

TSFN22



Thoroton Solar Farm, Nottinghamshire

GEOPHYSICAL SURVEY REPORT

Headland Archaeology Yorkshire & North
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On behalf of Neo Environmental Ltd

14/04/2022

PROJECT INFORMATION:

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PROJECT SUMMARY

Headland Archaeology (UK) Ltd was commissioned by Neo Environmental Ltd to undertake a geophysical (magnetometer) survey covering approximately 116 hectares at the site of a proposed solar project on land situated between Hawksworth and Thoroton, Nottinghamshire. This report will be submitted together with other supporting information to accompany a planning application for Thoroton Solar Farm and will also inform future archaeological strategy at the site, if required.

The survey has recorded anomalies indicative of significant, dense, and extensive archaeological activity bordering the current and former alignment of a watercourse that meanders through the eastern half of the PDA. There are two main foci of archaeological activity, close to the northern and north-eastern limits of the PDA and secondly, and more extensively, in the most easterly part of the PDA. At both locations anomalies indicative of multiple, clustered enclosures of varying size and shape are recorded linked by trackways and with numerous discrete anomalies, likely to be caused by activity associated with settlement, also numerous. Archaeological activity (cropmarks interpreted as enclosures, trackways, and other features) has been previously recorded on the Nottinghamshire HER at both locations although the survey has provided significantly greater detail on the complexity and extent of the archaeological remains. In the second, easterly, area of archaeological activity (AAA) a cluster of sub-circular anomalies on the opposite (southern) side of the watercourse from the main settlement suggests a perhaps earlier phase of activity.

Although the western side of the PDA has clearly been subject to a significant amount of drainage work, weak, discontinuous, and ephemeral anomalies are also recorded although no clear pattern can be discerned due to the low magnitude of the responses in this part of the PDA. These anomalies are also interpreted as of likely archaeological origin.

Overall, the extent of the two major areas of archaeological activity appears to be restricted to the slightly higher areas of ground situated on the river terrace or head superficial deposits bordering the current and former courses of a tributary of Back Dyke which flows through the PDA. Where there are no superficial deposits, or the bedrock is overlain by alluvium there are either no recorded anomalies or they are very low magnitude and difficult to discern. This raises the possibility that the archaeological resource may be more extensive than the survey has revealed in those areas where the prevailing pedological and geological conditions are not as favourable for detection.

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THOROTON SOLAR FARM, NOTTINGHAMSHIRE

GEOPHYSICAL SURVEY REPORT

1. INTRODUCTION

Headland Archaeology (UK) Ltd was instructed by Neo Environmental Ltd (the Client) to undertake a geophysical (magnetometer) survey on land between Hawksworth and Thoroton in Nottinghamshire (Illus 1) where a solar farm development is being proposed. The results of the geophysical survey will be submitted in support of a planning application for Thoroton Solar Farm, the development of which will involve the installation of a renewable energy generating station comprising ground mounted photovoltaic solar arrays together with substation, transformer stations, site accesses, internal access tracks, security measures, access gates, other ancillary infrastructure and landscaping and biodiversity enhancements. The results will also inform future archaeological strategy at the site, if required.

The survey was undertaken in accordance with a Written Scheme of Investigation for Geophysical Survey (WSI) (Headland Archaeology 2022), submitted to the Client prior to commencement, and following guidance contained in the National Planning Policy Framework (MHCLG 2021). It was also undertaken in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016).

The survey was carried out between March 14th and March 23rd, 2022.

1.1. SITE LOCATION, TOPOGRAPHY AND LAND-USE

The Proposed Development Area (PDA), centred at NGR SK 76205 43350, is located between the small villages of Thoroton to the south and Hawksworth to

the west, and comprises an irregularly shaped parcel of land comprising nine fields (F1 to F9) covering approximately 116 hectares. The PDA is bound by Longhedge Lane to the north, Newfield Lane to the west and Thoroton Road to the south and is bisected by Cliffhill Lane in the east. The A47 (Fosse Way) lies 3km to the west.

Two watercourses flow through the PDA; Back Dyke flows through the western half of the PDA on a north-east/south-west alignment with a tributary of Back Dyke flowing through the north-eastern part of the PDA.

Topographically the PDA is generally flat at between 20m and 28m Above Ordnance Datum (AOD).

At the time of survey, the PDA was predominantly under immature arable crops except for F6 which had been ploughed and left to weather (Illus 2 to Illus 5 inclusive).

1.2. GEOLOGY AND SOILS

The bedrock geology underlying the PDA comprises largely of Branscombe Mudstone Formation – Mudstone, with Arden Sandstone Formation – Sandstone to the north-east. This is overlain with a mixture of superficial deposits. Alluvium – Clays, Silt, Sand and Gravel, with River Terrace Deposits – Sand and Gravel, and Whatton Sand and Gravel – Sand and Gravel to the north of the PDA. Areas where no superficial deposits are recorded are also present (BGS 2022).

The soils are classified in the Soilscape 8 Association, being described as acidic loams and clays with impeded drainage, as well as in the Soilscape 20 Association, described as floodplain loams and clays

with naturally high groundwater (Cranfield University 2022).

2. ARCHAEOLOGICAL BACKGROUND

Several Heritage Assets are recorded on the Nottinghamshire HER within the PDA dating from the prehistoric to modern periods. Scatters of prehistoric worked flint are recorded over the site at three locations (MNT1492, MNT1493, MNT1498), along with findspots of Iron Age pot sherds (MNT1497) and Roman pottery (MNT8056). Several undated enclosures, possible trackways and pit alignments are recorded as cropmarks, predominantly in the centre and east of the PDA (MNT1496, MNT10642, MNT1500). In the south of the PDA, a post-medieval to modern windmill is recorded, marked on historical mapping (MNT1718).

