ATCE19

A12 CHELMSFORD TO A120, ESSEX

GEOPHYSICAL SURVEY REPORT

commissioned by Jacobs UK Ltd
on behalf of Costain Ltd

September 2020

HEADLAND ARCHAEOLOGY

REGISTERED ORGANISATION CIfA

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

PROJECT INFO:

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HEADLAND ARCHAEOLOGY

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PROJECT SUMMARY

Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of c 495 hectares on land between junctions 19 and 23 within the A12 Chelmsford to A120 Proposed Scheme, to inform an archaeological assessment of the proposed road. The survey has successfully evaluated the geophysical survey areas within the Proposed Scheme with the exception of a small number of areas where ground conditions were deemed unsuitable for survey. A number of anomalies of either, likely, or possible, archaeological potential have been identified. Of particular significance are settlement anomalies to the north of the old Roman Road at Area 27, the remains of a possible Icehouse in Area 1, a possible kiln structure in Area 25, a ring-ditch in Area 29 and a large pit in Area 10. Other groups of linear and discrete anomalies, which might have an archaeological origin, have been identified in other areas as indicated in the results. Several dipolar anomalies have been detected which are consistent with modern activity such as buried service pipes, trackways, a former railway line, demolition rubble, and even a disused, Cold War observation post. A large number of linear anomalies consistent with typical responses from former field boundaries, and in many cases corresponding to boundaries marked on old OS maps, have also been detected throughout the survey areas. Several low magnitude anomalies have been detected which probably relate to natural or geological causes.

The majority of the scheme contains no anomalies of any archaeological potential and therefore, on the basis of the geophysical survey, the survey area is assessed as of low to moderate archaeological potential, and locally high in the vicinity of the clearly defined areas of archaeological activity.

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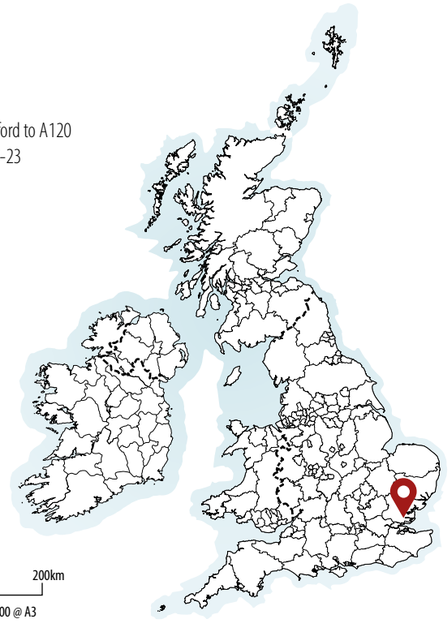

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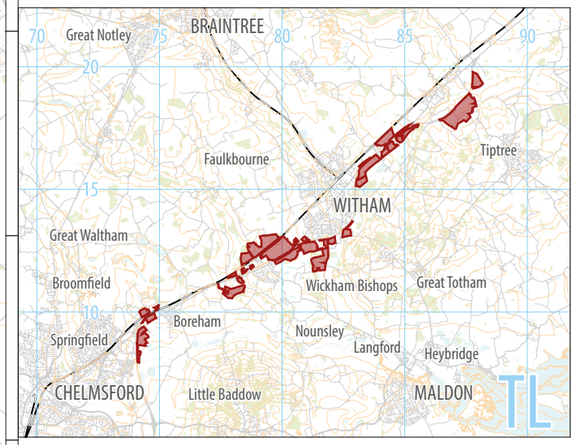

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geophysical survey area

ILLUS 1 Site location

A12 CHELMSFORD TO A120, ESSEX

GEOPHYSICAL SURVEY REPORT

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Jacobs UK Ltd (The Consultant), on behalf of Costain Ltd (The Principal Contractor), and Highways England (The Client) to undertake a geophysical (magnetometer) survey from junctions 19 to 23 within the A12 Chelmsford to A120 Proposed Scheme (PS). This consists of 31 separate geophysical survey areas, as numbered in Table 1, totalling c 495 ha.

The results of the survey will inform future archaeological strategy at the site. The survey was undertaken in order to assess the impact of the (PS) on the historic environment. It was undertaken in accordance with an Archaeological Written Scheme of Investigation (WSI) (Jacobs 2019), with guidance within the National Planning Policy Framework (MHCLG 2019) and in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016). The results will be disseminated through the preparation and deposition of an ordered archive submitted to the Archaeology Data Service (ADS) and a suitable final repository.

The surveys were carried out between December 6th 2019 and March 6th 2020.

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

This section of the PS starts at junction 19 (Boreham Interchange) on the north-east side of Chelmsford, extending to junction 23 (Kelvedon South Interchange), to the south-west of Kelvedon. All of it lies within the county of Essex, and it passes through the local planning authority areas of Chelmsford, Braintree, and Maldon. The Great Eastern Main Line travels parallel with the A12 for the whole length of the scheme.

This section of the PS passes through predominantly open countryside, in the form of large open arable fields and Grade 2 (very good) agricultural land. A number of towns and villages are located along the route including Boreham, Hatfield, Peverel, Witham, and Kelvedon. Part of the eastern end of the Proposed Scheme, south of Witham and Kelvedon, lies within the Blackwater Valley. The Blackwater Valley has large areas of floodplain associated with the River Blackwater. Other floodplains that cross the Proposed Scheme include those associated with the Boreham Brook and the River Ter.

Further details of land use for each area are given in Table 1, below.

1.2 GEOLOGY AND SOILS

The vast majority of the area for archaeological geophysical survey is underlain by London Clay, part of the Thames Group, mainly consisting of clay with some silts and sands. All the survey areas have a covering of superficial geology, and these comprise Lacustrine deposits (clay); Till – Diamicton; Brickearth (silt); Glacial Sand and Gravel; and River Terrace Deposits (sand and gravel) (NERC 2019). Full details for each area are given in Table 1, below.

Most of the soils covered by the geophysical survey area are classified in the Soilscape 6 Association, characterised as freely draining slightly acid loamy soils. Areas 1, 2, 23, 24, 26, and 30 have soils in the Soilscape 8 Association, characterised as slightly acid loamy and clayey soils with impeded drainage. Areas 9–17 inclusive have soils in the Soilscape 9 Association, characterised as lime-rich loams and clays with impeded drainage. (Cranfield University 2020).

2 ARCHAEOLOGICAL BACKGROUND

Essex is a rich county, archaeologically, with evidence for human occupation dating back approximately 500,000 years and the area along the A12 has, in places, been extensively archaeologically investigated. The underlying geology of sands and gravels are recognised as favourable conditions for early settlement and the A12 formed a significant communications route within the area from at least the Roman period. There are therefore a large number of archaeological remains recorded for the area within the Essex Historic Environment Record. Recent archaeological excavation around junction 19 (the Boreham Interchange) has confirmed the presence of considerable archaeological activity from the Neolithic through to the medieval periods in an area where known archaeological remains were limited or restricted to cropmarks. This suggests that there is a high potential for the presence of unknown archaeological remains throughout the PS.

A full archaeological and historical background for the study area and a gazetteer is presented in the Cultural Desk Based Assessment (Jacobs 2018). A summary of the archaeological and historical background for each geophysical survey area is included in Table 1, below.

3 AIMS, METHODOLOGY AND PRESENTATION

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

The specific archaeological objectives of the geophysical survey were:

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

TABLE 1 Description of Archaeological Geophysical Survey Areas (modified from Jacobs 2019, table 5.1)

GEOPHYSICAL SURVEY AREA	APPROXIMATE CENTRAL NATIONAL GRID REFERENCE	APPROXIMATE EXTENT OF GEOPHYSICAL SURVEY AREA (HA)	DESCRIPTION (KNOWN HERITAGE ASSETS, TOPOGRAPHY, AND SUPERFICIAL GEOLOGY)
1	TL7421708824	29.4	South-west of Grade I Listed Boreham House which is located within a Grade II Registered Park and Garden. Also within an area of dense cropmarks indicative of potential field systems, pits, trackways and enclosures. Southern portion is within the Chelmer and Blackwater Navigation Conservation Area. Arable fields. Superficial geology comprises Lacustrine Deposits – Clay.
2	TL7459909740	9.2	Bisected (north to south) by an area that was stripped for the Boreham to Springfield water pipeline which runs just west of Boreham Brook; monitoring work recorded evidence for prehistoric activity and a palaeochannel. Encompasses the area of the former Boreham Mill. Arable fields. Superficial geology comprises Till – Diamicton.
3	TL7743010983	0.8	Cropmarks of linear features. Arable field. Superficial geology comprises Till – Diamicton and Brickearth.
4	TL7800810813	24.4	Cropmarks of field boundaries, including of an enclosure representing the boundary of 'round wood' depicted on 1st edition Ordnance Survey mapping. Arable field, River Ter runs along eastern boundary. Superficial geology comprises Brickearth and Glacial Sand and Gravel.
5	TL7796011489	3.5	Probable site of old parish church of Hatfield Peverel. Arable field. Superficial geology comprises Brickearth and Glacial Sand and Gravel.
6	TL7827611318	4.1	No known archaeological remains. Arable field, stream at eastern boundary. Superficial geology comprises Glacial Sand and Gravel.
7	TL7840911672	2.2	No known archaeological remains. Arable field. Superficial geology comprises Glacial Sand and Gravel and Till – Diamicton.
8	TL7875811844	1.4	No known archaeological remains. Field. Superficial geology comprises Till – Diamicton.
9	TL7857712192	16.1	Probable site of a deserted medieval settlement, including potential location of medieval church. Arable field. Superficial geology comprises Glacial Sand and Gravel and Till – Diamicton.

GEOPHYSICAL SURVEY AREA	APPROXIMATE CENTRAL NATIONAL GRID REFERENCE	APPROXIMATE EXTENT OF GEOPHYSICAL SURVEY AREA (HA)	DESCRIPTION (KNOWN HERITAGE ASSETS, TOPOGRAPHY, AND SUPERFICIAL GEOLOGY)
10	TL7919912781	51.9	No known archaeological remains. Arable field. Superficial geology comprises Till – Diamicton
11	TL7983012547	64.8	An underground Cold War Nuclear Monitoring Post is located within the field. An area of brick works is denoted in part of the area on Ordnance Survey maps of 1987 and 1947. Arable field. Superficial geology comprises Till – Diamicton.
12	TL8031812319	23.2	Cropmarks of rectangular enclosure and linear features, and a potential double ditched trackway. Incorporates part of an historical mineral extraction site from the 1980s, indicated on the Ordnance Survey mapping as a general area of small pits which were infilled and flooded before 1999. Arable field. Superficial geology comprises Till – Diamicton.
13	TL8051112750	1.2	No known archaeological remains. Open land, appears as an unpaved parking area. Superficial geology comprises Till – Diamicton.
14	TL8058912908	1.5	No known archaeological remains. Arable field. Superficial geology comprises Till – Diamicton.
15	TL8070712705	0.9	No known archaeological remains. Arable field. Superficial geology comprises Till – Diamicton.
16	TL8108612630	24.6	No known archaeological remains. Arable field. Superficial geology comprises River Terrace Deposits and Till – Diamicton
17	TL8094012947	3.8	Incorporated within the vicinity of a site investigated in the 1970s; though it does not appear to have been trial trenched. Arable field. Superficial geology comprises Till – Diamicton.
18	TL8173712249	43.1	Cropmarks of two linear features have been identified within the study area. Arable field. Superficial geology comprises River Terrace Deposits.
19	TL8202412924	6.6	Cropmarks indicative of linear features. An evaluation conducted in advance of the construction of the electricity substation in the south-west corner of the area revealed no archaeological features, deposits, or artefacts. Arable field. Superficial geology comprises River Terrace Deposits.
20	TL8262713223	9.1	No known archaeological remains. Arable field. Superficial geology comprises River Terrace Deposits.
21	TL8273413539	1.2	Arable field. Superficial geology comprises River Terrace Deposits and Till – Diamicton.
22	TL8322615321	11.9	No known archaeological remains within this area, however the land to the north-east of this area has had substantial intrusive archaeological investigations, identifying prehistoric and Roman enclosures, ditches and finds. Arable field. Superficial geology comprises River Terrace Deposits and Till – Diamicton.
23	TL8321515992	1.0	No known archaeological remains. Field. Superficial geology comprises Till – Diamicton.
24	TL8340916155	0.6	A 1716 map identified a possible field enclosure in this general location that may originate in the later Roman and Saxon periods. Arable field. Superficial geology comprises Till – Diamicton.
25	TL8419916534	7.6	Cropmarks indicating an enclosure, ring ditch and barrow have been identified extending into this survey area. Worked flint and a medieval silver-plated ring were also recovered from this area. Arable field and recent tree planting. Superficial geology comprises River Terrace Deposits and Till – Diamicton.

GEOPHYSICAL SURVEY AREA	APPROXIMATE CENTRAL NATIONAL GRID REFERENCE	APPROXIMATE EXTENT OF GEOPHYSICAL SURVEY AREA (HA)	DESCRIPTION (KNOWN HERITAGE ASSETS, TOPOGRAPHY, AND SUPERFICIAL GEOLOGY)
26	TL8422117075	24.1	Cropmarks indicating a possible field boundary and a wide double-ditch feature extend into this survey area. Arable fields. Superficial geology comprises Till – Diamicton.
27	TL8485317370	4.2	Cropmarks indicating trackways, ring ditches, linear features and a potential circle of pits, which extend into this survey area. Additionally, finds of Roman and medieval to post-medieval periods have also been recovered adjacent to this survey area. Arable fields. Superficial geology comprises River Terrace Deposits and Till – Diamicton.
28	TL8478917060	5.5	Finds dating from the early Neolithic to the post-medieval period have been recovered from within this survey area. Arable fields. Superficial geology comprises River Terrace Deposits and Till – Diamicton.
29	TL8514917360	11.0	A cropmark of a single ring ditch extends into this survey area. Additionally, several finds dating from the middle Bronze Age to the post-medieval period have also been recovered from within this survey area. Arable field. Superficial geology comprises River Terrace Deposits.
30	TL8727918143	88.4	A possible Roman tile kiln and double-ditched linear feature have been identified in this area. Additionally, several finds dating from the medieval to post-medieval period have been recovered from within this survey area. Arable fields. Superficial geology comprises River Terrace Deposits and Till – Diamicton.
31	TL8791919418	17.8	No known archaeological remains, however cropmarks interpreted as field boundaries and garden features, as well as find-spots have been identified to the east and south of this survey area. Arable fields. Superficial geology comprises River Terrace Deposits and Till – Diamicton.

3.1 MAGNETOMETER SURVEY

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

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

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

3.2 REPORTING

A set of general site location plans with greyscale data and interpretations are shown in Illus 2–9 at a scale of 1:15000. Fully processed (greyscale) data, minimally processed data (XY trace plot) and an interpretative plot are presented at a scale of 1:2,500, and numbered by sector, Illus 10 to Illus 97 inclusive. A summary of the findings detected by the geophysical survey are presented in Table 2, below.

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 (Jacobs 2019), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2014). All illustrations from Ordnance Survey (OS) mapping are reproduced with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

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

4 RESULTS AND DISCUSSION

Ground conditions were very good throughout the PS contributing to a high standard of data collection. A small number of areas were either not surveyed at all, or were partly surveyed due to a variety of reasons. These are shown in the illustrations and discussed in the summary (Table 2). The survey has detected a moderate level of background magnetic variation which is characterised by frequent, evenly dispersed, discrete low magnitude anomalies. This is likely due to the depth and composition of the topsoil and the superficial deposits from which they derive. Against this background several anomalies have been identified. These are discussed further as part of an area by area list below, Table 2.

4.1 FERROUS AND MODERN ANOMALIES

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

Low magnitude parallel linear trend anomalies, aligned parallel with the surrounding field boundaries, are typical of modern ploughing. A number of stronger linear anomalies throughout the PS, form the characteristic patterns of modern land drains, and have been interpreted accordingly.

4.3 GEOLOGICAL ANOMALIES

Low magnitude irregular anomalies, sub-linear and curvilinear, occur in many areas of the PS. There are a number of floodplains crossed by the route and some of the anomalies are probably associated with palaeochannels and other fluvial events. Periglacial effects can also be seen in some areas.

4.4 POSSIBLE ARCHAEOLOGICAL ANOMALIES

A number of high magnitude anomalies (relative to the magnetic background) have been identified throughout the PS as having possible archaeological potential. Of particular significance are likely settlement anomalies to the north of the old Roman Road at Area 27, the remains of a possible Icehouse in Area 1, a possible kiln structure in Area 25, a ring-ditch in Area 29 and a large pit in Area 10. Other groups of linear and discrete anomalies, which might have an archaeological origin, have been identified in Areas 10, 11, 16, 18, 20, and 25–31 inclusive.

TABLE 2 Summary of findings by Geophysical Survey Area

GEOPHYSICAL SURVEY AREA AND SECTOR NO	SUMMARY OF FINDINGS
1 Sectors 1–2 Illus 10–15	Strong magnetic disturbances were detected along the side of the A12. Two large areas of ferrous disturbance in F1.3 are likely to be modern, one adjacent to the present route of the A12 and more or less bounded by modern tracks, and the other immediately adjoining an existing quarry pit. Similar areas of ferrous disturbance flank the currently occupied, and thus unsurveyed, section that lies in between fields F1.4 and F1.6. A number of strong, dipolar linear anomalies indicative of modern services cross F1.1, F1.3, F1.5 and F1.6. Several linear anomalies have been detected in F1.3 and F1.5, and have been interpreted as, either former field boundaries possibly relating to the former parkland at Boreham House, or land drains. Anomalies associated with the possible remains of an Icehouse, DB1, depicted on historic OS maps is evident in F1.6.
2 Sector 3 Illus 16–18	A strongly magnetic modern service bisects the field F2.2, and another follows along the eastern side of the Boreham Brook. On either side of the brook lightly curving linear anomalies correspond to field boundaries on early OS maps. Several land drains criss-cross F2.2 and F2.3 There are a number of geological anomalies (periglacial?) in F2.3. Ferrous disturbances along the northern edge of the area could be from modern services or the proximity of the A12. A large area of ferrous disturbance in the south-western corner of F2.3 may relate to the former Boreham Mill.
3 Sector 4 Illus 19–21	The northern part of this narrow strip is covered by an area of strong ferrous disturbance, and a possible service pipe adjacent to and parallel to the A12. The rest consists of isolated dipole anomalies and small areas of ferrous disturbance. No evidence of the cropmarks seen in parts of this field (Jacobs 2019) were detected.
4 Sectors 4–5 Illus 19–24	A small part of F4.2 was not surveyed due to bird cover. The areas to the north and south (F4.1) of the cover are characterised by a large number of irregular anomalies of low magnetic response These have been interpreted as of probably geological origin. The central part of F4.2 is criss-crossed by field drains. Two broad, irregular linear anomalies in the eastern part of the field may well represent flooding incursions, or palaeochannels, reflecting the presence of the River Tey just to the east. The course of several former field boundaries corresponding with earlier OS maps have been detected and indicated. Some of these may have been seen in cropmarks discussed in the WSI (Jacobs 2019).
5 Sector 6 Illus 25–27	Magnetic response in this field, situated between the railway line and the A12 is dominated by ferrous disturbance. The WSI (Jacobs 2019) suggests this as a probable site of old parish church of Hatfield Peverel. No foundations are visible but the high noise level would be consistent with a demolished building.
6 Sector 6 Illus 25–27	The survey has detected two former field boundaries known from earlier maps, and a modern service trench running east-west across the field. There are several areas of ferrous disturbance around the farm buildings, adjacent to the A12, and along part of the western boundary of the field.
7	Area not surveyed due to overgrown vegetation.
8	Area not surveyed as the area is a construction site.

GEOPHYSICAL SURVEY AREA AND SECTOR NO	SUMMARY OF FINDINGS
9 Sector 7 Illus 28–30	The 1898 OS map show this field area as being split into three fields, and the former boundaries have all been detected. Magnetic responses in the two former fields to the west are dominated by faint, irregular patterns likely to be related to the River Tey and its floodplain. No clear evidence of anomalies that might be associated with the deserted medieval settlement and church, believed to lie to the west of the site, (Jacobs 2018) have been detected. Throughout the whole area a complex network of field drains, probably representing multiple phases, have been detected. Some of the natural anomalies in the north-east of the area may be related to an early drainage regime. Strong ferrous activity is present along the extant field boundaries, and by the side of the railway, adjacent to the southern boundary.
10 Sectors 7–11 Illus 28–42	The survey has, detected two possible areas of archaeological interest: a large isolated pit-like anomaly P1, in the northern part of F10.1, and a potential enclosure E1, with associated anomalies, in the south-west corner of F10.2 This latter group are cut by the railway line but align with a similar group of anomalies in the north-eastern corner of F11.1 on the southern side of the railway. Although interpreted as possible archaeology, they could represent an earlier agricultural regime as they also align approximately with former field boundaries shown in earlier OS maps. The two large fields, F10.3, and F10.4, both have faint polygonal anomalies typical of periglacial anomalies. Both fields have clear drainage regimes, F10.3 a series of parallel field drains, F10.4 with characteristics more like those seen in Areas 9, and the western half of Area 10. Ferrous disturbances are concentrated along the side of the railway line and around the eastern and northern boundaries.
11 Sectors 9–12 Illus 34–45	F11.2 which includes the site of a former brick works, was not surveyed due to overgrown vegetation. The most significant finding in F11.1 are a series of linear anomalies, indicative of ditches, D1–D11, forming a rectangular pattern on a similar orientation as those seen in F10.2, and have been interpreted as possible archaeology for the same reasons. Most of the fields in this area are dominated by drainage anomalies and former field boundaries. There are a cluster of periglacial-type anomalies in F11.1. Ferrous disturbances have been recorded around the edges of the field, and within, including over the known site of a Cold War Nuclear Monitoring Post in F11.3.
12 Sectors 12–14 Illus 43–51	The outline of the known mineral extraction area has been clearly detected in the south of F12.2. A series of parallel drain anomalies cross north-west to south-east, and a strongly magnetic linear feature indicates a modern service pipe. Field boundaries known from earlier OS maps have also been detected, and may account for cropmarks seen in this field (Jacobs 2019). Several patches of ferrous disturbance have been indicated within F12.2 and along the road boundary along the north of the survey area. A small area in the east of the F12.2 has been interpreted as a possible quarry pit.
13 Sector 11 Illus 40–42	Dominated by modern ferrous anomalies. Possibly related to this area's former use as a car park (Jacobs 2019).
14 Sectors 11 & 14 Illus 40–42 & 49–51	A series of strongly magnetic linear anomalies indicate modern services. Extensive ferrous activity close to buildings to the west and the road to the south.
15 Sector 14	This area not surveyed due to the field being heavily ploughed at the time of the survey.
16 Sectors 13–14 & 16–17 Illus 46–51 & 55–60	A number of linear and discrete anomalies have been indicated as possibly archaeological ditches, D12–D16, and pits in the north of the F16.1 A strongly magnetic service pipe crosses the field south-west to north-east. A series of parallel drains have been detected across the field as well as a cultivation pattern trending roughly west to east. Several broad, irregular linear anomalies have been interpreted as geological.
17 Sector 14 Illus 49–51	This small field is sandwiched between the old A12 and the modern bypass around Witham, and a few small areas in the centre were overgrown and unsuitable for survey. There are large areas of ferrous disturbance in the south-east corner and along the field's boundaries. The survey has, however, identified linear anomalies as agricultural cultivation, and a former field boundary. A few discrete anomalies have been indicated as possibly archaeological due to their nature and proximity to similar anomalies in Area 16 on the other side of the A12.
18 Sectors 13 & 15–17 Illus 46–48 & 52–58	The fields in Area 18 still retain almost the same boundaries as an OS map of 1898, and most of the area could be surveyed apart from a strip of bird cover in F18.3. The most significant finds within this area are a group of linear anomalies, D17–D23, in F18.1 which form a rectilinear pattern, and might represent a system of ditches or enclosure or early field system. Irregular anomalies, similar to those seen in Area 16, and present in all the fields here, have been interpreted as likely to have a geological origin. Cropmarks seen in F18.9 (Jacobs 2019) may be geological. Some of the fields, F18.1, and F18.4–6 have well-developed systems of parallel drains. Most of the field boundaries that butt against trackways, or roads, have ferrous disturbances along them. The western edge of F18.3 has a line of equally spaced ferrous dipoles a few metres in from the boundary, possibly representing the bases of fence posts still in situ. The northern edge of F18.9 has a strong linear dipolar feature running along the side of the A12 and is likely to be a modern service.
19 Sector 17 Illus 58–60	The modern service pipe seen in Area 18 continues into this area, following the road edge. The only other notable anomalies in this area are cultivation trends, and two former field boundaries which correspond to early OS maps and may account for cropmarks recorded in this field (Jacobs 2019).
20 Sector 18 Illus 61–63	Three linear anomalies, D24–D26, have been interpreted as possible archaeological ditches due to their common alignment. A series of broad, amorphous linear anomalies, some of which run parallel to the River Blackwater, nearby to the east, have been interpreted as natural variations perhaps due to flood episodes. Two strongly magnetic parallel drains have been detected, and a number of probable service anomalies have been identified.
21 Sector 18 Illus 61–63	Narrow section along the side of the A12 is completely dominated by the strong dipolar feature seen in Area 20.

GEOPHYSICAL SURVEY AREA AND SECTOR NO	SUMMARY OF FINDINGS
22 Sector 19 Illus 64–66	Areas to the east and west of the area, and a strip between F22.1 and F22.2 were unsurveyable due to areas of quarrying. Although archaeological features had been discovered during an excavation prior to the building of the substation to the north, and Prehistoric finds are known in fields to the east (Jacobs 2019), no further archaeology was detected in this area. Linear anomalies characteristic of service pipes emanate from the substation in F22.1 and F22.2 and there is a large area of ferrous disturbance in the north of F22.1 which may relate to theIR construction. A clear field drain arrangement can be seen in all three fields.
23 Sector 20	No access allowed to this area.
24 Sector 20 Illus 67–69	Responses in this narrow strip are dominated by modern ferrous disturbance from the adjacent A12. A service pipe has been detected crossing the strip.
25 Sector 21 Illus 70–72	The survey has detected a strong anomaly in the north-west corner of F25.1 which has the characteristics of a feature such as a kiln or furnace, K1. Curvilinear and discrete anomalies nearby have been indicated as possibly archaeological. Roman and medieval finds have been made in this field, and fields to the south and east of this area, and cropmarks recorded to the east Jacobs 2018), but no further archaeological anomalies, other than those described above, have been detected by the survey. A clear pattern of cultivation in this field has also been noted, as has geological features perhaps related to the nearby brook. The two small fields in the east of the area, and immediately next to the brook, have a very quiet magnetic background, and the only anomalies detected are ferrous dipoles and a patch of ferrous disturbance along the roadside.
26 Sectors 21–22 Illus 70–75	A group of discrete anomalies and pit-like anomalies in the eastern corner of F26.2 have been interpreted as possible archaeology, particularly with their proximity to the more certain archaeology detected in Area 27 and known Roman finds nearby (Jacobs 2019). Other anomalies in the area include a series of parallel drains, and irregular, sinuous low magnetic anomalies interpreted as geological, the northern and southern boundaries are littered with ferrous disturbances, probably due to the railway, and A12 road, respectively.
27 Sector 23 Illus 76–78	A group of likely archaeological anomalies detected in the western part of the area, including probable linear ditches D27–D30, an enclosure E2, and a ring-ditch RD1, correspond to known cropmarks in F27.3 (Jacobs 2019). A few linear anomalies, and a number of discrete pit-like anomalies scattered throughout the field have been interpreted as possibly archaeological. Three former field boundaries have been identified within F27.3.
28 Sector 23 Illus 76–78	A large number of find-spots dating form early Neolithic to post-medieval had been recorded for the fields surrounding Hole Farm. The only archaeological anomalies to be detected by the survey, however, were a likely ring-ditch RD2 in F28.3, near to a possible ditch D31, and a few pit-like anomalies. F28.2 was not surveyed because of a maize crop, and in the fields to the west of the farmhouse, the survey has mostly detected ferrous disturbance, apart from a single former field boundary, and a small pit-like anomaly that might be of archaeological origin.
29 Sector 23–24 Illus 76–81	In the field to the east of Hole Farm, F29.1, the survey has detected a substantial area of geological anomalies and a few former field boundaries, and cultivation trends. The far eastern part of the field is disturbed by ferrous anomalies. Cropmarks identified to the south of F29.1 either do not appear to have spread into this area or have not been detected.
30 Sectors 25–28 Illus 82–93	Three distinct areas of possible archaeological significance have been identified in F30.3, F30.4 and F30–5. These consist of linear anomalies indicative of ditches, D32–D41 and a large cluster of discrete anomalies. The group of anomalies identified in F30.3 is close to a 1976 record of dark earth and kiln material (Jacobs 2018). A large number of irregular anomalies of probable geological origin have been detected throughout the area, and drainage anomalies identified in F30.3 and F30.4. Ferrous disturbance are record along most of the extent field boundaries, and a number of former field boundaries have been identified. Two distinctive service pipes are indicated passing through F30.6, the eastern edge of F30.5, and diagonally across F30.7. A double-ditched feature, marked as modern is probably the 'trackway' identified in the WSI (Jacobs 2019). The anomalies associated with the former Kelvedon, Tiptree and Tollesbury Light Railway, FR1, have been recorded in F30.7. The railway first appears on the 1923 OS mapping and appears to have become disused by the production of the 1969 OS mapping. Areas of bird cover were not surveyed in F30.1, F30.5, and F30.7.
31 Sector 29 Illus 94–96	A group of linear and discrete pit-like anomalies in the northern half of F31.2 have been interpreted as possible archaeology, D42–D45. A fairly extensive, network of former field boundaries have also been identified in both F31.2 and F31.3, and a small number of irregular anomalies have been interpreted as of geological origin. Cropmarks in the field to the east have been previously interpreted as boundaries and garden features connected to nearby Prested Hall (Jacobs 2019).

5 CONCLUSION

The survey has successfully evaluated the geophysical survey areas within the Proposed Scheme except for a few small areas where ground conditions were deemed unsuitable for survey. A number of anomalies of either likely or possible archaeological potential have been identified. Of particular significance are settlement anomalies to the north of the old Roman Road at Area 27, the remains of a possible Icehouse in Area 1, a possible kiln structure in Area 25, a ring-ditch in Area 29 and a large pit in Area 10. Other groups of linear and discrete anomalies, which might have an archaeological origin, have been identified in other areas as indicated in the results.

Several dipolar anomalies have been detected which are consistent with modern activity such as buried service pipes, trackways, a former railway line, demolition rubble, and even a disused, Cold War observation post. A large number of linear anomalies consistent with typical responses from former field boundaries, and in many cases corresponding to boundaries marked on old OS maps, have also been detected throughout the survey areas. Several low magnitude anomalies have been detected which probably relate to natural or geological causes.

The majority of the scheme contains no anomalies of any archaeological potential and therefore, on the basis of the geophysical survey, the survey area is assessed as of low to moderate archaeological potential, and locally high in the vicinity of the clearly defined areas of archaeological activity.

