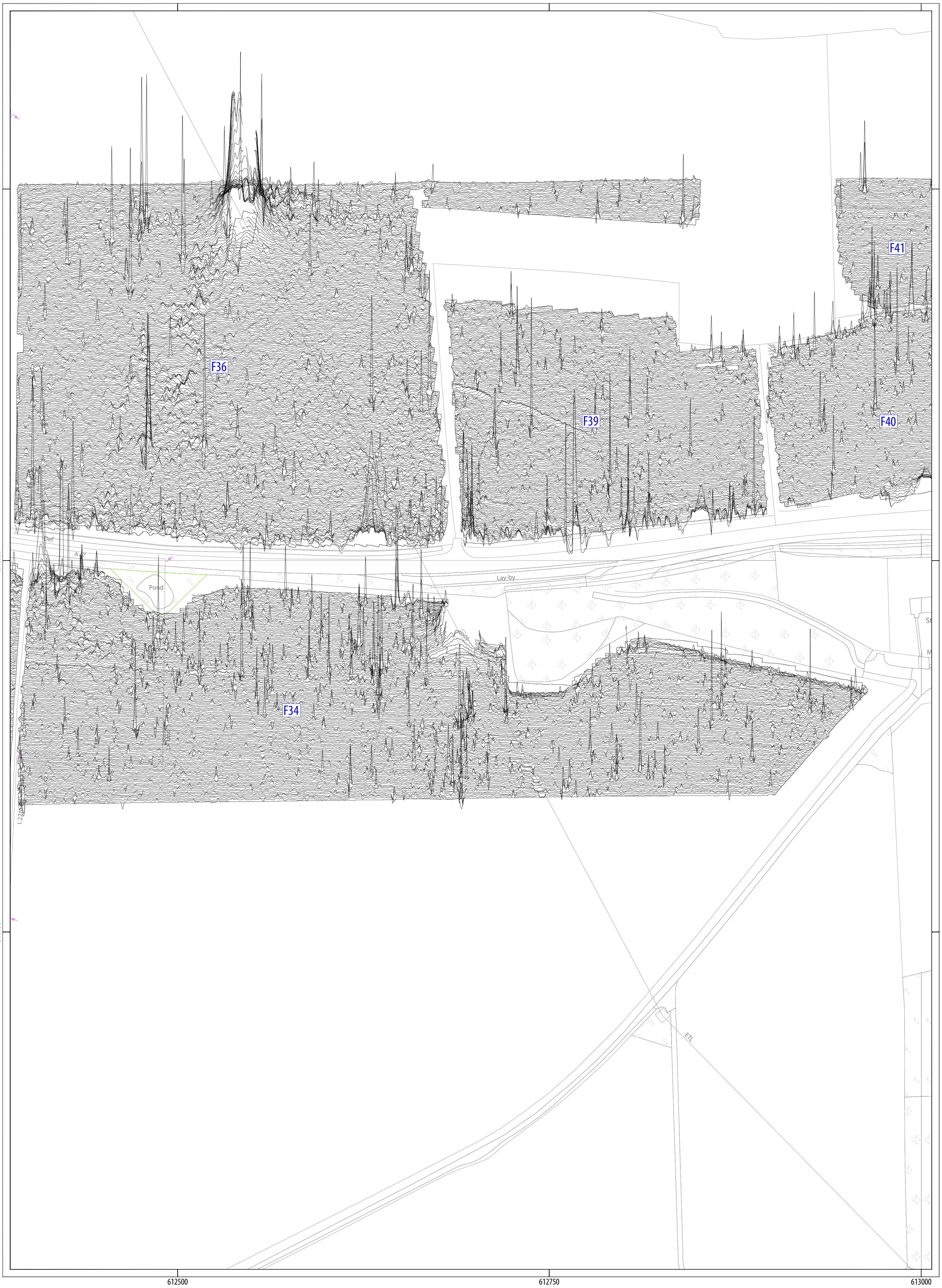
ILLUS 47 Processed greyscale magnetometer data, Sector 12



area unsuitable for survey

43.0nT/cm

0 50m
1:2,500 @ A3

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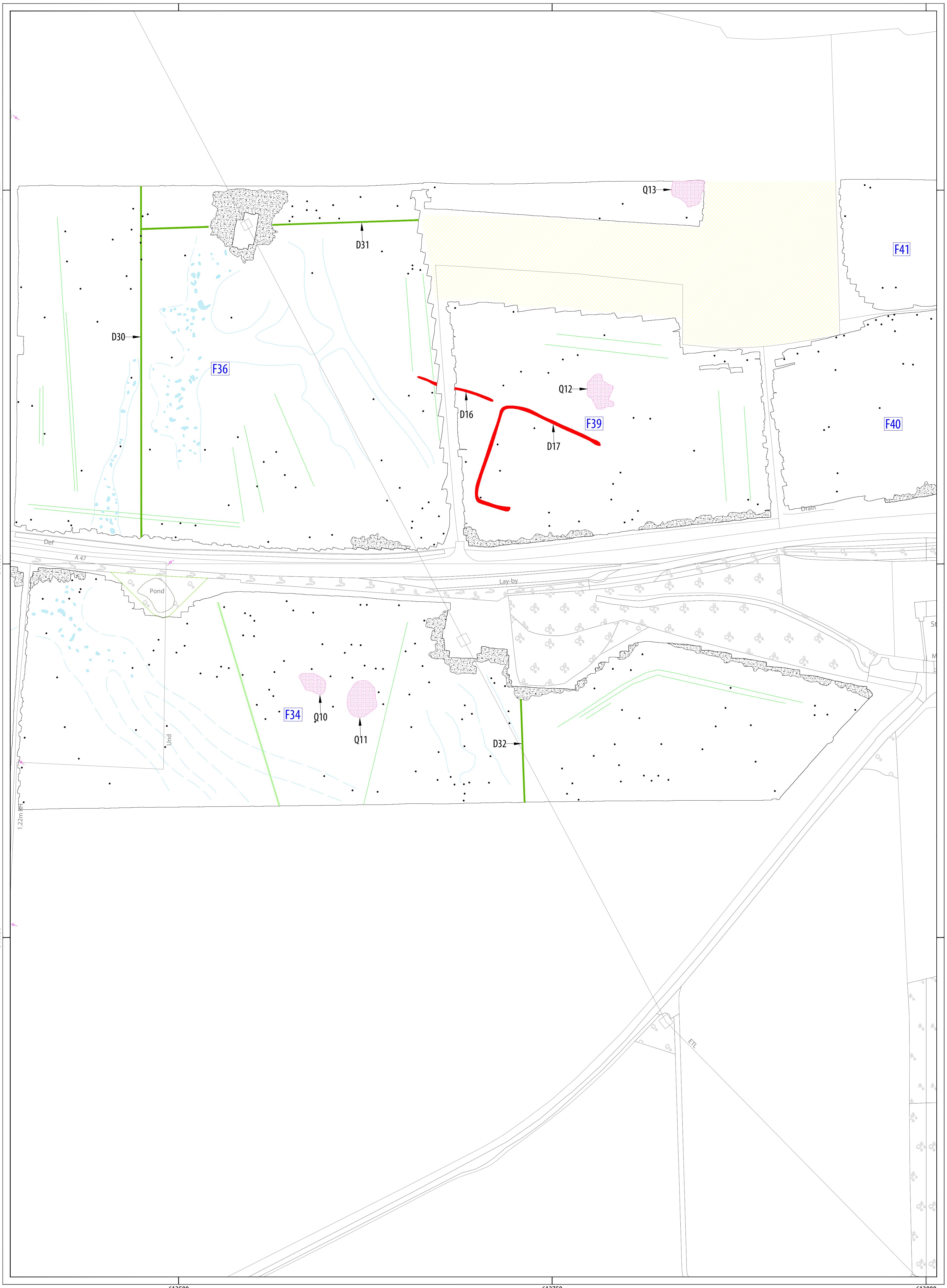
ILLUS 48 XY trace plot of minimally processed magnetometer data, Sector 12