3. AIMS, METHODOLOGY & PRESENTATION

3.1. AIMS & OBJECTIVES

The principal aim of the programme of geophysical survey was to gather information to establish the presence/absence, character, and extent of any archaeological remains within the PDA. This will enable an assessment to be made of the impact of any proposed development on any sub-surface archaeological remains, if present, and thereby inform any further investigation strategies, as appropriate.

The specific archaeological objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified,
- to therefore determine the likely presence/absence and extent of any buried archaeological features, and
- to prepare a report summarising the results of the survey.

3.2. METHODOLOGY

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.

Magnetometry is the most widely used geophysical survey technique in archaeology as it can quickly evaluate large areas and, under favourable conditions, identify a wide range of archaeological features including infilled cut features such as large pits, gullies and ditches, hearths, and areas of burning and kilns and brick structures. It is therefore good at locating settlements of all periods, prehistoric field systems and enclosures and areas of industrial or modern activity, amongst others. It is less successful in identifying smaller features such as post-holes and small pits (except when using a non-standard sampling interval), unenclosed (prehistoric) settlement sites and graves/burial grounds. However, magnetometry is by far the single most useful technique and was assessed as the best non-intrusive evaluation tool for this site.

The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid 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 (Illus 6). These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point.

MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Terrasurveyor V3.0.37.0 (DWConsulting) software was used to process and present the data.

3.3. DATA PRESENTATION & TECHNICAL DETAIL

A general site location plan is shown in Illus 1 at a scale of 1:20,000. Illus 2 to Illus 5 inclusive are site condition photographs. Illus 6 shows the GPS swaths and photograph locations at 1:7,500. Overall greyscale magnetometer data and interpretation are displayed at 1:7,500 in Illus 7 and Illus 8 respectively.

Fully processed (greyscale) data, minimally processed data (XY trace plot) data and interpretative plots are presented, at a scale of 1:2,500, by Sector, in Illus 9 to Illus 23 inclusive. Larger scale plots at 1:1,000, of two areas of archaeological activity are presented in Illus 24 to Illus 35 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 Written Scheme of Investigation (Headland Archaeology 2022), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2014). All illustrations from Ordnance Survey (OS) mapping are reproduced with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The illustrations in this report have been produced following analysis of the data in 'raw' (minimally processed) and processed formats and over a range of different display levels. All illustrations are presented to display and interpret the data to best effect. The interpretations are based on the experience and knowledge of Headland management and reporting staff.

4. RESULTS AND DISCUSSION

4.1. SITE CONDITIONS

Magnetometer survey can generally be recommended over any sedimentary bedrock (English Heritage 2008; Table 4), although Quaternary superficial deposits can lead to variability of results. Nevertheless, it was considered that magnetometry was the most appropriate geophysical technique for evaluating the PDA taking account of the limitations noted in Section 3.2 above.

The magnetic background across the PDA is extremely homogeneous, particularly in those areas where there are no superficial deposits overlying the bedrock sedimentary geology, such as in the north-

western part of the PDA. The homogeneity is due to the clay nature of the soils, a factor that also accounts for the extensive system of field drains recorded in this part of the PDA (see Section 4.4 below).

Some variability in the magnetic background is noted in the areas where there are unsorted river terrace deposits (sands and gravels) as well as a small 'island' of head and these areas seem to be the foci of the archaeological activity (see Section 4.5 below).

The extent of alluvial deposition and/or perhaps the channels of former streams also clearly show up in the data as broad low magnitude areas of magnetic enhancement alongside current or former watercourses (see Section 4.3 below).

Surface conditions across the PDA were very good throughout and subsequently data quality was also good with only minimal post-processing required. No problems were encountered during the fieldwork.

The anomalies have been classified into categories according to their origin/type and are described below.

4.2. FERROUS AND MODERN ANOMALIES

Ferrous anomalies, characterised as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris is common on most sites, often being introduced into the topsoil during manuring or tipping/infilling. There is no obvious clustering to the ferrous anomalies within the PDA that would suggest an archaeological origin was likely. Far more probable is that the 'spike' responses are caused by the random distribution of ferrous debris in the upper soil horizons.

Large 'halos' of magnetic disturbance recorded in F4, F6 and F7 (Illus 8) are due to the proximity of three electricity pylons carrying overhead cables.

Bands or small areas of disturbance are also recorded along field boundaries and in gateways, such as at the intersection of F1 and F3, and along the southern edge of F2 close to housing on the outskirts of Hawksworth. This disturbance is typically due to the accumulation of ferrous debris around field margins, the presence of barbed wire or wire mesh in the boundary itself or the tipping of material to improve access to/from fields.

4.3. GEOLOGICAL ANOMALIES

As mentioned in Section 4.1 the magnetic background is very uniform across most of the PDA. The only anomalies identified as being geological in origin are either due to the accumulation of alluvial deposits adjacent to the current and former course of a small watercourse that meanders across the PDA or to the former meanders of the same stream whose course has clearly altered either naturally or by human intervention.

4.4. AGRICULTURAL ANOMALIES

Linear anomalies due to various agricultural activities are recorded across all fields within the PDA (Illus 8). Perhaps the most obvious are the regular pattern of field drains recorded in F1 and F2.

At least six field boundaries have been removed since the mid-19th century to increase field size, including those in F6 and F7, and these are also recorded in the data set as linear anomalies (Illus 8 – FB1 to FB6 inclusive).

Parallel and slightly curving linear anomalies, which are most extensive in F4 and F7, are indicative of the former practice of ridge and furrow cultivation. The straighter, more closely spaced linear anomalies, such as those in F2, reflect the direction of more recent cultivation.