6 REFERENCES

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

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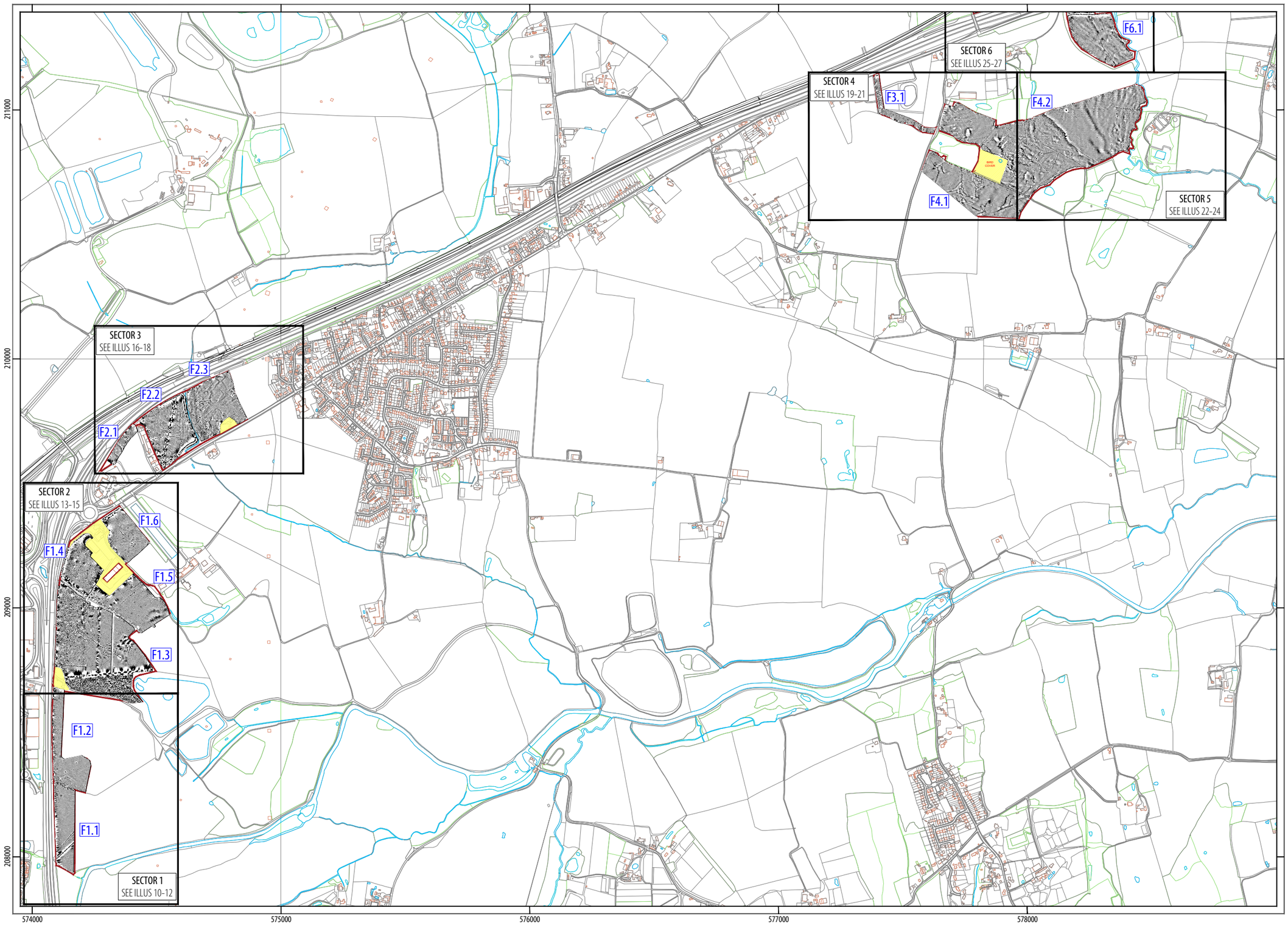
Jacobs 2019 ***A12 Chelmsford to A120 Invitation to tender volume 2: Archaeological geophysical survey written scheme of investigation*** [unpublished client document]



geophysical survey area
field number
unsuitable for survey

nT
-1.0 2.0

0 400m
1:15,000 @ A3

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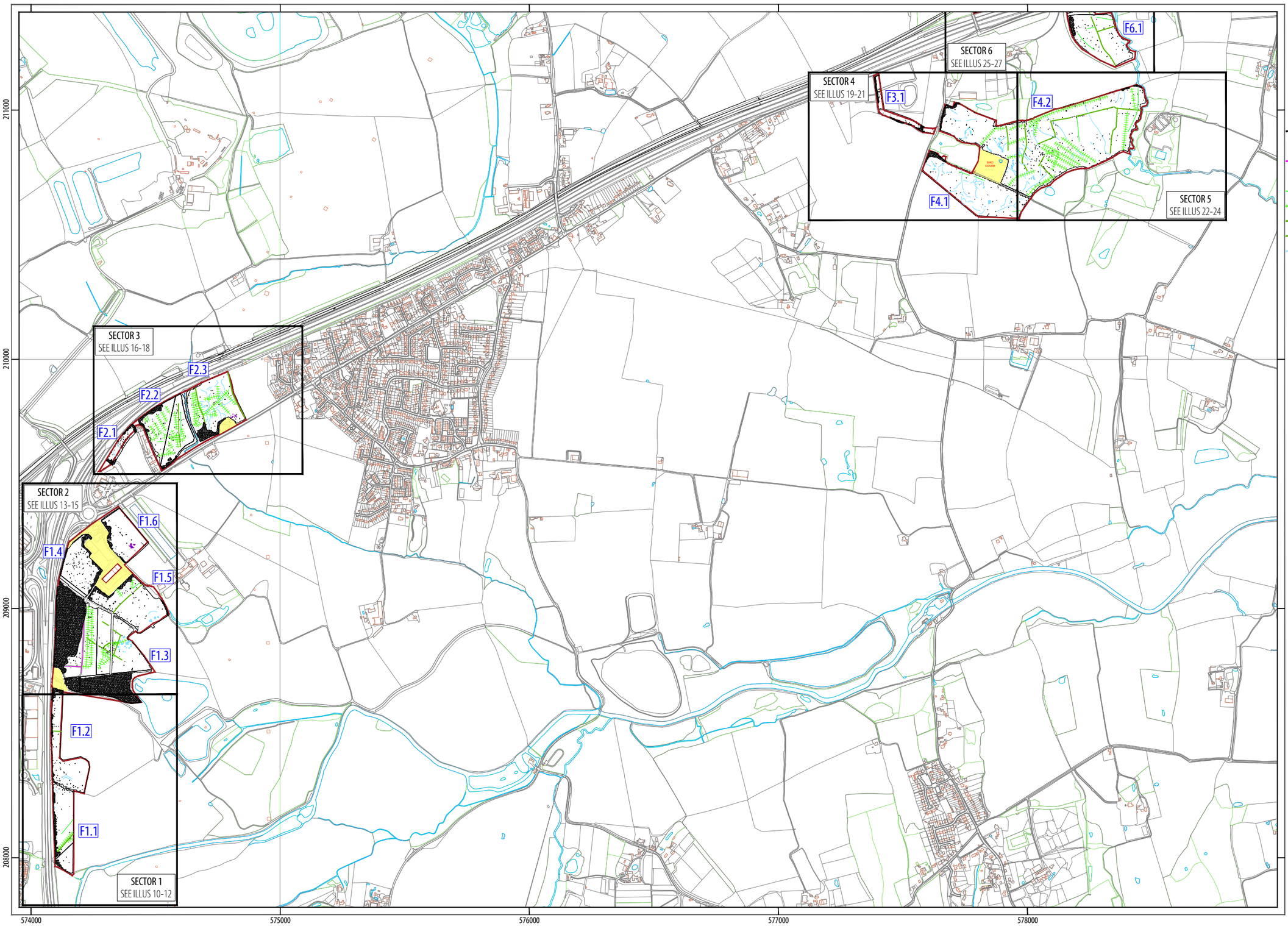
ILLUS 2 Overall greyscale plot of magnetometer data, West



geophysical survey area
field number
unsuitable for survey

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
null value	overhead cables
linear	modern track
magnetic enhancement	former building
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear	former field boundary?
linear trend	geological variation
magnetic enhancement	geology

0 400m
1:15,000 @ A3

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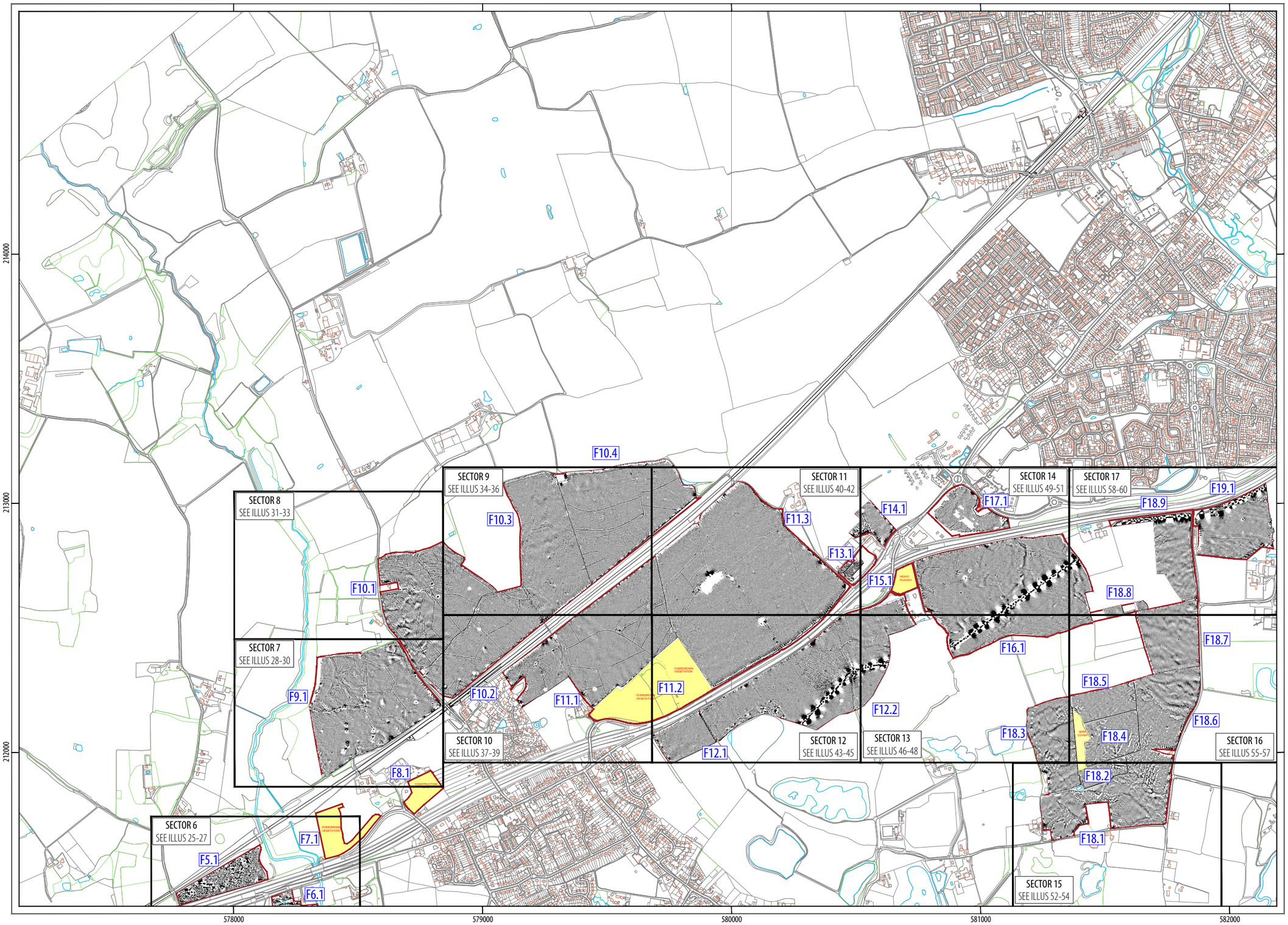
ILLUS 3 Overall interpretation plot of magnetometer data, West



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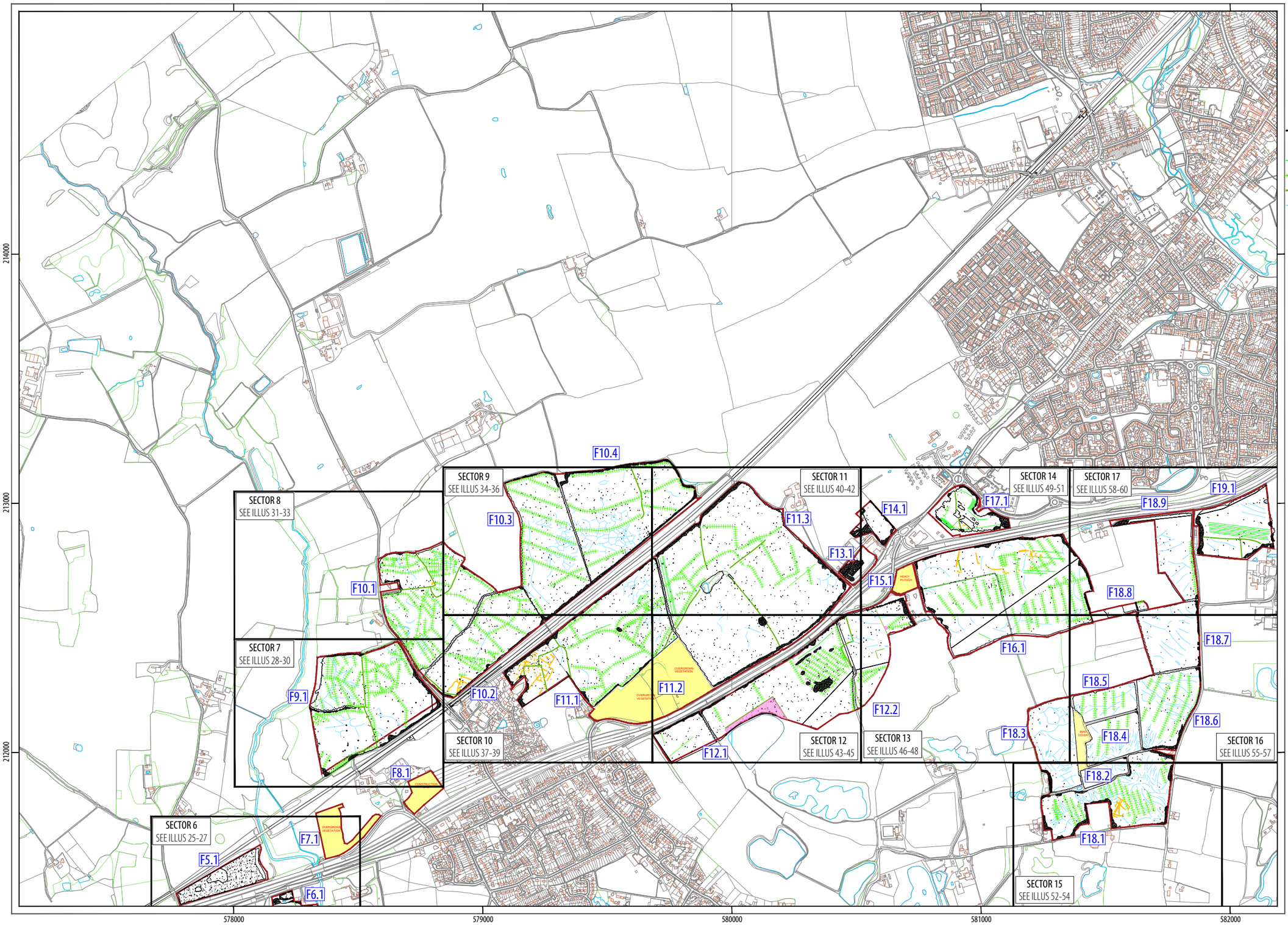
ILLUS 4 Overall greyscale plot of magnetometer data, Centre West



- geophysical survey area
- field number
- unsuitable for survey

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

0 400m
1:15,000 @ A3

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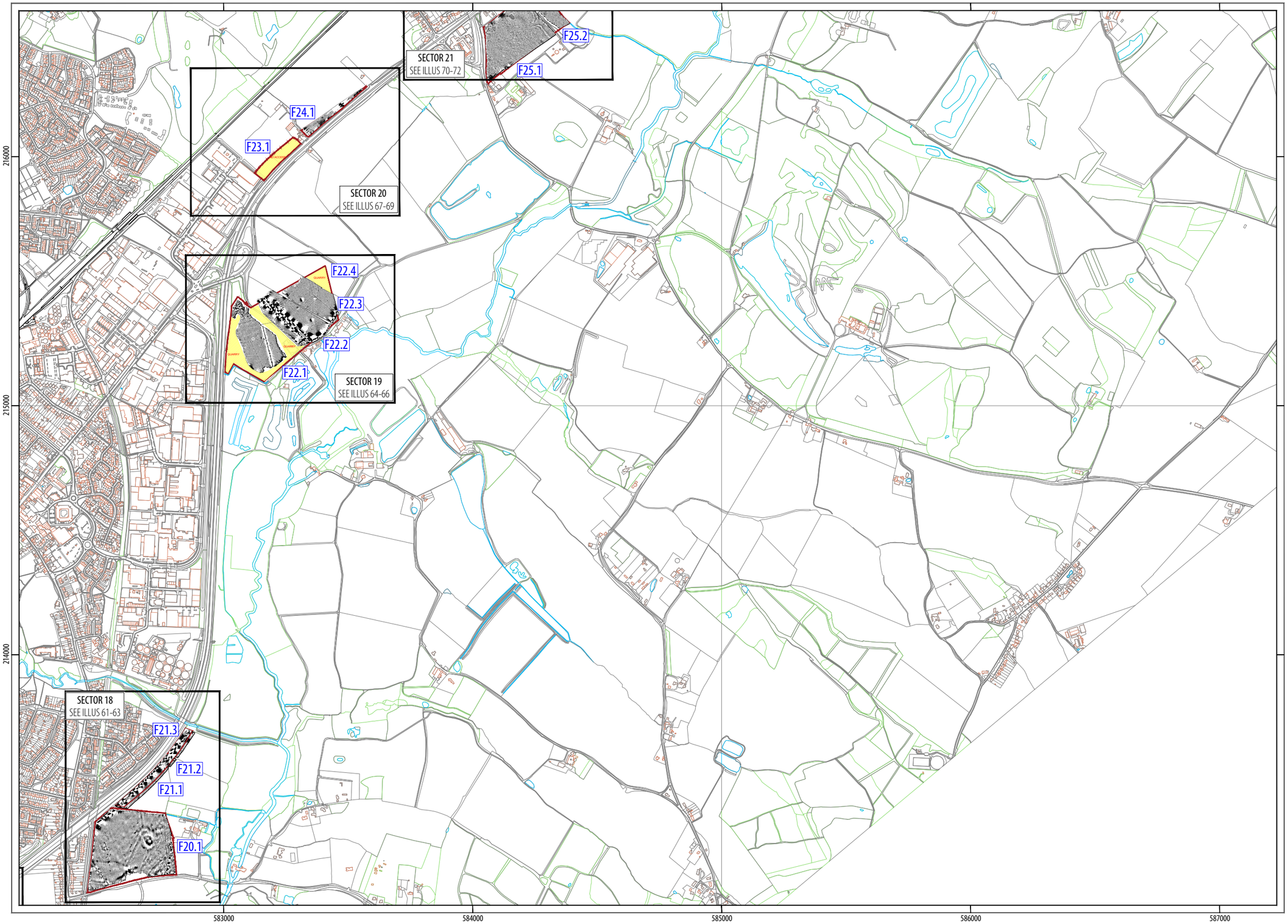
ILLUS 5 Overall interpretation plot of magnetometer data, Centre West



geophysical survey area
field number
unsuitable for survey

nT
-1.0 2.0

0 400m
1:15,000 @ A3

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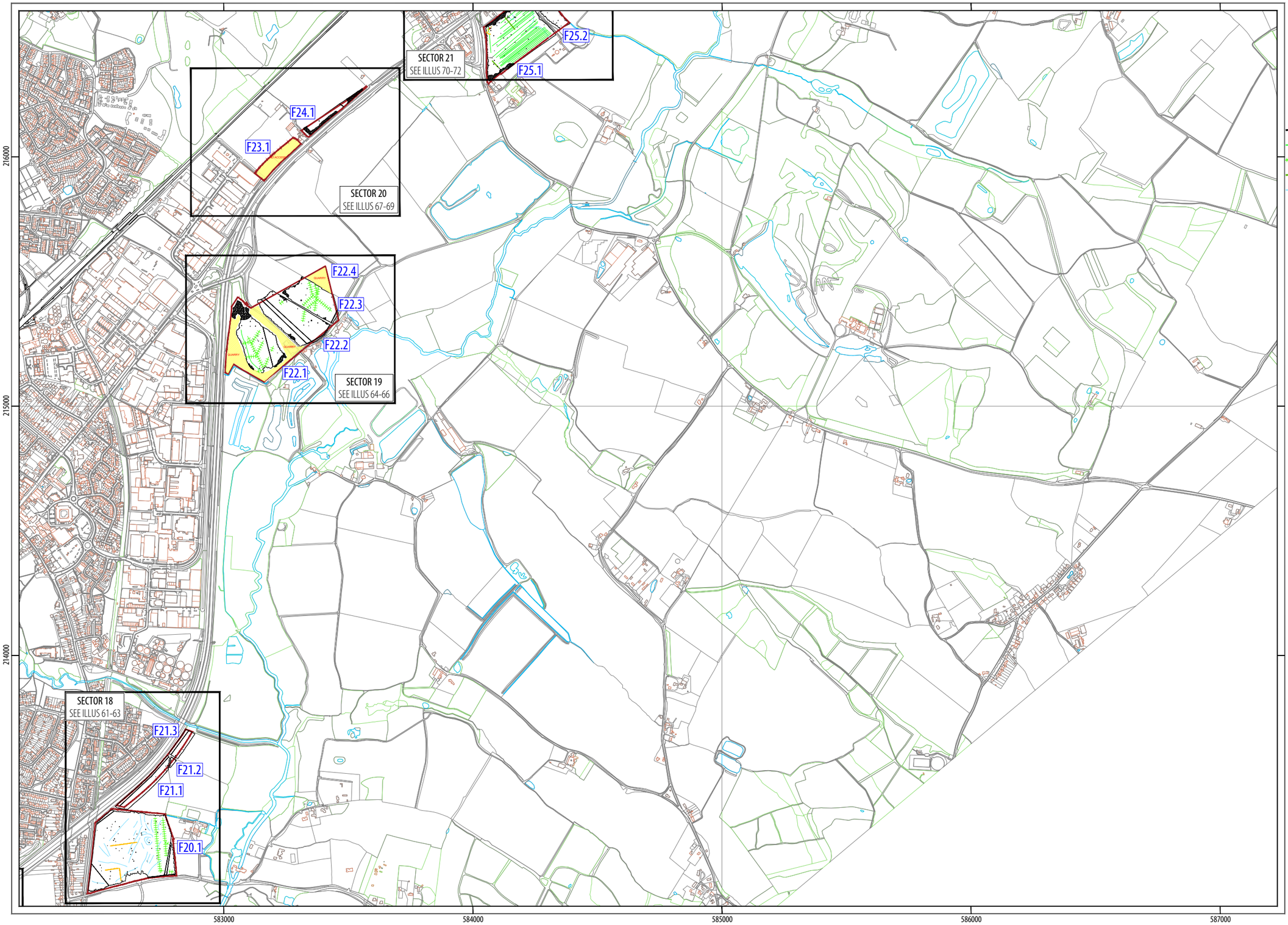
ILLUS 6 Overall greyscale plot of magnetometer data, Centre East



- geophysical survey area
- field number
- unsuitable for survey

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 trend	geological variation
magnetic enhancement	archaeology?
magnetic enhancement	kiln/burning

0 400m
1:15,000 @ A3

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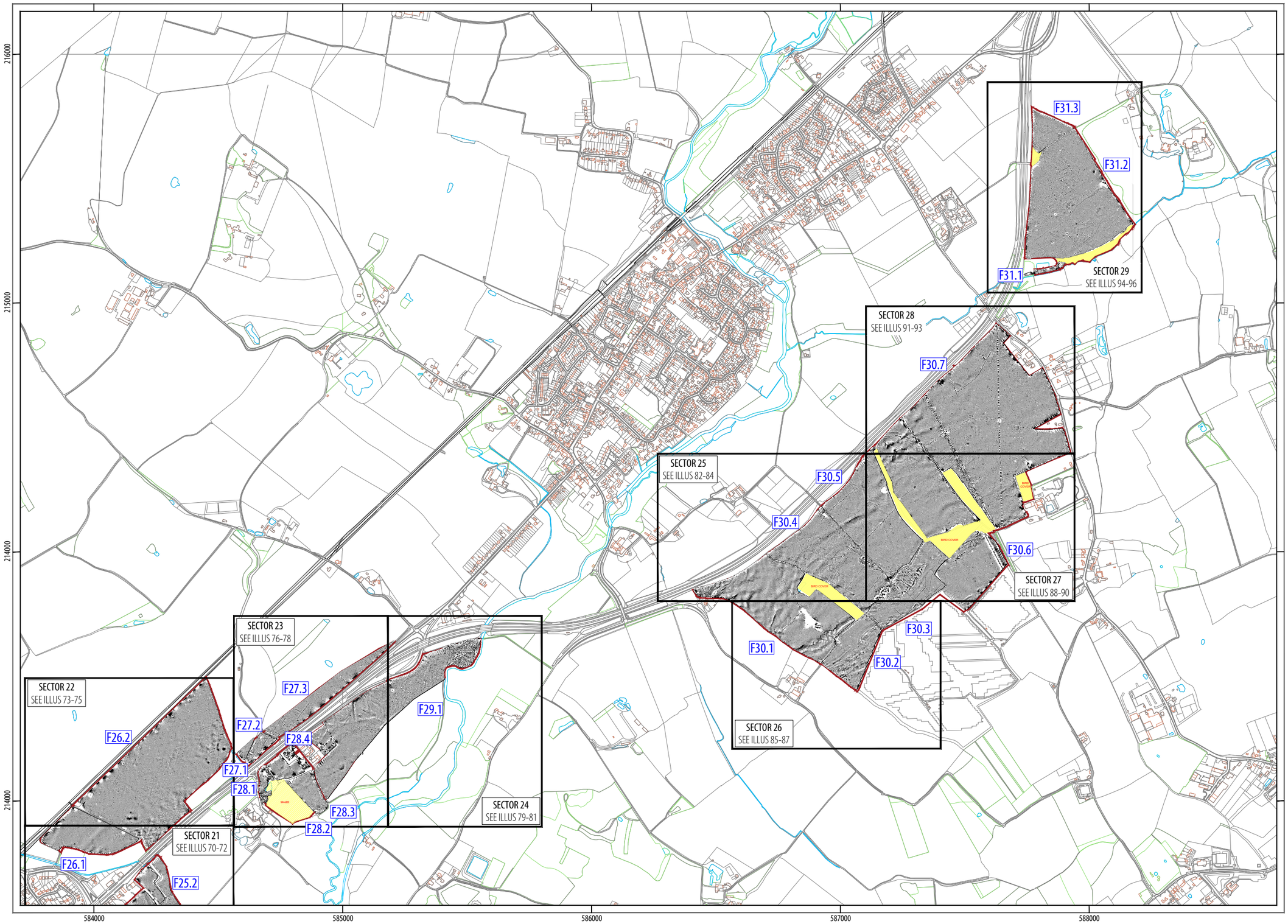
ILLUS 7 Overall interpretation plot of magnetometer data, Centre East



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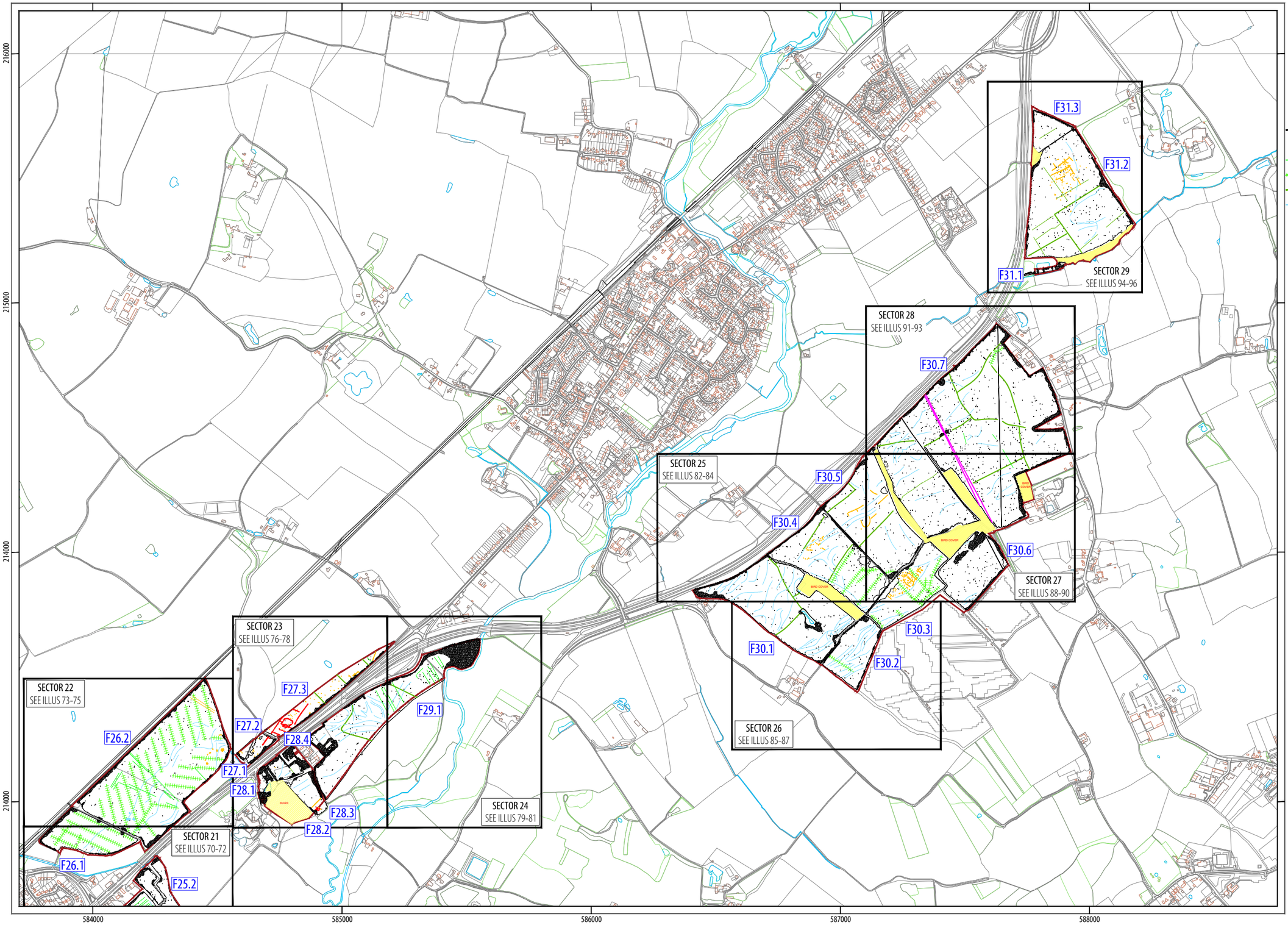
ILLUS 8 Overall greyscale plot of magnetometer data, East



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ILLUS 9 Overall interpretation plot of magnetometer data, East

F1.3

F1.2

F1.1

208500

208000

574000

574500

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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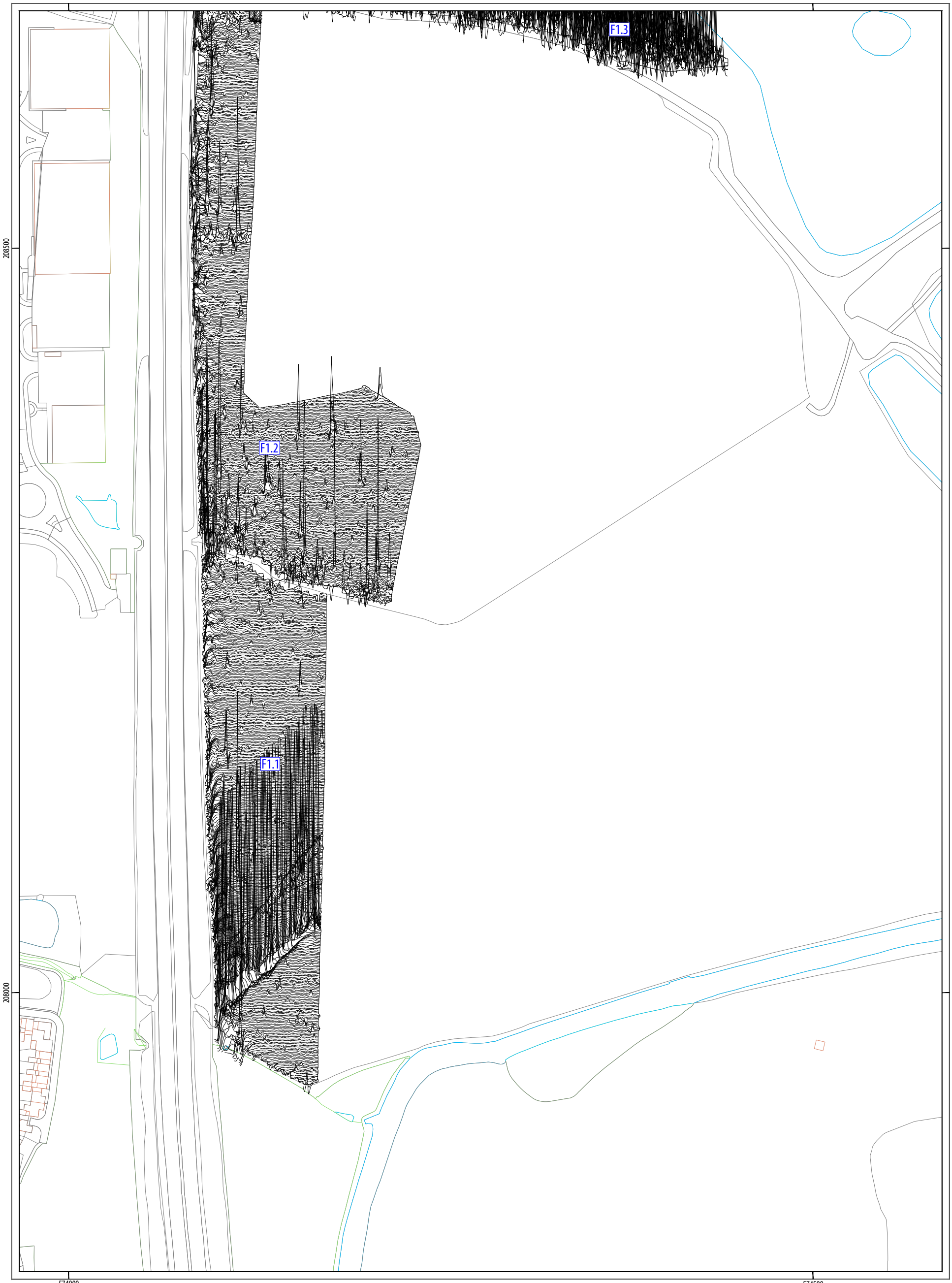
ILLUS 10 Processed greyscale magnetometer data; Sector 1