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	quarrying
linear trend	agricultural
linear trend	former field boundary
linear trend	geological variation

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	geology
magnetic enhancement	archaeology

ABBREVIATIONS

D ditch
FB field boundary
Q extraction

area unsuitable for survey

0 50m
1:2,500 @ A3

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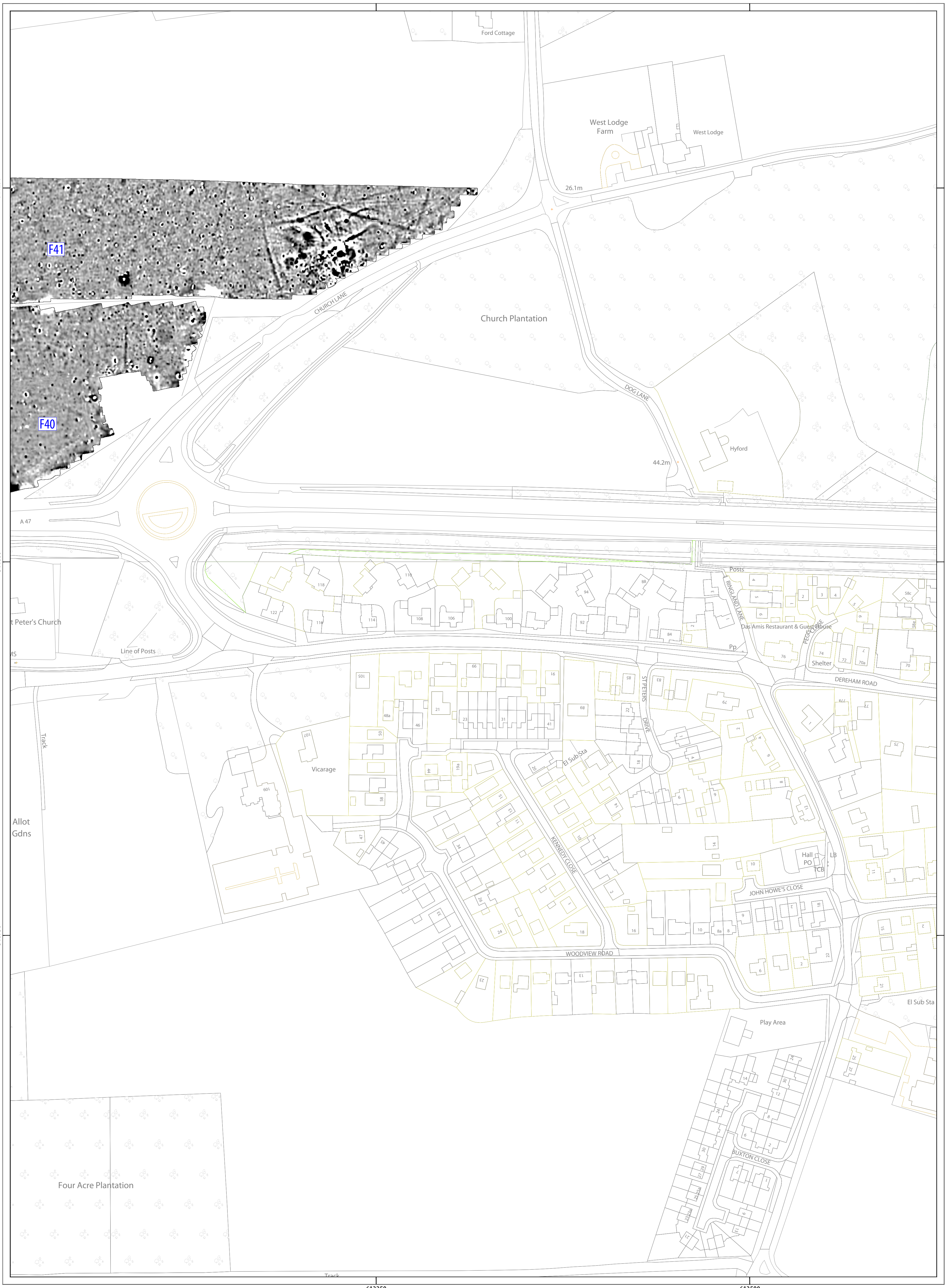
ILLUS 49 Interpretation of magnetometer data, Sector 12



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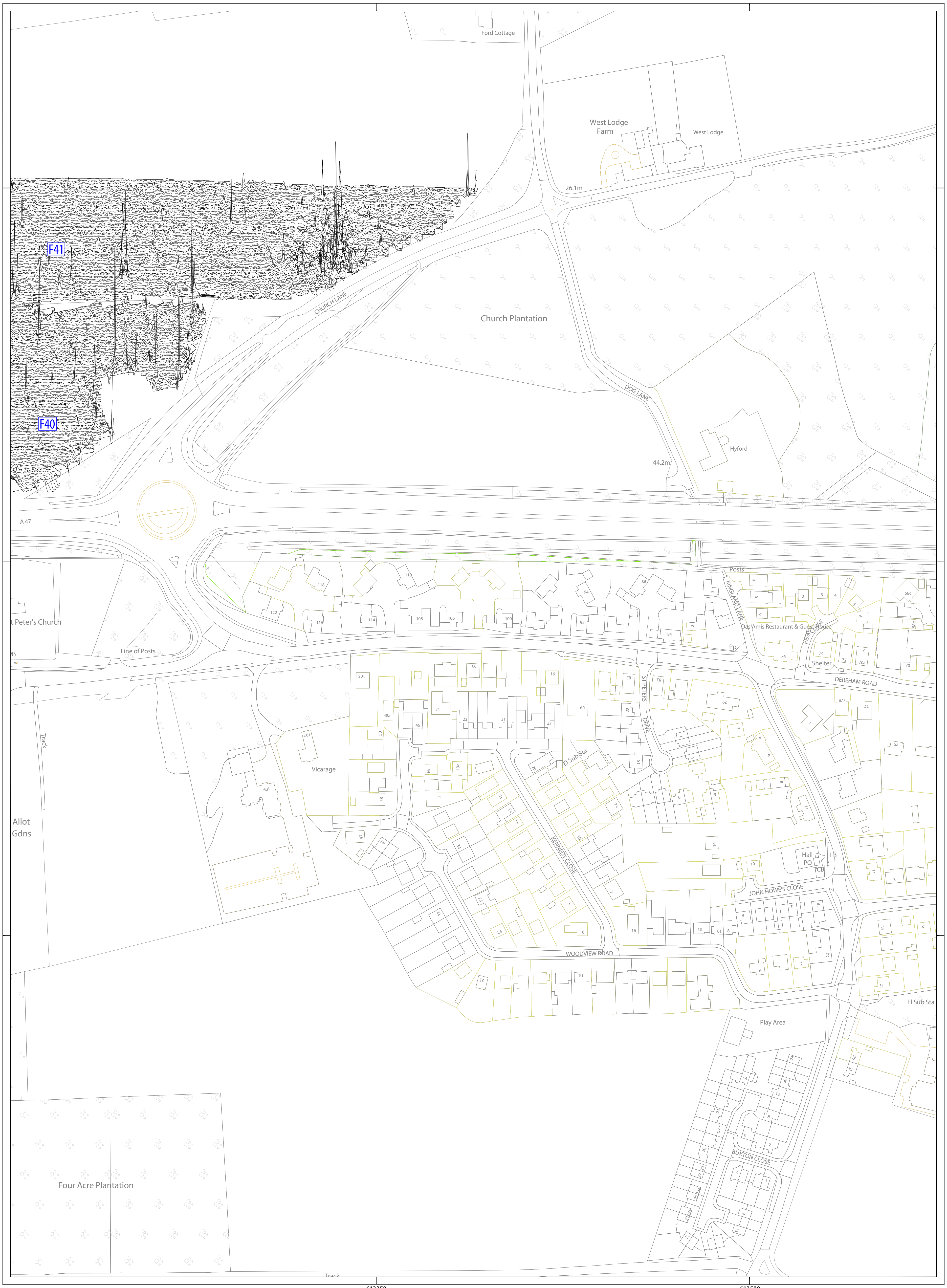
ILLUS 50 Processed greyscale magnetometer data, Sector 13