4.5. AREAS OF ARCHAEOLOGICAL ACTIVITY

A plethora of anomalies interpreted as of possible or probable archaeological potential have been identified across the PDA at two locations. To aid description these clusters of anomalies have been grouped into main areas of archaeological activity (AAA1 and AAA2). Unless stated otherwise these anomalies are caused by soil filled (mostly) linear features, usually ditches forming enclosures or fields or defining areas of settlement, or discrete features such as pits or possible sites of burning.

AAA1 (Illus 24 to 29)

AAA1 covers a much wider area than AAA2. It comprises two major component parts, possibly of different period.

The first part comprises is a relatively small area of sub-divided enclosures, indicative of possible occupational activity on the eastern edge of the former course of a stream whose course now forms the eastern boundary of F3 (see Section 4.3). The anomalies become weaker approaching the former watercourse suggesting that later flooding and

deposition may have subsumed part of the settlement. Directly to the north, on the northern side of the former watercourse is a second and smaller cluster of enclosures.

To the east a wider area comprising of enclosures/fields, such as E1 and E2, appended to and accessed by trackways, TR1 and TR2, is recorded extending across most of F4. It is not clear whether these features are contemporary with the settlement activity adjacent to the watercourse in the field to the west or perhaps of later date. Certainly, the orientation of the ridge and furrow cultivation strips at least in part respects the alignment of the two trackways. Parts of at least two small enclosures, E3 and E4, are also recorded on the edge of the floodplain in the south-western corner of F4.

AAA2 (Illus 30 to Illus 35)

AAA2 is confined within a single field, F9. Here a very densely packed cluster of enclosures is recorded arcing along the northern side of the former watercourse. The archaeological activity extends across the full width of the field, approximately 400m, with the enclosures being most densely packed together at the eastern side of the field, possibly focussed around a single square enclosure, E5, which, unlike all the other enclosures, is devoid of any anomalies of likely archaeological origin within its interior. Further west the enclosures become larger with fewer anomalies recorded within the enclosures themselves and the activity seems to peter out close to Cliffhill Lane, the road that separates F9 from the remainder of the PDA; there are no archaeological anomalies in F8 immediately west of the road. Of particular note are a series of high magnitude anomalies on the southern fringe of the enclosures at the western end of the complex and two parallel anomalies, D1 and D2 at the eastern end of the complex which may be ditches flanking a trackway, TR?3, leading to a possible crossing point of the watercourse; parallel, but much weaker anomalies can just be discerned on the southern side of the watercourse suggesting the track continued in a south-westerly direction beyond the survey limits.

On the southern side of the former watercourse, opposite the main settlement area, is a small, aggregated, cluster of small sub-circular features, (collectively E6), probable enclosures, with a couple of smaller outlying circular features, E7 and E8, possible barrows, further to the south-east. The possible trackway, TR?3 may overlie one of the possible barrow features (E8) although it is very

difficult to phase features based on the geophysical data.

4.6. OTHER ANOMALIES OF POSSIBLE OR PROBABLE ARCHAEOLOGICAL ORIGIN

Outside the two obvious areas of archaeological activity other anomalies have been recorded in two other locations. The anomalies form no obvious distinct pattern or definite cluster of associated features but are interpreted as being of definite archaeological potential.

The first location is south of the watercourse in F6. Here several circular or sub-circular anomalies, including E9 and E10 are recorded on, or just beyond, the limits of the extent of the alluvium. The magnetic responses from these anomalies are weak and the anomalies in some instances discontinuous. Nevertheless, these anomalies do stand out against the very flat magnetic background and are clearly of archaeological potential.

Further afield and well away from all the other archaeological activity in the PDA, in F2, are a series of again very low magnitude, discontinuous but linear anomalies, possibly forming a series of adjoining enclosures with a probable trackway, TR74 aligned north-west/south-east at the northern edge of the possible enclosures.

5. CONCLUSION

The survey has recorded anomalies indicative of significant, dense, and extensive archaeological activity bordering the current and former alignment of a watercourse that meanders through the PDA. There are two main foci of archaeological activity; close to the northern and north-eastern limits of the PDA and secondly, and more extensively, in the most easterly part of the PDA. At both locations anomalies indicative of multiple, clustered enclosures of varying size and shape are recorded linked by trackways and with numerous discrete anomalies, likely to be caused by activity associated with settlement, also numerous. Archaeological activity (cropmarks interpreted as enclosures, trackways, and other features) has been previously recorded on the Nottinghamshire HER at both locations although the survey has provided significantly greater detail on the complexity and extent of the archaeological remains. Roman pottery has also been found. In the second, easterly, area of archaeological activity (AAA) a cluster of sub-circular anomalies on the opposite

(southern) side of the watercourse from the main settlement suggests a perhaps earlier phase of activity.

Although the western side of the PDA has been subject to a significant amount of drainage, as evidenced by the data, weak, discontinuous, and ephemeral anomalies are also recorded which are interpreted as of likely archaeological origin. However, no clear pattern can be discerned due to the low magnitude of the responses in this part of the PDA.

Overall, the extent of the two major areas of archaeological activity appears to be restricted to the slightly higher areas of ground situated on the river terrace or head superficial deposits bordering the current and former courses of tributary of Back Dyke. Where there are no superficial deposits, or the bedrock is overlain by alluvium there are either no recorded anomalies or they are very low magnitude and difficult to discern. This raises the possibility that the archaeological resource may be more extensive than the survey has revealed in those areas where the prevailing pedological and geological conditions are not as favourable for detection.