25.0nT/cm

0 50m

1:2,500 @ A3

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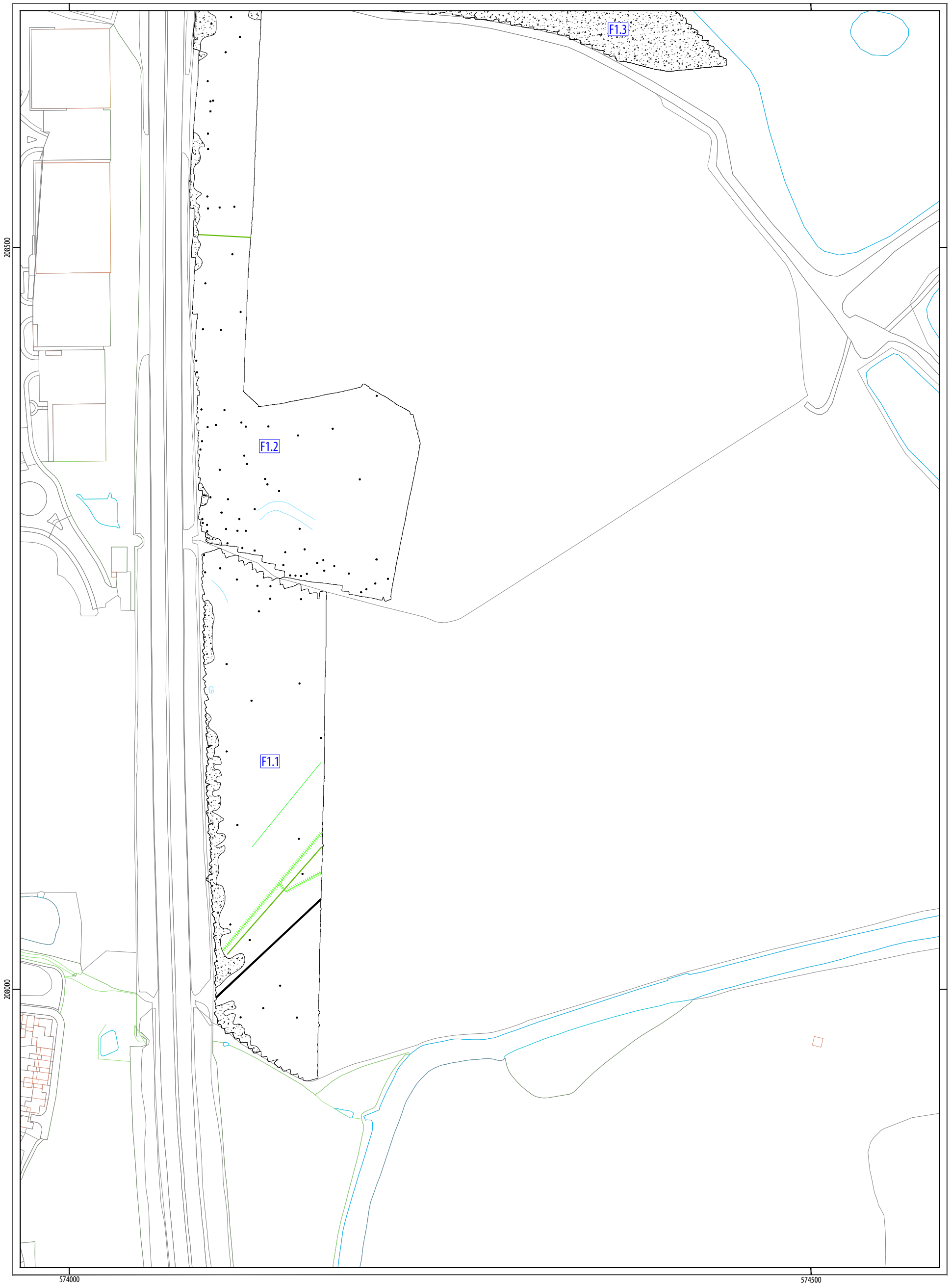
ILLUS 11 XY trace plot of minimally processed magnetometer data; Sector 1



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

TYPE OF ANOMALY	INTERPRETATION
linear trend	geological variation

0 50m
1:2,500 @ A3

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ILLUS 12 Interpretation of magnetometer data; Sector 1

209500

209000

F1.6

F1.4

F1.5

F1.3

F1.2

574000

574500

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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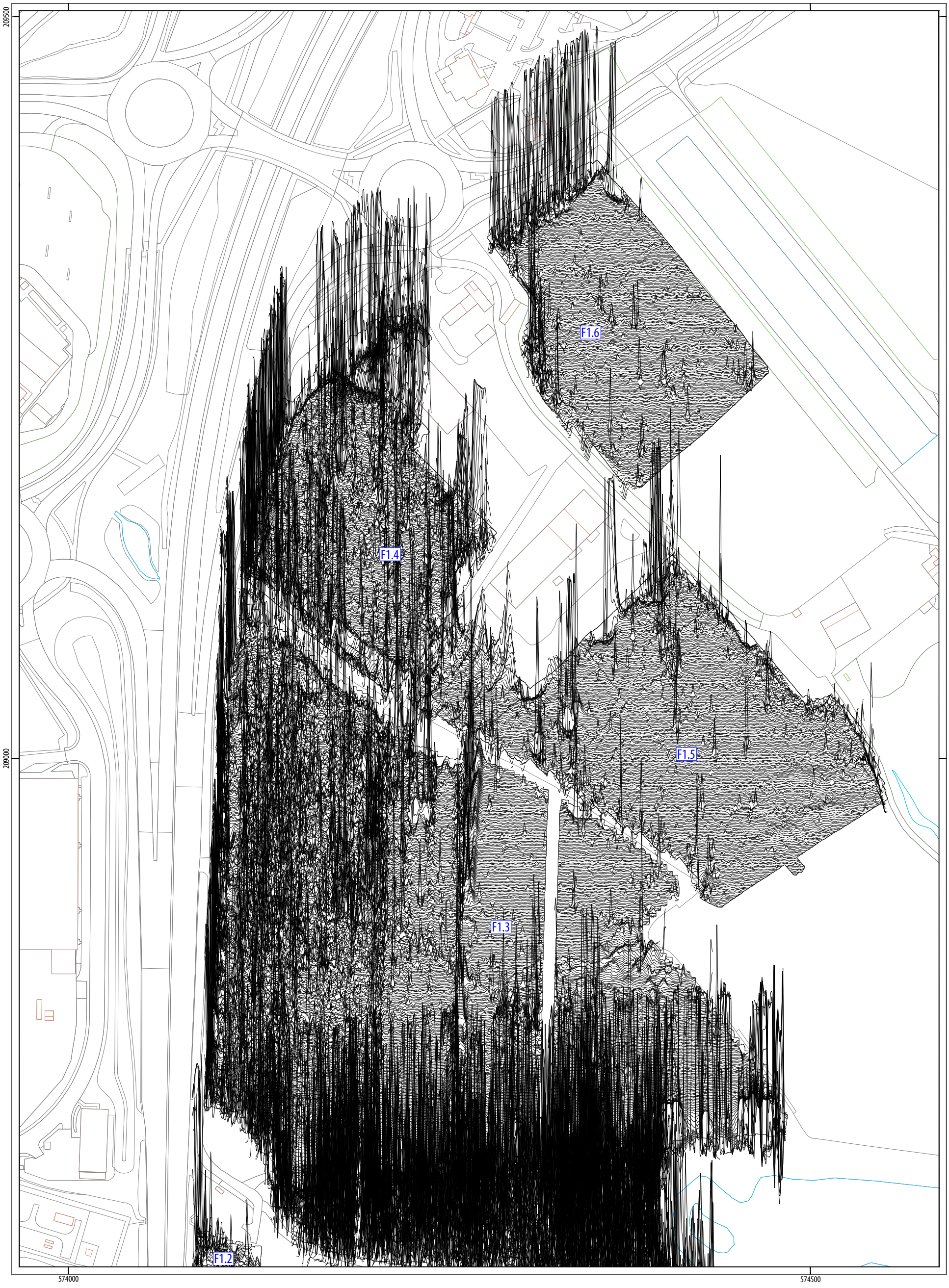
ILLUS 13 Processed greyscale magnetometer data; Sector 2



25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 14 XY trace plot of minimally processed magnetometer data; Sector 2

209500

209000

F1.6

DB1

F1.4

F1.5

F1.3

F1.2

574000

574500

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
magnetic variation	modern track
magnetic enhancement	demolished building
linear trend	agricultural

TYPE OF ANOMALY	INTERPRETATION
linear trend	field drain
linear	former field boundary
linear trend	geological variation
magnetic enhancement	geology

ABBREVIATIONS

DB demolished building

0 50m

1:2,500 @ A3

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ILLUS 15 Interpretation of magnetometer data; Sector 2

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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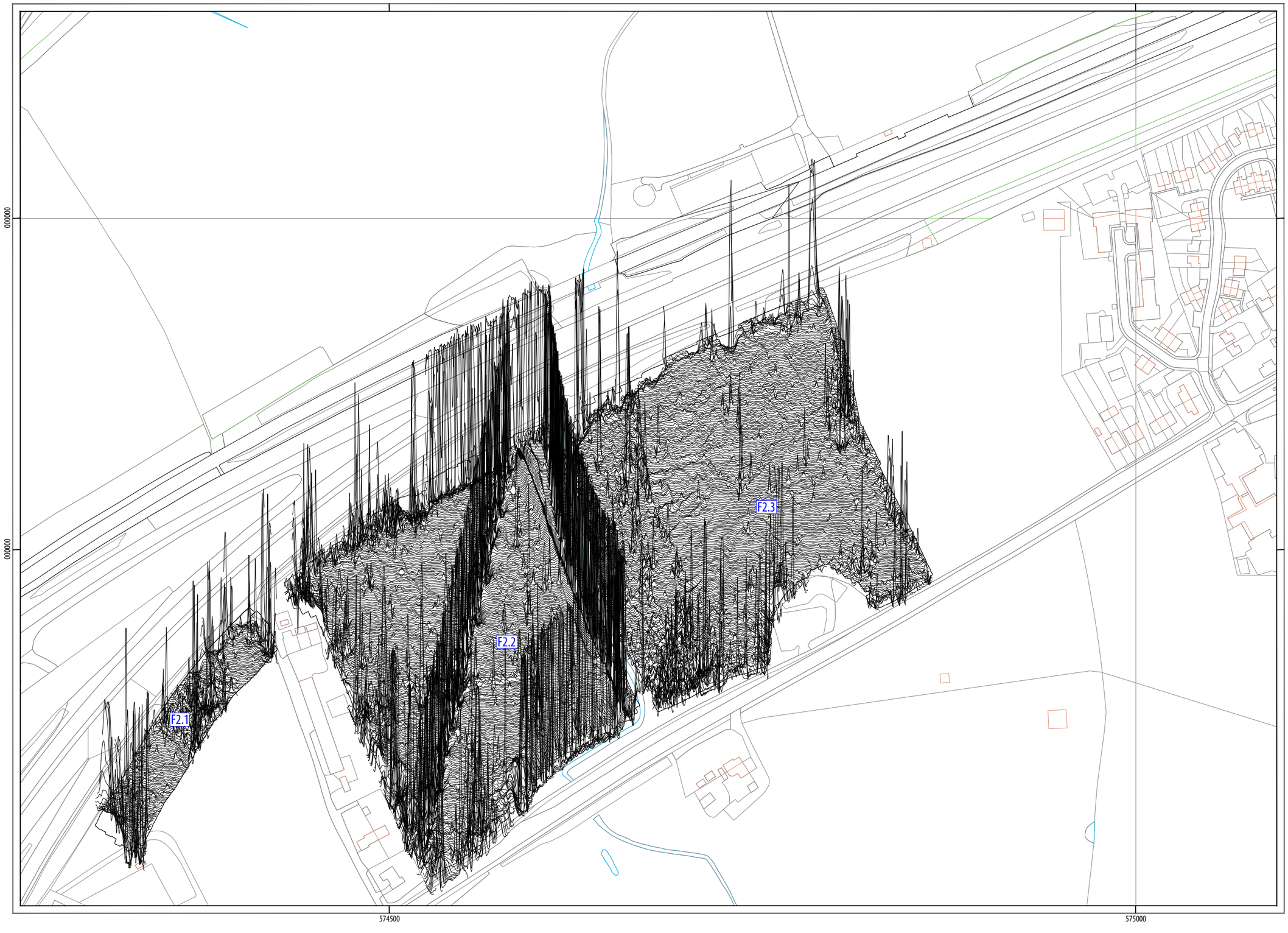
ILLUS 16 Processed greyscale magnetometer data; Sector 3



25.0nT/cm

0 50m

1:2,500 @ A3

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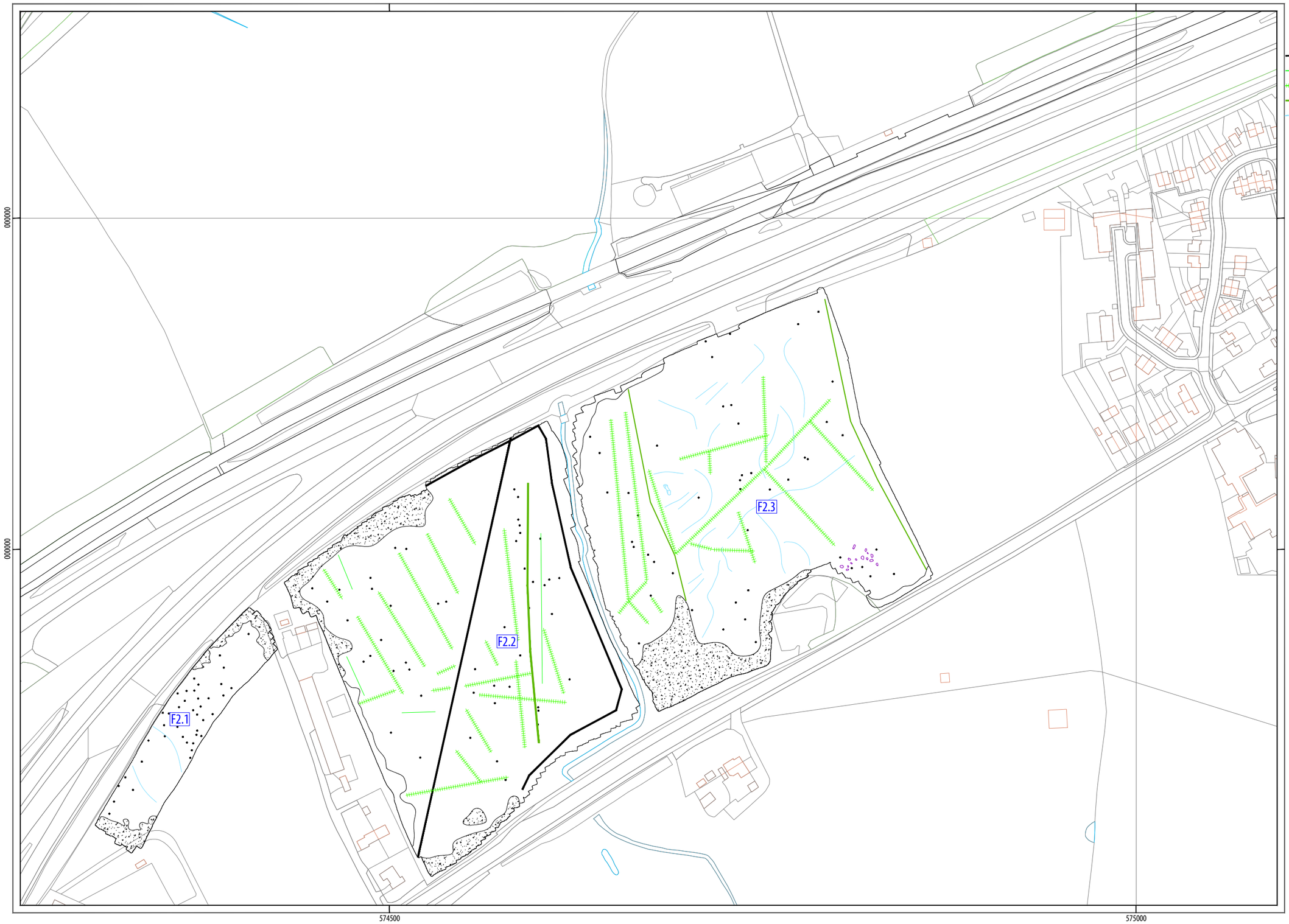
ILLUS 17 XY trace plot of minimally processed magnetometer data; Sector 3



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 trend	geological variation
magnetic enhancement	geology

0 50m
1:2,500 @ A3

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Junctions 19 to 23
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ILLUS 18 Interpretation of magnetometer data; Sector 3

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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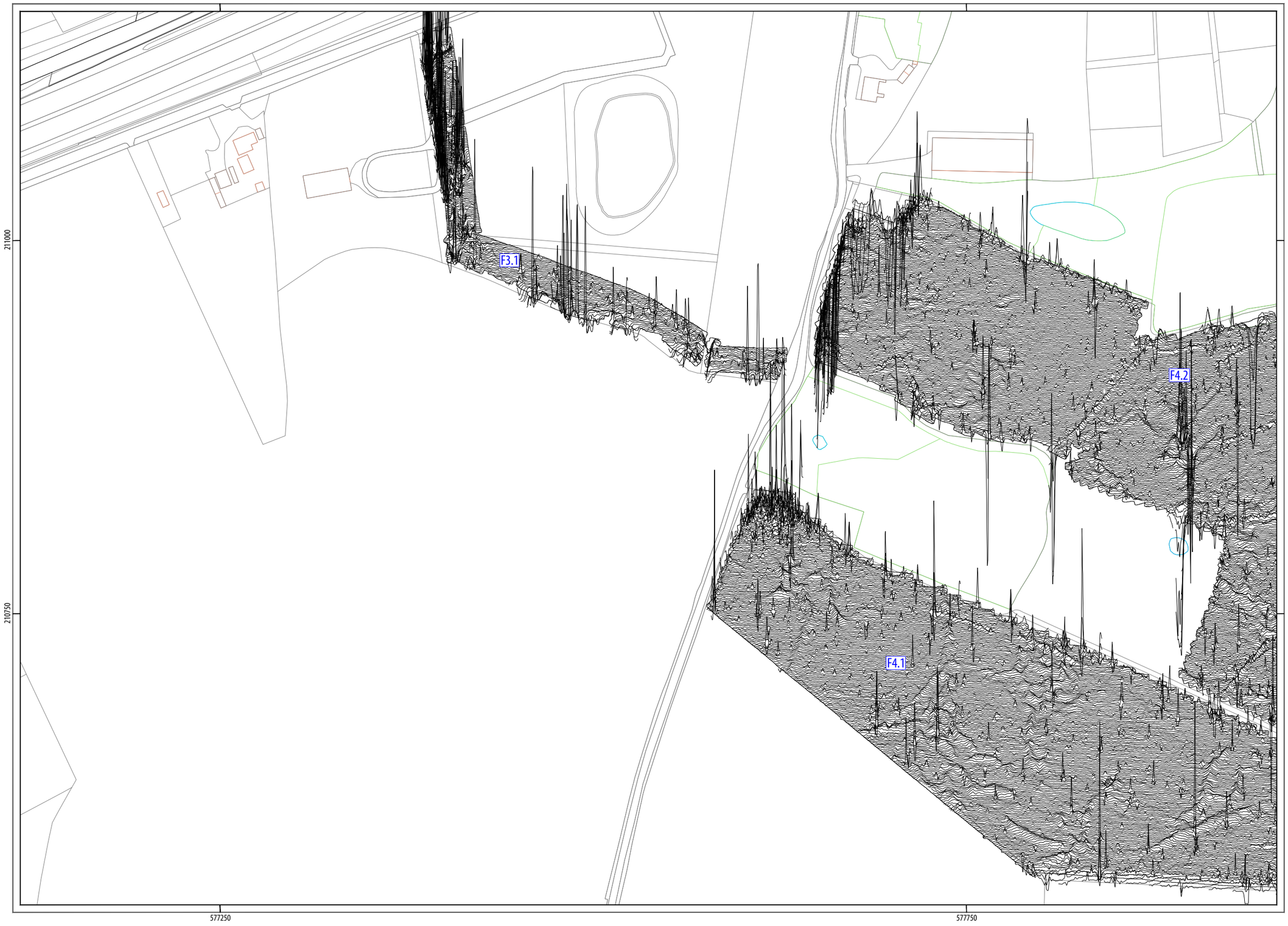
ILLUS 19 Processed greyscale magnetometer data; Sector 4



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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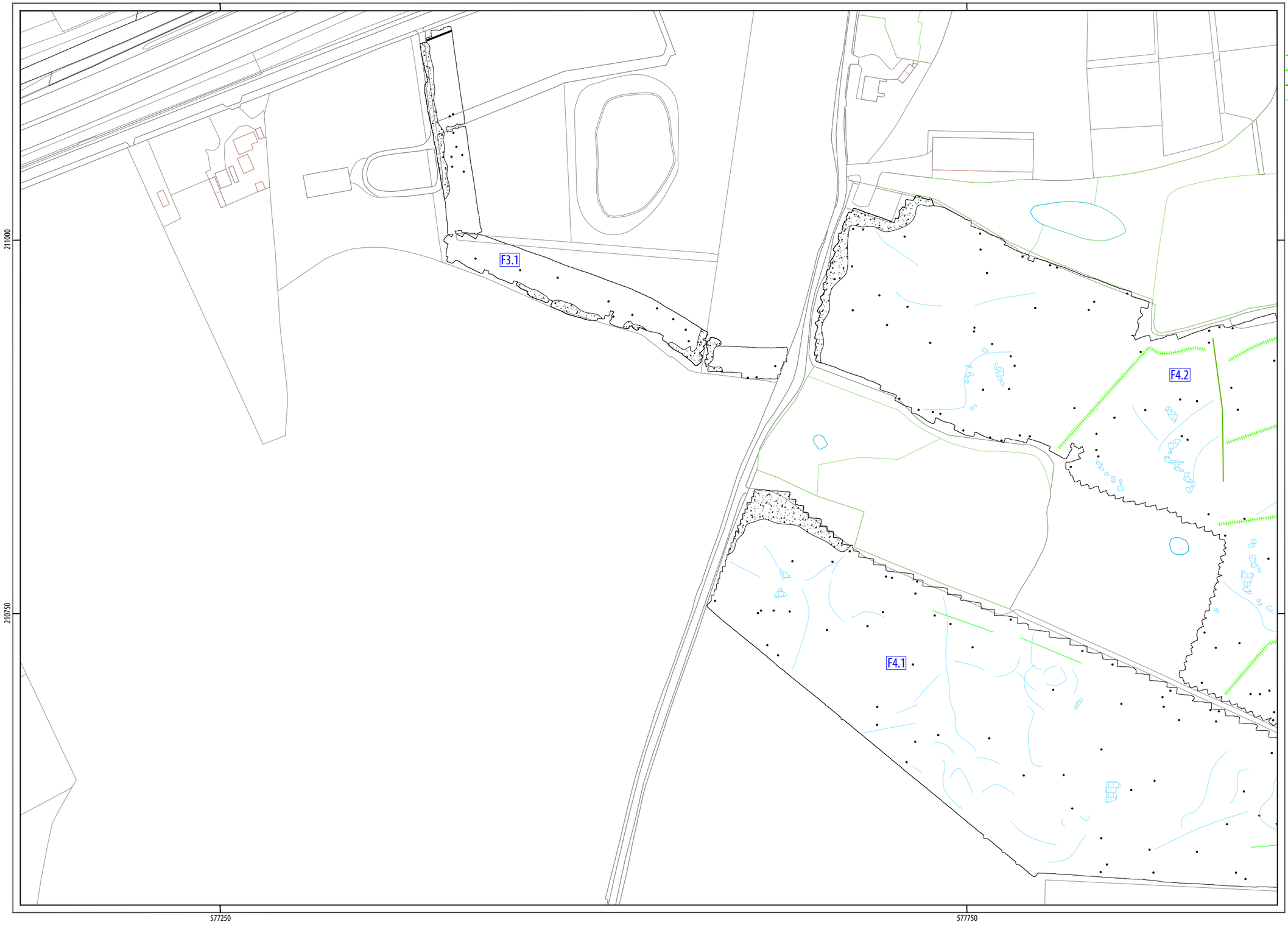
ILLUS 20 XY trace plot of minimally processed magnetometer data; Sector 4



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

0 50m
1:2,500 @ A3

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Junctions 19 to 23
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ILLUS 21 Interpretation of magnetometer data; Sector 4

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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ILLUS 22 Processed greyscale magnetometer data; Sector 5

25.0nT/cm

0 50m

1:2,500 @ A3

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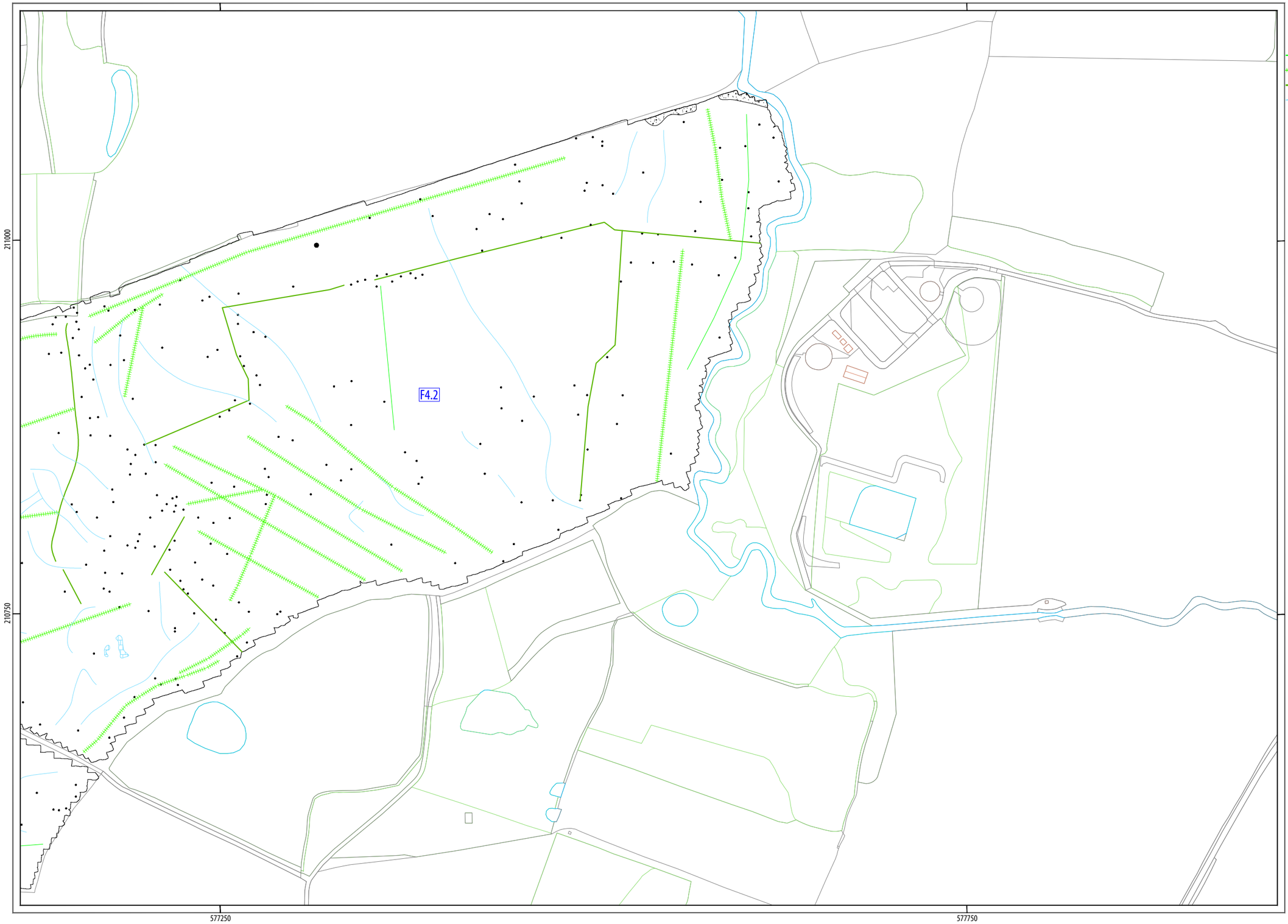
ILLUS 23 XY trace plot of minimally processed magnetometer data; Sector 5



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

0 50m

1:2,500 @ A3

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ILLUS 24 Interpretation of magnetometer data; Sector 5

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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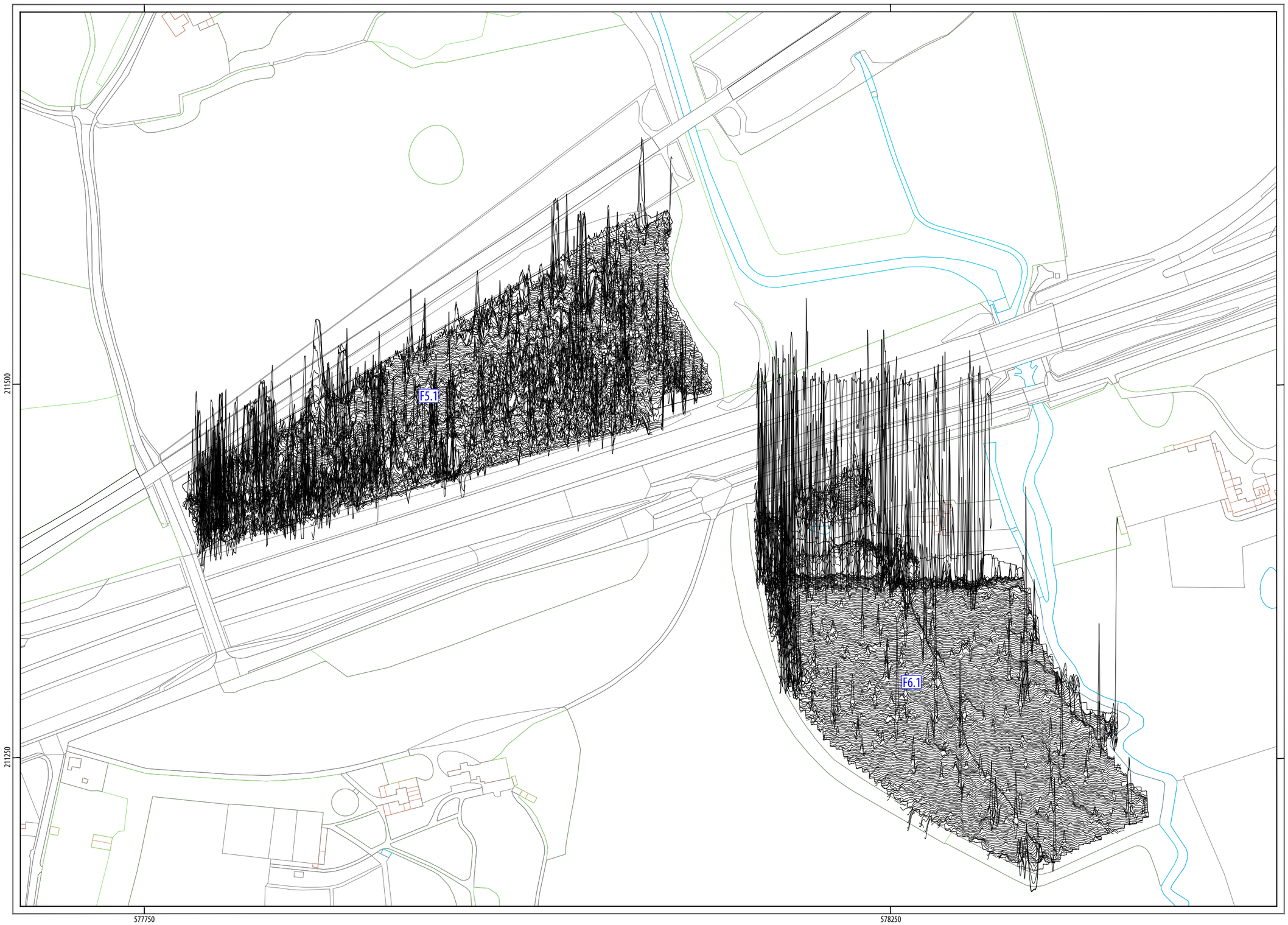
ILLUS 25 Processed greyscale magnetometer data; Sector 6



25.0nT/cm

0 50m

1:2,500 @ A3

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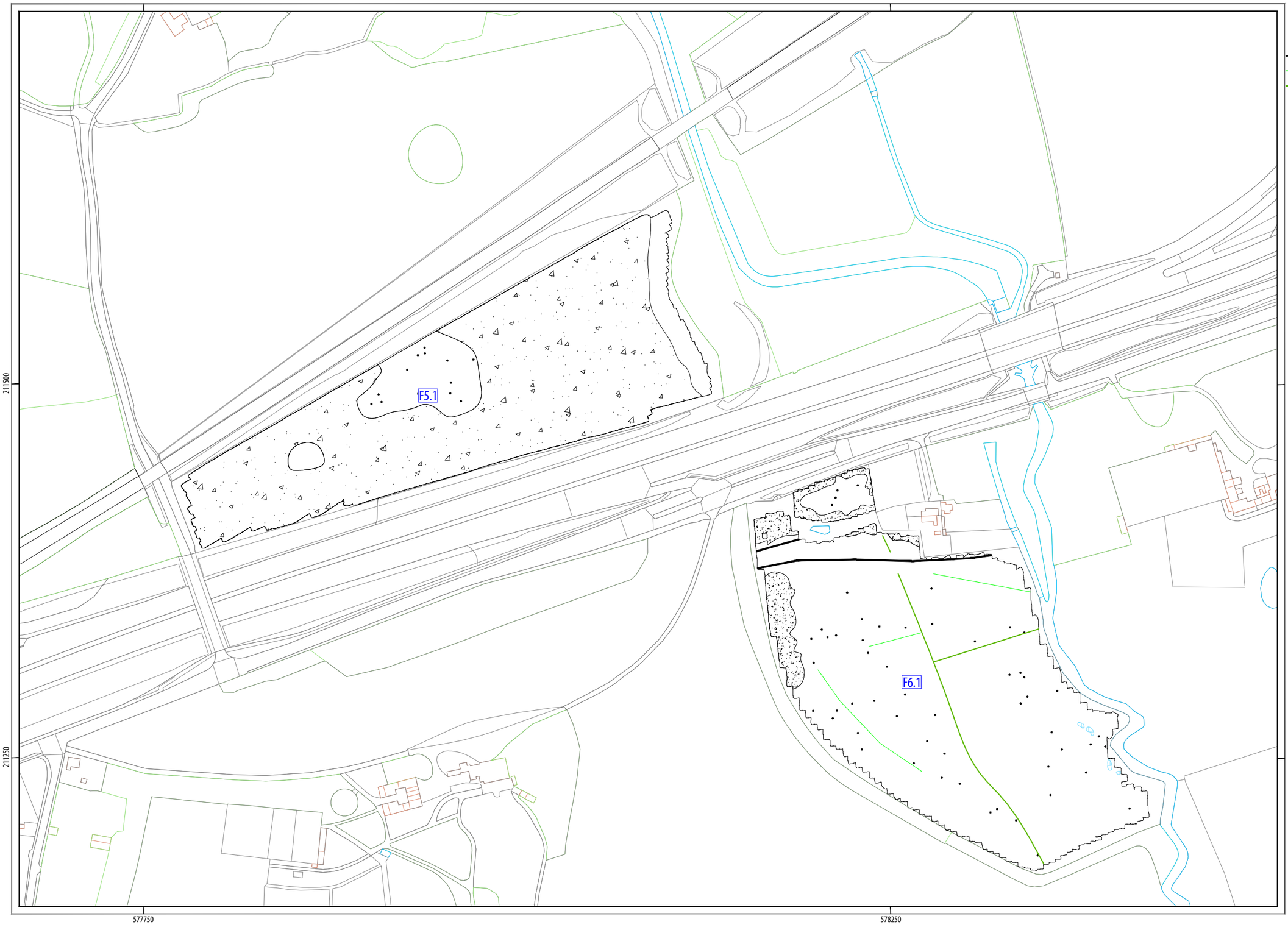
ILLUS 26 XY trace plot of minimally processed magnetometer data; Sector 6