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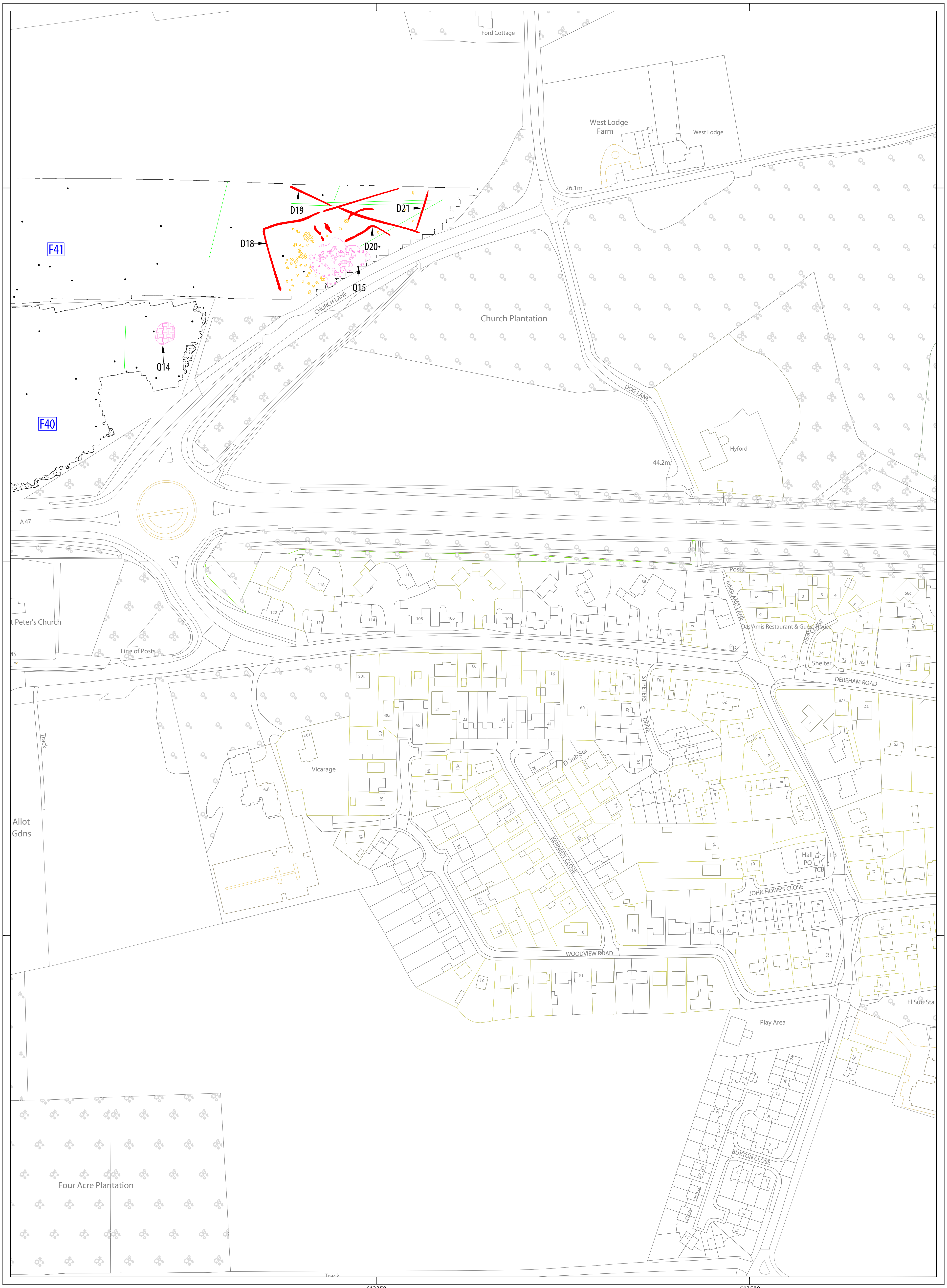
ILLUS 51 XY trace plot of minimally processed magnetometer data, Sector 13



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	quarrying
linear trend	agricultural
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