6. REFERENCES

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Ministry of Housing, Communities and Local
Government (MHCLG) 2021 National Planning Policy
Framework

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2022

Natural Environment Research Council (BGS) 2022
British Geological Survey <http://www.bgs.ac.uk/>
accessed 14th April 2022



Illus 2 F1 and F2, looking south-east



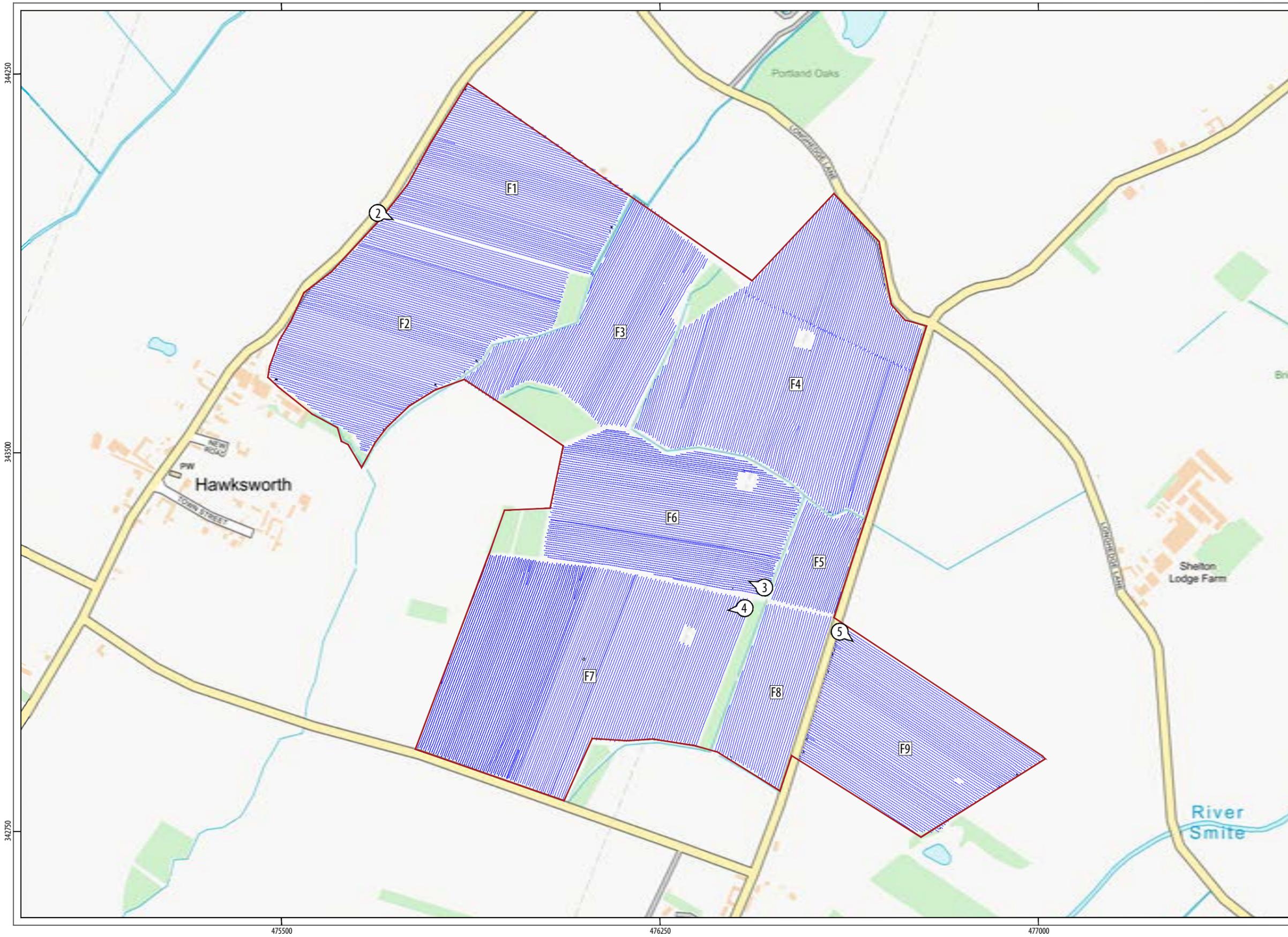
Illus 3 F6, looking north-west



Illus 4 F7, looking south-west



Illus 5 F9, looking south-east



- geophysical survey area
- GPS swaths
- location and direction of ILLUS 2-5