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

0 50m
1:2,500 @ A3

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ILLUS 27 Interpretation of magnetometer data; Sector 6

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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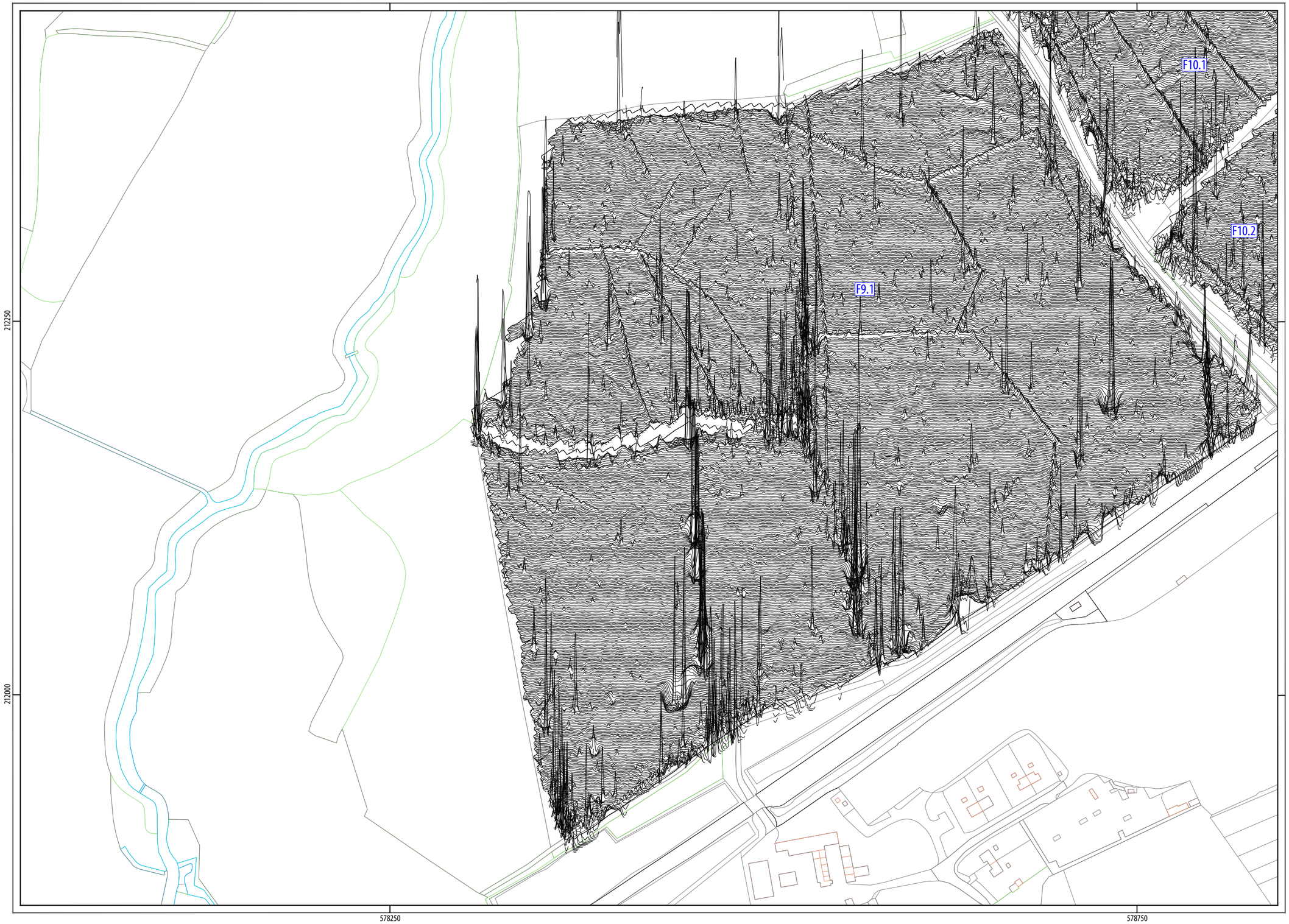
ILLUS 28 Processed greyscale magnetometer data; Sector 7



25.0nT/cm

0 50m

1:2,500 @ A3

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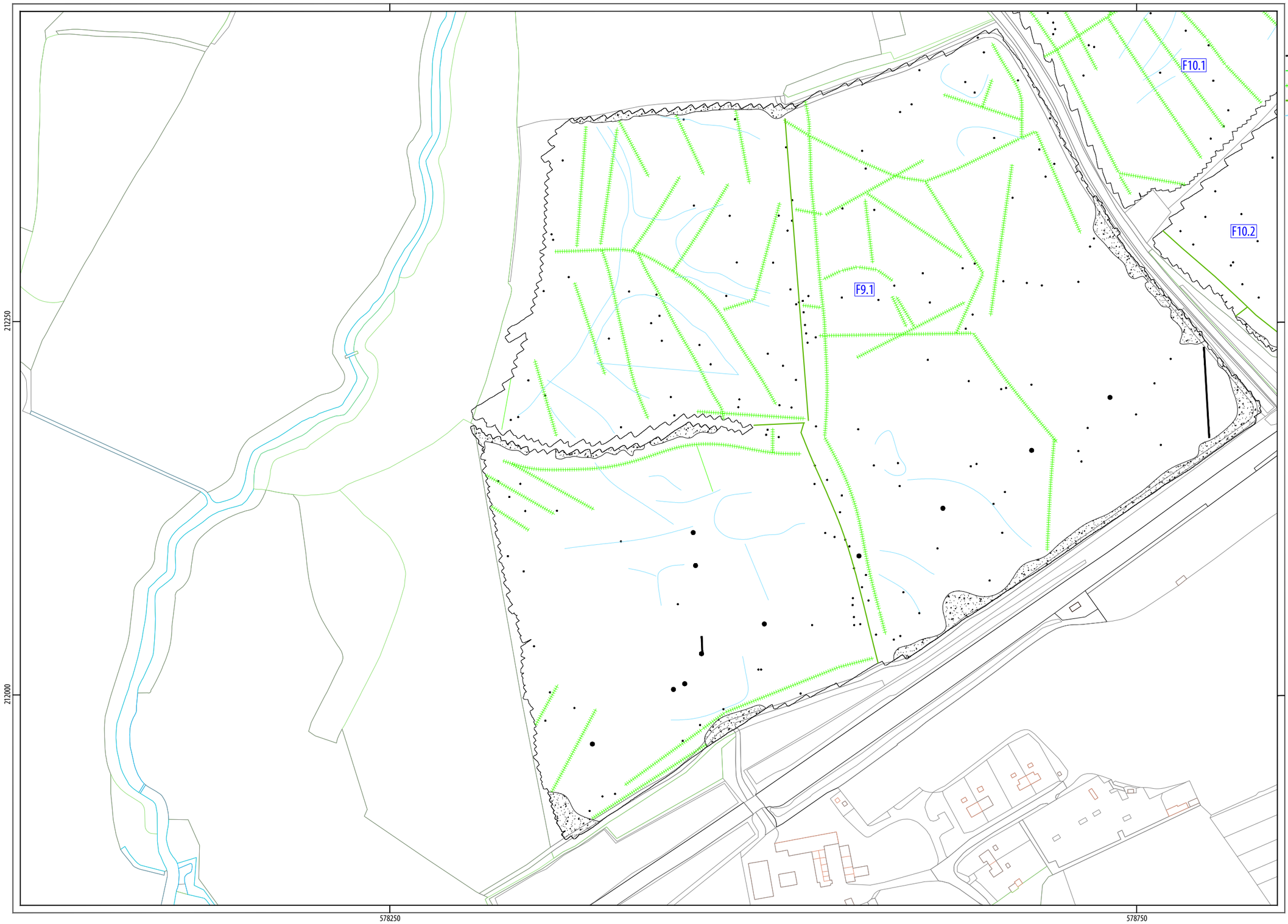
ILLUS 29 XY trace plot of minimally processed magnetometer data; Sector 7



TYPE OF ANOMALY | INTERPRETATION

- dipolar isolated — ferrous material
- magnetic disturbance — ferrous material
- dipolar linear — service pipe
- linear trend — agricultural
- linear trend — field drain
- linear — former field boundary
- linear trend — geological variation

0 50m
1:2,500 @ A3

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ILLUS 30 Interpretation of magnetometer data; Sector 7

213000

212500

578250

578750

F10.1

-1.0 nT 2.0

0 50m

1:2,500 @ A3

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ILLUS 31 Processed greyscale magnetometer data; Sector 8

25.0nT/cm

0 50m

1:2,500 @ A3

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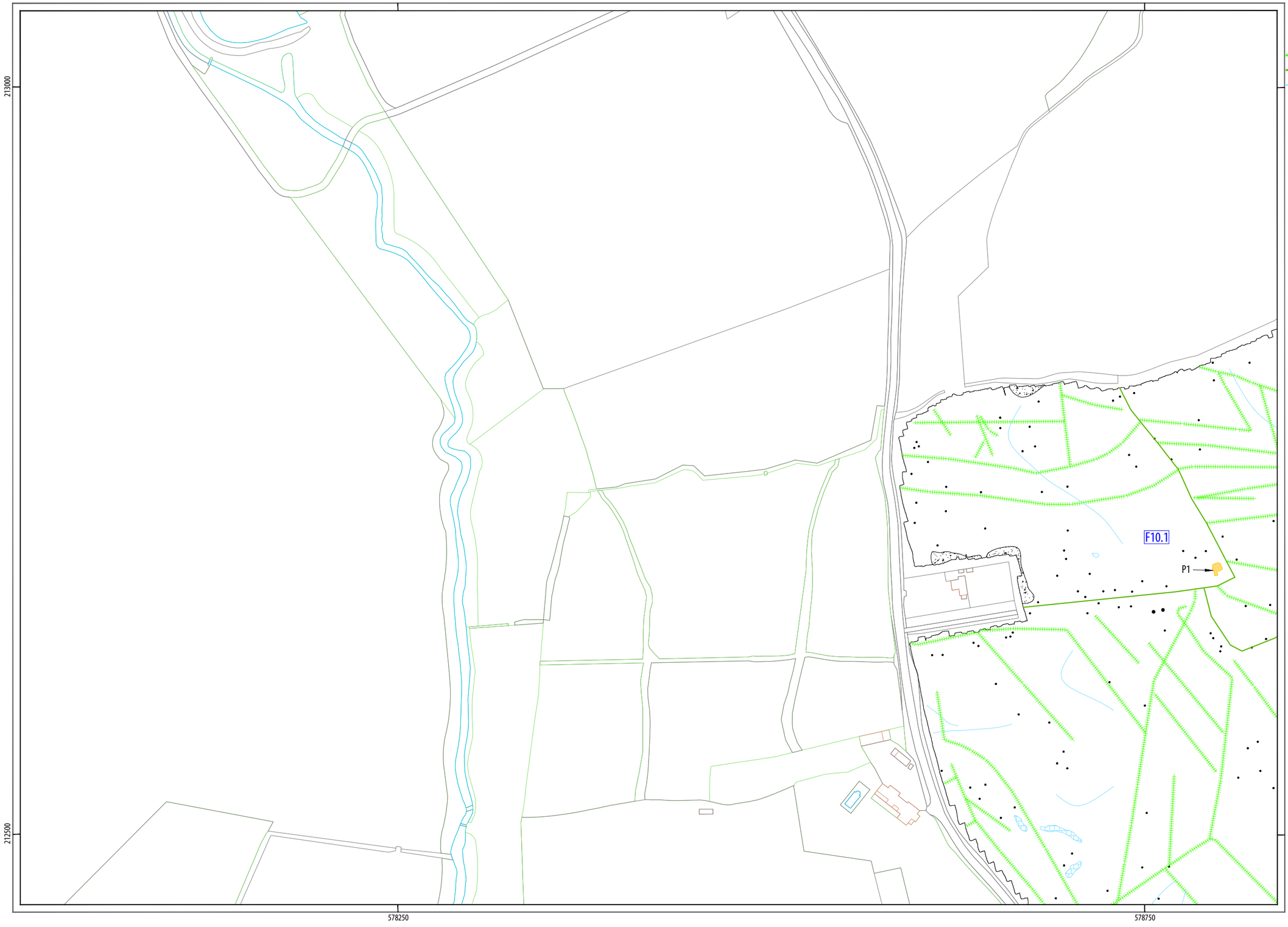
ILLUS 32 XY trace plot of minimally processed magnetometer data; Sector 8



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

ABBREVIATIONS

P pit

0 50m

1:2,500 @ A3

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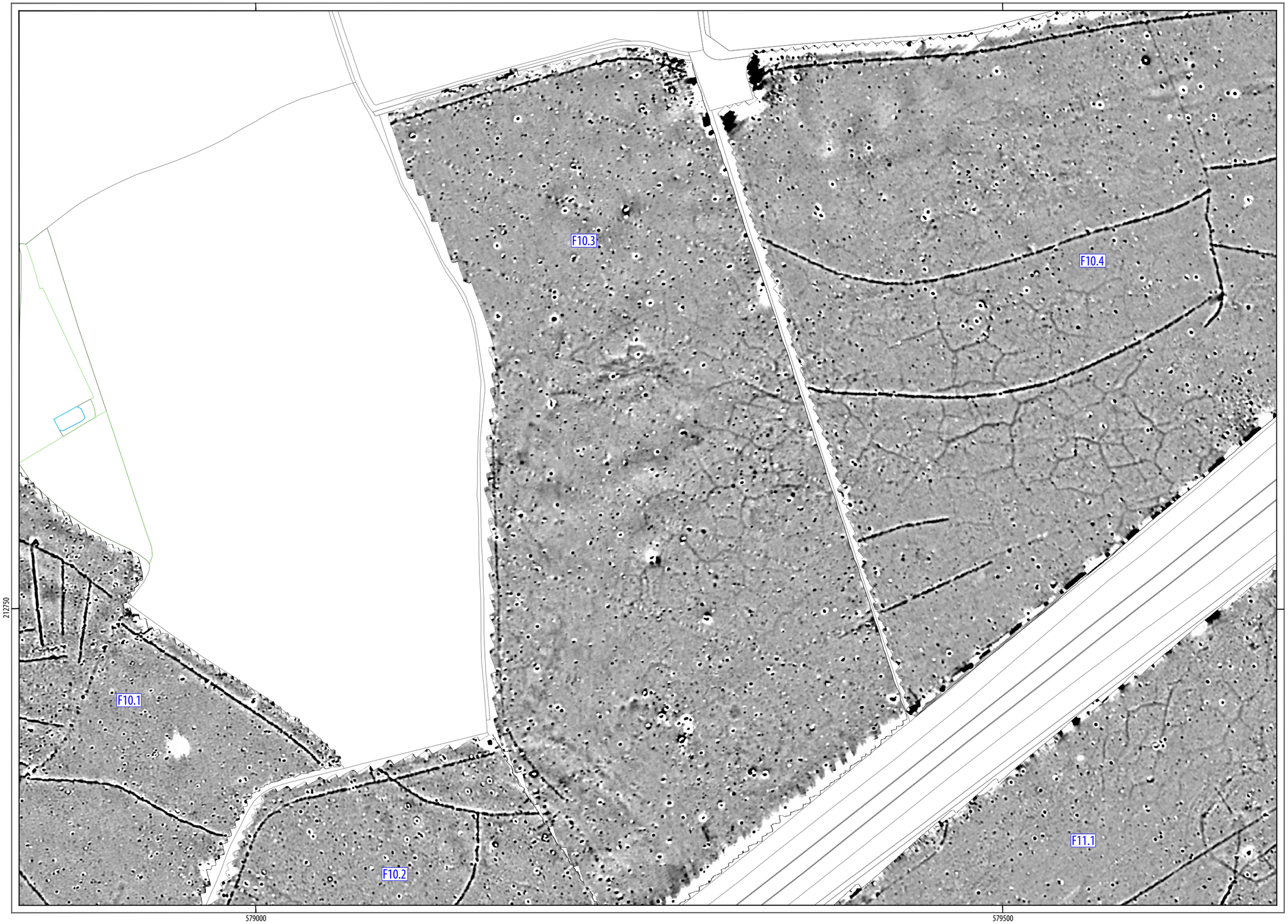
ILLUS 33 Interpretation of magnetometer data; Sector 8



nT
-1.0
2.0

0
50m
1:2,500 @ A3

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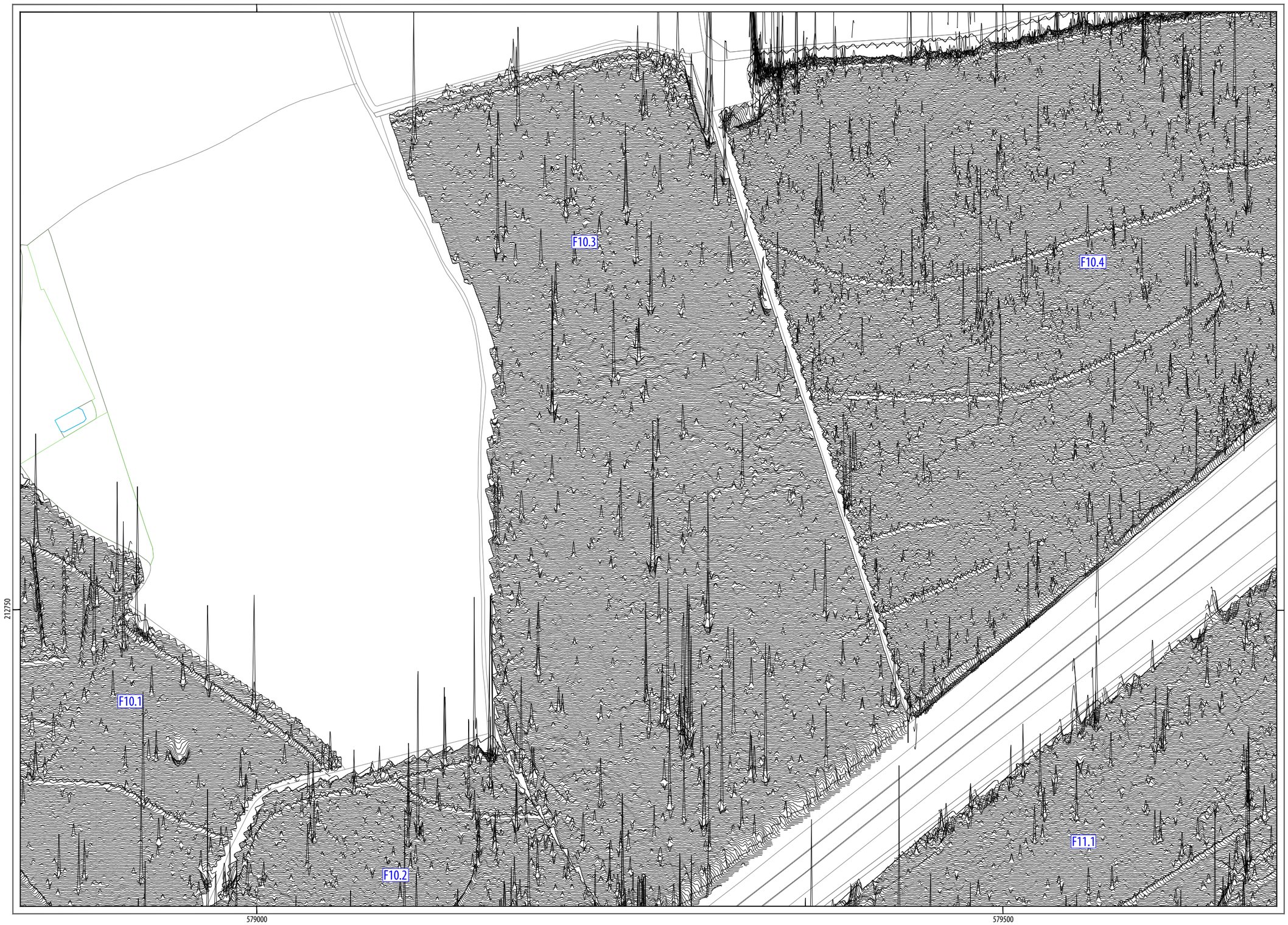
ILLUS 34 Processed greyscale magnetometer data; Sector 9



25.0nT/cm

0 50m

1:2,500 @ A3

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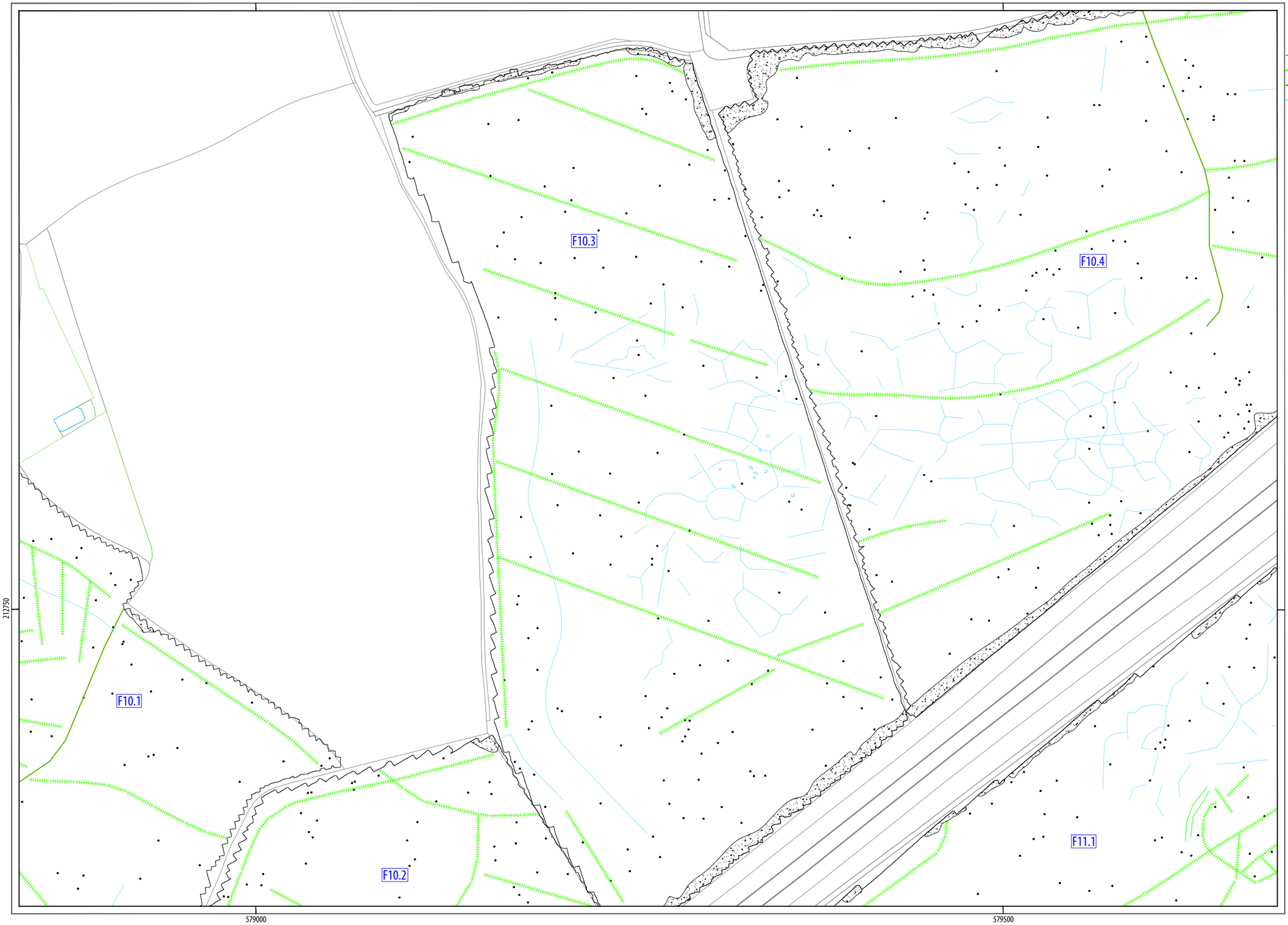
ILLUS 35 XY trace plot of minimally processed magnetometer data; Sector 9



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

0 50m
1:2,500 @ A3

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ILLUS 36 Interpretation of magnetometer data; Sector 9

-1.0 nT 2.0

0 50m
1:2,500 @ A3

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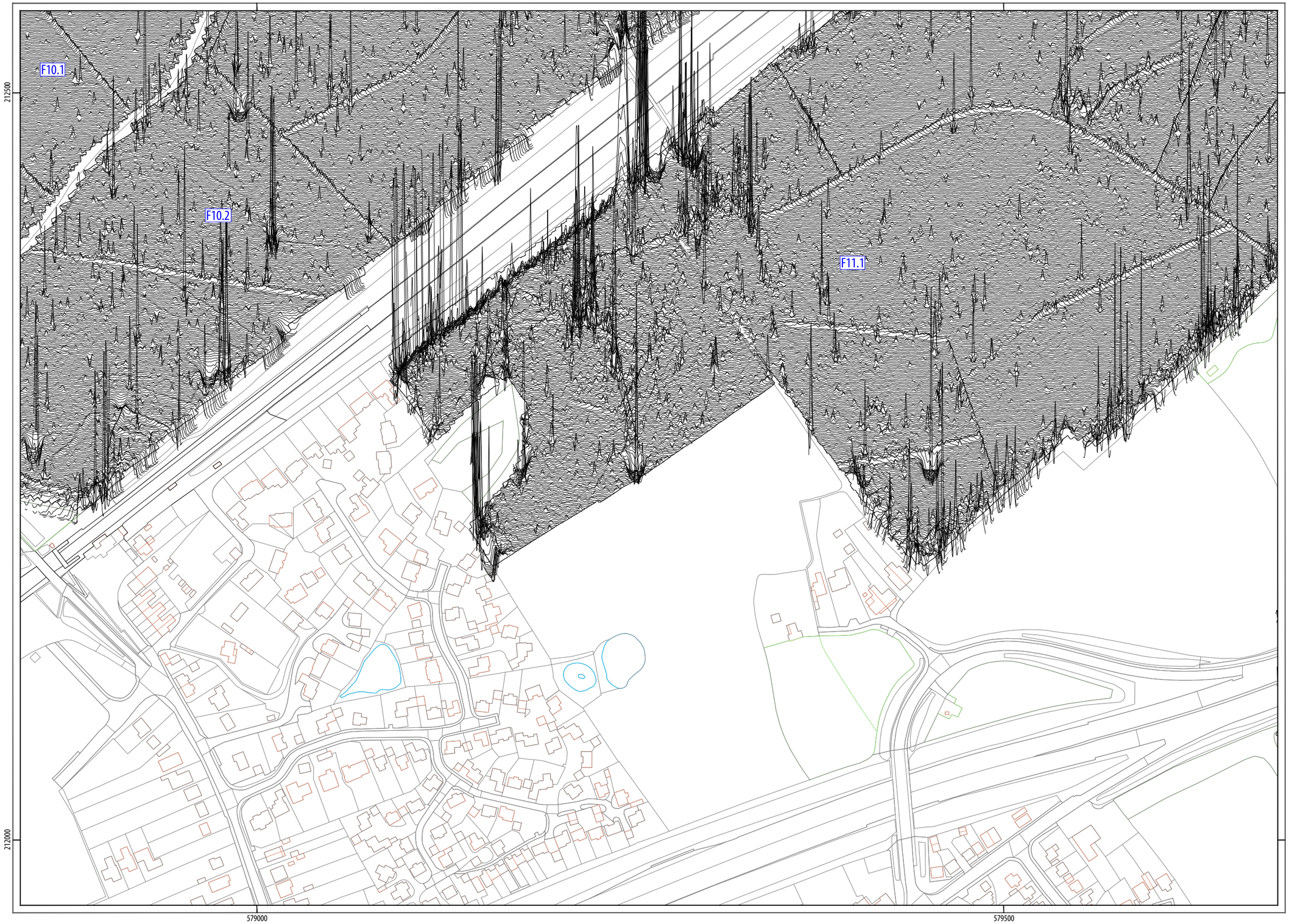
ILLUS 37 Processed greyscale magnetometer data; Sector 10



25.0nT/cm

0 50m

1:2,500 @ A3

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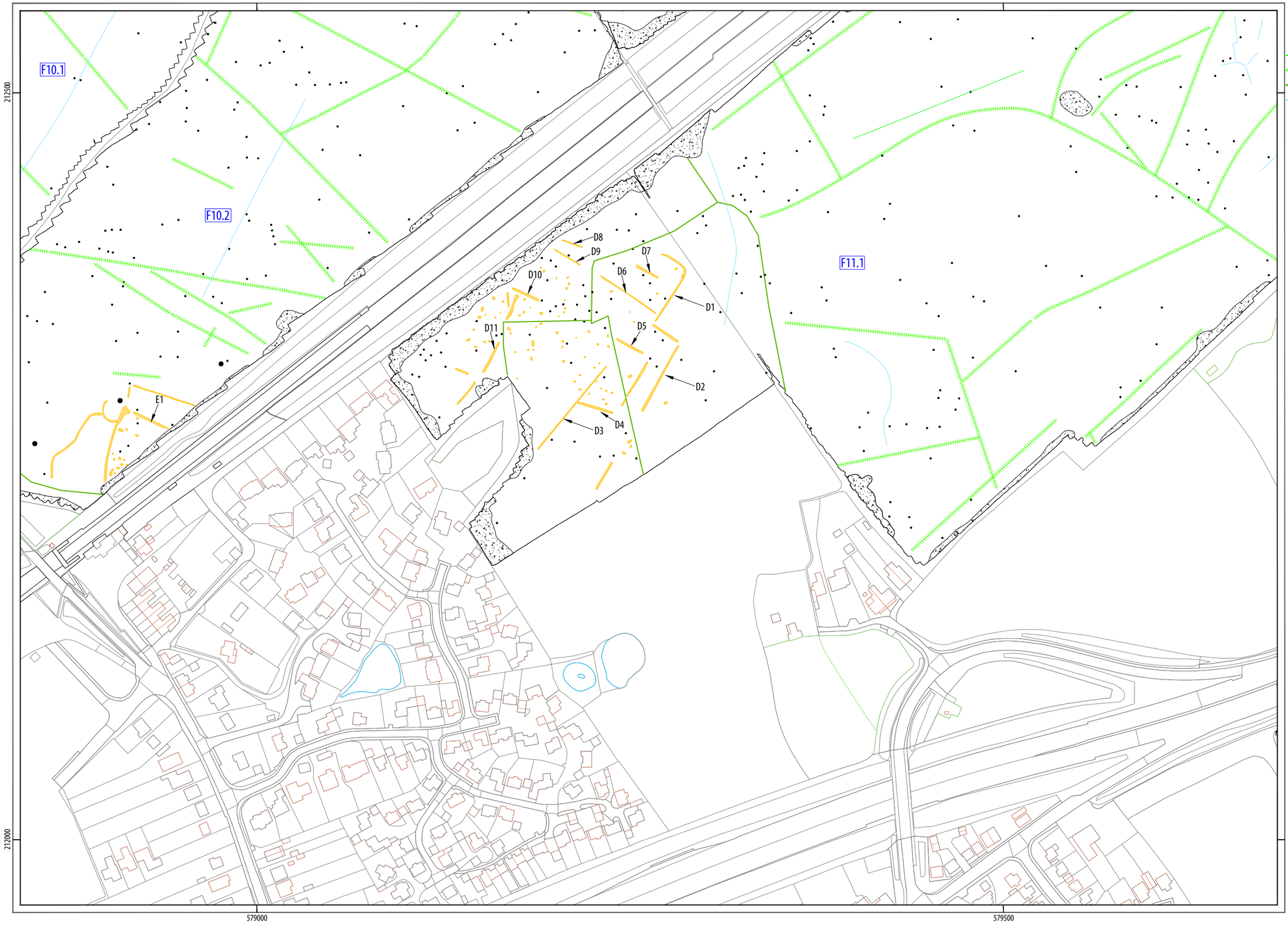
ILLUS 38 XY trace plot of minimally processed magnetometer data; Sector 10



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	archaeology?