D ditch

Q extraction

0 50m

1:2,500 @ A3

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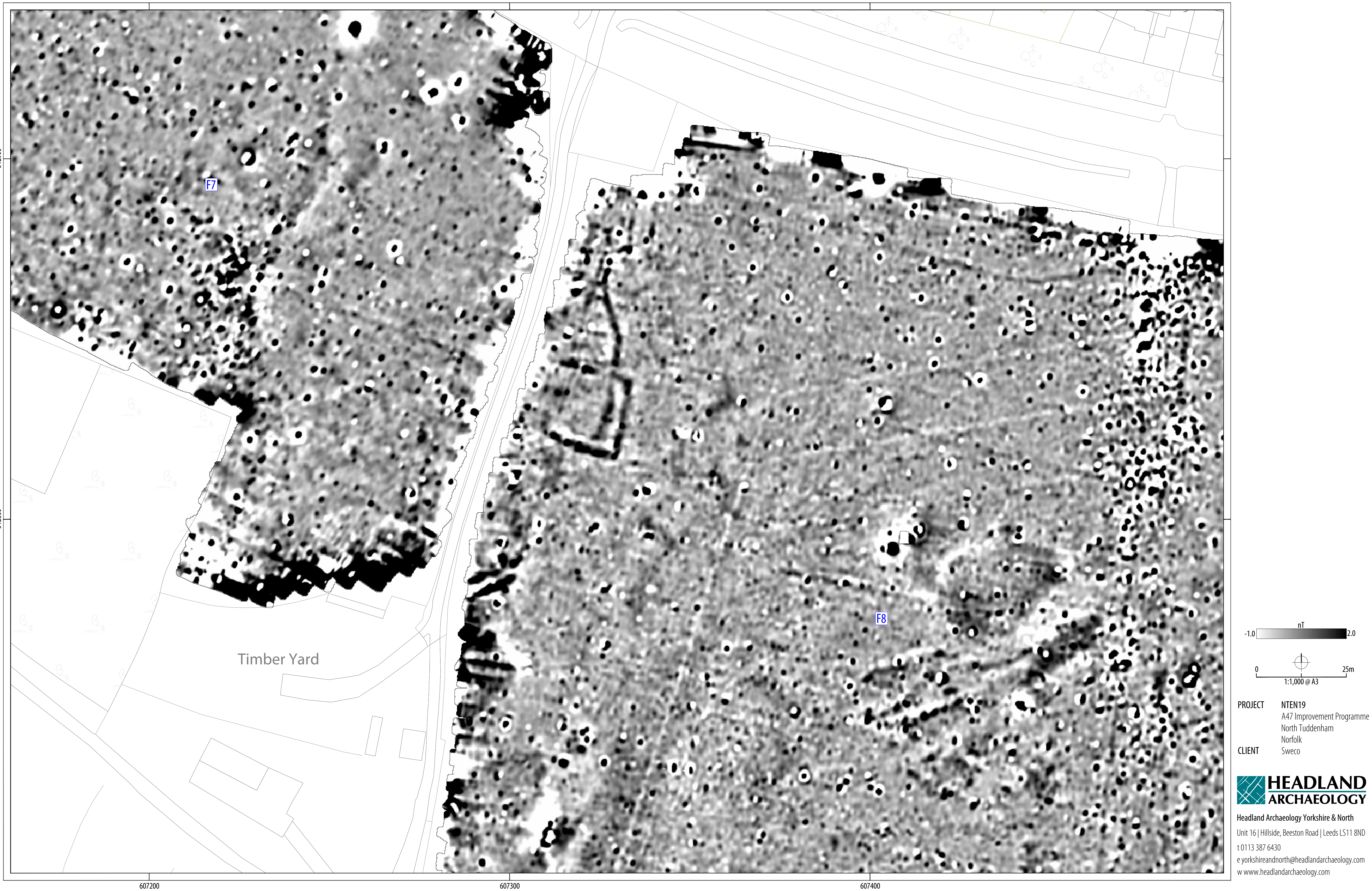
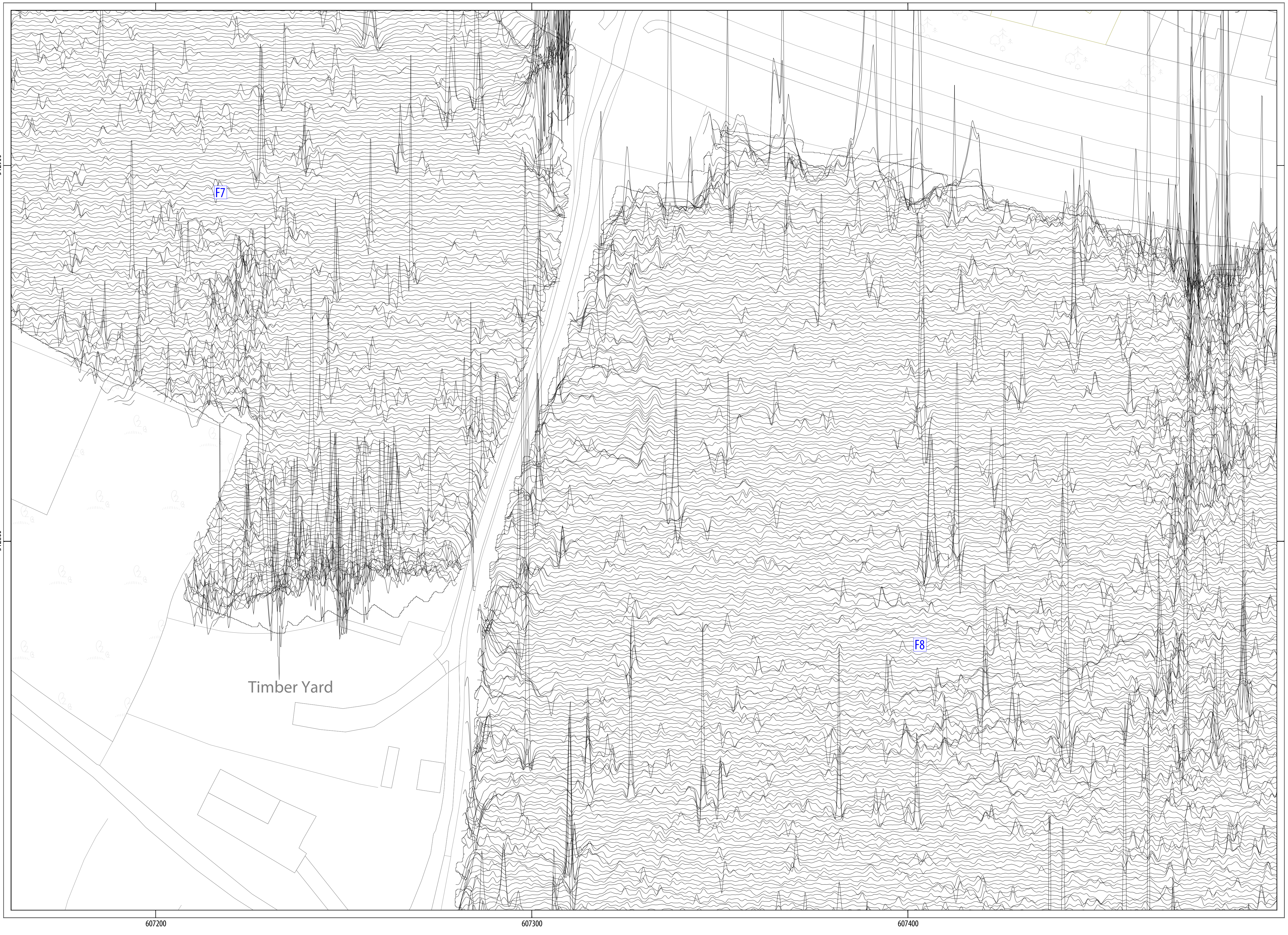
ILLUS 52 Interpretation of magnetometer data, Sector 13