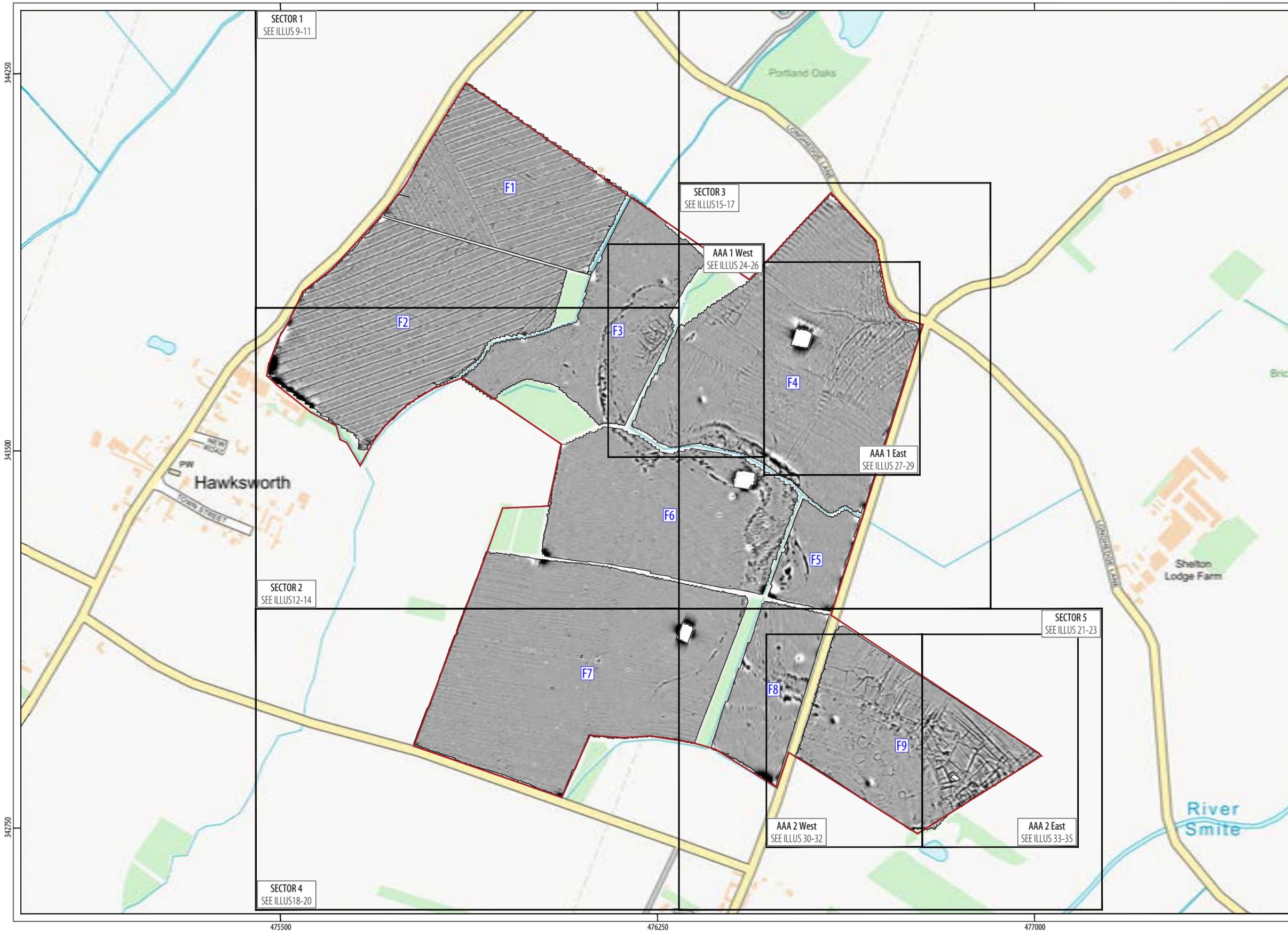
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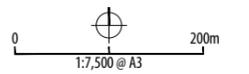


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ILLUS 6 Survey location showing GPS swaths and photograph locations



geophysical survey area

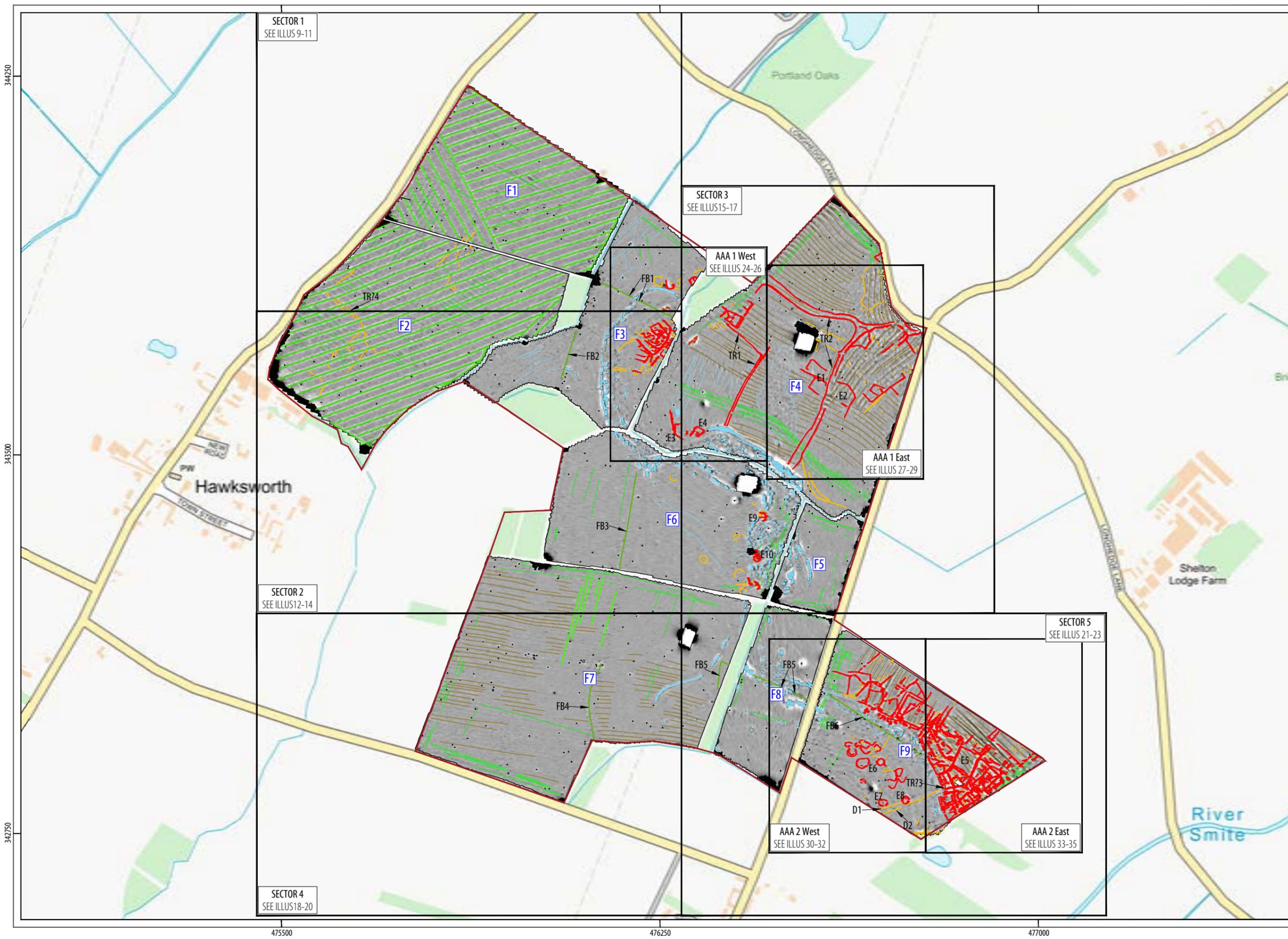


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ILLUS 7 Overall greyscale plot of processed magnetometer data



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

ABBREVIATIONS
D - ditch
E - enclosure
FB - former boundary
TR - trackway
TR? - trackway?