ABBREVIATIONS

D ditch

E enclosure

0 50m

1:2,500 @ A3

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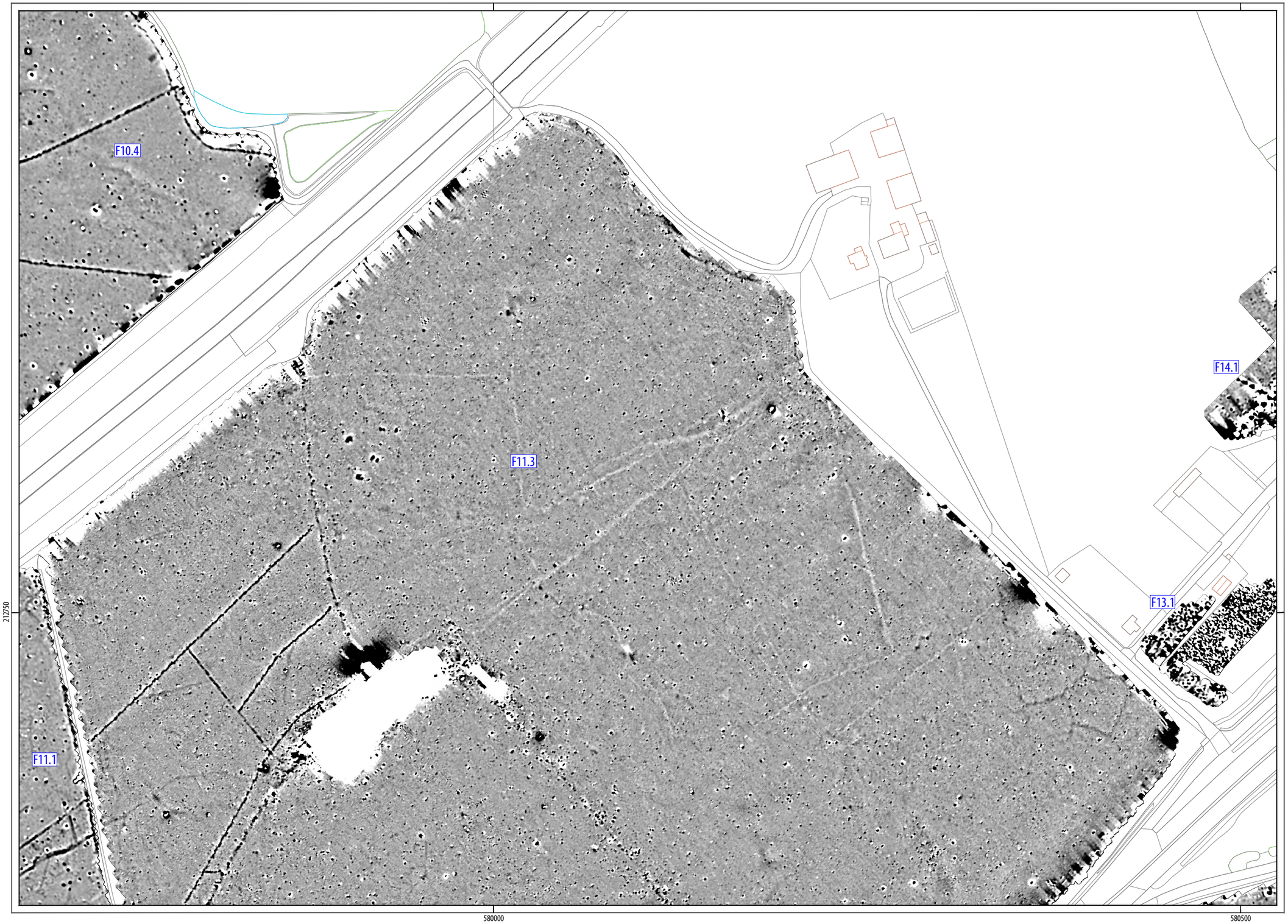
ILLUS 39 Interpretation of magnetometer data; Sector 10



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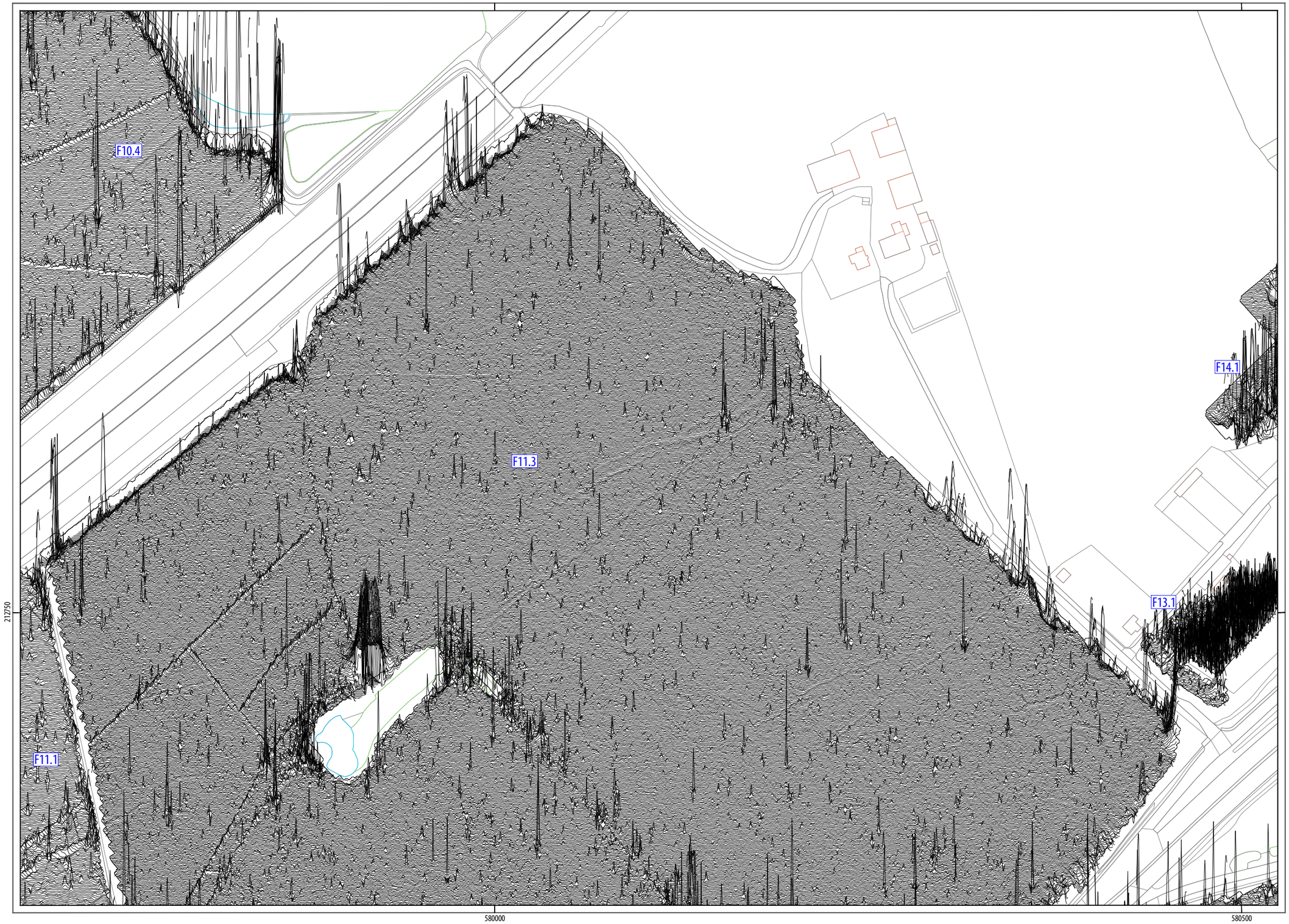
ILLUS 40 Processed greyscale magnetometer data; Sector 11



25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 41 XY trace plot of minimally processed magnetometer data; Sector 11

F10.4

F11.3

F11.1

F14.1

F13.1

212750

580000

580500

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 trend	geological variation

0 50m

1:2,500 @ A3

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ILLUS 42 Interpretation of magnetometer data; Sector 11

F11.1

F11.3

F12.2

F12.1

212250

580000

580500

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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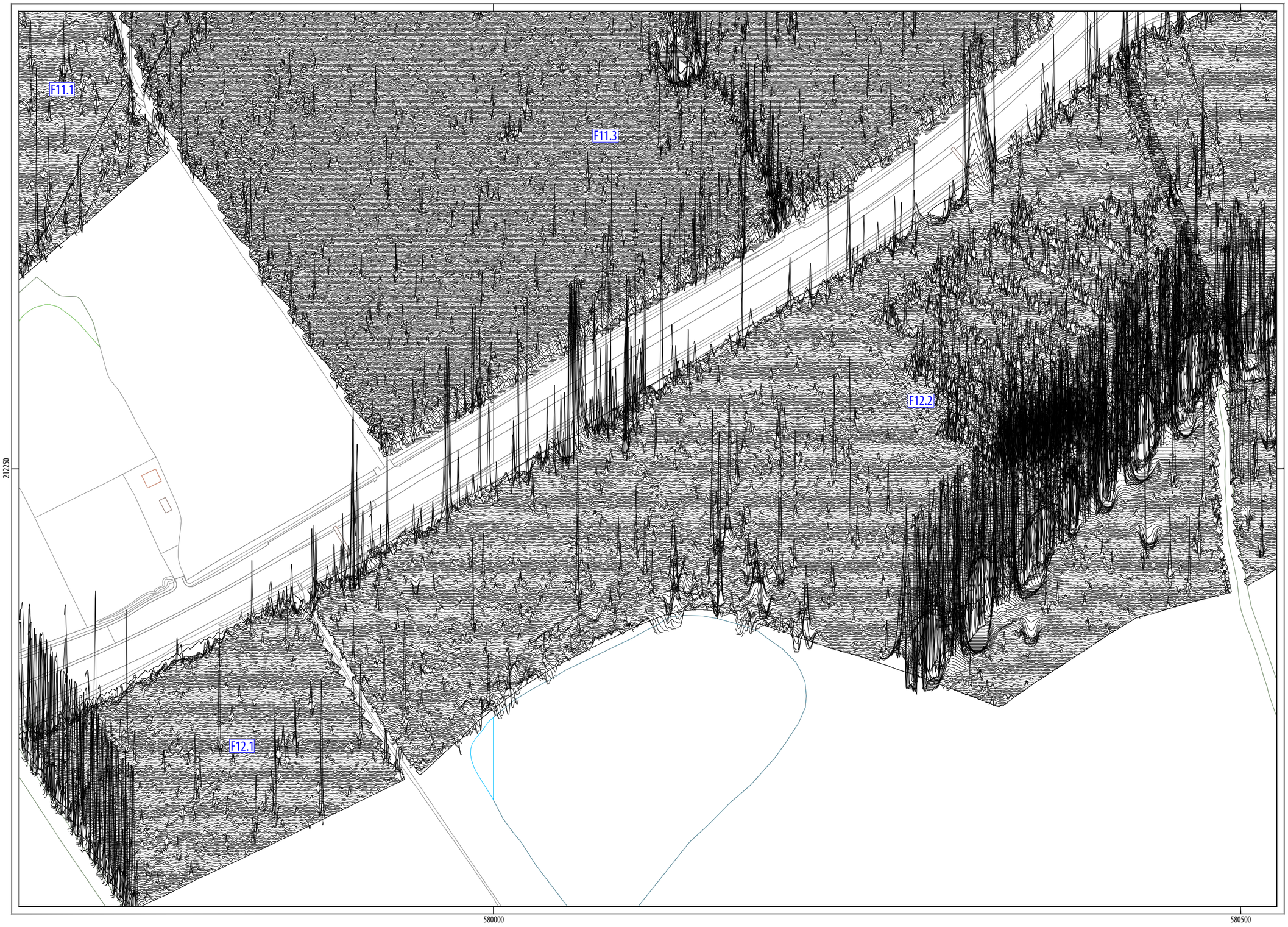
ILLUS 43 Processed greyscale magnetometer data; Sector 12



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
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ILLUS 44 XY trace plot of minimally processed magnetometer data; Sector 12

F11.1

F11.3

F12.2

F12.1

212250

580000

580500

TYPE OF ANOMALY | INTERPRETATION

- dipolar isolated | ferrous material
- magnetic disturbance | ferrous material
- dipolar linear | service pipe
- magnetic variation | quarrying
- linear trend | agricultural
- linear trend | field drain
- linear | former field boundary
- linear trend | geological variation

0 50m

1:2,500 @ A3

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ILLUS 45 Interpretation of magnetometer data; Sector 12

-1.0 nT 2.0

0 50m
1:2,500 @ A3

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ILLUS 46 Processed greyscale magnetometer data; Sector 13

25.0nT/cm

0 50m

1:2,500 @ A3

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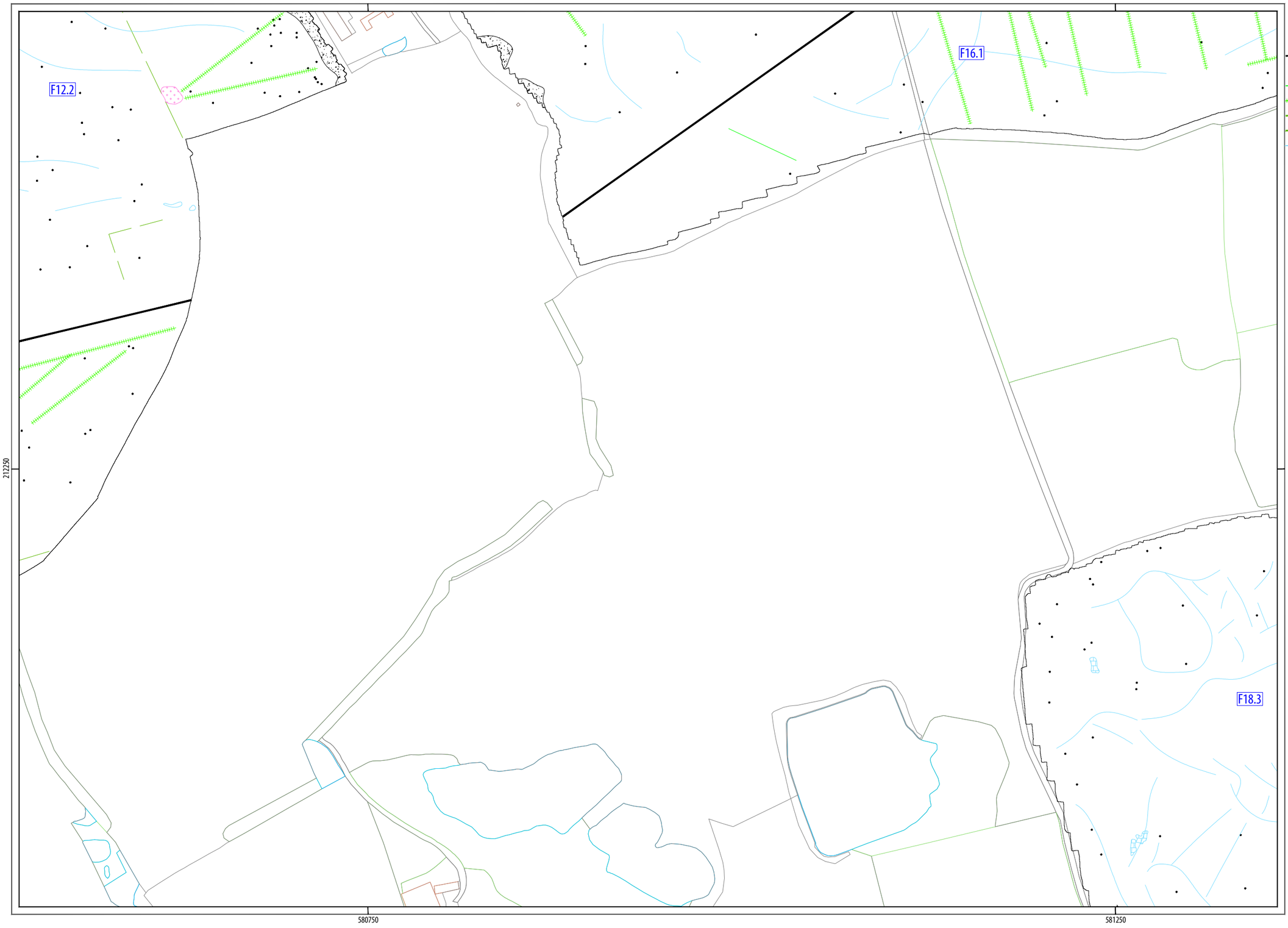
ILLUS 47 XY trace plot of minimally processed magnetometer data; Sector 13



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

0 50m
1:2,500 @ A3

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ILLUS 48 Interpretation of magnetometer data; Sector 13

F14.1

F17.1

F16.1

F12.2

212250

580750

581250

nT
-1.0
2.0

0
50m
1:2,500 @ A3

PROJECT ATCE19
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Junctions 19 to 23
Essex

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ILLUS 49 Processed greyscale magnetometer data; Sector 14

F14.1

F17.1

F16.1

F12.2

212250

580750

581250

25.0nT/cm

0 50m

1:2,500 @ A3

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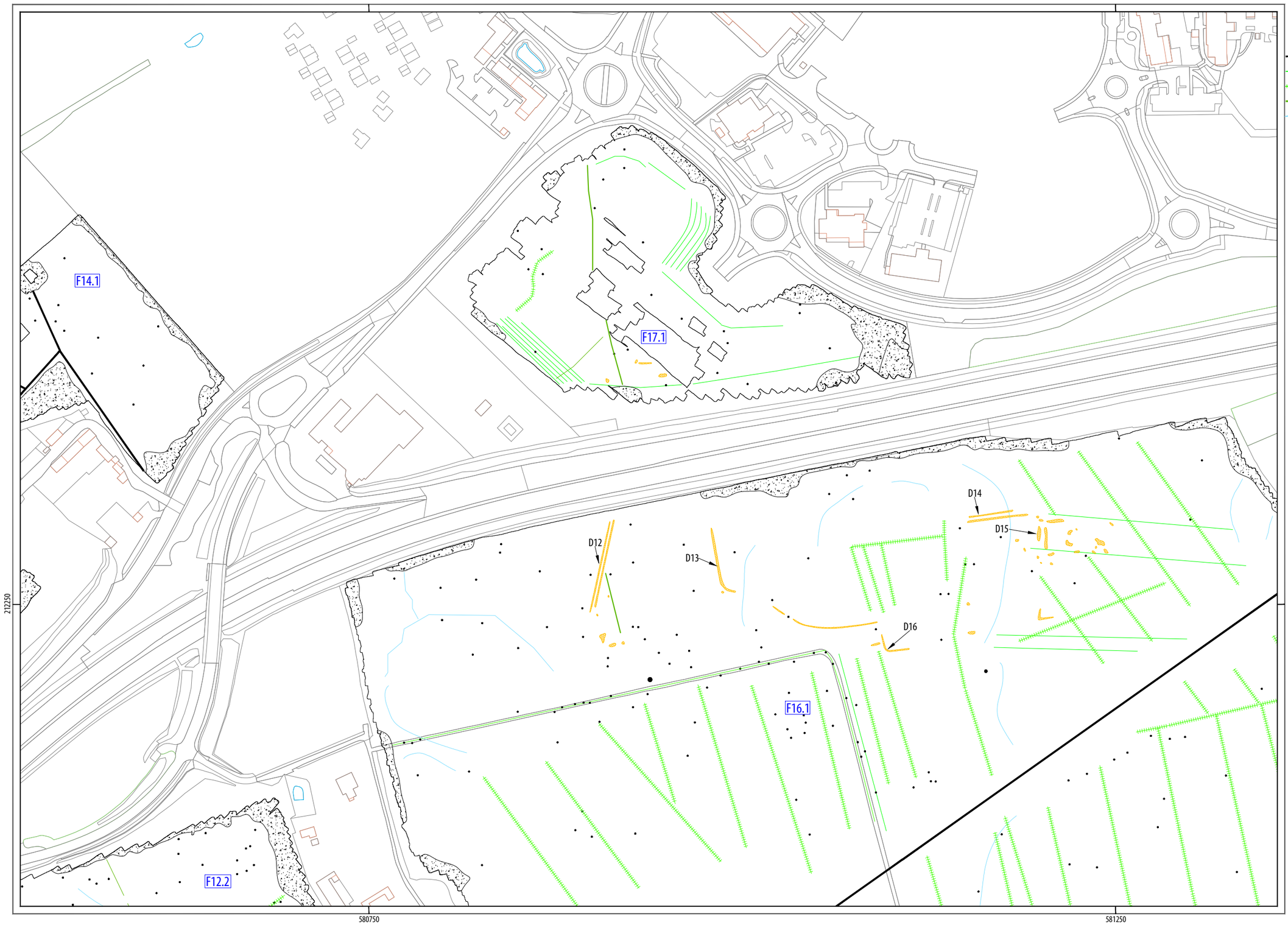
ILLUS 50 XY trace plot of minimally processed magnetometer data; Sector 14



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 trend	geological variation
magnetic enhancement	archaeology?

ABBREVIATIONS

D ditch

0 50m

1:2,500 @ A3

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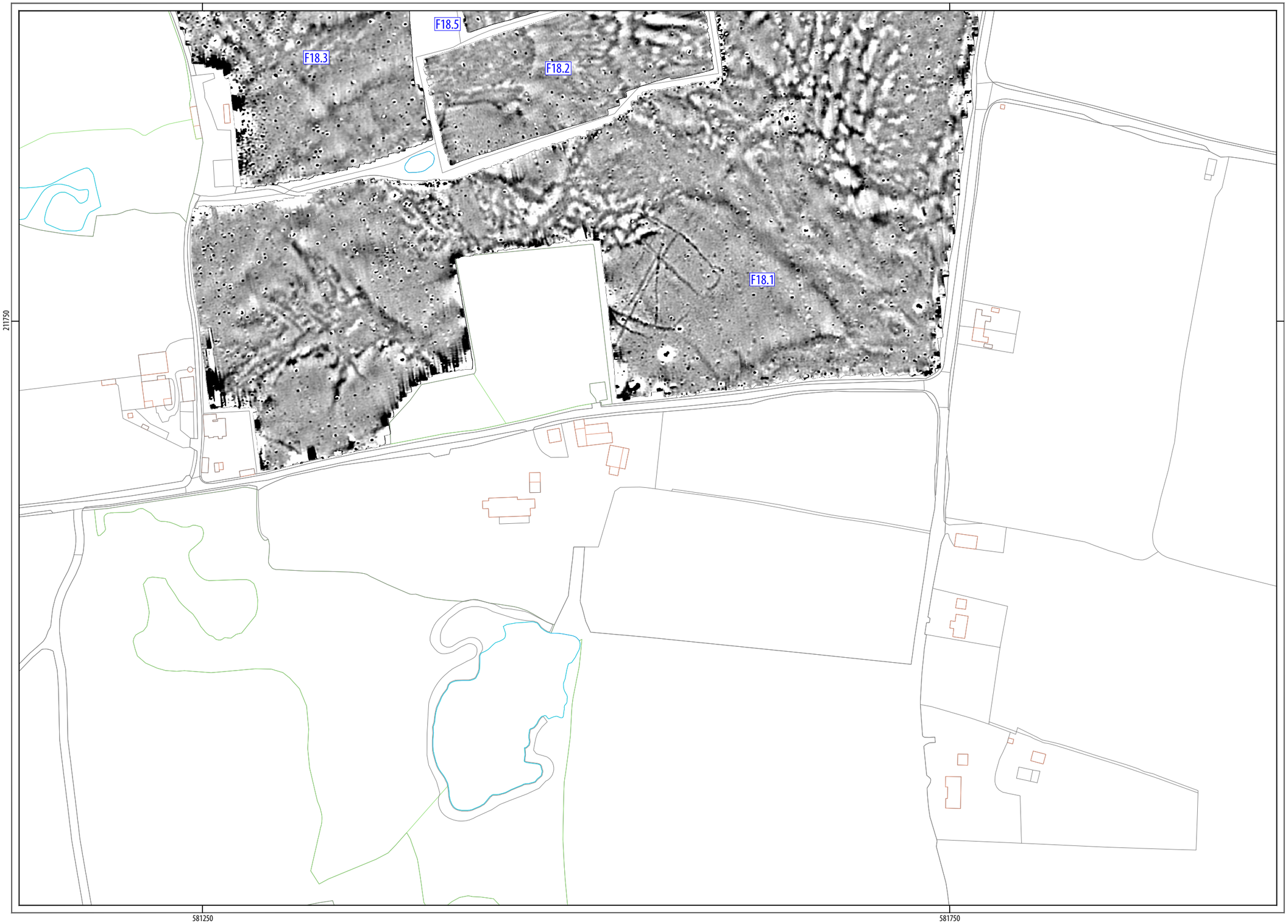
ILLUS 51 Interpretation of magnetometer data; Sector 14



-1.0 nT 2.0

0 50m
1:2,500 @ A3

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ILLUS 52 Processed greyscale magnetometer data; Sector 15

25.0nT/cm

0 50m

1:2,500 @ A3

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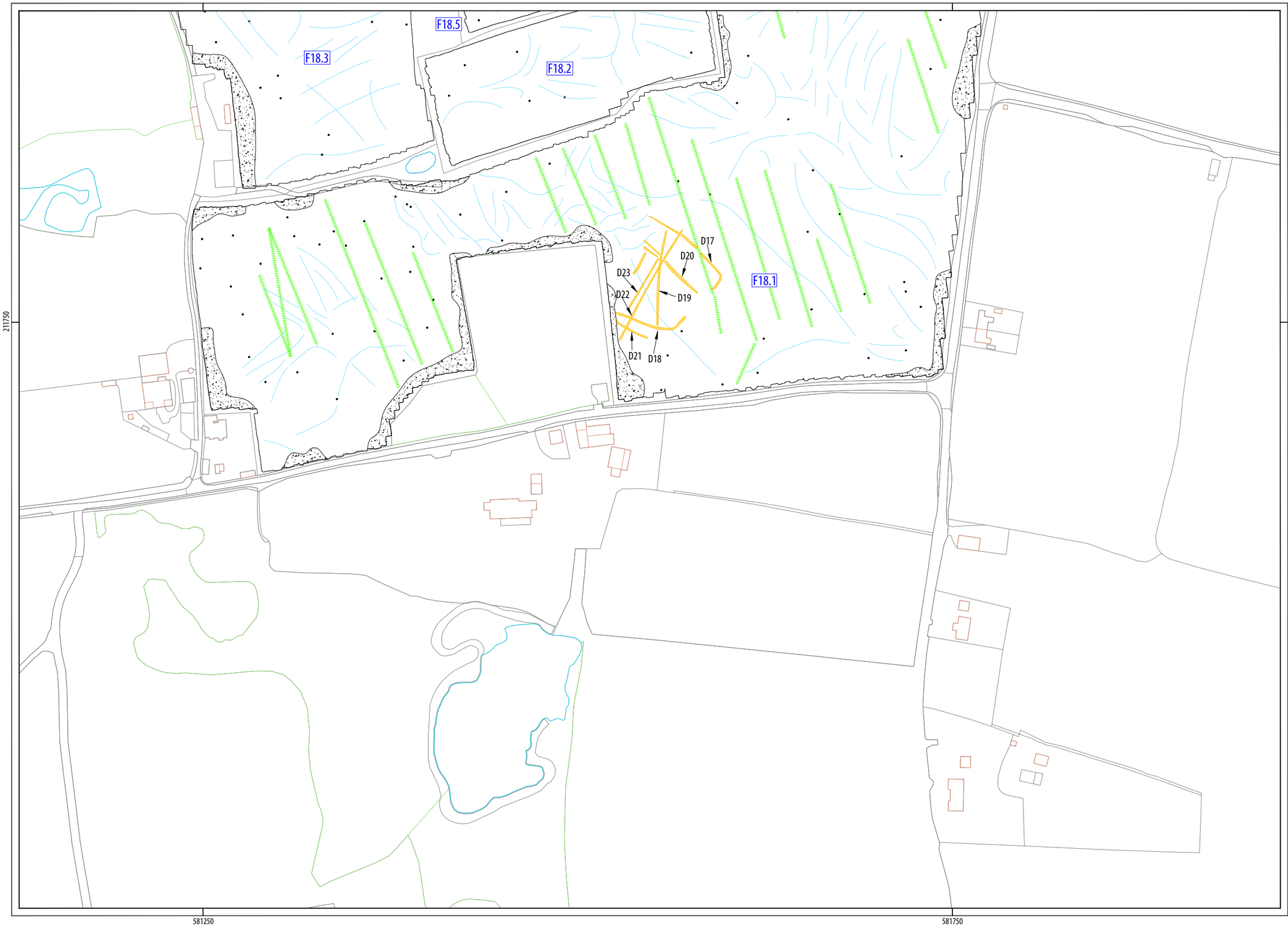
ILLUS 53 XY trace plot of minimally processed magnetometer data; Sector 15



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

ABBREVIATIONS

D ditch

0 50m

1:2,500 @ A3

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ILLUS 54 Interpretation of magnetometer data; Sector 15

F16.1
F18.8
F18.7
F18.6
F18.5
F18.4
F18.3
F18.2
F18.1

212250

581500

582000

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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ILLUS 55 Processed greyscale magnetometer data; Sector 16

F16.1
F18.8
F18.7
F18.6
F18.5
F18.4
F18.3
F18.2
F18.1
212250
581500
582000

25.0nT/cm
0
50m
1:2,500 @ A3

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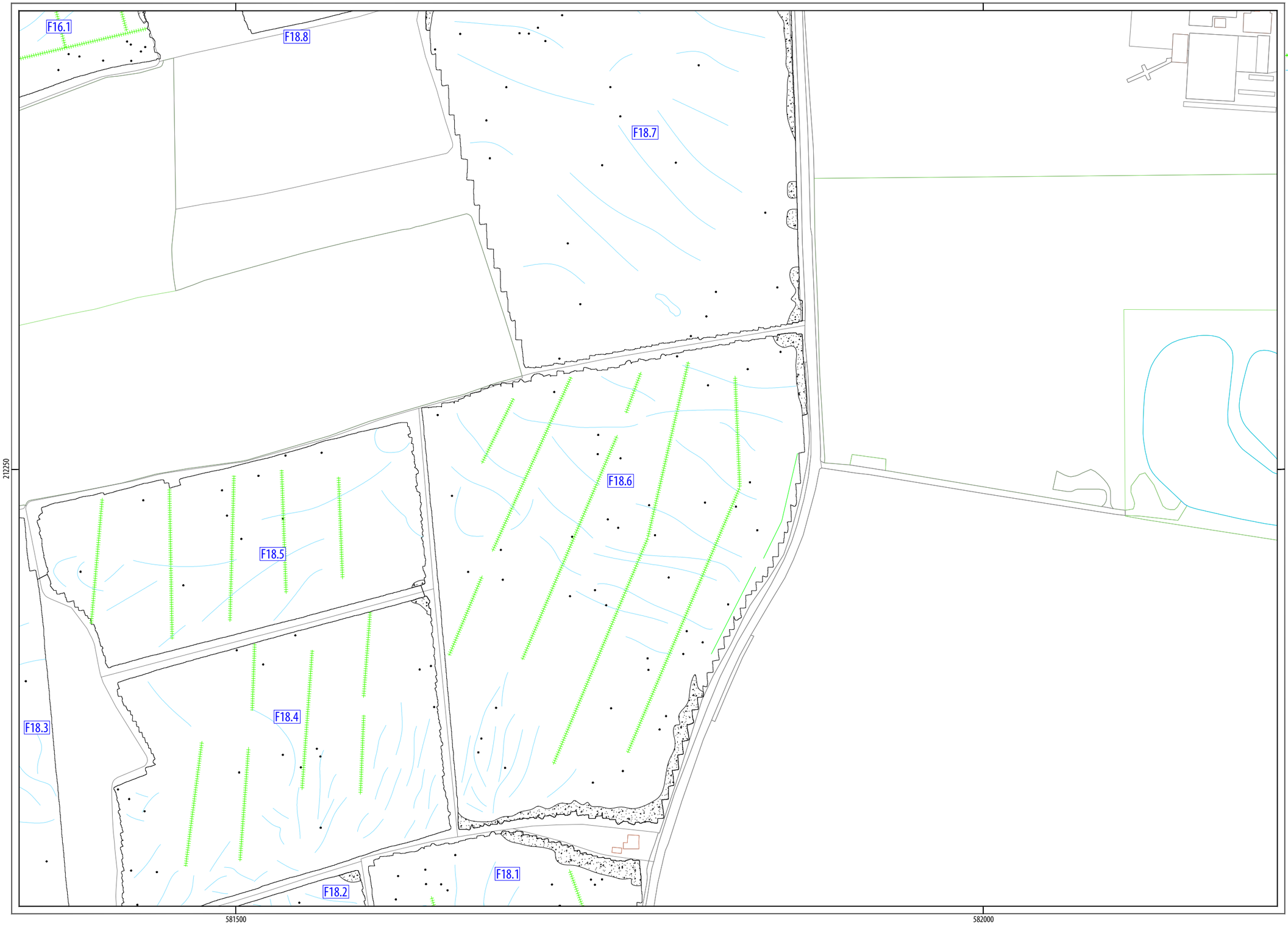
ILLUS 56 XY trace plot of minimally processed magnetometer data; Sector 16



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear trend	field drain
linear trend	geological variation

0 50m

1:2,500 @ A3

PROJECT ATCE19
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ILLUS 57 Interpretation of magnetometer data; Sector 16

-1.0 nT 2.0

0 50m
1:2,500 @ A3

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Junctions 19 to 23
Essex

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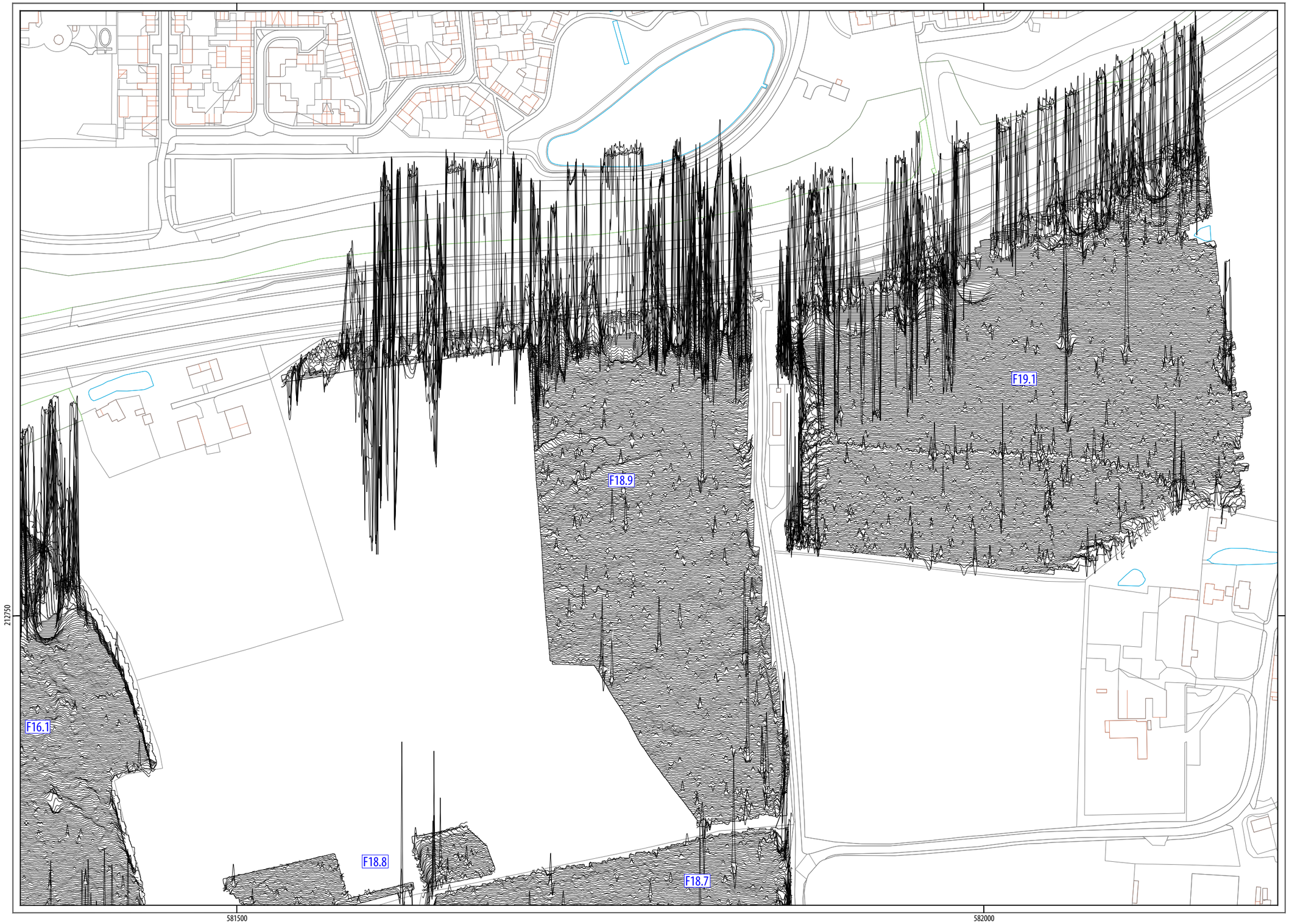
ILLUS 58 Processed greyscale magnetometer data; Sector 17