ILLUS 53 Processed greyscale magnetometer data; AAA 1



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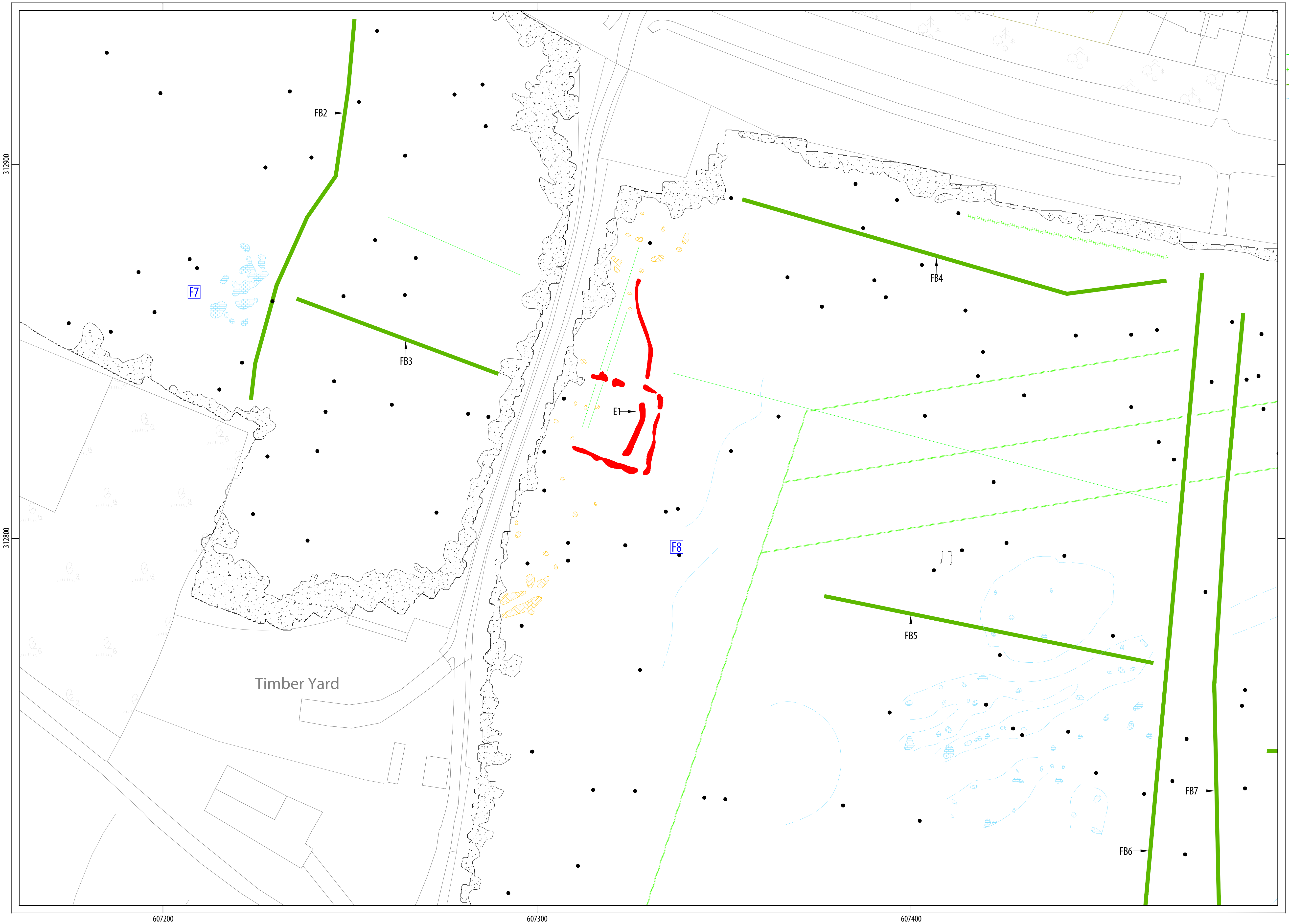
ILLUS 54 XY trace plot of minimally processed magnetometer data; AAA 1



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

ABBREVIATIONS

E enclosure
FB field boundary

0 25m
1:1,000 @ A3

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ILLUS 55 Interpretation of magnetometer data; AAA 1

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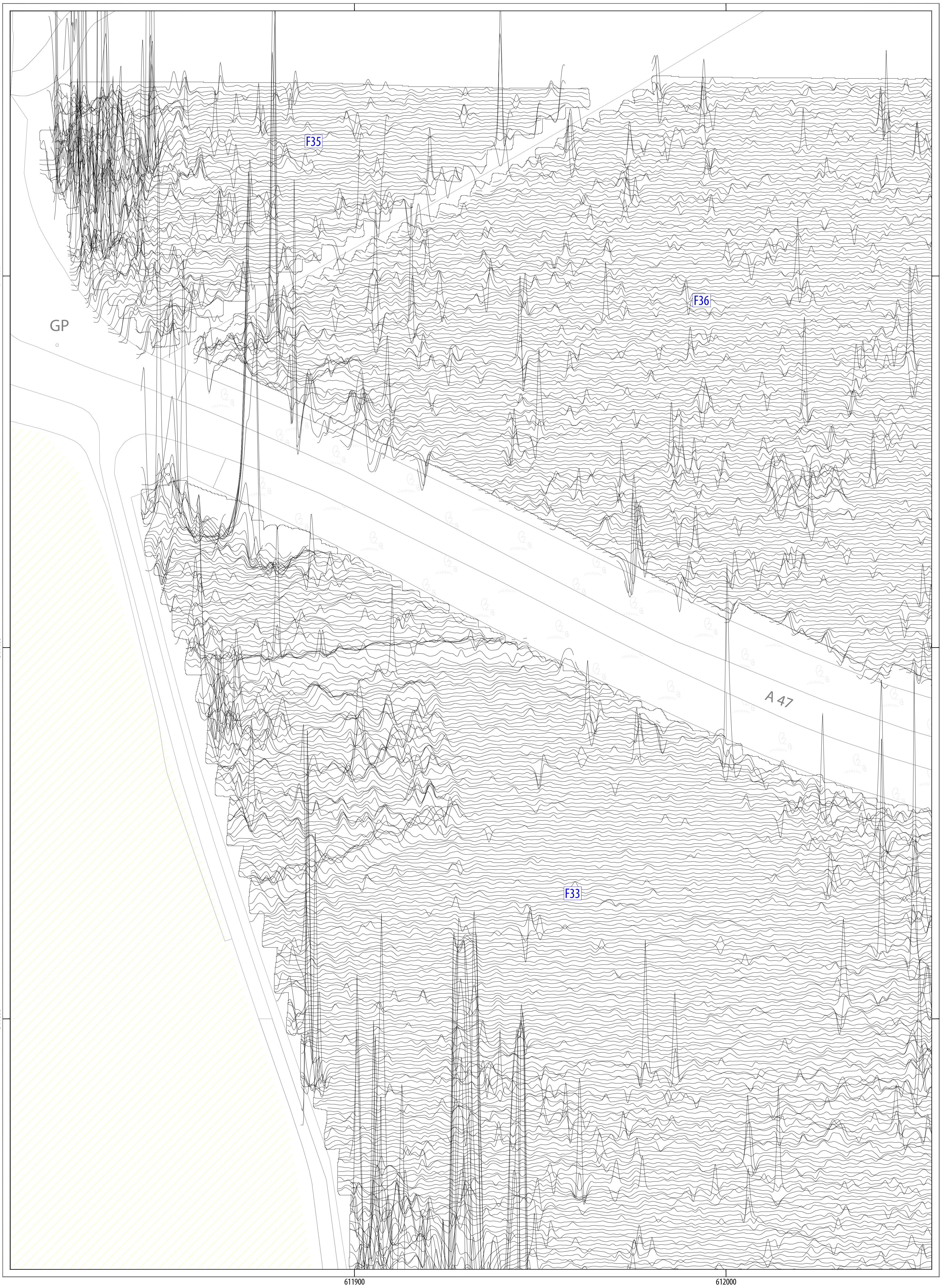
ILLUS 56 Processed greyscale magnetometer data, AAA 2