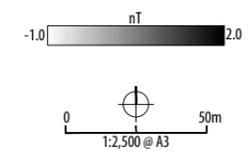
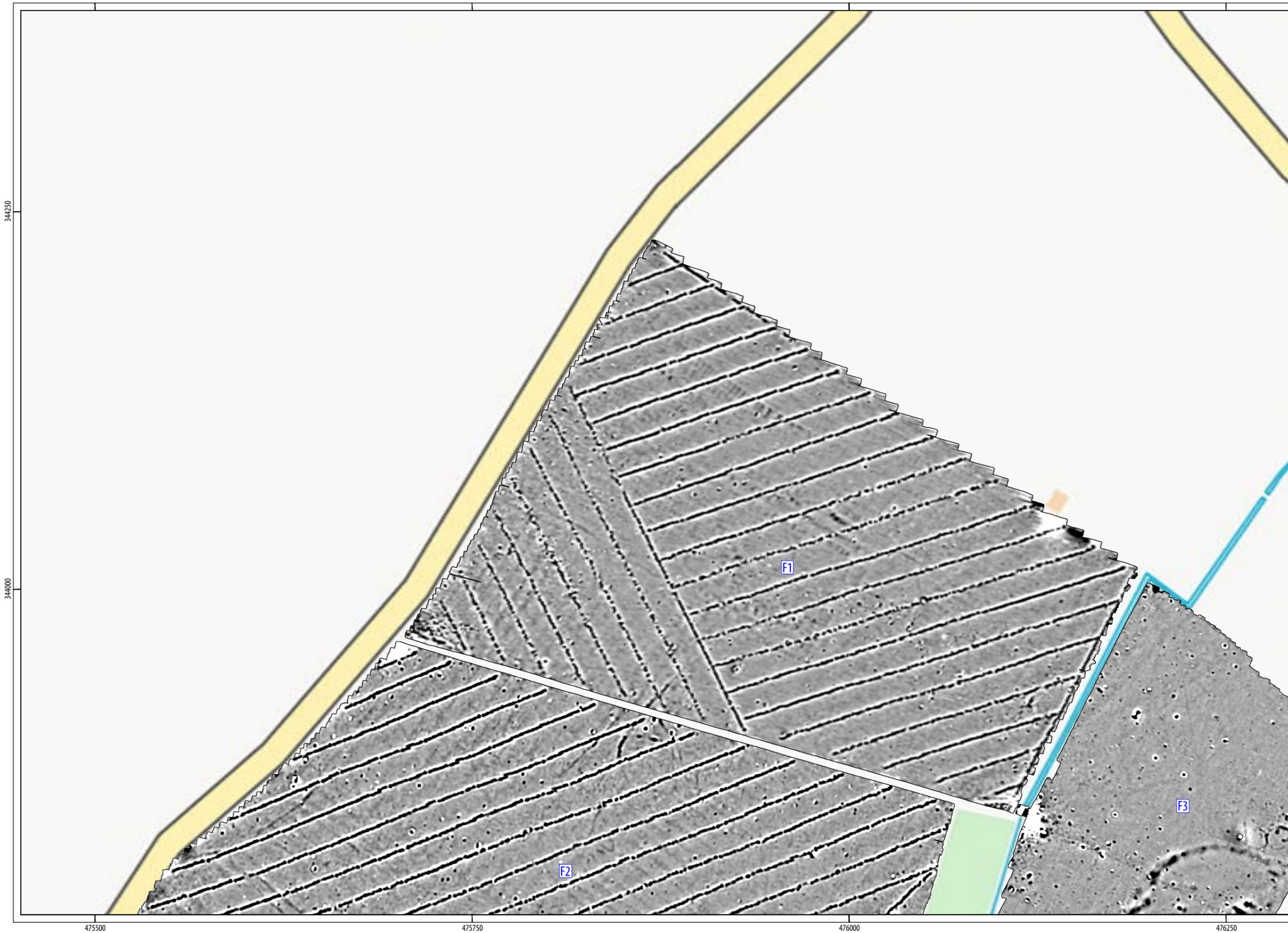
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ILLUS 8 Overall interpretation of magnetometer data