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

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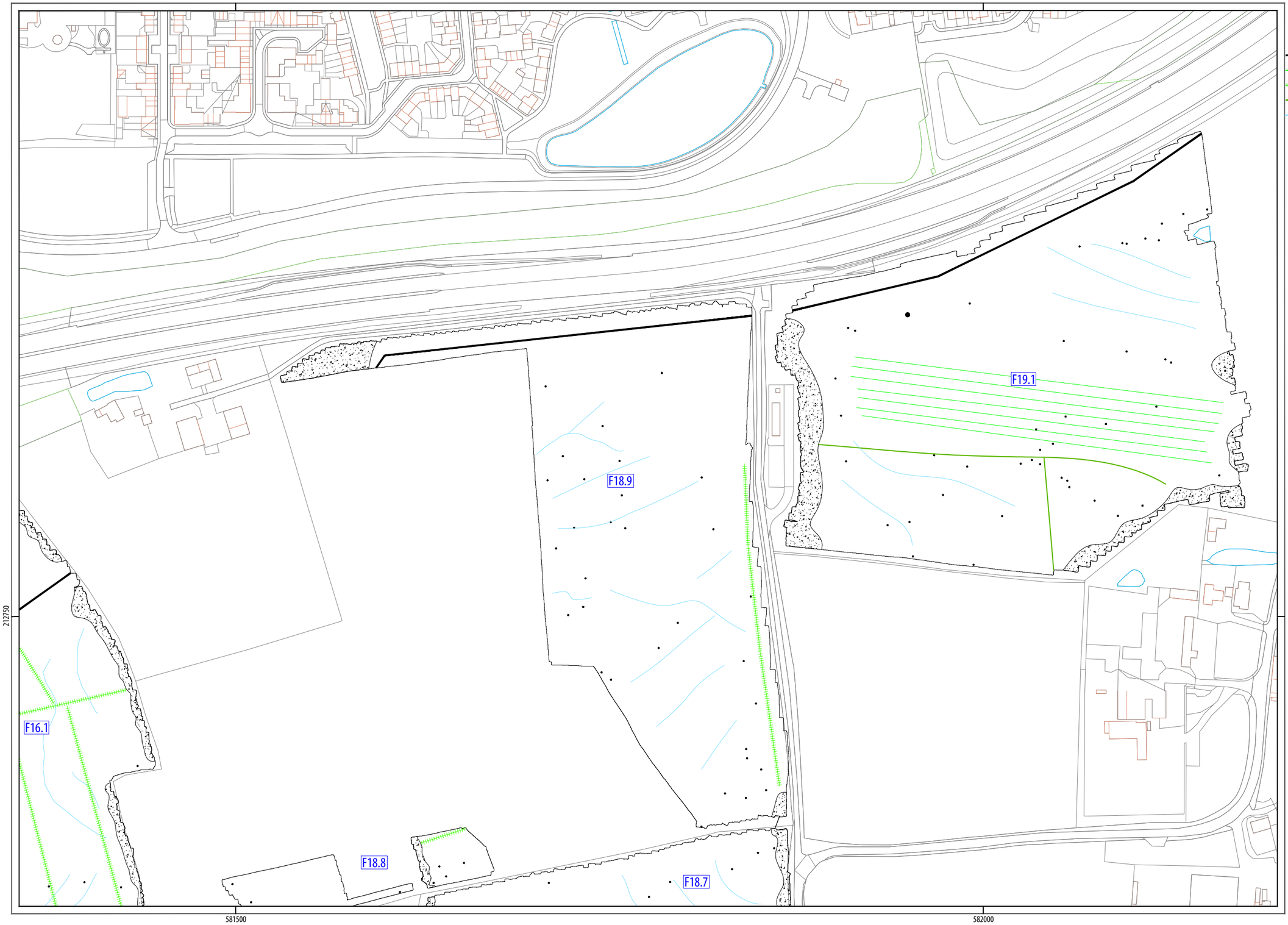
ILLUS 59 XY trace plot of minimally processed magnetometer data; Sector 17



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 trend	geological variation

0 50m
1:2,500 @ A3

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ILLUS 60 Interpretation of magnetometer data; Sector 17

213750

F21.3

F21.2

F21.1

F20.1

213250

582500

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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ILLUS 61 Processed greyscale magnetometer data; Sector 18

25.0nT/cm

0 50m

1:2,500 @ A3

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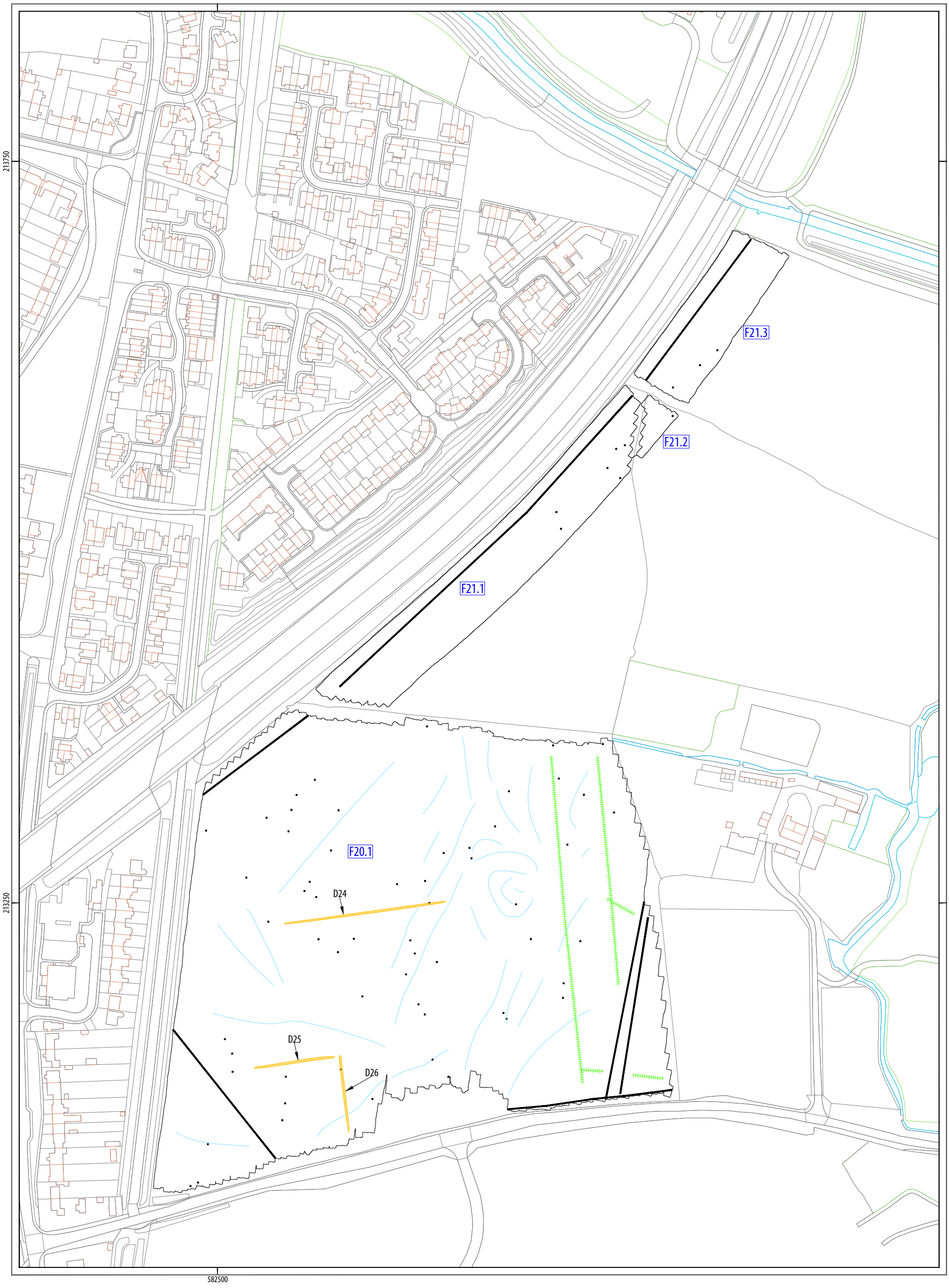
ILLUS 62 XY trace plot of minimally processed magnetometer data; Sector 18



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
dipolar linear	service pipe
linear trend	field drain
linear trend	geological variation
magnetic enhancement	archaeology?

ABBREVIATIONS

D ditch

0 50m

1:2,500 @ A3

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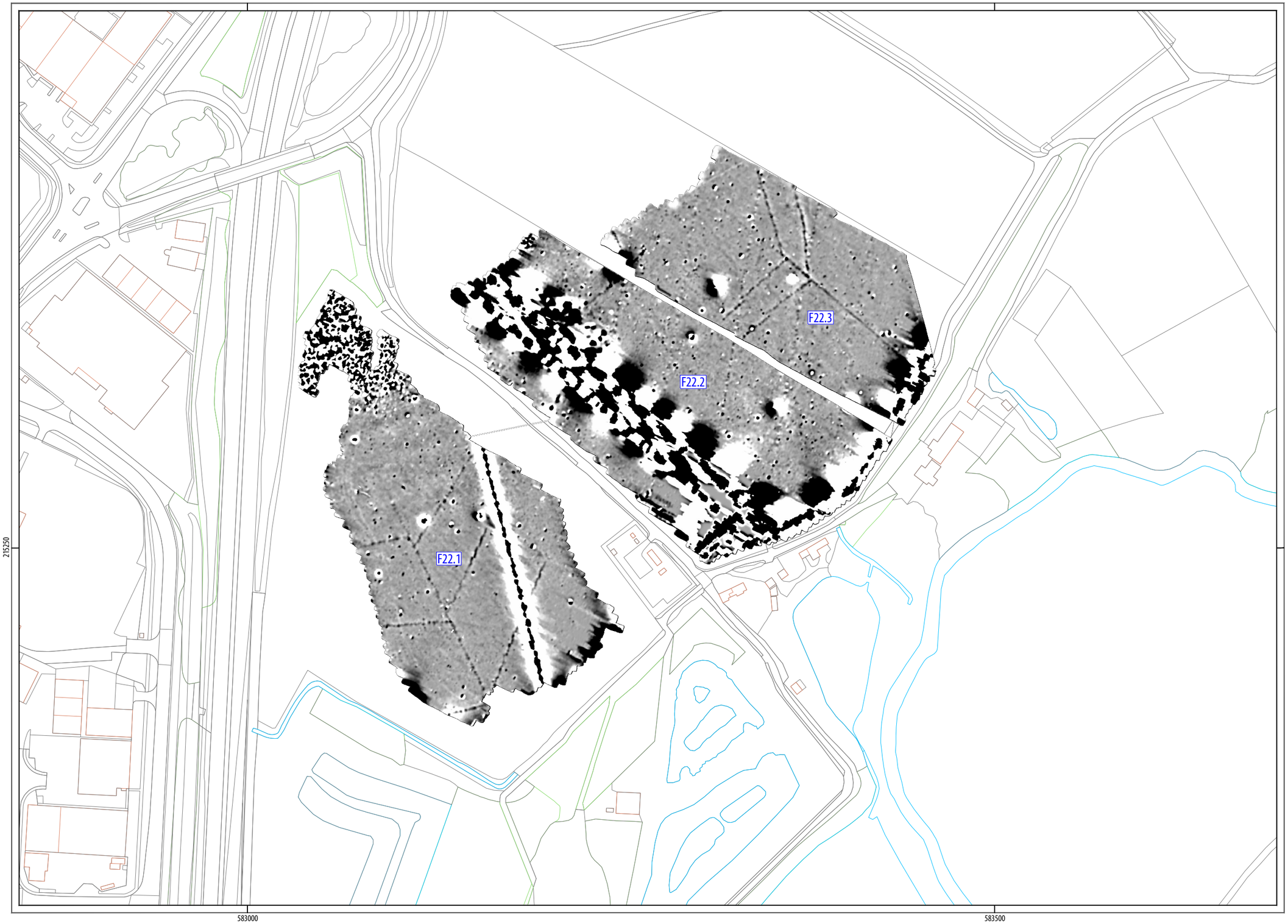
ILLUS 63 Interpretation plot of magnetometer data; Sector 18



nT
-1.0
2.0

0
50m
1:2,500 @ A3

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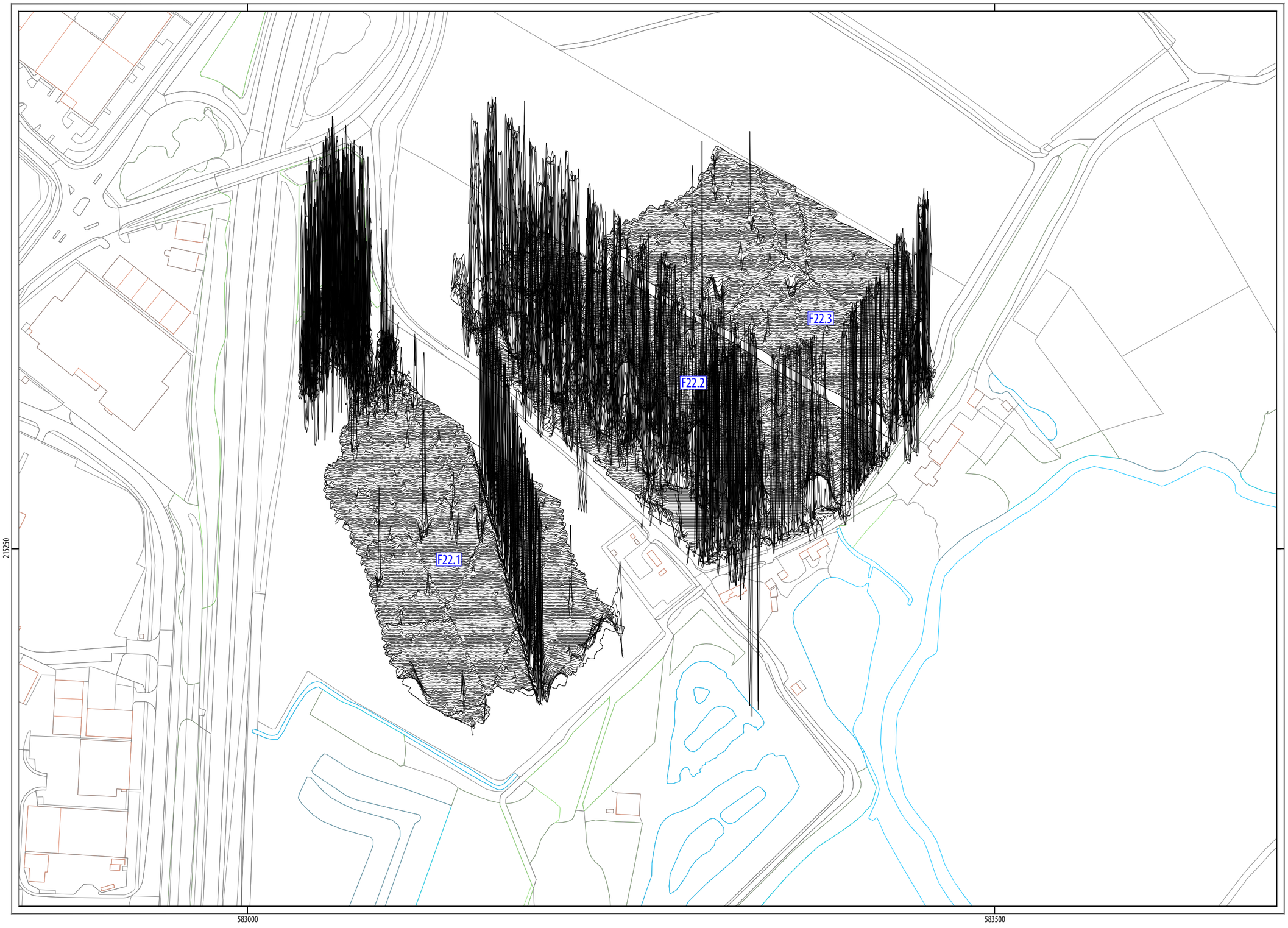
ILLUS 64 Processed greyscale magnetometer data; Sector 19



25.0nT/cm

0 50m

1:2,500 @ A3

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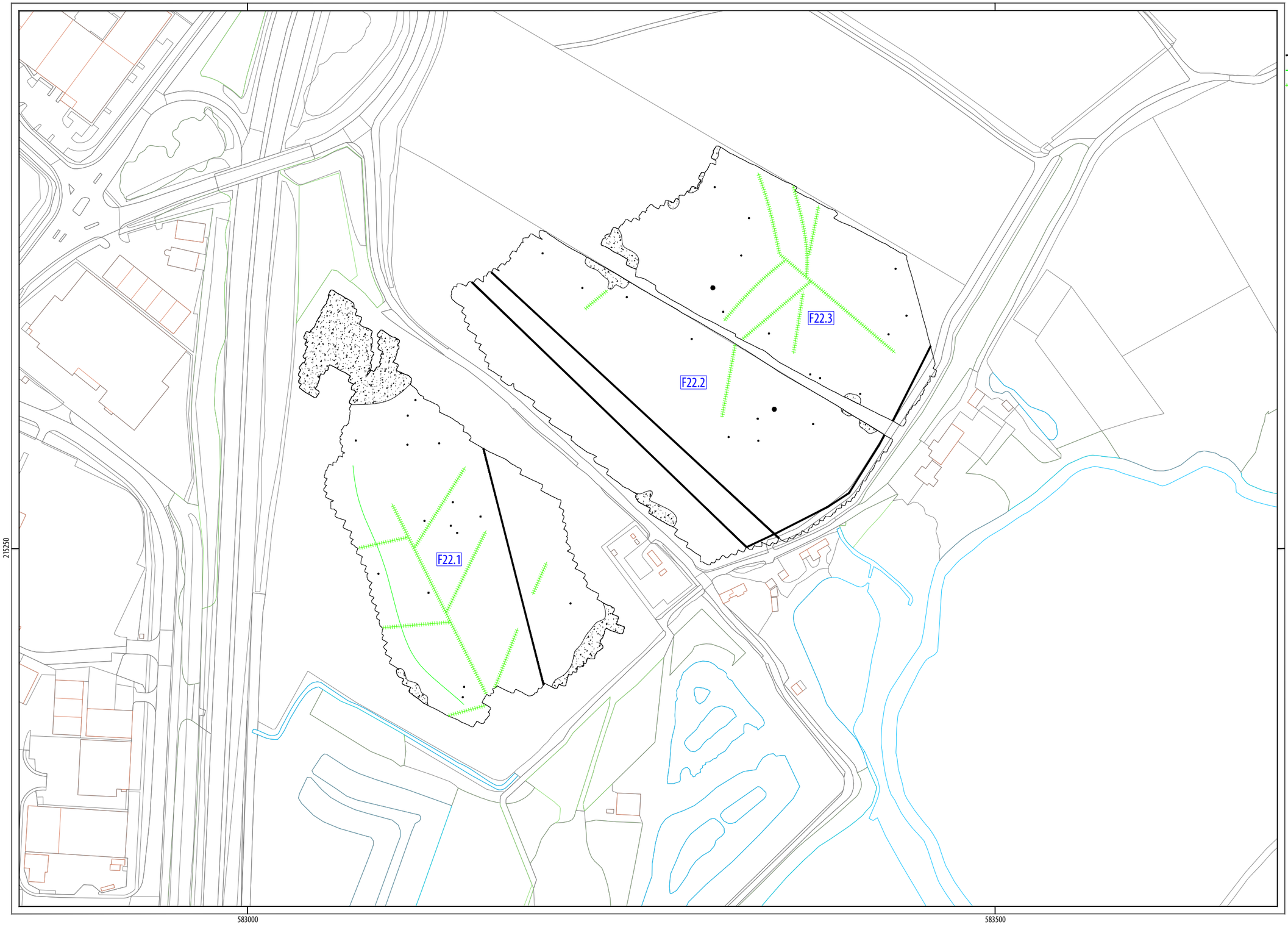
ILLUS 65 XY trace plot of minimally processed magnetometer data; Sector 19



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
linear trend	agricultural
linear trend	field drain

0 50m
1:2,500 @ A3

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ILLUS 66 Interpretation of magnetometer data; Sector 19

F24.1

216000

583000

583500

-1.0 nT 2.0

0 50m

1:2,500 @ A3

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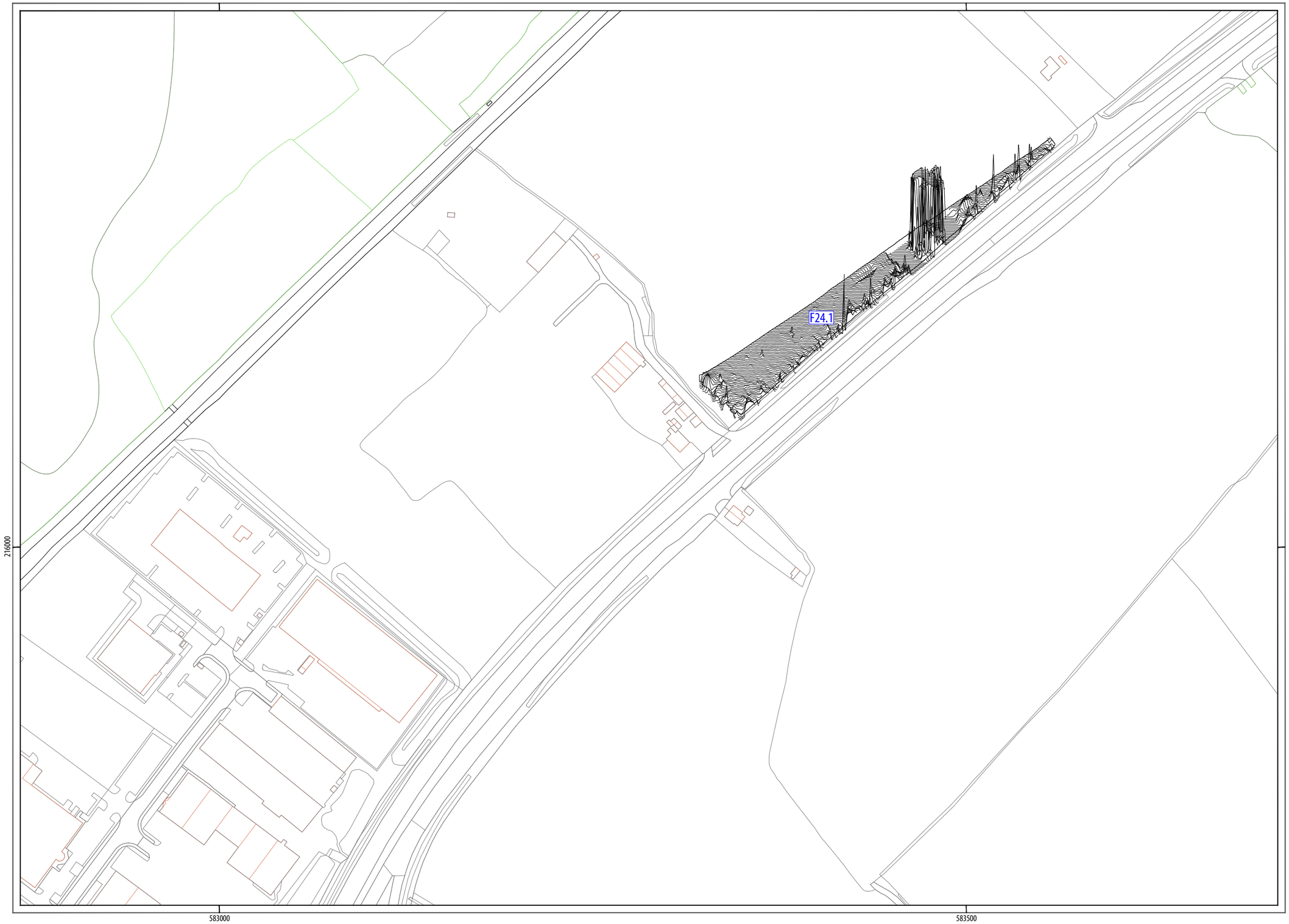
ILLUS 67 Processed greyscale magnetometer data; Sector 20



25.0nT/cm

0 50m

1:2,500 @ A3

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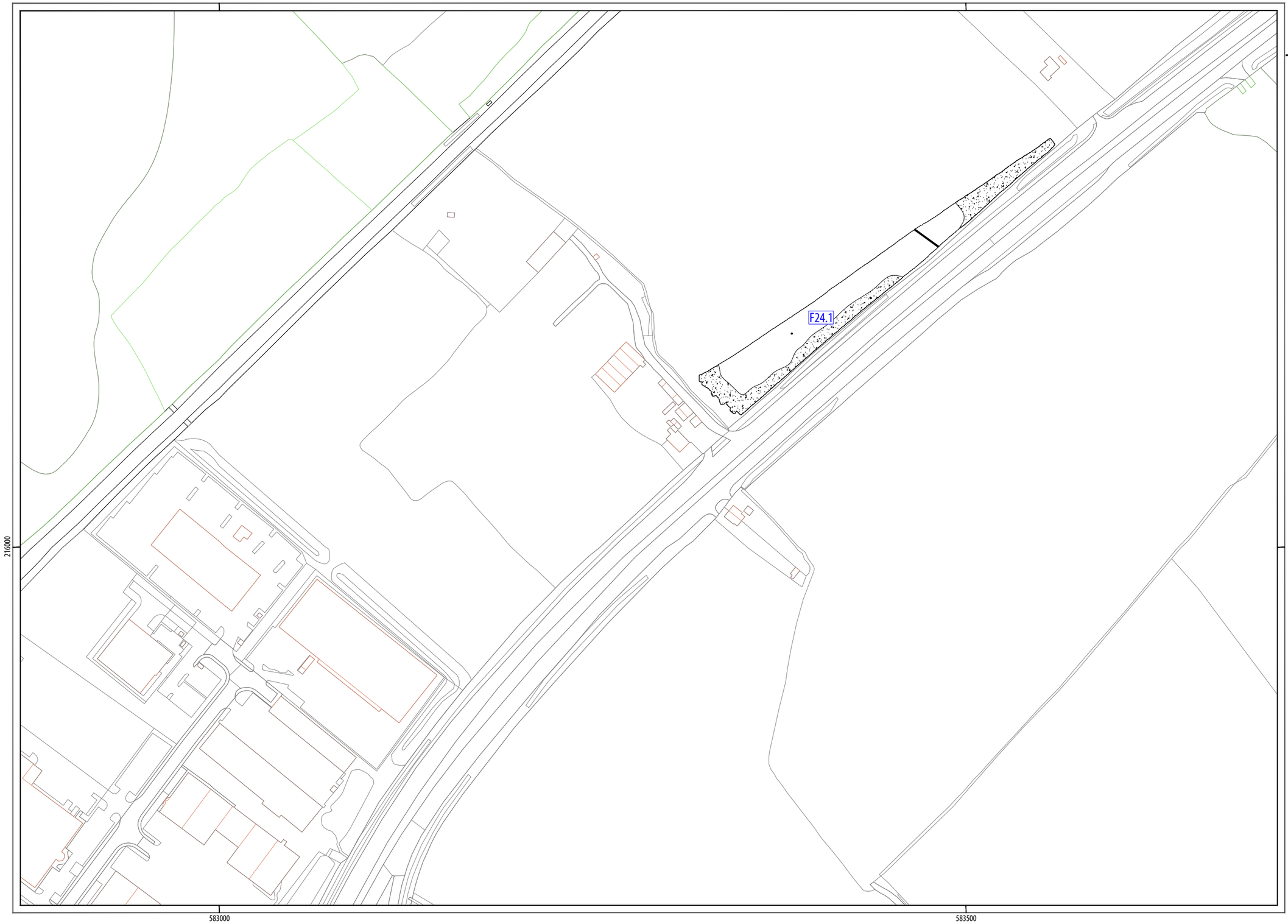
ILLUS 68 XY trace plot of minimally processed magnetometer data; Sector 20



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe

0 50m
1:2,500 @ A3

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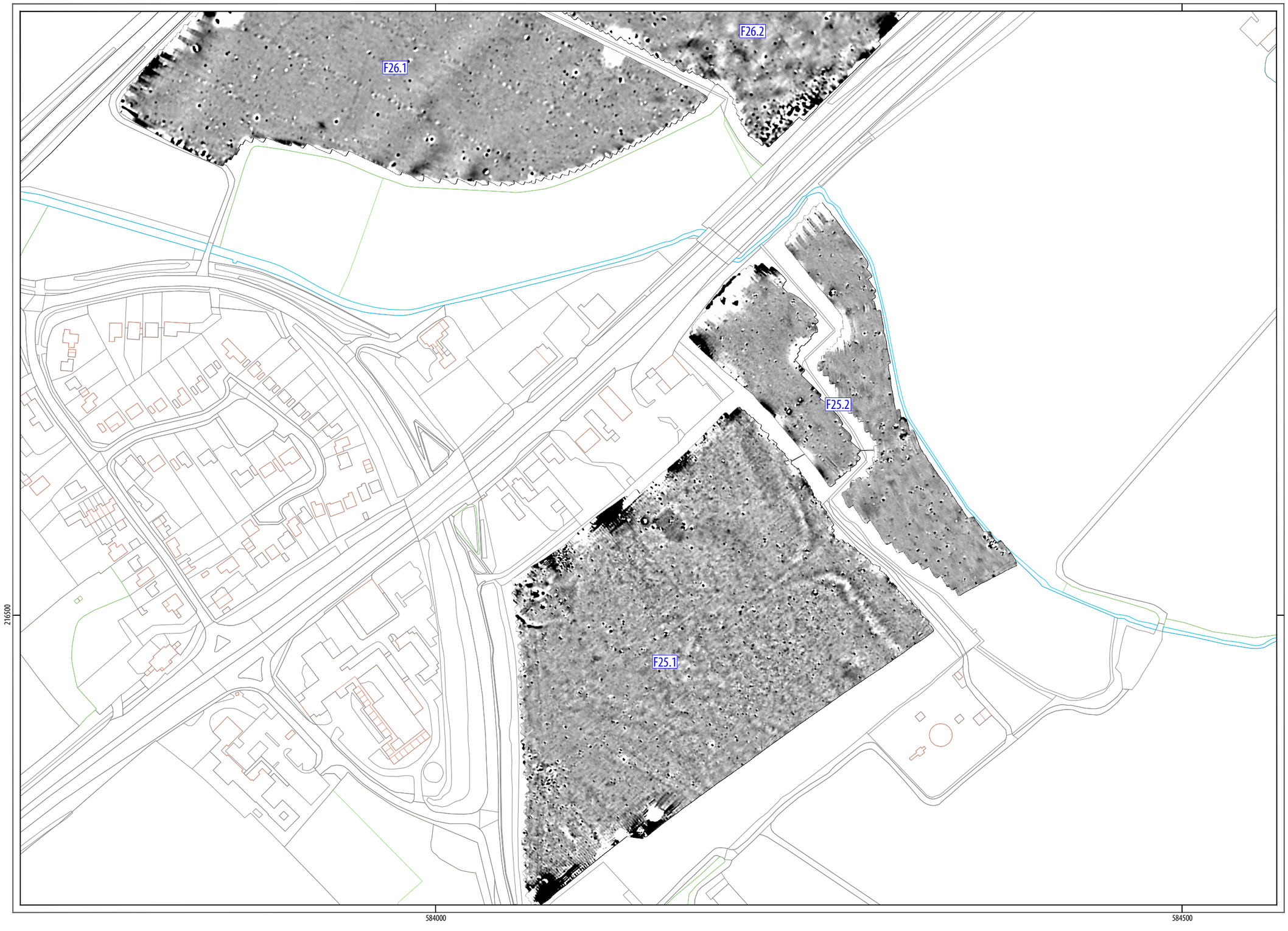
ILLUS 69 Interpretation of magnetometer data; Sector 21



nT
-1.0 2.0

0 50m
1:2,500 @ A3

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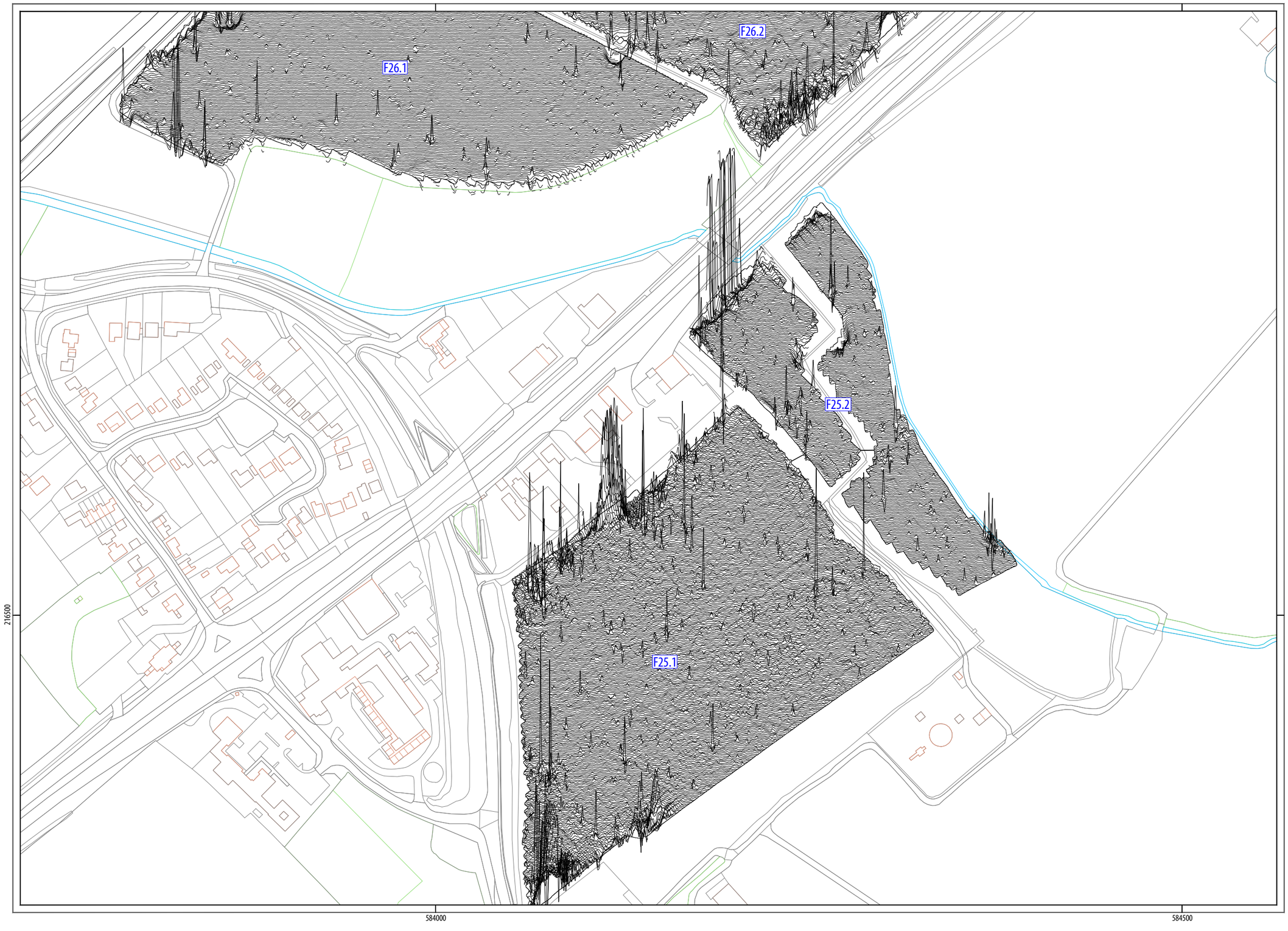
ILLUS 70 Processed greyscale magnetometer data; Sector 21