area unsuitable for survey

19.0nT/cm

0 25m
1:1,000 @ A3

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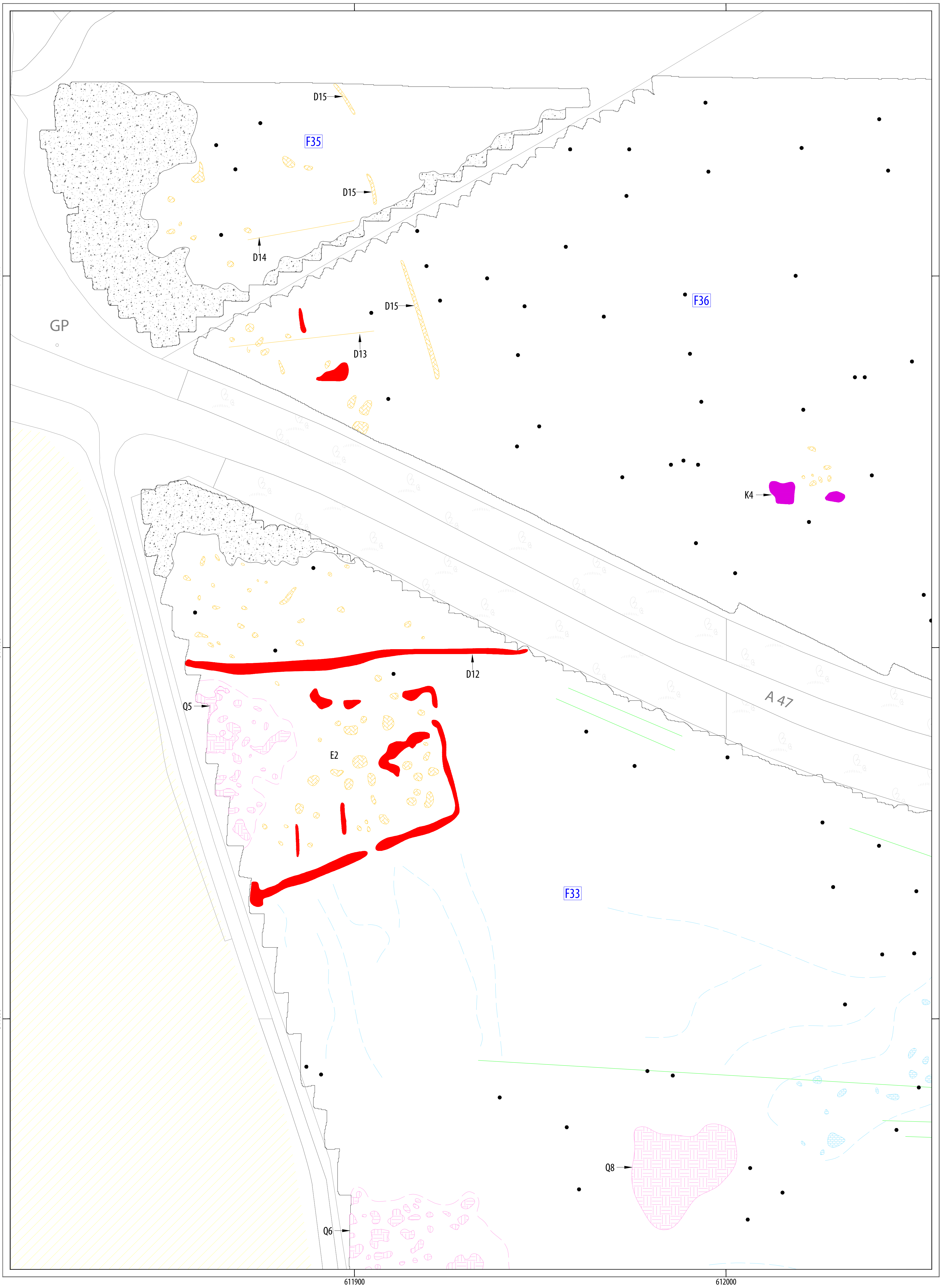
ILLUS 57 XY trace plot of minimally processed magnetometer data, AAA 2



TYPE OF ANOMALY	INTERPRETATION	TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material	magnetic enhancement	kiln/burning
magnetic disturbance	ferrous material	linear trend	archaeology?
magnetic disturbance	quarrying	magnetic enhancement	archaeology?
linear trend	agricultural	magnetic enhancement	archaeology
linear trend	geological variation		
magnetic enhancement	geology		

ABBREVIATIONS

D ditch
E enclosure
Q extraction
K kiln
area unsuitable for survey

0 25m
1:1,000 @ A3

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ILLUS 58 Interpretation of magnetometer data, AAA 2

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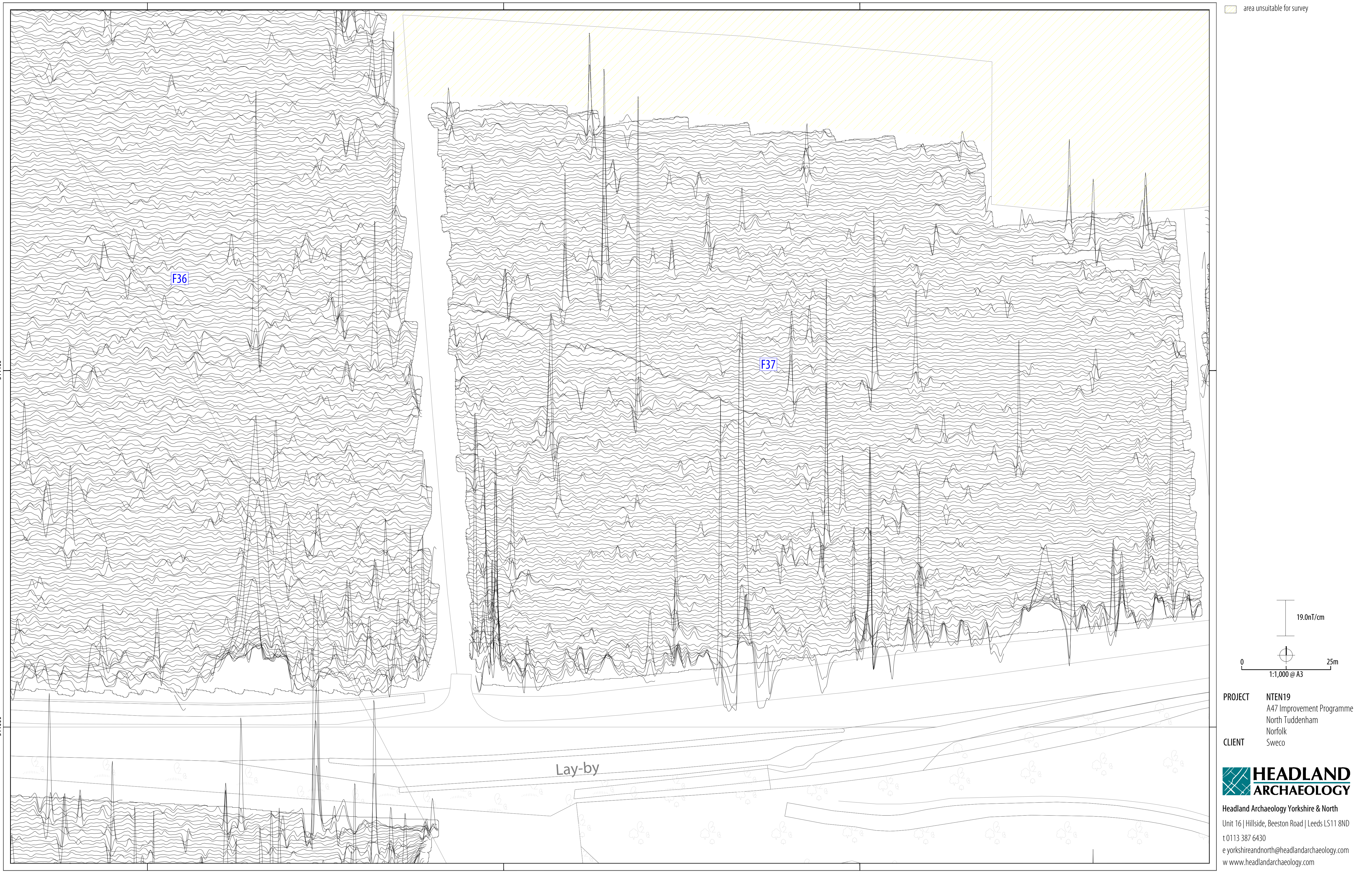
ILLUS 59 Processed greyscale magnetometer data; AAA 3