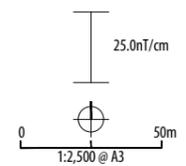
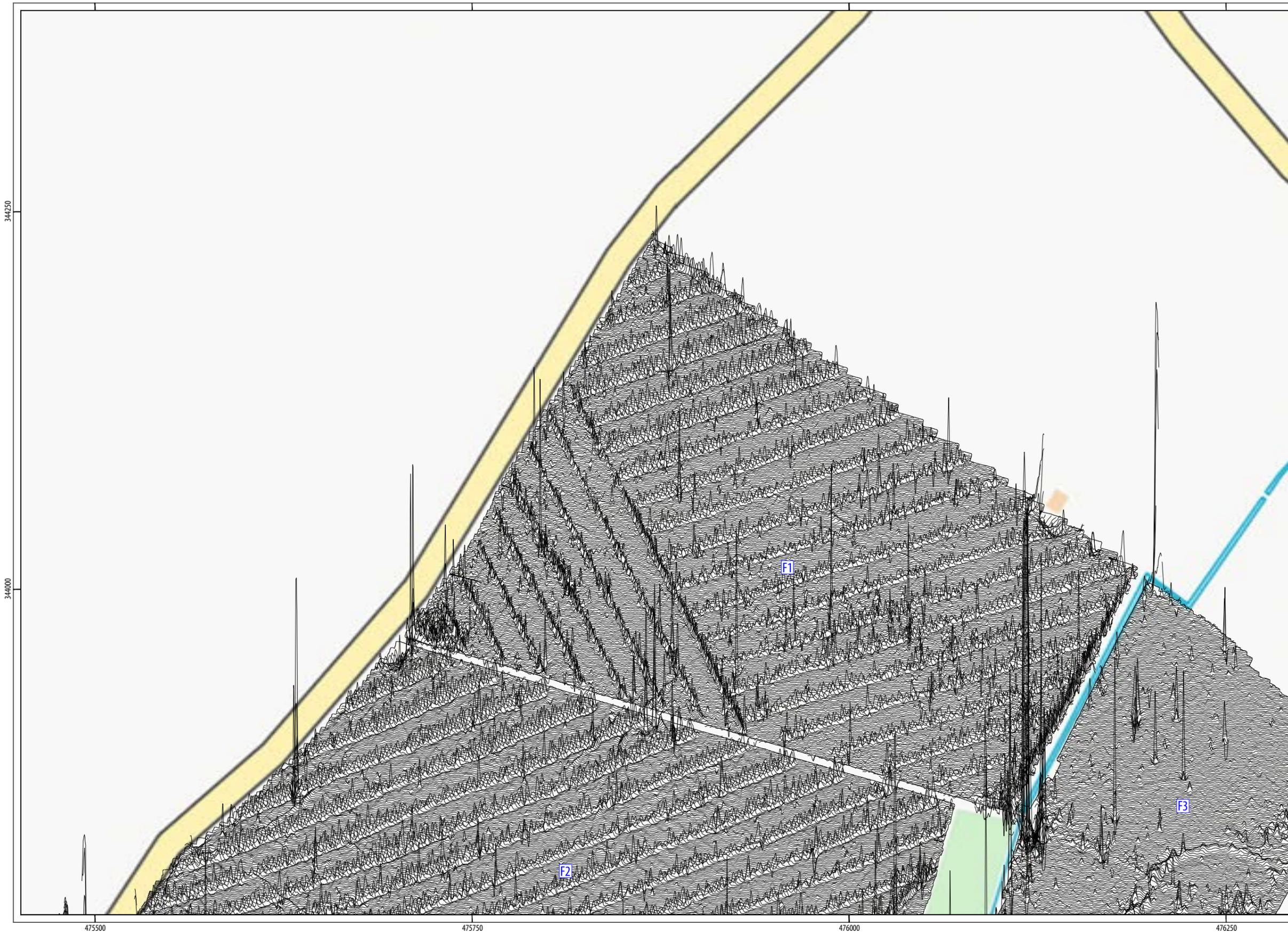
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ILLUS 9 Processed greyscale magnetometer data; Sector 1



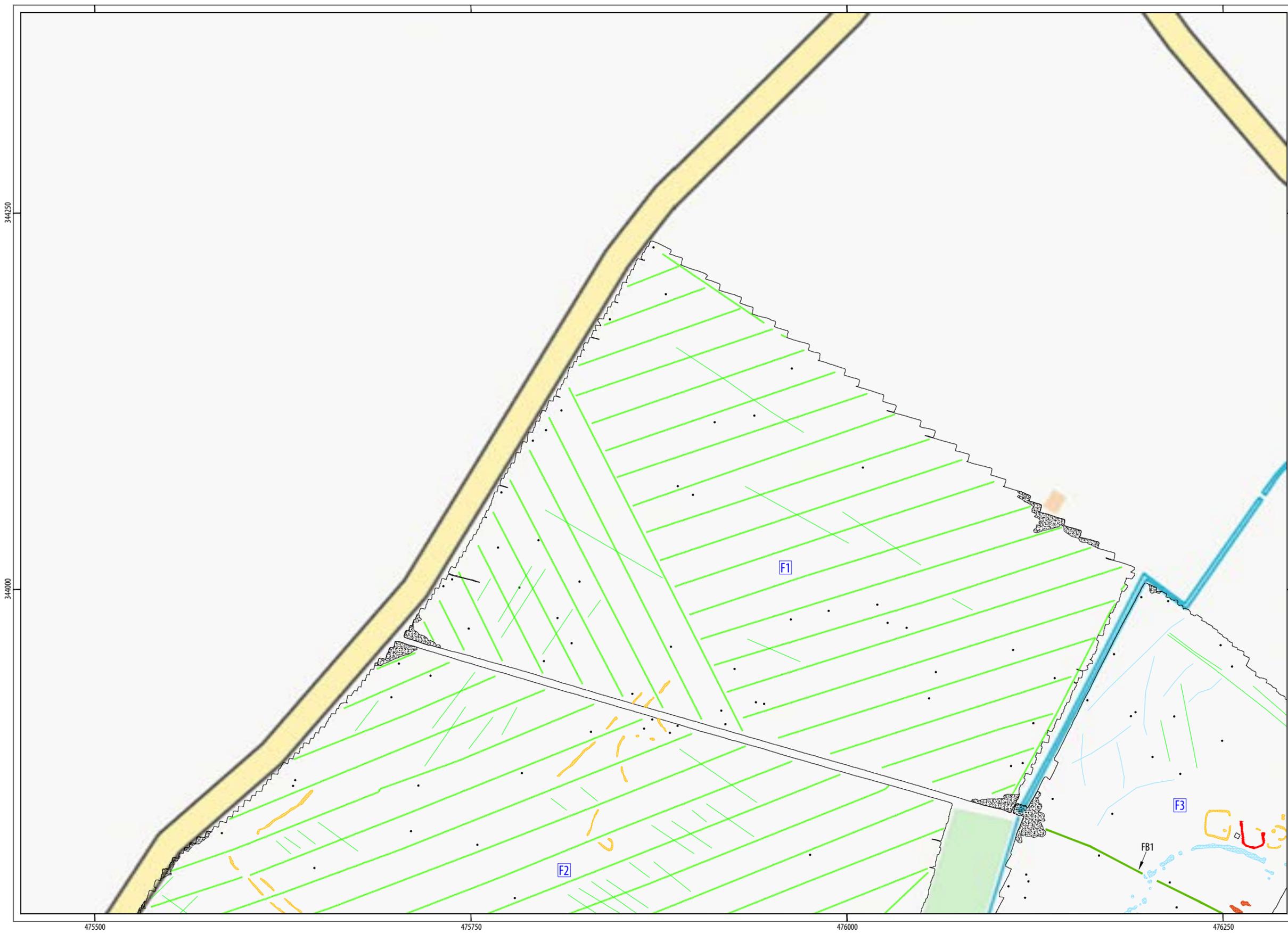
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ILLUS 10 XY trace plot of minimally processed magnetometer data; Sector 1