25.0nT/cm

0 50m

1:2,500 @ A3

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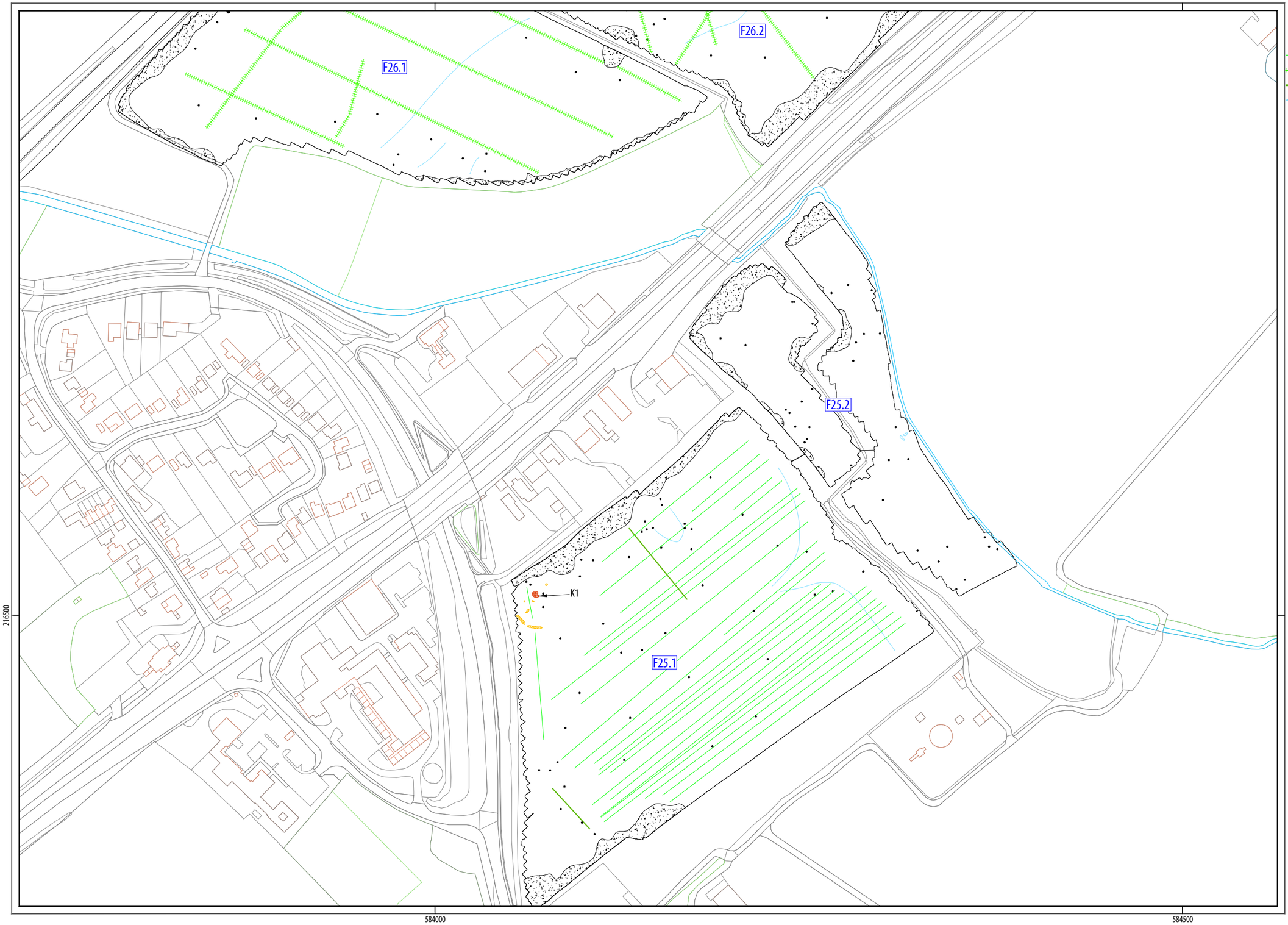
ILLUS 71 XY trace plot of minimally processed magnetometer data; Sector 21



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

ABBREVIATIONS

K kiln

0 50m

1:2,500 @ A3

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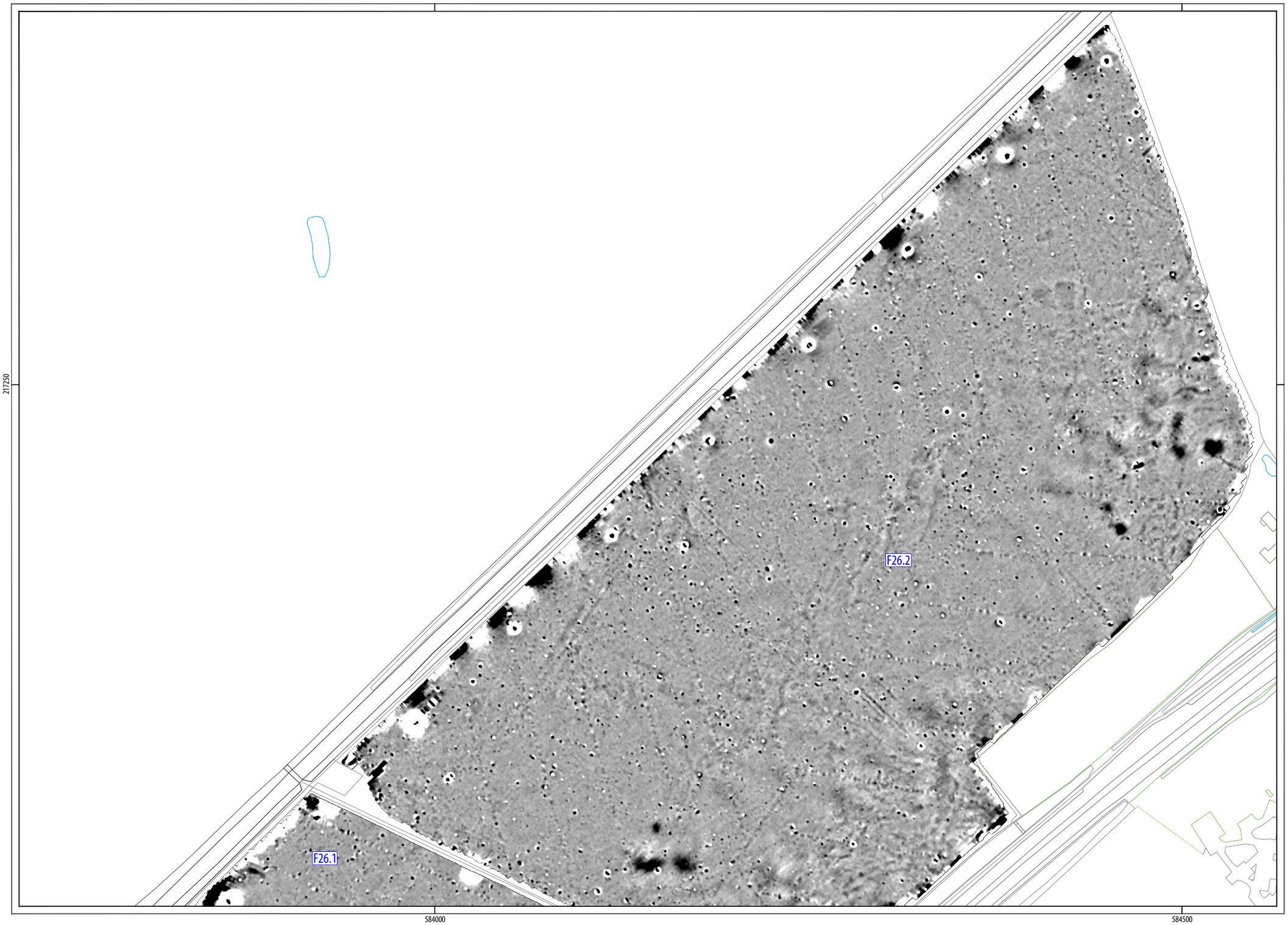
ILLUS 72 Interpretation of magnetometer data; Sector 21



nT
-1.0 2.0

0 50m
1:2,500 @ A3

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Junctions 19 to 23
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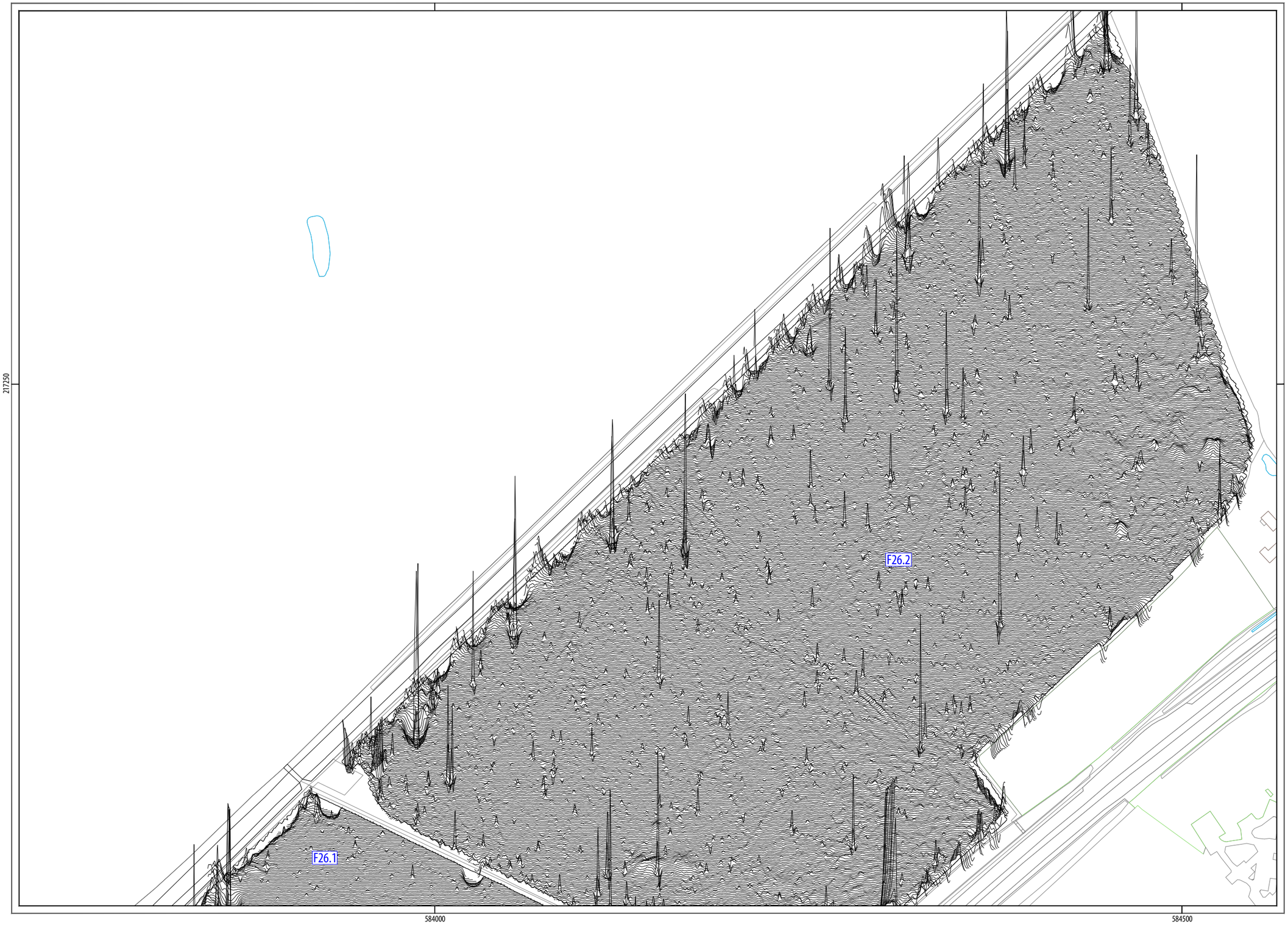
ILLUS 73 Processed greyscale magnetometer data; Sector 22



25.0nT/cm

0 50m

1:2,500 @ A3

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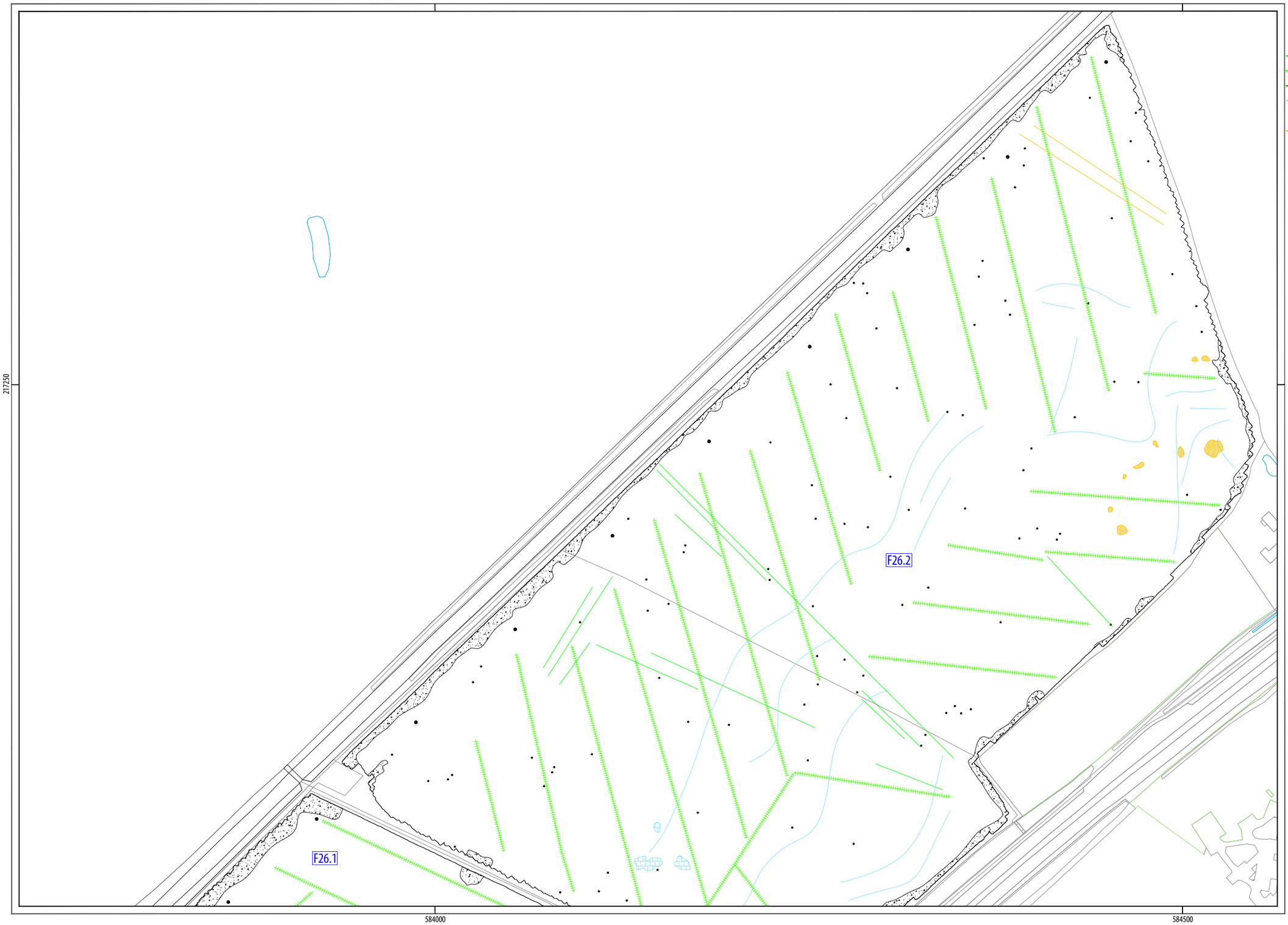
ILLUS 74 XY trace plot of minimally processed magnetometer data; Sector 22



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
linear trend	archaeology?
magnetic enhancement	archaeology?

0 50m
1:2,500 @ A3

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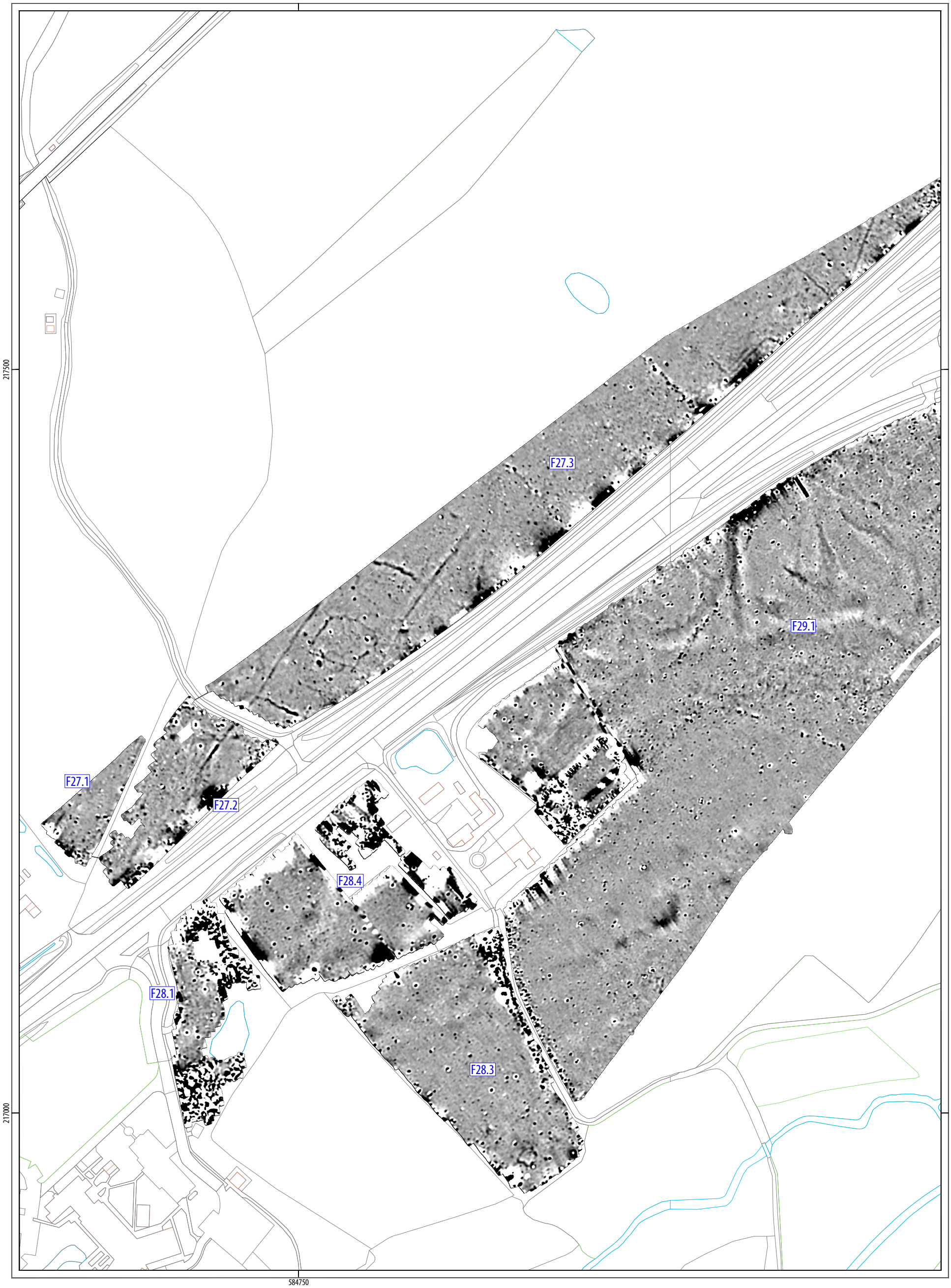
ILLUS 75 Interpretation of magnetometer data; Sector 22



nT
-1.0
2.0

0
50m
1:2,500 @ A3

PROJECT ATCE19
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Junctions 19 to 23
Essex

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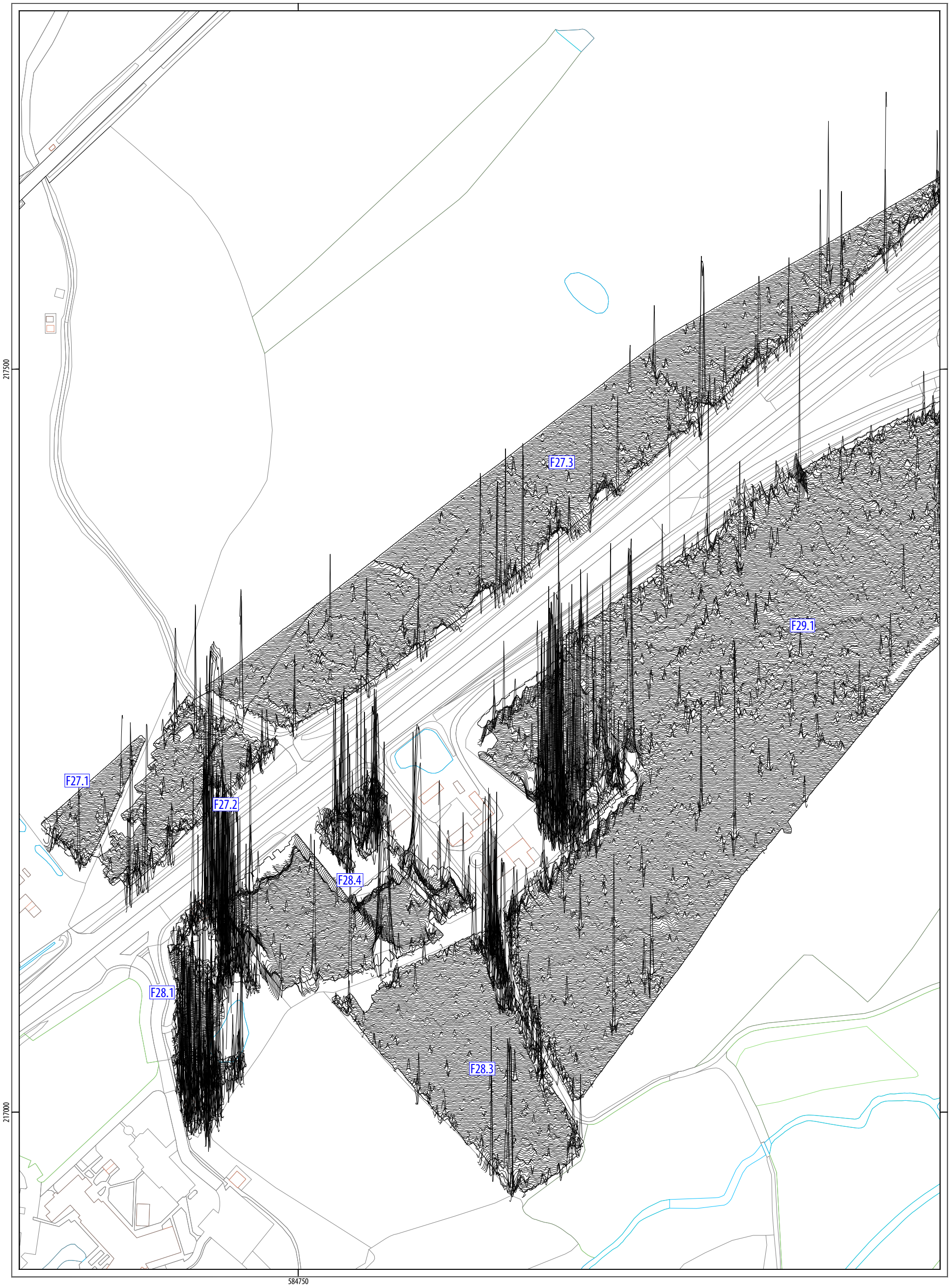
ILLUS 76 Processed greyscale magnetometer data; Sector 23



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
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Junctions 19 to 23
Essex

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ILLUS 77 XY trace plot of minimally processed magnetometer data; Sector 23

217500

F27.3

D29

D28

E2

RD1

D27

D30

D27

F29.1

F27.1

F27.2

F28.4

F28.1

F28.3

D31

RD2

217000

584750

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

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	archaeology

ABBREVIATIONS

D ditch

RD ring-ditch

0 50m

1:2,500 @ A3

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ILLUS 78 Interpretation of magnetometer data; Sector 23

F27.3

F29.1

217500

217000

585550

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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ILLUS 79 Processed greyscale magnetometer data; Sector 24

25.0nT/cm

0 50m

1:2,500 @ A3

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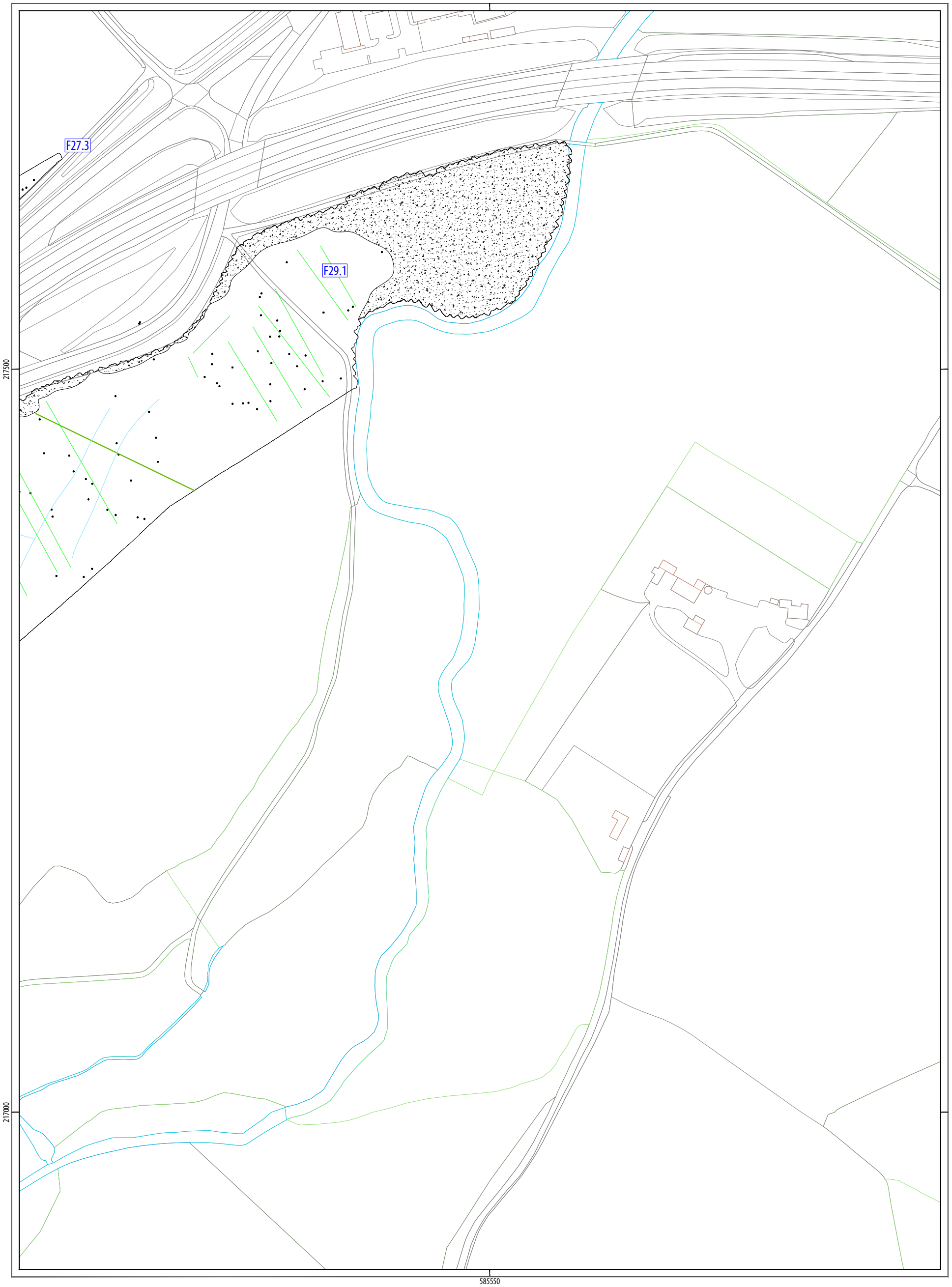
ILLUS 80 XY trace plot of minimally processed magnetometer data; Sector 24



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

0 50m
1:2,500 @ A3

PROJECT ATCE19
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Junctions 19 to 23
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ILLUS 81 Interpretation of magnetometer data; Sector 24

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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Junctions 19 to 23
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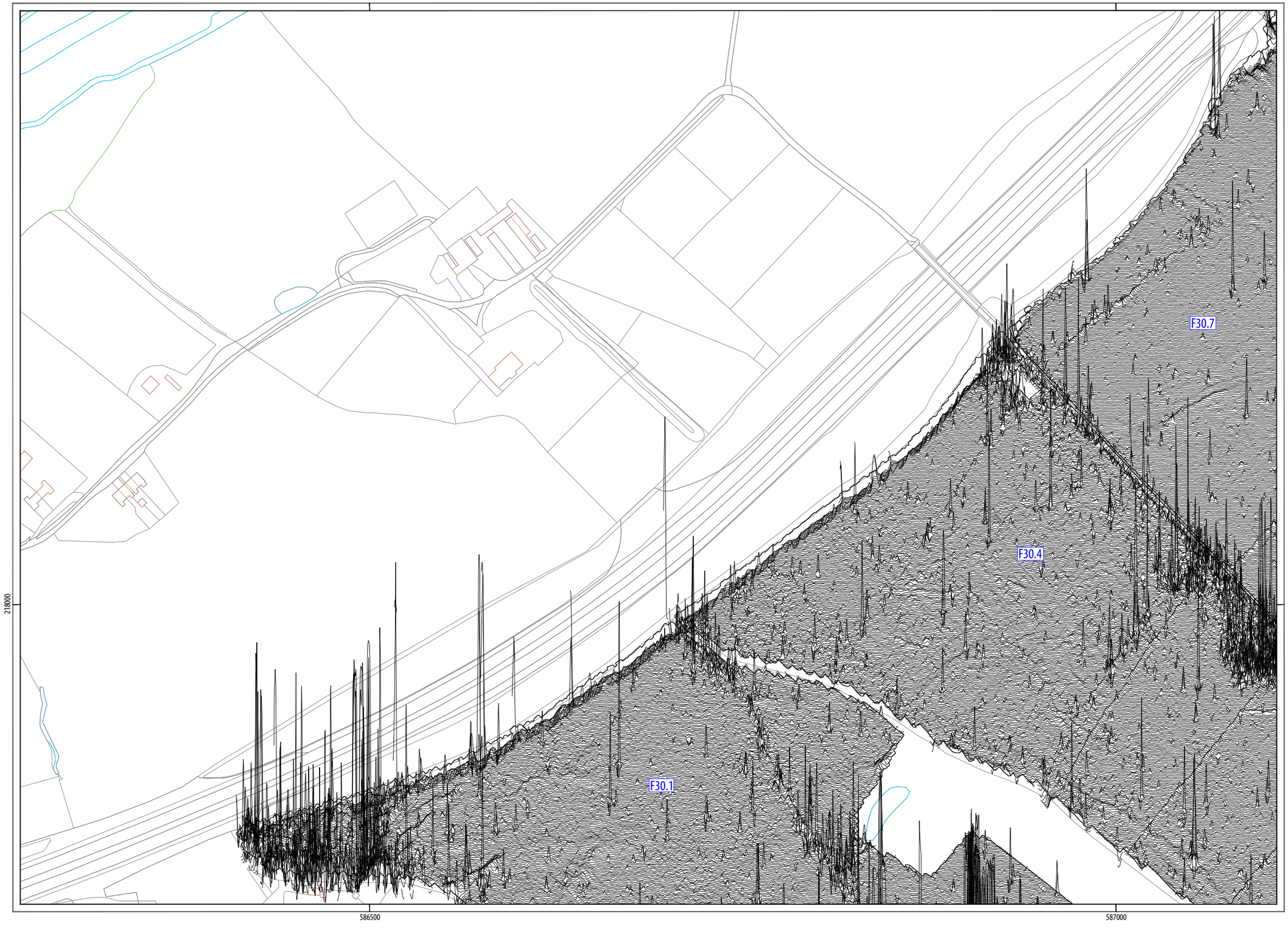
ILLUS 82 Processed greyscale magnetometer data; Sector 25



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
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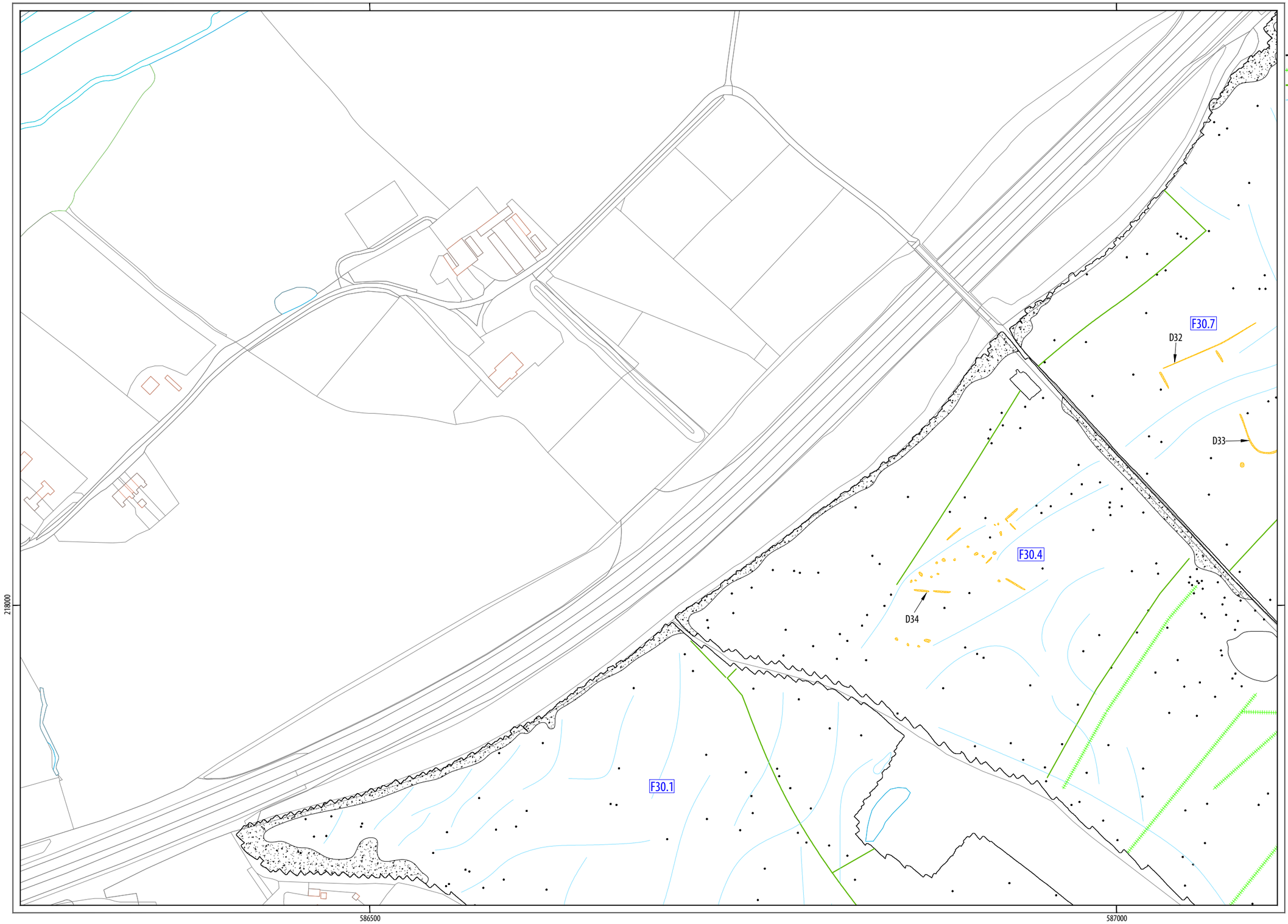
ILLUS 83 XY trace plot of minimally processed magnetometer data; Sector 25



TYPE OF ANOMALY | INTERPRETATION

- dipolar isolated — ferrous material
- magnetic disturbance — ferrous material
- dipolar linear — service pipe
- linear trend — field drain
- linear — former field boundary
- linear trend — geological variation
- magnetic enhancement — archaeology?