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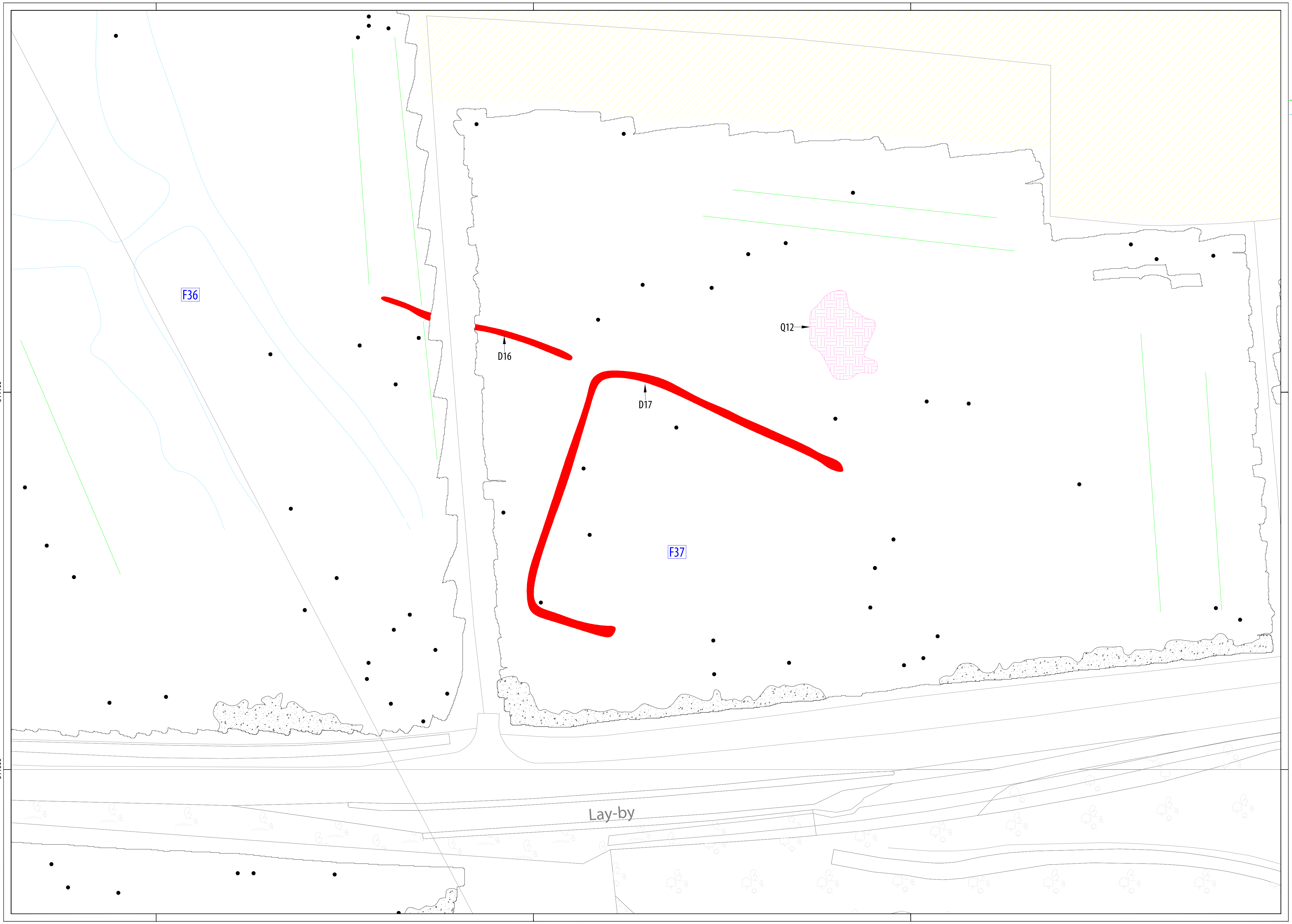
ILLUS 60 XY trace plot of minimally processed magnetometer data; AAA 3



area unsuitable for survey

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	quarrying
linear trend	agricultural
linear trend	geological variation
magnetic enhancement	archaeology

ABBREVIATIONS

D ditch

Q extraction

0 25m

1:1,000 @ A3

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e yorkshireandnorth@headlandarchaeology.com
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ILLUS 61 Interpretation of magnetometer data; AAA 3