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

ABBREVIATIONS
 FB - former boundary

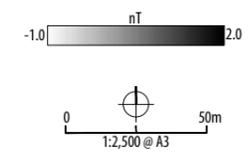


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ILLUS 11 Interpretation of magnetometer data; Sector 1



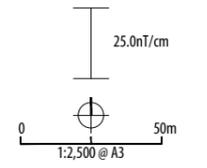
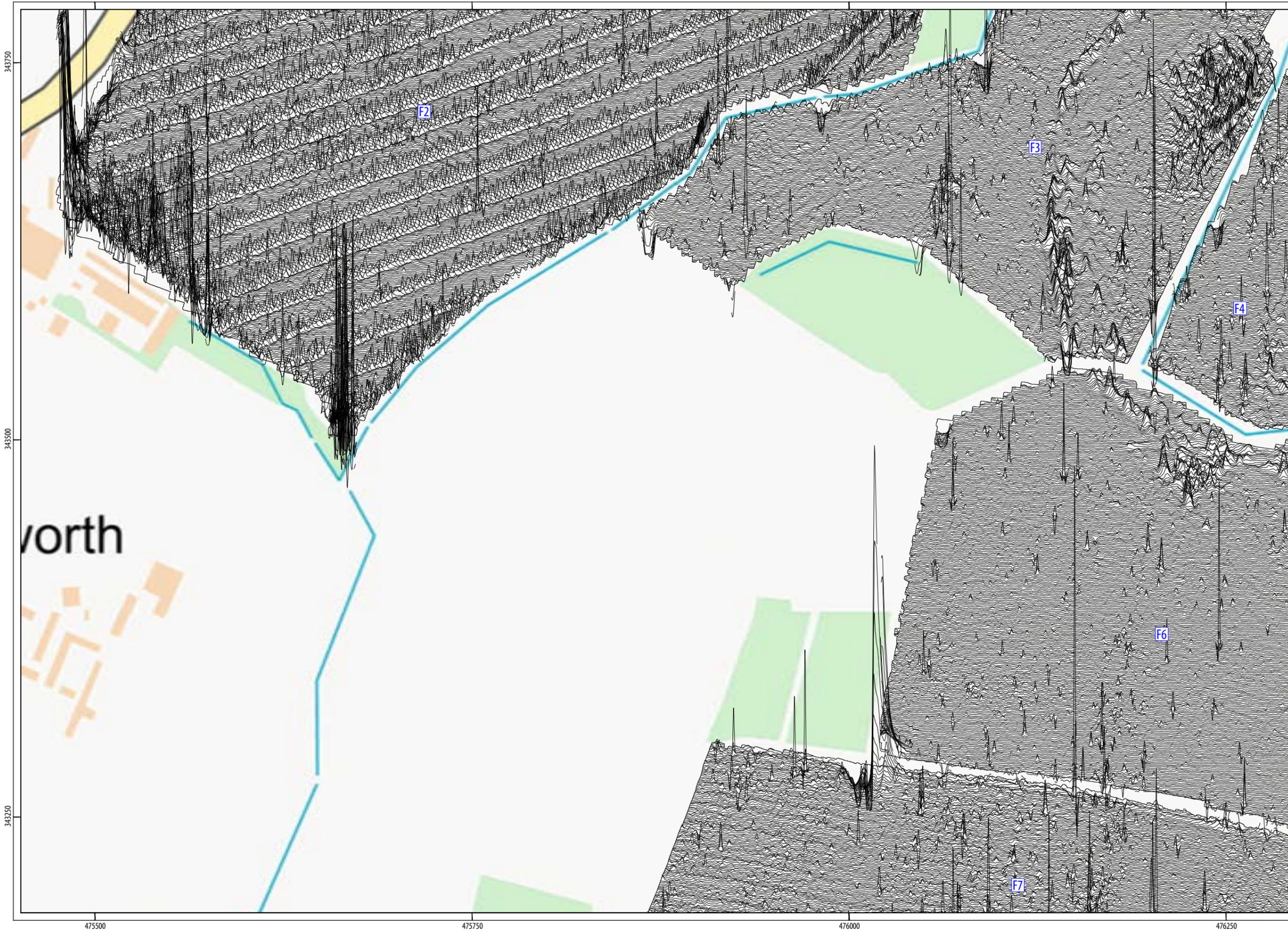
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ILLUS 12 Processed greyscale magnetometer data; Sector 2



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ILLUS 13 XY trace plot of minimally processed magnetometer data; Sector 2