ABBREVIATIONS

D ditch

0 50m
1:2,500 @ A3

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ILLUS 84 Interpretation of magnetometer data; Sector 25

-1.0 nT 2.0

0 50m
1:2,500 @ A3

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ILLUS 85 Processed greyscale magnetometer data; Sector 26

25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 86 XY trace plot of minimally processed magnetometer data; Sector 26

F30.1

F30.2

F30.3

F30.4

217500

586750

587250

TYPE OF ANOMALY
- dipolar isolated
- magnetic disturbance
- linear trend
- linear
- linear trend

INTERPRETATION
- ferrous material
- ferrous material
- field drain
- former field boundary
- geological variation

0 50m
1:2,500 @ A3

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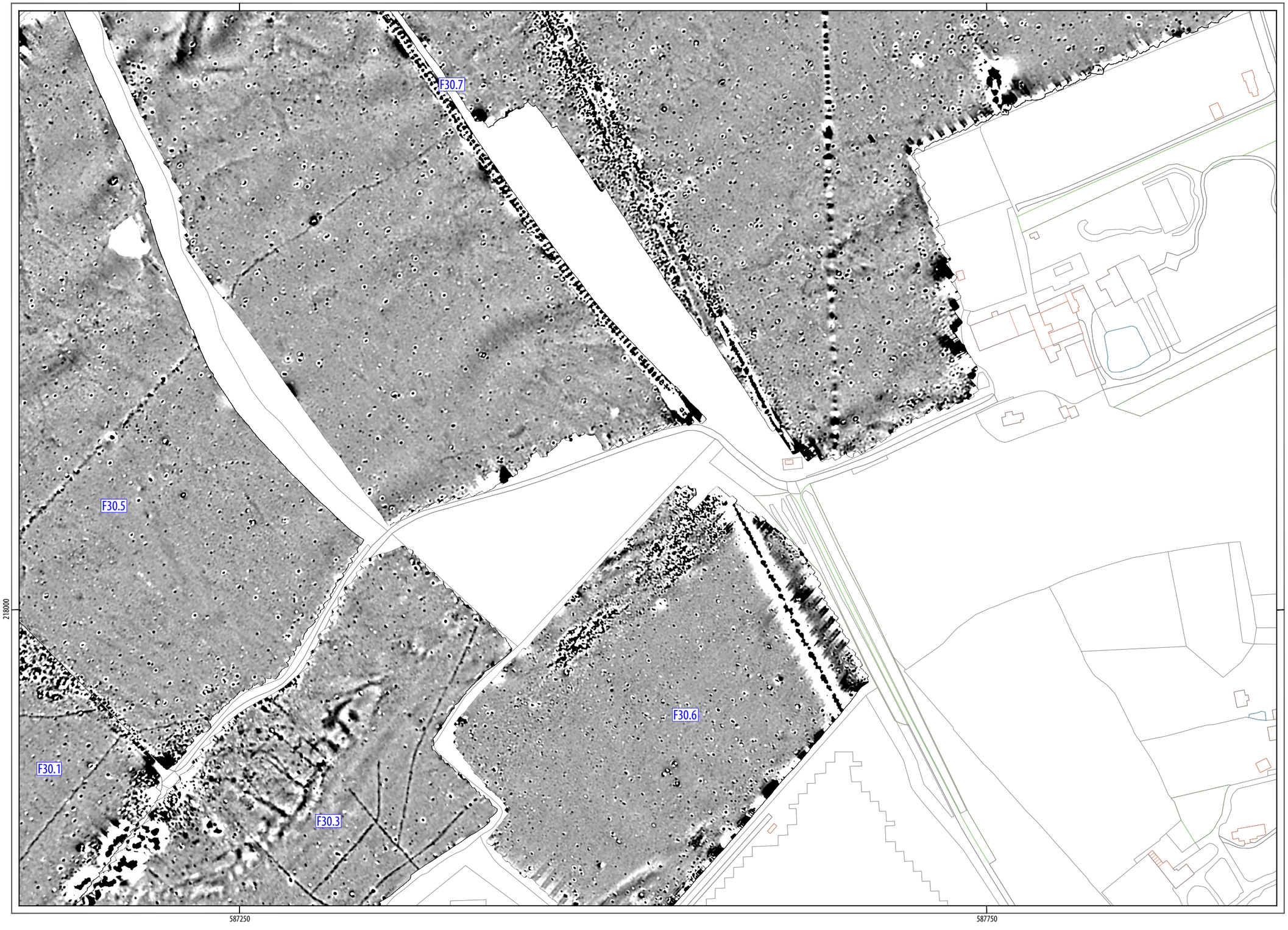
ILLUS 87 Interpretation of magnetometer data; Sector 26



nT
-1.0 2.0

0 50m
1:2,500 @ A3

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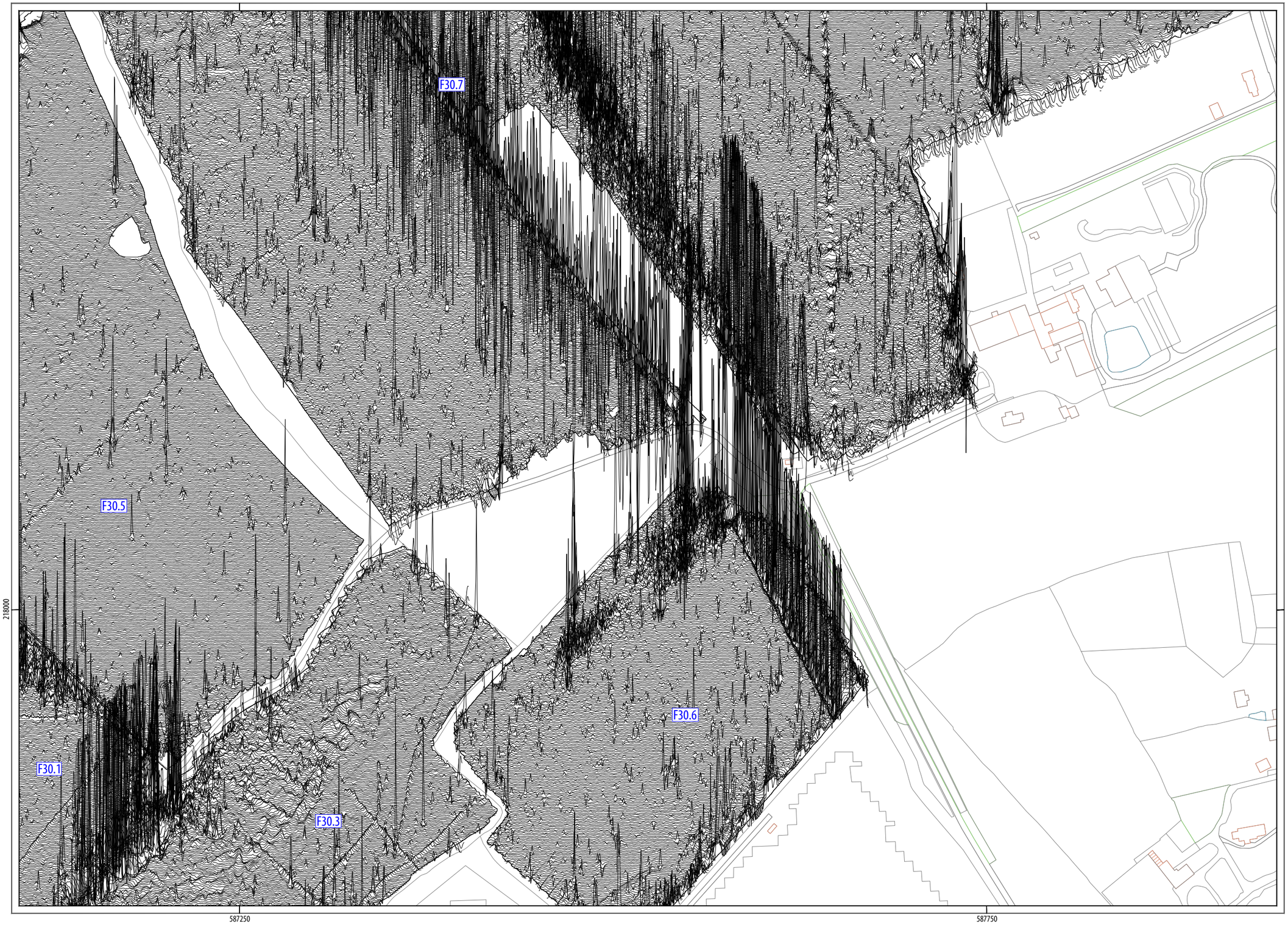
ILLUS 88 Processed greyscale magnetometer data; Sector 27



25.0nT/cm

0 50m

1:2,500 @ A3

PROJECT ATCE19
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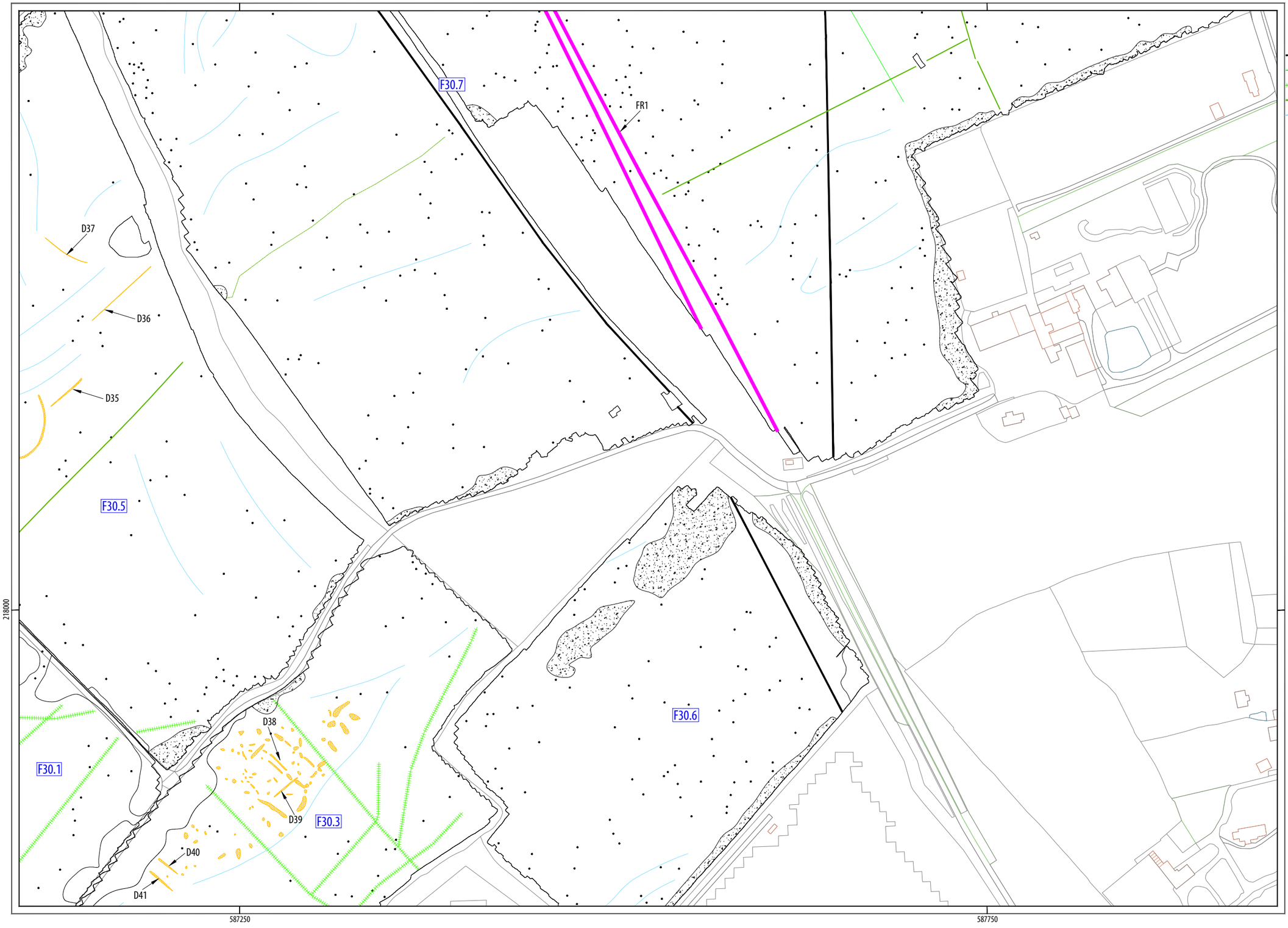
ILLUS 89 XY trace plot of minimally processed magnetometer data; Sector 27



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 trend	geological variation
magnetic enhancement	archaeology?

ABBREVIATIONS

D ditch

FR former railway

0 50m

1:2,500 @ A3

PROJECT ATCE19
A12 Chelmsford to A120
Junctions 19 to 23
Essex

CLIENT Costain

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ILLUS 90 Interpretation of magnetometer data; Sector 27

218750

F30.7

587250

587750

-1.0 nT 2.0

0 50m

1:2,500 @ A3

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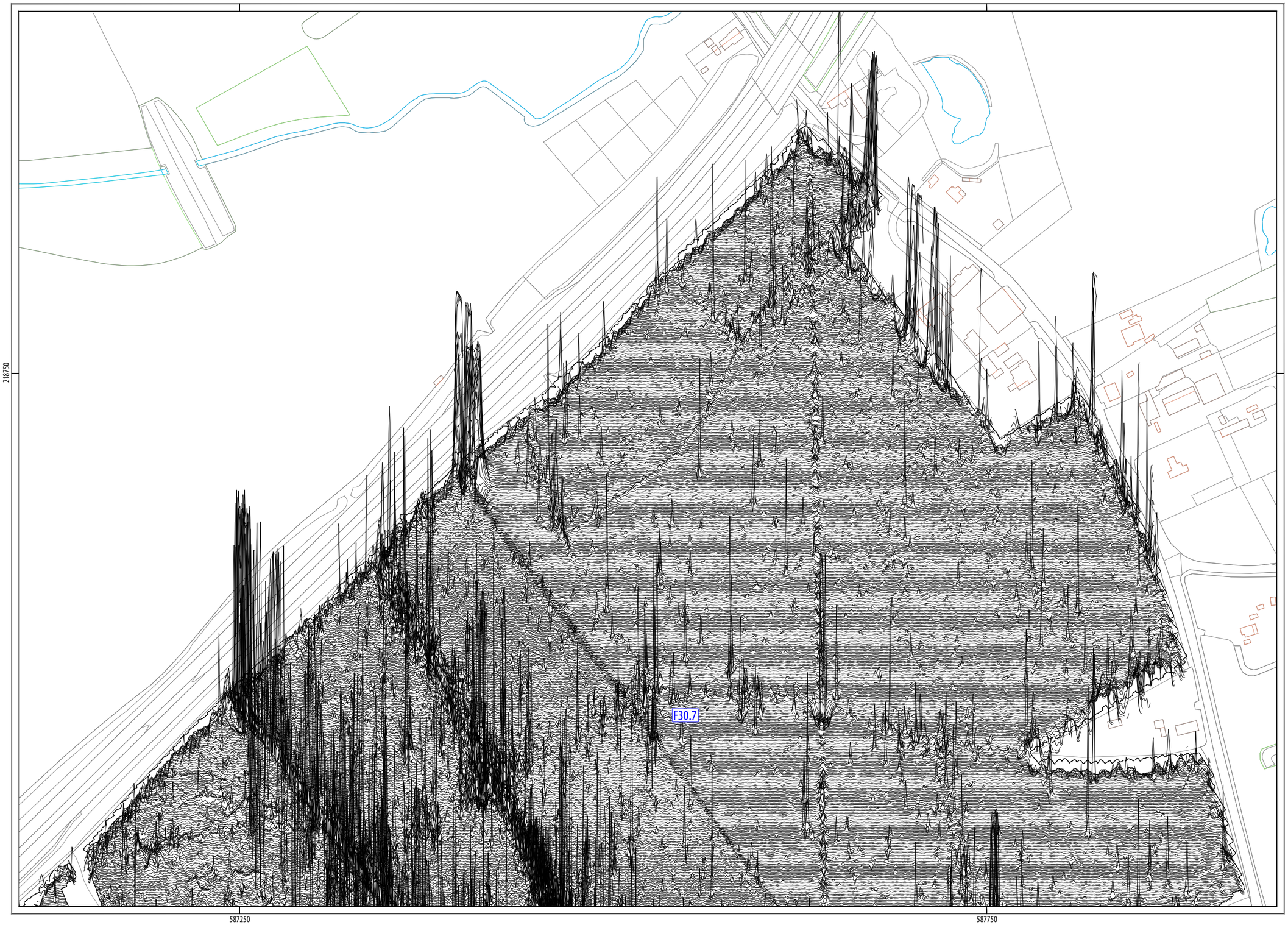
ILLUS 91 Processed greyscale magnetometer data; Sector 28



25.0nT/cm

0 50m

1:2,500 @ A3

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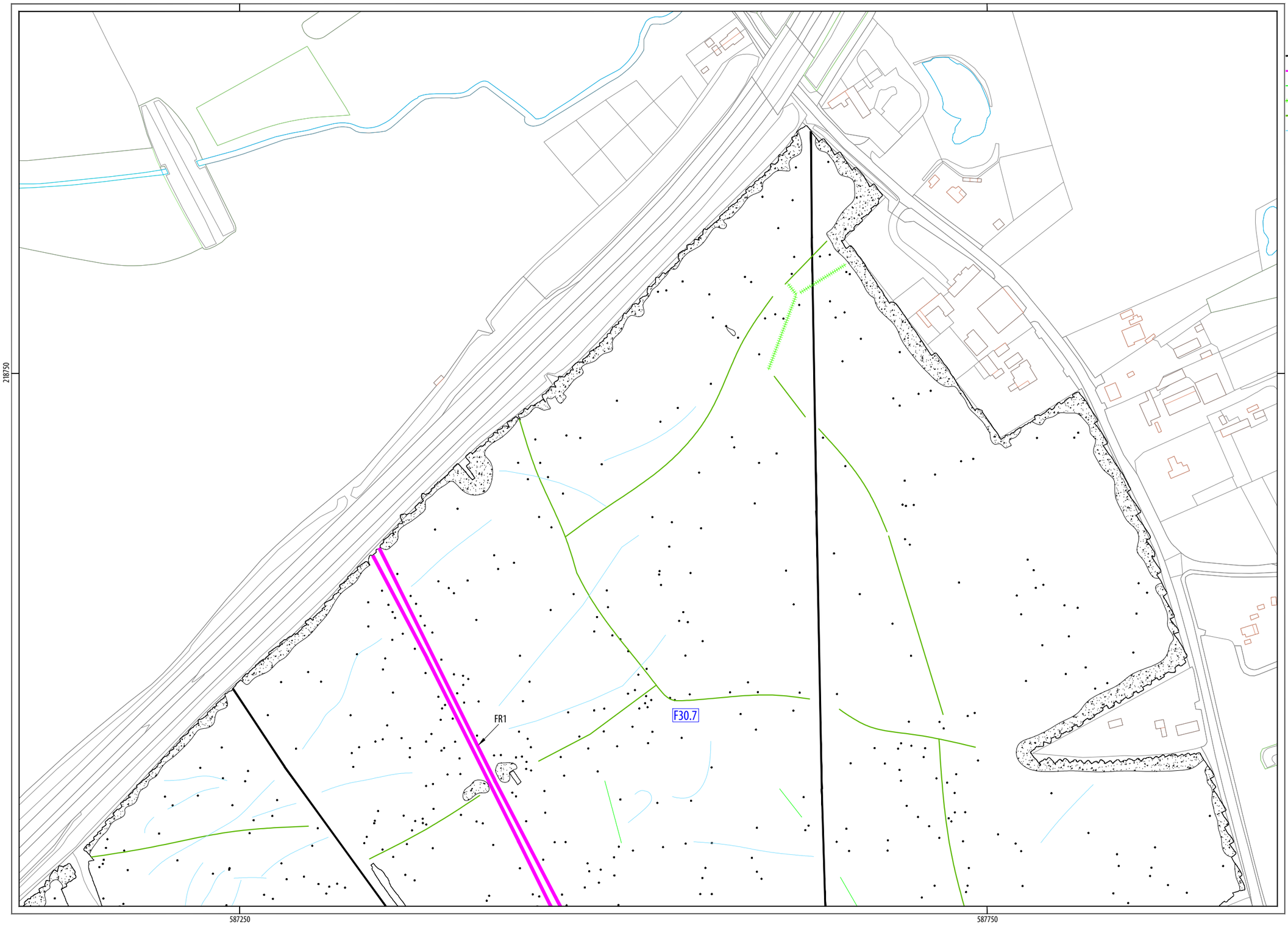
ILLUS 92 XY trace plot of minimally processed magnetometer data; Sector 28



TYPE OF ANOMALY | INTERPRETATION

- dipolar isolated — ferrous material
- magnetic disturbance — ferrous material
- dipolar linear — service pipe
- linear — former railway
- linear trend — agricultural
- linear trend — field drain
- linear — former field boundary
- linear trend — geological variation

ABBREVIATIONS

FR former railway

0 50m
1:2,500 @ A3

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ILLUS 93 Interpretation of magnetometer data; Sector 28

219750

F31.3

F31.2

F31.1

219250

588000

nT
-1.0
2.0

0
50m
1:2,500 @ A3

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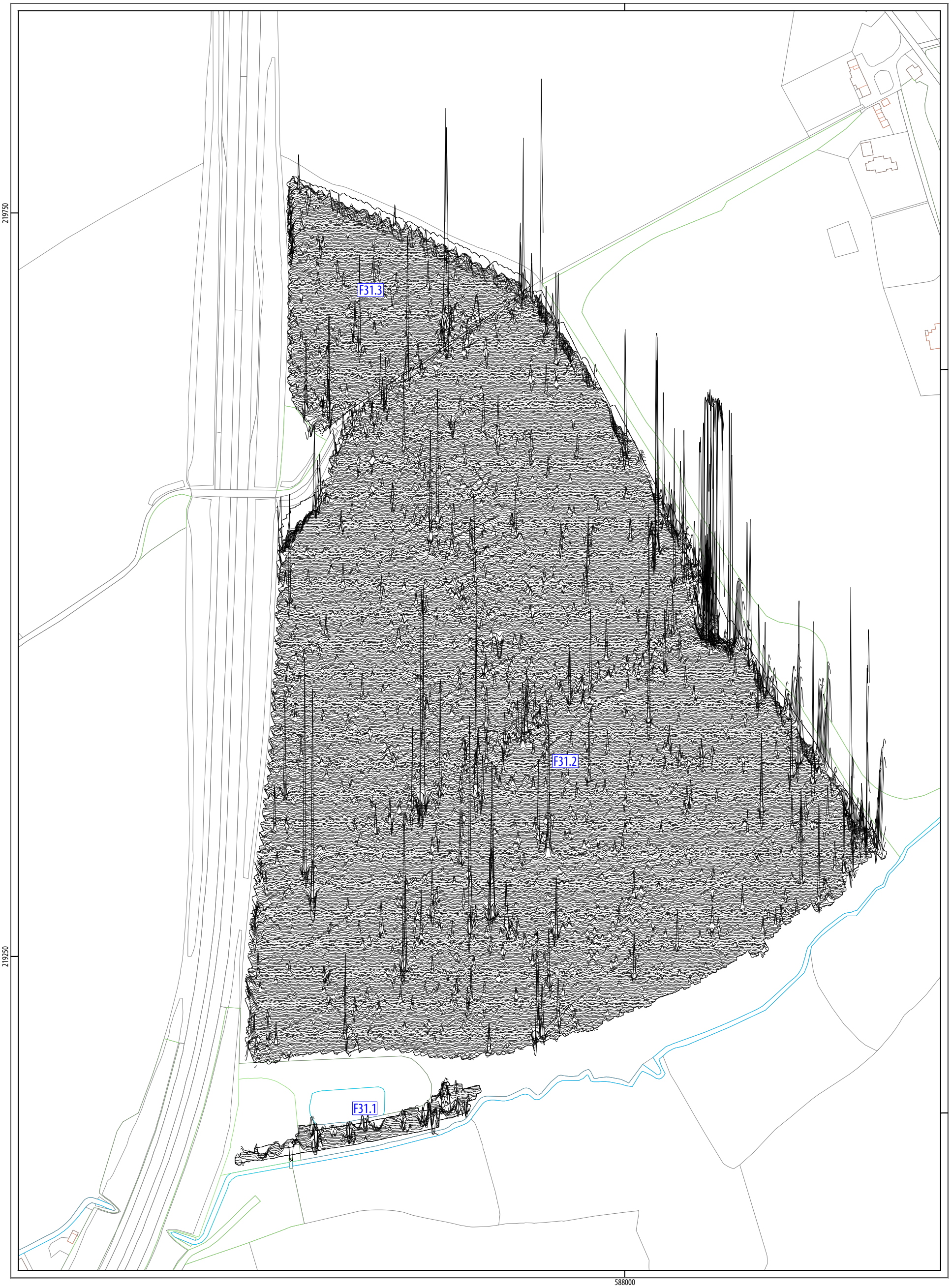
ILLUS 94 Processed greyscale magnetometer data; Sector 29



25.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 95 XY trace plot of minimally processed magnetometer data; Sector 29

219750

F31.3

D45

D44

D43

D42

F31.2

F31.1

219250

588000

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

ABBREVIATIONS

D ditch

0 50m

1:2,500 @ A3

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ILLUS 96 Interpretation of magnetometer data; Sector 29

7 APPENDICES

APPENDIX 1 MAGNETOMETER SURVEY

Magnetic susceptibility and soil magnetism

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

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

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

Types of magnetic anomaly

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

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

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

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

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

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

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

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

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

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

APPENDIX 2 SURVEY LOCATION INFORMATION

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

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

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

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

APPENDIX 3 GEOPHYSICAL SURVEY ARCHIVE

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

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

APPENDIX 4 DATA PROCESSING

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

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

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

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

APPENDIX 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5-402756

PROJECT DETAILS	
Project name	A12 Chelmsford to A120, Essex
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey of c. 495 hectares on land between junctions 19 and 23 within the A12 Chelmsford to A120 Proposed Scheme, to inform an archaeological assessment of the proposed road. The survey has successfully evaluated the geophysical survey areas within the Proposed Scheme with the exception of a small number of areas where ground conditions were deemed unsuitable for survey. A number of anomalies of either, likely, or possible, archaeological potential have been identified. Of particular significance are settlement anomalies to the north of the old Roman Road at Area 27, the remains of a possible Icehouse in Area 1, a possible kiln structure in Area 25, a ring-ditch in Area 29 and a large pit in Area 10. Other groups of linear and discrete anomalies, which might have an archaeological origin, have been identified in other areas as indicated in the results. Several dipolar anomalies have been detected which are consistent with modern activity such as buried service pipes, trackways, a former railway line, demolition rubble, and even a disused, Cold War observation post. A large number of linear anomalies consistent with typical responses from former field boundaries, and in many cases corresponding to boundaries marked on old OS maps, have also been detected throughout the survey areas. Several low magnitude anomalies have been detected which probably relate to natural or geological causes. The majority of the scheme contains no anomalies of any archaeological potential and therefore, on the basis of the geophysical survey, the survey area is assessed as of low to moderate archaeological potential, and locally high in the vicinity of the clearly defined areas of archaeological activity.
Project dates	Start: 06-12-2019 End: 06-03-2020
Previous/future work	Not known / Yes
Any associated project reference codes	ATCE19 - Sitecode
Any associated project reference codes	headland5-402753 - OASIS form ID
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	Road scheme (new and widening)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Not known / Not recorded
Solid geology	LONDON CLAY
Drift geology	LACUSTRINE CLAYS, SILTS AND SANDS
Techniques	Magnetometry

PROJECT LOCATION	
Country	England
Site location	ESSEX BRAINTREE WITHAM A12 Chelmsford to A120
Site location	ESSEX BRAINTREE RIVENHALL A12 Chelmsford to A120
Site location	ESSEX BRAINTREE SILVER END A12 Chelmsford to A120
Site location	ESSEX BRAINTREE KELVEDON A12 Chelmsford to A120
Site location	ESSEX BRAINTREE FEERING A12 Chelmsford to A120
Site location	ESSEX COLCHESTER MESSING CUM INWORTH A12 Chelmsford to A120

Study area	495 Hectares
Site coordinates	TL 74217 08824 51.750476274958 0.5241654679 19 51 45 01 N 000 31 27 E Line
Site coordinates	TL 87919 19418 51.841183862983 0.72819596972 51 50 28 N 000 43 41 E Line

PROJECT CREATORS

Name of Organisation	Headland Archaeology
Project brief originator	Jacobs
Project design originator	Jacobs
Project director/manager	Harrison, S
Project supervisor	Vansassenbrouck, O.
Type of sponsor/funding body	Developer

PROJECT ARCHIVES

Physical Archive Exists?	No
Digital Archive recipient	ADS
Digital Contents	"other"
Digital Media available	"GIS","Geophysics","Images raster / digital photography","Images vector"
Paper Archive Exists?	No

PROJECT BIBLIOGRAPHY 1

Publication type	Grey literature (unpublished document/manuscript)
Title	A12 Chelmsford to A120, Essex: Geophysical Survey
Author(s)/Editor(s)	Cottrell, P. and Harrison, S
Other bibliographic details	ATCE19
Date	2020
Issuer or publisher	Headland Archaeology
Place of issue or publication	Edinburgh
Description	A4 Glue Bound report and PDF/A

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Entered on	3 September 2020

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