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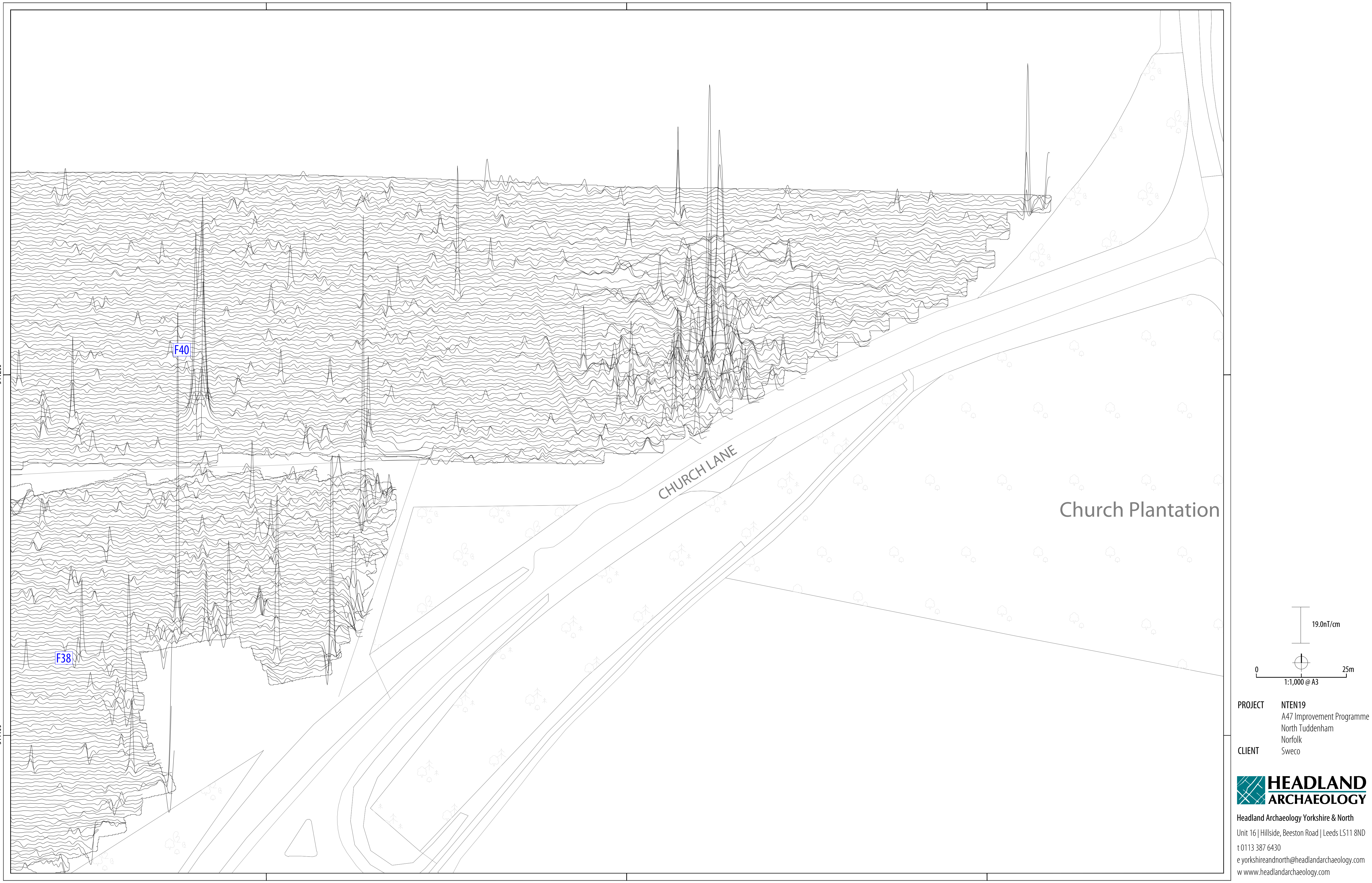
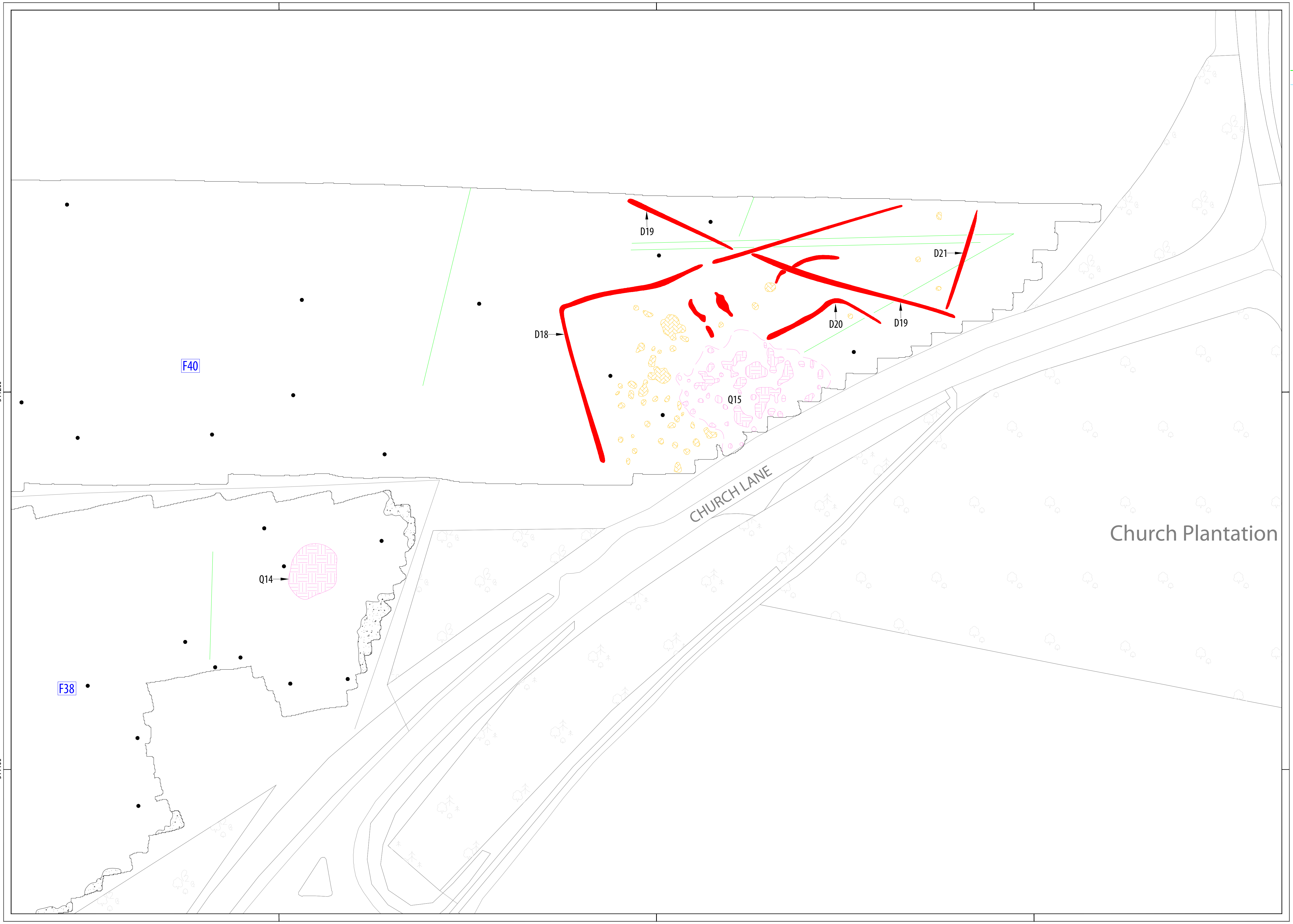
t 0113 387 6430
e yorkshireandnorth@headlandarchaeology.com
w www.headlandarchaeology.com

ILLUS 62 Processed greyscale magnetometer data; AAA 4



ILLUS 63 XY trace plot of minimally processed magnetometer data; AAA 4



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	quarrying
linear trend	agricultural
linear trend	geological variation
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

D ditch

Q extraction

0 25m
1:1,000 @ A3

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t 0113 387 6430
e yorkshireandnorth@headlandarchaeology.com
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ILLUS 64 Interpretation of magnetometer data; AAA 4

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Headland Archaeology Scotland
13 Jane Street
Edinburgh EH6 5HE
t 0131 467 7705
e scotland@headlandarchaeology.com

Headland Archaeology Yorkshire & North
Unit 16 | Hillside | Beeston Rd
Leeds LS11 8ND
t 0113 387 6430
e yorkshireandnorth@headlandarchaeology.com

Headland Archaeology South & East
Building 68C | Wrest Park | Silsoe
Bedfordshire MK45 4HS
t 01525 861 578
e southandeast@headlandarchaeology.com

Headland Archaeology Midlands & West
Unit 1 | Clearview Court | Twyford Rd
Hereford HR2 6JR
t 01432 364 901
e midlandsandwest@headlandarchaeology.com

Headland Archaeology North West
Fourways House | 57 Hilton Street
Manchester M1 2EJ
t 0161 236 2757
e northwest@headlandarchaeology.com

www.headlandarchaeology.com